Urbanization is the most dramatic human form of environmental transformation, resulting in widespread changes to the structure and functioning of ecosystems including those of agricultural systems (Seto et al., 2012). Urbanization has several impacts on agricultural systems. As discussed elsewhere in this volume (see Murray et al., Chapter 2 in this volume), urbanization has direct impacts on the conversion and loss of agricultural land. Urbanization also exerts indirect impacts on agricultural systems. Changes in urban diet put additional pressure on agricultural systems and rural–urban migration, driven by better economic and employment opportunities leads to agricultural land abandonment.

Urban settlements have existed for hundreds of years. Beginning with the Neolithic revolution, the transition from hunter-gatherers to agriculture and eventually sedentary societies began more than 10,000 years ago. Advances in food cultivation including irrigation systems and food storage allowed for an increase in food supply, which enabled larger and larger populations. The modern urbanization process initially flourished during the 18th century due to the Industrial Revolution. As humanity became more technologically advanced, economies became more dependent on natural resources, which in turn catalyzed intensive land conversion for urban development.

Urban expansion and associated land conversion are key components of the urbanization process. Currently, the rate of urban land expansion is slower in developed countries such as North America and Europe, in part because they experienced their large-scale urban expansion during the 19th and 20th centuries (Seto et al., 2011). In contrast, many low- to middle-income countries such as India and China are now undergoing large-scale urban expansion in conjunction with economic development and industrialization (Naab et al., 2013).

Urbanization tends to result in conversion of agricultural lands in part because of relatively high levels of rural population densities and proximity to urban centers. Thus, as urban areas grow, they tend to expand into adjacent areas, which are often agricultural areas. Throughout the world, there are many examples where the area of cultivated land decreases as urbanization and industrialization increase. For example, in Asia, cultivated land in Japan has been declining 1 percent annually from the 1970s to the 2000s due to economic development and unprofitable agricultural production (Saizen et al., 2006); South Korea also experienced declines in agricultural areas during the 1970s (Kim and Pauleit, 2007). In many countries of Europe, agricultural land decreased slightly between 1975 and 1995 (Antrop, 2000) and in the United
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States, agricultural land declined at a rate of 0.1–0.3 percent annually due to economic development and despite environmental conservation efforts (Imhoff et al., 2004; Jantz et al., 2005).

This chapter explores agricultural land loss due to urbanization as a pathway through which urbanization impacts environmental systems and becomes a driver of regional environmental change. The case of China is examined in order to better understand how current urbanization trends affect the supply and integrity of agricultural systems. Additionally, the opportunities for sustaining agricultural land are discussed and guidelines for future policy-making making regarding sustainable land development are provided.

The effects of urbanization on agricultural land

Agriculture contributes to urbanization in the form of food provision, raw material, labor, capital and land. Urbanization also plays an important role in the development of agriculture by providing markets for edibles and other agricultural products as well as technological advances. Since the late 1970s, China has experienced rapid urban transformation, resulting in large-scale expansion of the urban landscape. Studies using high resolution satellite imagery show that the urban extent of China grew by nearly 25 percent during the 1990s (Liu et al., 2005). Throughout the country, the expansion of urban land cover is growing faster than the growth of urban population (Seto et al., 2011).

One result of urban expansion is the loss of agricultural land throughout the country, but especially in the coastal and central provinces. At the same time, the rising demand for agricultural products and the loss of agricultural land results in cultivating land previously not used for agriculture. The cultivation of new lands is especially noteworthy in the northern and border provinces of the country (Deng et al., 2006). Although figures for site-specific agricultural productivity are unavailable, some studies find that yields from these new agricultural lands are lower than the converted land (Yan et al., 2009). In fact, the productivity of the agricultural land converted for urban use was found to be 80 percent higher than marginal lands converted for agricultural use (Yan et al., 2009). This is in part due to the differences in inherent geographic features that affect agricultural productivity including soil quality, water availability, slope, aspect and drainage. Much of the lands that are brought into cultivation are less suited for agricultural production than the original farmlands that were lost to urban expansion. In fact, much of the lower quality cultivated land is converted from grassland (Deng et al., 2006).

In China, urban land expansion is correlated with agricultural land loss, and GDP growth associated with industrial activity has negative impacts on agricultural land (Jiang et al., 2012). Throughout the country, high quality cultivated lands are converted to industrial, commercial and residential uses. This will change the spatial patterns of agricultural land use. In the inland provinces, areas of ‘intensive farming’ are likely to occur, with significant environmental consequences. In order to compensate for lower agricultural suitability, farmers will need to increase inputs such as fertilizers and/or apply alternate management practices. Thus, it can be argued that land use throughout a country—and not just land immediately adjacent to urban areas—is continually shaped by demand-driven economic growth from within urban areas (Deng et al., 2010).

Spatial patterns of agricultural land loss

Studies of agricultural land loss in China have largely focused on one of two scales: national or city-region. The majority of the research on urban expansion is devoted to the study of
the growth of individual cities or metropolitan regions (He et al., 2008; Long et al., 2007). Among the studies at the national scale (Tan et al., 2005; Liu et al., 2003, 2005; Deng et al., 2008, 2010), few examine spatial variations in the causes or patterns of agricultural land loss. Results from Jiang et al. (2012, 2013) are referred to here as well as unpublished results from those studies to explore the spatial patterns of agricultural land loss.

Agricultural land conversion is most prevalent in low- and middle-income provinces. For example, the Beijing–Tianjin–Hebei metropolitan area expanded by 71 percent between 1990 and 2000. Seventy-four percent of the urban expansion occurred on arable land (Tan et al., 2005). Why does urban expansion occur largely on agricultural land? One explanation is the relative differences in land rent between urban areas and cultivated land (Seto and Kaufmann, 2003; Jiang et al., 2013). Relatively higher urban land rent stimulates more cultivated land conversion, which in turn can result in a further rise of the urban land rent of a region. New urban development typically occurs near or adjacent to existing urban areas. Due to the differences in land rent, farmland near existing urban areas is the most at risk of conversion.

Additionally, agricultural land is at risk for conversion due to the differences in wages. When off-farm (non-agricultural) wages increase, the opportunity costs of farming increase, and may result in labor scarcity in the agricultural sector. This in turn can lead to farmland abandonment and a higher risk of the conversion of farmland into non-agricultural uses (Jiang et al., 2013). Across the country, small cities tend to experience high rates of agricultural land conversion due to urbanization, as urban land is highly correlated with arable land in terms of the spatial distribution (Tan et al., 2005). Moreover, the cumulative effects of succession and dominance factors related to land change have made land increasingly scarce for peri-urban farmers (Naab et al., 2013).

In China, the total conversion of cultivated land to other types of land uses led to a total net loss of 347.56 million tons of grain or about 0.1 percent of the total production potential in 1988–2008; but a decrease of 499.28 million tons of grain (about 65.4 percent of the total production potential) was due to the conversion of cultivated land to built-up area.

Furthermore, rapid urban growth coupled with inadequate land and building regulation has led to inefficient urban land use and fragmented landscapes, with dire consequences for environmental quality. An example of this is the city of Ordos in Inner Mongolia, a typical resource-based medium-sized city, which entered into a period of rapid urbanization in the 1990s. The population increased from 812,000 in 1990 to more than one million in 2007 (Dong et al., 2012). Urbanization has had profound effects on the local ecology, society and economy. The landscape has become fragmented, with different patch types exhibiting distinctive spatial characteristics. Ordos has become a symbol of unsuccessful urbanization: it sits largely empty. In the new district of Kangbashi, prime farmland was developed into housing and high-rises that are vacant or incomplete. It is an example of wasted farmland and under-utilized urban land.

From a national perspective, agricultural land in some regions has been ‘sacrificed’ in order to support urbanization and environmental protection elsewhere. For instance, some cultivated lands in Inner Mongolia have been converted to grasslands or woodlands in order to provide some level of protection for Beijing from sand storms. Other national projects such as the Payments for Environmental Services and Grain for Green Program (also known as the Sloping Land Conversion Program), have set aside land in anticipation for supporting strategic urbanization. One large drawback, however, is that economists have provided only weak evidence that these programs benefit the poor, or that farmers have been able to obtain gainful employment from off-farm activities (Uchida et al., 2007).
Additionally, the accelerated urbanization following population increases has greatly affected agricultural land through rural–urban migration and the transformation of rural settlements into towns and cities. Cities can more easily provide cheap, plentiful labor for emerging factories and offer abounding job opportunities, attracting rural residents. Rural–urban migration and urbanization policies have further promoted additional agricultural land loss, which has been most significant in recent decades. To some extent, urbanization promotes higher average income in cities, but lower average income in rural areas. The large amounts of cultivated land left by agricultural laborers, the high rates of rural unemployment, low income from farming, combined with uncertain and unfavorable climate conditions and natural hazards are drivers of rural–urban migration.

Additionally, urban remittances to rural family members are significantly changing the structure of agricultural households. In China, statistics show that around 250 million rural residents have moved to cities for employment (China Development Research Foundation, 2012). This means that roughly half of all Chinese farmers are either partially or entirely separated from agricultural production, and instead derive their incomes mainly from working in urban or off-farm conditions (Démurger and Li, 2013). The majority of these agricultural workers are middle-aged with technical farming expertise. While they leave for the cities, their children and aging parents remain in rural areas, further creating new rural sociologies and household dynamics. The prevalence of farmers working in off-farm employment further increases the rural–urban income gap and encourages even more agricultural workers to migrate to cities, creating a vicious cycle of agricultural abandonment (Feng et al., 2010).

Debates on the impacts of urbanization on agricultural land

Large-scale urban conversion of agricultural land consumes natural resources, often negatively impacts the environment and causes many serious socio-economic problems. Rural–urban migration may lead to the scarcity of infrastructure for urban housing, stimulating urban expansion on to the peripheries of agricultural land. Abandoned cultivated land can be transferred to another farmer, but more often these lands are left unused. In order to make up for the reduction of cultivated land and the loss of agricultural production, large amounts of grassland and unused land are often converted into cultivated land, which creates another threat to natural environments. In this sense, urbanization near cultivated land tends to result in a net decrease of cultivated land area.

In developed countries like the United States and Canada, the loss of agricultural labors can be balanced by industrial farming. However, this is difficult in countries with lower levels of economic development where farming technologies may be too expensive or unavailable. This is particularly true for remote and hilly areas in developing countries, where rates of agricultural mechanization are low and considerable labor and expertise are necessary in order to operate the available machinery on small-scale farms (Siciliano, 2012). There is also debate over whether the abandoned agricultural land is cultivated by the remaining farmers in rural areas. In reality, the flight of farmers to urban areas tends to be of large magnitude, and generally, land tenure is usually transferred among farmers without permission from local government. In some countries such as China, property is not individually owned. In turn, economic growth and associated urbanization along with low farm commodity prices often means that it is far more profitable in the long-term for farmers to rent or even abandon their land than to continue farming. The key challenge of urbanization with respect to agriculture is the large-scale conversion of prime agricultural land. Urbanization often occurs where there are good natural conditions for farming.
Although urbanization often results in the loss of agricultural land, there is also potential in some places for urbanization to increase land use efficiency. Urbanization can increase the accessibility of agricultural land and therefore reduce the time from farm to market. The reduced cost of transportation and close linkages with the markets can increase agricultural productivity by making inputs cheaper, agricultural technology more accessible and farm-gate prices of agricultural commodities higher. If households are refocused into intensive agriculture and off-farm employment, the pressure on cultivated land may actually be reduced. Worldwide, average urban incomes are higher than average rural incomes, and the price index in urban areas is also higher than that in many rural areas. Thus, from an economic perspective, new urban land results in higher economic values than other types of land. The intensive land use in urban areas leads to higher densities of built-up land. Under these circumstances, converting other types of land into built-up land may benefit economic development.

Overall, urbanization is an important process for industrialization and economic development. However, it should not continue to the extent that it diminishes the functions of agricultural land. This reverts back to the debate about their relationship: in order to assess the economic and ecological value of urbanization and agricultural land, future development modes must examine tradeoffs.

**Sustaining agricultural land**

Rapid urbanization is expected to continue so long as it is considered an engine of economic growth. To formulate policy that promotes economic growth and urban development while minimizing environmental impacts, policy-makers must understand the factors that drive urban expansion. Without a clear sense of the conditions that cause urban encroachment on farmland, policies are likely to be ineffectual.

Loss of agricultural land through urban expansion is not the only concern for policy-makers. As discussed in this chapter, migration from rural communities is a major threat to the sustainability of agricultural land. In order to preserve and sustain agricultural production, we need a better understanding of the socio-economic-political causes of farmland abandonment. A few studies have found that increasing opportunity cost of farming—that is, the increasing economic opportunities of off-farm employment—is one of the main factors why farmers abandon farmland (Xie et al., 2014). Abandonment of farmland in turn leads to a reduction in farmland labor, which further increases the cost of farming. The lack of technical on-farm expertise also threatens farmland sustainability.

Another issue with respect to sustaining agricultural land is that of agricultural land quality. Although the total amount of agricultural land in China remains somewhat stable, it is clear that the quality of agricultural land that is converted to urban uses is much higher than the quality of marginal land that is brought into agricultural production. Thus, it will be critical for policy-makers to develop strategies to not only maintain total agricultural land, but rather to keep highly productive land in production. However, this is challenging because national-scale land use assessments mainly keep track of the total amount of farmland, not quality. The government has established that China needs a minimum of 1.8 billion mu (120 million hectares) of arable land to maintain food security (XinhuaNet, 2007). Policy-makers call this the ‘red line’ for food security that cannot be breached (Xinhua News Online, 2010). This functional and psychological ‘red line’ uses farmland quantity as a proxy for quality. In order to truly sustain agricultural land, policy-makers must develop new accounting measures that explicitly include quality.
However, the challenge of sustaining quality agricultural land in China is not only a matter of mitigating agricultural land loss. Sustaining agricultural land will require mitigating pollution on agricultural land. It is estimated that more than three million hectares of farmland in China are contaminated with pollution (Kong, 2014). The Ministry of Environmental Protection confirms that more than 16 percent of Chinese soil exceeds national standards for pollutants and that an estimated 20 percent of agricultural soils are polluted (Duggan, 2014). Metal contamination of soils and plants can be traced throughout the food chain. In some regions, rice is grown in soils contaminated with cadmium and zinc, commonly found in heavy industries, metals mining, smelting and untreated wastewater (Wang et al., 2003), posing risks to food security and ultimately human health.

In addition to soil contamination, water pollution and water scarcity are already posing significant risks to agricultural sustainability. In northern and northwestern China, two of the country’s main wheat producing regions, severe water shortage is a major problem for sustainable agricultural production. By some accounts, the region has less than half the water per person as Egypt (Varis and Vakkilainen, 2001). Water infrastructure in many agricultural regions is outdated and inefficient, leading to overuse of a limited resource. Water pollution in China is due to industrial discharges as well as agricultural activities. For many years, increasing agricultural output in China was dependent on increasing agrochemical inputs. If current trends of fertilizer and pesticide use are not reversed, the long-term capacity of sustaining agricultural production will be compromised. Zhang Weili, a prominent agricultural expert with the Chinese Academy of Sciences, argues that water pollution caused by intensive use of agricultural inputs is one of the most significant challenges to sustainable development (Outlook, 2010). Thus, China’s agriculture faces two critical issues with regard to water: there is simply not very much of it and what it has is highly polluted.

**Integrated urban–rural planning**

For China, it is clear that a new path forward is necessary in order to harmonize urbanization with agricultural land preservation. The key to sustaining urbanization and agricultural land lies in the coordination of their relationship and the dynamic balance of policies for development of urban and rural areas. For instance, more job opportunities and improved infrastructure would incentivize rural living and agricultural livelihoods. In coastal China, land is too scarce to support local development needs. However, local governments are implementing a national policy that aims to offset increases in urban land with decreases in rural built-up land. Centralized efforts to develop human settlements is the principal model, but it is causing land displacement while building new countrysides in coastal China (Long et al., 2009). Integrated urban–rural development indicates that urban functions are being spread over larger and larger geographic areas so that the traditional distinction between urban and rural is becoming increasingly blurred.

Integrated urban–rural planning will also require urban and national leaders to explicitly acknowledge the links between sustainable urban development and sustainable agricultural areas. Peri-urbanization and peri-urban communities are increasingly the norm in China, referring to spatially and structurally dynamic transition zones where land use, populations and economic activities are neither fully urban nor rural. Peri-urban households may have some family members living in rural areas, but not employed in agricultural activities and other family members living in urban areas but engaged in agricultural activities. At the same time, urban remittances to rural areas are changing the character of what it means to be an agricultural household. In other words, rural and urban livelihoods and landscapes are
increasingly intertwined in China, and policy-makers need to acknowledge these new realities and conditions and adjust development strategies accordingly so that development in one area does not come at the expense of the other.

**Key messages and concluding thoughts**

- As China continues to urbanize, it is highly likely that prime farmland will continue to be abandoned or converted.
- Urbanization in China affects agricultural land not only through direct land conversion, but also through rural to urban migration and the reduction in farm laborers.
- Rural to urban migration is creating new household dynamics in rural farming areas in China.
- Integrated rural–urban planning and development is key for the long-term sustainability of both urban and agricultural areas.

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