The UNIVERSITY CONSORTIUM

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André Unger studies how municipalities can sustainably manage their water resources and infrastructure using a variety of tools, including groundwater and surface water modeling, and water infrastructure asset management tools.

Professor Unger also studies the financial and health risks associated with re-developing hazardous waste sites known as "brownfields" using alternative clean-up techniques.

Financially sustainable water resource supply and infrastructure:
Professor Unger's research focuses on assessing the risk associated with securing the future water supply using groundwater/surface water hydrologic models at the watershed scale.

The Province of Ontario has recently issued legislation mandating that all municipalities with a permit to issue water to residents must ensure that their water system is self-financing in order to have their permit renewed. In other words, the fee consumers pay per cubic meter of water consumed must be sufficient to cover all expenses needed to operate and maintain the system in a safe and reliable manner.

While this seems like an obvious requirement, it is a fundamental paradigm shift in how municipalities operate.
Professor Unger is also investigating project finance strategies to rehabilitate and expand the infrastructure needed to deliver and collect water to and from households given the uncertainty in population growth and the residential/commercial demand for water; the uncertainty in commodity prices consumed during all capital works and O&M activities used to maintain the infrastructure; and the uncertainty in the degradation rate and operable lifespan of the infrastructure.

Financially sustainable brownfield's redevelopment:
Professor Unger also examines the financial risk associated with cleaning up former industrial sites. These properties, called "brownfield's", sometimes have a high enough land value that a developer will remediate and redevelop the brownfield site for either commercial or residential purposes. These end uses expose the developer to substantial future risk in that contamination remaining in the subsurface after remediation and redevelopment may pose a public health risk. For example, people working or living at the redeveloped site can inhale soil gases flowing across the foundation of buildings and impacting the indoor air.

Professor Unger's research focuses on developing financial strategies to quantify, value and hedge this risk assuming that the developer will take immediate action to retrofit, demolish, or reconstruct the building and comply with regulatory exposure level of contaminants within the indoor air rather than be exposed to unlimited punitive damages from real or perceived adverse health impacts. He has also been examining this issue by developing multi-phase multi-component compositional/thermal numerical models to simulate the expected behavior and uncertainty in the performance of alternative remediation technologies to clean-up brownfield sites. He also simulates the likelihood that remaining contamination will impact the indoor air and consequently exceed regulatory exposure levels.

Finally, he is developing financial models to price the risk that post-development remedial action will need to be undertaken. His objective is to ensure that the brownfield redevelopment project remains solvent and financially sustainable over its lifespan as all stakeholders seek to recoup their costs.

Selected Papers

A. Unger, A., Enouy, R., Malton, I., Ioannidis, M., Sihota, N. 2019. A Transport Rate Limited Model for Simulating Cell Growth and Biodegradation Rates in Porous Soil and Rock. AGUFM. H14I-03.

K Walton, F Manna, A Unger, BL Parker. 2019. Advances in simulating multiphase flow in fractured porous media-a modeling study of DNAPL invasion and fate. AGUFM 2019, H41I-1812.

RW Enouy, AJA Unger, R Rehan. 2019. An advective-dispersive transport model for residential water consumption. Journal of Hydroinformatics 21 (4), 607-623

K Walton, AJA Unger, MA Ioannidis, BL Parker. 2019. Benchmarking NAPL redirection and matrix entry at fracture intersections below the water table. Water Resources Research

H Mohammadifardi, MA Knight, AJA Unger. 2018. Integrated Asset Management Planning of Wastewater Collection and Treatment Systems. Pipelines 2018, 86-94

A Ganjidoost, MA Knight, AJA Unger, CT Haas. 2018. Benchmark Performance Indicators for Utility Water and Wastewater Pipelines Infrastructure. Journal of Water Resources Planning and Management 144 (3), 04018003

KM Walton, AJA Unger, MA Ioannidis, BL Parker. 2017. Impact of eliminating fracture intersection nodes in multiphase compositional flow simulation. Water Resources Research 53 (4), 2917-2939

R Rehan, R Younis, AJA Unger, B Shapton, F Budimir, MA Knight. 2016. Development of unit cost indices and database for water and wastewater pipelines capital works. Journal of Cost Analysis and Parametrics 9 (2), 127-160

R Younis, R Rehan, AJA Unger, S Yu, MA Knight. 2016. Forecasting the unit price of water and wastewater pipelines capital works and estimating contractors' markup.
Journal of Cost Analysis and Parametrics 9 (1), 46-68

R Enouy, R Rehan, N Brisley, A Unger. 2015. An Implicit Model For Water Rate Setting Within Municipal Utilities. American Water Works Association 107 (9)

R Rehan, A Unger, MA Knight, C Haas. 2015. Strategic water utility management and financial planning using a new system dynamics tool. American Water Works Association 107 (1), E22-E36

M Knight, A Unger. 2014. Funding Municipal Water Infrastructure, Part 2 – A proposal to capture the support of pension funds, banks and insurance companies. Strategic Asset Management, 2-5

M Knight, A Unger. 2014. Funding Municipal Water Infrastructure: A story in two parts - Part 1. Strategic Asset Management, 7-10

X Wang, A Unger, B Parker. 2014. Risk-Based Characterization for Vapour Intrusion at a Conceptual Brownfields Site: Part 1. Data Worth and Prediction Uncertainty. Journal of Civil Engineering and Science 3 (3), 150-170

X Wang, A Unger, B Parker. 2014. Risk-Based Characterization for Vapour Intrusion at a Conceptual Brownfields Site: Part 2. Pricing the Risk Capital. Journal of Civil Engineering and Science 3 (4), 189-208

T McAlary, X Wang, A Unger, H Groenevelt, T Górecki. 2014. Quantitative passive soil vapor sampling for VOCs-part 1: theory. Environmental Science: Processes & Impacts 16 (3), 482-490

R Rehan, MA Knight, AJA Unger, CT Haas. 2014. Financially sustainable management strategies for urban wastewater collection infrastructure–development of a system dynamics model. Tunnelling and Underground Space Technology 39, 116-129

R Rehan, AJA Unger, MA Knight, CT Haas. 2014. Financially sustainable management strategies for urban wastewater collection infrastructure–Implementation of a system dynamics model. Tunnelling and Underground Space Technology 39, 102-115

R Rehan, MA Knight, AJA Unger, CT Haas. 2013. Development of a system dynamics model for financially sustainable management of municipal watermain networks. Water research 47 (20), 7184-7205

H-T Hwang, Y-J Park, EA Sudicky, AJA Unger, WA Illman, SK Frape, O Shouakar-Stash. 2013. A multiphase flow and multispecies reactive transport model for DNAPL-involved compound specific isotope analysis. Advances in water resources 59, 111-122

A Shadpour, AJA Unger, MA Knight, CT Haas. 2013. Numerical DAE Approach for Solving a System Dynamics Problem. Journal of Computing in Civil Engineering 29 (3), 04014054

X Wang, AJA Unger, BL Parker. 2012. Simulating an exclusion zone for vapour intrusion of TCE from groundwater into indoor air. Journal of Contaminant Hydrology 140, 124-138

S Yu, AJA Unger, B Parker, T Kim. 2012. Allocating risk capital for a brownfields redevelopment project under hydrogeological and financial uncertainty. Journal of Environmental Management 100, 96-108