Proceedings of the Second Forum on Energy, Environment and Sustainable Communities

Organized by

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IEESC
Institute for Energy, Environment and Sustainable Communities

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EXECUTIVE SUMMARY

In January 2016, the University of Regina Institute for Energy, Environment and Sustainable Communities hosted its 2nd major forum. The Forum on Energy, Environment and Sustainable Communities provided an opportunity for invited speakers from industry, government and academia to learn about how the University and its partners are addressing the impacts and challenges related to energy, environment and sustainability issues affecting society.

Presentations summarizing the latest research areas and opportunities were made, followed by discussions on the next steps for proceeding toward new collaborative activities.

The desired outcome of this forum was to generate new ideas and projects for collaboration among IEESC's network. The goal was to identify new partnerships and expertise that will bring value to projects and ongoing research.

PRESENTATIONS

SaskPower - Michael Monea

SaskPower Integrated Carbon Capture and Storage Demonstration Project at Boundary Dam

The Boundary Dam Carbon Capture and Storage Project came online in late 2014. Located near near Estevan, Saskatchewan, it is the first commercial-scale coal-fired power plant with amine solvent absorption carbon capture.

The aging unit at Boundary Dam was retrofitted for integration with carbon capture. This enabled SaskPower to meet Canadian greenhouse gas emission regulations. At full capacity the project will capture up to 1 million tonnes of carbon dioxide per year. The CO_2 will be geologically stored at two locations: at an oil reservoir at Cenovus' CO_2-EOR operation near Weyburn, and in a deep saline aquifer at the SaskPower Carbon Storage and Research Centre. Byproducts such as sulfur dioxide and fly ash will be sold for industry use. SaskPower also operates a Carbon Capture Test Facility for technology suppliers to optimize and verify their processes. Lessons learned and knowledge accumulated from the project will aid how CCS technology will be adopted for future commercial deployment.

SaskPower has formed a new partnership to promote industry oriented research opportunities and accelerate the global development of CCS. SaskPower is connected internationally with coal-intensive economies such as China to advance CCS technology through collaboration. The new SaskPower knowledge centre will work closely with the University of Regina and the community to promote greenhouse gas reducing CCS development in technology, knowledge transfer, policy development, training and public acceptance and awareness through its programs and initiatives.

Ministry of Economy – Howard Loseth

The Ministry of Economy's mission is to advance economic growth to generate wealth and opportunity in Saskatchewan. It has three core lines of business: 1) to advance and regulate responsible resource development; 2) to develop, attract and retain skilled workers; and 3) to enhance economic growth and competitiveness in the province.

Source: economy.gov.sk.ca

Ministry of Environment Climate Change Branch – Peter Pan and Matt Nasehi

The Ministry of Environment provides science-based solutions, compliance and mitigation measures aimed at protecting the environment, safeguarding communities and helping to ensure balanced economic growth and a better quality of life for all Saskatchewan residents. The Climate Change Branch of the Saskatchewan Ministry of the Environment fosters relationships with many groups throughout the province of Saskatchewan, and Canada as a whole, to create a more sustainable environment. The Climate Change Branch acts as a connection between academia, private industry and regulatory oversight. The Climate Change Branch strongly believes in evidence based decision making. As such mathematically, economically, and academically rigorous

methods need to be applied to environmental issues. The Climate Change Branch is committed to strategic partnership with academia and industry in order to help forge a better environmental future for all.

Dr. Shahid Azam

Dr. Shahid Azam's research focuses on soil mechanics for applications in mine waste management and civil infrastructure systems. He uses cross-disciplinary concepts of engineering, hydrology, geology, and geochemistry in a variety of applied research projects. Over the last two decades, he has developed laboratory characterization and field monitoring protocols and mathematical (numerical, analytical, statistical) modeling schemes to understand and improve the dewatering behavior of mining wastes and the swell-shrink behavior of soils in arid and semi-arid regions of the globe. His recent work focused on footprint reduction for oil sand tailings (one billion tonnes of loose oil-containing sludge covering an area of 40 km^2 in Alberta) and the development of a soil-climate interaction framework for buried infrastructure in expansive clays (the 850 km long water supply network in Regina costs $2 million in annual maintenance).

Possible areas of collaboration with IEESC are as follows:

- Local and regional-scale hydrological modeling for understanding groundwater recharge and for efficient flood control;
- Multi-phase (oil, water, and air) flow through saturated and unsaturated porous media for understanding contaminant migration through expansive soils and tailings; and
- Environmental risk assessment of drinking water supply facilities in remote areas for sustainable First Nation communities.

Dr. Yan Chen

Dr. Yan Chen is a visiting scholar with IEESC from the Ecological Security and Protection Key Laboratory of Sichuan Province, Mianyang Normal University, China. Dr. Chen's research is focused on two topics. First, the coevolution dynamics of *Ficus* species and their specific pollinating fig wasps, focusing mostly on *Ficus pumila*, *F. tikoua* and their pollinating fig wasps. The morphological and genetic differentiations of natural populations of both hosts and pollinators, and linked the divergence to environmental changes were explored. Dr. Chen explained it is too early for definite conclusions, however, different dynamics did show between these two systems. *F. pumila* and its pollinators responded to the environmental variations independently, while *F. tikoua* and its pollinators responded concordantly. Gene flow might be a major contributor to the difference. The second topic is concern over biodiversity monitoring in two national natural reserves in Sichuan Province, China, focusing on the natural regeneration of conifer forests.

Dr. Xia Ji

Dr. Xia Ji's research focus is science education and sustainability education. Dr. Ji recently completed a research project aimed at demystifying science education and in that process empower pre-service elementary teachers through hands-on experiences with science.

Dr. Yee-Chung Jin

Dr. Yee-Chung Jin's research interests include hydraulic engineering, erosion and sediment transport in rivers, groundwater contamination, numerical modelling, environmental hydraulics, remote sensing, and GIS application in hydrological systems. In a recent study, Dr. Jin used sediment transport as a typical multiphase flow in numerical simulation through a particle-based method and efforts focused on reducing interface instability between phases. A new multiphase model, a particle-method based rheology model, and a higher order viscosity smoothening scheme were used in a particle-based method to reproduce the sediment transport. Model applications including open channel flow scouring on sand beds and various water-sediment dam break flows were simulated. The particle-based multiphase method can predict both free surface and sediment profiles. Additionally, the simulated velocity distributions of water-sediment dam break flow demonstrated agreement with measured data, which was seldom considered in previous studies using a particle-based method. The successful implementation of the sediment transport simulation confirmed the strong capability of the particle-based Lagrangian method for predicting multiphase flow and provides an alternative numerical tool in sediment transport study.

Dr. Garth Pickard

The focus of Dr. Garth Pickard's ongoing research addresses 'Education for Sustainability,' which includes: re-orienting educational and research practices to address sustainability at the local, national and international level reflecting the UNESCO Global Action Programme, the Integral Nature of Sustaining Well-Being, Education for Sustainable Development and the Implications for Sustainable Communities. Of significance is the Qu'Appelle Research Initiative (QRI) designed to provide empirical insight into what socio-cultural and scientific factors strengthen the integral well-being of the Qu'Appelle Watershed. The QRI provides a research platform that is inclusive, multi-dimensional and oriented toward understanding better what would contribute to the health and prosperity of its peoples, lands, waters, and, the integral nature of the biosphere the Qu'Appelle watershed represents.

Dr. Hairuo Qing

Characterization of hydrocarbon reservoirs for better exploration strategies and for the assessment of using hydrocarbon reservoirs as potential sites for carbon capture and sequestration

Dr. Hairuo Qing's primary research focus is on reservoir characterization and modeling to develop effective exploration and production strategies, and assessment of hydrocarbon reservoirs for potential carbon capture and sequestration sites. Reservoir characterization consists of the following three aspects:

- Petrographic characterization: The quality of hydrocarbon reservoirs is directly related to petrology of host rocks. A better understanding of petrology and related sedimentary and diagenetic processes would help predict the architecture of heterogeneous hydrocarbon reservoirs.

- Geochemical characterization: Reservoir attributes such as oxygen, carbon, and strontium isotopes, and fluid inclusions would help us to understand processes of reservoir development, which in turn would constrain: 1) the relative timing and origin of reservoirs; and 2) to predict the connectivity and spatial distribution of reservoirs.
- Petrophysical characterization: Reservoir characteristics including porosity, permeability and wettability provide fundamental information for the development of effective production strategies, particularly with respect to the selection of suitable secondary and tertiary recovery techniques.

Dr. Chris Somers

Applied Wildlife and Fisheries Research in Biology

Dr. Chris Somers' research program continues to address issues related to the conservation and management of animal populations with a particular emphasis on understanding interactions with humans. Dr. Somers' program incorporates elements of field biology, molecular genetics, and chemistry. His research team is working on a number of reptile species of conservation concern at their northern range limit in central Canada, including the eastern yellow-bellied racer, which is protected by the federal *Species at Risk Act*. They are also working on understanding the impacts of catch and release fishing on popular game species in Saskatchewan. In the province of Saskatchewan, recreational fisheries generate over $300 million annually, so it is important to make science-based management decisions to protect this valuable resource. Dr. Somers' largest ongoing program is an industrial partnership with Bruce Power from a NSERC CRD grant, which examines the environmental impacts of cooling water management. His group recently published work showing that economically valuable fish spawning in areas near Bruce Power are not genetically or ecologically distinct from other such groups, which is important when formulating management plans.

Dr. Peng Wu

Dr. Peng Wu's research interests include water supply and drainage, cold region research and hydraulic studies, local scour, hydraulic structures, river hydraulics and fluvial morphology. Local scour around bridge piers is one of the most common reasons for bridge failure in recent decades. Splitter plates have the potential to reduce the maximum scour depth around bridge piers. To test the effect of splitter plates at different locations, Dr. Wu conducted a study using various splitter plates ($1 \leq L/D \leq 2$). The front splitter was put in front of the pier as well as behind for scour profile measurement. It showed that a front splitter plate with 1.33D has the strongest impact in reducing maximum scour around piers. Results also showed that with the increase in front splitter height, the maximum scour depth and the scouring areas decreased correspondingly. In this study, back splitters with or without a gap show limited impact on reducing the local scour around the pier.

Dr. Xuedong Yang

Dr. Xuedong Yang's research areas include computer graphics, such as hair modeling and rendering, and modeling of complex natural phenomenon; image processing such as multi-resolution and Hierarchical Image Analysis, segmentation algorithms, 3D object recognition and facial recognition; and visualization, including scientific and information visualization and visual web search techniques. Dr. Yang explained that computer science has applications to every field, producing "tools" for users in different application areas, and he is enthusiastic about collaborating with others in IEESC on challenging industrial projects.

Dr. Yiyu Yao

Turning Complexity into Simplicity with Three-Way Decisions

An area of Dr. Yiyu Yao's research is Three-Way Decisions (3WD). A theory of 3WD draws inspiration from a particular way of everyday problem solving and information processing. It has two basic components of trisecting and acting. The task of trisecting divides a whole into three parts called a trisection or a tri-partition of the whole. The task of acting develops appropriate strategies to process one or more parts. Through three-way decisions, complexity is turned into simplicity by working on a meaningful and manageable three parts. Three-way decisions have been widely used in many fields and disciplines, including computer science, statistical science, information science, management science, engineering, social science, medical decision-making.

The ideas of trisecting and acting are a common human practice in problem solving with a solid cognitive basis. For example, temporally there is past-present-future; spatially there is left-middle-right, top-middle-bottom, or front-middle-back; volumetrically there is small-medium-large; judgmentally there is for-neutral-against, or acceptance-noncommitment-rejection. A trisecting-and-acting model explains three-way decisions in general terms. Depending on the construction and interpretation of a trisection, it is possible to derive many concrete models, embracing ideas from rough sets, interval sets, three-valued approximations of a fuzzy set, shadowed sets, orthopairs (i.e., a pair of disjoint sets), three-valued approximations of a many-valued logic, and many others.

Dr. Zhou Zhang

Expanding Finance Research into Interdisciplinary Fields

Conventional finance research focuses on solving the following two questions: 1) How can a firm raise sufficient external funding for required investments? and 2) What short-term and long-term investment should a firm engage in? To maximize their value, firms have to balance interests among management, shareholders and debt-holders in the process of making financing and investment decisions. Recent social science research, however, argues that such a perspective is too narrow and the shareholder focus should be expanded to other important stakeholders. For example, a sustainable business should consider optimizing the relationship among customers, employees, suppliers, and community. Climate change and environmental sustainability have become a mainstream and paramount subject among policy makers, social enterprises, households

and investors. Saskatchewan's economy is primarily driven by three sectors – agriculture, energy and mining. Since firms in these sectors are more sensitive to business cycles and issues related to social responsibility and environment sustainability, future finance research should be expanded into more interdisciplinary areas and consider other important factors that could potentially improve long-term corporate valuation. The research findings will be relevant for firms in Saskatchewan. Dr. Zhang's research aims to apply new knowledge to impact business practices and assist public policy design.

Summary

Topics covered at the forum included image analysis and visualization, interactions between humans and wildlife, finance and accounting, environmental education and civic discourse, sustainable development of a nearby watershed, mine waste management, and hydropower.

After the presentations and a break, an open discussion was held. Participants provided feedback and noted the following opportunities for attention and further synthesis:

- Industry can help leverage funding
- Concrete problems/issues/projects that could form the foundation for possible funding applications
- Multidisciplinary fields: sciences, engineering, social sciences
- Wide spectrum of expertise at the University of Regina
- Nice to see a variety of topics from multiple disciplines
- Discuss bridging engineering, science and social science research to enrich outcomes
- How are Saskatchewan companies dealing with challenges in environmental sustainability
- Hold a future forum on specific funding opportunities
- Forum is good for expanded networking opportunities
- The Boundary Dam CCS project can be used as a "workhorse"
- Be strategic; find areas where IEESC can contribute
- Starting small and ensuring meeting project outcomes can result in new/additional research funding collaborations

In his closing remarks, Dr. Gordon Huang thanked all participants for attending the forum and making the annual event a success.

Forum Participants

Chunjiang An, Laboratory Scientist, Institute for Energy, Environment and Sustainable Communities

Shahid Azam, Professor, Environmental Systems Engineering, Faculty of Engineering and Applied Science

Yan Chen, Professor, Ecological Security and Protection Key Laboratory of Sichuan Province, Mianyang Normal University, China

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Xia Ji, Associate Professor, Faculty of Education

Yee-Chung Jin, Professor, Environmental Systems Engineering, Faculty of Engineering and Applied Science

Howard Loseth, Director Energy Development and Climate Change, Ministry of Economy

Michael Monea, President, Carbon Capture and Storage Initiatives, SaskPower

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