

MORPHOLOGICAL APPROACH TO CHINESE URBAN SUSTAINABILITY

中国可持续性发展城市的形态学方法

Science and Design informing Sustainability in High-density Cities

关于高密度城市可持续性发展的科学和设计

- **The Project 项目**
- **The Building Scale : the Eco Home in Shanghai**
建筑规模: 上海沪上生态家
- **From Green Buildings to Eco Districts**
从绿色建筑到生态小区
- **Global Study of Urban Morphologies**
城市形态的研究
- **Assessing Urban Forms 城市形态评估**

■ **The Project 项目**

□ The Building Scale : the Eco Home in Shanghai

□ From Green Buildings to Eco Districts

□ Global Study of Urban Morphologies

□ Assessing Urban Forms

Chinese eco-cities and sustainable buildings of the future

中国生态城市和未来可持续发展建筑

The CSTB project is mainly financed by a FASEP fund (administered by the DGTresor, French Ministry of Economy).

法国建筑科学技术中心（CSTB）项目由FASEP基金提供资金（该基金专门用于由法国经济部的巴黎财税及经济政策总署(DGTresor)领导的私人领域的研究.）



It aims at creating synergies between innovative French firms, which have until now offered separate systems and products, in order to build sustainable buildings and cities.

项目旨在协调为中国提供了建筑系统和产品的法国企业，以建造可持续发展的建筑和城市。

The CSTB (French Scientific and Technical Construction Center) brought its scientific and technical expertise to develop concepts and guidelines to build eco-cities and sustainable buildings, as a support of an integrated offer of systems and products.

法国建筑科学技术中心（CSTB）将其科技经验带入到生态城市和可持续发展建筑的概念和指导原则中，为整体化系统和产品服务提供了有力的支持。

The Partners in France 在法国的合作伙伴





□ The Project

■ **The Building Scale : the Eco Home in Shanghai** 建筑规模: 沪上生态家

□ From Green Buildings to Eco Districts

□ Global Study of Urban Morphologies

□ Assessing Urban Forms

The Eco Home project 项目

The project has been done in cooperation with the SRIBS, CSTB's counterpart in Shanghai. CSTB has contributed to the conception of the Ecohome Pavilion.

该项目和上海建筑科学研究院合作进行，它是在上海的和法国建筑科学技术中心同类型的机构。法国建筑科学技术中心为沪上生态家的设计和建造做出了贡献。

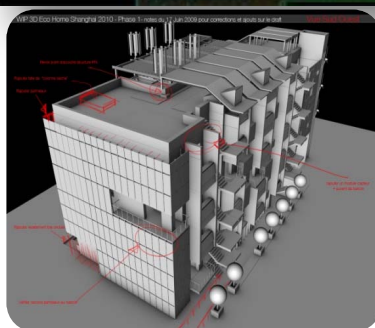


The Eco Home project 项目

Built by the SRIBS (Shanghai Research Institute of Building Sciences), it is a prototype of the perfect sustainable building, aiming at being reproduced in the whole China after the expo. Being the only Chinese building of this type, its influence goes past the city of Shanghai.

沪上生态家由上海市建筑科学研究院（SRIBS）**技术支持**，是理想的可持续建筑的原型，计划在世博会后向全国推广。作为中国唯一此种类型的建筑，其影响范围超越了上海市。

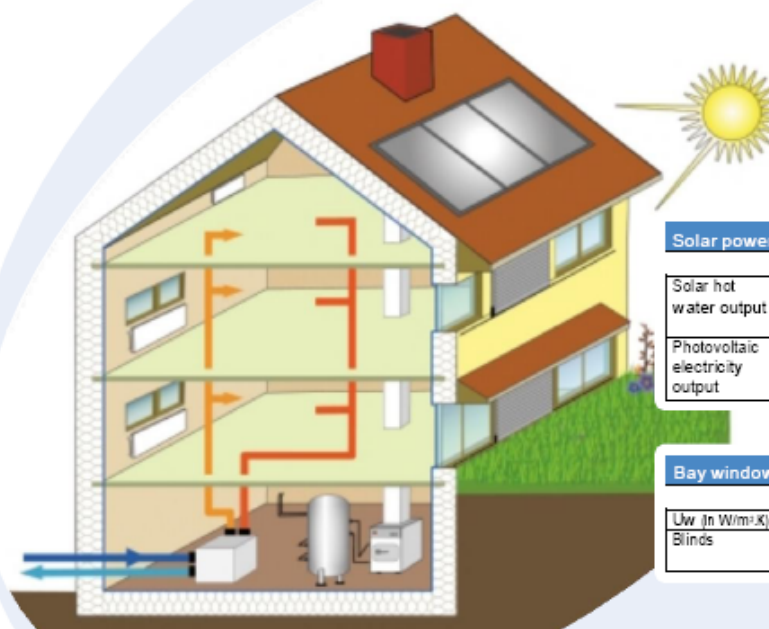




Several common solutions and performances in effinergie projects

Architectural design		
	effinergie	RT 2005
Compactness	Recommended	Not taken into account
South exposure	Recommended	To consider
Summer comfort control	Required	Often necessary

Insulation of opaque walls		
	effinergie	RT 2005
R Roof (in m ² .K/W)	6,5 to 10	4 to 6
R Wall (in m ² .K/W)	3,2 to 5,5	2,2 to 3,2
R Floor upon a platform of earth (in m ² .K/W)	2,4 to 4	1,7 to 2,9
R Floor upon crawl space (in m ² .K/W)	3,4 to 5	2,4 to 4
Thermal bridges	Very low	Medium to low



Solar power		
	effinergie	RT 2005
Solar hot water output	Recommended	To consider
Photovoltaic electricity output	To consider	Rare

Bay windows		
	effinergie	RT 2005
Uw (in W/m ² .K)	1,7 to 0,7	2 to 1,6
Blinds	Required	Often necessary

Ventilation	
effinergie	RT 2005
Low-consumption ventilators	A or B hygro-adjustable mechanical ventilation

B hygro-adjustable mechanical ventilation or bypass mechanical ventilation with an exchange unit output > 80%

Heating and hot water		
	effinergie	RT 2005
Electricity	HP COP ≥ 3,5	Joule effect (radiant)
Gas or fuel oil	Condensing boiler	Low-temperature boiler
Wood	Automatic wood burner class 3	

Proposal and integration of efficient solutions by the industrial partners of the project 项目双方的有效技术方案的建议和整合

Shading system



Thermal diagnosis

热效诊断



Isolation

walls



ceilings



windows



Automatisms

自动化

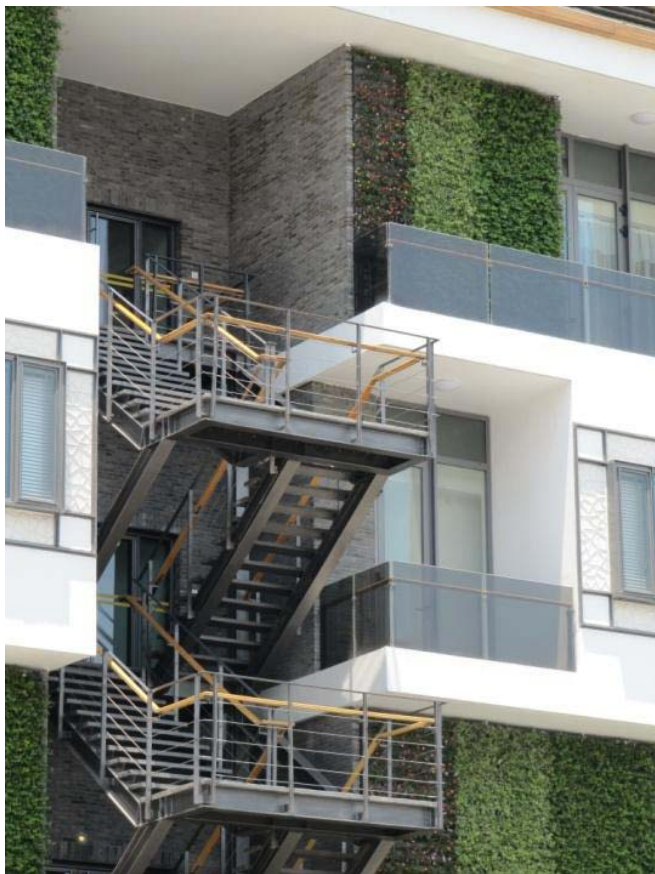


Motors



Implemented technologies

成果：细致明确的技术提供



□ The Project

□ The Building Scale : the Eco Home in Shanghai

■ **From Green Buildings to Eco Districts**

从绿色建筑到生态小区

□ Global Study of Urban Morphologies

□ Assessing Urban Forms

8 Design principles for an eco-district

8个生态小区的设计原则:

Principle 1 – High density / Mixed use

Principle 2 – A pedestrian and bicycle network

Principle 3 – A strong density of short connections

Principle 4 – Public space

Principle 5 – Self-sufficient districts

Principle 6 – Heterogeneous communities

Principle 7 – The existing conditions of the site

Principle 8 – The relationship of people to space

From Green Buildings to Eco Districts

从绿色建筑到生态小区

Design principles for an eco-district

设计原则



Left.

The facilities of the eco-district in the Shanghai region, Françoise Labbé architect.

One of the major goals of the prototype eco-neighborhood in the Shanghai region is to afford a variety of functions. The project proposes the creation of housing but also employment. It also provides local shops and amenities in the neighborhood. Constructive typology is modulated according to this diversity, especially with a gradient of heights near transit stops. Housing supply is diverse, with offers for all income groups.

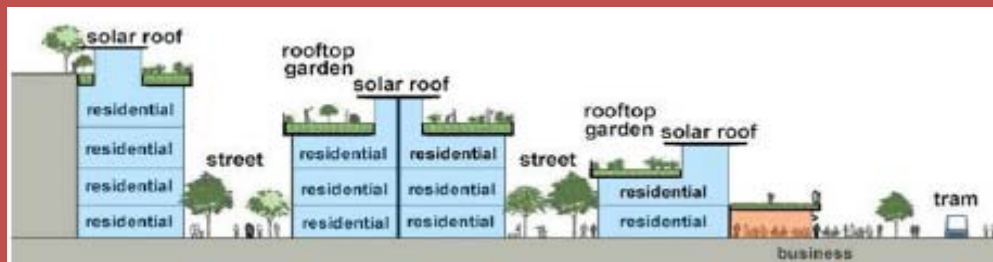
- Schools
10 schools
(6,000 m² each)
- Health facilities
1 hospital (17,000m²)
10 health facilities (550 m² each)
- Administrative facilities
Town Hall, libraries...
- Public green spaces
- Shops, services, offices
96,000 m²
- Office towers

From Green Buildings to Eco Districts 从绿色建筑到生态小区

A project at the size of a district: pilot programme in Shanghai area

小区层面的项目：上海示范小区

Plan the integration of the building in the district 将建筑物融入小区中

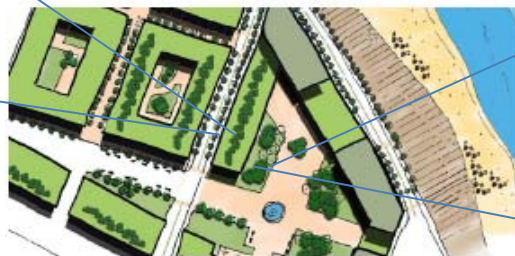


Heat networks
热能网络

集合多种资源，提供创新科技



Integrated Systems for energy
efficiency
整合效率能源系统



AREP Groupe

Design institutes : Design of the
sites
设计部门：场地设计



会刊 国际城市规划与设计工作站 2009年3月14-28日
建设生态健康之城葫芦岛

Session Book

14th - 28th march 2009

International Workshop of Urban Design

DESIGNING AN ECO-CITY PROPOSAL FOR HULUDAO CHINA





The building scale: Ecohome
建筑层面：生态家园

Hu Lu Dao International
Workshop, March 2009



From Green Buildings to Eco Districts

从绿色建筑到生态城市

Changzhou Workshop

常州工作站

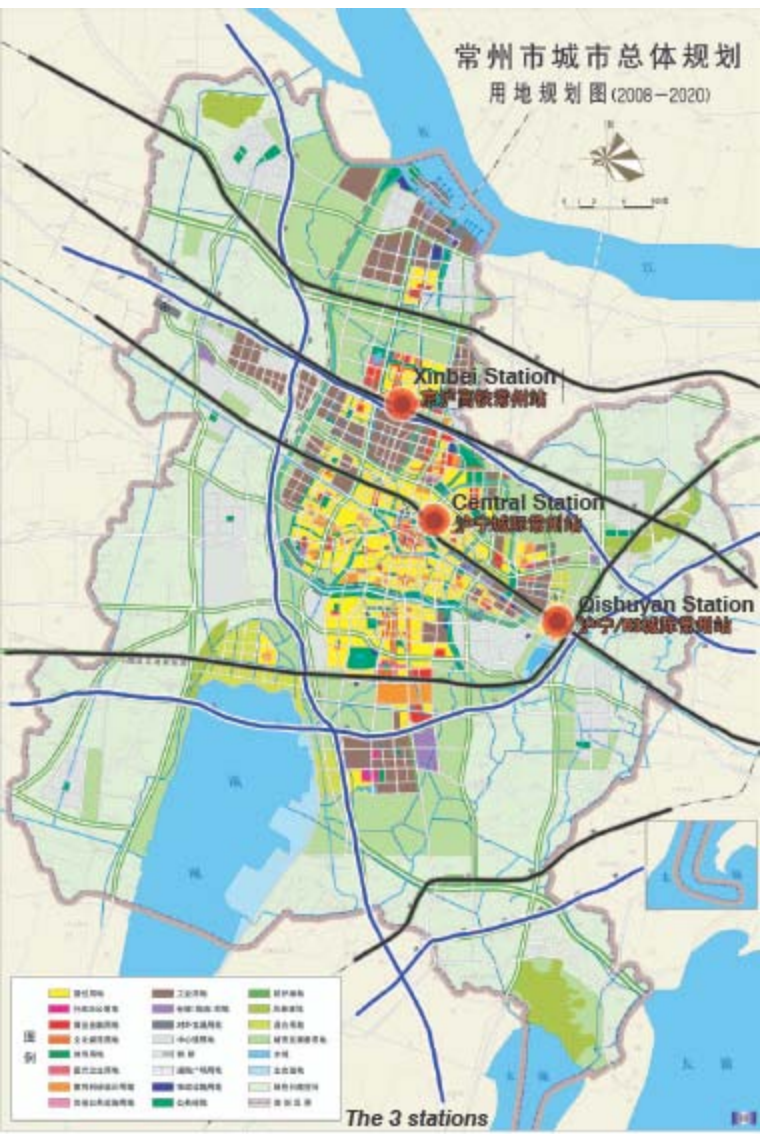
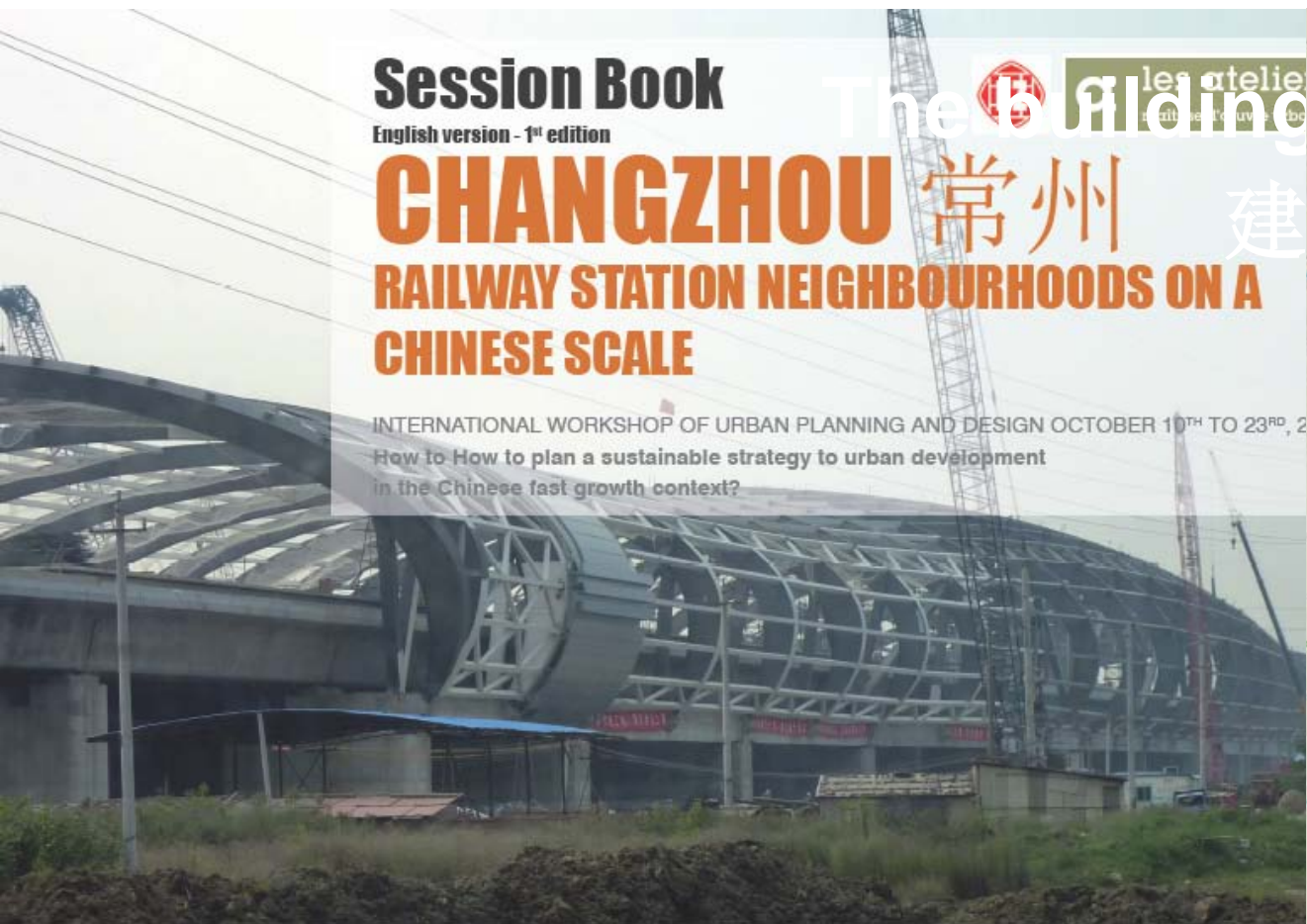
Session Book

English version - 1st edition

CHANGZHOU 常州 建

RAILWAY STATION NEIGHBOURHOODS ON A CHINESE SCALE

INTERNATIONAL WORKSHOP OF URBAN PLANNING AND DESIGN OCTOBER 10TH TO 23RD, 2011
How to plan a sustainable strategy to urban development in the Chinese fast growth context?



The main axis

Between Qishuyan and central station, the axis concentrates **many characteristics for a new way of life and a sustainable economic development** :

- Access to the transport facilities
- Proximity with the canal which could become a lively public space reflecting the soul of the city
- A lot of available areas
- Proximity with the 2 stations

This axis is **east gateway of the city**. It is crossed by the most used line between Shanghai and Nanjing.
Sequences organised around the economic activity and green pockets.



□ The Project

□ The Building Scale : the Eco Home in Shanghai

□ From Green Buildings to Eco Districts

■ **Global Study of Urban Morphologies**

城市形态研究

□ Assessing Urban Forms

A comparison of the urban morphologies and energy-efficiency of selected cities around the world.

Studied cities:

Paris

Shanghai (*Tongji University*)

Hong Kong (*The University of Hong Kong*)

Guangzhou (*Guangzhou Urban Planning & Design Survey Institute*)

Kyoto (*Ritsumeikan University*)

Tokyo (*University of Tokyo – Todai*)

In progress:

Shenzhen (*Shenzhen Institute of Building Research*)

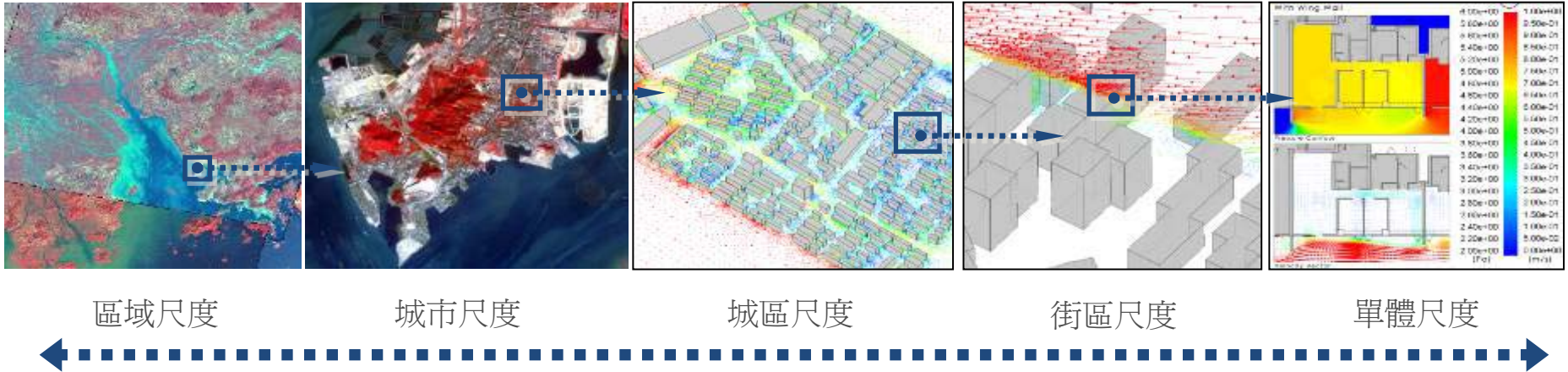
Beijing (*Tsinghua University*)

Suzhou (*Suzhou Municipality, Tongji University*)

Vienna (*University of Vienna*)

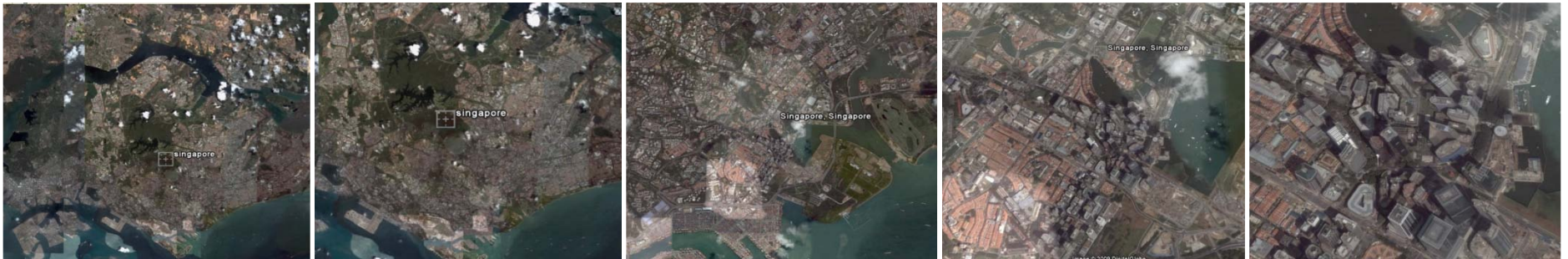


Various Scales of Urban Analysis 城市规模分析



Source: Chinese University of Hong Kong

Most research in the field of sustainability in the built environment is focused on either large-scale urban planning, or the design of individual buildings and systems. The intermediate scale of the urban fabric is often left unaddressed.



Urban Morphology Parameters: 城市形态因素



- Building mass organization (built-up area, FAR, contiguity, height of the buildings, compacity...)
- Openness to the sky (occlusivity, solar admittance)
- Passive volume
- Street networks

Energy Usage 能源利用:

- Heating
- Cooling
- Lighting
- Transport

Scale of the Urban Fabric

Singapore City



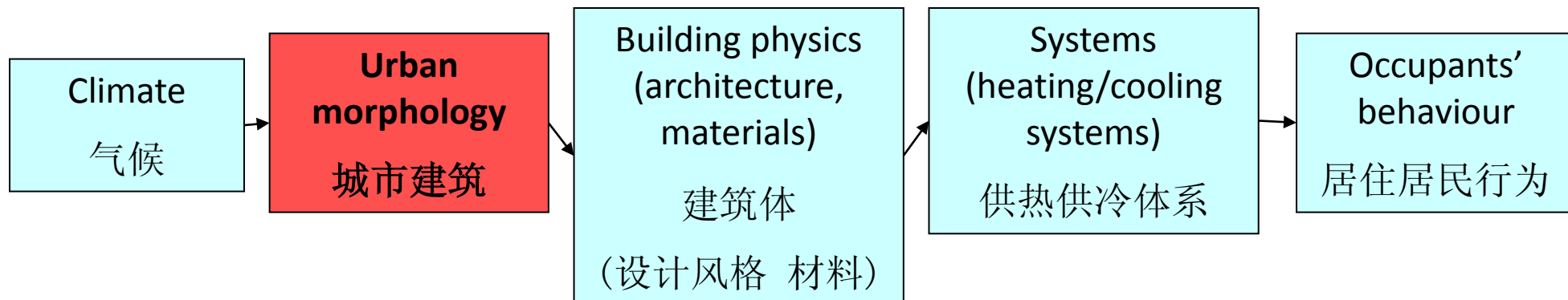
*800m*800m sample*



*200m*200m sample*



Why Urban Morphology? 为什么要研究城市形态



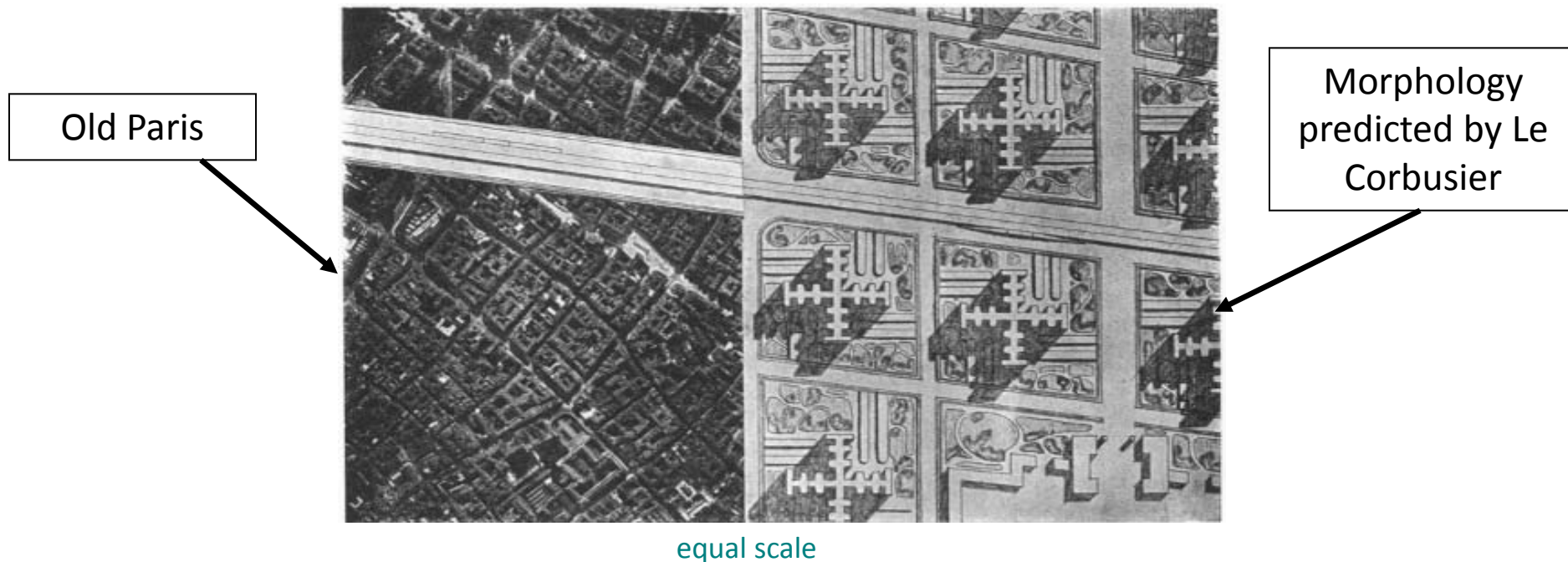
Our research has shown that an efficient urban fabric alone can reduce energy consumption and carbon emissions by **a factor of 2 - a factor too large to ignore.**

This means that Urban Morphology has the potential to halve a city's energy and carbon emissions. It is an essential lever towards more sustainable cities in the future.

Avoiding Le Corbusier's Mistake

避免科布西耶的错误

Le Corbusier wanted to replace the dense, historic urban fabric of Paris by large towers and mega forms:

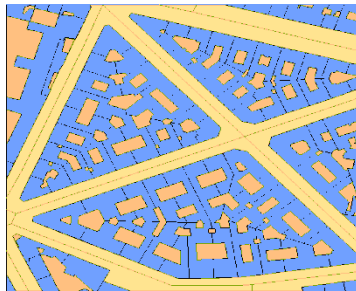


Le Corbusier's modernist morphologies turned out not to be energy efficient at all !

A study of Paris

18-19th C Traditional courtyard

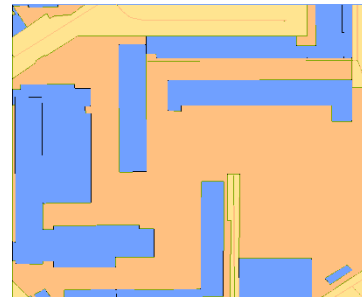
- Very high building density
- High FAR and high block density
- Good ratio V_p/V_t
- Bad solar admittance



0,21
GJ/year/m²

1918-1980 Modernist fabric

- High solar admittance, bad shape factor and low ratio Passive Volume/total Volume (V_p/V_t)
- Very low building density, FAR and block density



0,36
GJ/year/m²

1980-2000 Contemporary courtyard

- Medium building density
- Medium block density and ratio Passive Volume/Total Volume



0,20
GJ/year/m²

Heating Energy density
due to factors of urban
morphology
(GJ / year / m²)

Due to urban morphology, the modernist texture consumes **1.7 times** more energy for heating than contemporary or traditional Paris urban blocks!

Combination of all Influential Urban Morphology Parameters 对城市形态有影响的所有因素

Good urban fabric
Good building
Good heating system
Good people behavior

~ 25 times less
energy
consumption than

- Bad urban fabric
- Bad building
- Bad heating system
- Bad people behaviour

While in reality some parameters compensate others, between the two extreme cases the **overall factor for carbon emissions** per inhabitant can be **as important as 9 !**

Building Mass Organization: Built-up area density

宏观建筑规划: 城市密度的建立

Shanghai, Hong Kong, Guangzhou

上海 香港 广州



Shanghai (Lianyang), residential area



*Hong Kong (Central and Western District)
Offices and residential*



*Guangzhou (Tianhe)
Offices and residential*

High-rise high density **VS** High-rise low density

Building Mass Organization: FAR & building height

宏观建筑规划: 占地密度和建筑高度

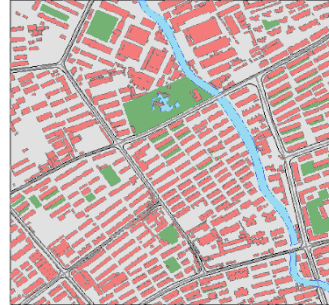
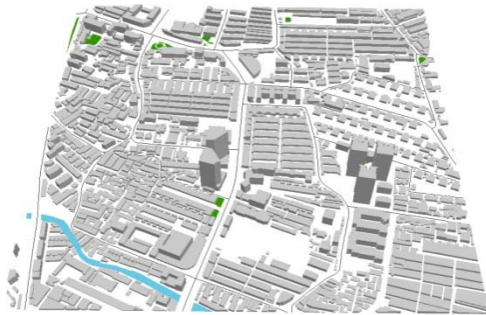
Shanghai, China

中国上海

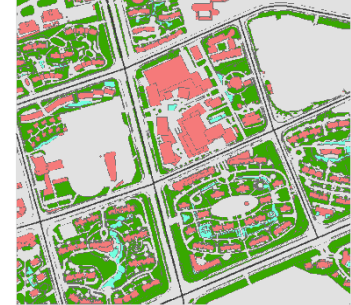
Ancient morphologies in Shanghai can reach FAR similar or > to the new development, but with low-rise construction, due to an efficient use of land.



FAR = 1.9



FAR = 1.2



FAR = 1.2



Ancient morphologies (lilongs)

New development

Old Paris versus Modern Asian Cities

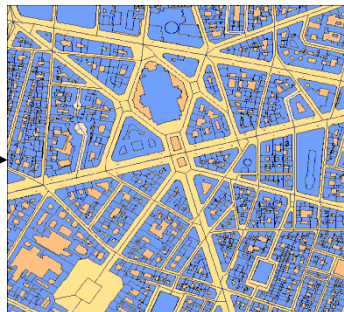
巴黎老城和亚洲现代城市

HK, North Point

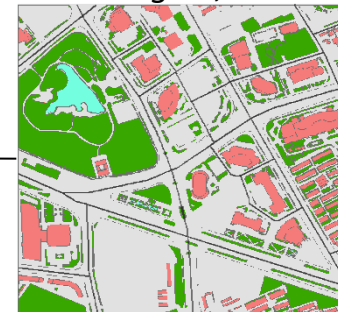


FAR * 1.5
Height / ~6

Old Paris



Shanghai, CBD



FAR * 1.2
Height / ~9

Built-up area density = 19%

FAR = 3.1

Buildings height = mainly above 30 – 40 floors

Built-up area density = 61%

FAR = 4.5

Buildings height = about 6 - 7 floors high

Built-up area density = 11%

FAR = 3.7

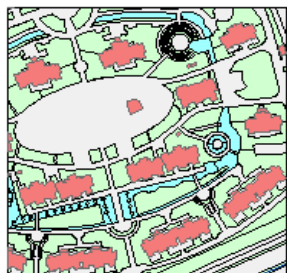
Buildings height = mainly above 45 floors



Dense low-rise versus high rise

200*200 meters urban sites

Shanghai



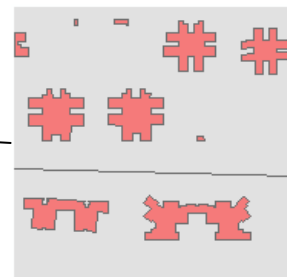
FAR * 5
Height * ~1.8

Hong Kong



FAR * 2.3
more or less
similar
heights

Guangzhou



Built-up area density = 14%

FAR = 2.2

Buildings height = mainly 10 to 25 floors



Built-up area density = 54%

FAR = 11.8

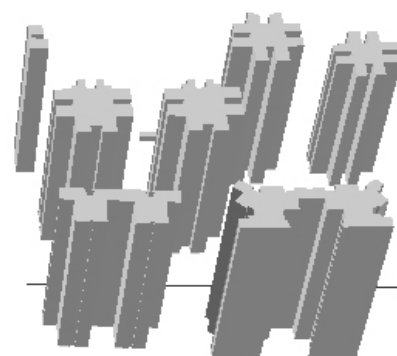
Buildings height = mainly 20 to 50 floors



Built-up area density = 15%

FAR = 5

Buildings height = mainly 30 floors



Conclusions: Building Height & Density

结论：建筑高度和密度

Land management plays a major role.

A dense area is not synonymous with high rise constructions.

Some high-rise (40+ floor) districts in HK have similar FAR to 4-6 storey Paris!

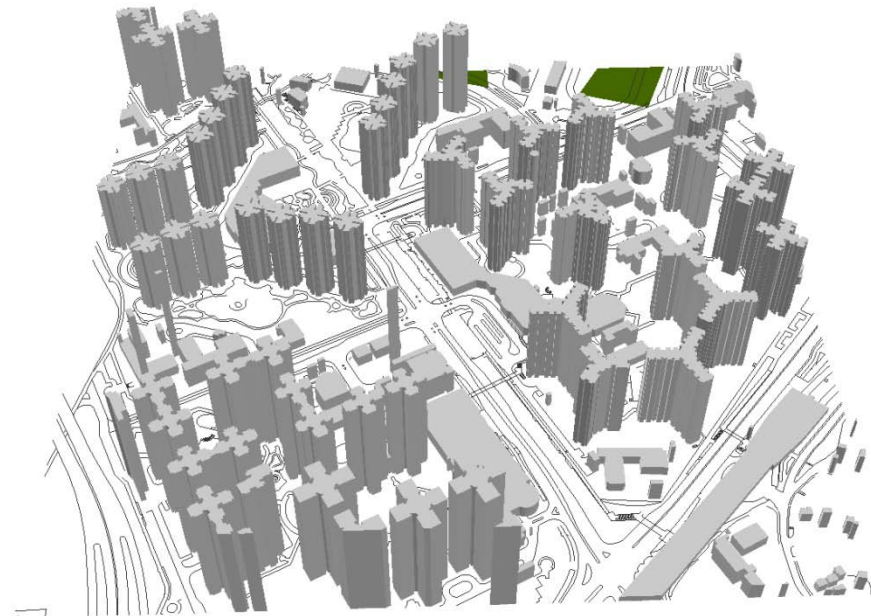


Conclusions: Building Height & Density

结论：建筑高度和密度



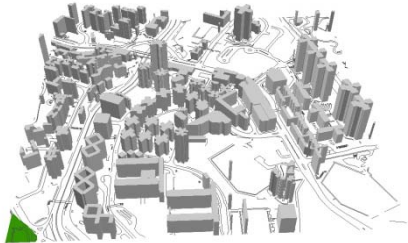
Paris: 40 % of Paris reaches a density superior to 40000 hab/ km², without resorting to high-rise constructions. Current average living space in Paris: **32 m²/hab .**



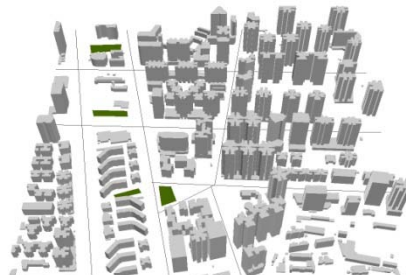
Hong Kong: population density reaches an average of 40000 hab/ km² in most places . Very high-rise buildings and average living space only **12 m²...!**

New high-rise developments

$C \sim 8$



HK



Guangzhou

Shanghai



Historic urban fabric

$C \sim 5$

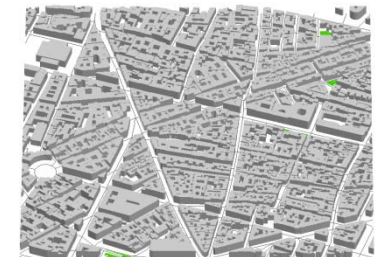


Old parts of Guangzhou
and Shanghai

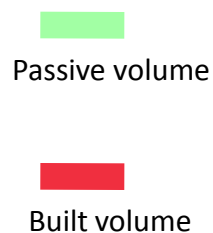
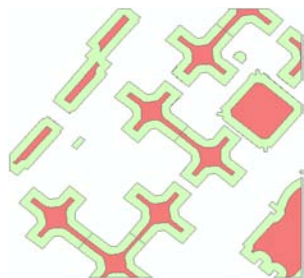
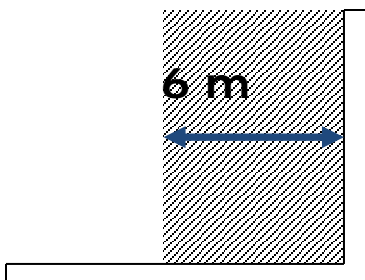
$C \sim 3$



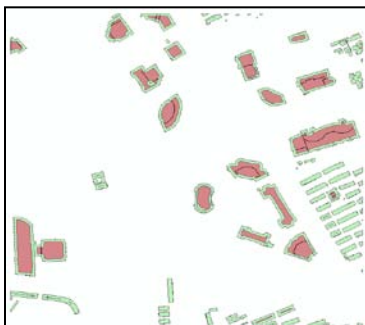
Old Paris



Effect of Passive Volume 自然採光效应

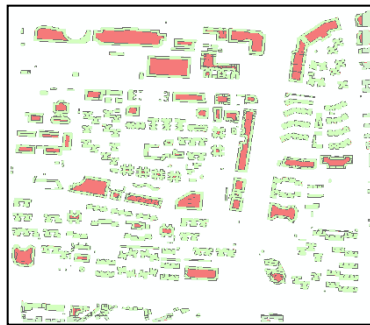


$$Ratio = \frac{\sum_{buildings} Passive Volume}{\sum_{buildings} Built Volume}$$



Shanghai, Lujiazui
(CBD)

Ratio = 43 %



Guangzhou,
Tianhe

Ratio = 66 %



Hong Kong, North
Point (residential)



Shanghai,
Hongkou (lilongs)



Paris, 19th
century

Ratio ~ 80%

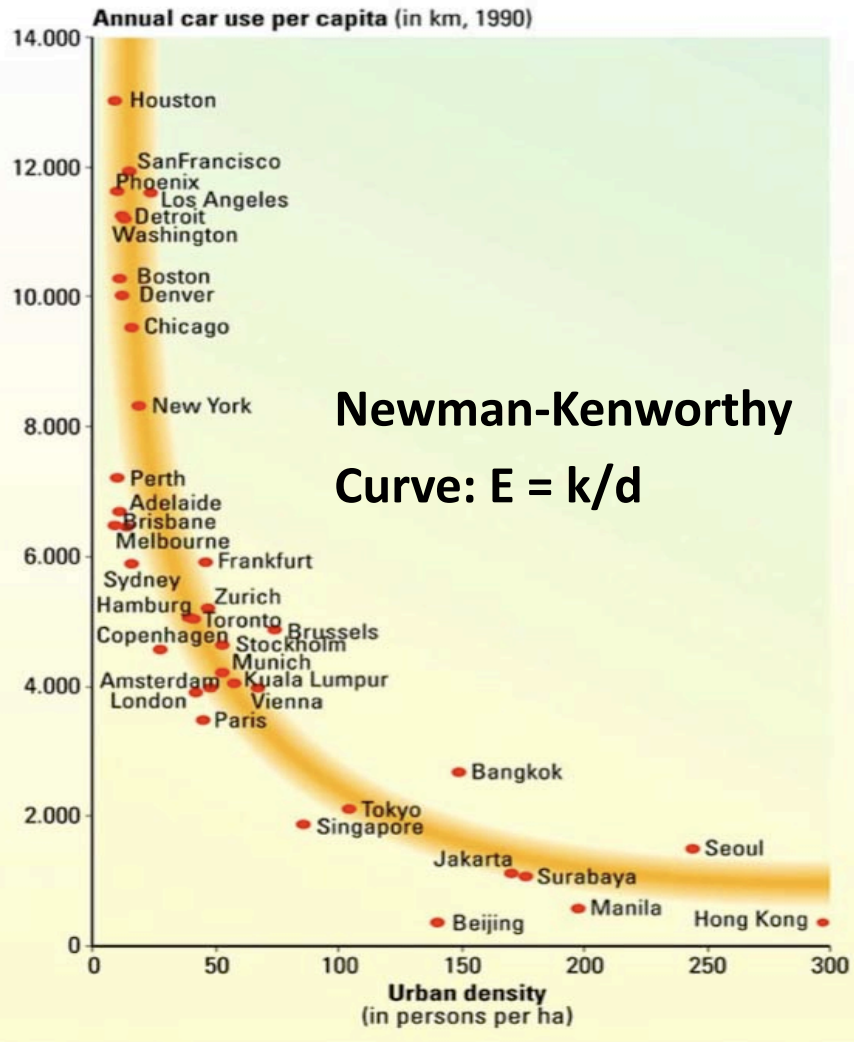
Ex. of Singapore Morphology

新加坡形态案例



Effect of Street Network and Density

街道网络和密度效应



Traffic is one of the main reasons for energy consumption and greenhouse emissions.

The effect of urban sprawl on transportation energy is huge.



Traffic in Beijing

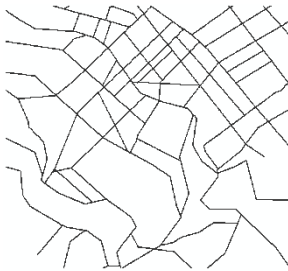
Comparative analysis of Street Networks in our various studied cities have shown a number of conclusions thus far regarding connectivity:

- **Greater cyclomatic number (average # connections between 2 points);**
- **Smaller distances between intersections;**
- **And greater density of intersections, generally indicate a more connected, accessible city fabric.**

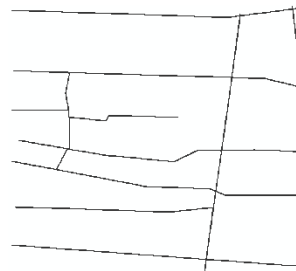
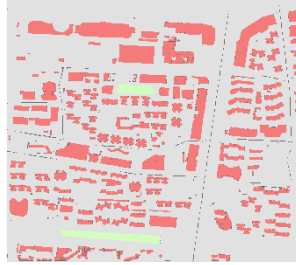
Street Network & Connectivity

街道网络和相互联系性

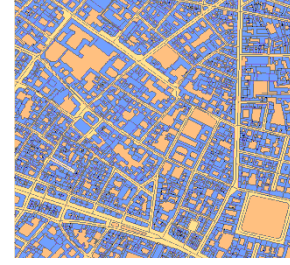
HK, C & W District



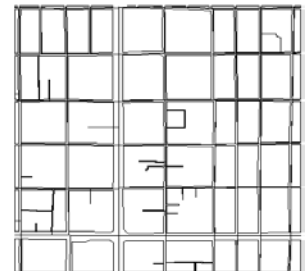
Guangzhou, CBD



Old Paris



Kyoto



Cyclomatic number

51

6

88

83

Average distance btw
intersections

6.38

1.93

6.5

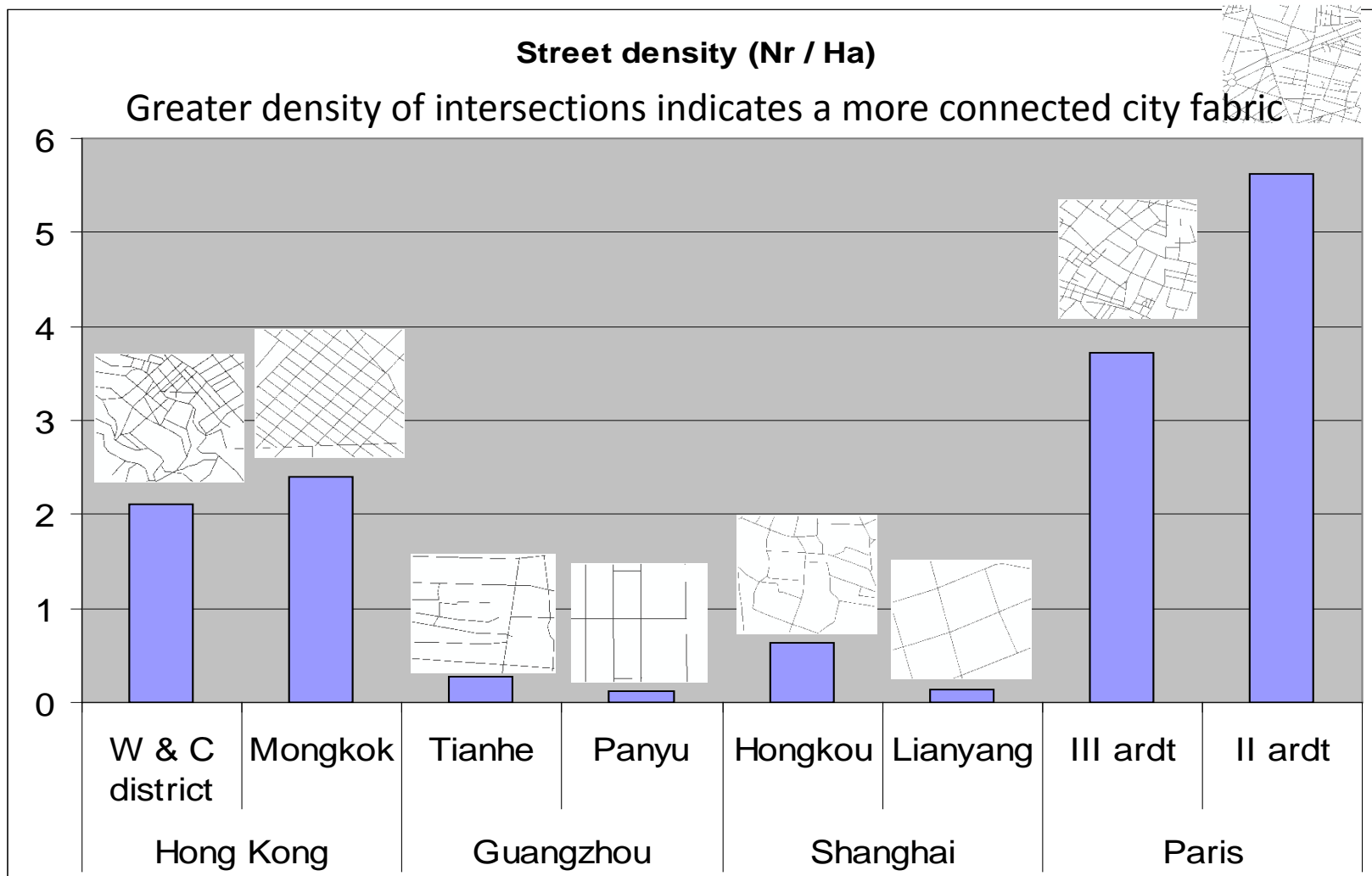
19.24

Intersection density

Based on graph theory

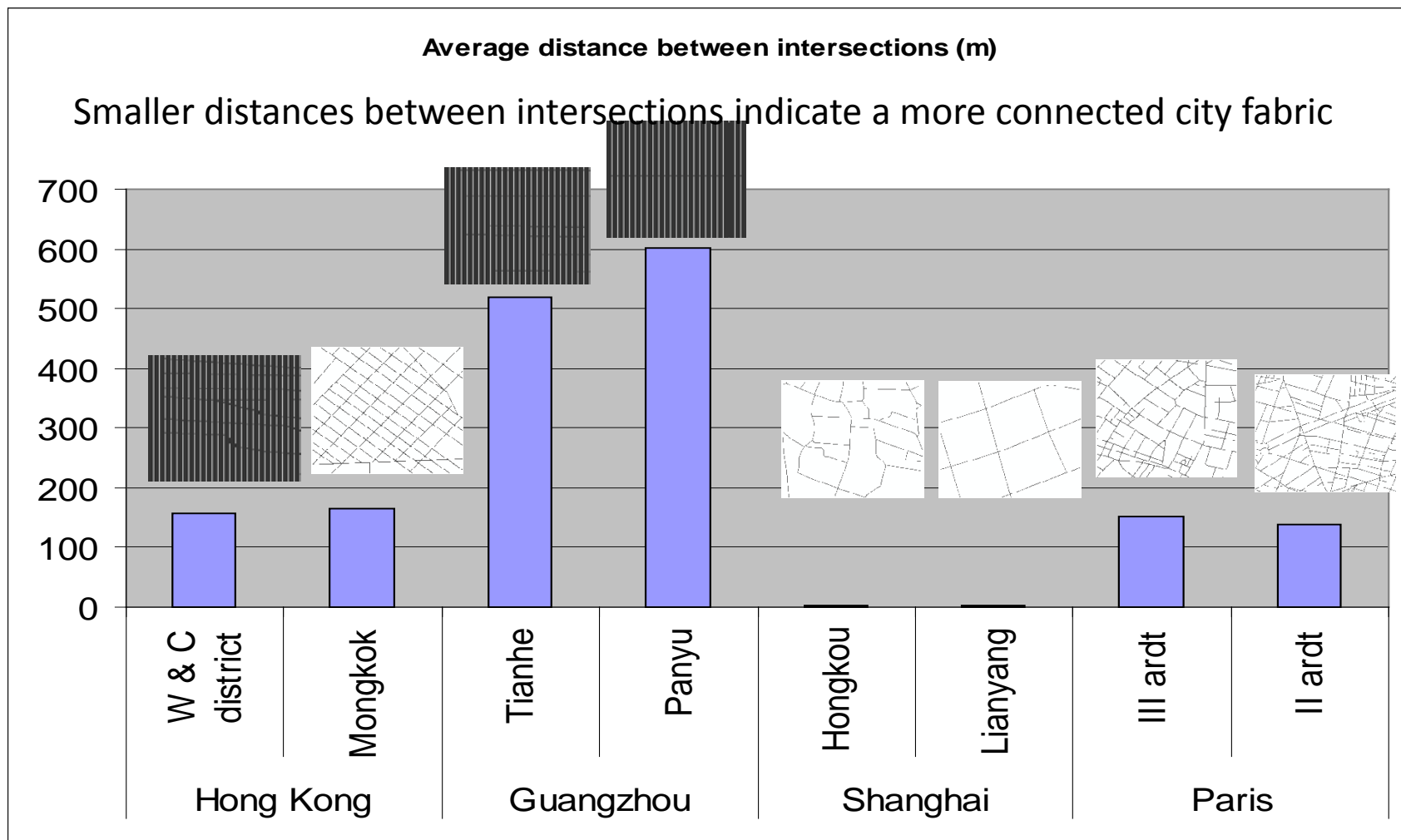
Effect of Street Network Street density

街道网络和街道密度的效应



Effect of Street Network distance between Intersections

交接口之间街道网络距离的效应



Effect of Street Network 街道网络效应

The analysis of various networks of streets in Singapore, and comparisons with other cities will reveal the degree of connectivity, traffic congestion and accessibility.



Urbanisation in High Density Cities 高密度城市的城市化

How to deal with population growth in a restricted land area with an already high level of urbanisation?

如何解决在有限的土地 (而这个土地有已高度城市化)上不断壮大的人口?



High rise tendencies for “Densification” 高密度化高空发展趋势

Current and future development tends to be high-rise to accommodate “density”...



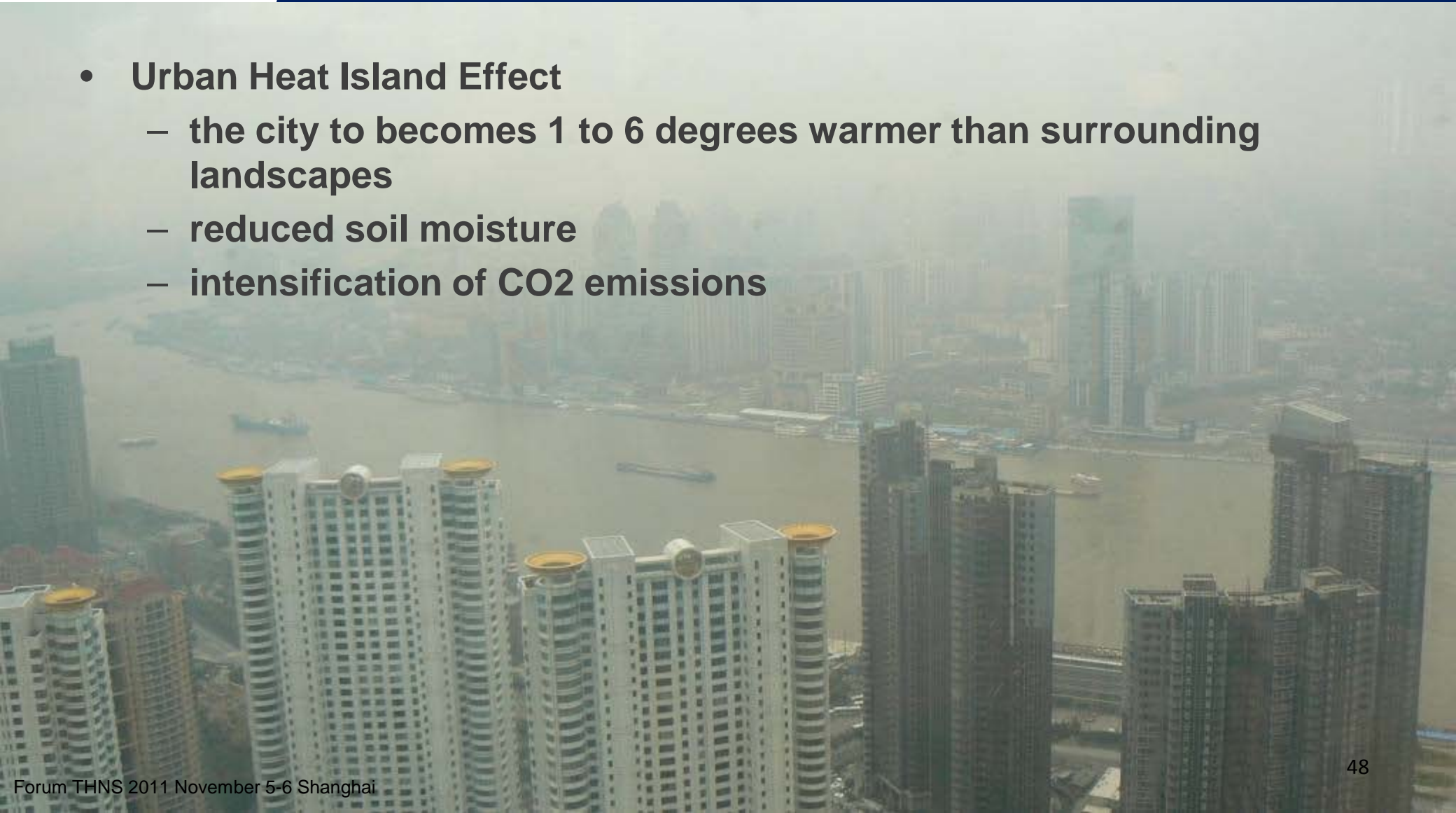
The Impact of Future Development 对未来发展的影响

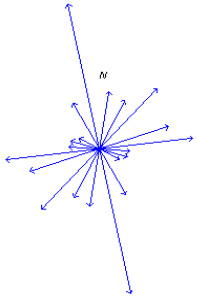
New design proposals have the potential for massive environmental impact...



...and should be assessed for their resultant energy-efficiency

- **Urban Heat Island Effect**
 - the city to becomes 1 to 6 degrees warmer than surrounding landscapes
 - reduced soil moisture
 - intensification of CO2 emissions





Urban Morphology Analysis can help to:

- **Optimize density of population and housing**
- **Reduce the need for building energy through actions on:**
 - heat transmission through buildings walls
 - penetration of sunlight and solar heat
 - wind penetration
- **Reduce the need for private transportation**
- **Reduce CO2 emissions through impact on the dispersion of pollutants**
- **Reduce the impact of climate change**



The results of Urban Morphology Analysis can be used to inform more energy-efficient urban design and planning:

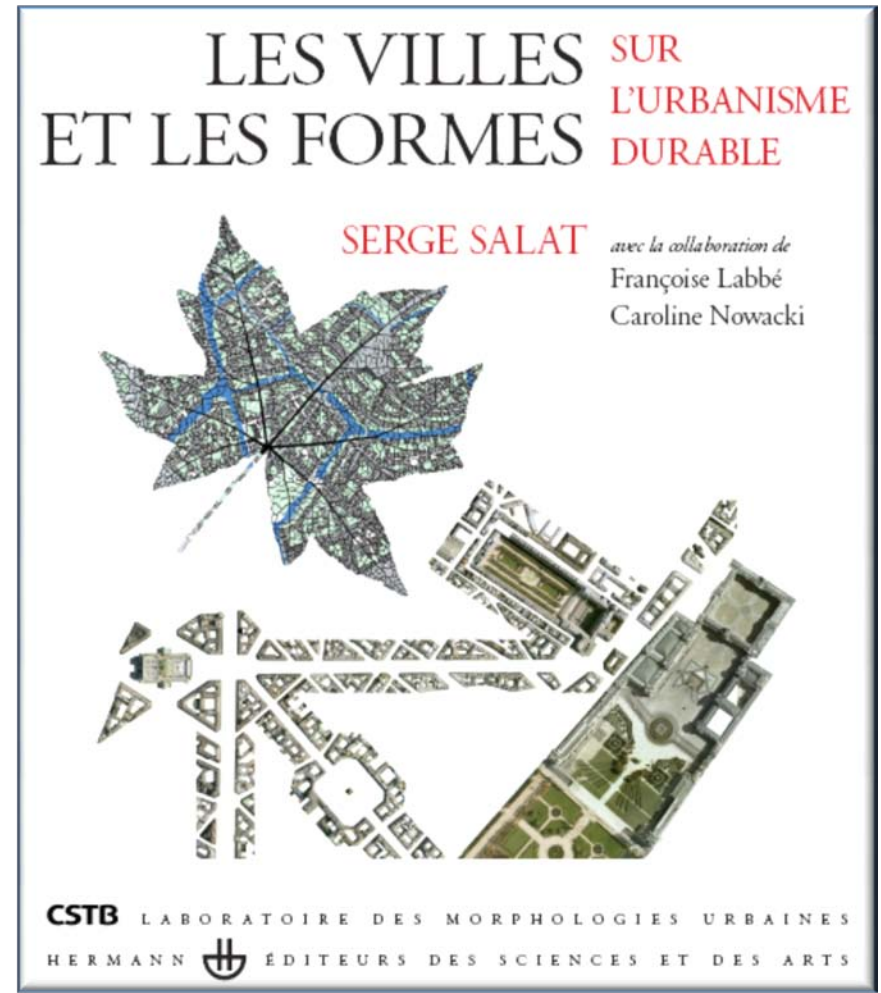
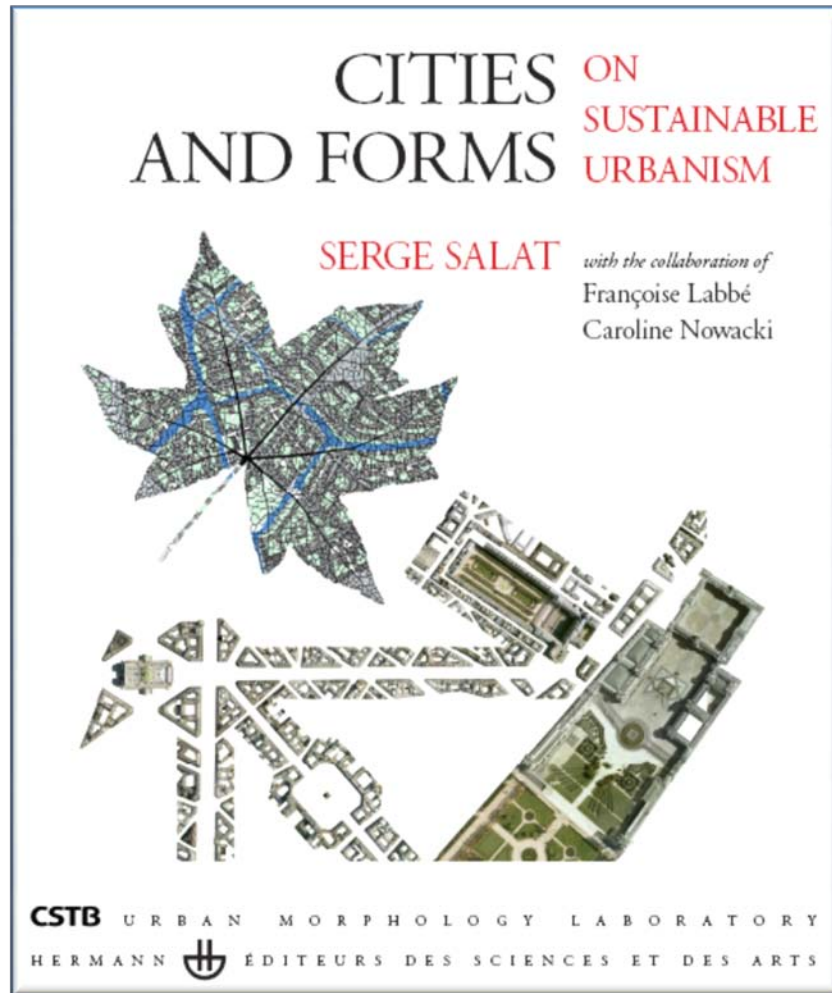
- **Identification of low energy performance areas requiring priority attention**
- **Identification of future areas for development to minimize environmental impact**
- **Performance evaluation of current design guidelines**
- **Assessment of the energy performance of future development proposals**
- **Creation of ‘energy-efficient’ urban design guidelines**
- **Assistance in the calculation of a set of sustainability indicators**

- ❑ The Project
- ❑ The Building Scale : the Eco Home in Shanghai
- ❑ From Green Buildings to Eco Districts
- ❑ Global Study of Urban Morphologies
- **Assessing Urban Forms**

The Book论著

Cities and Forms on Sustainable Urbanism

城市可持续性发展, 城市和形状



Thank you for your attention
感谢您的殷切关注！

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