CURRICULUM VITAE

Ni-Bin Chang

FNAI, FAAAS, FASCE, FIEEE, FSPIE, F.RSC, FAAIA, FIAAM, FEurASc, LEED

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SUMMARY

Dr. Ni-Bin Chang is Professor of Sustainable System Engineering having held this post in the United States (U.S.) since 2002. Chang's research covers a suite of topics interfaced among environmental infrastructure systems, physical infrastructure systems, and cyberinfrastructure systems. He cultivated a collaborative community across the U.S., Spain, Netherlands, Portugal, France, the United Kingdom, Czech Republic, Denmark, Germany, Taiwan, Hong Kong, China, Vietnam, Canada, Honduras, Nicaragua, Brazil, and Algeria for transdisciplinary research of sustainable development. In the past three more decades, Chang combined theory and experimentation to resolve key contemporary challenges of planning strategies, sustainable design, intelligent monitoring, integrated modeling, and preventive practices with scales, involving buildings, communities, urban infrastructures, watersheds, and coastal regions. These cross-linked research topics deepened the understanding of coupled nature and engineered systems via technology hub integration and system analyses. He strived to promote sustainable resources management and industrial ecology in a circular economy, fix disrupted nitrogen cycle in the built environment, improve remote sensing and environmental monitoring, explore multi-scale modeling, and conduct complex adaptive system analysis through feedback loops and interconnected processes to reduce human health impact and restore ecosystem function. He has been looking for interdisciplinary sustainability solutions with synergistic knowledge rooted among intertwined issues such as urban food-energy-water-waste nexus under rapid urban sprawl and climate change impact. To fix the nitrogen cycle and remove various contaminants in aquatic environments, his inventions of green sorption media (GSM) are cost-effective, scalable, adaptable, and sustainable for the removal of nutrients, heavy metals, E. coli, tannic acid, algal toxins, and fluorinated surfactants simultaneously from stormwater runoff, agricultural discharge, groundwater, and wastewater effluent. Chang was granted 16 U.S. patents, creating a paradigm shift of passive water treatment approach (e.g., low impact development) that ended up with various fit-for-purpose GSM applications at 300+ sites in the U.S. His efforts of research and education have led to intellectual development providing risk-informed, forward-looking, cost-effective, and environmental benign solutions. Since 1987, he has received 49 honor/awards, including the ASCE Outstanding Achievement Award, the Bridging the Gaps Award from the Engineering and Physical Sciences Research Council and the Distinguished Visiting Fellowship from the Royal Academy of Engineering in the United Kingdom in 2012 and 2014, respectively, and the Blaise Pascal Medal from the European Academy of Sciences in 2016. Chang served as program director in the Hydrologic Sciences Program and the Cyber-Innovated Sustainability Science and Engineering (CyberSEES) Program at the National Science Foundation from Aug. 2012 to Aug. 2014. He is one of the executive board members of the Florida Climate Institute, promoting the sector-based exploration of decarbonization pathways. He served as the Editor-in-Chief of the SPIE Journal of Applied Remote Sensing from 2014 to 2023, and he is the current Editor-in-Chief of the IWA Journal of Hydroinformatics (2023~present). Chang is a Fellow of the National Academy of Inventors (FNAI), the American Society of Civil Engineers (FASCE), the Institute of Electrical and Electronics Engineers (FIEEE), the International Society of Optics and Photonics (FSPIE), the American Association for the Advancement of Science (FAAAS), the Royal Society of Chemistry (FRSC) in the United Kingdom, the International Association of Advanced Materials (FIAAM), the Asia-Pacific Artificial Intelligence Association (FAAIA), and a foreign member of the European Academy of Sciences (FEurASc) in the European Union.

PROFESSINAL PREPARATION AND EDUCATION

Ph.D. Environmental Systems Engineering (Major field), Operation Research and Environmental Economics (Minor fields), Cornell University, NY, USA, Aug. 1989-Aug. 1991.
M.S. Environmental Systems Engineering, Cornell University, NY, USA, Aug. 1987-Aug. 1989.
B.S. Civil Engineering, National Chiao-Tung University, Taiwan, Aug. 1979-June 1983.

ACADEMIC APPOINTMENTS

<u>Date</u>	<u>Position</u>
1. Aug. 2005~the present	Professor Department of Civil and Environmental Engineering (primary appointment) University of Central Florida (UCF) Orlando, FL, 32816, USA
2. May 2024~ the present	Professor Department of Computer Science (secondary appointment) University of Central Florida (UCF) Orlando, FL, 32816, USA
4. Aug. 2009~July 2014	Professor Department of Industrial Engineering and Management Science (secondary appointment) University of Central Florida (UCF) Orlando, FL, 32816, USA
5. Oct. 2011~the present	Director, UCF Stormwater Management Academy http://www.stormwater.ucf.edu/ University of Central Florida (UCF) Orlando, FL, 32816, USA
6. Dec. 2024 ~ Dec. 2024	Visiting Professor Department of Civil and Environmental Engineering Duke University Durham, NC, USA
7. Jan. 2009~May 2009	Visiting Scientist Center of Remote Sensing and Modeling for Agricultural Sustainability, USDA, Fort Colin, CO, USA
8. Sept. 2008~Jan. 2009	Visiting Scientist National Risk Management Research Laboratory, USEPA Cincinnati, Ohio, USA
9. Jan. 2002~ Aug. 2005	Professor Department of Environmental Engineering Texas A&M University-Kingsville (TAMUK) Kingsville, Texas, 78363, USA
10. Aug. 1997 ~ Jan. 2002	Professor Dept. of Environmental Engineering National Cheng-Kung University (NCKU) Tainan, Taiwan

11. June 1999 ~ Sep. 1999   Visiting Professor
Department of Systems Engineering
University of Pennsylvania (UPenn)
Philadelphia, PA, USA

12. Jan. 2000 ~ June 2000   Adjunct Professor
Graduate Institute of Environmental Science
Tunghai University (TU)
Taichun, Taiwan

13. Jan. 1998 ~ June 1998   Adjunct Associate Professor
Graduate Institute of Environmental Engineering
National Taiwan University (NTU)
Taipei, Taiwan

14. Aug. 1992 ~ Aug. 1997   Associate Professor
Dept. of Environmental Engineering
National Cheng-Kung University (NCKU)
Tainan, Taiwan

INDUSTRIAL AND NON-ACADEMIC APPOINTMENTS

<u>Date</u>	<u>Position</u>
1. Aug. 2012 ~ Aug. 2014	Program Director, Hydrological Sciences Program Program Director, Cyber-enabled Sustainability Science and Engineering (CyberSEES) Program National Science Foundation Arlington, VA, USA <u>Major work</u>: Management of the proposal review processes and panels, budget distribution, serve and support the research community, engagement with researchers across various disciplines, and involvement of cross-foundation and cross-federal-agency collaborative programs
2. Feb. 1992 ~ July 1992	Deputy Manager Division of Environmental Engineering Fichtner Pacific Engineers, Inc. (German-based Consulting Firm) Taipei, Taiwan <u>Major work</u>: System planning of one sanitary landfill and four municipal incinerators for solid water management
3. Aug. 1991 ~ Feb. 1992	Deputy Manager Ecology & Environment, Inc. Taiwan Branch Office (US-based Consulting Firm) Taipei, Taiwan <u>Major work</u>: Hazardous water management in industrial complexes and soil and groundwater remediation in an urbanized region
4. Jan. 1986 ~ Aug. 1987	Senior Environmental Engineer Dept. of Environmental Engineering Housing and Urban Development Bureau Taiwan Provincial Government Taipei, Taiwan

	Major work: Design of sanitary sewer system and coastal wastewater treatment plant in connection with an ocean outfall system
5. Aug. 1985 ~ Jan. 1986	Junior Environmental Engineer Bureau of Environmental Protection Kaohsiung City Government Kaohsiung, Taiwan Major work: Environmental management of petrochemical industry, and water quality monitoring in an urban river and coastal water system
6. Oct. 1983 ~ Aug. 1985	Junior Lieutenant (facility engineer in the Marine Corps Training Center), the Navy of Taiwan Major work: Maintenance of water supply and drainage system, and construction supervision of a four-story building and a tennis court in a Navy Base

HONOR AND AWARDS

1. Member, Engineering Section, Florida Academy of Sciences, July 2024. (ID: 3564)
2. IEEE Most Active Technical Committee Award in Human-Machine System, IEEE Systems, Man, and Cybernetics (SMC) Society, Oct. 2024.
3. Listed among top 0.28% and 0.21% of environmental scientists and environmental engineers, respectively, and top 0.42% of the engineering community globally, in terms of citations from 1993 to 2023, as summarized by Stanford University and released by Elsevier, Sept. 2024. https://elsevier.digitalcommonsdata.com/datasets/btchxktzyw/7
4. Listed as an inaugural Highly Ranked Scholar worldwide by ScholarGPS on May 3, 2024 (with a global ranking of four subject areas: #1 Municipal Solid Waste, #4 Environmental Resources Management; #7 Waste Management; #14 Urban Area Research). In specialty areas, Chang was listed as top 0.13% in environmental systems, top 0.27% in machine learning, top 0.3% in data fusion, and top 0.3% in remote sensing.
   ScholarGPS is a California-based company that applies artificial intelligence, data mining, machine learning, and other data science techniques to its massive database of over 200 million publications and 3 billion citations to rank over 30 million scholars and 55,000 institutions worldwide. https://scholargps.com/scholars/10967519059777/ni-bin-chang?e_ref=40ae3b4c3d9a9023b106
5. UCF Research Incentive Award, March 2023.
6. Fellow, Asia-Pacific Artificial Intelligence Association (AAIA), Aug. 2023. https://www.aiia-ai.org/col.jsp?id=245
7. Certified World's AI Top Scientist, International Artificial Intelligence Industry Alliance (AIIA), Nov. 2023. https://www.aiia-ai.org/nd.jsp?id=275&fromMid=3681&groupId=31
8. Fulbright Canada Research Chair in Interdisciplinary Sustainability Solutions, the Department of State in the US and the Fulbright Canada, May 2020. (Finalist)
9. Fellow, the International Association of Advanced Materials (IAAM) (Citation: "in recognition of his contribution to advancement of recycling and waste management"), Sept. 2020.
10. University Excellence in Research Award, UCF, Feb. 2019. (Citation: in recognition of his outstanding contributions in research and commitment to excellence in scholarly and creative activities)
11. Excellence in Research Award, College of Engineering and Computer Science, UCF, USA, Jan. 2019.
12. UCF Research Incentive Award, USA, March 2018.

13. IEEE Distinguished Lecturer, the IEEE Systems Council, May 2018 (2018-2027).
14. Fellow, the National Academy of Inventors (NAI), Dec. 2018 (Citation: for his contributions to the field of nutrient monitoring, removal, and possible recovery in aquatic environment.)
15. UCF Chapter Member, the National Academy of Inventors (NAI), USA, Nov. 2017. (Citation: in recognition of his advanced technology development and innovation issued by the United States Patent and Trademarks Office.)
16. Fellow, the Institute of Electrical and Electronics Engineers (IEEE), Nov. 2017. (ID: 90573668) (Citation: for contributions to computational techniques for the analysis of environmental sustainability".)
17. The Blaise Pascal Medal (in Earth and Environmental Sciences), the European Academy of Sciences, Nov. 2016. (Citation: "for his contributions to the environmental sustainability, green engineering, and systems analysis").
18. Fellow, the Royal Society of Chemistry (RSC), the United Kingdom, June 2015. (ID: 571142)
19. Executive Board Member, Florida Climate Institute, Aug. 2015 ~ Present.
20. Fellow, the International Society of Optics and Photonics (SPIE), Dec. 2014. (ID: 882117) (Citation: "for contributions to remote sensing and modeling for earth observations").
21. Distinguished Visiting Fellowship, Royal Academy of Engineering (RAE), the United Kingdom, Feb. 2014, hosted by the University of Bristol and Heriot-Watt University, United Kingdom.
22. IEEE Meritorious Services Award, IEEE Systems, Man, and Cybernetics Society, Oct. 2014.
23. UCF Research Incentive Award, March 2013.
24. UCF Innovator Award, Aug. 2012.
25. Fulbright Specialist Award, Department of State in the United States and the German-American Fulbright Commission, hosted by the Institute of Bio and Geoscience (IBG) of the Forschungszentrum Jülich, Germany, Jülich, Germany, July 2012.
26. Honorary Distinguished Chair Professor, Tunghai University, Taiwan, June 2012.
27. Bridging the Gaps Award, Engineering and Physical Sciences Research Council (EPSRC), the United Kingdom, hosted by University of Exeter, the United Kingdom, May 2012.
28. Intergovernmental Personnel Award, National Science Foundation, USA, Aug. 2012 – Aug. 2014. (Program director in the Hydrologic Sciences Program and the Cyber-Innovation Sustainability Science and Engineering Program at the NSF for two years.)
29. Fellow, American Association for the Advancement of Science (AAAS), Feb. 2012. (ID: 40295539) (Citation: "for contributions to the integrated sensing, monitoring and modeling for decision making".)
30. Outstanding Achievement Award, Environmental and Water Resources Institute (EWRI), ASCE, May 2010.
31. Board Member, Earth Science and Environmental Science Division, the European Academy of Sciences, 2010-2016.
32. Honorary Distinguished Chair Professorship, National Science Council, Taiwan, June 2010.
33. Honorary Visiting Professor, Chaoyang University of Technology, Taiwan, May 2010.
34. Fellow, the American Society of Civil Engineers (ASCE), USA, Feb. 2009. (ID: 285056)
35. Fellow (Foreign Member), European Academy of Sciences (http://www.eurasc.org), European Union, Oct. 2008.
36. Best Paper Award in the 6th International Conference on Environmental Informatics, Bangkok, Thailand, Nov. 21-23, 2007.
37. International Fellowship Award for Visiting Europe (The United Kingdom), National Science Council, Taiwan, 2001.
38. International Fellowship Award for Visiting Europe (Germany), National Science Council, Taiwan, 2000.
39. Young Engineer Award, Chinese Institute of Engineers, Taiwan, 1999.

40. Research Excellence Award, National Science Council, Taiwan, 1999-2001.
41. Research Excellence Award, National Science Council, Taiwan, 1997-1999.
42. Best Paper Award, Chinese Institute of Environmental Engineering, Taiwan, April 1997.
43. Annual Research Award, National Science Council, Taiwan, Feb. 1996.
44. Annual Research Award, National Science Council, Taiwan, Feb. 1995.
45. Russell Ackoff Award, 1994, International Conference of Solid Waste Technology and Management, Univ. of Penn., USA, Oct. 1994.
46. Annual Research Award, National Science Council, Taiwan, Feb. 1994.
47. National Scholarship Award for Overseas Graduate Study, Ministry of Education, Taiwan, Aug. 1987-July 1990.
48. No. 1 in ranking of the National Professional License Examination of Environmental Engineering, Taiwan, 1986
49. No. 1 in ranking of the National Civil Servant Examination of Environmental Engineering, Taiwan, 1986

PROFESSIONAL AFFILIATIONS

1. Florida Academy of Sciences (FAS) (Member, 2024 Class)
2. Asia-Pacific Artificial Intelligence Association (AAIA) (Fellow, 2023 Class)
3. International Association of Advanced Materials (IAAM) (Fellow, 2020 Class)
4. National Academy of Inventors (NAI), (Fellow, 2018 class)
5. Institute of Electronics and Electrical Engineers (IEEE) (Fellow, 2017 Class)
6. Royal Society of Chemistry (RSC), the United Kingdom (Fellow, 2015 Class)
7. International Society of Optics and Photonics (SPIE) (Fellow, 2014 Class)
8. American Association for the Advancement of Science (AAAS) (Fellow, 2012 Class)
9. American Society of Civil Engineers (ASCE) (Fellow, 2009 Class)
10. European Academy of Sciences, European Union (Fellow, 2008 Class)
11. CUAHSI (Consortium of Universities for the Advancement of Hydrologic Science, Inc.) – Representative of University of Central Florida (Member) (2010-present)
12. International Water Association (IWA) (Member) (2015-present)
13. Florida Climate Institute (FCI) (Executive Board Member) (2014-present)
14. American Geophysical Union (AGU) (Lifetime Member) (2010-present
15. Member of the Professional Engineers of Texas (2004-present)
16. ISO14001 Environmental Management System Leader Auditor (Certificate) (1997-present)
17. Leadership in Energy and Environmental Design (LEED), U.S. Green Building Council (Certificate) (2004-present)

RESEARCH PUBLICATION SUMMARY

1. **Refereed English Books**: 3
2. **Edited English Books/Proceedings**: 6
3. **Refereed Journal Papers**: 320
4. **Invited Book Chapters, Encyclopedia, and Newsletters:** 30+
6. **Conference Papers/Invited Presentations**: 300+
7. **Technical Reports**: 100+
8. **US Patents**: 16

Chang explored intertwined transboundary water, air, land, and waste management issues for

sustainable development. His research is highly interdisciplinary in nature and covers a broad spectrum of topics lying at the intersection of multiple disciplines after fostering new research directions and global collaborative network with partners and stakeholders. He has been looking for interdisciplinary sustainability solutions with synergistic knowledge system rooted among intertwined issues, such as urban food-energy-water-waste infrastructure systems under rapid urbanization process and climate change impact. Chang created many comprehensive and multifaceted approaches in response to challenges and opportunities for sustainable development. His endeavor of sensing and monitoring water, air, and land management systems aided in forensic identification of environmental system status and ecosystem state, and flourished science commons across infrastructure systems by linking natural science, engineering science, data science, open science, and knowledge communities together. In dealing with highly nonlinear and nonstationary challenges, he used component-specific artificial intelligence and machine learning knowledge and sustainability criteria for monitoring, prediction, and controlling of environmental quality, examining ecosystem integrity, and evaluating land use patterns via complex adaptive system intelligence. His work of system analysis constituted a new information-processing paradigm in simulating and exploring underlying relationships of environmental media and infrastructure systems that are not fully understood in relevant domain sciences. His research findings have been published by many flagship or high-impact journals, such as *Journal of Hazardous Materials*, *Water Research*, *Environmental Science and Technology*, *Environment International*, *Critical Reviews in Environmental Science and Technology*, *Applied Energy*, *Remote Sensing of Environment*, *Earth System Science Data*, *Earth Science Reviews*, *Scientific Reports, Nature-Food*, *Resources Conservation and Recycling*, *IEEE Transactions on Neural Networks and Learning Systems, IEEE Transactions on Systems, Man, and Cybernetics: Systems*, *Journal of Photogrammetry and Remote Sensing*, etc. According to Google Scholar, as of March 2025, his research publications have been cited by 19,243 times (h-index: 73; i10-index: 288). His publications can be culminated and classified and listed below according to the five topical areas, including: 1) Water Infrastructure Systems Analysis in Response to Global Change Impact and Sustainable Development; 2) Hydrological and Environmental Remote Sensing and Monitoring Networks; 3) Surface Water, Groundwater and Wastewater Treatment Process Optimization and Control; 4) Industrial Ecology, Green Engineering, and Ecological Engineering; and 5) Waste Management and Resources Recycling for Municipal and Industrial Waste Streams.

RESEARCH TOPICS AND PUBLICATIONS

In this section, relevant refereed journal papers, patents, encyclopedia articles, book chapters and books are categorized based on the five research topics, contributing significantly to the advancement of sustainable engineering and sustainability science for global sustainable development in new fields and disciplines with policy implications.

Water Infrastructure Systems Analysis in Response to Global Change Impact and Sustainable Development

Book

1. Chang, N. B. (2010) Systems Analysis for Sustainable Engineering. Published by McGraw Hill, New York, USA, 688 pp. ISBN-13: 978-0071630054

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.

3. Drunpob, A., Chang, N. B., Beaman, M. (2012) Stream flowrate prediction using genetic programming model in a semi-arid coastal watershed, in Impacts of Global Climate Change (ASCE), 1-12.

Journal Papers: Coupled Natural System and the Built Environment

Theory and Concepts

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.

5. 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.

6. 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.

7. 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.

8. 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.

9. 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.

10. 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.

11. Sun, Z., Lotz, T., and Chang, N. B. (2017) Assessing the long-term effects of land use changes on runoff patterns and food production in a large lake watershed with policy implications. *Journal of Environmental Management,* **204(1)**, 92-101.

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. <u>Chang, N. B.</u>, 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. <u>Chang, N. B.</u>, 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. <u>Chang, N. B.</u>, 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. <u>Chang, N. B.</u> 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 <u>Chang, N. B</u>. (1998) Water pollution control in a river basin by genetic algorithm-based fuzzy multi-objective programming. *Water Science and Technology*, **37(8)**, 55-63.

7. <u>Chang, N. B.</u>, 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 <u>Chang, N. B.</u> (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 <u>Chang, N. B.</u> (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: Information Technologies

1. <u>Chang, N. B,</u> Chen, H. W., Ning, S. K. and Cheng, 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 <u>Chang, N. B.</u> (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 <u>Chang, N. B.</u> (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., <u>Chang, N. B.,</u> 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: Sustainability and Ecosystem Services Assessment under Climate Impact

Ecosystem Valuation and Environmental Economics

1. Chen, H. W., <u>Chang, N. B.</u> 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.

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.

Water Quality Classification

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

Journal Papers: Global Change, Hydrology, and Drainage Infrastructures

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 ungauged basin confluences: a case study for Nashville, TN. *Journal of Hydrologic Engineering*, ASCE, **17(7)**, 790-800.

4. Sun, Z., 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.

5. 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.

6. Chang, N. B., Valdez, M., Chen, C. F., Imen, S., and Mullon, L. (2015) Global nonlinear and nonstationary climate change effects on regional precipitation and forest phenology in Panama, Central America. *Hydrological Processes,* **29(3)**, 339-355.

7. Bai, K., Chang, N. B., and Gao, W. (2016) Quantification of relative contribution of Antarctic ozone depletion to increased austral extratropical precipitation during 1979-2013 period. *Journal of Geophysical Research - Atmospheres*, **121(4),** 1459–1474.

8. Bai, K., <u>Chang, N. B.</u>, Shi, R., Yu, H., and Gao, W. (2017) An inter-comparison of multi-decadal observational and reanalysis data sets for global total ozone trends and variability analysis. *Journal of Geophysical Research - Atmospheres,* **122***,* 7119–7139.

8. Joyce, J., <u>Chang, N. B.</u>, Harji, R., Ruppert, T., and Imen, S. (2017) Developing a multi-scale modeling system for resilience assessment of green-grey drainage infrastructures under climate change and sea level rise impact. *Environmental Modelling and Software*, **90**, 1-26.

9. <u>Chang, N. B</u>., Yang, J., Imen, S., and Mullon, L. (2017) Multi-scale quantitative precipitation forecasting using nonlinear and nonstationary teleconnection signals and artificial neural network models. *Journal of Hydrology*, **548**, 305-321.

10. <u>Chang, N. B</u>., Imen, S., Bai, K., and J. Yang (2017) The impact of global unknown teleconnection patterns on terrestrial precipitation across North and Central America. *Journal of Atmospheric Research*, **193**, 107–124.

11. Lu, Q., Joyce, J., Imen, S., and <u>Chang, N. B.</u> (2017) Linking socioeconomic development, sea level rise, and climate change impacts on urban growth in New York City with a fuzzy cellular automata-based Markov chain model. *Environment and Planning B: Urban Analytics and City Science*, DOI: 10.1177/2399808317720797.

12. Joyce, J., <u>Chang, N. B.</u>, Harji, R., Ruppert, T., and Singhofen, P. (2017) Cascade impact of hurricane movement, storm tidal surge, sea level rise, and precipitation variability on flood assessment in a coastal watershed. *Climate Dynamics,* **51(1)**, 383-409.

13. Joyce, J., <u>Chang, N. B.</u>, Harji, R., and Ruppert, T. (2018) Coupling infrastructure resilience and flood risk assessment via copulas analyses for a coastal green-grey-blue drainage system under extreme weather events. *Environmental Modelling and Software,* **100**, 82-103.

14. Lu, Q., <u>Chang, N. B.</u>, and Joyce, J (2018) Predicting long-term urban growth in Beijing (China) with new factors and constraints of environmental change under integrated stochastic and fuzzy uncertainties. *Stochastic Environmental Research and Risk Assessment,* **32(7)**, 2025-2044.

15. Lu, Q., <u>Chang, N. B.</u>, Joyce, J., Chen, A. S., Savic, D. A., Djordjevic, S., and Fu, G. (2018) Exploring the potential flood impact on urban growth in London by a cellular automata-based Markov chain model. *Computers, Environment, and Urban Systems,* **68**, 121-132.

16. Bellanthudawage, K. A. B. and <u>Chang, N. B.</u> (2021) Hurricane Irma impact on biophysical and biochemical features of canopy vegetation in the Santa Fe River Basin, Florida. *International Journal of Applied Earth Observation and Geoinformation*, **102**, 102427.

17. Bellanthudawage, B. K. A. and <u>Chang, N. B.</u> (2022) Spectral index-based time series analysis of canopy resistance and resilience in a watershed under intermittent weather changes. *Ecological Informatics,* **69**, 101666.

Journal Papers: Agricultural Sustainability

1. <u>Chang, N. B.</u>, 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. <u>Chang, N. B.</u>, Mani, S., Gomathishanker, G., and Srilakshmi Kanth, R. (2009) Pesticide simazine impact assessment via using Enzyme-linked Immunosorbent Assay (ELISA) technique in the Lower Rio Grande River Basin, Texas. *Journal of Exposure and Health*, **1(3)**, 145-158.

<u>**Summary of Research in Water Infrastructure System Analysis for Global Change Impact and**</u>

Sustainable Development

Major Accomplishments: Global changes such as economic development, population growth and migration, climate change, and urbanization effect have resulted in a collective impact on the environment and ecosystem. Emphasis of Chang's work was placed on linking climatology, hydrology, and ecology with urbanization processes and exploring the intertwined issues among globalization, urbanization, and sustainability to enhance decision-relevant understanding of weather and climate extremes and their impacts on watershed function, urban metabolism and ecology, urban infrastructure systems, flood risk analysis, and coastal management. Based on the multi-physics-informed artificial intelligence concept, his research strived to identify interdisciplinary sustainability solutions and sought pathways for science to become policy when promoting the implications of complex large-scale system analysis through operation research, decision science, and data science in concert with geophysical experiment and machine learning design. First, global sea surface temperature (SST) anomalies have a demonstrable climate change effect on spatial and temporal precipitation patterns in terrestrial systems via ocean-atmosphere interactions for actionable climate science and water resource management. To realize the atmospheric circulation effect, his research group analyzed a series of short-term (10-year), and long-term (30 years) nonstationary and nonlinear teleconnection signals of SST anomalies at the Atlantic and Pacific Oceans with the aid of big data mining, machine learning, and geophysical analytics. Chang was a leading scientist who discovered some non-leading/unknown teleconnection patterns that showed salient effect on terrestrial precipitation and forest greenness in North and Central America that signified tropical-subtropical-extratropical interactions across space and time. These non-leading teleconnection spatiotemporal patterns combined with existing leading teleconnection patterns such as the El Nino Southern Oscillation (ENSO) and North Atlantic Oscillation (NAO) were integrated to contribute to more accurate seasonal (long-lead) precipitation forecasting with artificial intelligence-based wavelet analysis. Long-term forest greenness evolution also reflected terrestrial biosphere-climate interactions in relation to dynamics, impacts, and pathways to sustainability from earth system science perspective. However, SST is not the only driving force affecting long-lead precipitation. After analyzing the global total ozone trends and variability, quantification of relative contribution of Antarctic ozone depletion to increased austral extratropical precipitation during 1979-2013 period was also conducted at the global scale to prove the hypothesis, which represents an advancement in sustainability science. At the watershed scale, Chang investigated the impact of extreme weather events, such as hurricane impact on more biophysical and biochemical features of canopy vegetation in Florida and New England areas, which magnifies the importance of using earth observation data for disaster resilience assessment in a changing world with the aid of modeling and untangling climate-hydrology-ecology interactions through extreme events. When the large-scale climatological impact on regional precipitation and watershed landscape can be linked and realized, his work of exploring climate change's impact on watershed hydrology and urban development further aids in water infrastructure planning, design, and operation in terms of water availability and water quality finally. This exploration was achieved by integrated prediction, simulation and optimization models based on possible multitemporal land-use and land-cover changes, flow control of water system, water demand forecasting, renewable energy transition, urban agriculture, urban ecology, and chemical source, fate and transport processes in soil, air, and water environments. Such scientific understanding led to develop a more sustainable and resilient urban food-energy-water-waste-transport nexus with policy implication and societal impact based on the "System of Systems Engineering" approach. A set of new processes, tools, concepts, theories, frameworks, algorithms, methods, and platforms for designing, re-designing and deploying solutions support sustainable infrastructure planning, design, and operation, leading to generate sustainable urban land use management strategies. For example, a series of urban studies accounting for urban growth in three megacities (London, New York, and Beijing) under the impact of climate change was conducted to evaluate urbanization effect on flooding potential. His work of its kind led to couple infrastructure

resilience and flood risk analyses for assessing a coastal green-grey-blue drainage system in Tampa Bay under compound climate and weather hazards (multi-hazards). His work integrated water continuum from SST to atmospheric moisture delivery to regional precipitation to river system discharge to low impact development under global changes induced disturbances in coastal flood prone regions demonstrated an endeavor for smart and connected communities, especially for two low-income communities. Such endeavor integrated multi-scale modeling techniques for water resource management in coupled hydrological and social systems for those flood prone low-income mobile homes. To improve water quality management, Chang and his students developed the fuzzy synthetic evaluation approach to address risk levels in decision making due to uncertain water quality classification and contradictory diagnosis in coupled human and natural ecosystems from plot to watershed scales leading to reflect linguistic uncertainty via fuzzy decision making for interbasin transfer of water resource. Examples of generating spatially varied low impact development options in urban regions for stormwater management and permit trading of pollution load with respect to dynamic permit trading prices among upstream and downstream polluters for watershed management confirmed the application potential of his work in environmental economics. This series of work explored some scientific frontiers toward achieving UN's Sustainable Development Goals (SDGs).

Role: In this subject area, Chang was the team leader in a few multi-year extensive research projects funded by NSF, EPA, NOAA Florida Sea Grant, the British Council, and other agencies in collaboration with students, post-docs, visiting scientists and foreign partners from several countries. Chang led this series of research and conceived, developed, and/or tested several different types of hypotheses in systems analysis and simulation/optimization models for environmental sustainability assessment. In cooperation with partners worldwide, he mentored students and scholars to conduct forward-looking strategic endeavor with integrated sensing, monitoring, and modeling techniques toward sustainable decision making.

Impact: The ability to quantitatively evaluate the cascade impact of climate change from global to continental to regional to urban region is crucial for sustainable development by opening transparent modeling workflows for decision support, especially for watershed management, regional planning, and urban design. The body of his work of teleconnection signal propagation studies with pattern recognition via wavelet analysis has strengthened the foundations of climate informatics in relation to terrestrial precipitation, streamflow, and vegetation greenness in North and Central America. In addition to sea surface temperature anomalies, relative contribution of Antarctic ozone depletion to increased austral extratropical precipitation in terrestrial systems in Australia was published to extend the milestone. The integrated wavelet-based empirical orthogonal function for precipitation forecasting driven by climatological patterns resulted in a new dimension of geophysical knowledge for large watershed management. His work for the Cross Bayou Watershed in Tampa Bay promoted the implications of advanced modeling and numerical experiment design for risk assessment of extreme events. Such series of advancements deepened the understanding of how climate factors and multiscale teleconnection signals could bridge big data analytics to decisions with the aid of earth observation and modeling for informed water security strategies at the global and regional scale. Chang also carried out research at the watershed scale for pollution load allocation and relocation based on permit trading schemes across different pollution units in a river system. With such advancements, the publication of "watershed-based point sources permitting strategy and dynamic permit trading analysis, "published by *Journal of Environmental Management* was 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 impacted the policy making for water resources management in different part of the world. Besides, the publication of "identification of river water quality using the fuzzy synthetic evaluation approach published by the *Journal of Environmental Management* has been cited by 462 times as of June 2024, due to its novelty in dealing with the

uncertainty embedded in water quality classification and diagnosis in a river system. To create multifunctional working landscapes in the Nueces River watershed, South Texas that benefit both people and the environment, his work via the use of remote sensing-based genetic programming model for streamflow forecasting, the assessment of seasonal changes of riparian buffer in the river corridor, and the optimal deployment of hydrological monitoring stations in the watershed. These efforts seamlessly integrated machine learning and physics-based optimization models for watershed science and collectively advanced remote sensing-based soil moisture research for better water resource management. Such a series publications exhibited a milestone, demonstrating sustainable watershed management strategies in the context of global environmental change under uncertainty. Chang's research has also significantly impacted urban water infrastructure assessment and advanced flood prediction and risk assessment in coastal, inland and transition zones as well as hurricane landfall impact on ecosystems (food web in lakes and greenness in forested land) in East Asia and North America, which is deemed the premier urban water management studies under global environmental change. He was invited to present such findings in dealing with natural hazard impact (flood, drought, and hurricane landfall) in several countries, providing sustainable resources management strategies for a growing human population in regard to mitigating and adapting to climate change and preventing biodiversity loss. His endeavor confirmed the UN's SDGs which include SDG 4 (Quality Education), SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), SDG 10 (Reduce Inequalities), SDG 11 (Sustainable Cities and Communities), SDG 13 (Climate Action), SDG 15 (Life on Land), SDG 16 (Peace, Justice, and Strong Institutions), and SDG 17 (Partners for the Goals). Chang was elected as a Fellow of ASCE in 2009 and IEEE in 2017 "for contributions to computational techniques for the analysis of environmental sustainability". He received the Blaise Pascal Medal (the Fields Medal in Earth and Environmental Sciences) from the European Academy of Sciences in Nov. 2016, with a citation: "for his contributions to the environmental sustainability, green engineering, and systems analysis".

Hydrological and Environmental Remote Sensing and Monitoring Networks

Books

1. Chang, N. B. and Yang Hong (Eds) (2012) Multi-scale Hydrological Remote Sensing: Perspectives and Applications. Published by the CRC Press, Boca Raton, FL, USA, 568 pp. ISBN: 978-1439877456
2. Chang, N. B. (Ed) (2012) Environmental Remote Sensing and Systems Analysis. Published by the CRC Press, Boca Raton, FL, USA, 550 pp. ISBN: 978-1439877432
3. Chang, N. B. and Bai, K. (2018) Multisensor Data Fusion and Machine Learning for Environmental Remote Sensing. Published by the CRC Press, Boca Raton, FL, USA, 508 pp. ISBN: 978-1498774338
4. Weng, Q., Gamba, P., Chang, N. B., Wang, G., and Yao, W., Proceedings of The Fifth International Workshop on Earth Observation and Remote Sensing Applications (EORSA 2018)
IEEE Catalog Number: CFP1839E-ART, ISBN: 978-1-5386-6642-5.

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-source 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. Khan, S., Chang, N. B., Hong, Y., Xianwu Xue, and Yu Zhang (2015) Remote Sensing for Multi-scale Hydrological Studies: Advances and Perspectives, in Remote Sensing of Water Resources, Disasters and Urban Studies, Vol. III, Ed, Prasad Thenkabail (Taylor and Francis Group-CRC Press).

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. (2015) 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*, **45(2)**, 101-166.

Journal Papers: Environmental Monitoring Network Assessment, Multidimensional Statistics, and Data Science

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.

4. Bai, K., Chang, N. B., Yu, H., and Gao, W. (2016) Statistical bias corrections for creating coherent total ozone records with OMI and OMPS observations. *Remote Sensing of Environment*, **182**, 150–168.

5. Bai, K., Chang, N. B., Zhou, J., Gao, W., and Guo, J. (2019) Diagnosing atmospheric stability effects on the modeling accuracy of $PM_{2.5}$/AOD relationship in Eastern China using radiosonde data. *Environmental Pollution*, **251**, 380-389.

6. Bai, K., Li, K., Chang, N. B., and Gao, W. (2019) Advancing the prediction accuracy of satellite-based $PM_{2.5}$ concentration mapping: A perspective of data mining through in situ $PM_{2.5}$ neighborhood information. *Environmental Pollution*, **254**, Part B, 113047.

7. Bai, K., Ma, M., Chang, N. B., Gao, W. (2019) Spatiotemporal trend analysis for fine particulate matter concentrations in China by using high-resolution satellite-derived and ground-measured $PM_{2.5}$ data. *Journal of Environmental Management,* **233**, 530-542.

8. Wei, X., Chang, N. B., Bai. K., and Gao, W. (2020) Satellite remote sensing of aerosol optical depth: Advances, challenges and perspectives. *Critical Reviews in Environmental Science and Technology*, **50(16)**, 1640-1725.

9. Bai, K., Li, K., Guo, J., and Chang, N. B. (2020) Filling the gaps of in-situ hourly $PM_{2.5}$ concentration data with the aid of empirical orthogonal function constrained by diurnal cycles. *Atmospheric Measurement Techniques*, **13**, 1213–1226.

10. Wei, X., Chang, N. B., and Bai, K. (2020) A comparative assessment of multi-sensor data merging and fusion algorithms for high resolution surface reflectance data. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, **13**, 4044-4059.

11. Bai, K., Li, K., Chang, N. B., and Guo, J. (2020) A homogenized daily *in situ* $PM_{2.5}$ concentration dataset from national air quality monitoring network in China. *Earth System Science Data*, **12(4)**, 3067–3080.

12. Wei, X., Chang, N. B., Bai, K., and Gao, W. (2021) Multisource hierarchical data fusion for high-resolution AOD mapping in a forest fire event. *International Journal of Applied Earth Observation and Geoinformation*, **102**, 102366.

13. Li, K., Bai, K., Li, Z., Kao, J. and Chang, N. B. (2022) Synergistic data fusion of multimodal AOD

and air quality measurements for hourly full coverage air pollution assessment. *Journal of Environmental Management*, **302(37)**, 114121.

14. Bai, K., Li, K., Guo, J., and Chang, N. B., (2022) Multiscale and multi-source data fusion for full-coverage PM$_{2.5}$ concentration mapping: Can spatial pattern recognition come with modeling accuracy? *ISPRS Journal of Photogrammetry and Remote Sensing*. **184**, 31-44.

15. Bai, K., Li, K., Ma, M., Li, K., Li, Z., Guo, J., Chang, N. B., Tan, Z., Han, D. (2022) LGHAP: The Long-term Gap-free High-resolution Air Pollutants concentration dataset derived via tensor flow based multimodal data fusion. *Earth System Science Data*, **14(2)**, 907–927.

16. Li, K., Bai, K., Ma, M., Guo, J., Li, Z., Wang, G., and Chang, N. B. (2022) Spatially gap free analysis of aerosol type grids in China: First retrieval via satellite remote sensing and big data analytics. *ISPRS Journal of Photogrammetry and Remote Sensing*. **193**, 45–59.

17. Bai, K., Li, K., Sun, Y., Wu, L., Zhang, Y., Chang, N. B., and Li. Z. (2023). Global synthesis of two-decades research on improving PM2.5 estimation models from remote sensing and data science perspectives. *Earth Science Reviews*, **241,** 104461.

18. Bai, K., Li, K., Shao, L., Li, X., Liu, C., Li, Z., Ma, M., Han, D., Sun, Y., Zheng, Z., Li, R., Chang, N. B., and Guo, J. (2024) LGHAP v2: A global gap-free aerosol optical depth and PM$_{2.5}$ concentration dataset since 2000 derived via big earth data analytics. *Earth System Science Data*, 16(5), 2425–2448.

19. Li, K., Bai, K., Jiao, P., Chen, H., Shao, L., Sun, Y., Zheng, Z., Li, R., and Chang, N. B. (2024) Developing unbiased estimation of atmospheric methane retrieval via machine learning and multiobjective programming based on TROPOMI and GOSAT data. *Remote Sensing of the Environment*, **304**, 114039.

Water Quality Monitoring Networks

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.

4. Imen, S., Chang, N. B., and Yang, J. (2015) Developing a remote sensing-based early warning system for monitoring TSS concentrations in Lake Mead. *Journal of Environmental Management*, **160**, 73-89.

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: Remote Sensing for Hydrological Processes in Terrestrial 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. 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.

7. 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.

8. 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 a heterogeneous terrain. *Hydrology and Earth System Sciences*, **15**, 119-139.

9. Chen, C. F., Valdez, M. C., Chang, N. B., Chang, L. Y., and Yuan, P. Y. (2014) Monitoring spatiotemporal surface soil moisture variations during dry seasons in Central America with multi-sensor cascade data fusion. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, **7(11)**, 4340-4355.

10. Chang, N. B., Crawford, A. J., and Mohiuddin, G. (2015) Low flow regime measurements with an Automatic Pulse Tracer Velocimeter (APTV) in heterogeneous aquatic environments. *Flow Measurement and Instrumentation*, **42**, 98–112.

11. Crawford, A. J. and Chang, N. B. (2015) Developing the Groundwater Variability Probes (GVP) and wireless sensor networks for characterizing the subsurface low flow field. *IEEE Sensors Journal,* **99**, 1-10.

12. Doña-Monzó, C., Chang, N. B., Caselles, V., Sánchez-Tomás, J. M., Lluís Pérez-Planells, L., del Mar Bisquert, García-Santos, V., Imen, S., and Camacho, A. (2016). Monitoring seasonal hydrological patterns of temporary lakes using remote sensing and machine learning models: case study of La Mancha Húmeda Biosphere Reserve in Central Spain. *Remote Sensing*, **8**, 618.

13. Gao, Y., Yao, L., Chang, N. B., and Wang, D. (2021) Diagnosis toward predicting mean annual runoff in ungauged basins, *Hydrology and Earth System Sciences*, **25(2)**, 945–956.

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 <u>Chang, N. B.</u> (2011) Spatial analysis of terrain-impacted Photosynthetic Active Radiation (PAR) using MODIS data. *GIScience & Remote Sensing*, **48(4)**, 1-21.

3. Doña-Monzó, C., <u>Chang, N. B</u>., Sánchez-Tomás, J. M., Delegido-Gómez, J., Camacho-González, A., Caselles-Miralles, V., and Vannah, B. W. (2015) Integrated satellite data fusion and mining for monitoring lake water quality status of the Albufera de Valencia in Spain. *Journal of Environmental Management*, **151**, 416-426.

Journal Papers: Remote Sensing for Water Quality Monitoring in Aquatic Environments

1. <u>Chang, N. B.</u>, 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.

4. <u>Chang, N. B.</u>, 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. <u>Chang, N. B.</u>, 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. <u>Chang, N. B.</u>, 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. <u>Chang, N. B</u>., Xuan, Z., and Yang, J. (2013) Exploring spatiotemporal patterns of phosphorus concentrations in a coastal bay with MODIS images and machine learning models. *Remote Sensing of Environment*, **134**, 100-110.

8. <u>Chang, N. B</u>., Vannah, B., Yang, Y. J., and Elovitz, M. (2014) Integrated data fusion and mining techniques for monitoring total organic carbon concentrations in a lake. *International Journal of Remote Sensing*, **35(3)**, 1064-1093.

9. <u>Chang, N. B</u>., Vannah, B., and Yang, J. (2014) 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,* **7(6)**, 2426-2442.

10. <u>Chang, N. B.,</u> Bai, K., and Chen, C. F. (2015) Smart information reconstruction via time-space-spectrum continuum for cloud removal in satellite images. *IEEE Journal of Selected Topics in Applied Earth Observations*, **99**, 1-19.

11. Bai, K., <u>Chang, N. B.</u>, and Chen, C. F. (2015) Spectral information adaptation and synthesis scheme for merging cross-mission consistent ocean color reflectance observations from MODIS and VIIRS. *IEEE Transactions on Geoscience and Remote Sensing,* **54(1)**, 311-329.

12. <u>Chang, N. B</u>., Bai, K., Imen, S., Chen, C. F., and Gao, W. (2018) Multi-sensor satellite image fusion, networking, and cloud removal for all-weather environmental monitoring. *IEEE Systems Journal*, **12(2)**, 1341-1357.

13. Imen, S., <u>Chang, N. B</u>., Yang, J., and Golchubian, A. (2016) Developing a model-based drinking water decision support system featuring remote sensing and fast learning techniques. *IEEE Systems Journal*, 99, 1-11.

14. <u>Chang, N. B.</u>, Bai, K., and Chen C. F. (2017) Integrating multisensor satellite data merging and image reconstruction in support of machine learning for better water quality management. *Journal of Environmental Management,* **201(1)**, 227-240.

15. Sun, Z., <u>Chang, N. B.</u>, Chen, C. F., Mostafiz, C., and Gao, W. (2021) Ensemble learning via higher order singular value decomposition for integrating data and classifier fusion in water quality monitoring. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, doi:10.1109/JSTARS.2021.3055798.

Journal Papers: Ecosystem Dynamics, Restoration, and Carbon Fluxes

1. Makkeasorn, A. and <u>Chang, N. B.</u> (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 <u>Chang, N. B.</u> (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., <u>Chang, N. B.</u> 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., <u>Chang, N. B.</u>, 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.

5. Chen, C. F., Son, N. T., <u>Chang, N. B.</u>, 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.

6. Son, N. T., Chen, C. F., <u>Chang, N. B.</u>, Chen, C. R., and Thanh, B. X. (2015) Mangrove mapping and change detection in Ca Mau Peninsula, Vietnam using Landsat data and object-based image analysis. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing,* **8(2)**, 530-510.

7. Chen, C. F., Lau, V. K., <u>Chang, N. B.</u>, Son, N. T., Tong Phoc, H. S., and Chiang, S. H. (2016) Multi-temporal change detection of seagrass beds using integrated Landsat TM/ETM+/OLI imageries in Cam Ranh Bay, Vietnam. *Ecological Informatics*, **35**, 43-54.

8. <u>Chang, N. B.</u> Wei, X., Mostafiz, C., Yang, J., Weiss, J., and Belavel, M. (2019) Reconstruction of sea-land interactions between terrestrial vegetation cover and water quality constituents during a hurricane landfall. *International Journal of Applied Earth Observation and Geoinformation,* **83**, 101929.

9. Sun, Z., <u>Chang, N. B.</u>, Chen, C. F., and Gao, W. (2022) Lake algal bloom monitoring via remote sensing with biomimetic and computational intelligence. *International Journal of Applied Earth Observation and Geoinformation,* **113**, 102991.

Journal Papers: Land Use/Land Cover Changes, Hazard Impact, and Land Thermal Fluxes

1. Gao, W., Zhang, W., Gao, Z. and <u>Chang, N. B.</u> (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. 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.

7. Mostafiz, C. and Chang, N. B. (2018) Tasseled Cap Transformation (TCT) for assessing hurricane landfall impact on a coastal watershed. *International Journal of Applied Earth Observations and Geoinformation,* **73**, 736-745.

Journal Papers: Environmental Exposure and 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.

Journal Papers: Sensing, Networking, and Control of Water Treatment and Distribution Networks

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.

4. Gudla, R., Cheng, J., and Chang, N. B. (2024) An attention-driven and autoencoder-based bidirectional LSTM for long interval gap-filling in a water treatment process data set. *IEEE Intelligent Systems,* 1-10, DOI: 10.1109/MIS.2024.3513159.

Summary of Research in Environmental and Hydrological Remote Sensing and Monitoring Networks

Major Accomplishment: Delineating accurate distributions of the quality and quantity of water, air pollutants and greenhouse gases in atmosphere, ecosystem state in natural environments, as well as land use and land cover changes in urban environments requires delicate integration of multiscale remote sensing technologies. Chang group is dedicated to seeking emerging digital solutions to transform governance of coupled human-air-water-terrestrial systems and interconnected urban infrastructure and rural agriculture sectors by integrating space-borne, air-borne, and ground-based remote sensing and sensor networks. First, nutrient fluxes in surface and groundwater systems may be driven by atmospheric deposition, agricultural runoff, and urbanization effect such that space-borne, air-borne and *in situ* sensors are all needed for monitoring the fate and transport of them. Chang's research team developed a suite of water quality, air quality, land use, and ecosystem monitoring techniques for a broader range of understanding of atmospheric, hydrologic, ecological, geospatial, and geochemical function in regard to environmental flux movement and storage as well as environmental quality and ecosystem state within watersheds, urban areas, and coastal regions. To empower remote sensing potential, his group developed a series of new machine learning-based image processing algorithms and methods for embedded feature extraction by integrating different satellite platforms and sensors via data mining (clustering, classification, and association rules), data fusion, image fusion, and sensor fusion. These seminal advancements enhanced monitoring and assessment capacity by observing changing air quality, water quality, ecosystem state, and land use patterns exploring complexity from risk analysis to resilience assessment. Well-known algorithms and methods of his work at the intersection between sustainability science and earth system science include the integrated data fusion and mining (IDFM) algorithm for improving spatial and temporal resolution of images, the Spectral Information Adaptation and Synthesis Scheme (SIASS) algorithm for coupling several satellites to work together synchronously for cloudy pixel recovery, and the SMart Information Reconstruction (SMIR) method to complement the SIASS for final cloudy pixel reconstruction from the time-space-spectrum continuum with the aid of a machine learning tool. These efforts through developing the IDFM, SMIR and SIASS algorithms have culminated into his most recent improvement of the cross-mission data merging with image reconstruction and mining (CDMIM) which is deemed a promising decision support system of its kind providing monitoring capacity in a timely manner over extensive area with accuracy. To enlarge the impact of artificial intelligence on remote sensing, Chang's group further advanced a plethora of remote sensing technologies by integrating deep learning and ensemble learning via tensor flows. These advancements were demonstrated by monitoring turbidity and Chlorophyll-a concentrations in Lake Okeechobee, nutrient concentrations in Tampa Bay, Total Organic Carbon (TOC) in Lake Harsha, water transparency in Lake Valencia, nutrients in Lake Nicaragua, microcystin in Lake Erie, and Total Suspended Solid and TOC in Lake Mead. Linking hurricane landfall impact with sea-land interactions between terrestrial vegetation cover and TOC concentration in coastal water signifies the implications of land-atmosphere-sea feedback loop and magnifies the essence of natural hazard mitigation in sustainability science and environmental management. Such endeavor of earth observations for monitoring and assessment of risk and resilience of local communities deeply improved the understanding of relationship between life support infrastructures and ecosystem health. Our current knowledge is insufficient to appropriately quantify the trade-offs of land use at applicable decision-making scales. To further deepen the understanding of the global change effect on urban environment, Chang and his research partners analyzed the patterns

of land use and land cover changes at two types of coastal urban systems with intensive harbor operations. The intelligent image processing techniques are based on the partial lanczos extreme learning machine for processing SPOT satellite images and the neural-fuzzy inference approach for processing Formosat-2 satellite images, respectively. This series of techniques were extended to examine urban heat island effect under local hydroclimatic conditions using MODIS satellite images and dynamic linkages between evapotranspiration (ET) and land use/land cover changes with Landsat TM and ETM+ satellite data, which demonstrated advances in understanding land system change and new perspectives of urban growth and sustainability issues. Such endeavor clearly advanced the integration of in situ ET measurements and remote sensing-based ET estimation, mapping, and evaluation in regular and rugged terrains. To account for climate change impact on water resources management, Chang and his collaborators explored a unique hydrometeorological process of precipitation patterns and associated summer extreme flow on ecosystem restoration using TRMM/PR satellite data. The paper titled "Multi-Decadal Mangrove Forest Change Detection and Prediction in Honduras, Central America, with Landsat Imagery and a Markov Chain Model' demonstrated the pioneering effort to forecast the possible mangrove forest changes using remote sensing and Markov Chain technologies. Chang also worked with his students and partners to develop a global gap-free air quality database of PM2.5 and aerosol optical depth (AOD) (abbreviated as LGHAP – the Long-term Gap-free High-resolution Air Pollutant concentration dataset) after innovating a series of machine learning-based gap-filling techniques. Finally, in response to the needs for long-term water quality monitoring in drinking water distribution systems, one of the most significant challenges currently facing the water industry is to investigate the physical, chemical, and biological sensor placement strategies with modern concepts of and approaches to assessing and communicating risk related to life support systems. In this area, most of previous work in literature mainly focused on using optimization models to deal with small-scale drinking water networks. Yet the challenge of computational burden (curse of dimensionality) when handling large-scale networks can hardly be overcome. Chang and his students conducted pioneering work of using graph theory-based optimal sensor deployment strategies in a Rule-based Expert System to reduce computational burden as compared to various types of large-scale optimization analyses. For empowering ground-based sensor network, Chang's group developed both Automatic Pulse Tracer Velocimeter and Groundwater Variability Probe to measure the low flow regime in heterogeneous aquatic environments such as wetlands, coastal marshes, lagoons, and groundwater aquifers. This series of research efforts created a new direction in the field.

Role: Chang conceived the research niches and led these research activities to conduct many of the retrospective and perspective analyses in remote sensing and sensor network deployment. He initiated this series of remote sensing research, developed the hypotheses, led the methodology advancement and framework construction to support laboratory analyses and field experiments. With the funding support from NASA, EPA, Texas Higher Education Research Program, and international partners, Chang advanced remote sensing image processing and feature extraction techniques based on space-borne, air-borne, and ground-truth data sets to explore condition monitoring of non-stationary and nonlinear phenomena via data fusion, data merging and data mining. With international coordination, the scope of his work expanded over time involving a large team across several countries (Spain, Nicaragua, China, Taiwan, Vietnam, Honduras, USA, etc.) to support global-scale and regional-scale studies focusing on extreme events associated with hydrological, ecological, atmospheric, oceanographic, and geospatial impact and hazards during the common era in the Holocene.

Impact: Chang advanced machine learning for earth science by developing AI-driven innovations via a wealth of new image processing and feature extraction techniques in support of sustainable engineering and sustainability science studies. In 2004, for instance, With NASA's support of six corner reflectors being deployed in Texas (mid-latitude region) for his project, Chang demonstrated the ability to monitor large-scale soil moisture variations in a big watershed (over 14,000 km^2) in Texas

using RADARSAT-1 L-band microwave imageries processed by his newly invented genetic programming model. It led to support stream flow forecasting under climate change given the salient teleconnection signatures and ecosystem health assessment in riparian zones in South Texas. It linked hydrometeorological, precipitation and river discharge processes with watershed management through the eyes of machine learning, evolutionary computing, and complex large-scale system analysis. These results elevated the importance of soil moisture measurements and extended research within NASA's Earth Observation Program, demonstrating new and emerging perspectives in observing Earth from space. With the funding support from the EPA national laboratory, such applications were extended gross soil moisture measurements at the watershed scale to support drought monitoring and water availability assessment for neighboring urban regions. With a strong global networking, graduate students from University of Valencia in Spain, East China Normal University in China, and National Central University in Taiwan came over to UCF for carrying out their dissertation work. These projects were successful at addressing a broad range of the optimal sensor integration and deployment strategies at different scales and had been the basis for many advanced applications. Chang was a leading scientist who implemented a wealth of evolutionary computing techniques, such as genetic programming, fast learning, deep learning, and multimodal imaging techniques via a tensor-flow-based ensemble learning framework (i.e. higher order singular value decomposition), to enhance feature extraction for earth observations. Case studies covered many regions such as Central America with the water quality data collected from Lake Nicaragua and Lake Managua. Besides, LGHAP for global air quality management is an open-source dataset online allowing global users to use for free. This contribution advanced trust in data repositories for enabling interdisciplinary uses of open data. Chang and his team members empowered a diverse and global earth science, water resources, and environmental engineering community through education, public engagement, and innovative science along the U.S. Atlantic shoreline, the Great Lake region, and Gulf of Mexico. His multifaceted and multidisciplinary applications of AI tools further enabled hydrological/environmental/ecological sciences observations and monitoring, analytics and assessments, as well as modeling, prediction and early warning systems. As a result of this series of research, new discoveries and insights involving the complex multi-sensor and multi-temporal change detection deeply affected decision making for environmental management. Results from this body of research in concert with his work in environmental system analysis collectively advanced understanding for urban growth, coastal assessment, and land use planning that have been recognized as highly innovative and significant by a SPIE highlighted online news that reported his achievement of using SPOT-5 high resolution satellite images for urban area research. This online article is titled "Satellite-based Multi-temporal Change Detection in Fast Growing Urban Environments" in the SPIE Newsroom published on 21 January 2011. With such abundant advancements, he published a few books via the CRC Press, including: 1) Multi-scale Hydrological Remote Sensing: Perspectives and Applications, 2) Environmental Remote Sensing and Systems Analysis, and 3) Multisensor Data Fusion and Machine Learning for Environmental Remote Sensing. He was the Editor-in-Chief of the SPIE Applied Remote Sensing journal from 2014 to 2023 and has been the Editor-in-Chief of the IWA journal of Hydroinformatics since 2023. Such a myriad of leadership, advancements, and publications appears to be a breakthrough in remote sensing science for environmental protection and sustainable development. Overall, his studies promoted the UN's Sustainable Development Goals (SDGs), which include SDG 4 (Quality Education), SDG 6 (Clean Water and Sanitation), SDG 9 (Industry, Innovation, and Infrastructure), SDG 11 (Sustainable Cities and Communities), SDG 13 (Climate Action), SDG 15 (Life on Land), and SDG 17 (Partners for the Goals). Chang was elected as a Fellow of the AAAS in 2011 and the SPIE in 2014, respectively, "for contributions to the Integrated Sensing, Monitoring and Modeling for Decision Analysis". He was selected as the IEEE Distinguished Lecturer by the IEEE Systems Council in 2018-2024 to disseminate his most renowned work of remote sensing and system analysis to the community via a series of annual workshops from 2019 to the present.

Surface Water, Groundwater and Wastewater Treatment Process Optimization and Control

Books

1. <u>Chang, N. B.</u> (Ed) (2010) The Effects of Urbanization on Groundwater: An Engineering Case-based Approach for Sustainable Development. Publisher: American Society of Civil Engineers (ASCE), Reston VA, USA, 400 pp. ISBN: 978-0-7844-1078-3

Book Chapters

1. <u>Chang, N. B.</u>, Wanielista, M. P., 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. <u>Chang, N. B.</u>, Wanielista, M. P., 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

To fix the disruptive nitrogen cycle and remove toxins in the aquatic environment, his inventions of green sorption media that are mixture of recycled materials and natural minerals, as a kind of geo-inspired hybrid materials, for pollution control are cost-effective, scalable, adaptable, and sustainable in a circular economy. Such inventions led to the simultaneous removal of nutrients, heavy metals, E. coli, algal toxins, color, algal toxins, and/or fluorinated surfactants from stormwater runoff, agricultural discharge, groundwater, wastewater effluent wastewater effluent, and source water for drinking water supply. These efforts ended up with receiving 16 US patents and applied for various fit-for-purpose applications at over 300 sites, and another 7 pending for approval as of Dec. 2024, as listed below.

1. Passive Nutrient Removal Material Mixes. <u>US Patent 7824551,</u> issued on Nov. 2, 2010, Inventors: Martin P. Wanielista, Ni-Bin Chang.

2. Passive Nutrient Removal Material Mixes (DIV). <u>US Patent 8002985,</u> issued on August 23, 2011, Inventors: Martin P. Wanielista, Ni-Bin Chang.

3. Retention/Detention Pond Stormwater Treatment System. <u>US Patent 8153005,</u> issued on April 10, 2012, Inventors: Martin P. Wanielista, Ni-Bin Chang.

4. Retention/Detention Pond and Green Roof Passive Nutrient Removal Material Mixes. <u>US Patent 7897047,</u> issued on March 1, 2011, Inventors: Martin P. Wanielista, Ni-Bin Chang.

5. Passive Underground Drainfield for Septic Tank Nutrient Removal Using Special Functionalized Green Filtration Media. <u>US Patent 7927484,</u> issued on April 19, 2011, Inventors: Martin P. Wanielista, Ni-Bin Chang, Ammarin Makkeasorn

6. Functionalized Green Filtration for Passive Underground Drainfield for Septic Tank Nutrient Removal. <u>US Patent 7955507</u> issued on June 7, 2011, Inventors: Martin P. Wanielista, Ni-Bin Chang, Ammarin Makkeasorn.

7. On Site Wastewater Treatment Using a Functionalized Green Filtration Media Sorption Field. US Patent 8101079, issued on Jan. 24, 2012, Inventors: Martin P. Wanielista, Ni-Bin Chang, Ammarin Makkeasorn.

8. Green Sorption Material Mixes for Water Treatment. US Patent 8002984, issued on August 23, 2011, Inventors: Martin P. Wanielista, Ni-Bin Chang.

9. Subsurface Upflow Wetland System for Nutrient and Pathogen Removal in Wastewater Treatment Systems. US Patent 8252182, issued on August 28, 2012, Inventors: Ni-Bin Chang, Martin P. Wanielista.

10. Automatic Pulse Tracer Velocimeter (APTV), US Patent 10612952, issued on April 7, 2020, Inventors: A. James Crawford, Ni-Bin Chang.

11. Water Treatment Using an Iron and Clay-Based Sorption Media, US Patent 10,696,567, issued on June 30, 2020, Inventors: Ni-Bin Chang, Martin P. Wanielista.

12. Iron Filings-Based Green Environmental Media for Nutrient Removal and Methods of Use, US Patent 10,787,373, issued on Sept. 29, 2020, Inventors: Ni-Bin Chang, Martin P. Wanielista.

13. Synergistic Iron and Clay-Based Green Environmental Media for Nutrient Removal, U.S. Patent US 10,947,131 B2, issued on March 16, 2021, Inventors: Ni-Bin Chang, Martin P. Wanielista.

14. Filtration System and Method for Treating Water Containing Nitrogen and Phosphorus Compounds, US Patent 11,235,307 issued on February 1, 2022, Inventors: Ni-Bin Chang, Martin P. Wanielista.

15. Synergistic Zero-Valent Iron-Based Green Sorption Media for Contaminant Removal. U.S. Patent 11,896,948, issued on Feb. 13, 2024. Inventors: Ni-Bin Chang, Debra Reinhart, and A. H. M. Anwar Sadmani.

16. Contaminant Removal by Zero-valent Iron-based Green Sorption Media. U.S. Patent 11,980,865 B2 issued on May 14, 2024. Inventors: Ni-Bin Chang, Debra Reinhart, and A. H. M. Anwar Sadmani.

17. Color Removal with ZIPGEM Filtration Media for Water and Wastewater Treatment, Inventors: Ni-Bin Chang, UCF Reference No.: 2022-038-01, and filing date is April 20, 2023, with the U.S. App. No. 18/303,973 (CIP), pending for USPTO approval.

18. Nanofiltration System and Method Including Pretreatment with Green Sorption Media. Inventors: Ni-Bin Chang and Anwar Sadmani, Submission date UCF Office of Technology Transfer is April 4, 2023, and filing date is Sept. 11, 2024, with the Application No.: 18/830,799, pending for USPTO approval.

19. Synergistic Green Sorption Media for Cyanobacterial Toxin Remediation. Inventors: Ni-Bin Chang, Submission date to UCF Office of Technology Transfer is March 9, 2023, and filing date is July 18, 2024, with the Application No.: 18/776,678, and publication number is US-2025-0026666-A1 (publication date is January 23, 2025), pending for USPTO final approval.

20. Phosphorus Removal with ZIPGEM Filter Media and Method on Water Treatment Processes. Inventors: Ni-Bin Chang, Submission date to UCF Office of Technology Transfer is May 4, 2023, and filing date is July 5, 2024, with the U.S. App. No. 18/303,973, pending for USPTO approval.

21. Enhanced Nitrogen Removal with BIPGEM Filter Media and Method for Water Treatment Processes, Inventors: Ni-Bin Chang, Submission date to UCF Office of Technology Transfer is June 14, 2024, UCF reference number is 2024-125-01, pending for attorney submission.

22. Adsorbent and Method for Removing Per- and polyfluoroalkyl Substances (PFAS) in Water Matrices, Inventors: Ni-Bin Chang and A H M Anwar Sadmani, UCF reference no.: 2024-058-01, Application No.: 63/661,274, Filing Date: June 18, 2024, pending for USPTO approval.

23. Visible-Light Semiconductor Heterostructure for PFAS Degradation, Ni-Bin Chang, A H M Anwar Sadmani, and Md Touhid Islam, UCF reference no.: 2025-035-01, Application No.: 63/763,384., Filing Date: February 26, 2025, pending for USPTO approval.

Journal Papers: Green Sorption Media for Improving Wastewater, Groundwater, and Surface Water Treatment

Overviews

1. Chang, N. B., Hossain, F. and Wanielista, M. P. (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. P., 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. P., 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. P., 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 Exposure and Health*, **1(3-4)**, 31-46.

3. Chang, N. B., Wanielista, M. P., 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.

Technology Development – Surface Water Treatment for the Removal of Nutrients, Heavy Metals, and Dissolved Organic Matters

1. Chang, N. B., Wanielista, M. P., 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. P., 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. P., Chang, N. B., Xuan, Z. and Harris, W. G. (2012) Nutrient removal using biosorption activated media: Preliminary biogeochemical assessment of an innovative stormwater infiltration basin. *Science of the Total Environment*, **432**, 227-242.

4. O'Reilly, A., Wanielista, M. P., <u>Chang, N. B.</u>, Harris, W. G. and Xuan, Z. (2012) Soil property control of biogeochemical processes beneath two subtropical stormwater infiltration ponds. *Journal of Environmental Quality*, **41**, 1-18.

5. O'Reilly, A., <u>Chang, N. B.</u> and Wanielista, M. P. (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., <u>Chang, N. B.</u>, 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.

7. Jones, J., <u>Chang, N. B.</u>, and Wanielista, M. P. (2015) Reliability analysis of phosphorus removal efficiencies of stormwater runoff with green sorption media under varying influent conditions. *Science of the Total Environment*, **502(1)**, 434–447.

8. <u>Chang, N. B.</u>, Houmann, C., and Wanielista, M. P. (2016) Scaling up the sorption media reactors for copper removal with the aid of dimensionless numbers. *Chemosphere*, **144**, 1098-1105.

9. <u>Chang, N. B.</u>, Lin, K. S., Houmann, C., and Wanielista, M. P. (2016) Fate and transport with material response characterization of green sorption media for copper recovery via adsorption process. *Chemosphere*, **144**, 1280-1289.

10. <u>Chang, N. B.</u>, Lin, K. S., Houmann, C., and Wanielista, M. P. (2016) Fate and transport with material response characterization of green sorption media for copper recovery via desorption Process. *Chemosphere*, **154**, 444-453.

11. <u>Chang, N. B.</u>, Lin, K. S., Wanielista, M. P., Crawford, A. J., Hartshorn, N., and Clouet, B. (2016) An innovative solar energy-powered floating media bed reactor for nutrient removal (I) reactor design. *Journal of Cleaner Production,* **133**, 495-503.

12. Lin, K. S., <u>Chang, N. B.</u>, Hartshorn, N., Wanielista, M. P., and Chiang, C. L. (2016) An innovative solar energy-powered floating media bed reactor for nutrient removal (II) material characterization. *Journal of Cleaner Production,* **133**, 1128–1135.

13. <u>Chang, N. B.</u>, Wen, D., McKenna, A., and Wanielista, M. P. (2018) The impact of carbon source as electron donor on composition and concentration of dissolved organic nitrogen in biosorption-activated media for stormwater and groundwater co-treatment. *Environmental Science and Technology,* **52(16)**, 9380–9390.

14. Wen, D., <u>Chang, N. B.</u>, and Wanielista, M. P. (2018) Comparative copper toxicity impact and enzymatic cascade effect on biosorption activated media and woodchips for nutrient removal in stormwater treatment, *Chemosphere,* **213**, 403-413.

15. <u>Chang, N. B.</u>, Wen, D., and Wanielista, M. P. (2018) Impact of changing environmental factors and species competition on iron filings-based green environmental media for nutrient removal in stormwater treatment, *Environmental Progress and Sustainable Energy*, **38(4)**, 13087.

16. <u>Chang, N. B.</u>, Wen, D., Colona, B., and Wanielista, M. P. (2019) Comparison of biological nutrient removal via two biosorption activated media between laboratory-scale and field-scale linear ditch for stormwater and groundwater co-treatment, *Water, Air, and Soil Pollution*, **230**, 151.

17. Valencia, A., <u>Chang, N. B.</u>, Wen, D., Ordonez, D., and Wanielista, M. P. (2019) Optimal recipe assessment of iron filings-based green environmental media (IFGEM) for improving nutrient removal from stormwater runoff. *Environmental Engineering Science,* **36(10)** https://doi.org/10.1089/ees.2019.0094.

18. Wen, D., Valencia, A., Lustosa, E., Ordonez, D., Rice, N., Shokri, M., Gao, Y., Kibler, K., Chang, N. B., and Wanielista, M. P. (2020) Evaluation of green sorption media blanket filters for nitrogen removal in a stormwater retention basin at varying groundwater conditions in a karst environment. *Science of the Total Environment*, **719(1)**, 134826. 10.1016/j.scitotenv.2019.134826.

19. Wen, D., Ordonez, D., McKenna A., and Chang, N. B. (2019) Fate and transport processes of nitrogen in biosorption activated media for stormwater treatment at varying field conditions of a roadside linear ditch, *Environmental Research*, **181**, 108915.

20. Valencia, A., Kilner, J., Chang, N. B., and Wanielista, M. P. (2019) Chemophysical evaluation of green sorption media for copper removal from stormwater runoff for improving ecosystem and human health. *Water, Air and Soil Pollution,* **230(1)**, 1-28.

21. Wen, D., Valencia, A., Ordonez, D., Chang, N. B., and Wanielista, W. P. (2020) Comparative nitrogen removal via microbial ecology between soil and green sorption media in a rapid infiltration basin for co-disposal of stormwater and wastewater, *Environmental Research,* **184**, 109338.

22. Wen, D., Chang, N. B., and Wanielista, M. P. (2020) Assessing nutrient removal in stormwater runoff for urban farming with iron filings-based green environmental media, *Scientific Reports-Nature,* 10:9379.

23. Ordonez, D., Valencia, A., Chang, N. B., and Wanielista, M. P. (2020) Synergistic effects of aluminum/iron oxides and clay minerals on nutrient removal and recovery in water filtration media, *Journal of Cleaner Production*, **275**, 122728.

24. Valencia, A., Ordonez, D., Wen, D., McKenna, A., Chang, N. B., and Wanielista, M. P (2020) The interaction of dissolved organic nitrogen removal and microbial abundance in iron-filings based green environmental media for stormwater treatment. *Environmental Research*, **188(4)**,109815.

25. Ordonez, D., Valencia, A., Elhakiem, H., Chang, N. B., and Wanielista, M. P. (2020) Adsorption thermodynamics and kinetics of Advanced Green Environmental Media (AGEM) for nutrient removal and recovery in agricultural discharge and stormwater runoff, *Environmental Pollution*, **266(1)**, 115172.

26. Valencia, A., Zhang, W., and Chang, N. B. (2021) Integration of machine learning classifiers and higher order tensors for screening the optimal recipe of filter media in stormwater treatment. *Science of the Total Environment*, **771**, 145423.

27. Ordonez, D., Valencia, A., Cheng, J., and Chang, N. B. (2023) Exploring the differential effect of adsorption ingredients in three green sorption media for phosphorous removal from river water, *Journal of Water Process Engineering*, **55**, 104073.

28. Kilgus-Vesely, S., Valencia, A., Ordonez, D., and Chang, N. B. (2024) Developing upflow filters operated in a cascade sequence to compare two green sorption media for phosphorus removal. *Sustainable Materials and Technologies,* **39**, e00808.

29. Cheng, J., Robles Lecompte, A., McKenna, A., and Chang, N. B. (2024) Deciphering linkages between DON and microbial community for nitrogen removal using two green sorption media at a surface water filtration system. *Chemosphere,* **357**, 142042.

30. Ordonez, D., Valencia, A., and Chang, N. B. (2023) Investigating shared adsorption capacity and thermodynamics for simultaneous removal of microcystin and phosphorus via green sorption media in eutrophic water, *Sustainable Materials and Technologies,* **38**, e00777.

31. Cheng, J., Odeh, M., Robles Lecompte, A., Islam, T., Ordonez, D., Valencia, A., Sadmani, A. H. M., Reinhart, D., and <u>Chang, N. B.</u> (2024) Simultaneous removal of nutrients and biological pollutants via specialty absorbents in a water filtration system for watershed remediation, *Environmental Pollution,* **349**, 123903.

32. Robles Lecompte A., Cheng, J., McKenna, A. M., and <u>Chang, N. B.</u> (2024) Linking pattern shifts of dissolved organic nitrogen fractional removal with microbial species richness in a cascade upflow biofiltration process. *Water Research*, **264**, 122130.

33. Cheng, J. and <u>Chang, N. B.</u> (2024) Understanding the transitional phase of nitrate removal in three different specialty adsorbents for stormwater treatment, *Environmental Chemical Engineerin1,* **2**, 113971.

Technology Development – Surface Water Treatment for the Removal of Endocrine Disrupting Chemicals, Color (Tannins), or Contaminant of Emerging Concerns

1. Podder, A., Sadmani, A. H. M. A., Reinhart, D., <u>Chang, N. B.,</u> and Goel, R. (2021) Per and poly-fluoroalkyl substances (PFAS) as a contaminant of emerging concern in surface water: A transboundary review of their occurrences and toxicity effects. *Journal of Hazardous Materials*, **419**, 126361.

2. Ordonez, D., Valencia, A., Sadmani, A. H. M., and <u>Chang, N. B.</u> (2022) Green sorption media for the removal of Perfluorooctanesulfonic acid (PFOS) and Perfluorooctanoic acid (PFOA) from water, *Science of the Total Environment*, **819**, 152886.

3. Ordonez, D., Podder, A., Valencia, A., Sadmani, A. H. M., Reinhart, D., and <u>Chang, N. B.</u> (2022) Continuous fixed-bed column adsorption of Perfluorooctane Sulfonic Acid (PFOS) and Perfluorooctanoic Acid (PFOA) from canal water using zero-valent iron-based filtration media, *Separation and Purification Technology*, **299**(15), 121800,

4. Ordonez, D., Valencia, A., Pereira, B., and <u>Chang, N. B.</u> (2022) Color removal for large-scale interbasin water transfer: Experimental comparison of five sorption media, *Environmental Research*, 212, 113208.

5. Islam, T., Valencia, A., Ordonez, D., Sadmani, A.H.M., and <u>Chang, N. B.</u> (2023) The effect of green sorption media pretreatment on nanofiltration membrane for PFAS removal. *Separation and Purification Technology,* **324**, 124548.

6. Valencia, A., Ordonez, D., Sadmani, A. H. M., Reinhart, R., and <u>Chang, N. B.</u> (2023) Comparing fate and transport of long-chain and short-chain per- and polyfluoroalkyl substances (PFAS) in specialty absorbents, *Water Process Engineering,* **56**, 104345.

7. Valencia, A., Ordonez, D., Sadmani, A. H. M., Reinhart, R., and <u>Chang, N. B.</u> (2023) Comparing the removal and fate of long-chain and short-chain per- and polyfluoroalkyl substances (PFAS) during surface water treatment via specialty absorbents, *Water Process Engineering,* **56**, 104345.

8. Islam, T., Cheng, J., Sadmani, A.H.M., Reinhart, R., and <u>Chang, N. B.</u> (2024) Investigating removal mechanisms of long- and short-chain per- and polyfluoroalkyl substances using specialty absorbents in a field-scale surface water filtration system. *Journal of Hazardous Materials,* **474**, 134646.

9. Cheng, J., Islam, T., Sadmani, A.H.M., and <u>Chang, N. B.</u> (2024) The effect of biochar in a specialty adsorbent on enhanced PFAS removal from surface water, *Water Process Engineering*, 67, 106231.

Modeling Analysis and Tracer Studies to Address System Dynamics for Water Treatment

1. Hossain, F., <u>Chang, N. B.</u> and Wanielista, M. P. (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.

2. Xuan, Z. M., <u>Chang, N. B.</u> and Wanielista, M. P. (2012) Modeling the system dynamics for nutrient removal in an innovative septic tank media filter. *Bioprocess and Biosystems Engineering*, **35(4)**, 545-552.

3. <u>Chang, N. B.</u>, Xuan, Z. M. and Wanielista, M. P. (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.

4. Xuan, Z. M., <u>Chang, N. B.</u>, Wanielista, M. P., and E. S. Williams (2013) System dynamics modeling of nitrogen removal in a stormwater infiltration basin with biosorption activated media. *Journal of Environmental Quality*, **42**, 1086–1099.

5. Gao, Y., Libera, D., Wang, D., Kibler, K., and <u>Chang, N. B.</u> (2020) Evaluating the performance of BAM-based blanket filter on nitrate reduction in a karst spring. *Journal of Hydrology,* **591**, 12459.

Policy Analysis of Low Impact Development

1. <u>Chang N. B.</u>, Lu, G. W., Chui, T. F., and Hartshorn, N. (2017) Comparative policy analysis of low impact development for stormwater management in global urban regions. *Land Use Policy,* **70**, 368-383.

Potential Health Impact of Low Impact Development

1. Wilke, A. B. B., <u>Chang, N. B.</u>, Townsend, J., Benelli, G., and Ajelli, M. (2023) Unintended effects of urban policies on the risk of arbovirus transmission. *Trends in Parasitology*, **39(12)**,1001-1003.

Journal Papers: Water Quality Prediction and Control

Water Quality Prediction and Reclamation

1. Dong, S. Y., Shieh, W. K. and <u>Chang, N. B.</u> (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., <u>Chang, N. B.</u> and Shieh, W. K. (2003) Assessing wastewater reclamation potential by neural networks model. *Engineering Applications of Artificial Intelligence*, **16(2)**, 149-157.

3. Tahsin, S. and <u>Chang, N. B.</u> (2016) A fast eutrophication assessment method for stormwater wet detention ponds via fuzzy probit regression analyses. *Environmental Monitoring and Assessment*, 188(2), 1-18.

Controller Design

1. <u>Chang, N. B.</u>, 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., <u>Chang, N. B.</u> 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., <u>Chang, N. B.</u> 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 <u>Chang, N. B.</u> (2007) Mining the fuzzy control rules of aeration in submerged biofilm wastewater treatment process. *Engineering Applications of Artificial Intelligence*, **20**, 959-969.

5. Iratni, A. and <u>Chang, N. B.</u> (2019) Advances in Control Technologies for Wastewater Treatment Processes: Status, Challenges, and Perspectives, IEEE/CAA *Automatica Sinica*, **6(2)**, 337-363.

Journal Papers: Cost Benefit Analysis

1. Chen, H. W., Wu, C. C. and <u>Chang, N. B.</u> (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: Green Chemistry and Nanotechnologies

1. Lin, K. S., <u>Chang, N. B.</u> 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.

2. <u>Chang, N. B.</u>, 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 <u>Chang, N. B.</u> (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 <u>Chang, N. B.</u> (2008) Synthesis and characterization of titania nanotube for dye wastewater treatment. *NANO: Brief Reports and Reviews*, **3(4)**, 257-262.

Summary of Research in Surface Water, Groundwater, and Wastewater Treatment Processes and Filtration Media

Major Accomplishment:

Climate variability triggered more extreme precipitation, flood and drought impact on urbanization processes, challenging urban stormwater management in terms of both runoff control and water quality management. Besides, understanding nitrogen cycle in natural systems and the built environment has been deemed one of the fourteen grand challenges by the National Academy of Engineering. Eutrophication status and algal toxins driven by excess nutrients and harmful algal blooms in the receiving water body have received wide attention in stormwater, groundwater, and wastewater management. Chang promoted the restoration and protection of freshwater ecosystems, and his work involves measures such as reducing pollution, assessing sustainable land use practices, and monitoring protected areas for aquatic species in lakes, coastal wetlands, and stormwater treatment areas. He was dedicated to investigating the fate, transport, and transformation of nitrogen species and other pollutants in terrestrial and aquatic ecosystem. The use of treated stormwater or river water by cost-effective specialty adsorbents as an alternative sources of water supply have the potential to create resilience to climate change and enhance water security. By linking water to exposure to health, Chang and his team members reviewed a broader range of field conditions and developed a series of green sorption media (GSM) mixed with natural and recycled materials for pollutant removal. His inventions of the five generations of GSM have been proven effective for the removal of nutrients, heavy metals, algal toxins, dissolved organic matters, E coli, algal mass, and endocrine disrupting chemicals (e.g., PFAS). Chang was one of the scientific pioneers, who invented a series of GSM and applied them for low impact development (stormwater treatment), wastewater treatment, groundwater treatment, and

surface water treatment (river water and lake water), based on a myriad of experimental settings at lab- or field-scale. The use recycled materials in GSM provides necessary adaptation measures in circular economy, leading to understand water contamination, water scarcity, and alternatives of water supply. GSM promote the circular economy through the full life cycle, including improving manufacturing efficiencies with confirmed recipes, reducing waste and emissions, and creating environmentally conscious sustainable materials and products that may be based on computational materials design and optimization. Along this line, his work further explored the dynamics of microbial species in nitrogen cycle and nutrient speciation during the fractional removal of dissolved organic nitrogen in different reactor systems filled with different GSM with the aid of material characterization techniques, quantification of microbial population dynamics, and heteroatom distribution of lipids, tannins, lignins, proteins, aromatics, and hydrocarbons. To achieve water sustainability, he also investigated sustainable governance of available surface and groundwater resources in a food-transition-water nexus that is key to solving water problems by improving water reuse efficiency and cost-effectiveness, evaluating process optimization for water infrastructure, and developing alternative water sources. Additionally, modeling these stormwater, groundwater and wastewater treatment processes for urban sustainability was conducted by using system dynamic modeling approach. Along this line, more results from extended modeling investigations were produced in concert with these extended optimal control studies, tracer studies, kinetics studies, ending up with more robust design platforms and better planning strategies for decision making. Findings and discoveries opened a new path to urban applications through various Best Management Practices using GSM and elucidate the potential of restoring the disrupted nitrogen cycle in various urban environments via pollution drivers, nutrient removal mechanisms, GSM recipes changes, and potential impacts on treatment efficiencies. Overall, this body of work demonstrated deepened understanding regarding water infrastructure sustainability in urban regions and risk management of hydrosystems in different types of watersheds and urban environments and answered the question "where we are today and where to tomorrow in urban infrastructures".

Role: With the funding support from FDOT, FDEP, EPA, and other agencies, Chang conceived the research niches and selected research topics in metabolism of aquatic ecosystems, nutrient fate and transport, and water quality monitoring in a changing world and led these research activities by conducting literature review and initializing the concepts and philosophies of experimental work and modeling analysis. Based on the UN's sustainable development goals, Chang identified the study objectives, initiated a series of science questions, developed the hypotheses, and led the development of the experimental design and modeling analysis framework, cooperatively planned/designed the stormwater, river water, and wastewater test beds on/off campus, and performed part of the data analysis. Chang expanded the scope of the research program to involve a series of comparisons of results across several countries (i.e., Singapore, Hong Kong, China, and New Zealand) via coordinated activities and outreach endeavor.

Impact: Chang had successfully demonstrated the ability to remove nutrients, heavy metals, pathogens, algal toxins and PFAS with different recipes of GSM and conducted the possible sensitivity analysis with adsorption, kinetic, and system dynamic models at different scales. Chang was a leading scientist and engineer who brought together a diverse body of cost-effective GSM recipes via assessment from laboratory to field sale all the way up to an operational level in real world applications. These projects have been successful at addressing a broad range of application potential for low impact development resulting in a paradigm shift from flow control to water quality sensitive urban design. Relevant patents have been licensed to industry for initial production (Environmental Conservation Solution Inc.) in Florida after attracting $20 million industrial investment. Later, Golf Agronomics joined the production line as a certified producer in the supply chain. The products have been distributed through Ferguson Enterprises nationally and internationally. These GSM products

have been applied for improving low impact development (LID) over 300 locations for nutrient removal in Florida and elsewhere as of 2024, such as Alligator Creek for creek restoration, Ruskin, Zolfra Spring, and Palatka for restoration of stormwater wet ponds, and cities of Kissimmee and Dunnellon for retrofitting storm sewer to reduce nutrient loads, etc. Findings of nutrient removal associated with different low impact development options were adopted by the State Government of Florida receiving a credit via the stormwater management policies. The data were used in various studies of treatment train design for low impact development options statewide that went well beyond the initial research goals impacting flood mitigation and water treatment via green roof, stormwater infiltration ponds, exfiltration unit, advanced water filtration in river corridors, upflow media bed reactor, etc. Research findings in microbial mediated processes in filtration media for fractional removal of dissolved organic nitrogen, nitrification, and denitrification were also proven critical to field applications for conjunctive treatment of stormwater, wastewater, and groundwater. All the patents above have been commercialized and applied for over 300+ sites due to the need for controlling excess nutrients and eliminating harmful algal blooms in the US. These sites for stormwater management include various   LID design   options for non-structure stormwater management, such as bioretention-cells, dry-detention-pond, green roof, holding-pond-with-side-drain-filtration-system, open-arches-system, underground storage system (i.e., PIPE-R-system), exfiltration-trench,   pervious-pavement, rain-garden, retention-basin, swale-system, tree-well, upflow-filter, vegetated-filter, and wet-pond in addition to the drain fields at many onsite sewage treatment and disposal systems. These design options for nutrient control to restore the disrupted nitrogen cycle provide large flexibility to have fit-for-purpose engineering applications. Based on the record of retail dollar value of sales from 2017 to 2024, it requires recycling 5.7 million pounds of disposable waste tires and 9.1 million pounds of disposable iron filings to produce such GSM, which contributes to 17.7 million US$ total worth of resource savings. Given the media life cycle of at least 10 years, these deployed GSM are expected to remove 4.1 million pounds of total nitrogen, and 0.24 million pounds of total phosphorus. The recycle and reuse of tire crumb and iron filings in GSM achieved the reduction of 32.7 million pounds carbon dioxide emissions. Overall, his inventions of the five generations of GSM with full commercialization have been well received by industry after culminating a series of laboratory and field studies. His findings promoted the UN's Sustainable Development Goals (SDGs) which include SDG 4 (Quality Education), SDG 6 (Clean Water and Sanitation), SDG (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), SDG 11 (Sustainable Cities and Communities), SDG 13 (Climate Action), and SDG 17 (Partners for the Goals). Chang was elected as a Fellow of the National Academy of Inventors (NAI), 2018 with a citation "for his contributions to the field of nutrient monitoring, removal, and possible recovery in aquatic environment."

Industrial Ecology, Green Engineering, and Ecological Engineering

Book

1. Jorgensen, S. E., Chang, N. B., and Xu, F. L. (Eds) (2014) Ecological Modelling and Engineering of Lakes and Wetlands. Published by Elsevier in the book series of Developments of Environmental Modelling, Amsterdam, Netherland, 730 pp, ISBN: 978-0-444-63249-4

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., (2014) Chapter 1 Introduction, by Jorgensen, S. E. Change, N. B., and Xu, F. L. (Eds) (Elsevier). 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. (2014) Chapter 16 Floating Treatment Wetlands for Nutrient Removal in a Subtropical Stormwater Wet Detention Pond with a Fountain. In Ecological Modelling and Engineering of 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. (2014) Chapter 17 System Dynamics Modeling for Nutrient Removal in a Stormwater Wet Pond. In Ecological Modelling and Engineering of 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. (2014) Chapter 24 A Novel Subsurface Upflow Wetland with the Aid of Biosorption Activated Media for Nutrient Removal. In Ecological Modelling and Engineering of 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., (2014) Chapter 25 Tracer-based System Dynamic Modeling for Designing a Subsurface Upflow Wetland for Nutrient Removal. In Ecological Modelling and Engineering of Lakes and Wetlands, by Jorgensen, S. E. Change, N. B., and Xu, F. L. (Eds) (Elsevier).

7. de Lorena Diniz Chaves, G., Siman, R. R., Ribeiro, G. M. and Chang, N. B. (2022) The Potential of Reuse Derived Fuel Production in Reducing the Environmental Footprint of the Cement Industry, in *Environmental Footprints of Recycled Products* edited by Subramanian Senthilkannan Muthu and published by Springer Nature in Encyclopedia of Sustainable Technologies 2nd edition.

8. Chang, N. B. and Qiu J. (2024) Integrating Urban Agriculture and Stormwater Treatment Technologies across a Low Impact Development Region in a Food-Energy-Water Nexus., in *Environmental Footprints of Recycled Products* edited by Marta Panero/Ziqian Don and published by Springer Nature in Encyclopedia of Sustainable Technologies 2nd edition.

Journal Papers: Emergency Response Planning, 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 <u>Chang, N. B.</u> (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. <u>Chang, N. B.</u> 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. <u>Chang, N. B.</u> and Weng, Y. C. (2013) Short-term emergency response planning and risk assessment via an integrated modeling system for nuclear power plants in complex terrains. *Frontiers of Earth Science,* **7(1)**, 1-27.

Journal Papers: Environmental Management Systems

Optimal Production Planning and Food-Energy-Water-Waste Nexus

1. Wu, C. C. and <u>Chang, N. B.</u> (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 <u>Chang, N. B.</u> (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.

3. Zhang, W., Valencia, A., Gu, L., Zheng, Q., and <u>Chang, N. B.</u> (2020) Integrating emerging and existing renewable energy technologies for a community-scale microgrid in an energy-water nexus for resilience improvement. *Applied Energy*, **279**, 115716.

4. <u>Chang, N. B.</u>, Hossain, M. U., Valencia, A., Qiu, J., and Kapucu, N. (2020) The role of food-energy-water nexus analyses in urban growth models for urban sustainability: A review of synergistic framework, *Sustainable Cities and Society*, **63**, 102486.

5. <u>Chang, N. B.</u>, Hossain, M. U., Valencia, A., Qiu, J., Zheng, Q., Gu, L., Chen, M., Lu, J. W., Pires, A., Kaandorp, C., Abraham, E., ten Veldhuis, M. C., van de Giesen, N., Molle, B., Tomas, S., Mouheb, N. A., Dotta, D., Declercq, R., Perrin, M., Conradi, L., and Molle, G. (2021). Integrative technology hubs for urban food-energy-water nexuses and cost-benefit-risk trade-offs (I) Global trend and technology metrics. *Critical Reviews in Environmental Science and Technology*, **51(13)**, 1397-1442.

6. <u>Chang, N. B.</u>, Hossain, M. U., Valencia, A., Qiu, J., Zheng, Q., Gu, L., Chen, M., Lu, J. W., Pires, A., Kaandorp, C., Abraham, E., ten Veldhuis, M. C., van de Giesen, N., Molle, B., Tomas, S., Mouheb, N. A., Dotta, D., Declercq, R., Perrin, M., Conradi, L., and Molle, G. (2021) Integrative technology hubs for urban food-energy-water nexuses and cost-benefit-risk trade-offs (II) Design strategies for urban sustainability. *Critical Reviews in Environmental Science and Technology*, **51(14)**, 1533-1583.

7. Zhang, W., Valencia, A., and <u>Chang, N. B.</u> (2021) Synergistic integration between machine learning and agent-based modeling: A multidisciplinary review. *IEEE Transactions on Neural Networks and Learning Systems*, **34(5)**, 2170-2190.

8. Kapucu, N., Beaudet, S., <u>Chang N. B.,</u> Qiu, J., and Peng, Z. (2021) Partnerships and network governance for urban food-energy-water (FEW) nexus. *International Journal of Public Administration,* **46(1)**, 18-31.

9. Valencia, A., Zhang, W., and Chang, N. B. (2022) Sustainability transitions of urban food-energy-water-waste infrastructure: A living laboratory approach for circular economy. *Resources Conservation and Recycling,* **177**, 105991.

10. Valencia, A., Zhang, W., Gu, L., and Chang, N. B. (2022) Synergies of green building retrofit strategies for improving sustainability and resilience via a building-scale food-energy-water nexus. *Resources Conservation and Recycling,* **176**, 105939.

11. Valencia, A., Qiu, J., and Chang, N. B. (2022) Integrating sustainability indicators and governance structures via clustering analysis and multicriteria decision making for an urban agriculture network. *Ecological Indicators,* **142**, 109237.

12. Valencia, A., Hossain, M. U., and Chang, N. B. (2022) Building energy retrofit simulation for exploring decarbonization pathways in a community-scale food-energy-water-waste nexus. *Sustainable Cities and Society,* **87**, 104173.

13. Elkamel M., Valencia A., Zhang, W., Zheng, Q., and Chang, N. B. (2023) Multiagent modeling for linking a green transportation system with an urban agriculture network in a food-energy-water nexus. *Sustainable Cities and Society*, **89**, 104354.

14. Zhang, W., Valencia, A., and Chang N. B. (2023) Fingerprint networked reinforcement learning via multiagent modeling for improving decision-making in an urban food-energy-water nexus. *IEEE Transactions on Systems, Man, and Cybernetics: Systems*, **53(7)**, 4324 – 4338.

15. Qiu, J., Zhao. H., Chang, N. B., Wardropper, C. B., Campbell, C., Baggio, J. A., Guan, Z., Kohl, P., Newell, J., and Wu, J. (2024) Scaling up urban agriculture as a transformative change to advance social-ecological resilience. *Nature-Food*, **5**, 83–92.

16. Zhao, H., Clarke, M., Campbell, C. G., Chang, N. B., and Qu. J. (2024) Public perceptions of multiple ecosystem services from urban agriculture, *Landscape and Urban Planning,* **251**, 105170.

Green 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 nonlinear integer programming. *Computers and Chemical Engineering*, **27(6)**, 833-854.

Optimal Planning for Energy Transition in Water and Energy Nexus

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.

2. 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.

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. Qi, C. and <u>Chang, N. B.</u> (2012) Integrated carbon footprint and cost evaluation in a drinking water infrastructure system for screening expansion alternatives. *Journal of Cleaner Production*, **27**, 51-63.

Journal Papers: Water Sustainability, Ecosystem Modeling and Climate Change

1. Qi, C. and <u>Chang, N. B.</u> (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. Jin, K. R., <u>Chang, N. B.</u>, 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.

3. <u>Chang, N. B.</u> 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.

4. Liu, S. and <u>Chang, N. B.</u> (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.

5. Xuan, Z. and <u>Chang, N. B.</u> (2014) Modeling the climate-induced changes of lake ecosystem structure under the cascade impacts of hurricanes and droughts. *Ecological Modelling*, **288**, 79-93.

6. <u>Chang N. B.</u> and Wen, D. (2017) Enhanced resilience and resistance assessment with virtual ecoexergy for a lake ecosystem under the intermittent impact of hurricanes and droughts. *Ecological Informatics,* **39**, 68-83.

Journal Papers: Life Cycle Assessment

1. Pires, A., <u>Chang, N. B.</u> 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., <u>Chang, N. B.</u> 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., <u>Chang, N. B.</u>, and Hong, M. C. (2013) Comparative streamlined life cycle assessment of two types of municipal solid waste incinerator. *Journal of Cleaner Production*, **53(15)**, 56-66.

4. <u>Chang, N. B.</u>, 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 Management

1. Xuan, Z. M., <u>Chang, N. B.</u>, 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 Exposure and Health*, **1(3)**, 159–169.

2. Xuan, Z. M., <u>Chang, N. B.</u>, Daranpob, A. and Wanielista, M. (2010) Modeling the Subsurface Upflow Wetlands (SUW) systems for wastewater effluent treatment. *Environmental Engineering Science*, **27(10)**, 879-888.

3. <u>Chang, N. B.</u>, 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.

4. <u>Chang, N. B.</u>, Islam, K., and Wanielista, M. P. (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.

5. <u>Chang, N. B.</u>, 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.

6. <u>Chang, N. B.</u>, 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.

7. Marimon, Z. A., Xuan, Z., and <u>Chang, N. B.</u> (2013) System dynamics modeling with sensitivity analysis for floating treatment wetlands in a stormwater wet pond. *Ecological Modelling*, **267**, 66–79.

8. <u>Chang, N. B.</u>, Mohiuddin, G., Crawford, A. J., Bai, K., and Jin, K. R. (2015) Diagnosis of the AI-based predictions of flow regimes in a constructed wetland for stormwater pollution control. *Ecological Informatics*, **28**, 42-60.

9. Hartshorn, N., Marimon, Z., Xuan, Z., Cormier, J., <u>Chang, N. B.</u>, and Wanielista, M. (2016) Complex interactions among nutrients, chlorophyll-a, and microcystins in three stormwater wet detention ponds with floating treatment wetlands. *Chemosphere*, **144**, 408-419.

10. Hartshorn, N., Merimon, Z., Xuan, Z. M., <u>Chang, N. B.</u>, and Wanielista, M. (2016) Effect of floating treatment wetlands on the control of nutrients in three stormwater wet detention ponds. *Journal of Hydrologic Engineering, ASCE*, **21(8)**, 04016025.

Summary of Research in Industrial Ecology, Green Engineering, and Ecological Engineering

Major Accomplishment: Sustainable cities and society require taking industrial symbiosis relationships among food-energy-water-waste (FEWW) sectors into account on one hand and building knowledge of spatial decision support via information and communication technologies for emergency response planning and operation of FEWW infrastructure systems on the other hand. With emphasis on multi/inter-disciplinary expertise in computational methods, Chang and his team members explored stormwater management as an alternative water supply for promoting urban agriculture operated by linking microgrid with utility grid based on a local renewable energy network and reflecting climate change impact. Such a local renewable energy network can be sustained flexibly by harvesting biogas from anaerobic digester, running waste-to-energy facilities, and concatenating regional wind, solar, and tidal energy supply chains. Rooted among intertwined urban FEWW issues, Chang examined the industrial symbiosis options over different scales. The international team led by Chang compared 7 cities from Global North to Global South, including Orlando and Miami (USA), Amsterdam (the Netherlands), and Marseille (France) as well as the three Brazilian cities located in Florianópolis (Santa Catarina state), Vitória (Espírito Santo state), and Fortaleza (Ceara state) in regard to the pattern shift driven by different urban metabolism, urban ecology, social equity. His feasibility studies empowered multi-scale energy transitions from utility grids to local renewable energy supply (i.e., solar photovoltaic, windmills, tidal energy, hydrogen gas, biogas, waste-to-energy etc.) for green buildings, local communities, urban agriculture, and regional FEWW infrastructures. Case studies explored the path to net zero carbon emissions, leveraging technological innovations and demand-side

strategies for decarbonization. He was a leading scientist who developed a comprehensive multi-objective programming model, based on building information modeling (e.g., EnergyPlus) outputs, which systematically considers the cost, water consumption, and GHG emissions for a community-scale eater-energy nexus. His work looks to the regional resilience via decarbonization of the built environment, focusing on climate change adaptation and infrastructure resilience simultaneously, which covered the aspect of institutional structures and functions in association with policy and regulation aspects of carbon neutrality. As part of the effort of its kind, he extended this body of work to a green building design leading to optimally balance the energy and water consumption under precipitation uncertainty. In later stage, his work extended to investigate a much broader sustainability issue in the food-energy-water-waste-transport (FEWWT) nexus directed to assess the possibility of using electrified vehicles for transportation sustained by a microgrid system to harmonize the food supply chain across urban agricultural networks simulated by agent-based modeling. Chang was a leading scientist for the initiation of a series of sustainability issues in diverse types of FEWWT contexts with the aid of various system dynamic models for applied system analysis and synergistic integration between machine learning and agent-based modeling accounting for the interactions of each sector in the nexus. The part of modeling effort considers mobility equity, logistics systems, urban planning, building performance evaluation, resources management, trade-off for valorization, and decision support. Through computational simulation, modeling, and training, human-building-community interactions during the scale-up of urban agriculture network can be realized. Findings bridged the gap across different industrial sectors and catalyze & inform possible change of urban ecology and urban mentalism in different urbanization processes with scales. In South and Central Florida, Chang also extended the work to conduct eco-hydraulics study in a constructed wetland area – the Stormwater Treatment Area located at the Everglagde Agriculture Area – creating a diagnosis of the AI-based predictions of flow regimes in regard to the flow patterns and the hydraulic retention time in the constructed wetland for improving phosphorus uptake for the Everglagde restoration demonstrating recent advances in sensing, measurements, modeling, and syntheses. Besides, two types of new floating treatment wetlands were examined at the field cale, modeled by system dynamic models, and applied to deal with nutrient removal for stormwater runoff that uniquely addressed critical issues of implementing green technology to realize the complex interactions among nutrients, chlorophyll-a and microcystins, given storm vs. non-storm events. For improving the sustainability implications in drinking water infrastructure systems, integrated simulation an optimization models were developed to conduct carbon-regulated flux analyses in the Lower Manatee River basin, South Florida. To improve the essence of industrial ecology in the nexus of green and smart cities, Chang and his students performed a unique green optimal production planning for a textile dying industry under uncertainty using grey compromise programming (GCP). Chang was a leading scientist who developed a genetic algorithm-based solution procedure to solve the GCP overcoming the instability concern theoretical and computational advances in mathematical programming. Chang developed a series of spatial decision support systems (SDSSs) with information and communication technologies for emergency response planning for three nuclear power plants nearby Taipei and Kaohsiung metropolitan regions in Taiwan. These three SDSSs tailored for emergency response of three different nuclear power plants were designed as hybrid source term, fate and transport modeling and digital twin systems for nuclear reactors with a graphical, interactive, problem-structuring scenarios at computer interfaces demonstrating strategies of risk management. This accomplishment demonstrated the first generation of digital twins that simulated the accidental release and deposition scenarios based on sources, abundance, dynamics, and prediction of radionuclide concentrations in rugged terrains, producing mitigation measures and control actions through user-friendly interfaces. Overall, his work enhanced resources allocation outcomes via cross-sectoral modeling of water, energy, food, waste, and transport industries in liquid, gas, and solid forms for improved policy coherence via novel multi-scale

modeling and system analysis with respect to extreme variability, scales and complexity from theory to computational techniques.

Role: With the funding support from NSF, FDOT, FDEP, Taiwan Power Company, and other agencies, Chang conducted a wealth of green engineering or industrial ecology research. Funded by the NSF, for instance, the ENLARGE project titled "Enabling large-scale adaptive integration of technology hubs to enhance community resilience through decentralized urban food-water-energy nexus decision support". ENLARGE's goal was to explore the evolutionary pathways of various urban FEW systems across four countries including France, the Netherlands, Brazil, and the US. Chang catalyzed international collaboration through Belmont Forum and Joint Programming Initiative (JPI) Urban Europe. Chang was the PI of this international project in the US. The collaborative framework inspires different member states around the globe to explore possibilities of developing a decentralized decision support system for exploring environmental, economic, and societal impact of interdependent and interconnected FEW infrastructures and for optimizing resource management in various cities or regions. While the research team in the United States (University of Central Florida and University of Florida) was funded by the NSF, the Dutch team (Delft University of Technology and Amsterdam Institute for Advanced Metropolitan Solutions) was funded by The Dutch Research Council (NWO), and the French team (Institut National ;'de Recherche en Sciences et Technonologie pour l'Environnement et l'Agriculture (IRSTEA, now called INRAe), ECOSEC, Ec ofilae) was funded by French National Research Agency (ANR). The Brazilian team members funded by the Department of State in the US (the Fulbright Scholar program) joined the project in later years. With a collaborative work, Chang conceived those research niches in America and led some of research tasks internationally, developed science questions and hypotheses with the aid of team members, and extend the FEW nexus analysis to the FEWWT nexus analysis to minimize the food desert impact for low-income communities while exploring the economic resilience with the aid of renewable energy transition and carbon neutrality potential via different agent-based or system dynamic modeling analyses. Chang was the PI of the two projects for nuclear and chemical emergency response planning in Taiwan leading to the planning and design of dynamic 3D fly-through simulation and visualization (virtual reality) modules in a digital twin framework in the late 1990s.

Impact: Recent advances in artificial intelligence have changed the landscape of scientific tools available to conceptualize, frame, and explore research. Chang developed different machine learning methods and models to realize multisector dynamics, such as fingerprint-networked reinforcement learning, and investigated complex adaptive Human-Urban Systems in a FEWWT nexus, leading to foster a dynamic digital channel for end users to access energy and water utilities. His efforts in technology hub integration based on industrial symbiosis relationships for multi-sector systems could benefit many cities. On the top of these advancements, he was a leading scientist who proposed the FEWWT nexus analysis for a big metropolitan region (Miami-Fort Lauderdale-West Plam Beach metropolitan region in South Florida) to elevate the odds of success in the application of industrial ecology knowledge. The differences between the cities in global south were particularly characterized and highlighted from a social equity perspective. Besides, he was dedicated to investigating environmental exposure and risk assessment developed for emergency response planning and operation which deepened the understanding of the use multi-media chemical fate and transport models, remote sensing, 3D dynamic visualization, and geographical information systems to aid in decision making. Within the tailored SDSSs, the integrated database was constructed for local conditions in which detailed information regarding the terrain and meteorological complexes, the toxicity of nuclides being released, the exposure assessment protocol using simulations models, the deployment alternatives of regional emergency service, and the parametric data sets required for the operation of those tasks were gathered from a realistic sense to support decision analysis. These SDSSs provided a first-hand impact assessment if there is any unexpected accidental release of radionuclides

or chemical toxins for nuclear power plants or petrochemical industry close to Kaohsiung and Taipei metropolitan regions in Taiwan, which were proven critical to the validation of decision making. Besides, Chang developed a suite of new optimization approaches to modeling the green production planning for textile industry that laid down a milestone by resolving a long-standing instability issue in the traditional grey linear programming model in operation research. His work presented a key step for advancing the green engineering in relevant industrial sectors. Chang has not only pioneered significant environmental technological advancements but has also championed the principles of sustainability, efficiency, cost-effectiveness, and environmental stewardship globally. Overall, his work promoted the UN's Sustainable Development Goals (SDGs) after culminating a wealth of studies and these SDGs include SDG 2 (zero hunger), SDG 4 (Quality Education), SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), SDG 10 (Reduce Inequalities), SDG 11 (Sustainable Cities and Communities), SDG 13 (Climate Action), SDG 14 (Life Below Water), SDG 16 (Peace, Justice, and Strong Institutions), and SDG 17 (Partners for the Goals). <u>Chang received the Blaise Pascal Medal from the European Academy of Sciences in 2016 with a citation "for his contributions in environmental sustainability, green engineering, and systems analysis".</u>

Waste Management and Resources Recycling for Municipal and Industrial Waste Streams

Book

1. <u>Chang, N. B.</u> and Pires, A. (2015) Sustainable Solid Waste Management: A Systems Engineering Approach. In IEEE Book Series on Systems Science and Engineering, Published by Wiley/IEEE, New York, USA, 920 pp, ISBN: 978-1-118-45691-0

Book Chapters

1. <u>Chang, N. B.</u>, 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. <u>Chang, N. B.</u>, 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.

3. Chang, N-B., Pires, A., & Martinho, G. (2020) Solid Waste Management: Life Cycle Assessment. In B. D. Fath, & S. E. Jorgensen (Eds.), Managing Human and Social Systems (2nd ed.). CRC Press. https://doi.org/10.1201/9781003053514-30

Journal Papers: Integrated Solid Waste Management Strategies

Overviews

1. Pires, A., Martinho, G. and <u>Chang, N. B.</u> (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 municipal solid waste generation in a fast-growing urban region with 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 Modelling 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, J., 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.

4. Lu, J., Chang, N. B., Liao, L., and Liao, M. Y. (2015) Smart and green urban waste collection systems: advances, challenges, and perspectives. *IEEE Systems Journal*, **99**, 1-14.

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. P., 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. Huang, W. L., Lin, D. H., Chang, N. B., 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., <u>Chang, N. B.</u>, 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. <u>Chang, N. B</u> 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. <u>Chang, N. B,</u> 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.

Petrochemical Waste Treatment

1. Lin, K. S. and <u>Chang, N. B.</u> (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., <u>Chang, N. B.</u> 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 <u>Chang, N. B.</u> (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.

Decision Support System

1. <u>Chang, N. B.</u> 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. <u>Chang, N. B.</u> (2008) Economic and policy instrument analyses in support of the scrap tires recycling program in Taiwan. *Journal of Environmental Management*, **86**, 435-450.

2. <u>Chang, N. B.</u>, 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 <u>Chang, N. B.</u> (2010) Environmental performance evaluation of large-scale municipal incinerators using Data Envelopment Analysis (DEA). *Waste Management*, **30**, 1371–1381.

4. Chaves, G. L. D., Simon, R. R., and <u>Chang, N. B.</u> (2021) Policy analysis for sustainable refuse derived fuel production in Espirito Santo, Brazil, *Journal of Cleaner Production,* 294, 126344.

5. Chaves, G., Siman, R. R., Ribeiro, G. M., and <u>Chang, N. B.</u> (2021) Synergizing environmental, social, and economic sustainability factors for refuse derived fuel use in cement industry: A case study in Espirito Santo, Brazil, *Journal of Environmental Management,* 288(15), 112401.

Summary of Research in Waste Management and Resources Recycling for Municipal and Industrial Waste Streams

Major Accomplishment: This body of research relates urban waste management to systems analysis to household recycling programs and material recovery facilities to various cost-benefit criteria, policy implications, econometric analyses, and financial factors in decision making. Different environmental constraints in flow control networks and treatment processes were integrated and evaluated through a myriad of forecasting, simulation, optimization, and control analyses. Emphases were placed on the linkages of engineered waste management units, smart and green urban waste collection schemes, governance structure, regulatory contexts, as well as economic, environmental and social concerns toward an interdisciplinary sustainability solution. The spectrum of the planning alternatives covers all stages of waste management in the contexts of technical, social, economic, and environmental sustainability. To meet various needs of waste collection, recycling, treatment, and disposal, the series of his work addressed sustainability challenges across environmental, economic, social dimensions based on possible urbanization pathways and industrial transitions under global change impacts. He has been seeking to deepen the understanding of pros and cons of decentralized versus centralized waste management systems in North America, South America, Europe, and East Aisa. Issues and concerns may include but are not limited to the valorization of refused derived fuel, recycling of construction and demolition waste in sustainable construction, the effect of scrap tires and scrap cars recycling in circular economy, sustainable siting strategies of landfills and material recovery facilities, intelligent control of waste-to-energy facilities, and integrated waste management options in relation to various sizes and types of intermediate waste management infrastructures and shipping patterns in different flow control networks when reducing the reliance of landfill space for final disposal. Extended research areas include mitigation of environmental effects of waste management, optimal distribution of raw waste streams under intensive recycling impact, environmental justice and social equity concerns when siting waste management facilities, balanced energy recovery between incineration and material recycling, the role of life cycle assessment for decarbonization regulated by varying shipping patterns, enhanced reuse of recycled materials, and decarbonization of waste management systems. The sustainability metrics includes a wide range of anticipated social, economic, environmental, and health indices in various geographic contexts, accounting for the relationship among climate change, recycling and waste prevention. Chang was a leading scientist who systematically explored almost all aspects of waste management alternatives. On one hand, he considered household recycling, collection, shipping, presorting, waste-to-energy, and landfilling based on the "System of Systems Engineering" approach. On the other hand, he conducted inferential statistics, qualitative and quantitative decision analysis, soft computing and machine learning, behavioral and experimental methods, or mixed methods to study topical areas in waste management or governance including transboundary collaboration, managerial adaptation, regulatory reforms, benefit and cost analysis, and environmental justice. His work generated a variety of promising managerial strategies to address contemporary issues by looking into complex system dynamics in a waste management cycle from planning to design to operation and control. It led to promote urban and regional sustainability by fostering smart and green infrastructures with seamless integration of new concepts, methods, frameworks, tools, algorithms, and theories in environmental system analysis.

Role: With the funding support from NSF CREST center in Texas, National Research Council in Taiwan, and other local agencies in the Lower Rio Grande River Basin (the Valley, South Texas), Chang conducted a series of seminal research. He developed science questions and hypotheses, integrated simulation and optimization models, curated planning scenarios, fostered genuine ideas for systems analysis under uncertainty, cooperatively designed the decision support systems, carried out part of the policy analysis with foreign scholars. For instance, to synergize the impact of waste recycling on waste incineration, Chang visited serval material recovery facilities (MRFs) in Germany in 1997 and tried to integrate a refuse-derived fuel process for a new waste-to-energy facility in Taipei metropolitan region, Taiwan. He performed complex large-scale systems analysis to evaluate how the forthcoming household recycling program and regional MRFs could affect the operation of five new

and existing waste-to-energy facilities in Taipei metropolitan region, Taiwan. In parallel with this complex large-scale systems analysis, an ARIMA timer series forecasting model with intervention was formulated to assess the household recycling impact on annual waste generation given the changing economic and social conditions influencing waste composition and heat value over time as more waste-to-energy facilities appeared in the system. In the US, he organized a thorough investigation of waste composition in the Lower Rio Grande River Basin (the Valley, South Texas) from which a plethora of waste collection, shipping, recycling, incineration, composting, and landfilling alternatives among 11 cities in the Valley were integrated for system analysis. He also worked with scholars in China, Portugal, and Brazil to conduct various types of municipal and industrial waste management research.

Impact: Change placed an emphasis on his waste management alternatives with respect to not only waste-to-energy, recyclability, and cost-benefit aspects but also life cycle assessment for decarbonization, multi-dimensional environmental impact, as well as environmental justice and social equality concern via fair fund distribution. This body of work contributed greatly to the foundations of urban waste management systems, leading to deepen the fundamental understanding of the complexity of centralized versus decentralized waste management alternatives. His academic endeavor has produced new direction regarding pattern shifts from shipping scenarios to flow control to formidable waste management strategies, underscoring short-term or long-term perspectives that value multiple knowledge systems. The breadth and depth of Chang's waste management studies in relation to social, economic, environmental, and health impacts demonstrated the niches of using "System of Systems Engineering" approach and "Decision Science" methods such as minimization of maximum regret or maximization of minimum financial benefit. Critical to the actualization of these centralized or decentralized waste management systems he planned out are social components. These social components include the active participation of multiple stakeholders at the urban or township scale, effective intersectoral coordination and relevant policy integration, leading to improve the understanding of managerial pressures and opportunities, flexible governance systems, mechanisms for social learning, and continuous adaptive management. As a result of this advancement, new discoveries and insights involving the connection with smart/green city initiatives generated profound impact on relevant fields such as system analysis for food-energy-water-waste nexus. The culmination of this body of work from 1987 to 2015 led to the generation of a book over 900 pages, titled "Sustainable Solid Waste Management: A Systems Engineering Approach" published by IEEE Book Series on Systems Science and Engineering, through John Wiley/IEEE in 2015. This was a featured book of its kind to thoroughly explore the waste management issues with strong urban sustainability implications. Besides, as part of the waste management research in the Valley (Texas), the paper titled "Combining GIS with fuzzy multiple attribute decision making for landfill siting in a fast-growing urban region" has been cited for over 940 times as of July 2024 according to Google Scholar database. Graduate students working with many universities around the world, such as Huazhong University of Science & Technology in China, Tunghai University in Taiwan, University of Regina in Canada, and Universidade Nova de Lisboa in Portugal, adopted waste management methods developed by Chang. The UN's Sustainable Development Goals (SDGs) were promoted by his work after culminating a wealth of studies, which include: SDG 4 (Quality Education), SDG 7 (Affordable and Clean Energy), SDG (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), SDG 10 (Reduce Inequalities), SDG 11 (Sustainable Cities and Communities), SDG 13 (Climate Action), SDG 16 (Peace, Justice, and Strong Institutions), and SDG 17 (Partners for the Goals). He was listed as an inaugural Highly Ranked Scholar worldwide by ScholarGPS on May 3, 2024 (#1 Municipal Solid Waste, #4 Environmental Resources Management; #7 Waste Management; #14 Urban Area Research). Chang received the Blaise Pascal Medal from the European Academy of Sciences in 2016 with a citation "for his contributions in environmental sustainability, green engineering, and systems analysis". Only 3 scholars around the world received this fields medal in 2016.

RESEARCH FUNDING

Since 1992, Dr. Chang has continuously held many grants from International, Federal, State, and Local government agencies. At UCF, he was the. Project Leader for a series of research grants of nutrient management in the Stormwater Management Academy as well as PI or Co-PI of many research grants funded by the NSF, EPA, NOAA/Florida Sea Grant, USACE, Florida Department of Environmental Protection, Florida Department of Transportation, Florida Fish and Wildlife Commission, South Florida Water Management District, and Southwest Florida Water Management District for various types of research in relation to environmental sustainability in Florida. From 2002 to 2005, he was the associate director of the Centre for Excellence of Science and Technology (NSF funded CREST Center) for waste management and stormwater management research at TAMUK as well as the PI or Co-PI of remote sensing projects funded by NASA and Texas Higher Education Board. Before 2002, he was PI or Co-PI of a plethora of innovative waste management and watershed management projects in Taiwan.

Funded Research Grants and Contracts: From 1992 to 2024, Chang has involved in a total budget of about 19 million USD as PI, Co-PI or senior personnel for highly interdisciplinary research as summarized below.

- "Sabbatical Travel Grant", Ni-Bin Chang, funded by the Florida Academy of Sciences ($1,000, from July 2024 – May 2025).
- "Exploring Green Sorption Media for Simultaneous Removal of Per- and Polyfluoroalkyl Substances (PFAS) and Endocrine Disrupting Chemicals from Wastewater Effluent" PI Ni-Bin Chang, funded by the Innovative Wastewater Treatment Technology Program, Florida Department of Environmental Protection ($333,628, from May 2024 – Oct. 2026).
- "Bench scale Evaluation of Filtration Media for Color Removal" funded by the St. Johns River Water Management District (PI: Ni-Bin Chang) ($15,000) (100% effort), Sept. 2020 – Dec. 2020.
- "Biosorption Activated Media Filtration to Reduce Nutrients and Algal Mass" funded by the Florida Department Environmental Protection Innovative Technology Program (PI: Ni-Bin Chang; Co-PIs: A H M Anwar Sadmani, R. Reinhart) ($2,000,000) (50% effort), July 2020 – July 2024.
- "Watershed Master Planning Initiative Pilot Program (Phase I)" funded by the Federal Emergency Management Agency and Florida Department of Environmental Protection (In partnership with Florida Atlantic University) (PI: Ni-Bin Chang) ($75,000) (100% effort), Aug. 2019- Sept. 2020.
- "(ENLARGE) Enabling large-scale adaptive integration of technology hubs to enhance community resilience through decentralized urban food-water-energy nexus decision support," National Science Foundation Award ID: ICER 1830036 (PI: Ni-Bin Chang, Co-PIs: Qipeng Zheng, Naim Kapucu, Lixing Gu, Philip Fairey) ($838,416 from NSF and $147,297 match on campus; in total $985,708) (60% effort) in partnership with the University of Florida and Florida Solar Energy Center in the United States, the Delft University of Technology in the Netherlands, and the Ecofilae/IRSTEA/ECOSEC in France; total consortium budget of three countries is 1.7 million Euro dollars, equivalent to 2 million USD, July, 2018 – June, 2023.
- "Innovative and Integrative Best Management Practices (BMPs) for Surface and Groundwater Protection," funded by Florida Department of Transportation, PI (Kelly Kibler), Co-Pis: Ni-Bin Chang, Dingbao Wang) (total budget: $792,160) (28% effort), June 2017-Sept. 2019.
- "Developing Software Platform of Cross-mission Data Merging with Image Reconstruction and Mining (CDMIM) in support of Water Quality Monitoring in Lake Nicaragua," funded by National Central University, Taiwan, (PI: Ni-Bin Chang) ($28,933) (100% effort), funded, Aug. 2016-July 2018.

- "Empowering Satellite Remote Sensing with Integrated Inverse Modeling Techniques for Feature Extraction of Water Quality Constituents in Lake Managua," funded by National Central University, Taiwan, (PI: Ni-Bin Chang) ($28,787) (100% effort), funded, June 2016-May 2017.
- "Bio-sorption Activated Media for Nitrogen Control in a Rapid Infiltration Basin," funded by Florida Department of Environmental Protection, (PI: Ni-Bin Chang and Co-PIs: Steve Duranceau, Dingbao Wang, Arvind Singh) ($119,305 with match $100,000 from City of DeLand, $200,000 from SJRWMD, and $100,000 from FDEP providing for construction) (30% effort), funded, July 2016-June 2018.
- "Optimal Design of Stormwater Basins with Bio-Sorption Activated Media (BAM) in Karst Environments – Phase II: Field Testing of BMPs – Construction," funded by Florida Department of Transportation (PI: Kelly Kibler, Co-PI: Ni-Bin Chang) ($151,946) (40% effort), July 2016-Dec. 2017.
- "Optimal Design of Stormwater Basins with Bio-Sorption Activated Media (BAM) in Karst Environments – Phase II: Field Testing of BMPs – Monitoring," funded by Florida Department of Transportation (PI: Kelly Kibler, Co-PI Ni-Bin Chang) ($230,634) (40% effort), Oct. 2016-Dec. 2019 (expanded budget of $172,873 in 2018 for one-year extension till Dec. 2019).
- "Demonstration of a Passive On-site Sewage Treatment Drainfield for Nitrogen Removal at Wekiva State Park," funded by Florida Department of Environmental Protection, (PI: Ni-Bin Chang) ($34,911) (50% effort), Dec. 2015-Nov. 2017.
- "Removal Effectiveness of Co-mingling Off-site Flows with FDOT Right-of-way Stormwater," funded by Florida Department of Transportation, (PI: Ni-Bin Chang) ($149,991) (50% effort), Dec. 2015-Nov. 2017.
- "Comparative Nitrogen and Pesticide Removal with Sorption Media in Linear Ditch for Groundwater and Stormwater Treatment," funded by June 2015, Florida Department of Transportation in partnership with the AECOM consulting company with match $200,000 from Swanee River Water Management District. (PI: Ni-Bin Chang) ($208,600) (60% effort), Nov. 2015-Oct. 2017.
- "Water Availability and Water Quality Forecasting Tool with Environmental Change Reconstruction (Phase II)," funded by the NRMRL, US Environmental Protection Agency (US EPA) (PI: Ni-Bin Chang) ($68,280), (100% effort), Dec. 2015-Nov. 2016.
- "Multi-temporal Change Detection of the Water Quality in Lake Nicaragua and Lake Managua with Remote Sensing Technologies," funded by National Central University in partnership with the National Autonomous University of Nicaragua with cost share $80,000, (PI: Ni-Bin Chang) ($29,560) (100% effort) Feb. 2015-Jan. 2016.
- "Multi-Sensor Fusion of Satellite Remote Sensing Images for Water Leaving Reflectance Data Fusion under Cloudy Conditions," funded by National Central University in partnership with the National Autonomous University of Nicaragua with cost share $80,000, (PI: Ni-Bin Chang) ($29,556) (100% effort) Feb. 2015-Jan. 2016.
- "Optimal Design of Stormwater Basins with Bio-sorption Activated Media (BAM) in Karst Environments – Phase I: Site Screening and Selection," funded by the Florida Department of Transportation, (PI: Ni-Bin Chang) ($39,673) (60% effort), Feb. 2015-Jan. 2017.
- "Flood Impact Assessment in Mega Cities under Urban Sprawl and Climate Change," in partnership with University of Exeter in the UK and Tsinghua University in China, funded by British Council Global Innovation Initiative, (PI: Dragan Savic; Co-PI: Ni-Bin Chang) ($230,000) (30% effort) April 2015-March 2017.
- "Coupling Risk and Resilience Assessment for Networked Sustainable Drainage Systems in a Coastal City under Climate Change Impact," (total: $306,000) funded, NOAA Florida Sea Grant, (PI: Ni-Bin Chang) in partnership with Pinellas County Government and Florida Sea Grant College

program (NOAA's National Sea Grant College Program) ($199,000 with match $107,000) (100% effort), Dec. 2014-Nov. 2016.

- "Monitoring the Water Quality of Lake Nicaragua and Lake Managua with Remote Sensing Technologies in Wet Seasons," funded by National Central University, Taiwan, (PI: Ni-Bin Chang) ($39,500) (100% effort) Feb. 2014-Jan. 2014.
- "Water Availability and Water Quality Forecasting Tool with Environmental Change Reconstruction (Phase I)," funded by the NRMRL, US Environmental Protection Agency (US EPA) (PI: Ni-Bin Chang) ($76,000) (100% effort), Dec. 2013-Nov. 2014.
- "Developing a Sustainable Hong Kong through Low Impact Development: from Science to Innovation Policy (PI: May Chiu; Co-PI: Ni-Bin Chang) (HK$455,975), funded by the Hong Kong Research Council, (5% effort), July 2013-May 2014.
- "IPA Assignment of the Program Director of the Hydrological Science Program," (PI: Ni-Bin Chang) funded by National Science Foundation ($217,066), NSF IPA grant, (100% effort), Aug. 2013-July 2014.
- "Stormwater Management Area (STA) Hydrodynamic Study," funded by the South Florida Water Management District (PI: Ni-Bin Chang) ($59,000) (100% effort), May 2013-April 2014.
- "Developing the Next Generation Remote Sensing Algorithms and Platforms for Lake Water Quality Monitoring (PI: Ni-Bin Chang) ($25,000) funded by National Central University, (100% effort), May 2013-April 2014.
- "Improvement of Water Availability Index Forecasting Tool with Environmental Change Reconstruction," funded by the NRMRL, US Environmental Protection Agency (US EPA) (PI: Ni-Bin Chang) ($70,000) (100% effort), Dec. 2012-Nov. 2013.
- "Demonstration Project for Bio-sorption Activated Media for Ultra-urban Stormwater Treatment," funded by the Florida Department of Transportation (FDOT) (PI: Martin Wanielista; Co-PI: Ni-Bin Chang) ($277,999) (25% effort), Sept. 2012-Aug. 2014.
- "IPA Assignment of the Program Director of the Hydrological Science Program," (PI: Ni-Bin Chang) National Science Foundation ($208,175), funded by the National Science Foundation, NSF IPA grant, (100% effort), Aug. 2012-July 2013.
- "Best Management Practices for Aquatic Restoration in Lakes, Streams, and Wetlands," (PI: Ni-Bin Chang) funded by the Florida Fish and Wildlife Conservation Commission (FFWCC) ($80,000) (50% effort), Oct. 2011-Sept. 2013.
- "Maintenance Practices of Stormwater Runoffs," funded by Florida Department of Transportation (FDOT) (PI: Ni-Bin Chang) ($285,000) (50% effort), Nov. 2011-Oct. 2013.
- "Multi-scale Water Infrastructure Characterization Study Using Remote Sensing (Phase III) Improvement of Water Availability Index Forecasting Tool with Environmental Change Reconstruction," funded by the NRMRL and NHEERL, US Environmental Protection Agency (US EPA), (PI: Ni-Bin Chang) ($80,000) (100% effort), Aug. 2011-March 2012.
- "A Mesocosm Study of Biohaven Floating Islands for Nutrient Removal in Stormwater Ponds," (PI: Ni-Bin Chang), ($25,000), funded by Floating Islands Environmental Solutions, Inc., (100% effort), March 2011-Feb. 2013.
- "Floating Wetland Systems for Nutrient Removal in Stormwater Ponds" funded by the Florida Department of Transportation (FDOT), (PI: Ni-Bin Chang, Co-PI: Patrick Bohlen) ($200,706) (50% effort), Feb. 2010-Jan. 2012.
- "Multi-scale Water Infrastructure Characterization Study Using Remote Sensing (Phase II)," funded by the NRMRL and NHEERL, US Environmental Protection Agency (US EPA), (PI: Ni-Bin Chang) ($89,000) (100% effort), Jan. 2009-May 2010.

- "Analysis of Predrainage Lake Okeechobee and Upper Everglades Modeling," funded by the South Florida Water Management District, Florida, (PI: Ni-Bin Chang) ($20,000) (100% effort), Sept. 2009-Dec. 2009.
- "CERP (Comprehensive Everglades Restoration Program) ASR Alkalinity, Metal, and Mineral Impacts on Phosphorus Fate and Transport in Lake Okeechobee," funded by the South Florida Water Management District and US Army Corps of Engineers (USACE), Florida, (PI: Ni-Bin Chang) ($25,000) (100% effort), Feb. 2009-June 2009.
- "Denitrification Study beneath Stormwater Infiltration Ponds for Promoting Stormwater Reuse and Drinking Water Quality," funded by the UCF Boardman Foundation, (PI: Ni-Bin Chang) ($5,000) (100% effort), Jan. 2009-De. 2010.
- "Sediment Characterization in Lake Okeechobee," funded by the South Florida Water Management District, Florida, (PI: Ni-Bin Chang) ($90,000), (100% effort), March 2008-June 2008.
- "Multiscale Water Infrastructure Characterization Study Using Remote Sensing (Phase I)," funded by the NRMRL and NHEERL, US Environmental Protection Agency (US EPA), (PI: Ni-Bin Chang) ($138,000), (100% effort), Sept. 2008-Oct. 2009.
- "Improving Local Water Supply in Rural Communities via a Sensor Network with the Aid of a Rule-based Expert System in a GIS Platform," funded by the Kentucky Science & Engineering Foundation, (PI: Andrew Ernest; Co-PI: Ni-Bin Chang) ($150,000), (33% effort), April 2007-March 2009.
- "Performance-based and Passive On-site Wastewater Treatment Systems Evaluation for Nutrients Removal," funded by the Florida Department of Environmental Protection, (PI: Ni-Bin Chang) ($1,050,558), (67% effort), March 2007-Feb. 2010.
- "Alternative Stormwater Sorption Media for Control of Nutrients," funded by the Southwest Florida Water Management District, Florida, (PI: Martin Wanielista; Co-PI: Ni-Bin Chang) ($100,000), (50% effort), Nov. 2006-May 2007.
- "Assessment of Nonpoint Source Pollution in the Arroyo Colorado River Basin due to Intensive Agricultural Practices in the Coastal Watershed," funded by the Texas Soil and Water Conservation Board (TSSWCB) and US Environmental Protection Agency (EPA 319 grant), (PI: Ni-Bin Chang) ($223,000), (100% effort, career move before start date), July 2005-June 2007.
- "Enhancing Instrumentation Capabilities at TAMUK to Perform Advanced Environmental Analysis," funded by the Department of Defense (DOD), (Senior Personnel) ($399,897), Jan. 2005-De. 2007.
- "Composting Feasibility Study and Regionalization Assessment for the City of Harlingen," funded by City of Harlingen, Texas (PI) ($30,000), (100% effort), Oct. 2004-Spet. 2005.
- "Composting Feasibility Study and Regionalization Assessment for the City of Mission," funded by City of Mission, Texas (PI) ($30,000), (100% effort), Oct. 2004-Sept. 2005.
- "Biosolid Treatability Study and Pilot Plant Planning" funded by City of Edinburg, Texas (PI) ($10,000), (100% effort), Oct. 2004-Sept. 2005.
- "Municipal Solid Waste Landfill Site Selection Analysis" funded by City of Harlingen (PI) ($25,000), (100% effort), May 2004-April 2005.
- "The Planning and Design of Decentralized Wastewater Treatment System in Suburban Colonias, Lower Rio Grande Region, Texas," funded by the Rensselaerville Institute, (PI) ($ 45,000), (100% effort), May 2004-April 2005.
- "Remote Sensing and Variable Rate Technology for Citrus Pest Management and Impact on Water Quality," funded by the Advanced Technology Program (ATP) in Texas Higher Education Coordination Board, (PI) ($100,000), (Project Number: 003639-0019-2003), (50% effort), Nov. 2003-Oct. 2004.
- "Feasibility Study of the Potential for Re-routing Domestic Wastewater Streams," funded by City

of Pharr, Texas, USA. (PI) ($2,900), (100% effort), Nov. 2003-Oct. 2004.

- "Storm Water Management Plans for Various Municipalities in the Lower Rio Grande Valley," funded by the Regional Task Force of Storm Water Management, Texas, USA. (PI) ($60,000), (100% effort), July 2003-June 2004.

- "Lower Rio Grande Valley Texas Pollutant Discharge Elimination System (TPDES) Task Force Project" funded by the Storm Water Management Task Force in Lower Rio Grande Valley, Texas, USA. (PI) ($55,000), (100% effort), Oct. 2003-Sept. 2006.

- "Stream Flow Prediction by Remote Sensing and Genetic Programming Technologies," funded by National Aeronautics and Space Administration (NASA), USA. (PI) ($300,000), (NAG13-03008), (100% effort), Oct. 2002-Sept. 2005.

- "Research on Environmental Sustainability of Semi-Arid Coastal Areas (RESSACA)" Center for Research Excellence in Science & Technology (CREST) at Texas A&M University-Kingsville, funded by National Science Foundation, USA. (award ID: 0206259) (Senior Personnel/Associate Director) ($5,000,000), (5% effort), Sept. 2002-Aug. 2007.

- "Acquisition of a GC/MS for the Study of Hydrocarbons in the South Texas Region," funded by National Science Foundation, USA. (Co-PI) ($180,000) (25% effort), Aug. 2002-June 2005.

- "Feasibility Study of Reusing the Scrap Solvent as Auxiliary Fuel in the Cement Kiln" funded by the Cleanaway International Corporation, Taiwan Branch Office, (PI) ($13,000) (100% effort), April 2001-Dec. 2001.

- "Feasibility Study of Using Plasma Arc Process for Handling Oily Sludge" funded by the Kaohsiung Harbor Management Bureau, Kaohsiung, Taiwan, (PI) ($80,000) (100% effort), April 2001-Dec. 2001.

- "Nonpoint Sources Pollution Modeling and Application" funded by National Science Council, Taiwan, NSC 90-2211-E-006-044, (PI) ($33,000) (100% effort), May 2001-April 2002.

- "Combined Research and Curriculum Development: Environmental Informatics and Systems Analysis" funded by National Science Council, Taiwan, NSC 90-2511-S-006-044, (PI) ($170,000) (100% effort), June 2001-May 2004.

- "National Cost-Benefit Database for Environmental Pollution Control: Master Plan (II)" funded by the National Science Council, Taiwan, NSC89-2211-E-006-006, (PI) ($13,000) (100% effort), June 2000-May 2001.

- "National Cost-Benefit Database Construction for Solid Waste Management (II)" funded by the National Science Council, Taiwan, NSC89-2211-E-006-005, (PI) ($9,500) (100% effort), June 2000-May 2001.

- "Environmental Restoration of Zen-Ai River in Kaohsiung – Master Plan" funded by the National Science Council, Taiwan, NSC89-2621-Z-006-002, (PI) ($19,000) (100% effort), June 2000-April 2002.

- "Environmental Restoration of Zen-Ai River in Kaohsiung – Optimization Analysis for Sewage Treatment and Ocean Outfall System" funded by the National Science Council, Taiwan, NSC89-2621-Z-006-002, (PI) ($15,000) (100% effort), May 2000-April 2002.

- "Sustainable Management and System Planning in the Tseng-Wen River Basin" funded by the National Science Council, Taiwan, NSC88-2211-E-006-050, (PI) ($7,000) (100% effort), June 1999-May 2001.

- "National Cost-Benefit Database Construction for Environmental Pollution Control – Master Plan (I)" funded by the National Science Council, Taiwan, NSC88-2211-E-006-074, (PI) ($14,000) (100% effort), June 1999-May 2000.

- "National Cost-Benefit Database Construction for Solid Waste Management (I)" funded by the National Science Council, Taiwan, NSC88-2211-E-006-073, (PI) ($10,000) (100% effort), June 1999-May 2000.

- "Use of Economic Instrument and Systems Analysis for Water Pollution Control in the Kao-Ping River Basin" funded by the Environmental Protection Administration, Taiwan, EPA-88-U1G1-03-001, (PI) ($114,000) (100% effort), May 1999-April 2001.
- "Community-based Allocation of Compensation Fund in the Proximity of Waste Incineration Facility via AHP-based Decision-Making" funded by the Taipei County Government, Taiwan, (PI) ($40,000) (100% effort), May 1999-April 2000.
- "Cost-benefit Analysis for Food Waste Recycling" funded by the Tainan County Government, Taiwan, (Co-PI) ($40,000) (50% effort), May 1999-April 2001.
- "Emergency Preparedness and Response Planning for Three Nuclear Power Plants via 3D Spatial Decision Support System" funded by the Taiwan Power Company, Taiwan, (PI) ($250,000), May 1999-April 2002.
- "Spatial Decision Support System for Scrap Automobile Management" funded by the 3R Foundation, Taiwan, 3RF-88-A-003-01, (PI) ($50,000) (100% effort), June 1999.
- "Environmental Tax/Charge Assessment for Scrap Tire Management" funded by the Environmental Protection Administration, Taiwan, EPA-88-HA21-03-419, (PI) ($160,000), (100% effort), June 1999-May 2001.
- "Resources and Energy Recovery for Combustible Demolition Waste Using a Redundant Brick Tunnel" funded by Brick Tunnel Association, Taichung, Taiwan, (PI) ($38,000) (100% effort), May, 1999-April 2000.
- "Environmental and Ecological Investigation of the Hou-lung River Basin in Central Taiwan" funded by the Ministry of Economics, Taiwan, (Co-PI) ($100,000) with the Academia Sinica research team (10% effort), June 1999-May 2000.
- "Stabilization of Incineration Ash Using Phosphorous Compounds" funded by the Waste Management, Inc., Taiwan Branch Office, (PI) ($7,000) (100% effort), June 1999.
- "Environmental Impact Assessment for a Regional Mall in Kaoshiung City" funded by Fichtner Pacific Engineer, Inc., Taiwan, (PI) ($50,000) (100% effort), June 1998-May 2000.
- "Strategic Planning of Recycling in a Fast-growing Urban Region" funded by the National Science Council, Taiwan, NSC87-2211-E-006-011, (PI) ($6,000) (100% effort), June 1998-May 2000.
- "Resources Recovery from Incineration Process (III)" funded by National Science Council, Taiwan, NSC87-2621-P-006-004, (PI) ($14,000) (100% effort), Dec. 1998-Nov. 2000.
- "Use of Artificial Intelligence for Water Pollution Control in the River Basin" funded by the National Science Council, Taiwan, NSC87-2211-E-006-012, (PI) ($10,000) (100% effort), June 1998-May 2000.
- "Water Resources Systems Analysis and GIS Application for the Tseng-Wen River Basin" funded by the Ministry of Economics, Taiwan, (PI) ($62,000) (100% effort), May 1998-April 1999.
- "Optimal Planning of Presorting Process prior to Shu-Lin Municipal Incinerator in Taipei County" funded by the Taipei County Government, Taiwan, ($85,000) (100% effort), Dec. 1998-Nov. 2000.
- "Strategic Planning for ISO14001 Accreditation in the Textile Dying Industry" funded by the Environmental Protection Administration, Taiwan, EPA-86-G03-09-11, (PI) ($31,000) (100% effort), Oct. 1997-Sept. 1999.
- "Computer Aided Engineering Design of Large-scale Municipal Incinerators" funded by the China Ship Manufacturing Inc., Taiwan, (PI) ($42,000) (100% effort), May 1997-April 1998.
- "Management Information System and Network Communication Planning for Solid Waste Management in Taiwan" funded by the Department of Environmental Protection, Taiwan Provincial Government, Taiwan, (CO-PI) ($33,000) (100% effort), June 1997-May 1999.
- "Resources Recovery from Incineration Process (II)" funded by the National Science Council, Taiwan, NSC86-2621-P-006-004, (PI) ($13,000) (100% effort), June 1997-May 1999.
- "Genetic Algorithm-based Optimization Analysis for Regional Solid Waste Management Planning"

funded by the National Science Council, Taiwan, NSC86-2211-E-006-017, (PI) ($8,000) (100% effort), June 1997-May 1999.

- "Chemical Emergency Preparedness and Response Planning Program" funded by the funded by Environmental Protection Administration, Taiwan, EPA-85-E3J1-09-06, (PI) ($80,000) (100% effort), June 1996-May 1999.
- "Chemometric Analysis for the prediction of Dioxins/Furans Emissions from Large-scale Municipal Incinerators" funded by the Environmental Protection Administration, Taiwan, EPA-85-13S4-09-07, (PI) ($16,000) (100% effort), June 1996-May 1998.
- "Environmental Informatics for Metropolitan Solid Waste Management" funded by the Environmental Protection Administration, Taiwan, EPA-85-L105-03-20, (PI) ($35,000) (100% effort), June 1996-May 1999.
- "Resources Recovery from Incineration Process (I)" funded by the National Science Council, Taiwan, NSC85-2621-P-006-033, (PI) ($14,000) (100% effort), Jan. 1996-Dec. 1998.
- "Strategic Planning and Regionalization Assessment of Solid Waste Management in Taipei Metropolitan Region" funded by the Environmental Protection Administration, Taiwan, EPA-044-840-040, (PI) ($80,000) (100% effort), May 1995-April 1997.
- "Optimization Analysis for Solid Waste Collection, Recycling, Treatment and Disposal System" funded by the National Science Council, Taiwan, NSC87-2211-E-006-011, (PI) ($10,000) (100% effort), June 1995-May 1997.
- "Compatible Analysis between Recycling and Energy Recovery in Tainan City" funded by the Tainan City Government, Taiwan, (PI) ($15,000) (100% effort), Dec. 1993-June 1994.
- "Recovery and Reuse of RFCC Scrap Catalyst for Removing VOCs in the Petrochemical Industry" funded by the National Science Council, Taiwan, NSC83-0421-P006-001Z, (PI) ($21,000) (50% effort), Jan. 1994-Dec. 1996.

TEACHING AND RESEARCH SUPERVISION

At UCF, the following courses were created or modified by Dr. Chang to promote Sustainable Engineering Education. Such efforts advanced the convergence of hydrosystem science, sustainable engineering, environmental system engineering, sustainability science, and geoscience research and education. Chang emphasized research-oriented teaching and teaching oriented research in academia.

- Undergraduate course "ENV4341 - Sustainable Resources Management" modified in May, 2020
- Undergraduate course "EES4053 - Fate and Transport of Contaminants in the Environment " created in March, 2022
- Undergraduate course "Solid Waste Facility Design" created May, 2024
- Graduate course "ENV5636 – Environmental and Water Resource System Analysis" created in June, 2006
- Graduate course "EES5318 – Industrial Ecology" created in June, 2009
- Graduate course "ENV6047 – Environmental Informatics and Remote Sensing" created in June, 2010
- Graduate course "ENV6616 – Ecological Engineering – Receiving Water Impact" created in June, 2015

From 1992 to 2024, Chang taught the following courses: environmental economics (undergraduate, NCKU), environmental systems analysis (undergraduate and graduate, NCKU), eenvironmental system modeling (graduate, TAMUK), environmental policy and regulation (graduate, TAMUK), engineering process optimization (graduate, TAMUK), advanced hydrology (graduate, UCF), fluid mechanics (undergraduate, UCF), hydraulics (undergraduate, UCF), groundwater hydrology (graduate,

UCF), groundwater modeling (graduate, UCF), environmental informatics and remote sensing (graduate, UCF), environmental & water resources systems analysis (graduate, UCF), ecological engineering (graduate, UCF), industrial ecology (graduate, UCF), introduction to environmental engineering (undergraduate, UCF), sustainable resource management (undergraduate, UCF), and workshop courses at the graduate and undergraduate levels. Courses taught in the US are summarized below. Courses were well received by the students.

Fall 2002	EVEN 6342	Environmental Systems Engineering (Graduate)
Spring 2003	EVEN 6318	Environmental Systems Modeling (Graduate)
Fall 2003	EVEN 6342	Environmental Systems Engineering (Graduate)
Spring 2004	EVEN 6340	Decision Analysis for Environmental Systems (Graduate)
Fall 2004	EVEN 6354	Environmental Regulation and Policy (Graduate)
Spring 2005	EVEN 6342	Engineering Optimization for Environmental Systems (Graduate)
Fall 2005	ENV 3001	Introduction to Environmental Engineering (Undergraduate)
Fall 2005	CWR 4203	Hydraulics (Undergraduate)
Spring 2006	ENV 3001	Introduction to Environmental Engineering (Undergraduate)
Spring 2006	CWR 4203	Hydraulics (Undergraduate)
Fall 2006	CWR 3201	Fluid Mechanics (Undergraduate)
Fall 2006	CWR 4203	Hydraulics (Undergraduate)
Spring 2007	CWR 6102	Advanced Hydrology (Graduate)
Spring 2007	ENV 3001	Introduction to Environmental Engineering (Undergraduate)
Fall 2007	EES 5318	Industrial Ecology (Graduate)
Fall 2007	ENV 5636	Environmental and Water Resources Systems Analysis (Graduate)
Spring 2008	CWR 6102	Advanced Hydrology (Graduate)
Fall 2008	On Sabbatical	-
Spring 2009	On Sabbatical	-
Fall 2009	ENV 5636	Water Resources and Environmental Systems Analysis (Graduate)
Spring, 2010	EES 5318	Industrial Ecology (Graduate)
Fall, 2010	CWR 5125	Groundwater Hydrology (Graduate)
Fall, 2010	CWR 3201	Fluid Mechanics (Undergraduate)
Spring, 2011	CWR 3201	Fluid Mechanics (Undergraduate)

Fall, 2011	ENV 5636	Environmental and Water Resources Systems Analysis (Graduate)
Fall, 2011	ENV 6047	Environmental Informatics and Remote Sensing (Graduate)
Spring, 2012	EES 5318	Industrial Ecology (Graduate)
Spring, 2012	CWR 6126	Groundwater Modeling (Graduate)
Fall 2012	Working with National Science Foundation	
Spring 2013	Working with National Science Foundation	
Fall 2013	Working with National Science Foundation	
Spring 2014	Working with National Science Foundation	
Fall, 2014	ENV 5636	Environmental and Water Resources Systems Analysis (Graduate)
Spring, 2015	EES 5318	Industrial Ecology (Graduate)
Fall, 2015	ENV 6616	Ecological Engineering: Receiving Water Impact (Graduate)
Spring, 2016	ENV 6047	Environmental Informatics and Remote Sensing (Graduate)
Fall, 2016	On Sabbatical	-
Spring, 2017	On Sabbatical	-
Fall 2017	ENV 4341	Sustainable Resources Management (Undergraduate)
Fall 2017	ENV 5636	Environmental and Water Resources Systems Analysis (Graduate)
Spring 2018	EES 5318	Industrial Ecology (Graduate)
Fall 2018	ENV 4341 ENV 6616	Sustainable Resource Management (Undergraduate) Ecological Engineering: Receiving Water Impact (Graduate)
Spring, 2019	EES 5318 ENV 3001	Industrial Ecology (Graduate) Introduction to Environmental Engineering (Undergraduate)
Fall, 2019	ENV 5636	Environmental and Water Resources Systems Analysis (Graduate)
Spring, 2020	ENV 6047	Environmental Informatics and Remote Sensing (Graduate)
Fall 2020	ENV 6616	Ecological Engineering: Receiving Water Impact (Graduate)
Spring 2021	EES5318	Industrial Ecology (Graduate)

Fall 2021	ENV 4341 ENV 5636	Sustainable Resource Management (Undergraduate) Environmental and Water Resources Systems Analysis (Graduate)
Spring 2022	ENV 6047	Environmental Informatics and Remote Sensing (Graduate)
Fall 2022	ENV 4341 ENV 6616	Sustainable Resource Management (Undergraduate) Ecological Engineering: Receiving Water Impact (Graduate)
Spring 2023	EES5318	Industrial Ecology (Graduate)
Fall 2023	ENV 4341 ENV 5636	Sustainable Resource Management (Undergraduate) Environmental and Water Resources Systems Analysis (Graduate)
Spring 2024	ENV6047	Environmental Informatics and Remote Sensing (Graduate)
Fall 2024	On Sabbatical	-
Spring, 2025	On Sabbatical	-

Chang has mentored 8 post-doctoral and 11 visiting scholars (including Fulbright scholars). Additionally, he has been mentoring several mid-career research scientists overseas promoting collaborative research among Germany, the United Kingdom, China, Taiwan, Hong Kong, Japan, Spain, Denmark, and the US. He has been mentoring many undergraduate students either on thesis track or non-thesis track as well. Under his supervision, for example, one of undergraduate honor students (Mr. Brent Wimberly) received the UCF Founder's Day Award in Feb. 2013 due to thesis's originality and depth, level of research, and amount of social impact through 3 journal paper publications he coauthored. Another honor student (Mrs. Sydney Kilgus-Vesely) graduated in Spring 2024 and published her undergraduate thesis work for "developing upflow filters operated in a cascade sequence to compare two green sorption media for phosphorus removal" through a prestigious journal "Sustainable Materials and Technologies". As of Aug. 2024, Chang has supervised or co-supervised over 68 graduate students (as summarized in the following tables) who have successfully completed their graduate degrees and now hold meaningful employment in industry, academia and government. Below are two summary tables of his graduate students.

a. M.S. Thesis Students (name and year for master's degree conferred)

Wang, San-Fei, 1995	Chang, Der-Quay, 2002	Mohiuddin, Golam, 2015
Yang, Zhen-Hsin, 1995	Syamala, Diwakaruni, 2004	Crawford, James, 2015
Wang, M., 1995	Ko, Andi, 2005	Hartshorn, Nickolas, 2016
Wu, Si-Long, 1995	Davila, Eric, 2005	Lu, Qi, 2017
Lu, Hon-Yi, 1996	Hossain, Fasim Nipun, 2008	Joyce, Justin, 2017
Chen, Yu-Liang, 1996	Handerson, Devan, 2008	Mostafiz, Chandan, 2018
Lin, Yu Ting., 1996	Moberg, Mikhal, 2008	Alqassar, Abdullah, 2019
Wei, Yu-Lin., 1997	Ryan, Patrick, 2008	Valencia, Andrea, 2019
Tseng, Chen-Chien, 1997	Xuan, Zhemin, 2009	Ordonez, Diana, 2019

Wu, Chia-Chin, 1998	Rivera, Brian, 2009	Elhakiem, Hanan 2019
Chen, Wei Chen., 1998	Liu, Sha, 2010	Bellanthudawage, Kushan, 2021
Xu, Hsin-Yi, 2000	Prapinppongsanone, Natthaphon, 2011	Alejandra Robert Lecompte, 2023
Chen, Zen-Thian, 2001	Mullon, Lee 2012	Jinxiang Cheng, 2024
Weng, Yu-Chi, 2001	Jones, Jamie, 2013	
Wu, Ming Chan., 2001	Vannah, Benjamin W. 2013	
Dug, C. H., 2001	Islam, Kamrul, 2014	
Chang, Yin-Hsin, 2002	Houmann, Cameron, 2014	
Cheng, Kai-Yu, 2002	Marimon, Zachary, 2014	

b. Ph.D. Students (name and year for Ph.D. degree conferred)

Chang, Yin-Hsin, 1998	Lu, Jia-Wei, 2011	Valencia, Andrea, 2022
Chen, Ho-Wen, 1999	O'Reilly, Andrew, 2012	Ordonez, Diana, 2023
Ning, Shu-Kuang, 2001	Valdez, Miguel Conrado, 2013	
Chen, Jeng-Chung, 2002	Bai, Kaixu, 2014	
Makkeasorn, Ammarin, 2007	Imen, Sanaz, 2015	
Pires, Ana Lourenco, 2009	Doña Monzo, Carolina, 2017	
Hossain, Fasim Nipun, 2010	Wen, Dan, 2018	
Qi, Cheng, 2011	Wei, Xiaoli, 2021	

SERVICE TO THE NATION

During the tenure with the National Science Foundation from Aug. 2012 to Aug. 2014, Chang was the program director of the Hydrologic Sciences Program under the Earth Science Division of the Directorate of Geosciences and the Cyber-enabled Sustainability Science and Engineering (CyberSEES) program. Chang has helped to manage the panel meeting twice in a year for the Hydrologic Sciences Program and once in a year of the CyberSEES program handling a broad ranges of research topics relation to geophysics, geochemistry, and engineering topics. Each program has about $12 million annual budget. In total, Chang was involved a total of $50 million budget for the two programs in the two service years. While serving as the cognizant program director, he was also designated as a member of the Statistical Committee under the Directorate of Geosciences. As a cognizant program director, the main efforts include: 1) Program Planning and Management - Program directors play a central role in managing this merit review process for all proposals with integrity. In addition, they are called upon to anticipate future trends to ensure that the science, engineering, and education activities supported by the Foundation will transform the frontiers of knowledge, technology, and educational practice; 2) Coordination and Liaison - NSF places a high value on interdisciplinary activities and their management. Supporting such activities often requires working across divisional and directorate lines and with interagency partners; 3) Communication and Outreach - A strong relationship with the research and education community is a traditional and important strength of NSF. Through this relationship, NSF is alerted to new areas of investigation, new technologies, and new members of the science and engineering community; and 4) Execution of Independent Research/Development – NSF encourages program directors to sustain his or her own knowledge base at the forefront of the core science areas and at the cutting edges of the interdisciplinary and emerging areas of concerns.

Besides, Chang is an executive board member of Florida Climate Institute since 2016, working closely with the rest of board members from 12 universities in Florida. He is representative of University of Central Florida in the Consortium of Universities for the Advancement of Hydrologic Science, Inc.

(CUAHSI) since 2010-present. He supported the budget allocation in NSF to maintain CUAHSI. He was invited by CUAHSI as a keynote speaker in the CUAHSI Hydroinformatics Conference, held in Provo, UT on July 29 – 31, 2019. The topic he presented in this CUAHSI conference titled "Contemporary Challenges in Optical Remote Sensing for Hydroenvironmental Change Detection" was well received by the audience. He has been continuously promoted advanced research for hydroinformatics in the past 20 more years. After he was appointed as the Editor-in-Chief of the IWA journal of Hydroinformatics in 2023, he expanded the editorial board by recruiting managing editor and associate editors from Louisiana, Oklahoma, Florida, South Carolina, Washington DC, etc. to promote hydroinformatics research and education and support the global service.

After Chang visited the National Risk Management Research Laboratory (NRMRL), EPA, Cincinnati, Ohio in 2009, he was active in working with Water Supply and Water Resources Division in NRMRL, and different EPA Regional Offices to explore some challenging research topics of hydroinformatics and hydrosystem analysis, including: 1) Regional 1 for the reconstruction of simultaneous impacts of Hurricane Bob on the vegetative cover of the Mattapoisett River watershed and the water quality (total organic carbon, TOC) of the Mattapoisett Harbor with the aid of remote sensing, leading to identify the most impactful upstream area that triggered the TOC increase in the estuary of the Mattapoisett River and affect the TOC concentration in the coastal groundwater aquifer and in turn the source water from the aquifer for drinking water treatment; 2) Region 5 for tracking and monitoring the microcystin plume (algal toxins) in Lake Erie due to the nutrient impact from the Maumee River watershed in Ohio, using a comparative sensor fusion approach between hyperspectral and multispectral satellite sensors; 3) Region 4 for monitoring nutrient concentrations in Tampa Bay area and screening novel expansion strategies of urban water infrastructure system for the Cities of Bradenton and Sarasota in the Manatee River watershed, FL via a geospatial intelligence approach for optimization of water demand and supply with the aid of life cycle assessment; and 4) Las Vegas Valley Water District in Region 9 for monitoring TOC concentrations in Lake Mead under a long-term drought impact, providing intake pumping strategies through a spatial decision support system, and improving the understanding of forest fire impacts in the Lower Virgin watershed on lake water quality, ecosystem structure, and biogeochemical cycles in the watershed area.

Besides, Chang was the Graduate Coordinator at the Department of Environmental Engineering, Texas A&M University – Kingsville from 2003-2004. Chang has served his colleagues in numerous capacities at the departmental faculty and university levels at University of Central Florida (UCF) including the Civil, Environmental and Construction Engineering (CECE) Department and the College of Engineering and Computer Science (CECS), as summarized below:

- Member of the Promotion and Tenure Committee at the CECE Department
- Member of the Library Committee at the CECE Department
- Member of the Faculty Recruitment Committee at the CECE Department
- Member of the Chair Search Committee at the CECE Department
- Member of the ABET Review Committee at the CECE Department
- Member of the College Research Committee - Review internal proposals of CECS
- Member of the College Research Incentive Award Committee of CECS
- Member of the College Award Committee of CECS
- Member of the College Scholarship Committee of CECS
- Member of the College Sabbatical Committee of CECS
- Member of the Junior Faculty NSF CAREER Mentoring Committee at the University level
- Member of the Environmental Management Council at the University level

He has been serving as director of the Stormwater Management Academy (SMA) since 2012, from which he is in charge of fostering the growth of a stormwater infrastructure system from both quantitative and qualitative perspectives, and managing the research, educational internship, and industrial outreach. Responsibilities include promotion of the research funding level from state and federal agencies, industry, and private foundations; operational and strategic planning; establishment, implementation, and measurement of goals and objectives; implementation of policy and procedures; performance evaluation, and partnership strengthening and communication, as summarized by the following major contributions:

- The creation of three laboratories including 1) Water Treatment and Sustainability Research Laboratory for treatability study (column study and pilot study), upflow reactor, ecotoxicity testing, stormwater harvesting and reuse (exfiltration trench, pipe reactor, road side harvesting), baffle box with nutrient removal, and treatment train testing; 2) Bioenvironmental Systems Research for Laboratory: green roof, biosorption activated media (BAM), subsurface upflow wetland system for wastewater and stormwater treatment, bioretention swale, floating wetland technologies, stormwater infiltration basin with BAM for stormwater treatment – biogeochemical cycle study, microbial ecology study – real-time polymerase chain reaction (PCR) for underground drainfield with BAM for wastewater treatment, lake, streams, and wetland restoration Best Management Practices (BMPs), green chemistry and advanced materials, and ecological engineering and receiving water impact assessment and BMP development; and 3) Hydroenvironmental and Ecological Monitoring and Modeling Laboratory for treatment train design software, watershed modeling and waste load reduction planning, environmental and water resources systems analysis, Geographical Information System (GIS) and spatial analysis, environmental cyberinfrastructure and sensor networks, and environmental, hydrological, and ecological remote sensing and informatics.
- Develop a suite of low impact development technologies for the treatment of stormwater runoff, wastewater effluent, and agricultural discharge, leading to receive 16 US Patents along with his colleagues and partners together as of Dec. 2024, which have been licensed to industry for various fit-for-purpose applications at 300+ sites in the US. He was inducted as a Fellow of the NAI due to this accomplishment.
- Follow the direction of the Sustainable Development Action Plan approved by the American Society of Civil Engineers (ASCE) Board of Direction in May 2008 to create and teach 4 graduate courses (i.e., Environmental System Analysis, Industrial Ecology, Environmental Informatics and Remote Sensing, and Ecological Engineering) and two undergraduate courses (i.e., Sustainable Resource Management and Fate and Transport of Contaminants in the Environment) to enrich the Sustainable Engineering and Sustainability Science Program at UCF.
- Create a Global Strategic Alliance for the Stormwater Management Academy at UCF in which over 40 academic institutions worldwide had signed the Memorandum of Understanding (MOU) and promote national and international collaboration over numerous activities such as hosting a few international interns/scholars from Asia, Europe, and South America.
- Host ASCE/EWRI Orlando Chapter professional training workshop in Orlando, FL (e.g., November 2013; Aug. 2014; May 2024; etc.).
- Support international education for the 8th Primary School of Chania, Crete, Greece to translate the teaching material of stormwater management and water resource management produced by the Stormwater Management Academy.

SERVICE TO THE WORLD

<u>**Journal Editorship:**</u>

1. Advances in Water Resources, published by Elsevier (<u>editorial board member</u>) (2008-2013)
2. Journal of Applied Remote Sensing, published by the International Society for Optics and Photonics (SPIE) (<u>guest editor</u>, <u>associate editor</u>, and **<u>editor-in-chief</u>**) (2014-2023)
3. Ecological Informatics, published by Elsevier (<u>guest editor</u>, <u>editorial board member</u>) (2009-2016)
4. Environmental Informatics, published by the International Society for Environmental Information Sciences (<u>founding editor-in-chief</u>, <u>guest editor</u>) (<u>associate editor</u>, 2003-present)
5. IEEE Systems Journal, published by the Institute of Electrical and Electronics Engineers (<u>guest editor</u>, <u>associate editor</u>) (2014-2019)
6. Journal of Environmental Management, published by Elsevier (<u>editorial board member</u>) (1997-2015)
7. Stochastic Environmental Research & Risk Assessment, published by Springer (<u>guest editor</u>, <u>editorial board member</u>) (2009-2019)
8. Journal of Environmental Modeling & Assessment, published by Springer (<u>guest editor</u>, <u>editorial board member</u>) (1999-2018)
9. Frontiers of Earth Sciences, published by Springer (<u>associate editor-in-chief</u>) (2013-2023)
10. Journal of Exposure and Health, published by Springer (<u>scientific advisory board member</u>) (2009-2022)
11. International Journal of Environmental Science and Technology, published by Springer (<u>associate editor</u>, 2013-2022)
12. Journal of Hydroinformatics, published by International Water Association (<u>editorial board member</u>, 2009-2022) (**<u>editor-in-chief</u>,** 2023-present)
13. Earth Science Informatics, published by Springer (<u>editorial board member</u>) (2012-2018)
14. Journal of Cleaner Production, published by Elsevier (<u>editorial board member</u>) (2010-2019)
15. Journal of Civil Engineering and Environmental Systems, published by Taylor and Frances (<u>guest editor</u>, <u>editorial board member</u>) (1998-2021)
16. Advances and Applications in Bioinformatics and Chemistry, published by Taylor and Frances (<u>editorial board member</u>) (2009-2018)
17. Journal of Water Resources Research, published by American Geophysical Union (<u>associate editor</u>) (2008-2013)
18. Journal of Hazardous, Toxic, and Radioactive Waste Management, published by American Society of Civil Engineers (<u>guest editor</u>, <u>editorial board member</u>) (2004-2010)
19. Journal of Hydrological Engineering, published by American Society of Civil Engineers (<u>guest editor</u>, <u>associate editor</u>) (2008-2012)
20. Environmental Impact Assessment Review, published by Elsevier (<u>editorial board member</u>) (2004-2018)

<u>**Keynote Speech:**</u>

Chang was invited guest speaker or keynote speaker over 70 universities, national laboratories, professional associations, and governmental agencies nationally and internationally. Since 1992, Chang has presented his work in the United Kingdom, United States, France, Germany, Taiwan, Singapore, Switzerland, Hong Kong, Belgium, China, Japan, Portugal, the Netherlands, and Nicaragua, summarized below:

- Graduate Institute of Environmental Engineering, National Chiao-Tung University, Taiwan (Feb. 1997)
- National Taiwan University, Taiwan (April 1998)
- Chinese Academy of Sciences, China (June 1998, Sept. 2002)
- Eastern China University of Science and Technology, China (May 2002)
- University of Louisiana – Lafayette, USA (March 2004)
- Arizona State University, USA (April 2005)
- University of Louisville, USA (May 2005)
- Louisiana State University, USA (March 2006)
- University of Texas – San Antonio, USA (Oct. 2007)
- Georgia Institute of Technology, USA (Nov. 2007)
- Natural Resource Ecology Lab., Colorado State University, USA (Dec. 2008)
- Center of Remote Sensing and Modeling for Agricultural Sustainability, USDA, USA (April 2009)
- Research Center of Environmental Changes, Academia Sinica, Taiwan (June 2009)
- Chung-Hua Institution for Economic Research, Taiwan (June 2009)
- National University of Kaohsiung, Taiwan (June 2009)
- George Mason University, USA (Oct. 2009)
- University of Cincinnati, USA (April 2010)
- Dalian University of Technology, China (June 2010)
- Chaoyang University of Technology, Taiwan (June 2010)
- National University of Kaohsiung, Taiwan (June 2010)
- Eastern China Normal University, China (June 2010)
- University of Tokyo, Japan (June 2010)
- University Nova de Lisboa, Lisbon, Portugal (Jan. 2011)
- Huazhong University of Science and Technology, China (May 2011)
- Nanyang Technological University, Singapore (June 2011)
- National University of Singapore, Singapore (June 2011)
- National Central University, Taiwan (June 2011, June 2012)
- Tunghai University, Taiwan (June 2011, June 2012; Dec. 2014)
- University of Exeter, the United Kingdom (Sept. 2011, May 2012)
- Wessex Institute of Technology, the United Kingdom (Sept. 2011)
- The Instituto Nicaragüense de Estudios Territoriales (Nicaraguan Geosciences Institute, INETER), Nicaragua (May 2012)
- The Institute of Bio and Geoscience (IBG) of the Forschungszentrum Jülich, Germany (July 2012)
- University of Waterloo, Canada (Sept. 2012)
- University of Oklahoma, USA (Sept. 2013)
- University of Hong Kong, China (Dec. 2013)
- The EurASc annual meeting at Toulouse, France (Nov. 2013)
- University of Bristol, the United Kingdom (Feb. 2014)
- Heriot-Watt University, United Kingdom (Feb. 2014)
- EPSRC, the United Kingdom (Feb. 2014)
- NERC, the United Kingdom (Feb. 2014)
- Northeastern University, USA (Feb. 2014)
- Colorado School of Mines, USA (March 2014)
- University of California-Irvine, USA (May 2014)
- Disaster Prevention and Water Environment Research Center, National Chiao-Tung University, Taiwan (July 2014)
- Institute of Water and Environment at Technische Universität München, Germany (Sept. 2014)
- Florida Atlantic University, USA (Nov. 2014)

- The King Abdullah University of Science and Technology (KAUST), Saudi Arabia (May 2015)
- University of Oxford, the United Kingdom (June 2015)
- University of Exeter, the United Kingdom (July 2015)
- De Montford University, the United Kingdom (Aug. 2015)
- University of Hong Kong, China (Oct. 2015)
- City University of Hong Kong, China (Oct. 2015)
- National Central University, Taiwan (Oct. 2015)
- Research Center of Environmental Changes, Academic Sinica, Taiwan (Oct. 2015)
- Institute of Geographical Science and Natural Resources, Chinese Academy of Science, China (April 2016)
- Department of Hydraulic Engineering, Tsinghua University, China (April 2016)
- Departmento de Computación, CINVESTAV-IPN, Mexico (May 2016)
- Delft University of Technology, the Netherlands (Nov. 2016),
- European Academy of Science, Belgium (Nov. 2016),
- National Space Organization Center, Taiwan (Dec. 2016)
- East China Normal University, China (Jan. 2017)
- Research Center of Environmental Changes, Academia Sinica, Taiwan (Jan. 2017)
- Fudan University, China (Jan. 2017)
- Swiss Federal Institute of Technology in Zurich, Switzerland (May 2017)
- China Meteorological Administration (CMA), China (Nov. 2017)
- Chinese Academy of Meteorological Sciences, China (Nov. 2017)
- University of Hong Kong, China (May 2018)
- Sun-Yet-Sen University, China (May 2018)
- National Taipei University of Technology, Taiwan (June 2018)
- Xi'an University of Science and Technology, China (June 2018)
- University of Florida, USA (Aug. 2018)
- California State University – Long Beach, USA (Oct. 2018)
- Yuan Ze University, Taiwan (Nov. 2018)
- University of Iowa, USA (Sept. 2019)
- IEEE Distinguished Speaker Series, presented online to the audience of the IEEE Systems Council (April 2023)
- Taiwan Agriculture Research Institute, Taiwan (July 2023)
- Hong-Kong Polytechnic University, China (Jan. 2024)
- IEEE Distinguished Lecture, presented online to the audience of the IEEE Systems Council (Oct. 2024)

External Examiner of Ph.D. Dissertation:

Chang was invited as an external examiner for Ph.D. dissertation for various universities in China, Hong Kong, Portugal, Spain, Taiwan, India, Singapore, Australia, the United Kingdom, and Canada.

External Proposal Reviewer and/or Panellist:

Chang served as a proposal reviewer, book reviewer, or a panelist for many organizations worldwide, including:

- National Science Council, Taiwan 1998-2001.

- National Science Foundation (NSF) Office of Cyberinfrastructure (OCI) "Cyberinfrastructure Training, Education, Advancement, and Mentoring for Our 21st Century Workforce (CI-TEAM) program", 2007
- The Louisiana Sea Grant, Nov. 2008
- Science Foundation Ireland (SFI) Research Frontiers Programme (Dublin, Ireland), 2008
- NSF Environmental Engineering Program - Water Quality/Pollution Control, 2008
- New Jersey Sea Grant College Program, Nov. 2010
- National Council for Scientific Research, Romania - the "Complex Exploratory Research Projects" in "Ideas" research program, 2012
- Environmental Protection Agency (EPA) STAR Graduate Fellowship Program, 2013
- The Netherlands Organisation for Scientific Research, Nov. 2013
- National Research Foundation in Singapore, Nov. 2014
- Florida Solid and Hazardous Waste Management Center, Nov. 2014
- National Oceanic and Atmospheric Administration (NOAA), Center for Sponsored Coastal Ocean Research (CSCOR) – MERHAB Program, Nov. 2014
- The Portuguese Foundation for Science and Technology (FCT), Nov. 2014
- The Israel Science Foundation (ISF), Oct. 2014
- KU Leuven Impulse Fund Program (University of Leuven, Belgium), Nov. 2014
- National Science Foundation-International Fellowship program, Nov. 2014
- Joint German-Israeli Research Program in Germany and Israel, Nov. 2011
- The State University of New York (SUNY) 4E Network of Excellence Collaboration Grants, 2014
- Water Environment Federation, Oct. 2014
- U.S. - Israel Binational Science Foundation, Nov. 2014
- National Science Foundation (NSF) Office of Cyberinfrastructure (OCI) "Cyberinfrastructure Training, Education, Advancement, and Mentoring for Our 21st Century Workforce (CI-TEAM) program", Nov. 2014
- NSF Environmental Eng. Program, Nov. 2014
- Department of Defense (DOD) Environmental Remediation Technology Program, 2015
- Department of Energy (DOE) Recovery Act: Energy Efficiency and Conservation Block Grant (DOE Environmental Management Consolidated Business Center (EMCBC)), 2015
- Geological Survey (USGS) National Initiative of Water Resources (NIWR) program, 2015
- Oak Ridge Associated Universities (ORAU), 2015
- National Science Council (NSC) in Taiwan, 2015
- NSF Hydrological Sciences Program and International Research Fellowship Program, 2015
- NASA Postdoctoral Program (NPP), May 2015
- The New Zealand Ministry of Business, Innovation & Employment (MBIE) - Science Investment Round, June 2015
- The New Zealand Ministry of Business, June 2015
- National Aeronautics and Space Administration (NASA) Postdoctoral Program, May 2015
- The Research Grants Council (RGC) of Hong Kong, April 2016
- The National Centre of Science and Technology Evaluation, Republic of Kazakhstan, May 2015
- The Isreal Science Foundation, April 2016
- Join the Panel of the EPA National Priorities: Impacts of Water Conservation on Water Quality in Premise Plumbing and Water Distribution Systems, April 2016
- The China (CAS, CASS, MoE, MOST)-Netherlands (OCW, KNAW, NWO) Joint Scientific Thematic Research Programme (JSTP), March 2017
- Department of Homeland Security (DHS) Office of University Programs, March 2018
- National Science Foundation-Division of Earth Sciences, Instrumentation and Facilities Program, March 2018

- National Science Foundation-Hydrological Science Program, March 2019
- The Research Grants Council (RGC) of Hong Kong, May 2018
- University of the Chinese Academy of Science, Nov. 2018
- National Science Foundation-Hydrological Science Program, April 2019
- The Research Grants Council (RGC) of Hong Kong, Feb. 2019
- NSF EPSCOR Program, Feb. 2020
- National Science and Engineering Research Council of Canada (NSERC) in Canada, May 2019
- The Research Grants Council (RGC) of Hong Kong, March 2020
- Swiss National Science Foundation, May 2020
- The Science & Technology Foundation (NWO) - Domain Applied and Engineering Sciences, the Netherlands, Oct. 2020
- The Ohio Water Resources Center in Conjunction with the National Institutes for Water Resources (NIWR) State Water Resources Research Institute 104(b) Grant Program, Nov. 2020
- United Arab Emirates University (UAEU), Aug. 2020
- Research Grant Council in Hong Kong, China, Jan. 2021
- New York Sea Grant Program, June 2021
- The Louisiana Sea Grant, June 2022
- The U.S. National Institute of Standards and Technology (NIST) via the U.S.-Israel Binational Industrial R&D (BIRD) Foundation, April 2023
- The National Nuclear Security Administration (NNSA) Nonproliferation and Arms Control Climate Change Program (NPAC-C), July 2023
- The Israel-U.S. Binational Industrial Research and Development Program (The BIRD Foundation), July 2023
- The U.S.-Egypt Science and Technology Joint Fund (Cycle 22) at the National Academies of Sciences, Engineering, and Medicine, Jan. 2024
- Ralph E Powe Junior Faculty Award Application Review for Oak Ridge Associated Universities (ORAU), Feb 2024
- The Mitacs Accelerate Research Program, Canada, April 2024
- Panel of Engineering Research Centers (ERC) in the National Science Foundation, Nov. 2024.
- The International Assessment Committee for the program "KIC Greenhouses in transition: Opportunities in water, energy and agriculture," Dutch Research Council (NWO), in collaboration with the Foundation for Food & Agriculture Research (FFAR) in the United States, Oct.-Dec., 2024.

Professional Societies and Academic Conferences:

Chang has been highly active in many professional societies of the American Society of Civil Engineers (ASCE), the European Academy of Sciences (EurASc), the International Water Association (IWA), the International Association of Advanced Materials (IAAM), the American Association for the Advancement of Science (AAAS), the International water Association (IWA), the International Society for Optics and Photonics (SPIE), the Institute of Electronics and Electrical Engineers (IEEE) (IEEE Geoscience and Remote Sensing Society; IEEE Systems, Man and Cybernetics Society; IEEE Computational Intelligence Society; and IEEE Computer Society) etc., as listed below:

- Founding member and board member of the International Society of Environmental Information Management (ISEIS) since 2004
- Chair, conference sessions on "Urbanization Effect on Groundwater" the annual conferences of the ASCE/EWRI, 2008

- Member of Groundwater Management Committee, International Council, Watershed Management Systems Analysis Task Committee, Green Roofs Task Committee, Environmental and Water Resources System Committee in EWRI/ASCE since 2009
- Chair, the Workshop of Green Engineering and Industrial Ecology, the University of Kaohsiung, on June 3 – June 14, Kaohsiung, Taiwan, 2010
- Chair, the special session in Hydrological and Environmental Remote Sensing for Global Changes, the Western Pacific Geophysical Meeting (WPGM), May 22-25, 2010, Taipei, Taiwan
- Member, International Program Committee, IEEE International Conference on Grey Systems and Intelligent Services in 2011 and 2012
- Member, International Advisory Board of the 7th ASCE International Engineering and Construction Conference on "Green Infrastructure System" held at Brisbane, Australia on February 13-15, 2012
- Chair, special session in the international conference on "Stochastic and Statistical Methods in Hydrology and Environmental Engineering, in Koblenz, Germany, 2013
- Board member, the International Society of Grey Systems and Uncertainty Analysis (ISGSUA) 2015-2019
- Chair of the task committee of "Urbanization Effect on Groundwater" in EWRI/ASCE 2009-2014
- Member of Watershed and River Basin Management Specialty Group in IWA since 2014
- Member, the Leadership Team (LT) of the Joint IAHR-IWA Hydroinformatics Committee sine 2017
- Session Chair and Co-Chair "Remote Sensing and Modeling of Ecosystems for Sustainability, SPIE Remote Sensing Conference, held in San Diego, CA, USA, from 2007 to 2017
- Co-Chair of session "Water Purification and Monitoring under Minimal Resource Setting" in 2013 AAAS Annual Meeting, Boston, held on 14-18 Feb. 2013
- Co-chair of the Technical Committee for "Environmental Sensing, Networking and Decision-Making", "Intelligent Transportation System", and "Grey System Technical Committee" in the IEEE Systems, Man and Cybernetics (SMC) Society sine 2013
- Member of the technical committee on "Conflict Resolution" in IEEE SMC sine 2013
- Member of the technical committee on "Earth Science Informatics" in the IEEE Geosciences and Remote Sensing Society sine 2015
- Member of the IEEE Intelligence System Applications Technical Committee in IEEE Computational Intelligence, Society since 2014
- Co-chair 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.
- Chair of the Best Paper Award Committee and 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
- Chair of the IEEE International Conference on Networking, Sensing and Control (ICNSC) held at Miami, FL, USA on April 7 – 10, 2014
- Co-chair of the SPIE Remote Sensing and Modeling for Ecosystem of Sustainability in San Diego, CA from 2014 to 2018
- Member of the organizing committee of the "Encyclopedia for Environmental Management" published by the Taylor and Francis Group, Jan. 2013
- Co-editor of a book entitled "Advances in Ecological Modelling and Ecological Engineering - Lakes and Wetlands" published by Elsevier, June 2014
- Chair, IEEE Conference for Sensing, Networking, and Control, Miami, Florida, May 2014
- Guest editor of a special issue of IEEE Systems Journal titled "Cyber-innovated Environmental Sensing, Monitoring and Modeling for Sustainability" in 2015

- Member of the IEEE Environmental Engineering Initiative since 2015
- Guest editor of a special issue of SPIE Journal of Applied Remote Sensing titled "Remote Sensing and Sensor Networks for Investigating the Coupled Biogeophysical and Biogeochemical Process of Harmful Algal Blooms" in 2015
- Board Member, Earth Science and Environmental Science Division, the European Academy of Sciences, 2010-2016.
- Editor-in-chief, Journal of Applied Remote Sensing, SPIE, 2014-2023
- Keynote speaker of the International Association of Advanced Materials (IAAM) Fellow Lecture (Nov. 2020)
- Invited speaker of the Anniversary of Fulbright Canada, Feb. 2021
- Invited speaker of the First IAHR Online Forum, The International Association for Hydro-Environment Engineering and Research (IAHR), July 2021
- Member, the Steering Committee of the International Conferences on Water and Environment Research (ICWRER) since 2012
- Chair, the 9th International Conference on Water Resources and Environment Research (ICWRER), April 25 -27, 2022, sponsored by the UCF Stormwater Management Academy
- Keynote speaker of the IEEE Distinguished Speaker Series, presented online to the audience of the IEEE Systems Council, April 2023
- Keynote speaker of the Hong-Kong Polytechnic University, China, Jan. 2024
- Keynote speaker of the IEEE Distinguished Lecture, presented online to the audience of the IEEE Systems Council, Oct. 2024
- Editor-in-chief, Journal of Hydroinformatics, Official Journal of International Water Association (IWA), the United Kingdom, 2023-present
- Member, the IEEE Medal for Environmental & Safety Technologies Committee from 2023 to 2025
- Book proposal reviewer, "A Hardware-in-Loop Digital Twin Approach to Intelligent Optimization of Municipal Solid Waste Incineration". In IEEE Book Series on Systems Science and Engineering, Published by Wiley/IEEE, New York, Oct. 2024

External Evaluation of Promotion and Tenure Dossiers

- One associate prof. dossier for the promotion to be a professor, School of Civil Engineering and Environmental Science, University of Oklahoma, Norman, Oklahoma, 2011
- One associate prof. dossier for the promotion to be a professor, Department of Electronic Engineering, Gorve School of Engineering, the City College of New York, 2011
- One assistant professor dossier for promotion to be an associate professor in the School of Civil and Environmental Engineering at the Nanyang Technological University, 2015
- One assistant professor dossier for promotion to be an associate professor in the Faculty of Engineering and Physical Science at the University of Exeter, the United Kingdom, 2016
- One associate professor dossier for promotion to be a professor in the Faculty of Engineering and Physical Science at the University of Exeter, the United Kingdom, 2018
- One assistant professor dossier for promotion to be an associate professor in the Civil and Environmental Engineering Department at the University of Tennessee, Knoxville, 2018
- One assistant professor dossier for promotion to be an associate professor in the Faculty of Engineering at the University of Jordon, 2019
- One associate professor dossier for promotion to be a professor in the Faculty of Engineering and Physical Science at the University of Exeter, the United Kingdom, 2020
- One associate professor dossier for promotion to be a professor in the Civil Engineering Department at the Asian Institute of Technology, Thailand, 2020

- One assistant prof. dossier for promotion and tenure to be an associate professor in the Department of Civil and Environmental Engineering, University of Iowa, 2020
- One associate professor dossier for promotion to be a professor Department of Geography & Geoinformation at the George Mason University, 2020
- One professor dossier for promotion to be a distinguished professor of Civil and Environmental Engineering at New Jersey Institute of Technology,2020
- One associate prof. dossier for promotion to be a professor in Bar Ilan University (BIU), Israel in 2021
- One associate prof. dossier for promotion and tenure to be a professor in the Department of Civil and Environmental Engineering at the University of Vermont, 2021
- One associate prof. dossier for promotion to be a professor in the Department of Biological and Environmental Engineering at Cornell University, 2022
- One assistant prof. dossier for promotion and tenure to be an associate professor in the Department of Civil and Environmental Engineering at Auburn University, 2022
- One associate professor dossier for promotion to be a professor in the Faculty of Engineering and Physical Science at the University of Exeter, the United Kingdom, 2022
- One assistant prof. dossier for promotion and tenure to be an associate professor in the Department of Water Management, Faculty of Civil Engineering and Geosciences at Delft University of Technology (TU Delft), The Netherland, 2023
- One associate prof. dossier for promotion to be a professor in the Department of Earth and Environment, Florida International University, 2024
- Member of Promotion and Tenure Committee at UCF to evaluate promotion package from Associate to full professor and from assistant professor to Associate Professor annually from 2005 to the present

Other Prestigious Outcome, External Evaluation, or Global Service Activities:

- Chang was the founder of the Department of Civil and Environmental Engineering (CEE), National Kaohsiung University in Taiwan from 2000 to 2001. He worked with the founding team of this new University in a 2-year time frame to build up the capacity the CEE department all the way from scratch to a new department. The Chang's "generosity of time, talent, and experience" was essential to the department's and university's launch.
- Chang helped Taiwan Power Company to create the first-generation digital twins for decision support of the nuclear emergency response planning and management at three nuclear power plants in 1999-2001. Two of the nuclear power plants are located at Taipei and the third is located at Pingtung in Taiwan. The decision support system has been used till the decommissioning phase of the three nuclear power plants in 2023 and 2024, respectively.
- Invited by the Editor-in-Chief (Dr. Philip Campbell) to serve on the reader panel of *Nature*, Nov. 2008
- Invited to visit the Jet Propulsion Laboratory, NASA and California Institute of Technology, in Aug. 2013
- Invited to evaluate R1 Commission Evaluator - Dubois Center, University of North Carolina-Charlotte, May 2021
- Invited to evaluate one dossier for the membership of the Royal Irish Academy in Ireland, Nov. 2022
- Affiliated with the Center for Global Economic and Environmental Opportunity (GEEO) as a Faculty Fellow at UCF and the GEEO is part of the Sustainable Development Solution Network (SDSN) in the United Nations

- Knowledge dissemination of research findings and education efforts globally that echo the United Nation's Sustainable Development Goals (SDGs) such as SDG 2 (zero hunger), SDG 4 (Quality Education), SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), SDG 10 (Reduce Inequalities), SDG 11 (Sustainable Cities and Communities), SDG 13 (Climate Action), SDG 14 (Life Below Water), SDG 15 (Life on Land), SDG 16 (Peace, Justice, and Strong Institutions), and SDG 17 (Partners for the Goals)

- Knowledge dissemination and global networking as an International Conference Chair for the IEEE International Conference on Networking, Sensing and Control (ICNSC) 2014. The conference theme is "Integrated Environmental Sensing, Monitoring, and Modeling for Optimal Decision Making". This conference accepted about 120 papers after a rigorous review process. Contributors are from 15 countries or regions, including France, Jordan, Japan, Spain, Tunisia, Saudi Arabia, India, Brazil, Mexico, the Netherlands, PR China, Hong Kong, Taiwan, Malaysia, and USA. Accepted papers were presented in 24 technical sessions. IEEE ICNSC 2014 is honored to have four distinguished plenary talks provided by Prof. Vincenzo Piuri Università degli Studi di Milano, Italy, Dr. Thomas J. Jackson Agricultural Research Service, Hydrology and Remote Sensing Laboratory, United States Department of Agriculture, USA, Prof. Saïd Mammar Computer Science, Integrative Biology and Complex Systems Lab (IBISC), Evry val-d'Essonne University, France, and Prof. Carlos Artemio Coello Coello Computer Science Department at CINVESTAV-IPN, Mexico City, Mexico.

- Knowledge dissemination and global networking as an International Conference Chair for the 9th International Conference on Water Resources and Environment Research (ICWRER), held on April 26-29, 2022. There were about 100 participants who joined this conference from all over the world. The theme of this conference is "Bridging the gaps of interdisciplinary sustainability solutions for complex water and environmental systems." The ICWRER 2022 conference program is composed of 5 keynote presentations provided by Prof. Slobodan P. Simonovic, Prof. Roger Falconer, Prof. Soroosh Sorooshian, Prof. Jun Xia, and Prof. David Butler. ICWRER 2022 received paper submissions from 14 countries, including Asia (Singapore, Korea, Iran, China, Japan), Europe (the United Kingdom, Austria, Switzerland, the Netherlands, France), Africa (South Africa), North America (Canada, the United States), and South America (Brazil). 56 paper submissions were accepted for presentations in the ICWRER 2022. Presentation scheduling considers 11 sessions.

International Collaboration:

Chang has been active in organizing and participating numerous international activities. Dr. Chang fostered over thirty strategic alliances worldwide for research collaboration between the Stormwater Management Academy (SMA) and other 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 20 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, IAHR, IWA, SPIE and IEEE from which he built on an international collaborative network. Over the last 10 years, Chang participated in the various

international collaborative channels via the co-supervision of overseas Ph.D. students in China, United Kingdom, Spain, Portugal, Singapore, and Taiwan. Throughout his career, Dr. Chang has regularly presented leading-edge research accomplishments over 50 institutes and universities around the globe vis various partnerships with United Kingdom (University of Exeter and University of Bristol), Canada (University of Waterloo), Taiwan (National Central University and Tunghai University), Japan (Tokyo 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 editor-in-chief of *SPIE official Journal of Applied Remote Sensing* and *IWA official journal of HydroInformatics* as well as an editorial board member of 30+ prestigious international journals by which he made a strong networking with international scholars worldwide. In short, Chang is active in international research collaboration and has been working on common research projects across the globe in 2007-the present as briefly described below:

- Universitat de València (Spain) Working on lake eutrophication issue and water resources management
- Eastern China Normal University (China) Working on global climate change issue, lake eutrophication issue, and air quality assessment and management
- University of Exeter (the United Kingdom) Working on urban flood impact assessment, and mega-city management
  Tsinghua University (China) Working on urban flood impact assessment, and mega-city management
- National Autonomous University of Nicaragua (Nicaragua) Working on lake eutrophication and paleolimnology issues
- National Central University (Taiwan) Working on lake eutrophication, climate change, ecosystem conservation, and mangrove forest assessment issues
- University of Hong Kong (China) Working on stormwater management, low impact development, and hydrological modeling issues
- Huazhong University of Science and Technology (China) and University of Central Florida (USA) Working on urban waste management, sustainable development, and sensor network issues.
- Dalian University of Technology (China) Working on coastal land use management, sustainable development, and urban growth issues
- Tonghai University (Taiwan) Working on waste management, sustainable development, and urbanization issues
- Yuan Ze University (Taiwan) and University of Central Florida (USA) Working on green material and nanomaterial development for pollutant removal and material characterization issues.
- Universidade Nova de Lisboa (Portugal) Working on waste management, sustainable development, and environmental management issues
- National University of Kaohsiung (Taiwan) Working on industrial ecology and water management issues
- Chinese Academy of Science (China) Working on river and lake management, sustainable development, and ecosystem restoration issues
- The Institute of Bio and Geoscience (IBG) of the Forschungszentrum Jülich (Germany) Working on global climate change and critical zone observatory issues
- Delft University of Technology (The Netherlands) Working on urban food-energy-water system optimization
- The National Research Institute of Science and Technology for Environment and Agriculture (IRSTEA)(France) Working on urban food-energy-water system optimization

- Federal University of Espirito Santo – UFES, Brazil: Working on refuse-derived fuel production in a water management system

Global Education:

Dr. Chang's dedication to education and mentoring is highly impressive. Through collaborative research in environmental systems engineering with colleagues, co-supervising MSc and PhD students, and lecturing in strategic courses and outreach for community services, he strived to advance innovation in education for diversified students globally. Out of the 45 graduate students he had advised in the US, 13 are female and 8 are Hispanic students. International graduate students in his team were recruited from all over the world, including the United States, Portugal, Spain, Brazil, China, Sudan, Iran, India, Bangladesh, Sri Lanka, Myanmar, Indonesia, Thailand, Honduras, Colombia, Kerea, etc. He is active as a mentor, advising visiting scholars from Spain, France, Taiwan, China, Honduras, and Czechia, and Fulbright scholars from Taiwan, Sri Lanka, Myanmar, Algeria, and Brazil, for their academic growth and professional development. His role as a Graduate Faculty Scholar at the UCF has been pivotal in nurturing the next generation of engineers, scholars, and entrepreneurs. One of his former graduate students started his own company (i.e., Mr. Zachary Marimon, CEO and President at Agrarian Land and Pond, LLC), dedicated to stormwater pond management in Central Florida rigth after graduation, and his company has been growing up quickly since 2014. A few of his former graduate students became faculty members or researchers contributed to the academic community or government agencies in China, Taiwan, and the US in the past 3 decades.

SELECTED RECENT PRESENTATIONS FROM 2012 TO THE PRESENT OUT OF 330+

P1. Chang, N. B. and Vannah, B. (2012) Monitoring Changing Environment and Ecosystems with an Integrated Data Fusion and Mining (IDFM) Technique, The Instituto Nicaragüense de Estudios Territoriales (Nicaraguan Geosciences Institute, INETER), Nigaragua, May 5, 2012. (Local)

P2. Chang, N. B., Jones, J., Islam, K, and Xuan, Z. (2012) Assessment of Ecosystem Restoration in Lake Istoppoga, Florida. The 23rd Annual Florida Lake Management Society Conference at Gainesville, Florida, USA, June 18-22, 2012. (Regional, Local)

P3. Jones, J., Islam, K, Chang, N. B., and Lumbert, L. (2012) Assessment of Best Management Practices of Sediment Dredging in Lake Apopka-Beauclair System, Florida. The 23rd Annual Florida Lake Management Society Conference at Gainesville, Florida, USA, June 18-22, 2012, (Regional, Local)

P4. Chang N. B. (2012) The Challenges of Design for Water-Energy-Environment-Infrastructure Systems under Climate Change Impacts toward Urban Sustainability, Tunghai University, Taiwan, June 25, 2012. (International)

P5. Chang N. B. (2012) The Assessment of Climate Change Impact on Regional Precipitation via Various Teleconnection Signal Propagation Patterns, The Center for Space and Remote Sensing Research, National Central University, Zhungli, Taiwan, July 11, 2012. (Local)

P6.   Chang N. B. (2012) The Use of Biosorption Activated Media for Nutrient Removal, The Institute of Bio and Geoscience (IBG) of the Forschungszentrum Jülich, Germany, Invited by the Fulbright Scholar program, Jülich, Germany, July 19, 2012. (Local)

P7.   Wanielista, M. P., Chang, N. B., and Islam, K. (2012) Floating Wetland Field Assessment of Nutrient Removal in a Stormwater Wet Pond, The National Hydraulics and Hydrology Engineering Conference (NHEC), Nashville, Tennessee, USA, Aug. 20-27, 2012. (National)

P8.   Chang N. B., Vannah, B., and Xuan, Z. (2012) Monitoring the Total Organic Carbon Concentrations in a Lake with the Integrated Data Fusion and Mining Technique, SPIE OP403: Remote Sensing and Modeling of Ecosystems for Sustainability VII Symposium at San Diego, California, USA, August 12-16, 2012. (International)

P9.   Chang N. B., L. Mullen, and J. Weiss (2012) Cross Wavelet Analysis for Retrieving Climate Teleconnection Signals between Sea Surface Temperature and Forest Greenness, SPIE OP403: Remote Sensing and Modeling of Ecosystems for Sustainability VII Symposium at San Diego, California, USA, August 12-16, 2012. (International)

P10.   Chang N. B. and Xuan, Z. (2013) Monitoring Nutrient Concentrations in Tampa Bay under Hurricane Impact with MODIS Images and Machine Learning Models, The IEEE International Conference on Networking, Sensing and Control (IEEE Systems, Man, and Cybernetics Society), Paris, France, April 10-12, 2013. (International)

P11.   Marimon, Z., Xuan, Z. M., and Chang, N. B. (2013) Modeling the Treatment Efficiency of a Stormwater Wet Detention Pond with Floating Treatment Wetlands, The 29th Annual Water Resources Seminar, Environmental Water Resources Institute, ASCE, Orlando, FL, April 19, 2013. (Regional, Local).

P12.   Yang, Y., Chang, N. B., Li, Z., Buchberger, S. G., Tong, S., Wang, X., Levine, A., Hinchman, A., Fang, M., Swertfeger, J., and Goodrich, J. A. (2013) A Systems Approach to Manage Drinking Water Quality through Integrated Model Projections, Adaptive Monitoring and Process Optimization. ASCE/EWRI World Environmental and Water Resources Congress at Cincinnati, Ohio, USA, May 20-22, 2013. (International, National, Regional)

P13.   Yang, Y., Chang, N. B., Neal, J., Wei, H., Liang, S., and Keener, T. C. (2013) Water and Carbon Footprints for Sustainability Analysis of Urban Infrastructure, ASCE/EWRI World Environmental and Water Resources Congress at Cincinnati, Ohio, USA, May 20-22, 2013. (International, National, Regional)

P14.   Vannah, B., Chang, N. B., and Yang J. (2013) Integrated Data Fusion and Machine-learning (IDFM) for Monitoring Spatiotemporal Microcystin Distributions in Lake Erie, International Conferences on Water and Environment Research (ICWRER), Koblenz, Germany, June 3rd to 7th, 2013. (International)

P15.   Mullon, L., Chang, N. B., and Yang J. (2013) Prediction of Precipitation Based on Long-term Teleconnection Signal with Remote Sensing-based Wavelet Analysis," International Conferences on Water and Environment Research (ICWRER), Koblenz, Germany, June 3rd to 7th, 2013. (International)

P16.   Imen, S., Chang, N. B., and Yang J. (2013) Exploring the Effect of Teleconnection Signal Propagation on Terrestrial Precipitation in North America, International Conferences on Water and Environment Research (ICWRER), Koblenz, Germany, June 3rd to 7th, 2013. (International)

P17.   Mullon, L., Chang, N. B., and Yang J. (2013) Short- term Interactions between Sea Surface Temperature and Precipitation Patterns in Northeast America," International Conferences on Water and Environment Research (ICWRER), Koblenz, Germany, June 3rd to 7th, 2013. (International)

P18. Chang, N. B. and Vannah, B. (2013) Integrated Data Fusion and Bio-optical Models for Monitoring Microcystin Concentrations in Lake Erie, Proceedings of SPIE Vol. 8869: Remote Sensing and Modeling of Ecosystems for Sustainability VII Symposium at San Diego, California, USA, August 26-28, 2013. (International, National)

P19. Chang, N. B. (2013) Remote Sensing and Sensor Networks in Support of Environmental Monitoring for Agricultural Sustainability. The 2nd International Conference on Agro-geoinformatics Fairfax, US, Aug. 12, 2013. (International)

P20. Chang, N. B. and Vannah, B. (2013) Fusion of Hyperspectral and Multispectral Remote Sensing Data for Near Real-time Monitoring of Microcystin Distributions in Lake Erie, Proceedings of SPIE Vol. 8871 Satellite Data Compression, Communications, and Processing VII Symposium at San Diego, California, USA, August 26-28, 2013. (International, National)

P21. Chang, N. B. and Imen, S. (2013) Periodicity Analysis for Teleconnection Signal Propagation between Sea Surface Temperature and Forest Greenness across North America, Proceedings of SPIE Vol. 8869: Remote Sensing and Modeling of Ecosystems for Sustainability VII Symposium at San Diego, California, USA, August 26-28, 2013. (International, National)

P22. Chang, N. B. (2013) Prediction of Precipitation Based on Long-term Teleconnection Signals via Wavelet-driven Artificial Neural Network Models, University of Oklahoma, Norman, Sept. 8, 2013. (Regional, Local)

P23. Chang, N. B. and Vannah, B. (2013) Comparative Data Fusion between Genetic Programming and Neural Network Models for Remote Sensing Images of Water Quality Monitoring, 2013 IEEE International Conference on Systems, Man, and Cybernetics (SMC), Manchester, UK, October 13th to 16th, 2013. (International)

P24. Chang, N. B. (2013) Monitoring Water Quality from Space: A New Frontier on Satellite Sensor Fusion, 2013 Annual Meeting of European Academy of Science, Nov. 5, 2013. (International)

P25. Chang, N. B. (2013) Monitoring Water Quality for Coupled Urban Water Infrastructure and Natural Systems with Remote Sensing and Sensor Networks, University of Hong Kong, Hong Kong, China, Dec. 24, 2013. (International)

P26. Chang, N. B. (2014) Integrated Data Fusion and Mining (IDFM) for Monitoring Water Quality in Lake Erie, University of Bristol, Bristol, United Kingdom, Feb. 22, 2014. (Receiving the Distinguished Visiting Fellowship Award, Royal Academy of Engineering, United Kingdom) (International)

P27. Chang, N. B. (2014) Multiscale Monitoring of Coastal City Development and Environmental Impact with Satellite Remote Sensing, Heriot Watt University, Edinburgh, United Kingdom, Feb. 26, 2014. (Receiving the Distinguished Visiting Fellowship Award, Royal Academy of Engineering, United Kingdom) (International)

P28. Chang, N. B. (2014) Integrated Sensor Fusion and Data Mining for Monitoring Water Quality and Ecosystem in Coastal Cities, Northeastern University, Boston, March 2, 2014. (Regional, Local)

P29. Chang, N. B. (2014) Integrated Data Fusion and Mining (IDFM) for Monitoring Water Quality in Lake Erie, Colorado School of Mines, Golden, CO, March 20, 2014. (Regional, Local)

P30. Chang, N. B. (2014) Sustainability Science and Engineering: A New Paradigm under the Global Change Impact, The Center for Hydrometeorology & Remote Sensing (CHRS), University of California-Irvine, May, 10, 2014. (Regional, Local).

P31. <u>Chang, N. B.</u> (2014) Remote Sensing for Improving Pumping Strategies in Reservoirs and Lakes for Water Treatment, 2014 Sustainable Water Management and Green Technology Workshop, Disaster Prevention and Water Environment Research Center, National Chiao-Tung University, Hsinchu, Taiwan, June 30-July 1 2014. (International)

P32. <u>Chang, N. B.</u> (2014) Tackling the Challenges of Water Resources Management from Space: A Long-term Perspective on Satellite Sensor Networks and Data Fusion, Symposium of Photonic Innovations and Solutions for Complex Environments and Systems (PISCES), San Diego, California, USA, August 17-21, 2014. (International, National)

P33. <u>Chang, N. B.</u> and Vannah, B. (2014) Satellite Data Fusion and Information Retrieval with Ground-based Sensor Networks for Monitoring Ecosystem Evolution," Remote Sensing System Engineering Symposium at San Diego, California, USA, August 17-21, 2014. (International, National)

P34. <u>Chang, N. B.</u>, Imen, S., and Yang, J. (2014) Linkages between Turbidity Levels in Lake Mead and Associated Forest Fire Events in the Lower Virgin Watershed, SPIE: Remote Sensing and Modeling of Ecosystems for Sustainability VII Symposium, San Diego, California, USA, August 17-21, 2014. (International, National)

P35. <u>Chang, N. B.</u> and Imen, S. (2014) Impact of Teleconnection Phenomena and Local Environmental Factors on Forest Greenness in North and Central America, SPIE Symposium of Remote Sensing and Modeling of Ecosystems for Sustainability, San Diego, California, USA, August 17-21, 2014. (International, National)

P36. <u>Chang, N. B.</u> (2014) The Development of Urban Water Systems Engineering in Florida under Rapid Global Change Impact, The Institute of Water and Environment, Technische Universität München, Germany Sept. 27, 2014. (International)

P37. Imen, S., <u>Chang, N. B.,</u> and Yang, J. (2014) Spatiotemporal Monitoring of TOC Concentrations in Lake Mead with a Near Real-Time Multi-sensor Network," 2014 IEEE International Conference on Systems, Man, and Cybernetics (SMC), San Diego, CA, USA, October 6-9, 2014. (International, National, Regional)

P38. <u>Chang, N. B.</u> (2014) Multi-scale Modeling for Developing Smart Stormwater Management Grids: An Integrated Modeling, Informatics and Cybernetics Approach," Stormwater Modeling Workshop in City of Fort Lauderdale, Fort Lauderdale, Florida, Oct. 29, 2014. (Regional, Local).

P39. <u>Chang, N. B.</u> (2014) Satellite Sensor Fusion and Data Mining for Monitoring Water Quality Status in Aquatic Environments, Florida Atlantic University, Boca Raton, FL, Nov. 19, 2014. (Regional, Local).

P40. <u>Chang, N. B.</u> (2014) Integrative Approaches towards a Sustainable Environment and Society: Principles and Practices with Collaborative Networking, Tunghai Univeristy, Taiwan, Dec. 14, 2014. (International)

P41. <u>Chang, N. B.</u>, Houmann, C., Crawford, A. J., and Wanielista, M. (2015) Field-Scale Evaluation of Floating Treatment Wetlands for Nutrient Removal and Algal Toxin Control in Wet Detention Ponds across Florida," ASCE LID Conference, Houston, TX, Jan. 17-21, 2015. (National, Regional)

P42. Crawford, A. J., Houmann, C., <u>Chang, N. B.</u>, and Wanielista, M. (2015) Attaining Additional Nutrient Removal in Eutrophic Stormwater Wet Detention Pond Using a Floating Media Bed Reactor," ASCE LID Conference, Houston, TX, Jan. 17-21, 2015. (National, Regional)

P43. Doña, C., <u>Chang, N. B.</u>, Caselles, V., Sánchez, J. M., and Camacho, A. (2015) Investigating the Hydrological Signature of Seasonal Lagoons in La Mancha Húmeda Biosphere Reserve, Spain with Remote Sensing Technologies, Conference on Mapping Water Bodies from Space, The European Space Agency, Rome, Italy, March 18-19, 2015. (International)

P44. Chang, N. B. and Imen, S. (2015) Improving the Control of Water Treatment Plant with Remote Sensing-based Water Quality Forecasting Model, he 12th IEEE International Conference of Netowrking, Sensing, and Control (ICNSC), Taipei, Taiwan, April 9-12, 2015. (International)

P45. Di, Y., Ding, W., Small, D. L., Islam, S., and <u>Chang, N. B.</u> (2015) Applying Machine Learning for the Long-Lead Heavy Precipitation Predication, The 12th IEEE International Conference of Netowrking, Sensing, and Control (ICNSC), Taipei, Taiwan, April 9-12, 2015.

P46. <u>Chang, N. B.</u> (2015) Multi-sensor Fusion and Data Mining for Sustainable Urban Water Infrastructure Systems Analysis, The 12th IEEE Conference of Netowrking, Sensing, and Control (ICNSC), Taipei, Taiwan, April 9-12, 2015. (International)

P47. Doña, C., Niclòs, R., <u>Chang, N. B.</u>, Caselles, V., Sánchez, J. M., and Camacho, A., (2015) Water Area Variations in Seasonal Lagoons with Remote Sensing Classification Methods and Data Mining Techniques in La Mancha Húmeda, European Geophysical Union, Venna, Austria, April 12-17, 2015. (International)

P48. Doña, C., Caselles, V., <u>Chang, N. B.</u>, Sánchez, J. M., and Camacho, A. (2015) Developing Integrated Remote Sensing Data Fusion and Mining Techniques for Environmental Monitoring of the Water Qaulity in Spansih Reservoirs, International Conference of Remote Sensing of Environment, presented in Berlin, Germany, May 10-12, 2015. (International)

P49. <u>Chang, N. B.</u> (2015) Multi-sensor Image Fusion and Data Mining for Environmental Sensing, Networking and Decision-Making, The Sensor Innovation Colloquium, the King Abdullah University of Science and Technology (KAUST), Saudi Arabia, May 23-25, 2015. (International)

P50. <u>Chang, N. B.</u> (2015) The Growth of Sugar Cane and Bagasse Energy Recovery with Nutrient-laden Stormwater Treatment Area in South Florida, the Water-Energy-Food Nexus Workshop at the University of Oxford, UK, June 28rd to 30th, 2015. (International)

P51. <u>Chang, N. B.</u> (2015) A New Dimension in Industrial Ecology: Coupling the Resilence and Risk Assessment of Municipal Utility Parks, the Chemical Engineering Seminar Series at the University of Oxford, UK, July 3, 2015. (Local)

P52. <u>Chang, N. B.</u> (2015) Urban Growth Modeling Analysis and Flood Impact Assessment in Mega Cities, The Center for Water Systems at the University of Exeter, UK, July 6, 2015. (Local).

P53. <u>Chang, N. B.</u> (2015) Flood Impact Assessment under Urban Sprawal and Climate Change in Three Mega Cities, The Center for Water Systems at the University of Exeter, UK, July 6, 2015. (Local)

P54. <u>Chang, N. B.</u>, Imen, S. and Bai, K. (2015) Long-Term Precipitation Forecasting Based on Teleconnection Signal Propagation across North America, Remote Sensing and Modeling of Ecosystems for Sustainability VII Symposium at San Diego, California, USA, August 8-11, 2015. (International)

P55. <u>Chang, N. B.</u> (2015) Grey Mathematical Programming for Industrial Decision Making: Challenges and Perspectives, The 5th IEEE Grey System and Intelligent Service, De Montfort University, Leicester, U.K., Aug. 18-20, 2015. (International)

P56.   Di, Y., Ding, W., Imen, S., and <u>Chang, N. B.</u> (2015) Teleconnection Signals Effect on Terrestrial Precipitation: Big Data Analytics vs. Wavelet Analysis, The 5th International Workshop on Climate Informatics, Boulder, Colorado, NCAR Mesa lab., Sept. 24-25, 2015. (International, National)

P57.   O'Reilly, A. M., <u>Chang, N. B.</u>, and Wanielista, M. P. (2015) An Innovative Stormwater Infiltration Basin: Integrating Green Infrastructure with the Urban Critical Zone, 42nd IAH (The International Association of Hydrogeologists) Congress, Rome, Italy, Sept. 13-18, 2015. (International)

P58.   <u>Chang, N. B.</u> (2015) Coupling Multi-scale and Multi-attribute Models to Assess the Risk and Resilience of the Sustainable Urban Drainage System, The Univeristy of Hong Kong, Hong Kong, China, Oct. 6, 2015. (Local)

P59.   <u>Chang, N. B.</u> (2015) Promoting Low Impact Development via the Land Development Permitting Procedure and the Water Utility District System," The Univeristy of Hong Kong, Hong Kong, China, Oct. 6, 2015. (Local)

P60.   <u>Chang, N. B.</u> (2015) Remote Sensing and Sensor Networks in Support of Smart and Green Municipal Water Infrasructure Systems, The Center of Chaos and Comlex Networks, City Univeristy of Hong Kong, China, Oct. 8, 2015 (Local).

P61.   <u>Chang, N. B.</u> and Imen, S. (2015) Multi-Sensor Acquisition, Data Fusion, Criteria Mining and Alarm Triggering for Discerete Event Analysis in Urban Water Infrastructure Systems. IEEE System, Man, and Cybertics Annual Conference, Hong Kong, China, Oct. 9-12, 2015. (International)

P62.   <u>Chang, N. B.</u> (2015) Quantification of Relative Contribution of Teleconnection Signals to Terrestrial Precipitation Variability in America, Academia Sinica, Taipei, Taiwan, Oct. 12, 2015. (Local)

P63.   <u>Chang, N. B.</u> (2015) Can the Climate Change Assessment Framework Be Reshaped by the Advances of Climate Informatics Technologies? National Taiwan Univeristy, Taipei, Taiwan, Oct. 15, 2015. (Local)

P64.   <u>Chang, N. B.</u> (2015) Advances in Multi-sensor Image Fusion and Data Mining for Environmental Monitoring in All-weather Conditions, The Center for Space and Remote Sensing Research, National Central Univeristy, Chongli, Taiwan, Oct. 14, 2015. (International)

P65.   Doña, C., Caselles, V., Sánchez, J. M., <u>Chang, N. B.</u>, and Camacho, A. (2015) Evolución de la cubierta de agua en lagunas temporales mediante técnicas de teledetección. Aplicación a La Mancha Húmeda, Spanish Association of Remote Sensing Conference. The 16th Congress of the Spanish Remote Sensing Association, Seville, Spain, Oct. 21-23, 2015. (International)

P66.   <u>Chang, N. B.</u>, (2016) Cyber-Physical Systems for Sustainable Operation of Urban Water Supply System in the Water-stressed Western U.S., Univeristy of Virginia, USA, March 14, 2016. (Local)

P67.   <u>Chang, N. B.</u> (2016) Promoting Sustainable Urban Water Infrastructure Management with Cyber-Physical System Technologies, George Mason Univeristy, USA, March 21, 2016. (Local)

P68.   Joyce, J., <u>Chang, N. B.</u>, Harji, R., and Ruppert, T. (2016) Assessing the Drainage Infrastructure in a Coastal Urban Watershed via a Worst-Case Scenario of Storm Surge and Sea-Level Rise Impacts, 2016 Annual FFMA Conference, the World Golf Village Renaissance in St. Augustine, Florida, USA, March 30 - April 01, 2016. (State, Local)

P69. Hartshorn, N., Crawford, A. J., Chang, N. B., and Wanielista, M. P. (2016) Stormwater Treatment for Nutrient Removal with Solar-Powered Media Bed Reactors, 2016 EWRI (Orlando Chapter) Seminar, Orlando, FL, April 8, 2016. (Regional)

P70. Chang, N. B., (2016) Cross-mission Sensor Image Fusion with Spatial Reconstruction and Data Mining for Lake Eutrophication Assessment, Institute of Geographical Sciences and Natural Resources, Chinese Academy of Sciences, April 18, 2016. (Lcoal)

P71. Chang, N. B. (2016) Cross-Mission Satellite Data Merging and Mining for Water Quality Monitoring in All-weather Conditions, Department of Hydraulic Engineering, Tsinhuang Univ., China, April 20, 2016. (Local)

P72. Imen, S. and Chang, N. B. (2016) Developing a Cyber-Physical System for Smart and Sustainable Drinking Water Infrastructure Management, the 2016 IEEE International Conference of Networking, Sensing, and Control presented in the Special Session: Hybrid Machine Learning Approach in Support of Big Data Analytics for Smart Environments, Mexico City, Mexico, April 28-30, 2016. (International)

P73. Chang, N. B. (2016) "Data Mining for Attributional Assessment of Teleconnection Signals in Relation to Terrestrial Precipitation Variability in America, Departmento de Computación, CINVESTAV-IPN, Mexico, April 30, 2016. (Local)

P74. Hartshorn, N., Wen, D., Chang, N. B., and Wanielista, M. P. (2016) Comparative Nitrogen Removal with Sorption Media in Linear Ditch for Groundwater and Stormwater Treatment, ASCE EWRI Annual Congress, May 22-26, 2016, West Palm Beach, FL, USA. (National)

P75. Hartshorn, N., Chang, N. B., and Wanielista, M. P. (2016) Inventive Engineering Design for Nutrient Removal at Stormwater Infiltration Basins with Bio-sorption Activated Media in Karst Environments, 2016 ASCE EWRI Annual Congress, May 22-26, 2016, West Palm Beach, FL, USA. (National)

P76. Joyce, J., Chang, N. B., Harji, R., and Ruppert, T. (2016) Integrated Analysis of Storm Tidal Surge, Sea Level Rise, and Precipitation for Flood Hazard Assessment in a Coastal Urban Watershed, The ASCE EWRI Annual Congress, West Palm Beach, FL, USA, May 22-26, 2016. (National, Regional, State, Local)

P77. Joyce, J., Imen, S., Chang, N. B., Harji, R., and Ruppert, T. (2016) Analyses for Adaptation of Drainage Infrastructure in a Coastal Urban Watershed from Impacts of Long-term Precipitation Variability and Sea Level Rise, ASCE EWRI Annual Congress, May 22-26, 2016, West Palm Beach, FL, USA. (National, Regional, State, Local)

P78. Joyce, J., Imen, S., Chang, N. B., Harji, R., and Ruppert, T. (2016) Sustainable Drainage Infrastructure Planning in a Coastal Urban Watershed under Long-term Precipitation Variability and Sea Level Rise, The 7th International Conference on Water Resources and Environment Research (ICWRER2016), Kyoto TERRSA, Kyoto, Japan, June 5-9, 2016. (International)

P79. Chang, N. B. (2016) Remote Sensing for Water Availability and Quality Management: Contemporary Challenges and Perspectives, The EPA National Risk Management Research Laboratory, Cincinnatti, OH, Aug. 24, 2016. (National).

P80. Chang, N. B., Yang, J., Joice, J., and Mostafiz, C. (2016) Prediction of Sea Surface Salinity Based on Landsat 8 Optical Images and MODIS with a Storm Surge Model during the 1991 Hurricane Bob Event in the Mattapoisett Harbor, The Remote Sensing and Modeling of

Ecosystems for Sustainability VII Symposium at San Diego, California, USA, August 28-Sept. 1, 2016. (National, International)

P81.   Chang, N. B., Joyce, J., Mostafiz, C., and Yang, J. (2016) Prediction of Sea Surface Salinity Based on Landsat Optical Images and Storm Surge Model in a Small Coastal Bay, The Remote Sensing and Modeling of Ecosystems for Sustainability VII Symposium at San Diego, California, USA, August 28-Sept. 1, 2016. (National, International)

P82.   Joyce, J., Chang, N. B., Harji, R., Ruppert, T., and Singhofen, P. (2016) Exploring Drainage Infrastructure Resilience with LID Technologies for a Coastal Urban Watershed, National Society of Black Engineers Fall Regional Conference-Region III Location: Sheraton Gateway Atlanta Airport, Atlanta, GA, Nov. 4-5, 2016. (Reginal, Local)

P83.   Chang, N. B. (2016) Multi-signals-based Drought Prediction with Both Known and Unknown Teleconnection Signals in the Upper Colorado River Basin, the International Conference of Mechanisms of Drought - Meteorology, Hydrology and Human Agency, Delft University of Technology, Delft, The Netherlands, Nov. 14-15, 2016. (International)

P84.   Chang, N. B. (2016) How Does Artificial Intelligence Work with Remote Sensing Technologies for Multi-scale Environmental Change Detection? The Annual Meeitng of the European Academy of Sciences, Nov. 18, 2016. (Receiving the Balise Pascal Medal from the European Aacdemy of Sciences) (International)

P85.   Chang, N. B. (2016) Intelligent Learning of Environmental Features from Satellite Remote Sensing Images with Cross-Mission Data Merging and Mining, National Aerospace Center, Hsinchu, Taiwan, Dec. 27, 2016. (International)

P86.   Chang, N. B. (2016); Developing Intelligent Multi-sensor Data Merging, Fusion and Feature Extraction for Space-borne Water Quality Monitoring, Research Center for Environmental Changes, Academia Sinica, Taiwan, Dec. 29, 2016. (International)

P87.   Chang, N. B., Developing Floating Media Bed Reactors and Floating Treatment Wetlands for Nutrient Removal in Stormwater Ponds, presented to Department of Environmental Science and Engineering, Fudan University, Shanghai, China, Jan. 9, 2017 (invited speech, international).

P88.   Chang, N. B. (2017) Developing an Intelligent Multi-sensor Decision Support System for Space-borne Earth Observations, East China Normal University, Shanghai, China, Jan. 9, 2017. (Receiving the Zijiang Scholar Award) (International)

P89.   Chang, N. B. (2017) Developing Floating Media Bed Reactors and Floating Treatment Wetlands for Nutrient Removal in Stormwater Ponds, The Department of Environmental Science and Engineering, Fudan University, Shanghai, China, Jan. 9, 2017. (International)

P90.   Joyce, J. and Chang, N. B. (2017) Using ICPR for Resilience Assessment of Green-Grey Drainage Infrastructures under Climate Change and Sea Level Rise Impact, The 2017 EWRI (Orlando Chapter) Water Resources Seminar, Orlando, FL, April 8, 2017 (Regional, State, Local)

P91.   Chang, N. B. (2017) Contemporary Challenges and Solutions in Satellite Remote Sensing for Water Quality Monitoring, presented to Institute of Environmental Engineering (IfU), Earth Observation and Remote Sensing, ETH Zurich (Swiss Federal Institute of Technology in Zurich), Zurich, Switzerland, May 14, 2017. (International)

P92. Wen, D., <u>Chang, N. B.</u>, and Wanielista, M. P. (2017) Comparative Nitrogen Removal study with Innovative BMPs for Groundwater and Stormwater Treatment, NWFWMD, Florida Media Day, Tallahassee FL, Jan. 20, 2017. (State, Local)

P93. Lu, J. W., <u>Chang, N. B.</u>, Zhu, F., Hai, J., and Liao, L. (2018) Smart and Green Urban Solid Waste Collection System for Differentiated Collection with Integrated Sensor Networks. The 15th IEEE International Conference on Networking, Sensing, and Control, Zhuhai, China, March 27-29, 2018. (International)

P94. Yang, Y. J., Neil, C. W., <u>Chang, N. B.</u>, Jun, Y. S., Bierwagen, B. (2018) Multi-scale Systems Analysis for Engineering Optimization in Water Supply Infrastructure Systems. ACS National Meeting & Expo - Nexus of Food, Energy & Water, March 18 - 22, 2018 | New Orleans, LA, USA. (National)

P95. Valencia, A., <u>Chang, N. B.</u>, Wen, D. (2018) The Use of Green Sorption Media for Polishing Nitrogen Removal in Wastewater Effluents via a Rapid Infiltration Basin, presented at 33rd Annual Water Resources Seminar, East Central EWRI Section, ASCE, Double Tree by Hilton at Sea World, Orlando, FL, USA, April 20, 2018. (Regional, Local)

P96. Wen, D., <u>Chang, N. B.</u>, and Wanielista, M. P. (2018) Green Sorption Media for Nitrogen Removal in a Linear Ditch for Integrated Groundwater and Stormwater Treatment, presented at 33rd Annual Water Resources Seminar, East Central EWRI Section, ASCE, Double Tree by Hilton at Sea World, Orlando, FL, USA, April 20, 2018. (National)

P97. <u>Chang, N. B.</u>, Wanielista, M. P., Wen, D., and Hartshorn, N. (2017) Comparative Nitrogen Removal with Sorption Media in Linear Ditch for Groundwater and Stormwater Treatment, Hilton Orlando Lake Buena Vista, Orlando, Florida, April 28, 2017. (Local)

P98. <u>Chang, N. B.</u> Sun, Z., Chen, C. F., Mostafiz, C., and Gao, W. (2017) Developing a Prototype Satellite-based Cyber-Physical System for Smart Wastewater Treatment, 2017 IEEE International Conference of Networking, Sensing, and Control, Calabria, Italy, May 16-18, 2017. (International)

P99. Wanielista, M. P., <u>Chang, N. B.</u>, and Rios, A. (2017) Passive On-site Wastewater Treatment for Nutrient Removal, WEFTEC Nutrient Symposium, Fort Lauderdale, Florida., USA, June 12-14, 2017. (National)

P100. <u>Chang, N. B.</u> (2017) Deep and Fast Learning for Feature Extraction of Merged or Fused Remote Sensing Images to Observe Lake Eutrophication, in the Remote Sensing and Modeling of Ecosystems for Sustainability VII Symposium at San Diego, California, USA, Aug. 8- 10, 2017. (International)

P101. <u>Chang, N. B.</u> and Ruppert, T. (2017) Coupling Risk and Resilience Assessment for Networked Sustainable Drainage Systems in a Coastal City under Climate Change Impact, Coastal Sustainability Symposium Florida Sea Grant Meeting, Gainesville, FL, USA, Sept. 26, 2017. (Regional)

P102. <u>Chang, N. B.</u> (2017) Challenges and Perspectives for Urban Stormwater Management: Linking Environmental Engineering and Hydrologic Science with Meteorological Dynamics, China Meteorological Administration (CMA), Beijing, China, Nov. 19, 2017. (International)

P103. <u>Chang, N. B.</u> (2017) Multi-scale Precipitation Forecasting based on Long-term Teleconnection Signals, Chinese Academy of Meteorological Sciences, Beijing, China, Nov. 20, 2017. (International)

P104. <u>Chang, N. B.</u> (2017) Periodicity Analysis for Teleconnection Signals Propagation Between Sea Surface Temperature and Forest Greenness across North America, Chinese Academy of Meteorological Sciences, Beijing, China, Nov. 20, 2017. (International)

P105. <u>Chang, N. B.</u> (2017) How Does Artificial Intelligence Work with Remote Sensing Technologies for Multi-scale Environmental Change Detection? Chinese Academy of Meteorological Sciences, Beijing, China, Nov. 21, 2017. (International)

P106. <u>Chang, N. B.</u> (2017) Integrating Multisensor Satellite Data for Better Environmental Quality Monitoring, Chinese Academy of Meteorological Sciences, Beijing, China, Nov. 21, 2017. (International)

P107. <u>Chang, N. B.</u> (2018) Remote Sensing for Water Sustainability and Climate. Department of Civil Engineering, University of Hong Kong, Hong Kong, March 26, 2018. (International)

P108. <u>Chang, N. B.</u>, Wei, X., Bai, K., and Gao, L. (2018) Developing a Cyber-Physical System for Mobility Service in Smart Cities Based on Multi-sensor Satellite High-Resolution PM2.5 Concentration Map. The 15th IEEE International Conference on Networking, Sensing, and Control, Zhuhai, China, March 27-29, 2018. (International)

P109. <u>Chang, N. B.</u> (2018) Teleconnection signals can aid in long-term precipitation forecasting: The North America Experience. School of Meteorological Science, Sun-Yet-Sen University, Zhuhai, China, March 29, 2018. (International)

P110. Wanielista, M. P., <u>Chang, N. B.</u>, and Duranceau, S. (2018) Integrated Wastewater and Stormwater Management using BAM for Water Quality Control, 2018 APWA Florida Chapter Conference & Exposition Florida Public Works EXPO, April 16-20, 2018. (Regional, Local)

P111. <u>Chang, N. B.</u> (2018) Intelligent Feature Extraction from the Fused Satellite Images for Environmental Monitoring with Spatial-Spectral Ensemble Learning, National Taipei University of Technology, Taipei, Taiwan, June 11, 2018. (Local)

P112. <u>Chang, N. B.</u> (2018) Multisensor Fusion between Hyperspectral and Multispectral Remote Sensing Data for Monitoring Microcystin Distribution, Presented to Xi'an University of Science and Technology, Xian, China, June 17, 2018. (Local)

P113. <u>Chang, N. B.</u> (2018) Recent Progress in Remote Sensing for Environmental Change Detection in Water Cycle. Invited Keynote Speaker, The Fifth International Workshop on Earth Observation and Remote Sensing Applications (EORSA), Xi'an, China, June 18-20, 2018. (International)

P114. <u>Chang, N. B.</u> (2018) Coupling Coastal Transportation and Drainage Infrastructure under Climate Change Impact for Urban Sustainability. presented to Department of Urban and Regional Planning University of Florida, Gainesville, Florida, Aug. 17, 2018. (Local)

P115. <u>Chang, N. B.</u> and Sun, Z. (2018) Ensemble Learning of Satellite Remote Sensing Images via Integrating Deep and Fast Learning Algorithms for Water Quality Monitoring," Proceedings of SPIE, Remote Sensing and Modeling of Ecosystems for Sustainability, San Diego, California, USA, August 21-23, 2018, (Invited presentation).

P116. Wanielista, M. P., Wen, D., Comier, J., and <u>Chang, N. B.</u>, and Duranceau, S. (2018) Bio-Sorption Activated Media for Control of Nutrients and Fecal Coliforms, the 13th Annual Regional Stormwater Conference, Hilton Head Marriot, SC, Oct. 3-5, 2018. (Regional)

P117. <u>Chang, N. B.</u> (2018) Multi-sensor Satellite Image Fusion, Data Merging, and Machine Learning for Monitoring Changing Urban Environment, presented to the IEEE Green Energy and Smart

Systems Conference at University of California - Long Beach, Oct. 29, 2018 (IEEE Distinguished Lectures, sponsored by the IEEE Systems Council).

P118. Chang, N. B. (2018) Food-Energy-Water Nexus Analysis for Urban Sustainability: A System Engineering Approach, Yuan Ze University, Zhongli, Taiwan, Nov. 21, 2018. (Local)

P119. Chang, N. B. (2018) How Does the Integrated Artificial Intelligence and Big Data Analytics Help Remote Sensing for Environmental Change Detection? Yuan Ze University, Zhongli, Taiwan, Nov. 21, 2018. (Local)

P120. Wen, D., Ordonez, D., Chang, N. B., and Wanielista, M. P. (2019) Linear Ditch Microbial Ecology within Biosorption Activated Media under Different Field Conditions, ASCE-EWRI 35th Annual Water Resources Seminar, Doubletree Hotel, Orlando, Florida, May 3, 2019. (Regional, Local)

P121. Chen, M., Chang, N. B., and Chen, Q. (2019) Smart Operations of Municipal Utility Parks – A Water, Energy, Waste Nexus Approach,1st International Conference on Smart Tourism, Smart Cities and Enabling Technologies, Rosen College of Hospitality Management, Orlando, Florida, USA, May 1-4, 2019 (Local).

P122. Lu, J. W., Chang, N. B., Huang, Y., Xie, Y., and Hai, J. (2019) Developing a Cyber-Physical System for promoting Green Engineering of Solid Waste Incineration, the 2019 IEEE International Conference on Networking, Sensing and Control, Banff, Canada, May 09, 2019 - May 11, 2019. (International)

P123. Chang, N. B. (2019) Technological Advancements in Urban Food-Energy-Water-Waste Nexus: A Breakthrough in Urban Sustainability, Yuan Ze University, Zhong Li, Taiwan, May 8, 2019. (International)

P124. Chang, N. B. (2019) Frontiers of Engineering Research and Education: Integration between Sustainable Engineering and Industrial Ecology, Yuan Ze University, Zhong Li, Taiwan, May 15, 2019. (International)

P125. Chang, N. B., Wei, X., Bai, K., and Gao, W. (2019) Comparative Analysis of Data Fusion and Merging Algorithms for the Prediction of Aerosol Optical Depth, SPIE conference of Imaging Spectrometry XXIII: Applications, Sensors, and Processing, San Diego, California, United States, August, 11 – 15, 2019 (International).

P126. Chang, N. B., Wei, X., Bai, K., and Gao, W. (2019) Synthesis of Multi-sensor Top of Atmosphere and Ground Level Reflectances to Support High-resolution AOD Estimation with Machine Learning, SPIE conference of Earth Observation Systems, San Diego, California, United States, August 11 – 15, 2019 (International).

P127. Chang, N. B., Hossain, M. U., Zheng, Q., and Chen, M. (2019) Enhancing Urban Resilience via the Food, Energy and Water Nexus through a Municipal Utility Park, the 8th International Conference on Water Resources and Environment Research, (ICWRER 2019), Hohai University, Nanjing, China June 14 - 18, 2019 (International).

P128. Chang, N. B. (2019) Contemporary Challenges in Optical Remote Sensing for Hydroenvironmental Change Detection, Keynote speaker - CUAHSI Hydroinformatics Conference, Provo, UT, July 29 – 31, 2019 (National).

P129. McKenna, A. M., Chen, H., Wen, D., Ordonez, D., and Chang, N. B. (2019) Molecular Characterization of Dissolved Organic Nitrogen Removal in Biosorption Activated Media based on Ultrahigh Resolution Mass Spectrometry, Oral Session: Environmental: Stormwater

Treatment & Green Infrastructure: from Research to Practice, ACS Annual Meeting, San Diego, Aug. 25-29, CA, 2019 (National).

P130. Shokri, M., Gao, Y., Kibler, K. M., Wang, D., and <u>Chang, N. B.</u> (2020) Characterizing Near-surface Karst System under Three Stormwater Retention Basins in Silver Springs, Florida. The 16th Sinkhole Conference, April 20-24 2020, Puerto Rico, USA (International).

P131. Beaudet, S., Kapucu, N., and <u>Chang, N. B.</u> (2020) Stakeholder Engagement for Sustainability: U.N. Sustainable Development Goals (SDGs) Implementation Networks Public Administration Research Conference, March 19 - 20, 2020, UCF Downtown, Orlando, FL (Local)

P132. Beaudet, S., Kapucu, N., and <u>Chang, N. B.</u> (2020) Partnerships and Network Governance for Sustainability in an Urban Environment for Food-Energy-Water (FEW) Nexus, the American Society for Public Administration's 81st Annual Conference. April 3 through Tuesday April 7, 2020, in Anaheim, California at the Hyatt Regency Orange County, FL (Local).

P133. Beaudet, S. Kapucu, N., & <u>Chang, N.-B.</u> (2020) Partnerships and Network Governance for Sustainability: An Urban Food-Energy-Water (FEW) Nexus. American Association for Public Administration (ASPA) Annual Conference, April 3-7, 2020, Anaheim CA (National).

P134. <u>Chang, N. B.</u> (2020) Enhancing Urban Stormwater Management Research, Orange County Virtual Research Seminar, May 6, 2020 (Local).

P135. <u>Chang N. B.</u> (2020) Cost-effective, Adaptable, and Sustainable Filtration Media for Multi-pollutant Removal: An Interdisciplinary Sustainability Solution" the International Association of Advanced Materials (IAAM) Fellow Lecture 2020 in the Advanced Materials Lecture Series, Nov. 3, 2020 (International).

P136. <u>Chang, N. B.</u> (2020) Synergizing Technology Innovation and Integration in an Urban Food-Energy-Water Nexus under Global Change Impact. College Seminar Presentation. Sept. 25, 2020 (International).

P137. <u>Chang, N. B.</u> (2021) Sustainable Development via Soil and Water Research. 25 Anniversary of Fulbright Canada. Feb. 4, 2021 (International).

P138. Kapucu, N., Beaudet, S., <u>Chang, N. B.</u>, and Morcol, G. (2021) Partnerships and network governance for sustainability in an urban environment for food-energy-water (FEW) nexus. the ASPA Annual Conference, online, April 9-15, 2021 (National).

P139. <u>Chang, N. B.</u> (2021) Digital transition of resilient constructed wetlands for ecosystem conservation, Keynote speaker of the 1st IAHR Online Forum - the special session on "Digital Transformation of Urban Water System, in the First IAHR Online Forum, The International Association for Hydro-Environment Engineering and Research (IAHR), July 7, 2021 (International).

P140. Valencia A. and <u>Chang, N. B.</u> (2021) Integrating green infrastructure with food-energy-water nexus for decision support via system dynamics modeling. Symposium on Food-Water-Energy, Stuttgart, Germany, September 14 and 15, 2021 (International).

P141. Valencia A., Zhang, W., and <u>Chang, N. B.</u> (2022) Sustainability assessment in an urban Food-Energy-Water-Waste Nexus. Proceedings of the 9th International Conference on Water Resources and Environment Research (ICWRER), April 25-27, 2022 (International).

P142. Ordonez, D. and <u>Chang, N. B.</u> (2022) Nutrient removal via zero-valent iron based green environmental media. Proceedings of the 9th International Conference on Water Resources and Environment Research (ICWRER), April 25-27, 2022 (International).

P143. Zhao, H., <u>Chang, N. B.</u>, and Qiu, J. (2022) Dynamical system modeling analysis of urban agriculture in a Food-Water-Energy Nexus. Proceedings of the 9th International Conference on Water Resources and Environment Research (ICWRER), April 25-27, 2022.

P144.Valencia A. and <u>Chang, N. B.</u> (2022) Urban food-energy-water-waste nexus analysis for sustainable development: A case study in Florida. Sustainable Urban Growth Initiative (SUGI) Symposium, March 22, 2022 (Local).

P145. Valencia, A., Zhang, W., and <u>Chang, N. B.</u> (2022) Sustainability Assessment in an Urban Food-Energy-Water-Waste Nexus. Proceedings of the 9th International Conference on Water Resources and Environment Research (ICWRER), April 25-27, 2022 (International).

P146. Ordonez. D. and <u>Chang, N. B.</u> (2022) Nutrient Removal via Zero-valent Iron Based Green Environmental Media. Proceedings of the 9th International Conference on Water Resources and Environment Research (ICWRER), April 25-27, 2022 (International).

P147. Zhao, H., <u>Chang, N. B.</u>, and Qiu, J. (2022) Dynamical System Modeling Analysis of Urban Agriculture in a Food-Water-Energy Nexus. Proceedings of the 9th International Conference on Water Resources and Environment Research (ICWRER), April 25-27, 2022 (International).

P148. <u>Chang, N. B.</u> (2023) Integrating Tensor Flows with Spectral Dimensions for Improving Earth Observations via Satellite Remote Sensing, IEEE Distinguished Speaker Series, Presented online to the audience of the IEEE Systems Council. April 18, 2023 (International).

P149. <u>Chang, N. B.</u> Sustainable Agricultural Water Resources Management under Climate Change Impact, (2023) Invited talk by the Taiwan Agricultural Research Institute, Taichung, Taiwan, July 25-27, 2023 (International).

P150. <u>Chang, N. B.</u> (2024) Urban Food-Energy-Water-Waste Nexus Analysis for Sustainable Development: North America Experience, invited talk by the Department of Industrial and System Engineering, the Hong Kong Polytechnic University, Jan. 4, 2024 (International).

P151. Yang Y. J. <u>Chang, N. B.</u>, Wei, H., Ma, C., Shao, and Y., Liu, J. Carbon Accounting and Socioeconomic Attributes for Urban Infrastructure Renewal and Adaptation (2024) ASCE/EWRI Annual Congress, Henderson, Nevada, May 21-24, 2023 (National).

P152. <u>Chang, N. B.</u> (2024) Simultaneous Removal of Multiple Pollutants via Specialty Absorbents in a Tailored Water Filtration System. American Advanced Material Congress, Miami, FL, USA, 26th February - 01st March 2024, held by International Association of Advanced Materials (International).

P153. <u>Chang, N. B.</u> (2024) Current Interdisciplinary Research in the Stormwater Management Academy, ASCE/EWRI Water Resources Seminar, Orlando, FL, May 17, 2024 (Local).

P154. <u>Chang, N. B.</u> (2024) Big Data Analytics for Long-term Large Interval Gap-Filling in a Field-scale Water Filtration System toward AI-Powered Performance Predictions. IEEE Systems Council, Oct. 9, 2024 (International).

P155. Cheng, J. and <u>Chang, N. B.</u> (2024) A Pilot Study of Biosorption Activated Media Filtration to Reduce Nutrients and Bacteria from Surface Water. presented in the ASEMFL annual meeting (poster presentation), Nov. 2, 2024 (Local).

P156. <u>Chang, N. B.</u> (2024) Harnessing AI-Powered Multimodal Imaging and Machine Intelligence Potential for Multi-scale Water Quality Monitoring and Prediction. Department of Civil and Environmental Engineering, Duke University, Dec. 5, 2024 (Local).

P157. Gudla, R. and <u>Chang, N. B.</u> (2025) An Adaptive Pattern Resonance System for Complex Adaptive Gap Filling of Environmental Datasets. Complex Adaptable Systems Conference, Massachusetts Institute of Technology, Cambridge, MA, March 3-5, 2025 (International).