Science for Sustainable Societies

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Sustainable Landscape Planning in Selected Urban Regions

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Foreword

Sustainability is one of the most important issues with which mankind is faced in the early twenty-first century. The impact on nature of single individuals may not appear to be severe; however, the impact of the human species as a whole is immense and cannot be ignored. We are responsible for considerable disturbances to the Earth's environment. Sustainability can be regarded as an issue of how our society should be designed given the limitations in the Earth's capacity to sustain human life. Asia is a particularly key area in the question of sustainability as it is home to nearly half the global population and rapid economic growth is predicted in the region. Energy, food, and other demands such as those for natural resources are growing exponentially, and it is anticipated that there will be an increase in social and political conflicts as well as severe pollution issues.

The University of Tokyo (UT) has maintained the Alliance for Global Sustainability (AGS) with MIT, ETH, and Chalmers University since 1998 in order to promote sustainability science in an academic arena. To further facilitate the development of this research field, UT also organized a network of research organizations, such as the Integrated Research System for Sustainability Science (IR3S), which includes 10 Japanese universities and one research institute, in 2005. At the same time, the Transdisciplinary Initiative for Global Sustainability (TIGS) was established, in order to promote transdisciplinary research activities within UT. TIGS specifies the following five research areas: (1) energy and global warming, (2) environmental risk, (3) food and water, (4) urban–rural environment, and (5) technology development. Of these five research areas, we believe that urban–rural environment is the key issue for sustainability in Asia.

There are a number of developing countries in Asia, and as such the issue of economic development should not be neglected. On the other hand, there remain many rural areas in which poor farmers make their living. As there are fewer job opportunities in these rural areas, there is a tendency for residents there to migrate to city regions. Many of the world's megacities are also located in Asia, and there are many issues specifically associated with megacities. However, it is not within the capacity of megacities to overcome such issues by themselves—as even if such issues are solved the cities will be faced with further influxes of people. These issues should be solved in cooperation with surrounding rural areas.

Primary industry is another major issue for future sustainable society. As a general rule, as an economy develops, there tends to be a decrease in the numbers of people working in primary industry. Global trading systems contribute to the acceleration of this trend. Large-scale capitalistic farming systems overwhelm small local farmers such that they cannot earn sufficient amounts to sustain their livelihoods. Can we depend on imports of food? Should agriculture be maintained for food security? Will we be able to provide jobs to farmers from these rural regions in the future? These are just some of the many major issues that are associated with the question of the role of primary industry in future sustainable society.

It has become evident to us that Asian city regions have many unique characteristics. Specifically, these regions consist of different series of mixed land-use zones containing various combinations of "rural" and "urban" regions. In contrast, the distinction between rural areas and city areas in Europe is clear. We believe that this distinct characteristic of Asian regions is a key for future sustainable society—that is, the key concept for future sustainable development is in the harmonization between cities and rural areas. There is a strong trend to single out megacities as a discrete problem. However, the megacity issue should be considered alongside the village issue. Harmonized development of cities and villages is imperative for sustainable development.

To date, we have organized three workshops. The First International Workshop on Sustainable City Regions was held in Bali, February 24–25, 2009; the second in Tainan, February 24–25, 2010; and the third in Manila, August 14–15, 2011. The topics of these workshops were as follows: (1) Urban Rural Systems: urban–rural socioeconomic linkage, and local and regional governance, (2) City Regional Forms: landscape and spatial planning and sustainable transport and mobility, (3) Water Management: eco-physical integration and preservation, water shortage, and water environmental management, (4) Culture and Settlements: cultural preservation, lifestyle, and the form of settlements, and community-based initiative, and (5) Shrinking City and Urban Agriculture.

This volume was edited based on interdisciplinary and international discussions during and after the workshops. These are both highly informative and contain many ideas that point the way towards future sustainability. It is my hope that this book will contribute to future sustainable development in Asia and elsewhere in the world.

National Institute for Environmental Studies Akimasa Sumi
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Preface

Today's extended urban regions often maintain rural features within their boundaries and also have strong social, economic and environmental linkages with the surrounding rural areas. Consequently, scholars who study cities, professionals who develop urban policies and citizens who advocate for better urban environment are inevitably facing rural issues including food production, forestry and agricultural water management. These intra- and inter- linkages between urban and rural systems produce complex interdependences with global sustainability issues, including those of climate change, resource exploitation, ecosystem degradation and, ultimately, human wellbeing. The spatial patterns of mixed rural-urban land uses further affect energy use in various sectors; therefore, also have significant impact on aggregated GHG emissions from an urban region. In addition, urban encroachment over rural areas invokes transformations not only in production but also in the demand of food and other natural resources. Rural-urban gradient across urban region have a strong impact on biodiversity and ecosystem functioning.

Emerging rural-urban land uses can also bring a variety of benefits to humankind. Distinctive example of these benefits can be illustrated through the worldwide expansion of urban agriculture. For instances, urban communities are increasingly transforming vacant lots into productive farming areas. While, at large, these activities contribute towards urban and regional food security, urban dwellers can also obtain fresh food from these sources. Urban agricultural lands are also capable of delivering multiple ecosystem services. For example, they provide the cooling effects to mitigate the impacts of urban heat island phenomenon, contribute to storm water retention through infiltration, and subsequently reduce the risks of urban flooding. In addition, organic wastes generated from urban activities can be suitably transformed to manure for use in these agricultural land and can greatly facilitate in waste recycling in an urban context.

Traditional disciplines that study urban regions (e.g. urban planning, urban economics, urban geography), however, tented to consider agricultural and rural issues outside their research domain. The term "urban" inherently stand upon the worldview of rural-urban dichotomy thus "urban" disciplines inevitably lack appropriate concepts, languages, tools and models for dealing with environmental and socio-economic issues of today's extended urban regions. Planning and other prospective actions for the sustainability of urban regions, therefore, cannot solely depend on "urban" approaches; rather, they need to integrate broader landscape perspectives that take extended social and ecological systems into consideration. Here, we are not arguing that landscape sciences as an alternative to urban approaches, but suggest the term landscape as a common language to describe an urban region equally from the view of rural and urban systems. The term landscape, defined as "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors" by European Landscape Convention in 2000, also has a potential to link land, water, food, ecosystem, human, policy, transportation, innovation and other key components of sustainability issues, to the realm of urban regions.

This book provides a unique contribution to the science of sustainable societies by challenging the traditional concept of rural-urban dichotomy. This volume addresses diverse environmental, social and planning issues in today's urban regions from interdisciplinary perspectives and shows how to untangle, diagnose, and transform urban regions through distinctive thematic contributions across a variety of academic disciplines ranging from environmental engineering, geography to landscape ecology and urban planning. Case studies, selected from across the world, investigate urban regions in Asia, Europe and North America, including South-East Asian regions (Bangkok, Jakarta, and Metro Manila and others) that remain relatively less studied. These contributions collectively illustrate shared and differentiated drivers of sustainability challenges and provide informative inputs to global and local sustainability initiatives. They also provide innovative ideas to better understand and manage the linkages between urban and rural issues, especially for the researchers, policy planners and professionals engaged in urban and regional planning.

The Roadmap

This book has four parts and they bring insights from various academic fields and geographic regions. Part I provides theoretical fundamentals of sustainable landscape planning. Part II and III together compose the scientific bases of sustainable landscape planning in urban regions and deal with intra- and inter- linkages between urban and rural systems. Part IV introduces on-site activities which implementing novel ideas of sustainable landscape planning.

Part I Untangling Urban Regions: Theoretical Frameworks for Sustainable Landscape Planning

The chapters in Part I contribute to untangle the interrelated concepts of urban regions, rural-urban linkages, sustainability and landscape planning. Trends in contemporary urbanization and theories of sustainability are introduced for readers in various backgrounds (Yokohari and Khew, Chap. 1; McGee, Chap. 2; Takeuchi et al., Chap. 3). Yokohari and Knew (Chap. 1) trace urbanization history in modern Japan and propose a planning framework for integrate rural-urban land uses. McGee (Chap. 2) provides key ideas for stimulating discussions on the main challenges for urban policy and research in the Asian region. Takeuchi et al. (Chap. 3) introduces their "urban–rural fusion" concept by using the examples of local food production and organic material recycling in Asian urban regions. Harata (Chap.4) and Kidokoro (Chap. 5) explain evolving theories in urban planning for sustainability by using the examples of transportation (Harata, Chap 4) and innovation (Kidokoro, Chap 5) cases.

Part II Diagnosing Urban Regions: Social and Environmental Consequences of Urbanization

This part provides case studies on urbanization and environmental and socio-economic impacts. Study sites in this part include Indonesia (Murakami et al., Chap. 6; Irham and Sudirman, Chap. 8), the Phillipines (Bravo, Chap. 9), Thailand (Thaitakoo and McGrath, Chap. 10) and Vietnam (Nga and Fukushi, Chap. 11). Environmental issues mentioned in this part include cultivated land loss (Irham and Sudirman, Chap. 8; Bravo, Chap. 9), flooding (Thaitakoo and McGrath, Chap. 10; Nga and Fukushi, Chap. 11), urban heat island (Murakami et al., Chap. 6) and renewable energy (Soni and Salokhe, Chap. 11). Murakami et al. (Chap. 6) introduces the relationships between the characteristics of urbanization in South-East Asia and various environmental issues and serves as an introductory chapter for this part. Soni and Salokhe (Chap. 7) broadly explain about challenges in urban and peri-urban agriculture in Asian countries. Following four chapters (Irham and Sudirman, Chap. 8; Bravo, Chap. 9; Thaitakoo and McGrath, Chap. 10; Nga and Fukushi, Chap. 11) illustrate in-depth investigation into crucial environmental and socio-economic issues in each region.

Part III Diagnosing Urban Regions: Rural-Urban Linkages and Sustainability Challenges

While Part II focuses on environmental and socio-economic issues within urban regions, Part III looks beyond urban regions and extend our understandings on how urban regions have strong social, economic, and environmental linkages with the surrounding rural areas. Four chapters in this part illustrate cutting-edge challenges in studying rural-urban linkages and their consequences. First two chapters tell how rural-urban linkages of food (Hara and Tsuchiya, Chap. 12) and water (Mouri and

Oki, Chap. 13) affect GHG emissions. Following two chapters deal with urban contamination issues and explain how the contamination will affect not only people in urban regions but also surrounding rural and natural environments and people therein (Rauch, Chap. 14, Parikesit et al., Chap 15).

Part IV Transforming Urban Regions: Toward Regional Sustainability

This part addresses planning activities in current practice. The intent is to show how planners and other regional actors respond to the growing interests in rural-urban linkages mentioned in Part I, II and III. Gruehn (Chap. 18) and Potteiger (Chap. 17) explain European and North American experiences in sustainability initiatives in post-industrialized societies. Both Guzuman (Chap. 16) and Palijon et al. (Chap. 19) illustrate growing urban agricultural activities in Metro Manila, the Philippines. Sudjono (Chap. 20) and Peng (Chap. 21) provide insights into water management in today's extended urban regions.

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Contents

Part I
Untangling Urban Regions: Theoretical Frameworks for Sustainable Landscape Planning

Chapter 1
Landscape Planning for Resilient Cities in Asia: Lessons from Integrated Rural–Urban Land Use in Japan

Makoto Yokohari and Yu Ting Joanne Khew

Abstract Rural and urban landscape components have traditionally maintained a clear separation in the morphology of European cities. In contrast, the historical landscape of Edo Japan consists of mixed rural and urban land uses, due in part to a period of relative peace that rendered contained and fortified cities redundant. Despite European and Japanese cities having very different historical drivers of their resultant urban forms, modern landscape planning discourses in both regions have shifted toward a common aim for a clear rural–urban separation. However, prevailing socioeconomic factors (associated mainly with farmers' rights) that have sustained the mixed urban–rural pattern of Japanese landscapes resulted in a partial uptake of the modern landscape planning morphology. Instead of labeling the resultant "chaotic" urban–rural mix characteristic of modern Japanese landscapes as a "failure," one could instead draw lessons for a better future. The initial motivator for separating the rural from the urban landscape in modern landscape planning was to limit chaotic urban expansion. However, there has been increasing recognition that cities of today have to be resilient to new challenges, such as the increased instances of extreme events. This chapter makes the case that a city with an integrated rural–urban landscape is ideal for increasing urban resilience to natural disasters. The historical Japanese landscape could, ironically, function as an urban-planning model that ensures the functional connectivity needed for food security and simultaneously ensures the provision of adequate, accessible green spaces.

Keywords Integrated urban–rural landscape • Landscape planning • Europe • Japan • Landscape form • Urban resilience • Urban agriculture • Food-security • Disaster planning • Historical perspective

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Permanent human settlements appeared as early as 700 BC (Antrop 2004). Cities and their associated econopolitical systems were formed as an indirect result of successful agricultural movements that allowed humans to expand their daily activities beyond the realm of hunting and gathering (Pacione 2001; Antrop 2004). The urbanizing landscape has long been one of the fundamental characteristics of modern man ever since he learned to shape rural land to manage food production.

Although a consensus on a singular definition to describe the components that constitute a landscape has not been reached, as a testimony to the importance of urban spaces, landscape definitions have always included anthropogenic impacts. According to the European Landscape Convention (2000), the landscape is defined as "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors" (Council of Europe 2000). This definition paints the "landscape" as a broad area that has been modified by humans, and also includes the cultural and environmental impacts of the resultant modifications. A landscape can thus enclose both urban and associated rural areas that have been shaped in accordance with the prevalent social discourses characteristic to specific historical periods and geographical locations.

This opening chapter aims to present and contrast the morphology of rural and urban landscapes in two distinct portions of the globe: Europe and Japan in the Asia-Pacific region. In doing so, it explores the important historical driving forces that have resulted in a landscape with a clear urban–rural distinction in Europe and a mixed urban–agricultural landscape in Japan.

Despite starting out with different historical landscape templates, modern landscape planning discourses in the two regions have tended to shift toward an aim for a clear rural–urban separation, resulting in Japanese landscapes trying to conform to the traditional European landscape morphology (Yokohari and Amati 2005). Motivated by the need to address the social and environmental problems of urban sprawl, this was often enacted through the creation of greenbelts and special urbanization promotion areas to geographically partition urban from rural areas (Yokohari and Amati 2005). However, the mixed urban–rural pattern in Japan was firmly entrenched in the historical evolution of the landscape's character, contributing to an eventual, partial success of this modular form of landscape planning. On the surface, this may seem to be a failure in terms of achieving the goals set out by the modern landscape planning movement. Although the motivation of achieving a clear urban–rural separation was a noble attempt at creating orderly urban landscapes, this chapter aims to make the case that its partial "failure" in Japan's case has valuable lessons for a better future.

Insofar as the landscape remains intertwined with prevalent social needs, planning cities is no longer just an issue of creating an organized and contained urban form. Since the 1990s, buzzwords encompassing (but not restricted to) the descriptors "sustainable," "resilient," "ecological," and "green cities" have gained great official recognition around the globe (Satterthwaite 1997). Cities of today have to be designed with the promotion of urban resilience in mind. Addressing issues such as energy efficiency, proper waste disposal, and adequate green-space provision have thus been at the forefront of city planning in the twenty-first century (Satterthwaite 1997; Burton et al. 2013).

Unfortunately, one of the main motivators powering this change is the increased instances of extreme events. Consequently, planners and policy makers have realized that designing landscapes that promote socioeconomic resilience against disasters has become a pressing issue (Burton et al. 2013). Along these lines, this chapter closes by proposing an alternative landscape pattern for resilience building, inspired by the historical pattern of integrated rural–urban land use in the Japanese landscape fabric. The chapter puts forward the argument that such a landscape design would address two major concerns of resilient city planning especially in the face of disasters: (1) ensuring food security for urbanites; and (2) providing adequate green spaces that can contribute to human and environmental well-being.

1.1 Historical Urban and Regional Planning in Europe and Japan

Since urbanization swept from Southeastern Europe to the rest of the continent around 700 BC, landscape patterns have historically maintained a clear rural and urban separation in terms of both form and function (Antrop 2004). The morphology of a typical late medieval European city (sixteenth century) can be found to contain a dense urban core, which is separated from the surrounding rural area by castle walls and/or moats (Spirn 1984; Antrop 2004).

The form of a city often betrays its function and the fortifications surrounding medieval urban areas are no exception. These bear testimony to tumultuous periods when knights and lesser lords often fought each other for human and natural resources. While the nobility had the fortune to be holed up within the safety of the city walls, the logistical difficulty in building walls around productive land had resulted in farmers being left to conduct small-scale agriculture further away in the surrounding lands (Pinker 2011). This separated land into zones with distinct urban, agricultural, and rural functions. Farmlands were scattered throughout the countryside and connected to relatively distant cities mainly through waterways or through horse-drawn carriages (Antrop 2004).

In comparison, the morphology of urban areas in Japan does not exhibit the clear rural–urban separation characteristic of late medieval cities in Europe. Japanese cities of that time (for example, the ancient capitals of Nara and Kyoto, as well as the Kofu basin in Yamanishi), were instead characterized by mixed urban–agricultural land use (Yokohari et al. 2010). This landscape form was also prevalent in the capital city of Japan during the sixteenth to the nineteenth centuries—Edo City.

Edo was established in 1603 by Ieyasu Tokugawa and for about 250 years, there was relative peace in the country of Japan under the Tokugawa shogunate government (Yokohari and Amati 2005). It is arguable that this period of relative peace allowed the continued existence of integrated urban–rural land use systems.

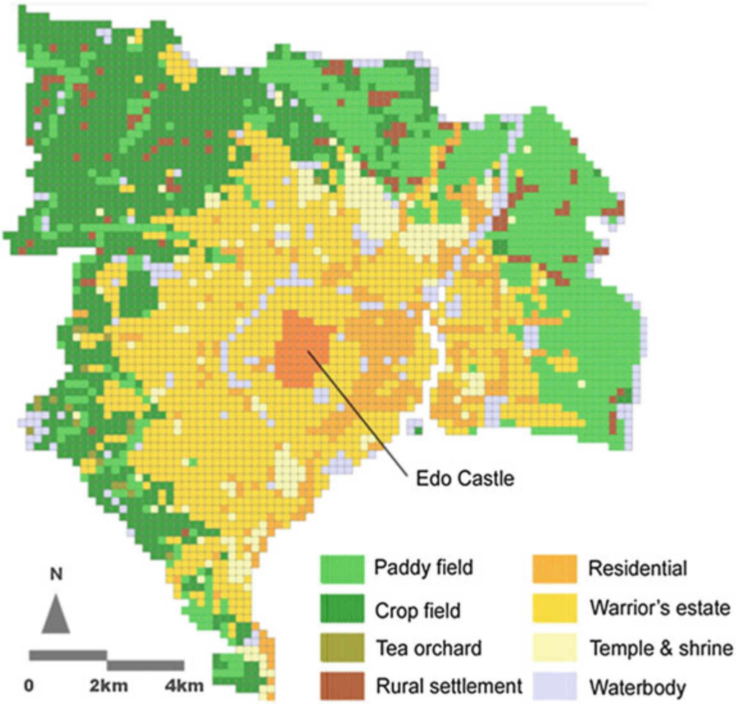

Fig. 1.1 Land use map of Edo City in the mid-nineteenth century. About 40 % of the land was dedicated to agricultural use (Fujii et al. 2002)

Stability has always been a product of peace. In a period that saw the growth of a national culture, commercial and material linkages between agricultural and urban areas also flourished (Guth 1996), without fear of disruption by dangerous raids.

By the mid-nineteenth century, up to 40 % of land within Edo City was dedicated to paddy fields, crop fields, and tea orchards (Fig. 1.1) (Fujii et al. 2002). The origin of having agricultural land as an “urban” fixture could have been a result of Japanese cities adopting a grid system, which originated from China, whereby agricultural land was featured as part of an urban grid. In this time of relative peace, feudal lords unconsciously perpetuated this mixed land use by renting out vacant land within their Edo estates to citizen farmers while they traveled back to other properties located elsewhere in Japan (Watanabe 1983).

The distinct landscape morphologies of late medieval European and Edo-era Japanese landscapes resulted in two noticeable contrasts in terms of the status of agricultural products and the status of sanitation within the city. While having a more functional role in European cities of old, agriculture in Edo City was accorded an arguably more respected position—even to the point of having its own “brand image” (Yokohari et al. 2010). Today, vegetables found in a Japanese supermarket carry names that tell of the area they were famously grown in during the Edo era (JA Tokyo 1992)—for example, Yanaka-shouga (a variety of ginger grown in what is presently the central northeast part of Tokyo) and Nerima-daikon (a type of radish grown in what is presently the northwest of Tokyo).

Sanitation within the city of Edo Japan was maintained at an acceptable level by having agriculture in close proximity to urban dwellings. Farmers in Edo City were able to establish a waste-cycling system where night soil was collected and transported easily to nearby farmland, where it was used as fertilizer (King and Bruce 1911; Yokohari and Amati 2005). In turn, produce from the farmland was easily transported to local markets for consumption by the city dwellers. This system efficiently connected rural and urban land geographically and functionally, and allowed about 1 million people to reside in relative comfort in Edo City as of 1721 (Gordon 2003), making the city one of the largest in the world at that time. It is also interesting to note that the population density in some areas of Edo City exceeded that of modern day Tokyo by five to six times (Yokohari et al. 2010).

In contrast, this waste and food recycling system did not exist in medieval Europe, where farmland was scattered over varying distances beyond the city wall. An unfortunate repercussion was the grim sanitary conditions faced by the urban populace as city streets started running foul with human waste (King and Bruce 1911). Many of the deaths resulting from illnesses and diseases prevalent in medieval European cities were attributed to the lack of proper waste disposal (King and Bruce 1911; Pinker 2011). Unfortunately, this problem continued even into the Industrial Age, when human waste was still recorded as being quite casually flung out of windows as a means of disposal (Pinker 2011).

As mentioned earlier, one of the main driving forces in the creation of a livable city was a climate of stability and peace. Establishment of a sound central government system, coupled with the establishment of mutually beneficial commercial linkages that made raids become a zero-sum game, occurred slowly throughout and after the Middle Ages (Pinker 2011). The civilizing process negated the necessity of walled cities and gave intellectual space for prominent thinkers throughout Europe to ponder solutions to the poor sanitation and overcrowding issues present in premodern cities. As a silver lining, these unfortunate urban conditions thus gave rise to ideas that were to later form the backbone of modern landscape planning in Europe and the rest of the world.

1.2 Trends Coalesce: Rural–Urban Land Use Separation in Modern Landscape Planning

The "garden city" concept as proposed by Ebenezer Howard in 1898 was one of the most famous ideas to conceptualize a modern city where people would live in harmony with nature. Howard designed the garden city to be an urban core in the middle of six radial boulevards, which held alternating blocks of residential estates, industrial land, and agriculture. He believed that this grouping of different mosaics of land functions would solve the problem of "crowded, unhealthy cities" (Howard

1902). Howard's concept was eventually successfully implemented in many cities in Europe and in North America. Some examples of actualized cities were Letchworth Garden City, Parma in Cleveland, and Baldwin Hills Village in Los Angeles (Horley 1998).

Although the garden city was designed to solve the problems inherent in European medieval and industrial cities, Howard's vision was still inherently derived from the landscape and history in his context. Although his vision did contribute greatly to making modern Western cities very livable, his understanding of the medieval city's structure contributed to the garden city still delineating urban and rural functions (Yokohari et al. 2010). In essence, the urban core in the garden city was still clearly separated from the rural land uses, which were confined to outer layers of the radial boulevards.

This clear separation of rural and urban land has been succeeded in other later landscape planning movements in Europe. The implementation of greenbelts around urban areas, such as the Greenbelt of the Greater London Plan (1944) by Patrick Abercrombie, is another notable example whereby the uncontrolled expansion of urban areas was controlled from spilling over into the surrounding countryside (Yokohari and Amati 2005).

The Greenbelt and Howard's earlier garden city concept combined another important feature of modern European landscape planning: zoning. In a nutshell, zoning aims to realize a juxtaposition of homogenous land units that specialize in a single function (or a few functions), while still keeping a distinct rural–urban boundary (Fig. 1.2) (Yokohari et al. 2000). For example, land dedicated to industry and housing would be represented as distinct units within the urban fabric, while land designated for uses such as forestry and farming would also be assigned to distinct units within the rural portion of the landscape.

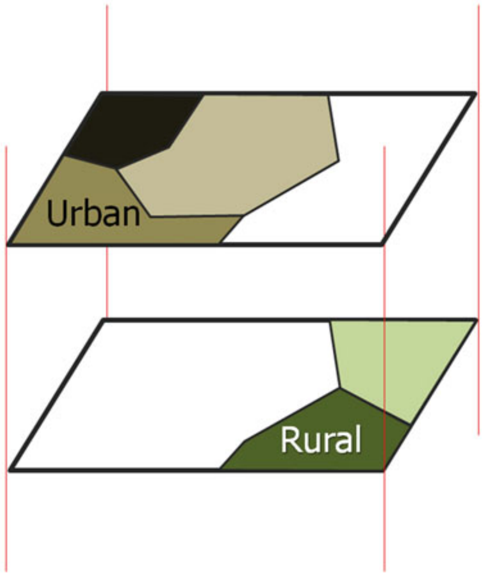

Fig. 1.2 Diagrammatic representation of the zoning concept in modern Western landscape planning. Functionally distinct land units are juxtaposed within the broad category of urban and rural areas

On its own, good zoning practice can contribute significantly to population redistribution and thus contributed positively to alleviating the phenomenon of overcrowding that plagued European medieval and industrial cities. However, in order to address other problems arising from the lack of material flow between rural and urban land mosaics, zoning can only work in conjunction with a robust transport and road infrastructure network. This is because each specialized land unit is not self-sufficient on its own (Yokohari et al. 2000). For example, urban residential land units require food from the agricultural land units within rural mosaics. Likewise, material required for building and industry may come from timber plantations in the rural landscape. This concept extends also to the flow of people from rural and/or peri-urban residential land mosaics to urban commercial areas where the main economic activity of the city takes place.

While zoning as modern landscape planning had its roots in Europe and the West, it soon influenced planning throughout the world. Greenbelts started to feature prominently in landscape planning in Asian cities such as Seoul (Yokohari and Amati 2005) and Tokyo (Ishida 1992).

Improvements in modern transportation systems and the efficiency of chemical fertilizers meant that Japan could also adopt a zoning system as there was no absolute necessity to place agricultural lands close to urban areas (Yokohari et al. 2010). As a result, Japanese planners readily accepted the idea of zoning. This manifested most prominently in the 1968 City Planning and Zoning Act.

Under this act, Japanese planners drew up designated urbanization promotion areas, especially in the 23 wards of Tokyo, where historically existing farmland was supposed to be converted entirely to urban use (Yokohari and Amati 2005). Although the density of urban areas did increase in central Tokyo, as well as in its surrounding suburbs (the outer limits of the 23 wards of Tokyo), the historical integrated urban–rural land use pattern persisted throughout nearly 40 years of the act's implementation. As a result, typical land use in Japanese cities such as Tokyo consisted of overlapping patches of land with dense urban use and rural agricultural (and, in some cases, secondary plantation forest) patches (Fig. 1.3).

The reasons for the persistence of farmland in urban areas are numerous and complex. A few are listed here:

1. Scholars like Fukutake (1967) speculated that farmers tend to resist selling their farmland especially in peri-urban areas despite it being ripe for development, due to a culture that discourages the sale of family-owned land assets.
2. Even when the 1968 City Planning and Zoning Act was active, land development regulations existed that allowed farmers to subdivide and sell parts of their farmland at urban prices, but with no requirement to provide urban services (Hanayami 1988; Mori 1998).
3. Persistence of farmland in urban areas were, to a certain extent, testimony to the bargaining power of the Farmers Lobby over the Liberal Democratic Party of Japan and its associated urban policy. Farmers were successful in lobbying for attractive tax reductions on farmland in urban areas, making it economic to maintain their farmland at a reduced price (Sorensen 1999).

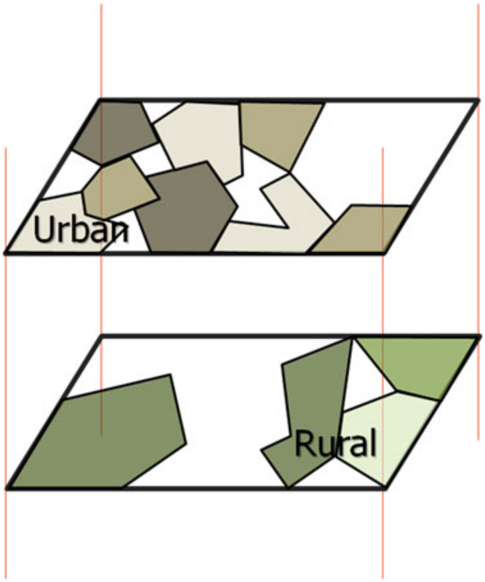

Fig. 1.3 Diagrammatic representation of the landscape with overlapping urban and rural land use in a typical Japanese city after the 1968 City Planning and Zoning Act

Today, as much as 3 % of the land in Setagaya, a suburb of Tokyo, is dedicated to agriculture (Yokohari and Amati 2005). If one takes a trip in the direction away from central Tokyo, in about 20 km, perhaps the only difference in landscape morphology one would notice is the thinning out of urban development and the slight increase in land area dedicated to agriculture and open green-space use. However, if one were to take a similar trip away from a central European city—for example, London—the landscape is likely to exhibit a transition from built areas to land with almost completely agricultural and rural use.

The apparent "disorganization" inherent in Japanese landscapes has been seen by many as a failure in terms of modern urban-planning acts, such as the 1968 City Planning and Zoning Act. The present-day Japanese landscape has been described as "chaotic" and disorderly (Sorensen 1999) and has even been compared to a malignant form of agricultural cancer (Fukutake 1967, p 21).

Should the case of modern Japanese landscape planning be considered a "textbook example" of failed policy implementation? This chapter aims to put forward the idea that such urban forms could instead be beneficial in underlying the urban-planning discourse of the twenty-first century.

1.3 Integrated Rural and Urban Land Uses in the City: The Way Forward for Resilient Asian Cities

Since the 1980s, when environmental concerns were a prominent part of the global agenda, the focus of the landscape planning discourse of today has changed from creating an organized urban form to one of planning resilient and sustainable cities

(Satterthwaite 1997). Cities of today have to tackle issues that enable the maximization of human comfort while minimizing environmental impact (Satterthwaite 1997).

Notably, with the advent of climate change, instances of extreme events have increased (Munich Reinsurance 2015). In the wake of disasters such as Hurricane Katrina (New Orleans) in 2005 and the 2011 floods and tsunami in Thailand and Japan, respectively, there is a pressing need to develop cities that can address the issue of ensuring food security and ecosystem service provision in terms of providing effective urban green spaces. Both functions contribute to the mitigation of disaster impacts, while the latter is also tied to climate-change alleviation functions that reduce the instances of disasters before they occur.

In particular, Asian countries are the most in need of cities that are resilient to climate change and its associated disaster impacts. A recent survey conducted by the Munich Reinsurance company revealed Asia to be the continent with the highest number of natural disaster–related causalities from a time span of 1980 to 2014 (Munich Reinsurance 2015). Notable recent disasters have included the devastating Typhoon Haiyan, which hit the Philippines in November 2013, resulting in the loss of about 6300 lives (National Disaster Risk Reduction and Management Council 2014). Floods have also occurred in increased magnitude in Thailand. A severe flood, which occurred in 2011, resulted in 890 fatalities and inundation in 66 out of 75 provinces (Aon Benfield 2011).

Furthermore, 18 % of the total number of disasters occurring in Asian countries were attributed to seismic hazards, as compared with 8 % in North America and Europe (Munich Reinsurance 2015). In Japan itself, major earthquakes have rocked the country since the largest disaster in the country's history (The Great Kanto Earthquake) in 1923, which killed nearly 60,000 people. Other instances of earthquakes include the 1995 Kobe earthquake (6000 causalities) and the recent March 2011 Tohoku Earthquake and Tsunami, where 20,000 fatalities were reported.

Therefore, a resilient Asian city would ideally have to contribute to the reduction of climate-related disasters and ensure food security within the city in the case of geological disasters when the transport systems characteristic of the zoning system have ceased to function. Planners should ideally keep the concept of disaster resilience at the forefront when designing urban and regional areas in Asia.

This could mean that the resultant city would deviate in morphology from the conventional zoning concept birthed in the West in view of the higher overall disaster risk and higher seismic hazard risk present in Asia as compared with cities in North America and Europe. After all, the zoning system relies heavily on urban transport networks in order to sustain the interunit functional relationships between components of the rural and urban landscape. Having such a transport system spread over great geographical distances in Asian landscapes could make the city more vulnerable to functional disruptions in the case of natural disasters.

Especially in the Asian context, looking back at the apparent "failure" of Japanese cities to conform to a strict rural–urban zonation may, in fact, provide answers as to how to plan the city of the future. A city with integrated agricultural/productive land within the urban fabric has been recognized as one that is able to offer urban dwellers an option for food security, should contact with surrounding rural agricultural land be cut off suddenly (Burton et al. 2013). Having a city planned with multiple patches of agriculture land within the urban fabric provides much-needed redundancy, which would come in handy in the event of a disaster.

The concept of redundancy was first introduced in ecology (Holling 1973) and is positively correlated with system resilience. The more redundant a system is, the more it is able to absorb disturbances without sustaining significant change to its original function (Brand and Jax 2007). The classic illustration of redundancy utilizes an ecological food web where an increase in redundancy can be demonstrated through increasing the number of flows (connections between species) per node (any given species) (Costanza et al. 1995). A low level of redundancy, and accordingly low resilience, can be represented in a simple one-predator, one-prey-food chain model (Costanza et al. 1995). A food web system represents an increase in redundancy and resilience due to the increased number of flows from a single node at a higher tropic level to nodes at a lower tropic level. Upon application to agriculture in an urban landscape model, more resilient cities would have a greater number of productive agricultural land patches, which would provide urban dwellers with a food source that is independent of long-distance transport chains.

A question that one might ask would then be: can agriculture within the urban fabric really provide enough food to sustain an urban population? Taking a look at the case of Tokyo, with its historically integrated landscape, 900 ha of land (about 1.5 % of the land area in the 23 wards of Tokyo) has been continuously farmed by 6500 professional farmers (Yokohari and Amati 2005). This small amount of land has managed to produce 0.3 % of the vegetables and 0.2 % of the flowers and ornamental trees produced in the whole of Japan (Yokohari and Amati 2005). This seems like a small percentage when spread out over the entirety of the country. However, should all the resources be required in just the city of Tokyo in the event of an emergency, the net volume of agricultural produce could arguably be sufficient to sustain the urban population at least till major long-distance transport networks are reestablished.

Furthermore, urban agriculture is a viable solution for food security worldwide and not only in Tokyo (Burton et al 2013) as areas where cities develop historically coincide with areas with fertile agricultural soil (Deelstra and Girardet Undated). Studies by Smit et al. (1996) and Hodgson et al. (2011) have estimated that urban agriculture can provide an estimated 15–20 % of the global food supply at its current productive levels.

Agriculture in urban areas is required beyond the realm of addressing the problems of food security. Earlier, we mentioned the need for resilient cities to provide adequate ecosystem services in order to mitigate the impacts of climate change and contribute to the reduction of extreme weather events. It is in this realm that agricultural green spaces integrated within the urban fabric can also prove effective.

Beneficial ecosystem services attributable to urban agriculture have been widely studied (see Deelstra and Girardet, Undated; Lin et al. 2015 for examples). Areas with agriculture help to combat heat island effects by reducing ambient temperatures in their immediate surroundings by as much as two degrees Celsius (Yokohari et al. 1997). When sown with native crops (this again brings to mind crops that were characteristically grown in specific areas of Edo City in feudal Japan), agriculture has been able to contribute positively to biodiversity conservation within urban confines. This, in turn, has positive spillover effects characteristic of a robust ecosystem: storm water runoff treatment and pollution control, pest control, and the provision of pollination services (Daily 1997; Lin et al. 2015).

The positive effects of urban agriculture have even permeated the traditional zoning system in the West, where 600 community gardens have been registered in New York City alone under the nongovernmental organization called the Green Thumb. Much popular and academic literature has also been written to encourage the popularization of this form of agriculture, lauding it as a solution for the alleviation of climate change and food security provision (Burton et al 2013; Lin et al. 2015).

This is a heartening trend, though slightly ironic, as cities of the future may begin to look once again like cities of the past. Even in the West, perhaps a new standard of acceptance is to be found in "chaotic" cities whereby rural and urban land uses work together to achieve functional and morphological integration. However, there has to be a greater understanding of the interaction between functional urban–rural integration, as well as its side effect of urban sprawl, in order for the integrated land use model to work optimally. Perhaps, there is space to consider the city structure of Edo in feudal Japan as a starting point in understanding that integrated land use models are necessary for resilient cities of today. The city model can then serve as a springboard to launch further discussion about how much rural–urban integration is necessary in a specific region, given its disaster risk profile and urban sprawl potential. In its totality, flexibility is strongly encouraged in planning for resilient cities and there is a need to recognize that in a changing world, there is very seldom a "one size fits all" solution. Planners must always be mindful of their context and its inherent qualities while taking a forward-looking stance when adopting the ideas of tomorrow.

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Chapter 2
The Sustainability of Extended Urban Spaces in Asia in the Twenty-First Century: Policy and Research Challenges

Terry G. McGee

Abstract This chapter focuses on the main challenges that the processes of demographic, spatial, and social political change present to current urbanization trends of the Asian region. The chapter argues that one of the major challenges is the present development trajectory of many Asian countries, which emphasizes economic growth, increasing integration into the global economy and making Asian countries competitive in the global economy. This process leads to the growth of large urban regions—“extended urban spaces” (EUSs)—that present many challenges to the urban future. In particular, the chapter argues that the most fragile areas of the EUSs are the rural urban margins where urban activities are expanding into densely populated agricultural regions, which the author calls “desakota.” It is argued that in these areas, local policies should be developed that adapt to local ecosystems. The chapter presents a research agenda for policy interventions in these areas and their implications for urban policy.

Keywords Asian urbanization • Desakota • Extended urban spaces • Urban ecosystems • Urban policy • Urban expansion

2.1 Introduction

This chapter is intended as an “ideas” piece to stimulate discussion on the main challenges for urban policy and research in the Asian region. In particular, I focus on the discourse about environmental change and urbanization. My reading of this literature suggests that three levels of analysis can be identified: (1) the global reading of these processes that is carried out by “global agencies” who utilize national or global data bases as their major source of information; (2) national or “metalevel” data, which include both national data and scaled-up data from other levels of government such as provinces; (3) “local level” data, which include case

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studies that are scaled up to "thicken" data assembled at the national and global levels. These microstudies focus on the activities at many levels from the household up to the largest multinational or international agency as they operate in particular urban sites. They rarely attract enough attention to force policy action.

As one of the major entry points for this ongoing research I argue that another level of analysis needs to be added to the global and national and local levels, which would involve the assembling of data at the level of what I call "extended urban spaces" (EUSs), which are the spreading areas of urban activities that are occurring at the edges of the urban cores of EUA's of urban spaces. This is not only at the level of the administratively defined urban areas but also at the levels of the urban core and the EUSs, which, while they are most ubiquitous in the largest urban agglomerations, are also occurring in smaller urban places in the urban hierarchy. If this definition of the EUS is accepted then it is clear that the pace of global urbanization is much more rapid than is accepted by most data analysis. This means that the current level of global urbanization (50 %) is almost certainly an underestimate, although sharp contrasts remain between the developed countries and the global South. A basic assumption of this chapter is that the lives of urban dwellers in EUSs are being shaped by their activities, consumption patterns, and resource demands, and by the quality of the urban environments in which they live. These EUSs are also the locations in which an increasing proportion of national GDP is generated. As the population and economic wealth of these EUSs increase it can be argued that these demands on resources will increase as will the effects of environmental change, thus placing greater pressure on local, national, and global resources. This process increases the vulnerability of these EUSs to growing environmental, fiscal, social, and political problems (McGranahan et al. 2007). However, this assertion raises many issues. Most prominent is that it does not interrogate the spatial spread of the urbanization process. Most data on the urbanization process are derived from national data collection systems that are taken from national definitions of urban places often defined on the basis of administrative divisions such as cities or municipalities, cities, or towns. These vary substantially at a national level but generally severely underestimate the spatial extent of urbanization beyond urban administrative boundaries. At a national level this is increasingly being recognized by the creation of larger statistical units such as the SMA in the USA. But this statistical "rethinking" is still falling short of measuring "true urbanization" as for instance measured by the proportion of the workforce engaged in "nonagricultural activities" in EUSs. In fact it is now generally recognized that EUSs are an ubiquitous part of the contemporary urbanization process. This urban spread has been driven by the changes in transport technology (particularly motor vehicles and road systems) and communications, and by industrial, service, and residential growth, which, while it is occurring at a different pace though out the globe, is now a common feature. This has created large zones of urban activity outside the city cores of many urban-defined places that have been variously labeled peri-urban, urban fringe, etc.

My argument is that prevailing urban definitions still fall short of capturing the full extent of "urban space," neglecting large and important zones of rural and nonrural activity that are part of EUSs. In the last 30 years I have carried out research that has attempted to conceptually reconfigure the understanding of urban space (see McGee 1991, 2008). Further, I would argue that in doing policy relevant research on these broad global processes we need "entry points" that recognize the significant drivers of these processes that are shaping urban space. These entry points might be "global" and process driven (e.g., carbon emissions, sea-level rise), they could be "place driven" (e.g., EUS), or they could be government policy or issue driven as, for example, in the case of "food security" or "urban poverty." However, the complexity of these entry points suggests a need to focus the research on the largest EUSs that are vitally important to the overall impact of the urbanization process.

One other research issue remains. On which geographic region of the globe should this research be focused? I would argue that the overarching reality of Asia's importance at a global level as the location of almost 66 % of the world's population makes it vitally important to any assessment of global and urban futures. But it is estimated that the level of urbanization was 43 % in 2010; one of the lowest of any large region in the world, which means that the growth of the urban population in the Asian region will be very large in the next five decades, making up an estimated 80 % of all global urban population increase. The early postwar economic growth of the NICs of Japan, Korea, Hong Kong, Singapore, and Taiwan has now been joined by the growth of other Asian countries, particularly the two economic giants of India and China, and so the region is beginning to become a third pivot of the global economy along with North America and Europe. If this region was eventually to achieve the economic and consumption levels of the developed countries with the present levels of environmental control, this would greatly accelerate the processes of global environmental change. It is also important to emphasize that because of the very large population involved in the urban transition the number of mega-urban regions in Asia will be by far the largest in the world. This situation suggests that an Asian focus for the research can be justified as driven by global imperatives. McGee 2007, McGee (2008) discusses these arguments.

This introductory statement generates many research questions that have policy relevance, of which five main research questions have priority:

1. How can EUSs be defined and how can data collected at the EUS level contribute to policy solutions?
2. Why are these EUSs of major importance in the investigation of processes of global, economic, and social change?
3. What conceptual approach offers the most viable entry to the study of EUSs?
4. What is the vulnerability and resilience of EUSs to the processes of global, environmental, economic, and social change?
5. What are the policy implications of this research for the governance, management, and planning of "adaptive" strategies in these EUSs to the challenges outlined above?

2.2 Priority Research Clusters for Urban Sustainability

This preceding section has identified a number of research questions, which can be collapsed into four main research clusters.

2.2.1 Research Cluster 1: Understanding the Reconfiguration of EUSs

Conventional approaches to the measurement of urbanization focus on the administrative definitions of urbanization. But the spread of urbanization outward from urban cores into surrounding areas has created an "underbounding of urbanization." This has been reinforced by the persistence of ideas of rural–urban differences that are breaking down under the impact of this spatial spread of urbanization. I have analyzed the reasons for this process of spatial spread in recent decades, using the concept of "telescoping transitions" developed by Marcotullio and Lee (2003), arguing that the current era of urbanization is characterized by faster urbanization and forces of change (technology, communications, globalization) that accelerate both urbanization and spatial spread of urbanization particularly in developing countries. This means that in most of the larger EUSs of developed countries we now have three spatial elements of the urban form: (1) city cores consisting of the built-up core areas of the city; (2) a peri-urban region that is made up of built-up extensions of the city in linked suburbs and industrial and commercial activity; and (3) a rural–urban region of diffusing urbanization, which extends for up to 100 km particularly along major arterial transportation routes into the hinterlands of these extended urban regions. Within the Asian context such EUSs often penetrate important agricultural regions that have developed dense rural populations and are important sources for food provision for the city core and periphery. In earlier work I have labeled these regions as "desakota"—a word coined from the Indonesian language, meaning "village" and "town"—designed to capture the mixture of rural and urban activities that occur in such zones (see McGee 1991; Mc Gee et al. 2007: 68–73; Mc Gee (2012)). These three zones of urban space form part of the integrated urban regions, the largest of which form EUSs of more than 10 million population in size, often called mega-urban regions. Almost 60 % of the world's mega-urban regions are located in Asia, dominated by the population giants of India and China. The foundation for their economic wealth stems from their dual role within their national economies and their links with the global economy. Within the Asian context many of these mega-urban regions are located in the low-lying areas at the mouths of rivers that form part of the deltaic regions of major river systems. This places them at greater risk from climate hazards such as cyclones, flooding, coastal erosion and deposition, and sea-level rise. As the population grows they are also exceptionally vulnerable to environmental deterioration that affects resource availability, resulting in water shortages, threats to food systems, and problems of energy provision, which are major challenges to economic growth. Research should be focused on the effects of the processes of urban spatial expansion on urban sustainability.

2.2.2 Research Cluster 2: Understanding the Functional Integration of EUSs

A second component of research should be recognition that EUSs are functionally linked by "flows" that include transportation and communication systems, including the movement of goods, people, and information, and the flows of energy and resources. These form overlapping networks that involve various densities of transactions. In another context these "flow networks" have been labeled "transaction networks" and it is argued that their functionality is crucial to the economic performance of these mega-urban regions (Marton 2000). In the Asian context the rural–urban linkages within these EUSs are of major importance in the flows of food, commodities, and people. In general it is true to say that most governments perceive these EUSs as places where flows are congested and inefficient. The policy response of most governments that have the resources to invest in such developments is to rapidly increase investment in infrastructure (the built environment, energy provision, and transportation systems) to increase the efficiency of these "transaction networks." This is one important driver of the spread of cities, for the space demands of new industries and upper-income housing development can be provided more cheaply in the lower-cost land markets of the outer two zones of the mega-urban regions. This process of urban expansion thus involves a constant depletion of resources in the outer zones (now most marked in the desakota zones) that is leading to restructuring of the two-way flows of food, biomass, water, energy, products, consumer goods, and services between the desakota and the two inner-urban zones of the mega-urban regions. Until recently, while this situation presented many challenges to national and local governments (e.g., environmental pollution), it was not regarded as a threat to the sustainability of the mega-urban regions, because governments assumed they would be able to extend the reach of these flow networks both nationally and internationally. This process has already occurred for instance in Japan and South Korea. Taiwan and other Asian countries have benefited from becoming part of those countries' extended "flow networks" as well as other international trading partners.

But this "development trajectory" is reliant upon cheap fossil energy, which has fueled the extension and ubiquity of these networks. With the increasing volatility in the prices of oil and gas, questions are raised whether this "fossil-fuel-dependent development trajectory" is viable in the context of the developing countries. Therefore the challenge to Asian governments must be whether they can develop a more "sustainable urban development trajectory" that might be more appropriate, involving engagement with alternative strategies of energy provision, food sourcing, and resource utilization that involve greener systems of production and consumption. This raises questions of whether new urban forms will emerge in response to such developments. For example the policy push for "compact cities" (Marcotullio 1991). Priority should be given to research on the policy interventions that can be developed for sustainable models of urban growth.

2.2.3 Research Cluster 3: Establishing the Strategic Policy Importance of Desakota Regions in Developing a Sustainable Urban Development Trajectory

In the Asian context I would argue that the rural–urban margins of these EUSs (desakota) are crucial zones in which a new "sustainable development trajectory" will need to be implemented because of their resource base and proximity to mega-urban cores. They also become pivotal areas in the "food security" policies that need to be restructured as a result of global volatility in gas and food prices in global markets. Desakota regions are often perceived to present negative challenges in the development of these strategies because the mixed character of economic activities in these regions places great pressures on the ecosystems and the management of these systems which involve new institutional responses to the management of joint resources by agricultural and nonagricultural users as well as the management of the interaction flows between the urban cores and the desakota zones. On the other hand the adoption of new sustainable development trajectories means that local responses become more important and could lead to reemphasis of the agricultural activities in the desakota regions. This was recognized by Yokohari et al. (2000) as a new ecological planning concept appropriate for Asian mega cities. These arguments have also been made by other researchers in Asia (Desakota Team 2008; Abdul Samad Hadi et al. 2006). In particular, the research of Dipak Gyawali is an important idea statement of the research that is needed in these areas. In a draft report he raises the question "What kind of science is needed to understand the relationship between ecosystem stress and livelihoods in the desakota regions?" (Gyawali. 2008: 10). Utilizing definitions used in the Millennium Ecosystem Assessment he points out that ecosystem services are benefits that people obtain, and they include (1) provisioning services such as food and water; (2) regulating services, including floods, droughts, land degradation, and diseases as well as climate regulation; and (3) sociocultural services such as aesthetic, spiritual, recreational, and other nonmaterial benefits. These services are held in place by the supporting services of ecosystems such as soil formation and nutrient recycling, and mitigation of climate events through floodplain inland water bodies storage mechanisms and mangrove buffering.

The key scientific question that this formulation of the ecosystem raises is how to determine how "*resilient*" ecosystems can be in the face of processes of population increase and increasing intensity of urban activity as well as the environmental deterioration that is occurring in the desakota regions of EUSs. The concept of ecosystem resilience has a well-established tradition in biosystems research and is usually defined as the capacity of an ecosystem to tolerate disturbance. This is often broken down into three components: (1) the amount of change a system can undergo and still retain some controls on function and structure; (2) the degree to which a system is capable of self-organization; and (3) the ability to build and increase the capacity for learning and self-organization. Thus a key component of this research would focus on developing a system of defining the resilience of ecosystems to these forces of change being driven by a combination of "drivers" within the biosystem and the societal system, which occur at a number of scales: global, national, EUSs, and local.

It is important to separate the concepts of resilience and "vulnerability." Vulnerability can be defined "as the degree to which a system or unit is likely to experience harm due to perturbations or stresses" (De Sherbinen et al. 2007: 41) and has most frequently been applied in research examining risks or hazards. But increasingly it is being realized that the concept of vulnerability needs to include "the responses of, and impacts on systems (social groups, ecosystems, places) exposed to such perturbations" (De Sherbinen et al. 2007: 41). In addition it is necessary to disentangle the relations between the macroforces (e.g., climate change) and the other systems levels on which they are impacting. "Different pressures across scales come together in various sequences to create unique 'bundles' of stress that affect local systems" (De Sherbinen et al. 2007: 41).

Any study of the desakota region must see its local urban ecosystem within a wider urban metabolic footprint (see Curtis 2004). Four areas of interlinked rapid change are impacting it: (1) the overall political economy, characterized by migration, urbanization, food supply, consumerism, and restructuring of economic activity—particularly industrialization and communication—driven by investment from international, national, and local firms and governmental and quasigovernmental agencies; (2) the policy environment in which these processes occur, which particularly in the governmental context is driven by the desire to achieve rapid modernization imitative of the developed countries of their own region and elsewhere; (3) the forces of global and environmental change in climate, water availability and quality, land degradation and loss of biodiversity, sea-level change, etc.

2.2.4 Developing Policy Responses to the Challenges of Extended Urban Spaces

The final research cluster focused on the policy implications of the research findings and the major policy challenges of EUSs, particularly the desakota zones. The following priorities can be suggested: (1) it must be established that the desakota zones are regions that deserve priorities in policy development; and (2) the contemporary challenges in the fossil fuel energy–driven mode of urban expansion raise questions about the viability of these areas for the development strategies of governments. This also means adaptation in the systems of management, government, and governance that exist in the EUSs

2.3 Conclusion: Toward Asian Urban Futures

It should be emphasized that what happens to the urbanization process in Asia is central to the global urban future. While the global level of urbanization increased from 36.8 % in 1980 to 50 % in 2010, Asia's urbanization level increased from 23.4 to 42.0 %. UN population estimates suggest that in the next 30 years this urbanization trend will continue, at a global level reaching 60 % while Asia will increase to 51 % by 2030. Since Asia contained an estimated 60 % of the global population in 2000 this means that in the next 30 years some 1.3 billion people will have to be absorbed into urban areas while the population resident in rural areas remains virtually at the same numerical level (see United Nations Population Division 2004; UNPF 2007).

The numerical dimensions of these demographic trends are unique in the world experience of urbanization. For example in Western Europe it was estimated that in the nineteenth century the increase of urban levels to 40 % involved a shift of only about 50 million people. Of course at the subregional and national levels within Asia this demographic picture is dominated by the large developing Asian countries in excess of 100 million in population, including China, India, Pakistan, Bangladesh, and Indonesia, which will be joined by the Philippines and Viet Nam in the next 30 years. By 2030 these large countries (in excess of 100 million people) will make up almost 80 % of Asia's population and 59 % of the global population. These numerical dimensions thus present a basic challenge to the management of the urban transition.

In the light of the preceding discussion it is possible to imagine two very different futures for the cities of Asia. An alarming scenario sees ongoing global environmental change increasing the vulnerability of these EUSs within a framework of ongoing globalization that depletes resources, destroys the ecosystems on which these extended urban spaces rely, and presents major challenges to the sustainability of these urban forms. Another part of this scenario is the increasing social vulnerability of urban populations to an increasingly volatile global economy (most obvious in the current global financial crisis), which threatens local jobs and incomes and widens social divisions, creating socially fragmented cities. This creates political tension that dominates the governance concerns of urban administrations.

Another more optimistic scenario suggests that as global awareness of these urban challenges is growing, local urban governments in Asia are experiencing considerable expansions of power that enable locally elected leaders, whose roots are deeply embedded in the urban place and who have a much wider understanding of local civil society, to develop and implement policies that reflect the distinctiveness of different places in which the priorities are placed on creating more socially inclusive and sustainable cities. This will involve radical rethinking of the way cities are managed, the mix of public and private transportation, and local participation in the planning of cities. While economic policies designed to increase the economic wealth–generating capacities of cities cannot be discarded and are, in part, dependent upon the international trade and other flows that are part of globalization, they must be set within the local context and priorities of creating sustainable cities.

Central to this recognition is the understanding that global forces impact on an uneven terrain of culture, politics, economic conditions, and power, and this leads to different responses. In some cases globalization will be a major generator of economic growth but many experts argue that there also be an increasing emphasis on "local economic development". This means that the creation of sustainable EUS systems that emphasize local production and consumption should be promoted. This is not advocacy of self reliance or "autarchy," for all countries and local places within countries will rely upon "exports" and "imports" of goods, services, knowledge, and people; rather, the creation of sustainable cities involves the local people taking control of the efforts to create sustainable urbanization. But, undoubtedly, a powerful shift is needed in the way knowledge about sustainability becomes part of the common conscience of nations. This is necessary for the ongoing sustainability of all societies in the twenty-first century and it suggests a very different urban future (Maruyama 2006).

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Chapter 3
Establishing A Sustainable Community Through Urban and Rural Fusion

Kazuhiko Takeuchi, Koji Harashina, and Yuji Hara

Abstract Urban and rural fusion has been a main subject of urban planning discussed for over 100 years. Recently it is drawing attention from the viewpoint of "sustainable cities" in particular. In Japan, along with consolidation of municipalities, local administrations including broad rural areas are emerging one after another. This should be regarded as a good opportunity to reestablish bioresource-circulating spheres through creating preferable landscapes and ecological networks as well as promoting the movement toward local production for local consumption. This concept of the urban and rural fusion might contribute to establishing sustainable urban communities in Asia.

Keywords Urban rural fusion • Bio-resources • Resource circulating society • Asian cities

3.1 Introduction

The Laboratory of Landscape Ecology and Planning of the Graduate School of Agricultural and Life Sciences at The University of Tokyo, with which the first author was affiliated until recently, was created about 80 years ago in 1929 with a

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contribution by Marquis Nabeshima for the Second Course in Horticulture. The Second Course in Horticulture is responsible for ornamental plants and landscape gardening, and for many years the main research has been (1) floriculture science and planting theory and methods; and (2) landscape planning and design and urban and regional planning. The latter field has an especially close relationship to urban planning.

Teizo Niwa, who was for many years an assistant and full professor in the pre- and postwar years, and Tokutaro Kitamura, who came here to be a professor after serving as a technical official with the former Ministry of the Interior, then the Postwar Reconstruction Authority, participated in the Tokyo Green Space Planning Council and were involved in Tokyo Green Space Planning, a blueprint for radial-ring green spaces. It was in this plan that the term *ryokuchi* ("green space") was first defined, and as a result of discussions it was formally decided to recognize farmland near cities as one kind of green space called "productive green zones."

In the prewar years, people who had studied in the Second Horticultural Laboratory were deeply involved in urban planning for a new city construction in Manchukuo (Koshizawa 1988). The term used at that time was "city and village planning" (Fig. 3.1), which is seen as being in character with what is now called "urban and rural planning" (Ishida 2004). Standing in the giant footsteps of our predecessors, we have been conducting studies and research in the Laboratory of Landscape Ecology and Planning on the possibility of attaining urban–rural fusion from the viewpoint of conserving and creating green spaces, and we intend to propose this to society.

3.2 Strategy for an Environmental Nation in the 21st Century, and Creating Sustainable Cities

In recent years it has been said worldwide that urban sustainability is important for considering global sustainability. The urban portion of the world population has already surpassed the rural population, and it is predicted that megacity populations will further increase, especially in the developing countries. It is said that in Asia too, megacities in China, India, and Southeast Asia will further continue to grow, bringing about heavy energy consumption and environmental deterioration, and thereby further worsening global environmental problems.

Accordingly, how to make cities sustainable has a decisive significance for global sustainability. The first author of this chapter was involved in the process of formulating the Strategy for an Environmental Nation in the 21st Century, which was approved by the Cabinet in June 2007, and in that process the first author arrived at the idea that we should conceive of "sustainable cities" as a combination of three images of society: the "low-carbon society," the "resource-circulating society," and the "nature-harmonious society."

The low-carbon society is an important goal for climate change mitigation in terms of international politics as well. With the resource-circulating society the aim

Fig. 3.1 City and village planning for Andong City and Dadong City (from materials published in 1933 in the collection of the Laboratory of Landscape Ecology and Planning)

is to create a society with little waste by using resources effectively and cyclically. With the nature-harmonious society the aim is to shape a society in which people and nature are in harmony (Takeuchi 2010). Of crucial importance is how we integrate these three society images and construct a sustainable society.

Conceived at the city level, a sustainable city is impossible to achieve in the urbanized portion alone. To develop low-carbon, resource-circulating, and nature-harmonious cities, it is necessary to first conceive of cities in the broader sense of urbanized areas plus their rural hinterlands in an integrated manner. Needless to say, one should give full consideration to the elements of local character, naturalness, and natural features. This is important also when applying the idea of sustainable cities to cities in monsoon Asia, such as in China and Southeast Asia (Yokohari et al. 2000).

3.3 Wide-Area Municipality Mergers and Urban–Rural Fusion

Under the municipality mergers in recent years, integration is proceeding toward an approximate one-third reduction in the number of cities, towns, and villages. Among the advantages of such mergers are the streamlining of administrative organizations, which will contribute to sounder public finance, the effective use of wide-area public facilities such as schools and hospitals, and facilitating community development in a wide-area, integrated manner. On the other hand, many people express concerns that for example local characteristics and cultures that have been traditionally maintained will be lost, and that administrative services will deteriorate in rural areas. Amid widening disparities between cities and rural areas, a major problem is how municipalities should be run after mergers.

It is our position that the process by which cities consisting mainly of urbanized areas take in their vast rural hinterlands should actually be positively seen as an occasion for the birth of a new city through urban–rural fusion. That is to say, we think a city that now covers a large area due to a merger should be redefined as a "new type of city" that fuses the urban and the rural. In fact, after wide-area mergers there are now many municipalities that could be conceived as cities integrating everything from upstream forests to midstream farmland and villages to downstream urbanized areas, even down to the coast.

In the years of rapid economic growth, making a sharp distinction between urban and rural areas was planned, with the thinking that "cities are cities, rural areas are rural areas." That thinking is apparent in the "land use coordination" pursuant to Japan's Urban Planning Law and the Act Concerning Establishment of Agricultural Promotion Areas. However, we submit that under conditions in which society matures and urban growth slows, it is important to fuse the urban and the rural, promote new regional development based on reinforcing partnerships between the two, and create frameworks enabling the maintenance of distinctive regions even after merging.

The thinking behind urban–rural fusion was set forth in Ebenezer Howard's *Garden Cities of To-Morrow* over 100 years ago (Howard 1902). He tried to create the ideal city through the "marriage of town and country." Since then, town and country planning, which plans urban and rural areas in an integrated manner, has established itself in Britain and other countries influenced by Howard. It would seem important in Japan as well to legislate town and country planning to deal with the new situation arising from rapid wide-area municipal mergers.

3.4 Conserving Landscapes and Ecological Networks

In the coming years as the population declines, we face the extremely serious problem of how to maintain regional vitality in places such as rural areas, where population decline and population aging are already marked. In such areas, we must foster a sense of value and pride in living there, not just deal with economic problems. In other words, a major challenge is how to create gratifying livelihoods based on the local natural environment and culture.

To contribute to that effort, the National Spatial Strategies, which were newly formulated after a fundamental review of the National Comprehensive Development Plan, advocate the "shaping of sound and fulfilling landscapes" (Ministry of Land, Infrastructure, Transport and Tourism 2007). Recently the word *keikan* ("landscape") has been frequently used since enactment of the Three Laws on Scenery and Greenery; however, the English loanword "landscape" embraces the concepts of view and scenery and shows a total image of a region formed by the relationship between people and nature.

In Europe, the European Landscape Convention has a framework that provides for the integrated implementation of each country's urban plans and landscape plans. Most important here is respecting local natural environments and cultures and pursuing distinctive regional development. New national spatial plans can incorporate the landscape concept, and although insufficient, this may be considered a measure of progress.

An important element supporting such landscapes is the "ecological network." If we systematically conserve and maintain the natural environments of ridgelines in mountainous and hilly regions and along rivers and coastlines, they will serve as the framework of a region's natural environment. They are also places for recreation and rest, and they help improve the quality of urban areas' landscapes and scenery. Therefore, reviving such ecological networks is important for regional development.

As shown in Fig. 3.2, the Japanese government has already taken the ecological network concept into consideration. It shows that in an urban area the remaining rivers and forests on the narrow terrace scarp lines are considered as core elements

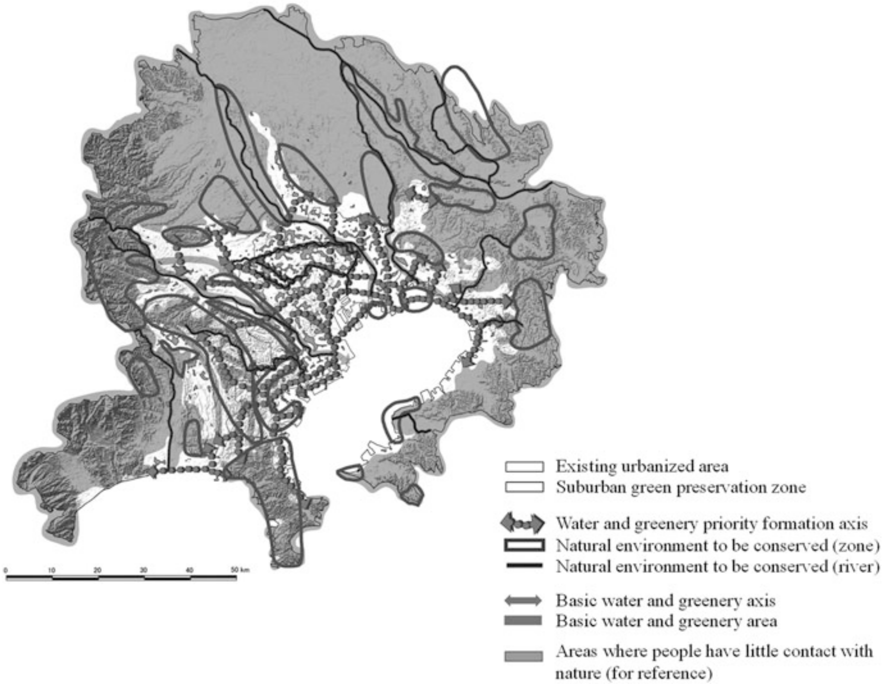

Fig. 3.2 Conceptual diagram of the Greater Tokyo ecological network (Council on Overall Examination of the Natural Environment 2004)

of the ecological network. It helps decision makers to identify which area should have priority to start ecosystem conservation and restoration using limited budgets.

In the years when urbanized areas were expanding owing to rapid population growth, reviving city ecological networks was nothing but a dream. But now, as Japan heads toward population decline and the shrinking of urbanized areas, it is easy to discuss which urbanized areas to keep and where the natural environment should be revived. We would say it is a good idea for those involved in urban planning to consider obtaining the participation of various actors to regain the natural environment as ecological networks.

In addition, in the Japanese archipelago we must keep natural disasters in mind. Nature in Japan is a blessing, but also a threat. As the Chuetsu earthquake showed, proper maintenance and management of farmland and forests helps reduce disaster damage. It is also important to build local communities (disaster subcultures) that can quickly respond to natural disasters. Additionally, the building of ecological networks must be linked to the building of regional structures that are resistant to natural disasters.

Also important are upstream–downstream links between urban and rural areas through watersheds. As noted previously, municipality mergers should be able to integrate regions and unify them from the perspective of community development.

That offers the additional promise of conferring greater resistance to natural disasters, and of building good landscapes and ecological networks. It is necessary to structure watershed environmental conservation plans with attention to the environmental conservation functions of farmland and forests.

3.5 Local Production for Local Consumption and Urban–Rural Interaction

One major problem when considering the sustainability of Japan's land and cities is the reality that Japan is too reliant on agriculture and forestry products from abroad. On a calorie basis, Japan's food self-sufficiency rate is a mere 39 %, which is the lowest among developed countries. At the same time, there are questions about this from the perspective of the burdens imposed on citizens' health and the environment by large imports of agricultural products from abroad. Regarding lumber as well, Japan's self-sufficiency rate is only 20 % even though two-thirds of Japan is forested.

To improve this situation, it is desirable to conceive urban and rural areas as an integrated whole, promote local production and local consumption of agriculture and forestry products, form biomass-based regional cycling zones, and use those zones to achieve urban–rural interaction. It is also desirable to build systems for a resource-circulating society based on biomass, in which biological waste produced in cities is returned to farmland or used for energy. Additionally, it is important to secure new people for continuing management of farmland and forests, and that will necessitate businesses promoting farming and forestry.

In big cities, it is important to be aware of the significance of the environmental conservation function of farmland and have an awareness of how farmland can serve as a venue for children's environmental education. It is also important to put effort into the production of fresh vegetables and other produce grown by people whom consumers actually know. In Tokyo also, with its 1 % food self-sufficiency rate, there is an awareness of the need to preserve Tokyo farmland, which supplies Tokyo residents with a fair portion of their farm and livestock products (Fig. 3.3). It is highly desirable to conserve urban agriculture by such motivated farmers in a planned manner (Tokyo Metropolitan Government 2008).

For achieving a resource-circulating society, the revised Basic Plan for Establishing a Recycling-Based Society proposes a new concept called "spheres of resource circulation." The idea is that resources confined within a certain locality are used cyclically to the greatest possible extent. Food and wood are resources that are easy to confine locally, while resources such as metals that cannot be confined require different thinking that sees them cycled more widely, which is more appropriate.

Of course, with resources such as rare metals, which are recovered in small quantities from large amounts of waste with advanced technology, it may

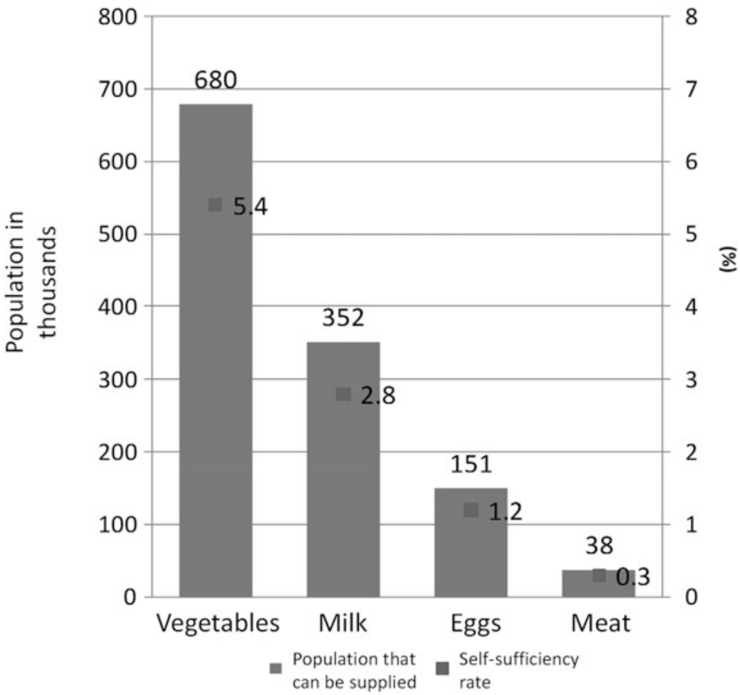

Fig. 3.3 Supply capacity of Tokyo's main farm and livestock products, in terms of population and self-sufficiency rate (according to the Tokyo Metropolitan Government, Bureau of Industrial and Labor Affairs 2005)

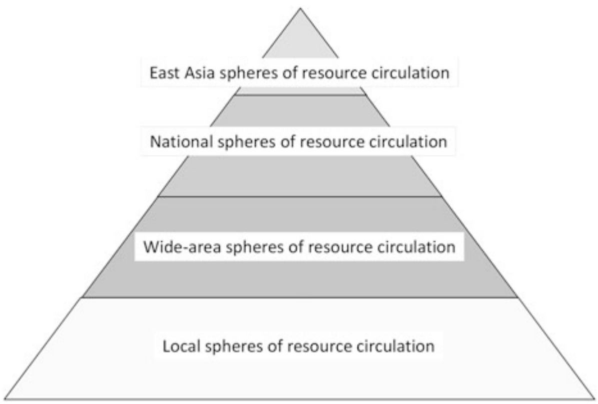

Fig. 3.4 Conceptual diagram of the East Asia hierarchical regional resource cycling zone

sometimes be desirable to have wide-area cycling throughout Japan, or international cycling on large scales such as East Asia. In that sense, it will be necessary to consider widening spheres of resource circulation depending on the nature of the resource (Fig. 3.4). People will have to analyze in detail the resource flows in cities and make decisions on where to set the boundaries of their local zones, and what they will leave to resource cycling zones outside their own.

3.6 Possibilities of Building Cyclical Societies Through Urban–Rural Fusion in West Java, Indonesia

The traditional land use system of rural areas in West Java, Indonesia, which is said to be sustainable, now faces collapse owing to factors such as rapid population growth and permeation of the commodity economy in conjunction with economic development in recent years, and the impacts of urbanization. Such changes also symbolize the transformation of traditional rural societies, which were the basis for self-sufficiency. From the perspective of material flow, it is thought that closed systems within comparatively small localities in traditional farming villages are changing into open systems that actively exchange material with the outside.

We therefore conducted a study of the artificial material flows arising in the course of agricultural activities and livelihoods in three West Java farming villages located at different elevations in the Cianjur–Cisokan watershed so as to sample different types of material flow according to landscape structure. The rural ecosystem in each village was divided into several components and material transfers between components due to human activities were estimated, mainly by interview, and converted to nitrogen. The study found that all three villages have open-system material flows dependent on the outside (Fig. 3.5), thereby making it difficult, in view of both the supply and consumption amounts of local resources, to form material cycling systems that are closed at the village level. Recent years have brought changes in economic development and spatially expanded human activities and the development of shipping and transportation. In consideration of these, rebuilding cyclical societies based on biological resources without lowering agricultural production or living standards would seem to necessitate examining the problem on a spatial scale larger than that of a traditional rural society. There are many possible arguments on the matter of how far to expand the spatial scale for consideration, but here we chose the watershed, which enables one to consider the problem using, as the base unit, the cycling of material in natural ecosystems via water flows. We used the following calculations to examine the possibility of building cyclical societies based on biological resource cycling that is closed at the watershed level.

Our investigation covered 63 cities, towns, and villages in the Cianjur–Cisokan watershed, an area with a population of about 460,000 and a total size of about 25,000 ha. This area has not only farming villages but also the mid-sized city of Cianjur, which has a population of about 140,000. The biological resources treated were food, fertilizer, and livestock feed. To examine each, we used statistical data and land use maps to calculate the balances between the potential supply amount and consumption amount. With respect to food, we investigated rice and found that it is possible to produce enough rice for 490,000 people within the area, thereby

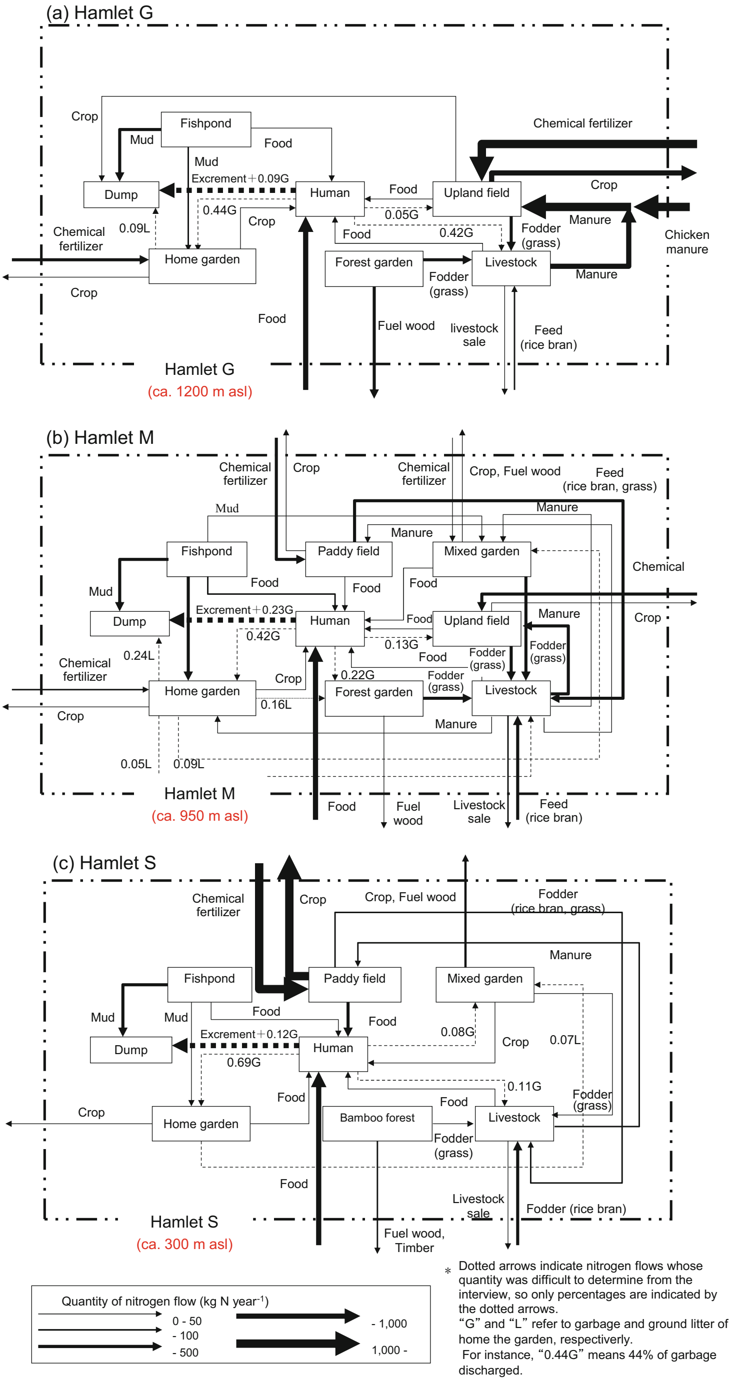

Fig. 3.5 Nitrogen flows in West Java farming villages (After Harashina et al. 2003)

allowing self-sufficiency. We calculated fertilizer on a nitrogen basis and determined that even if all livestock waste in the area is used as organic fertilizer, it can supply only up to 18 % of the nitrogen currently applied to farmland there. However, we estimated that up to 46 % could be supplied if kitchen waste and human waste were also used. In this case, including urban areas was very effective. For livestock feed, calculations on rice bran, which is the feed most generally available for purchase, found that it would be sufficient for village chickens, but we estimated that bran could supply only up to 57 % of consumption when the broilers and laying hens of poultry farms are included.

The study therefore found that it would be hard to establish an independent closed system with the material flow at the village level, but that if the spatial scale is expanded to the watershed level, the area could be self-sufficient to a certain extent if one excludes such facilities as poultry farms. Although calculations at the watershed level just compare the balance between the potential supply amount and consumption amount, this does offer suggestions for establishing a resource-circulating society in that it showed the possibility of building an independent system at the watershed level. The future challenge will be how to optimize allocation and distribution of biological resources and build sustainable regional ecosystems, including social systems and other components, based on biological resource cycles.

3.7 Asian Commonality and Sustainable Regional Development

East Asia and Southeast Asia share the "irrigated rice paddy culture." Rice paddies are an intensive use of land, and the preparation of dry fields and land development in conjunction with the construction of roads and water channels are progressing. Thus, paddy fields can be easily converted into urban land just by filling them with soil, and in the megacities that have grown on the deltas in East and Southeast Asia, urban sprawl advances readily.

It is necessary to take advantage of the circumstances of having such shared characteristics, and the mixed presence of cities and farming areas on a microscale, to consider measures for urban–rural coexistence. In January 2008, China enacted the Urban and Rural Planning Law. It is desirable to reinforce Japan–China academic collaboration while closely watching the trend under this law.

From now on, Asia, including Japan, should replace the planning doctrine followed so far, which distinguishes sharply between urban and rural areas, and should reassess planning systems in an effort to build desirable relationships by means of urban–rural partnerships. Cities that are a fusion of the urban and the rural are not homogeneous, but instead are inherently diverse. For the additional purpose of creating distinctive cities with diversity that can be held up to the world with pride, “sustainable regional development that fuses the urban and the rural” should be promoted.

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Chapter 4
Sustainable Urban Structure and Transport Policy in the Metropolitan Region

Noboru Harata

Abstract This chapter discusses the needs and requirements of a sustainable urban structure as a tool in order to provide sustainable mobility in a metropolitan region. First, the objectives and effective tolls of a sustainable transport strategy are discussed. As an objective, sustainable mobility is defined to satisfy the balance among different policy objectives. As an effective tool of transport planning, a sustainable urban structure is needed to reduce travel needs with a supportive legal framework. In particular, to satisfy the social dimension of sustainable mobility, a sustainable urban structure is needed to alleviate social exclusion and the mobility gap between people who can use cars and those who cannot. Second, the essential elements of a sustainable urban structure are discussed. In a metropolitan region, high-density development is needed to accommodate a high concentration of activities. Also, a hierarchal center structure with a public transport axis can be observed in many proposals such as the Finger Plan (Copenhagen), 2040 Growth Concept (Portland), and "Dango to Kushi" (Toyama). Some of them have already shown success in providing sustainable mobility. Finally, it is recommended to use mobility management for mobility choice and space–time accessibility analysis of major activity centers to support a sustainable urban structure.

Keywords Accessibility • Sustainable mobility • Urban density • Urban structure • Public transport axis

4.1 Introduction

In a metropolitan region where many different activities are located separately, it is difficult for people to live without a good transport service. For example, good transport between one's residence, work, and leisure is an essential element to support daily urban life. From a probe person trail in an actual city, it is possible to imagine how people use different facilities in different locations and with different

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timing. In fact, to support daily life, education, health, welfare, sports, culture, suppliers, and municipal guard should be accessible for all people. The fundamental role of transport planning is to provide a transport service to facilities that people want to access to satisfy daily needs of life.

In many metropolitan regions, there is a mobility gap between people who can use a car and those who cannot. Without a car, many people have difficulty in accessing shopping facilities, hospitals, and city centers. They are excluded from society due to the lack of a transport service. Recently, short-term measures such as travel demand management (TDM) and technology measures such as eco-cars have been recommended to alleviate transport problems such as air pollution and GHGs. However, they have no effects on social exclusion problems. The social cost of a car-dependent society is widely recognized, including not only traffic congestion, but also destruction of the natural environment, wastage of energy, and global warming. Growth management is essential to provide sustainable mobility to satisfy economic needs within tolerable environmental impacts and social impacts, including the mobility gap problem. As a promising tool of growth management, this chapter discusses needs and requirements for a sustainable urban structure.

4.2 Sustainable Transport Strategy

Sustainability is a key concept to guide transport policy and planning. This section provides a basic definition for a sustainable transport strategy to provide a transport service to support daily life. The objectives and effective tools of a sustainable transport strategy are discussed.

4.2.1 Objectives; Sustainable Mobility

Sustainable mobility is the ability to meet society's need to move freely, gain access, communicate, trade, and establish relationships without sacrificing other essential human or ecological values, today or in the future (WBCSD 2001).

The purpose of assessing sustainability is to check the balance among different policy objectives and to prevent intolerable impacts on the environment and society. Then, it is recommended to assess not only needs but also important aspects of impacts and feasibility. The policy objectives should cover needs (efficiency, safety, security, and robustness in facing natural disasters), and impacts (energy and the environment, social aspects), and feasibility (organization, finance).

These objectives directly relate the social costs of a car-dependent society, such as economic costs (traffic congestion, traffic accidents, inefficient land use), environmental costs (GWGs, air pollution, noise), and society costs (social exclusion, financial failure, decline of the center). Therefore, TDM and eco-cars are widely used to reduce the social costs. However, in a long-term strategy to alleviate social

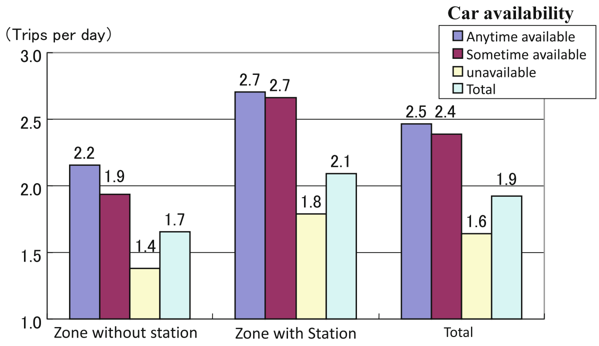

Fig. 4.1 Mobility gap of the elderly in Tokyo

exclusion and financial failure of local government, policies and measures toward sustainable urban structure are needed. For example, even in the Tokyo metropolitan region, which is famous for its excellent railway system, there are mobility gap problems for elderly people (Fig. 4.1).

4.2.2 Effective Tool; Sustainable Urban Structure

Figure 4.2 shows a toolbox for transportation planning (Harata et al. 2001). Historically, an anticlockwise trail to TDM can be found in this figure. In the 1950s, capacity expansion was proposed to catch up with future travel demand. In the 1970s when transport planners experienced difficulty in realizing the transport master plan, transport system management and short-term supply-side measures were introduced. After the 1990s when environmental objectives and social objectives were reevaluated, TDM was introduced and developed. Now growth management is needed to manage developments for future network capacity.

In order to create sustainable mobility in the real world, it is inevitable to change the direction of transport planning to minimize the social cost of the car-oriented society. In fact, the package plan for land use and the transport network can reduce car traffic and related social costs while maintaining the level of activities, if the connection of activity centers and public transport is considered carefully. The package plan will realize a sustainable urban structure where it is possible to provide a transport service to support daily life of both people who can use a car and people who cannot.

Additionally, communication measures will be powerful to change mobility bundle choices such as residential locations and environmentally friendly car ownership, if they can inform the merits and demerits of the change effectively.

Lastly, it would be better to refer the Organizational and Institutional problem, because there are many unrealized plans due to the lack of an implementing body and/or a financial system for the plan.

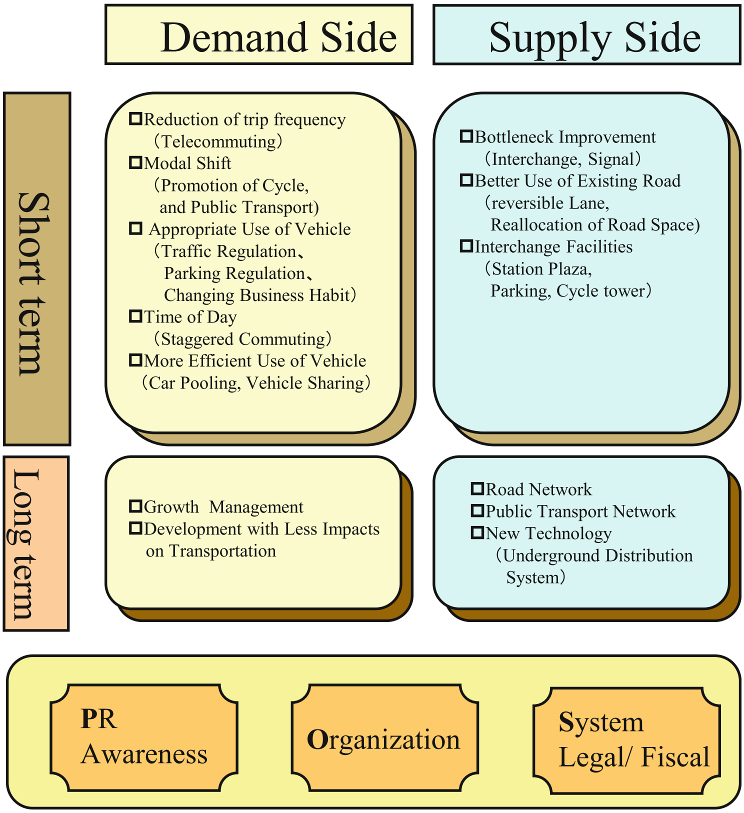

Fig. 4.2 A toolbox for transport planning

4.3 Sustainable Urban Structure

4.3.1 Urban Density and Social Cost of Travel

From the 1960s, many researchers have been pointed out that high density cannot allow car dependence (HMSO 1963; Bendtshen 1961; Kitamura 2003). The famous Buchanan report in 1963 stated that at the saturated level of car ownership, it is difficult to provide a sufficient road network for car use in a city in terms of physical and financial capacity (HMSO 1963). If a high-density city wants to have a greater population, it is reasonable to coordinate the transport system and land use in both density and quality.

As has been shown many times, Asian high-density cities look sustainable because the per capita burden of environmental impacts in Asia is much lower than that in America, Canada, and Europe (Newman and Kenworthy 1999; Barter 2000).

Based on the international comparison, UITP pointed out that per passenger × kilometer transported, public transport is more economical than the car once density is higher than 20 inhabitants par hectare (UITP 2002). They calculated the social costs to the community and showed an 8 % difference in the social cost share of GDP between cities with more than 50 inhabitants per hectare and those with fewer than 10 inhabitants per hectare.

4.3.2 Public Transport Axis

The transport corridor is one of the basic concepts in the urban transport plan and it is possible to see a multimodal transport corridor plan in the Hamburg Transport Plan 1965 (Harata et al. 2008). It is an integrated transport network with a railway axis. The railway frequency increases toward the city center. Some railway stations are transfer points with commercial facilities where feeder bus and park-and-ride facilities are well connected. From everywhere in the corridor, it is possible to get to the city center by using a combination of the railway and access modes including feeder bus and park-and-ride facilities, and on foot.

In a metropolitan region with a multicenter structure, public transport is used to provide a transport service between them. For example, the nodal city concept is proposed to change the low-density and car-oriented urban structures found in the USA, Canada, and Austria into more sustainable ones (Newman and Kenworthy 1999).

The most famous example is the 2040 Growth Concept of Portland, constructed in 1990. They compared alternative growth concepts and showed the advantages of the “urban growth boundary fixed, grow up” concept in terms of modal share, public transport passengers, VMT/capita and NOx emissions per day (Metro 1997). Also, postevaluation after 14 years of implementation showed success in increasing the modal split of public transportation and reducing VMT/capita from 1996 to 2003, and failure in reducing traffic congestion and the absolute level of VMT/capita from 1990 to 2003 (Adler and Dill 2004).

After 1945, Japan enjoyed population growth and urban expansion resulting in lower-density cities and smaller centers. Many cities become car-oriented societies and difficult places to live for people who could not use a car. With expectations of a population decrease and greater numbers of elderly people in the future, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) has recently discussed desirable urban structures. The major problems of the car-oriented urban structure are summarized as (1) the difficulty of senior citizen daily movement; (2) further decline of the downtown area; (3) increasing environmental impacts; and (4) financial pressure on the city government. The proposed “intensive” urban structure is to make the density of urban centers such as the city center and railway station–surrounding areas higher by accumulating urban functions and to connect urban centers and the other areas by public transport. This will secure sustainable developments and improve easiness for many people to live in the metropolitan area.

The most famous example is the "compact city with a public transport axis" of Toyama. The urban master plan defines a multicenter urban structure connected by a public transport axis. The plan has a target to increase the percentage of citizens who live in the accessible area to convenient public transport from the current level of 30 to 40 % within 20 years. The plan includes financial assistance to stimulate house relocation to the accessible area for convenient public transport and new railway stations to make new accessible areas.

The new LRT port line, opened in 2006, has proved its effects on new apartment development and land values increasing alongside the line and has also made elderly people more active to go to the city center more frequently than before. Many improvements have been made; headway has improved from 30–60 min to 15 min, the last train from 2100 to 2300 hours, and the number of stations from 9 to 13. With well-designed low/flat floor LRVs, this has created a new people-friendly image of the port line.

Historically, as a root of the "compact city with a public transport axis", the Finger Plan of Copenhagen in 1947 had a clear principle to live no more than 1 km away from an S-train and green areas (Andersen and Jorgensen 1995). This principle was still alive in the Greater Copenhagen Regional Plan in 2007. Any regional plan should pay attention to accessibility of both facilities to support daily life and green and natural areas to support human well-being.

4.3.3 *Mobility Management (MM)*

In order to realize a compact city with a public transport axis, it is highly recommended to introduce effective mobility management of mobility choices for locations, housing, automobile ownership, and modes for work.

MM is widely used to give people information about the impacts of car use and alternative ways of travel on social costs and health effects and to make them think about changes in travel behavior. It is also possible to give people information about the impacts of different mobility choices and make them select choices with less environmental/social impacts.

The potential of MM for location choices is high. It has been estimated that a 30 % reduction in CO_2 emissions can be achieved by minimizing commuting distances in Tokyo, Utsunomiya, and Okinawa (Maruyama and Harata 2005). Also, the housing demand survey of the MLIT has revealed that within 5 years from 1999 to 2003, about 20 % of house-owning households changed their residential location in Japan. The percentage was about 40 % for house-renting households and higher in households with younger heads. There are many opportunities to use MM for making residential choices.

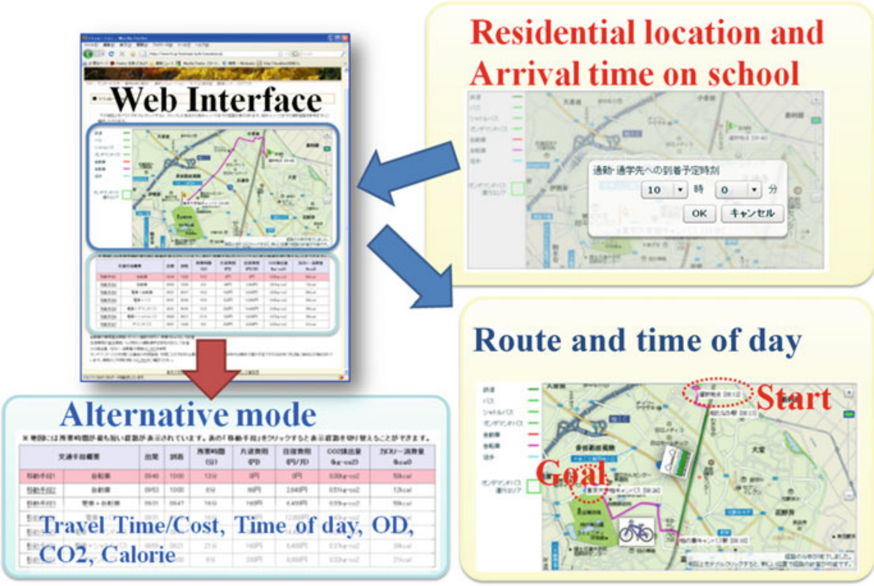

Fig. 4.3 A communication website on residential choice and commuting modes

For example, Fig. 4.3 is a web-page image of a commuting game to select a combination of commuting modes and residential locations with different travel times/costs, CO_2 emissions, and calorie expenditures around the Kashiwa Campus of the University of Tokyo. It has been shown to be effective in changing new-comers' residential choices to be much closer to the campus. Every year, the campus welcomes about 700 newcomers and they have a chance to change their residential location on seeing information on the communication website.

For elderly people, space/time accessibility of hospitals is a key issue in daily life. It is easy to show a big difference in space/time accessibility in terms of activity duration time between car users and bus users (Fig. 4.4). The percentage of elderly people who can stay at the hospital for more than two hours and see a doctor becomes lower when a car is not available to them (Izumiyama et al. 2007). It is possible to give elderly people information about space/time accessibility of hos-pitals as important items in their residential location choice. Also, the information is vital for the location choice of the hospital.

Generally, the mobility choice of job–house locations gives the basic framework of daily life and the time budget available for activities. It is recommended to design a communication website that gives a visual presentation of the daily time budget of different job–housing location choices.

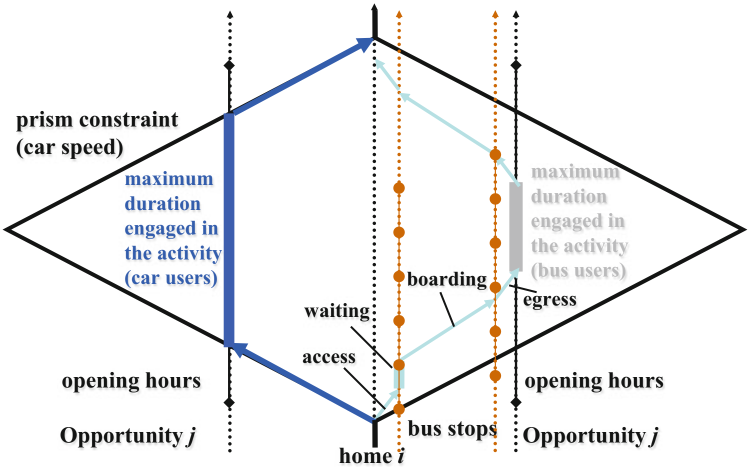

Fig. 4.4 Space–time accessibility by car (*left*) and bus (*right*)

4.4 Conclusions

This chapter discusses needs and requirements for a sustainable urban structure as a tool in order to provide sustainable mobility in metropolitan regions. First, the objectives and effective tolls of a sustainable transport strategy are discussed. As objectives, sustainable mobility is defined to satisfy the balance among different policy objectives and should cover needs, impacts and feasibility. As an effective tool for transport planning, a sustainable urban structure is needed to reduce social costs of the car society. In particular, to satisfy the social dimension of sustainable mobility, a sustainable urban structure is needed to alleviate social exclusion and the mobility gap between people who can use a car and people who cannot.

Second, the essential elements of sustainable urban structures are discussed. In metropolitan regions, high-density development is needed to accommodate a high concentration of activities. Also, a hierarchal center structure with a public transport axis can be observed in many proposals such as the Finger Plan (Copenhagen), 2040 Growth Concept (Portland), and “Dango to Kushi” (Toyama). Some of them have already shown success in providing sustainable mobility.

It is also recommended to use mobility management with mobility choice and space–time accessibility analysis of major activity centers to support a sustainable urban structure. It has been shown that the potential of MM for location choices is high and there are many chances for MM to improve location choices.

A sustainable urban structure is now widely recognized as an important tool for a sustainable transport strategy and some cities have already shown these effects. It is highly recommended to sophisticate the evaluation method to check whether the proposed urban structure can satisfy the fundamental role of transport and daily activities.

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Chapter 5
Creation of Collaborative Networks at the City-Regional Level: Two Innovative Cases in Japan

Tetsuo Kidokoro

Abstract City regions are regarded as the networks of cities, towns, and villages that are closely linked to each other. Spatially, city regions can be understood as being composed of three dimensions: an urban service network, eco-cultural network, and regional innovation network. The polycentric network structure of city-regional space proposes an interactive functional relationship in which cities, towns, and villages provide their own unique services for each other. Against such a background, this chapter aims to firstly discuss the spatial concept of sustainable city regions, secondly illustrate the evolution of collaborative networks in polycentric city regions through examination of two Japanese cases, and finally address the importance of frame making, setting up a forum, and forming a strong-tie community and weak-tie network in order to establish effective polycentric city-regional governance.

Keywords Regional governance • City-region • Urban–rural linkage • Regional innovation network

5.1 Introduction

When the city-regional space is examined from the viewpoint of functional linkages of urban and rural areas, mainstream thinking on the sustainable form is the need for formation of a polycentric network structure. In order to establish sustainable city regions, we should respond to new issues such as regional vitalization under globalization, creation of a low-carbon society and reformation of life services for an aged society. All these issues cannot be solved by policies focused only on the local scale. Regional-scale governance will definitely be needed to tackle those issues. The first step to establish such regional-scale governance will be to create

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collaborative networks among various stakeholders in the region. Against such a background, this chapter aims to firstly discuss the spatial concept of sustainable city regions and secondly illustrate the process of the evolution of collaborative networks at the city-regional governance level through examination of two innovative Japanese cases.

5.2 Spatial Concept of Sustainable City Regions

5.2.1 Three Dimensions of City-Regional Space

In this chapter, regions are regarded as the networks of cities, towns, and villages that are closely linked to each other, and they are called city regions. Spatially, city regions can be understood as being composed of three dimensions: an urban service network, eco-cultural network, and regional innovation network (Fig. 5.1).

The urban service network means the network of life-services jobs, including education, health, cultural services, and commercial services.

The eco-cultural network is conceptually understood as the network of local culture and lifestyle fostered by local ecosystem services. The reason why it is understood as a network is that local culture and lifestyle is created through interactions with nature. River basins are the most typical units of local ecosystems and have worked as traditional communication networks, which have been the basis of local cultural interaction. Urban–rural linkage is understood as a typical social and cultural interaction based on ecosystem services at the regional level.

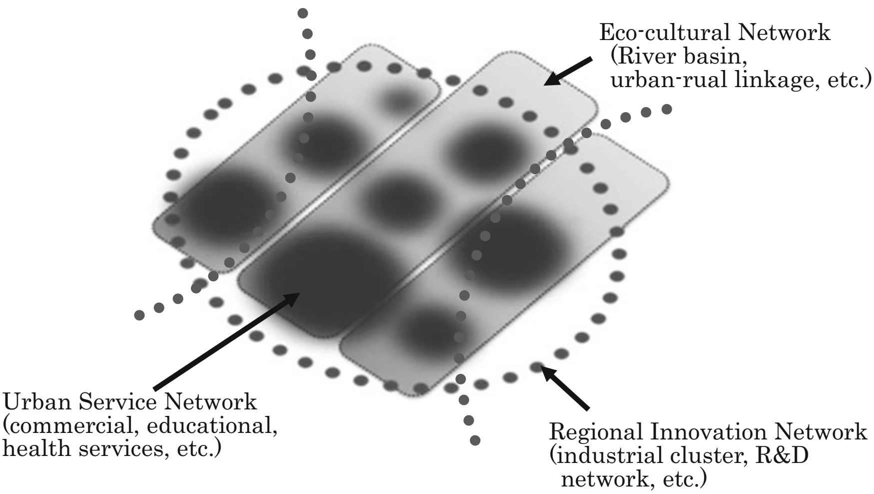


Fig. 5.1 Three dimensions of city regions

Under the knowledge economy, it is often pointed out that face-to-face communication is essential to create new ideas and thus both formal and informal networks such as exchange of knowledge through outsourcing, seminars, education and training, informal gathering in the town, and spillover of new inventions in the region through competitive behavior among firms, as well as a social and cultural atmosphere to favor inventive collaboration. The regional innovation network means such regional space where close networks among various economic players—including firms, research institutions, and government agencies—exist in geographical proximity.

5.2.1.1 Polycentric Network Structure

When the city-regional space is examined from the viewpoint of functional linkages of urban and rural areas, mainstream thinking on the sustainable form is the need for formation of a polycentric network structure (Hall and Pain 2006: Kidokoro et al. 2008). Conventional urban–rural functional linkages have been conceptualized as the hierarchical structure of services such as educational services, medical services, and commercial services—that is, regional core cities as the primary centers, small cities and towns as secondary or tertiary centers, and rural areas as their hinterlands. On the other hand, the polycentric network structure proposes an interactive functional relationship in which core cities, towns, and villages provide their own unique services for each other (Fig. 5.2). Villages can promote a wide range of services for urban people, such as agricultural tourism.

Spatially, the polycentric structure means the space where urban space and agricultural space, as well as the ecological network, are interwoven with each

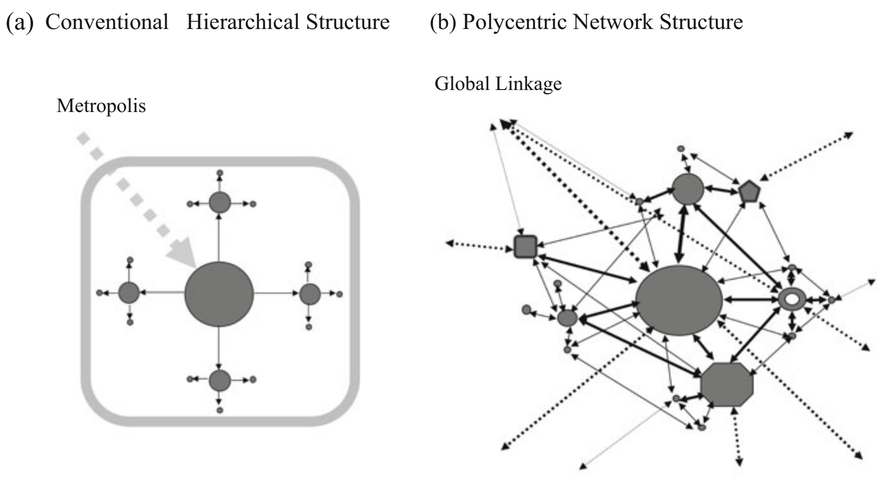


Fig. 5.2 Polycentric network structure of the city region

other and peripheral areas are covered by the natural environment in a one-day trip distance (Forman 2008). Functionally, the polycentric space will facilitate the innovative environment of a face-to-face relationship between creative people in different areas who live in their unique and diverse environments in various cities, towns, and village in the networked region.

5.3 Process of the Evolution of Collaborative Networks in the Polycentric City Region

Collaborative networks among various stakeholders will be the first step to establish polycentric city-regional governance where a unitary regional government will not be an solution for regional governance in nature. If so, how can such collaborative networks be created in correspondence with the polycentric functional structure as well as the political structure of city regions? This section examines this question through two innovative cases in Japan. One is the case of the emergence of a regional innovation network in Nagano Prefecture in Japan. The other is the case of the evolution of urban–rural linkage–based participatory governance in Uchiko Town in Japan.

In order to examine the process of evolution of collaborative networks, four analytical concepts are used here: (1) the *community*, which means a group of people who share a common sense of values; (2) the *forum*, where various stakeholders meet; (3) the *network*, which means the collaborative relationship among various stakeholders; and (4) the *frame*, which provides a common frame of thinking for various stakeholders (Healey 1997).

5.3.1 Case of Nagano Prefecture, Japan: Emergence of a Regional Innovation Network

Nagano Prefecture has polycentric geographical characteristics where medium-sized cities such as Nagano City (380,000 pop. approx.), the Suwa area composed of six municipalities (210,000 pop. approx.), and Matsumoto City (230,000 pop. approx.) exist within about a one-hour distance, together with small towns and villages. The Chuo and Nagano Expressways and the JR Chuo and Shin-etsu railway line function as the spine of the region, which also connect these cities to Tokyo.

From the viewpoint of the industrial structure, Nagano Prefecture functions as a supply center for the huge market of the Tokyo metropolitan areas. In particular, it is generally characterized by the concentration of small and medium enterprises (SMEs), which supply various parts in the field of precision machinery and electronics to the client large-scale companies located in the Tokyo metropolitan areas. SMEs have often worked as subcontractors for specific large-scale companies and thus there is no incentive for SMEs to collaborate with each other. Yet, large-scale companies have increasingly dispersed their global production systems since the 1990s, thus SMEs have been requested to be self-dependent and not to rely on specific clients. As a result, SMEs have been pressured to develop their own unique products and do marketing by themselves. The size of each SME is not enough to do so, thus collaboration among SMEs is needed.

In order to overcome the adverse conditions of the region, the Ministry of Trade and Industry of the National Government (MITI) identified this region as the Chuo Expressway Industry Cluster area under their industrial cluster policy and has provided assistance to create collaborative linkages among the private sector, research institutions, and local government. There is no specific law to base the industrial cluster policy of MITI on, and thus no legal, top-down arrangements exist. Yet, recently, collaboration among SMEs possessing different competencies has been successfully generated in this region. In this sense, the case of Nagano Prefecture provides quite an interesting case to look into the process of the evolution of informal economic regional governance.

5.3.1.1 Evolution of Community Among Entrepreneurs

Given these situations, the Suwa Regional Center of the Nagano Techno Foundation (NTF), founded by the Nagano Prefecture Government, has played an important role as a catalyst and created various collaborative groups participated in not only by SMEs in this region but also local universities, the research institution of the prefecture government, and city governments, as well as the regional office of MITI. It is noted that opinion leaders among the entrepreneurs in this region participate in those groups in an overlapping way and, through daily communication in various groups, common understanding and a sense of economic community has been generated among the leaders of the entrepreneurs.

5.3.1.2 Creation of a Forum for SMEs

The Suwa Area Industrial Messe (SAIM) started in 2002 voluntarily and has been held every year since then. The objective of SAIM is to let SMEs in the region get together and do marketing as an event. It is reported that through participation in SAIM, many SMEs get to know each other and this has nurtured an atmosphere of collaboration. SAIM has played an important role for the community created by the leaders to be successfully enlarged into one that includes other general business people in this region.

5.3.1.3 Formation of a Network with Research Institutions

The formation of a strong-tie community is seen in the Suwa area, but participants in other areas of Nagano Prefecture are rather limited. On the other hand, a network among stakeholders, which represents weak and flexible ties, has been formed in wider areas covering the whole region and beyond through intermediary support from local and prefecture government support agencies such as NTF. In particular, the collaborations among research institutions, SMEs, and the government agencies are also active in this region. Universities located in this region—such as Shinshu University in Nagano City, Yamanashi University in Kofu City, and Suwa University of Tokyo Science and Technology in the Suwa area—have positively collaborated with SMEs in the region, and a wider network among research institutions and SMEs as well as government agencies is emerging.

5.3.1.4 Role of Frame Making

It is clearly pointed out that the idea of an industrial cluster from the regional office of MITI played a role in frame setting and helped to create a common understanding about the future of the region. The idea of the industrial cluster itself does not regulate the direction of future economic development of the region, yet rough demarcations of the areas that have common economic environments and activities to try to link stakeholders in those areas seem to foster consensus building through various communications centered on common topics based on the agenda of the industrial cluster policy. It can be said that the highly flexible nature of the industrial cluster policy advocated by the regional office of MITI in Nagano Prefecture could successfully link the various bottom-up activities for collaboration among private firms, local government, and research institutions, and fostered consensus building among them through its ability to evoke the image of the interrelated region.

5.3.2 Case of Uchiko Town, Japan: Evolution of Urban–Rural Linkage–Based Participatory Governance

Uchiko Town (population: 19,885 in 2007) is located 30 km to the southwest of Matsuyama City in Shikoku Island, which once flourished as a small market town and thus its approximately 150-year-old historic market townscape remained. Uchiko Town started efforts for the conservation of its historic townscape in 1976 and it was designated as an Important Historic Townscape Area under the Cultural Heritage Law in 1982. In 1985 the historic timber-made theater Uchiko-za was renovated and since then many cultural events have been performed, including top-class performing arts, such as *Kabuki*, the traditional Japanese Opera. After these efforts, today, about 850,000 visitors visit Uchiko Town annually. Importantly, the Uchiko Town government successfully linked the revitalization of the town center with the revitalization of villages as well, based on participatory development activities. The case of Uchiko Town is a good example to observe the evolution of participatory governance based on polycentric urban–rural linkage.

5.3.2.1 Formation of the Community of Village Women

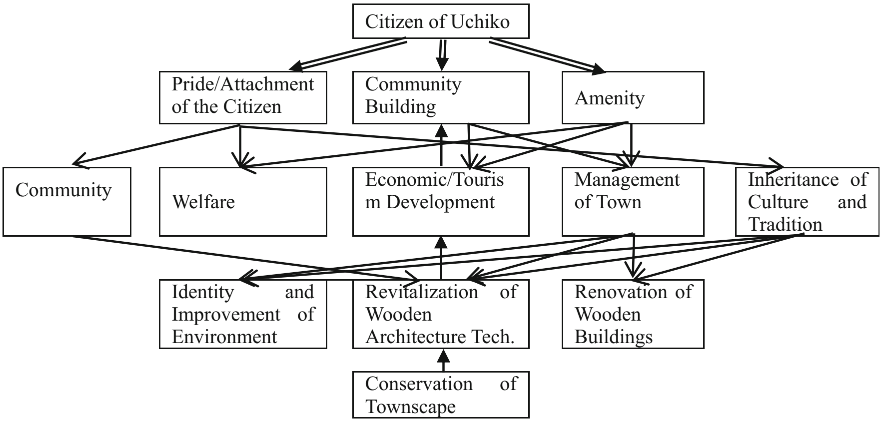
The opening of Uchiko Fresh Park Karari in 1995, a direct-sale shop selling agricultural products at the edge of the traditional town center, highlights the success of urban–rural linkage in Uchiko Town. In rural areas, traditional community organizations led by older men are strong, and young people, especially young women, often find it difficult to start new enterprises. In Uchiko Town, this was also the case in the beginning, but gradually their activities were admitted as a new approach for the revitalization of villages. The town government has facilitated this change of perception among the villagers by providing moral as well as financial support to the group of young village women.

During 1993 and 1994 the town government started running workshops with villagers, which took place as many as 50 times. Through the series of workshops, many villagers—in particular, women—formed a group for direct sale of agricultural products. These workshops organized by the town government are understood as having operated as a forum, which connected women who had not been organized as a business community, though they have close ties in daily life activities.

A normal sale's route through the agricultural cooperative is rather under the control of household heads who are normally men. Thus women are more positive about alternative routes of sale and they tried to do this through participation in this group. Uchiko Fresh Park Karari was established through the partnership of the town government and the group of villagers who participate in direct-sale activities: half of the capital (20 million yen in total) was paid by the town government and the other half was collected from the participants. The operation of direct-sale activities is managed by the group of participating villagers and not by the town government, which is regarded as one of the important factors in the success of these activities.

5.3.2.2 Making Networks of Town Centers and Villages

The unique feature of the case of Uchiko Town is that the conservation of the historic town center and its revitalization movement through tourism development have been closely interconnected with the revitalization efforts of surrounding villages. One of those efforts is the conservation of the unique rural landscape, which started in 1987, such as the conservation of a rice terrace and a wooden bridge with a roof. A farm-stay facility, the Ishidatami Inn, was opened by a group of young village women.



Source: Adapted from the material of the Uchiko Town Government

Fig. 5.3 Concept of *Machizukuri* in Uchiko Town

5.3.2.3 Participatory Governance

It is noted that tourism development is not the objective per se in Uchiko Town. The Uchiko Town government emphasizes the importance of fostering the pride and attachment of the citizens of the town as well as increasing amenity through the movement for conservation of the townscape (Fig. 5.3). This concept of *Machizukuri* (participatory town making) is successfully working as the guiding framework and has facilitated the people's collaboration with the town government.

5.4 Conclusion

This chapter has firstly explored the spatial characteristics of sustainable city regions and secondly examined the process of the formation of collaborative networks among stakeholders, which can become the basis of polycentric-type regional governance, through two Japanese cases. In order to establish city-regional policies, it is essential that city-regional governance is formed. Conventionally, the creation of unitary regional governments or inter-municipal associations whose councils are directly elected is considered to be the most appropriate model of regional governance. Yet, in the real world, there should be various styles of institutional setups in response to the specific social and political conditions of the city regions in consideration—in particular, in the case of polycentric city regions. This will allow polycentric network-type governance in correspondence with the polycentric functional structure of city regions, in which establishing collaborative networks among various stakeholders will be the first step for the formation of local and regional governance. The two Japanese cases discussed in this chapter reveal that frame making, setting up a forum, and forming a strong-tie community, as well as a weak-tie network, are the critical steps for collaborative networks to be created.

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Part II
Diagnosing Urban Regions: Social and Environmental Consequences of Urbanization

Chapter 6
Features of Urbanization and Changes in the Thermal Environment in Jakarta, Indonesia

Akinobu Murakami, Shinji Kurihara, Koji Harashina, and Alinda M. Zain

Abstract Asian megacities have experienced rapid population growth and continue to grow, causing serious environmental problems. The characteristics of urbanization in these areas differ from those experienced during the growth of cities in Western countries. It is perilous to consider an environmental planning system only from the experience of a highly developed country, since the underlying processes in developed countries often differ from those in developing countries. In order to deal with urbanization and environmental problems caused by urbanization in Asian megacities—adding to the interactions between humans and the natural environment—what environmental functions the landscape elements exhibit, how they connect with each other, and how the relationships between them change in the course of urbanization must be understood. This study describes landscape changes and processes that occurred in the urban fringe of Jakarta, and examines the environmental impacts of the changes in urban climate through numerical simulation analyses and field surveys. It then discusses how to guide urbanization along a more sustainable trajectory in terms of the future landscape structure and human behavior.

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Keywords Urban sprawl • Heat island • Thermal comfort • Numerical simulation

6.1 Introduction

Asian megacities have undergone rapid population growth in recent decades, and this growth is increasing. The explosive population growth has resulted in serious environmental problems, including air and water pollution and lack of adequate infrastructure. Since the features of urbanization in this region differ from the patterns of city growth experienced in Western countries, it is inappropriate to consider environmental planning systems only in terms of the experience of such highly developed nations. Gottmann (1957) describes how Western urbanization caused a huge migration of rural populations to the cities, which evolved from being initial population centers to major cities before developing into megalopolises. Most megacities in Asia have undergone a similar development. Rapid urbanization in Asia during the late twentieth century has, however, exhibited a different transaction from that in Western countries. The major difference is that urbanization in Asia has taken place in already densely populated rural regions adjacent to large cities. Instead of a huge rural-to-urban migration, Asian urbanization has been characterized by the economic transformation of heavily populated areas from agricultural to nonagricultural activities (Sui and Zeng 2001).

This urbanization process in Asia has also contributed to the emergence of a unique landscape that is characterized by a chaotic mixture of urban and rural land use. McGee (1991) defines areas in Indonesia with such mixed land use as *desakota*, an Indonesian term that expresses the mixture of country (*desa*) and city (*kota*) features. The desakota landscape is a type of landscape that characterizes many Asian cities (Takeuchi 1998).

Although the features of the desakota landscape differ from those of typical urban and suburban landscape in Western countries, the fundamental propositions hold. The environmental elements are associated with the dynamics of the landscape structures. And changes in the elements or the relationships between the elements caused by urbanization may lead to environmental degradation. Water flow, for example, is ever changing. When the ground surface and permeability in one place within a watershed are changed in the process of urbanization, it will influence floodplain boundaries and the shape of stream beds in other places. From the viewpoint of hydrological processes, the water flow system of the region consists not only of channels, but also all the surfaces and water reservoirs within a watershed, including roofs of buildings, roads, gardens, forests, pavements, and crop lands. Each roof, garden, crop land area, road, and pavement, therefore, counts. Land use conversion from crop land to impermeable built-up land in the process of urbanization may cause severe flooding in other places in the same watershed. What environmental functions the elements exhibit, how they connect with each other, and how the relationships between them change in the course of urbanization must be understood. The same holds true for other environmental issues. Human activities interact with and influence natural processes to create the urban climate, soils, the plant community, and flows of energy and materials. Not only conditions and entities, but also changes and processes, therefore, must be focused on.

Adding to changes and processes, human behavior is another key for the future sound environment. While human activities influence the environment, environmental changes modify human behavior. To establish sound landscape planning, it is necessary to understand the characteristics of the desakota landscape and their changes in terms of the dynamics of the landscape structures, including human behavior related to the environment.

This study presented in this chapter describes landscape changes and processes that have occurred in the urban fringe of Jakarta, and it examines the environmental impacts of the changes in the urban climate through numerical simulation analyses and field surveys. It then discusses how to guide urbanization along a more sustainable trajectory in terms of the future landscape structure and human behavior.

6.2 Urbanization in Jakarta

The city of Jakarta, or Daerah Khusus Ibukota (DKI) Jakarta, is the capital of Indonesia. Jakarta lies in a lowland area on the northern coast of the western part of Java (Fig. 6.1). The city occupies an area of 640 km^2, or 0.03 % of the national land area. Jakarta has a flat terrain, and the land gradually rises 5–50 m above the mean sea level. Jabodetabek is the official name of the metropolitan area around Jakarta, and it includes four municipalities and three regencies. The population of Jabodetabek in 2005 was reported as 23.7 million (Central Bureau of Statistics), which makes it the largest metropolitan area in Indonesia. Jabodetabek straddles DKI Jakarta and the provinces of West Java and Banten, and it also includes three regencies in those provinces: Bekasi and Bogor in West Java, and Tangerang in Banten. In addition, Jabodetabek includes the Kota (formerly Kotamadya) independent municipalities of Bogor, Depok, Bekasi, and Tangerang.

Fig. 6.1 Location of Jakarta and Jabodetabek

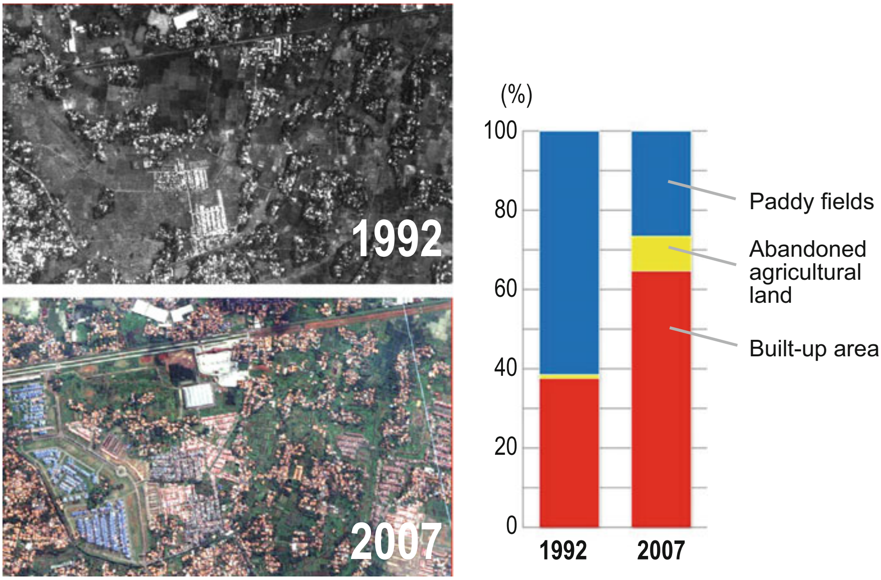

Fig. 6.2 Land use changes at the study site

The target site for this study was located in Tangerang, which is a municipality located about 20 km west of Jakarta. After Jakarta and Bekasi, Tangerang is the third-largest urban center in the Jabodetabek region. Tangerang has an area of 164.54 km^2, and its official intercensal estimated population was 1,537,244 in 2005. We assessed land use distribution at the site by means of aerial photos taken in 1992 and QuickBird images (Google Earth images) taken in 2007. We classified land use into three categories: built-up and road areas, paddy fields, and vacant land (abandoned agricultural land). We created a vector geographic information system dataset for land use, calculated the ratio of areas in each land use category for 1992 and 2007, and then compared the results.

The 1992 aerial photo indicates that paddy fields dominated the sites then. The 2007 image, however, indicates that a new residential area had been constructed in the western part of the site. This area took the form of a subdivision, and it consisted of discrete blocks of land. The development of this subdivision replaced the paddy fields that had occupied that western area. During the same period, the residential area in the eastern part of the site expanded, and the result was a mixture of residential and agricultural areas. These findings suggest that the population growth at this site was absorbed by two types of residential areas: expanded residential areas in the eastern part, and new subdivision developments replacing paddy fields in the western part. The paddy fields that were adjacent to the newly developed subdivision area were abandoned, and they subsequently became vacant land. In the eastern part of the site, the paddy fields became fragmented and some of them reverted to vacant land. Figure 6.2 indicates that the amount of agricultural land (paddy fields) decreased while that of vacant land increased from 1992 to 2007.

6.3 Impact of Urbanization on Environment

A small-scale examination at the study site was then conducted to analyze the processes responsible for the land use changes and to determine the accompanying environmental developments. This small-scale study site was located in Kelurahan Porisgaga Baru, which has experienced rapid population growth since the 1960s. Although the growth rate is now decelerating, population growth is continuing.

We defined a 200 × 200-m quadrate in the eastern part of the study site and conducted a field survey to collect information relating to building form, size, structure, construction materials, and year of construction. There were 57 houses at the examination site, the oldest of which was built in the 1950s. The building structures were all simple, but they differed in whether they possessed a ceiling. There was another difference in the roofing materials, which were mainly either tiles or asbestos. Asbestos is much cheaper than tiles. The relationships among the year of construction, roofing materials, and the presence or absence of a ceiling are shown in Fig. 6.3. The figure indicates that almost all the houses built before 1994 used tiles for their roofs. Asbestos began to be used instead of tiles in around 1994, and the proportion of asbestos roofs has increased drastically. The surface temperature of asbestos can increase to 60–70 °C at noon, and if there is no ceiling this will directly affect the thermal comfort within the house. Figure 6.3 also indicates that as the ratios of the houses that lack a ceiling increase, the ratios of the residents suffering from bad thermal conditions also increase. These features of the impact of changes would not come to light from just analysis on land use change.

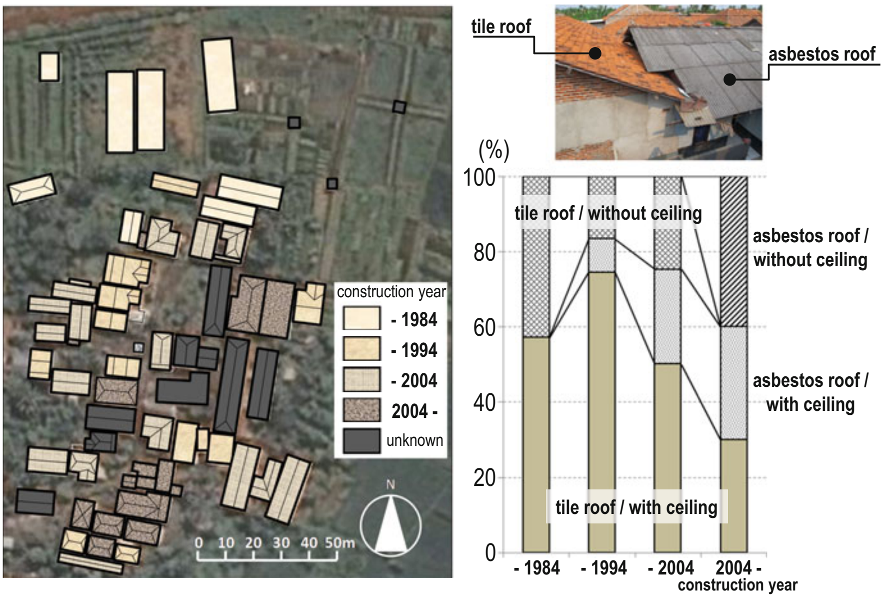

Fig. 6.3 Relationships among construction year, materials, and type of structure

Evaluation of the environment must be done in a quantitative and objective way to discuss the impacts of changes on the environment. In addition to information on buildings' form, size, structure, and construction materials, the following data, therefore, were also acquired through field investigations to examine the change of spaces in detail: (1) the materials used for the walls, roofs, and floors; and (2) the height and width of the surrounding vegetation.

The basic information relating to the substantial urban sprawl area was collected precisely as indicated above, and it was used to generate a 3D-CAD model, into which the material data and details of the physical properties were also entered. We generated 3D-CAD models not only for the present circumstances, but also for the 1980s and 1990s. We did so using information on the year of a building's construction and on the land use distribution, which was acquired through interviews with residents. We then applied a numerical simulation system, which was developed to evaluate the effects of spatial forms and materials on the outdoor thermal environment. The composition and flow of the simulation program were as follows:

1. Buildings, the ground, and tree shapes were drawn using 3D-CAD software for the conditions in 1984, 1994, and 2008.
2. Material data were selected from the database we prepared.
3. The 3D-CAD models generated by this process were then transformed into grid models, which were used to calculate the radiative heat transfer and surface heat balance.
4. The heat balance and one-dimensional heat conduction were determined for each grid. Solar and atmospheric radiation was calculated from the sky factor for each grid. The convective heat transfer calculation assumed that there was homogenous air temperature and wind velocity distribution in the outdoor space. The weather data used the vertical quantity of the total solar radiation, air temperature, relative humidity, wind velocity, and cloud coverage. This study assumed an August day with a clear sky in Jakarta.

In this study, two indices were used to evaluate the outdoor thermal environment:

1. Surface temperature distribution determined by the 3D-CAD model: The CAD model allows for observation of the surface temperature distribution from almost any viewpoint and at various times to completely evaluate the effects of specific spatial forms and materials.
2. Heat island potential (HIP): This is proposed by the authors and is expressed in Eq. 6.1. HIP is an index of the sensible heat flow rate on all surfaces in an urban block. In this equation, HIP is in degrees Celsius, T_s is the surface temperature of the microspace (°C), T_a is the air temperature (°C), ds is the area of the microspace (m^2), and A is the total area (m^2).

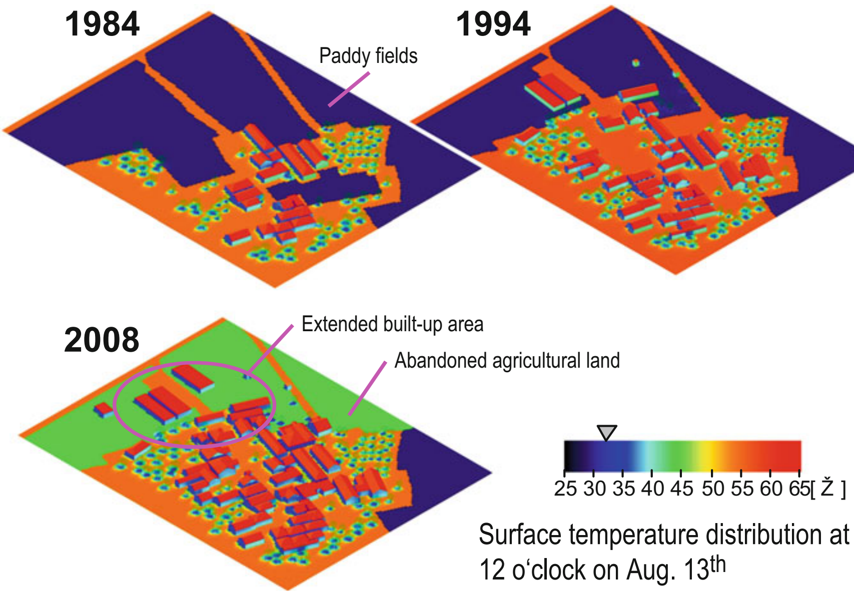

Fig. 6.4 Surface temperature distribution (at 12:00)

$$\mathrm{HIP}[^{\circ}\mathrm{C}] = \frac{\int_{\text{all surfaces}} (T_{\mathrm{s}} - T_{\mathrm{a}})\mathrm{d}s}{A} \tag{6.1}$$

Figure 6.4 shows the calculated surface temperature distribution at noon. The surface temperature of a house roof increased approximately 20–30 °C above the air temperature (32.5 °C, as indicated by the triangle on the color bar). This can be explained by the small heat capacity of the roofing material. The surface temperature of the paddy field was similar to the ambient air temperature. The wall temperatures of the houses were also 10 °C higher than the air temperature because of the low quantity of direct solar radiation. The surface temperatures of other ground surfaces were 10–20 °C above the air temperature of the entire area. Many paddy fields were abandoned and turned into vacant land during the period 1994 to 2008. Since those vacant land areas were covered by grasses, there seemed to be no significant change in the visual landscape. The surface temperature of the vacant land, however, scored 10–15 °C higher than the surface temperature of the paddy fields. In the process of urbanization, many farmers opted to quit farming and abandoned the paddy fields. And those paddy fields turned into vacant grass land and began to worsen the thermal environment. Urbanization has caused changes in landscape elements and such processes have influenced the environment.

Figure 6.5 shows the diurnal changes in HIP for 1984–2008. The differences in HIP amounted to almost 12 °C at noon. This indicates that the development in the

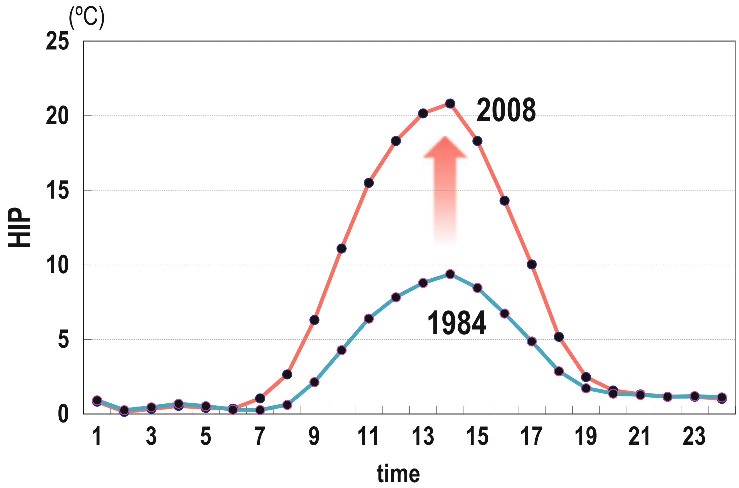

Fig. 6.5 Diurnal changes in HIP

area has increased the ambient air temperature and exacerbated the urban heat island phenomenon compared with conditions in 1984. As described in Eq. 6.1, HIP is strongly associated with the total sensible heat load of the study site. Landscape change caused by urbanization doubled the sensible heat load, which induced the urban heat island during the period 1984 to 2008. This rapid increase can be largely explained by the conversion of paddy fields to vacant land and by the increase in housing construction from Fig. 6.4.

6.4 Urbanization and Human Behavior

As well as the simulation, we investigated the present thermal conditions at the study site. First, the residents of the oldest and the newest houses at the study site were interviewed to obtain details of their daily behavior—when, where, and what they did in the course of a day. A field survey was conducted to determine the thermal comfort at the places that the residents used or where they stayed, and the wet bulb globe temperature (WBGT) was measured. WBGT is a composite temperature used to estimate the effect of temperature, humidity, wind speed (wind chill), and solar radiation on humans. Measurements were taken from 1000 to 1500 hours on a day in August 2009. The weather was fine on the day of measurement.

The residents of the oldest house at the site reported that the indoor conditions of the house were comfortable throughout the day. This was confirmed by the recorded WBGT measurements. However, the residents of the newest house stated that their house interior was uncomfortable, especially in the daytime. Figure 6.6 shows the changes in WBGT in areas that the residents used and where they stayed in addition to their behavior. Residents reported that in the morning, they would remain in the shade provided by their house and a neighbor's. However, around noon, they would go indoors owing to the increased heat and lack of shade, and they would take a nap. They noted that the heat was intolerable if they remained standing or sitting. This can be explained by the increase in the surface temperature of the roof. The surface temperature of the roof would increase to 60–70 °C at noon, and since there is no ceiling this would directly increase the radiation flux and worsen the thermal comfort within the house. However, it was clearly comfortable enough for them to sleep. This was because when they lay down, they received thermal comfort from the conductive heat flow of the floor to their bodies, not from the air temperature; the surface temperature of the floor was low because of the underlying earth. After taking a nap, they would go outside again because otherwise they were unable to stay indoors. They usually moved to a spot next to a paddy field, where they could enjoy the shade of coconut trees and the cool air from the paddy.

The above observations indicate that the residents who have lived in the area the longest are able to carry out their lives without regard to the thermal conditions. However, the daily behavior of residents who live in recently built houses and moved to the area as part of the recent urbanization is determined by the thermal conditions. In the rapid urbanization process, cheaply constructed houses are becoming common. The thermal conditions within those houses are poor. The

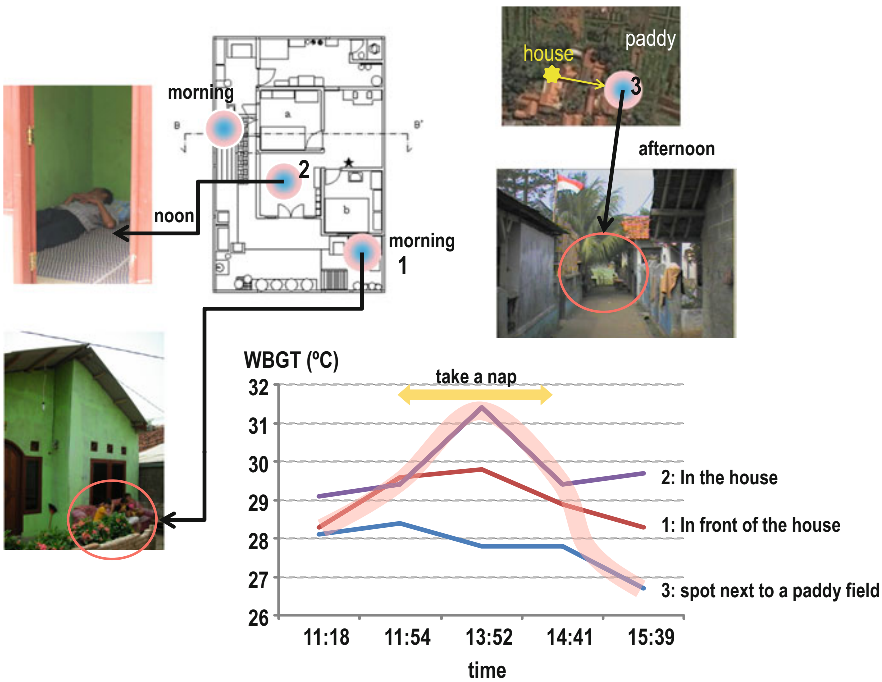

Fig. 6.6 Changes in WBGT

needs for the residents of those houses to fit their daily behavior to the thermal conditions, therefore, are increasing. In such circumstances, the cooling effect of the remaining paddy fields is becoming more precious for the residents, although the land conversion from paddy fields to built-up areas and abandonment of paddy fields are continuing.

6.5 Discussion

In a case study of a suburban area of Jakarta, we observed land use conversion in the process of increasing urban sprawl. Population growth was found to be absorbed by two types of residential areas: one consisted of expanded settlements; the other was subdivision development on an area that had formerly been used as paddy fields. The latter type may have a severe influence on the water flow system of the region.

A small-scale investigation in an expanded settlement area on building structures and construction materials and years indicated that houses have become cheaper. There is cause for concern that cheaper houses, especially ones constructed without a ceiling, are injurious to health because of their poor thermal conditions. This observation was affirmed by WBGT measurements.

The results of the numerical simulation of the thermal environment indicate that the thermal conditions of the study area have worsened: a severe urban heat island phenomenon has developed during the urbanization of the last 25 years. Since it is assumed that the growing urban sprawl will continue and the population will increase, and that urbanization will cause changes in industrial structures in the area and that the numbers of farmers quitting agriculture will increase, land use conversion from paddy to development sites or vacant land would appear to be inevitable in the future. Therefore, countermeasures against the heat island problem, such as utilizing the changed and remaining water flow system, clearly need to be implemented to improve land cover and surface conditions. Observations of the behavior of residents at the study site showed that the lifestyle of those who had recently moved to the area and lived in cheaper houses typically constructed in the recent rapid urbanization process was determined by the poor thermal conditions of their homes. These residents enjoyed the cool air provided by paddy fields. However, if those fields become converted to development sites, that cooling influence will be lost, and this could have negative effects on the residents' health. When we readjust and utilize the changed and remaining water flow system as a countermeasure against the urban heat island, efforts should be made to induce paddy fields to be located at the most appropriate place to exhibit their cooling effect, considering residents' daily behavior, in the trend of increasing abandonment of paddy fields.

Although the land use change itself may seem to be simple in urban fringe areas, the changes and processes occurring there are very complicated. Landscape elements, the interactions between them, and the relationships between them and human behavior are being influenced by urbanization both directly and indirectly. Yet the modified landscape elements still exhibit some function, and based on them, new relationships between the landscape and humans come into being. These features of changes and processes caused by urbanization and the potentials with regard to human behavior must be understood. It is not possible to address these complicated circumstances by using only land use control or zoning systems. Interventions would be needed not only in land use and cover change, but also in construction of housing, industry, and human behavior, based on a deep understanding of changes and processes, realignment of landscape elements, and establishment of sustainable interactions between the landscape and human activities. To guide urbanization in Asian cities along a more sustainable trajectory, such deep analysis and dynamic intervention in landscapes and human activities must be done.

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Chapter 7
Strategic Analysis of Urban and Peri-urban Agriculture in Asia: Issues, Potential and Challenges

Peeyush Soni and Vilas M. Salokhe

Abstract About 43 % of Asians lived in urban areas in 2010 and with an accelerating urbanization rate (about 2 % per year; 2005–2010), Asia is expected to become 50 % urbanized by 2020–2025. By mid-century, Asia is projected to see its urban population increase by another 1.8 billion. This urban population explosion in Asia, mainly in developing countries, has posed severe challenges for town planners as well as researchers. Growing urban food requirements, increased city waste and effluent production, and environmental degradation are some of those challenges. The size of a city should at least closely match the supply of food it is able to procure. In Asian metros, where most of the urban growth has concentrated, procurement of food—especially fresh, perishable products—is becoming increasingly difficult. To strategically analyze urban/peri-urban agriculture in Asian cities, this chapter highlights some key issues, potentials, and challenges in this context.

Keywords Urban/peri-urban agriculture • Asian cities • Rooftop agriculture • Agricultural systems

7.1 Introduction

For many people, cities represent the good life and rural agriculture is synonymous with drudgery. On average, urban dwellers have higher incomes, are healthier, and enjoy easier lives than their rural counterparts. Asia is changing from a predominantly rural to an increasingly urban continent. But the benefits are not universal. One out of every three people living in cities in the developing world lives in a slum: 43 % in South Asia, 37 % in East Asia, 28 % in Southeast Asia, and 24 % in

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West Asia. Urban/peri-urban agriculture could probably engage this population in employment (PUDSEA 2001; UN-HABITAT 2008).

Urban/peri-urban agriculture helps address food and ecological challenges. This type of agriculture, according to FAO, provided 25 % (700 million) of the world's urban population with food in 2005 (FAO 2008). It supplies urban markets with a wide range of products, creates jobs, and makes towns greener by virtue of fruit orchards and market gardens. Rising transportation costs per food-mile, traffic jams, insufficient storage space, environmental pollution, and health risks and declining quality of life of urban tenants have been the major driving forces behind this special agricultural system for in-house/in-town production of agricultural products. Nonetheless, draining as much as 50–70 % from middle class families' incomes in developing Asian countries, food claims its economic significance also. Cities grow around economic activities. They are encouraged by the accumulation of skilled labor. Large numbers of people are migrating to cities in search for work as agricultural mechanization reduces the demand for labor in the countryside.

Issues favoring this agri-urban tie up mainly include (a) growth of agricultural markets in cities; (b) increased urban awareness of organic products and functional food; (c) growing importance of intensive urban agriculture for self-provisioning of poor families living in cities who are struggling for adequate nutrition and are victims of double health risks; (d) off-season vegetable/fruit production; (e) potential to use renewable energy sources, including solar, wind, and biogas; (f) potential to run recirculating/recycling resource systems; (g) agricultural or nonagricultural use of urban biological waste; (h) enhanced urban sustainability; (i) addition of social and economic value to urban natural and physical resources; and (j) trending popularity among hobby/part-time growers.

Issues that are yet to be addressed to popularize urban/peri-urban agriculture mainly include (a) urban resource recognition and use; (b) dependency on a skilled workforce; (c) policy, infrastructure design, and city planning issues; (d) insufficient production capacity to meet year-round needs of building residents; (e) complicated setup and expensive maintenance; (f) energy-intensive farming; (g) receiving little or no research attention and frequent ignorance by municipal authorities; and (h) lack of knowledge on different types of technological support systems that exist, their contribution to livelihood, and the environmental and health risks and benefits they bring.

7.2 Cities and Sustainability

The urban population explosion in developing countries has set major challenges for the towns involved, such as growing food requirements and increased waste and effluent production. Moreover, as a result of migration, urban poverty is growing. The most underprivileged have greater difficulty in finding the food they need.

Cities have a large ecological footprint. They call on resources over a wide range stretching from the need to provide food to acquisition of raw materials. Locally, cities put huge strains on natural ecosystems, pollute rivers and coastal waters, consume forests and water, degrade soils, disrupt drainage, and stunt crops. Today, humanity's ecological footprint is 2.2 global ha per person, which is over 21 % greater than the earth's biocapacity (1.8 ha), or its capability to regenerate the resources used. It now takes more than 1 year and 2 months for planet Earth to regenerate what we, its inhabitants, use in a single year. It is now necessary to know whether wealthy cities can generate and justify a large ecological footprint and whether development policies can reduce that footprint. The challenge today the world is facing is whether cities can transform themselves into self-regulating, sustainable systems—not only in their internal function but also in their relationship to the world outside the "concrete" world—or become a source of ecological disasters. The challenge today is to understand what it takes to sustain a city (Grazi et al. 2007; Fiala 2008; Moran et al. 2008).

Innovative interdisciplinary designers refer to *green buildings* as a concept that includes a multitude of elements, components, and procedures, which are expected to maintain high levels of environmental, economic, and engineering performance. Benefits of such designs include energy efficiency and conservation, improved indoor air quality, resource and material efficiency, and occupants' health and productivity (Samer 2008). Efforts are being made to create buildings and infrastructure in such a way that minimizes the use of resources, reduces harmful effects on ecology, and creates better living environments (Chatterjee 2009; Kamana and Escultura 2011).

Peri-urban areas are a transition belt with both urban and rural characteristics. They have major characteristics (PUDSEA 2001) such as (a) mosaic-type areas of agriculture, housing, and industry; (b) strong development dynamics; (c) rapid urbanization and increasing land prices; (d) direct access by residents to goods and services; (e) more than 50 % of households receiving their major income from industrial and urban employment; (f) semicommercial and commercial agriculture; and (g) opportunities for sustainable development.

7.3 Cities and Agriculture

Traditionally, the size of a city is closely related to the food it is able to procure from its outskirts. With efficient and less expensive transportation becoming available, cities have increasingly drawn on food sources from outlying areas, with the ability to pay being a determining factor. In Asia, where most of the urban growth has concentrated in metropolitan areas, the problem of food availability and access is becoming more acute. In these urban centers, uneven distribution of incomes, the prevalence of poverty, diminishing farmlands, inefficient distribution systems, and rising expectations have contributed to increasingly critical problems of food supply and distribution, particularly as they affect the urban poor.

Food insecurity is drawing more and more people in growing cities in developing countries to the practice of urban agriculture—the production of food and

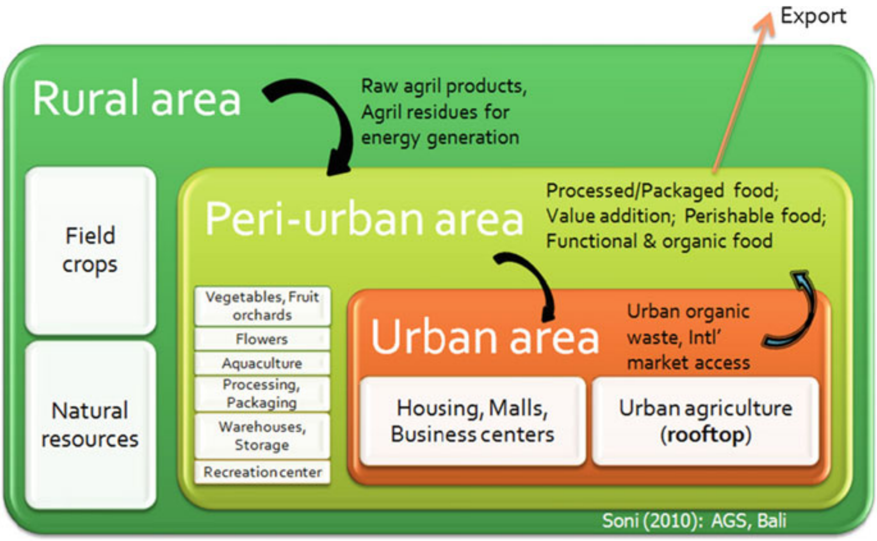

Fig. 7.1 Flow of resources

nonfood crops and animal husbandry in built-up areas. The challenge is to design more closed nutrient and energy cycles than are currently prevalent, taking the economic and social demands of people into consideration. The question is: how can we develop economically and environmentally sustainable spatial settlements that link peri-urban agricultural production (e.g., raw materials for small-scale industries) with the development of small-scale industries (e.g., food processing units) and that offer employment opportunities for local people in the periphery while organic household waste is used as a source of nutrients in agricultural production (PUDSEA 2001)? And how can we ensure food hygiene if irrigation water from sewers is contaminated with heavy metals or pathogens from untreated night soils from the city? An intertwined linkage of urban/peri-urban areas in the context of interaction of resources is shown by Soni and Salokhe (2009) (Fig. 7.1).

Urban and peri-urban agriculture can help solve major food and ecological problems. This type of agriculture provided food for around 25 % of the world's urban population (700 million urban inhabitants) in 2005 (Moustier and Danso 2006). It supplies urban markets with a wide range of products, creates jobs, and makes towns greener by virtue of fruit orchards and market gardens. However, urban agriculture is under many threats, such as competition for land between agricultural and residential or industrial uses, or the use of imports by food distribution groups and supermarkets.

For the urban majority of poor people in developing countries, food is turning into a very expensive commodity. Households in nearly half of the developing countries' largest cities spend 50–80 % of their average income on food. Surveys in Kenya, Egypt, India, Bolivia, Bangkok, La Paz, Bamako, and Dar es Salaam show that poor urban households spent around 60 %—and in some cases as much as

89 %—of their income on food (Mougeot 1993). Poor people in cities have fewer options than rural inhabitants. Price surveys of five developing countries showed that city dwellers had to pay 10–30 % more for their food than rural dwellers (Mougeot 1993). Furthermore, as many as 360 million urban inhabitants in developing countries suffer from chronic calorie deficits. Five of every six urban families in India typically spend 70 % of their income on food. In Kuala Lumpur, 45–50 % of total household expenditure goes on food. Consequently, lower-income groups in cities in Asia are often worse off nutritionally than their rural counterparts (Yeung 1987).

7.4 Potential

The role of urban/peri-urban agriculture has been reevaluated for several reasons: it requires little energy for transportation and conservation; it provides urban employment opportunities; it permits stronger and more varied interactions between natural and urban spaces; and it can be used as a means to control urban growth.

Urban/peri-urban agriculture often makes a significant contribution to many major cities' food self-reliance. In some large Latin American centers about 33 % of vegetable demand is met by urban production. Cities such as Kathmandu, Karachi, Singapore, Hong Kong, Shanghai, and others in China produce between 25 and 85 % of their supply in vegetables and fruits, while Hong Kong, Kampala, and Singapore meet between 70 and 100 % of their poultry demand. Some cities even manage to export products to other countries.

Urban agriculture gives us good reasons for recognizing the comparative advantages of rural and urban areas in meeting large cities' growing needs for reliable, cheap supplies of sufficient and nutritious food. Apart from nutrition and health, farming in or near cities contributes to producers' well-being in a number of ways, including cash saving and income generation. Among lower-income groups, self-produced food can cover a considerable share of a household's total food intake and can save cash income that otherwise would be spent on food. Depending on the income group, self-produced food is found to account for between 18 and 60 % of household food consumption in East Jakarta, Dar es Salaam, and Kampala. Home-produced food has enabled families in Addis Ababa cooperatives and Dar es Salaam's poor families to save 10–20 % and 37 % of their income, respectively. In Bolivia, urban food projects supply women producers with a quarter of their total income.

Supplying at least a part of fresh food (vegetable and fruit) needs, or even ornamental flowers, through urban agriculture is becoming a part of sustainable urban landscaping and development for a number of reasons. Several megacities now have a policy to produce food within the cities. Recycling of waste water for aquaculture is also becoming an attractive option, which confirms a sizable potential existing on rooftops and in home gardens. According to Ghosh (2004), it is likely that in the future, urban agri-horti-aquaculture will be incorporated into the design of cities for ecological, aesthetic, functional, economic, and environmental benefits. Agricultural activities are now seen as an effective way of reducing the ecological footprint of cities. With the existing conventional food and agricultural production–distribution model, fragmented urban settlements mean greater energy use, CO_2 emissions from transport, energy and product losses during cold chains, and large-scale marketing requirements (Cerón-Palma et al. 2012). It is well known that modern cities almost exclusively rely on the import of resources to meet their daily basic needs; in particular, food materials are transported from long distances. As more people now reside in cities, and almost all future population growth is expected to occur in cities, urban/peri-urban agriculture has potential for developing cities with local self-reliance.

This type of agriculture is visualized on land unsuited to building, undeveloped land, idle public land and bodies of water, and household spaces. Urban farming thus does not obstruct more appropriate land development; rather it puts to use small, inaccessible, unserviced, hazardous, and vacant areas. The adaptability of this agriculture is due to a range of farming systems and crop selection that make the best of site and locational constraints and resources in the urban setup. Several appropriate farming systems could be identified, including aquaculture, horticulture, livestock, agroforestry, silkworms, and medicinal and culinary herbs. Rooftop agriculture is one such integration of these farming systems (Fig. 7.2) (Soni et al. 2009).

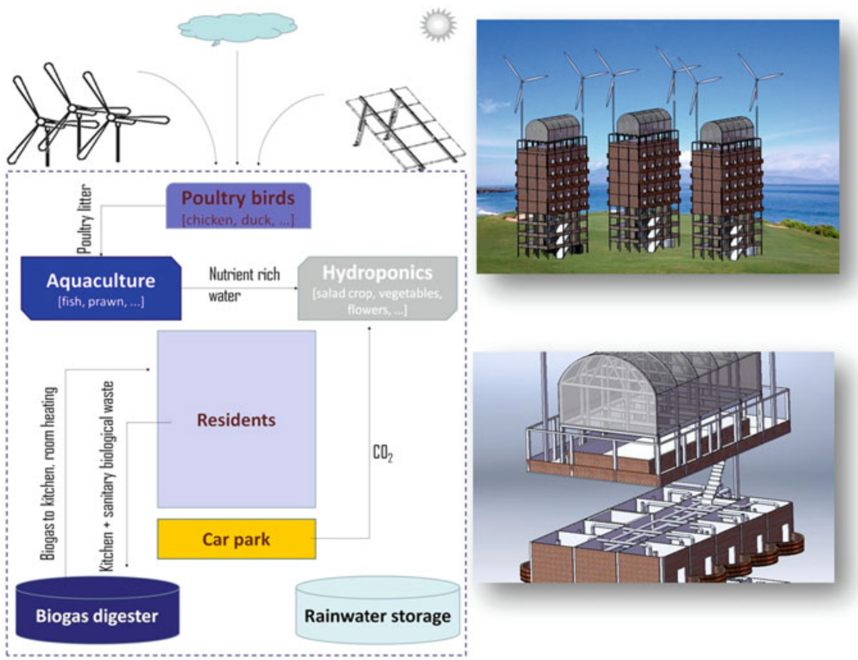

Fig. 7.2 "Green top—clean bottom" rooftop agriculture schematic (Soni et al. 2009)

Rooftop eco-greenhouses are seen as a high-technology setup, where greenhouses are connected to a building in terms of energy, water, and CO_2 flows. These are considered an eco-innovative concept of sustainable production of high-quality fresh products. The interconnection of the building and greenhouse improves sustainability of the building in cities by reusing/recycling the building's waste, as well as lowering transportation requirements in the food chain. Such rooftop farming in Singapore's nationwide public housing estates has been shown to have the potential to result in a 700 % increase in domestic vegetable production, satisfying domestic demand by 35.5 %, and eventually reducing Singapore's carbon footprint by 9052 tonnes of emissions annually by reducing its food imports (Astee and Kishnani 2010). Grewal and Grewal (2012) considered a scenario of utilizing 80 % of vacant lots in the City of Cleveland, USA, and showed that it could generate between 22 and 48 % of the city's demand for fresh produce (vegetables and fruits) depending on the production technique used (conventional gardening, intensive gardening, or hydroponics), 25 % of both poultry and shell eggs, and 100 % of honey. In another scenario 80 % of vacant lot and 9 % of occupied residential lot was considered, which could generate between 31 and 68 % of needed fresh produce, 94 % of both poultry and shell eggs, and 100 % of honey. Their analysis revealed that enhanced food self-reliance would result in $29–115 million being retained in the city annually, depending on the scenario adopted.

Estimates suggest that typical buildings in megacities account for about 40 % of the greenhouse gas emissions, 70 % of electricity consumption, and 12 % of water consumed in the USA (Samer 2008). *Green roofs*—roofs covered with vegetation—not only offer the 'production advantage' of agriculture but also provide passive cooling for the building structure below. The use of vegetation on roofs improves not only thermal comfort conditions but also the energy performance of the building by lowering the solar radiation reaching the structure below (Ouldboukhitine et al. 2011). Such roofs directly weaken the heat effect and greenhouse gases by using CO_2 in photosynthesis. Therefore, such buildings are considered one of the effective measures toward developing a low-carbon society (Cai et al. 2011). In order to propose green sustainable strategies to reduce greenhouse gas emission associated with energy consumption in Merida, Mexico, Cerón-Palma et al. (2013) considered eco-technology (efficient equipment) and green spaces (sedum + food production). The CO_2 eq emissions avoided by the transport of food (tomatoes) from the production site to the consumers—including distribution, packaging, and retail—were calculated. These strategies could prevent emissions of up to 1.06 tonnes of CO_2 eq/year, representing 67 % of the emissions originating from a reference household (34 % avoided by eco-technology, 24.5 % fixed by green spaces and 8.4 % avoided by food logistics).

Closing the nutrient loop is one of the important benefits of such urban agriculture. Reuse of wastewater and organic waste in such agriculture may contribute to environmental sanitation, nutrient recycling, and improved public health and resource management (Schertenleib et al. 2004). Urban agriculture is clearly far more than a means of subsistence, an informal activity, or an illegal business. There can be several urban farmer categories, ranging from low-income survival to middle-income home gardeners to agribusiness. Urban agriculture could further reduce its use of high-quality water if sewerage systems were designed to recycle sewage locally. Irrigation with untreated wastewater is a problem that requires the adaptation of low-cost pathogen and vector elimination processes and assessments of crop susceptibility to contamination. Research results could guide crop selection accordingly—for instance, whether to plant food crops or nonfood crops. Solid waste is already used in a variety of ways, but the practice should be further encouraged. Current centralized management systems may hinder solid waste reuse for city farming, as solids are dumped at sites with restricted access and wastes are unsorted.

7.5 Training and Technological Considerations

The increasing urbanization of agriculture means that the agricultural sector needs to be more professional and look more closely at the requirements of urban inhabitants. It is increasingly necessary to raise awareness among urban authorities for social, sanitary, and land management reasons.

It is also necessary to improve the skills of the private- and public-sector staff involved in this type of agriculture, so as to ensure sustainable food supplies. A network must be established to respond better to local demand for vegetables and make the switch to commercial production. Technical solutions have been found in order to be able to respond to market opportunities and boost farmers' incomes (out-of-season production, etc.). New sanitary quality certification systems should be tested, and an economical daily price information gathering and dissemination system could be developed to facilitate communication between producers and traders.

It is vital that the local and national public authorities, private urban development players and the agricultural sector realize the issues involved in this type of farming. In order to ensure the sustainability of agricultural activity in and around urban areas, various stakeholders, primarily the town councils and urban inhabitants, need to realize the functions of this type of agriculture. It is also vital that urban agricultural producers, and their organization in the form of groups, be recognized by the authorities.

In Vietnam, CIRAD (2006) evaluated the impact of supermarket development on poor populations, considering them as both consumers and traders. Supermarkets accounted for only a small share of food distribution (<5 %). However, they were expanding at a rate of more than 15 % per year. This is having many adverse consequences for poor consumers—who have limited access due to the higher prices in supermarkets than in traditional markets, and transport constraints—and for the number of jobs created, which is small in comparison with traditional markets and street sellers. Moreover, poor producers cannot supply supermarkets due to the demands they make in terms of consistency and quality and due to the time they take to pay. However, certain producers' organizations allow small-scale producers to develop the taste and sanitary quality of their products and reward that quality with a seal of approval. This enables such producers to gain a foothold in the sector, ensuring higher, more stable incomes than traditional supply chains.

Urban agriculture requires higher technological and organizational precision than rural/conventional agriculture because it needs to be more intensive, more tolerant of environmental stress, responsive to market behavior, and carefully monitored to protect public health. Many highly valued systems must be adapted to smaller-scale operations, such as hydroponics and stall feeding. Where poorer urban households have little land, technologies must be adapted to make more efficient use of tiny household spaces.

In the era of advanced information technology, there exists a tremendous opportunity for using low-cost agricultural automation using the "Internet of things" (IOT) to describe several things or objects that are able to communicate with each other to reach common goals. This includes sensors, actuators, tags, RFID (radiofrequency identification), and others. Applications of the IOT include, but are not limited to, smart homes/smart buildings, smart cities, environmental monitoring, health care, smart business/inventory and product management, and security and surveillance. Marhaenanto et al. (2013) showed the application of a greenhouse control system over the Internet and reaffirmed its potential for part-time farmers, especially in urban agriculture.

7.6 Conclusions

Based on the aforementioned discussion, the following can be concluded as driving factors, benefits, potentials and challenges pertaining to urban/peri-urban agriculture in Asian countries:

Driving Factors

(a) Rapid urbanization and an aging population
(b) Environmental pollution, health risks, and declining quality of life of urban residents
(c) Part-time/hobby farming options for homemakers/senior family members
(d) Advancement in low-cost automation technology for minimum drudgery in control, maintenance, and operation

Benefits

(a) Access to safe, fresh, and affordable vegetables
(b) Off-season vegetable/fruit production
(c) Green roofs: reduced air pollution in the surroundings and energy control in buildings
(d) Increased social interaction among building residents
(e) Increased awareness among kids/youth toward agriculture and the environment

(f) Localized production and consumption, lowering transportation and storage costs and resulting in self-reliance
(g) Enhanced urban sustainability
(h) Addition of social and economic values to urban natural and physical resources

Potentials

(a) Growth of agricultural markets in cities: growing urban demand for fresh vegetables and animal products
(b) Increased urban awareness of organic products and functional food
(c) Growing importance of intensive urban agriculture for self-provisioning for poor families living in cities who are struggling for adequate nutrition and are victims of double health risks
(d) Potential to use renewable energy sources, including solar, wind, and biogas
(e) Potential to run on recirculating/recycling resource systems
(f) Agricultural or nonagricultural use of urban biological wastes

Challenges

(a) Needs a skilled workforce: lack of technical/agricultural skills among urban residents
(b) Large variations in the economic/technological performance of the system
(c) Policy, infrastructure design, and city planning issues
(d) Low-volume production: insufficient production capacity to meet continuous/year-round needs of building residents
(e) Complicated setup and expensive maintenance
(f) Lack of commercially available, ready-to-install, customization systems
(g) Urban/peri-urban agriculture receives little or no research attention and is frequently ignored by municipal authorities
(h) Dissemination of knowledge about the different types of urban/peri-urban agriculture systems that exist, their contribution to livelihoods, and the environmental and health risks and benefits they bring

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Chapter 8
Farmland Conversion and the Sustainable City: The Case of Yogyakarta, Indonesia

Irham and Senthot Sudirman

Abstract The objectives of this study are: (1) to determine the change in farmland use in the fringe areas of Yogyakarta; (2) to analyze the process of farmland conversion and assess its conversion rate; (3) to identify the factors that affect this farmland conversion; and (4) to ascertain the implications related to sustainable city development in Yogyakarta.

The study showed that farmland has been intensively converted to other functions. The most noticeable change in farmland to nonresidential use occurred in the city itself, whereas in the fringe areas agricultural land has mostly been converted to residential use.

The results of regression analysis indicate that the population density, regional GDP, and number of houses built show a positive relationship with land conversion. However, only housing development has a significant effect on land conversion. Thus, it is not surprising that housing development has become the key factor in the massive farmland conversion that has taken place in Yogyakarta. This study suggests the following: (a) stringent regulations and penalties for improper behavior by developers and district officials should be imposed; (b) farmland owners need to be given incentives to continue farming their land; and (c) it is necessary to establish a "fixed sufficient farmland" in every subdistrict to secure food sufficiency.

Keywords Sustainable city • Land-use changes • Farmland conversion • "Fixed sufficient farmland"

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8.1 Introduction

Sustainable development of a city like Yogyakarta municipality should not be separated from the development of its nearby rural areas. Takeuchi et al. (2009) noted that municipalities could be regarded as cities that integrate everything from upstream forests to midstream farmland and villages to downstream urbanized areas, even extending to the coast. Thus, it is necessary for a sustainable city region that harmonious relations exist between the urban and rural areas. Protection of agricultural systems, which belong to the rural sphere, is thus a matter of concern for the city management.

Although the growth and expansion of city is inevitable (Clawson 1971), effective land use planning and policy are necessary to control the ongoing conversion of farmland (Isberg 1975), especially fertile land, to other uses. In the case of Yogyakarta, strong land use policy is a must due to a number of factors, such as: (1) expansion of the city takes place on farmland area; (2) farming activity is an important source of employment for the farmers and farm workers; (3) the soil is very fertile; (4) the loss of farmland will negatively affect food self-sufficiency program of the government; and (5) the conversion of farmland to other uses is irreversible.

The most serious impact of farmland conversion around the city of Yogyakarta is the loss of irrigated fertile land, that threaten Indonesia's national food security program. The intensive farmland conversion that has taken place in Yogyakarta is a result of the ignorance of ordinances and spatial development guidance that prohibit the use of productive agricultural land, especially irrigated land.

Initiatives to control this farmland conversion are essentially based on two considerations. First, there is the need to protect Indonesia's long-term food-producing capacity: without adequate protection of agricultural land resources, the country will find it difficult to meet the food needs of its growing population, especially in urban regions. Second, there is growing recognition of farmland's important aesthetic and spatial attributes.

Expansion of the city has caused the reduction of farmland area (Furuseth 1982; Pacino 1990). The growth of population, per capita income, establishment of new housings, and construction activities are factors that affect this change.

The issue of preserving farmland needs to become a major focus for sustainable city development (Conklin and Bryant 1974; Lapping 1977) including the city of Yogyakarta. For these reasons, government authorities in Indonesia are very concerned to protect farmland. The search for methods to ensure an adequate supply of agricultural land has led to mounting pressure on various levels of government to become involved in preservation programs. The implementation of strategies to preserve agricultural land, however, should rely not only on government initiatives but also on support from the community as a whole.

This chapter aims to: (1) understand the landuse changes in the fringe area of Yogyakarta; (2) determine the conversion rate of farmland area; (3) analyze the factors that affect farmland conversion; and (4) identify the implications of farmland conversion for sustainable city development in Yogyakarta.

8.2 Materials and Methods

8.2.1 Study Area

This study was conducted in the city of Yogyakarta Province and its fringe areas. The study area covered the municipality of Yogyakarta (the city center) and two adjacent districts in the urban fringe—Sleman and Bantul. For Yogyakarta city, only five of 14 subdistricts with agricultural land area were selected: Mantrijeron, Mergangsan, Umbulharjo, Kotagede, and Tegalrejo. Five of 17 subdistricts of Sleman (Gamping, Mlati, Depok, Ngemplak, and Ngaglik) and three of 11 subdistricts of Bantul (Banguntapan, Sewon, and Kasihan) were chosen as study areas (Fig. 8.1).

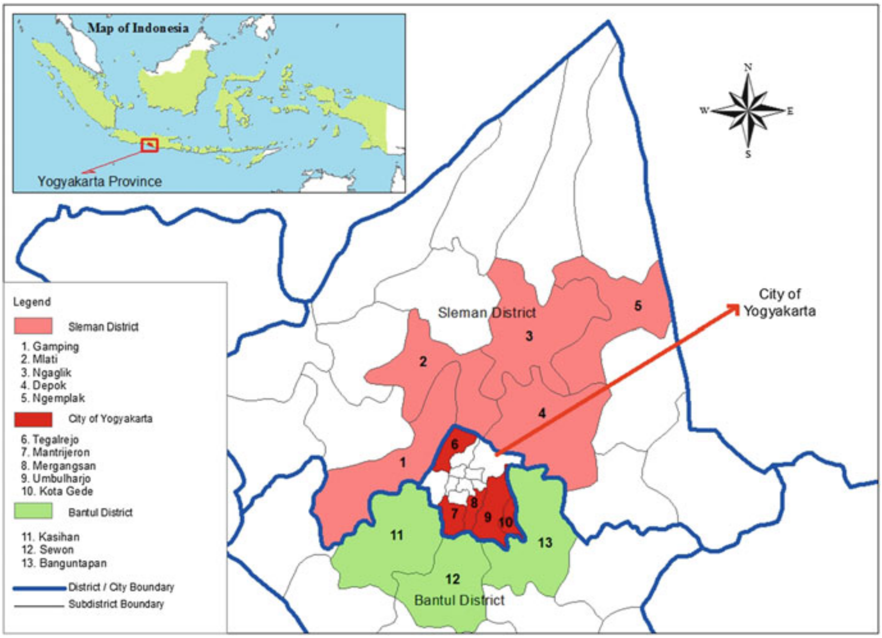

Fig. 8.1 Sites of the study

8.2.2 Data Use and Method of Analysis

Agricultural land data for different years were used to analyze the changes in land use. Data on farmland being converted to other uses were employed to analyze the converted areas and the rate of conversion. Agricultural land data were collected from the Statistical Office of the local government; data on farmland being converted to other uses were collected from the Regional Land Board of Yogyakarta Municipality and Districts of Sleman and Bantul.

To analyze factors that influence land conversion, the fringe area of Sleman was chosen because this district is where the conversion process has been intensively occurred. The time series data used in this study covered 5 years period (2002–2006) and five subdistricts (*kecamatan*) in this region: Gamping, Mlati, Depok, Kalasan, and Ngaglik. Those data were collected from different sources, such as the Statistical Office and the Housing and Infrastructure Office of Sleman District.

To test the factors influencing farmland conversion, a regression analysis model was employed. By using panel data that combined time series and cross-section data, a logarithmic regression equation model was constructed as follows:

$$\log Yit = \beta 0 + \beta 1 \log X1it + \beta 2 \log X2it + \beta 3 \log X3it + \mu it$$
$$i = 1, 2, 3, 4, 5; \quad t = 1, 2, 3, 4, 5,$$

where Y is farmland conversion, $X1$ is the population density, $X2$ is the gross regional product, $X3$ is the number of houses built by developers, and μit is the disturbance term.

8.2.2.1 Selection Model Test

Three possible estimation approaches were tested—common effect, fixed effect, and random effect models (Gujarati 2003). The common effect model (CEM) was used to estimate the data without distinguishing between individual and intertemporal differences. By this model, it was assumed that the intercept and slope were the same. With this model, we considered that the characteristics of the data were similar among the various subdistricts as well as for different years. With the fixed effect model (FEM), it was assumed that the intercept was different but the slope was the same among the various subdistricts. With the random effect model (REM), it was assumed that each subdistrict had a different intercept and the intercept was regarded as a random or stochastic variable. To determine the appropriate model between CEM and FEM, a significance F-test was carried out with the F-statistic as follows:

$$\text{F-stat} = \frac{(\text{RSSR} - \text{RSSUR})/m}{\text{RSS UR}/\ (n-k)}$$

where RSSR is the residual sum of squares of the common effect, RSSUR is the residual sum of squares of the fixed effect, m is the number of restrictions in the model, n is the number of observations, and k is the number of independent variables.

The Hausman test (h-test) was used to select the appropriate model between FEM and REM. If the value of h was greater than its critical value ($h > \lambda^2$ d$f = k$, $k =$ number of independent variables), FEM was indicated; if the reverse was true, REM was indicated.

8.2.2.2 Statistical Tests

The statistical significance of coefficient test (t test), goodness-of-fit test (R^2), and overall explanatory variables test (F-test) were performed for statistical interpretation of the results of the regression analysis. A normality test (Jarque–Bera test), multicollinearity test (correlation between independent variables), autocorrelation test (Durbin–Watson test), and heteroskedasticity test (White's heteroskedasticity test) were also conducted to fulfill the classic assumptions of the regression model.

8.3 Results and Discussion

Population density is a fairly good index to measure the influence of a city development on its surrounding areas. As indicated in Table 8.1, there was a great variation in the population density in different subdistricts, though there was a consistent increase from 1990 to 2010. Subdistricts outside the city center with more open spaces and less developed area had a relatively lower density. In Table 8.1, it can also be observed that five subdistricts in Sleman and three subdistricts in Bantul had a density of fewer than 33 people per hectare in 2010; an exception was the Depok subdistrict of Sleman.

Over the 10 years from 2000 to 2010, though the city of Yogyakarta underwent relatively low growth in population density, the subdistricts in the fringe areas experienced high population density growth, especially Sleman. In 2010, almost all the subdistricts exhibited a higher density than the average density of each district. Among the five subdistricts in Yogyakarta, Umbulharjo and Kotagede have long been relatively sparsely settled parts of the city, and their population density was relatively low. In the district of Sleman, only the Ngemplak subdistrict showed a relatively low density compared with other subdistricts, among which Depok had the highest population density. This is consistent with the fact that Depok is the area in Sleman that has undergone the greatest development. The Kasihan subdistrict of

Table 8.1 Population density of Yogyakarta and its fringe areas

District/subdistrict	Area (km^2)	Population density (people/km^2)		Growth (%)
		2000	2010	
Yogyakarta Municipality			11,941	
Mantrijeron subdistrict	2.61	14,844	17,980	21.1
Mergangsan subdistrict	2.31	17,819	20,381	14.4
Umbulharjo subdistrict	8.12	8,039	9,951	23.8
Kotagede subdistrict	3.07	9,034	10,747	19.0
Tegalrejo subdistrict	2,91	13,195	16,001	21.3
Sleman district (fringe area)			2,033	
Gamping subdistrict	29.25	2,249	3.205	47.2
Mlati subdistrict	28.52	2,351	3.398	50.7
Depok subdistrict	35.55	3,069	3.660	98.9
Ngemplak subdistrict	35.71	1,243	1.713	36.0
Ngaglik subdistrict	38.52	1,712	2.556	54.5
Bantul district (fringe area)			1,910	
Banguntapan subdistrict	28.48	2,597	4,214	62.3
Sewon subdistrict	27.16	2,717	3,843	41.4
Kasihan subdistrict	32.38	2,324	3,424	47.3

Source: Statistical Office of Yogyakarta Province, 2001, 2011

Bantul experienced less development than the other two subdistricts—Banguntapan and Sewon—where development has been very intensively carried out (Table 8.1).

Changes in patterns of farmland use in the fringe areas between 2000 and 2010 (Table 8.2) indicate that over that period, agricultural land has been intensively converted to other functions, mostly to residential use. Although the conversion rate of agricultural land in Yogyakarta (the city center) was very high, the area converted was relatively small and amounted to the conversion of only residual areas of farmland. In contrast to the city center, the most noticeable transformation of agricultural land to urban use occurred in the fringe areas, particularly in Sleman. This is not surprising, because massive, unregulated development of housing complexes has been intensifying in this area. Since the development of housing complexes in the fringe areas has increased, so has the demand for farmland conversion. Therefore, the fringe district of Sleman, especially its Mlati and Ngaglik subdistricts, and other subdistricts in Bantul have experienced great loss of agricultural land.

The conversion of farmland in five subdistricts in the city center and the two fringe districts resulted from several interrelated forces in terms of spatial use and socioeconomic structures. It has been suggested that population density, economic growth (the regional GDP), and housing development (the number of houses built) stimulated the conversion of farmland to urban use (Mariyono et al. 2007). Linear regression analysis was used to analyze those influencing factors with respect to farmland conversion. To ensure the linearity of the relationship, the data

Table 8.2 Area of converted farmland and conversion rate

District/subdistrict	Area (ha)		Conversion rate	
	2000	2010	Ha	%
Yogyakarta				
Mantrijeron subdistrict	4	0.0	4.0	100
Mergangsan subdistrict	5	4.0	1.0	19.2
Umbulharjo subdistrict	74	46.8	27.2	36.7
Kotagede subdistrict	26	0.0	26.0	100.0
Tegalrejo subdistrict	29	9.4	19.6	67.5
Sleman district (fringe area)				
Gamping subdistrict	1214.7	1128.7	86.0	7.1
Mlati subdistrict	1132.6	945.0	187.6	16.6
Depok subdistrict	591.23	531.2	60.0	10.2
Ngemplak subdistrict	2034.8	1935.6	99.2	4.9
Ngaglik subdistrict	1915.5	1769.2	146.3	7.6
Bantul district (fringe area)				
Banguntapan subdistrict	1466	1316.8	149.2	10.2
Sewon subdistrict	1373	1247.1	125.9	9.2
Kasihan subdistrict	707	527.2	179.8	25.4

Source: Provincial Land Board (BPN), 2001, 2011

distribution of independent variables (population density, regional GDP, number of houses built) is presented as scatter diagrams (Figs. 8.2, 8.3, and 8.4).

The results of the regression analysis showed that the value of R^2 was 0.873, which indicates that the population density, regional GDP, and number of houses built in the fringe areas together accounted for 87 % of the land conversion in the study region. The remaining variation is explained by factors that were not included in the model. The result of the F-test showed that all independent variables (the population density, regional GDP, and number of houses built in the fringe area) had an F-statistic of 8.013, which means that the statistical significance was at the 1 % level.

The result of the regression analysis showed that the population density, regional GDP, and number of houses built in the fringe area of Yogyakarta within the Sleman district demonstrated a positive relationship with land conversion (Table 8.3). However, if the other factors were kept constant, only the number of houses built in that fringe area exerted a significant effect on farmland conversion. This result underlines the fact that the development of housing complexes in the Yogyakarta fringe area has been very intensive. There are many reasons for this great change, one of which is the lack of effort by the local government of Sleman to protect fertile, irrigated farmland from being converted to housing complexes. This implies that the loss of agricultural land will continue since the conversion rate is positive and very high. In the long run, this trend will threaten the sustainability of food security in the region.

The population density does not show a significant effect on farmland conversion in the fringe area of Sleman. This probably because the population density is

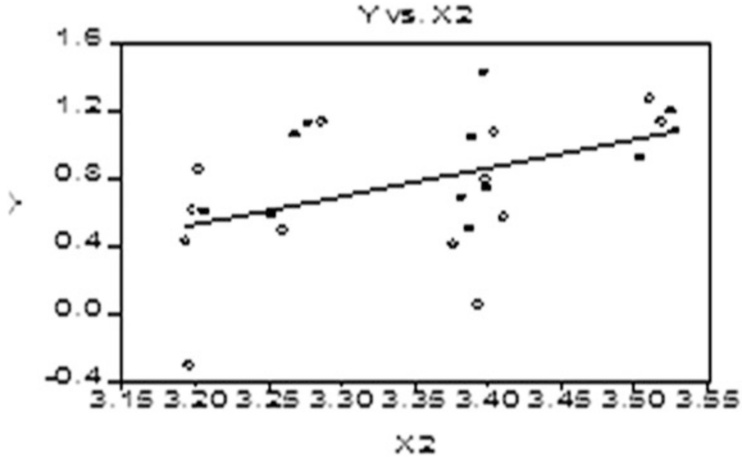

Fig. 8.2 Scatter diagram of population density

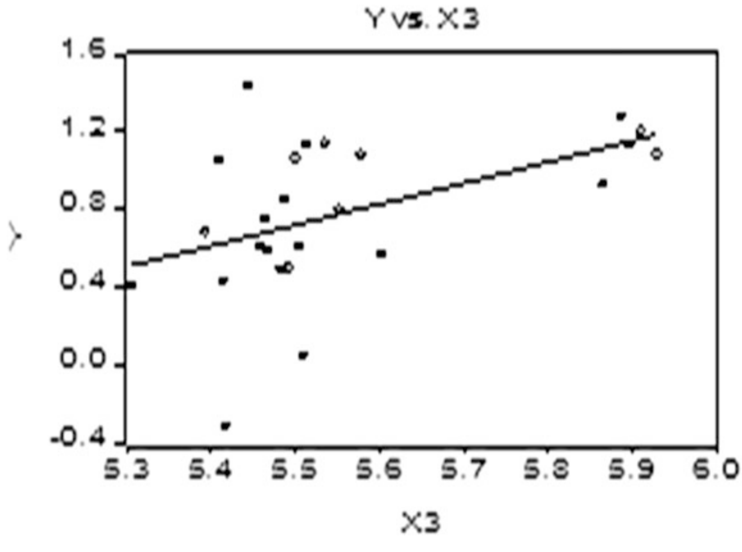

Fig. 8.3 Scatter diagram of regional GDP

not as high as it is in the city center. The regional GDP, which represents the economic growth in the city and its region, also has no significant effect on farmland conversion. This is most probably because the regional GDP may affect only the conversion in the city center, which was not tested in the present study.

In Table 8.3, the intercept (C) −36,153 is the average value of the random error component for all subdistricts. The value of the random effect shows the level of the difference in the random error component for a certain subdistrict toward the

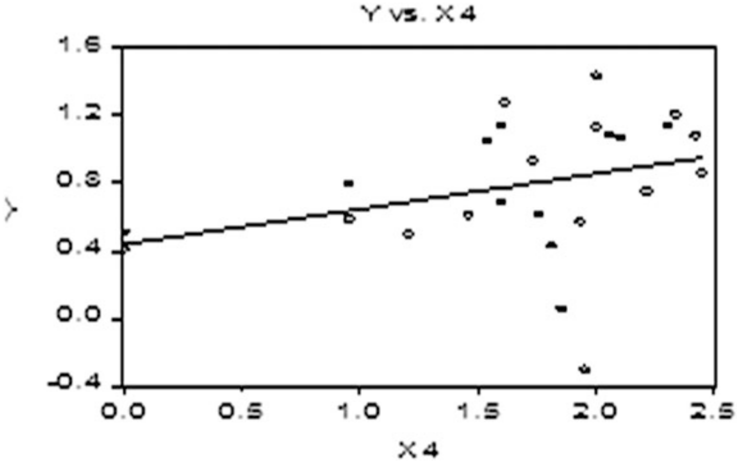

Fig. 8.4 Scatter diagram of number of houses built

Table 8.3 Regression results with the random effect model

Variables	Coefficients	Standard errors	*t* statistics	Probability
C	−36,153	16,009	−2,258	0.0347
LOG (*X*1?)	0.687	2,624	0.261	0.7960
LOG (*X*2?)	2,480	1,514	1,637	0.1164
LOG (*X*3?)	0.372	0.079	4,680	0.0001
Random effects				
GPG-C	1.2132			
MLT-C	−0.1533			
DEP-C	−1.5692			
KAL-C	−0.1325			
NGA-C	0.6419			

intercept for the whole district (average). The regression equations for each subdistrict are as follows:

Gamping Subdistrict

$$\log Y = -34,940 + 0.687\ \log X1 + 2,480\ \log X2 + 0.372\ \log X3$$

Mlati Subdistrict

$$\log Y = -36,307 + 0.687\ \log X1 + 2,480\ \log X2 + 0.372\ \log X3$$

Depok Subdistrict

$$\log Y = -37{,}723 + 0.687 \log X1 + 2{,}480 \log X2 + 0.372 \log X3$$

Ngemplak Subdistrict

$$\log Y = -36{,}286 + 0.687 \log X1 + 2{,}480 \log X2 + 0.372 \log X3$$

Ngaglik Subdistrict

$$\log Y = -35{,}511 + 0.687 \log X1 + 2{,}480 \log X2 + 0.372 \log X3$$

$$t \text{ statistic} \quad (-2{,}258) \quad (0{,}261) \quad (1{,}637) \quad (4{,}680)^{***}$$

$R^2 = 0.8734$; Durbin–Watson statistic = 1,6378; *** = significant at α 1 %; t table = 2,807

Given that housing development is the key factor behind the massive farmland conversion that has taken place in Yogyakarta, protecting farmland has to be undertaken if the development of the city is to be sustainable. In this regard, a number of approaches can be implemented. The first is controlling the city development itself—specifically, housing development. Strict regulation needs to be implemented by district officials and decision makers, and developers need to be restricted. In other words, there is a need for not only strict regulation but also strict implementation of the regulation on farmland protection. Actually, the government regulation related to farmland protection at the national level was issued in 1992, such as Law No. 24 Year 1992 regarding spatial zoning, including agricultural land use zoning, followed by Presidential Decree No. 55 Year 1993 regarding procurement of agricultural land for public use. However, these laws did not work effectively, as shown by the high conversion rate of agricultural land in the country, including Yogyakarta Province, until the year 2010. It took nearly 20 years (1992–2011) for the government to produce Government Regulation No. 1 Year 2011 regarding determination of sustainable agricultural land for food. In response to this national policy, the provincial government of Yogyakarta ratified Provincial Regulation No. 10 Year 2011 regarding protection of sustainable agricultural land for food. Yet, the effectiveness of this regulation is not known, since this study did not cover the period after the regulation was ratified. Here, it should be noted that the district government (district headman/*bupati*) plays a significant role in issuing permits to housing developers in each district. Although a number of laws and regulations on farmland protection have been made, the enforcement of those regulations in fact is very weak, especially at district level. Unless there is a strong sanction stated in the law and a heavy punishment for district officials who violate the regulation, particularly the district headman, the regulation itself will not be effective, and therefore, the conversion of farmland will continue. The second approach consists of providing incentives for farmland owners, such as tax relief and subsidies, so that farming continues to be a viable operation. The third approach involves establishing a certain fixed area of farmland in every subdistrict or village. This area would operate under strict laws and regulations, and it would be able to ensure long-term food security.

8.4 Conclusions

1. The study has shown that farmland has been intensively converted to other uses, mostly to residential uses, in the city of Yogyakarta, owing to unregulated development of housing complexes over the period from 2000 to 2010.
2. The result of regression analysis shows that the number of housing complexes in the fringe areas of Yogyakarta has a significant effect on farmland conversion. This underlines the fact that the development of housing complexes in the fringe areas has been very intensive.
3. The study found that the loss of agricultural land will continue since the conversion rate is positive and very high. Since this will threaten the sustainability of food security in the region, farmland has to be protected if the city's development is to be sustainable.
4. The study suggests the following: (a) strict controls on housing development are badly needed in the form of strict regulations for developers and heavy penalties levied on corrupt district officials and decision makers; (b) incentives need to be provided for farmland owners to reduce the tendency to sell their farmland; and (c) it is necessary to establish a certain fixed area of fertile farmland in every subdistrict or village accompanied by tax relief program for agricultural land under strict regulations to secure long-term food security. Amendment for such farmland procurement program is badly needed to ascertain the program runs well.

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Chapter 9
Urbanization in the Philippines and Its Influence on Agriculture

Marideth R. Bravo

Abstract This study examined the level and speed of urbanization in the Philippines and its influence on agriculture. Over the last 20 years, the level of urbanization in the Philippines has stabilized, but the tempo has decreased, which implies a higher growth rate in the rural population than in the urban population. The influence of urbanization is seen in terms of the declining share of agriculture in the national economy and a minimal reduction in employment in the agricultural sector. Urbanization has resulted in decreases in the area and fragmentation of farm parcels as well as in the conversion of agricultural lands to urban use.

The process of urbanization resulted in substantial land conversion, which, in turn, led to a drastic decrease in crop production areas and changed the agricultural landscape of the Metropolitan Manila area. It also placed pressure on urban fringes, making land use conversion inevitable in cities. Findings point to the need for concomitant policies to preserve agricultural lands and sustain domestic food production, and promote urban agriculture to create and preserve the green and open spaces in the cities.

Keywords Agriculture • Land-use conversion • Urban agriculture • Urbanization

9.1 Introduction

Urbanization is the process by which rural areas are transformed into urban areas. This transformation process has a number of consequences. In the Philippines, the 1970 definition of urban areas (National Statistics Office (NSO) 1980) was based on the demographic, social, and economic characteristics of the area. This classification is primarily based on population density and the presence of street patterns, establishments, and facilities for basic services.

Under the said definition, urban areas included the following: (a) all cities and municipalities with a population density of at least 1000 people per square

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kilometer; (b) *poblaciones* or central districts of municipalities and cities with a population density of at least 500 people per square kilometer; (c) *poblaciones* or central districts characterized by a street pattern, with at least six establishments and three facilities for social services; and, (d) barrios with at least 1000 inhabitants that satisfied the conditions in (c) and where the inhabitants' occupations were not predominantly farming or fishing.

This 1970 definition was used in population and housing censuses in 1980, 1990, and 2000 (the latest published census). However, for the 2007 census, a new definition (2003) of urban areas[1] was adopted.

This chapter aims to determine the level and speed of urbanization in the Philippines and to establish the influence of urbanization on the agricultural sector in the country as a whole as well as in the National Capital Region (NCR or Metropolitan Manila).

9.2 Methods and Analysis

Data and information for the study were obtained from the following: NSO Census of Population and Housing for 1980, 1990, and 2000; NSO Census of Agriculture for 1991 and 2002 (Philippines and the National Capital Region); National Economic and Development Authority (NEDA) Philippine Statistical Yearbook for 2009; and Department of Agrarian Reform (DAR) data on land use conversion from 1989 to 2010.

Measures of urbanization included the level and speed of urbanization for the various census years. The level of urbanization was measured by the percentage of the urban population in the country and in all its regions. The speed of urbanization was measured using the tempo of urbanization as an indicator of the speed at which an area is moving toward an urban classification. It amounted to the difference between the growth rates in urban and rural populations.

The influence of urbanization on the agricultural sector was determined in terms of the share of the agricultural sector in employment and income as well as by the changes in the number, area, and size of farm parcels in the country as a whole and in the National Capital Region. Areas of agricultural land that had been converted to urban use were also included as a measure of the influence of urbanization on the agricultural sector.

[1]In the 2003 definition of urban areas, a *barangay* is considered urban if (a) it has a population of 5000 or more people; (b) it has at least one establishment with a minimum of 100 employees; or (c) it has five or more such establishments with a minimum of ten employees and five or more facilities for basic services within a 2-km radius of the *barangay* hall. In this definition too, all *barangays* of Metropolitan Manila are considered urban. The definition is cited in the National Statistical Coordination Board (NSCB) Resolution No. 9, Series of 2003.

9.3 Results and Discussion

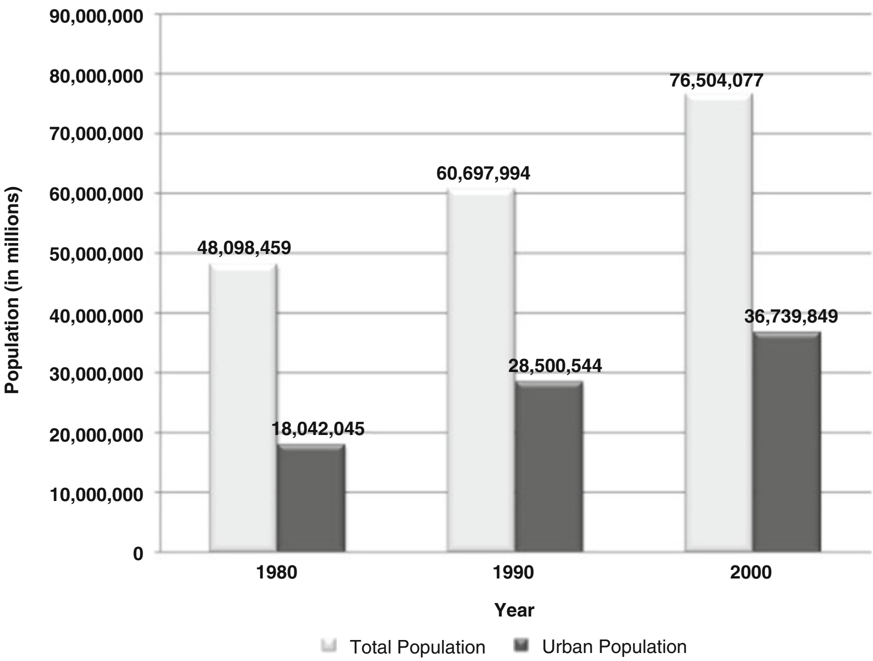
9.3.1 Measures of Urbanization

9.3.1.1 Level of Urbanization

In 1980, the Philippines had an urban population of 18 million, which signified a 37.5 % level of urbanization. In 1990, this figure had increased to 28.5 million or 47 % of the total population. From 1980 to 1990, urban population thus increased by 10.5 million, which corresponded to a 9.5 % increase in the level of urbanization. This indicates that the rise in the urban population was due in large part to increases in the urban area.

In 2000, the urban population was 36.7 million, and the level of urbanization was calculated to be at 48 %. From 1990 to 2000, the urban population increased by 8.2 million, which corresponds to only a 1 % increase in the level of urbanization. This indicates that there was a large increase in the population in rural areas.

Figures 9.1 and 9.2 present the total and urban populations, and the level of urbanization for various census years in the Philippines, respectively.



Source: NSO Census of Population and Housing 1980, 1990, 2000

Fig. 9.1 Total and urban populations in the Philippines (1980, 1990, 2000)

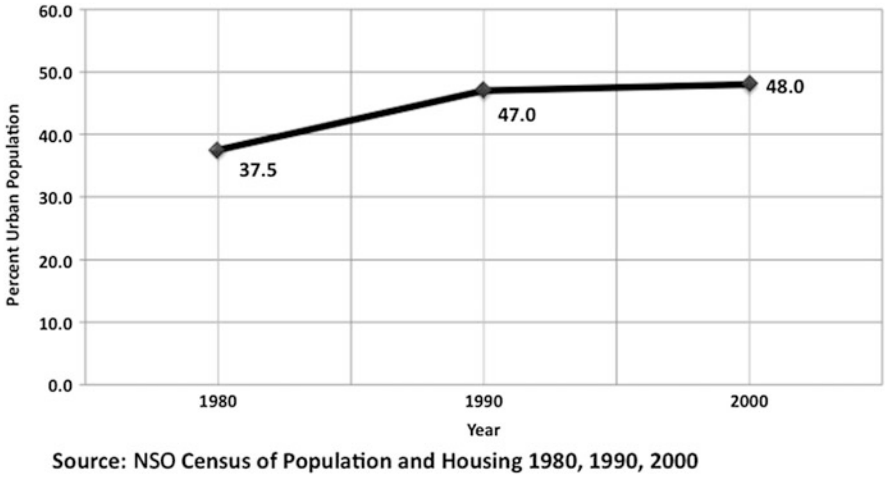


Fig. 9.2 Percentage urban population in the Philippines (1980, 1990, 2000)

9.3.1.2 Urban Population by Region

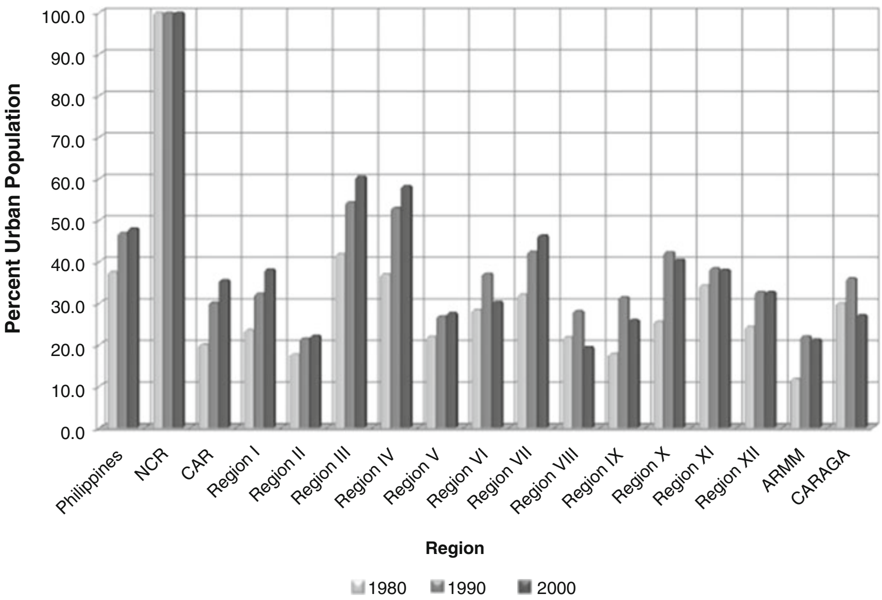
The results of disaggregated data show that all regions in the country experienced an increase in their respective percentages of urban population from 1980 to 1990. This, however, excludes the National Capital Region, which has exhibited a 100 % urban population since 1980. However, from 1990 to 2000, the percentage of the urban population decreased in Regions VI and VIII in the Visayas and in Regions IX and X and Caraga in Mindanao (Fig. 9.3).

All regions in the country manifested a decline in the percentage of average annual growth rate in their urban population in 1980–1990 and 1990–2000. Sharp reductions were evident in the Visayas and Mindanao regions. In fact, for the period 1990–2000, average annual growth rates in the urban population were negative for Regions VI and VIII in the Visayas and the Caraga region in Mindanao (Fig. 9.4). These are considered outmigration regions, where people leave the rural areas to go to key cities in other regions of the country.

9.3.1.3 Speed of Urbanization

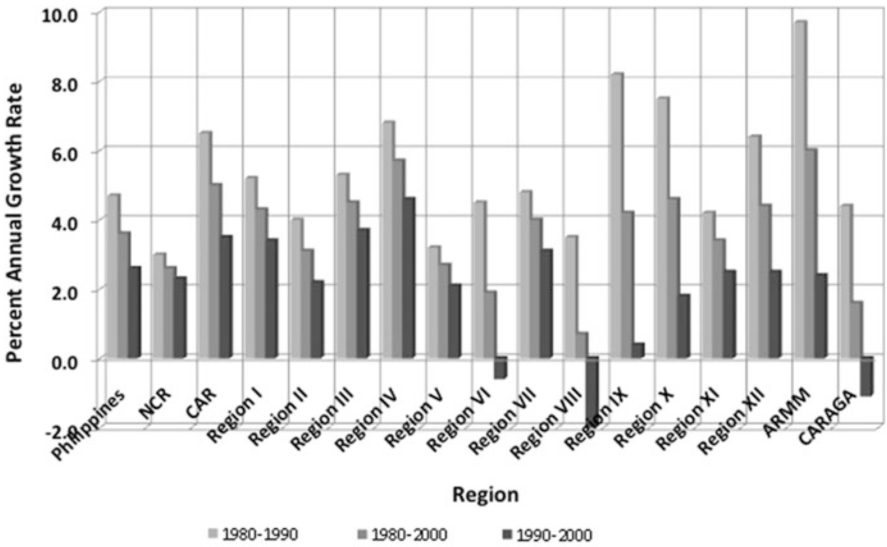
The average annual growth rate of the urban population in the Philippines was estimated at 4.7 % from 1980 to 1990 (Fig. 9.5). This declined to 2.6 % during the period of 1990–2000, which is a net reduction of 2.1 %. This may have been brought about by a large proportion of the urban population going abroad or migrating to other key cities. Two of the most urbanized areas in the Philippines are Regions III and IV-A.

Conversely, the annual average growth rate of the rural population was 0.7 % from 1980 to 1990. This increased to 2.1 % for the 1990–2000 period, which



Source: NSO Census of Population and Housing 1980, 1990, 2000

Fig. 9.3 Percentage urban population by region in the Philippines (1980, 1990, 2000)



Source: NSO Census of Population and Housing 1980, 1990, 2000

Fig. 9.4 Average annual growth rate of urban population by region in the Philippines (1980–1990, 1990–2000, 1980–2000)

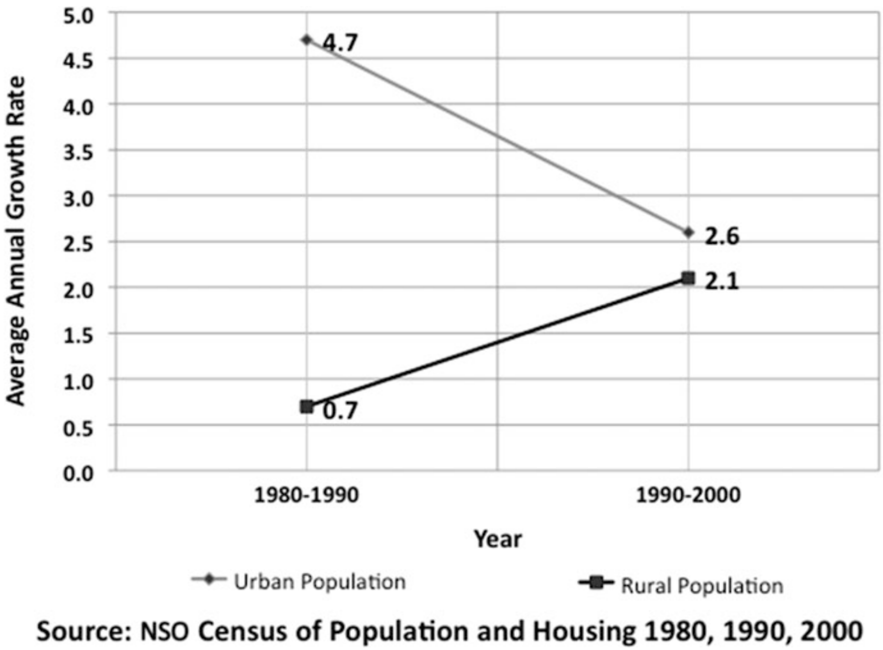


Fig. 9.5 Average annual growth rates of urban and rural populations in the Philippines (1980–1990, 1990–2000)

indicated a net growth of 1.4 %. The increase in ruralization may have been due to inadequate opportunities in urban areas, which made the rural population decide to stay where they were. Population increases in rural areas are brought about largely by natural increase together with a low rate of migration, or movement, to urban areas.

The tempo of urbanization in the Philippines was 4 % from 1980 to 1990 (Fig. 9.6), while the period of 1990 to 2000 marked a decline in the tempo of urbanization to a low of 0.5 %. The reduced speed of urbanization signifies a higher growth rate in the rural population than in the urban population.

The reduction in the speed of urbanization in the country can be explained by the declining trend in the tempo of urbanization in all regions of the country (Fig. 9.7). In fact, Regions VI and VIII in the Visayas and all regions in Mindanao exhibited a negative tempo of urbanization. This means that the rural population increased at a much higher rate in the rural areas during the 1990–2000 period. These regions may be considered outmigration areas. In addition, a very low speed of urbanization was noted in Regions II and V in Luzon.

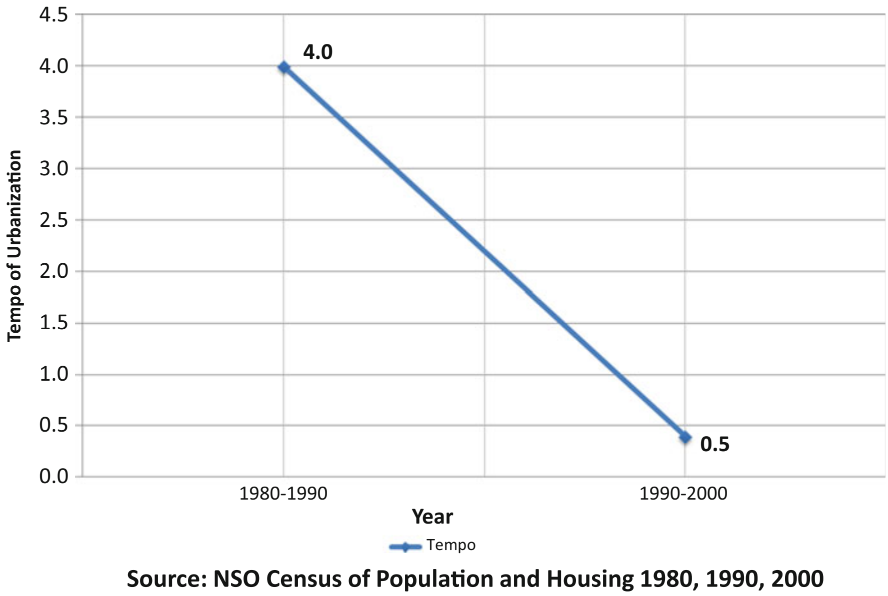


Fig. 9.6 Tempo of urbanization in the Philippines (1980–1990, 1990–2000)

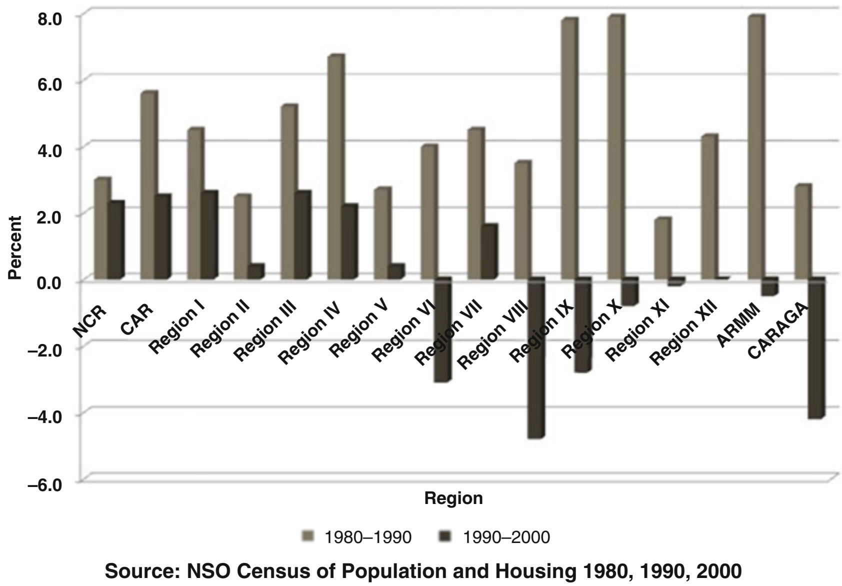


Fig. 9.7 Tempo of urbanization by region in the Philippines (1980–1990, 1990–2000)

9.3.2 *Influence of Urbanization on Agriculture*

9.3.2.1 Shift from Agriculture to Services

From 1994 to 2008, agriculture evidenced a declining share of the gross national product (GNP) and gross domestic product (GDP), which indicates that there was a shift in economic activity from the primary (agriculture) to the tertiary (services) sector (Fig. 9.8). In terms of real GNP, the share of the agricultural sector decreased from 21 % in 1994 to barely 13 % in 2008. As a corollary to this, the share of the agricultural sector in real GDP declined from 22 % in 1994 to only 15 % in 2000 (Fig. 9.9). This sector of industry's shares in GDP and GNP also slightly decreased during that period. This signifies a shift in the nature of economic activity from agriculture to the services sector.

9.3.2.2 Minimal Decline in Employment in Agriculture

Employed persons in the Philippines in the major groups of agriculture, industry, and services totaled 10.8 million in 2001. This figure increased to 12 million in

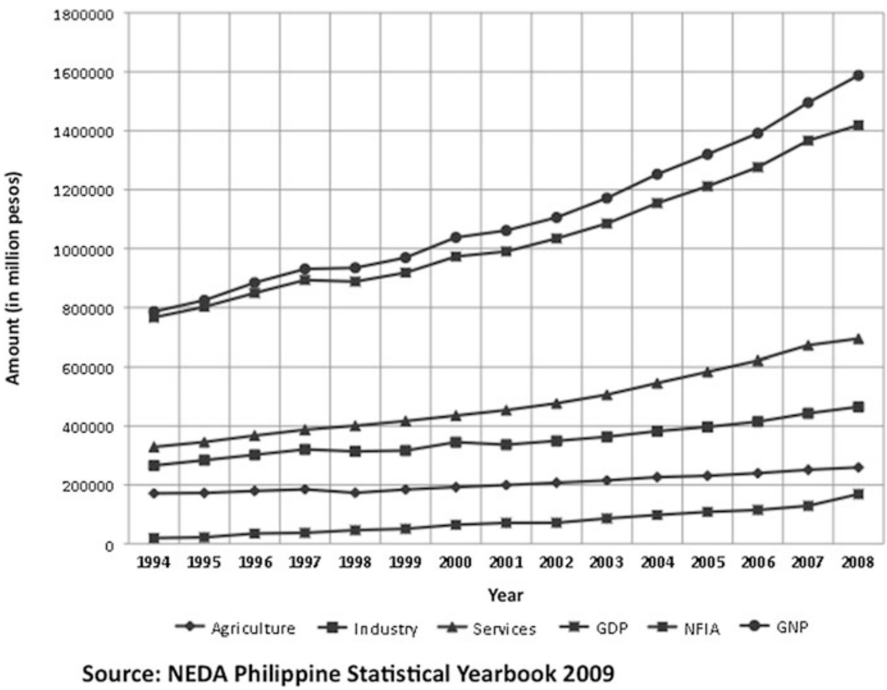


Fig. 9.8 GDP and GNP by industrial origin in the Philippines, 1994–2008 (in million pesos at constant 1985 prices)

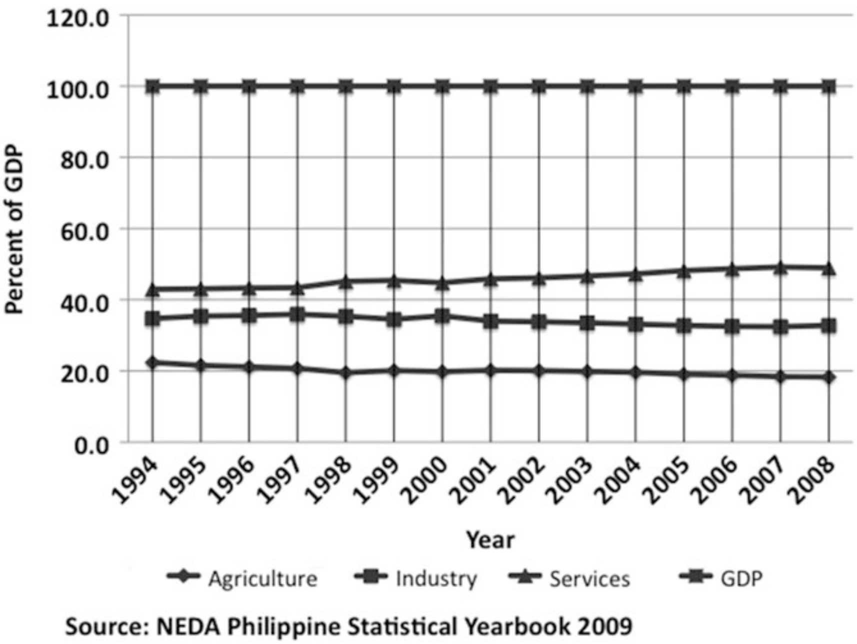


Fig. 9.9 Share of industrial origin in GDP in the Philippines, 1984–2008 (in million pesos at constant 1985 prices)

2008. The share of the agricultural sector in total employment minimally declined by 2 %—from 37 % in 2001 to 35 % in 2008. The average growth rate of employment in agriculture was 0.8 % per year for the period under consideration. The share of this industrial sector in total employment likewise decreased from 16 % in 2001 to 15 % in 2008 or an average annual rate of decline of 1 %. The share of the services sector accounted for almost half of total employment: it increased from 47 % in 2001 to 50 % in 2008—an average annual growth rate of 1 %. Considering the share of these sectors in the national economy, the results imply the decreasing productivity of labor in the agricultural sector vis-à-vis industry and services. Figure 9.10 shows the share of employment by major industry group in the country from 2001 to 2008.

9.3.2.3 Decrease in Area and Size of Farms

The Census of Agriculture data show that the total area of farm parcels in the Philippines decreased from about 9.97 million ha in 1991 to 9.56 million ha in 2002. This indicated a decrease of 414,000 ha over a period of 12 years. Nonetheless, there was greater fragmentation of the farm parcels, as evidenced by the increase in the number of farm parcels by 125,000—from 4.8 million to 4.9 million—and the reduction in the average size per parcel from 2.1 to 1.9 ha during

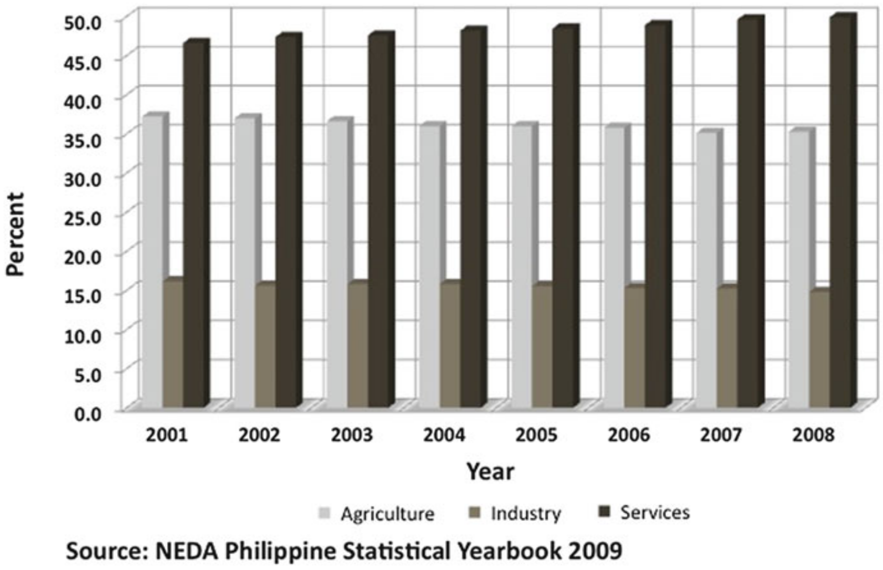


Fig. 9.10 Share of employed persons by major industry group in the Philippines, 2001–2008

the same period. The figures point to fragmentation of the farm parcels in the Philippines.

There was a reduction in the area planted in palay from 4 million ha in 1991 to 3.8 million ha in 2002—a decline of 200,000 ha over 12 years. There was also a decrease in the area planted in corn—from 2.7 million ha in 1991 to 2.4 million ha in 2002 (NSO, 2002). These results imply a threat to food production, considering that such major crops as palay and corn are staple foods in the Philippines. The planting of these crops is unable to compete with the spread of urban sprawl.

9.3.2.4 Conversion of Agricultural Lands

From a physical perspective, urbanization is linked to changes in land use from predominantly agricultural to urban utilization. This leads to a shift in economic activities toward the industrial and service sectors.

Applications for land use conversion approved by the government from 1989 to 2010 totaled 35,015 ha. About half of this land (46 %) was intended for mixed-use development and 28 % for residential purposes (Fig. 9.11). This implies the continuing demand for more land for various urban uses as a consequence of increasing urbanization. Regions IV-A (CALABARZON) and III (Central Luzon), which are the leading regions in terms of urbanization, accounted for the highest share in land use conversion (Fig. 9.12). The land use conversion, however, is concentrated in the urban fringes of Metropolitan Manila.

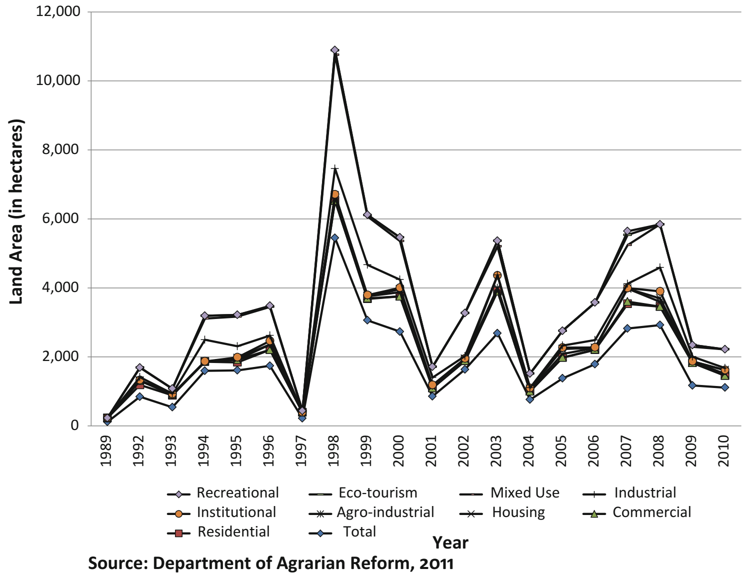


Fig. 9.11 Land use conversion approved by the Department of Agrarian Reform in the Philippines, 1989–2010

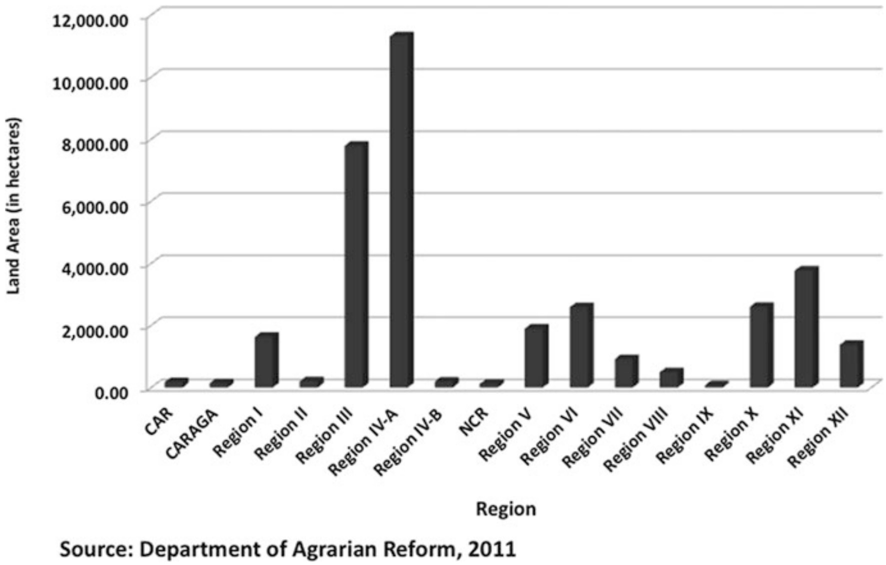


Fig. 9.12 Land use conversion approved by the Department of Agrarian Reform by region in the Philippines, 1989–2010

Cost-benefit analysis of various combinations of agricultural lands converted to urban uses in Cavite, a province in the urban fringe of Metropolitan Manila, showed the financial viability, as well as the net benefits to society, of the new land uses (Cardenas 2009). Nonetheless, urban sprawl may pose a threat to the ability to meet the demand for food due to land use changes associated with urbanization and increased competition for irrigation water (Matuschke 2009).

The process of urbanization led to rapid land use conversion in urban fringe landscapes featuring idle agricultural lands because of residential subdivision lots that remain unsold and abandoned agricultural lands (Malaque and Yokohari 2007). This is consistent with the findings by Azadi et al. (2010) that agricultural land loss is more intensified in developing countries experiencing rapid economic growth and a transition in economic structures. This implies the need for land policies to preserve agricultural lands in order to sustain food production in the country.

9.3.3 Urban Agriculture in the National Capital Region

Using the Census of Agriculture data for 1991 and 2002, we take a closer look at the consequences of urbanization on agriculture in the National Capital Region. The area of farm parcels drastically declined from 4494 ha in 1991 to only 818 ha in 2002. The number of farm parcels likewise decreased from 12,667 to 7260 over the same period. Thus, the average size per parcel sharply declined from 0.35 ha in 1991 to only 0.11 ha in 2002.

In 1991, there were still areas planted in palay (988 ha), corn (159 ha), cantaloupes, honeydew and other melon varieties (91 ha), watermelon (67 ha), and native tobacco (48) in the National Capital Region. In 2002, only 21 ha were planted in palay and a few hectares were planted in *gabi* tubers, camote, camote tops, and *alogbati* (NSO 2002a, b). In terms of irrigation, a total of 186 ha were irrigated in 2002, consisting of individual systems (43 %), the national irrigation system (6 %), and other irrigation systems (51 %) including water fetching and the use of water wheels. These findings affirm the effects of agricultural land conversion on food production, as a result of the urbanization process.

Areas under permanent crops and temporary crops constituted 52 % and 38 %, respectively, of the total area of farm parcels in 1991 (Fig. 9.13). By 2002, the agricultural landscape had drastically changed, considering that 90 % of the agricultural area was now categorized as home lots. By 2002, areas under temporary and permanent crops sharply declined to less than 10 % of the total. Urbanization has intrinsically caused the loss of green and open space in Metropolitan Manila. Likewise, the number of other agricultural activities, primarily in growing ornamental plants other than orchids, decreased in the National Capital Region. Increasing agricultural activity was, however, noted in growing orchids, mushroom culture, bee culture, and vermiculture (NEDA 2009).

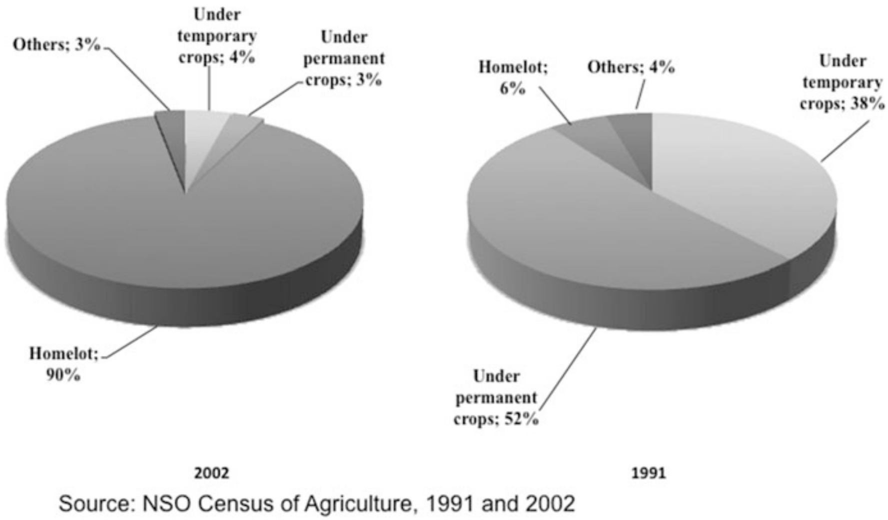


Fig. 9.13 Distribution of area of farms by main land use in the National Capital Region, 1991 and 2002

The urbanization process also placed pressure on the urban fringe of the National Capital Region due to a national policy on industrial dispersal, making land use conversion a common phenomenon in the cities (Azadi et al. 2010).

The above findings point to the need for policies aimed at creating and conserving green spaces in the National Capital Region as a potential ecological function to absorb pressures brought about by urbanization (Malaque and Yokohari 2007). Concomitantly, a policy or program on urban agriculture is essential to promote green and open spaces and to enhance the adoption of appropriate agricultural technologies on limited agricultural lands.

9.4 Conclusion

The level of urbanization in the Philippines has stabilized at about 48 % over the last 20 years despite the continued increase in the urban population. The speed of urbanization has declined from 4 % to 0.5 % during the same period. This signifies a higher growth rate in the rural population than in the urban population.

Urbanization has brought about a shift in economic activity from the primary (agricultural) to the tertiary (service) sector in the country. This is evidenced by the declining share of the agricultural sector in the country's GNP and GDP in favor of the service sector. Despite this change, however, there has been a minimal decrease in employment in the agricultural sector. This means that labor productivity in agriculture has declined vis-à-vis the industrial and service sectors.

Urbanization has led to a decrease in the total area of farm parcels by 414,000 ha over the last 12 years, but the number of farm parcels has increased by 125,000, which indicates smaller parcel sizes. There has been a decline in the area planted in staple crops, such as rice and corn, and an increasing trend in the proportion of home lots. This is a cause of concern for domestic food production.

Urbanization has resulted in a continuing demand for urban land. This is evidenced by the land use conversion from agricultural to urban utilization, predominantly for mixed-use and residential development.

Although the agricultural landscape has drastically changed in the National Capital Region in terms of decreased areas under temporary and permanent crops, agricultural activity has increased in the limited available agricultural land. The urbanization process also puts pressure on the fringes of the National Capital Region, making land use conversion a phenomenon in the cities.

The consequences of urbanization point to the need for policies on urban agriculture to promote more green and open spaces, and to promote more agricultural activities and preservation of agricultural lands.

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Chapter 10
The Landscape of Bangkok's Agricultural Fringe and City Region Sustainability: An Ecological and Cultural Co-evolution

Danai Thaitakoo and Brian McGrath

Abstract The urban hydro-agricultural complex of the Chao Phraya River Delta was radically transformed as a result of Bangkok's rapid and expansive urbanization over the last 50 years. While the delta and the city are now in conflict, they were once entangled in a highly resilient absorbent agricultural matrix in concert with climatic cycles of monsoon and dry seasons. Urban planning and design education and research can begin to address the pressing need for adaptation to urbanization in this megacity through a careful reexamination of the evidence of the resilient performative capacity of this delta city's past through systematic archival, remote sensing, and field observation. Understanding of historical resilience and adaptation of living with water evident in indigenous and traditional processes are crucial in land and waterscape planning and design for the Chao Phraya Delta's city region future.

Keywords Agricultural fringe • Agricultural matrix • Landscape changes • Historical resilience and adaptation • Indigenous knowledge

10.1 Introduction

Day and night oscillate neatly between predictable 12 h divisions and months pass with little change in temperature. Between May and October, a shift in atmospheric currents brings monsoon rains from the Indonesian archipelago north to the mountain ranges ringing northern Thailand whose runoff feeds the Chao Phraya River Basin and Bangkok sprawling across its flat, silted tidal delta (Fig. 10.1). Seasonal cycles of precipitation rather than temperature extremes of winter and summer

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Fig. 10.1 The watery Chao Phraya Delta, with Bangkok sprawling into rice fields to the east and fruit orchards on the west bank (Satellite image source: The Global Land Cover Facility, www.landcover.org)

bring rhythm to life just above the equator, putting into motion human cycles of planting, harvest, and migration, as well as shaping Thai beliefs and rituals.

Bangkok, the capital of Thailand, is situated in a slight deltaic high amid a predominantly low-lying, flat terrain of the lower Chao Phraya River Delta (Fig. 10.2). The area was first urbanized during the Ayutthaya period (1350–1767), as a vast network of mixed-fruit orchards and market towns planted within a harsh marshland (Tachakitkachorn 2005). The rapid development of the lower delta for export rice cultivation affected the rapid urbanization of the city of Bangkok (Takaya 1987). In the early years, many canals were constructed and functioned as highways (Takaya 1987).

Fig. 10.2 Bangkok's urban–agriculture–rural mosaic

The canals radiated outward from the center of the city, providing access to the city center as well as the agricultural market towns along the waterways. Along the canal banks were homes and shop houses. The lands in between were fruit orchards and rice paddies. The early residents relied upon canal and river water for their basic needs (Jarupongsakul and Kaida 2000).

During the beginning period of city establishment (1782–1900), Bangkok grew rather slowly. The city's rapid urbanization and increase in population started after the Second World War (BMA 2004). These rapid changes brought the land-based infrastructure and other constructions that resulted in a rapid increase in the built-up area (BMA 2004) at the expense of cultivated land and the hydrological matrix. The swift expansion of Bangkok's industry and suburban development occurred in the late 1960s and 1970s.

Consequently, the growing demands for housing sprawled eastward into the paddy fields (Jarupongsakul and Kaida 2000). The rapid urbanization also affected the city's unique and vast canal network, which became secondary to the construction of roadways through the rapid urbanization. The network once considered a lifeline became much neglected and ignored, yet still fragility persists in many areas. The major mechanism that keeps the delta habitable and prolific has been damaged (Jarupongsakul 2000) and creates hardships for the many farmers who continue to rely on the waterways. Many canals were filled up for developments or replaced by the construction of new roads, while many others became stagnant and non-navigable, reduced to drainage ditches and open sewers.

A careful reexamination of the historical resilience and adaptability of living with nature of indigenous knowledge and local wisdom would be crucial for dealing with future uncertainty such as climate change.

10.2 Materials and Methods

This chapter is organized around three overlapping eras of historical research in the socionatural systems that constitute the Chao Phraya Delta region, as well as three periods of modern urbanization change in Bangkok. The first occurred from around 1950 to 1970. The long-term field work on the social ecology of the rice-growing village of Bang Chan, east of Bangkok, by social scientists from the Cornell Thailand project—Lucien M. Hanks' *Rice and Man: Agricultural Ecology in Southeast Asia* (1972)—is examined.

The second period of examination is from 1970 to 1990—research from the Center for South East Asian Studies at Kyoto University, Japan. The works examined include Shigeharu Tanabe's *Historical Geography of the Canal System in the Chao Phraya*, 1977, Yoneo Ishii's *Thailand: A Rice-Growing Society,* 1978, and Yoshikazu Takaya's *Agricultural Development of a Tropical Delta: A Study of the Chao Phraya Delta,* 1987. Together they produced comprehensive historical surveys of a rice-growing society.

Finally, we examine the development of Bangkok from 1990 to the present and the emergence of transnational researchers in the last 20 years in new research, which reflects an acute understanding of the challenges facing the city in the future in conjunction with systematic archival historical records, documents and maps, remote sensing, and field observation. This emergent research and educational field represents a method for achieving urban design models that grow out of more intimate knowledge of the Thai cultural and environmental historical contexts, especially in the examination of a complex ecosystem.

10.3 Results and Discussion

10.3.1 The East Bank: Wet Rice Cultivation and Subdivisions

Minburi was the site of Lucien Hanks' landmark human ecosystem study of the Ban Chan rice-growing community. Hanks demonstrated extended-family households who responded to changing market and technological conditions through an intricate feedback system and how village-level decisions affected environmental change in concert with shifting market trends (Hanks 1972). The present landscape is much more fragmented and heterogeneous, with many methods of cultivation and

Fig. 10.3 Wet rice cultivation: rice and festive fields

Fig. 10.4 Wet rice cultivation and subdivisions

income-producing activities competing, and various stages of planting, growth, and harvesting coexisting. Historical evolution and seasonal rhythms have collapsed into a mixed-time image of lapsed land use fragmentation and superposition.

The endless flat plain of Rangsit (Fig. 10.3) consists of 200,000 ha with no large rivers or topographic relief. In the 1890s, Dutch hydrologist Homan van der Heide, the first director-general of Siam Land, Canals and Irrigation Co., who worked for the Thai government between 1902 and 1909, rationally planned the diversion of water through 20 straight north–south canals, 30–40 km long and spaced at 2 km, with smaller numbered irrigation canals repeated at 1-km intervals. Large areas were opened up for habitation as feeder canals assured a steady water supply for newly developed paddy fields. In the early twentieth century, the Bangkok periphery became the primary rice bowl for the region and the kingdom's primary economic base. A modern irrigation system created a human-controlled water system where growing cycles could be in sync with markets rather than seasonal precipitation (Takaya 1987).

Now, however, the emerald-green carpet of Rangsit's fields extends in narrow rows checkered with a gray pattern of new housing and factory estates. Developers have planted these crowded single-family homes and factories in dense rows on the kingdom's most fertile soil (Fig. 10.4). Fishing nets are suspended over the waterway, and narrow wooden pedestrian bridges cross to rice-farming villages hidden behind jungle-like vegetation. A few kilometers down the road, a huge decorative

Fig. 10.5 Abandoned mixed-fruit orchards and coconut groves revert to wild grasslands awaiting new housing estate development and a vegetable farm consisting of a variety of market vegetables and herbs: lemon grass, ginger, spring onions, lettuce, and other leafy greens

gate marks the entrance to a new housing estate perpendicular to the canal. Inside, a faux-New-England-common green lawn is lined with concrete colonial homes with terracotta roofs crowded together within the former rice plot.

10.3.2 The West Bank: Crossing the Meanders—Orchards, Gardens, and Gated Communities

The thickly vegetated orchards along the river meander; this area is a poldered flood control reservoir, where excess water from the city center is discharged. A west bank orchard and vegetable garden consists of a corduroy pattern of rows of small dredged ditches alternating with built-up mounds (Fig. 10.5). The layered tree canopy of a deltaic mixed orchard consists of spindly betel nut and sugar palms at the highest level, blocking little sunlight from the next layer of coconut palm, durian, mango, pomelo, jackfruit, star fruit, mangosteen, guava, rambutan, rose apple, banana trees, and orange saplings. The lowest layer consists of vegetables or herbs, benefiting from the filtering of the strong tropical sun. However, all over the west bank, this cool, aromatic, and verdant mix—the green lung of greater Bangkok—is rapidly being replaced by upmarket gated housing estates taking advantage of the attraction of a lush green area now minutes away from the center of the city.

Coconut palms still line the major supply canals, but much land is uncultivated. Labor-intensive fruit production has declined and farmers widen irrigation ditches below in order to farm fish inside the orchard canals. The type of fish varies depending on market demands and water quality, and provides a temporary source of income on land awaiting redevelopment.

10.3.3 Landscape Structures, Functions, and Changes

The Chao Phraya River Delta's rice-growing society is a complex socioeconomic–ecological relationship of structures and functions and changes (Ishii 1978; Brummelhuis 2007). Based upon the conditions of the climate (Kyuma 1978), topography (Takaya 1987), and soil (Hattori and Kyuma 1978), the lowland/wet rice cultivation has been adopted in accordance with nature (Hattori and Kyuma 1978). The landscape and people evolved together through rice cultivation with indispensable water into a rice economy (Ishii 1978). The rice economy was significantly influenced by water availability, thus traditional water management was in place for distribution of water and flood control at a small scale in accordance with hydrological and topographical characteristics with a unique local social organization (Ishii 1978; Brummelhuis 2007).

The lower part of the Chao Phraya River—the geomorphologically younger part of the delta—is a part of "the center of the geographical living space" of Thailand (Tanabe 1977). This view was built upon the capability of the landscape to provide functions or potentials for human inhabitation and exploitation, such as the capacity to produce food and resources, and the capacity to build human habitats and places—a self-regulated environment, based on the resilience of the landscape's ecosystem and the capability to link with aesthetic, scientific, cultural, and other interest of human kind (Zonneveld 1988).

The alteration of the delta landscape during Bangkok's early days was land reclamation for rice culture and human settlement. The construction of vast canal networks was the process of turning the swampy land into a prolific producer by way of irrigation and drainage (Takaya 1987). The vast canal network also functioned as highways providing accessibility to the landscape, the surrounding area and beyond, as far as the waterway went (Takaya 1987). The Chao Phraya River and the vast network of canals were bloodlines for Bangkok's residents. As a part of their lives, people lived in concert with the natural hydro-ecological process floods and flooding. Adaptation was the key in living with the rhythm of the natural process by building their living environment according to hydro-ecological dynamics without any action against the course of the natural process.

The tributary cultural geography in the Chao Phraya River Basin terminates in the distributary network of an endlessly meandering network of natural streams and constructed waterways in and around greater Bangkok. Absorbing, distributing, and retaining water during the dry season and draining excess water during the wet season, the vast network of canals brings tangible evidence of the region's larger hydrological cycles to the details of everyday life in the historically urbanized delta.

The recent trend of urban growth is concentrated in the urban fringe area—a transition between the inner city and the outer part or suburb area. This urban–rural intermixed area can be characterized by the sprawl of old and new residential estate developments, clusters of industrial estates, strip developments of commercial areas along the roads, and large shopping centers. These settlements situated in

Fig. 10.6 The vanishing land and waterscape: rapid changes brought the number of land-based infrastructure and other constructions that resulted in a rapid increase in the built-up area at the expense of cultivated land and the hydrological matrix (Adapted from Sternstein 1982)

the old agricultural areas can be viewed as the pattern of patchy human developments in the matrix of agricultural and open fields.

The rapid development of the lower delta for export rice cultivation affected the rapid urbanization of the city of Bangkok (Takaya 1987). The growth of the nation and the city brought rapid urbanization to the low-lying flat terrain of the lower Chao Phraya Delta. Once considered unsuitable for human habitation (Takaya 1987), Bangkok has grown into a tropical megacity. One of the major losses through the rapid urbanization of the city is Bangkok's unique vast canal network (Fig. 10.6). The network once considered a lifeline has been neglected and abandoned (Jarupongsakul 2000). The plight of climate change compounds an already complex ecosystem with many conflicts between the delta and the city dynamics. The delta and the city present threats to each other due to a lack of both recognition of natural hydrological processes and the indigenous and traditional knowledge of living in concert with the natural cycles of the wet and dry seasons. The dynamic of the space–time relationships of humans and nature has failed to recognize the importance of the hydro-ecology of the landscape of the city.

10.4 Conclusions: Urban Agriculture and City Region Sustainability: A Coevolution

The daily acts of eating, breathing, and drinking bring awareness to the sensory aspects of existence and give insight into comprehending the city as an ecosystem. Taste and sensual pleasure are design tools that take into account the biophysical and sociocultural life-support conditions of a city. The periphery of Bangkok leaves the oily and bitter aftertaste of environmental degradation and rampant land speculation amid the struggles of small farmers.

Because of ineffective land use planning, an ambition greenbelt plan as a sprawl-containment strategy is not possible in this rapidly developing metropolis already marked by a vastly dispersed industrial and residential fringe, where orchard and rice farmers struggle behind car manufacturing plants and chains of suppliers, or in the path of voracious housing development. Instead, localized strategies must be deployed on the ground. The revaluation of pockets of the city's agri- and aqua-cultural fringe in order to provide breathing space, temperature moderation, water quality maintenance and new perspectives is critical.

The cultural production of localities within such disjunctive flows is quite complicated work and requires new collaborative tools developed between design, education, ecology, and social research. The ecological theory of patch dynamics (Pickett 2004) reflects a paradigm shift in the understanding of socionatural urban interrelationships, and better equips us to tackle the design and planning challenges of greater Bangkok's shifting mosaic of farm, factory, and housing development strung together along the urban fringe.

We suggest the possibility of a bottom-up approach for emerging democracy and sustainable development. In recognizing patchy rather than centralized urban development, localized air quality, water quality and food quality management could be strung among the underutilized open spaces concentrated on the orchard meanders and the long, ancient irrigation canals, made visible and publicly accessible. Physical connections provide feedback loops between farmers, consumers, and policy makers. This is not just an engineering solution toward sustainability, but the recognition of a patchy new symbolic realm as well as a sensual and seductive new cultural space where water and agricultural lands can become the fuel source for the mobile culture on both roads and canals to reweave the geo- and aqua-bodies into a new cultural landscape.

We also suggest a radical shifting in emphasis from the current "solid state" of "landscape" urbanism, toward a more systemic approach to urban ecosystem understanding in urban and landscape planning and design—a "waterscape" urbanism—a water-based urbanization based on agriculture. Thai urbanity and domesticity evolved from intimate association with climatic, topographic, and hydraulic conditions. River-, canal-, and lagoon-based garden cities retained 6 months of rainwater for the following six dry ones, staging ceremonies and rituals in sync with attentive observation of hydrological cycles and variations.

Contemporary Bangkok might look to the historical context of Thai waterscape urbanism for solutions to the pressing problems of vanishing urban agricultural land and climate change: a premodern, locally controlled, human ecosystem watershed model structured and sustained Thai cities for centuries. An animist tradition combined with an inherited Hindu–Buddhist cosmological framework created a tributary culture for a locally managed forest and agricultural production society with a Dhamma King, as the symbolic Lord of Life symbolized through water. A reassessment of how river and water flows have been adjusted to pass around and through cities, rather than being flushed under them, is critical in order to create new dynamic design models of urban ecosystems. The understanding of historical resilience and adaptability to living with water of indigenous and traditional

Fig. 10.7 Images of a house with differences in the water level during a normal high tide (Jan. 2011) (*left*) and during a flood (Nov. 2011) (*right*) demonstrate historical resilience and adaptation of the water community in terms of indigenous knowledge of living with water as the foundation of a bottom-up approach

processes would be crucial for dealing with future uncertainty. This is not just a historical model; contemporary urban ecosystem designs around the world are looking for ways to retain water in cities (McGrath et al. 2008). Contemporary urban ecosystem science and Thai urbanism both point to the creation of cities as water retention systems for sociocultural as well as environmental reasons.

During Thailand's worst flooding in recent history in 2011, when all government measures had failed, the human and community resilience and adaptability proved to be crucial capabilities that maintained livability through the disaster (Fig. 10.7). Learning from the survivability of indigenous knowledge, planning for resilience and adaptation is crucial and requires the integration of adaptation principles based upon the experiences of water communities (Thaitakoo and Shaw 2010) as follows:

Eco-community: Recognizing the intimate relationship between humans, communities, society, and the water system, eco-community means integrated environmental, ecological, social, and economic considerations in building a sustainable community with an adaptive organizational structure and function.

Livelihood: A livable livelihood of the water community will require appropriate livelihood adaptation strategies for the changing living environment. Water-related cultural activities are an essential part of raising awareness and building a profound relationship with the water system and other people in the community. Transboundary linkages and connectivity across all levels and scales, such as local, regional and national, will enhance livelihood, cooperation, and partnership among stakeholders.

Indigenous Knowledge and Traditional Systems: Indigenous knowledge and traditional systems of water management and governance structure and function have been through a long history of coevolution. Utilizing and building on indigenous knowledge and traditional systems is the proper establishment, enhancing indigenous knowledge and traditional systems potential and mitigating their limitations with practical technology. Transferring of indigenous knowledge and traditional systems across all levels and generations is the key to maintaining intimate knowledge and relationships between the community and the water system and also sustaining profound understanding of the water system and social dynamics in order to prepare a sustainable future pathway.

Adaptive Capacity: Learning, education, and transferring of indigenous knowledge and traditional systems are critical elements of the adaptive capacity of a community to recognize and respond to environmental changes. Strong social capital, such as trust, cooperation, profound partnership, and committed volunteerism coupled with capacity in terms of flexibility, resilience, and adaptability to change is the mechanism for adaptability. Community preparedness in terms of examining the capacity and conditions in the community from which strategies can be developed and enhanced is a key to develop resilience and adaptability.

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Chapter 11
Infectious Risk Assessment with Exposure to Pathogens in Floodwater—A Case Study of Manila's Vulnerability to Climate Change

Tran Thi Viet Nga and Kensuke Fukushi

Abstract Waterborne diseases are caused by pathogenic microorganisms that are directly transmitted when contaminated water is consumed or contacted. In the flood season, there is a higher risk of infection due to more frequent direct contact with severely polluted water over a longer period. In this chapter, we aim to characterize and quantify the human health risks associated with varying levels of exposure to pathogens present in flood water. In our analysis, exposure scenarios according to inundation levels are developed in which direct and indirect contact with polluted water is assumed to occur. The risk of gastrointestinal illness due to *Escherichia coli* via incidental ingestion of flood water in the City of Manila over the course of a year varies according to inundation level and age. The risk level ranges from 1 % to nearly 20 % in flood levels of l m or less to over 2 m. The highest level of risk is to the 5- to 14-year age group. However, if flood heights of more than 2 m become the norm due to climate change, and these floods occur more frequently and last longer, then the vulnerability baseline for all groups will shift accordingly. To verify the health risk estimation, data need to be collected for group behavior during floods and for the quality of the inundation water. Our purpose was to quantify climate change–related risks. In the case of illnesses caused by flooding, this quantification can be employed to make a rapid assessment of threatened areas where data, time, and resources are lacking.

Keywords Flood • Climate change • Infectious risk assessment • Manila City

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11.1 Introduction

Metro Manila is the social, economic, and political core of the Philippines (Fig. 11.1). One of the most serious problems this city faces is perennial flooding. Metro Manila is situated in a tropical monsoon climate zone, and the occurrence of typhoons and other serious climatic conditions combined with being located exactly at sea level results in frequent floods. Further, rapid urbanization, the poor capacity of river channels and drainage facilities, inadequate maintenance, growing informal settlements, institutional problems, and financial constraints exacerbate the flooding situation (JICA 2001).

Previous studies on infections related to flooding have largely been prospective epidemiological microbiological investigations into the measurable health effects associated with swimming in contaminated surface waters. Cabelli et al. (1982) reported an illness associated with such swimming as an acute, relatively benign form of gastroenteritis with a short incubation period and duration. In the flood season, people have a higher risk of infection by waterborne pathogens because of the frequent contact with water that may be severely polluted.

The study presented in this chapter aims to characterize and quantify human health risks associated with exposure to pathogens present in floodwater. In this analysis, different exposure scenarios according to various inundation levels were developed, whereby direct and indirect contact with floodwater was assumed to occur. The probabilities of gastrointestinal infection were estimated based on established dose–response relationships for the indicator pathogen—*Escherichia coli*—being present in the floodwater. The study area was Metro Manila (hereafter, Manila), which had a population of 1,158,117 as of May 2000.

A key factor in determining health risks involved in exposure to pathogens in surface water is the volume of water ingested. To date, no studies have estimated the volumes of accidental ingestion by a person living in a flood zone. We have therefore adopted the recommendations of the US Environmental Protection Agency (EPA) for exposure during swimming or wading for different age groups. We assumed that residents do not evacuate or move to another place after flooding occurs. Since we do not possess any field data to support our assumptions, the estimated results may be over- or underestimated.

11.2 Materials and Methods

11.2.1 Data

In this study, we used data provided by the Climate Risks and Adaptation in Asian Coastal Mega-Cities study, conducted jointly by the Japan International Cooperation Agency, World Bank, and Asian Development Bank, to create population density maps, evaluate the current situation with regard to risk from inundation,

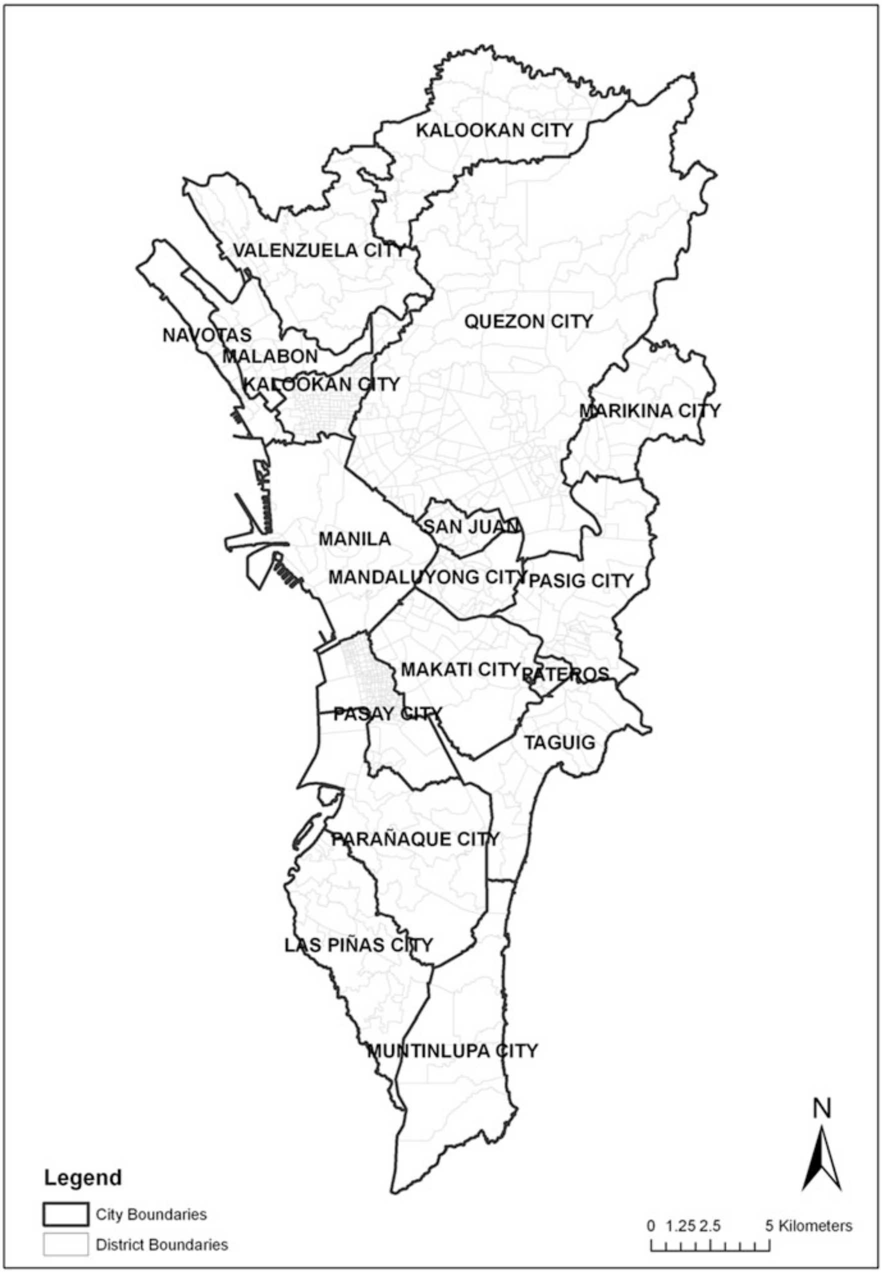

Fig. 11.1 Map of Metro Manila and the study area. This map was created by displaying polygons of district boundaries in ArcMap 9.2

and calculate risk assessment (JICA 2010). These data included the *barangay* boundaries of Manila as of 2003 as well as the city's barangays grouped by district (*barangay*: Philippines' lowest unit of administration; Filipino for village, district, or ward). Population statistics were based on the census conducted by the National Statistics Office in 2000 (NSO, 2000). GRID data were established using inundation scenarios

11.2.2 GIS

ArcGIS 9.2 software from the US Environment Research Institute (ESRI) was employed to match the population distribution with boundary districts. The shapefile we created contained data relating to the district boundaries of Manila as of 2000 and it was combined with population data for 2000. From this shapefile, the population density (people/ha) map was created. The GRID data on inundation were used to produce the inundation map. For this map, we employed the minimum level (in meters) of the inundation in 2003. Risk assessment was calculated with respect to different exposure scenarios according to various inundation levels. These results were then combined with the inundation map to create a new map that indicated the potential risk at different locations.

11.2.3 Exposure Scenarios

Human health risk assessment was conducted by evaluating the risk associated with pathogen (*E. coli*) exposure in flooded areas under the following scenarios: (1) an inundation depth of 0–50 cm; (2) an inundation depth of 50–100 cm; (3) an inundation depth of 100–200 cm; and (4) an inundation depth of over 200 cm (Table 11.1). These scenarios were chosen based on the impact of flooding on daily life (Flood Fighting Act, Japan 2001).

Owing to differences in gender, age, profession, and standard of living, there are differences in vulnerability, experience, coping behavior, and response with respect to flooding among various groups of people. Because of data limitations, the present analysis focused on the age factor. The population of Manila was divided into four age groups: (1) under 4 years; (2) 5–14 years; (3) 15–59 years; and (4) over 60 years (Fig. 11.2). The data were based on the census conducted by the National Statistics Office in 2000 (NSO 2000). The daily activity and behavior of each age group were then examined by reference to the literature to determine the amount of time individuals would spend in direct contact with the water in the event of a flood (Donovan et al. 2008).

In this study, the concentration of *E. coli* in floodwater was used to evaluate the health risk, and the exposure route was assumed to be ingestion. Default ingestion intake values were derived from the USEPA Risk Assessment Guidance for

Table 11.1 Classification of inundation depth

Level	Inundation depth	Human impact
I	0–50 cm	Most houses remain dry, and it is still possible to walk through the water
II	50–100 cm	There is at least 50 cm of water on the ground floor of houses
III	100–200 cm	The ground floor of houses becomes flooded
IV	>200 cm	Both the first floor and often also the roof are covered by water

Note: Classifications based on the Flood Fighting Act, which have been revised in 2001 to inundation mapping

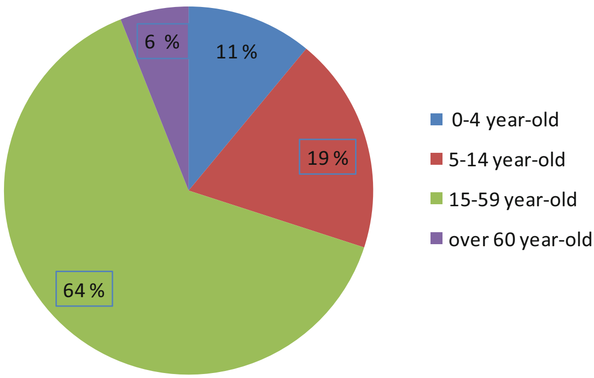

Fig. 11.2 Distribution of age in Metro Manila (Source: NSO, 2000 Census of Population and Housing)

Superfund (RAGS), volume I (USEPA, 1989). For each exposure scenario, risk was initially calculated for a single exposure event.

11.2.3.1 Inundation Depth of 0–50 cm

This scenario assumes direct contact with floodwater while walking on a road. For the purposes of this assessment, it was assumed that in one day the total amount of time spent outdoors for the age groups of under 4 years, 5–14 years, 15–59 years, and over 60 years would be, respectively, 2, 4, 4, and 1 h, assuming that 50 % of the total time outdoors would be spent in direct contact with the water. Since the inundation depth is less than 50 cm, it is likely that water contact would occur only while walking along flooded streets.

The probable route of pathogen exposure is indirect ingestion of floodwater through hand-to-mouth actions. Direct hand-to-mouth transfer may be significant for the youngest group (under 4 years), who may spend time playing with the water. In this analysis, the mean incidental ingestion rate was assumed to be 50 ml/h for the youngest children (under 4 years) and 10 ml/h for older children (5–14 years) and for the oldest children and adults (15–59 and over 60 years). These values were derived from the case for Individuals Exposed to Surface Water during Wading in the USEPA Guidance (USEPA, 1989).

11.2.3.2 Inundation Depth of 50–100 cm

With this inundation depth, it is likely that residents would find themselves in water whenever they went out. It was therefore assumed that the total time outdoors would be spent in direct contact with the water. The probable route of exposure is the same as in the previous scenario—indirect ingestion through moving or walking in the floodwater. In addition, floodwater would be used for bathing and washing personal belongings.

11.2.3.3 Inundation Depth of 100–200 cm

In this scenario, the water-contact time was assumed to be the same as in the previous scenario since the water would be everywhere. However, with this inundation depth, it is likely that people would have to swim or undertake swimming-like activities to get from one place to another. Because children would have the opportunity to play or swim in the water and sustain repeat exposure events in the course of the day, it was assumed that incidental ingestion of floodwater would be considerably higher than with other age groups. Some studies have indicated that children ingest about twice as much water as adults during swimming activities (Dufour et al. 2006). In our assessment, the incidental ingestion rate was assumed to be 100 ml/h for children and 50 ml/h for adults.

11.2.3.4 Inundation Depth of Over 200 cm

At this depth, both the first floor and often also the house roof become covered by water. Since there is extensive direct contact with water for people living in a flooded house, it was assumed that incidental ingestion of floodwater would be considerably greater than in the case of ordinary swimming. For the purpose of this assessment, we assumed the ingestion rate to be 200 ml/h for children and 100 ml/h for adults.

11.2.4 Dose–Response Relationship

The following equation was used to calculate the single-exposure illness rate (Haas et al. 1999) for *E. coli*:

Table 11.2 Assumptions in the risk calculation

Parameter	Symbol	Distribution/notes
Concentration of *E. coli*	C_E	A mean value of 30,000 most probable numbers (MPN) /100 ml (18,000–50000) was taken for *E. coli* concentration in floodwater (Nga 1999)
Water ingestion rate while walking		
Age <4 years		50 ml/h
Age 5–14 years		10 ml/h
Age 15–59 years		10 ml/h
Age >60 years		10 ml/h
Water ingestion rate while swimming		
Age 5–14 years		100 ml/h
Age 15–59 years		50 ml/h
Time spent outdoors	T	
Age <4 years		Assumed 1 h
Age 5–14 years		Assumed 4 h
Age 15–59 years		Assumed 4 h
Age >60 years		Assumed 1 h
Proportion of outdoor time spent in the water (%)	F	Assumed, varies according to inundation levels
Dose–response model (Haas equation)		
N_{50}		8.6×10^7
α		0.1778

$$\text{Risk} = 1 - \left[1 + (D/N_{50})\left(2^{1/\alpha} - 1\right)\right]^{-\alpha},$$

where Risk is the probability of infection, N_{50} the medium infectious dose, and α is the slope parameter. Table 11.2 provides a summary of assumptions used in the scenarios.

11.3 Results and Discussion

11.3.1 Flood Identification

Figure 11.3 shows that among 14 districts (named 1–14) in Manila, district 1 in the northeast has the highest population density—over 500 people/ha (Table 11.3). The area along the coast has the lowest population density—fewer than 110 people/ha.

We used the GRID inundation data to create the inundation map. We adopted the minimum level (in meters) of the inundation in 2003 in producing the map

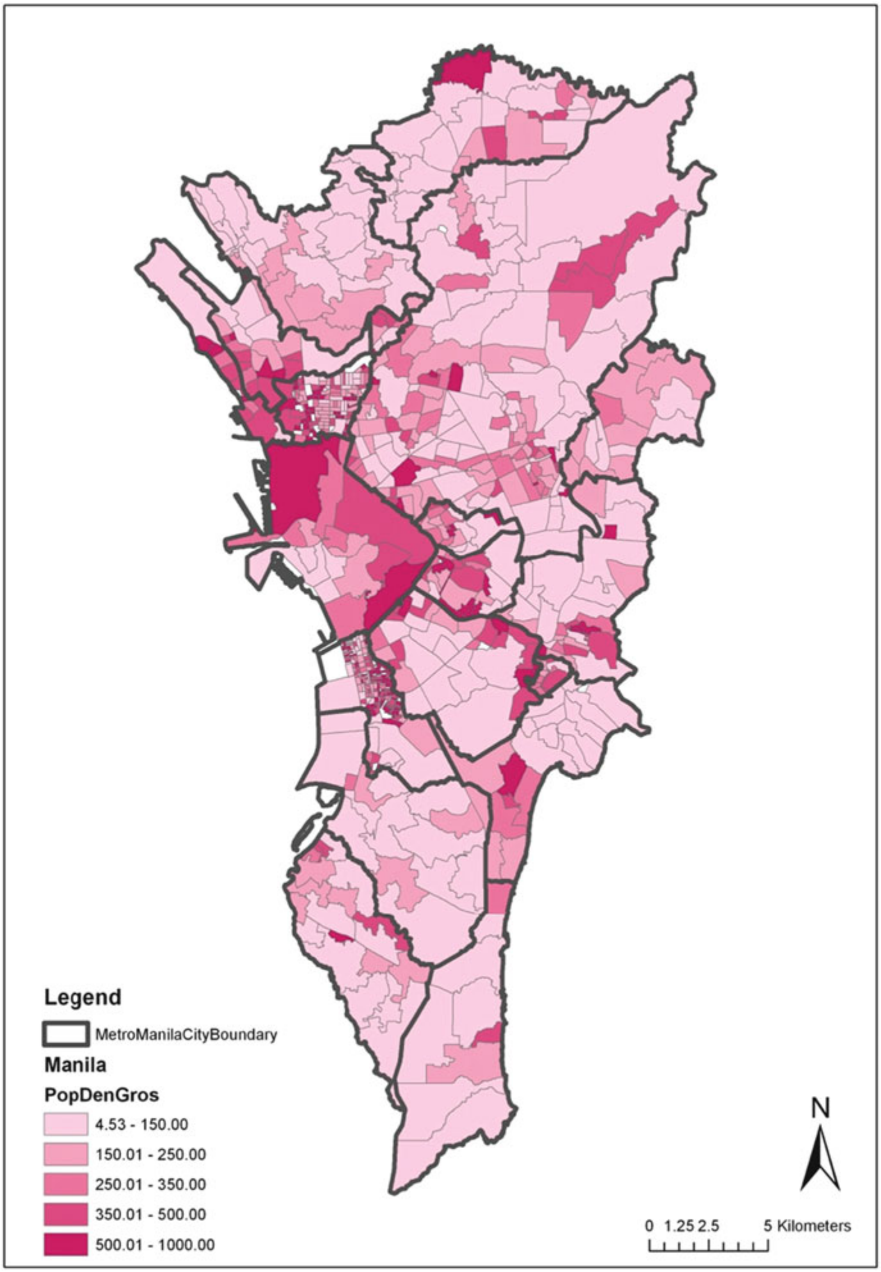

Fig. 11.3 Population density map of Metro Manila. The map was created by overlaying polygons of the 14 districts (named 1–14 by the authors) on classified population densities using ArcMap 9.2

Table 11.3 Population density in Metro Manila

District	Area (ha)	Population density (people/ha)
1	865.13	682
2	66.11	176
3	84.69	291
4	163.85	253
5	309.01	347
6	774.71	455
7	91.37	184
8	158.91	38
9	67.26	111
10	259.58	298
11	278.69	230
12	166.00	476
13	315.28	80
14	337.45	526

(Fig. 11.4). The areas subject to serious flooding with high inundation levels and high population density are districts 1, 6, 12, and 14 (Table 11.4).

11.3.2 Exposure Assessment and Estimated Infection Risk

Figures 11.5 and 11.6 are the results of the risk assessment. The infection risk was calculated using the mean *E. coli* exposure level of 30,000 MPN/100 ml from the contaminated surface water data (Nga 1999). The daily risks of gastrointestinal illness via incidental ingestion were 0.000674, 0.001345, 0.005631, and 0.010328, respectively, for the inundation scenarios of 0–50 cm, 50–100 cm, 100–200 cm, and over 200 cm, respectively. The map was created in ArcMap 9.2 by overlaying polygons of the district's boundaries on the classified risk levels (Table 11.5).

According to Zoleta-Nantes (2002), 18–20 floods occur in Manila every year. The JICA survey in 2001 reported that the duration of flooding ranged from 10 to 20 h. In the present analysis, one flood was considered as one exposure to the floodwater, and we assumed the length of time for one exposure to be 1 day. We were therefore able to calculate the annual risk based on the risk from a single exposure.

The results show that the risk of gastrointestinal illness due to *E. coli* via incidental ingestion of floodwater in the City of Manila over the course of a year varies according to the inundation level and age (Table 11.6). The risk level ranges from 1 % to nearly 20 % in flood levels of l meter or less to over 2 m. The highest level of risk is to the 5- to 14-year age group. However, if flood heights of more than 2 m become the norm due to climate change, and these floods occur more frequently and last longer, then the vulnerability baseline for all groups will shift accordingly.

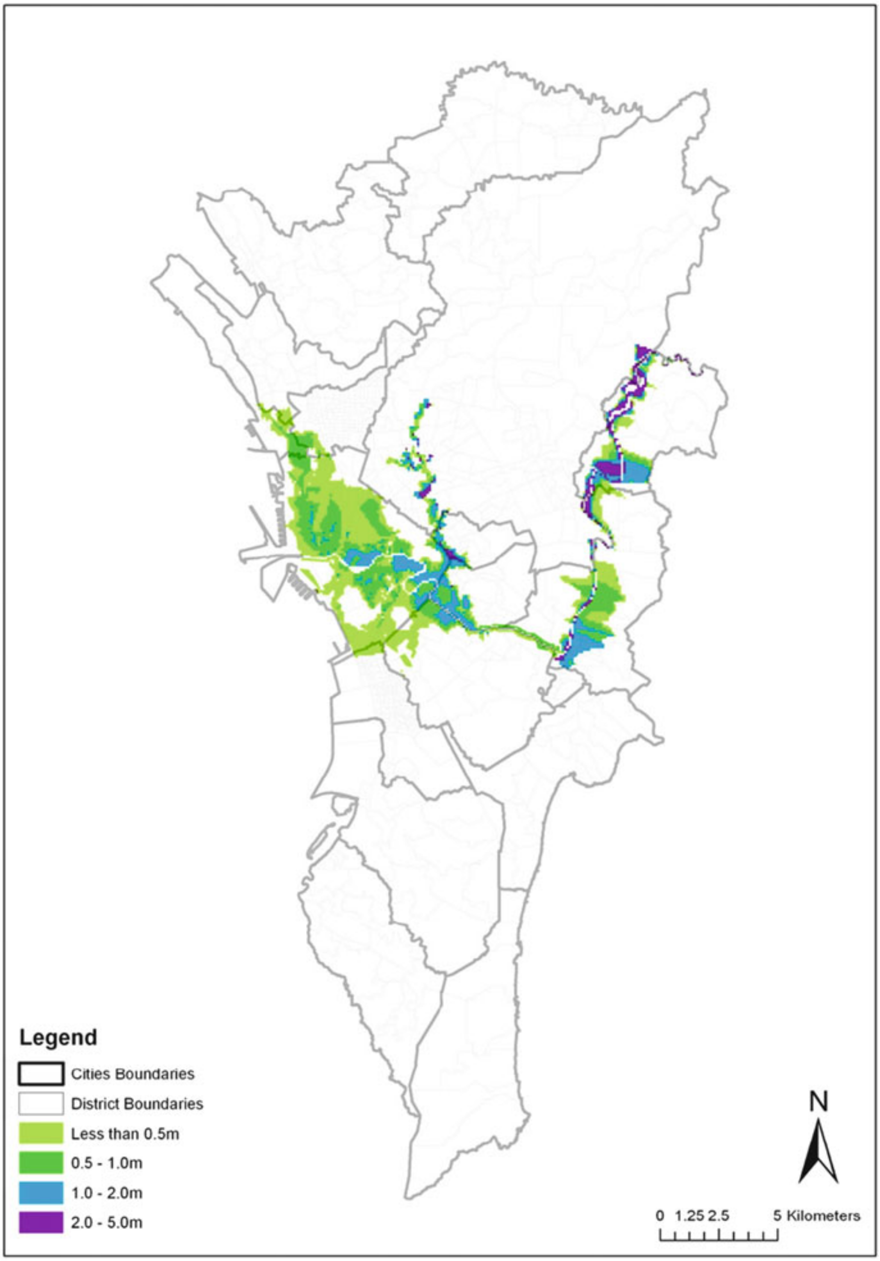

Fig. 11.4 Inundation map of Metro Manila (data for 2003). The map was created in ArcMap 9.2 by overlaying polygons of the district boundaries on the following inundation levels: (1) 0–50 cm; (2) 50–100 cm; (3) 100–200 cm; and (4) over 200 cm. This classification is based on the human impact of flooding (Flood Fighting Act, Japan 2001)

Table 11.4 Flooded area by district in Manila

District	Area (m^2)	Flooded area (m^2) by inundation depth			
		0–50 cm	50–100 cm	100–200 cm	>200 cm
1	8,651,257	3,133,920	2,418,052	97,081	
2	661,052	97,532	433,096	107,356	
3	846,864	221,356	331,086	283,055	
4	1,638,521	374,456	224,576	40,318	
5	3,090,140	1,436,061	621,836	57,987	
6	7,747,139	2,694,595	1,716,456	469,742	13,187
7	913,711	20,703	204,298	535,774	
8	1,589,072	666,652	230,610	14,628	
9	672,642	87,122			
10	2,595,763	1,394,040	31,988		
11	2,786,865	664,108	1,326,063	172,772	
12	1,660,035	354,012	304,645	723,402	
13	3,152,817	923,386	14,442	9,459	4,634
14	3,374,456	1,184,077	508,537	702,738	

As with any risk assessment, there are many sources of uncertainty in this analysis. While the health risks associated with *E. coli* in this assessment are considerable, the level of risk for gastrointestinal illness, in fact, may be significantly higher, because other pathogenic microorganisms may be present in the flood water. They could affect those who are exposed frequently. The most susceptible may also include women. As women are generally more involved than men in supervising the outdoor activities of young children, they may also incur a higher risk of accidentally ingesting polluted water. Urban poor women are also more involved in street trading, food preparation, washing, and other water-related activities.

The data presented here are suggestive. To verify the health risk estimation, data need to be collected for group behavior during floods and for the quality of the inundation water. But our purpose was to quantify climate change–related risks. In the case of illnesses caused by flooding, this quantification can be employed to make a rapid assessment of threatened areas where data, time, and resources are lacking. A useful contribution can thus be made to strategic health planning, and in particular prepositioning health resources to manage areas under threat. When field-tested and validated, predictive quantitative assessments of climate change flood–related risks may also promote the development of financial instruments such as insurance.

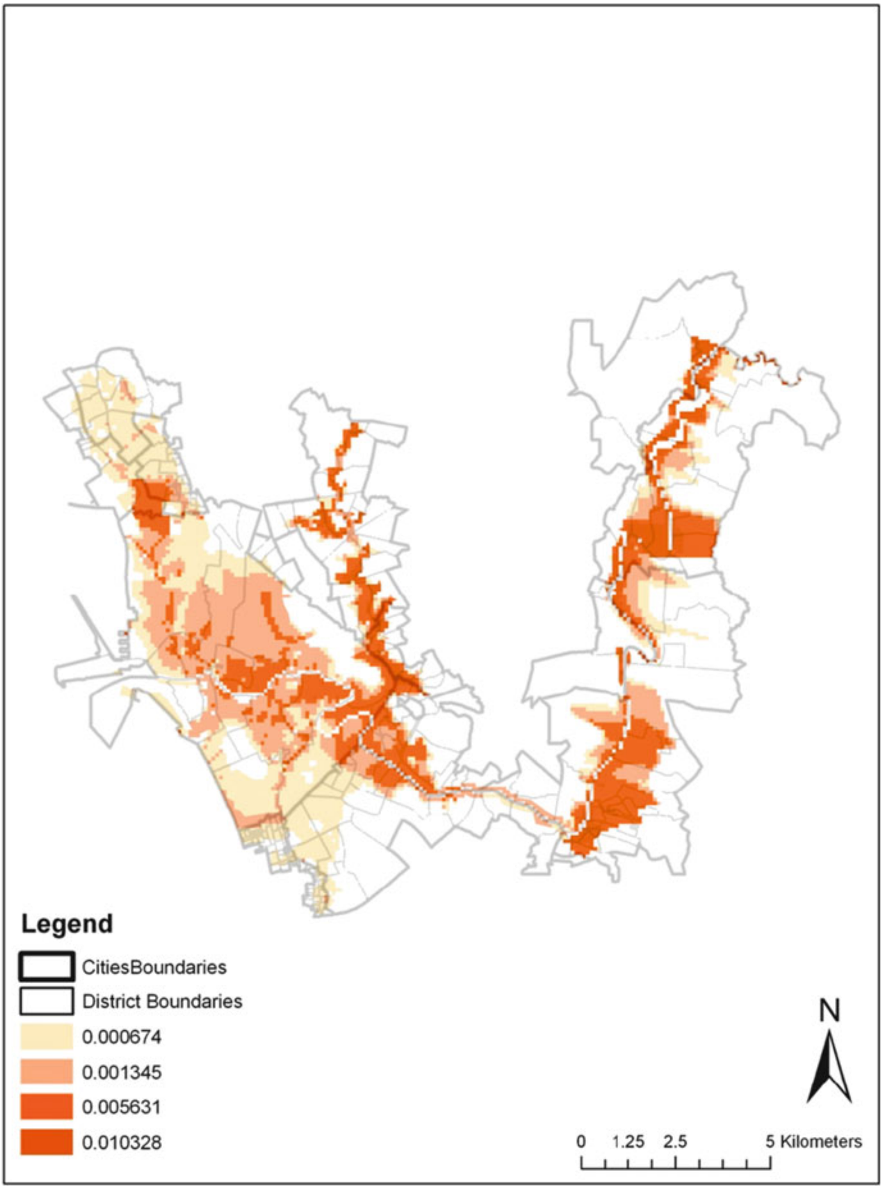

Fig. 11.5 Estimated daily risk of infection via accidental ingestion of floodwater in Metro Manila. The infection risk was calculated using the mean *E. coli* exposure level of 30,000 MPN/100 ml from the contaminated surface water data (Nga 1998). The daily risks of gastrointestinal illness via incidental ingestion were 0.000674, 0.001345, 0.005631, and 0.010328 for the inundation scenarios of 0–50 cm, 50–100 cm, 100–200 cm, and over 200 cm, respectively. The map was created in ArcMap 9.2 by overlaying polygons of the district boundaries on the classified risk levels

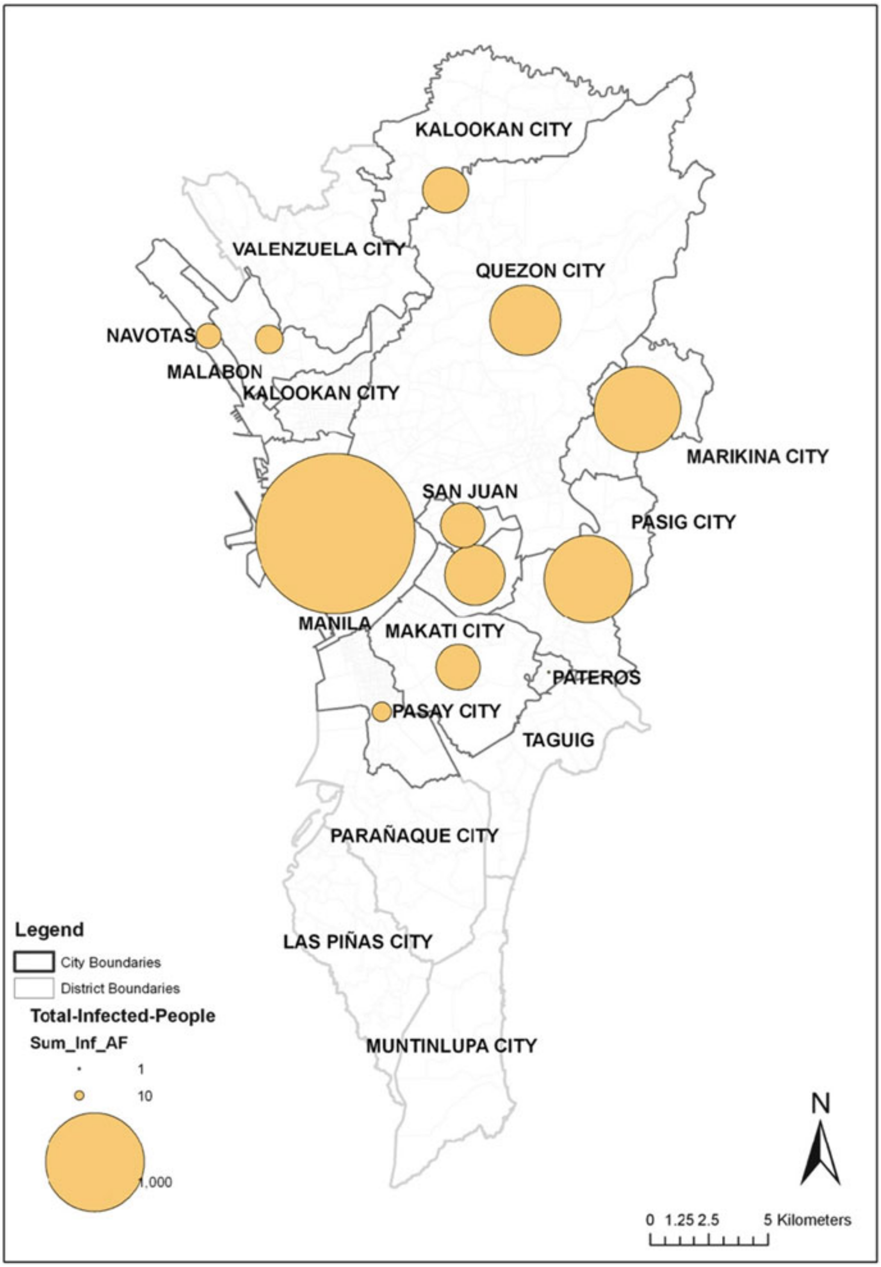

Fig. 11.6 Number of infected people suffering from gastrointestinal illness through accidental ingestion of floodwater in Metro Manila. The map was created in ArcMap 9.2 by overlying the classified risk map on the population density map. Note: The infected risk was calculated using the mean *E. coli* exposure level of 30,000 MPN/100 ml from the contaminated surface water data (Nga 1999) and the daily risks of gastrointestinal illness via incidental ingestion were 0.000674, 0.001345, 0.005631 and 0.010328 for the inundation scenarios of 0–50 cm, 50–100 cm,

Table 11.5 Number of infected people per day as a result of gastrointestinal illness through accidental ingestion of floodwater in Manila (based on inundation data for 2003)

District	Population	Infected people by inundation depth				Total (persons)
		0–50 cm	50–100 cm	100–200 cm	>200 cm	
1	590,307	142	223	37	0	402
2	11,619	1	10	10	0	21
3	24,615	4	13	46	0	63
4	41,517	6	7	6	0	19
5	107,154	33	29	12	0	74
6	352,329	83	105	119	6	313
7	16,798	0	5	55	0	60
8	5,969	2	1	0	0	3
9	7,466	1	0	0	0	1
10	77,398	28	1	0	0	29
11	64,184	9	42	22	0	73
12	79,003	11	19	193	0	223
13	25,243	5	0	0	0	5
14	177,480	41	34	208	0	283

Table 11.6 Single risk and annual risk associated with pathogen exposure during flooding for different age groups

Age group	Risk	Inundation depth (cm)			
		< 50	50–100	100–200	>200
0–4	Daily risk	0.001491	0.002968	0.005879	0.005879
	Total risk	0.029407	0.057715	0.111231	0.111231
5–14	Daily risk	0.000598	0.001194	0.005879	0.011536
	Total risk	0.011898	0.023615	0.111231	0.207095
15–59	Daily risk	0.000598	0.001194	0.005879	0.011536
	Total risk	0.011898	0.023615	0.111231	0.207095
>60	Daily risk	0.000150	0.000299	0.001491	0.001491
	Total risk	0.002992	0.005972	0.029407	0.029407
Total	Daily risk	0.000674	0.001345	0.005631	0.010328
	Total risk	**0.013398**	**0.026556**	**0.106796**	**0.187491**

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Fig. 11.6 (continued) 100–200 cm, and over 200 cm, respectively. The map was created in ArcMap 9.2 by overlaying polygons of district boundaries on the classified risk levels

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Part III
Diagnosing Urban Regions: Rural-Urban Linkages and Sustainability Challenges

Chapter 12
Feeding Urban Regions: Estimating the Energy Consumption of Domestic Vegetable Supplies for Osaka, Japan

Yuji Hara and Kazuaki Tsuchiya

Abstract This study aimed to assess Japan's recent local production for local consumption (LPLC) movement, with a special focus on vegetables in the Osaka city region of central Japan. After collecting statistics data from multiple sources, we determined the weights of the vegetables that flowed into the Osaka city region in 2003. To do so, we aggregated the 14 major vegetables into two categories according to their preservation properties: leaf and fruit vegetables, and root vegetables. We also calculated the energy consumption embodied in the vegetable flows into the Osaka city region in 2003. The results showed that vegetables consumed in the Osaka city region came from prefectures throughout Japan, the large majority of vegetables consumed in the Osaka city region currently come from remote prefectures, and this is associated with a high level of energy consumption. Scenario analysis suggested that a decrease of more than 3.7×10^5 GJ of energy inputs could be achieved through the promotion of LPLC activities in the Osaka city region.

Keywords Food systems • Vegetables • Material and energy flow analysis • Osaka city region

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12.1 Introduction

Recently, local food systems have drawn increasing public attention worldwide because of their roles in improving food security, food safety, human health, the environment, and sustainability (Gatrell et al. 2011; Heer and Mann 2010; Hein et al. 2006). In the USA, a lack of access to healthy food due to the current supermarket-based supply chain, in which one or more suppliers may supply food obtained from a wide territory, has been referred to as a "food desert" (Russell and Heidkamp 2011)—that is, little or no food is produced near a typical city, making the area surrounding the city analogous to a desert. Recognition of this problem has led to a growth in local food movements, such as community gardens and "buy local" movements (Metcalf and Widener 2011). These local food movements are believed to contribute to both community stability and environmental sustainability (Jones 2002).

In Japan, local food movements have recently been promoted by the government and by advocacy groups. In particular, the "local production for local consumption" (LPLC) movement is booming (Kuroki and Manabu Horita 2007; Oba et al. 2006). These movements focus on the production of fresh food as close as possible to where it will be consumed, with less use of synthetic chemicals and more use of organic production methods, thereby promoting food safety. Yokohari (2012) pointed out that this also improves accessibility to food, thereby promoting food security, particularly after disasters such as the 2011 Tohoku Earthquake, when long-distance transportation infrastructures may be badly damaged.

Yokohari et al. (2000) summarized how Japan's national-scale topographic features and agricultural history have influenced small-scale urban-rural land use mixtures in peri-urban areas. Rice cultivation has historically been able to sustain large local populations using the country's limited area of alluvial plains, but ongoing urbanization has led to migration from rural to urban areas. Along with urbanization, a land fragmentation process that has resulted from decisions by individual landowners has led to the replacement of flat, rectangular areas of rice cultivation and dry fields by housing and other urban infrastructure, and the use of other agricultural facilities such as irrigation canals for urban drainage and farm ridges for urban streets. In addition, ineffective land use zoning has encouraged the emergence of small-scale urban-rural land use mosaics in peri-urban areas. These spatial characteristics of Japanese urban regions differ from those of North American cities, which are surrounded by a huge territory that still includes large parcels of agricultural land, and differs from those of European cities, which have clear urban-rural boundaries due to the pastoral development history and the long history of urban planning by these cities.

Several researchers have emphasized that these spatial characteristics of Japanese urban regions are highly advantageous for a form of agriculture in which there is a short distance between food producers and consumers (e.g., Takeuchi and Yuji Hara 2006). In particular, vegetables that cannot stay fresh for long periods could be produced in such a city region because of the inherent spatial adjacency of urban and rural land uses (Namiki et al. 2006). Hence, Japanese government agencies (e.g., MAFF 2006) and associations (e.g., JOAA 2011) have promoted LPLC movements as ideal environmentally friendly agricultural activities without relying on quantitative data and other evidence to support their opinions. Recently, LPLC has also been emphasized in Japan as a countermeasure against the growing national debate over free trade under the Trans-Pacific Partnership negotiations, which are expected to greatly increase food imports from other countries. LPLC is also expected to become a tool for the effective utilization of emerging vacant lots in urban regions that are shrinking as a result of Japan's current depopulation trend (Yokohari and Bolthouse 2011).

We believe that the time has come to provide quantitative data that can be used to evaluate the LPLC movement in terms of food security, safety, and (especially) environmental sustainability. There have been a few previous quantitative studies of LPLC. These focused on transportation energy consumption using prefectural-level statistics and input-output tables (Yoshikawa et al. 2007), regional-scale food-shed mapping using geographical information system (GIS) software (Kurita et al. 2009), a special agricultural product using an ecological footprint approach (Gadda and Gasparatos 2009), and energy consumption during production and transportation using field data and a bottom-up life-cycle assessment approach (Nishizono and Moteki 2007). However, these studies occurred at a single spatial scale and thus could not assess the total environmental impact of LPLC along the spatially hierarchical vegetable flows that occur between producers and consumers.

To solve this problem, we chose the Osaka city region in central Japan as a case study and assessed the national-scale vegetable production and flows into the Osaka city region and the associated energy consumption in comparison with LPLC within this region. We also estimated the possible amount of reduced energy consumption when the region promoted the LPLC movement. Our goal was to provide basic information that could be used to support discussions about the value of LPLC, for which the potential varies among perspectives and situations.

12.2 Methods

We focused on the Osaka city region, which comprises six prefectures: Osaka, Hyogo, Kyoto, Shiga, Nara, and Wakayama (Fig. 12.1). The region's total population was approximately 20 million people in 2010, making it the second largest urban region in Japan after Tokyo Metropolitan Region, which has a population of approximately 37 million. The region includes several urban centers and broad hinterlands as urban-rural mixed land uses. In these urban-rural mixed areas, rice fields are located on relatively low-lying landforms and dry vegetable fields are located on higher landforms, surrounded by sprawled housing. We used Microsoft Excel (Microsoft, Redmond, WA, USA) and version 10 of ArcGIS (ESRI, Redlands, CA, USA) for the analyses.

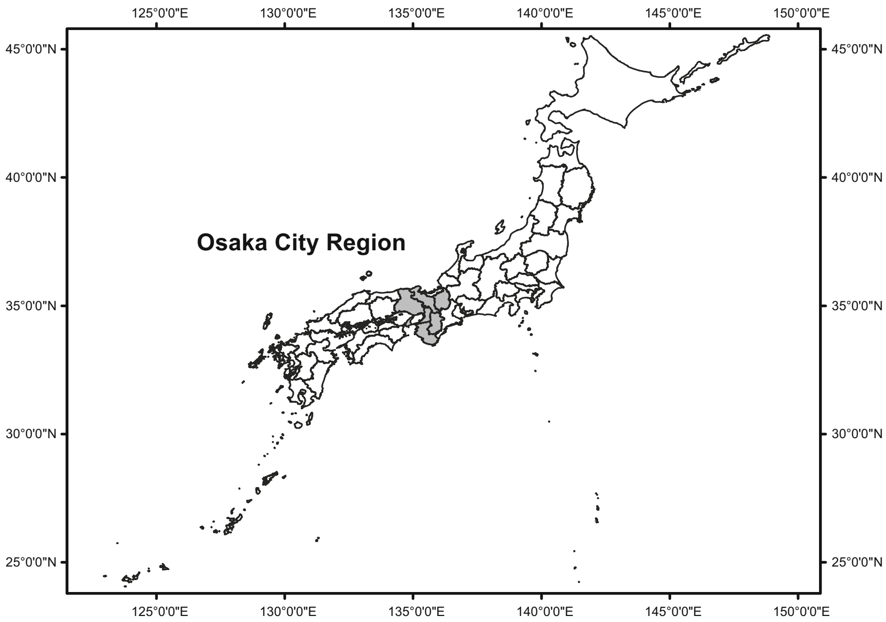

Fig. 12.1 Location of the Osaka city region

12.2.1 National-Scale Analysis Using Prefectural-Level Statistics

Although our study focused on LPLC activities in the Osaka city region, it was necessary to understand the proportions of the total volume of vegetables consumed by residents of this region that are produced outside and inside the region and the associated energy consumption. Because imports from other countries account for only a small proportion of the national total vegetable consumption (18 % by weight in 2003; MAFF 2011), and because of difficulties obtaining the required data, we chose not to deal with imported vegetables in the present study. We collected the data shown in Table 12.1.

First, we determined the weights of the vegetables that flowed into the Osaka city region in 2003. To do so, we aggregated the 14 major vegetables described in Table 12.1 into two categories according to their preservation properties: leaf and fruit vegetables, and root vegetables. Next, we calculated the energy consumption embodied in the vegetable flows into the Osaka city region in 2003 using the following formula after converting the raw data into a consistent set of units to facilitate our calculations:

$$\text{Energy consumption} = [C \times D \times (E + F) \times (A/B)] + (G \times H)$$

Table 12.1 Data used for the national-scale analysis

Variable	Data	Source[a]	Unit	Explanation
A	Vegetable marketing statistics	MAFF (2003a)	t	Japan's 14 major vegetables[b] (based on consumption) that flowed into wholesale markets in the Osaka city region from each prefecture in 2003
B	Vegetable production statistics	MAFF (2003b)	t	The vegetable production in each prefecture in 2003
C	Agricultural land use statistics	MAFF (2003c)	ha	The area used for planting these vegetables in each prefecture in 2003
D	Agricultural household statistics on production costs	MAFF (2003d)	thousand JPY/10 are	Production cost for each vegetable in 2003
E	Energy consumption statistics by prefecture	RIETI (2003)	GJ/million JPY	Energy needed for agricultural sector activities in each prefecture in 2003
F	Energy consumption per item	NIES (2005)	GJ/million JPY	Energy needed for producing inorganic fertilizer and pesticides
G	Energy consumption during transportation by trucks[c]	NIAES (2003)	GJ/km	Energy consumption during transportation by 10-t trucks
H	Distance between prefectures	ESRI Japan	km	Distance between the centers of polygons used to represent the prefectures. Calculated using ArcGIS version 10

[a]For *A*, the newest available data were from 2003; we therefore used data obtained in 2003 for *B*, *C*, *D*, and *E*

[b]Leaf and fruit vegetables: Chinese cabbage, cabbage, spinach, long green onions, lettuce, cucumber, eggplant, tomato, and green pepper. Root vegetables: Japanese white radish, carrot, potato, taro, and onion

[c]According to Fujitake et al. (2011), more than 99 % of vegetables are transported by trucks in Japan, so we ignored other transportation modes

Yoshikawa et al. (2006) stated that energy consumption during vegetable production processes can be approximated using two parameters for inorganic fertilizer and pesticide production, and another parameter for onsite electricity consumption and heating. Hence, we selected these three items for calculation of energy consumption during the production process.

12.2.2 Estimating the Reduced Amount of Energy Consumption Through LPLC

We developed a scenario for reducing energy consumption and estimated the amount of energy: consumption of the whole current vegetable production inside the Osaka city region within the region (without export to other prefectures), thereby replacing a lot of the vegetables that are currently imported from remote prefectures.

12.3 Results and Discussion

Figure 12.2 presents the amounts and origins of the vegetables flowing into the wholesale markets of the Osaka city region in 2003. The national-scale amount of vegetables flowing into Osaka city region totaled 695 365 t for leaf and fruit vegetables, and 520 263 t for root vegetables. Figure 12.2 shows that 20.1 % of the total vegetables, 23.3 % of leaf and fruit vegetables, and 17.2 % of the root vegetables came from six prefectures in the study area: Osaka, Hyogo, Kyoto, Shiga, Nara, and Wakayama. By maximizing the spatial adjacency of these food sources, purchasers can more easily maintain freshness. Nagano prefecture, located in Japan's central mountainous area, accounted for 18 % of the leaf and fruit vegetables. This is because Nagano is relatively close to Osaka city region and the mountainous topography provides a cool climate that allows planting of a lot of vegetables during the summer under its cool climate (Uezu et al. 2003). The largest portion of the root vegetables (37 % of the total) came from Hokkaido, Japan's northern island. This island has a relatively short agricultural history, dating back to the introduction of Western-style agriculture during the Meiji era (1868–1912).

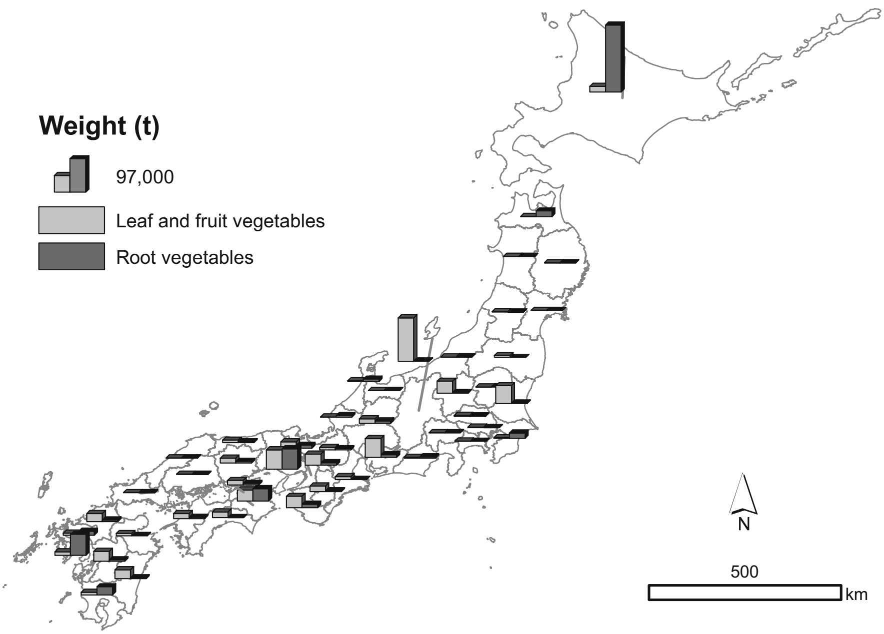

Fig. 12.2 Total amounts of vegetables flowing into the Osaka city region in 2003

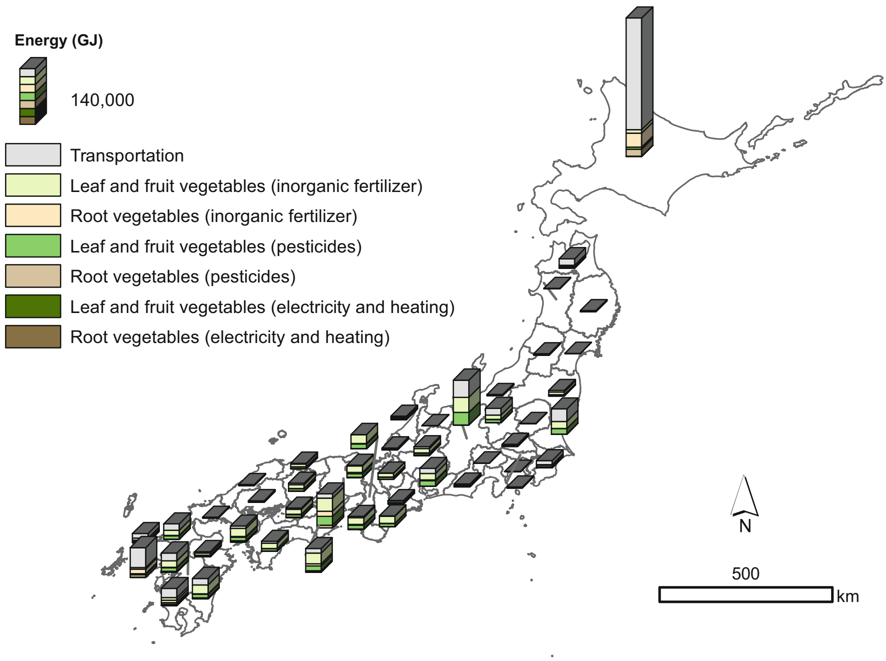

Fig. 12.3 Total energy consumption for the production and transportation of vegetables flowing into the Osaka city region in 2003

In addition, because of the island's relatively low population density, farmers can produce many easily preserved root vegetables using the island's less fragmented farmland (Nihei 2007).

Figure 12.3 shows the energy consumption resulting from production and transportation processes for the vegetables that flowed into the Osaka city region in 2003. The energy consumption resulting from transportation from Hokkaido (2.9×10^5 GJ) was much larger than the transportation component for any other region because of the large production of root vegetables on this island and the island's long distance from Osaka city region. Other remote prefectures also had large energy consumption due to transportation. In nearby prefectures, transport distances were shorter, leading to much lower transportation energy consumption levels. The dominant consumption of energy in these prefectures became the application of inorganic fertilizers and pesticides, which accounted for more than 80 % of the total energy consumption. Energy consumption for electricity and heating accounted for a very small portion of total energy consumption in nearby prefectures, probably because the warmer climate decreases the need for agricultural facilities such as greenhouses to protect against cold weather. This is quite different from the situation on Hokkaido, where the colder climate increased heating costs. On a national scale, the amount of energy consumption through transportation of products flowing into the Osaka city region totaled 6.4×10^5 GJ, versus 8.5×10^5 GJ used for production processes.

Under the estimated scenario, the total amount of vegetables produced in the Osaka city region was 580 765 t (MAFF 2003b), and wholesale markets in the region consumed only 251 373 t of this total (MAFF 2003a), so the difference (329 392 t that currently flow out of the region) could replace produce transported from remote prefectures. This number is almost equivalent to the total current transportation from Hokkaido, Aomori Prefecture (the most remote northern prefecture), Kagoshima Prefecture, Miyazaki Prefecture, Oita Prefecture, and Kumamoto Prefecture (the most remote southern prefecture). If this scenario is adopted, energy consumption by transportation could be reduced by approximately 3.7×10^5 GJ. This is equivalent to 25 % of the current total energy consumption through flows of vegetables into Osaka city region (15.0×10^5 GJ). However, this approach would affect the energy footprint for vegetables in other regions, so there is some uncertainty in this scenario.

12.4 Conclusion

Our study implied that energy consumption related to vegetable transportation from remote prefectures significantly contributed to the total vegetable consumption-related energy consumption in Osaka city region. The promotion of LPLC may mitigate the environmental impact by replacing the vegetables from those remote prefectures by production within the city region. Further quantitative research is necessary to understand the complex national-scale food system.

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Chapter 13
Catchment-Scale Water Management of Wastewater Treatment in an Urban Sewerage System with CO_2 Emission Assessment

Goro Mouri and Taikan Oki

Abstract In this study, a dynamic numerical model was developed to examine catchment-scale wastewater management, including urban household wastewater treatment. The model allowed both water quality and energy consumption to be evaluated. This system was applied to an actual sewerage system, and the effects of management strategies on water quality and energy consumption were assessed in a numerical simulation. The entire water resource system of a basin, including a forest catchment and an urban area, was evaluated synthetically from a spatial distribution perspective with respect to water quantity and quality. The life-cycle assessment technique was applied to optimize wastewater treatment management with the aim of improving water quality and reducing CO_2 emissions. A numerical model was developed to predict the water cycle and contamination in the catchment and the city; the effect of a wastewater treatment system on the urban region was evaluated; pollution loads were quantitatively assessed; and the effect of excluding rainwater from the treatment system during flooding and the effect of urban rainwater control on water quality were examined. Analysis indicated that controlling the amount of rainwater inflow into a wastewater treatment plant in an urban area with a combined sewerage system has a large impact on reducing CO_2 emissions because of the load reduction on the urban sewerage system.

Keywords Environmental impact assessment • Life-cycle assessment (LCA) • CO_2 emissions • Numerical hydrological model

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13.1 Introduction

Water shortages and water pollution are global problems. Population increases can have an acute effect on water cycles and on the availability of water resources. Wastewater management thus plays an important role in mitigating the negative impacts on natural ecosystems and the human environment, and it is an important area of research (Entem et al. 1998; Mouri et al. 2013a). A system optimization model for river basin water quality management has been proposed that considers the total costs to water users and wastewater discharges in a basin (Chia and Defilippi 1970; Shih 1970). Real-time control of the sewerage system has also been proposed to further improve water quality (Entem et al. 1998; Petruck et al. 1998; Vanrolleghem et al. 2005). The effects of source control and real-time storm water management of sewerage systems on receiving water quality in an urban catchment were examined. In the study presented in this chapter, we modeled catchment-scale hydrology, including water balance, rainfall, contamination, and urban wastewater treatment. The entire water resource system of a river valley from the catchment area to an urban area was evaluated synthetically, adopting a spatial distribution perspective with respect to water quantity and quality. The life-cycle assessment (LCA) technique was applied to optimize wastewater treatment management with the aim of improving water quality and reducing CO_2 emissions (Mouri and Oki 2010a, b; Mouri et al. 2013b). A numerical model was developed that predicted the water cycle and contamination in the catchment area as well as the city; the effect of a wastewater treatment system on the urban region was evaluated; pollution loads were evaluated quantitatively; and the effect of excluding rainwater from the treatment system during flooding and the effect of urban rainwater control on water quality were examined. Analysis indicated that controlling the amount of rainwater inflow into a wastewater treatment plant (WWTP) in an urban area with a combined sewerage system has a large impact on reducing CO_2 emissions because of the load reduction on the urban sewerage system.

13.2 Materials and Methods

In the model, the effects of floods, low water, flow rate changes, and water quality were calculated for subcatchments (unit grids), and a synthetic evaluation was performed to determine the effect of wastewater treatment on water quality. Subsequently, the results for the entire grid were unified and the catchment-scale effects were evaluated. In addition, one object of the evaluation was to determine the amount of CO_2 emitted in the process of handling wastewater; this parameter represents an important measure of the environmental impact, and hitherto it has not been easy to evaluate (Ichinose et al. 1997). Optimal management methods that maximize water quality improvement and minimize energy consumption (CO_2 emissions) in a wastewater treatment system are proposed. This model is divided into a natural-system submodel and an urban-system submodel (Mouri and Oki 2010a, b; Mouri et al. 2013b).

13.2.1 Natural-System Submodel

To improve the appearance and predictive accuracy of the catchment submodel, spatial data on geography, precipitation, temperature, and land use were used as inputs to develop a distributed-type model that can reproduce and predict the amount of water and the pollution load within a catchment (Fig. 13.1). A distributed-type rainfall runoff model using a grid-type digital elevation model (DEM) was built, and a space–time distribution evaluation of the amount of water, water quality, and sediments in the entire catchment was performed (Fig. 13.2). Flood and low-water conditions were modeled, and the influence of urban wastewater treatment on water quantity, contaminants, and sediment levels was quantified. This model's performance was validated, including assessments during a heavy-rainfall event and a low-water period.

13.2.2 Urban-System Submodel

With rain and wastewater as natural and artificial external forces, respectively, the effect of wastewater treatment was calculated. Variations over time in the amount of influent and water quality were determined by performing a dynamic simulation of wastewater treatment using an ASM. We examined the response of a natural system to the input conditions, i.e., the amount of water, water quality model, flood flow, rate of drainage, and temporal response in water quality. We confirmed that it was possible to reproduce wastewater treatment process results under dry weather conditions and that the obtained calculations were in general agreement with past observations (Fig. 13.3). Influent quality (Fig. 13.4) was based on survey data provided by the city of Matsuyama. Removal of an organic substance by heterotrophic microbes, expressed as a ratio, is defined as being proportional to the microbes' multiplication rate. Therefore, the main chemical oxygen demand (COD) components in the final treated water reflect the presence of substances that are inert biodegradable substances (Fig. 13.5).

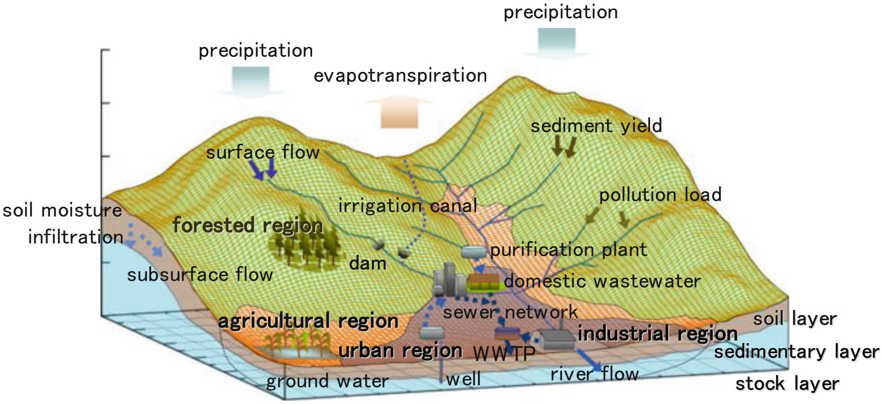

Fig. 13.1 Map of the modeled catchment

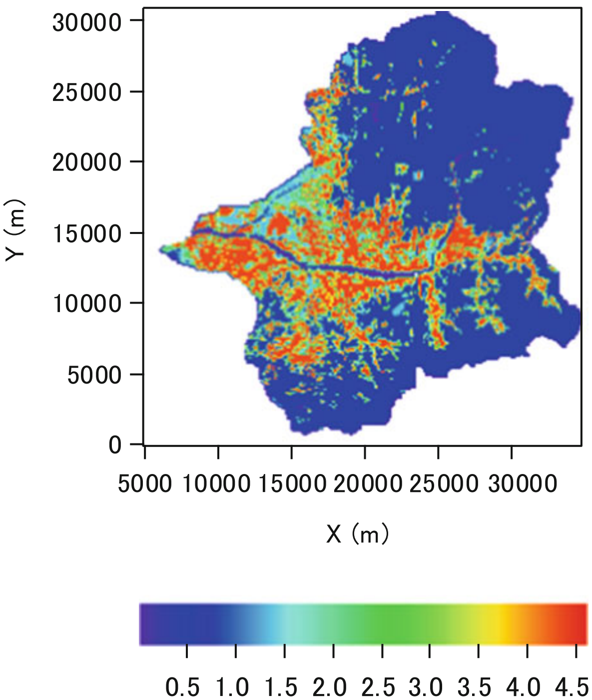

Fig. 13.2 Typical simulation result of total nitrogen load (mg/l) at the time of a flood

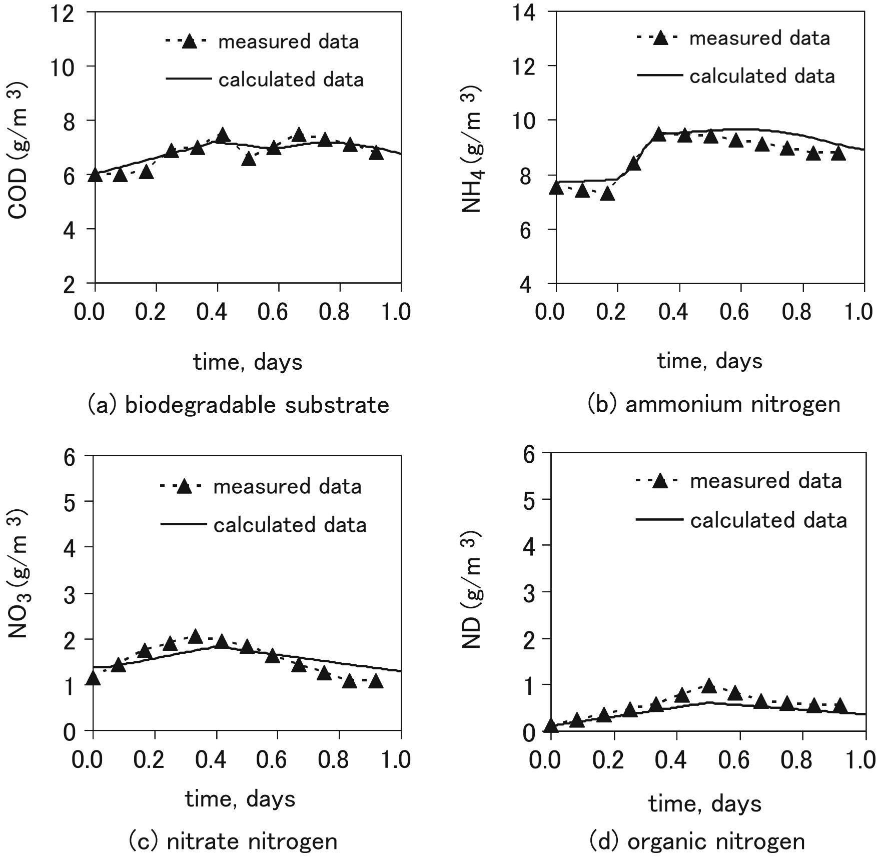

Fig. 13.3 Results of wastewater treatment validation

13.2.3 Environmental Impact Calculation Module During Construction and Operation

With the LCA technique, it is presumed that CO_2 emissions occur, and a wastewater treatment system was evaluated using this technique. Thus far, LCA has mainly been applied to evaluate commercial products. In the present study, it was used to evaluate CO_2 emissions for sewerage system optimization. Tables 13.1 and 13.2 list the CO_2 emission data associated with the construction and operation of WWTPs and pumping stations. The construction-phase data were based on energy consumption figures from annual sewerage statistics (JSWA 2004). Annual energy consumption in the operation phase was computed using data on the annual consumption of electric power and fuel by a sewage-treatment plant; CO_2 emission calculations were based on the fuel use rate. About 30 % of the CO_2 generated by

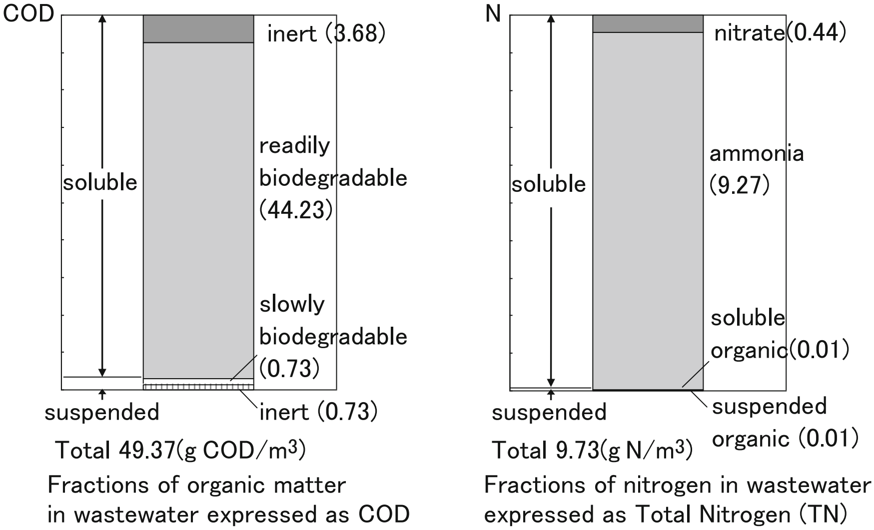

Fig. 13.4 Typical wastewater influent contents

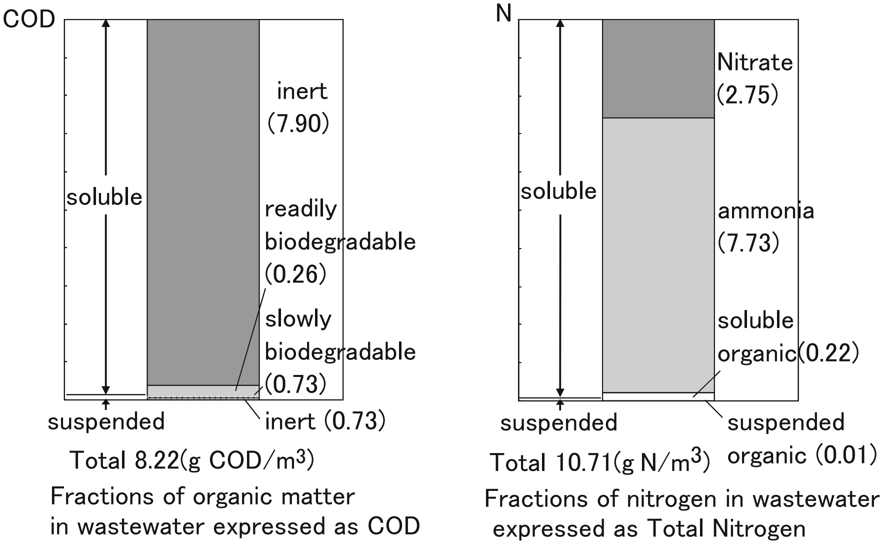

Fig. 13.5 Typical wastewater effluent contents

building a plant was associated with pipe construction, and about 60 % of the pipes were basic pipes with a diameter of less than 600 mm.

Table 13.1 CO_2 emissions associated with maintenance and operation of a sewerage system

Component	CO_2 emission (T-C/y)	%
Drainage pipe construction	7982.5	27.9
Drainage pipe maintenance	32.1	0.1
Pumping station construction	399.3	1.4
Pumping station operation	2468.6	8.6
Water treatment plant construction	8776.2	30.7
Water treatment plant operation	8910.0	31.2

Table 13.2 CO_2 emissions per unit of treated water

	Pumping station	Wastewater treatment plant
Annual treatment quantity (1000 m^3)[1]	5938	48584
Energy consumption ($kcal^3/m^2$)	815	381
CO_2 emission ($kg\text{-}C^3/m^3$)	0.416	0.183

13.3 Results and Discussion

13.3.1 Management Scenario Analysis of a Drainage System in an Urban Region

To quantitatively evaluate the effect of flood management and a plan for an optimal strategy, the levels of influents from all parts of an urban sewerage system, the WWTP, and the catchment were assessed, and integrative numerical simulation of the water quantity and quality was carried out (Schutze et al. 1999). These elements are required to evaluate water quality improvement, synthetic evaluation of energy consumption (CO_2 emissions) reduction effects, and the entire catchment modeling system. Here, the trade-off between water quality improvement and energy consumption was considered in the management strategy, which used wastewater treatment technology. The following features were taken into account when setting up the management strategy for wastewater treatment in rainy weather. The generation of rainwater can be sudden, and the amount of water and loading dose can be huge. Trials for each flood management strategy were performed as indicated below.

13.3.1.1 Scenario 1

This is the present condition—the present situation (PS) scenario. The present condition, which involves not performing wastewater treatment system management, is represented by this PS scenario. In the combined sewerage system, the pollution loading under rainy conditions is very great, and untreated water is discharged into public water areas, such as rivers. Wastewater treatment is required to reduce the load. However, technology that allows for comprehensive, advanced treatment of drainage has not yet been put into practical use in the case of rainy weather.

13.3.1.2 Scenario 2

This is the influence of drainage overflow in the case of rainy weather—the combined sewer overflow (CSO) scenario. In the CSO scenario, the height of the overflow structure of a drainpipe is optimized. Under conditions of heavy rain, water containing suspended particles of nitrogen and organic substances overflows from the combined sewerage system. Also, the load flowing into a WWTP increases greatly compared with the load under fine-weather conditions. Under the CSO scenario, the amount of inflow into the WWTP is controlled at about 2.1 m^3/s, which is the maximum throughput. Under this scenario, it is difficult to completely process contamination substances using the existing combined drainage system. The effect of a portion of the unsettled drainage discharging to public water areas was considered. Moreover, the CSO scenario is taken into consideration as a component of the drainage pipe system.

13.3.1.3 Scenario 3

This is the effect of a storage tank installed at the end of a drainpipe system—the detention tank (DT) scenario. The DT scenario examines the effect of temporarily storing WWTP influent in a tank installed at the end of the drainage pipe system in the case of rainy weather. Under this scenario, the amount of inflow into a WWTP is controlled, as in the CSO scenario, at about 2.1 m^3/s. However, the unsettled overflow sewage is not discharged to public water areas but is temporarily stored in the tank. After a flood, the stored water is processed at 1.5 m^3/s and then discharged to public water areas.

13.3.1.4 Scenario 4

This is the effect of solid matter residence time in a WWTP—the solids retention time (SRT) scenario. With the SRT scenario, the effect of increasing the residence time in the WWTP by a factor of 1.2 (about 9.5 h) was examined. Because WWTP residence time is determined by the multiplication rate of the microbes in activated sludge, a longer residence time promotes the nitrification of ammonia. Furthermore, because the oxidization decomposition of organic substances in a flood is carried out by autotrophic microorganisms, the COD concentrations will decrease. Therefore, although the quality of the final WWTP effluent may improve, the energy used to aerate the reaction vessel increases. This effect was examined.

13.3.1.5 Scenario 5

This is the effect of load reduction by source control of household effluent—the source control (SC) scenario. The SC scenario involves reducing the WWTP inflow under rainy conditions by reducing the amount of water used in each home by 20 %. Despite the relatively low loads, controlling sewage discharge from homes is difficult. However, because reductions may be expected owing to advances in household water-saving technologies in recent years, the effect was examined.

13.3.1.6 Scenario 6

This is the effect of reducing the extent of impervious areas—the reduction of impervious area (RIA) scenario. In the RIA scenario, the extent of impervious surfaces, which exacerbate flooding conditions, is reduced, and the amount of inflow into a drainage pipe system is decreased by 10 %. Reductions in the extent of impervious surfaces may also reduce the sewage overflow in a combined-type drainage system. Moreover, RIA was not applied in the second (CSO) scenario.

13.3.1.7 Scenario 7

This is a combination of SC and DT—the SC + DT scenario. In the SC + DT scenario, source control of household effluent and the storage tank concept are both used, and the effect of limiting WWTP influent rates at about 2.1 m^3/s at the time of a flood was examined.

13.3.1.8 Scenario 8

This is a combination of RIA and DT—the RIA + DT scenario. The RIA + DT scenario examined the effect of limiting the amount of influent entering the WWTP to less than about 2.1 m^3/s by impervious area reduction and the use of a storage tank.

13.3.1.9 Scenario 9

This is a combination of flocculation treatment (FT) and the DT system—the FT + DT scenario. The FT + DT scenario examines the effect of FT in physical chemistry, separation of solid particles to reduce aeration energy, and the use of a storage tank.

13.3.2 Effect and Impact Evaluation of Drainage System Management

A comparison of the effects of the different management scenarios was carried out on September 23, 2004. A management strategy to improve the environmental conditions in the catchment will be further examined once the model accuracy and numerical simulation have been improved. The effects of floods, low water, flow rate changes, and water quality were calculated for subcatchments (unit grids), and a synthetic evaluation was performed to determine the effect of wastewater treatment on water quality by using an integrated hydrodynamic model. The results for the entire grid were unified and the catchment-scale effects were evaluated. In addition, one object of the evaluation was to determine the amount of CO_2 emitted in the process of handling the wastewater, a parameter that represents an important measure of environmental impact and that has not been easy to evaluate. Although such an operating method may have an effect on water quality, the effect on CO_2 emissions also means that it is an energy-saving operation and it is important to reduce the energy burden of the entire wastewater treatment system of a catchment. Though it was evident that the eight proposed scenarios are effective in controlling the amount of water in a wastewater treatment system at the time of flooding and the water quality characteristics were appropriately modeled, it was also evident that real-world applications of this wastewater treatment management system require high precision. The amount of influent entering the WWTP changed under the different management scenarios, as shown in Fig. 13.6.

Under the SC and RIA scenarios, the inputs were reduced by 20 % and 10 %, respectively, at the time of a flood; under the SRT and DT scenarios, the input was the same as under the PS scenario. The effects of a complex scenario—from the pollution loading amounts to the final effluent leaving the WWTP—are shown in Fig. 13.7. Reducing the amount of influent entering the WWTP greatly affected the

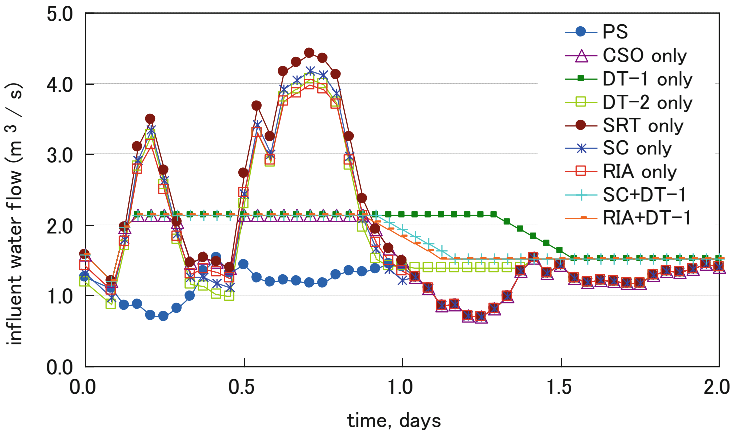

Fig. 13.6 Amount of influent entering the WWTP under each management strategy

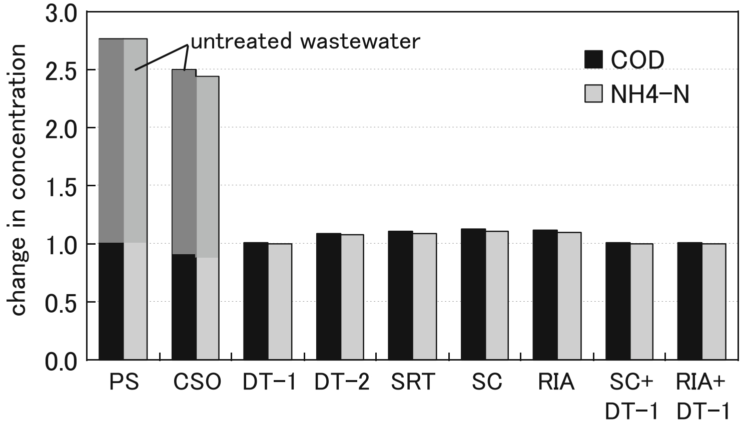

Fig. 13.7 Amount of effluent leaving the WWTP under each management strategy

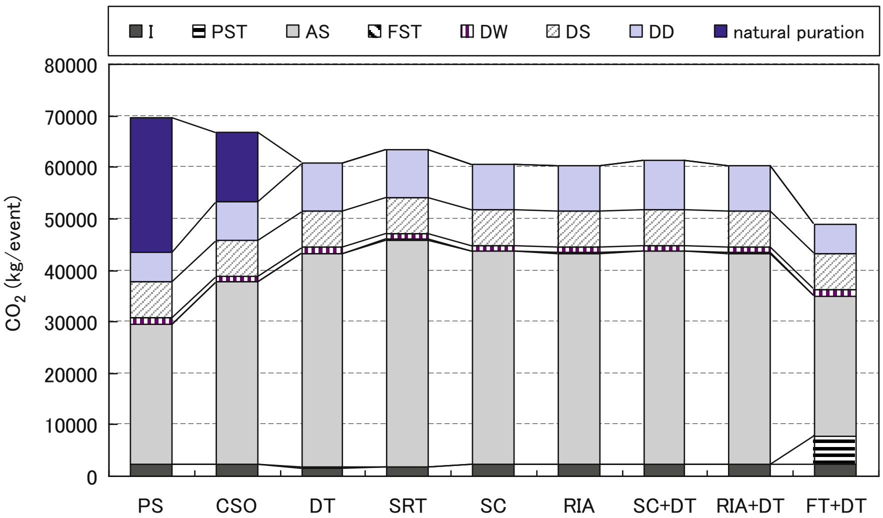

Fig. 13.8 Comparison of CO_2 emissions under each management strategy

energy consumed and CO_2 emissions (Fig. 13.8). A large proportion of the energy used for water quality improvement was consumed by aeration in the reaction vessel of the WWTP system. Hence, the energy consumed is proportional to the amount of WWTP influent.

13.4 Conclusions

In this study, nine flood management scenarios were examined using (1) technology that predicts the amount and quality of water in a catchment's water cycle; and (2) LCA technology to evaluate the synthetic management of a wastewater treatment system in a city. The technology employed is able to evaluate the impact of the amount of water from a natural drainage basin and the quality of water accompanying a flood event. Subsequently, this technology can be used to optimize existing wastewater treatment systems and it may be applied to an actual WWTP—as in the eight scenarios examined here. Further improvements in the model accuracy can be undertaken to further optimize the wastewater treatment systems. We found that reducing the extent of impervious surfaces can reduce the load during a flood, and we demonstrated the CO_2 emissions associated with such a strategy. Therefore, the results of this model have practical benefits and applications.

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Chapter 14
Dispersion of Contaminants in Urban Regions and Beyond

Sebastien Rauch

Abstract Cities are important sources of contaminants at the local, regional, and global scales. In urban areas, automobile traffic, leaching from building materials, urban runoff, and industrial sources are resulting in the occurrence of elevated concentrations of metals, including Ag, Cd, Cu, Pb, Pt, Rh, Sb, Sn, W, and Zn. Here, we show that in addition to local impacts, urban contamination extends beyond the urban boundary. Two examples are provided to show that atmospheric and water-based dispersion result in regional-scale contamination. In Stockholm, contaminants are found in sediments downstream from the urban center. Platinum-group elements (PGEs) are used as tracers of urban contamination and show that a significant fraction of contaminants emitted into the atmosphere can be transported at regional scales. The projected growth of cities will lead to an increase in pollution, especially in developing countries where environmental legislation is still lagging and material use is soaring. There is in general an urgent need to raise awareness and implement programs to reduce the environmental impact of urban activities.

Keywords Trace elements • Platinum group elements • Urban environment • Dispersion

14.1 Introduction

Today, over 50 % of the global population lives in urban areas. Cities concentrate human activities and our impact on the environment, including the release of potentially hazardous contaminants. Air and soil pollution is a well known problem in many urban areas. Transport of contaminants during rain events and discharges also result in the contamination of the aquatic environment. Although the contamination is most severe in cities, i.e., close to the sources, contaminants can be transported at regional and global scales. Elevated heavy metal concentrations

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have, for instance, been found in Alpine glaciers (Barbante et al. 2004) and as far away as Greenland (Hong et al. 1996; Barbante et al. 2001), indicating that our cities have a widespread impact.

Trace elements, which are normally found at low concentrations in the environment, are valuable markers of human activities. This chapter presents two studies that have aimed to assess local and global contamination by human activities, respectively. First, the concentrations of trace elements are provided for an urban region to determine the impact of specific human activities on trace element levels and assess water-based dispersion. Second, platinum-group elements (PGEs) are presented as a tracer of automobile traffic in urban and remote environments, to assess atmospheric dispersion at both regional and global levels.

14.2 Materials and Methods

14.2.1 Assessment of Water-Based Dispersion

Sediments are an interesting source of information on trace element contamination because aquatic systems integrate deposition in a watershed and many elements are in a particulate or particulate-reactive form. Sediments were collected at selected locations in Stockholm, Sweden, including background, upstream, urban, and downstream sites. Collection was performed using a piston corer and surface sediments were retained for analysis. Samples were prepared by microwave-assisted acid digestion using *Aqua regia* and analyzed by quadrupole ICP-MS (Elan 6000, PE Sciex) with pneumatic nebulization and using conventional settings (Rauch 2007).

14.2.2 Assessment of Atmospheric Dispersion

The impact of urban emissions on the occurrence and cycling of PGEs has been assessed using data obtained in our laboratory during the past 15 years. These data are complemented by results obtained in collaborative studies, as well as results presented in the literature. A variety of urban samples have been collected, including airborne particles, road dust, roadside soil, water, sediments, and vegetation in European, North American, Asian, and African cities. In addition, samples from non-urban locations have been collected to assess regional and global impacts of cities. Elemental analysis has been performed by inductively coupled plasma-mass spectrometry, using quadrupole or sector field instruments with single or multicollector detection (e.g., Rauch et al. 2001, 2004, 2005b).

14.3 Results and Discussion

14.3.1 Assessment of Water-Based Dispersion

Trace element concentrations (i.e., antimony (Sb), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), platinum (Pt), rhodium (Rh), silver (Ag), tin (Sn), tungsten (W), and zinc (Zn)) in sediments in Stockholm are present at elevated concentrations relative to background sites as a result of urban contamination. Copper is present at high concentrations at most sampling sites according to Swedish EPA sediment concentration guidelines. Zn and Pb are only present at high concentrations at specific sites. In addition, Ag concentrations exceed the apparent threshold concentration for Ag at several sites, whereas it is exceeded at one site for Sb. Urban emissions of Pt, Rh, and W were also found, but no guideline exists for these metals, making the assessment of potential risks difficult. This study indicates that the occurrence of trace elements in Stockholm is a potential risk for humans and the environment.

The spatial distribution of trace elements in sediments demonstrates that the contamination is the result of diffuse sources of many elements and it is therefore difficult to control. Major sources of trace elements include automobile traffic, urban surfaces (road pavements), buildings, and combustion, as well as location-specific sources. The lowest concentrations were found upstream and at background sites for most elements. Spatial trends indicate that these elements have urban sources, characterized by a concentration increase upstream and in most cases a decrease downstream. Elevated Ag downstream from Stockholm indicates that this element is released into the Baltic sea with higher efficiency than that of other analyzed elements (Fig. 14.1). The results suggest that water-based transport results in regional contamination, with urban regions being contaminated downstream from urban sites.

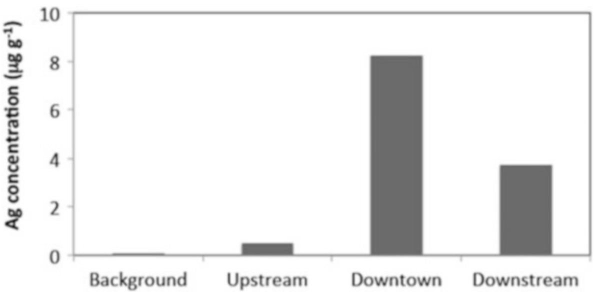

Fig. 14.1 Ag concentrations in Stockholm sediments showing elevated Ag concentration at the downstream site

14.3.2 Assessment of Atmospheric Dispersion

Platinum-group elements (PGEs; i.e., Pd, Pt, Rh, Ru, Ir, Os) are among the least abundant elements in the continental crust. Increasing use has, however, resulted in the occurrence of elevated concentrations of these normally rare metals in urban areas. Automobile exhaust catalysts are generally believed to be the main source of PGEs in the environment. These catalysts use Pd, Pt, and Rh to promote the removal of gaseous pollutants in vehicle exhausts and a fraction of the PGEs in catalysts is emitted during vehicle operation. Emissions are expected to be in the ng km^{-1} range (Moldovan et al. 2002). PGEs are potential candidates for the tracing of urban contamination at regional and global scales owing to their generally low natural concentration and specific emissions from automobile sources, which are typically concentrated in urban areas, as well as the atmospheric character of Pt and Rh emissions. PGEs are among the elements whose global biogeochemical cycles are the most affected by human activities (Rauch 2010).

A global catalyst emission of 1–4 metric tons of Pt $year^{-1}$ can be inferred, assuming that 500 million vehicles are equipped with catalysts with an average yearly mileage of 15,000 km $vehicle^{-1}$ and an average emission rate of 0.1–-0.8 µg km^{-1} (Rauch and Morrison 2008). Other less significant urban sources include discharges from hospitals where Pt-based drugs are used in cancer treatment (Kummerer et al. 1999). In addition, it is possible to infer PGE accumulation based on concentrations measured in environmental samples, known material accumulation rates, and surface areas (Rauch et al. 2005a). Yearly accumulation Pt estimates are presented in Fig. 14.2.

While concentrations are highest in urban environments where the human population is directly exposed to emitted PGEs, a significant fraction of emitted PGEs is dispersed at a regional scale where food is often produced, owing to their

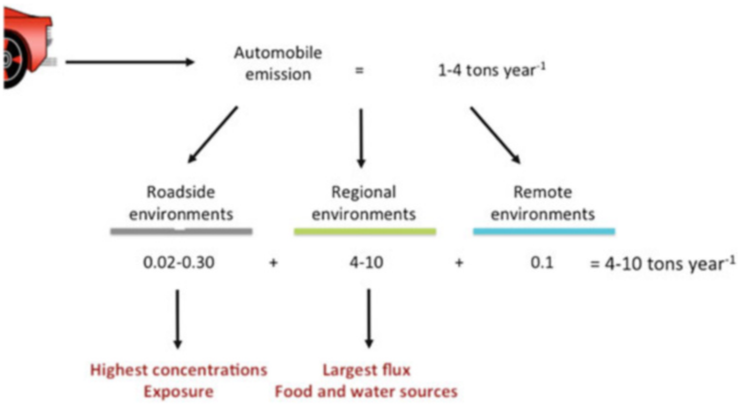

Fig. 14.2 Accumulation of Pt in roadside, regional, and remote environments estimated based on measured concentrations, material accumulation rates, and surface areas. Further details on the definition of roadside, regional, and remote environments are provided in Rauch et al. (2005a)

occurrence in fine particles (Rauch et al. 2005a). Elevated PGE concentrations have also been reported at remote sites (Barbante et al. 2001; Moldovan et al. 2007; Rauch et al. 2010).

Although present concentrations do not support the presence of acute effects on humans and the environment, chronic effects cannot be excluded. As environmental PGE concentrations are increasing, there is a need to provide a reliable assessment of potential risks. Risk assessment should include chronic effects; therefore, toxic effects need to be determined for low exposure concentrations under environmentally relevant conditions.

14.4 Conclusions

Urban areas are an important source of contaminants at local, regional, and global scales. Elements including Ag, Cd, Cu, Cr, Pt, Pd, Rh, Sb, and W have been found to be present at elevated concentrations in urban areas. The regional impact of cities on trace element contamination is demonstrated by the analysis of downstream samples and the use of PGEs as tracers of automobile-derived contaminants. The presence of contaminants raises concern over potential environmental and human health risks. While the occurrence of elevated contaminant concentrations in urban areas can result in direct exposure and subsequent effects, accumulation of contaminants at regional scales can lead to the contamination of agricultural production and food supply. Cities are projected to grow in the coming years and environmental contamination is expected to follow a similar trend, especially in the developing world where environmental legislation is lagging and material consumption is soaring. The use of metals in Asian cities is, for instance, increasing rapidly and emissions are at present poorly controlled. It is important to limit emissions from urban sources to limit potential risks and reduce our impact on the environment.

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Chapter 15
Urban–Rural Interrelations in Water Resource Management: Problems and Factors Affecting the Sustainability of the Drinking Water Supply in the City of Bandung, Indonesia

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Abstract Urban areas in Indonesia frequently rely on the water supply from rural areas located outside their administrative boundaries. This urban–rural interrelation through water resources and the problems related to sustainability of the supply

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apply to the Indonesian city of Bandung, where the demand is increasing for clean water for daily needs. This provincial capital relies on water supplies generated in catchment areas located in different towns and districts outside the city. A multidisciplinary study was carried out to elucidate the present and future conditions of the water supply for Bandung as well as factors affecting the sustainability of that supply. This study demonstrates that the present situation in the catchment areas is a cause for concern, and environmental conditions are worsening in some parts of the catchment. Among the measures adopted to deal with the current problems are reforestation and land conservation; however, other essential factors relating to agricultural practices and efficient water use have not been properly considered. A conceptual plan needs to be implemented at the landscape level—a plan that takes into account both biophysical and social aspects of the area where the rehabilitation program for maintaining sustainability of the water supply will be carried out.

Keywords Catchment • Bandung • Drinking water • Intensive agriculture • Land conversion

15.1 Introduction

Among other ways, urban–rural interaction is maintained in many parts of Indonesia through the supply and demand the of water supply. It is quite common for many urban areas to be absolutely reliant on surrounding rural areas for their water. This has led to the sustainability of the water supply to urban areas being highly dependent on how water resources are managed in sources beyond their urban boundaries. Sustainable water resource management that guarantees the maintenance of urban–rural interaction has become an important issue in Indonesia in general and in Java in particular. This is because in many parts of the country, the availability of drinking water is an important issue—not only from the perspective of water quantity and quality, but also in terms of social and national development in general. As noted by Saravanan (2008) and Antunes et al. (2009), water availability is an important element in socioeconomic development and poverty eradication; water resource management is a complex and challenging issue because it covers hydrological and biological systems in addition to the needs, values, and concerns related to human purposes. Moreover, the potential regional impacts of global environmental change, such as with climate, may also pose a great challenge for users and managers of water resources (Bharati et al. 2008); many cities in Java are experiencing great difficulties because of their inadequate water management infrastructure and are in a state of crisis with respect to their water supply.

This situation certainly applies to the city of Bandung in West Java. The provincial capital with a population of about 2.45 million (Bandung Central Agency on Statistics 2012), Bandung is absolutely dependent on surrounding rural areas for its water supply. Catchment areas for the city's drinking water are located to the north and south of the city outside its administrative boundary (City of Bandung 2011). The catchment areas occur within 13 subwatershed regions, and administratively they belong to six neighboring districts: the districts of Bandung, West

Bandung, Cimahi, Sumedang, Cianjur, and Garut (Board of Regional Planning and Development of District Bandung 2008). In these regions, agriculture and other bioresource-based extractive activities are still predominant, and this has a great effect on the water supplied to Bandung.

The demand for drinking water in Bandung is projected to increase along with the city's population growth, which is currently above 1 %/year. The projected average year-on-year increase in water demand from 2008 to 2015 was about 3.8 %. Nevertheless, the city's supplier of drinking water, Perusahaan Daerah Air Minum Kota Bandung (Bandung Drinking Water Company), stated that it would not be able to fulfill this increasing demand. This was due to the fact that the company was facing serious problems, among which were infrastructure, deteriorating conditions in the water resource and catchment areas, conflicts in water usage, and institutional-related aspects. Along the same lines, the West Java Regional Planning and Development Agency (2004) reported that by 2010 there would be a water shortage, the estimated deficit being about 0.13 billion m^3/year for the Bandung Metropolitan Area. At present, the city's water company is able to provide drinking water to only about 74.2 % of Bandung's population (Bandung Drinking Water Company 2012). However, the company set itself the target of increasing the proportion of households with drinking water to about 85 % by 2015. Bandung's water company thus needs to make a fundamental change in its water supply and management strategy from traditional supply-based management to demand management (Vairavamoorthy et al. 2008).

The catchment areas that currently supply drinking water to Bandung are experiencing serious degradation owing to population growth, land conversion for new settlements and expansion of agricultural land, reduced forested land, and unsustainable agricultural practices. These factors have affected not only the amount of available water but also the quality of the raw water flowing to water treatment plants in the city. Catchment rehabilitation has to be undertaken in the Citarum watershed, which is the most important watershed for supplying drinking water to Bandung. The present condition of the watershed is critical because of various unsustainable practices in the agricultural, industrial, and domestic sectors. In this regard, integrated measures have to be implemented; this is because water resource management has to consider complex interactions among social, economic, and environmental systems that occur within the catchment, including the impacts of usage and management decisions on the overall sustainability of the catchment system (Letcher 2005).

15.2 Materials and Methods

The data presented in this chapter are part of the results derived from a multidisciplinary study carried out by the Institute of Ecology, Padjadjaran University, Bandung, in cooperation with the Bandung Drinking Water Company (Institute of Ecology 2009). The collected primary data cover biophysical and social aspects related to water resource management. Biophysical aspects comprise hydrology (including water quality), environmental geology, climate and rainfall, soil and land use, and the agroecosystem. Social aspects consist of demographics, socioeconomics, sociocultural issues, and institutional arrangements (including leadership and social orientation).

The study area was divided into two main subcatchment areas—Cisangkuy and Cilaki. Hydrological sampling to measure water quantity and quality was performed at 31 sampling sites located in the two subcatchment areas. In all, 34 parameters of water quality were measured in the field and analyzed in the laboratory. The results were then compared with the standards detailed in provincial regulations concerning raw water for drinking water. For social and agroecosystem surveys, a number of villages located in the two subcatchment areas were selected based on socioecological characteristics that might affect water resource management.

15.3 Results and Discussion

15.3.1 Current Situation and Conditions Related to Water Resources in Bandung

The main sources of raw water for the drinking water in Bandung are the Cisangkuy and Cilaki rivers, located in south Bandung (both rivers are part of the Citarum watershed); they supply about 80 % of the city's raw water. The catchment area in south Bandung is located in an upland region with undulating, hilly areas; there are scattered areas of flat land, particularly at lower elevations. From spatial data measurements, about 36 % of the catchment area has a slope >40 %. With these topographic conditions, in conjunction with Andosols and Latosol as the dominant soil types and declining tree cover, the catchment is vulnerable to severe erosion. The average annual erosion rate is about 146.5 tonnes/ha, which causes high turbidity in the Cilaki and Cisangkuy rivers, and the great majority of the area (about 93 %) is categorized as having a "severe" to "very severe" erosion rate. Therefore, appropriate land management is essential.

The dynamics of river water discharge in the catchment area in south Bandung are evident in its intermittent character (Narulita et al. 2006). The water discharge depends on the amount of rainfall: the greater the rainfall, the greater the water discharge into the river. However, during the dry season, the water discharge drops considerably, and it has been decreasing over the last few years. The ratio between the maximum and minimum discharge can be used as an indicator of deteriorating conditions in the watershed. A previous study determined that the coefficient between the maximum and minimum water discharge in the Upper Citarum watershed was >50 (West Java Environmental Management Agency 2002). This result

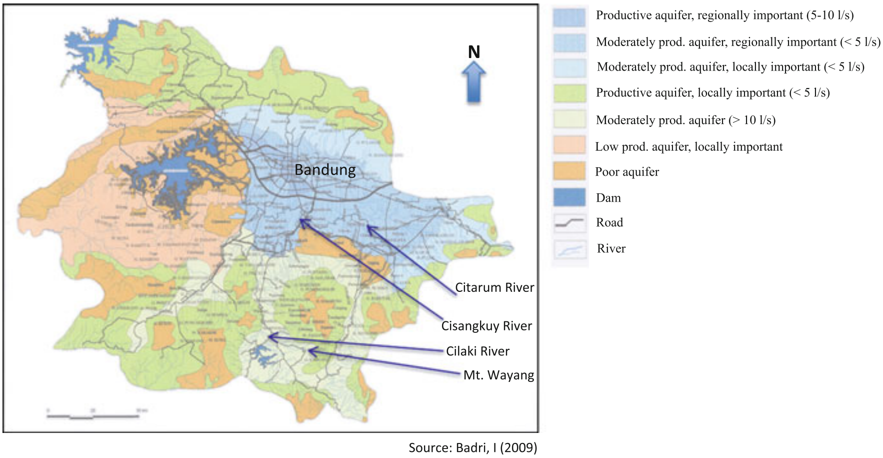

Fig. 15.1 Map of hydro-geological conditions and important rivers supplying water to Bandung

indicates that environmental conditions in the catchment area that supplies drinking water to Bandung are undergoing a moderate decline.

The surface water entering the Cisangkuy and Cilaki rivers consists of main and supplementary sources (the latter consists of an irregular supply from areas surrounding reservoirs). These sources have their headwaters in Mount Wayang in addition to some tributaries; about 13 major tributaries supply water to the Cisangkuy and Cilaki rivers. From these two rivers, water is then run as raw water to the intake before being treated as drinking water in the water treatment plant in Bandung. Based on field measurements, the water discharge varies from site to site: the range is 0.02–8.4 m^3/s, and the water velocity is 0.07–2.3 m^3/s.

Water discharge in the Cilaki River decreased during the period 1993–2006 (Indonesia Power 2008). The maximum water discharge was 4.79 m^3/s, which was recorded in March 1993; the lowest water discharge was 0.1 m^3/s, which was observed in August 2006. The average water discharge in the 1993–2006 period was 1.24–3.68 m^3/s. Based on annual data, though there has been some fluctuation, the water discharge has shown a declining trend over the last 5 years. In general, the catchment area in south Bandung has low to moderate aquifer productivity (Fig. 15.1).

In addition to this decreasing water quantity, the water generated from the catchment area in south Bandung is also suffering from a deterioration in quality. Water quality measurements at several sampling sites in the Cisangkuy and Cilaki rivers indicate worsening in the case of a number of parameters. At some sites in the Cisangkuy and Cilaki rivers, the measured values for certain parameters do not meet the standards stipulated in decree number 39 concerning raw water for drinking (category B) issued by the governor of West Java in the year 2000. These parameters are hydrogen sulfide, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, surfactant, sulfate, manganese (only in the

Cisangkuy River), fecal coliforms, and total coliforms. Overall, the quality of water in the Cilaki River is categorized as "poor" as raw water for drinking water.

The declining water quality in the catchment area is caused by several related factors, such as expansion of intensive agricultural practices without implementation of appropriate measures for land conservation and water source protection, and expansion of human settlements. All these factors appear to derive from continuing population growth and the increasing number of resource-poor farmers. The majority of farmers own agricultural land measuring 0.3 ha or less; this has caused a land conservation program through tree planting in critical land outside the forest area to not be too successful. Only about 62 % of the planted trees can grow well in farmers' land as compared with 95 % in the forest area. Therefore, integrated measures that incorporate various biophysical and social aspects need to be considered to improve the water quality in the catchment area of south Bandung. Some necessary measures have been taken, though these have not yet produced the desired results. Reforestation, land conservation, reducing water pollution, and law enforcement are among the measures put into effect, and they have involved local and regional governmental offices, academic institutions, nongovernmental organizations, and the public. In relation to this, the Indonesian Ministry of Public Works has established management planning for the Citarum watershed (Directorate General of Water Resource 2012) but, so far, management of this watershed has tended to be only partially carried out (only in certain sectors) owing to a lack of mutual understanding among the relevant stakeholders. It is likely that the absence of common principles that accommodate the interests of all parties is a factor behind this situation. In addition, the relevant stakeholders do not as yet properly understand such notions as adopting an ecosystem (landscape) approach as the basis for watershed rehabilitation. Water managers need to recognize more clearly that there are additional, but no less critical, issues beyond the watershed itself—issues of a sociological, ecological, and also political nature (Merrey 2008).

15.3.2 Stakeholders Involved in Water Resource Management System

The stakeholders of the water resource management system of drinking water for Bandung can be categorized into five groups: provincial and district government, community, public and private enterprises, university, and nongovernmental organizations. In terms of their status in the management of the water resource, these stakeholders can be categorized as "holders" (controllers), users, and regulators. Based on this, they can be classified into three different levels (Fig. 15.2). Level one consists of "holders" of water sources; there are three main actors, namely the state's forestry company, tea plantation estate, and natural resource conservation agency. Headwaters are scattered within the forested and plantation areas managed or controlled by these state-owned companies and agency. The tea plantation is also

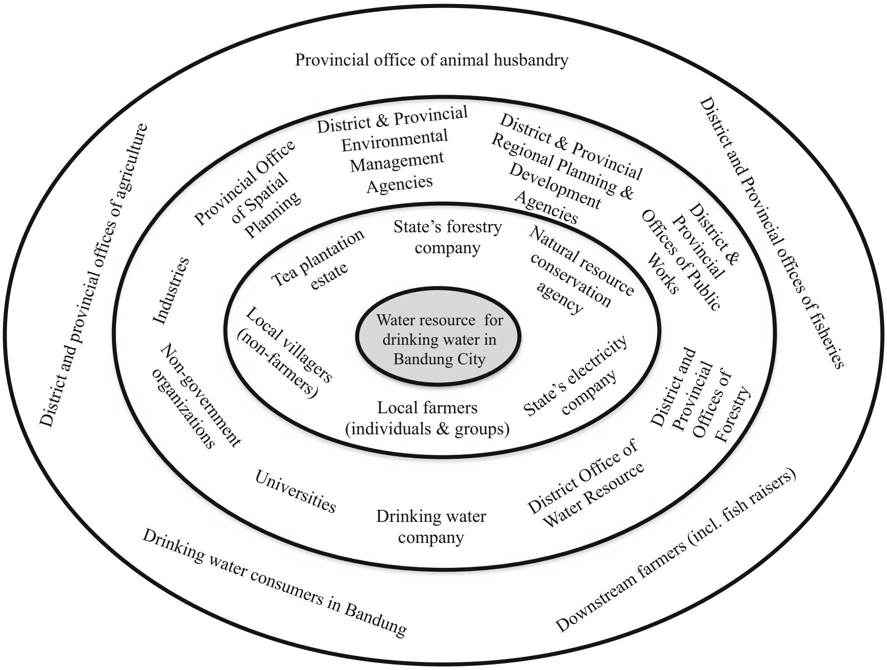

Fig. 15.2 Stakeholders involved in the water resource management system of drinking water in Bandung City

a direct user of the water resource. Other direct users are local farmers, local villagers working outside the agricultural sector, and the state's electricity company.

Level two mainly consists of government agencies and offices involve in policy and regulation making. Bandung's drinking water company also belongs on this level since the company does not have direct access to the water sources. The largest portion of raw water to supply the company' s needs comes from water spillage from a hydropower plant owned by the state's electricity company. This condition suggests that the drinking water company heavily relies on other stakeholders to maintain its water supply. Level three consists of drinking water consumers in Bandung city and downstream water users, and other district and provincial government agencies and offices.

It is obvious that the water resource management system of drinking water for Bandung is quite complex as indicated by the fact that there are many stakeholders directly and indirectly involved. The presence of stakeholders with different level of importance and influence might affect the sustainability of the water supply to the city of Bandung to fulfill the present demand and the future development of drinking water services. In relation to this, Tortajada and Joshi (2013) stated that it is very important to gradually involve more sectors and actors who can make positive additions with their participation in the complex task of efficient water resource management. Furthermore, Thornton et al (2013) pointed out that collective actions of stakeholders are necessary in order to achieve exceptional and outstanding water resource management in the watershed context.

15.3.3 Direct and Indirect Factors Affecting Water Supply Sustainability

The sustainability of the drinking water supply for Bandung depends on how the water resources, including of course the watershed, are managed. The prime factor that profoundly affects the sustainability of the water supply to Bandung is population growth; this generates several affecting factors, such as land conversion, unsustainable agricultural practices, forest encroachment, and poverty. This condition is in line with what was stated by Vairavamoorthy et al. (2008), whereby population increase and urbanization cause the present hydrological cycle to undergo rapid changes, which are difficult to predict. These factors affect the condition of the catchment area, where raw water is generated to supply drinking water for Bandung.

Environmental degradation in the catchment area in south Bandung is the result of the majority of villagers relying on local natural resources for their livelihood. Over 70 % of the population living in the catchment area subsists on income-generating activities in agriculture and extractive activities. However, landlessness is a persistent problem in the area. The average area of land ownership among farmers does not generally exceed 0.3 ha. Environmental degradation is also due to the reduction in forest cover caused by forest encroachment, which has occurred over the last 10 years. Encroachment has caused the disappearance of about 17,533 ha of forest cover (Bandung District Regional Planning and Development Agency 2008). Some parts of the forested area have also been designated as production forest, where tree cutting is commonly practiced. As a result of the expansion of human settlements, it is estimated that about 47 % of the catchment area has become or is becoming built up.

Deteriorating environmental conditions in the catchment area are obvious in the Cisangkuy watershed, where 30 % of the area is currently suffering very severe erosion (>480 tons/ha/year). Although there are no official data, it is believed that water utilization for agricultural, domestic, and other purposes (e.g., the tea plantation) has increased. This has resulted in growing conflicts over the use of water resources between fulfilling the need to supply Bandung with drinking water and the local domestic and agricultural needs for water in the catchment area of south Bandung.

From an institutional perspective, it is apparent that there is still a lack of coordination among the various institutions (government, private, and public) at different administrative levels (local and provincial). As described in the previous section, there are diverse stakeholders involved in the supply of drinking water for

Bandung; therefore, the need for harmonization of different interests among them through consensus building to establish mutual relational capital is unavoidable. Wallis and Ison (2011) stated that institutional innovation is required to build relational capital aimed at achieving an effective water resource management system that takes into account socioecological perspectives. Above all, law enforcement with respect to managing water and land resources is another issue that has not been properly executed. The current problems related to water resources in south Bandung are summarized in Tables 15.1, 15.2, and 15.3.

Table 15.1 Summary of problems directly and indirectly related to water resources in the catchment area of south Bandung: climatic and geological aspects

Aspects	Directly related to water resource issues	Indirectly related to water resource issues
1. *Climate and rainfall*	1. Tendency for increasing mean monthly temperature and evaporation in both the rainy and dry seasons in 1991–2008, causing increased evaporation and evapotranspiration	
	2. Tendency for decreasing air pressure in August–April and May from 1991 to 2008, resulting in increased evaporation	
	3. Increased daily, monthly, and annual evapotranspiration in 1991–2008, tending to decrease base flow and direct runoff in the catchment	
	4. Tendency for decreasing monthly and annual precipitation in 1991–2008, causing reduction in base flow and direct runoff in rivers within the catchment	
2. *Geology*		
2a. *Geomorphology*	1. The catchment area has high runoff and low infiltration capacity	
	2. The area where groundwater accumulates has moderate runoff and low infiltration capacity	
	3. The area where groundwater is stored and outflows have low runoff and high infiltration capacity	
2b. *Topography, relief*	Sloping areas with low or no vegetation cover, causing high runoff, erosion, and sedimentation	Cut and fill in sloping areas for agricultural land causes high runoff, erosion, and sedimentation; water springs disappear

(continued)

Table 15.1 (continued)

Aspects	Directly related to water resource issues	Indirectly related to water resource issues
2c. *Rocks*	Exposed rock and weathered soils with high landslide potential	Cut and fill activities for agriculture and access openings (roads) disturb rock layers, which in turn may affect the condition of water springs
2d. *Soil*	1. Weathered rock has low resistance to erosion and landslides	1. Cut and fill activities for agriculture and road access disturb rock layers, which in turn may affect the condition of water springs
	2. Poor soil stability in some parts of the catchment areas	2. Poor soil stability causes frequent landslides, which in turn may change the depth of water bodies (rivers and lakes)
	3. Soil texture has moderate to high erodibility	3.Land clearing for agriculture causes the loss of vegetation cover and increases erosion, landslides, and sedimentation, resulting in shallow water bodies in some parts of the catchment
	4. Low to moderate soil permeability	4. Lack of measures to support land conservation, such as drainage systems and terraces

Table 15.2 Summary of problems directly and indirectly related to water resources in the catchment area of south Bandung: hydrological and land use aspects

Aspects	Directly related to water resource issues	Indirectly related to water resource issues
1. *Hydrogeology*		
1a. *Infiltration zone*	Little or no vegetation cover has caused a reduction in water infiltration, resulting in lower water discharge, disappearance of water springs, and decreasing water refilling of aquifers	
1b. *Spring*	Reduced water debit in a number of springs from 5 l/s to only 1–2 l/s	Decreasing land cover around water springs
2. *Hydrology*	1. Over the last 15 years, there has been reduced water discharge from various rivers that function as major suppliers for Bandung's drinking water	
	2. Impairment of facilities that channel water from some sources, causing loss of potential debit of about 337 l/s; the result is decreased supply to water reservoirs and thus reduced supply of raw water to Bandung	

(continued)

Table 15.2 (continued)

Aspects	Directly related to water resource issues	Indirectly related to water resource issues
	3. Severe sedimentation in Cipanunjang Reservoir at about 10.91 tonnes/day and in Cileunca Lake at about 12.87 tonnes/day, reducing the reservoir storage capacity	
	4. Three hydropower plants for generating electricity tend to use more water, indicating the reduced efficiency of the plants' turbines	
	5. Water extraction from some main rivers for agricultural land, which tends to increase during the dry season; such activity affects water quantity and quality	
	6. Water extraction from reservoirs to water cash crops cultivated in the drawdown area surrounding the reservoirs	
3. *Water quality*	Intensive agricultural practices (both crop and livestock production) have caused water in some areas to be categorized as "poor"	
4. *Land use*	1. About 15,260 ha of land within the catchment area are in a critical condition, and a rehabilitation program has not yet been implemented	1. Rehabilitation programs through tree planting cannot be properly achieved, because most farmers possess very small areas of land (0.15 ha)
	2. Ongoing changes to land use; better water-conserving land use, such as forest and tea plantations, has undergone conversion to annual crops	2. Plantation is the dominant land use type and is managed independently by the state's plantation estate; to some extent, direct control by provincial or municipal government is lacking
	3. Land resource utilization in some areas in the catchment is not in accordance with the spatial planning ordinances established by the District of Bandung	3. Land utilization in tea plantation areas is not properly carried out as designated: "illegal" cultivation is encountered in remote parts of plantations
	4. Future conflicts in water use regarding the development of the water supply system in the District of Bandung	4. Increasing tendency for land to be needed for settlement and agriculture through population growth; this especially occurs in tea plantation areas

Table 15.3 Summary problems directly and indirectly related to water resources in the catchment area of south Bandung: agroecosystem and social aspects

Aspects	Directly related to water resource issues	Indirectly related to water resource issues
1. *Agroecosystem*	1. Intensive agriculture performed all year round tends to be monospecific, resulting in continuous use of water (in the dry season) and pesticide spraying	
	2. Crops usually require large amounts of water	
	3. Livestock production in the catchment area needs great water availability	
	4. Extracting water from water bodies is commonly practiced by farmers cultivating land near such bodies	
2. *Agricultural land conservation*	Agricultural activity, especially in sloping areas, tends to oblige farmers to neglect considerations of land conservation, which affects water quality	Tree planting is rarely performed by sharecroppers and farmers cultivating small piece of sloping land
3. *Demography, socioeconomic factors*	1. High dependency on water resources for domestic and agricultural use in both the rainy and dry seasons; this dependency is increasing with population growth	1. Increasing pressure on land resources due to population growth
	2. Economic activities performed by local residents are highly reliant on using large volumes of water	2. High dependency on free biomass energy causes locals to encroach on forests and cut down forest trees as well as using nonforest sources
		3. The low educational level produces poor awareness among most villagers about becoming actively involved in conserving water and land resources
4. *Institutions, leadership, local orientation*		1. Plantation estates "control" large portions of land and water resources; this could hamper efforts to coordinate integrated land and water management
		2. The role and involvement of local informal leaders in conserving land and water resources is still lacking

15.4 Conclusions

Bandung is experiencing a serious problem with regard to its water supply for drinking water. This may affect its aim to improve its drinking water supply and service in the coming years. The problems faced in current water resource management are caused by deterioration in environmental conditions in the catchment area, owing to biophysical and social factors. A conceptual plan needs to be established at the landscape level by taking into account biophysical as well as social aspects of the area in which the rehabilitation program to maintain water supply sustainability will be carried out.

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Part IV
Transforming Urban Regions: Toward Regional Sustainability

Chapter 16
Urban Agriculture in the Philippines: Initiatives, Practices, Significance, and Threats

Constancio C. De Guzman

Abstract This chapter provides an overview of urban agriculture (UA) in the Philippines. Several academic and government initiatives are described that relate to UA and have led to an awareness and recognition of UA. The practice of UA is illustrated through studies conducted on commercial vegetable production within Metro Manila and also on a peri-urban livelihood system based on the jasmine species known as *sampaguita* (*Jasminum sambac* Ait), which is used to make garlands in San Pedro, Laguna, a municipality adjacent to Metro Manila. These studies reveal the positive impact of urban and peri-urban agricultural activities on employment and income generation as well as the promotion of positive social values. Most crop production in Metro Manila has been discontinued owing to the inability to compete with land use prioritization. The lack of clear government policy with respect to UA has contributed to the decline of the practice. Recommendations are made for the promotion of urban and peri-urban agriculture.

Keywords Livelihood system • Metro Manila • Urban and peri-urban agriculture • Jasmine garland

16.1 Introduction

In today's world, so-called megacities, which have a population of 10 million or more, are undergoing rapid development. The majority of these megacities are expected to expand from several urban centers of the developing countries of Asia. It is estimated that by 2015, Karachi, Jakarta, Shanghai, Mumbai, and Tokyo (the latter topping the list) will each have a population of over 20 million (Hall 2001). With a predicted population of just under 15 million by that time, Metro Manila will rank number 11 among Asia's megacities. Metro Manila, also referred to as the

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National Capital Region, is the economic and political center of the Philippines. The population of Metro Manila in 2010 was estimated at 11.6 million (www.nscb.gov.ph/secstat/d_popnProj.asp, 2012). The projected increase in the population of Metro Manila is expected to parallel a huge demand for land for residential, recreational, and industrial purposes. More critical, however, will be the enormous demand for food among urban households. Since food security is already a problematic issue, it will of course become a far greater one in 10 years' time unless appropriate measures are undertaken. In light of this scenario, urban agriculture (UA) is seen to play a pivotal role.

The paper presented in this chapter discusses UA within the context of the Philippines. The chapter provides some examples of academic and government initiatives relating to UA, the practice of UA in intra-urban (primarily Metro Manila) and peri-urban settings, some of the benefits derived from the practice, and the problems encountered by urban farmers.

16.2 Local UA Efforts

16.2.1 Academic and Government Initiatives

In 1995, the University of Philippines Los Baños initiated the Urban Agriculture Planning Workshop to produce a situation report on various aspects of local UA, including the identification of issues and omissions with respect to possible research and development. A significant offshoot of the workshop was the creation of the Urban Agriculture Project under the Agro-Industrial Program of the College of Agriculture; this extension project aimed at strengthening the capabilities of local government units (LGUs), state colleges and universities (SCUs), and nongovernmental organizations in the transfer and promotion of urban agricultural technologies (De Guzman and Banatlao 1999).

Similarly, Cavite State University in Indang, Cavite, has promoted various urban agricultural technologies at its Sanayan sa Kakayahang Agrikultura project site, showcasing examples of protected cultivation and soilless culture. In the north of the country, Central Luzon State University in 1999 established models of container gardening as a production strategy for UA (Nitural 2001). In 1997 in the city of Cagayan de Oro, the Xavier University College of Agriculture initiated a research project titled Urban and Peri-urban Small and Medium-Sized Enterprise Development for Sustainable Vegetable Production and Marketing Systems. The project focused on the following areas of research: socioeconomic interactions of peri-urban vegetable production, consumption, and marketing; crop improvement; soil management and plant nutrition; waste management; and integrated pest and disease management (Holmer 2001). The pioneering efforts of these SCUs have paved the way for the growing recognition of UA in the Philippines.

In 1998, the Office of the Presidential Assistant on Food Security, in coordination with the Department of Agriculture Regional Field Unit, launched its UA Program in various cities and municipalities of Metro Manila. The program is basically a government extension project implemented through the Community Gulayan Projects and the Gulayan at Bulaklakan Projects. A total of 46 ha was allocated for the projects in various parts of Metro Manila, and they had almost 4000 family beneficiaries (Duldulao 2001). More recently, the Department of Science and Technology funded an urban agricultural project for growing plants by means of hydroponic culture (Department of Science and Technology 2010).

16.2.2 Commercial Intra-urban Agriculture—Vegetable Gardens in Metro Manila

In the 1970s, the most visible example of UA in Metro Manila was in Barangay Pilipino in the city of Pasay, just 300 m from Manila Domestic Airport. A 10-ha area of land owned by the government was converted to market gardens and planted with vegetables (Fojas 1982). The area eventually became used for the construction of the Light Railway Transit depot.

Current statistics on the volume of crops produced in Metro Manila are virtually nonexistent. Data obtained from the Bureau of Agricultural Statistics in 1998 showed that the volume of production of vegetables in Metro Manila amounted to 3362 tons over a total area of 262 ha (De Guzman and Tusi 2001). Vegetables grown in these commercial urban farms in 1998 were commonly of the leafy type with a short gestation cycle. At that time, *pechay* was the most popular crop and was grown from a single harvest, with more than 1500 tons harvested from an area of 151 ha. This was followed by mustard (354 tons from 298 ha), spring onions (174 tons from 132 ha), and celery (155 tons from 115 ha). In 1998, there were about 600 urban farmers in the metropolis. The city of Muntinlupa had the largest number (40 % of the total) followed by Quezon City (with a little under 30 %). Pasay and Pateros had the smallest numbers of urban growers.

Today, farming in Metro Manila is usually carried out on vacant lots of subdivisions or community gardens allotted by the LGUs (Fig. 16.1). According to Hardiyanto (2002), city farmers in Las Piñas and Parañaque cultivated areas of 180–5000 m^2 in subdivision vacant lots.

Fresh produce is immediately sold or delivered not only to nearby wet markets but also to major supermarkets that cater to high-income consumers, e.g., Farmers' Market, SM Megamall, and Glorymart Trading. It is also not uncommon for traders and middlemen to bid for vegetables in garden plots before harvesting (De Guzman and Banatlao 1999).

Based on the survey of Hardiyanto (2002) of 76 farmers in the cities of Las Piñas and Parañaque, urban farmers can be characterized as follows. Over 50 % of the urban farmers had an average age of 34 years and more than 70 % had only

Fig. 16.1 Urban farming in community gardens allotted by local government units (*left*) and on vacant lots of subdivisions (*right*)

elementary-level education. Almost all (97 %) cited city farming as their main occupation. Most urban farmers were migrants from various provinces of the Philippines, with 31 % coming from the Visayan Region and 64 % from the Bicol Region. About 83 % had engaged in farming in the city for 10 years or less.

16.2.3 **Sampaguita** *System in San Pedro, Laguna—A Peri-Urban Enterprise*

The bulk of UA activities observed in Metro Manila and elsewhere in the Philippines is geared toward the production of short-cycle vegetable crops. The following discussion will consider the study conducted by De Guzman and Tusi (2001) on a livelihood system operating in San Pedro, Laguna, that is centered on the species of jasmine known in the Philippines as sampaguita (*Jasminum sambac* Ait). Though the commercial vegetable gardens in Metro Manila are characteristically intra-urban, the sampaguita system is a good example of a commercial, non-food-crop peri-urban enterprise.

San Pedro is one of the urban municipalities of the province of Laguna, and it serves as the strategic gateway from Metro Manila to the country's southern

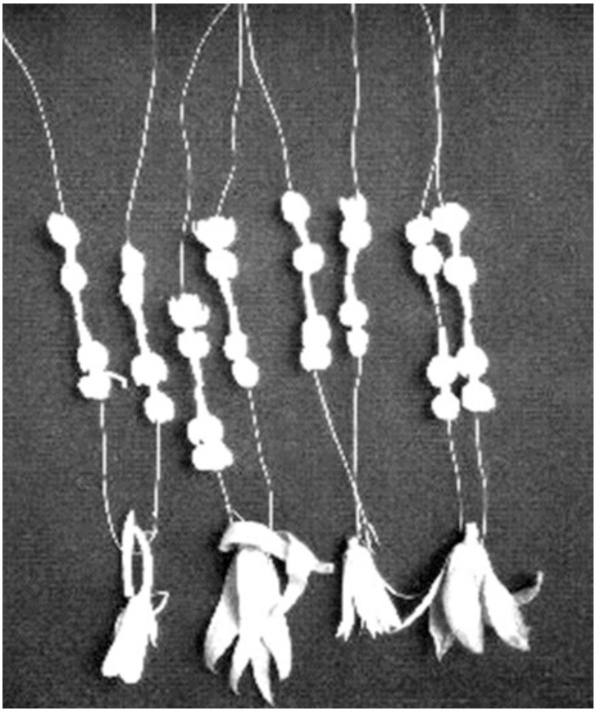

Fig. 16.2 The sampaguita garland consists of unopened sampaguita flowers strung together by abaca fiber as a pendant with a single blossom of *camia*, *ilang-ilang*, or *champaca* (*white* and *golden*)

provinces. The sampaguita garland is the major product of the sampaguita enterprise in San Pedro. The unopened blossoms are taken from evergreen sampaguita shrubs and strung together into garlands, which are used in religious ceremonies and as personal adornments (Fig. 16.2).

The livelihood system begins with the farmers, who are based not only in San Pedro but also in neighboring towns in Laguna and the provinces of Cavite, Quezon, and Pampanga (Fig. 16.3).

The other players in the sampaguita system are as follows: (1) flower pickers, who harvest the floral buds; (2) traders and suppliers, who take the raw materials needed for garland making to the vendors; (3) vendors in San Pedro, who directly sell the raw materials; (4) fiber cleaners, who clean and cut the fibers into the required garland length; (5) garland-making contractors, who buy all the raw materials needed for making sampaguita garlands; and (6) garland makers, who produce the garlands (Fig. 16.4).

Almost all the garlands produced in San Pedro are brought to Metro Manila by garland-making contractors. The garlands are subsequently distributed to garland peddlers. The garland peddler, therefore, serves as the final link from the sampaguita farmer to the consumer. The sampaguita system in San Pedro is an excellent example of the close interaction among rural, peri-urban, and intra-urban agricultural and related activities (from crop production to processing and marketing) (Fig. 16.5).

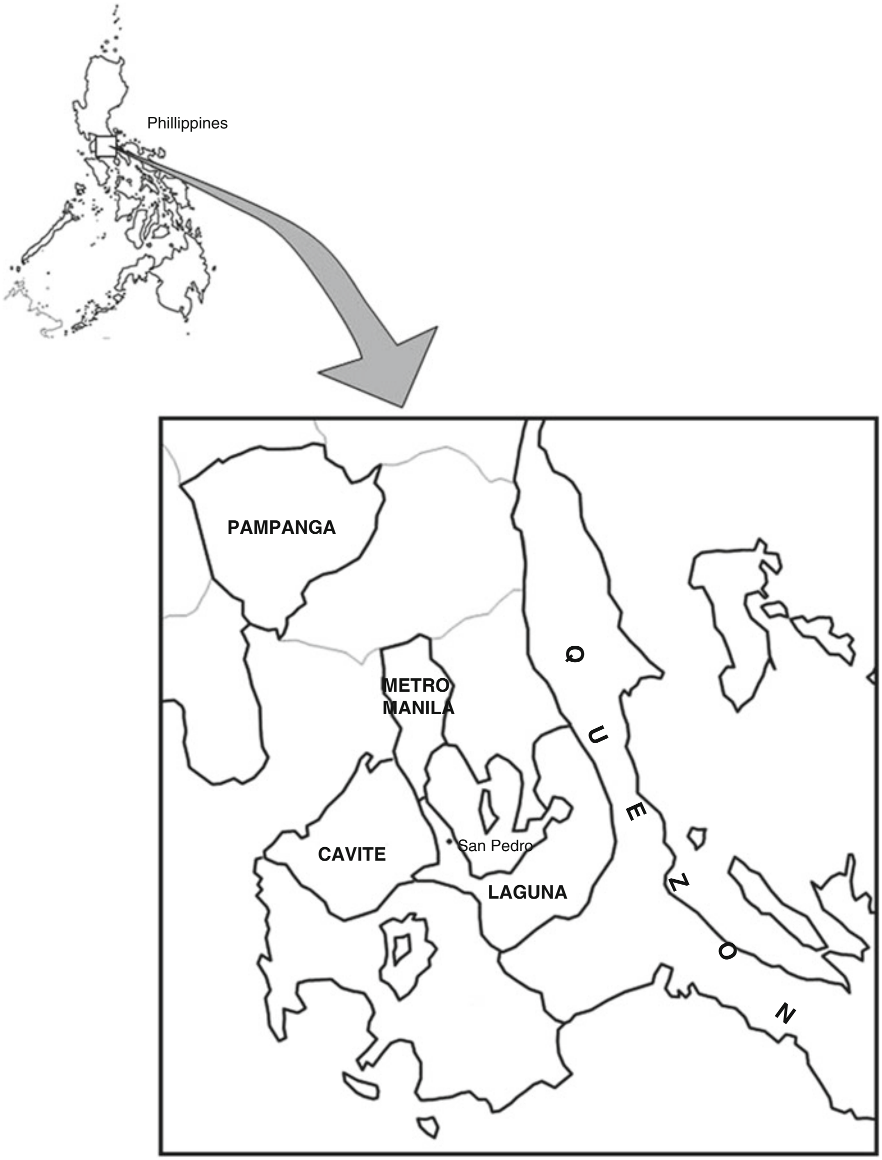

Fig. 16.3 Map showing the relative location of the municipality of San Pedro (where the sampaguita garlands are prepared), Metro Manila (where the garlands are sold), and the different provinces (where sampaguita floral buds are sourced) involved in the sampaguita livelihood system

Fig. 16.4 The key actors in the sampaguita livelihood system (*1*—farmer; *2*—flower picker; *3*—traders; *4*—vendors; *5*—fiber cleaner; *6* and *7*—garland makers, and *8* and *9*—garland sellers)

16.3 Significance of Local UA

There is no doubt that vegetable production in Metro Manila is an important source of income and employment for a number of urban farmers. Hardiyanto (2002) reported that urban farmers in Las Piñas and Parañaque could earn an average of 2617–6382 Philippine pesos (US$ 50.32–122.73) from a 400-m^2 farm lot per month by growing leafy vegetable crops. With the sampaguita business in San Pedro, there is, however, a large number of potential jobs. Garland makers in San Pedro alone number more than 3000; there are no statistics with respect to garland sellers in Metro Manila, but the number is certainly considerable.

One of the nonfinancial benefits of UA is the promotion of positive values as exemplified by the sampaguita system in San Pedro. The sampaguita system is generally perceived as a way of making young people productive. Sampaguita flower picking, garland making, and garland selling are relatively uncomplicated activities that can keep young people busy, particularly in summer when the flower yield is at its peak and students are on vacation. A number of women garland-making contractors in San Pedro became widowed at an early age, and because of their work they are able to support their families. More importantly, this has provided them with self-confidence in being able to accomplish simple aspirations in life. In San Pedro, garland making is viewed not just as an individual's means of

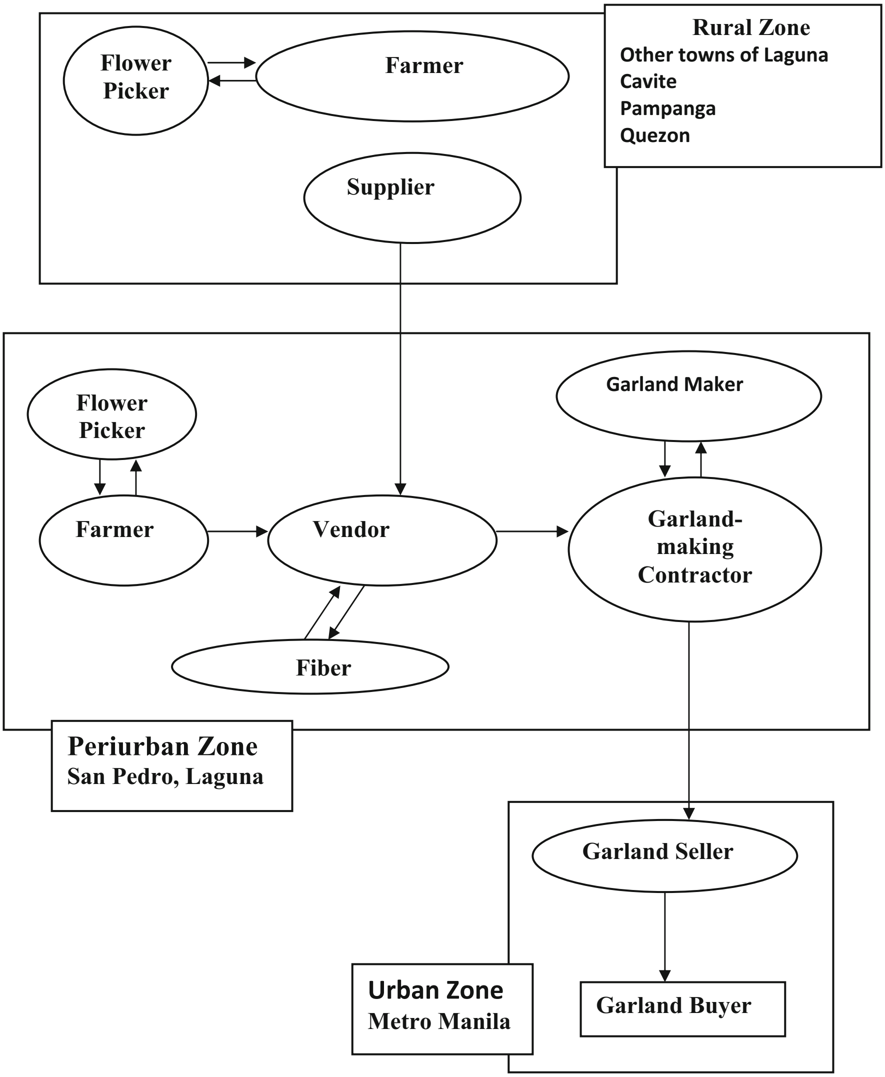

Fig. 16.5 Key players in the sampaguita livelihood system

deriving income but also as a community tradition handed down from one generation to the next.

UA also has the potential to contribute to urban household food supply and the greening of the environment. According to Delfinado (1998), food in the Philippines accounts for 54 % of families' personal consumption expenditure. Self-produced food through UA can allow some money allocated for food to be diverted to other uses. UA also offers possible alleviation of the problem of malnutrition prevalent among lower-income families. Farming in Metro Manila can complement the government's current drive toward the efficient disposal and management of city waste. Composting the organic fraction of city waste provides a potential solution to the problem of solid-waste management in urban areas while augmenting the media inputs into urban farming.

16.4 Threats to UA

One of the major constraints for UA is competition for land use other than for crop production. That is certainly the case with the sampaguita enterprise in San Pedro. The population of San Pedro was estimated to have expanded from 218,442 in 1999 to 323,700 in 2010. This increase of almost 50 % would engender a corresponding demand for residential, commercial, industrial, and road land uses. It was estimated that San Pedro would require an additional 1990 ha to satisfy that demand. Land for industrial use would receive the largest share of this additional area followed by land for residential use. Agricultural areas, including those growing sampaguita, amount to only about 153 ha, and vacant areas of open grassland will eventually undergo development. Vegetable farms located in subdivisions surveyed by De Guzman and Tusi (2001) in North Fairview and Hardiyanto (2002) in Las Piñas and Parañaque no longer exist: houses have been built by the owners in their place.

Another potential threat is the lack of a definite government policy on UA. Despite its good intention to modernize the agriculture sector, Republic Act No. 8435, also known as the Agriculture and Fisheries Modernization Act of 1997, did not make specific provisions for UA. Concerns about UA in that act can be gained indirectly from some provisions related to forestry and urban housing. Palijon (2001) reported that the Department of Environment and Natural Resources incorporated urban forestry as a major component of the Master Plan for Philippine Forestry Development in the late 1980s, which led to the implementation of various beautification and greening programs. Pabuayon (1995) cited the Urban Development and Housing Act of 1992 as being favorable to the development of UA and forestry in terms of the rational use of and development of urban land particularly that related to "parks, reserves for flora and fauna, forest and watersheds…to maintain ecological balance or environmental protection." Recently, House Bill 4750, also known as the Urban Agriculture Act of 2011, was filed in the Philippine Congress to promote urban farming in cities to address food security concerns and regenerate the functions of ecosystems (Rosario 2011).

The practice of UA, both in Metro Manila and in other cities, may present a potential health risk because of problems with air pollution, contaminated water sources, and pesticide application. This aspect requires closer investigation.

16.5 Recommendations

Very few researchers in the field of agriculture and social sciences are aware that UA exists and therefore do not realize that urban farmers face a number of problems. As a multidisciplinary field, UA offers a wide range of topics that can be investigated—from production to socioeconomics. The establishment of the Urban Agriculture National Research, Development and Extension Network by the Department of Agriculture Bureau of Agricultural Research in the Philippines was a significant effort to address several issues related to UA.

There is a need for agriculture to be included as an important and critical component of urban development. To this end, urban planners and city government officials should be shown the advantages of agriculture in an urban setting so that they can accept agriculture as a legitimate form of land use. Some specific actions that can be proposed include the provisions of short or medium-term occupancy licenses to interested growers by local government officials and identification of zones where the practice of agriculture can be permitted. The wisdom of incorporating space for community gardens in the development of new housing subdivisions may also be looked into. The still-existing community garden in Barangay Holy Spirit, Quezon City, which was established in 1998, shows that with full support and political will from local government officials, UA can be a viable venture.

UA activities should be promoted as an agritourism venture and a showcase of a thriving enterprise. A clear example of this is the sampaguita garland–making industry in San Pedro. The municipality holds an annual Sampaguita Flower Festival, which has attracted a considerable number of local and foreign tourists.

If properly developed, UA could help mitigate some of the negative impacts of the expansion of megacities in the near future. City administrators should view UA as an asset to urban development.

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Chapter 17
Scaling-Up: An Overview of Urban Agriculture in North America

Potteiger Matthew

Abstract This overview addresses the most recent decade of growth and change in urban agriculture in North America. Based on a series of case studies and review of current practice it identifies four directions of urban agriculture: growing up—vertical farming, growing in urban voids, growing systems, and going public. These directions respond to three critical questions: how has urban agriculture responded to both processes of deindustrialization and urban growth? What are the strategies to “scale up” what has largely been many small-scale community-based efforts into more significant land use patterns? How can urban agriculture have a significant impact on the social, ecological, and spatial systems of the city? Collectively, the new forms of practice and projects of the emerging Urban Agriculture Movement offer critical alternatives for reorganizing and shaping urban forms and processes.

Keywords Urban agriculture • Community gardens • Food systems • Landscape architecture • Design and planning

17.1 Introduction

The industrial revolution in North America greatly exaggerated the urban–rural dichotomy by increasing the scale of spatial separation between agricultural production and urban sites of consumption. In 1881, Frederick Law Olmsted erased the fields, hedgerows, buildings, and other infrastructure of twelve working farms at the edge of the expanding industrial city of Boston in order to create Franklin Park, an aestheticized rural landscape devoid of any actual production (Zaitzevsky 1992). At the time this erasure and replacement made aesthetic, social, and even economic sense. The leisure value of the park reflected the changing relationship between the industrial city and its food source as the production value of these farms had become marginal with the development of commodity farms in the Midwest linked by continental rail lines. Today, Franklin Park is surrounded by communities

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characterized as "food deserts"—places where it is difficult to find affordable, healthy food because they have been abandoned by supermarket chains (Magnuson 2009). Yet, these neighborhoods also support the greatest number of urban agriculture sites as well as the largest community garden in the city (Database of the Greenspaces and Neighborhoods in the heart of Boston). Just as the Urban Parks Movement responded to and helped shape the form and processes of urbanization in the late nineteenth century, the Urban Agriculture Movement has the potential to play a critical role in contemporary cities of the twenty-first century.

The following overview addresses the most recent decade of growth and change in urban agriculture in North America. It takes as its baseline a series of surveys of community gardens and urban agriculture conducted in the late 1990s (American Community Gardening Association 1998; Kaufman and Bailkey 2000; Brown et al. 2002). These inventories help to mark a point of transition from community gardens (Fig. 17.1) as the dominant form of urban agriculture to the first indicators of new trends and enterprises that would expand in the first decade of the twenty-first century into a vital and diverse movement (Hodgson et al. 2011). New constituencies from disciplines such as food security, public health, sustainable agriculture, and planning and design—as well as the popular movements of organic, local, and slow food—have converged around urban agriculture to make it a much larger "cultural project." Three questions structure this discussion:

- *How has urban agriculture responded to both processes of deindustrialization and urban growth?*
- *What are the strategies to "scale up" what have largely been many small-scale community-based efforts into more significant land use patterns?*
- *How can urban agriculture have significant impacts on the social, ecological, and spatial systems of the city?*

This discussion is based on a series of case studies of the cities of Detroit, Philadelphia, New York, and Toronto. For each city, the documentation included site visits to urban agriculture projects and interviews with agencies, organizations, designers, and gardeners/farmers. This research was supplemented with a literature review of work in other cities. From that survey, this chapter outlines four different directions of urban agriculture:

- Growing Up—Vertical Farming
- Growing in the Urban Voids
- Growing Systems
- Going Public

Fig. 17.1 The Aspen Street Community Garden, Philadelphia—in operation for over 30 years—is one of the oldest community gardens in the city. The mural illustrates an attempt to reconnect the urban and rural realms (Author photo)

17.2 Growing Up—Vertical Farming

One of the critiques of the industrial food system is the consumption of energy and lack of transparency resulting from long-distance circulation of food through global commodity chains. It follows then that one of the goals of urban agriculture is to reduce this distance between production and consumption. The installation of PF1 (or Public Farm #1) captures this strategic move in midair (Fig. 17.2). Designed by WORK Architects Dan Wood and Amale Andraos, PF1 suspends a quarter acre of organic fruits and vegetables growing in structural cardboard above the outdoor courtyard of PS1 (a former public school in Queens, NY, USA, transformed into an extension of the Museum of Modern Art). In the summer of 2008, large crowds of people milled about under the canopy formed by the folded plane of cylindrical planters reading stenciled labels on plants in containers growing 20–30 feet above their heads, listening to audio recordings of farm animals, and peeping into a chicken coop. Solar panels powered the whole urban agro-infrastructure of irrigation pumps and fans circulating the scent of potted herbs. The designers summarized their intention:

Fig. 17.2 PF1, Queens, New York, a temporary urban agriculture installation by Amale Andraos and Dan Wood (Author photo)

> As a live urban farm, PF1 was testament to the possibilities of rural engagement in urban environments and proposed that cities be reinvented to become a more complete and integrated system capable of producing their own food, producing their own power and using their own water while creating new shared spaces for social interaction and pleasure. (WORKac 2008)

This modest-scale vertical farm represents a much larger set of proposals for vertical farms that have garnered a great deal of public attention. The most notable projects are the vertical pig farm by MRDV Architects from Holland (Gorgolewski et al. 2011) and the proposals by Dickson Despommier, an epidemiologist at Columbia University (Despommier 2010). Despite the scale, extending fifty stories and more in many schemes, these visions are essentially microcosms providing a comprehensible system and a sense of direct, immediate control over the vagaries of weather, pests, and soil that make conventional agriculture risky. The argument for concentrating production in cities is also couched in terms of the global environmental crisis: the vertical farm as an alternative to the horizontal expansion of agriculture required to feed the growing world population, which would cause even greater ecological destruction. The contraction and concentration in the vertical farm allows the extensive rural landscape to return to a state of ecological grace.

While innovative, this concentration of agriculture into an architectural form also raises serious questions. Buildings increase the capital costs of production.

The one tenth of a hectare production area of PF1 was funded with $70,000, making for expensive kale and carrots (Andraos and Wood 2010). There is also the question of labor. In the case of PF1 much of the labor was provided by prisoners from Rikers Island, which provided a distinct social benefit. However, as with conventional agribusiness, this aspect of production was not readily visible and it served as a very cheap form of subsidized labor. Intense capitalization and labor issues raise questions of who controls and benefits from these larger ventures (Vitiello and Nairn 2009/2010). However, the main issue for urban planning is that vertical farming restricts urban agriculture to a real estate investment and a building program on a single site cut off from the possibilities of integrating food production into the larger ecological, cultural, and spatial systems of the city. For places such as New York City, where real estate is at a premium, some form of vertical farming will necessarily be part of the system, as has already been demonstrated by the viability of several rooftop farms. However, a majority of North American cities face the challenges of deindustrialization and loss of density, and land is relatively plentiful.

17.3 Growing in the Urban Voids

The primary site for urban agriculture in North America has historically been in the voids left by decades of outmigration of population to the suburbs and further accentuated by the migration of capital, jobs, and manufacturing to the global South and Asia. Nowhere are the effects of deindustrialization more visible than in Detroit (Fig. 17.3). With the steady decline and then the recent collapse of the auto industry, Detroit's population shrank from its peak of over two million people in 1950 to less than half of that by 2000. It is projected to go as low as 600,000 before stabilizing. This has left an estimated 100,000 vacant properties or approximately 30 square miles of vacant land in the city (Atkinson 2009a).

Vacant lots are the one abundant resource in many disadvantaged urban communities, and they have been used strategically to rebuild the community and to provide food and economic benefit. In fact, it was in Detroit during an earlier economic collapse in the 1890s that the first community gardens in North American cities were created (Lawson 2005), providing a model for other cities. Almost 100 years later, in the 1980s, as an alternative to Mayor Coleman Young's proposal for casinos, activist Grace Lee Boggs and her husband James helped organize an intergenerational program around community gardens to rebuild Detroit from the ground up. This laid the framework for the current resurgence of individual and community gardens that have reclaimed vacant lots as productive spaces (Boggs 2009).

The Earthworks Garden on the east side of Detroit (Fig. 17.4) illustrates the transformation of vacant lots into a patchwork of productive sites. This side of Detroit has some of the highest vacancy rates—over 50 % in most of the area—and some blocks are completely vacant. Earthworks Garden is a project that grew out of

Fig. 17.3 A vacant block on Detroit's East Side neighborhood. Much of Detroit now has a rural density (Author photo)

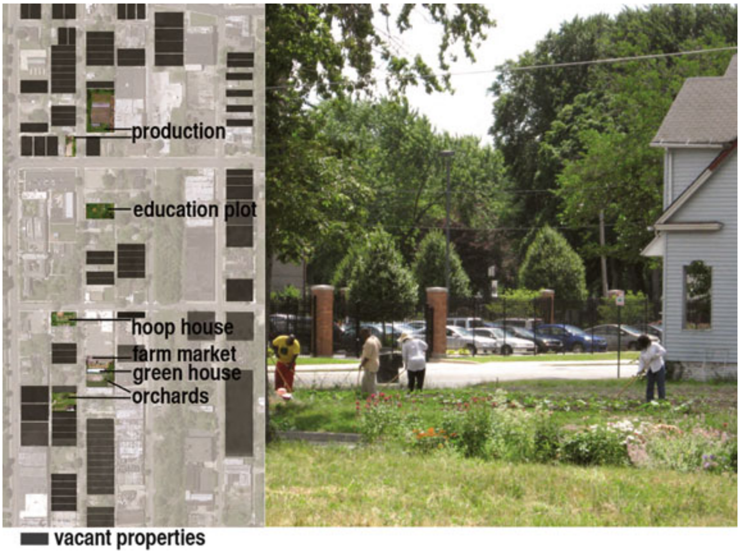

Fig. 17.4 Earthworks garden on the east side of Detroit, demonstrating the strategy of piecing together scattered vacant lots. Each lot is a different type of production system linked to different types of programs such as youth training or market farming. This section of Detroit has one of the highest vacancy rates in the city

the Capuchin Soup Kitchen in the area. It is composed of a series of sites scattered across four blocks and includes areas of row crops, wild edibles, bee hives, a hoop house, a green house, a youth garden, and two small orchard sites.

However, the reliance on vacant land has also limited urban agriculture to the status of marginal and temporary land use, often without legal title to the land or governmental, financial, and organizational support. The effects of this can be seen in Philadelphia where the once extensive landscape of over 500 community gardens in 1994 shrunk to 226 active gardens in 2008 (Vitiello and Nairn 2009). The urban community garden on vacant lots also holds an ambiguous status as public space. As soon as economies rebound, the very community gardeners who have contributed to revitalized neighborhoods are pushed out to make room for more valuable, tax-generating uses. By the 1990s in New York City, community gardeners had restored vacant lots that, in turn, increased the attractiveness and land values of these neighborhoods. In 1998, Mayor Rudolph Giuliani transferred the control of hundreds of community gardens from the Parks Department to the Department of Housing through which the lots were to be sold in response to pressure by developers and to generate income for the city (Nordahl 2009). Protests by community groups argued that these were public spaces. In the end, 113 sites were spared through a $4.2 million purchase of land trusts (Staeheli et al. 2002). While the land trust agreement secured the lots, their role as public spaces and the question of who actually controls the spaces remains ambiguous.

Others are looking to capitalize on the potential to aggregate vacant land as a speculative investment opportunity. John Hantz, CEO of an investment firm in Detroit, intends to create the largest urban farm in North America by assembling vacant land, the value of which is as low as that of rural land outside the city. His idea is to create scarcity of land through agricultural use, thereby driving up the land values of the rest of Detroit to attract other investment and other uses. Urban agriculture in this case becomes the driver of urban development. The initial proposal for Hantz Farms called for a 200 ha farm but, in the face of strong community opposition, he scaled down the plan to 20 ha to be replicated thereafter as a series of "pods" in different sections of the city (Allen 2009). People who have helped to establish the community-based urban agriculture network have raised questions about who will actually benefit (Crouch 2009). As a response to this project, the city is in the unprecedented process of developing guidelines for urban agriculture.

The extensive vacancy of places like Detroit offers a unique opportunity in urban history to shape new urban morphologies. Urban agriculture is a central component in many of these visions and linking vacant land into larger patterns is a common strategy. The American Institute of Architecture sponsored a design charrette in 2008 to reimagine Detroit as a series of urban villages surrounded by productive agricultural landscape. On the east side of Detroit in the same neighborhood as the Earthworks Garden, the Recovery Park project is using urban agriculture as the basis for an extensive neighborhood revitalization plan developed through a public citizen participation process (Cross 2013). Other shrinking cities—Cleveland, Ohio, and Flint, Michigan—are using GIS analysis to determine how planning policy can shape the process of abandonment and vacancy to create land use patterns to restore ecological patterns with the potential for productive agricultural use (Nassauer and VanWieren 2008).

17.4 Growing Systems

The individual urban agriculture site is vulnerable to many different forces, from development threats and vandalism to simple aging of the gardeners (Vitiello and Nairn 2009). The alternative strategy is to link many scattered sites into a system of mutual support and integrate them into larger social, environmental, and spatial patterns. In the last 10 years, effective organizational networks have created more sustainable, resilient urban agriculture systems. By 2000, Detroit community gardening was in decline as federal and city support disappeared. In 2003, a consortium of groups—Michigan State University, Earthworks Garden at the Capuchin Soup Kitchen, and a nonprofit agency, the Greening of Detroit—formed the Detroit Agricultural Network and the Garden Resources Program (Atkinson 2009a). This established the organizational framework for creating a larger system.

As the name suggests, the Garden Resources Program provides and coordinates critical resources for the network of gardens throughout the city. Three times a year it distributes seedling plants from three different greenhouse locations and coordinates volunteers. It was discovered early on that the most critical resource the program manages is knowledge, so, in order to receive resources, people have to participate in one learning workshop. This social network supported over 700 gardens in 2008 and increased that number to over 900 in 2009 (Atkinson 2009b). Currently, the system of over 1400 gardens involves a diverse network of 843 family, 408 community, 86 school, and 79 market gardens (Garden Resource Program Collaborative 2012). Similar collaborations between grassroots organizations, social service agencies, and municipalities operate across North American cities, including cities as small as Lewiston, Maine, with a population of 35,000.

Not only is there a move to “scale up” urban agriculture by expanding the size, type, and network of sites, but there is also a move to “scale out” by linking it to other sectors of the food system. This move connects urban agriculture to a larger “food movement,” which is actually a collection of related social movements—including food justice, organic food, slow food, local foods, sustainable agriculture, and food security—addressing health, environmental, and social justice issues of food at a systemic level. Public health paradigms, for instance, have shifted from an exclusive focus on *infectious* disease to the *chronic* health issues that result from diet (Roberts 2009). And diet and nutrition are related to spatially determined food choices, as well as to the kind of production system they come from.

From a food system approach, then, urban agriculture plays a critical role. In food deserts, for instance, urban agriculture sites are the only alternative food source to the convenience stores in the communities around Boston’s Franklin Park or the “party stores” in Detroit. These stores stand out as the lone food retail outposts in areas long abandoned by any supermarket of significant size. The handpainted signs advertise beer, lotteries, and cigarettes, and the few shelves inside offer high-calorie food at high prices. The consequences of eating at this end of the food chain are measurable, including diabetes and low infant birth weight (Lane et al. 2007).

Because the vacant lot and the convenience store selling processed foods result from the larger systemic relationship, change must also come at a system level, well beyond the individual site of agricultural production. In this manner, urban agriculture practice is integrated into alternative systems of distribution, markets, and food security. The Garden Resources Program in Detroit provides a distribution infrastructure for aggregating production from the gardens and markets them in farmers markets and other venues around the city, including attempts to get fresh produce into corner stores. Other organizations are working to link urban agriculture with institutions—school gardens, hospitals, soup kitchens, and food banks.

With networks of gardens linked together and joined to broader food system initiatives, urban agriculture is a system situated within other systems. In Detroit, Toronto, New York, and Philadelphia, as in many other cities, there are multiple organizations supporting urban agriculture integrated with multiple sectors of food systems. In Toronto the Stop Community Food Centre supports community gardens linked to school programs as well as its own soup kitchen. FoodShare, also in Toronto, promotes urban agriculture sites, farmers markets at those sites, cooking, education programs, and distribution of food boxes throughout the city (Fig. 17.5).

From an initial assessment, the small scattered sites of urban agriculture in North American cities seem woefully inadequate for the urgencies of food insecurity and the task of forging more sustainable food systems. However, their strength lies in the less visible social networks that have responded to challenges of vacancy,

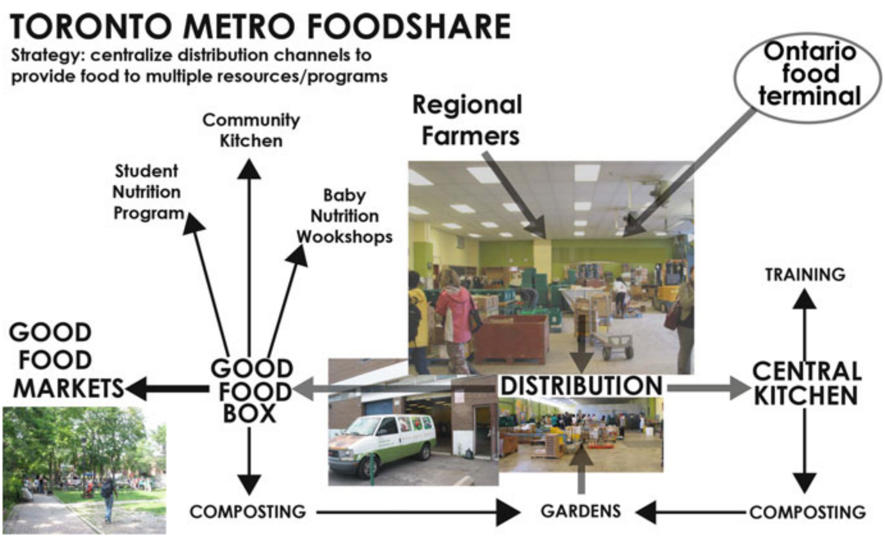

Fig. 17.5 Toronto's FoodShare is a network organization that links urban agriculture to other sectors of the food system (Diagram by Potteiger and Washburn)

impermanent land tenure, lack of funding, restrictive zoning, and government regulations in innovative ways. Using tools of social organization, advocacy, mapping technologies, unique land tenure arrangements, and business models that combine community building with economic return, these networks are able to organize the complexities of urban situations into more robust and resilient systems. This pattern of "distributed" or "networked urban agriculture" linking many small and diverse sites is a flexible model for adapting agriculture to the variety of urban spatial typologies—from vacant lots to rooftops, walls, boulevards, and parks (Cohen 2009). The 5 Borough Farm Project in New York City provides a network for linking all the urban farming activities in the five boroughs of the New York area so that it can be seen as a whole system of spaces as important as the parks, highways, and other infrastructures of the city (Cohen et al. 2012a). In this aggregate networked form, urban agriculture also meets the goal of scaling up production. It is estimated that the variety of Philadelphia's community gardens produced $4.9 million worth of summer vegetables, which was more food than all of the city's farmers markets sold in 2008. Considering food harvested directly, sold at market, distributed in food pantries, "cumulatively, these patterns constitute the most direct form of fresh food production and distribution in cities." (Vitiello and Nairn 2009)

These networks also have the potential to shape the larger urban spatial and ecological patterns and systems. Mill Creek Farm in Philadelphia is one example of this potential. It is a for-profit venture on a site leased from the Water Authority (Fig. 17.6). It also adjoins a long-standing community garden farmed for decades by

Fig. 17.6 Mill Creek urban farm, an entrepreneurial market farm located on publicly owned land, demonstrates how urban agriculture can serve multiple functions integral to urban infrastructure systems

African-American residents from the South. The lease arrangement, sharing of resources, volunteer labor, infrastructure, and complimentary functions illustrate the sophistication of the socially networked urban agriculture. In addition, the lot it sits on is part of a larger pattern of vacancy that emerged as houses that were built over the former streambed of Mill Creek began to settle and crack above the unstable fill. The city demolished and cleared the sites. This project illustrates the potential to use urban agriculture to reestablish the former streambed as a recreational and productive corridor through the neighborhood. Already the farm provides an environmental service by reducing storm water runoff (Walker 2009).

17.5 Going Public

One of the great unrecognized potentials for scaling up urban agriculture and creating coherent spatial, social, and ecological systems is the exiting pattern of public spaces—parks, plazas, streets, courthouses, or even municipal parking lots—the great abundance of land within public control (Nordahl 2009). Unlike vacant lots these public spaces have a greater security of land tenure and protection from development. In cities—such as New York, Boston, or Toronto—that have retained their economic status in a global market place, vacant lots are at a premium, as is open space at the urban edge, leaving public land as the most attractive option for urban agriculture. In either case, deindustrial cities or thriving metropolis, public land provides a coherent infrastructure that can be further enhanced with productive agricultural use. As parkways, institutional grounds, or ecological corridors, these spaces have already been selected and shaped to serve as a common infrastructure, and communities often cohere around them. Victory gardens established in parks during WWII provided a precedent for using public space as productive space, and these gardens still produce food in a portion of Boston's Emerald Necklace (Lawson 2005). At Romanowski Park the Detroit Garden Resources Program has installed a productive farm for the community and an adjacent school. At a comprehensive planning level, a study by FoodFirst in Oakland, California, assessed the potential of all public lands—parks, rights of way, school property—for expanding urban agriculture (McClintock and Cooper 2009).

There are also opportunities even in expanding cities for urban agriculture to be part of the public space infrastructure. In a moment comparable to the creation of Franklin Park, at the other side of the North American continent in the planned community of Irvine, California, the city is in the process of creating the Orange County Great Park, described as "the first great park of the 21st century." Redeveloping and restoring a former military air base, the proposed 545 ha park is twice the size of Central Park and will form the central open space for a housing and mixed-use development. It is intended as a model for how to integrate recreation, ecological restoration, and urban agriculture. In fact it is the agricultural component that is the first major phase of development to be completed. The lead landscape architect of the design team, Ken Smith, noted that urban agriculture is "one of the less costly things to do to engage a large acreage."(Dyer 2009) The design includes a community farm and a 2500-tree citrus orchard as well as community gardens and a agricultural pavilion, which will serve as a community center and farmers' market.

17.6 Conclusion

Since the 1990s the Urban Agriculture Movement in North America has expanded the scope and scale of food production to include brownfield sites, rooftops, parks, parking lots, and many other types of urban spaces. Much of the change was initiated by grassroots organizations and pioneering entrepreneurial individuals. Urban agriculture now attracts a broad spectrum of people from different economic classes, ages, and culture groups (Fig. 17.7). However, this increased attention and attempt to scale up urban agriculture has also run into barriers, including ambiguous or restrictive municipal zoning codes, lack of secure land tenure, physical infra-structural needs, and the need for better organizational capacity. In addition many of the problems that urban agriculture is meant to address, such as the disparities of access to fresh produce in food deserts, are the result of much larger structural

Fig. 17.7 Lafayette Greens in downtown Detroit, sponsored by the Compuware Corporation, illustrates the diverse constituencies that have developed around urban agriculture

processes such as the planning decisions that contributed to the hollowing out of urban cores and the growth of suburbs (McClintock 2008). These limitations and the broader structural issues point to the need for increased municipal involvement in planning and policy making for urban agriculture.

Many municipalities are leading the way in incorporating urban agriculture as a means of addressing issues of food security, environmental sustainability, community development, and public health. Several low- or no-cost policy initiatives can have significant effects on supporting these multiple values (Cohen et al. 2012b). Revising zoning codes to allow urban agriculture activities is a critical action that requires little up-front investment. However, this requires a shift in the urban–rural dichotomy to allow food production, typically perceived as a rural land use, to occupy urban real estate. In addition urban agriculture is also perceived as a lower-value land use, and even the conversion of vacant lots for agriculture can be seen as a loss of future property tax revenues. Documenting the multiple values of urban agriculture, such as the 5 Borough Farm Project in New York City, is important for developing baseline metrics for public decision making (Cohen et al. 2012a).

Certain cities are taking more active measures to promote urban agriculture by creating incentives, targets, and special funding. In 2008 the citizens of Seattle voted to provide $2 million in funding for the development of new community gardens (Cohen et al. 2012b). The city of Baltimore initiated a program of providing land for new farm ventures if individuals submit viable plans that meet city guidelines. Mayor Nutter of Philadelphia placed food systems as a priority and set a goal of having fresh produce within a 10-minute walk in every neighborhood. Likewise, the City of Oakland established a new Food Policy Council and is working to meet a benchmark of providing 30 % of the city's food consumption from local sources in and around the city (Harper 2009).

The most significant realization to emerge from efforts to scale up urban food agriculture is that food production is one part of a comprehensive food systems approach. As it turns out, scaling-up not only involves increasing the size, diversity, and number of sites of production, but it also involves creating new networks of food distribution, markets, and communities of consumers around the food grown in the city. Urban agriculture becomes part of a larger system that is also linked to other vital urban systems of transportation, water, open space, housing, and the regional ecology. The development of Food Policy Councils at the municipal level represents a comprehensive and synthetic approach to complexities of urban agri-food systems that is linked to major land use and other key planning and policy decisions. In this way urban agriculture has the potential to play a critical role in urban sustainability, similar to the role the Urban Parks Movement played in the growing industrial cities of the nineteenth century in North America. This broader vision of the role of urban agriculture builds on a movement that has grown beyond the limitations of the vacant lot to expand into new spatial typologies, building new urban networks to help to create more socially just and sustainable food systems.

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Chapter 18
Regional Planning and Projects in the Ruhr Region (Germany)

Dietwald Gruehn

Abstract This chapter gives an outline on the development of regional planning and important contemporary regional projects in the Ruhr region. In the 1920s, when Germany first became a democracy within the Weimar Republic, regional planning was established in the Ruhr region (Siedlungsverband Ruhrkohlenbezirk (SVR)) to organize traffic as well as urban and economic development and to protect greenbelts on a supralocal level. After World War II, SVR underwent several changes, which led to new terminologies. SVR was replaced by KVR (Kommunalverband Ruhrgebiet (Association of Local Authorities of the Ruhr Region) in 1979. Since 2004 the same organization has been called RVR (Regionalverband Ruhr (Regional Association of Ruhr)). New legislation at the federal state level has extended the competencies of RVR in the field of regional planning in 2009. Despite of the chances for the Ruhr region, which are linked with the responsibility for regional planning in one authority, there have been many benefits for the region in recent decades, emerging from informal planning instruments, processes or events, such as the International Building Exhibition (IBA) Emscher Park in 1989, which was succeeded by a huge number of further projects contributing to implementation of major goals of IBA Emscher Park. The efforts that have been undertaken in the Ruhr region in recent decades have contributed not only to structural change in terms of economics but also to mental changes in how people perceive the region.

Keywords Emscher revitalization • Regional planning • Ruhr region • Structural change

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18.1 Introduction

Traditionally, from a German perspective, the Ruhr region was regarded as an industrial zone, characterized by environmental damage, low life quality, and a predominantly uneducated population. The industrial production mainly focused on coal and steel production. Apart from the University of Duisburg, which was founded in 1655 and closed by the Prussian King in 1818, the first universities were founded in the 1960s, such as Ruhr University of Bochum (1965) and Dortmund University (1968). Since those times universities have played an important role in the Ruhr region to master the need for a fundamental structural change, caused by a gradual decline of the coal and steel sector (Henze et al. 2009).

With the process of closing down both collieries and steel production plants, huge areas within the urban fabric fell out of use. Parallel to this, the numbers of inhabitants in most cities within the region decreased, caused by migration and other demographic changes. Hence, cities like Essen or Gelsenkirchen lost about 100,000 inhabitants within two or three decades and therefore were among the most rapidly shrinking cities in Germany. The decline of the major pillars of the regional economy did not only lead to a high unemployment rate (Prossek et al. 2009). Much more, it was sensed by the local people as a decline of the total region itself. A depressed atmosphere diffused into this hopeless region.

Today's Ruhr region is more and more developing as a vital agglomeration, characterized by an exceptional industrial heritage, a broad range of cultural supply, large areas of parks and greenbelts, and a huge number of revitalized brownfields, which at large enhance both life quality and the reputation of the Ruhr region (Dpt. of Urban Design and Land Use Planning 2008). What are the reasons for this paradigm shift?

Due to the fact that Germany has established a rather sophisticated planning system (Gruehn 2006), in the past decades not only formal planning instruments but also informal instruments have been applied in the Ruhr region. While formal planning instruments in Germany are defined in planning law at a federal level as well as at a federal state level with regard to the responsible authorities, planning area, contents of plans, planning procedures, legal impact, etc., there are no regulations for informal planning instruments. Consequently, planning authorities have a higher degree of flexibility in using informal planning instruments, such as the Master Plan of Emscher Landscape Park or the Master Plan of Future Emscher Valley. The category of formal planning instruments in the Ruhr region comprises regional plans, comprehensive plans, landscape plans, and zoning plans. The crucial questions from the perspective of planning sciences concerning the different paths of development in this region are:

- What was/is the role of formal planning instruments in governing the process of future-oriented regional development?
- What was/is the role of informal instruments, processes, or events in supporting or even inducing the abovementioned paradigm shift?

18.2 Methods and Area Description

18.2.1 Methodological Approach

This chapter is based on two methodological approaches: an analysis of the historical development of the Ruhr region and an interpretation of laws and formal instruments, which are the basis for decision making by the responsible authorities, compared with the effect of informal instruments, processes, or events. The chapter includes findings from the most relevant investigations carried out in the last couple of years.

18.2.2 Area Description

The Ruhr region is the largest urban agglomeration in Germany. It is located in the federal state of North Rhine-Westphalia and has more than 4000 km^2 and a population of about five million. The Ruhr region is considered part of the larger Rhine-Ruhr metropolitan area of more than 12 million people (Henze et al. 2009).

The Ruhr region consists of several large, formerly industrial cities, which are located on the Ruhr, Lippe, and Emscher rivers (Fig. 18.1). The latter one flows through the central part of the Ruhr area. Therefore, geographically the term "Emscher region" would have been more adequate than "Ruhr region." But for more than 100 years, local people were ashamed of the Emscher, because the 83 km–long river was used as an open sewer, whereas the Ruhr and Lippe were

Fig. 18.1 Area of the Regional Association Ruhr (RVR), Germany (Ullrich 2004)

used for the supply of potable water. Due to subsidence caused by mining it was not possible to build subsurface sewers in the region. Hence, the only possible solution to get rid of sewage as well as pit water was to make use of the Emscher river.

From west to east, the area includes the cities of Duisburg, Oberhausen, Mülheim, Bottrop, Essen, Gelsenkirchen, Bochum, Herne, Hagen, Dortmund, and Hamm, as well as parts of the counties of Wesel, Recklinghausen, Unna, and Ennepe-Ruhr-Kreis (Fig. 18.1). Historically, the western part of the Ruhr region, including Duisburg and Essen, belonged to the Rhineland, whereas the eastern parts, including Gelsenkirchen, Bochum, Dortmund, and Hamm, belonged to Westphalia. Since the nineteenth century, these districts have grown together into a large complex with a vast polycentric industrial landscape—the fourth largest urban area in Europe after Moscow, London, and Paris (Henze et al. 2009). Nevertheless, administrative organization and responsibilities in the Ruhr region have been divided according to the historical structure up to the present. The Ruhr region still belongs to three different administrative regions (Regierungsbezirke), namely Düsseldorf, Münster, and Arnsberg (Fig. 18.1), which are in charge of a broad range of tasks, since 2009 excluding the competency for regional planning within Ruhr area.

Before the process of industrialization started in the early nineteenth century, the region's character was mostly agrarian and thus indistinguishable from surrounding parts of Westphalia and Rhineland (Häpke 2009). Its fertile loess soils made it one of the richer parts of western Germany. By 1850, almost 300 coal mines were in operation. The coal was processed in coking ovens into coke, which was needed to fuel the region's blast furnaces, which produced iron and steel. Before the coal deposits along the Ruhr were exploited, new mines were sunk. The mining industry migrated northward from the Ruhr to the Emscher and finally to the Lippe (Henze et al. 2009).

18.3 Results and Discussion

In 1920, regional planning was established in the Ruhr region (Siedlungsverband Ruhrkohlenbezirk (SVR)) to organize traffic as well as urban and economic development and to protect greenbelts on a supralocal level (Gruehn 2010). SVR was responsible for regional planning until 1975. When SVR was replaced by KVR (Kommunalverband Ruhrgebiet) in 1979, this organization obtained competency for elaborating formal landscape plans according to the North Rhine-Westphalian Landscape Law. Later, local authorities started to complain about the political power of KVR concerning environmental aspects. The result of this process was the loss of responsibility for landscape planning in 1998. In 2004, KVR was renamed RVR (Regionalverband Ruhr (Regional Association of Ruhr)). After the elections in 2005, North Rhine-Westphalia was governed by a conservative–liberal coalition. The new government started a controversial debate on the realignment of administrative structures in North Rhine-Westphalia, aiming to establish a higher

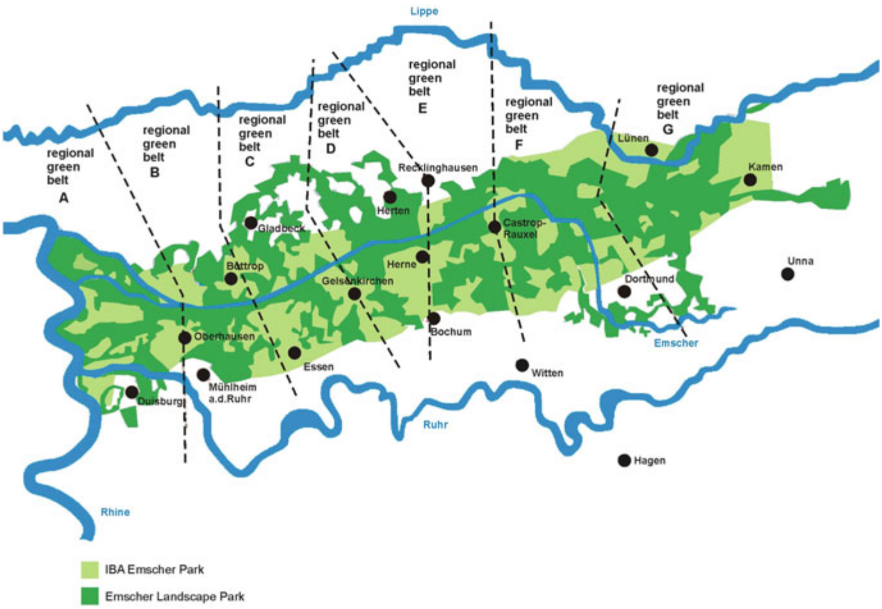

Fig. 18.2 IBA Emscher Park and Emscher Landscape Park according to the Department of Urban Design and Land Use Planning (2008)

degree of autonomy for RVR, especially in the field of regional planning. Parallel to this process, local authorities of the Ruhr region cities, which are predominantly governed by the Social Democratic Party, started a joint regional land use plan as a bottom-up counterplan against the projected Ruhr regional plan. In 2009, a new Regional Planning Act was adopted. As a result, RVR is responsible for regional planning in the whole Ruhr region again.

Another institution of outstanding importance is the Emscher Association (Emschergenossenschaft), founded in 1899. Its task was to organize sewage disposal. For this purpose the Emscher river was converted to an open canal at the beginning of the twentieth century. Since mining activities went to the North, the Emscher Association started to rebuild and to revitalize the Emscher watercourse in 1990.

Nevertheless the main idea of this huge 20-year project was developed within the International Building Exhibition (IBA) Emscher Park, which started in 1989 (Fig. 18.2). IBA Emscher Park was initialized as a future program by the government of North Rhine-Westphalia in cooperation with 17 cities, two counties, and the Regional Association Ruhr (RVR). The aim was to improve life quality by means of architecture, urban design, and ecology as a sound basis for the economic change of this old industrial region. A total of 120 projects with a budget of €2.5 billion were developed and realized within IBA Emscher Park, for instance:

- Emscher Landscape Park (300 km^2 open space)

Figs. 18.3 and 18.4 Comparison of two Emscher sections: the Emscher canal in Dortmund-Mengede (*left*) and the revitalized Emscher river in Dortmund-Barop (*right*)

- Revitalization of the Emscher river
- Historic monuments to industrial architecture
- Urban development projects

IBA Emscher Park is considered a key factor for the abovementioned paradigm shift. From that point the Ruhr region was no longer regarded as an ugly and devastated "no-go area." The region itself became presentable by including historic monuments in the future "green concept," which disclosed unanticipated perspectives.

Figures 18.3 and 18.4 illustrate the impact of the revitalization projects. Emscher in Dortmund-Mengede is still an unprepossessing sewer canal, whereas the revitalized Emscher in Dortmund-Barop mirrors the beauty of a natural watercourse.

In Fig. 18.5, Nordsternpark in Gelsenkirchen is presented, which was designed as the German State Garden Show in 1997. It was constructed on a former colliery site. After closing the colliery in 1993, the area was developed in accordance with IBA Emscher Park to connect two city quarters of Gelsenkirchen by a newly created park, considering the historic architecture of the industrial age. The idea was to create a new park, which is a symbiosis of a landscape park and a commercial park.

From today's point of view, IBA Emscher Park was a starting point for a huge number of single projects, which have been carried out by different local and

Fig. 18.5 Nordsternpark in Gelsenkirchen (Vincentz 2012)

regional authorities in recent decades. Its impact is still noticeable. Most of those single projects integrate well into the visionary concept of IBA Emscher Park. Hence, the ascertainable trend of different authorities to adopt ideas and to support the implementation of IBA Emscher Park goals verifies its strong impact.

The next step to continue the process, which was triggered by IBA Emscher Park from 1989 to 1999, was the development of the Master Plan of Emscher Landscape Park 2010 (Fig. 18.6 and Projekt Ruhr GmbH Projekt Ruhr 2005). This process took 5 years, starting in 2001. During the whole planning process, the government of North Rhine-Westphalia and all concerned local and regional authorities were involved, including the Regional Association Ruhr as well as the Emscher Association. The total area of the landscape park (457 km^2) is larger than that of IBA Emscher Park (300 km^2). The added park areas are primarily greenbelts in the inner cities and green connections. The Master Plan of Emscher Landscape Park 2010 comprises more than 400 single projects, which will be realized within a time frame of 30 years.

A further step to rearrange the Emscher river system was the Master Plan of Future Emscher—The New Emscher Valley (Figs. 18.7, 18.8, 18.9) with a main focus on flow conditions and technical requirements of the Emscher revitalization within the whole catchment area. This master plan comprises an 83-km watercourse of the Emscher as well as 270 km of tributaries. The estimated costs are about €4.5 billion (Emschergenossenschaft 2006).

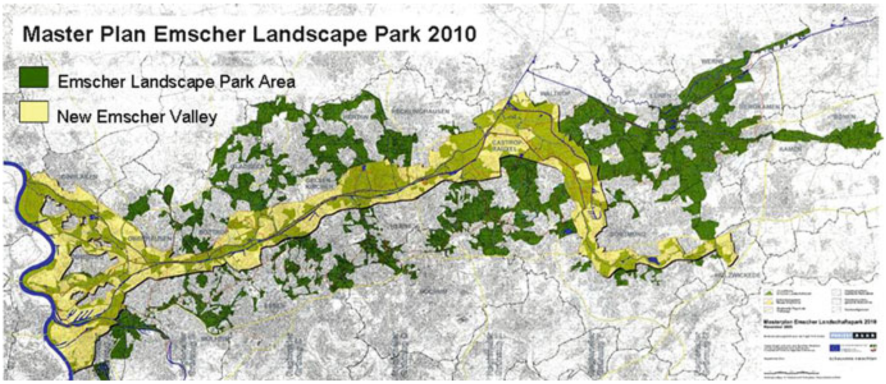

Fig. 18.6 Master Plan of Emscher Landscape Park 2010 (Projekt Ruhr GmbH 2005)

Fig. 18.7 Master Plan of Future Emscher—The New Emscher Valley (Emschergenossenschaft 2006)

The cooperation between the Regional Association Ruhr and Emscher Association during the coordination process induced permanent cooperation with a long-term perspective within a common working group, the New Emscher Valley.

The described projects were implemented without formal planning instruments. Despite the fact that formal planning instruments in empirical investigations have proved successful (Gruehn 2006), informal approaches as described here seem to be more promising, especially in complex situations such as in the Ruhr region. Important prerequisites, at least in the case of the Ruhr region, are a long-term perspective, a comprehensive budget, and political consensus, which facilitates maximum support for the project goals.

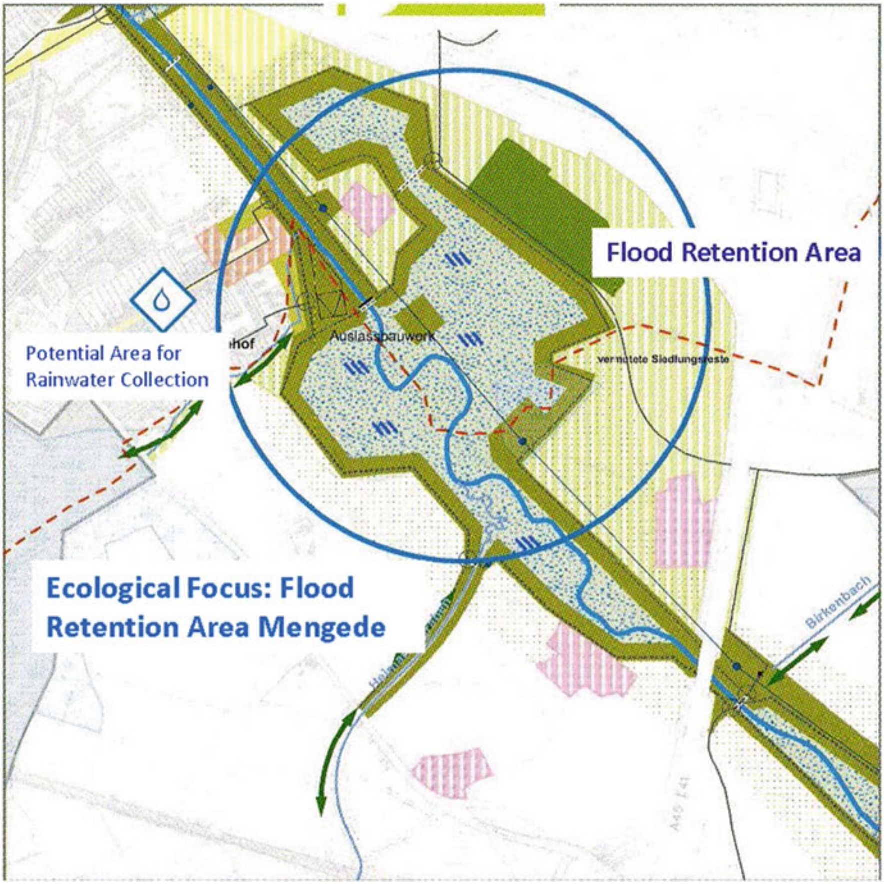

Fig. 18.8 Detail of Master Plan of Future Emscher—The New Emscher Valley in the area of Dortmund North-West (Emschergenossenschaft 2006)

18.4 Conclusions

In the past decades, formal planning instruments such as regional plans seemed to have a low impact on the future development of the Ruhr region. In the past, those instruments consistently were causes for disputes between different authorities. Informal approaches, such as the IBA Emscher Park, Master Plan of Emscher Landscape Park 2010 and Master Plan of Future Emscher—New Emscher Valley have essentially contributed to a paradigm shift in the Ruhr region in many respects. The region's gray has turned into green, life quality is enhanced, a sewer is about to be transformed into a natural watercourse, and a neglected area has become an attraction not only for tourists. Informal instruments in the Ruhr region have enabled stakeholders to develop a sustainable future perspective for the whole region. Despite this success, the Ruhr region is still characterized by a relatively

Fig. 18.9 Map legend for Figs. 18.7 and 18.8 (Emschergenossenschaft 2006)

high unemployment rate of more than 10 %. The future challenge of the region is to further develop its economy. In particular, the Master Plan of Emscher Landscape Park 2010 has provided the Ruhr region with a huge amount of development area for different types of parks, including high-technology parks, which will improve not only the environmental but also the economic conditions of the area.

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Chapter 19
Biowaste Reuse Through Composting: The Response of Barangay Holy Spirit in Quezon City, Philippines, to Solid-Waste Management

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Abstract Biowaste is the large volume of solid waste generated daily by households, and it presents environmental and health hazards if not reused. Composting is one of the best options for such reuse. This study documents biowaste generation and collection from households and reuse through composting in Barangay Holy Spirit, Quezon City, Philippines. This barangay (the smallest administrative unit) has made pioneering efforts in composting, having developed it from a simple process to a mechanized process. The barangay's composting has been integrated with its vegetable and flower urban garden, which serves as a demonstration and training center on how to provide livelihood opportunities and environmental benefits. However, to enhance the compost's marketability, issues relating to

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quality, such as the high organic carbon, high carbon-to-nitrogen ratio, and low levels of nitrogen, phosphorus, and potassium, need to be addressed. The barangay intends to boost compost production and sales, thereby increasing income, which can further improve the solid-waste management and increase staff salaries. Barangay Holy Spirit is one of the most developed barangays in terms of solid-waste management, and it can serve as a model for other barangays.

Keywords Bio-waste • Composting • Generation • Households • Re-use • Solid-waste management

19.1 Introduction

As a result of the ever-increasing socioeconomic and environmental problems associated with solid waste, the Philippine government passed a comprehensive law—the Republic Act (RA) 9003, or *Ecological Solid Waste Management Act* of 2000—to cover the entire chain of solid-waste management (SWM), from waste generation to disposal, in a more holistic fashion. A previous law—RA 7160, known as the *Local Government Code* of 1990—provides the framework for establishing an SWM system. Through RA 7160, *local governments*, such as provincial and municipal or city governments, possess the authority to implement RA 9003, and so do the barangays (smallest administrative unit of the country).

Quezon City (QC) is one of the cities in Metro Manila (MM) that has implemented RA 9003 as mandated by RA 7160. QC is administratively subdivided into 142 barangays, of which 78 (54.9 %) have created their own barangay SWM committee. Only 25 of these 78 barangays were able to develop their own barangay SWM programs. Of these 25 barangays, just eight undertake composting activities; *Barangay Holy Spirit* is one of them. This barangay began composting in 1998, 2 years before RA 9003 was passed. Thus, this barangay was selected for the present study on *biowaste* utilization. This barangay utilizes composting and the processes involved as a viable option for biowaste reuse.

19.2 Methodology

19.2.1 Study Site

Barangay Holy Spirit (Fig. 19.1) is one of the 31 barangays in District 2 of QC. It covers an area of 328 ha and is one of QC's five most populous barangays, all of which are located in District 2, where more than half of QC's residents live. *Barangay Holy Spirit* has 20,000 households (Sumayao and De Guzman 2006), 102,194 residents, and an estimated population density of 31,157 per km^2 (Hara et al. 2011). It has an annual income of PhP16 million (US1 = PhP43.54).

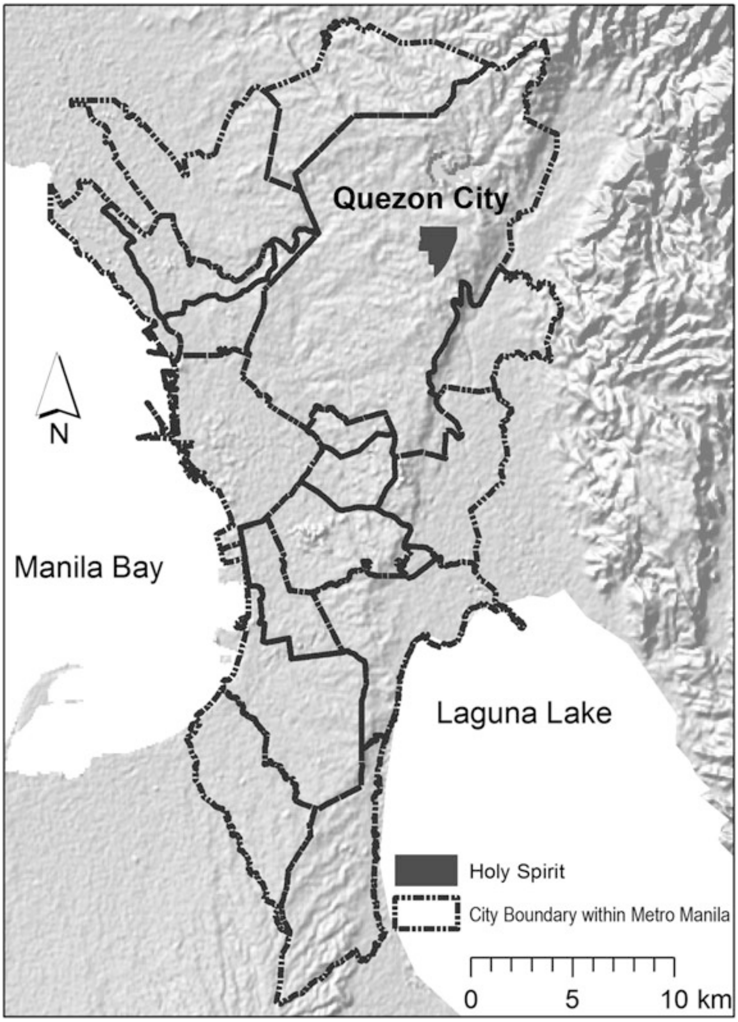

Fig. 19.1 Barangay Holy Spirit in Quezon City

19.2.2 Information Gathering

Secondary information, particularly related to the SWM system in the barangay, was gathered from the Environment Protection and Waste Management Department (EPWMD) of QC and the Ecological SWM Center of the barangay. The EPWMD is responsible for implementing the SWM plan and helps each barangay in the city to organize barangay SWM committees and plan and design barangay SWM programs. Primary information was sourced through direct observations and interviews with workers and staff of the SWM Center and households in the barangay. The actual process of composting was observed and recorded.

19.3 Results and Discussion

19.3.1 Waste Generation and Collection

Collection and transport of waste is carried out by means of garbage trucks and pushcarts. The frequency of collection is daily for markets, schools, and commercial areas; it operates on a scheduled basis for households. Waste generated from all sources has to be segregated.

A survey of 50 households in Barangay Holy Spirit revealed the following: the types of waste normally generated from households, in decreasing order of amount, were plastics, kitchen and food waste, napkins, cans, paper, glass bottles, and cardboard. Biowaste classified as kitchen and food waste was the second-largest type of waste produced by households. This finding corroborates with that of Sumayao and De Guzman (2006) in a study conducted in some barangays in MM and QC.

Each year, 10,800 tons of *solid waste* is collected in Barangay Holy Spirit. This waste is subdivided into biowaste and non-biowaste, which amount to 5292 and 5508 tons per year, respectively. The quantities of non-biowaste recycled and disposed at a dump site in Payatas, QC, are 2700 and 4692 tons per year, respectively. Of the 5292 tons of *biowaste* collected each year in Barangay Holy Spirit, only 600 tons are composted. These figures are similar to those reported by QC's EPWMD (2007) and Cuevas et al. (2006). According to the staff of the Barangay Eco-Waste Management (EWM) Center, the current amount of generated, collected, recycled, reused, and disposed *solid waste* may vary somewhat from the 2007 figures, though not by too much.

19.3.2 Biowaste Reuse

The promotion of reusing biowaste has increased considerably. Segregating household biowaste from solid waste and utilizing *biowaste* (food waste, green waste, and other organic materials) will greatly help in reducing the amount of waste dumped in landfills or dump sites. According to Snyman and Vorster (2011), the disposal of *biowaste* is a major issue for landfills. When buried in a landfill, biowaste decomposes anaerobically, producing methane—an extremely potent and highly polluting greenhouse gas. During the decomposition process, *leachates* are also generated; unless these leachates are captured and treated totally, they pollute the groundwater and runoff water, with detrimental effects on the environment.

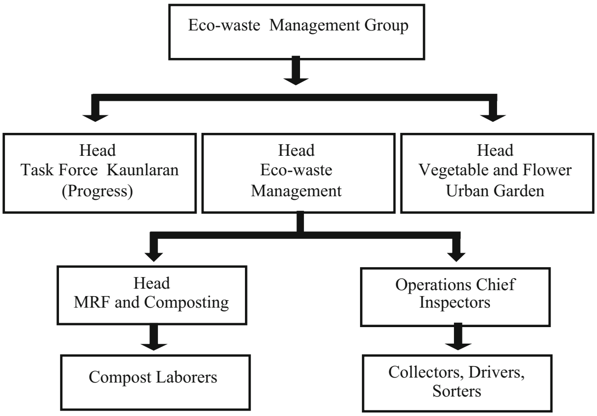

Fig. 19.2 Organizational chart for SWM in Barangay Holy Spirit

Incentives given by the various cities to the barangays have encouraged some in QC and MM to implement SWM programs (Hara et al. 2011). If source-segregated waste collection results in a 50 % or greater reduction in the frequency of collection by garbage trucks, a rebate equal to half the cost of that saving is provided by QC. Likewise, if the barangay efficiently executes its own waste reduction and implements its own collection system, the barangay receives a rebate equivalent to the entire saved amount. *Barangay Holy Spirit* and barangays Bagumbuhay and Phil-Am have received recognition as being highly cooperative and developed in their SWM efforts. Thus, they commonly receive the above rebates.

Barangay Holy Spirit has organized its own EWM group with a functional organizational chart (Fig. 19.2). Its major unit is eco-waste management, with a *material recovery facility* (MRF) and *composting* as the principal components.

19.3.3 Biowaste Composting

Barangay Holy Spirit is a pioneer in composting, which has developed from a simple process to a mechanized process. A composter processes the volume of *biowaste* generated every day, mainly by households. The barangay is equipped with six composters as well as shredders, sieves, metal forks, shovels, water hoses, scales, and wheelbarrows. Funds are provided by the QC government as well as grants from politicians. The entire process of composting by the barangay is shown in Fig. 19.3. There are 12 collectors, seven drivers, one compost processor, one sorter, and one screener involved in the operation; their salaries range from PhP4500 to PhP5000.

Biowaste collection in the barangay is done on a door-to-door basis. The collection is carried out at a specified time of day and is done either daily or every other day using dump trucks. Pushcarts are used in areas where the roads are narrow and inaccessible to trucks. There is also curb collection, whereby the

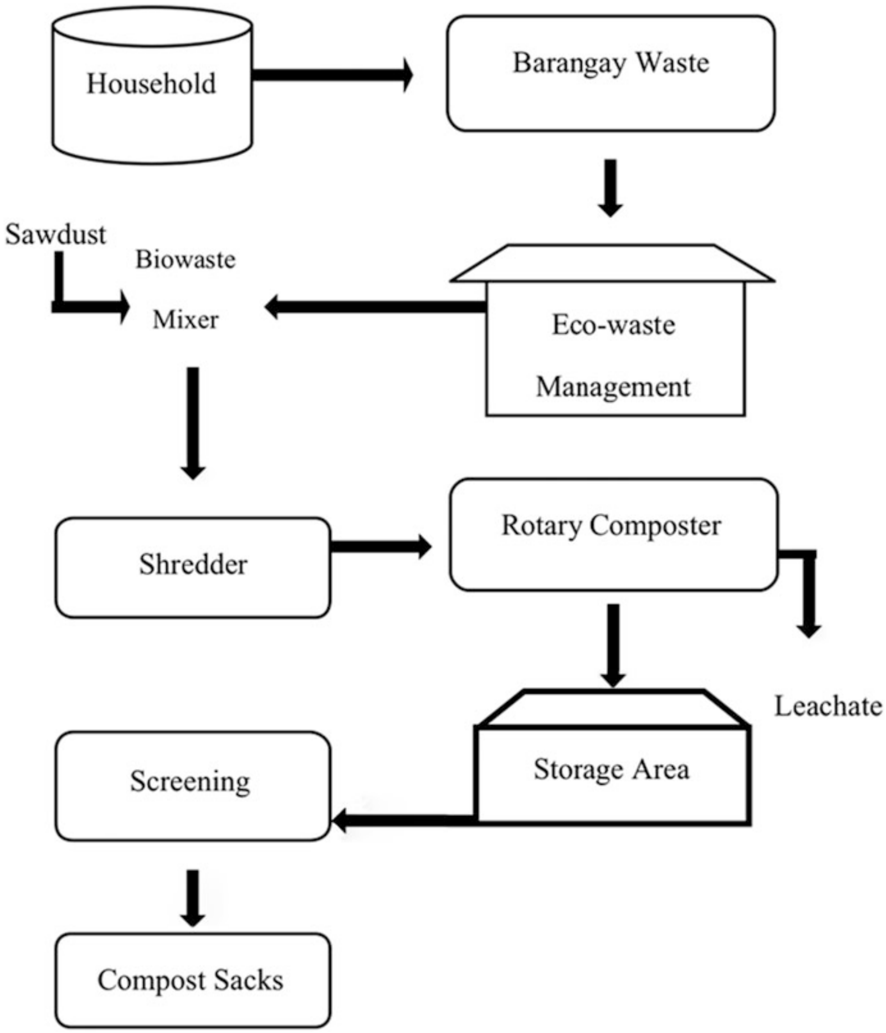

Fig. 19.3 Composting process in Barangay Holy Spirit

waste is collected at specified times at particular points by the collectors that operate the dump trucks or pushcarts (De Guzman et al. 2006; EWMC 2007). The main problem with biowaste collection is the lack of cooperation among a number of households: they bring out their waste for collection but not at the right time. The waste thus lies uncollected, is exposed to the elements, attracts stray animals, and poses environmental and health hazards. However, the situation is improving thanks to increased awareness among residents about the importance of SWM.

Collected biowaste is brought to the EWMC for composting. It first undergoes shredding, which reduces the volume of waste and optimizes the limited space of the composting area. Shredding biowaste also renders it more suitable for microbial activity.

The process of composting in the barangay's EWMC uses a rotary composter. The machine has a capacity of 1.8–2.0 tons of biowaste per composting cycle. It is driven by a 1/3-horsepower electric motor; the composter is in the form of a horizontal cylindrical steel drum, and it rotates at 1 revolution per 4.5 min.

One feature of this composting technology is its use of an *inoculant*, *Lactobacillus bacteria*. Coconut coir dust is used as a carrier of the inoculant. In the composter, the shredded biowaste with the inoculant and coconut coir dust is protected from the weather, insects, and animal vectors of diseases. Thus, this technology helps minimize environmental and health hazards. Owing to the high cost of commercially available inoculant, the EWMC has tried producing the same *Lactobacillus bacteria* to meet its requirement for *composting*.

The *composting process* requires continuous, slow rotation of the composter. This provides good aeration by sustained mixing of the substrates and constant entry of air from small openings over different parts of the drum. Fast buildup and conservation of heat in the drum help kill harmful organisms present in the substrates. However, a short composting period of only 5–7 days is practiced because of the limited number of composters relative to the volume of collected biowaste to be processed.

The *biowaste reuse* flow is presented in Fig 19.4. The *biowaste* is here described as organic waste, and the volume collected from households was calculated on a daily basis. The average volume of *organic waste* in the source-segregated collection was 2602 kg per day, of which 1500 kg per day was composted. This daily volume of processed biowaste is a little lower than the 2500 kg reported by De Guzman et al. (2006). As noted, one composting run normally takes a week. It was

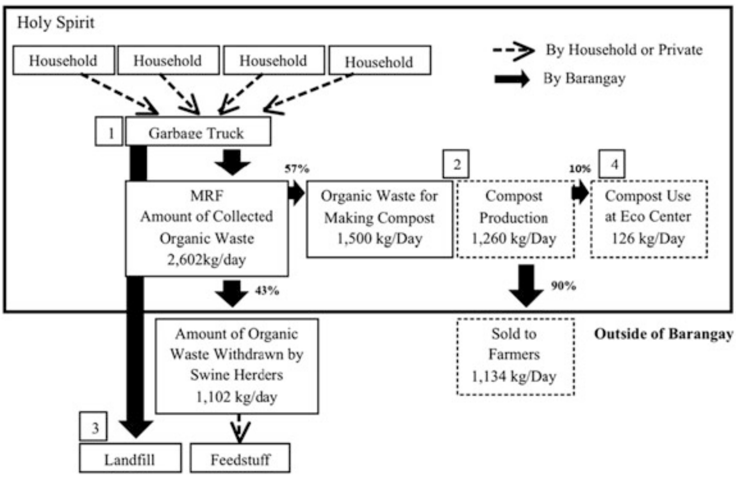

Fig. 19.4 Biowaste reuse flow in Barangay Holy Spirit

estimated that if all six composting drums were operated, the process could produce 1260 kg of compost a day.

Only 10 % of the *compost* produced is used by the barangay in its vegetable and flower urban garden. The rest is sold or freely distributed to barangay residents. Uncomposted biowaste (1102 kg) is collected by swine herders from San Mateo Rizal. This type of *biowaste reuse* is normal practice in Barangay Concepcion Uno of Marikina City (De Guzman et al. 2006) and Barangay Bagumbuhay (Hara et al. 2011). This initiative in reusing biowaste in Barangay Holy Spirit is an indication of the growing need for biowaste as feedstuff.

The *compost* produced in *Barangay Holy Spirit* is highly alkaline (pH 9.2), has a good moisture content (76 %), and possesses high organic matter (71 %), high *organic carbon* (OC; 41 %), and a high *carbon-to-nitrogen ratio* (42 %). However, it has low nitrogen (1 %), phosphorus (1.19 %), and potassium (0.49 %), which are all below the Fertilizer Product Standard (FPA) of 3–4 %. Additionally, its zinc level is low (not exceeding the toxic level), and it does not contain lead or cadmium. The high OC can be attributed to the addition of the large amount of coconut coir dust (about 20 % of the waste volume), which is used not only as a carrier of the inoculant but also to control moisture, improve aeration, and reduce the foul smell. Neither nitrogen nor phosphorus sources are added during composting; hence, decomposition of the carbonaceous materials is slow. At the end of the composting period, the compost is not fully mature. It still has a high carbon-to-nitrogen ratio. Therefore, when it is applied in large quantities as an organic fertilizer, it can cause plants to suffer from nitrogen deficiency.

19.4 Conclusions

19.4.1 Benefits of SWM and Composting

The reuse of biowaste through composting provides employment. Some workers feel that the pay is comparatively low, but they are still thankful for having a job. They consider the skills training relating to SWM, which is sponsored by QC and the barangay, an incentive.

The EWMC serves as a demonstration of *composting* in particular and management of MRF and other SWM activities in general. The barangay's vegetable and flower urban garden is used as both a demonstration and training venue for workers, farmers, and practitioners of urban agriculture. Increasing compliance among the households in the barangay SWM program is an indication of growing awareness of the importance of such programs for sustainability of the urban environment.

At present, *composting* may not be economically rewarding. However, the conversion of *biowaste* into compost minimizes, though does not totally eliminate, environmental and health hazards posed by unprocessed biowaste. The composting technology is ecologically sound if *leachates* from the composter drums are collected, treated, and properly disposed of. *Biowaste* conversion provides benefits in the form of avoiding landfill costs and the savings that accrue to local government units (LGUs) from solid-waste collection and disposal.

19.4.2 Sustainability

The EWM center is basically run and managed by members of the community. The leaders are innovative and continually improve the SWM system. Reusing biowaste through composting has high *sustainability* potential. It is integrated with a *vegetable and flower urban garden* demonstration farm. Some concerns need to be addressed, such as the high carbon-to-nitrogen ratio of the compost, leachate disposal, hygiene, and sanitation. The sale of compost could increase considerably if the high OC and *carbon-to-nitrogen ratio* could be reduced, and the nitrogen, phosphorus, and potassium could be adjusted to appropriate levels. Increasing the amount of composted biowaste would increase income, which could be used to enhance operations, including a possible raise in salary or incentives for workers and staff. This would improve the efficiency and ultimately the sustainability of the system. That *sustainability* cannot of course be achieved without the full cooperation and support of the citizenry. Barangay Holy Spirit has made tremendous progress with SWM and serves as a model that should be emulated not only by other barangays in QC but also elsewhere in the country.

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Chapter 20
A Concept of Integrated Groundwater Management for Sustaining Indonesian Cities Using the System Interrelationship Model

Priana Sudjono and Fitri Prabarani

Abstract Groundwater is an important resource for cities, but its management is still characterized by partial measures. Unsuccessful management is evident in inland seawater intrusion, land subsidence, and a permanent drop in the water table, which have taken place in many cities in Indonesia. To manage groundwater, a system interrelationship model is proposed here as a concept that integrates knowledge about components related to groundwater and defines their interrelationships. These interrelationships signify that any alterations to one component inevitably affect connected components. The components that make up the system are housing, agriculture, industry, laws and regulations, water supply companies, seawater, shallow groundwater, surface water, and the recharge area. Knowledge is mapped in the form of a diagram to establish how knowledge relating to the components plays a role in the defined system. By understanding how the system works, ideas on interventions in the components can be identified so that the system may be shifted toward defined goals. Thus, knowledge about the role of the system's components and the mutual relationships among those components forms the basis for an integrated approach to interventions that aim to sustain groundwater.

Keywords City • Groundwater • Integrated • Management • Sustain • System interrelationship model

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20.1 Introduction

In many of Indonesia's large cities, the water supply infrastructure has a very limited capacity. As a solution, many urban residents use groundwater for domestic and industrial purposes. Since groundwater abstraction is ultimately uncontrollable, several problems emerge, e.g., permanent water table drawdown. Conventional efforts to conserve groundwater, such as imposing regulations on abstraction, have been undertaken by the government, but the results have mostly been disappointing, as in the cases of Bandung, Surabaya, Jakarta, and Semarang. A system interrelationship model offers the possibility of taking into account several components related to groundwater within a comprehensive model, thereby allowing an integrated solution to be achieved.

The number of people in Indonesia's cities has almost doubled every 20 years, but development of the water supply infrastructure has been mostly stagnant. City residents have long suffered from a lack of piped water, and factories, hotels, and hospitals are likewise unable to receive sufficient piped water. Since the only available clean water is groundwater, these individuals and facilities exploit it. Though the control of groundwater abstraction is largely weak, conflicts about water resources arise (Aulia 2008). In addition, housing development on recharge areas in a city's hinterland reduces the percolation rates (Utami 2007; Narulita 2008). As a result, groundwater yield diminishes or at least water table drawdown takes place. In densely populated areas of a city, this situation can promote poor sanitation (Poedjiastoeti et al. 2008), the water in some city natural ponds is of low quality (Batara et al. 2008), and decreasing areas of green open spaces produce negative consequences for human health (Suryanti 2008). Thus, groundwater management is a central issue in sustaining good quality of life in Indonesia's cities.

Conventional solutions to prevent groundwater depletion have long been unsuccessful. Sihwanto and Iskandar (2000) proposed the zoning of city areas based on several criteria: (a) groundwater yield; (b) maximum allowable groundwater drawdown and rate of drawdown; (c) maximum water quality degradation; and (d) negative impacts on the environment indicated by alteration of the surface cover, land subsidence, migration of groundwater from pervious layers, and dispersion of pollutants. Some regulations have been imposed, and certain government institutions have the authorization to control groundwater. However, there are reports in some cities about the replacement of freshwater by saline water in coastal areas, permanent drawdown of the water table (Taufiq and Iskandar 2000; Soetrisno 1991), and land subsidence (e.g., Wahid 1998; Mulyana et al. 1993; Abidin et al. 2003). It is clear that to sustain life in cities, conservation of groundwater should proceed through conservation of rural areas, especially those that are agricultural areas and housing in recharge areas. Interaction between urban and rural areas involves complex relationships among components constituting a system.

It is necessary to develop a concept of integrated groundwater management since the various attempts to solve groundwater issues have only been partial solutions that created problems in other areas. At present, groundwater is unable to play an optimal role in sustaining the quality of life in Indonesia's cities. A new concept of groundwater management has to be developed based on the fact that policies in this area need to take into consideration all related groundwater problems and provide a solution for them all. An integrated concept of groundwater management to sustain city life can be developed by acquiring knowledge about the roles of each component in the whole groundwater system together with an understanding about the interactions among these components before putting the components into a system that is able to indicate their effects on the groundwater. This chapter presents the concept of a system interrelationship model applied to managing groundwater in a city that is under the influence of rural areas as recharge areas so an integrated way between urban and rural can be achieved.

20.2 System-Wide Focus

A system-wide focus, which is achieved by applying systemic thinking techniques, is an attempt to examine the components that constitute the problem at hand. Bartlett (2001) applies a system-wide focus to a system that combines analytic and synthetic thinking processes. Based on this idea, groundwater problems with respect to sustaining city life were analyzed, and then background knowledge relating to the various components was acquired from experts and research findings. There are many ways to obtain knowledge from experts. One effective way is a Delphi-based approach, which integrates the knowledge of numerous experts (Chu and Hwang 2008). Then, synthesizing the knowledge relating to each component to form solid interrelationships is the essence of the system interrelationship model (SIM).

An SIM consists of components that are interconnected by lines. A line that connects two components indicates mutual dependencies between those components. In other words, the line is a symbol of knowledge about the interactions that is acquired from research results or expert opinion. The interaction can be in the form of cause–effect, chronology, or processes. Changes of data on a component will impact data on the connected component. A component is defined as something that has a physical form, such as groundwater, recharge area, or houses. Each component has data such as groundwater yield, type of vegetation in the recharge area, and number of houses in an area. Alteration of data pertaining to a component will impact data pertaining to the connected component, and the alteration will continue on to any other connected components to form a specific behavior as a system. In order to reach the desired condition, intervention in the components by modified data pertaining to the components leads to a wanted value. Thus, the interventions shift the equilibrium of the system toward the desired conditions.

20.3 Groundwater Management

To sustain life in Indonesia's cities, it is necessary that groundwater management be conducted in an integrated way. The goal of groundwater management is to efficiently distribute that water and use it to support human activities. Conversely, groundwater conservation is related to the future use of that water (Goetz 1985). Thus, both groundwater management and conservation have a similar goal in that water should be used wisely without leading to any damaging effects. In addition, integrated groundwater management means utilizing groundwater-related components in a harmonious fashion toward that goal. Seppala (2002) confirmed that effective solutions to complex water problems are highly interrelated. This means that groundwater-related components should be organized to form an SIM as a strategic step in managing the groundwater.

20.4 System Interrelationship Model for Groundwater

The SIM is a model that describes real-world phenomena according to the developer's interests in order to draw interrelationships among the components of the system under consideration. In developing an SIM, it is possible to acquire knowledge about the system's behavior, then intervention strategy can be imposed.

A study on groundwater management based on systemic thinking was conducted in the Indonesian city of Semarang, and an SIM for groundwater together with expert-system-like programming that incorporated expert knowledge, such as in the area of programming, was developed (Sudjono et al. 2003). Further study refined the SIM and the computer program (Zulkarnaeni and Sudjono 2007; Prabarani and Sudjono 2008). The results of the study indicated that the role of groundwater is influenced by the recharge area, seawater, water supply companies, wastewater, housing, shallow groundwater, surface water, laws and regulations, industry, and agriculture. The defined SIM for Semarang appears in Fig. 20.1.

The groundwater model in Fig. 20.1 consists of components and lines that correspond to knowledge of the interactions. The system can be described as follows. Water demand grows with the increasing number of houses, which is a common trend in most cities in Java, where Semarang is located. In addition, agricultural land located in suburban areas close to a city become rapidly converted to factories. Further, industrial activity leads to greater demands on the land in suburban areas. This means that recharge areas become significantly reduced. In such a situation, water supply companies have to raise their production. However, these companies face problems in expanding their investment in addition to the difficulties in obtaining a steady supply of surface water. As a consequence, groundwater is exploited for domestic and industrial purposes as a source of clean water. Although groundwater abstraction by industries is subject to the government's laws and regulations, seawater intrusion has extended far inland in

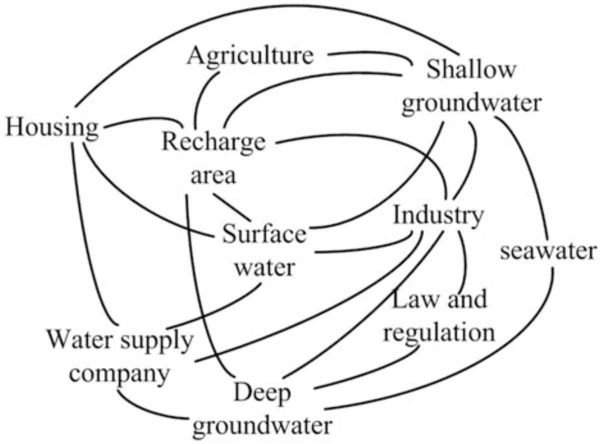

Fig. 20.1 A system interrelationship model for groundwater that applies to most cities in Indonesia

the case of some cities. Further, industry produces wastewater, which, if not properly treated, reduces the quality of the surface water and shallow groundwater in downstream areas such as Semarang city. In other words, activities of industry in rural or suburban areas can reduce sanitation conditions in urban areas.

Since these components are interrelated, they create bounded cycles. Making an alteration to one component may have an effect on other connected components. The interrelationships are complex and require expert knowledge with respect to each component in explaining the role it plays in the system. The knowledge relating to each component is then mapped in the form of diagrams developed for every *kecamatan* (district). In the same way, a database on each component will be developed based on the *kecamatan* that administratively collects any data on the area. Although the groundwater boundary is not the same as the kecamatan boundary, the administrative boundary was chosen for management purposes. Diagrams showing knowledge correlation relating to groundwater and industry are presented, respectively, in Figs. 20.2 and 20.3. Similar diagrams have been developed for other components.

Figures 20.2 and 20.3 are examples of knowledge taxonomy pertaining to the components in the form of a diagram. Figure 20.2 indicates that knowledge on deep groundwater, such as geological conditions, and facts on water quality and land subsidence together with computation on allowable abstraction and prediction of its impacts should, finally, conclude the zoning. Similarly, Fig. 20.3 shows knowledge on industry that should lead to conclusions on the conditions of wastewater treatment, wastewater quality and patterns, and the serviced water. To make the diagram operational, the knowledge related to the components is transformed to a logic database storing facts and production rules that correlate the facts. Referring to Fig. 20.1, a component is connected to one or more components by lines indicating that there are mutual interactions among the connected components. In other words, the line is a representation of knowledge on how data pertaining to a component will change in the event that data on a connected component has been changed. The

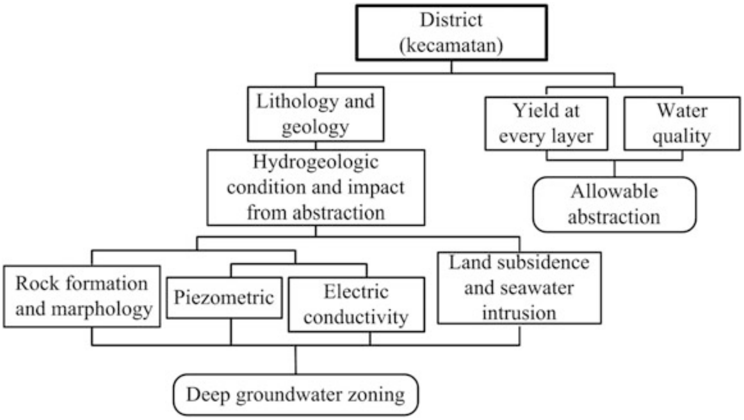

Fig. 20.2 Knowledge correlation relating to deep groundwater

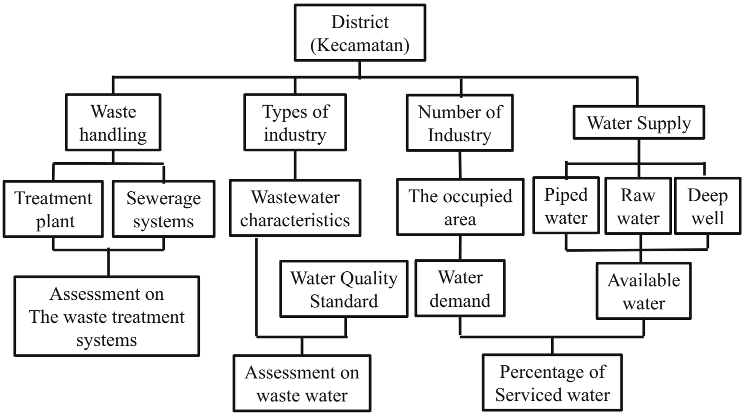

Fig. 20.3 Knowledge correlation relating to industry

interactions involve production-rule systems and an object-oriented approach to knowledge-based systems (Chau and Alberman 2002). The dynamicity of the components in the system is a representation of the system's behavior. The interactions among the components involving knowledge modeled in Fig. 20.1 can identify any required data, and it is possible to trace the flow of the interactions. Examples of data and knowledge interactions on deep groundwater are presented in Tables 20.1 and 20.2.

Based on Fig 20.1, deep groundwater is under the influence of the water supply company (WSC), recharge area, industry, laws and regulations, and seawater, as indicated by connection lines. The data on the components influencing the deep groundwater are indicated in Table 20.1 and also how they influence the deep groundwater is described in the explanation column. The explanation column is the core of the system dynamicity that shows how the data on the influencing

Table 20.1 Direct influence of connected components on the deep groundwater

Component	Influential components	Data required	Explanation
Deep groundwater	Water supply company (WSC)	Flow of groundwater abstraction, service area	If the WSC exploits the deep groundwater, the water table may decrease rapidly. Continued abstraction takes place if the demand is greater than the available raw water especially during the dry season
	Recharge area	Soil characteristics, land use, topography	The recharge area may sustain the continuity of the groundwater flow. Land use determines the capability of the area to recharge the groundwater
	Industry	Water demand, flow of groundwater abstraction, area of industry, type of industry	High industrial water demand may encourage the engineer to find solutions by making more wells. As a consequence, the abstracted water exceeds the permitted flow, which causes permanent drops in the water table. Industry located in the recharge area may reduce the recharge rate
	Laws and regulations	Laws related to groundwater and environmental protection	Laws and regulations may secure the water table if they are properly enforced
	Seawater	Distance inland of the intrusion	Seawater may enter the groundwater if the groundwater is excessively abstracted

Table 20.2 Direct influence of groundwater on connected components

Component	Influential components	Data required	Explanation
Water supply company	Deep groundwater	Yield, depth of permeable layer, water quality	Groundwater may become a source of water
Recharge area			None
Industry			An area with a high groundwater yield is preferred by investors wishing to build a factory
Laws and regulations			A poor groundwater situation requires further efforts to implement laws and regulations
Seawater			None

components can change the data on the deep groundwater. Similarly, Table 20.2 has been developed to present the influence of deep groundwater on the WSC, recharge area, industry, laws and regulations, and seawater. Tables 20.1 and 20.2 represent reciprocal interactions between deep groundwater and industry, but the strength of the influence is not similar between the two ways.

The number of lines in Fig. 20.1 is 21. This means that there are 21 pairs of components connected with one another, involving 42 interactions. This chapter only presents interactions of a pair of components, i.e., interactions between deep groundwater and industry, in order to show how important the groundwater is in supporting city life. Figure 20.4 presents the influence of industry on deep groundwater while Fig. 20.5 presents the influence of deep groundwater on industry in the form of diagrams. The interactions should be of an appropriate extent with regard to knowledge of the real-world applications. The influence of industry on deep groundwater, as in Fig. 20.4, implicates prediction and computation on groundwater abstraction, groundwater yield, and the land occupied by the industry. Decisions on what actions are to be taken are then presented in the diagram. Similarly, the situation of deep groundwater may affect the situation of industry. The situation of deep groundwater has been classified into critical, amber and safe zones (Sihwanto and Iskandar 2000) as has been adopted in Fig. 20.5. Mapping of the groundwater zones in the area needs geological investigation, then the results are required by databases in order to decide source of waters to provide for industry. In general, the development of industry depends on the availability of water for their activity. In cases where groundwater is limited, water should be provided by the water supply company or a private treatment plant. The scope of the interactions for daily tasks in management includes prediction of future situations using tools such as geographic information systems and computer models. In other words, the tools are used to simulate situations given new data on one or several components at a time. So, the behavior of the systems can be learned through changing data on the components.

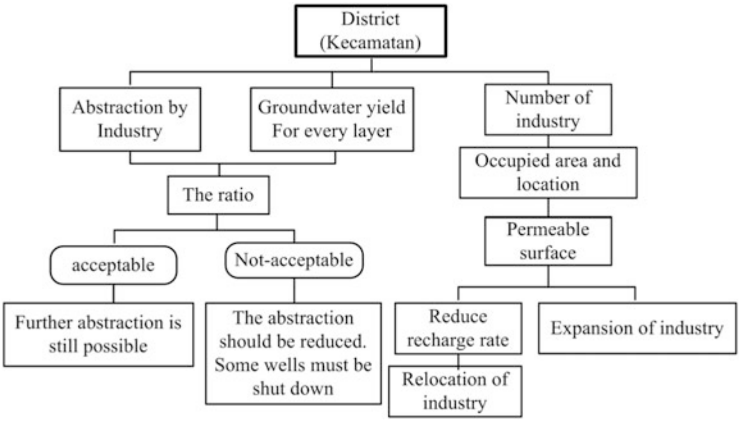

Fig. 20.4 Influence of industry on deep groundwater

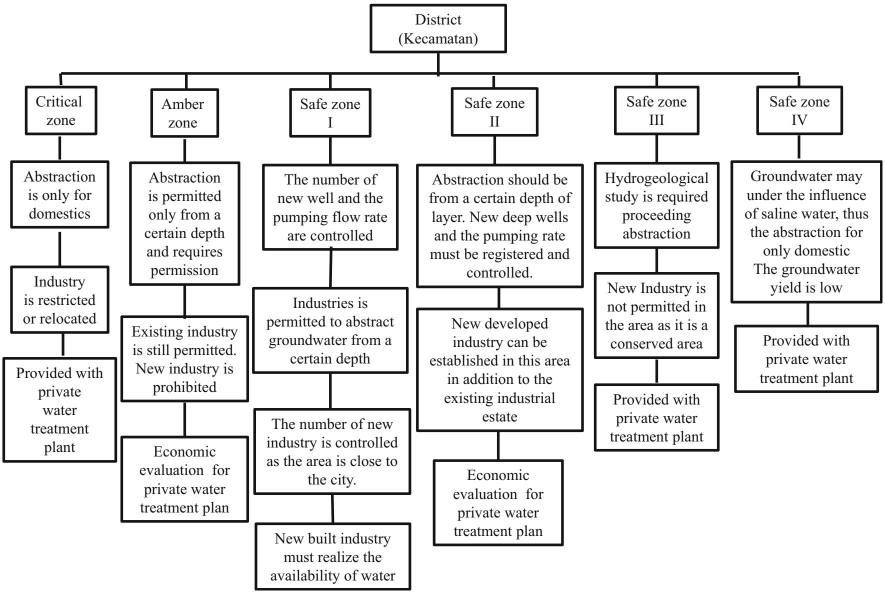

Fig. 20.5 Influence of deep groundwater on industry

20.5 Intervention Strategy

Intervention is an effort to change data on one or several component at a time. The purpose of intervention in the components is to shift data on all components of the system, as presented in Fig. 20.1, toward the desired values. Intervention is necessary because the system should be in the situation that has been defined as the goal of the groundwater management. So, a strategy on what components warrant intervention can be devised when the behavior of the system has been understood. The automation of the behavior of the system in cases where data on the components have changed is developed through making use of knowledge correlation relating the components and the logic of the influence on components by the connected components into object-oriented programming. The general idea of intervention to components of the systems in order to sustain city life has been proposed in Table 20.3 (Sudjono 2008). Components that have significant influences on other components will be nominated for intervention by changing the data. As a consequence, the data on the connected components will change and this continues to the whole set of components to form a new equilibrium of the system. By making use of the knowledge on the components and the interactions, an intervention strategy in the management of groundwater can systematically shift the equilibrium of the system toward a desired situation.

Table 20.3 Proposed interventions in the system components

Components	Intervention
Water supply company	Raise the service percentage for domestic and industrial use (Purnama et al. (2006))
Groundwater	Provide protection from overexploitation
Seawater	None
Shallow groundwater	Shallow groundwater must be protected from domestic and industrial wastewater; also solid-waste disposal has to be properly located
Housing	Housing should not be located in recharge areas. It should be provided with wastewater treatment and solid-waste collection and disposal facilities. Housing development as urban needs must be provided by piped water to avoid uncontrolled groundwater abstraction
Agriculture	Agricultural practices should avoid erosion and make minimal use of pesticides and fertilizers. Agriculture in recharge areas should be avoided in order to prevent discontinuity of rainwater entering the soil layers
Recharge area	Recharge areas must be kept green. Water retention should be increased by prohibition of converting the area to housing, agriculture land, and industrial estates
Industry	Groundwater consumed by industry should be replaced by piped water provided by a water supply company. Otherwise, individual mini-treatment is a solution to obtain clean water. In such cases, industry should be located within industrial estates to ensure raw water delivery. As well, communal wastewater treatment can be implemented to reduce costs and achieve efficient control
	Development of industrial estates in recharge areas and growth of housing sprawl around industrial estates should be prohibited
Surface water	Surface water should be protected from pollutant discharge by industry, households, and agricultural activity
Laws and regulations	Law enforcement and control are required

20.6 Conclusions

In many cities in Indonesia, as well as in other developing countries, there is a lack of water supply infrastructure. This means that piped water reaches only a small percentage of the population or the amount of water demand is greater than the supply. Groundwater then becomes an alternative source if it is of acceptable quality. Unfortunately, uncontrollable abstraction in addition to failed land use planning may result in a permanent reduction in the groundwater table, seawater intrusion, and land subsidence. The SIM offers a new approach to integrate knowledge on the significant components that is not only related to urban areas but also to rural areas where domestic, agricultural, and industrial activities take place. The system can represent the comprehensive interrelations among the components within a defined domain such that alterations to one component can easily be traced to the effects of such alterations on other components. This means that when simultaneous intervention in the components is carried out in an integrated manner, the equilibrium of the system can be shifted toward attaining the desired goal. Thus, groundwater management amounts to using water efficiently by taking account of the system's components such that conditions are able to sustain city life.

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Chapter 21
Informal Collaborative Network: A Case Study of Meinung, Taiwan

Li-Pei Peng

Abstract Since 1994, collaborative planning has gradually become more commonplace in Taiwan following the introduction of bottom-up policies for community development. Collaborative planning is a possible way for a city region to achieve sustainability. Thus far, however, few studies have examined regional decision making in Taiwan that involves collaborative planning with local voluntary organizations. Without such local involvement, planning efforts for a city region may give rise to conflicts between core and peripheral areas. To fill this gap in the research, this chapter investigates a case of local voluntary organizations that were able to establish an informal collaborative network, which was able to achieve governance at the city-regional level. This chapter describes the processes and issues relating to informal collaborative networks in Meinung, a city region in southern Taiwan. This study reveals that adaptation and flexibility are necessary for the formation, consolidation, multifunctional character, and development of an informal collaborative network.

Keywords Collaborative planning • Voluntary organization • Network • Governance • City-region • Taiwan

21.1 Introduction

The effect of globalization on social and spatial fragmentation has become a critical issue. Development commonly concentrates on core cities; thus, other—mostly rural—areas suffer as a result of regional disparity. Ideally, governments at the regional level should undertake measures to redress this imbalance; however, in the case of Taiwan, regional governments or institutions lack the capacity to do so. According to John (2001), governance is "a flexible pattern of public decision making based on loose networks of individuals." In this sense, the blurred boundaries between and within public and private sectors become manifest (Stoker 1998). This

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points to a shift from government-style to flexible governance–style decision making. Christiansen and Piattoni (2003) have further defined informal governance as “the operation of networks of individual and collective, public and private actors pursuing common goals through regular though noncodified and not publicly sanctioned exchanges in the institutional context.” Thus, instead of the formal government style, the informal governance style highlights flexible networks among multiple actors in which the networks among organizations such as national government agencies, local governments, the private sector, and voluntary organizations are necessary to establish the notion of collaborative planning for regional governance. However, voluntary organizations with somewhat limited resources at the local level can access greater resources at the regional level. Citizens’ involvement in public decision making may be ineffective because they lack experience in dealing with regional issues. In this regard, it is important that voluntary organizations be established at the local level so that they can address issues relating to governance at the city region level; this will also create an arena where all the stakeholders are able to collaborate (Kidokoro et al. 2008). The paper presented in this chapter addresses a process whereby voluntary organizations at the local level were able to maintain an informal collaborative network at the city region level. Both adaptation and flexibility are necessary in the collaborative planning process for governance at the city region level.

21.2 City Regions and Informal Collaborative Networks in Taiwan

In Taiwan, the interaction of spatial networks of local industries is often studied by means of a dynamic analysis of regional development policies and planning (Chou 2003). Because of its relatively small size, Taiwan can be considered a node in the global network. Economic power has been established mainly in the northern, middle, and southern city regions of Taiwan. The city region concept is appropriate for the future development of Taiwan: it has played an important role in restructuring the Taiwan economy in an era of globalization. The establishment of the city region concept in Taiwan is associated with three main benefits (Chiang 2009): first, it allows an urban and rural partnership to be constructed in the same region; second, regional governance is not segmented or disturbed through administrative boundaries; and third, each city region can be integrated with other such regions so as to enhance competitive ability. The western corridor is the most highly developed part of Taiwan. Friedmann (2007) wrote, “There is no longer any ‘peri-urban’ in Taiwan, since urban growth sprawls uninterruptedly from north to south along the west coast of this island nation, backed by a chain of mountains some of which rise to over 2000 m.” The changing industrial structure of Taiwan is not likely to transform the pattern of urban areas exploiting rural villages.

Since martial law was repealed in 1987, Taiwan's governments have emphasized the country's decentralization. Administrative units also underwent reform, and four counties were upgraded to city level in 2010. However, as part of this decentralization, it is necessary to create and integrate networks between local and regional administrative units. As a result of globalization, a small municipality is no longer obliged to become an efficient economic unit. Some regional governing bodies have to deal with cross-boundary disputes, such as water resource management. It is more difficult for municipalities to be effective in local development because of the marginalization of resources, which tend to be allocated to core cities. Formal governments are unable to play an adequate role in regional governance. Thus, informal collaborative networks (ICNs) allow voices at the municipality level to become involved in the decision-making process within a city region and thus play an active role in regional governance.

Taiwan's governments have promulgated community development policies since 1994. These policies have emphasized a bottom-up strategy for all residents affected so as to achieve total community development; they have done this in the following ways: promoting a community-level quality of life; mobilizing community members to participate in activities; searching for local characteristics such as handicrafts and historical heritage; achieving consensus; and applying creative strategies. Most construction projects in Taiwan related to local communities tend to be characterized by public involvement. Thus, the municipalities within a city region are able to collaborate with existing voluntary organizations, such as community development associations, cultural and historical bodies, and local chambers of commerce. However, local claims for resources have become more frequent. Especially at the city region level, there are few established ways to achieve the necessary bottom-up power for resource allocation. Thus far, regional projects have mostly been characterized by conventional top-down-style decision making rather than the informal bottom-up style. Hence, voluntary organizations would appear to present a link between local and city region governance. An ICN is able to achieve locally led collaboration among voluntary organizations, achieve better decision making, and produce a more effective force with respect to the management of local issues. An ICN features a high degree of in-group interaction and emotional solidarity, which helps strengthen collective actions (Chong 2000). Thus, an ICN can encourage resources to be allocated and integrated with flexibility, and it may help govern city regions in a way that is beyond the capacity of formal governments through its ability to adapt and face changes.

21.3 Case Study of Meinung

This chapter focuses on a case study of Meinung in southern Taiwan. The qualitative fieldwork was designed to adhere to the following aspects. The fieldwork focused on the institutional setting of the various processes of local development, critical issues, and achievements relating to the key actors. The method adopted was snowball sampling to identify key actors in certain organizations and thereafter conduct in-depth interviews. The unstructured interviews touched upon incidents, issues, and relevant processes with respect to their direct or indirect involvement in collaboration. This study was therefore able to identify significant organizations and demonstrate how the network structure developed among them. The aim was to conduct an accurate mapping of the morphology of the collaborative networks. The survey was implemented from January to July 2011 (Peng 2013). I personally recorded the interviews, analyzed the content, and made notes of the related opinions. The fieldwork aimed to record the most important activities of the organizations in Meinung from 1992 to 2010.

21.3.1 Context: Before 1992

As noted, Meinung is located in southern Taiwan, about 1 h by train from the cities of Kaohsiung and Tainan (see Fig.21.1). With a population of approximately 42,000, Meinung is now a district[1] of Kaohsiung. Meinung has conserved its traditional Hakka and rural culture owing to its self-contained geography and the high population—over 90 %—of Hakka people. Rice has been the major agricultural product since the Japanese colonial era. During World War II, Meinung began growing tobacco, and tobacco cultivation culture has deeply influenced the economic and social conditions in Meinung.[2] Most importantly, the collaborative labor exchange helped maintain mutual assistance and strong ties between such local organizations as the Meinung Rotary Club and the Farmers' Association; it also introduced ordinary residents to united labor conditions. These existing characteristics, which include aspects of the traditional culture, social structure, and spatial landscape, have been mutually influential and embedded in the connections between local residents and organizations. These characteristics have deepened the in-group interactions among farmers and also their emotional connection with their land and villages. In the 1960s, Meinung industry underwent the transition from agriculture to manufacturing. Owing to the impact of trade liberalization, the population began to decrease and also to age after 1990, and agricultural development likewise declined.

[1]Meinung has been a town at the municipality level within Kaohsiung County. However, the county changed its status to that of a city, which includes the original Kaohsiung City, in 2010.

[2]The labor market has been strongly related to the family-based agricultural economy (Cohen 1976) as well as Hakka kinship (Pasternak 1983); the benefits and high revenues from tobacco have improved living standards and educational conditions.

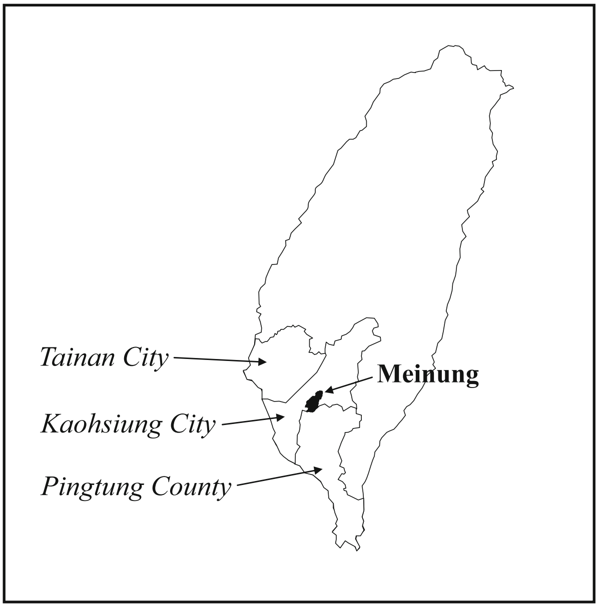

Fig. 21.1 Study area and location of Meinung

21.3.2 ICN Formation: 1992–1999

The formation of Meinung ICN is a recollection of the story of water resource management in the southern city region. In 1992, the Executive Yuan planned the Meinung dam project[3] (MDP) in Yellow Butterfly Valley (YBV) of Meinung Creek. Planning for the MDP began in the 1980s; however, local residents were not aware of this until 1992. At first, there was some local support for the dam project, but the atmosphere gradually changed. Educated young people in Meinung organized the Meinung People's Association[4] (MPA). The claims of this group focused on issues relating to the MDP, i.e., its location, safety, ecological destruction of YBV, damage to the agricultural economy to achieve industrial development, the Hakka cultural crisis, and blind decision making on the part of the Water Resource Committee (WRC) of the Ministry of Economic Affairs (MOEA).

In 1993, the MPA requested environmental groups in Kaohsiung to express support for the anti-MDP protests, and it tried to establish links with other organizations in the city region. The International Rivers Network assisted the MPA by providing reference materials regarding water resource preservation and anti-dam

[3]The MDP was a long-term water source project—an off-site-reservoir—whose main water source would have provided a system of over-basin diversions in the southern city region. To satisfy the predicted water demand of the southern region (i.e., the Binnan industrial complex) for 2021, the required dam would have been 147 m high, 220 m wide, and 32.8 million m^3 in size.

[4]The MPA, established in April 1994, has been identified as the representative organization for the protests. The protests were commonly known as the Meinung anti-dam campaigns (Simon 2011).

and other related information. This was the first time the MPA established a connection with an international organization. A local publication called *Moonlight-Mountain Magazine* carried reports related to anti-MDP activities. In this way and through interpersonal networks, the activities of the MPA attracted other local actors as well as outside scholars, who become concerned about this critical issue and felt motivated to participate in it. The MPA also recognized that while it faced opposition from urban areas facing problems of water deficiency, it had to gain the support of other individuals and organizations. By means of demonstrations and petitions, the MPA actions put pressure on the county government and the Legislative Yuan. These actions resulted in the Legislative Yuan cutting funds for the dam's construction in 1993 and 1994. After the MDP carried out strong protests in 1994, the WRC decided to relocate the dam project to Machia in Pingtung County. This move rapidly caused connections to be established between the groups in Meinung and others in Kaohsiung City, Kaohsiung County, and Pingtung County.

This issue of water resource allocation brought about collaborations at both the local and national levels. Groups[5] who were concerned with issues relating to the Kaoping River began acting with and supporting other groups engaged with similar issues, and they carried out joint training for their cadres' capacities. Through these efforts, the connections among the various environmental groups deepened, and the MPA maintained close relationships with other groups concerned with proposed changes to the Kaoping River. As a result of these developments, it was soon realized that issues related to common water resources had to be resolved at the city region level. Members of environmental groups in Meinung thus rebuilt their interpersonal networks. Along with other Meinung-based organizations, the MPA carried out anti-dam protests, and it maintained close contacts with traditional Hakka social networks—the Liudui culture. The involvement of the traditional Liudui culture attracted media attention and also that of various regional communities, and it served to promote the self-awareness of the Hakka.

In 1995, the MOEA announced the inauguration of a new project—the Binnan Industrial Complex—in the city of Tainan. In this scheme, the industrial complex would rely on the MDP for its water supply. Consequently, the MPA established links with environmental groups in the Binnan area. The various groups campaigned for sharing of water resources, environmental preservation, and rational development in this southern city region. The ruling Democratic Progressive Party of Kaohsiung City, Kaohsiung County, and Pingtung County made this into a political issue. It is fair to say that because of regional water issues, local organizations were able to establish links with the local city region government by means of ICNs.[6] When the ICNs were established, the area of anti-MDP activity shifted

[5]The core team included the Kaoping River Restoration Union, MPA, Blue Tunggang River Preservation Association, Wetland Protection Union of Republic Of China, and Machia Anti-dam Union, which joined forces and actively helped establish community groups with the river basin.

[6]In 1998, the mayors of Kaohsiung City, Kaohsiung County, and Pingtung County agreed to establish a team (which included the MPA) to deal with water-resource planning in southern

from the early focus on Hakka culture to the broader regional level, involving collaboration with outside organizations. These collaborative efforts provided learning opportunities regarding knowledge resources for the local organizations, such that they were able to present their problems at international forums.[7] Through this whole discourse and this series of actions, a comprehensive concept emerged relating to environmental issues in this southern city region.

The MPA and local residents started holding the annual Meinung Yellow Butterfly Festival in June 1995 as a major expression of anti-MDP sentiment. This well-attended festival has expanded to include community activities, such as efforts to revitalize the tobacco industry, holding reading classes for foreign wives, and performances by the local youth Chiaogong Band.[8] By way of opposition to such moves, the Meinung Development Association (MDA) was established in 1998 to provide support for the MDP. In response to this, another group—called the Meinung Anti-dam Union (MAU)—was formed to counter the MDA. The MAU played a coordinating role in mobilizing local groups and also made use of ICNs as a resource.[9] The MAU established links with Liudui Hakka groups in this southern city region, and it claimed that abandoning the MDP was an effort to preserve Liudui identity and protect Hakka hometowns. These aims were articulated in the MAU's Hakka Anti-dam Declaration.

The anti-MDP campaign took the form of various organized actions. The early motivation for this campaign arose out of allocation of water resources and ecological preservation. Local residents were easily able to achieve consensus, and they expanded their efforts by seeking support from outside individuals and organizations. Following this, the local groups adopted various activist strategies and gradually strengthened their links with other local organizations; this attracted the attention of the media, which resulted in higher levels of mobilization at the city region level. The network of relationships created by the local groups expanded to the regional level, which laid the basis for protests against the state. These local groups believed that activities such as engaging in dialogue, taking part in demonstrations, convergence with other voices, and pleading for their common needs were justified because they were in keeping with ideas of local empowerment.

Taiwan. The mayors assigned staff to collaborate with local organizations and environmental groups.

[7]In 1995, the International River Forum invited scholars and experts from various countries—the UK, Denmark, and the USA. In 1998, the International Baray and Groundwater Recharge Conference invited scholar from the Netherlands.

[8]The band consists of five Hakka youths. The term *chiaogong* means "labor-force exchange" to emphasize the previous significance of mutual assistance in rural villages (Lin 2011).

[9]The MAU is made up of different members, e.g., farmers, aqua-farmers, tourist agents, middle-class residents, teachers, cultural workers, and activists on environmental and political issues. They combined through their anti-dam sentiments and in an effort to establish a new future for Meinung.

21.3.3 ICN Consolidation: 2000–2004

By 2000, the anti-MDP campaign had achieved reached periodic success in that the dam project was cancelled through a change in policy adopted by Taiwan's then president. Thus, the anti-MDP campaign was gradually able to reinforce southern Liudui Hakka identity. The Meinung voluntary organizations expanded their area of operation to the city region level and they became stronger in the process. These voluntary organizations were able to transfer their energy to practical community development.[10]

After construction of the dam was abandoned, the organizational objective of the MPA was transferred to community development. Efforts were directed toward deepening the inherited sense of community identity and to promoting organizational capacity. In 1996, there were 26 registered voluntary organizations in Meinung (Meinung 1996). By 2005, the number of organizations registered in Meinung had risen to 42. At least 18 young individuals were hired as full-time staff members by these organizations in Meinung. The networks among the organizations also took on a multifunctional character in terms of cross-support among groups, overlapping membership of different groups, and lending assistance in training full-time workers in organizational management. In achieving certain specific tasks, all the organizations have their own particular areas of expertise and they lend assistance to other groups as appropriate. This flexible approach with ICNs helped consolidate the networks and deepened the interrelationships among the various organizations in a multifunctional framework.

21.3.4 ICN Multifunctional Character and Organizational Split: 2005–2010

The Meinung People's Foundation (MPF) adopted the Project of Meinung Cultural Town Building (MCTB)[11] in 2005. The approach taken with MCTB was different

[10]For example, the Chungliho Cultural and Educational Foundation concerned itself with the affairs of Kaohsiung Community University, focusing on issues of regional agricultural development in 2001. The foundation established a learning base for "standing and serving for the agricultural village," and it supported education in the Chimei area, which included nine municipalities in Kaohsiung County. The Pitta Association implemented the Forestry Community Development Project in 2002 and planned another possible use of the YBV through collaboration with the Forestry Affairs Bureau, Council of Agriculture. In 2003, the Chumen Water Power Plant was designated as a National Heritage after a sequence of negotiations and communications. The Trans Asia Sisters Association, Taiwan, was founded in 2003. The activities of the Environmental Protection Union were enriched by lengthy discussions on water resources and ecological preservation. The MPA holds the annual Meinung Yellow Butterfly Festival.

[11]The project was subsidized by the Hakka Affairs Council aimed at making a "friendly small town." Differing from an old blueprint of the urban standpoint, the project emphasized the rural

from the top-down planning style that had previously operated. The voluntary organizations that were mainly led by MPF and MPA attempted to produce a new urban–rural relationship, and they understood that top-down-style planning was inappropriate for the autonomous needs of the various communities. These organizations aimed at a bottom-up approach to planning: the aim here was to integrate local cultural resources, making use of previous collaborative efforts in an attempt to define a new future for Meinung. However, since it was a grassroots organization, the MPF assumed a kind of executive role in these governmental planning efforts. It is necessary to consider the underlying sectionalism ideology. The related conceptual propositions such as highlighting rural welfare, sustainable agriculture, and cultural regeneration were required to be modified as a spatial substance plan by the opinions of government officials and the review committee. The MPF was appointed as the official planning body and was given the authority to proceed with certain operations.[12] However, the MPF faced certain difficulties in its planning schemes to meet local needs owing to communication problems, and there were also setbacks with the contract due date. After the MPF had outlined its plans, it faced difficulties in implementing them owing to sometimes contradictory positions among civil sectors, experts, and local organizations. Various internal conflicts resulted in a new organization, the Meinung Rural Field Association[13] (MRFA), splitting from the MPF in 2009. Despite this split, the MPA remained strong, and it was able to provide support for the MRFA. Despite this development with the MRFA, the ICN maintained the capacity to initiate cooperative action between local organizations and governmental sectors. The ICNs have been able to emphasize Hakka culture and rural daily life as part of efforts to point out insufficiencies with official planning. The MPF and MRFA have developed into new hubs of collaborative planning. In this system, the spokes are the strong links that exist among the MPA, MPF, and MRFA. Some links can be identified between the original and the new hubs. Thus, despite the development of the new hubs, the relationships between the original and new organizations remain strong, and the spoke relationships can be regarded as functioning in a multifunctional framework.

This form of collaborative planning appears to be relatively stable, and it employs human resources in a variety of ways. The MRFA's activities were largely

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angle of the local people's daily life for future Meinung development (MPF 2006). Four strategies include recovering harmony with the natural environment, watching comfortable lifestyle of Hakka humanism, ensuring confident welfare of social life, and constructing an independent agricultural system. The project also increased opportunities for interactions and presented capacity accumulation for local organizations as well.

[12]The MPF was designated as the official planner, which meant that it had to utilize images from geographic information systems as it became involved in evaluating and making plans for the environment. The MPF had to analyze town-planning issues and also coordinate with local organizations and regional authorities.

[13]Various MPA members established the MRFA because of their frustrations with the planning action. Thus, the MRFA is an organization that split from the MPA. The MRFA's goals include promoting rural industry, studying local knowledge, and creating plans to protect the environment so as to pursue a sustainable rural lifestyle.

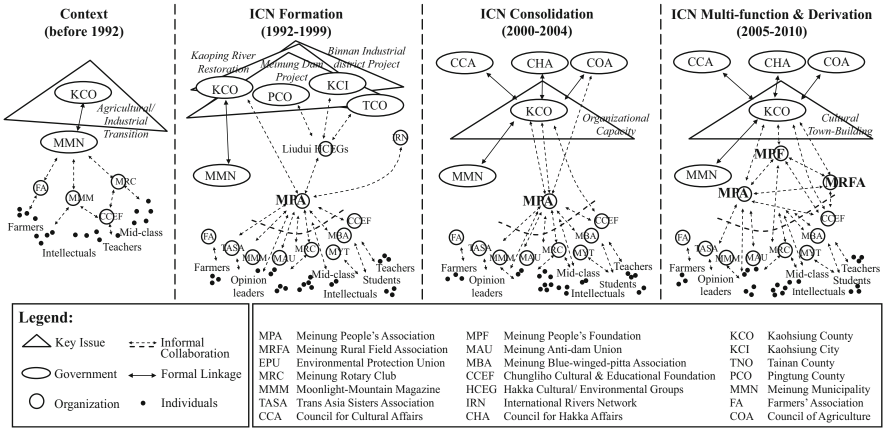

Fig. 21.2 Evolution of informal collaborative networks in Meinung

derived from those of the MPA. In addition to being rooted in local consciousness, ICNs make use of the complementary function of various organizations through mutual help, trust, and collaboration. The development of the ICNs in Meinung is depicted in Fig. 21.2. This development illustrates the local and regional networks that have become established among organizations and how they are related to the formation of multifunctional frameworks, interrelationships, and spontaneous action.

21.4 Conclusions

Community development policies have played a gradually increasing role in Taiwan since 1994. Voluntary organizations are able to deal with regional issues and they offer the possibility for establishing ICNs. People have conventionally tended to voice their protests directly at governments. However, the Meinung case shows another possibility. The Meinung approach has demanded a proper understanding of spatial planning, such as with regard to agricultural competitiveness, environmental preservation, and water resource management, and it has also made use of Hakka cultural identity. ICNs in Meinung have opened up the possibility for collaboration among voluntary organizations. The kind of collaborative planning exercised in Meinung demands adaptation and flexibility on the part of all organizations involved; however, it does signal that city region governance can go beyond the urban–rural dichotomy.

The protests carried out in Meinung have adapted to the collaborative efforts that have developed. Collaboration has grown from the efforts of voluntary organizations that aimed to oppose planning decisions made at the national level. ICNs have helped promote local knowledge and attracted human resources, such as young people who have returned to their hometowns from big cities; through ICNs, a number of voluntary organizations have been able to join forces and promote new relations at the city region level. Following the various campaigns in Meinung, the ICNs changed their objectives toward greater concern about collaborative planning issues at the city region level. For the benefit of community development, it became necessary for the voluntary organizations to open up new areas of discourse. As was evident with Meinung, when a voluntary organization takes on the role of a planner and operates under a formal contract with the government, it may be unduly influenced by overly rigid annual budgets in addition to various sectional issues. The optimal situation is one of regional governance characterized by coordination and multifunctional roles among the various organizations involved.

Flexibility is vital when establishing and operating an autonomous body that is responsible for collaborative planning between voluntary organizations and governments. Though professional planners are an important element in the planning process, ICNs should be involved in the decision making so that their own needs can be accommodated. If voluntary organizations become involved in the planning, this may create problems in coordination and with respect to the work of professional planners. Thus, the ideal governance pattern demands that the work of formal governments be reviewed and that a devolution policy be implemented as appropriate. Voluntary organizations face difficulties with regard to collaborating with government officials, and they also need to avoid discursive planning strategies, which undermine constructive efforts. Voluntary organizations need to integrate their various multifunctional roles and share their skills and abilities so as to sustain efficacy and efficiency. The sharing of multifunctional roles among these different organizations is important so as to flexibly utilize the available resources. The relationship among voluntary organizations is also crucial in collaborative planning.

This chapter concludes that the case of governance in Meinung represents an exploration of the collaborative planning model with respect to ICNs undergoing the transformation from the local level to the city region level, and thus it is a reflection of the potential that ICNs possess. The Meinung case reveals that the past cultural context and historical events, such as the anti-dam campaign, may induce formation and consolidation of voluntary organizations that ICNs have shaped. Despite insufficient skills for spatial planning, collaborative planning underpinned by ICNs can benefit governance. Therefore, a strategy to foster ICNs is significant to create an arena where voluntary organizations can collaborate at the city region level.

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Erratum to: Biowaste Reuse Through Composting: The Response of Barangay Holy Spirit in Quezon City, Philippines, to Solid-Waste Management

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In Chapter 19 titled "Biowaste Reuse Through Composting: The Response of Barangay Holy Spirit in Quezon City, Philippines, to Solid-Waste Management", the name of the author is incorrect.

The name should be **Makoto Yokohari** on the online and print version.

The author name is also updated in the Table of Contents of the Frontmatter.

The updated original online version for this chapter can be found at http://dx.doi.org/10.1007/978-4-431-56445-4_19

M. Yokohari et al. (eds.), *Sustainable Landscape Planning in Selected Urban Regions*, Science for Sustainable Societies, DOI 10.1007/978-4-431-56445-4_22

Index

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