

Spatial Patterns of Ecosystem Services in Response to Urbanization: Verifying the Hypothesis about the Relationships between Ecosystem Services and Urban-rural Gradient



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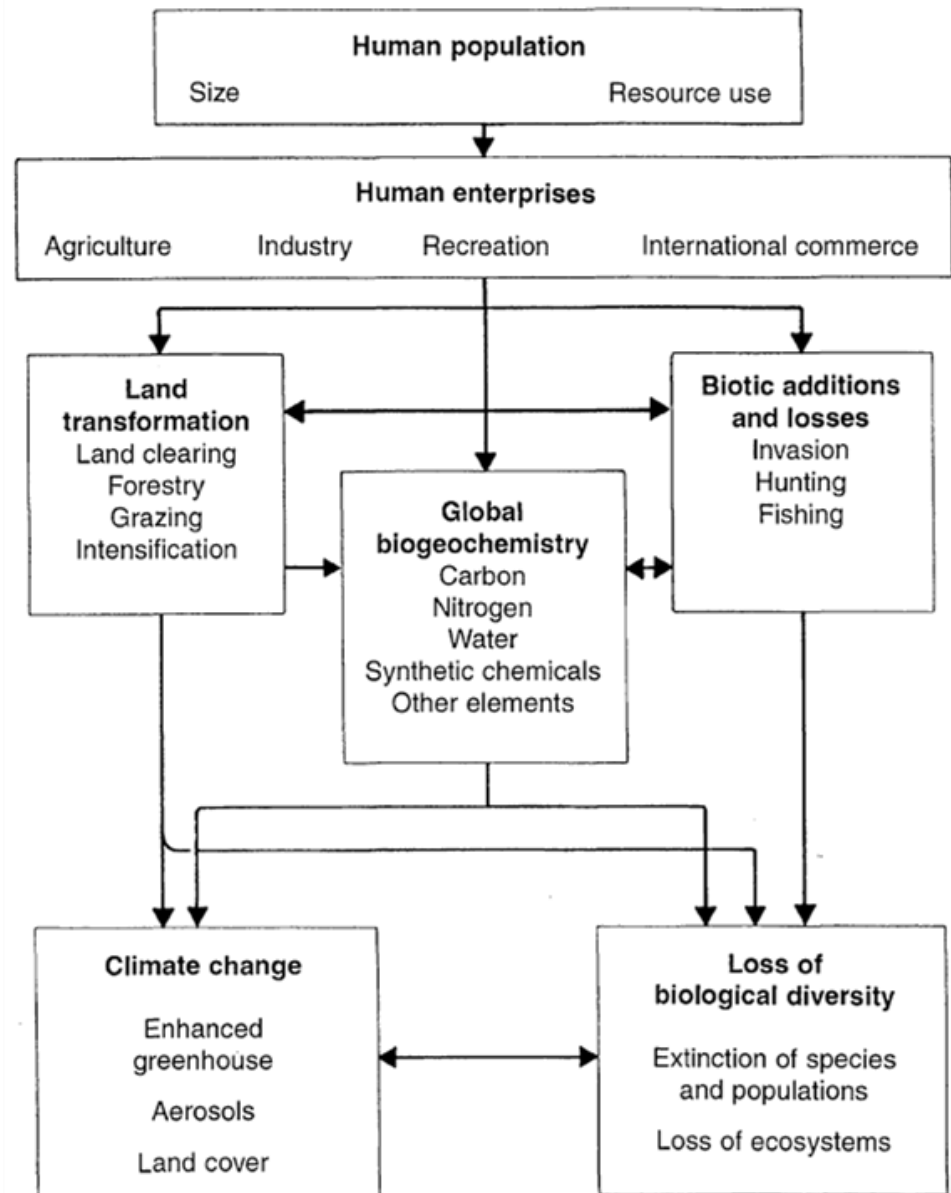
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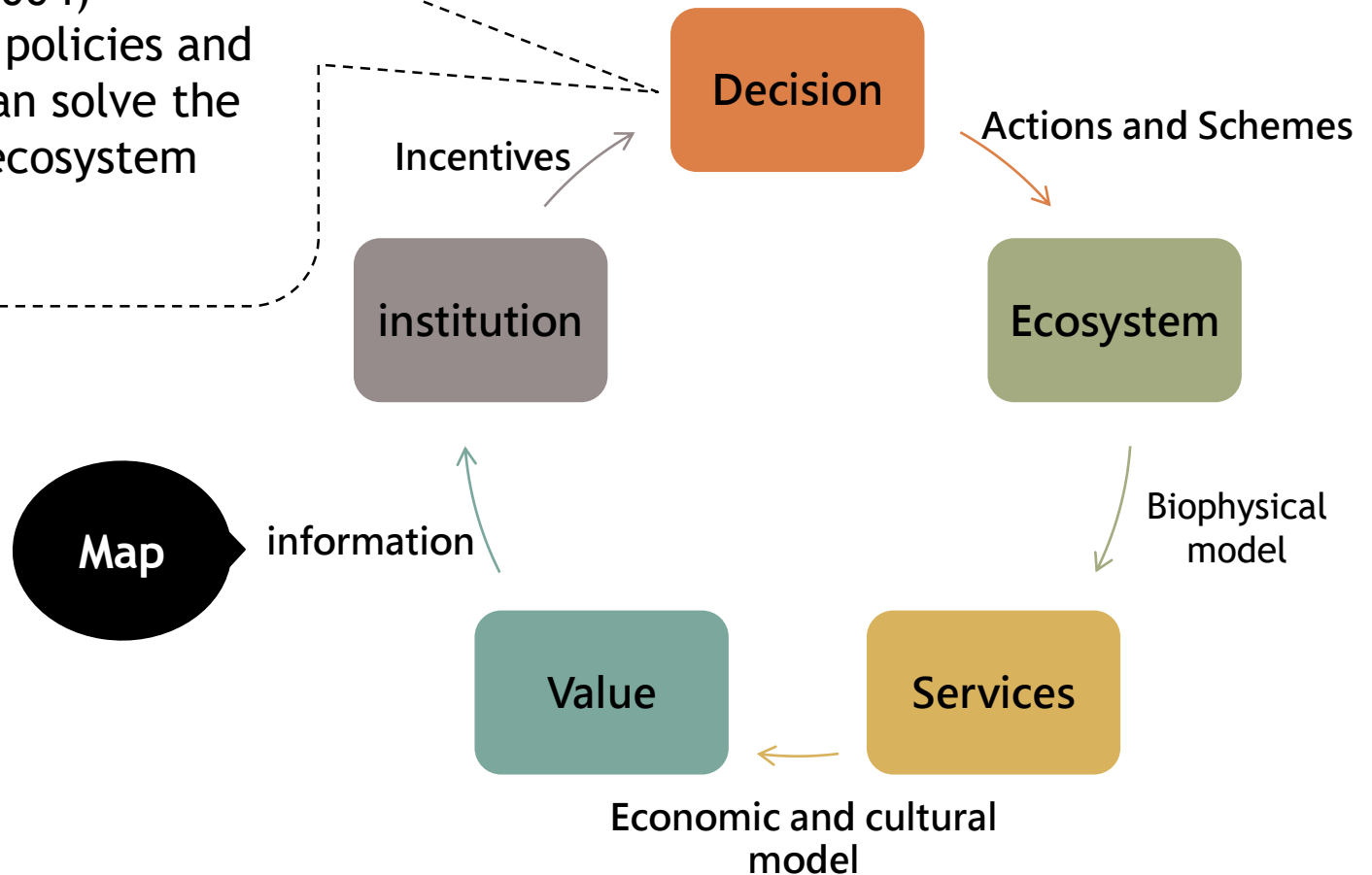
Background

- Growth of human population and human activities are the main factors to cause **irreversible losses of biological diversity** (Vitousek et al., 1997)
- The process of urbanization **transform land cover/ land use**, and directly or indirectly affect ecosystem functions (Foley et al., 2010).
- Activities in urban area have many **negative effects** on outer city, consume natural resource (food, water, climate regulation, recreation...etc.) providing by rural or natural area (Forman, 2008).



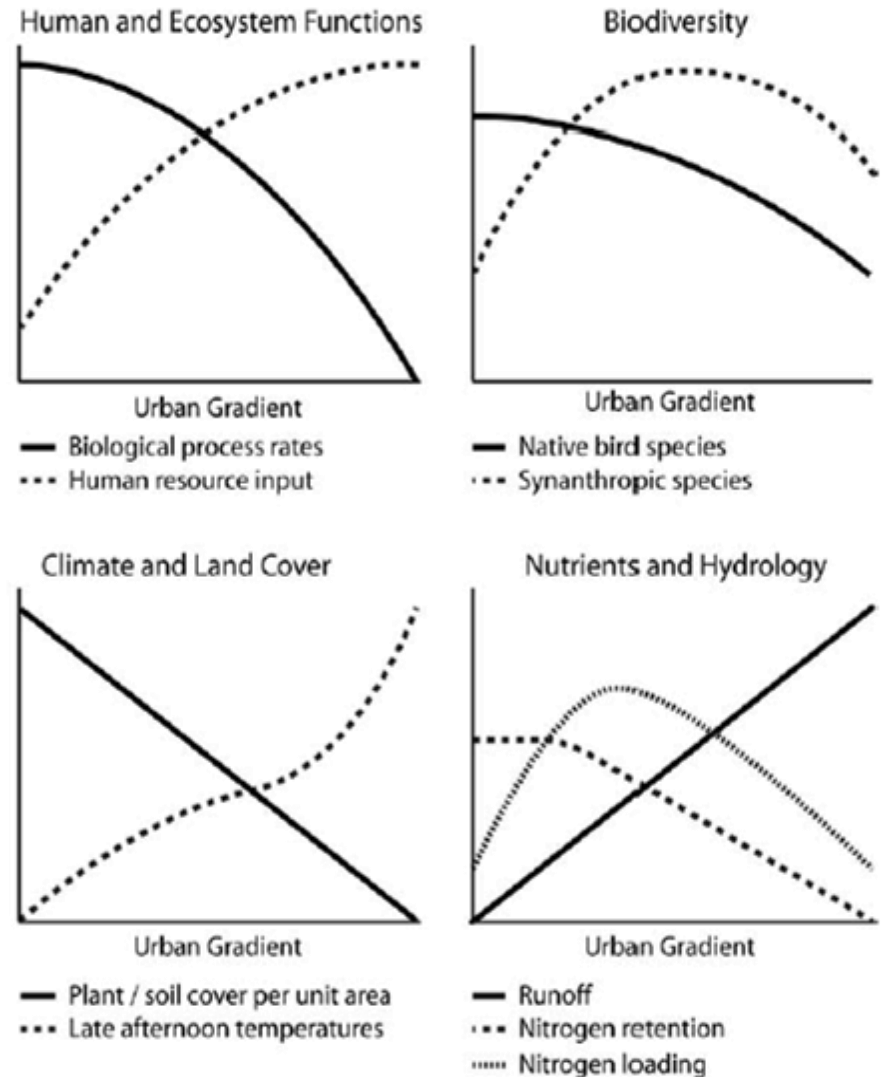
Background

Mooney et al. (2004) indicated sound policies and managements can solve the degradation of ecosystem services.



Background

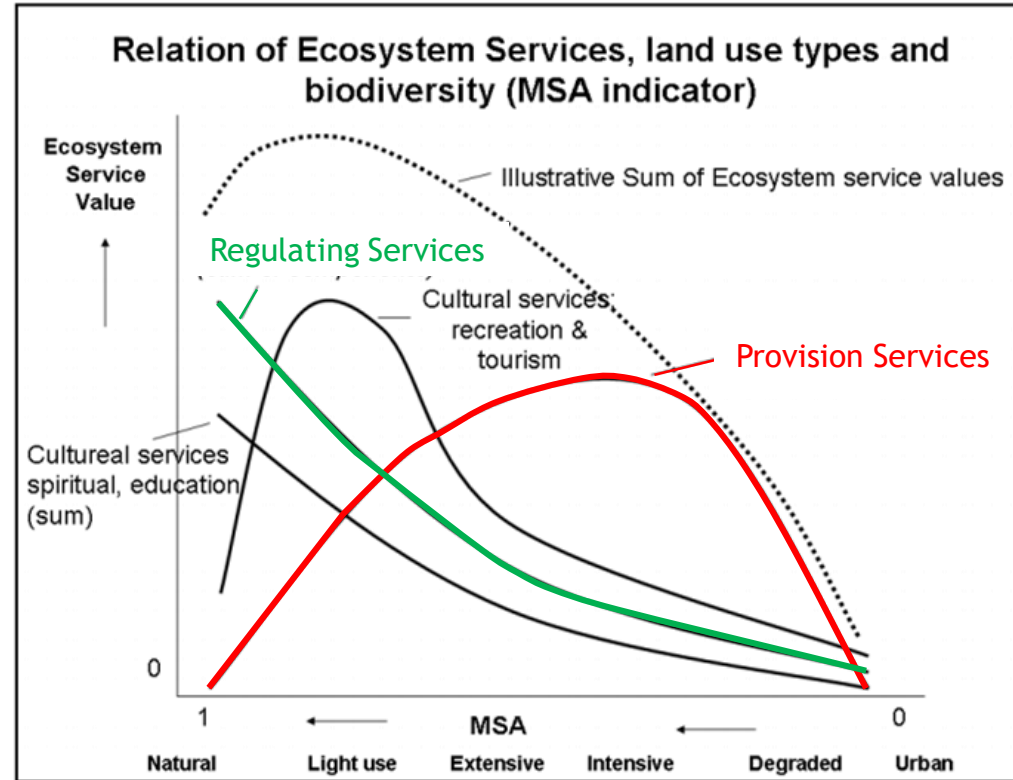
- Some scholars have raised important arguments about the relationship between urban gradient and ecosystem services (Braat and ten Brink, 2008; Alberti, 2009)
- Empirical studies have used gradient analysis to explore the relationship in many fields and regions.



Issues and Aims

■ Key Issue

- Previous studies have developed some methods for mapping ecosystem services, some well-known studies have developed formal hypotheses about the relationships between ecosystem services and urbanization. However, current empirical studies on the relationship are few.



Reference: Braat and ten Brink (2008)

■ Aims

1. To examine how urbanization affect the supply of ecosystem services in Tainan urban region.
2. To verify the hypotheses about the relationships between each ecosystem services and urbanization.

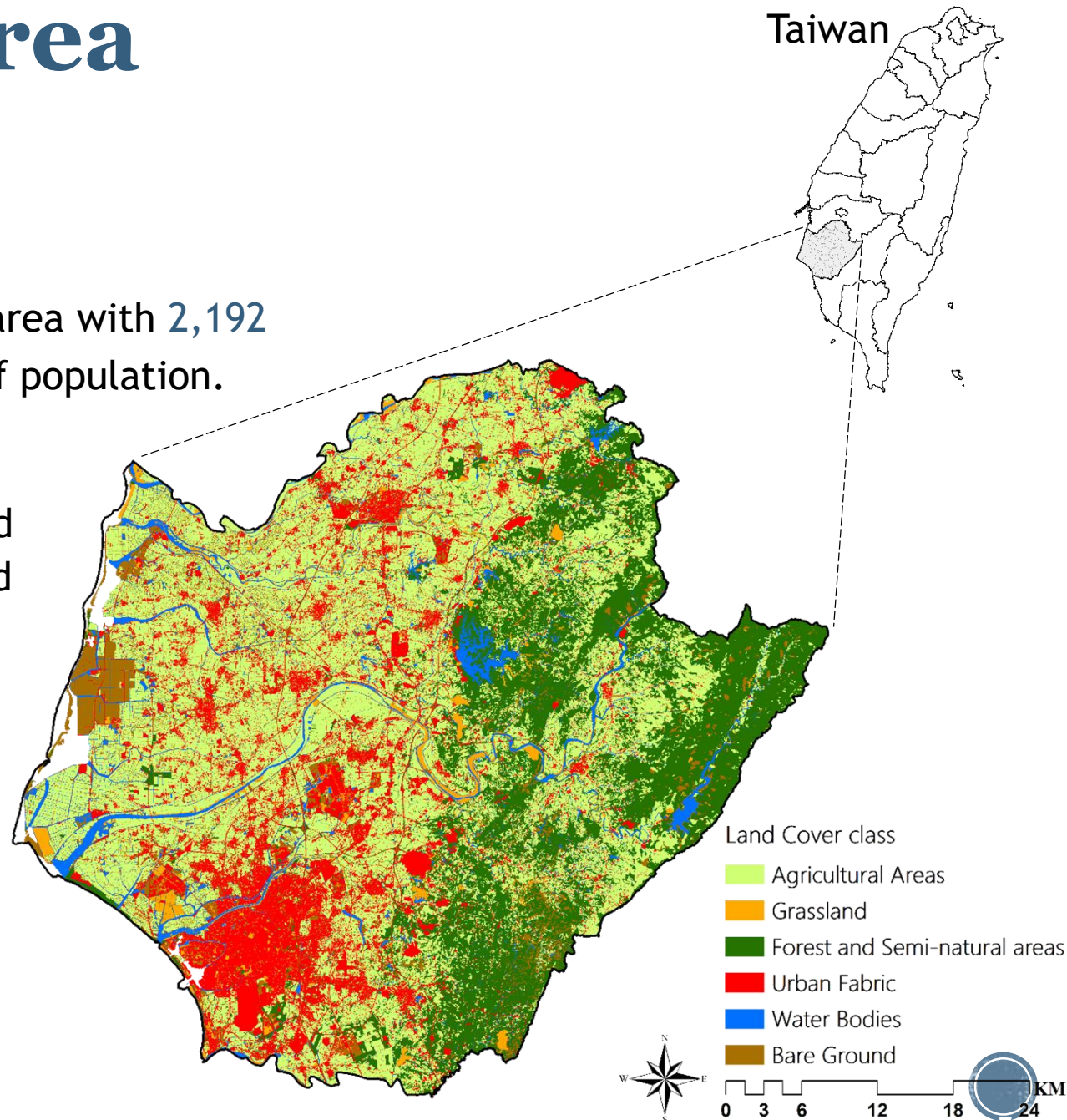
Study Area

■ Tainan City

- South-west of Taiwan
- The fifth largest city, area with 2,192 km² and 188 millions of population.

■ Land Cover

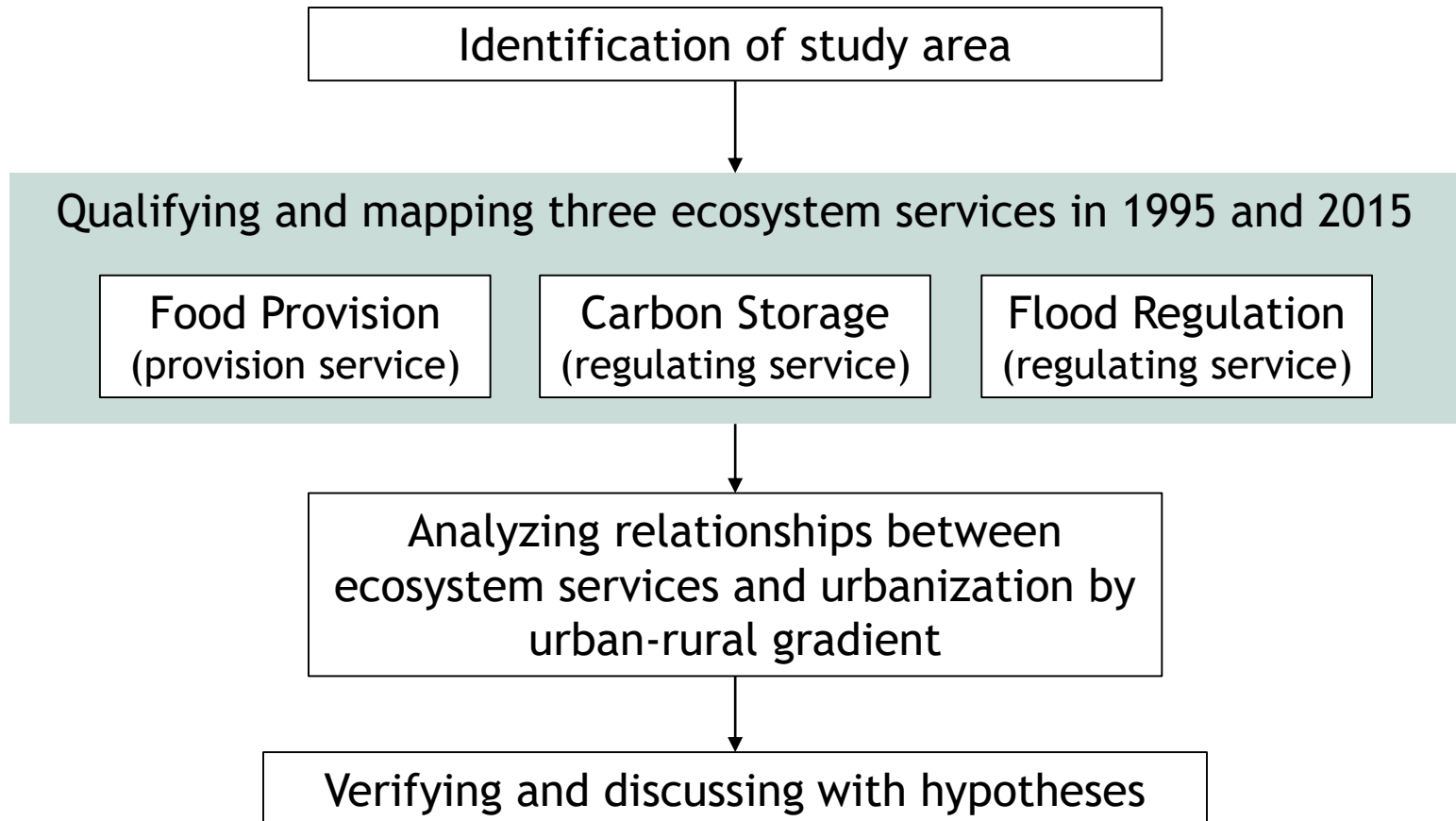
- Urban center is located at south-west side, and move gradually north-eastwards from there.
- Agricultural areas are the main landscape, accounting for around 50%
- Forest and mountains are located at east side.



Land cover of Tainan City in 2015

Methods

■ Research framework

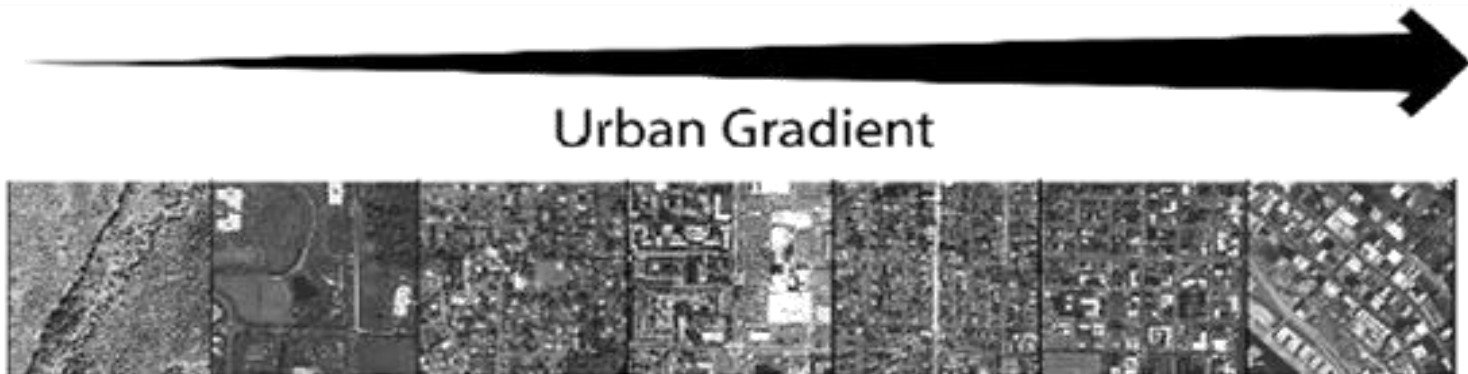


Methods

■ Urban-Rural Gradient indicator : degree of urbanization

$$P_{ur} = \frac{A_b}{A_{tv}}$$

- P_{ur} : the ratio of built area
- A_b : built area of each district
- A_{tv} : total area of each district

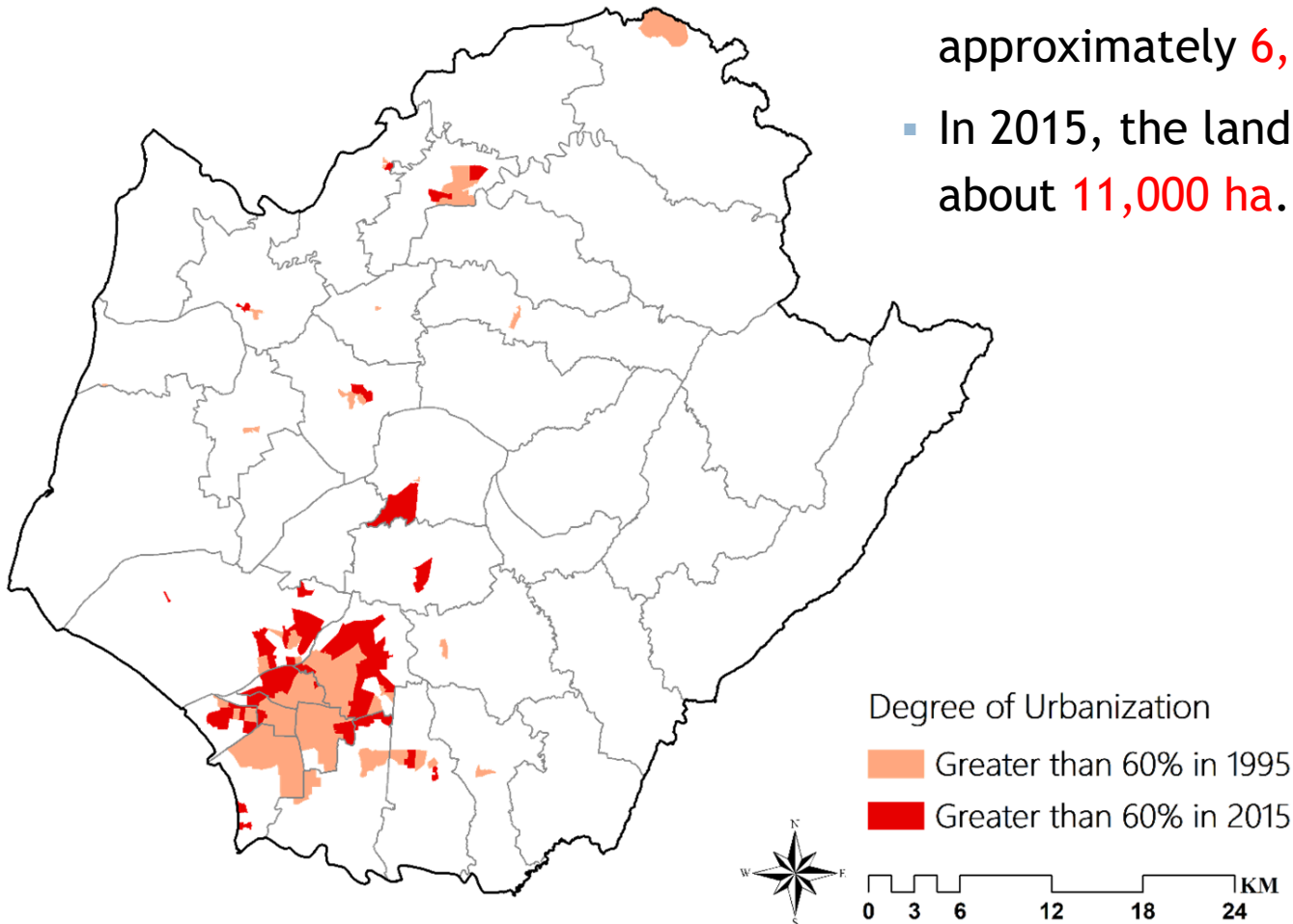


Reference: Alberti (2009)

Results and Discussion

■ Degree of Urbanisation

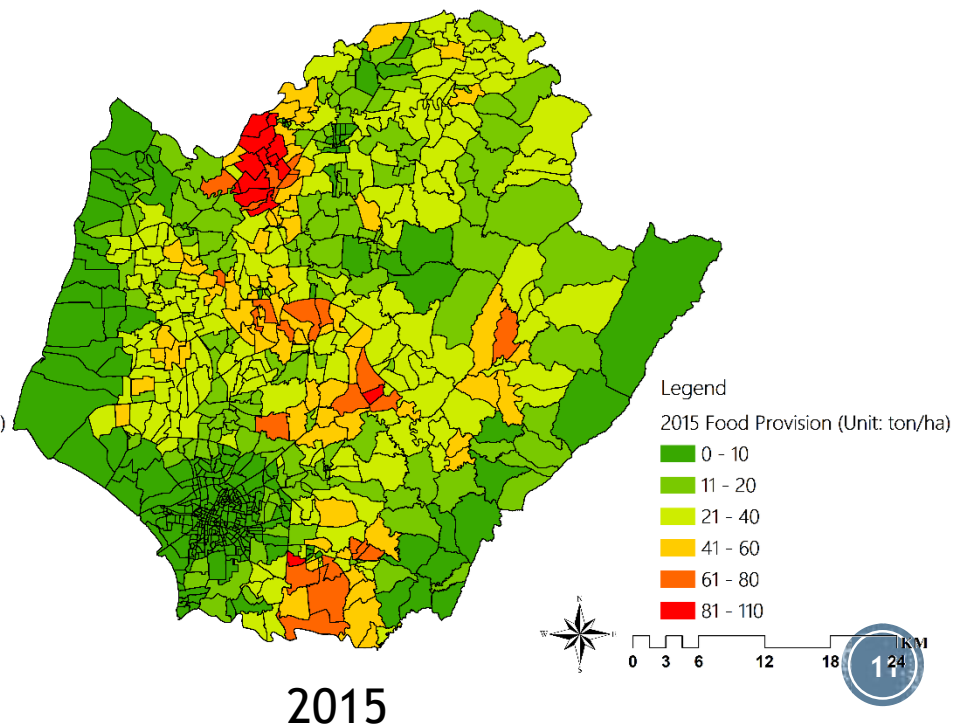
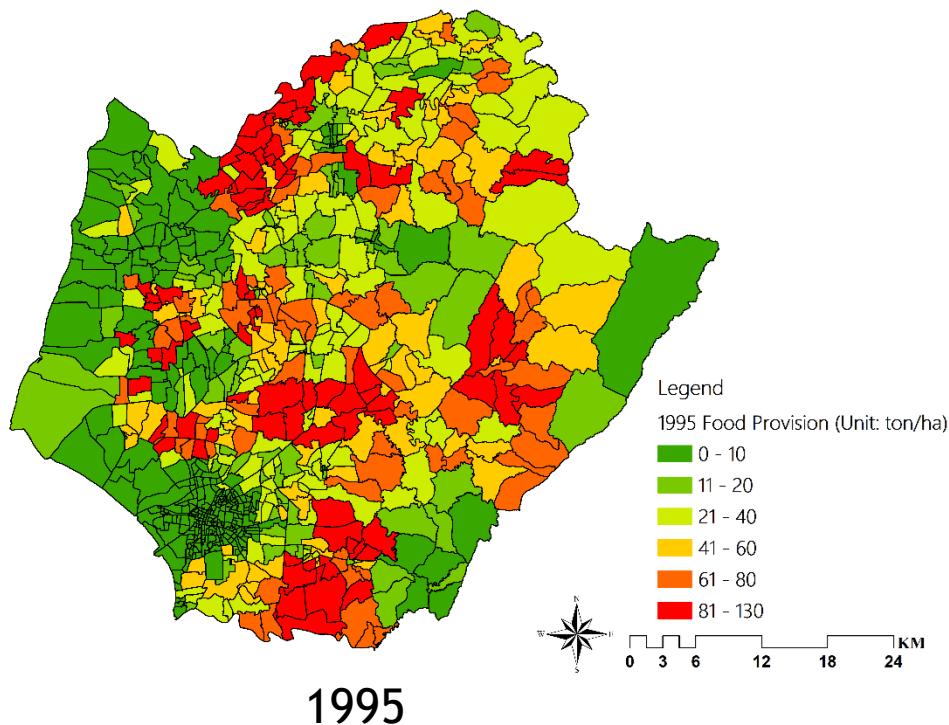
- In 1995, **area of the degree exceeding 60% of urbanization** that was approximately **6,500 ha.**
- In 2015, the land area reached at about **11,000 ha.**



Results and Discussion

■ Food Provision

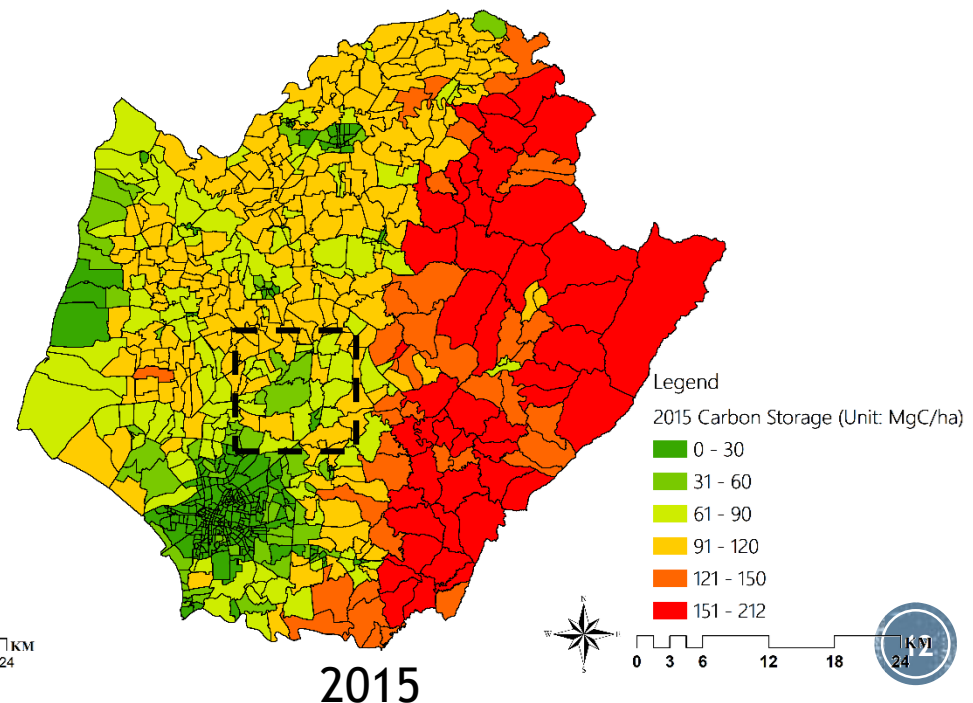
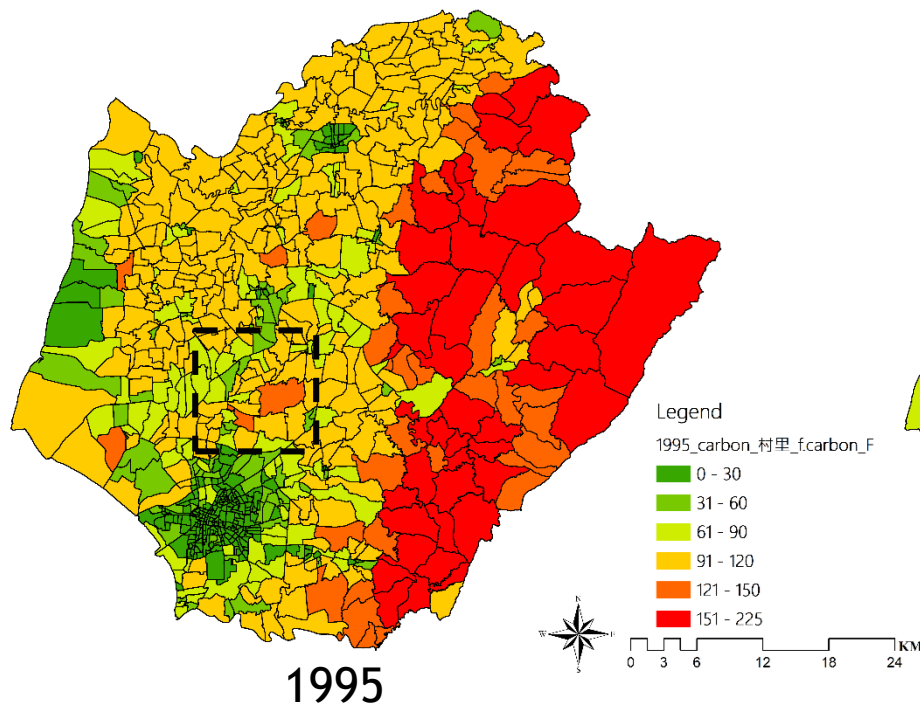
- The amount of food provision had a significant decrease between 1995 and 2015.
- Not only plain area can provide food production function, also hillside grow many fruit and crops that have high yield and economic value in Taiwan.



Results and Discussion

■ Carbon Storage

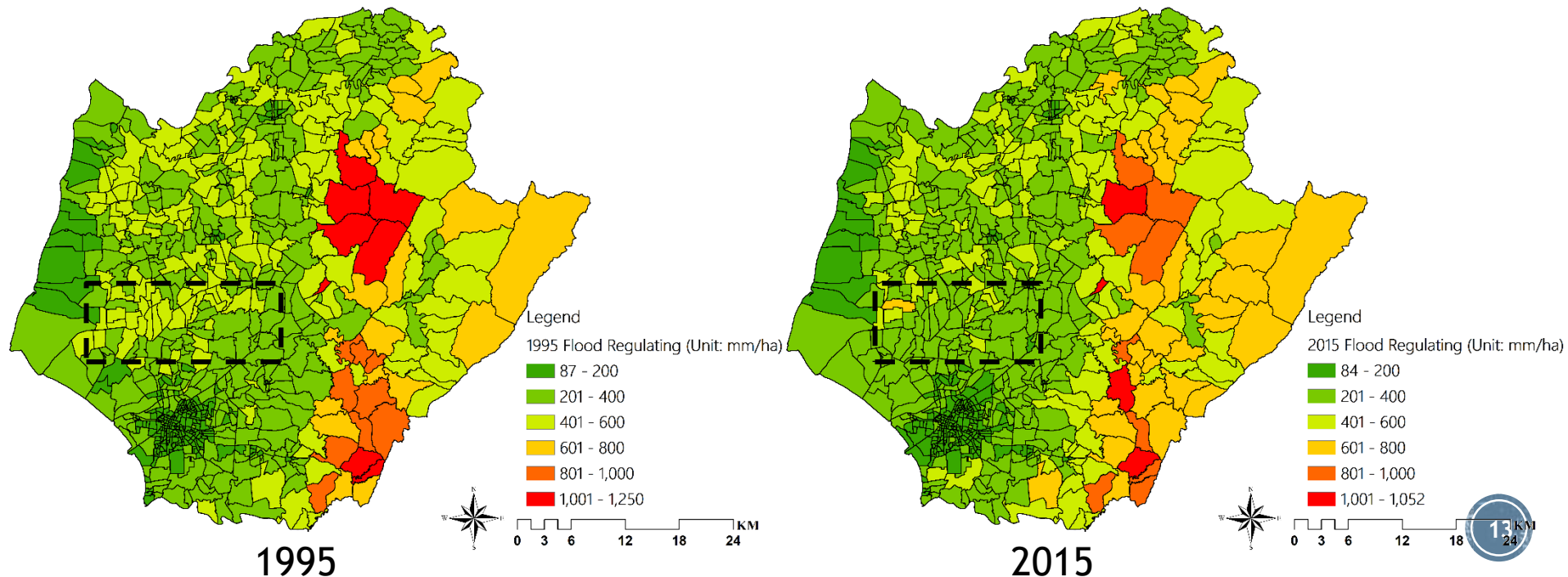
- In general, the results could reflect land cover types. For example, in east side of Tainan with forest area providing more carbon storage service.
- In plain area, the amount of carbon storage reduced slightly in the end of the time period.
- The spatial patterns of carbon storage really can respond to land use change, such as changed from agricultural land to built area.



Results and Discussion

■ Flood Regulation

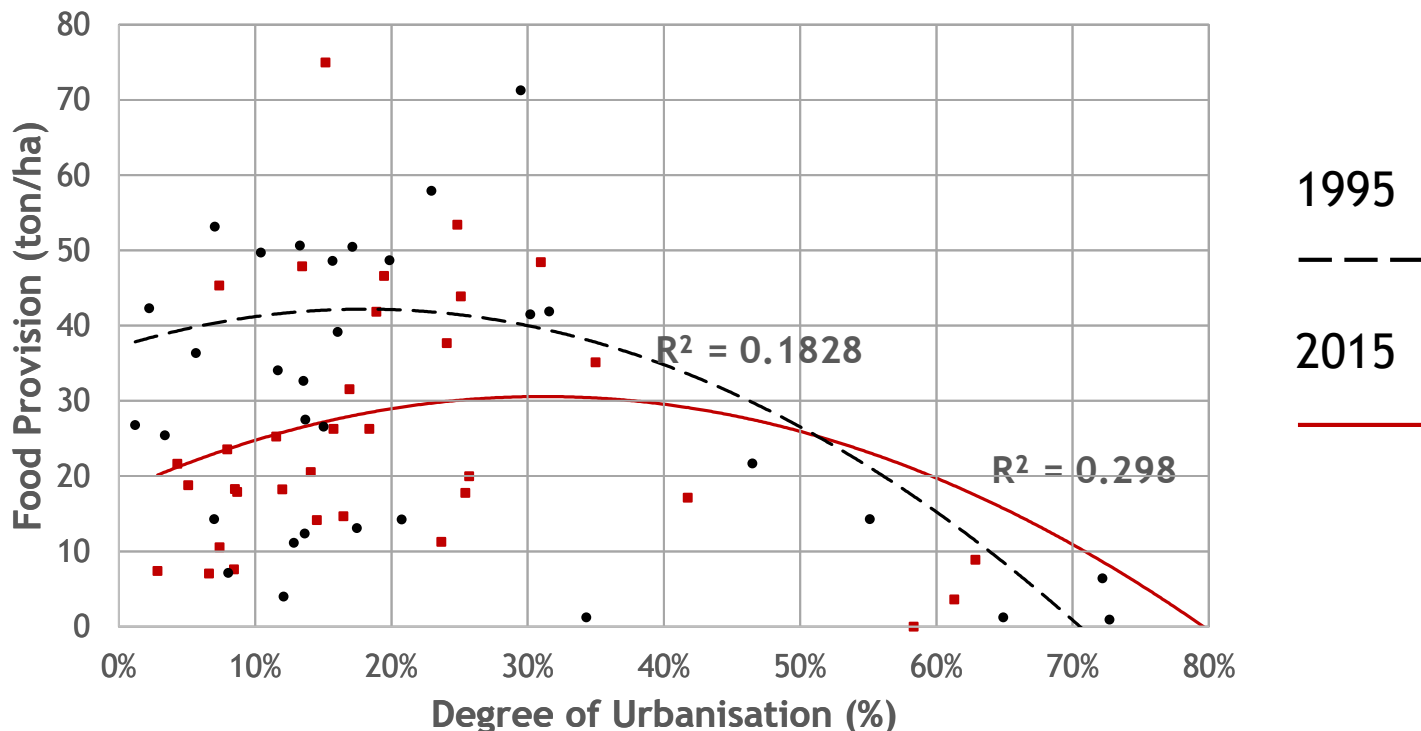
- Flood regulation also dropped a few amount between 1995 and 2015.
- At forest areas, in the east side of Tainan, they provide good flood regulation function, and the following is areas covering by agricultural land.
- However, urban area with high percentage of impervious pavement which cannot give good function for flood regulation.



Results and Discussion

■ Urban-Rural Gradient of Food Provision

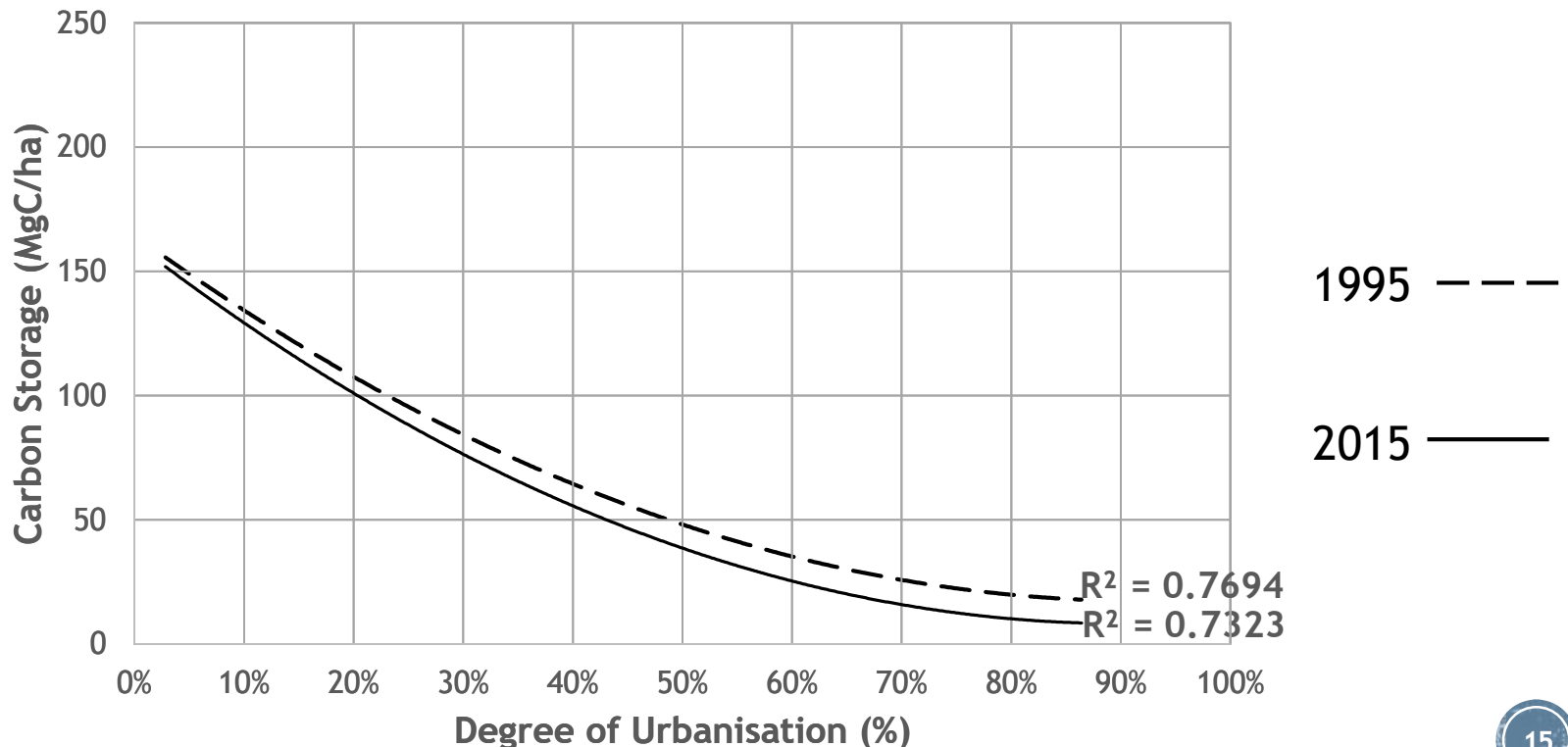
- The results skewed to the left which were different from the hypothesis (Braat and ten Brink, 2008).
- At the lower degree of urbanization in Tainan, 20% of 1995 and 30% of 2015, plain and hillside areas all can grow crops and yield higher production.
- The gradient curve of 2015 was lower than 1995, it can convey the production had a significant decrease between the two years.



Results and Discussion

■ Urban-Rural Gradient of Carbon Storage

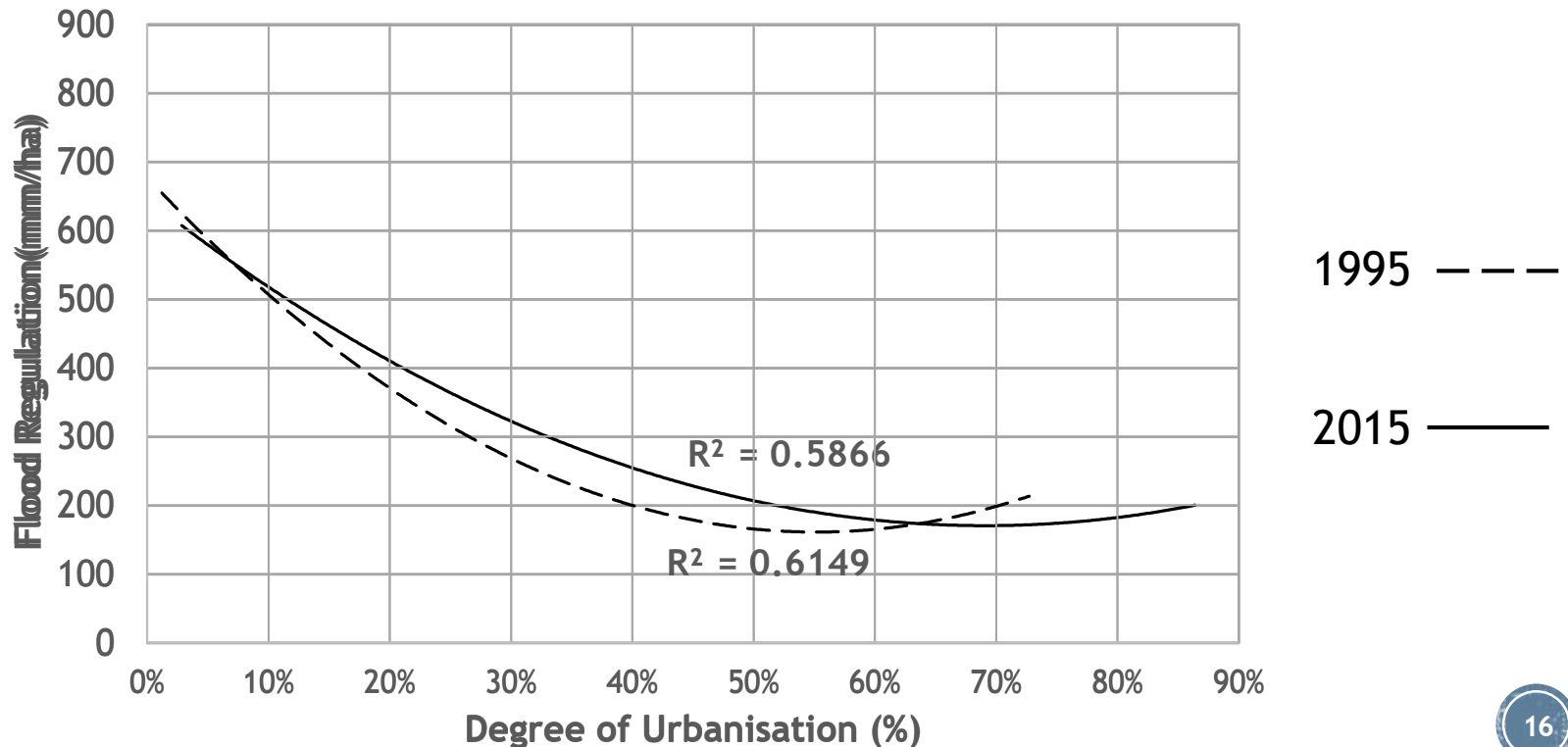
- Compared with the hypothesis (Braat and ten Brink, 2008), the pattern of carbon storage of the two years are **almost same with hypothesis**.
- The lines decreased progressively by urban-rural gradient.



Results and Discussion

■ Urban-Rural Gradient of Flood Regulation

- The trend of two lines have **high similarity** with the hypothesis(Braat and ten Brink, 2008).
- Due to Flood Regulation can also reflect land use change, so the two lines were same with carbon storage.



Conclusions

- With the research results, we can identify that urbanization and land cover change cause negative implications on ecosystem services, particularly reflect on regulating services (such as flood regulation or carbon storage).
- While food provision service is more related with terrain, production conditions, crop types, markets, transport..., there were no strong relationship with urbanization, so it was different from hypothesis.



Thank you very much.

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