An Interview with Professor Junye Wang

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An Interview with Professor Junye Wang

(Part One)

Abstract

An interview with Professor Junye Wang. He discusses: geographic, cultural, linguistic, and family background; influence on development; influences and pivotal moments in major cross-sections of early life including kindergarten, elementary school, junior high school, high school, and undergraduate studies (college/university); origination of interest in science and technology; educators that inspired in youth; previous professional positions including research scientist at Scottish Crop Research Institute (The James Hutton Institute) from July, 2003 to November, 2004, research associate at Loughborough University from November, 2004 to February, 2008, and principal research scientist at Rothamsted Research from March, 2008 to May, 2013 and the research experience from them; greatest take-home message from these positions; responsibilities to the public with these positions; current position is professor and CAIP Research Chair at Athabasca University beginning in August, 2013 and its targeted teaching objectives in addition to duties to the public and students; research objectives and concomitant responsibilities with the CAIP Research Chair position; and implications in funding and research for the CAIP Research Chair.

Keywords: Athabasca University, CAIP Research Chair, Loughborough University, Professor Junye Wang, responsibilities, Scottish Crop Research Institute.

An Interview with Professor Junye Wang (Part One)[1,2,3,4]

Footnotes throughout the interview, and bibliography and citation style listing after the interview.

1. In terms of geography, culture, and language, where does your family background reside?

In the late 1950s, many state farms were built in Jiangxi province, China. Thus, many educated urban youth cadres and veterans were mobilized, and sent to these state farms by the movement of "up to the mountains and down to the villages." My parents were sent to the Comprehensive Reclamation and Cultivation Farm at Yunshan. I was born in the state farm in the year just after Great Leap Forward and "Three Bitter Years" started. My childhood was difficult, and meals were meager. Because my parents were busy with their careers, my maternal grandmother came to Yunshan to look after us children. She was not accustomed to life in Jiangxi and was missing her hometown, Shuangpai village, Lanxi, Zhejiang province. Therefore, my grandmother brought me and my sister to travel between the hometown and the place that my parents worked. When she came to Yunshan, she brought us to Yunshan. When she came back to the hometown, I was with her to live in Shuangpai and we weren't living with my parents. Thus, I had many friends of peasant children. The peasant children were more hardship than the state farm children. Some of them had to take care of their younger brother/sisters and fed pigs because their parents had no salaries. I saw some classmates to

[1] Professor and CAIP Chair, Science and Technology, Athabasca University.
[2] Individual Publication Date: TBD, 2016 at www.in-sightjournal.com; Full Issue Publication Date: May 1, 2016 at www.in-sightjournal.com.
[3] Ph.D. (1993 – 1996), Chemical Engineering and Mechanical Engineering, East China University of Science and Technology; M.Sc. (1986 – 1989), Aerospace, Aeronautical and Astronautical Engineering, Harbin Shipbuilding Engineering Institute.
[4] Photograph courtesy of Professor Junye Wang.

bring their young sister or brother to school. In China, life in cities was much better than our own. My family wanted to move back to the cities from the farm. However, the great majority of those at the farm found themselves trapped in the countryside, condemned to a life of back-breaking labor, and hoping for a recall to the city that never came. My family was the same. In Yunshan, our time there would be lengthy, perhaps permanent. The students did not need to study for both Shuangpai or Yunshan school due to the Cultural Revolution. I didn’t have any forehead mark indicating that I have any special abilities, and I didn’t have any opportunities to study, so my childhood and teenage years were mainly full of activities that I enjoyed, and labor work such as collecting firewood, fishing in creeks, and collecting wild fruits.

2. **How did this influence development?**

Rural youths in developing countries had fewer opportunities than those in the cities due to poor educational resources. They needed to make more of an effort as a result. However, difficult circumstances can temper one's will. I did not have a good education, but I was educated by our experiences during the Cultural Revolution and rural hardship.

3. **What about influences and pivotal moments in major cross-sections of early life including kindergarten, elementary school, junior high school, high school, and undergraduate studies (college/university)?**

I had no experiences of kindergarten. My grandmother looked after my preschool and primary school. Like those who lived in rural regions in China, their grandmothers were a housewife for cooking and looking after their grandsons and granddaughters. When I attended primary school, the Cultural Revolution broke out, and the school was changed into a forum for political propaganda. All the students in the school recited Quotations from Chairman Mao Zedong and became Little Red Guards. They criticized Capitalism and revisionism in their terms, and studied a little math, physics, and chemistry. For the rural students, they also learned weeding rice plots in Spring and rice harvest in Summer and Fall from the poor and lower-middle peasants. When I was 14 years old, I did not attend high school, but The Communist Labor University at Yunshan [*John Cleverley, In the Lap of Tigers: The Communist Labor University of Jiangxi Province, Rowman & Littlefield Publishers (March 1 2000)*]. All students in the branch worked for periods in field or forest without exception. Although, I was the youngest student in the university, no one was exceptional to undertake the heavy labor work because our branch was on demands of students for rice production throughout. Generally, two days were in field or forest and 3 days were in class rooms like that described by John Cleverley. However, in my memory, the physical labor time on demand were much more than study time because of too many busy farming seasons, such as seeding, weeding rice plots in Spring, and harvesting rice in Summer and Fall, and building/maintaining the irrigation system and cultivating economic trees in Winter. All days were in fields except for breakfast and lunch. The rice was weeded and harvested by hand using a sickle. This was harder work: “back to the sky, face to the land.” Cuts to legs and arms easily became infected and leeches followed water motion disturbed by legs to attach to bare feet scars. Despite the heavy physical work required, it did not feel hard to do these labor jobs for a rural youth. As a student who was major in the forest, I was also required to cultivate trees in Winter and Spring. Also, we studied basic soil sciences and forest surveys. Studying English would have been impossible because that was realized to be impractical. After I graduated from the University in early 1976, I was assigned to do a similar job. Therefore, what I regret most is that I didn't get a good education in my teenage years, there is a best age for studying, and we missed it. That was the torrent of the times, you couldn't resist it. We have to let history judge.

In 1977, the National Higher Education Entrance Examination was officially restored as the traditional examination based on academics. Like most of the hopefuls who had accumulated during the ten years of the Cultural Revolution, I simply wanted to try my luck to emerge from society for the examination. Due to my poor school education, I failed in 1977 and then I had a distinction in the national examination in 1978. I entered the College of Jiangxi Electric Power to study thermal energy and power engineering for a three-year technical college diploma. The examination was highly competitive and admission rate in both 1977 and 1978. In late 1970s, the admission rates were much low in the history of the People's Republic of China (PRC). We treasured the college years, and we studied harder than the current generation of students. After I graduated, I was assigned to Jiujiang Power Plant, where I worked for 5 years. Although, I was satisfied with my job. I had a dream of higher education in a prestigious university. Thus, I started to be a self-learner by studying university courses for the National Postgraduate Entrance Examination, which was highly competitive too. I needed to study until midnight every day because I had a full-time job. I faced numerous challenges. For example, I needed a university curriculum and syllabus that I could follow, and then I could buy textbooks. Furthermore, a diploma student was not eligible to participate in the National Postgraduate Entrance Examination, except for an approval letter from your company. However, this was not easy to have such a letter from your units. After I failed twice, I had a distinction in National Postgraduate Entrance Examination in 1986. Particularly, I earned the highest score in the Advanced Mathematics examination among all participants in the Harbin Shipbuiding Engineering Institute (Harbin Engineering Institute). As an exception of diploma students, I was admitted to the Master's program by the Institute history under direction of my first supervisor, Prof. Bingcheng Sang. The institute admitted a first by being the 1st to give the Master's admission to a technical diploma student. I started my research project on laser measurement of propellant combustion. I became confident after National Postgraduate Entrance Examination. I found myself capable of doing things that other students thought were impossible. It might be important that I found effective and efficient learning methods.

4. Where did interest in science and technology originate for you?

My original interests were in engineering, particularly energy engineering, which originated from problem-solving. Energy engineering is certainly an old science that constitutes multiple areas of special interest in this respect, since the most important theoretical issues and the contentious relations with other sciences are clear. However, energy issues could not be solved by a single discipline of energy science and technology itself. Environmental pollution and sustainability are closely related to energy consumption, security and technology development. Thus, because of the adaptability to such an interdisciplinary issue, some profound changes have taken place, which leads to my transformations from energy to environment and sustainability. With regard to these transformations, many traditional disciplinary boundaries should be broken as the interdisciplinary nature. Therefore, my motives for the interdisciplinary research are to transform and integrate in my research when faced complex problems with conceptual and methodological changes. This adaptability is for the problems of today, and out of an interest for the past unrelated to present-day concerns from within the discipline itself or from a more general starting point.

5. Any key educators which inspired you in youth?

I grew up in a cultural revolution. In this special era, knowledge is nothing and education is not useful. However, my grandmother and mother believed in the importance of education. Though I did not agree with them in my childhood and youth, I realized the importance of the education as I grew up. In the latter 1970s and 1980s, only knowledge could change your fate for the rural youths in China. Higher education was a unique way that a Chinese youth could move to a city from the countryside.

6. You held previous professional positions including research scientist at Scottish Crop Research Institute (The James Hutton Institute) from July, 2003 to November, 2004, research associate at Loughborough University from November, 2004 to February, 2008, and principal research scientist at Rothamsted Research from March, 2008 to May, 2013.[5] What research experience came from these professional experiences?

In these jobs, I worked on different problems from chemical engineering, aeronautical engineering to biogeochemical processes in agroecosystems using analytical, numerical and

[5] Please see LinkedIn. (2015). Junye Wang. Retrieved from https://ca.linkedin.com/pub/junye-wang/15/a87/a87.

experimental approaches. I have acquired the experiences of various modelling methods, from high-resolution numerical approaches such as the lattice Boltzmann method (LBM) and computational fluid dynamics (CFD) (e.g., PHYSICA multi-physics package and the Rolls-Royce HYDRA CFD code) to process-based models of agroecosystems (e.g., DNDC and Roth-C). As a professional modeler, I am deeply familiar with a variety of numerical methods and have an exceptional ability to select the most suitable approach for a specific real-world problem and to integrate numerical methods for their mutual enhancement in modelling. Particularly, my experiences on multidiscipline lead to rethinking about the problem of today. As mentioned in Question 4, these experiences allow me to adopt a whole systems approach to complex watershed modelling. Our emphasis is on interdisciplinary and multiscale research and integration to support systematic, quantitative and comprehensive clarification of concepts and assumptions as we study the problems of sustainable resource development and management.

7. What were the greatest take-home messages which came from these positions?

Persistent efforts, keep going, do not give up, and fight to the end.

8. What responsibilities to the public came from these positions?

The Athabasca River Basin (ARB) is an ecologically and economically significant resource for the development and sustainability of northern Alberta communities. This oil sand resource helps establish Canada as a stable, dependable source of oil and natural gas for national and international markets. However, concerns over the extraction and management of this resource are causing public resistance from citizens and stakeholders because of the potential dangers, such as water contamination, toxic and known carcinogens from flow-back.

My basic research on multi-scale and multidisciplinary modelling will benefit Albertans and Canadians by leading to integrated watershed management, and recommendations for land- and water-use decisions for sustainable development of northern Alberta communities.

9. Your current position is professor and CAIP Research Chair at Athabasca University beginning in August, 2013.[6] What does the professorship include in terms of targeted teaching objectives? What duties to the public and students comes with this prestige?

As a CAIP Chair, I promote research-driven teaching and learning at AU. A cutting-edge research project is usually an example to face various challenges. Thus, it is an excellent opportunity for students to acquire skills of critical thinking and problem-solving through the real problems-driven learning. Through the cutting-edge research, research students can be involved in discussions by asking interesting questions on the project or by facing challenging concepts and sometimes paradoxes from the real world. Particularly many cutting-edge research projects require teamwork, which helps students view different problems from different perspectives and disciplines. This program is to provide a hub for student training in multidisciplinary collaboration and one of the main outcomes will be the delivery of highly trained researchers, including postdoctoral research fellows, visiting scholars, graduate

[6] Please see LinkedIn. (2015). Junye Wang. Retrieved from https://ca.linkedin.com/pub/junye-wang/15/a87/a87.

students and technical staff who will undertake cutting edge science, with specific training in computational modelling, experimental design, biogeochemistry, microbiology, integrating qualitative and quantitative data, statistical analyses, report writing and presentation of research.

10. What about research objectives in addition to concomitant responsibilities with the CAIP Research Chair position?

The Athabasca River Basin (ARB) is a natural resource, and its sustainable resource development is a priority of the 2012 Alberta Research & Innovation Plan. Alberta's Water for Life Strategy and Land-use Framework include the necessity of managing cumulative effects from both agricultural and oilsands industrial activity in the ARB. Athabasca University's research foci and expertise align closely with these provincial priorities. It is essential for Canada's and Alberta's competitiveness to take advantage of available resources and to have the knowledge and technology to perform complex quantitative simulations of integrated terrestrial and aquatic systems. The CAIP Chair research program is to establish a modelling framework of integrated terrestrial and aquatic systems through coupled biogeochemical and hydrological processes so that we can directly simulate dynamics of nutrients, water and pollutants in the ARB, as well as GHGs. This is currently a significant knowledge gap, and therefore will generate new evidence to increase understanding of non-point source pollution and to develop improved technologies to mitigate GHGs and toxic pollutants, thereby providing a new tool of land-use management and decision-making for managing and protecting watersheds. This information could then be used to develop 'Opportunity Mapping for Optimised Resource Development in the Athabasca River Basin,' a concept which the program will demonstrate. In the long-term, such spatially-resolved data will provide a framework and methodology for those interested in delivering a low-carbon economy, sustainable resource development and climate change that can be adapted to other river basins and industries in Canada and beyond and will thus be of wide significance.

11. What does the CAIP Research Chair implicate – in funding and research?

Alberta is really interesting, particularly the Athabasca River basin, because there is no other place that has to deal with water, oilsands, agriculture, environment and sustainability. My basic research on multi-scale and multidisciplinary modelling will benefit Albertans and Canadians by leading to integrated watershed management, and recommendations for land- and water-use decisions. The CAIP program provides long-term funding. This allows me to focus on development of an ambitious framework: the modelling framework of integrated terrestrial and aquatic systems.

(Part Two)

Abstract

An interview with Professor Junye Wang. He discusses: most effective means of teaching students through an online education; benefits to the professor-researcher; LinkedIn self-description and breadth of experience brought to Athabasca University; unifying theme for select research articles; *Domain-decomposition method for parallel lattice Boltzmann simulation of incompressible flow in porous media* (2005); pragmatic implications for implementation to research on the Athabasca River Basin; *Flow simulation in a complex fluidics using three turbulence models and unstructured grids* (2009); *Development and application of a detailed inventory framework for estimating nitrous oxide and methane emissions from agriculture* (2011); extrapolations about average annual emissions in the United Kingdom 2011 to the present and in the next decade; *Theory of flow distribution in manifolds* (2011); greater generality create more or less functionality; *Discrete approach for flow field designs of parallel channel configurations in fuel cells* (2012); and *Modelling nitrous oxide emissions from grazed grassland systems* (2012).

Keywords: Athabasca River Basin, Athabasca University, CAIP Research Chair, LinkedIn, Professor Junye Wang.

An Interview with Professor Junye Wang (Part Two)[7,8,9,10]

Footnotes throughout the interview, and bibliography and citation style listing after the interview.

12. What is the most effective means of teaching students through an online institution such as Athabasca University?

E-learning, digital course, and distance learning has been very important part of higher education. An online course could aim at unlimited participation and open access via the web. In addition to traditional course materials such as filmed lectures, readings, and problem sets, a massive open online course can provide interactive user forums to support community interactions between students, professors, and teaching tutors. AU is internationally a leader in open and distance education. AU is dedicated to the removal of barriers that restrict access to and success in university-level study and to increasing equality of educational opportunity for adult learners worldwide through widely researched development in distance education, such as mobile learning, multi-media, and online activities.

13. What benefits come to the professor-researcher such as yourself?

[7] Professor and CAIP Chair, Science and Technology, Athabasca University.
[8] Individual Publication Date: February 1, 2016 at www.in-sightjournal.com; Full Issue Publication Date: May 1, 2016 at www.in-sightjournal.com.
[9] Ph.D. (1993 – 1996), Chemical Engineering and Mechanical Engineering, East China University of Science and Technology; M.Sc. (1986 – 1989), Aerospace, Aeronautical and Astronautical Engineering, Harbin Shipbuilding Engineering Institute.
[10] Photograph courtesy of Professor Junye Wang.

My basic research is on multi-scale and multidisciplinary modelling. The CAIP program provides long-term funding so that I can focus on development of an ambitious framework: the modelling framework of integrated terrestrial and aquatic systems.

14. According to LinkedIn, circa 2015, you self-describe, as follows:

> *Junye's research mainly focus on energy, environment and sustainability. [He] has over 30 year experience of multi-scale and multidisciplinary modeling and is internationally recognized as a leader in energy, environment and sustainability. His research program is aimed at integrating agroecosystem, land use change and Geographic Information System (GIS) to assess environmental impacts of expanding biogas, bioenergy crops and land use change with emphasis on their interactions. He has developed various modeling and simulation of various physical, chemical and biological systems using various numerical and empirical approaches, such as lattice Boltzmann method (LBM) and computational fluid dynamics (CFD) and agroecosystem modelling (IPCC and process-based approaches) with a broad range of applications, such as agroecosystems, soil carbon sequestration, greenhouse gas emission and mitigation, nutrient cycling, water and hydrology, fuel cells/microbial fuel cells, thermofluid systems, porous media and bioenergy. His researches were highlighted by governments and organisations, such as European Commission in Science for Environment Policy, Earth Emphasis and Renewable Energy Global Innovation. He looks to expand capacity of agroecosystem modeling and computational sustainability to develop an integrated framework for assessment of environmental impacts of unconventional oil and gas (oil sands and*

hydraulic fracturing) production on agroecosystem and identify key factors of the cumulative effects for watershed management across Alberta and Canada. He has authored about 50 refereed journal papers and serves associate editor and editorial board member of several international journals. He is a reviewer of papers for about 40 journals and a reviewer of proposals and final reports for three research councils in the UK (EPSRC, NERC and ESRC).[11]

What does this breadth of experience bring to the educational and research work at Athabasca University?

A river basin is a complex system of physical, chemical and biological processes. Any single method is insufficient to build such an ambitious research hub and infrastructure. It is necessary to integrate multiple approaches and disciplines for establishing a relationship between physical, chemical and biological processes that reflects real-world problems. I have the unique background and experience of various modelling methods, from high-resolution numerical approaches such as the lattice Boltzmann method (LBM) and computational fluid dynamics (CFD) (e.g., PHYSICA multi-physics package and the Rolls-Royce HYDRA CFD code) to process-based models (e.g., DNDC and Roth-C). As a professional modeller, I have a strong experience of a variety of numerical methods and an exceptional ability to select the most suitable approach for a specific real-world problem and to integrate numerical methods for their mutual enhancement. Thus, my expertise and experience make it easier to adopt a whole systems approach and multidisciplinary collaboration to study dynamic interactions of

[11] Please see LinkedIn. (2015). Junye Wang. Retrieved from https://ca.linkedin.com/pub/junye-wang/15/a87/a87.

nutrients, water, energy, pollutants, human activities and land-use management in river basin research. On the other hand, my experience and expertise in multidisciplinary and interdisciplinary integration and collaboration, can promote research-driven teaching and learning at AU. A cutting-edge research usually requires students to face various challenges. Thus, it is an excellent opportunity for students to acquire skills of critical thinking and problem-solving through the real problems-driven learning.

15. You have authored a number of articles including *Domain-decomposition method for parallel lattice Boltzmann simulation of incompressible flow in porous media* (2005), *Flow simulation in a complex fluidics using three turbulence models and unstructured grids* (2009), *Development and application of a detailed inventory framework for estimating nitrous oxide and methane emissions from agriculture* (2011), *Theory of flow distribution in manifolds* (2011), *Modelling nitrous oxide emissions from grazed grassland systems* (2012), *Discrete approach for flow field designs of parallel channel configurations in fuel cells* (2012), *Pressure drop and flow distribution in a mini-hydrocyclone group: UU-type parallel arrangement* (2013), *Barriers of scaling-up fuel cells: Cost, durability and reliability* (2015), and *Theory and practice of flow field designs for fuel cell scaling-up: A critical*

***review* (2015)[12,13,14,15,16,17,18,19,20] Before exploration of these particular articles, what core theme unites these research articles, and, more generally, their respective topics and sub-topics?**

These articles are on various topics from chemical engineering and energy, to environment and biogeochemical processes. A core theme is on energy, environment and sustainability. The world consists of fluid and solid. Despite very different phenomena in the real world, they are all essentially interactions between fluids, solids or fluid and solid, which are controlled by three transports (mass, energy and momentum) and two reactions (chemical and biological). These articles are to establish relationships between the three transports and the two reactions for different real-world problems using various analytical and numerical methods.

16. *Domain-decomposition method for parallel lattice Boltzmann simulation of incompressible flow in porous media* (2005) describes the lattice Boltzmann method for the simulation of flow in porous media, and a "cell-based domain-decompositions method for the parallel lattice Boltzmann simulation of flow in porous media."[21] It relates to parallel or

[12] Please see Wang, J., Zhang, X., Bengough, A. G., & Crawford, J. W. (2005). Domain-decomposition method for parallel lattice Boltzmann simulation of incompressible flow in porous media. *Physical Review. E, Statistical, Nonlinear, And Soft Matter Physics*, *72*(1 Pt 2), 016706.
[13] Please see Junye, W., & Geoffrey H., P. (2009). Flow simulation in a complex fluidics using three turbulence models and unstructured grids. *International Journal Of Numerical Methods For Heat & Fluid Flow*, *19*(3/4), 484-500.
[14] Please see Wang, J., Cardenas, L. M., Misselbrook, T. H., & Gilhespy, S. (2011). Development and application of a detailed inventory framework for estimating nitrous oxide and methane emissions from agriculture. *Atmospheric Environment*, *45*(7), 1454-1463. doi:10.1016/j.atmosenv.2010.12.014
[15] Please see Wang, J. (2011). Theory of flow distribution in manifolds. *Chemical Engineering Journal*, *168*(3), 1331-1345. doi:10.1016/j.cej.2011.02.050
[16] Please see Wang, J., Cardenas, L. M., Misselbrook, T. H., Cuttle, S., Thorman, R. E., & Li, C. (2012). Modelling nitrous oxide emissions from grazed grassland systems. *Environmental Pollution*, *162*223-233. doi:10.1016/j.envpol.2011.11.027
[17] Please see Wang, J., & Wang, H. (2012). Discrete approach for flow field designs of parallel channel configurations in fuel cells. *International Journal Of Hydrogen Energy*, *37*(14), 10881-10897. doi:10.1016/j.ijhydene.2012.04.034
[18] Please see Huang, C., Wang, J., Wang, J., Chen, C., & Wang, H. (2013). Pressure drop and flow distribution in a mini-hydrocyclone group: UU-type parallel arrangement. *Separation & Purification Technology*, *103*139-150. doi:10.1016/j.seppur.2012.10.030
[19] Please see Wang, J. (2015). Barriers of scaling-up fuel cells: Cost, durability and reliability. *Energy*, *80*509-521. do i:10.1016/j.energy.2014.12.007.
[20] Please see Wang, J. (2015). Theory and practice of flow field designs for fuel cell scaling-up: A critical review. *Applied Energy*,*157*640-663. doi:10.1016/j.apenergy.2015.01.032
[21] Please see Wang, J., Zhang, X., Bengough, A. G., & Crawford, J. W. (2005). Domain-decomposition method for parallel lattice Boltzmann simulation of incompressible flow in porous media. *Physical Review. E, Statistical, Nonlinear, And Soft Matter Physics*, *72*(1 Pt 2), 016706.

high performance computation. What are the advantages in this method? How was this cell-based domain-decompositions method utilized in this paper?

A personal computer does not have capacities to complete a large scale simulation in time. Parallel computation is a type of computation in which a big job of simulation is divided uniformly into many smaller ones. Then, these smaller jobs are distributed on many CPUs. Thus, many calculations are carried out simultaneously, operating on the principle that each CPU takes approximate job load. Therefore, it is central in the parallel computation how a big job is divided uniformly into many smaller ones, which is called "domain-decompositions." The algorithm of the cell based domain decomposition is a generalized method of domain-decompositions for complex geometries. It has the following advantages: i) automatically decomposes a complex flow domain, ii) optimizes computer memory using sparse matrix that only store fluid cells, iii) exact load balance, iv) simple communication pattern and nearest communication connection among processors, and v) high parallel efficiency in agreement with the theoretical efficiency. Therefore, the algorithm is flexible, efficient and reliable for modeling flow in any complex geometry and is superior to other similar methods for complex geometries.

17. **What seem like some of the pragmatic implications for implementation to research on the Athabasca River Basin?**

Ensuring sustainable resource development is a top priority of Alberta strategic plans. The development of next generation modeling tools is key to drive new and deeper understanding in terrestrial and aquatic systems for sustainable resource management. Such an analysis of the real system such as the Athabasca River Basin based on the multidisciplinary and interdisciplinary research and integration will enforce systematic, quantitative and comprehensive clarification of concepts and assumptions and impose rational methods for approaching the problem of sustainable resource development and management in a river basin. It is likely that the research results will offer new approaches and improved technologies to achieve sustainable resource development and management in the Athabasca River Basin system.

18. *Flow simulation in a complex fluidics using three turbulence models and unstructured grids* (2009) aimed to simulate "symmetrical turn-up vortex amplifier (STuVA)" for the maximal flow-rate of an "eight-port STuVA."[22] The paper described the utilization for the methodology as 3 turbulence models known as the standard k-epsilon", the renormalization group (RNG) k-epsilon " model and the Reynolds stress model (RSM)"; wherein, each of them has simulated flow in an eight-port STuVA for maximum flow minus swirling in the flow. From this, the article compared, or better contrasted, with the flow rate in ambient conditions. RSM appeared to match the experimental observations and measurements more than RNG and the standard k-epsilon models. How can research in different models of flow rate be utilized in the Athabasca River Basin – in practical terms?

[22] Please see Junye, W., & Geoffrey H., P. (2009). Flow simulation in a complex fluidics using three turbulence models and unstructured grids. *International Journal Of Numerical Methods For Heat & Fluid Flow, 19*(3/4), 484-500.

Fluid mechanics is fundamental to studies of hydrological processes. The computational fluid dynamics (CFD) is a high-resolution method of fluid mechanics to simulate three transports (mass, energy and momentum) and two reactions (chemical and biological). Though the background of this article is on STuVA, the three turbulence models and numerical algorithms of the CFD in this paper are the same as those of various industrial and hydrological problems. In practice, there have been many applications of the CFD in hydrological modelling, such as coast wave modelling, flooding and flume diffusion. Therefore, the CFD is not unsuitable for the watershed modelling but computers lack sufficient power and memory. At least the numerical treatments and algorithms of the CFD can inspire our thinking in the watershed modelling during simplifying hydrological models.

19. In *Development and application of a detailed inventory framework for estimating nitrous oxide and methane emissions from agriculture* (2011)[20], the team utilized Intergovernmental Panel on Climate Change (IPCC) default or country-specific emission factors (EFs) with census data from England, Northern Ireland, Scotland, and Wales to develop a detailed inventory framework for the estimation of nitrous oxide (N_2O) and methane (CH_4).[23] This framework was used to calculate the mean annual emissions of CH_4 and N_2O from crops and livestock, as well as leaching or runoff for nations bound within the United Kingdom. What other findings came from this research?

[23] Please see Wang, J., Cardenas, L. M., Misselbrook, T. H., & Gilhespy, S. (2011). Development and application of a detailed inventory framework for estimating nitrous oxide and methane emissions from agriculture. *Atmospheric Environment*, *45*(7), 1454-1463. doi:10.1016/j.atmosenv.2010.12.014

The UK ratified the United Nations Framework Convention on Climate Change (UNFCCC) in December 1993 and the Convention came into force in March 1994. Parties to the Convention are committed to developing, publishing and regularly updating national inventories of GHG emissions. The inventory framework was constructed to resolve local differences and regional heterogeneity. Thus, local-level EFs were replaced easily using either local-specific EFs (Tier 2) or more complex ones from process-based models (Tier 3). Here we demonstrated a capability of the present framework for the estimate of a national inventory with four country-level resolution. The emissions from England, Wales, Scotland and Northern Ireland, were estimated separately using the IPCC approach. The total emission from the four countries was aggregated to the U.K. national total. Although the framework was illustrated using four country-level data, it is easy to be extended to higher resolution without any code structural change. Furthermore, it is ready to integrate with Geographic Information System (GIS) to resolve spatial variation and map emissions pattern.

20. What extrapolations remain relevant to the current condition of average annual emissions in the United Kingdom from 2011 to the present, and in the next decade?[24]

The IPCC inventory approach is simple, comparable, transparent and global coverage for estimate of GHG inventory. The IPCC inventory is based on statistical approach to report national greenhouse gas (GHG) with a view to providing internationally acceptable inventory methodologies. Therefore, the IPCC inventory is not for prediction of GHGs but for reporting

[24] Please see Wang, J., Cardenas, L. M., Misselbrook, T. H., & Gilhespy, S. (2011). Development and application of a detailed inventory framework for estimating nitrous oxide and methane emissions from agriculture. *Atmospheric Environment*, *45*(7), 1454-1463. doi:10.1016/j.atmosenv.2010.12.014

national GHG emissions though IPCC inventory allows different policy options and different land-use to be compared and to be evaluated.

21. ***Theory of flow distribution in manifolds* (2011) delineates the theory of flow distribution and pressure drop in the prediction of dynamic performance and efficiency for manifold systems which occurred within the methodological and the theoretical models.[25] The paper unified existing models, momentum theory, Bernoulli theory, and discrete & continuum models – a novel generalised model without a concomitant neologism. End result: a user-friendly design tool to evaluate the interaction among structures, operational conditions, and manufacture "tolerance." Could this model become more generalized through incorporation of more (disparate) models?**

Flow distribution in manifolds is fundamental issue of fluid mechanics and encounters in a wide range of areas, from radial flow reactors in chemical engineering and boiler header in mechanical engineering, to fuel cells in energy engineering and irrigation in agricultural engineering. In the past fifty years, hundreds of different models have been developed for flow distribution in manifolds that are scattered in different areas. However, some models are empirical and most of all the existing models are only suitable for some specific flow region or specific manifold structure. A generalized theory is suitable for all the flow conditions and more general manifold structure, but it is a well-known challenge to develop a generalized theory in the past fifty years. The point is not to incorporate more models in manifolds, but to solve the practical problem of flow distributions. This theory has included the main models

[25] Please see Wang, J. (2011). Theory of flow distribution in manifolds. *Chemical Engineering Journal*, *168*(3), 1331-1345. doi:10.1016/j.cej.2011.02.050

and methods that have been developed in the past fifty years. In other words, these existing models and methods become a special case of this generalized theory.

22. Would this greater generality create more or less functionality?

No, this generality is not to create more or less functionality, but to be useful for more structures and operating conditions.

23. In *Discrete approach for flow field designs of parallel channel configurations in fuel cells* (2012), the paper describes the difficulty, the problem, in transformation of single, or multiple, laboratory scale fuel cells into industrial scale production for mass utility, which involves a number of problems to maintain "throughput, operating life, low cost, reliability and high efficiency in R&D of fuel cells."[26] You intended the research to find a uniform flow distribution and pressure drop in a homogenous, or parallel, set of channel setups, or "configurations."[27] How did the "present approach" improve upon the performance of "different layout configurations, structures, and flow conditions"?[28]

The upscaling of fuel cells is based on a basic assumption of repeat units that a successful cell performance can be repeated by all other cells in the stack since they use the same materials, seals, catalyst and structures, and undertake the same electrochemical processes. This means that the issues of chemistry, materials, water, and heat have been solved in a single cell scale.

[26] Please see Wang, J., & Wang, H. (2012). Discrete approach for flow field designs of parallel channel configurations in fuel cells. *International Journal Of Hydrogen Energy*, *37*(14), 10881-10897. doi:10.1016/j.ijhydene.2012.04.034
[27] Please see Wang, J., & Wang, H. (2012). Discrete approach for flow field designs of parallel channel configurations in fuel cells. *International Journal Of Hydrogen Energy*, *37*(14), 10881-10897. doi:10.1016/j.ijhydene.2012.04.034
[28] Please see Wang, J., & Wang, H. (2012). Discrete approach for flow field designs of parallel channel configurations in fuel cells. *International Journal Of Hydrogen Energy*, *37*(14), 10881-10897. doi:10.1016/j.ijhydene.2012.04.034

For this type of designs using repeat units, the uniformity of the flow distribution in a manifold system often determines efficiency, durability and cost of the unit stack. Under the ideal operating conditions, the electrochemical reaction is uniform over all the cells and the efficiency of the fuel cell stack is the highest and its reliability and durability is comparable to that of its individual cell. Therefore, the development of the theoretical model is to evaluate if the performance of a successful cell is repeated by all other cells in the fuel cell stack and if all the cells in the stack operate in the same operating conditions, such as flow rates and pressure drops. Thus, a design can be improved by optimization of flow conditions and structure.

(Part Three)

Abstract

An interview with Professor Junye Wang. He discusses: *Modelling nitrous oxide emissions from grazed grassland systems* (2012); *Pressure drop and flow distribution in a mini-hydrocyclone group: UU-type parallel arrangement* (2013); utilization of findings for commercial and industrial applications; *Barriers of scaling-up fuel cells: Cost, durability and reliability* (2015); most probable future for commercialization and industrialization of fuel cells in Athabasca, Alberta, and Canada; *Theory and practice of flow field designs for fuel cell scaling-up: A critical review* (2015); inter-relationship of CAIP Research Chair position, the Athabasca River Basin and Alberta, and the commercialization and industrialization of productions such as fuel cells from the laboratory scale of production; environmental impacts of the oil sands; environmental impacts of hydraulic fracturing; and top three energy sources for the next 10, 25, and 100 years.

Keywords: Alberta, Athabasca River Basin, Athabasca University, CAIP Research Chair, commercial, fuel cells, industrial, LinkedIn, oil sands, Professor Junye Wang.

An Interview with Professor Junye Wang (Part Three)[29,30,31,32]

Footnotes throughout the interview, and bibliography and citation style listing after the interview.

24. In *Modelling nitrous oxide emissions from grazed grassland systems* (2012), the paper describes the grazed grassland systems and their role in the global carbon cycle in addition to influence on global climate change based in the identical emissions types from *Development and application of a detailed inventory framework for estimating nitrous oxide and methane emissions from agriculture* (2011) – namely: nitrous oxide and methane.[33] You, and others, note the uncertainty involved in the parameterisation of process-based, or dynamic, models for grazed grassland systems, which emerges out of the enormous biodiversity of flora and fauna in these grassland systems that are grazed. Insofar as the descriptive models are concerned, the dynamic models work in the United Kingdom, the DeNitrification-DeComposition (DNDC) or the "process-based biogeochemistry model" was used there.[34] What did the paper discover about the observations and its correspondence with the model?

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[29] Professor and CAIP Chair, Science and Technology, Athabasca University.
[30] Individual Publication Date: February 8, 2016 at www.in-sightjournal.com; Full Issue Publication Date: May 1, 2016 at www.in-sightjournal.com.
[31] Ph.D. (1993 – 1996), Chemical Engineering and Mechanical Engineering, East China University of Science and Technology; M.Sc. (1986 – 1989), Aerospace, Aeronautical and Astronautical Engineering, Harbin Shipbuilding Engineering Institute.
[32] Photograph courtesy of Professor Junye Wang.
[33] Please see Wang, J., Cardenas, L. M., Misselbrook, T. H., Cuttle, S., Thorman, R. E., & Li, C. (2012). Modelling nitrous oxide emissions from grazed grassland systems. *Environmental Pollution*, *162*223-233. doi:10.1016/j.envpol.2011.11.027
[34] Please see Wang, J., Cardenas, L. M., Misselbrook, T. H., Cuttle, S., Thorman, R. E., & Li, C. (2012). Modelling nitrous oxide emissions from grazed grassland systems. *Environmental Pollution*, *162*223-233. doi:10.1016/j.envpol.2011.11.027

The IPCC inventory methodology (Question 19 and 20) is a practical, first-order approach that uses simple default emission factors (EFs) and addresses the anthropogenic effects on sources and sinks of GHGs using a series of default EFs. However, emissions from livestock depend on a range of factors, such as animal type, their weight and age, proportion of time spent grazing, type of animal housing, type of manure and its storage and application, weather and soil type. The variability of all these control EFs, both in time and space, results in very heterogeneous GHG emissions. To contribute towards more reliable estimates of N_2O emissions from grazing systems, the process-based model and its corresponding validation technology in the UK were developed to provide a useful tool for integrating our knowledge of key processes and driving variables to estimate N and C trace gas emissions from grazed pastures.

The model generally captured the timing and intensity of N_2O pulses following rainfall, N fertilizer application or grazing events. The results imply that the external parameters used as inputs to run UK-DNDC take into account the main factors dominating variations of N_2O emissions from the grazed plots. However, discrepancies exist between the modelled results and observations. For example, the model missed some observed high peaks of N_2O emissions, especially the high peaks related to the high fertilizer rates and grazing intensity at the Cae Banadl site. Future improvements in the scientific processes of the model could provide opportunities to reduce the uncertainties in modelling N_2O emissions from grazing systems. Understanding the uncertainties or challenges is critically important for us to accurately address questions regarding the impact of land-management practices and future climate changes on GHG emissions.

25. *Pressure drop and flow distribution in a mini-hydrocyclone group: UU-type parallel arrangement* (2013) describes miniature hydro-cyclones based on the advantages for increased "separation precision, low cost, easy operation and high stability," where the single or multiple mini-hydro-cyclones need linkage in parallel for industrial utilization.[35] Of course, the article describes the great difficulty in the development of parallel single and multiple miniature hydro-cyclones for industrial application. The paper provides a general mathematical model for these parallel miniature hydro-cyclones known as the UU–type parallel mini-hydro-cyclone group.[36] What did the results of the research show about the parallelization of the UU-type?

Hydrocyclone separation technology has been widely applied in petroleum refining, petrochemical industry, coal liquefaction, coal separation, natural gas purification, methanol-to-olefin conversion, mineral processing, textile and pulp, and other environmental industries. Miniature hydrocyclones have received increasing attention due to their advantages of higher separation precision, low cost, easy operation, and high stability. However, because of small treatment capacity of a single mini-hydrocyclone, numerous mini-hydrocyclones need to be connected in parallel to meet the requirements of industrial scale treatments. Such a system of numerous mini-hydrocyclones in parallel connection can meet the requirement of large scale of industrial applications and at the same time achieve its maximum efficiency of separation. This is another example of repeated units that the performance of a successful hydrocyclone is

[35] Please see Huang, C., Wang, J., Wang, J., Chen, C., & Wang, H. (2013). Pressure drop and flow distribution in a mini-hydrocyclone group: UU-type parallel arrangement. *Separation & Purification Technology*, *103*139-150. doi:10.1016/j.seppur.2012.10.030

[36] Please see Huang, C., Wang, J., Wang, J., Chen, C., & Wang, H. (2013). Pressure drop and flow distribution in a mini-hydrocyclone group: UU-type parallel arrangement. *Separation & Purification Technology*, *103*139-150. doi:10.1016/j.seppur.2012.10.030

repeated by all other hydrocyclones in the system. Under the ideal operating conditions, every mini-hydrocyclone separation efficiency is similar as other hydrocyclones and the efficiency of the system is the highest. This paper extended the theory of flow distribution in manifolds into the more complex system of parallel miniature hydro-cyclones known as the UU–type parallel mini-hydro-cyclone group. The results demonstrate the capability of the present model to improve the separation efficiency and to meet treatment capacity for large-scale industrial applications.

26. How might this become utilized for commercial and industrial applications?[37]

The UU-type hydrocyclone group has been used successfully for many fields, such as wastewater treatment of delayed coking, washing soil contaminated by a variety of heavy metals and radioactive contaminants, separation of animal and microbial cells, and the recycling of sewage slurry with alkali and sulfur in many industrial projects in China.

27. *Barriers of scaling-up fuel cells: Cost, durability and reliability* (2015) describes the foundation of the fuel cell from 170 years ago in addition to its present status, industrially, as "fledgling," and the mainstream nature of the technology is, apparently, nil.[38] The article poses some problems with respect to the commercialization and industrialization of fuels cells:

[37] Please see Huang, C., Wang, J., Wang, J., Chen, C., & Wang, H. (2013). Pressure drop and flow distribution in a mini-hydrocyclone group: UU-type parallel arrangement. *Separation & Purification Technology*, *103*139-150. doi:10.1016/j.seppur.2012.10.030
[38] Please see Wang, J. (2015). Barriers of scaling-up fuel cells: Cost, durability and reliability. *Energy*, *80*509-521. do i:10.1016/j.energy.2014.12.007.

Why has scaling-up of fuel cells failed so often when many researchers have stated their successes in the small scale? Why do fuel cell stacks have lower durability, reliability and robustness than their individual cells? Could investments of a hydrogen fueling infrastructure stimulate advancements in the key issues of durability, reliability and robustness and substantially reduce fuel cell costs?[39]

How did the paper answer each query?

The immediate aim of this paper was to stimulate debate on the open issues of fuel cell technology, and to propose changes for improvement. Unless one understands the challenges of commercialization, there is little chance of meeting them. In this paper, I analyzed and confronted these critical questions to address the challenges of scaling-up technologies and identify key barriers. Further, root causes for the challenges of durability, reliability and robustness of fuel cells were analyzed. I elaborated on why durability and reliability of fuel cells are the biggest technical barriers to commercialization rather than establishing hydrogen fueling infrastructures. Future opportunities for the commercialization of fuel cells have been discussed with recommendations for change of priorities. An integrated approach is required for the fuel cell technology to substantially improve the durability and reliability of fuel cells and reduce their costs. I examine options and suggest a procedure for change to ensure that scaling-up targets for durability and reliability are met.

[39] Please see Wang, J. (2015). Barriers of scaling-up fuel cells: Cost, durability and reliability. *Energy*, *80*509-521. do i:10.1016/j.energy.2014.12.007.

28. What seems like the most probable future for commercialization and industrialization of fuel cells in Athabasca, Alberta, and Canada?

Fuel cell technologies have clear advantages of high efficiency, low emission and low noise over conventional engines, such as internal combustion (IC) engines and gas turbines. High efficiency means a low bill and low emissions. If the reliability and durability of fuel cells are comparable to IC engines or boilers, many end-users will choose the low bill engines even if a little bit of high capital. Particularly, if consider environmental-friendly, more and more end-users will choose the new technologies. Therefore, as a core technology of future engine and energy, fuel cells will play a pivotal role in revolutionizing the way we power our world; offering cleaner, more-efficient alternatives to the IC engine in vehicles and gas turbines or coal fired boilers and steam turbines at distributed power generating stations.

29. Finally, *Theory and practice of flow field designs for fuel cell scaling-up: A critical review* (2015) demarcates the laboratory and industrial scale fuels cells, akin to some problems involved with the commercialization and industrialization described in the earlier articles, and the scaling upwards of the "throughput, operating lifetime, cost, reliability and efficiency."[40] How does this article tackle these issues?

As an assembly of repeated units, the maximum power output of a stack should ideally be a linear sum of all cells in the stack and the lifetime, reliability and durability of a stack are determined by its worst individual cell. Although there are various outward appearances of

[40] Please see Wang, J. (2015). Theory and practice of flow field designs for fuel cell scaling-up: A critical review. *Applied Energy*,*157:* 640-663. doi:10.1016/j.apenergy.2015.01.032

scaling-up failures, such as water, heat and material issues, the failure of scaling-up is because of poor designs, leading to uneven gas intake of each cell in the stack due to uneven flow distribution. The performance degradation or failure of scaling-up is essentially due to some channels in a cell or some cells in a stack deviating from their design conditions due to an uneven gas intake distribution. As long as uneven flow distribution and pressure drop exceeds its operating windows, there will be a series of deteriorations, leading to an uneven chemical reaction. The uneven chemical reaction is the main cause of uneven water, heat, and current productions. An uneven heat production leads also to a heterogeneous distribution of temperature and thermal stress, an important indicator of duration and life of the cell. This deviation can significantly exceed the capacity of water removal and heat diffusion in a channel or a cell, leading eventually to larger issues, such as flooding, drying, and hotspots. This review addresses two key barriers facing engineers in flow field designs of fuel cells. One is how to find an optimal combination with high performance (high uniformity and low pressure drop) from thousands upon thousands of combinations among configurations, channel and header shapes, and flow conditions (pressure, flow rate, temperature and humidity). Another is to assess how far a fuel cell is from its optimal/given operating conditions and how a flow field design can be improved to meet specific operating ranges. Flow field designs are a strategic solution and provide a major opportunity to improve the durability and reliability of large scale stacks. To this end, remarkable progresses in the theory and tool of flow field designs have been achieved to establish a direct and explicit relationship of configurations, structures, flow conditions and performance that can be used to evaluate different design alternatives regarding the various structural and flow conditions with respect to performance and predictive capability. All these studies demonstrate the possibility of designs for fuel cell configurations to achieve an optimal performance, reliability, and durability of fuel cell scaling-up in terms of good flow distribution, low pressure drop and transient response through the four characteristic parameters.

30. What appears to inter-relate the CAIP Research Chair position, the Athabasca River Basin and Alberta, and the commercialization and industrialization of productions such as fuel cells from the laboratory scale of production?

A river basin such as the Athabasca River Basin (ARB) is a complex system which consists of terrestrial and aquatic systems. All processes of physics, chemistry, biology and society interact at different scales but such a system is artificially separated into different components according to their disciplines. This artificial separation is not due to the essence of the system but the limitation of our knowledge and understanding. In fact, a river basin has no clear boundaries of different disciplines. It is clear that such an analysis of the real system requires the multidisciplinary and interdisciplinary research and integration. However, it is unclear which discipline should be included or which discipline could definitely not be related to the complex system. This may be called their scientific identity crisis. Knowledge from other disciplines may make an important contribution to a river basin research. As you may know, engineering has provided research instruments and equipment for the development of many disciplines, such as chemistry, biology and society. Fuel cells are a type of energy devices but they can be developed for a specific instrumentation. Here, the biogeochemical processes in soil architecture are at the micro-scale. Soil pores permit the coexistence of air, chemicals such as nutrients, and water essential to soil microbial activities. Pore and channel structures determine how easily microbes can extract water and nutrients, and the rate of diffusion of nutrients and water into and out of the soil architecture. However, it is difficult to measure the pore-scale processes in the below ground using the conventional laboratory and field experiments because that requires very high resolution. Therefore, a specially designed microreactor has potentials to enable systematical tests for complex interactions of microbial and nutrients in porous media. For example, microbial fuel cells are commonly used for wastewater treatment or biosensors. Fuel cells are a special type of microreactor. Their theory can be fundamental to design special microreactors or microbial fuel cells for measurement of pore scale processes. This technology may deepen our understanding of soil processes; findings and knowledge at the micro-scale will be used to develop and improve the large-scale CAIP modelling framework of integrated terrestrial and aquatic systems. The goals and the evolution of this CAIP program have led to a growing integration of our research with that which is being undertaken by other researchers, while at the same time providing a stimulus for, and a new perspective on, the work on current issues in watershed management which is being carried out in the program.

31. What remain the environmental impacts of the oil sands?

Extraction of oil and gas from oil sands, are often associated with industrial processes. Wastewater and tailings can be generated in large quantities that contain constituents that are potentially harmful to human health and the environment. Cumulative effects can last hundreds of years if without appreciate remediation and reclamation.

32. What remain the environmental impacts of hydraulic fracturing?

Development of hydraulic fracking, from seismic and core hole exploration, production well pads, roads and pipelines, can create significant disturbance to the forest and grassland, which can negatively impact biodiversity of animals and plants. A growing number of active wells and inactive and abandoned wells are incurring significant environmental impacts because of the potential dangers of well leaching and spill from flow-back, such as contamination of groundwater, methane pollution and its impact on climate change and air pollution, exposure to toxic chemicals, blowouts due to gas explosion, waste disposal and large volume water use in water-deficient regions. This potentially harmful wastewater and gas creates a need for appropriate wastewater management infrastructure and practices. There are also major knowledge gaps in how the flow-back and leaching pollutants will degrade and diffuse through the biogeochemical and hydrological processes above and below ground once they are inputted to a site or a watershed.

33. What seem like the top three energy sources for the next 10, 25, and 100 years?

In the next 10 years, fossil and nuclear energy will still be dominant. In next 25 years, renewable energy will increase gradually their share with fossil and nuclear energy. Finally, renewable energy will replace fossil and nuclear energy in the future.

Thank you for your time, Professor Wang.

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