UNSW Connected Waters Initiative

Solving global groundwater problems, shaping future innovation

OUR VISION

To provide novel fundamental and applied groundwater research, based on scientifically validated evidence, to provide the best advice to government, industry and the community. By advancing knowledge of groundwater processes we will build a future that provides effective water management for governments, communities, agriculture, mining and other water users in the Asian Pacific region and internationally, while improving social equity and sustainable environmental outcomes.

The Connected Waters Initiative is a world leader in water research, innovation and problem solving. The Initiative is multidisciplinary and draws on water expertise from the Schools of Civil & Environmental Engineering, School of Minerals and Energy Resources Engineering, School of Biological Earth & Environmental Sciences, School of Law, School of Humanities and Languages and Environmental Humanities Program, as well as affiliates from ANSTO and other key research institutions. With our partners, we continue to train the next generation of expert researchers and groundwater professionals. We hold a diverse portfolio of well-instrumented field sites and state-of-art laboratory which attracts national and international research involvement. In particular CWI owns a nationally unique range of field equipment including surface and downhole geophysical logging tools. This capability provides tools to both validate large scale numerical models as well as upscale the laboratory measurements to field settings.

CWI's multi-disciplinary research team

We support a range of groundwater research projects, creating the nation's most advanced groundwater knowledge hub. Our research activities span a wide variety of groundwater-related fields, but our researchers place a core focus on two significant challenges: managing groundwater quality and maximising data analytics to help solve modern groundwater challenges.

The Connected Waters Initiative is proud to contribute to UNSW's research on water resources, which recently earned UNSW the title of premier research institution in the country and fifth in global rankings by the Academic Ranking of World Universities (ARWU) in July 2020.

KEY AREAS OF FOCUS

CWI has a diverse portfolio of well-instrumented field sites and state-of-art laboratory, data analysis and field equipment which attracts national and international research involvement. We explore, develop and test new technologies and approaches, focusing not just on the here and now, but on future needs, risks and opportunities. We connect the latest research and technologies to groundwater policy development and on-ground management, responding to major public issues, industry requirements and community needs. This includes:

Developing machine learning techniques to estimate the properties of geological formations responsible for phenomena including groundwater flow and contaminant transport, using available data measured by surface and downhole geophysical tools. This includes the use of Deep Learning (ANN) algorithms to estimate the permeability and porosity across formations of interest, as well as predicting the temporal and spatial contaminant plume migration in aquifers. The Machine Learning techniques can be also used to verify the results of numerical models of fluid/mass transport in geological formations such as groundwater flow.


A snapshot of CWI fieldwork

Statistical analysis and visualisation of large groundwater datasets:

Analysis of large groundwater quality and recharge datasets, such as mixed linear modelling of continental-scale global water quality data (McDonough et al 2020) and time-series analysis of large (>3 million data-point) hydrology data (Baker et al 2020) to quantify groundwater recharge thresholds. **Modelling of unsaturated zone recharge processes**, focusing on the use of lumped parameter models (Baker et al 2020) of soil and unsaturated zone water balance, and use of water isotope tracers (Baker et al; Markoswka et al). In addition to this, **isotope tracer modelling of groundwater residence times** using the USGS Tracer LPM model (Bryan et al 2020) is also utilised.

Furthermore, CWI research includes predicting spatial and temporal properties of hydrogeological and hydrogeochemical data sets using machine learning techniques such as Random Forest, Gradient Boosting and Neural Networks (Shuang et al. 2020), as well as modelling groundwater fluctuations using impulse response functions (Hocking & Kelly, 2016), and constructing 3D Geological Models using machine learning techniques in faulted and folded environments from field mapping data, borehole logs, and historical geological maps (Kelly 2009; Kelly and Giambastiani 2009).

CWI research also aims to develop **factor-based and actor-based modelling approaches to support a systematic and evidence-based analysis of policy and innovation options** in regulated water systems. This can be coupled with an existing hydro (hydrological/hydrogeological) model to represent the water regulation system and the behaviour of water users. The agent-based socio-technical model (Castilla-Rho et al 2017; 2020) generates and exert water demands on the hydro model. In turn, the hydro model will provide information on the condition of the water resource and environmental systems, which may or may not trigger regulatory decisions and or changes in behaviour of water users. This can provide a powerful tool for testing the impacts of regulatory strategies to hone policy judgments and make sound decisions in the face of uncertain conditions.


CWI researchers in the field

Coupling of physical, chemical and ecological groundwater processes:
Former director of CWI and current member of CWI management team Associate Professor Martin Andersen has a particular interest in how physical groundwater management impacts on water quality and ecological processes (Acworth et al 2020). He also manages the NSW NCRIS Groundwater Infrastructure field sites and data. These field sites have been in operation since about 2013 and has generated a large database of high frequency groundwater level time series and the bore fields are available for sampling and research (Andersen et al 2016; Burrows et al. 2017; McDonough et al. 2020b; 2020c).

Researchers in CWI are interested in the **use of near-surface geophysical sensors** to create digital soil maps (DSM) of the soil and vadose-zone. Associate Professor John Triantafilis and various students are using electromagnetic induction methods to create 2-d and 3-d images which can be calibrated to predict soil physical (clay) and chemical (salinity). The results are being used to better understand where recharge occurs in irrigated agricultural landscapes in Australia and south-east Asia (e.g. Thailand) and associated with conveyance canals. Recent research includes developing a 3-d clay regolith map beneath 50,000 ha in the lower Gwydir valley (Zhao et al, 2019) and a 2-d map of clay beneath a 4.2 km long supply canal in the lower Namoi valley (Zare et al, 2020).

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