

Project on
“Study of Energy Consumption and
Indoor Environment Problems of
Residential Buildings in China”
by
Research Committee of Architectural
Institute of Japan

Committee Members

Chairman :Toshiyuki Watanabe (Kyushu Univ.)

Secretaries :Hiroshi Yoshino (Tohoku Univ.),
Hiroyuki Kitahara (Total System Lab.)

The number of the members

Japanese : 13

Chinese : 12

Purposes of This Project

1. Data compilation of residential energy consumption and indoor environment based on literature survey, field investigation and numerical simulation.
2. Proposing and promoting technologies for energy conservation and sustainable environment creation with improving the living standard.

Contents of Three Years Project

- **The First Year (April, 2002 ~ March, 2003)**
 - **Literature survey and field investigation on energy consumption and indoor environment of residential buildings**
 - **Compilation of weather data for building design based on observed data in China**
- **The Second Year (April, 2003 ~ March, 2004)**
 - **Literature survey and field investigation on energy consumption and indoor environment of residential buildings**
 - **Estimation and verification of effect of various environmental symbiosis technologies**
- **The Last Year (April, 2004 ~ March, 2005)**
 - **Proposal of residential energy conservation technologies with taking account of regional characteristics**
 - **Proposal of design guideline of residential buildings based on sustainable environmental technologies**

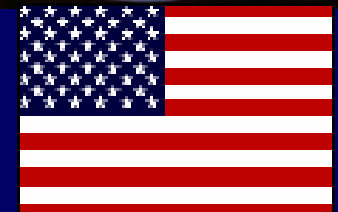
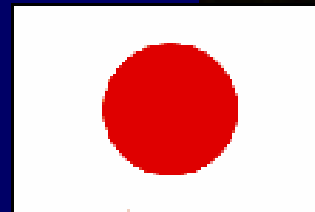
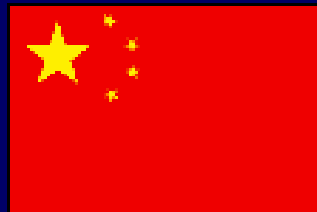
Basic Data of China

Total Land Area: 9,600,000 km²

Population: 1,265,830,000 persons

GDP: 1,230,000 million dollar

GDP: 911 dollar / person



	China	:	Japan	:	U.S.
Total Land Area	26	:	1	:	26
Population	10	:	1	:	2.2
GDP	1	:	3.4	:	8.5
GDP/person	1	:	36	:	37

Outline of Activities in the First Year (1/3)

- **Literature survey on energy consumption of residential buildings in China**
- **Literature survey on the regulations of residential buildings design in China**
- **Investigation on indoor environment and energy consumption of residential buildings in urban area**
- **Compilation of weather data for simulation of heating and cooling load**
- **Retrofitting of residential buildings in terms of thermal comfort and energy conservation in rural area**

Outline of Activities in the First Year (2/3)

- The 2nd International Workshop “Energy and Environment of Residential Buildings in China” at Tongji University in **Shanghai** (October, 2002)

The number of papers: 50

The number of participants: 85

(from Japan, the U.S., the Republic of Korea and People’s Republic of China)



The 3rd International Workshop is held in **Xi’an**, China next year.



Outline of Activities in the First Year (3/3)

- **Lecture “Traditional Dwellings in China and Regenerations” by Jiaping Liu (Xi’an University of Architecture and Technology) in Tokyo (March, 2003)**



Energy consumption of residential buildings in China (1/2)

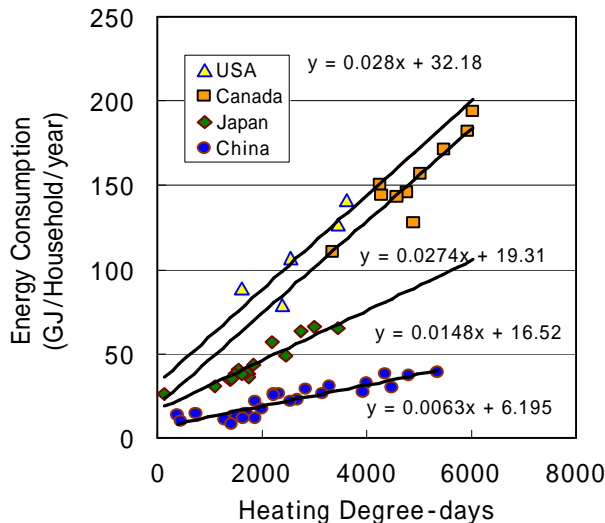
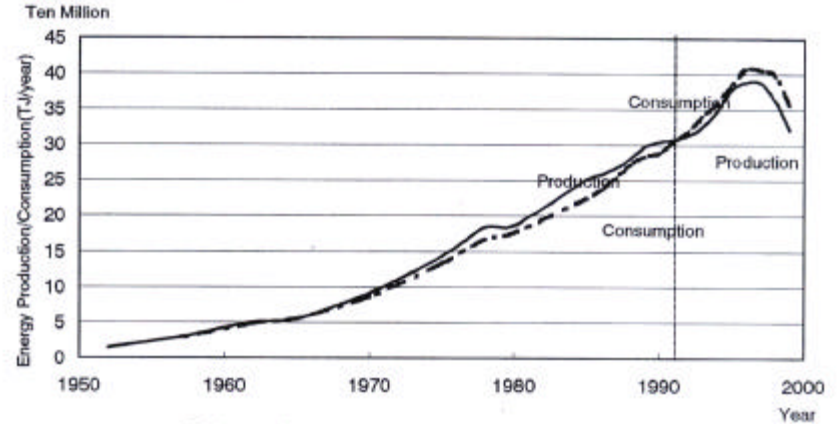
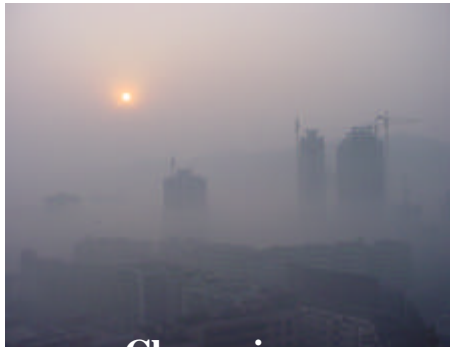
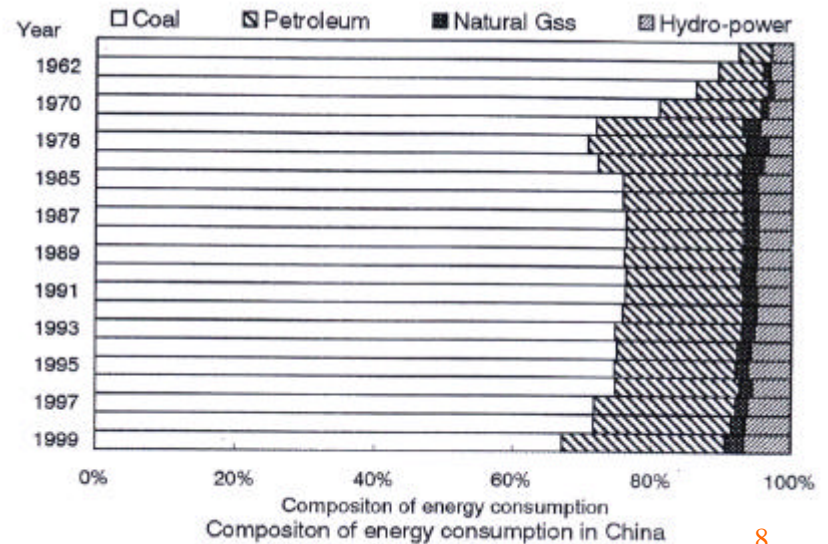


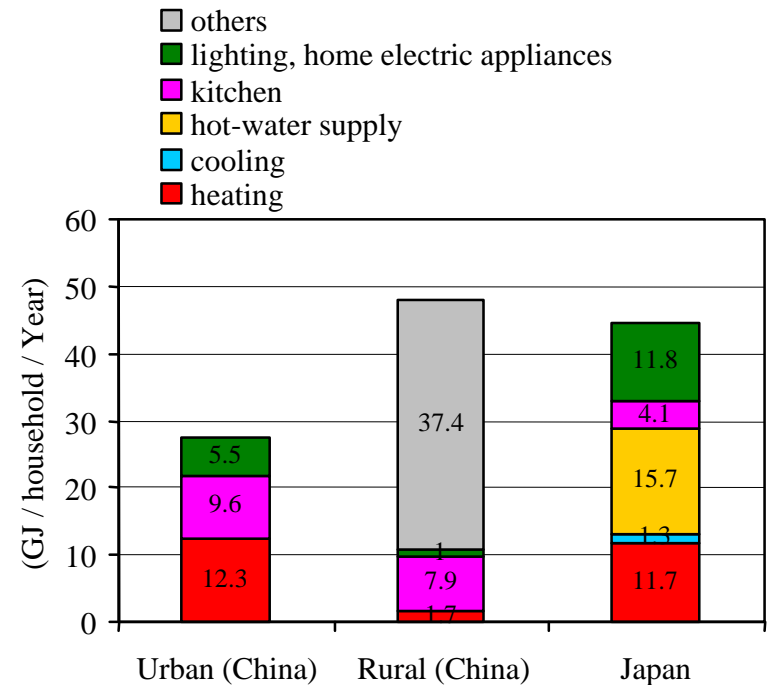
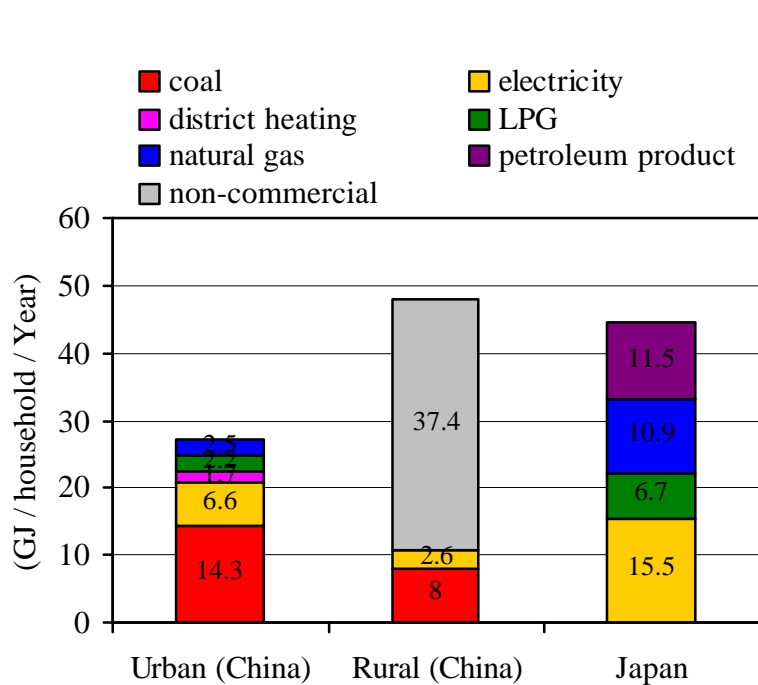
Fig.6 Relationship between Energy Consumption and Degree-days



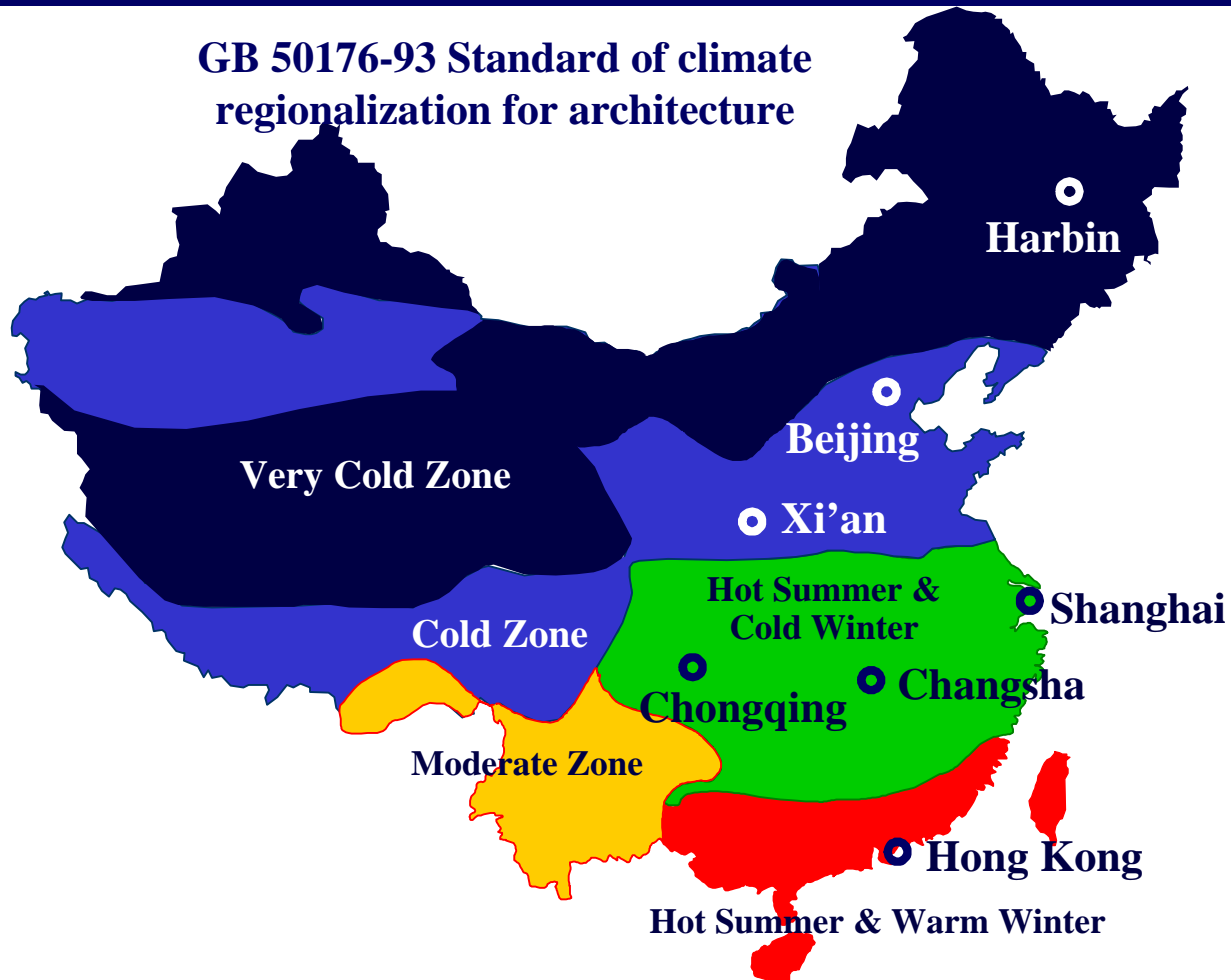
Balance of energy production and consumption in China



Energy consumption of residential buildings in China (2/2)



The regulations of residential buildings design in China (1/2)



The regulations of residential buildings design in China (2/2)

- Design code for heating, ventilation and air conditioning (GBJ19-87)
- Thermal design code for civil building (GB50176-93)
- Energy conservation design standard for new heating residential buildings (JGJ26-95)
- Design standard for energy efficiency of residential buildings in hot summer and cold winter zone (JGJ134-2001, J116-2001)

China (external surface area / dwelling unit volume 0.3)				Japan (reinforced concrete buildings, external insulation method)			
Heat Transmission (W/m ² K)				Heat Transmission (W/m ² K)			
	External Wall	Roof	Window		External Wall	Roof	Window
Very Cold Zone (Harbin)	0.52	0.50	2.50	Zone	0.49	0.32	2.33
				Zone			
Cold Zone (Beijing, Xi'an)	0.90	0.80	4.70	Zone	0.58	0.41	3.49
	1.16		4.00	Zone			
Hot Summer and Cold Winter Zone (Shanghai, Chongqing)	1.50	1.00	2.5, 3.2, 4.7	Zone	0.86	0.43	4.65
				Zone			
Moderate Zone				Zone	1.76		6.51
Hot Summer and Warm Winter Zone				Zone			

Investigation on indoor environment and energy consumption of residential buildings (1/2)

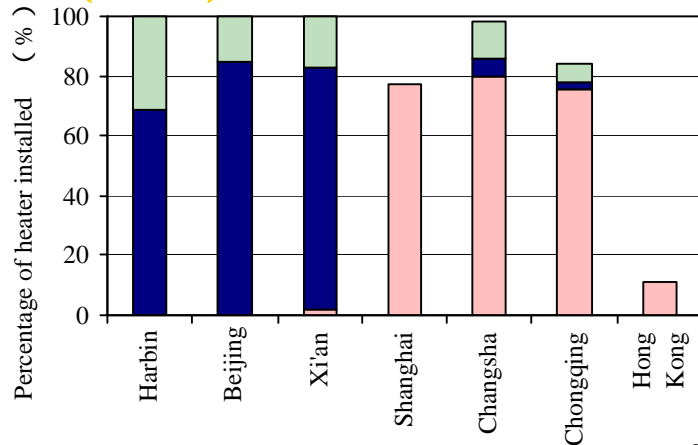


Fig. Ratio of heating equipped in families..

Contents of the questionnaire survey

- 1) Housing Equipments
- 2) Life Style
- 3) Building Characteristic
- 4) Residential Characteristic
- 5) Satisfaction ratings
- 6) Energy Consumption
- 7) Indoor Thermal Environment

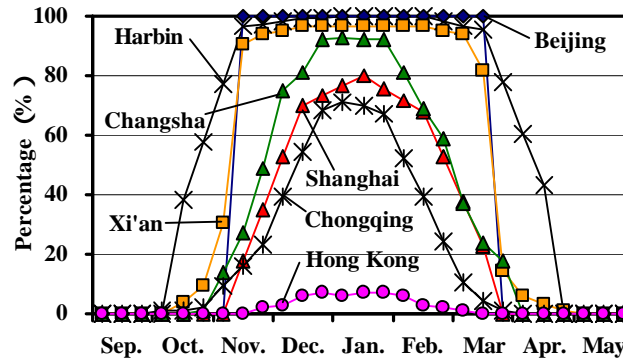


Fig. Ratio of use of heating system in winter months.

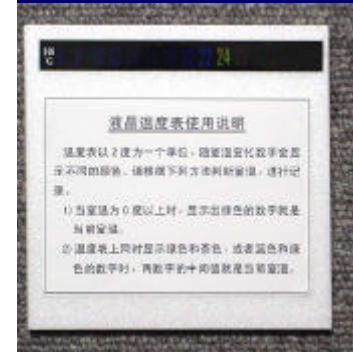


Fig. Liquid crystal thermometers.

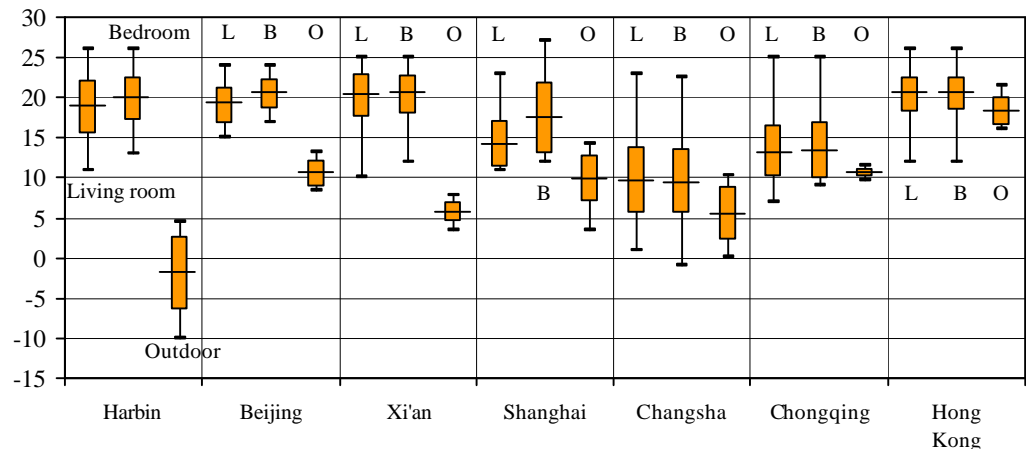
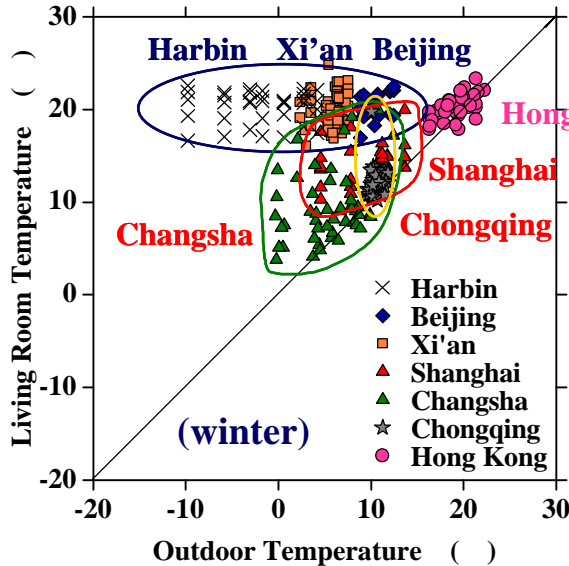
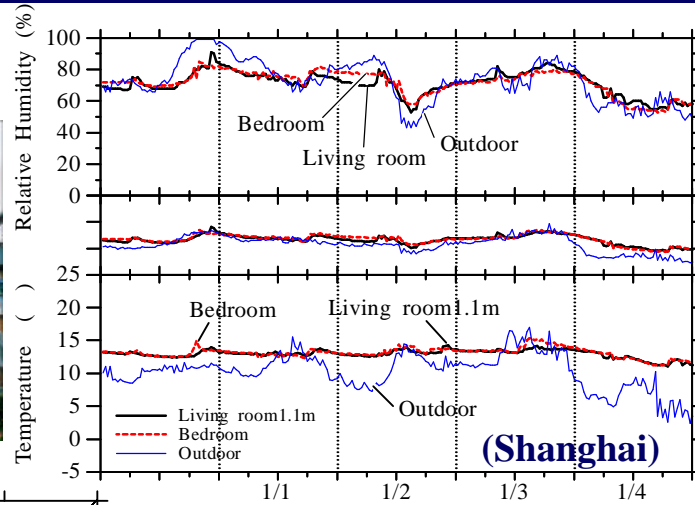


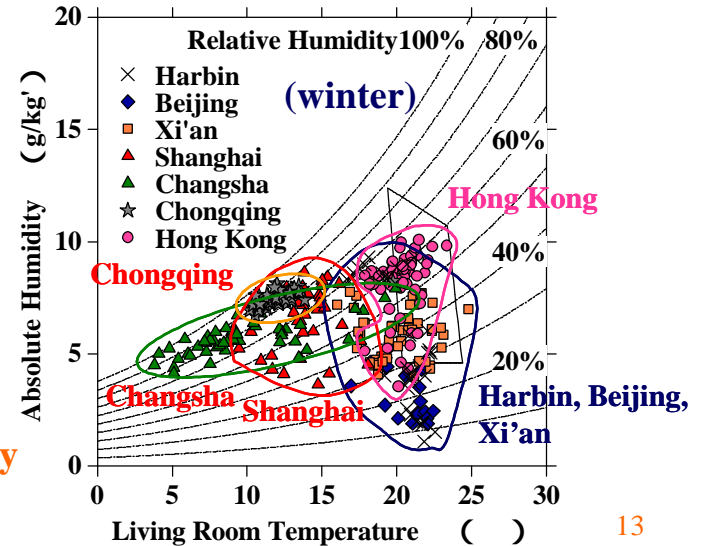
Fig. Average temperature of living room (L) and bedroom (B), in seven cities..

Investigation on indoor environment and energy consumption of residential buildings

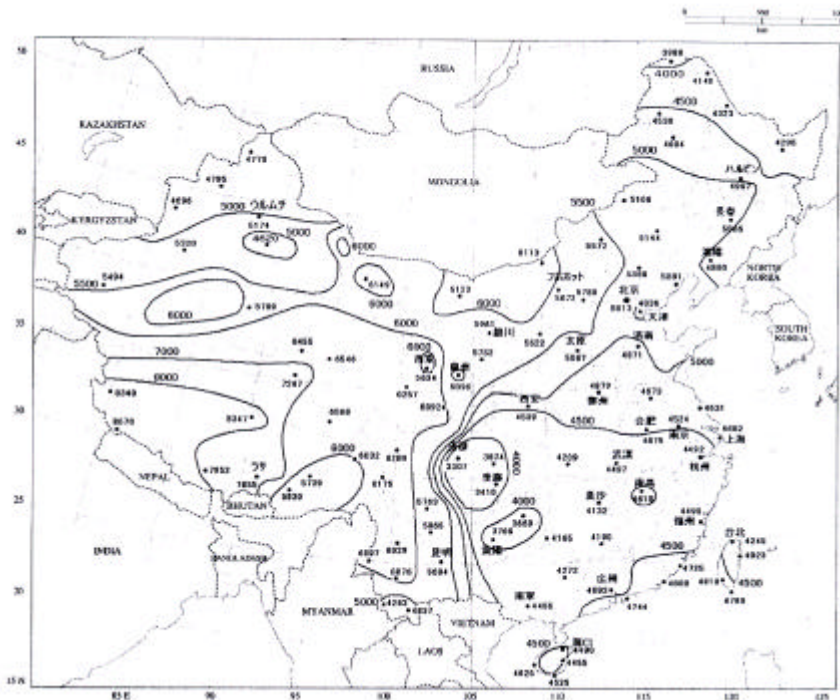
(2/2)



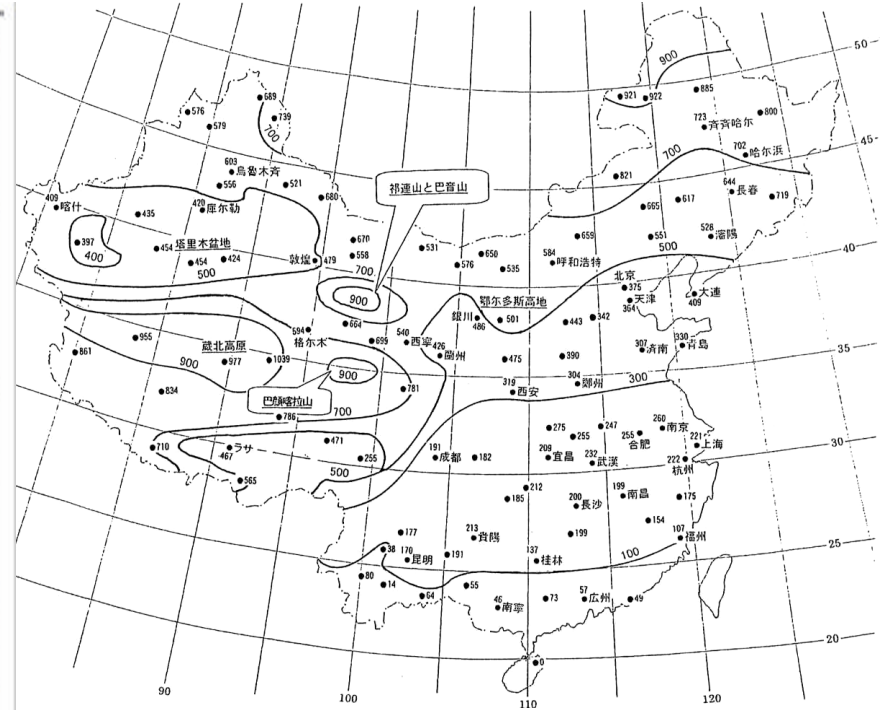
Temperature and humidity
(Field measurement)



Compilation of weather data for simulation of heating and cooling load (1/2)

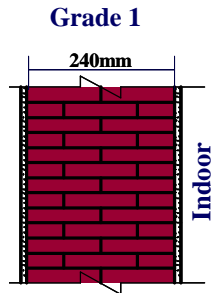
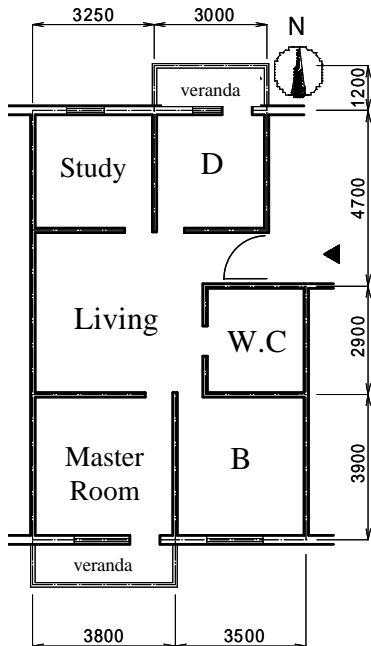


Solar radiation



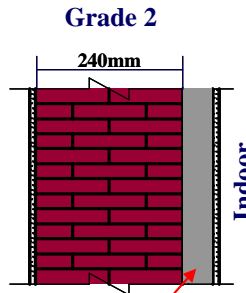
Heating load

Compilation of weather data for simulation of heating and cooling load (2/2)



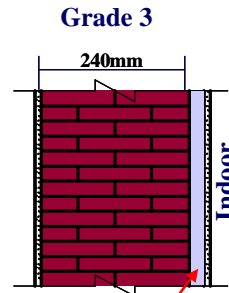
Insulation:
Nothing

Heat Transmission :
 $1.65\text{W/m}^2\text{K}$

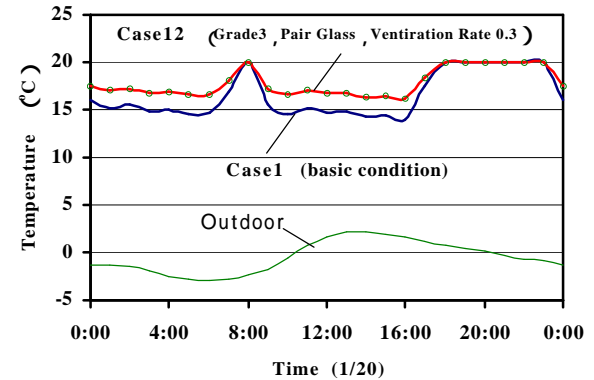


Insulation:
Cellular Concrete
120mm

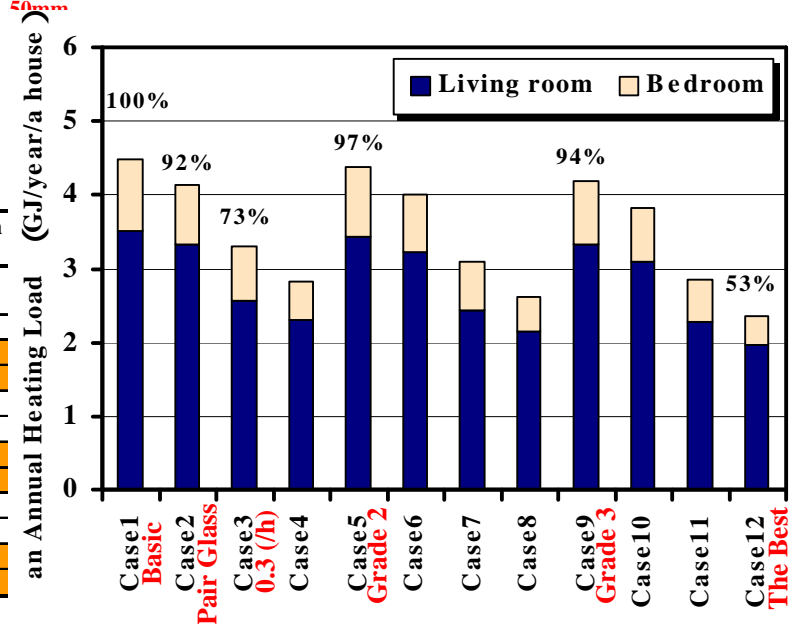
Heat Transmission :
 $0.87\text{W/m}^2\text{K}$



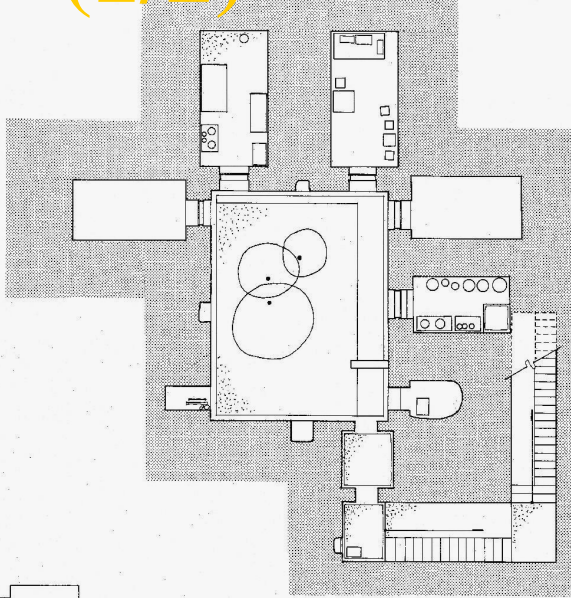
Insulation:
Form Polystyrene
50mm



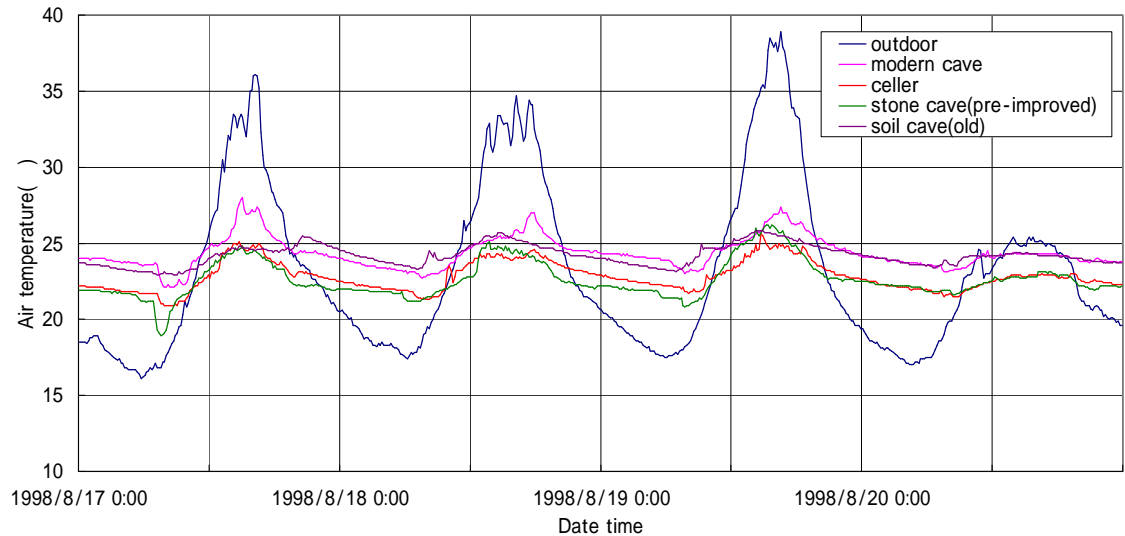
	Thermal Insulation of Outer Wall	Type of Window Glass	Natural Ventilation Rate (/h)
Case1 (basic condition)	Grade 1	Single	0.7
Case2	Grade 1	Pair	0.7
Case3	Grade 2	Single	0.3
Case4	Grade 3	Pair	0.3
Case5	Grade 2	Single	0.7
Case6	Grade 2	Pair	0.7
Case7	Grade 2	Single	0.3
Case8	Grade 2	Pair	0.3
Case9	Grade 3	Single	0.7
Case10	Grade 3	Pair	0.7
Case11	Grade 3	Single	0.3
Case12	Grade 3	Pair	0.3



Residential improvement in rural area (1/2)



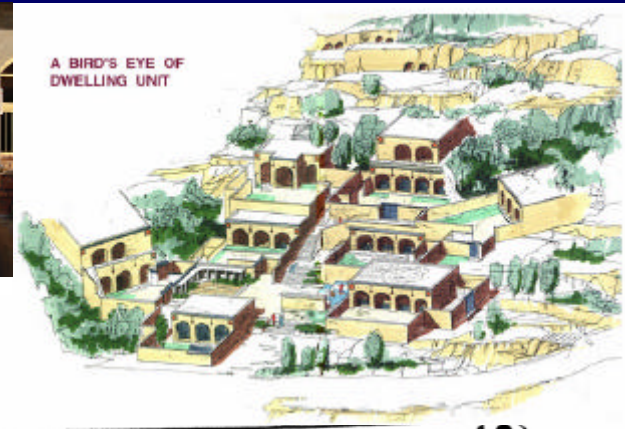
98Summer
Air temperature graph



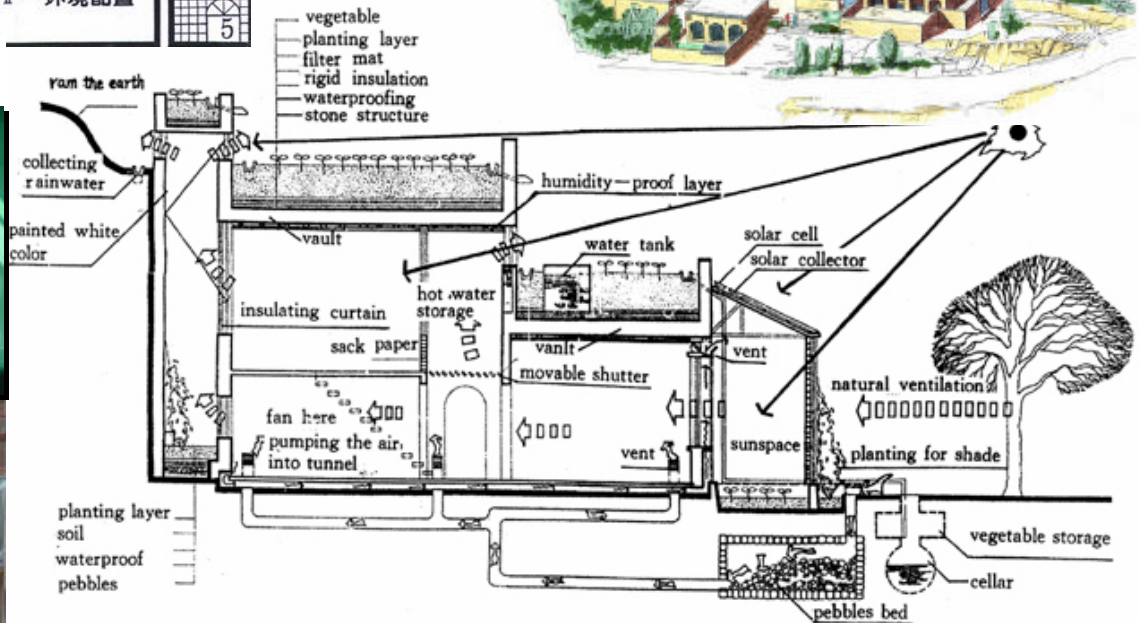
Residential improvement in rural area (2/2)



Section Plan of the village



New Yao Dong (built up type)



Renovation of Cave Dwelling