Geotechnologies and the Environment

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Urban Sustainability: Policy and Praxis

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The "Geotechnologies and the Environment" series is intended to provide specialists in the geotechnologies and academics who utilize these technologies, with an opportunity to share novel approaches, present interesting (sometimes counterintuitive) case studies, and most importantly to situate GIS, remote sensing, GPS, the internet, new technologies, and methodological advances in a real world context. In doing so, the books in the series will be inherently applied and reflect the rich variety of research performed by geographers and allied professionals.

Beyond the applied nature of many of the papers and individual contributions, the series interrogates the dynamic relationship between nature and society. For this reason, many contributors focus on human-environment interactions. The series are not limited to an interpretation of the environment as nature per se. Rather, the series "places" people and social forces in context and thus explore the many sociospatial environments humans construct for themselves as they settle the landscape. Consequently, contributions will use geotechnologies to examine both urban and rural landscapes.

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Chapter 1
Urban Sustainability: Perspectives on Change

Jay D. Gatrell and Mark W. Patterson

1.1 About This Book

Sustainability resides at the nexus of philosophy, practice, politics, and technology. As such, the policies, behaviors, and discussions associated with "sustainability" are often contested. Despite the potential for conflict, nearly all stakeholders at all scales recognize that sustainability and sustainable practices necessarily extend from and/or interact across three domains: Social Systems, Ecological Systems, and Economic Systems. The systems, most often referred to as the three pillars (Environment, Economic, and Social), are sometimes complementary; but often are juxtaposed in a functionally perpendicular fashion. As a result, theory and practice are often side-ways and often result in partial or imperfect results.

This book assembles a collection of papers that presents alternate approaches or views to understanding urban environments and sustainable initiatives across all three domains at the local and regional scale. In nearly all chapters, remote sensing technologies and techniques from GIScience are used to investigate, visualize, and understand social, economic, or environmental dynamics associated with sustainability on the ground and in place. While every effort has been made in this collection to broaden notions of sustainability, the book is not exhaustive—nor is it intended to be. Likewise, the book doesn't set out to chart a history of urban sustainability. Rather, the novel spatial applications, cases, and policy discussions are intended to provide the readers with new ways of thinking about sustainability on the ground and in place.

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1.2 Chapters

This collection is comprised of 15 substantive chapters organized (or at least conceptualized) in three parts. Part 1—Environmental Change and Urban Morphology focuses on more traditional geotechnical applications of the natural and built environments within the context of broader sustainability initiatives and/or the implications of urban land use change on the overall sustainability of cities. Part 2—Economic Change, Industry, and Sustainable Local Alternatives examines industrial adaptations, innovations, and practices associated with sustainability. In the process, the contributions include novel examples associated with non-traditional industries such as brewing, urban agriculture, and metal recycling. The papers will deploy descriptive statistics, mapping, and other visualization techniques. Part 3—Socio-Political Change and Adaptation draws on concepts from political ecology, new social movements, and even cultural geography to understand observed change on the ground—as well as the broader implication of urban environmental change on the every lives of urban and peri-urban residents.

In Part 1, five chapters provide a solid foundation for understanding and assessing urban environmental systems. The contributions examine urban water management issues (Chap. 2 Lawrence), the emergence of new inter-disciplinary approaches towards assessing and managing complex eco-systems (Chap. 2 Portman and Elhanan) and the several real world examples rapidly changing urban systems in multiple contexts using a variety of tools (Lulla and Jensen, Jensen and Hardin, and McLean et al.). In concert, these five chapters underscore the importance of assessing urban environmental change over time and across space (Table 1.1).

The six chapters in Part 2 focus more squarely on economic systems and the many ways in which cities, their residents, and industries have responded to the realities of globalization, increased competition, and historical market failures. The papers examine multiple facets of dynamic local food systems (Chaps. 7, 9, and 11), an investigation of a sustainable practices in urban craft breweries (Chap. 10), and even novel adaptations of residents to economic decline that promote sustainability (Chap. 8). While the topics of the chapters may appear to be disparate, each of the authors interrogates the empirical realities of economic responses to change and efforts to enhance the long term sustainability (or viability) of economic systems and/or strategies to redefine local economics that enhance urban ecologies. In the process, the contributions provide the reader with new ways to visualize (i.e., map) social networks, think about urban agriculture, and explore the real world implications of historically invisible industries like scrap metal recycling.

The final chapters in the book—Part 3—focus on the politics and decision making processes surrounding urban environmental change and sustainability. Lascell (Chap. 12) details the social and political movements and sustainability initiatives that have emerged in New Orleans since Hurricane Katrina devastated large portions of the city—notably the poorest and most vulnerable communities. In Chap. 13, Fuller examines the full range of environmental justice issues facing poor

Table 1.1 Summary of substantive chapters in this book

	Author(s)	Subject
2	Lawrence	Urban stream management
3	Portman and Elhanan	Ecosystem services assessment
4	Lulla and Jensen	Hyperspectral applications
5	Jensen and Hardin	Urban forests in arid environments
6	McLean et al.	Greenspace and sustainability in Las Vegas
7	Reid	Local food systems, sustainability, and networks
8	Chohaney et al.	Sustainable economic development and urban "Mining"
9	Hagelman et al.	Urban gardens and sustainable agriculture
10	Patterson et al.	Sustainability and breweries
11	Knigge et al.	Urban food hubs and sustainable local food
12	Lascell	Sustainability in Post-Katrina New Orleans
13	Fuller	Mapping environmental justice
14	Gallagher and Lawrence	Unmanned systems
15	Metcalf et al.	Greening as a social movement
16	Clay and Albers	Planning sustainable built environments

and working class neighborhoods as they struggle to enhance their personal environments, local economic conditions and the overall sustainability of neighborhoods. Chapter 14 presents the case for the use of unmanned systems to assess urban change and broader sustainability initiatives across space. In the final two chapters, the politics of greening (Metcalf) and decision making (Clay and Albers) are considered within the context of broader issues of sustainability across all three domains.

Chapter 2
Urban Stream Management Using Spatial Approaches for Stream Clean-Up Data

Patrick Lawrence

Abstract In recent decades many local communities, supported by state, federal and/or international programs, have engaged in efforts to remove human debris from urban stream systems. Typically these clean-up events have involved volunteers who collect garbage and other waste from stream banks or from the water. The aims of these programs are to improve overall stream conditions – especially aesthetics – and remove harmful materials from stream environments including tires, plastics, metals and other potential items of concern such as paint cans, and rubber products. Although many of these efforts report basic data on items collected, with the reports and information often submitted to agencies or the focus of media reports, beyond basic types and numbers of information collected, the data and report do not typically contain any geospatial aspects such as locations, areas cleaned, collection of specific items tied to locations, or addressing possible sources for the debris. Since 1997, local groups within the Maumee Area of Concern in northwest Ohio, USA have been organizing an annual stream cleanup event in their communities that has evolved to over 1000 participants working at more than 60 sites covering 4 streams. This chapter examines the results for the Ten mile Creek/Ottawa River clean-up sites using detailed site specific data from 1995 to 2006 that includes items collected and recorded on data forms and then compiled by location and types of items and examined in reference to spatial aspects of management actions including considering potential sources and addressing local land use and human activities contributing the specific items collected at locations along the stream. Results include identifying the top ten items collected and examples of locations where items can be tied to adjacent land uses for purposes of identifying actions to address continued and persistent sources of debris and needed responses. The recommendations and proposals based on this study are intended to inform decision-makers not only at the local scale but to influence how stream clean-up data can be utilized and to improve reporting of this information. And with the aim of encouraging the collection of geospatial and location aspects as a means of furthering utilization of urban stream clean-up data to support and assist management actions to address aesthetic aspects of urban stream environmental improvements and rehabilitation efforts.

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Keywords Urban • Water • Debris

2.1 Introduction

Among the many challenges facing urban streams is the growing issue of debris (or garbage) from various human activities and sources that end up in the waterway, along the banks, and within the riparian zone (which defines the edge of stream ecosystem). Common examples of this debris are paper and plastic products such as food containers and wrappers, construction materials, cigarette items, glass items, personal care products, household materials, clothing, and many other items discarded from residential, commercial or industrial sites typically found in urban settings (American Rivers n.d.). These items cause concern for their impact on visual or aesthetic appearances and as potential sources of water contaminants as they degrade in the natural environment (Allison et al. 1998; Burres 2009; Stickel et al. 2013). For example, the byproducts from the slow, but eventual, decay of rubber, plastic and other synthetic materials can be introduced into the stream aquatic environment. In recent decades concerted efforts have been undertaken in many urban communities to remove stream debris through directed local clean-up events organized by concerned groups and organizations (Riley 1998). These efforts mirror similar programs that focus on coastal and ocean debris.

In 2013, the Ocean Conservancy reported that the International Coastal Cleanup effort held worldwide resulted in 648,015 volunteers in 92 countries removing more than 12.3 million pounds of trash. The International Coastal Cleanup started in 1987 and has expanded to cover almost 13,000 miles of coastal and river/streams in more than over 80 countries worldwide (Ocean Conservancy 2014). In terms of cleanup of debris specifically from urban rivers and streams, several major programs have developed in many areas, including in the United States within California, Illinois, Wisconsin, Michigan, Ohio, Maryland, Pennsylvania, and New York State (Wang 2005; Missouri River Relief n.d.; Susquehanna River Basin Commission 1996). Internationally, examples include Australia, New Zealand, Israeli, Malaysia, and the United Kingdom.

Riley (1998) provides a comprehensive review and discussion of the challenges facing urban streams and rivers and provides science and community based solutions, that includes the need to remove unwanted debris.

> A *major portion of stream problems can be corrected by removing garbage, junk, and dumped waste from stream channels. Debris can deflect stream flows, causing significant bank erosion…may pollute the water… definitely destroys the aesthetic values of urban waterways; and it can back up flows, causing flooding*
>
> *Neighborhood stream cleanup projects are likely the most cost-effective flood damage reduction and water quality control projects a local organization can invest in (p. 328).*

Addressing debris from human activities has been the focus of numerous programs and policies within urban communities. The California Coastal Commission (n.d.) has produced a management plan to assist local municipalities in addressing

trash and debris from storm water and urban runoff before it ends up in ditches and streams. Their recommendations include installing catch basin screens, netting, separators, litter or trash booms, and using anti-littering enforcement and education, along with organized community volunteer cleanups. The California Water Boards (2007) completed extensive assessment of trash found in streams within the San Francisco Bay region to identify potential sources and recommend management and regulatory solutions. The U.S EPA (2011) produced an informational flyer highlighting the issues and challenges with trash found in urban and coastal communities and how streams and rivers can be a significant source of garbage that can be harmful to aquatic ecosystems and the associated economic impacts from the subsequently polluted and degraded waterways. The Maryland Department of Environment (2010) completed an extensive study of daily loads of trash into the Anacostia River, pointing out the need for addressing sources.

For international examples, Golik and Gertner (1992) counted litter removed from six beaches located in Israel noting a density of 36 pieces per 5 m transect and that 70 % of the litter consisted of plastic with wood, metal, glass, and other materials making up the remainder. Their results suggested that proximity to a population center resulted in an increase to the amount of beach litter and that the presence of waves and storm events resulted in re-accumulation of litter on beaches frequently throughout the year. They also noted that unlike other coastal areas where ocean shipping and dumping were sources, within their study it was apparent that the recreational users of the beach were the main contributors as the litter consisted of items resulting from their activities (items included food and beverage materials, cosmetics, plastic bags, toys and garments).

It is important to note that in reference to this study, the focus on urban stream cleanup programs is on the sources and types of urban stream debris or garbage that is the result of human activities, and not the removal of woody debris or other natural materials that can also accumulate in urban streams. There is considerable debate and disagreement as to the need and the potential harmful impacts from the intentional removal of woody debris (such as tree falls) from stream and river systems. Although some programs and efforts are in place to remove such materials from streams due to their potential for backing up water flow resulting in upstream flooding or diverting stream flow energy into an adjacent stream bank creating potential for increased erosion, the practice of removing woody and other forms of natural debris from urban streams remains controversial. The New York State of Environmental Conservation (n.d.) has provided guidelines for the removal of woody debris and trash from rivers and streams where the debris could impact water flows by blocking bridge and culvert openings, diverting streams and causing bank erosion. They recommend that large woody debris (trees) found in the stream should be removed when it presents a risk to infrastructure, bridges or homes. Lassettre and Kondolf (2012) promote whether possible the conservation of woody debris in urban streams channels in order to maintain their important and well documented benefits as forms of natural habitat, sources of organic matter, and potential food sources. Readers interested in more details and discussion focusing on the specific issue of removal of woody debris from urban streams are referred to Larson et al.

(2001) or NSW Department of Primary Industries (2007), and research focused on the role of woody debris, for example Marcus et al. (2002).

Another view is taken by Nemeth and Keirsey (1999) who argue that organizing debris removal along stream channels, including woody debris, can serve little purpose if the streams remain stressed and devoid of life due to other human impacts; so why undertake the effort. The aim to make urban streams more "scenic" could be impacting the aquatic health of such natural systems. Nemeth and Keirsey (1999) extend their comments further to suggest that even the removal of human debris, such as wooden pallets, shopping carts, and tires could be seen as a means of creating aesthetic benefits that masks more serious environmental concerns associated with contaminated urban streams and related significant water quality concerns all too often present in these environments.

However, for the purposes of this study, the focus will be on how organized efforts to remove debris from human sources are undertaken by community organizations along urban streams. Of specific interest are whether data on items removed are collected and intended to be utilized to address source areas to implement voluntary or regulatory means to eliminate the sources so as to stop continued and persistent locations of stream debris? If such efforts are intended, what measures and methods are used to collect and organize the data and are any spatially based approaches used to identify stream sites where debris is found and collected, along with noting proximal source locations for this debris to determine appropriate follow-up management actions.

2.2 Stream Clean-Up Programs

The Ocean Conservancy prepares annual reports on International Coastal Cleanup (ICC) efforts worldwide, but does not provide an indication of the total number of clean-up programs or sites or distinguish between coastal and rivers/streams. However, the data do provide some insight as to the number of cleanup events and types of debris collected. During the 2013 ICC event, 648,015 volunteers covered 12,914 miles of shoreline and rivers/streams, removing 12.3 million tons of debris (Ocean Conservancy 2014). The most common items collected were: cigarettes, food wrappers, plastic bottles and caps, straws, plastic bags, glass bottles, and beverage cans. The 2014 report also includes case studies and highlights from several locations and examples of efforts undertaken to reduce the amount of debris found at some sites. Beyond summary data by country (and by state within the U.S), there is no spatial context to the reporting of collections or responses to address sources.

Information on specific individual stream cleanup activities also appears to be limited, with most materials consisting of promotional items intended to inform and recruit volunteers and instructions/guidelines for conducting a cleanup event. The Western Michigan Environmental Action Council (n.d.) provides detailed instructions on how to undertake a stream cleanup, focusing on organizing volunteers, insurance and safety issues, gaining permission to access properties, materials and

supplies, and planning the event. Water Action Volunteers (2001) provides a simple ten step guide to conducting a stream and river cleanup, including list of materials and promotion of the event as well as the results and outcomes. In June 2011 the Friends of the Los Angeles River and Friends of the Chicago River (2011) produced a media release highlighting their friendly challenge to gather the most volunteers for their respective cleanup events. Since 1992 Friends of the Chicago River have collected thousands of pounds of garbage at 65 sites, while starting in 1989 the Friends of the Los Angeles River volunteers worked 15 sites, averaging 15 tons each year.

These types of summaries for urban stream cleanup activities appear to be the most the common form of reporting, with little information on specific sites or identification of sources areas that could be targeted for follow-up actions. In some cases urban stream cleanups are often undertaken in the context of larger regional watershed efforts as shown by such work undertaken within the Susquehanna River in Pennsylvania, where a local river basin compact was signed that dictated any dumping or littering upon the waters of the river or its tributaries was prohibited and was to be enforced by law enforcement officials (Susquehanna River Basin Commission 1996). There is very little evidence, reporting or documentation that urban stream cleanup efforts include methods or procedures – beyond counting number of volunteers, number of sites, miles cleaned, bags filled or weight of debris collected – to accurately document site specific results in terms of what is collected, where it is collected, and the identification of potential sources for the debris.

The focus of this study was to conduct a review of site level data from a multiple year period of cleanup activities within the Tenmile/Ottawa River watershed on the Maumee Area of Concern, located in northwestern Ohio, US. An annual stream cleanup event has been undertaken there since 1997, with detailed site information collected on types and total numbers of items collected by teams of volunteers. To date beyond summary reports by watershed, no detailed examination and analysis has been completed of the data from this cleanup activity. In addition, by working at the scale of the collection site it will be possible to examine the spatial context for items collected and consider proximal locations as sources for the debris collected. Such a study will provide opportunities to discuss and recommend how spatial aspects of urban stream cleanup activities should be examined and the benefits provided by such approaches in terms of future planning of subsequent cleanup events and addressing potential continued dumping or other site specific issues associated with the persistence of debris located at cleanup locations.

2.3 Maumee Area of Concern Clean Your Streams Event

Partners for Clean Streams (PCS) is the regional non-profit watershed organization in Northwest Ohio. PCS aims to strive for abundant open space and a high quality natural environment; adequate floodwater storage capacities and flourishing wildlife. Through various programs and activities, PCS encourages stakeholders to take

local ownership of their aquatic resources, striving for local rivers, streams and lakes that are clean, clear and safe. This mission is achieved through many habitat restoration projects, public education, and volunteer opportunities and partnering with local businesses and organizations.

PCS is the umbrella organization for the Maumee Remedial Action Plan Committee in the Maumee Area of Concern (AOC), which is located in northwestern Ohio, US (Fig. 2.1). The Maumee AOC, which is the largest Great Lakes Area of Concern in the state of Ohio, has a complex list of water quality issues – referred to as Beneficial Use Impairments (BUIs) – which PCS works with the Ohio Environmental Protection Agency, other federal and state agencies, local municipalities, community partners, and volunteers EPA to address (Lawrence 2011). Efforts to address BUIs within the Maumee AOC have been undertaken since 1987 through various local organizations and partnerships with numerous local and regional partners and agencies, including associated programs within the State of Ohio intended to address Lake Erie (Ohio Lake Erie Commission 2013). For more information on the work of PCS in the Maumee AOC, readers are referred to: www.partnersforcleanstreams.org.

The Degradation of Aesthetics (BUI #11) has been addressed by various stream cleanup programs in the community, including a major event – *Clean Your Streams* (CYS) held each fall since 1997. CYS targets all types of trash in five major waterways including many tributaries and ditches, all within the Greater Toledo Metropolitan Area of the Maumee AOC. More than 70 volunteer groups pre-register and hundreds more volunteers "walk in" the morning of *Clean Your Streams* held each September. This includes youth groups, small businesses and large corpora-

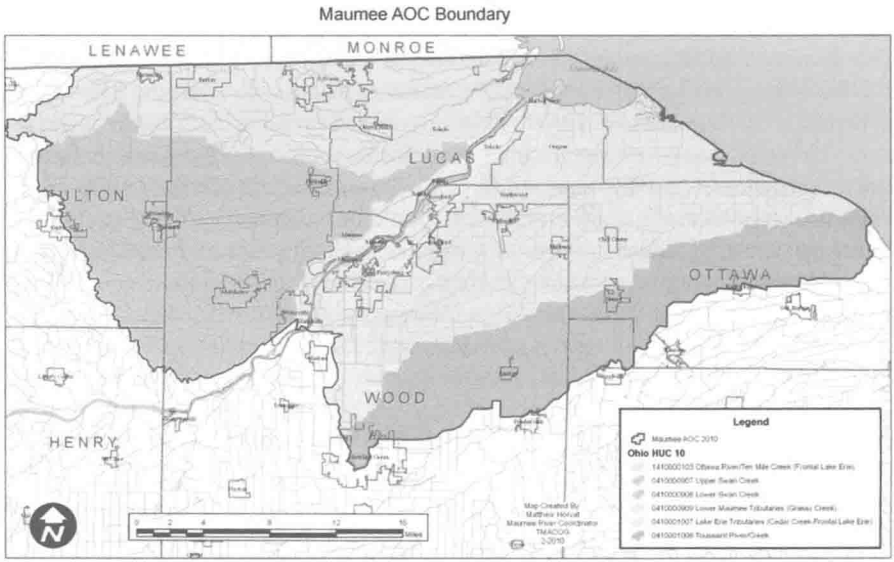

Fig. 2.1 Maumee Area of Concern, NW Ohio