

2012 Kappe Lecture Tour

Sponsored by the American Academy of Environmental Engineers

Lecturer: Vladimir Novotny, PhD, PE, BCEE

Lectures offered by the speaker:

1. Closing the Water Cycle, Recovering Energy and Resources in the Cities of the Future

Introducing the worldwide Cities of the Future initiative, the presentation highlighted current developments and concepts of the new (fifth) paradigm leading towards water centric sustainable communities whereby stormwater conveyance is mostly on the surface and rehabilitated and restored urban surface and ground water bodies are the integral parts of the entire water cycle system. The major drivers for the change are urban population increase and migration, impact of global climatic changes, deteriorating of decades old underground infrastructures incapable to cope with the 21st century challenges, and diminishing resources. The backbone of the new paradigm approach to building new cities and retrofitting the old to become sustainable, is distributed water and energy reclamation from used water and stormwater and reusing them in a partially or fully closed urban metabolic cycle based on the concept of the four R's: reduce (conserve), reclaim, reuse and restore. Implicit in these designs is a significant reduction of energy use from nonrenewable sources. Water conservation is the most efficient measure to reduce GHGs from water systems to net zero. Current and near future developments of sustainable water centric "ecocities" in Canada, China, United Arab Emirates, Sweden, and other countries were introduced.

2. Prevention and Remediation of Advanced (Hyper) Eutrophication of Multipurpose Impoundments - A Case For Integrated Watershed Management

As a result of the intensification of agriculture, use of phosphate detergents and implementing sewerage in growing communities over the last fifty years, nutrient loads to receiving surface and groundwater have, in the second half of the last century, dramatically increased throughout the world, creating eutrophic and hypereutrophic water quality in lakes and reservoirs providing water supply to communities, recreation, and fishing. The presentation focused on the hypereutrophic status exhibited by harmful algal blooms of cyanobacteria (Cyano-HAB) which are becoming endemic in Europe, Asia and also in the US. High nitrate loads are one of the causes of hypereutrophication; however, they also appear to suppress internal phosphate loading from sediments. The processes of in the water/sediment interface were described and a potential effect of denitrification on carbon sequestering outlined. The key processes in many hypereutrophic water bodies occur in sediments which may contain orders of magnitude larger concentrations of hibernating cyanobacteria than those in the water column during

the bloom. Also the phosphate content in the sediment of hypereutrophic impoundments may exceed by orders of magnitude the quantity in the incoming external annual load. The key processes in sediments affecting internal loads are denitrification, anaerobic digestion, reduction of iron and aluminum phosphate compounds and reduction of sulfate to sulfide. The last process is also responsible for formation of methyl mercury. New models need to be developed and the strategy of mitigation practices has to be reevaluated. Possible strategies were outlined.

Before each visit the Kappe lecture organizers at each university were provided with written materials (articles and book chapters) on both lectures.

Short biography of the speaker:

Vladimir Novotny is Professor Emeritus at Marquette University (Milwaukee, WI) and Northeastern University (Boston, MA) and an internationally recognized scholar and educator. Currently, he is also a partner of AquaNova LLC in Gloucester (MA). In 2006 he organized a workshop on Cities of the Future, attended by leading experts from several countries, held at the F.L. Wright built Wingspread Conference Center. Cities of the Future (COF) is now an acronym for a worldwide movement of water specialists, landscape architects, urban planners and NGOs towards a paradigm change, resulting in planning, building and retrofitting urban areas that would reduce water use, recover resources and energy, from used water, restore and protect water resources, and use energy without adversely contributing to the global climatic changes. He published three books and made numerous keynote presentations on this 21st century defining topic in China, Japan, Democratic Korea, Europe, Canada, and the US. In 2009 he was appointed to the IWA's Steering Committee for The Cities of the Future. For his 2011 endowed COF Freeman lecture at Massachusetts Institute of Technology he received an award by the Boston Society of Civil Engineers.

Academic Institutions Visited:

- | | |
|--|---------------------|
| 1. Stevens Institute of Technology, Hoboken, NJ | 9/11 – 9/12, 2012 |
| 2. University of Pittsburgh and Carnegie-Mellon University, Pittsburgh, PA | 9/27 – 9/28, 2012 |
| 3. University of Wisconsin, Madison | 10/4 – 10/5, 2012 |
| 4. University of Nebraska, Lincoln, NE | 10/11 – 10/12, 2012 |
| 5. University of Florida, Gainesville, FL (University of South Florida Patel School of Global Sustainability participated) | 10/18 – 10/19, 2012 |
| 6. North Carolina State University, Raleigh and Duke University, Durham | 10/25 – 10/26, 2012 |
| 7. University of Texas, Austin (Rice University participated) | 11/1 – 11/2, 2012 |
| 8. Clemson University, Clemson, SC | 11/8 – 11/9, 2012 |

Visit of Stevens Institute of Technology (host Professor David Vaccari)

STI is a relatively small but very reputable institution located across Manhattan Island of NYC on the bank of the Hudson River. The hosting Civil, Environmental and Ocean Engineering Department offers vibrant programs of undergraduate and graduate education in these fields and focuses both on research and practice. The department houses The Center for Environmental Systems/Environmental Modeling

and Davidson Laboratory of the Center for Maritime Systems. Both centers are involved in the metropolitan NYC research. Of note is the Davidson Laboratory real time monitoring of the Hudson River and near shore coastal waters. The visitor had a chance to visit and briefed by faculty and researchers from both laboratories.

The visit was mainly organized by the SVI student chapter of the American Academy of Environmental Engineers. The chapter, formed at Stevens in the Spring of 2012, is open to all students with an interest in the environmental field and the Kappe lectures visit was the first large event since its formation. In addition, the chapter is holding monthly student/faculty seminars and will be inviting other speakers. The chapter is active and their organization of the Kappe visit, with the collaboration and supervision of the Department Chair Professor David Vaccari, was very good.

Both lectures were presented. Lecture 2 (Hypereutrophic water bodies) was presented on 9/10 in an abbreviated to the AAEE student chapter and other students and the discussion also included question and answers on other topics such as job outlook for environmental engineers. About 20 students participated.

The main event was the Lecture 1 (Cities of the Future) which was attended by students, faculty and outside local professionals. Out of about 150 attendees, a large portion consisted of students of the Freshman Experience Program.

University of Pittsburgh (host Professor Radisav Vidic) and Carnegie – Mellon University (host Professor David Dzombak) in Pittsburgh, PA

This visit was jointly organized by the Departments of Civil and Environmental Engineering of the University of Pittsburgh (Chairman Professor Vidic) and Carnegie Mellon University (Professor Dzombak and the CEE Department Head Professor James Garrett).

On the first day (9/27), after lunch with Professor Vidic, Professor Dzombak and I (visitor) participated in the Water Economy Network tour at the Pittsburgh Water and Sanitation Authority water treatment plant. Professor Dzombak is a Member of NAE. This old facility appears now to be threatened by the (illicit) discharges of waste water from shale methane fracturing mining in the watershed above the water intake into the plant. The tour of the plant was followed by a discussion on carrier options, student research, activities of the AAEE and other professional organizations (e.g., IWA and its Cities of the Future initiatives) with the CMU graduate students. About 20 graduate students participated in the session which was then followed by a reception.

The second day was filled with the ½ hour meetings with faculties, morning at the CMU, starting with the CMU CEE Department Chair Professor Garrett, and followed with the visits of Professors VanBriesen, Casman, Karamalidis, Adams, and Gregory. It was evident that CMU researches are heavily involved in investigating the effects and mitigation of shale methane hydraulic fracturing and carbon sequestering in underground zones. As stated above, this is a great problem in Pennsylvania and specifically in Pittsburgh which is facing increasing concentrations of bromine in its water intake.

Lunch and visits after the lunch were with the Professors of CEE Department of the University of Pittsburgh. Therein, nanotechnology and water systems analysis was the main topic. Professors Casson, Bilec, Khana, Rizzo, and Neufeld were visited.

The late afternoon seminar featuring lecture 1 (Cities of the Future) was attended by about 120 undergraduate and graduate students and faculty from both universities. Discussion after the presentation, followed by a reception, was lively. The visit concluded by a dinner with Professors Vidic and Dzombak.

University of Wisconsin - Madison (host Professor Katrina McMahon)

The sponsors of this full two day visit were the Department of Civil and Environmental Engineering, Environmental Chemistry & Technology program, and UW- Madison Office of Sustainability. The first lecture was included in the endowed Weston Sustainability Roundtable Series by the Center for Sustainability and the Global Environment at the University of Wisconsin. The lecture is available on web at <http://www.sage.wisc.edu/weston> as a Webinar

The first day started with breakfast with the host, Prof. McMahon and the morning included discussions with post doctoral fellows and graduate students. The afternoon began with visitor's meeting with Professors Hansen from the Center on Limnology and Dr. Doran who is an adjunct professor conducting research on wastewater and stormwater systems. The seminar featuring Lecture 1 (Cities of the Future) was in late afternoon, followed by a reception. Professor Emeritus Mary Anderson (Member of NAE) who for many years collaborated with the visitor was in attendance and participated in the follow-up discussions. The number of participants at the seminar exceeded 170 (full house). The evening dinner included Professor McMahon, Professor and Mrs. Anderson, Professor Potter, and Professor (visitor) and Mrs. Novotny.

During the second day the visitor had discussions with Professor Wu from the hydraulic/hydrology program and Attorney Melisa Malott of the Dane County Lakes and Watershed Commission who was interested in information and advice on watershed management and Total Maximum Daily Load (TMDL). Lecture 2 (Hypereutrophic water bodies) was presented at noon to about 50 students and faculty.

University of Nebraska - Lincoln (host Professor Dvorak, acting Chair of the Civil and Environmental Department)

The host of the visit Dr. George Dvorak, Acting Chair of the Department of Civil and Environmental Engineering of the University of Nebraska prepared a diverse and busy program of meeting students, faculty, and outside stakeholders. On the first day, modified Lecture 2 (Hypereutrophic water bodies) was presented to the Nonpoint Pollution Class taught by Professor Hunt. This class is taught concurrently at UN Lincoln (Figure 1) and by videoconferencing in the Omaha campus of UN. The class has about 15 students. Discussions with other faculties (Professors Killic, Bartel, Schulte) continued throughout the day. Dr. Shuhai Zheng, Director of Water Resources at the NE Department of Natural Resources and former PhD student of the visitor participated at several technical and social activities related to the visit.

The second day started by a discussion with Professor Dahab, former President of Water Environment Federation, followed by a meeting with stakeholders. The noon seminar featuring Lecture 1 (Cities of the Future) had 40 attendees and was also videoed to Omaha. Lunch was hosted by professors Xu Li and Yusong Li and after lunch, again by videoconferencing, the visitor had a chance to discuss the cities of the future topics with Professors Admiral, Zhang, Strasbury, and Junke from the Omaha campus.

The visit concluded by a discussion with Drs. Franti and Eisenhauer from the Department of Biological Systems Engineering who conduct research on impacts of land and water practices in agricultural regions and engineering of buffer strips and wetlands. Evening wrap-up dinner was attended by Professors Dvorak Kilic and Professor and Mrs. Dahab.



A part of Nonpoint pollution class; additional students in Omaha participated by webinar



With Professors Kilic and Hunt in Lincoln

University of Florida, Gainesville (hosted by Professor James Heaney and the Department of Environmental Engineering Sciences (EES))

The mission of the EES Department is to provide quality undergraduate and graduate educational programs in environmental engineering sciences, to conduct an internationally recognized environmental research program that will substantially contribute to the benefit of the earth, and to provide authoritative guidance to individuals and organizations charged with preventing and solving local, state, national and global environmental problems.

Because of the noon arrival to Gainesville the visit started by the afternoon Lecture 2 (Hypereutrophic water bodies) attended by about 25 student and faculty (Figure 3). After the lecture the visitor met with the graduate students of Professor Heaney's Urban Water Systems Group. The group's focus is on water conservation, balancing water demand, and water reuse.

The second day started by a tour of the campus provided by Professor Heaney, highlighting sustainability. At 12:00 the visitor participated at an extended lunch meeting of the U. of Florida EES department faculty and some graduate students with a group of researchers from the University of South Florida Patel School of Global Sustainability headed by Professor Kalanithy Vairavamoorthy. The meeting

was chaired by Professor Heaney and was also attended by the Chair of the EES Department Prof. Chadik, representatives from the College Sustainability Department and other faculty from the department. It should be pointed out that the visitor (Novotny) has collaborated with Prof. Vairavamorthy for several years on the Cities of the Future Steering Committee of the International Water Association. The host Professor Heaney was a speaker and participant at the 2006 Wingspread seminar on Cities of the Future organized by the visitor. The main topics of the meeting at the University of Florida were brief descriptions of the missions of each group and discussions on possible cooperation. The South Florida group has a strong international record in Europe (Professor Vairavamorthy was previously affiliated with University of Birmingham in UK and Delft University in Holland and led a multimillion UNESCO sponsored urban sustainability project) and currently the group does Cities of the Future type of work in Africa.

The main event of the second day was afternoon Lecture 1 presentation which was videotaped and is available from

<http://www.ufedge.ufl.edu/sp/kappe-lecture-series>

The lecture was introduced by Professor Heaney who, in addition to introducing the visitor/speaker also introduced the University of South Florida team (Figure 4). The lecture was followed by discussion and reception. The estimated attendance number of this lecture was about 90 participants.



Audience of the *Hypereutrophic* Lecture 2



Professor Vairavamorthy (first from right) and his team listening to the *Cities of the Future* lecture

North Carolina State University-Raleigh (host and visit organizer Professor Detlef Knappe) and Duke University – Durham (host Professor Lee Ferguson)

This visit was jointly hosted by the Department of Civil, Construction and Environmental Engineering (CCEE) and Department of Biological and Agricultural Engineering (BAE) of NCSU and Department of Civil and Environmental Engineering (CEE) of Duke University. The visit began by a lunch with Professors Zechman, Aziz, and Knappe. The afternoon started by the first seminar featuring Lecture 2 (Hypertrophic Water Bodies) presented at the BAE Department (35 attendees). The seminar was preceded by a visit with Professor Wayne Skags (member of NAE and friend of the visitor) and followed by a discussion with a group of BAE graduate students supervised by Professor Hunt. The group is conducting and cutting edge research on removal of pollutants in wetlands, Low Impact Development best management practices, rainwater harvesting, and smart irrigation technologies. Evening dinner was attended by Professor Grieshop, de los Reyes, and Arumugan.

The second full day of activities included discussions with Professors Aziz, de los Reyes, Arumugan, Barloz (Department Chair) and Yu which was followed by a discussion and buffet lunch with graduate students. Professor Barloz was a previous Kappe lecturer of the AAEE.

The second presentation featuring Lecture 1 (Cities of the Future) started at noon and had attendance of about 100. It also included professors and students from Duke University. After the seminar and discussion the visitor was taken by Duke Professors Deshusses and Ferguson to Duke University where meetings continued and included also Duke Professors Marani and Hsu-Kim and several graduate students and post-doctoral fellows.

University of Texas in Austin (host Professor Joseph Malina)

The Environmental and Water Resources Engineering Program of the Department of Civil, Architectural and Environmental Engineering sponsored the visit. The UT-Austin was the largest institution applying for the Kappe lecture visit. The hosts requested only Lecture 1 to be presented. The Kappe lecture is jointly sponsored by Civil and Environmental Engineering Department of University of Texas in Austin, Rice University and University of Houston, and Texas A&M which rotate in applying for the lecture.

After arrival on the first day afternoon, the program was relaxing. Professor Malina provided a tour of the University and the Colorado River watershed. The afternoon ended by a dinner with the host.

The second day was packed with activities. It started with a breakfast and short campus tour with Professor Paula Passalacqua who took the visitor to the Department building. After a short meeting with Professor Malina, the visitor met Professor Kerry Kinney and her graduate students. Her group studies microbiological processes and application of microbiology. At 11:00 am the visitor met Professor Desmond Lawler and his students researching desalination processes and modeling of treatment processes. Both Professors Kinney and Lawler are leaders in their fields. Professor Lawler is the current (2012) Distinguished Lecturer of the Association of Environmental Engineering and Scientists Professors.

The lecture was presented after the noon networking buffet lunch with students and faculty. The lunch and seminar were also attended by about 10 students and a professor from Rice university and individuals from two other sponsoring universities. The total number of attendees was estimated by professor Malina as follows: 70 students from participating universities (UT, Rice, U Houston, Tex A&M), 20 faculty, 20 consulting engineers, and 10 municipal utilities personnel. As at other institutions, the lecture was followed by a reception.

The evening dinner was hosted by Professor Davis Ford (Member of NAE and former President of AAEE) and was also attended by Mr. Rajendra Bhattarai from the Austin Water Utility.

Clemson University (host and visit organizer Professor David Freedman)

The visit was sponsored by the Department of Environmental Engineering and Earth Sciences (EEES). This department is one of the largest environmental and earth sciences programs in the nation in areas of environmental engineering, bio-systems engineering, and geology.

The arrival of the visitor to the Clemson area occurred in the late afternoon. The dinner was attended by Professors Karanfil (Department Chair), Freedman (visit organizer) and Overcamp who provided a brief overview of the history of Clemson environmental engineering graduate research.

Breakfast was with Professor Finneran who provided transport to the Environmental Research Park that is located about 9 miles from the Clemson University campus. Therein the visitor met Professor Motz, followed by the discussion with graduate students. Students reported on their work contributing to understanding the characteristics of emerging contaminants, site assessment, physical and biologic treatment system design, life cycle assessment, and the development of best management practices, including also growing algae for energy. They were also interested to learn about the job prospects and careers in the environmental field.

After transport to the main campus, the first presentation was abbreviated version of Lecture 2 (Hypereutrophic water bodies) to the undergraduate class on Environmental Geology. The class had about 30 students in attendance. In spite of their junior level status, the students were interested in the topic and followed with a number of questions.

After the lecture, the visitor was transferred back to the Research Park where the Lecture 1 (Cities of the Future) was presented to about 60 graduate students and faculty. As at all other Kappe venues, the lecture was followed by a reception after which the visitor departed.

Reflection on the Kappe visits

Being a Kappe lecturer was a great honor and a humbling experience of having the opportunity to visit great institutions and learn about the cutting edge research therein. The interest in the Kappe lectures was great and reception outstanding. I am grateful and thankful to AAEE for being selected.

Lecture 1 (Cities of the Future) was by far the most popular program. Attendees were eager to learn about the concepts and developments of the new sustainable “water centric Cities of the Future”. This is important because the US is playing catch-up behind some EU countries, China, Australia and the small

Singapore. Interactions with colleagues and graduate students were lively and in many cases will continue. Lecture 2 challenged researchers to take a new look at a serious emerging water quality problem and finding new paradigm solutions. The total number of attendees of the two lectures at all visited campuses most likely surpassed one thousand.

A minor drawback was the limit \$ 700 on the travel expenses which was very tight and in some cases insufficient, specifically for visits requiring two overnight stays. Also, while some airline ticket prices may seem low, additional charges for leg room and luggage are significant. For example, Association of Environmental Engineering and Science Professors charges applying institutions \$1000 and provides a greater allowance to the Distinguished AEESP lecturer.