Developing Sustainable Urban Infrastructure to Solve Gigaton Problems
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Dr. John C. Crittenden is the director of the Brook Byers Institute for Sustainable Systems and a Professor in the School of Civil and Environmental Engineering at the Georgia Institute of Technology. He holds the Hightower Chair and is a Georgia Research Alliance Eminent Scholar in Environmental Technologies. He earned his BSE in Chemical Engineering and MSE and PhD in Civil Engineering from the University of Michigan. Since 1998 he has been the Associate Editor of the journal Environmental Science and Technology. Prof. Crittenden was elected to the National Academy of Engineering in 2002 and the Chinese Academy of Engineering in 2013. He is the co-holder of five patents and the primary author of the text book, Water Treatment: Principles and Design, now in its third edition. He is the author more than 162 articles in refereed journals and more than 100 book chapters, reports, and symposia. Prof. Crittenden has been invited to speak and present around the world on sustainable urban systems and water treatment infrastructure. Prof. Crittenden’s current research focus is on sustainable urban infrastructure systems. He and his colleagues are conducting research on alternative energy technologies, sustainable materials, advanced modeling of urban systems, sustainable engineering pedagogy, and urban form and policy. He also conducts research in various water treatment technologies (e.g., membrane nanofiltration, advanced oxidation processes, photocatalytic oxidation, adsorption, etc.) and energy harvesting technologies (photocatalytic water splitting and aqueous phase reforming of biomass).

ABSTRACT
Gigaton problems refer to those most severe problems challenging humanity, which can often be measured at the “gigaton (billion tons)” scale. For example, the annual world energy consumption is around 12 billion tons of oil equivalent (Gtoe), 80% of that from nonrenewable fossil fuels. The combustion of these fossil fuels emits approximately 29 billion tons (Gton) of CO2. In addition, the world uses more than 14 Gton of materials each year, only about 5% of which are renewable. These gigaton problems call for solutions which can meet the gigaton scale, or gigaton solutions. In response to the urgent need of solving the gigaton problems, the urban system plays a critical role as the primary sink of resources and source of wastes. In particular, urban centers are complex, adaptive systems that act like organisms: They process resources (water, energy, and materials) and information, create infrastructure and services, and produce wastes. Worldwide, urban centers dominate resource consumption as well as waste and pollution generation. By examining the complex interactions among social decision making, economic drivers, (re)development, sustainability metrics, and surface transportation, a simulation-based decision support tool and strategies are developed to allow stakeholders to design and choose infrastructure solutions that consume fewer resources and generate less waste. Case studies are presented for Atlanta, GA as an example to illustrate the ability of this tool to support the decision-making in constructing more sustainable cities.

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