Infrastructure Ecology: A New Paradigm of Sustainable Urban Development

Arka Pandit[1, 2], Bert Bras[3], Elizabeth A. Minné[1, 2], Ellen Dunham-Jones[4], Godfried Augenbroe[4], Hyunju Jeong[1, 2], Jean-Ann C. James[1, 2], Marc Weissburg[5], Marilyn A. Brown[6], Michael Chang[1], Ming Xu[7], Miroslav M. Begovic[8], Perry Yang[9], Richard M. Fujimoto[10], Steven P. French[9], Xuewei Yu[1, 2], Yongsheng Chen[2], Zhongming Lu[1, 2], Valerie Thomas[11], **John C. Crittenden**[1, 2]

[1]Brook Byers Institute for Sustainable Systems, Georgia Institute of Technology,
[2]School of Civil & Environmental Engineering, Georgia Institute of Technology[3]The George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology[4]School of Architecture, Georgia Institute of Technology
[5]School of Biology, Georgia Institute of Technology
[6]School of Public Policy, Georgia Institute of Technology
[7]School of Natural Resources and Environment, University of Michigan
[8]School of Electrical and Computer Engineering, Georgia Institute of Technology
[9]School of City and Regional Planning, Georgia Institute of Technology
[10]College of Computing, Georgia Institute of Technology
[11]School of Industrial Systems Engineering

With an increasing trend in urbanization, urban centers are at the forefront of achieving global sustainability and urban infrastructure plays a crucial role in determining the performance of an urban system. Urban infrastructure systems are analogous to ecological systems in terms that they are interconnected, complex, and adaptive and are comprised of interconnected components. Furthermore they can be scaled similar to ecological systems. Analyzing the urban systems as ecological systems, i.e. adopting an infrastructure ecology approach would provide a better understanding about the dynamics of urban infrastructure systems and would enable a system-level optimization for more holistic sustainable urban development.

In the past, we have optimized infrastructure components such as energy and water provision as separate infrastructures. While this has served us very well, it has resulted in sub-optimal solutions because it does not examine the potential savings of water energy and material use by considering the interactions among the infrastructure components. Recently, there has been some focus on two of the more prominent interactions are between water and energy, popularized as the *'Water-Energy Nexus'* and this has resulted in saving both water and energy. Now we must focus on the interactions of all the major infrastructures and develop a system wide optimal solution. System wide optimization that includes infrastructure interdependencies will reduce water, material and energy use for a give urban system.