Using GIS Network Analysis to Evaluate Spatial Accessibility and Equality of Green Space in Kunming, China
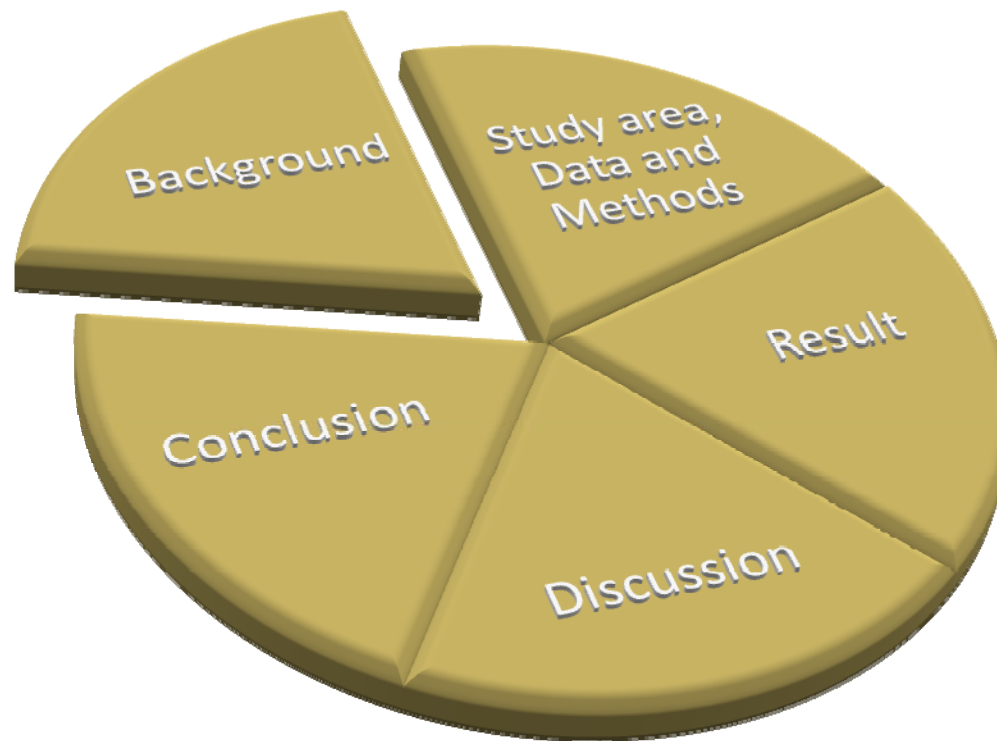
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[a] Department of Geography, National University of Singapore
[b] School of Resource and Environmental Science , Wuhan University

Principles of sustainable development

Concept: Meets the needs of the present without compromising the ability of future generations to meet their own needs. (Charles et al., 1998)

"Three E's" of Sustainability (Ahern, 2007)

Green space

Environmental well-being

Economic Development

Social Equality

Air Purification

Biodiversity conservation

Urban Climate Regulation

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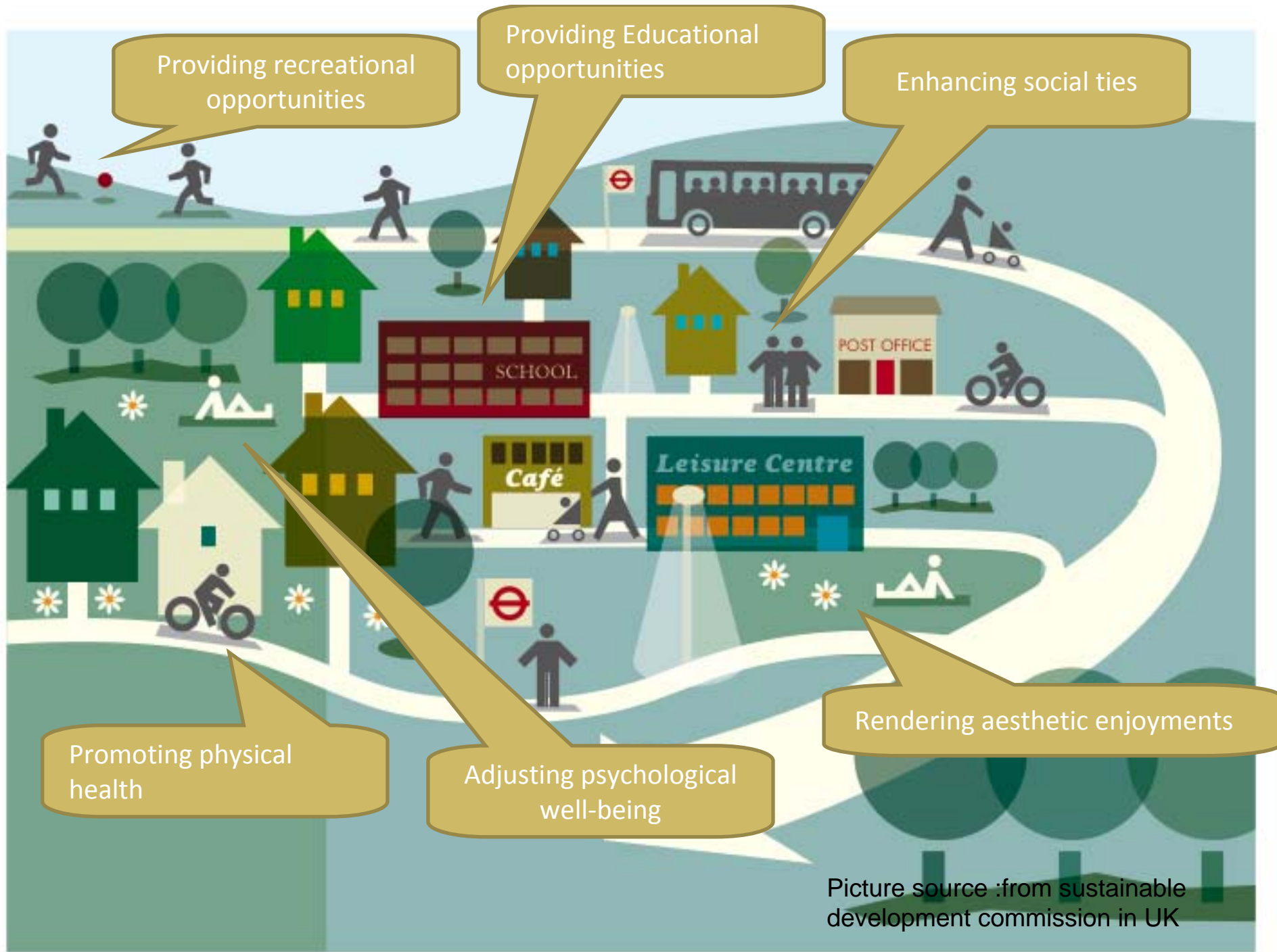
Increasing in land value

Promoting tourism

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Social functions of green space

Playgrounds

Scientific studies
Self concentration

Providing recreational opportunities

Rendering aesthetic enjoyments

Providing Educational opportunities

Green Space

Enhancing social ties

Promoting physical health

Adjusting psychological well-being

Attractive appearance

Euphonious sound

Fragrant smell

Physical activity in the agreeable environment

Social contacts
Communications

Psychological restorative
Emotional relief

Stress reducer

Adapted from sustainable development commission in UK

Picture source : from sustainable development commission in UK

Problems in urban green spaces

Pressure
- Growing number of urban population
- Fast rate of urban sprawl
- Pursuit of immediate economic yield

Problem
- Fragmentation
- Disproportionately distribution
- Abundant in suburb but scant in the city center

Implication
- Urban environment
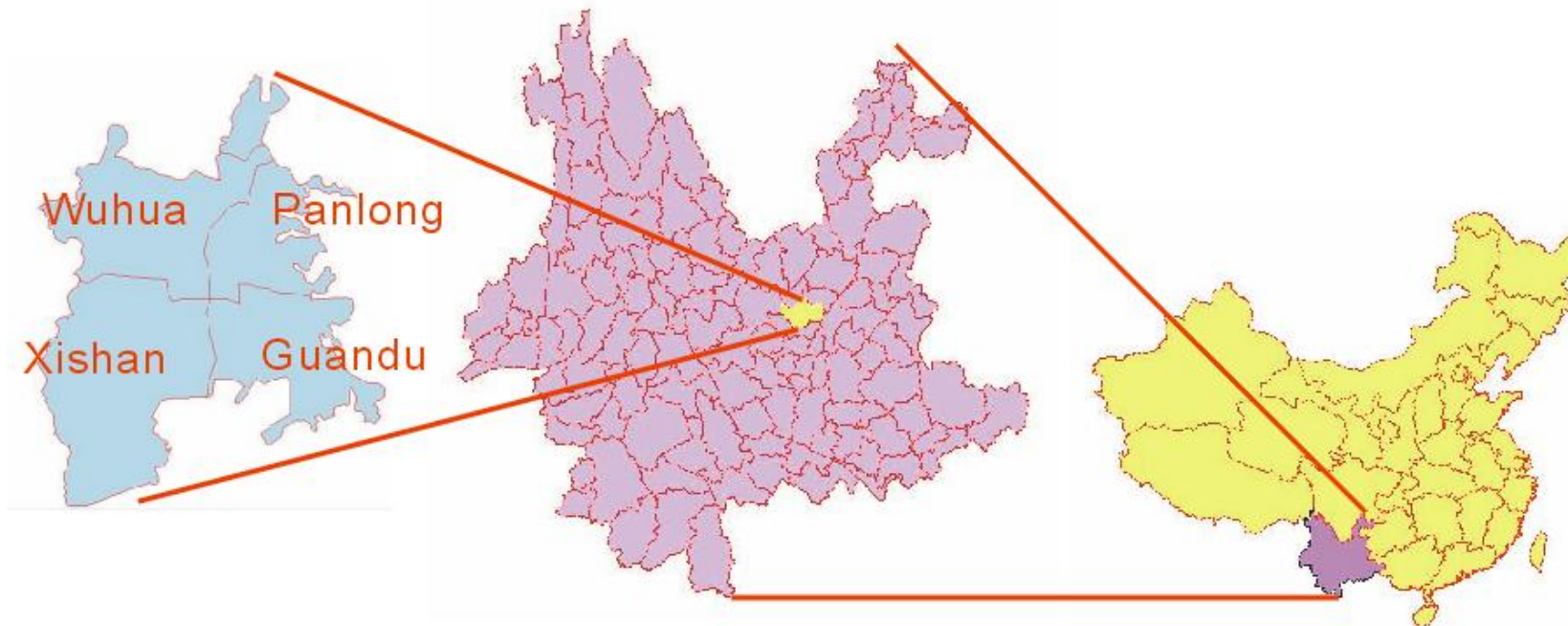- Spatial equality
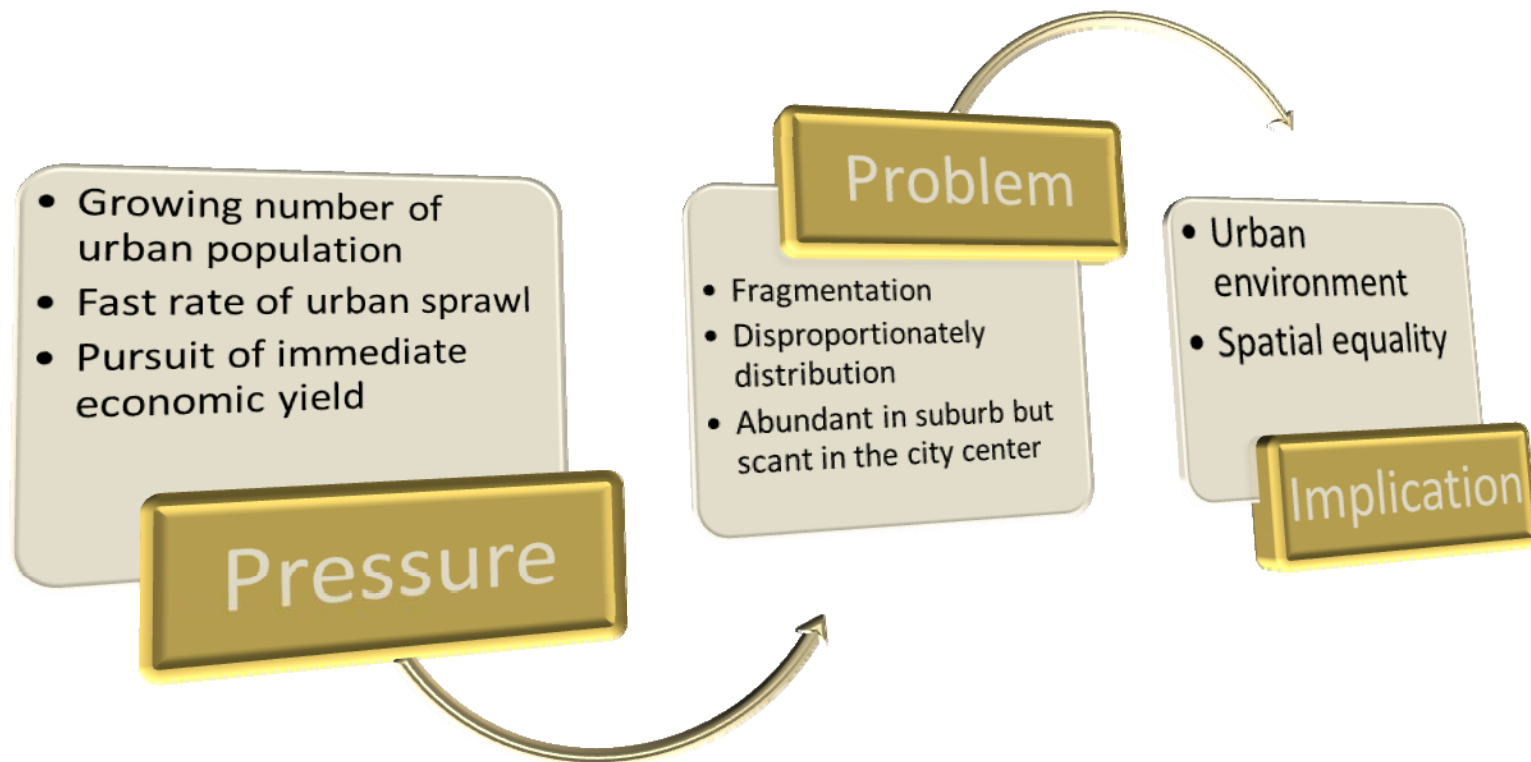
Accessibility

The ease extent to which one place may be reached from other places under a certain travel model (Liu & Zhu, 2004)

Picture source :from sustainable development commission in UK

Study Area

Why do we select Kunming as the study area?
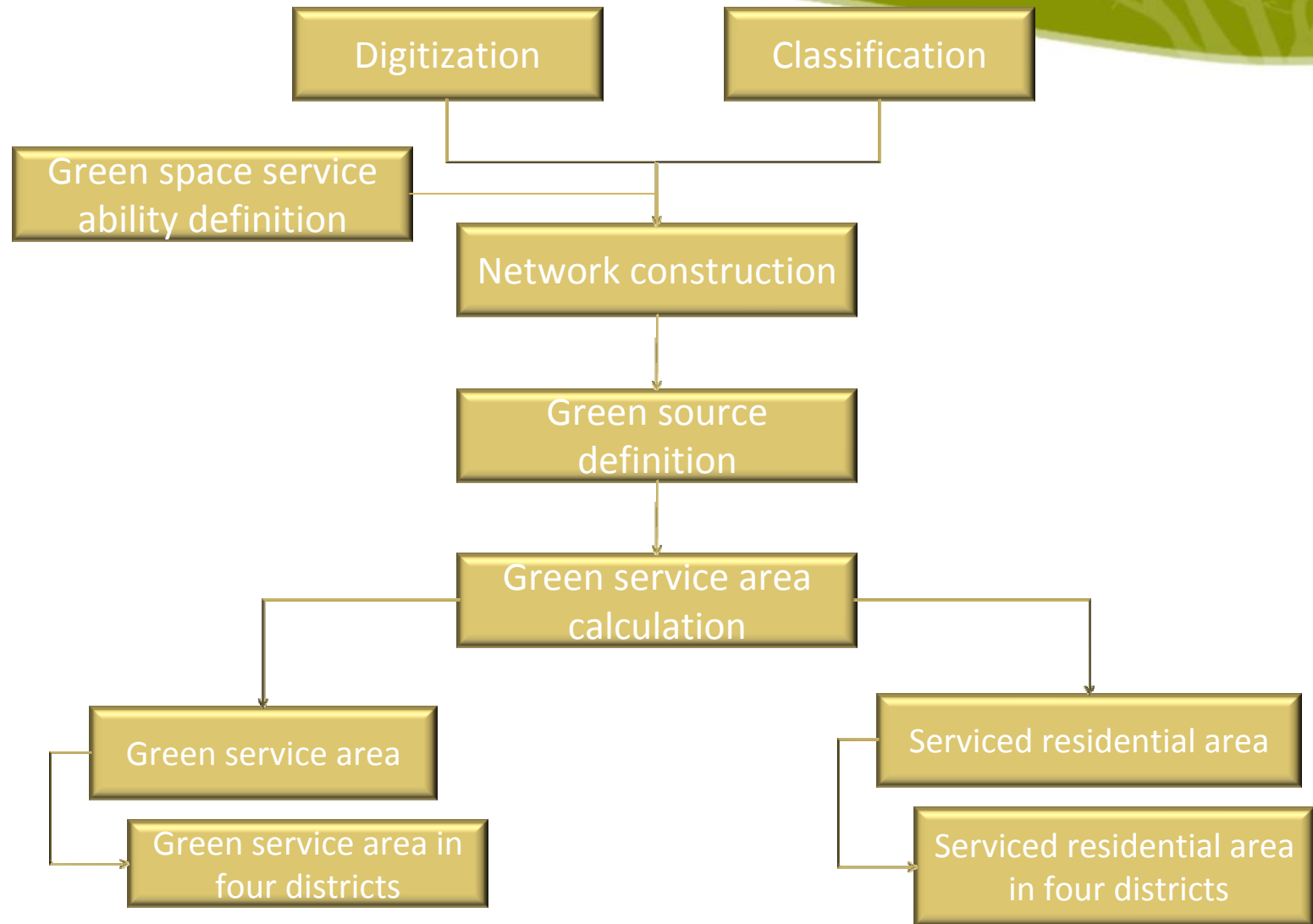a.Ecological City
b.Improvement in Green Space

Data

Planning Maps

- Map of green space distribution in the early month of 2009
- Planned green space map by the end of 2010
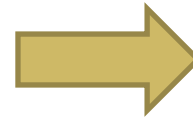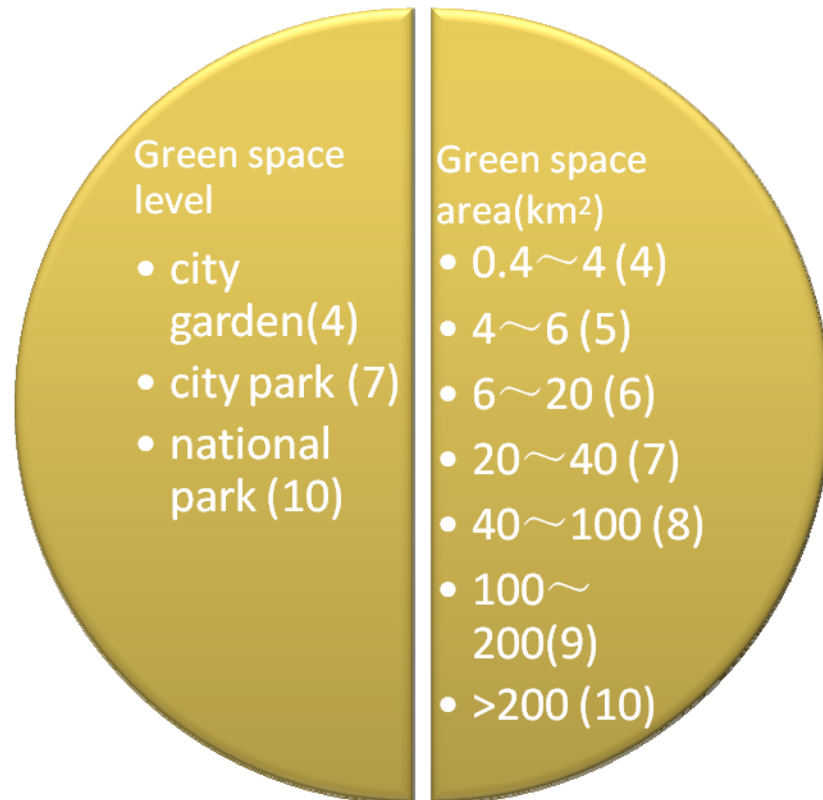- Land use map in 2006
- Transportation map in 2006

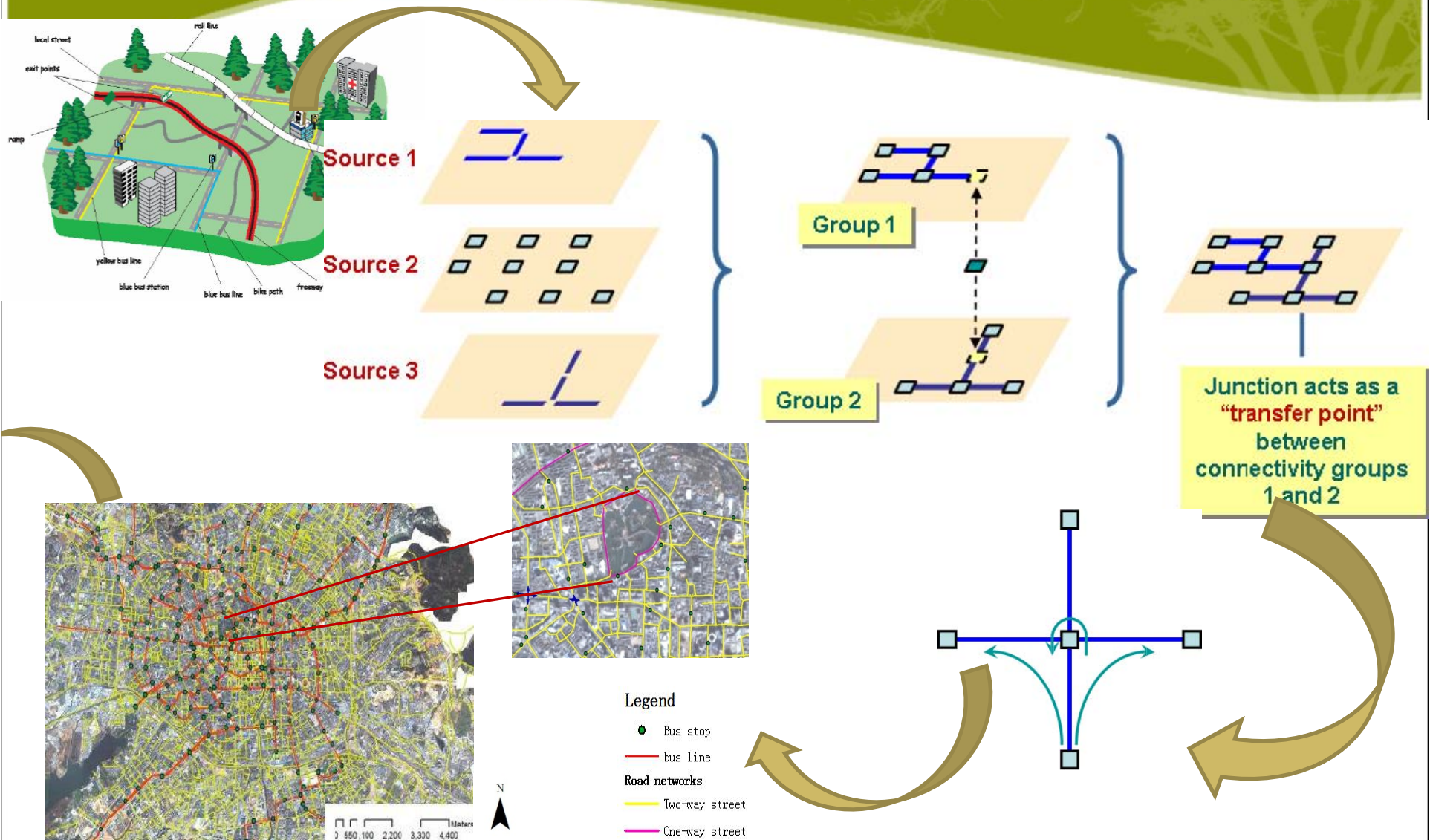## Quickbird Image

Google Earth Images

Methods

Digitization

Classification

Green space service ability definition

Network construction

Green source definition

Green service area calculation

Green service area

Green service area in four districts

Serviced residential area

Serviced residential area in four districts

Define green space service ability

Green space level
- city garden(4)
- city park (7)
- national park (10)

Green space area(km²)
- 0.4～4 (4)
- 4～6 (5)
- 6～20 (6)
- 20～40 (7)
- 40～100 (8)
- 100～200(9)
- >200 (10)

Area(50 %)	Level(50%)	Service ability
4	7	5.5
7	8	7.5
4	6	5
…	…	…

Network construction

Source 1

Source 2

Source 3

Group 1

Group 2

Junction acts as a "transfer point" between connectivity groups 1 and 2

Legend

- Bus stop
- bus line

Road networks
- Two-way street
- One-way street

Picture source :Networks analysis, Yang, K.C.

Legend

- Green Sources
- Pedestrian Service
- Transportation Ser
- Bus Line
- Road Networks

Meters
0 360 720   1,440   2,160   2,880

Background

Study area,Data and Methods

Result

Discussion

Conclusion
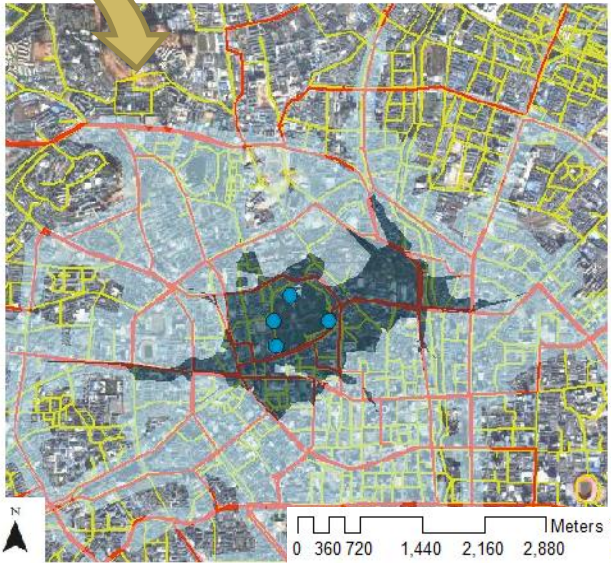
Service Area and Service Ability

Green Service Area and Ability in Two Years
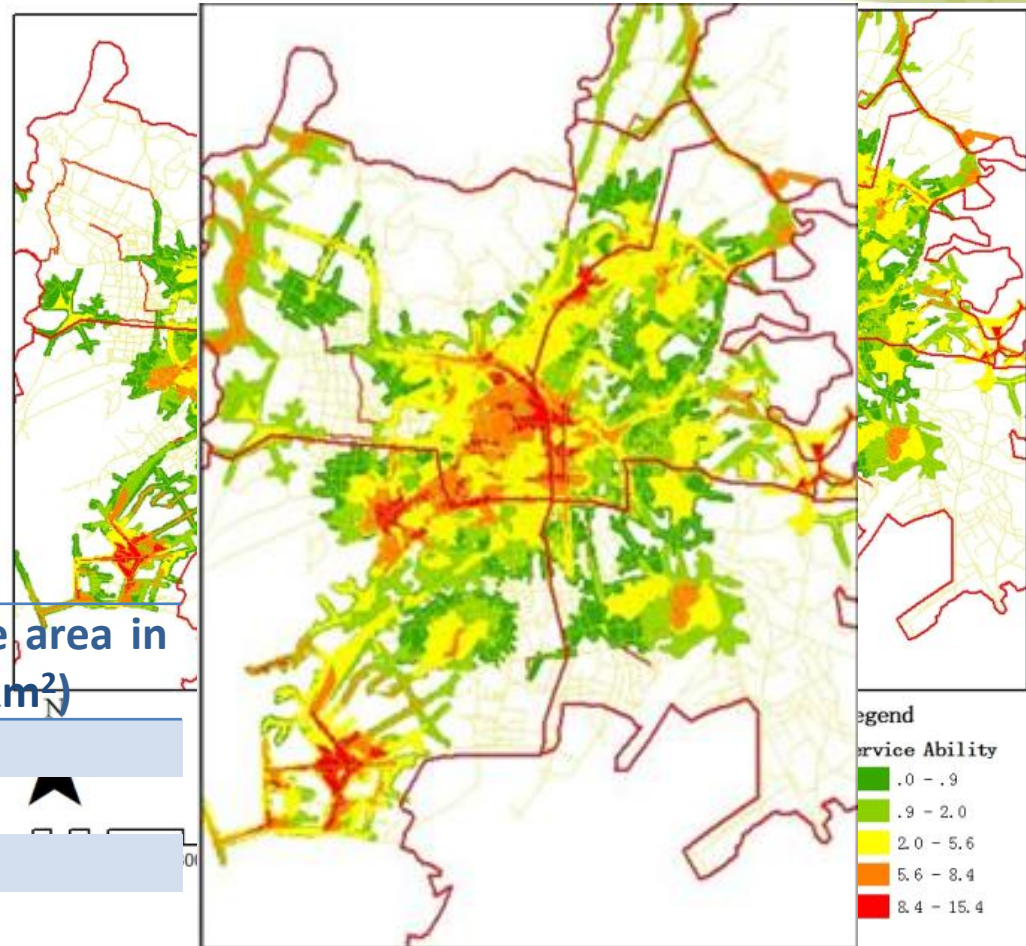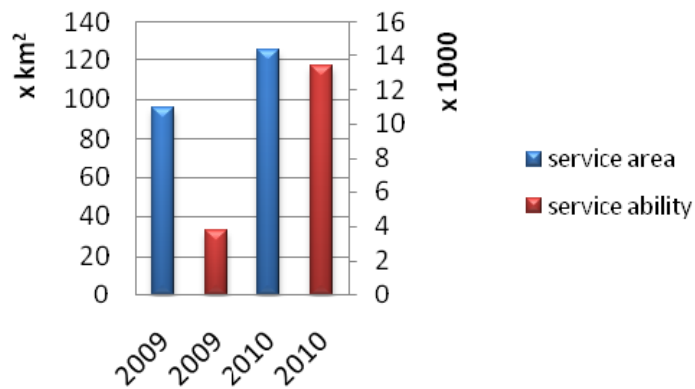
District	Service area in 2009(km²)	Service area in 2010(km²)
Wuhua	22.55	37.17
Panlong	20.88	29.19
Xishan	31.10	41.87
Guandu	16.94	20.15

Legend
Service Ability
.0 - .9
.9 - 2.0
2.0 - 5.6
5.6 - 8.4
8.4 - 15.4

Green covered residential area and green service ability
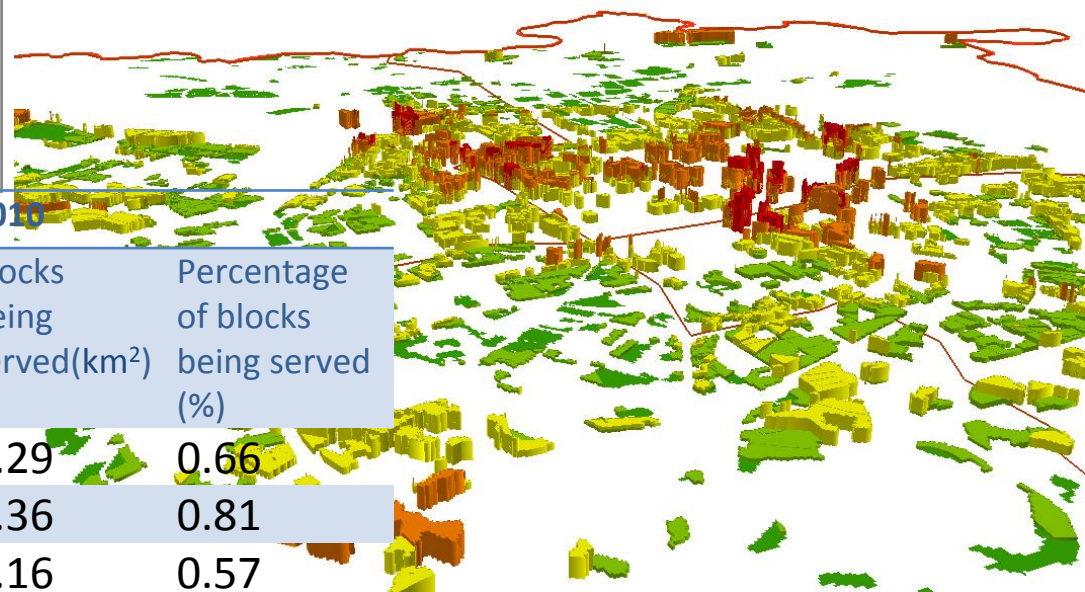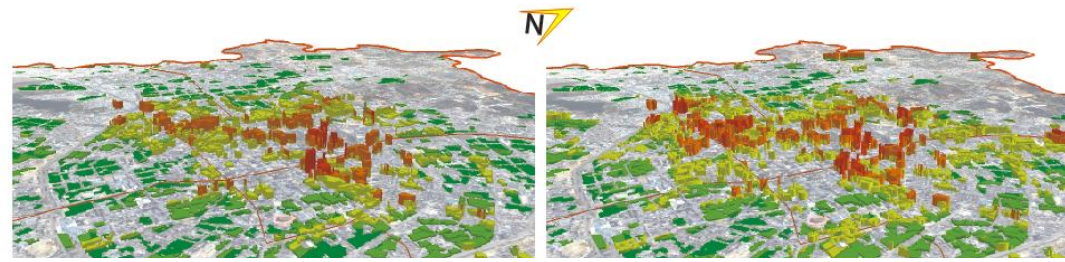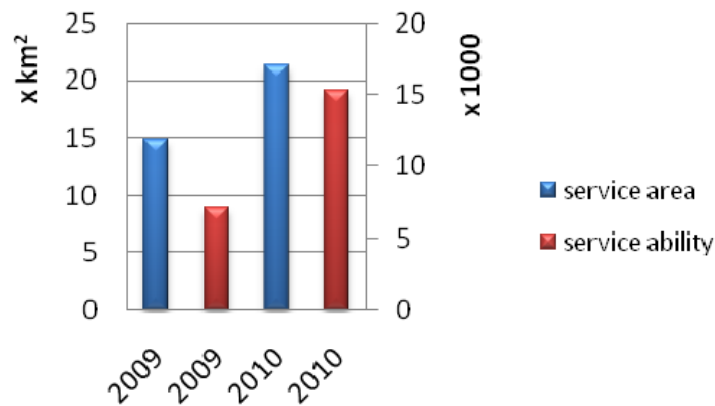
District	2009		2010	
	Blocks being served (km²)	Percentage of blocks being served (%)	Blocks being served(km²)	Percentage of blocks being served (%)
Wuhua	4.51	0.47	6.29	0.66
Panlong	3.85	0.58	5.36	0.81
Xishan	3.74	0.34	6.16	0.57
Guandu	1.82	0.41	2.51	0.57

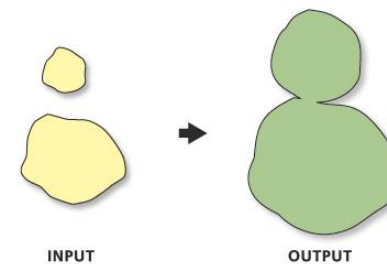- Improvements and defects in green space accessibility and service ability

- # Accessibility measurements
  - Buffer methods
  - Raster-based impedance model
  - Gravity-based model

INPUT   OUTPUT

Picture source: ArcGIS 9.2 Desktop Help

- # GIS in accessibility network analysis
  - Ability to simulate road networks
  - Accurate calculation of shortest route
  - Explicit expression of distance decay
  - Easy definition of the source attractiveness

Residence

Route

Green source

Residence

Green source

$$F_{ij} = G\frac{M_i M_j}{D_{ij}}$$
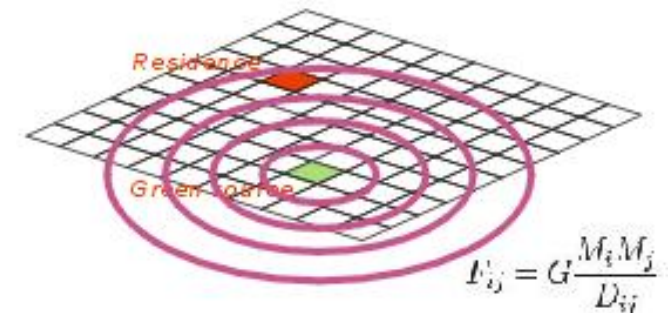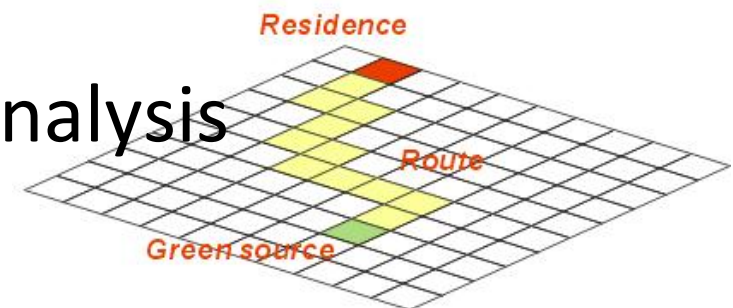
- # Further studies

  – Accessibility analysis combined with field survey to define service ability and to classify green space

  – Complete green space system

- This study explored the accessibility to green space in two time periods in Kunming. It found that the accessibility to green space will be conspicuously improved in 2010 Master Plan.

- There are still some communities are not well covered by green space service, the spatial equality cannot be put as perfect.

- GIS based accessibility analysis is a valuable means to measure the green space accessibility ,and therefore, viewed from an extensive perspective, it is also an important standard to measure the spatial equality.

Thanks