The study of the vulnerability of ecosystems and climate change has been a significant research direction in most ecological and environmental studies during the past several decades. The changes of ecological environment could threaten to shift vegetation, disrupting ecosystems, reducing biodiversity and even damaging human well-being(Gonzalez et al., 2010).

Panel on Climate Change (IPCC) pointed out that global greenhouse gas emissions rose by 70 percent due to human activities in the context of climate change topic from 1970 to 2004(Programme, 2009). Many experts considered that with the rapid development of urbanization, the world may experience potentially dangerous in climate and environmental change. It could have a significant impact on our environment, economies, and societies(Graham, 2009).

At the same time, the phenomenon named “urban sprawl” has also emerged in many countries, which has become a major concern because of its detrimental [effects on a](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/effect-on-the-environment) series of ecological, economic and social issues(Brueckner et al., 2001)(Jaeger et al., 2010). Urban sprawl could be specified as the spilling over of urban-type buildings and constructed land into the suburban and farmland areas and the disorganized growth of settlements in farmland areas(Wackermann, 1968). It would result in encroaching excessively on farmland, leading to a loss of amenity benefits from open space as well as the depletion of farmland resources(Brueckner et al., 2001), which could also lead to air pollution due to the long commutes generated by urban expansion(Fenger, 1999). Therefore, social ecological problem that caused by urban sprawl should not be ignored by governments. With ecological space becoming scarcer at an alarming rate, much higher efforts are necessary to conserve and properly use land and soils resource(Haber, 2007).

According to Demographia World Urban Areas, 15 of the world's 20 largest cities are in developing countries(Demographia World, 2021). It means that developing countries have become the main deriving force of global urbanization and thus would be the areas with the most intense urban sprawl conflicts(Yue et al., 2013).

At the same time, Urban sprawl from China has also attracted general concern from scholars. There has been a rapid and unprecedented urbanization in China, which also resulted in accelerating drastic urban sprawl over almost all of the last decade(Li and Li, 2019). However, due to the difference of urban form between China and other countries, there are relatively little research about the impact and future trends of urban sprawl in China compared with the rich literature on urban sprawl in developed countries(Wang et al., 2020). Therefore, it is necessary to research urban problem following with a dynamic analysis of social, economic, and ecological aspects of sprawl.

The urban fringe area could refer to the outer zone of the urban built-up area, which has unique cross-over characteristics(Cui et al., 2020).

Generally, urban fringe area is facing urbanization related social-ecological problems, especially in megacities in the background of urban sprawl (Peng et al., 2020b). There would be a discussion about pro-growth or anti-growth interests in many urban fringe areas(Pacione, 1991). However, it is popular to decentralize the population by minimizing the growing development pressure of the metropolis emergence to urban fringe area(Howlader and Sarkar, 2020). With the growth of urban population and the expansion of industries, there is no doubt that the expansion of constructed land can maintain a continuous rise in the socio-economic status of the city. However, the development of constructed land represents a reduction in ecological space and farmland in the urban fringe area. At the same time all energy and material resources are used to build and operate buildings would also cause the growth of greenhouse gas, impacting the supply of ecosystem services(Pedersen Zari, 2012). Therefore, there would be a trade-off relationship between urban growth and environmental change, and between urban growth and socio-economic growth(López et al., 2001).

Although urban fringe area is challenged with social-ecological problems with the urbanization process, there is no standard principle for researching urban fringe area due to its complexity, dynamicity and fuzzification(Dong et al., 2022). Accurately identifying the urban fringe can significantly help to integrate urban-rural development planning in megacities(Peng et al., 2020b).

Besides, in order to find the balance in urbanization and ecological space, researching dynamic changes between socio-economic development and environmental outcome in urban fringe areas in megacities would provide a scientific reference to urban growth management in specific megacities. Apart from the identification and assessment, the study would also attempt to discuss social-ecological problems in depth from a policy perspective by combining ecological restoration and regional management approaches，which can also explore the special characteristic of proper intervention policies in developing countries especially in China.

Therefore, the research question and framework could be shown below:

1. How to identify urban fringe area?

2. What are the changes between socio-economic development and environmental outcomes in urban fringe area in the past several years based on different cities?

3. Comparing results and existing urban fringe area management policies of different cities

4. What kinds of interventions (development priority or protection priority) should be taken in urban fringe area in different case cities?

与此同时，城市蔓延的现象时有发生，根据XXXX指出，世界，而XXX认为亚洲，中国城市蔓延更是。与此同时产生的社会生态问题，是不容忽略的

the built environment has a severe impact on the natural ecosystems

It is also important to note that, human activities in the built environment do contribute to loss of biodiversity affecting the ability of the ecosystem to support living organism(Pedersen Zari, 2012)

人类在建筑环境中的活动确实导致了生物多样性的丧失，影响了生态系统支持生物体的能力

it is a causal factor in rising sea levels, increased occurrence of severe weather events, food shortages, changing patterns of disease, severe water shortages and the loss of tropical forests.

由此可知，城市的发展会与生态问题产生一定程度程度的冲突，其中处于城市化进程中的发展中国家更是不容忽视其中的可持续发展问题

城市边缘区位于XXX，是XX中心。在其中两方面问题的冲突更加剧烈

可持续发展议程提出： 在中国，相关会议指出绿水XXXX。所以在XXX图中更是需要遵循XX要求发展城市化

In 2015, the United Nations Development Program (UNDP) has formed 17 global goals known as “[Sustainable Development Goals](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/sustainable-development-goals)” with 169 targets and 232 indicators to the protection of the planet for current and future generations(Pedersen Zari, 2012). According SDGs, Sustainable Development Goal 15 (SDG15) would be aimed at protecting, restoring and promoting sustainable use of [terrestrial ecosystems](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/terrestrial-ecosystem)(UN, 2015). Therefore, when it comes to the urban fringe area development, it should be basically focused to cope up with social, economic, and environmental benefits in the present scenario. In order to achieve the SDG15, it should be focused on three perspectives equally(Howlader and Sarkar, 2020). However, how to Balance the the social, economic, and environmental benefits of reservoir operation has become one of the most complicated problems facing the governments worldwide.

Since with the growth of megacities there has been a fear that farmland would be swallowed up by urban sprawl, it is generally considered that it is necessary to think the need for possible physical intervention at the urban fringe area(Gallent and Andersson, 2007). Gallent (2006) also think that the intervention method should be built on a wider urban agenda concerned with growth and the management of growth.

By considering this, what form should interventions take to manage urban fringe areas has been generally discussed in different countries and megacities.

Green Belt policy was used as a universal solution to urban growth by thinking urban fringe area(Gant et al., 2011). In London, intervention to urban fringe area would be fulfilling the function of fire break to protect the environment. The Green Belt has been a prime part of the land-use planning system from planner and could distinguish the area of urban and rural land use. Apart from the function of butter zone in ecological space, the Green Belt also provide opportunities for outdoor recreation near urban areas to citizens, retain and enhance attractive landscapes, and most impotantly, secure nature conservation interest as well land in agricultural, forestry uses(Ferguson and Munton, 1979).

The Green Belt policy successfully made urban containment in spatial distribution. However, Gant(2011) think that the intervention in the past has ignored the possibility that urban fringe area might have a varied character worthy of closed attention. Although urban planners realized that they had make a mistake of seeing fringe area as buffers and tried to relax Green Belt retractions, the urban fringe area were still disconnected to nearby urban and rural areas. Therefore, Gallent(2011) hold his opinion that Green Belt policy should recognize the strategic needs of public service development and importance of rural–urban fringes to view the urban fringe area in a wider subregional and regional context.

Besides, in the process of exploring sustainable development in urban fringe area, Netherland were treated as the success of current open space preservation policies. Green Heart planning was developed in the Hague Region, one of the most urbanized area in Netherland according to national spatial plan(Koomen and Dekkers, 2013).Apart from adopting a buffer zone policy, the government also assign the green infrastructure from urban fringe area to the status of a municipality or assign land ownership and stewardship to a community land trust(Aalbers et al., 2009). A unified system of management at a regional level provides greater clarity in the allocation of resources. Moreover, by developing glass and grass production and recreation area, it could successfully make market chains and urban-rural relationship compared with developing housing site in other cities. Therefore, urban fringe area in Netherland would be in a place where recreational facilities and natural areas were being developed by controlling its dynamic balance(Koomen and Dekkers, 2013).

It has been considered that urban fringe areas is a distinct entity because of their special characteristics and productive construction from each regions(Gallent, 2006). Many researches indicated that sustainable intervention of urban fringe area in developing countries would be different. Howlader and Sarkar (2020) thinks it is hard to achieve the SDG in Indian scenario of urban fringe area in fast growing megacities. With the rapid growth of population and environmental pressures in urban area, urban fringe area development is mainly focused on decreasing and decentralizing the pressure of the central area. Treated as a core sub center in the future, Indian megacities are other priorities on hand compared with sustainable development. Therefore, they are more likely to form the Development Authorities (DA) to adopt and implement integrated policies and plans towards inclusion.

According to Liu (2018),megacities in China sprawled most from 2000 to 2010, and the rate of urban sprawl has decreased since 2010. The Land Administrative Law and the Regulations on the Protection of Basic Farmland are promulgated to implemented open space preservation. Specifically, urban sprawl would show obvious difference in megacities depending on region, population, and administrative hierarchy(Li and Li, 2019).

Different cities would consider difference and formulate effective regulatory policies in the urban fringe area. In the context of rapid and large-scale city construction, scholars in China suggest local governments should enhance their control and propose local planning to serve the needs of growth(Tian et al., 2017). For example, according to planning outline of ecological civilization construction in Guangzhou(2016-2020), important green corridor and nodes companied with two ‘green forest rings’ with a total area of 86 km2 are proposed by Guangzhou environmental protection bureau to mitigate environmental pollution from urban sprawl(Guangzhou environmental protection bureau, 2016) (Yu and Ng, 2007). Besides, according to Shanghai City Master Plan (1999–2020), Shanghai from a development strategy, “One City, Nine Towns”, to alleviate the city from the significant pressure of urbanization(Tian et al., 2017). With a projected population of 800,000 to one million in each new towns, Shanghai also transferred local land revenues and land use from municipality government to district governments to ensure the efficiency of environmental reservation(Wang et al., 2020). In conclusion, Although the intervention strategies have achieved some success in China, urban development strategies in fringe areas are still imperfect due to their late start and the dominant power for urbanization. Therefore, more research should be applied to quantify the impact of planning on urban fringe area and sustainable development planning could be explored in the future based on the result.

Research technique

Identification of urban fringe area

Traditionally, it would be common to identify urban fringe area by using statistical analysis methods(Beibei, 2012). By considering single or multiple indicators including density, population, economic level and land use, research might also use [Multicriteria Analysis (MCA) to combine each indicators and finish the identification process(Yang et al., 2017). Due to the limitations such as not continuous statistical data and the difference of statistical standards, it would be difficult to obtain efficient and accurate results.](https://unfccc.int/files/adaptation/methodologies_for/vulnerability_and_adaptation/application/pdf/multicriteria_analysis__mca_pdf.pdf)

To minimize the uncertainty, a combination of multi-date Landsat Thematic Mapper (TM) with different years were used to detect urban detailed urban land-use (Turker and Asik, 2005) However, accurate and timely urban data would be difficult to obtain since the long-time processing and interpretation of certain [remote sensing](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/remote-sensing) images (Li and Li, 2019). Nighttime stable light data (NSL) could be another selection from much research. For example, Feng et al.( 2020) has used DMSP/OLS nighttime light data to identify fringe area. By detecting weak near–infrared radiation, It could be a good way to search urban spatial patterns, human activities and also recognize the ecological environment and other fields(Bennett and Smith, 2017). However, Zhang and Seto(2013) think only using nighttime data might accurately estimate spatial pattern in advanced countries but perform less accurate in developing economies. Considering this, spatial cluster analysis could be an improved method to the identification. Comminating the K–means algorithm and nighttime light data, it would be more likely to find more details related to urban–rural fringes when compared with the only indicator of nighttime data identification. Moreover, Peng et al. (2020a) also proposed a three-dimensional approach to integrating different analysis method including nighttime data and land use data. By applying cluster model of Self-Organizing Feature Map (SOFM) urban fringe area of Beijing were accurately identified. Apart from this, many interesting identification methods including wavelet transform method(Jing et al., 2016) and deep learning method (Guo et al., 2019) were tested by scholars worldwide.

The universal adoption of the 2030 agenda for [Sustainable Development](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/environmental-impact-assessment) which set out 17 [Sustainable Development Goals](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/sustainable-development-goals) and 169 targets, underpinned by 232 indicators is one major initiative towards the protection of the planet for current and future generations

Sustainable Development Goal 15 (SDG15) aims at “protecting, restoring and promoting sustainable use of [terrestrial ecosystems](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/terrestrial-ecosystem), sustainably manage forests, combat [desertification](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/desertification), and halt and reverse [land degradation](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/land-degradation) and biodiversity loss” (UN, 2015)

In 2015 the UNDP has formed certain global goals known as “Sustainable Development Goals”. The motto of the SDGs is “To provide a better future for everyone of the society”

生态保护存量发展会议文件解析

边缘区保护案例 英国 荷兰

国内边缘区 或者城市蔓延相关探索 广州 北京 杭州 上海或者规划文件

方法论

边缘区识别和应用 灯光 kmeans 城乡交错带

城市区域的识别因子 重组模式 组团模式之类

生态空间评价的因子 景观等等