CURRICULUM VITAE

Ni-Bin Chang

F.ASCE, F.AAAS, LEED, BCEE, DWRE, M.EAS

Professor, Department of Civil, Environmental and Construction Engineering
Director, Stormwater Management Academy
University of Central Florida
Orlando, Florida, 32816, USA
Telephone: (407) 754-7521
Email: nibinchang@gmail.com
Homepage: http://www.cece.ucf.edu/people/chang/index.html
Stormwater Management Academy: http://www.stormwater.ucf.edu/

Program Director
Hydrologic Sciences Program
Cyber-Enabled Sustainability Science and Engineering Program
Small Business Technology Transfer Program
National Science Foundation
Arlington, Virginia, 22230, USA

Board Member, Earth Sciences and Environmental Sciences Division
European Academy of Sciences
Homepage: http://www.eurasc.org/committees/Heads_Teams.asp

Jan., 2014

TABLE OF CONTENTS

SUMMARY OF RESEARCH INTERESTS AND ACHIEVEMENTS

Dr. Chang has been in industry and academia for twenty more years. His research has been primarily in the area of not only sustainable system engineering, environmental infrastructure planning and assessment, environmental informatics, remote sensing and sensor networks but also environmental management, hydrology and water resources, and coastal sustainability. With over the funding support of 6 million US dollars, this research has culminated over 210 scientific publications in peer-reviewed journals, 4 books and 8 US patents. Dr. Chang has established himself as an international expert in the field of sustainable systems engineering for environmental sustainability as evidenced by invited presentations internationally and nationally, contributions to books/book chapters, and journal papers on this topical area. Dr. Chang is a new Renaissance-type scientist for whom cross-disciplinary research is the norm. With the formation of many cross-domain teams for research, specific areas for which he has made substantial contributions include the following four sub-disciplines: *Environmental Sustainability & Urban Geosystems Science, Multiscale Hydrological and Environmental Informatics & Remote Sensing, Stormwater & Wastewater Treatment, and Environmental Management.* The emphasis of his research has been placed on the development of next-generation concepts, tools, methods, algorithms, and platforms for transdisciplinary integration of sensing, monitoring, and modeling in many critical decision making applications. Based on his scientific expertise, he is often invited to participate on proposal panels for DOE, NSF, EPA, and foreign institutions. These activities have a significant impact on research policy and shape the direction for a broad spectrum of the sciences of hydrology and environmental management. Dr. Chang has received twenty-seven awards since 1987. He is a Fellow of two professional societies; the American Association for the Advancement of Science (AAAS), the American Society of Civil Engineers (ASCE), and a Member of the European Academy of Science (EAS). He received the ASCE Outstanding Achievement Award and the Fulbright Scholar Award in 2010 and 2012, respectively. In 2012 and 2013, he received two prestigious awards, including the Distinguished Visiting Fellowship from the Royal Academy of Engineering and Bridging the Gaps Award from the Engineering and Physical Sciences Research Council in United Kingdom. His research in environmental systems modeling and leadership in multi-scale environmental and hydrological remote sensing and monitoring to establish and validate various systems engineering methods and algorithms have had extraordinary impact on hydrologic and environmental research over the past two decades. Beginning with those in the early 2000s through today these investigations have provided the research focus for a large and diverse scientific community and have been the foundation for PhD degrees throughout the world. Dr. Chang is known around the globe for his stellar research record. According to Google Scholar, his h-index is 38, i10-index 112 and his research documents have been cited 4,615 times as of Jan. 2014. His Scopus h-index record was ranked top 7 most cited Google Scholars in civil and environmental engineering community in the world in 2012.

HONOR AND AWARDS

National Awards

1. Fulbright Scholar Award, Department of State, USA, July, 2012.
2. Intergovernmental Personnel Award, National Science Foundation, USA, May, 2012.
3. Fellow, American Association for the Advancement of Science (AAAS), USA, Feb., 2012.
4. Outstanding Achievement Award, Environmental and Water Resources Institute (EWRI), ASCE, USA, May, 2010.
5. Fellow, American Society of Civil Engineers (ASCE), USA, Feb., 2009.
6. Russell Ackoff Award, 1994 International Conference of Solid Waste Technology and Management,

Univ. of Penn., USA, Oct., 1994.

International Awards

7. Distinguished Visiting Fellowship, Royal Academy of Engineering (RAE), United Kingdom, Sept., 2013.
8. Honorary Distinguished Chair Professor, Tunghai University, Taiwan, August, 2012.
9. Bridging the Gaps Award, Engineering and Physical Sciences Research Council (EPSRC), United Kingdom, May, 2012.
10. Distinguished Chair Professorship, National Science Council, Taiwan, June, 2010.
11. Haitian Scholar Award, Dalian University of Technology, China, June, 2010.
12. Honorary Visiting Professor, Chaoyang University of Technology, Taiwan, May, 2010.
13. Elected Foreign Member (Fellow), European Academy of Sciences (http://www.eurasc.org), European Union, Oct., 2008.
14. Distinguished Visiting Professor, Eastern China University of Science and Technology, China, July, 2002.
15. International Fellowship Award, National Science Council, Taiwan, 2001.
16. International Fellowship Award, National Science Council, Taiwan, 2000.
17. Young Engineer Award, Chinese Institute of Engineers, Taiwan, 1999.
18. Research Excellence Award, National Science Council, Taiwan, 1999-2001.
19. Research Excellence Award, National Science Council, Taiwan, 1997-1999.
20. Annual Research Award, National Science Council, Taiwan, Feb., 1996.
21. Annual Research Award, National Science Council, Taiwan, Feb., 1995.
22. Annual Research Award, National Science Council, Taiwan, Feb., 1994.
23. National Scholarship Award, Ministry of Education, Taiwan, Aug., 1987.

Best Paper Awards

24. Best paper award in the 6th International Conference on Environmental Informatics, Bangkok, Thailand, Nov. 21-23, 2007.
25. Best Paper Award, Chinese Institute of Environmental Engineering, Taiwan, April, 1997.

University of Central Florida Awards

26. UCF Innovator Award, USA, Aug. 2012.
27. UCF Research Incentive Award, USA, March, 2013.

DEGREES

Ph.D. in Environmental Systems Engineering, Cornell University, Aug. 1991.
M.S. in Environmental Systems Engineering, Cornell University, Aug. 1989.
B.S. in Civil Engineering, National Chiao-Tung University, June 1983.

ASSOCIATE EDITORSHIPS

1. SPIE Official Journal of Applied Remote Sensing (guest editor, associate editor) (editor-in-chief, current)
2. Ecological Informatics (guest editor, editorial board member) (current)
3. Advances in Water Resources (editorial board member) (current)
4. Journal of Civil Engineering and Environmental Systems (guest editor, editorial board member) (current)
5. ISEIS Official Journal of Environmental Informatics (founding editor-in-chief, guest editor) (current)

6. Journal of Environmental Management (editorial board member) (current)
7. ISEIS Official Journal of Environmental Informatics (associate editor) (current)
8. Stochastic Environmental Research & Risk Assessment (guest editor, editorial board member) (current)
9. Journal of Environmental Modeling & Assessment (guest editor, editorial board member) (current)
10. Journal of Information Technology Research (editorial board member) (current)
11. Journal of Environmental Modeling & Assessment (guest editor, editorial board member) (current)
12. Frontiers of Earth Sciences (associate editor-in-chief) (current)
13. Grey Systems: Theory and Application (editorial board member) (current)
14. Journal of Bioprocessing & Biotechniques (editorial board member) (current)
15. Journal of Water Quality, Exposure and Health (associate editor) (current)
16. International Journal of Environmental Science and Technology (associate editor) (current)
17. Journal of Hydroinformatics (editorial board member) (current)
18. Earth Science Informatics (editorial board member) (current)
19. Journal of Cleaner Production (editorial board member) (current)
20. Bioinformatics (editorial board member) (current)
21. Water (editorial board member) (current)
22. ASCE Official Journal of Hazardous, Toxic, and Radioactive Waste Management, ASCE (guest editor, editorial board member) (retired)
23. AGU Official Journal of Water Resources Research (associate editor) (retired)
24. ASCE Official Journal of Hydrological Engineering (guest editor, associate editor) (retired)
25. Environnemental Management (editorial board member)
26. Environmental Impact Assessment Review (editorial board member)

PROFESSIONAL AFFILIATIONS

1. American Society of Civil Engineers (ASCE) (Fellow)
2. American Association for the Advancement of Science (AAAS) (Fellow)
3. Institute of Electronics and Electrical Engineers (IEEE) (Senior Member)
4. Society of Photo-optical Instrumentation Engineers, SPIE) (SPIE is also the International Society of Optics and Photonics) (Senior Member)
5. CUAHSI (Consortium of Universities for the Advancement of Hydrologic Science, Inc.) - Representative of University of Central Florida (Member)
6. International Water Association (IWA) (Member)
7. American Water Work Association (AWWA) (Member)
8. American Society of Mechanical Engineers (ASME) (Member)
9. International Air & Waste Management Association (AWMA) (Member)
10. American Geophysical Union (AGU) (Member)
11. American Water Resources Association (AWRA) (Member)
12. Association of Environmental Engineering and Science Professors (AEESP) (Member)
13. Professional Engineer (PE) and Member of the Professional Engineers of Texas
14. ISO14001 Environmental Management System Leader Auditor (Certificate)
15. Leadership in Energy and Environmental Design (LEED), U.S. Green Building Council (Certificate)
16. Board Certified Environmental Engineering (BCEE) (Certificate)
17. Diplomat of Water Resources Engineering (DWRE) (Certificate)

ACADEMIC APPOINTMENTS

Date	Position
1. Aug. 2012~ the present	Program Director, Hydrological Sciences Program Program Director, Cyber-enabled Sustainability Science and Engineering Program Program Director, Small Business Technology Transfer Program National Science Foundation Washington D. C., USA
2. Oct. 2011~the present	Director, UCF Stormwater Management Academy http://www.stormwater.ucf.edu/ University of Central Florida Orlando, FL, 32816, USA
3. Jan. 2009~May 2009	Visiting Scientist Center of Remote Sensing and Modeling for Agricultural Sustainability, USDA, Fort Colin, CO, USA
4. Sept. 2008~Jan. 2009	Visiting Scientist National Risk Management Research Laboratory, USEPA Cincinnati, Ohio, USA
5. Aug. 2005~the present	Professor Department of Civil and Environmental Engineering (primary appointment from 2005 to the present) Department of Industrial Engineering and Management System (secondary joint appointment from Aug. 2009 to the present) University of Central Florida Orlando, FL, 32816, USA
6. Jan. 2002~ Aug. 2005	Professor Department of Environmental Engineering Texas A&M University-Kingsville Kingsville, Texas, 78363, USA Graduate Coordinator (from March 2002 to Jan. 2003) Associate Director, Center for Research Excellence in Science & Technology (CREST) (from Feb. 2003 to Jan. 2004)
7. Aug. 1997 ~ Jan. 2002	Professor Dept. of Environmental Engineering National Cheng-Kung University Tainan, Taiwan
8. June 1999 ~ Aug., 2000	Associate Director Research Institute of Resources Recycling and Management National Cheng-Kung University Tainan, Taiwan
9. June, 1999 ~ Sep., 1999	Visiting Professor Department of Systems Engineering University of Pennsylvania Philadelphia, USA
10. Jan. 2000 ~ June, 2000	Adjunct Professor Graduate Institute of Environmental Science Tunghai University Taichun, Taiwan
11. June, 1998 ~ Aug., 1998	Visiting Professor

	Institute of Engineering Thermophysics Chinese Academy of Science Bejing, China
12. Jan. 1998 ~ June, 1998	Adjunct Associate Professor Graduate Institute of Environmental Engineering National Taiwan University Taipei, Taiwan
13. Aug. 1992 ~ Aug. 1997	Associate Professor Dept. of Environmental Engineering National Cheng-Kung University Tainan, Taiwan

INDUSTRIAL AND NON-ACADEMIC APPOINTMENTS

Date	**Position**
1. Feb. 1992 ~ July 1992	Deputy Manager Division of Environmental Engineering Fichtner Pacific Engineers, Inc. (German-based Consulting Firm) Taipei, Taiwan
2. Aug. 1991 ~ Feb. 1992	Deputy Manager Ecology & Environment, Inc. Taiwan Branch Office (US-based Consulting Firm) Taipei, Taiwan
3. Jan. 1986 ~ Aug. 1987	Environmental Engineer Dept. of Environmental Engineering Housing and Urban Development Bureau Taiwan Provincial Government Taipei, Taiwan
4. Aug. 1985 ~ Jan. 1986	Environmental Engineer Bureau of Environmental Protection Kaohsiung City Government Kaohsiung, Taiwan
5. Oct. 1983 ~ Aug. 1985	Junior Lieutenant, the Navy of Taiwan

RESEARCH PUBLICATION SUMMARY

(Status as of Oct., 2013)

1. **Refereed Books** - 8
2. **Edited Books** - 5
3. **Refereed Journal Papers** - 211
4. **Invited Articles in Books, Encyclopedia, and Newsletters** - 20
6. **Conference Papers** - 196
7. **Technical Reports** - 69
8. **US Patents** - 8

Research publications under categories from 1 to 8 as mentioned above are not directly listed in this document. Instead, representative publications are classified according to research topics.

RESEARCH TOPICS

In this section, relevant refereed journal papers, encyclopedia articles, book chapters and books are categorized according to research topics.

Water Resources and Environmental Systems Analysis, Sustainability Sciences, and Global Changes

Book

1. Chang, N. B. (2010): Systems Analysis for Sustainable Engineering. Publisher: McGraw Hill, New York, USA, 688 pp.

Book Chapters

1. Fang X., Chang, N. B., Lee M. K. and Wolf, L. W. (2010): Chapter 3 Environmental Assessment of Using Stone Quarries as Part of an Integrative Water Supply System in Fast Growing Urban Regions. In: The Effects of Urbanization on Groundwater: An Engineering Case-based Approach for Sustainable Development, Ed. Chang, N. B. (ASCE), 26-50.
2. Chang, N. B. (2010): Chapter 1 The Frontiers of Sustainable Development in Urban Regions. In: The Effects of Urbanization on Groundwater: An Engineering Case-based Approach for Sustainable Development, Ed. Chang, N. B. (ASCE), 1-5.

Journal Papers: Coupled Human and Natural Systems

• Theories and Concept

1. Chang, N. B., Wen, C. G. and Wu, S. L. (1995): Optimal management of environmental and land resources in a reservoir watershed by multi-objective programming. *Journal of Environmental Management*, **44(2)**, 145-161.
2. Chang, N. B. and Wang, S. F. (1995): Optimal planning for the coastal wastewater treatment and disposal system. *Coastal Management*, **23**, 153-166.
3. Chang, N. B. (2005): Sustainable water resources management under uncertainty. *Stochastic Environmental Research and Risk Assessment*, **19(2)**, 1-2.
4. Chang, N. B. (2010): Hydrological connections between low impact development, watershed best management practices and sustainable development. *Journal of Hydrologic Engineering, ASCE*, **15(5)**, 1-2.

• Systems Analysis with Uncertainty

1. Chang, N. B. and Wang, S. F. (1995): A grey nonlinear programming approach for planning coastal wastewater treatment and ocean disposal system. *Water Science and Technology*, **32(2)**, 19-29.
2. Chang, N. B., Wen, C. G., Chen, Y. L. and Yong, Y. C. (1996): Optimal planning of the reservoir watershed by grey fuzzy multi-objective programming (I): theory. *Water Research*, **30(10)**, 2329-2334.
3. Chang, N. B., Wen, C. G., Chen, Y. L. and Yong, Y. C. (1996): Optimal planning of the reservoir watershed by grey fuzzy multi-objective programming (II): application. *Water Research*, **30(10)**, 2335-2340.
4. Chang, N. B., Wen, C. G. and Chen, Y. L. (1997): A fuzzy multi-objective programming approach for optimal management of the reservoir watershed. *European Journal of Operational Research*,

99(2), 304-323.

5. Chang, N. B. and Chen, H. W. (1997): Water pollution control in a river basin by interactive fuzzy interval multi-objective programming. *Journal of Environmental Engineering, ASCE*, **123(12)**, 1208-1216.
6. Chen, H. W. and Chang, N. B. (1998): Water pollution control in the river basin by genetic algorithm-based fuzzy multi-objective programming. *Water Science and Technology*, **37(8)**, 55-63.
7. Chang, N. B., Yeh, S. C. and Wu, G. C. (1999): Stability analysis of grey compromise programming and its applications. *International Journal of Systems Science*, **30(6)**, 571-589.
8. Chen, H. W. and Chang, N. B. (2006): Decision support for allocation of watershed pollution load using grey fuzzy multiobjective programming. *Journal of American Water Resources Association*, **42(3)**, 725-745.
9. Chen, H. W. and Chang, N. B. (2010): Using fuzzy operators to address the complexity in decision making of water resources redistribution in two neighboring river basins. *Advances in Water Resources*, **33**, 652–666.

Journal Papers: Sustainable River Basin Management Strategies

1. Ning, S. K., Chang, N. B., Yang, L., Chen, H. W. and Hsu, H. Y. (2001): Assessing pollution prevention program by QUAL2E simulation analysis for water quality management in the Kao-Ping river basin, Taiwan," *Journal of Environmental Management*, **61(1)**, 61-76.
2. Ning, S. K. and Chang, N. B. (2007): Watershed-based point sources permitting strategy and dynamic permit trading analysis. *Journal of Environmental Management*, **84(4)**, 427-446.
3. Ernest, A., Bokhim, B., Chang N. B. and Huang, I. J. (2007): Fluvial geomorphologic and hydrodynamic assessment in the tidal portion of the Lower Rio Grande River, US-Mexico Borderland. *Journal of Environmental Informatics*, **10(1)**, 10-21.

Journal Papers: Information Technologies

1. Chang, N. B, Chen, H. W., Ning, S. K. and Chen, K. Y. (2001): Prediction analysis of non-point pollutant loadings for the reservoir watershed via the use of GIS/GPS/RS information technology. *Water International*, **26(2)**, 239-252.
2. Ning, S. K., Cheng, K. Y. and Chang, N. B. (2002): Evaluation of non-point sources pollution impacts by integrated 3S information technologies and GWLF model in the Kao-ping river basin, Taiwan. *Water Science and Technology*, **46(6)**, 217–224.
3. Chang, Y. C. and Chang, N. B. (2002): The design of a web-based decision support system for the sustainable management of an urban river system. *Water Science and Technology*, **46(6)**, 131-139.
4. Chen, J. C., Chang, N. B., Chang, Y. C. and Lee**,** M. T. (2003): Mitigating the impacts of combined sewer overflow in an urban river system via web-based share-vision modeling analysis. *Journal of Civil Engineering and Environmental Systems*, **20(4)**, 213-230.

Journal Papers: Water Quality Monitoring and Classification

1. Chen, H. W. and Chang, N. B. (2001): Identification of river water quality using the fuzzy synthetic evaluation approach. *Journal of Environmental Management*, **63(3)**, 293-305.

Journal Papers: Ecosystem Service and Fuzzy Assessment

- **Ecosystem Valuation and Environmental Economics**

1. Chen, H. W., Chang, N. B. and Shaw, D. G. (2005): Valuation of in-stream water quality

improvement via fuzzy contingent valuation method. *Stochastic Environmental Research and Risk Assessment*, **19(2)**, 158-171.

- **Lake Sustainability, Natural Hazards, Adaptive Management, and Ecosystem Restoration**

1. Jin, K. R., Chang, N. B., Ji, J. and Thomas, J. R. (2011): Hurricanes affect sediment and environments in Lake Okeechobee. *Critical Reviews in Environmental Science and Technology*, **41(S1)**, 382-394.
2. Chang, N. B. and Jin, K. R. (2012): Ecodynamic assessment of the submerged aquatic vegetation in Lake Okeechobee, Florida under natural and anthropogenic stress. *International Journal of Design & Nature and Ecodynamics*, **7(2)**, 140-154.
3. Liu, S. and Chang, N. B. (2013): Geochemical impact of aquifer storage and recovery operation on fate and transport of sediment phosphorus in a large shallow lake. *Environmental Earth Sciences*, **68(1)**, 189-201.

- **Urban Sewer Systems and Sustainable Development**

1. Chen, J. C., Chang, N. B., Fen, C. S. and Chen, C. Y. (2004): Assessing the stormwater impact to an urban river ecological system using an estuarine water quality simulation model. *Journal of Civil Engineering and Environmental Systems*, **21(1)**, 33-50.
2. Chen, J. C., Chang, N. B. and Chen, C. Y. (2004): Minimizing the ecological risk of combined-sewer overflow in an urban river system by a system-based approach. *Journal of Environmental Engineering, ASCE*, **130(10)**, 1-16.
3. Chang, N. B. and Hernandez, E. A. (2008): Optimal expansion strategies for a sanitary sewer system under uncertainty. *Environmental Modeling and Assessment*, **13(1)**, 93-113.
4. Yeh, S. C., Chang, N. B., Wei, H. P., Chang, C. H., Chai, H. B. and Huang, J. W. (2011): Optimal expansion of coastal wastewater treatment and disposal system under uncertainty (I): simulation analysis. *Civil Engineering and Environmental Systems*, **28(1)**, 19-38.
5. Chang, N. B., Yeh, S. C. and Chang, C. H. (2011): Optimal expansion of coastal wastewater treatment and disposal system under uncertainty (II): optimization analysis. *Civil Engineering and Environmental Systems*, **28(1)**, 39 -59.

- **Interactions between Coupled Human and Natural Systems**

1. Ji, J. H. and Chang, N. B. (2005): Risk assessment for optimal freshwater inflow in response to sustainability indicators in a semi-arid coastal bay. *Stochastic Environmental Research and Risk Assessment*, **19(2)**, 111-124.
2. Chang, N. B., Parvathinathan, G. and Dyson, B. (2006): Multi-objective risk assessment of freshwater Inflow on ecosystem in San Antonio Bay, Texas. *Water International*, **31(2)**, 169-182.
3. Chang, N. B., Chen, H. W., Ning, S. K., Shao, K. T. and Hung, T. C. (2010): Sizing an off-stream reservoir with respect to water availability, water quality, and biological integrity. *Environmental Modeling and Assessment*, **15(5)**, 329-344.

Journal Papers: Stream Flows, Climate Change, and Ecosystem Response

1. Makkeasorn, A., Chang, N. B. and Zhou, X. (2008): Short-term stream flow forecasting with global climate change implications – A comparative study between genetic programming and neural network models. *Journal of Hydrology*, **352**, 336-354.

2. Wang, C., Chang, N. B. and Yeh, G. (2009): Copula-based Flood Frequency (COFF) analysis at the confluences of river systems. *Hydrological Processes*, **23**, 1471-1486.
3. Kao, S. C. and Chang, N. B. (2012): Copula-based flood frequency analysis at ungaged basin confluences: a case study for Nashville, TN. *Journal of Hydrologic Engineering*, ASCE, **17(7)**, 790-800.
4. Mullon, L., Chang, N. B., Yang, J. and Weiss, J. (2013): Integrated remote sensing and wavelet analyses for short-term teleconnection pattern identification between sea surface temperature and greenness in northeast America. *Journal of Hydrology*, **499**, 247-264.
5. Chang, N. B., Valdez, M., Chen, J. F., and Immen, S. (2013): Nonlinear and nonstationary global climate change effect on regional precipitation and forest phenology in Panama, Central America*, Hydrological Processes,* in press.

Journal Papers: Agricultural Sustainability

1. Chang, N. B., Srilakshmi Kanth, R. and Parvathinathan, G. (2008): Comparison of models of Simazine transport and fate in subsurface environment in a citrus farm. *Journal of Environmental Management*, **86**, 27-43.
2. Chang, N. B., Mani, S., Gomathishanker, G. and Srilakshmi Kanth, R. (2009): Pesticide impact assessment via using Enzyme-linked Immunosorbent Assay (ELISA) technique in the Lower Rio Grande River Basin, Texas. *Journal of Water Quality, Exposure and Health*, **1(3)**, 145-158.

Summary of my research in water resources and environmental systems analysis

Major Accomplishment: Integration of remote sensing (RS), global positioning system (GPS), and geographical information system (GIS) provides a powerful avenue to perform more accurate estimation of point and non-point sources pollutant loadings in a watershed scale. Dr. Chang was the first scientist to develop a method for assessing the effects of nonpoint source pollution, which allows for the accurate estimation of pollution loading with the aid of 3S (GPS/GIS/RS) technology. This method was firstly demonstrated in a reservoir watershed in South Taiwan in 2001. It was then expanded to cover a larger river basin and support simulation analysis based on multitemporal land-use and land-cover changes characterized by multispectral satellite remote sensing images, such as SPOT and LANDSAT images. With the aid of the 3S information technology, an integrated simulation and optimization analysis for generating spatially-varied permit trading ratios and evaluating seasonal transaction prices among different regions were proposed and accomplished by Dr. Chang, representing the pioneering achievement of its kind in the world. It holds considerable potential for industries and policy makers alike. Besides, global Sea Surface Temperature (SST) anomalies have a demonstrable effect on spatial and temporal precipitation patterns and terrestrial vegetation dynamics via ocean-atmosphere interactions. Dr. Chang was the first scientist who analyzed a series of short-term (10-year), nonstationary teleconnection signals of SST anomalies at the Atlantic and Pacific Oceans and identified some non-leading teleconnection patterns. These non-leading teleconnection patterns combined with existing leading teleconnection patterns, such as the El Nino Southern Oscillation (ENSO) and North Atlantic Oscillation (NAO), were integrated to examine the associated variations of forest phenology and precipitation changes under varying land surface temperatures at northeast and northwest of the United States as well as the La Amistad International Park at Panama, Central America. With the aid of space-borne satellite remote sensing images, such as sea surface temperature (AVHRR), forest greenness (MODIS Terra Enhanced Vegetation Index), land surface temperature (LANDSAT data), precipitation (TRMM data), and soil moisture (RADARSAT-1 images), some advanced tools were developed and integrated to support hydrological forecasting and climate change assessment. This series of work pioneered some scientific frontiers in climate change assessment regime.

Role: Dr. Chang was the team leader in a few multi-year extensive research programs that were funded by NASA and USEPA, with collaborative work with foreign universities, and visiting scientists from several countries. Dr. Chang led this research and conceived, developed, and tested several models with the aid of 3S information technology. He mentored students to conduct the remote sensing image processing and modeling analysis in cooperation with partners in domestic and foreign countries.

Impact: The ability to quantitatively evaluate the pollution load allocation and relocation based on permit trading ratios across differing pollution units was a milestone achievement in remote sensing-based watershed management. With such advancements, the publication of "Watershed-based point sources permitting strategy and dynamic permit trading analysis", published by *Journal of Environmental Management* above has been incorporated in the European Commission's environmental news service for policy makers, distributed to over 6,000 subscribers -- Science for Environment Policy News Alert (Feb. 10, 2008). It has been greatly impacted the policy making for water resources management in different part of the world. Besides, the body of work of teleconnection patterns studies has contributed greatly to the foundations of remote sensing for climate change impact assessment in relation to precipitation, streamflow, and vegetation greenness with. Such advancements with deepened understanding of the significance of these factors in data interpretation have resulted in new knowledge on the physical basis of multi-temporal space-frequency-spectrum analysis of remote sensing. Dr. Chang's studies of the residual or memorial effects of teleconnection signals are the only such investigations ever conducted and have been the basis for several extended climate change analyses. The principles established in Dr. Chang's work on the remote sensing-based genetic programming model for streamflow forecasting and wavelet-based empirical orthogonal function for precipitation forecasting have also had some impact on the development and expanded application of water resources management applications. Dr. Chang's basic and applied research has significantly impacted the development of the urban water infrastructure assessment in USEPA, which is the world's premier urban water management study under climate change impact. This research was the key to Dr. Chang's selection as an invited speaker by the National Weather Center, NOAA in Sept. 2013.

Hydrological and Environmental Remote Sensing and Monitoring Networks

Edited Books

1. Chang, N. B. and Hong, Y. (2012): Multi-scale Hydrological Remote Sensing: Perspectives and Applications. Publisher: the CRC Press, Boca Raton, FL, USA, 624 pp.
2. Chang, N. B. (2012): Environmental Remote Sensing and Systems Analysis. Publisher: the CRC Press, Boca Raton, FL, USA, 550 pp.

Book Chapters

1. Gao, W., Gao Z. and Chang, N. B. (2010): Chapter 10 Trends and Interannual Variability in Surface UV-B Radiation over 8-11 Years Observed across the United States. In: UV Radiation in Global Change: Measurements, Modeling and Effects on Ecosystems, Eds. Gao, W., Schmoldt, D. L. and Slusser, J. R. (Springer Verlag), 270-290.
2. Chang, N. B. (2012): Chapter 1 Linkages between Environmental Remote Sensing and Systems Analysis. In: Environmental Remote Sensing and Systems Analysis, Ed. Chang, N. B. (Taylor and Francis Group-CRC Press), 1-6.
3. Chang, N. B. and Xuan, Z. (2012): Chapter 2 Using Remote Sensing-based Carlson Index Mapping to Assess Hurricane and Drought Effects on Lake Trophic State. In: Environmental

Remote Sensing and Systems Analysis, Ed. Chang, N. B. (Taylor and Francis Group-CRC Press), 7-24.

4. Chang, N. B. and Nayee, K. (2012): Chapter 7 Estimating Total Phosphorus Impacts in a Coastal Bay with Remote Sensing Images and *In Situ* Measurements. In: Environmental Remote Sensing and Systems Analysis, Ed. Chang, N. B. (Taylor and Francis Group-CRC Press), 123-146.
5. Chang, N. B. and Han, M., Yao, W., and Chen, L. C. (2012): Chapter 12 Remote Sensing Assessment of Coastal Land Reclamation Impact in Dalian, China, Using High Resolution SPOT Images and Support Vector Machine. In: Environmental Remote Sensing and Systems Analysis, Ed. Chang, N. B. (Taylor and Francis Group-CRC Press), 249-276.
6. Gao, Z., Gao, W. and Chang, N. B. (2012): Chapter 17 Recent Trends of UVB and Stratospheric Ozone Concentrations at the Continental United States. In: Environmental Remote Sensing and Systems Analysis, Ed. Chang, N. B. (Taylor and Francis Group-CRC Press), 395-422.
7. Chang, N. B. and Hong, Y. (2012): Chapter 1 Towards Multi-scale Hydrologic Remote Sensing for Creating Integrated Hydrological Observatories. In: Multi-scale Hydrological Remote Sensing: Perspectives and Applications, Eds, Chang, N. B. and Hong, Y. (Taylor and Francis Group-CRC Press), 1-8.
8. Chang, N. B. and Xuan, Z. M. (2012): Chapter 6 Spatiotemporal Interactions between Soil Moisture, Vegetation Cover and Evapotranspiration in the Tampa Bay Urban Region, Florida. In: Multi-scale Hydrological Remote Sensing: Perspectives and Applications, Eds, Chang, N. B. and Hong, Y. (Taylor and Francis Group-CRC Press), 113-138.
9. Gao, Z., Gao, W. and Chang, N. B. (2012): Chapter 7 Developing a Composite Indicator with Landsat TM/ETM+ Images for Drought Assessment in a Coastal Urban Region. In: Multi-scale Hydrological Remote Sensing: Perspectives and Applications, Eds, Chang, N. B. and Hong, Y. (CRC Press), 139-168.
10. Sun, Z., Opp, C., Hennig, T. and Chang, N. B. (2012): Chapter 8 Modeling Stream Flow Changes with the Aid of Multi-sourced Remote Sensing Data in a Poorly Gauged Watershed. In: Multi-scale Hydrological Remote Sensing: Perspectives and Applications, Eds, Chang, N. B. and Hong, Y. (Taylor and Francis Group-CRC Press), 169-184.
11. Chang, N. B., Hong, Y., and Khan, S. (2014): Perspectives of Remote Sensing for Multi-scale Hydrological Studies, in Remote Sensing Handbook, Vol. III, Ed, Prasad Thenkabail (Taylor and Francis Group-CRC Press).
12. Chang, N. B. and Vannah, B. (2014): Comparative Computational Intelligence Algorithms of Hyperspectral Remote Sensing for Water Quality Monitoring, in Intelligent Environmental Sensing, Eds, Mukhopadhyay, S. C. and Leung, H. (Springer).

Journal Papers: Overviews

1. Huang, G. H. and Chang, N. B. (2003): The perspectives of environmental informatics and systems analysis. *Journal of Environmental Informatics*, **1(1)**, 1-6.
2. Zhou, X. B., Chang, N. B. and Li, S. S. (2009): Applications of SAR interferometry in earth and environmental science research. *Sensors Journal*, **9(3)**, 1876-1912.
3. Chang, N. B., Imen, S., and Vannah, B. (2013): Remote sensing for monitoring surface water quality status and ecosystem state in relation to the nutrient cycle: a 40-year perspective. *Critical Reviews of Environmental Science and Technology*, in press, July, 2013.

Journal Papers: Monitoring Network Optimization

• Air Quality Management

1. Chang, N. B. and Tseng, C. C. (1999): Optimal design of multi-pollutant air quality monitoring network in a metropolitan region using Kaohsiung, Taiwan as an example. *Journal of Environmental Monitoring and Assessment*, **57(2)**, 121-148.
2. Chang, N. B. and Tseng, C. C. (1999): Optimal evaluation of expansion alternatives for existing air quality monitoring network in an urban area by grey compromise programming. *Journal of Environmental Management*, **56(1)**, 61-77.
3. Chang, N. B. and Tseng, C. C. (2001): Assessing relocation strategy of urban air quality monitoring network by compromise programming. *Environment International*, **26**, 524-541.

• Water Quality Management

1. Ning, S. K. and Chang, N. B. (2002): Multi-objective, decision-based assessment of a water quality monitoring network in a river system. *Journal of Environmental Monitoring*, **4**, 121-126.
2. Ning, S. K. and Chang, N. B. (2004): Optimal expansion of water quality monitoring network by fuzzy optimization approach. *Environmental Monitoring and Assessment*, **91(1-3)**, 145-170.
3. Ning, S. K. and Chang, N. B. (2005): Screening and sequencing analysis for the relocation of water quality monitoring network by compromise programming. *Journal of American Water Resources Association*, **41(5)**, 1039-1052.

• Monitoring Network for Energy Infrastructures

1. Chang, N. B., Ning, S. K. and Chen, J. C. (2006): Multi-criteria relocation strategy of offsite radioactive monitoring network for a nuclear power plant. *Environmental Management*, **38(2)**, 197-217.

Journal Papers: Hydrological Processes in Watersheds and Coastal Environments

1. Ning, S. K., Chang, N. B., Jeng, K. Y. and Tseng, Y. H. (2006): Soil erosion and non-point sources pollution impacts assessment with the aid of remote sensing. *Journal of Environmental Management*, **79(1)**, 88-101.
2. Makkeasorn, A., Chang, N. B., Beaman, M., Wyatt, C. and Slater, C. (2006): Soil moisture prediction in a semi-arid reservoir watershed using RADARSAT satellite images and genetic programming. *Water Resources Research*, **42**, 1-15.
3. Chang, N. B. and Makkeasorn, A. (2010): Optimal site selection of watershed hydrological monitoring stations using remote sensing and Grey integer programming. *Environmental Modeling and Assessment*, **15(6)**, 469-486.
4. Zhou, X. B., Chang, N. B. and Li, S. S. (2007): Detection of coastal region sea ice decay from orthorectified RADARSAT-1 ScanSAR imagery: a case study of Bering Strait and Norton Sound, Alaska. *Journal of Environmental Informatics*, **10(1)**, 37-46.
5. Gao, Z., Gao, W. and Chang, N. B. (2011): Integrating Temperature Vegetation Dryness Index (TVDI) and Regional Water Stress Index (RWSI) for drought assessment with the aid of landsat TM/ETM+ images. *International Journal of Applied Earth Observation and Geoinformation*, **13(3)**, 495-503.
6. Gao, Z., Liu, C., Gao, W. and Chang, N. B. (2011): A coupled remote sensing and the surface energy balance with Topography Algorithm (SEBTA) to estimate actual evapotranspiration over heterogeneous terrain. *Hydrology and Earth System Sciences*, **15**, 119-139.

7. Sun, Z. and Chang, N. B., Huang, Q. and Opp, C. (2012): Precipitation patterns and associated summer extreme flow analyses in the Yangtze River, China using TRMM/PR data. *Hydrologic Sciences Journal,* **57(7)**, 1-10.

Journal Papers: Agricultural Sustainability

1. Du, Q., Chang, N. B., Yang, C. H. and Srilakshmi Kanth, R. (2008): Combination of multispectral remote sensing, variable rate technology and environmental modeling for citrus pest management. *Journal of Environmental Management*, **86**, 14-26.
2. Gao, Z., Xie, X., Gao, W. and Chang, N. B. (2011): Spatial analysis of terrain-impacted Photosynthetic Active Radiation (PAR) using MODIS data. *GIScience & Remote Sensing*, **48(4)**, 1-21.
3. Chen, C. F., Son, N. T., Chang, N. B., Chen, C. R., Chang, L. U., Valdez, M., Centeno, G., Thompson, C., and Aceituno, J. L. (2013): Multi-decadal mangrove forest change detection and prediction in Honduras, Central America with Landsat imageries and Markov chain model. *Remote Sensing, 5*(12), 6408-6426.

Journal Papers: Water Availability and Quality in Aquatic Environments

1. Chang, N. B., Daranpob, A., Yang, J., and Jin, K. R. (2009): A comparative data mining analysis for information retrieval of MODIS images: monitoring lake turbidity changes at Lake Okeechobee, Florida. *Journal of Applied Remote Sensing*, **3**, 033549.
2. Chang, N. B., Yang, J. and Daranpob, A. (2010): Medium-term Metropolitan Water Availability Index (MWAI) assessment based on synergistic potentials of multi-sensor data. *Journal of Applied Remote Sensing*, **4**, 043519.
3. Chang, N. B., Yang, Y., Goodrich, J. A. and Makkeasorn, A. (2010): Development of the Metropolitan Water Availability Index (MWAI) and short-term assessment with multi-scale remote sensing technologies. *Journal of Environmental Management*, **91**, 1397-1413.
4. Chang, N. B., Yang, J., Daranpob, A., Jin, K. R. and James, T. (2012): Spatiotemporal pattern validation of Chlorophyll-a concentrations in Lake Okeechobee, Florida using a comparative MODIS image mining approach. *International Journal of Remote Sensing*, **33(7)**, 2233-2260.
5. Chang, N. B., Wimberly, B. and Xuan, Z. M. (2012): Identification of spatiotemporal nutrient patterns in a coastal bay via an integrated K-means clustering and gravity model. *Journal of Environmental Monitoring*, **14**, 992-1005.
6. Chang, N. B., Xuan, Z. M. and Wimberly, B. (2012): Remote sensing spatiotemporal assessment of nitrogen concentrations in Tampa Bay, Florida due to a drought. *Journal of Terrestrial, Atmospheric and Oceanic Sciences*, **23(5)**, 467-479.
7. Chang, N. B., Xuan, Z., and Yang, J. (2013): Exploring spatiotemporal patterns of nutrient concentrations in a coastal bay with MODIS images and machine learning models. *Remote Sensing of Environment*, **134**, 100-110.
8. Chang, N. B., Vannah, B., Yang, Y. J., and Elovitz, M. (2013): Integrated data fusion and mining techniques for monitoring total organic carbon concentrations in a lake. *International Journal of Remote Sensing*, in press, Oct. 2013.
9. Chang, N. B. and Vannah, B., and Yang, J. (2013): Comparative sensor fusion between hyperspectral and multispectral remote sensing data for monitoring microcystin distribution in Lake Erie. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing,* in press, Sept., 2013.

Journal Papers: Ecosystem Dynamics, Restoration, and Carbon Fluxes

1. Makkeasorn, A. and Chang, N. B. (2009): Seasonal change detection of riparian zones with remote sensing images and genetic programming in a semi-arid watershed. *Journal of Environmental Management*, **90**, 1069–1080.
2. Gao, Z., Gao, W. and Chang, N. B. (2010): Impact of climate and land use/cover changes on the carbon cycle in China (1981-2000): a system-based assessment. *Biogeosciences Discussion*, **7(4)**, 5517-5555.
3. Sun, Z., Chang, N. B. and Opp, C. (2010): Using SPOT-VGT NDVI as successive ecological indicators of for understanding the environmental implications in the Tarim River Basin, China. *Journal of Applied Remote Sensing*, **4**, 043554.
4. Sun, Z., Chang, N. B., Opp, C. and Hennig, T. (2011): Evaluation of ecological restoration through vegetation patterns in the Lower Tarim River, China with MODIS NDVI Data. *Ecological Informatics*, **6**, 156-163.

Journal Papers: Land Use and Land Cover Changes and Land Thermal Fluxes

1. Gao, W., Zhang, W., Gao, Z. and Chang, N. B. (2009): Modeling the land surface heat exchange process with the aid of moderate resolution imaging spectroradiometer images. *Journal of Applied Remote Sensing,* **3**, 033573.
2. Chang, N. B., Han, M., Yao, W., Xu, S. G. and Chen, L. C. (2010): Change detection of land use and land cover in a fast growing urban region with SPOT-5 images and partial Lanczos extreme learning machine. *Journal of Applied Remote Sensing*, **4**, 043551.
3. Chen, H. W., Chang, N. B., Yu, R. F. and Huang, Y. W. (2009): Urban land use and land cover classification using the neural-fuzzy inference approach with Formosat-2 Data. *Journal of Applied Remote Sensing*, **3**, 033558.
4. Xie, H., Chang, N. B., Makkeasorn, A. and Prado, D. (2010): Assessing the long-term urban heat island in San Antonio, Texas based on MODIS/Aqua Data. *Journal of Applied Remote Sensing*, **4**, 043508.
5. Gao, Z., Gao, W. and Chang, N. B. (2012): Evaluation of dynamic linkages between evapotranspiration and land use/land cover changes with Landsat TM and ETM+ data. *International Journal of Remote Sensing*, **33(12)**, 3733-3750.
6. Sadeghi, Z., Zouj, M. J. V., Dehghani, M. and Chang, N. B. (2012): An enhanced algorithm based on persistent scatterer interferometry for high-rate land subsidence estimation. *Journal of Applied Remote Sensing*, **6(1),** 063573.

Journal Papers: Ultraviolet Exposure and Related Health Effects

1. Gao, Z., Gao, W., and Chang, N. B. (2010): Comparative analyses of the ultraviolet-B flux over the continental United States based on the NASA TOMS data and USDA Ground-based Measurements. *Journal of Applied Remote Sensing*, **4**, 043547.
2. Gao, Z., Gao, W., and Chang, N. B. (2010): Detection of multidecadal changes in UVB and total ozone concentrations over the continental US with NASA TOMS data and USDA Ground-based measurements. *Remote Sensing*, **2(1)**, 262-277.
3. Chang, N. B., Feng, R., Gao, Z. and Gao, W. (2010): Skin cancer incidence is highly associated with ultraviolet-B radiation history. *International Journal of Hygiene and Environmental Health*, **213**, 359-368.

4. Gao, Z., Gao, W. and Chang, N. B. (2012): Spatial statistical analyses to address the global trends of ultraviolet B fluxes in the continental US. *GIScience and Remote Sensing*, **49(4)**, 1–19.

Summary of my research in environmental and hydrological remote sensing

Major Accomplishment: Delineating accurate nutrient fluxes and distributions in natural environment requires the integration of vast amounts of remote sensing information. Such nutrient flows may be related to atmospheric deposition, agricultural runoff, and urbanization effect on surface and groundwater systems. Dr. Chang was the first scientist who reviewed these remote sensing technologies and models by the systems engineering approach associated with different platforms and sensors. With thorough coverage of over 50 satellite remote sensing sensors based on 40 years literature, such water quality monitoring information is valuable in a broad range of environmental assessment, ecosystem restoration, and agricultural applications; provided that it is collected in a timely manner over extensive area and that it is accurate. Besides, coastal management in the interface between river basins and neighboring water body are deemed critical for sustainable development. Dr. Chang was the first scientist who developed genetic programming model to retrieve the soil moisture information from space-borne RADARSAT-1 microwave satellite images in a vast semi-arid coastal watershed and detect coastal region sea ice decay from orthorectified RADARSAT-1 ScanSAR imagery. Space-borne remote sensing LANDSAT TM/ETM+ images were also used by Dr. Chang to help characterize the drought conditions based on two new indices - Temperature Vegetation Dryness Index (TVDI) and Regional Water Stress Index (RWSI). Dr. Chang and his collaborators in China also explored a unique hydrometeorological process of precipitation patterns and associated summer extreme flow using TRMM/PR data. This series of work pioneered some scientific frontiers in hydroinformatics regime with the aid of a suite of Earth observing systems. On the other hand, the impact of recent drought and water pollution episodes results in an acute need to project future water availability to assist water managers in water utility infrastructure management within many metropolitan regions. With long-term funding support from USEPA, Dr. Chang was the first scientist who conducted this series of research work building up a next-generation water availability index, which is known as Metropolitan Water Availability Index (MWAI) for short-term and middle-term assessment, using remote sensing technologies. By using remote sensing technologies and data processing techniques, continuous monitoring of spatial and temporal distributions of key water availability and quality variables is made achievable. The work was demonstrated in terms of turbidity and Chlorophyll-a concentrations in Lake Okeechobee, nutrient concentrations in Tampa Bay, It was the first success in the estimation of nutrients in a coastal bay using remote sensing technology. Besides, Dr. Chang developed the first algorithm for mapping TOC and microcystin using Integrated Data Fusion and Mining (IDFM) and thus opened up the path to widespread applications. Results from numerous investigations conducted by Dr. Chang and his students were utilized in the formulation of a physically based approach that recognized all aspects of the problem, particularly the need for and near-real-time monitoring of water quality. This was complemented by more satellite-based quantitative evaluation of a variety of retrieval algorithms using IDFM. Satellite remote sensing technology and the science associated with evaluation of LULC in an urban region make use of the wide range images and algorithms. Improved land management capacity is critically dependent on real-time or near real-time monitoring of land-use and land cover change to the extent to which solutions to a whole host of urban/rural interface development issues may be well managed promptly. Funded by NASA, Dr. Chang developed a new and innovative algorithm utilizing synthetic concepts that resulted in a solution to this critical problem. The algorithm is known as the RIparian Classification Algorithm (RICAL) to conduct the seasonal change detection of riparian zones in a vast semi-arid watershed, South Texas using RADARSAT-1 and LANDSAT remote sensing images. Dr. Chang was also the first scientist to apply the partial lanczos extreme learning machine (PL-ELM) for processing SPOT images and the neural-fuzzy inference approach for processing Formosat-2 data for two types of urban systems. This series of work was extended to examine urban heat island effect

associated with local hydroclimatic conditions using MODIS satellite data and dynamic linkages between evapotranspiration and land use/land cover changes with Landsat TM and ETM+ data, both of which demonstrate pioneered investigation of urban sustainability issues.

Role: Dr. Chang conceived and led these research activities and conducted the literature review, information processing, and retrospective and perspective analyses. Development of the first IDFM algorithm of its kind was basically an individual effort after culminating a series of remote sensing studies. Dr. Chang initiated this series of coastal and watershed research, developed the hypotheses, led the development of the methodology and framework, cooperatively designed field experiments of corner reflectors with the support of NASA and USEPA staff, conducted the ground-truth data collection, and performed the data analysis. The scope of the research program expanded significantly over time and involves a large team across several countries that was coordinated and managed by Dr. Chang for an extended period.

Impact: Dr. Chang had successfully demonstrated the ability to map and monitor soil moisture using RADARSAT-1 L-band imageries with genetic programming model under NASA funding support. Conclusions supported a satellite-based implementation in a vast data set in south Texas. These results elevated the importance of soil moisture measurement within NASA's Program. The project has also been highly successful at addressing a broad range of optimal sensor deployment strategies at the watershed scale and has been the basis for numerous advanced applications later on, including the similar research being conducted in UFZ Helmholtz Centre for Environmental Research in Germany. The data have been used in studies that went well beyond the initial research concept by impacting scientific research in hydrology and ecology, such as streamflow forecasting and riparian buffer zone monitoring. These studies were critical to the application of soil moisture products to support USEPA projects for multi-scale water resources management and the development of MWAI, and design of future missions. This was the first effort to bring together a diverse body of remote sensing research into an operational algorithm. This work is widely recognized by an US EPA national laboratory and it was critical to Dr. Chang's current effort of getting more study regions from South Florida to Nevada, to New York, and to Nicaragua. Expected applications include drought monitoring, water quality monitoring, and water availability forecasts in urban regions. In addition, the integration between microwave and optical remote sensing technologies resulted in new and significant contributions and went well beyond the original scope of the research. These have included contributions to watershed hydrology, ecosystem restoration, ecohydrology, and applied remote sensing. This work of a series of change detection of Land Use and Land Cover (LULC), led to a subsequent carbon flux study that has been successfully demonstrated in China under collaborative work with the Chinese Academy of Science. As a result of this research, new discoveries and insights involving the environmental physics of urban planning were made, in particular coherent thermal flux phenomena occurring during evapotranspiration process and heat island effect. Results from this research program have been recognized as highly innovative and significant by a SPIE highlighted online news reported his achievement of using SPOT-5 high resolution satellite images for this application. This online article is titled "Satellite-based Multi-temporal Change Detection in Fast Growing Urban Environments" under the SPIE banner of "Top Ten Hot Papers in Optics and Photonics published on 21 January 2011.

Stormwater and Wastewater Treatment Process Optimization

Books

1. Chang, N. B. (2010): The Effects of Urbanization on Groundwater: An Engineering Case-based Approach for Sustainable Development. Publisher: American Society of Civil Engineers (ASCE), Reston VA, 400 pp.

Book Chapters

1. Chang, N. B., Wanielista, M., Moberg, M. and Hossain, F. (2010): Chapter 8 Use of Functionalized Filter Media for Nutrient Removal in Stormwater Ponds. In: The Effects of Urbanization on Groundwater: An Engineering Case-based Approach for Sustainable Development, Ed. Chang, N. B. (ASCE), 199-223.
2. Chang, N. B., Wanielista, M., Daranpob, A., Hossain, F., and Xuan, Z. (2010): Chapter 9 Comparative Assessment of Two Standard Septic Tank Drain Fields Using Different Sand with Recirculation for Nutrient Removal. In: The Effects of Urbanization on Groundwater: An Engineering Case-based Approach for Sustainable Development, Ed. Chang, N. B. (ASCE), 224-250.

Patents

1. Passive Nutrient Removal Material Mixes. US Patent 7824551 issued on Nov. 2, 2010.
2. Retention and Detention Pond Passive Nutrient Removal Material Mixes. US Patent 7897047 issued on March 4, 2011.
3. Passive Underground Drainfield for Septic Tank Nutrient Removal Using Special Functionalized Green Filtration Media. US Patent 7927484 issued on April 19, 2011.
4. Functionalized Green Filtration for Passive Underground Drainfield for Septic Tank Nutrient Removal. US Patent 7955507 issued on June 26, 2011.
5. Passive Nutrient Removal Material Mixes. US Patent 8002985 B1 issued on August 23, 2011.
6. Retention/Detention Pond Stormwater Treatment System. US Patent 8153005 B1 issued on August 23, 2011.
7. Green Sorption Media for Water Treatment. US Patent 8002984 B1 issued on August 10, 2012.
8. A Subsurface Upflow Wetland System for Nutrient and Pathogen Removal in Wastewater Treatment Systems. US Patent 8252182 B1, issued on August 28, 2012.

Journal Papers: Green Sorption Media for Wastewater and Stormwater Treatment

• Overviews

1. Chang, N. B., Hossain, F. and Wanielista, M. (2010): Use of filter media for nutrient removal in natural systems and built environments (I): previous trends and perspectives. *Environmental Engineering Science*, **27(9)**, 689-706.
2. Chang, N. B., Wanielista, M. and Makkeasorn, A. (2010): use of filter media for nutrient removal in natural systems and built environments (II): design challenges and application potentials. *Environmental Engineering Science*, **27(9)**, 707-720.
3. Chang, N. B. (2011): Making a progress to speed up the nitrification and denitrification processes in novel biosorption activated media: can Archaea be in concert with Anammox? *Journal of Bioprocessing and Biotechniques*, **1(2)**, 1-5.

• Technology Development - Wastewater Treatment for Nutrient Management

1. Xuan, Z., Chang, N. B., Wanielista, M. and Hossain, F. (2010): Laboratory-scale characterization of the green sorption medium for wastewater treatment to improve nutrient removal. *Environmental Engineering Science*, **27(4)**, 301-312.

2. Hossain, F., Chang, N. B., Wanielista, M., Xuan, Z. M. and Makkeasorn, A. (2009): Nitrification and denitrification effect in a passive on-site wastewater treatment system with a recirculation filtration tank. *Journal of Water Quality, Exposure and Health*, **1(3-4)**, 31-46.
3. Xuan, Z. M., Chang, N. B., Makkeasorn, A. and Wanielista, M. (2009): Initial test of a subsurface constructed wetland with green sorption media for nutrient removal in on-site wastewater treatment systems. *Journal of Water Quality, Exposure and Health*, **1(3)**, 159–169.
4. Chang, N. B., Wanielista, M., Daranpob, A., Hossain, F. and Xuan, Z. (2010): New performance-based passive septic tank underground drainfield for nutrient and pathogen removal using sorption medium. *Environmental Engineering Science*, **27(6)**, 469-482.
5. Chang, N. B., Xuan, Z. M., Daranpob, A. and Wanielista, M. (2011): A subsurface upflow wetland system for nutrient and pathogen removal in on-site sewage treatment and disposal systems. *Environmental Engineering Science*, **28(1)**, 11-24.

• Technology Development - Stormwater Treatment for Nutrient Management

1. Chang, N. B., Wanielista, M. and Henderson, D. (2011): Temperature effects on functionalized filter media for nutrient removal in stormwater treatment. *Environmental Progress and Sustainable Energy*, **30(3)**, 309-317.
2. Ryan, P., Wanielista, M. and Chang, N. B. (2010): Reducing nutrient concentrations from a stormwater wet pond using a Chamber Upflow Filter and Skimmer (CUFS) with green sorption media. *Water, Air and Soil Pollution*, **208(1)**, 385-400.
3. O'Reilly, A., Wanielista, M., Chang, N. B., Xuan, Z. and Harris, W. G. (2012): Biogeochemical assessment of coupled nitrogen and carbon cycle beneath a stormwater infiltration basin with biosorption activated media. *Science of the Total Environment*, **432**, 227-242 .
4. O'Reilley, A., Wanielista, M., Chang, N. B., Harris, W. G. and Xuan, Z. M. (2012): Soil property control of biogeochemical processes beneath two subtropical stormwater infiltration ponds. *Journal of Environmental Quality*, **41**, 1-18.
5. O'Reilley, A., Chang, N. B. and Wanielista, M. (2012): Effects of cyclic biogeochemical processes on nitrogen cycling beneath a subtropical stormwater infiltration pond. *Journal of Contaminant Hydrology*, **133**, 53-75.
6. Lian, J., Xu, S., Chang, N. B., Han, C. and Liu, J. (2013): Removal of molybdate from mine tailing effluents with the aid of loessial soil and slag waste. *Environmental Engineering Science*, 30(5), 213-220.

• Design Models and Tracer Studies to Address System Dynamics

1. Xuan, Z. M., Chang, N. B., Daranpob, A. and Wanielista, M. (2010): Modeling the Subsurface Upflow Wetlands (SUW) systems for wastewater effluent treatment. *Environmental Engineering Science*, **27(10)**, 879-888.
2. Hossain, F., Chang, N. B. and Wanielista, M. (2010): Modeling kinetics and isotherm of functionalized filter medium for nutrient removal in stormwater dry ponds. *Environmental Progress and Sustainable Energy*, **29(3)**, 319–333.
3. Xuan, Z. M., Chang, N. B. and Wanielista, M. (2012): Modeling the system dynamics for nutrient removal in an innovative septic tank media filter. *Bioprocess and Biosystems Engineering*, **35(4)**, 545-552.
4. Chang, N. B., Xuan, Z. M. and Wanielista, M. (2012): A tracer study for addressing the interactions between hydraulic retention time and transport processes in a subsurface wetland system for nutrient removal. *Bioprocess and Biosystems Engineering*, **35(3)**, 399-406.

Journal Papers: Water Quality Prediction and Control

• Water Quality Prediction and Reclamation

1. Dong, S. Y., Shieh, W. K. and Chang, N. B. (2005): Real-time prediction of effluent water quality via adaptive grey dynamic modeling analysis. *The Journal of Grey Systems*, 17(1), 51-66.
2. Chen, J. C., Chang, N. B. and Shieh, W. K. (2003): Assessing wastewater reclamation potential by neural networks model. *Engineering Applications of Artificial Intelligence*, **16(2)**, 149-157.

• Controller Design

1. Chang, N. B., Chen, W. C. and Shieh, W. K. (2001): Optimal control of wastewater treatment plant via integrated neural network and genetic algorithms. *Civil Engineering and Environmental Systems*, **18**, 1-17.
2. Chen, W. C., Chang, N. B. and Shieh, W. K. (2001): Advanced hybrid fuzzy controller for industrial wastewater treatment. *Journal of Environmental Engineering, ASCE,* **127(11)**, 1048-1059.
3. Chen, W. C., Chang, N. B. and Chen, J. C. (2003): Rough set-based fuzzy neural controller design for industrial wastewater treatment. *Water Research*, **37(1)**, 78-90.
4. Chen, J. C. and Chang, N. B. (2007): Mining the fuzzy control rules of aeration in submerged biofilm wastewater treatment process. *Engineering Applications of Artificial Intelligence*, **20**, 959-969.

Journal Papers: Cost Benefit Analysis

1. Chen, H. W., Wu, C. C. and Chang, N. B. (2002): A comparative analysis of methods to represent uncertainty in estimating the cost of constructing wastewater treatment plants. *Journal of Environmental Management*, **65(4)**, 383-409.

Journal Papers: Nutrient Management Using Nanotechnologies

1. Lin, K. S., Chang, N. B. and Chuang, T. D. (2008): Fine structure characterization of zero-valent Iron nanoparticles for decontamination of nitrites and nitrates in wastewater. *Science and Technology for Advanced Materials*, **9**, 025105 (9pp), doi:10.1088/1468-6996/9/2/025015.
2. Chang, N. B., Wanielista, M., Hossain, F., Zhai, L. and Lin, K. S. (2008): Integrating nanoscale zero valent iron and titanium dioxide for nutrient removal in stormwater systems. *NANO: Brief Reports and Reviews*, **3(4)**, 297-300.
3. Lin, K. S., Chuang, T. D. and Chang, N. B. (2008): Decontamination of nitrates and nitrites in wastewater by zero-valent iron nanoparticles. *NANO: Brief Reports and Reviews*, **3(4)**, 291-295.
4. Lin, K. S., Lo, C. C. and Chang, N. B. (2008): Synthesis and characterization of titania nanotube for dye wastewater treatment. *NANO: Brief Reports and Reviews*, **3(4)**, 257-262.

Summary of my research in stormwater management and wastewater treatment

Major Accomplishment:

Rapid urbanization and climate variability impacts increase with more extreme precipitation and drought events, challenging stormwater management in terms of both flood control and water quality and wastewater treatment in rural and coastal areas. Understanding nitrogen cycle in natural systems and the built environment has been deemed one of the twelve grand challenges by the National Academy of Engineering. Dr. Chang was the first scientist who invented the Biosorption Activated Media (BAM) with having 8 relevant US patents approved for nutrient removal in dealing with

nutrient-laden stormwater and wastewater streams. With thorough laboratory and field testing, a broad range of field conditions for BAM applications were identified. Modeling these unique stormwater and wastewater treatment processes for planning, design and operation was conducted by using system dynamics modeling approach. Dr. Chang was the first scientist who conducted this series of research building a suite of physical with confirmed performance and Stella software models with calibrated and validated results thereby opening up the path to widespread applications. Conducted by Dr. Chang and his colleagues/students, results from extended investigations include optimal control studies, tracer studies, kinetics studies with temperature variations and possible combination with some nanomaterials. Overall, this body of work demonstrated pioneered investigation of water sustainability issues in urban regions.

Role: Dr. Chang conceived and led these research activities and conducted the literature review. Development of the BAM was confirmed with efforts after culminating a series of lab and field studies. With the long-term funding support from the state government of Florida Dr. Chang initiated this series of research, developed the hypotheses, led the development of the methodology and framework, cooperatively designed field experiments of stormwater and wastewater test beds on campus, and performed the data analysis. The scope of the research program expanded significantly over time and involves a series of comparisons of results across several countries (i.e., Singapore and New Zealand) that was coordinated and managed by Dr. Chang for an extended period.

Impact: Dr. Chang had successfully demonstrated the ability to remove nutrients with BAM and the possible sensitivity analysis with system dynamics modeling. This was the first effort to bring together a diverse body of sorption media research into an operational level. The project has also been highly successful at addressing a broad range of application potential. The data have been used in studies that went well beyond the initial research concept by impacting scientific research in flood treatment in stormwater infiltration ponds, canal treatment with pipe reactor and stormwater treatment with exfiltration and upflow media bed reactor. These studies were critical to the possible extended applications of spring field conservation and conjunctive treatment of stormwater and groundwater in Florida. These new discoveries and insights triggered a new spectrum of urban sustainability research.

Industrial Ecology and Ecological Engineering

Book

1 Jorgensen, S. E., Change, N. B., and Xu, F. L. (Eds) Advances in Ecological Modelling and Ecological Engineering - Lakes and Wetlands, to be published by Elsevier in 2014.

Book Chapters

1. Megic, B. and Chang, N. B. (2010): Chapter 11 Use of a Wetland System for Groundwater Recharge in an Urban Wastewater Treatment Plan in Orlando, Florida. In: The Effects of Urbanization on Groundwater: An Engineering Case-based Approach for Sustainable Development, Ed. Chang, N. B. (ASCE), 277-307.
2. Chang, N. B. and Xuan. Z. M., (2013): Chapter 16 Control of Phosphorus via Constructed Wetlands in the Everglades System. In Advances in Ecological Modelling and Engineering - Lakes and Wetlands, by Jorgensen, S. E. Change, N. B., and Xu, F. L. (Eds) (Elsevier).
3. Chang, N. B., Wanielista, M. P., Xuan. Z. M., and Marimon, Z. (2013): Chapter 17 Floating Treatment Wetlands for Nutrient Removal in a Subtropical Stormwater Wet Detention Pond with a Fountain. In Advances in Ecological Modelling and Engineering - Lakes and Wetlands, by

Jorgensen, S. E. Change, N. B., and Xu, F. L. (Eds) (Elsevier).

4. Chang, N. B., Xuan, Z., and Marimon, Z. (2013): Chapter 18 System Dynamics Modeling for Nutrient Removal in a Stormwater Wet Pond. In Advances in Ecological Modelling and Engineering - Lakes and Wetlands, by Jorgensen, S. E. Change, N. B., and Xu, F. L. (Eds) (Elsevier).
5. Chang, N. B., Wanielista, M. P., and Xuan. Z. M., (2013): Chapter 26 A Novel Subsurface Upflow Wetland with the Aid of Biosorption Activated Media for Nutrient Removal. In Advances in Ecological Modelling and Engineering - Lakes and Wetlands, by Jorgensen, S. E. Change, N. B., and Xu, F. L. (Eds) (Elsevier).
6. Chang, N. B., Wanielista, M. P., and Xuan. Z. M., (2013): Chapter 27 Tracer-based System Dynamic Modeling for Designing a Subsurface Upflow Wetland for Nutrient Removal. In Advances in Ecological Modelling and Engineering - Lakes and Wetlands, by Jorgensen, S. E. Change, N. B., and Xu, F. L. (Eds) (Elsevier).

Journal Papers: Risk Assessment and Management of Risk

1. Chang, N. B., Wei, Y. L., Tseng, C. C. and Kao, C. Y. (1997): The design of a GIS-based decision support system for chemical emergency preparedness and response in an urban environment. *Computers, Environment and Urban System*, **21(1)**, 67-94.
2. Chang, N. B., Kao, C. Y., Wei, Y. L. and Tseng, C. C. (1998): Comparative study of 3-D numerical simulation and puff models for dense air pollutants. *Journal of Environmental Engineering, ASCE*, **125(2)**, 125-134.
3. Chang, N. B. and Jang, C. (2000): Development and application of U.S. EPA's models-3: an integrated "One-Atmosphere" third-generation air quality modeling system. *Journal of Chinese Institute of Environmental Engineering*, **10(1)**, 19-34.
4. Weng, Y. C., Chang, N. B. and Lee, T. Y. (2008): Nonlinear time series analysis of ground-Level ozone dynamics in Southern Taiwan. *Journal of Environmental Management*, **87(3)**, 405-414.
5. Cheng, K. Y. and Chang, N. B. (2009): Assessing the impact of biogenic VOC emissions in a high ozone episode via integrated remote sensing and the CMAQ model. *Frontiers of Earth Science*, **3(2)**, 182-197.
6. Tseng, C. C. and Chang, N. B. (2009): Environmental exposure assessment for emergency response in a nuclear power plant using an integrated source term and 3D numerical model. *Environmental Modeling and Assessment*, **14(6)**, 661-675.
7. Chang, N. B. and Chang, D. Q. (2010): Long-term risk assessment of possible accidental release of nuclear power plants in complex terrains with respect to synoptic weather patterns. *Frontiers of Earth Science*, **4(2)**, 205-228.
8. Chang, N. B. and Weng, Y. C. (2013): Short-term emergency response planning and risk assessment via an integrated modeling system for nuclear power plants in complex terrain. *Frontiers of Earth Science,* 7(1), 1-27.

Journal Papers: Environmental Management Systems

• Optimal Production Planning and Pollution Prevention

1. Wu, C. C. and Chang, N. B. (2007): Evaluation of environmentally benign production program in the textile dying industry (I): an input-output analysis. *Civil Engineering and Environmental Systems*, **24(4)**, 275-298.

2. Wu, C. C. and Chang, N. B. (2008): Evaluation of environmentally benign production program in the textile dying industry (II): a multi-objective programming approach. *Civil Engineering and Environmental Systems*, **25(1)**, 299-322.

• Optimal Production Planning and Uncertainty Analysis

1. Wu, C. C. and Chang, N. B. (2003): Grey input-output analysis and its application for environmental cost allocation. *European Journal of Operational Research*, **145(1)**, 175-201.
2. Wu, C. C. and Chang, N. B. (2004): Corporate optimal production planning with varying environmental costs: a grey compromise programming approach. *European Journal of Operational Research*, **155**, 68-95.
3. Wu, C. C. and Chang, N. B. (2003): Global strategy for optimizing multiproduct textile dyeing process via GA-based Grey compromise programming. *Computers and Chemical Engineering*, **27(6)**, 833-854.

• Optimal Production Planning and Energy Infrastructures

1. Ko, A. and Chang, N. B. (2008): Optimal planning of co-firing alternative fuels with coal in a power plant by grey nonlinear mixed integer programming model. *Journal of Environmental Management,* **88**, 11-27.

Journal Papers: Water Sustainability and Climate Change

1. Qi, C. and Chang, N. B. (2011): System dynamics modeling for municipal water demand forecasting in a fast growing region under uncertain economic impacts. *Journal of Environmental Management,* **92**, 1628-1641.
2. Qi, C. and Chang, N. B. (2012): Integrated carbon footprint and cost evaluation in a drinking water infrastructure system for screening expansion alternatives. *Journal of Cleaner Production*, **27**, 51-63.
3. Chang, N. B., Qi, C. and Yang, J. (2012): Optimal expansion of a drinking water infrastructure system with respect to carbon footprint, cost effectiveness, and water demand. *Journal of Environmental Management*, **110**, 194-206.
4. Chang, N. B., Rivera, B. and Wanielista, M. (2011): Optimal design for water conservation and energy savings using green roofs in a green building under mixed uncertainties. *Journal of Cleaner Production*, **19**, 1180-1188.
5. Xuan, Z. and Chang, N. B. (2014): Modeling the Structurally Dynamic Change of Ecosystem in Lake Okeechobee to Account for Climate Change Impact, *Ecological Modelling*, in press.

Journal Papers: Life Cycle Assessment

1. Pires, A., Chang, N. B. and Martinho, G. (2011): Reliability-based life cycle assessment for future solid waste management alternatives in Portugal. *International Journal of Life Cycle Assessment*, **16(4)**, 316-337.
2. Thomas, N., Chang, N. B. and Qi, C. (2012): Preliminary assessment for global warming potential of leading contributory gases from a 40" LCD flat screen television. *Internal Journal of Life Cycle Assessment*, **17(1)**, 96-104.

3. Ning, S. K., Chang, N. B., and Hong, M. C. (2013): A comparative streamlined life cycle assessment of two types of municipal solid waste incinerator. *Journal of Cleaner Production*, **53(15)**, 56-66.
4. Chang, N. B., Qi, C., Islam, K. and Hossain, F. (2012): Comparisons between global warming potential and cost-benefit criteria for optimal planning of a municipal solid waste management system. *Journal of Cleaner Production*, **20(1)**, 1-13.

Journal Papers: Ecological Engineering for Stormwater Treatment and Low Impact Development

1. Chang, N. B., Islam, K. and Wanielista, M. (2012): Floating wetland mesocosm assessment of nutrient removal to reduce ecotoxicity in stormwater ponds. *International Journal of Environmental Science and Technology*, **9(3)**, 453-462.
2. Chang, N. B., Islam, K., Marimon, Z., Xuan, Z. M. and Wanielista, M. (2012): Assessing chemical and biological signatures of nutrient removal via the use of floating islands in stormwater mesocosms. *Chemosphere*, **88(6)**, 736-743.
3. Xuan, Z. M., Chang, N. B., and Wanielista, M. (2013): System dynamics modeling of nitrogen removal in a stormwater infiltration basin with biosorption activated media. *Journal of Environmental Quality*, **42**, 1086–1099.
4. Chang, N. B., Xuan, Z., Marimon, Z., Islam, K., and Wanielista, M. P. (2013): Exploring hydrobiogeochemical processes of floating treatment wetlands in a subtropical stormwater wet pond. *Ecological Engineering*, **54**, 66-76.
5. Marimon, Z. A., Xuan, Z., and Chang, N. B. (2013): System dynamics modeling with sensitivity analysis for floating treatment wetlands in a stormwater wet pond. *Ecological Modelling*, **267**, 66–79.

Journal Papers: Drinking Water Distribution Network Analyses Using Expert Systems

1. Chang, N. B., Pongsanone, N. P. and Ernest, A. (2011): Comparisons between a rule-based expert system and optimization models for sensor deployment in a small-scale drinking water distribution network. *Expert System with Applications*, **38**, 10685–10695.
2. Chang, N. B., Ernest, A. and Pongsanone, N. P. (2012): A rule-based decision support system for sensor deployment in small drinking water networks. *Journal of Cleaner Production*, **29**, 28-37.
3. Chang, N. B., Pongsanone, N. P. and Ernest, A. (2012): Optimal sensor deployment in a large-scale complex drinking water distribution network: comparisons between a rule-based decision support system and optimization models. *Computers and Chemical Engineering*, **43**, 191-199.

Summary of my research in industrial ecology and ecological engineering

Major Accomplishment: This body of work explored short-term emergency response planning and risk assessment via an integrated modeling system for chemical and energy industries. Dr. Chang was the first scientist who developed a series of spatial decision support systems for emergency response planning. Besides, in response to the needs for long-term water quality monitoring in drinking water systems, one of the most significant challenges currently facing the water industry is to investigate the sensor placement strategies with modern concepts of and approaches to risk management. Most of the previous research mainly focuses on using optimization models to deal with small-scale drinking water networks. Yet the challenge of computational burden when handling large-scale networks can never be overcome. Dr. Chang was the pioneer who developed the graph theory - based optimal sensor deployment strategy in a Rule-based Expert System (RBES) with no previous computational burden as we oftentimes encountered via various types of large-scale optimization analyses. This series of modeling efforts using graph theory and expert system to aid in sensor network deployment in drinking

water networks have created a new direction in this field. To confirm the sustainability of various alternatives of industrial products, streamlined life cycle assessment and carbon-regulated management systems were assessed with scales. The extended work along this line also included the development of the green building design to optimally balance energy and water consumption in a green building in Florida. Dr. Change was the first scientist for exploring such type of system design issues in a green building. Besides, a unique type of floating treatment wetland technology for nutrient removal in several types of stormwater wet ponds was tested for the enhancement of stormwater reuse. Dr. Change was also the first scientist for the initiation of a series of field experiments in diverse types of pond structures and environments that address critical issues of floating treatment wetland technology.

Role: Dr. Chang conceived and led this series of research, developed the hypotheses with the aid of some local utility engineers, and performed the data analysis.

Impact: These numerical experiments for water, energy, and chemical industries were critical to the validation of integrated sensing, monitoring, modeling for decision making. The approach to parameterization and modeling the strategies of monitoring and modeling for decision making has been adopted throughout the relevant industries and government agencies. It will be a key component of the approach used in the future in relevant industrial sectors.

Waste Management Strategies and Technologies for Municipal and Industrial Streams

Books

1. Chang, N. B. (1996): Solid Waste Management. Taipei, Taiwan. Published by Three Principles Bookstore, 300 pp. (in Chinese).
2. Chang, N. B. (1998): Systems Engineering Design of Solid Waste Incinerators (I). Taipei, Taiwan. Published by Prosperity Bookstore. 500 pp. (in Chinese).
3. Chang, N. B. (1998): Systems Engineering Design of Solid Waste Incinerators (II). Publisher: Prosperity Bookstore, Taipei, Taiwan, 650 pp. (in Chinese).
4. Chang, N. B. and Pire, A. (2014): Sustainable Solid Waste Management: A Systems Engineering Approach. in IEEE Book Series on Systems Science and Engineering, Publisher: John Wiley/IEEE, New York, USA, 500 pp, to be published.

Encyclopedia Articles

1. Chang, N. B., Pires, A., and Martinho, G. (2013): Chapter 17: Impacts of Life Cycle Assessment on Solid Waste Management. In Encyclopedia of Environmental Management, Ed, Jorgensen, S. E. (Taylor & Frances Group) Volume IV - page 2399 - 2414.
2. Chang, N. B., Pires, A., and Martinho, G. (2013): Chapter 29: Environmental Legislation for Solid Waste Management in EU Countries via the Use of Economic and Policy Instruments. In Encyclopedia of Environmental Management, Ed, Jorgensen, S. E. (Taylor & Frances Group) Volume II - page 892 - 913.

Book Chapter

1. Lin, Y. H., Chen, W. Y., Chen, H. W., and Chang, N. B. (2014): Fuzzy Non-cooperative Games for Running Municipal Incinerators with Redundant Capacity. in Conflict Resolution in Water

Resources and Environmental Management, Ed, Hipel, K., Fang, L., Bristow, M., and Cullmann, J. (Springer).

Journal Papers: Integrated Solid Waste Management Strategies

• Overviews

1. Pires, A., Martinho, G. and Chang, N. B. (2011): Solid waste management: in European countries: a review of systems analysis techniques. *Journal of Environmental Management*, **92**, 1033-1050.
2. Chang, N. B., Pires, A. and Martinho, G. (2011): Empowering systems analysis for solid waste management: challenges, trends and perspectives. *Critical Reviews in Environmental Science and Technology*, **41(16)**, 1449-1530.

• System of Systems Engineering and Integrated Waste Management Strategies

1. Chang, N. B., Schuler, R. E., and Shoemaker, C. A. (1993): Environmental and economic optimization of an integrated solid waste management system. *Journal of Resource Management and Technology*, **21(2)**, 87-98.
2. Chang, N. B. and Lin, Y. T. (1997): Optimal siting of transfer station locations in a metropolitan solid waste management system. *Journal of Environmental Science and Health*, **A32, (8)**, 2379-2401.
3. Chang, N. B., Davila, E., Dyson, B. and Brown, R. (2005): Optimal site selection and capacity planning of a municipal solid waste material recovery facility in an urban setting. *Waste Management*, **25(8)**, 833-846.
4. Chang, N. B. and Lin, Y. T. (1997): Economic evaluation of a regionalization program of solid waste management in a metropolitan region. *Journal of Environmental Management*, **51(3)**, 241-274.
5. Chang, Y. H. and Chang, N. B. (1998): Optimization analysis for the development of short-term solid waste management strategies using presorting process prior to incinerator. *Resources Conservation and Recycling*, **24**, 7-32.

• Multicriteria Decision Analysis

1. Chang, N. B. and Wang, S. F. (1996): Solid waste management system analysis by multi-objective mixed integer programming model. *Journal of Environmental Management*, **48**, 17-43.
2. Chang, N. B. and Chang, Y. H. (2001): Optimal shipping strategy of solid waste streams with respect to throughput and energy recovery goals of incineration facilities. *Civil Engineering and Environmental Systems*, **18**, 193-214.

• Comparative Risk Assessment and Waste Management

1. Chang, N. B. and Wang, S. F. (1994): A locational model for the site selection of solid waste management facilities with traffic congestion constraints. *Journal of Civil Engineering and Environmental Systems*, **11**, 287-306.
2. Chang, N. B., Yong, Y. C., and Wang, S. F. (1996): Solid waste management system analysis with noise control and traffic congestion limitations. *Journal of Environmental Engineering, ASCE*, **122(2)**, 122-131.
3. Chang, N. B., Shoemaker, C. A. and Schuler, R. E. (1996): Solid waste management system analysis with air pollution control and leachate impact limitations. *Waste Management & Research*, **14**, 463-481.
4. Chang, N. B. and Wang, S. F. (1996): Comparative risk analysis of solid waste management

alternatives in a metropolitan region. *Environmental Management*, **20(1)**, 65-80.

• Sustainability Analysis between Recycling and Incineration

1. Chang, N. B. and Wang, S. F. (1997): Integrated analysis of recycling and incineration programs by goal programming techniques. *Waste Management & Research*, **15(2)**, 121-136.
2. Chang, Y. H. and Chang, N. B. (2001): Regional shipping strategy assessment based on installing a refuse-derived-fuel process in a municipal incinerator. *Waste Management & Research*, **19**, 504-517.
3. Chang, Y. H. and Chang, N. B. (2003): Compatibility analysis of material and energy recovery in a regional solid waste management system. *Journal of Air & Waste Management Association*, **53**, 32-40.
4. Chen, J. C., Chang, N. B., Chen, W. H., Davila, E. and Tsai, C. H. (2005): Interactive analysis of waste recycling and energy recovery program in a small-scale incinerator. *Journal of Air & Waste Management Association*, **55**, 1356-1366.

• Uncertainty Analysis - Preference Elicitation

1. Chang, N. B. and Wang, S. F. (1996): Managerial fuzzy optimal planning for solid waste management systems. *Journal of Environmental Engineering, ASCE*, **122(7)**, 649-658.
2. Chang, N. B. and Wang, S. F. (1997): A fuzzy goal programming approach for the optimal planning of solid waste management systems. *European Journal of Operational Research*, **99(2)**, 287-303.
3. Chang, N. B. and Lu, H. Y. (1997): A new approach for long term planning of solid waste management systems using fuzzy global criterion. *Journal of Environmental Science and Health*, **A32(4)**, 1025-1047.
4. Chang, N. B. and Wei, Y. L. (2000): Siting recycling drop-off stations in an urban area by genetic algorithm-based fuzzy multi-objective nonlinear programming modeling. *Fuzzy Sets and Systems*, **114(1)**, 133-149.
5. Pires, A., Chang, N. B. and Martinho, G. (2011): An AHP-based fuzzy interval TOPSIS assessment for sustainable expansion of the solid waste management system in Satubal Peninsula, Portugal. *Resources Conservation and Recycling*, **56**, 7-21.

• Uncertainty Analysis - Minimax Regret

1. Chang, N. B. and Davila, E. (2007): Minimax regret optimization analysis for a regional solid waste management system. *Waste Management*, **27(6)**, 820-832.

• Uncertainty Analysis - Interval Programming

1. Davila, E. and Chang, N. B. (2005): Sustainable pattern analysis of publicly-owned material recovery facility under uncertainty. *Journal of Environmental Management*, **75(4)**, 337-352.
2. Chang, N. B., Chen, Y. L. and Wang, S. F. (1997): A fuzzy interval multi-objective mixed integer programming approach for the optimal planning of metropolitan solid waste management system. *Fuzzy Sets and Systems*, **89(1)**, 35-60.

Journal Papers: Landfill Management

1. Chang, N. B. and Schuler, R. E. (1991): Optimal pricing of the sanitary landfill use over time. *Journal of Resource Management and Technology*, **19(1)**, 14-24.
2. Davila, E., Chang N. B. and Diwakaluni, S. (2005): Dynamic landfill space consumption assessment in the Lower Rio Grande Valley, South Texas by GIP-based game theory. *Journal of*

Environmental Management, **75(4)**, 353-366.

3. Chang, N. B., Parvathinathan, G. and Breeden, J. B. (2008): Combining GIS with fuzzy multiple attribute decision making for landfill siting in a fast growing urban region. *Journal of Environmental Management*, **87**, 139-153.

Journal Papers: Waste Generation and Characterization

- **Forecasting Analysis of Waste Generation**

1. Chang, N. B., Pan, Y. C. and Huang, S. D. (1993): Time series forecasting of solid waste generation. *Journal of Resource Management and Technology*, **21(1)**, 1-10.
2. Chang, N. B. and Lin, Y. T. (1997): An analysis of recycling impacts on solid waste generation by time series intervention modeling. *Resources, Conservation and Recycling*, **19(3)**, 165-186.
3. Chen, H. W. and Chang, N. B (2000): Prediction of solid waste generation via grey fuzzy dynamic modeling. *Resources Conservation and Recycling*, **29**, 1-18.
4. Dyson, B. and Chang, N. B. (2005): Forecasting of solid waste generation in an urban region by system dynamics modeling. *Waste Management*, **25(7)**, 669-679.

- **Waste Characterization**

1. Chang, N. B. and Davila, E. (2008): Municipal solid waste characterization and management strategy for the Lower Rio Grande Valley, Texas. *Waste Management*, **28**, 776-794.

Journal Papers: Cost and Benefit Analysis

1. Chang, N. B., Mount, T. D. and Schuler, R. E. (1993): Econometric analysis of the construction and operating costs of solid waste incinerators. *Environmental Modeling and Software*, **8**, 173-186.
2. Chang, N. B. and Wang, S. F. (1995): The development of material recovery facilities in the United States: status and cost structure analysis. *Resources Conservation and Recycling*, **13(2)**, 115-128.
3. Chang, N. B., Chen, Y. L. and Yong, H. H. (1996): A fuzzy goal regression model for the construction cost estimation of municipal waste incinerators. *International Journal of Systems Science*, **27(5)**, 433-445.
4. Chang, N. B and Chen, Y. L. (1997): Construction cost analysis for landfill gas recovery system in the U.S. via fuzzy regression technique. *Journal of the Chinese Fuzzy Systems Association*, **3(1)**, 23-48.

Journal Papers: Risk Assessment

1. Chang, N. B. and Huang, S. H. (1996): A chemometric approach for the verification of dioxin/furan formation mechanism in municipal incinerators. *Chemosphere*, **32(1)**, 209-216.
2. Chang, N. B. and Huang, S. H. (1995): Statistical modeling for the prediction and control of PCDDs and PCDFs emissions from municipal solid waste incinerators. *Waste Management and Research*, **13**, 379-400.
3. Chang, N. B. and Chen, W. C. (2000): Prediction of PCDDs/PCDFs emissions from municipal incinerators by genetic programming and neural network modeling. *Waste Management & Research*, **18**, 341-351.

Journal Papers: Vehicle Routing and Scheduling for Collection of Waste Streams

1. Chang, N. B., Lu, H. Y. and Wei, Y. L. (1997): GIS technology for vehicle routing and scheduling in solid waste collection systems. *Journal of Environmental Engineering, ASCE*, **123(9)**, 901-910.
2. Chang, N. B., Chang, Y. H. and Chen, Y. L. (1997): Cost-effective and workload balancing

operation in solid waste management systems. *Journal of Environmental Engineering, ASCE*, **123(2)**, 178-190.

3. Chang, N. B. and Wei, Y. L. (1999): Strategic planning of recycling drop-off stations by multi-objective programming. *Environmental Management*, **24(2)**, 247-264.
4. Chang, N. B. and Wei, Y. L. (2002): Comparative study between heuristic algorithm and optimization technique for vehicle routing and scheduling in the solid waste management system. *Civil Engineering and Environmental Systems*, **19(1)**, 41-65.
5. Chang, N. B. and Davila, E. (2006): Siting and routing assessment for solid waste management under uncertainty using grey minimax regret criteria. *Environmental Management*, **38**, 654-672.

Journal Papers: Information Technologies

1. Chang, N. B., Lin, Y. T. and Chang, Y. H. (1998): A client-server computer framework for solid waste management decision analysis in Taiwan. *Journal of Hazardous Materials*, **58**, 15-31.
2. Chang, Y. C., Chang, N. B. and Ma, G. D. (2001): Internet web-based information system for handling scrap vehicles disposal in Taiwan. *Environmental Modeling and Assessment*, **6(4)**, 237-248.
3. Lu, G. W., Chang, N. B. and Liao, L. (2013): Environmental informatics for solid and hazardous waste management: advances, challenges, and perspectives. *Critical Reviews in Environmental Science and Technology*, **43**, 1557–1656.

Journal Papers: Waste Treatment, Recycling and Reuse Technologies

• Refuse-derived Fuel

1. Chang, N. B., Chang, Y. H. and Chen, W. C. (1997): Evaluation of heat values and its prediction for refuse-derived fuel. *Science of the Total Environment*, **197**, 139-148.
2. Chang, N. B., Chang, Y. H. and Chen, W. C. (1998): Systematic evaluation and uncertainty analysis of refuse-derived fuel process in Taiwan. *Journal of Air & Waste Management Association*, **48**, 537-544.
3. Lin, K. S., Wang, H. Paul, Chang, N. B., Huang, Y. J. and Liu, S. H. (1999): Pyrolysis kinetics of refuse-derived fuel. *Fuel Processing Technology*, **60**, 103-110.
4. Chang, N. B., Chen, W. C. and Chang, Y. H. (1999): Comparative evaluation of RDF and MSW incineration. *Journal of Hazardous Materials*, **58**, 33-45.

• Incineration Ash

1. Chang, N. B., Wang, H. P., Huang, W. L. and Lin, K. S. (1999): The assessment of reuse potential for MSW and RDF incineration ashes. *Resources, Conservation, & Recycling*, **25(3-4)**, 255-270.
2. Lin, K. S., Chang, N. B. and Wang, H. P. (2002): Development and applications of plasma melting technology for solid waste treatment. *Environmental Protection Monthly*, **15(9)**, 107-123.

• Construction and Demolition Waste Streams

1. Chang, N. B., Lin, K. S., Sun, Y. P. and Wang, H. P. (2001): Oxidation kinetics of combustible construction and demolition waste. *Journal of Environmental Quality,* **30**, 1392-1401.
2. Chang, N. B., Lin, K. S., Sun, Y. P. and Wang, H. P. (2001): An engineering assessment of the burning of the combustible fraction of construction and demolition waste in a redundant brick kiln. *Environmental Technology*, **22**, 1405-1418.
3. Chang, N. B., Huang, W. L., Lin, D. H. and Lin, K. S. (2002): Recycling of construction and

demolition waste via a mechanical sorting process. *Resources Conservation and Recycling*, **37(1)**, 23-37.

• Biowaste Reuse

1. Lin, K. S., Wang, H. P., Chang, N. B., Jou, C. J. G. and Hsiao, M. C. (2003): Synthesis of ZSM-type Zeolites from ashes of biowastes. *Energy Sources*, **25(6)**, 565-576.

• Controller Design to Promote Waste Heat Recovery

1. Chang, N. B and Chen, W. C. (2000): Fuzzy controller design for municipal incinerators with the aid of genetic algorithms and genetic programming Techniques. *Waste Management & Research*, **18(5)**, 429-443.
2. Chang, N. B, Chen, W. C. and Chen, J. C. (2002): GA-based neural-fuzzy controller design for municipal incinerators. *Fuzzy Sets and Systems,* **129(3)**, 343-369.
3. Chen, J. C., Chen, W. H. and Chang, N. B. (2008): Diagnosis analysis of a small-scale incinerator by neural networks model. *Civil Engineering and Environmental Systems*, **25(3)**, 201-213.

• Petrochemical Waste Treatment

1. Lin, K. S. and Chang, N. B. (2008): Control of PCDDs/PCDFs in a fluidized bed incinerator via activated carbon injection in petrochemical industry. *Petroleum Science and Technology*, **26(7/8)**, 764-789.

• Soil and Groundwater Remediation

1. Yen, H. K., Chang, N. B. and Lin, T. F. (2003): Bioslurping model to assess the light hydrocarbon recovery in a contaminated unconfined aquifer (I): simulation analysis. *Journal of Hazardous, Toxic, and Radioactive Waste Management, ASCE*, **7(2)**, 114-130.
2. Yen, H. K. and Chang, N. B. (2003): Bioslurping model to assess the light hydrocarbon recovery in a contaminated unconfined aquifer (II): optimization analysis. *Journal of Hazardous, Toxic, and Radioactive Waste Management, ASCE*, **7(2)**, 131-138.

Journal Papers: Decision Support Systems

1. Chang, N. B. and Wang, S. F. (1996): The development of an environmental decision support system for municipal solid waste management. *Computers, Environment and Urban System*, **20(3)**, 201-212.

Journal Papers: Policy Analysis

1. Chang, N. B. (2008): Economic and policy instrument analyses in support of the scrap tires recycling program in Taiwan. *Journal of Environmental Management*, **86**, 435-450.
2. Chang, N. B., Chang, Y. H. and Chen, H. W. (2009): Fair fund distribution for a municipal incinerator using a GIS-based fuzzy analytic hierarchy process. *Journal of Environmental Management*, **90**, 441-454.
3. Chen, H. W., Chen, J. C. and Chang, N. B. (2010): Environmental performance evaluation of large-scale municipal incinerators using Data Envelopment Analysis (DEA). *Waste Management*, **30**, 1371–1381.

Summary of my waste management research

This body of research relates urban waste management to transportation systems analysis with technical efforts in simulation, optimization, uncertainty and risk analysis with the linkages of models of engineered waste management systems to significant policy and economic analyses. The spectrum of the investigations covers all stages of waste management from planning, to design, to operation and to final disposal with rich social contexts. In particular, this series of work addresses environmental, economic, management, and sustainability challenges posed by a series of transitions under global change impacts seeking to generate alternatives from various decentralized versus centralized systems in the United States and other countries. Issues of concern include managing the entire waste management cycle with integrative insights of the design and implementation in relation to various sizes and types of waste management infrastructures and shipping patterns to reduce reliance on landfill space. Extended research areas include mitigation of environmental effects of waste management, optimal distribution of raw waste streams, environmental and social impacts, energy recovery, life cycle impact, carbon regulated shipping patterns, and reuse of recycled materials with system thinking. The sustainability metrics includes the wide range anticipated social, economic, environmental and health impacts across multiple media in various geographic contexts. Dr. Chang was the first scientist who systematically explored almost all aspects of waste management in relation to transportation strategies to promote urban sustainability in the world.

Role: Dr. Chang conducted this series of research, developed the hypotheses, led the development of the modeling analysis, cooperatively designed and carried out part of the research with foreign scholars, and performed the data analysis.

Impact: This body of work has contributed greatly to the foundations of urban waste management systems, contributing to understand the complexity of centralized versus decentralized management strategies, and has resulted in new knowledge on the systems analysis in waste management and urban sustainability. Dr. Chang's waste management studies in relation to simultaneous social, economic, environmental and health impacts are the only such investigations ever conducted on these factors and have been the basis for many additional analyses. As a result of this research, new discoveries and insights involving the use of "System of Systems Engineering" approach had some profound impact on the development and expanded applications in relevant fields. The culmination of this body of work led to the generation of a book titled "Sustainable Solid Waste Management: A Systems Engineering Approach" to be published by IEEE Book Series on Systems Science and Engineering, through John Wiley/IEEE. This is the first book of its kind in the world to thoroughly explored the waste management issues with strong urban sustainability implications.

RESEARCH SUPERVISION

To date, N.B. Chang has supervised or co-supervised 11 Ph.D. and 36 Master's students who have successfully completed their graduate degrees and now hold meaningful employment in industry, academia and government. Currently, Chang is supervising and co-supervising 7 Ph.D. students (2 in the US, 1 in China, 2 in Taiwan, 1 in Spain, and 1 in United Kingdom) and 4 Master's students. He has mentored 3 Post Doctoral and 2 Visiting Scholar. Additionally, he has been mentoring 2 mid-career research scientists in the Fellows Chinese Academy of Sciences on a long-term basis since 5 years' ago promoting collaborative research among Germany, China and the US. Under his supervision, one of undergraduate honor student (Mr. Brent Wimberly) received the UCF Founder's Day Award due to thesis's originality and depth, level of research, and amount of social impact, in Feb. 2013.

RESEARCH FUNDING

Since 1992, N.B. Chang has continuously held many grants from International, Federal, State, and Local government agencies. He was the Principal Investigator in a few NASA and EPA projects for

environmental remote sensing research, Project Leader for Stormwater Management Academy in Florida, and associate director of the Centre for Excellence of Science and Technology (NSF funded CREST Center) in Texas, and Project Leader for a series of research grants of nutrient management through innovative stormwater and wastewater treatment in the State of Florida, Principal- or Co-Investigator of several research grants funded by NSF, Florida Department of Environmental Protection, Florida Department of Transportation, Florida Fish and Wildlife Commission, South Florida Water Management District, Southwest Florida Water Management District, and Texas Higher Education Board for various types of water and waste management research in relation to sustainability studies. He has been awarded over $8 million of funded research up to now.

KEYNOTE ADDRESSES

Since 1992, Dr. Chang has presented several keynote addresses at national and international conferences held in United Kingdom, United States, Taiwan, and Nicaragua. Dr. Chang was invited guest speaker by thirty five universities, national laboratories, and governmental agencies nationally and internationally.

EXTERNAL EXAMINERS

External examiner for Ph.D. and Master's theses for universities in China, Portugal, Spain, Taiwan, Germany, India, and Canada.

TEACHING

Environmental system modeling (graduate), advanced hydrology (graduate), fluid mechanics (undergraduate), hydraulics (undergraduate), groundwater hydrology (graduate), groundwater modeling (graduate), environmental informatics and remote sensing (graduate), environmental & water resources systems analysis (graduate and undergraduate), environmental policy and regulation (graduate), industrial ecology (graduate), solid waste management (undergraduate), introduction to environmental engineering (undergraduate), engineering process optimization (graduate), environmental economics (undergraduate), environmental systems analysis (undergraduate), and workshop courses at the graduate and undergraduate levels. Courses were well received and consistently were given high ratings by the students.

EXTERNAL PROPOSAL REVIEWERS

Carried out proposal review as a panelist for National Science Council, Taiwan 1998-2001. NSF Office of Cyberinfrastructure (OCI) “Cyberinfrastructure Training, Education, Advancement, and Mentoring for Our 21st Century Workforce (CI-TEAM) program”, 2007, Science Foundation Ireland (SFI) of 2008 Research Frontiers Programme (Dublin, Ireland), NSF Environmental Engineering Program - Water Quality/Pollution Control, 2008, the “Complex Exploratory Research Projects” in “Ideas” research program, the National Council for Scientific Research, Romania, 2012, and the U.S. Environmental Protection Agency STAR Graduate Fellowship Program, 2013. Additionally, he has been an ad hoc proposal reviewer for NOAA Center for Sponsored Coastal Ocean Research (CSCOR) – MERHAB Program, DOD Environmental Remediation Technology Program, DOE Recovery Act: Energy Efficiency and Conservation Block Grant (DOE Environmental Management Consolidated Business Center (EMCBC)), USGS National Initiative of Water Resources (NIWR) program, Oak Ridge Associated Universities (ORAU), Water Environment Federation, National Science Council (NSC) in Taiwan, NSF Hydrological Sciences Program and International Research Fellowship Program, U.S. - Israel Binational Science Foundation, Research Grant Council in Hong Kong, China, National Science and Engineering Research Council of Canada (NSERC) in Canada, Joint German-

Israeli Research Program in Germany and Israel, National Research Foundation in Singapore, the Portuguese Foundation for Science and Technology (FCT), The State University of New York (SUNY) 4E Network of Excellence Collaboration Grants, the Netherlands Organisation for Scientific Research, and the Israel Science Foundation (ISF).

EUROPEAN ACADEMY OF SCIENCES

Since being elected foreign member of the European Academy of Sciences (EAS) in 2008, N.B. Chang has been involving in EAS activities. He served as one of the board members in Earth Sciences and Environmental Sciences Division. Chang organized and chaired with Dr. Sven Jorgensen (Chair of the Board) a two-day Workshop on the topics “Ecological Modeling for Stormwater Management”, which took place in the Stormwater Management Academy at University of Central Florida on Thursday and Friday, Sept. 27 and 28, 2012. Since 2008, N. B. Chang has voted for several new fellow candidates of the EAS at activities of the board. He co-edited with Dr. Sven Jorgensen a book entitled "Advances in Ecological Modelling and Ecological Engineering - Lakes and Wetlands" to be published by Elsevier in 2013. He is a member of the organizing committee of the "Encyclopedia for Environmental Management" published by the Taylor and Francis Group in Jan. 2013.

PROFESSIONAL SOCIETY ACITVITIES

N.B. Chang has been highly active in many professional societies such as American Society of Civil Engineers (ASCE), American Geophysical Union (AGU), International Water Association (IWA), American Association for the Advancement of Science (AAAS), International Society for Optics and Photonics (SPIE) and Institute of Electronics and Electrical Engineers (IEEE). Chang was the founding member and current board member of the International Society of Environmental Information Management (ISEIS). Chang has been the chair of the task committee of “Urbanization Effect on Groundwater” in ESRI/ASCE for many years. He has been with Groundwater Management Committee, International Council, Watershed Management Systems Analysis Task Committee, Green Roofs Task Committee, Environmental and Water Resources System Committee in EWRI/ASCE. He is a Member of Watershed and River Basin Management Specialty Group in IWA and a Member, the Leadership Team (LT) of the Joint IAHR-IWA Hydroinformatics Committee. He has been a Senior Member of SPIE, Session Chair, Co-Chair, and Chair of "Remote Sensing and Modeling of Ecosystems for Sustainability, SPIE Remote Sensing Conference, held in San Diego, CA, USA, since 2007 annually. Chang is the Chair of the Committee of Urbanization Effect on Groundwater in EWRI/ASCE. Besides, with the partnership from University of Alberta (Dr. Sushanta K. Mitra and Thomas Thundat), he Co-Chair of session "Water Purification and Monitoring under Minimal Resource Setting" in 2013 AAAS Annual Meeting, Boston, to be held on 14-18 February, 2013. Chang has been a Senior Members of the IEEE with affiliations in Systems, Man and Cybernetics (SMC) Society through activities such as being a co-chair of the Technical Committee for "Environmental Sensing, Networking and Decision-Making", "Intelligent Transportation System", and "Grey System Technical Committee". He is also affiliated with Technical Committee on "Intelligent Transportation System" and "Conflict Resolution" in IEEE SMC, "Earth Science Informatics" Technical Committee in IEEE Geosciences and Remote Sensing Society and IEEE Intelligence System Applications Technical Committee in IEEE Computational Intelligence Society. He is the chair of the Best Paper Award Committee and a member of the International Organizing Committee of the IEEE International Conference on Networking, Sensing and Control (ICNSC), IEEE Systems, Man, and Cybernetics Society held at Paris-Evry, France on April 10 – 12, 2013. He is the chair of the IEEE International Conference on Networking, Sensing and Control (ICNSC) held at Miami, USA on April 7 – 10, 2014. Chang is also an active member of IEEE Geosciences and Remote Sensing Society and IEEE Computational Intelligence Society.

INTERNATIONAL ACADEMIC COLLABORATION

N.B. Chang has been extremely busy in organizing and participating in numerous international activities. Chang fostered over twenty strategic alliances worldwide for research collaboration between the Stormwater Management Academy (SMA) and overseas institutions. He organized and edited 10 special issues of journals on a range of different topics for Journal of Applied Remote Sensing, Journal of Environmental Modeling & Assessment, Journal of Hazardous, Toxic, and Radioactive Waste Management (ASCE), Stochastic Environmental Research & Risk Assessment, Journal of Environmental Management, Journal of Environmental Informatics, Journal of Civil Engineering and Environmental Systems, Journal of Hydrological Engineering (ASCE), and Ecological Informatics. He was a member of the Graduate Program Assessment Committee of Graduate Institute of Environmental Engineering, National Taiwan University, Taiwan, in May, 2010. He has been an Editor, Associate Editor and Editorial Board member with over 30+ journals at present across the globe and been ad hoc reviewers of 80+ relevant journals. He has been highly active in many professional organizations such as the ASCE, AAAS, SPIE and IEEE from which he built on an international collaborative network. Over a 10-year period, Chang participated in the various international collaborative channels via the supervision of Chinese Ph.D. students and delivering short courses and seminars in China, Singapore, and Taiwan. Throughout his career, Chang has regularly presented leading-edge research accomplishments over 50 institutes and universities around the globe with a current focus on the partnership with United Kingdom (University of Exeter and University of Bristol), Canada (University of Waterloo), Taiwan (National Central University and Tunghai University), Japan (Tokyo University and Kumamota University), Portugal (Universidade Nova de Lisboa), Spain (University of Valencia) and Germany (the Institute of Bio and Geoscience (IBG) of the Forschungszentrum Jülich, the Helmholtz Association of German Research Centre). He was one of the founders of International Society of Environmental Information Management and a board member at present. He was the founding editor-in-chief of the *Journal of Environmental Informatics* and the *British Journal of Environment and Climate Change.* He is the editor-in-chief of SPIE official *Journal of Applied Remote Sensing* as well as an editorial board member of 30+ international journals by which he made a strong networking with international scholars worldwide.

CONFERENCE ORGANIZATION

N.B. Chang has been the Chair or Co-Chair and main organizer of many international conferences and been an active member of the scientific planning committee of more than 50 other conferences, many of which involved the planning and chairing of special tracks of sessions. Since 2008, Chang has helped to organize and chair special tracks of sessions on “Urbanization Effect on Groundwater” at the annual conferences of the ASCE/EWRI. He is a member of International Advisory Board of the 7th ASCE International Engineering and Construction Conference on “Green Infrastructure System” held on February 13-15, 2012 at Brisbane, Australia. He is a member of International Program Committee in 2011 and 2012 IEEE International Conference on Grey Systems and Intelligent Services. In 2010, he chaired the Workshop of Green Engineering and Industrial Ecology, held in the University of Kaohsiung, on June 3 – June 14, Kaohsiung, Taiwan, 2010 after he chaired the session in Hydrological and Environmental Remote Sensing for Global Changes, 2010, the Western Pacific Geophysical Meeting (WPGM), held on May 22-25, Taipei, Taiwan. In 2013, he organized a session in the international conference on "Stochastic and Statistical Methods in Hydrology and Environmental Engineering to be held in Koblenz, Germany. These ongoing conferences are now called the International Conferences on Water and Environment Research (ICWRER), for which Chang is a member of the ICWRER Steering Committee. He is also the general chair of 2014 IEEE Conference for Sensing, Networking, and Control to be held in Miami, Florida and the SPIE-wide Conference of

Remote Sensing and Modeling of Ecosystem for Sustainability to be held in San Diego, California in 2014.

PROGRAMMATIC LEADERSHIP IN THE NATIONAL SCIENCE FOUNDATION

Chang is the program director of the Hydrological Science Program under the Earth Science Division of the Directorate of Geosciences; besides, he is also involved in two ongoing Science, Engineering, Education, and Sustainability (SEES) programs, including the Cyber-enabled Sustainability Science and Engineering (CyberSEES) program and the Small Business Technology Transfer-Accelerating Sustainability using Enabling Technologies (STTR-ASET) programs serving as the cognizant program director. He is designated as a member of the Statistical Committee under the Directorate of Geosciences.

ADMINISTRATIVE DUTIES IN THE UNIVERSITY OF CENTRAL FLORIDA

Chang has served his colleagues in numerous capacities at the departmental faculty and university levels. For instance, he has been serving as director of the Stormwater Management Academy (SMA), from which a suite of low impact development technologies (8 US Patents) that are transferrable for green building systems were developed. At UCF, he has been a Member of numerous committees such as the Promotion and Tenure Committees, Chair Search Committee, ABET Review Committee at the Departmental level, the Sabbatical Committee at the College level, and the Environmental Management Council at the University level.