

# Urban Sprawl: Effects and Mitigation

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## Abstract

*This literature review details the negative effects of urban sprawl and strategies to mitigate them. The purpose of this review is to identify the consequences of urban sprawl on agricultural land and to explore possible solutions for improving global health and advancing progress toward meeting the United Nations' Sustainable Development Goals and the topics connected to the USDA's Agriculture and Food Research Initiative (AFRI) priority areas. In the review, the focus was to identify and analyze at least two effects that Urban sprawl has on rural or agricultural land and to analyze the techniques used to help lessen the effects on the land. The literature review included case studies from multiple countries to incorporate a variation of global viewpoints and to incorporate the findings applicable to a larger audience. Multiple scholarly sources and peer-reviewed journals published within the past ten years were used to include reliable and updated information in the review. The effects focused on are food insecurity, the global south, and pollution, an effect that occurs globally. The strategies researched to mitigate urban sprawl effects are the use of conservation easements, notably abundant in the United States (US), and urban development boundaries, common in China. Food insecurity is a pre-existing issue in the global south, and the loss of agricultural land amplifies it. This issue is intertwined with the second Sustainable Development Goal, which is to end hunger. Pollution surges when urban sprawl causes increased runoff and vehicle emissions, closely related to the third Sustainable Development Goal, ensuring healthy lives. The conservation easements and urban development boundaries work to prevent rural, agricultural, and forest land from being developed through the use of economic and legal tactics. These methods are closely linked to the USDA AFRI priority area of Agriculture Economics and Rural Communities. This literature review works to provide an overview of the effects and methods, also working to provide connections to global and country efforts to better the communities that suffer from urban sprawl. The main purpose is to inform people about the harm of urban sprawl and suggest methods that policymakers should implement to protect agricultural land.*

## Introduction

It is estimated that by 2030, the amount of farmland lost to urban sprawl will be 300,000 square kilometers, nearly the size of Germany (Global Agriculture, 2016). While there are multiple definitions of urban sprawl due to differences in perspectives (Banai & DePriest, 2014), this literature review will define it as the uncontrolled expansion of city or community development in an undesirable manner that replaces agricultural or rural landscapes at a rapid rate (Yasin et al., 2021). This paper aims to identify the negative implications of such intensive patterns of development by answering and analyzing the answer to the research question "What are the repercussions of urban sprawl on agricultural land, and how can the impacts be mitigated?" In order to investigate this, a selection of academic articles and peer-reviewed journals focusing on case studies, environmental data, and conservation policies was reviewed. These sources were

found in academic research sites such as JSTOR, Google Scholar, EBSCO, and the Virginia Tech Library. Sources that were chosen had keywords chosen for each subtopic and generally came from either an academic journal, study, or government/specialist-sponsored websites. Findings showed that urban development encroaches upon agricultural and natural land, leading to food shortages in the global south from a lack of arable land (Eburajolo, 2023) and major pollution due to construction and human interactions with the environment around the globe (AbdeUawad & Nagy, 2023). In order to combat these issues, local and federal governments implement policies encouraging conservation methods that vary throughout the world. In the US and other countries, conservation easements are a common practice to encourage biodiversity and preserve private or agricultural land from city development (Lee, 2025). Over 60 million acres of land and water resources have been protected due to conservation easements (Snape et al., 2021). Another method established globally is the implementation of Urban Growth Boundaries (UGBs). UGBs are geographical boundaries established around developmental areas. Development is only permitted within these boundaries, while land outside is preserved (Planetizen, n.d). This literature review is used to look deeper into the effects of urban sprawl and give the benefits and downfalls of the methods that are used to stall urban development. The USDA Agriculture and Food Research Initiative (AFRI) prioritizes the Agricultural Economics and Rural Communities (U.S Department of Agriculture, 2024) greatly, correlating with our research topic. As urban sprawl develops into agricultural land, environmental pollution accelerates and reduces the local food production capacity in some countries, threatening the sustainability of rural and urban food systems and land use. These consequences align with AFRI's mission to promote sustainable land and resource management, support agricultural productivity, and strengthen rural communities. The mitigation tactics discussed would reflect the kind of policies and conservation approaches that AFRI encourages to seek a development pressure balance with the long-term protection consideration of global farmland and ecosystem health. The conclusion is that using methods such as Conservation Easements and Urban Growth Boundaries could ensure the future stability of environments and agricultural land protection, with the benefits outweighing the cost. In addition, there is the proposed solution of providing government-monitored conservation easement placements and encouraging stricter punishment for crossing over UGBs.

### **Food Insecurity**

Urban sprawl disproportionately affects countries in the global south. Due to the global north countries subjugating the global south during the first age of imperialism, the global south has since then been excluded from wealth. This is due to extractive policies imposed by previous colonial institutions. Even after gaining independence, it is difficult for these countries to restructure their economy to benefit their own country and citizens, allowing Multinational corporations and the World Trade Organization's policies to make it exceptionally challenging for domestic industries to make profits. This leads to businesses closing, in turn lowering the job opportunities available, resulting in citizens and residents from purchasing domestic goods (Meyer, 2024). All of this contributes to slowing down the development of the global south and the persistent poverty of the countries. The domestic industries in the global south are economically and socially fragile, meaning that the economic and agricultural effects of urban development taking over the farm and rural land can cause massive negative effects for these countries, further

impacting their social and economic aspects, but most importantly, the availability of food to the residents.

A city that expands from the urban center it was created around will encroach on the rural and agricultural land. This leads to the consequence of farmers selling their land to big business dedicated to city development because of the lack of sufficient economic profits from farms and significant time requirement for cultivation, also leading to a negative impact on families' interpersonal lives (Peerzado et al., 2018). Due to the loss of agricultural lands and people dedicated to food production, the food insecurity issue has increased heavily in the global south. This is because these countries rely on their agricultural industries as their main source of food and income (AbdelJawad & Nagy, 2023). As the population of countries increases, their food supply must increase. By carrying out urban expansion and turning arable land into urban sprawl, productive agricultural land gets lost, which is linked with an increase in food insecurity (Hatab et al., 2019). The price of food will increase with low supply and high demand, which will further make food inaccessible for residents in the global south.

### **Pollution**

Urban sprawl's main, and arguably most dangerous, consequences are the intensive environmental damage and pollution that come with the process and lifestyle. Pollution such as runoff is incredibly common due to the rain and precipitation that ends up picking up fertilizer and pesticides from nearby farm and city land, depositing it into rivers, lakes, and oceans, destroying and damaging large ecosystems at an increasing speed (Laalaoui et al., 2024). An additional impact of runoff is the water eroding farmland soil, which often contains natural minerals and fertilizers that are critical for plant and crop growth. This consequently pollutes the waters around farmlands with phosphorus and nitrogen, chemicals capable of destroying aquatic ecosystems (Xia et al., 2021). Water pollution caused by urban sprawl also affects sewer systems and irrigation, causing blockage due to increased algae and plant growth, as well as spreading disease (Youssef et al., 2020).

Urban sprawl additionally leads to the use of vehicles by people commuting, in turn leading to an increase in vehicle emissions, releasing toxins such as carbon oxides, nitrogen oxides, sulfur dioxide, aldehydes, soot, lead, and many other harmful chemicals into the atmosphere (Renz, 2021). Vehicle emissions are increasing due to urban sprawl consisting of car-centric infrastructure, which disincentivizes environmentally friendly methods of traveling, such as walking or biking to locations (Yasin et al., 2020). These pollutants increase the risk of mortality, reduce agricultural productivity, deteriorate materials, and harm ecosystems (Masseti & Mendelsohn, 2017). Vehicle exhaust may also have the consequence of haze pollution, a type of air pollution that reduces visibility. This phenomenon was found in a case study that took place in China, where researchers identified a positive correlation between haze pollution and urban sprawl (Huo, 2024). The exhaust and fumes coming from vehicles, along with additional factors from urban sprawl, lead to negative effects on agricultural land as it also blocks out the sun, leading to difficulty in plant growth and cultivation.

Negative effects of urban sprawl, such as food scarcity and pollution, lead to the importance of finding solutions that will mitigate these problems, which is crucial for global health and well-being (Genovese et al., 2023).

## Conservation Easements

With urban sprawl being a global issue, governments and conservationists work together in forming policies and methods to combat its effects. An example of this, most common in the United States, is conservation easements (CEs). These are making a common appearance in the US, with over twenty-five thousand being signed by April 2025 (U.S. Department of Agriculture, 2025). In the US, farmers and landowners voluntarily sign, stating that their land will not be used for development. This means that development of any sort, not including agriculture or contracted purposes, may occur on the land (Moore & Linder, 2024). When referring to CEs, it should be noted that there are many versions that differ slightly throughout the states and organizations. However, a common similarity is that they often come with economic benefits, are adjustable, and overall prove satisfactory for the organizations and landowners. CEs are considered a useful tool for protecting the environment and ecosystems on private property (Bastian et al., 2016). It was found in a 2023 review that privately owned lands part of CEs have a better chance of preserving natural wildlife, supporting previous research findings that CEs are pivotal in protecting high-quality land and sustaining the surrounding environments (Brown et al., 2023; Kolarik et al., 2025)

CEs provide economic benefits that farmers can take advantage of. Drastic changes to the land are not allowed, so landowners are compensated with tax credits, deductions, or payments from the contract holders (Farmer et al., 2015). In some states, such as Virginia, farmers are able to get tax credits or deductions that are worth the difference in their land between the sale price and true value (Virginia Department of Conservation and Recreation, 2025; Horton et al., 2017). This is beneficial because the money saved can be used to care for debt retirement, farm expansion, or farm modernization for those who may be facing financial hardships (Schilling et al., 2019). Farmers may sell and trade their tax credit, providing an opportunity to make money. The reason that these economic opportunities are offered is that agricultural land is worth more to develop. Therefore, if a landowner decides to sign an easement, they have to sell their property for a lower price; however, being paid the difference by organizations or federal departments bridges this gap and improves monetary gain (Schilling et al., 2019). The tax deductions are seen as favorable because they would mean more money to spend on equipment and management in the long run. The financial considerations can be different based on the range of requirements and state legislation, but it is a common occurrence for farmers to be paid the difference on their land and to receive tax or income benefits (Brown et al., 2023). With tax benefits, they can use and manage their farm efficiently without having to be concerned with economic strain.

Economic opportunities are not the only benefit to CEs. They also offer a substantial amount of flexibility. CEs are written and formed to accommodate the farmer and their land (Moore & Linder, 2024). A few examples are excluding a portion of land or retaining the ability to continue practice that would usually go against a contract (Schilling et al., 2019). These types of adjustments that can be made open up the opportunity for more farmers to participate and find comfort in knowing that they still hold control over their land, a common fear and misconception of CEs (Horton et al., 2017). CEs, under any sort of program, may have specific requirements that are needed, but universally will follow the farmers' needs, leading to satisfaction and improvement towards sustainable development practices.

However, CEs have limitations. CEs usually do not require the land to be actively farmed. While they block housing and shopping centers, they do not always make sure farming continues (Phelps, 2017). This means that certain agricultural sites may be left unused or converted into hobby farms. These conditions not only limit the land's productive capacity but also can jeopardize communities that rely on farming for a living. But some easement programs can have terms that encourage farmers to keep using the land for farming or give priority to farms that are already farming. In some circumstances, the land is both protected and productive, which benefits local economies and food systems. Additionally, because CEs are voluntary, their effectiveness depends on landowners choosing to participate, which limits widespread adoption (National Agricultural Law Center, n.d.). While the voluntary nature of these agreements ensures that landowners are not forced into agreements against their will, it also means that valuable agricultural lands may go unprotected if they choose not to participate. Nonetheless, voluntary participation increases public support for conservation programs. As educational resources grow, engagement may broaden to cover larger regions.

### **Urban Development Boundaries**

A solution that was recently founded in China and studied is the Urban Development Boundaries (UDB) policy (Jiang et al., 2016). The precursor of the UDB was the Urban Growth Boundary (UGB). UGBs were first developed in Europe in the mid-1950s, specifically in London, in the form of a greenbelt, a type of conservation easement. Since then, these strategies became extremely popular in many big cities in the US, such as Lexington, San Francisco, and Las Vegas, to slow down urban sprawl (Wang et al., 2025). The basic premise of the UGB is to limit urban expansion by drawing an arbitrary line to preserve any rural, agricultural, or forest lands outside of the boundary to limit low-density urban sprawl from overtaking rural lands. The UGB strategy is primarily a policy to strategically plan and control urban expansion into rural lands, with emphasis placed on ensuring that enough agricultural land needed for food production and ecological protection remains. An UDB, however, is a clear line between lands available and unavailable for construction (Wang et al., 2025). UDBs aim to balance urban expansion and conservation, but studies have reached mixed conclusions regarding their effectiveness in containing and minimizing urban sprawl (Kim, 2019).

Geographical Information Systems (GIS) are computer systems that analyze geographic information. GIS systems are primarily used to gather spatial data of cities' growth concerning their patterns. GIS systems are usually combined with satellite images of cities from a bird's eye view when deciding boundaries. For example, when investigating case studies of Urban Development Boundary success in cities of China, Jiang P. used a series of Landsat images, which are satellite images of the Earth. They included some from the Landsat 5 Thematic Mapper (TM) and the Landsat 7 Enhanced Thematic Mapper (ETM+), which created images of the city from 1990 until 2014 (Jiang et al., 2016). Another study, which investigated the effectiveness of Beijing's UGBs, used different types of GIS data to measure travel starting points and ending points. If the starting points and the destinations were usually inside the UGB, it indicated that it was successful in containing sprawl. However, if one of the start or end points were inside the UGB while the other was outside, it would indicate that it was unsuccessful in containing sprawl (Long et al., 2015).

While these solutions are intended to preserve agriculture from urbanization, they have limitations that reduce their overall effectiveness. Effective containment is more likely when paired with supportive zoning, strong regional governance, and market demand alignment. In contrast, decentralized and fast-growing areas without strong centralized planning fail, as companies will still participate in leapfrogging, a pattern of development that skips over unavailable land and leaves gaps in development (Jiang et al., 2016). UGBs are also found to increase the population density of the city. From 2001 to 2011, a study measured the population density increase for 35 cities with UGBs and 50 cities without UGBs, finding that cities with UGBs saw a 0.085% greater increase in population compared to cities without UGBs (Kim, 2019).

Another issue with UDBs is that local governments rely heavily on leasing land to developers for revenue, so they may resist UDB policies that limit this source of income (Luo et al., 2021). While central governments promote sustainable land use, local officials face pressure to meet economic growth targets tied to land sales. As a result, enforcement of UDBs can be weak or inconsistent, especially if the boundaries interfere with financial or political incentives. This tension can reduce the policy's effectiveness and may result in unplanned development just outside the boundary, where land is less regulated. The same UDB policy cannot be applied uniformly everywhere, as cities have distinct development needs and growth rates (Zhuang et al., 2016). This disparity can lead to situations where certain areas face excessive restrictions while others do not have adequate protection. Consequently, UDBs may fail to safeguard agricultural land in some regions effectively.

UDBs also struggle due to the difficulty of predicting how much land a city will need in the future. If cities grow faster than expected, they may run out of space within their boundaries. Because it is difficult to predict land demand, UDBs often do not match real development needs (Zhuang et al., 2016). If farmland is over-protected or set aside too early, it may block proper growth. However, if it is not protected soon enough, it might be lost permanently. Still, regular reassessment of UDBs can help adjust the boundaries based on updated forecasts and housing needs. This adaptability guarantees that the borders are not permanent obstacles, but rather adjustable guidelines. In this approach, UDBs can adapt to changing urban situations without giving up farming protection entirely.

Nevertheless, UDBs continue to provide long-term planning benefits by directing urban growth into already built areas, potentially lowering infrastructure costs. They also help towns coordinate housing, transportation, and environmental planning more effectively. Even if enforcement is sporadic, UDBs provide policymakers with a more deliberate way to balance growth and preservation.

### **Conclusion**

Urban sprawl removes agricultural land, leading to an increase in food insecurity and environmental pollution. When agricultural land is removed, food production decreases, and job opportunities are lost, making food less affordable to the general public. The pollution is caused by increased runoff and vehicle emissions from the new homes and construction done to build said homes. This harms and disrupts the balance of surrounding ecosystems, leading to a loss in biodiversity. This loss in biodiversity is dangerous because it leads to land and water resources becoming dry and undernourished. After looking at these dangerous effects of urban sprawl, an

analysis of two different methods was conducted. To contain development, Urban Development Boundaries establish clear lines where urban development is permitted. This research took place mostly in China, but it should be noted that Urban Development Boundaries are found around the globe. The other method of research was conservation easements. Conservation easements prove effective in permanently preserving land, slowing the loss of biodiversity, and offering economic opportunities for landowners. By preserving land, agricultural farms are able to continue to function, which improves global health across the world. Solutions to urban sprawl, especially Urban Development Boundaries, need strong institutions that support regulation to develop smartly, efficiently, strategically, and without any waste of space. There is no one-size-fits-all solution to reduce urban sprawl, as different countries and regions require methods tailored to their circumstances. However, the strategies included in this literature review are examples of policies governments can adopt and strengthen to promote sustainability. By working to contain urban sprawl, governments can support the progress towards meeting the United Nations' Sustainable Development Goals, including ending hunger, promoting well-being, and creating resilient cities.

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