International Conference of Urban Climate -- Toulouse

Adapting Asian Cities to Climate & Urban Climatic Changes

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ICUC9 20th-24th July 2015 Toulouse France

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A manifesto written in 2014

May I ask: When was the last time you model-simulate and discovered a phenomenon so important that you immediately start writing your next journal paper? When was the last time you went around measuring our urban environment and found out features so illuminating that you spent the whole week investigating it. And when was the last time you talked to and drank with a planner and managed to convince him/her to announce a new policy guideline on urban climate the next day?

You do not need to answer the questions. I am merely trying to demonstrate that 2 of the above questions are kind of familiar to us all. And the third one is absurd as it should never be part of our academic or professional life; and it has nothing to do with the scholarship and the knowledge pursuit of urban climate.

I believe urban climate is not about climate, but it is about the future and the betterment of mankind living in cities. I believe that there is a need to engage more with those who are shaping our cities. I believe we need to dialogue with them in order to formulate steps towards urban transformation. We have been very good at getting something scientifically right. It is now time to also become good at creating cities and places that support life, comfort, health and enjoyment. The future of our cities can be in our hands.

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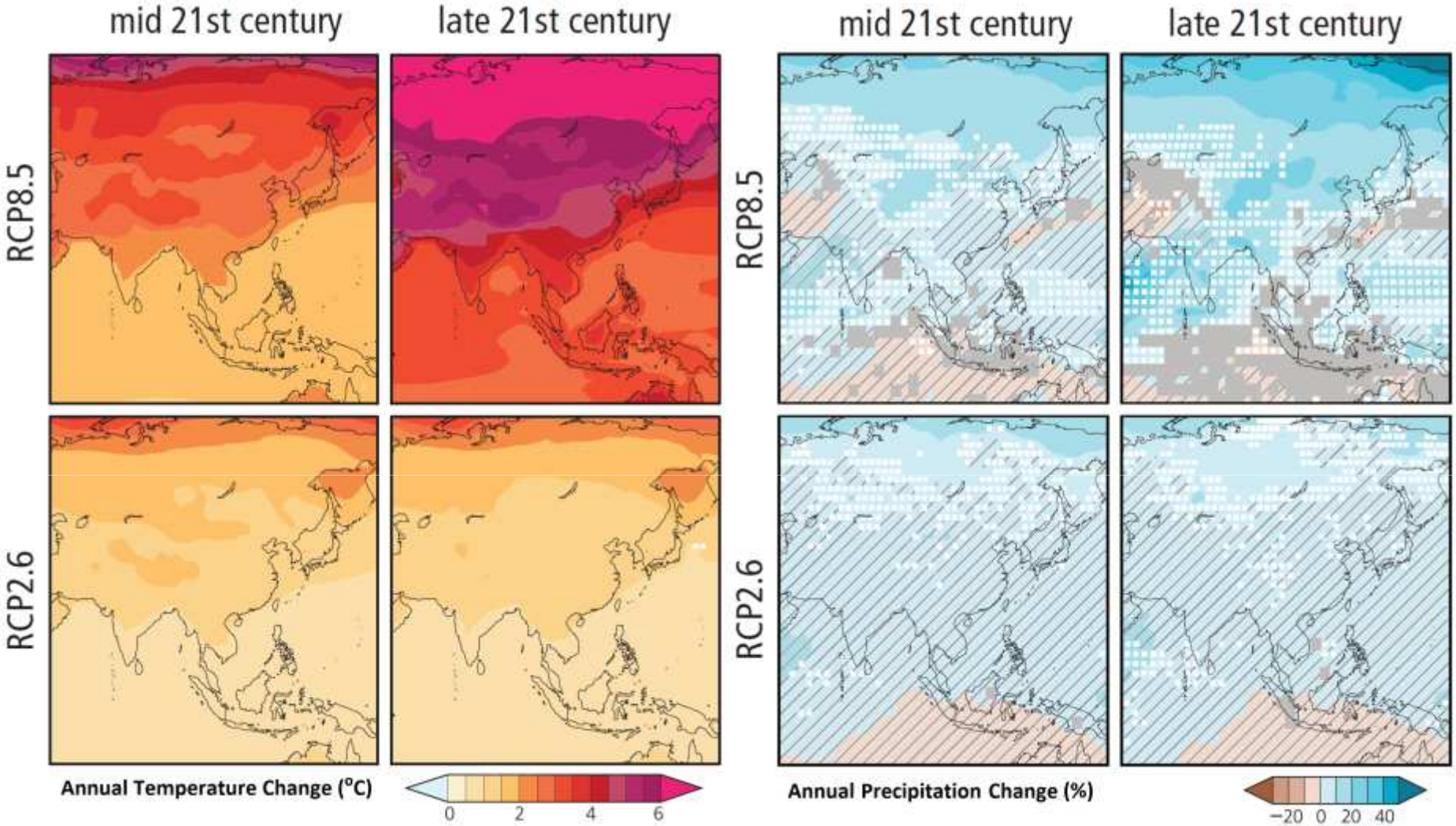
Climate Change in Asia



Hijioka, Y., E. Lin, J.J. Pereira, R.T. Corlett, X. Cui, G.E. Insarov, R.D. Lasco, E. Lindgren, and A. Surjan, 2014: Asia. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1327-1370.

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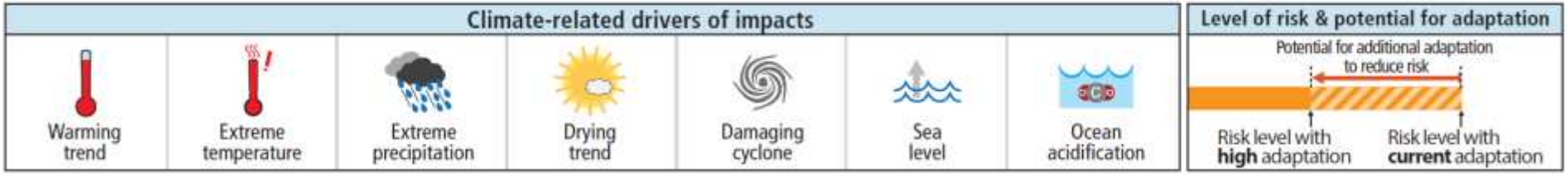
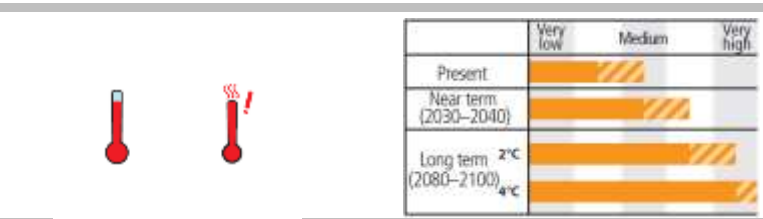
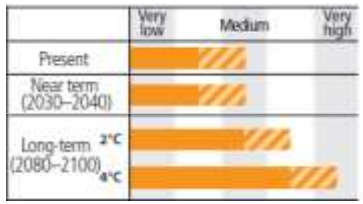
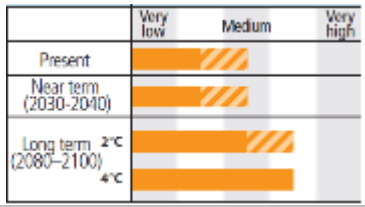
Climate Change in Asia

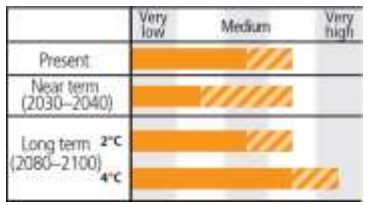


Key Risks	Climate Drivers	Timeframe	Urban Climate Strategy
Heatwave and heat-related mortality			Urban Land Use Building Design Urban Vegetation
Flooding and related deaths, injuries, diseases			Urban Infrastructure Seawall and Drainage Water Supply Network
Food and water security			Urban Planning Population Control
Urbanization and Urban Poverty			Urban Governance City Planning and Design









Global Climate → **Urban Climate**

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Threats to Asian Cities

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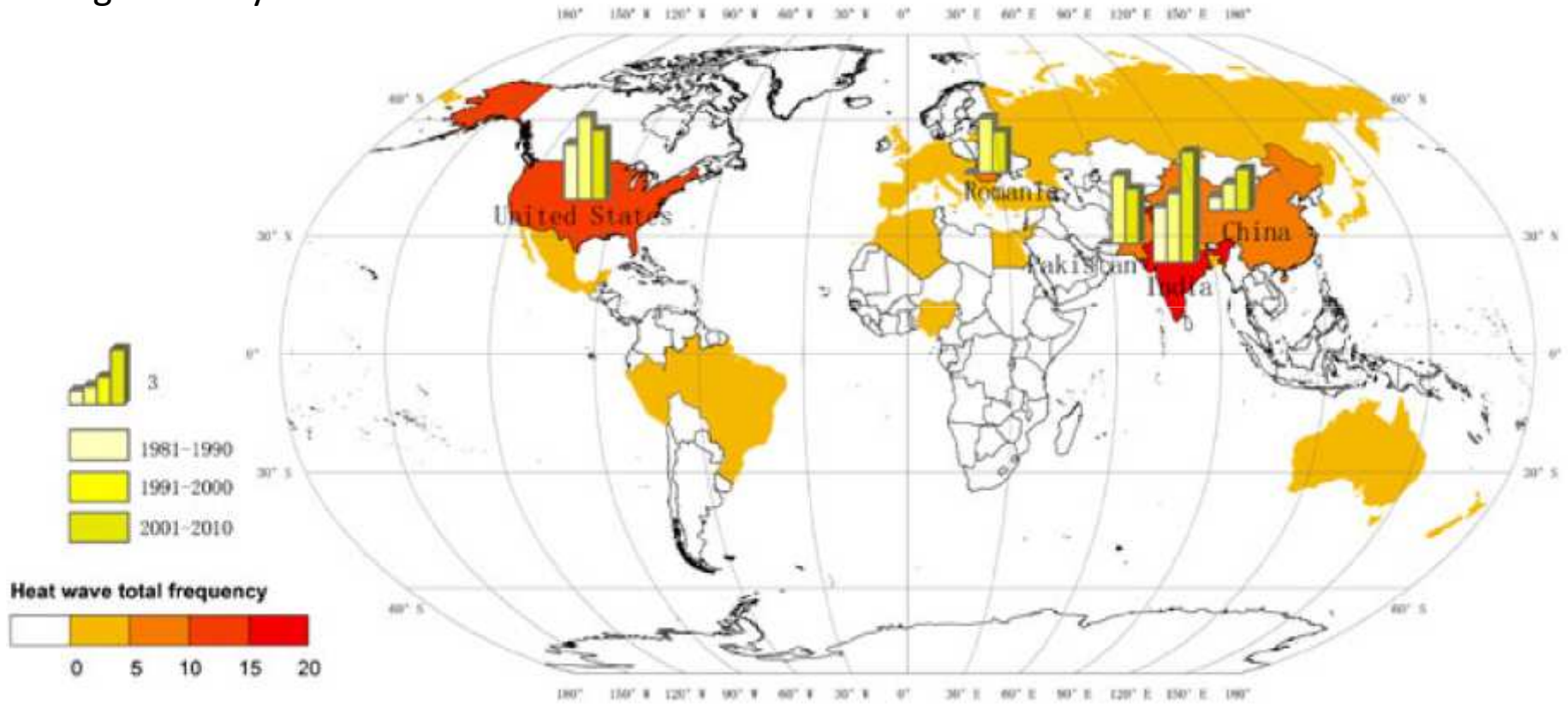
Heatwaves

Large population of Asian countries such as India, Pakistan and China

- High vulnerability
- Lack of access of cooling systems
- Huge scarcity of water



Song et al. (2014). Spatiotemporal changes of global extreme temperature events (ETEs) since 1981 and the meteorological causes. Natural Hazards 70(2): 975–994.

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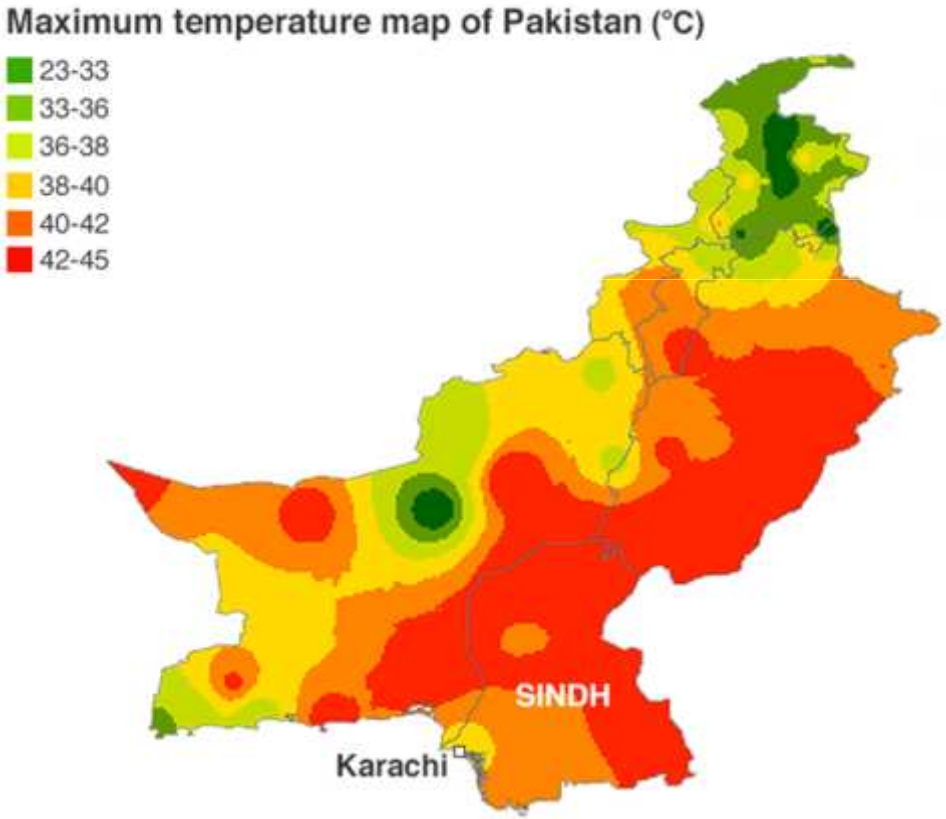
Heatwaves in South Asia

- Death toll: >2500 in India, >1000 in Pakistan
- Causes: delayed monsoonal rain, attributed to climate change
- Increase in PM2.5 due to hot dry wind from desert



Picture source: http://www.bbc.com/news/world-asia-33236067

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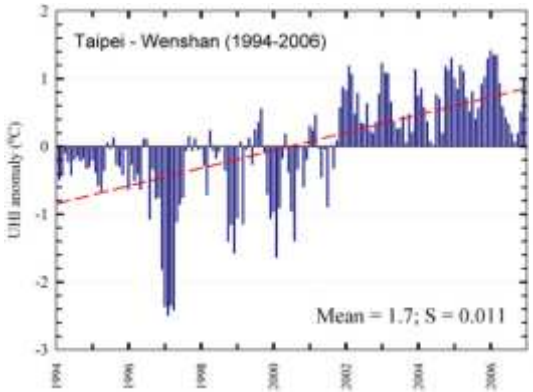
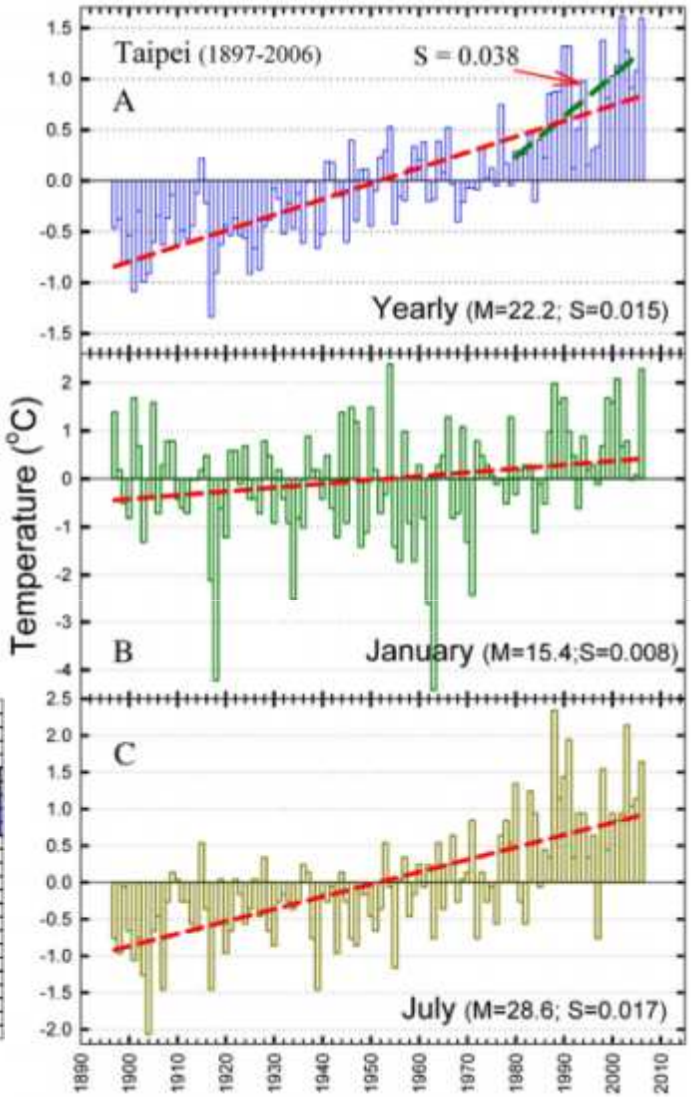
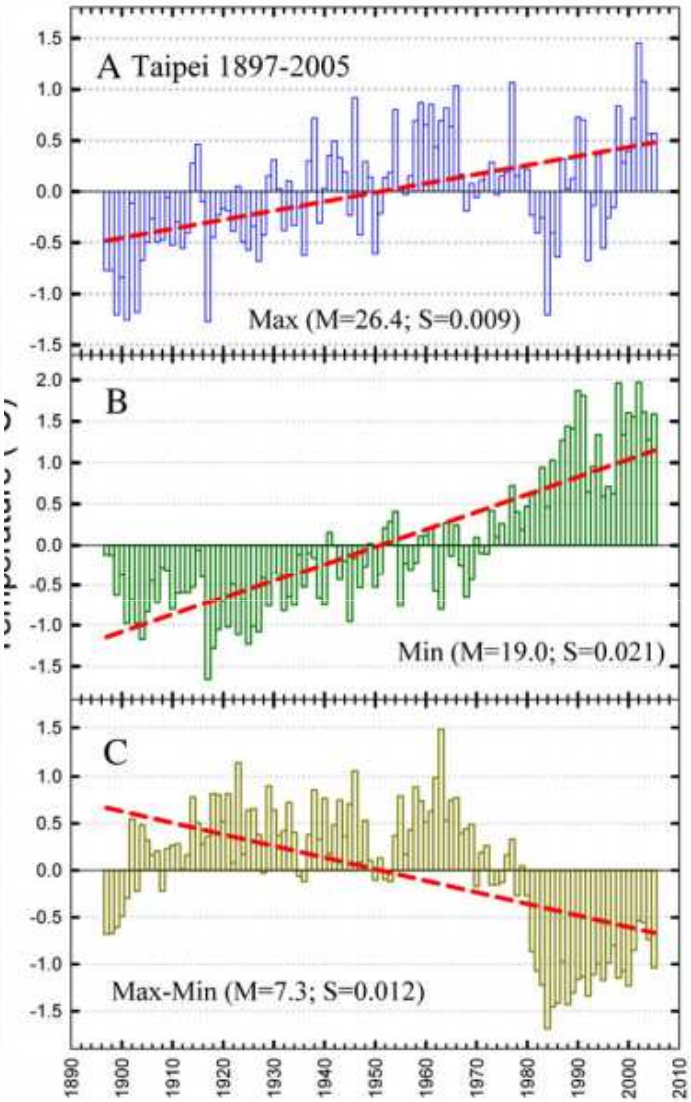
Urbanization and Climate Change in Asian Cities

Taipei

- Increased in a faster rate in last few decades
- Higher increasing trend in summer
- Higher increasing trend in minimum temperature
- High UHI intensity







Wang et al. 2008. Temperature and hydrological variations of the urban environment in the Taipei metropolitan area, Taiwan. Science of the Total Environment 404:393-400.

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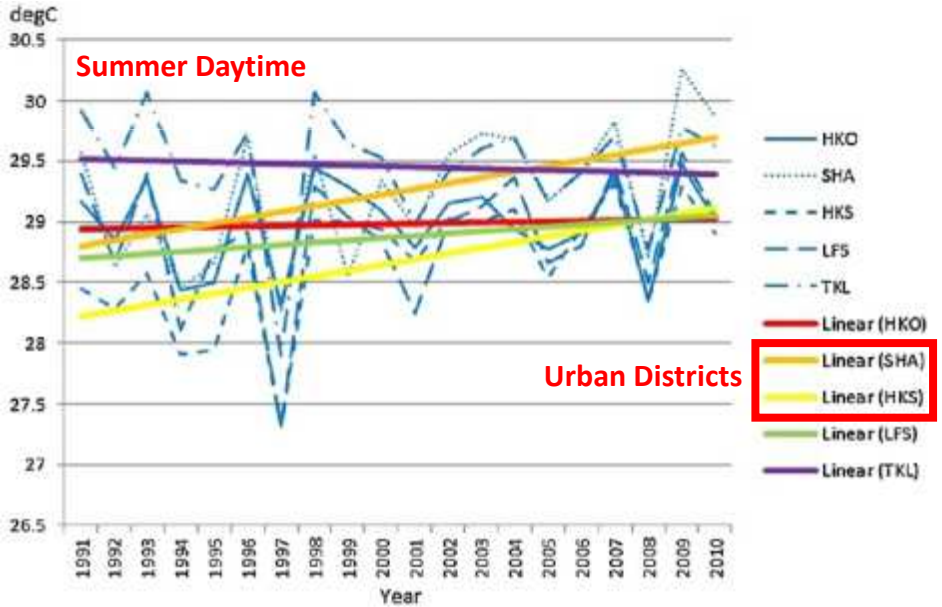
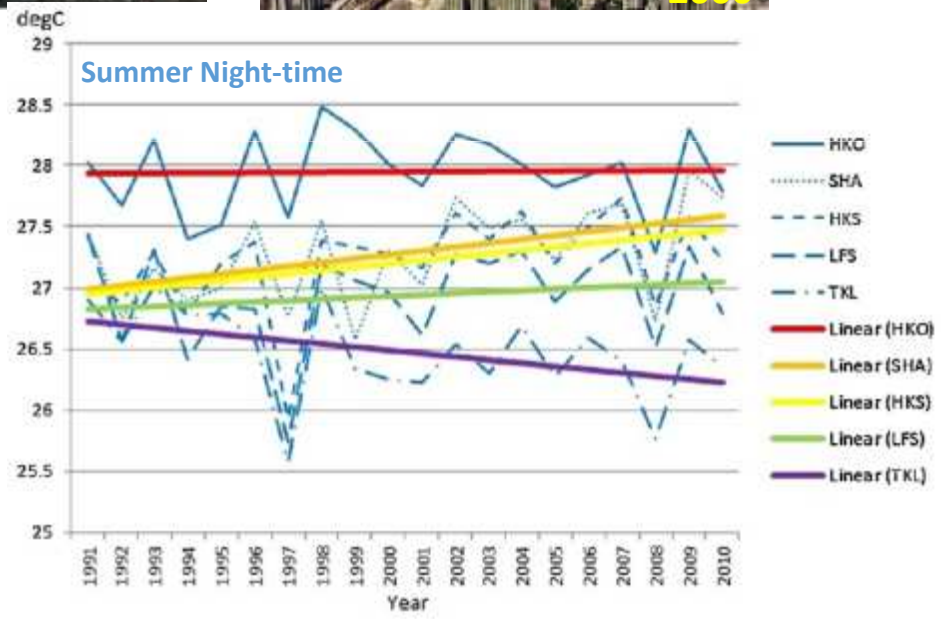
Climate Change in Asian Cities

Hong Kong

- 40-year air temperature record
- Higher increasing rate in urban areas, particularly during night-time





Lau K.L. and Ng E., 2013. An investigation of urbanization effect on urban and rural Hong Kong using a 40-year extended temperature record. Landscape and Urban Planning 114: 42–52.

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Nocturnal UHI and sleepless nights

… An average of 1 degree C increase in daily mean temperature above 28.2 degree C was associated with and estimated 1.8% increase in mortality. Heat-related mortality varied with sociodemographic characteristics …

(Chan et al 2012)

"When you go to sleep, your set point for body temperature -- the temperature your brain is trying to achieve -- goes down, … Think of it as the internal thermostat. If it's too cold, or too hot, the body struggles to achieve this set point. (H. Craig Heller 2012)

Sleep deprivation alters the expression of hundreds of genes, including some whose activity normally varies depending on the time of day.

(Derk-Jan Dijk et al 2013)

Derk-Jan Dijk et al . Sleepless nights affect gene activity. Nature 495, 9 (07 March 2013) doi:10.1038/495009d

H. Craig Heller, 2013. Secrets of Sleep Science: From Dreams to Disorders. The Teaching Company, USA.

Emily Ying Yang Chan, William B Goggins, Jacqueline Jakyoung Kim, Sian M Griffiths, 2012. A study of intracity variation of temperature-related mortality and socioeconomic status among the Chinese population in Hong Kong. J Epidemiol Community Health 2012;66:322-327 doi:10.1136/jech.2008.085167.

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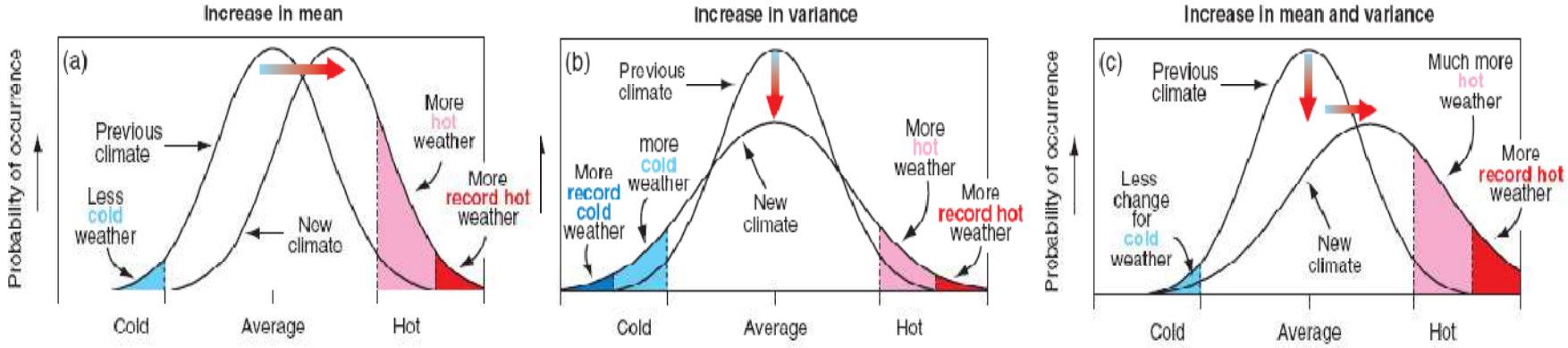
What 3 degree temperature rise means



HKO data	**Very hot days**		Hot days	Hot nights		**Very hot nights**
	(Tmax>=33)	(Tmax>=32)	(Tmax>=30)	(Tmin>=25)	(Tmin>=27)	**(Tmin>=28)**
T_{iu} increase	T_{iu}= 0	T_{iu}= +1	T_{iu}= +3	T_{iu}= +3	T_{iu}= +1	T_{iu}= 0
	No., of very hot days			No., of very hot nights		
2008	**15**	42	74	115	48	**15**
2007	**25**	61	117	121	52	**23**
2006	**3**	25	82	117	53	**15**
2005	**12**	33	93	135	51	**26**
2004	**6**	26	94	123	47	**19**
2003	**14**	40	91	139	62	**20**
2002	**10**	32	93	133	45	**17**
2001	**9**	38	90	121	41	**16**
2000	**10**	40	99	124	51	**22**
1999	**6**	49	113	133	55	**17**
average	**10.6**	38.2	96.9	127.3	50.8	**19.5**

Ng, E., (2009) Wind and Heat Environment in Densely Built Urban Areas in Hong Kong, (invited paper) A special issue on Wind Disaster Risk and Global Environment Change, the Association of International Research Initiatives for Environmental Studies (AIRIES), Journal of Global Environmental Research, Vol.13, No.2, 2009, pp169-178.

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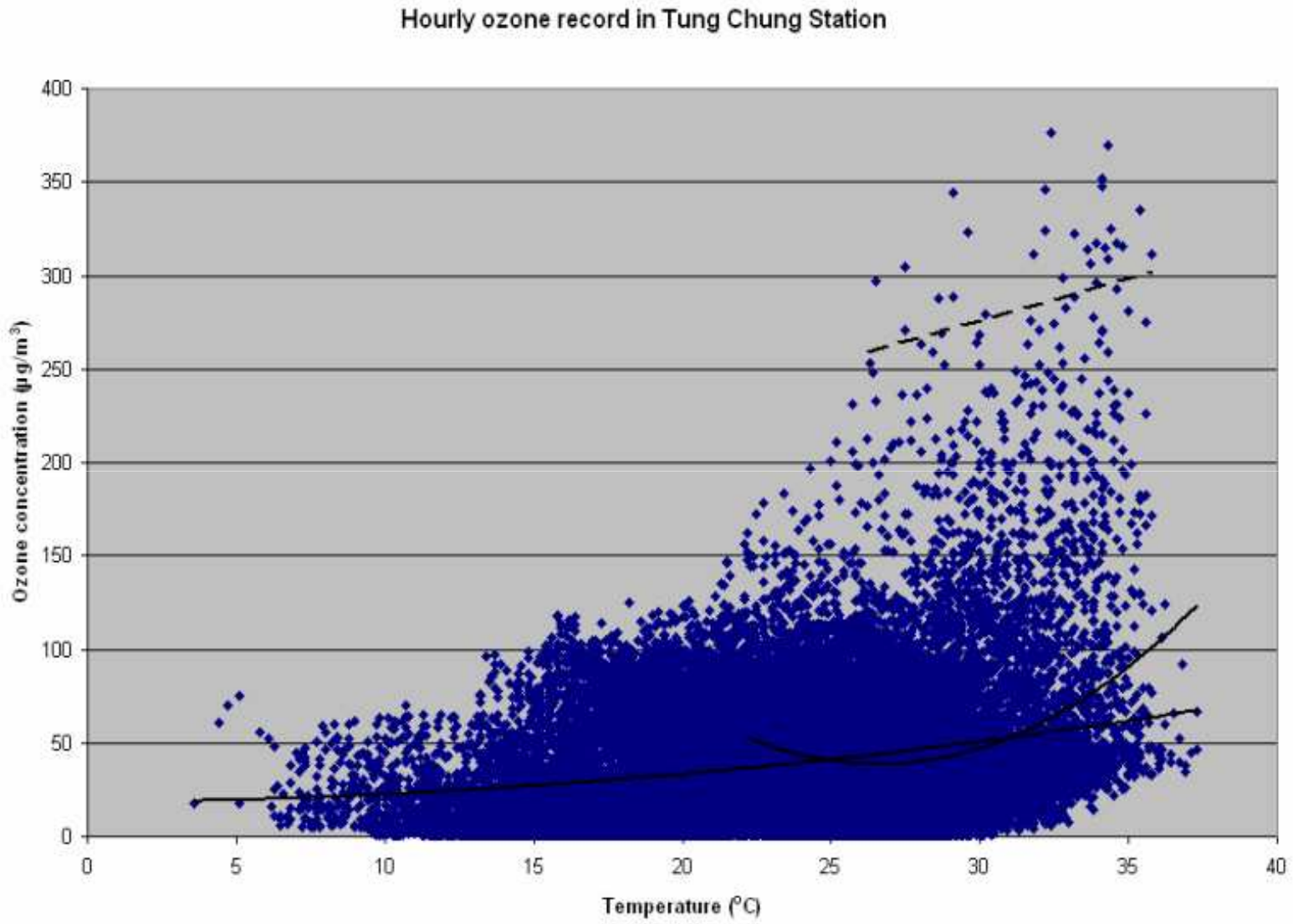
O3 and higher temperature



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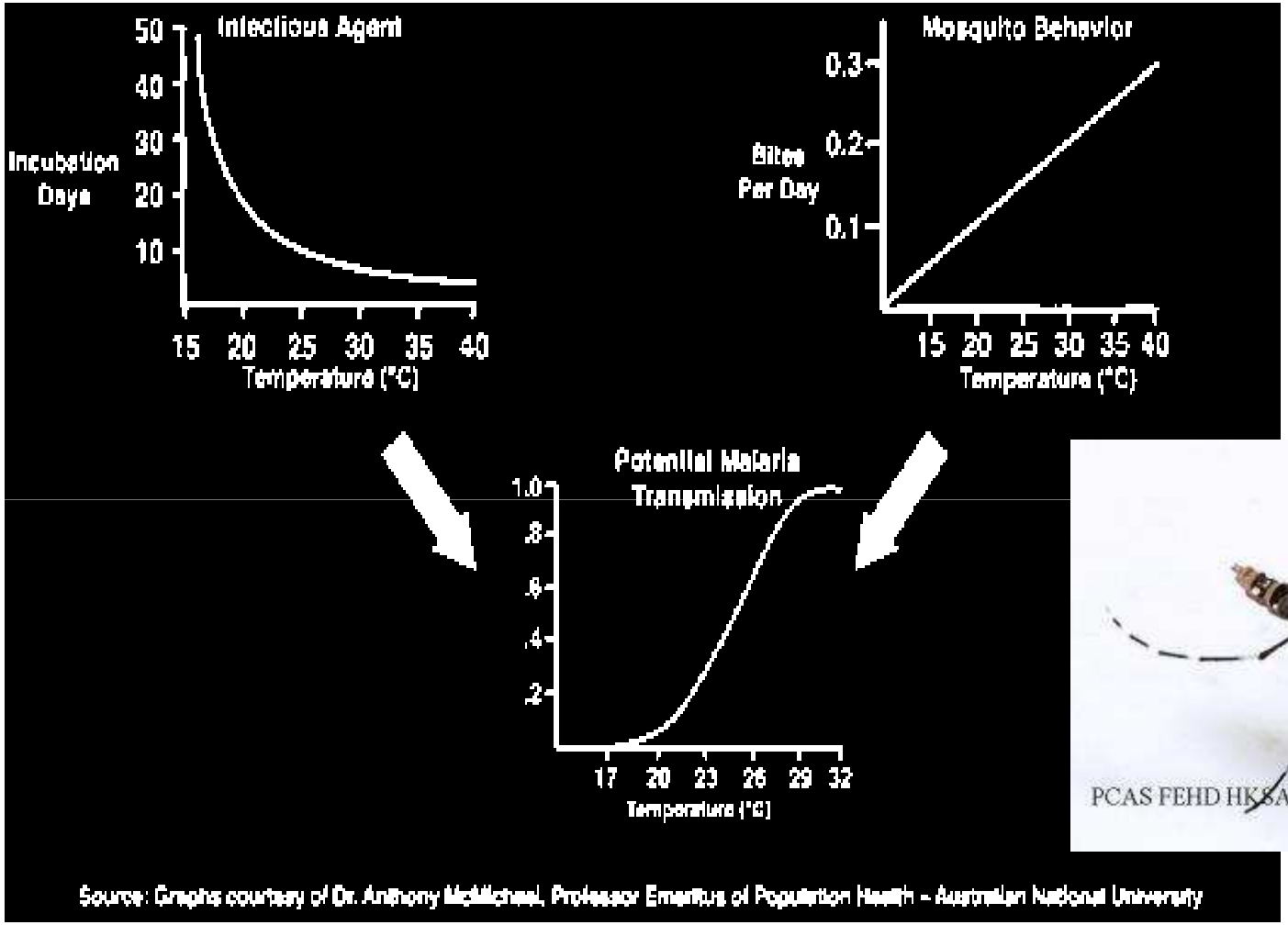
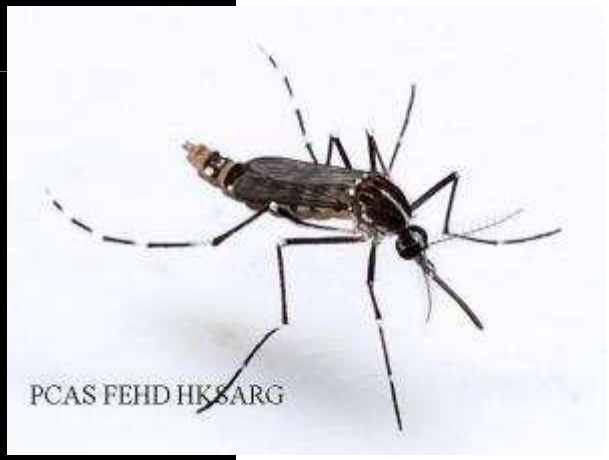
malaria and higher temperature





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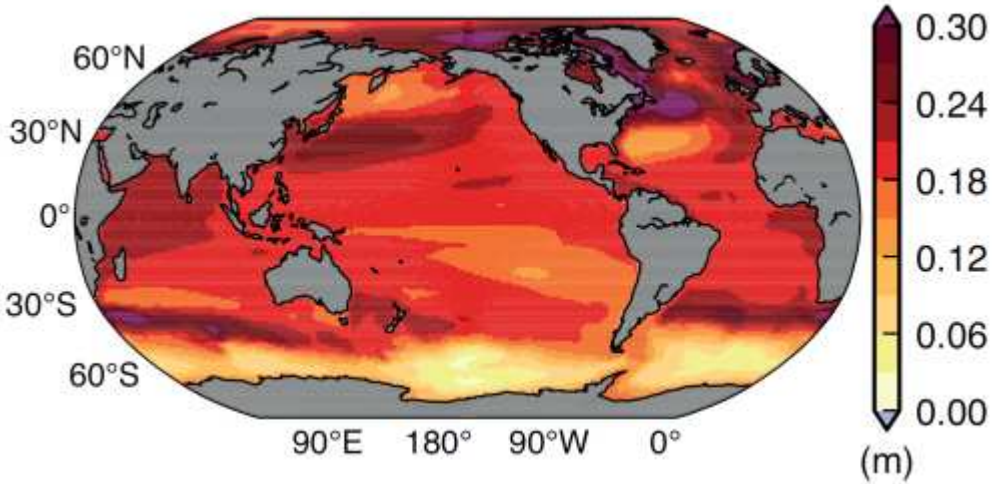
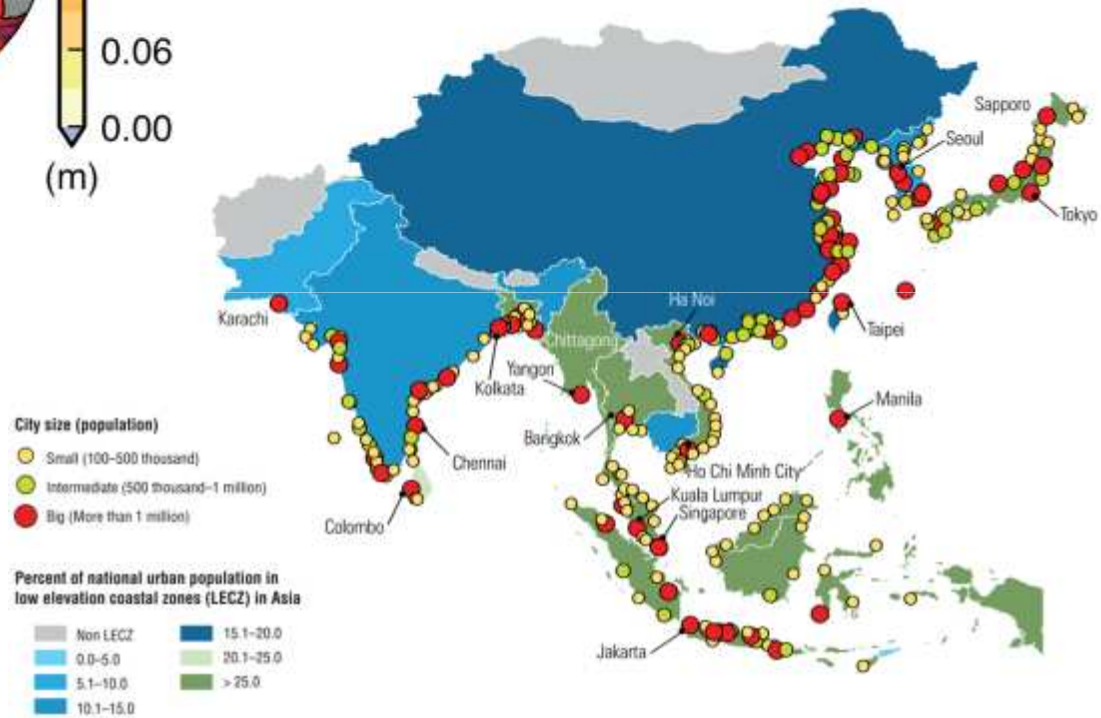
Sea Level Rise





Impacts of Sea Level Rise

- Inundation of coastal plain
- Beach and coastal erosion
- Removal of protective sand dunes and vegetation
- Intrusion of salt water into freshwater supplies
- Amplified storm surge and flooding

Fuchs (2010), Cities at risk: Asia's coastal cities in an age of climate change. Asia Pacific Issues 96: 1–12.

Church, J.A. et al., 2013: Sea Level Change. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

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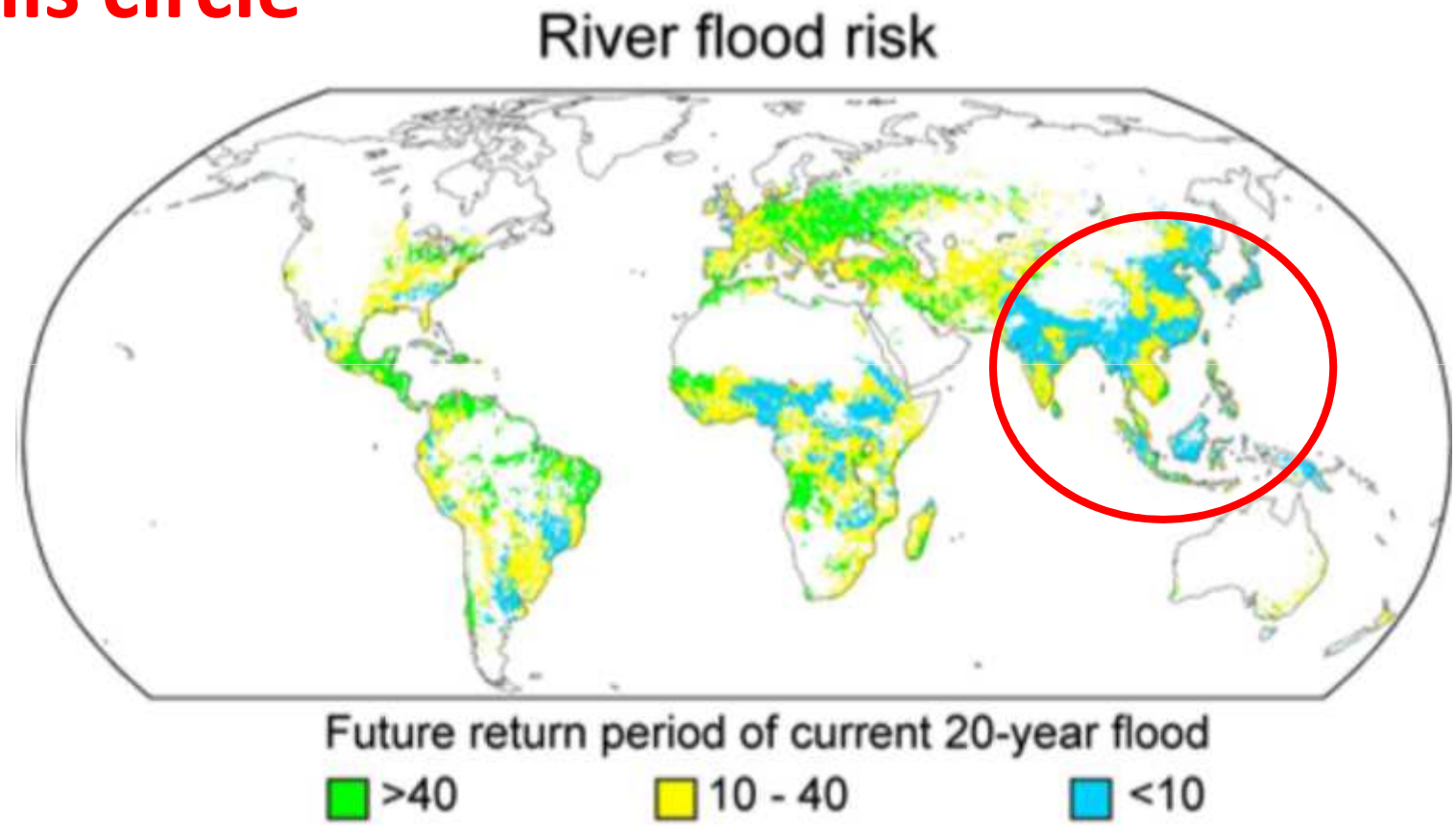
Flooding

More than half of the world population lives inside this circle



Arnell et al. (2014), The impacts of climate change across the globe: A multi-sectoral assessment. Climatic Change, in press.

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Storm surge

Typhoon Hagupit (2014) (180 km SSW of HK) brought a 1.4 m storm surge at Victoria Harbour, raising the sea level to a height of 3.53 m above Chart Datum [2nd highest after Typhoon Wanda (1956)]

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Storm surge

Typhoon Hagupit (2014) (180 km SSW of HK) brought a 1.4 m storm surge at Victoria Harbour, raising the sea level to a height of 3.53 m above Chart Datum [2nd highest after Typhoon Wanda (1956)] …

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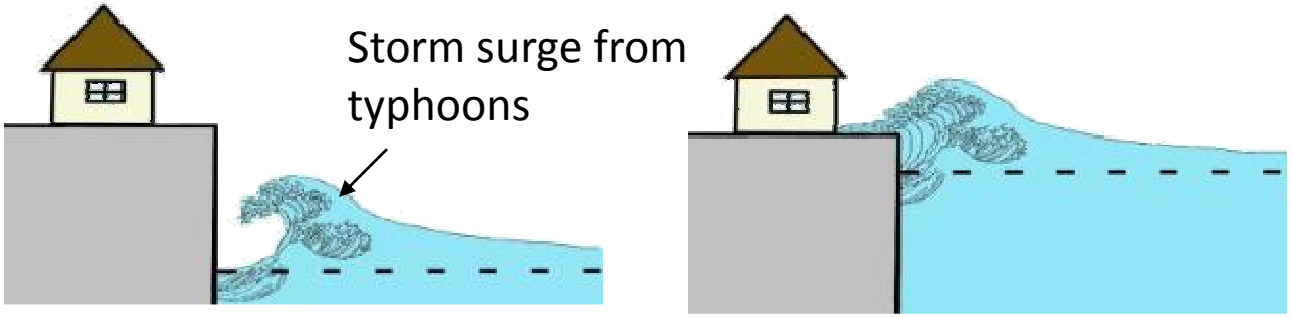
Subsiding house foundation at Cheung Chau - erosion due to Typhoon Hagupit

Storm surge

Storm surge risks increase with sea level rise

Hagupit (50 yr event) becomes an annual/biennial event



IPCC Assessment Report No. 5 projects that in the last decades of 21st century, global sea level rises by 0.26-0.82m

Return period (yr)	Extreme sea level above chart datum (m)		
	With current sea level	Mean sea level rises by 0.26m	Mean sea level rises by 0.82m
2	2.9	3.2	3.7
5	3.1	3.4	3.9
10	3.3	[illegible]	4.1
20	3.4	3.6	4.2
50	3.5	3.8	4.4

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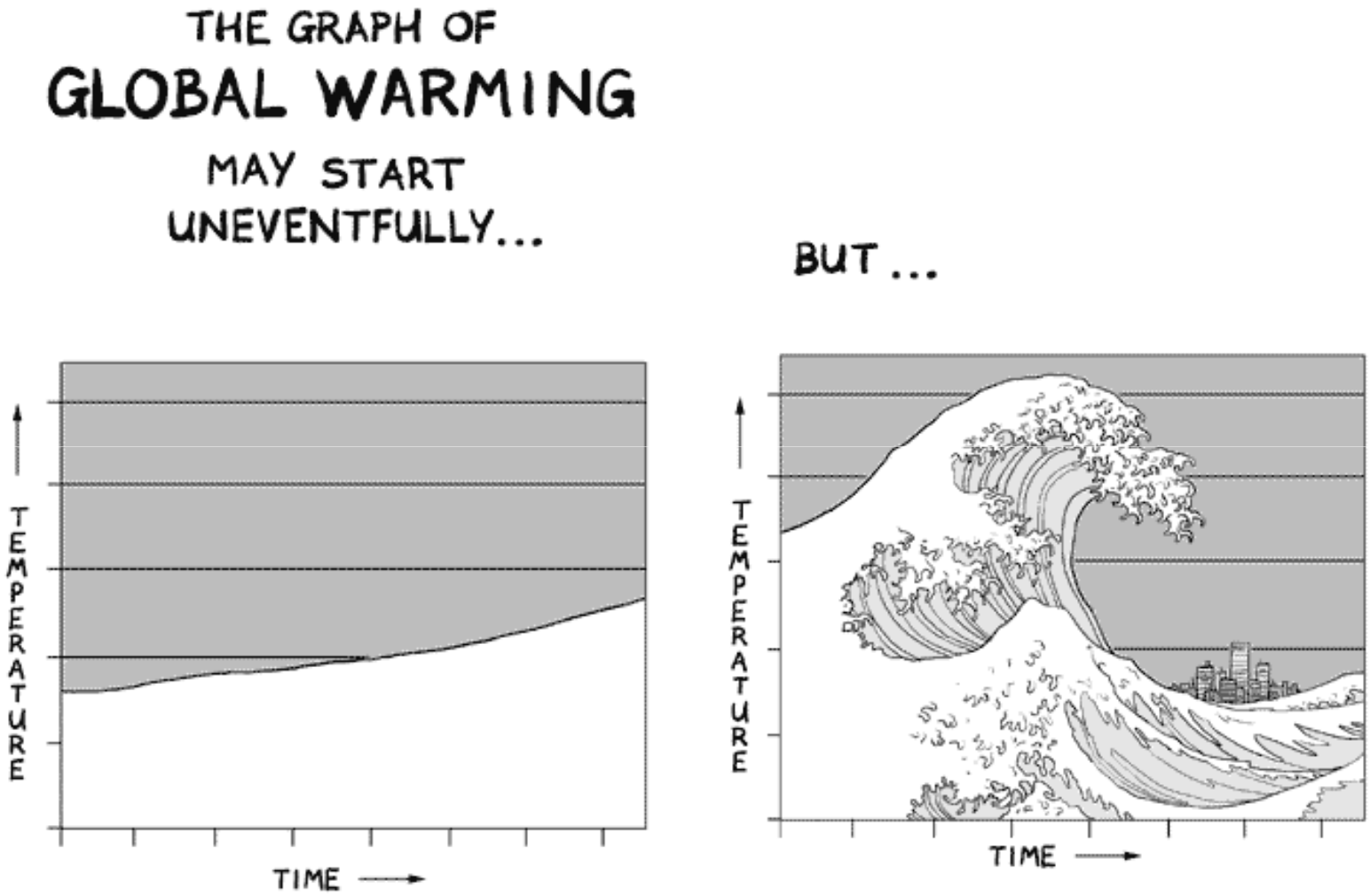
The threshold



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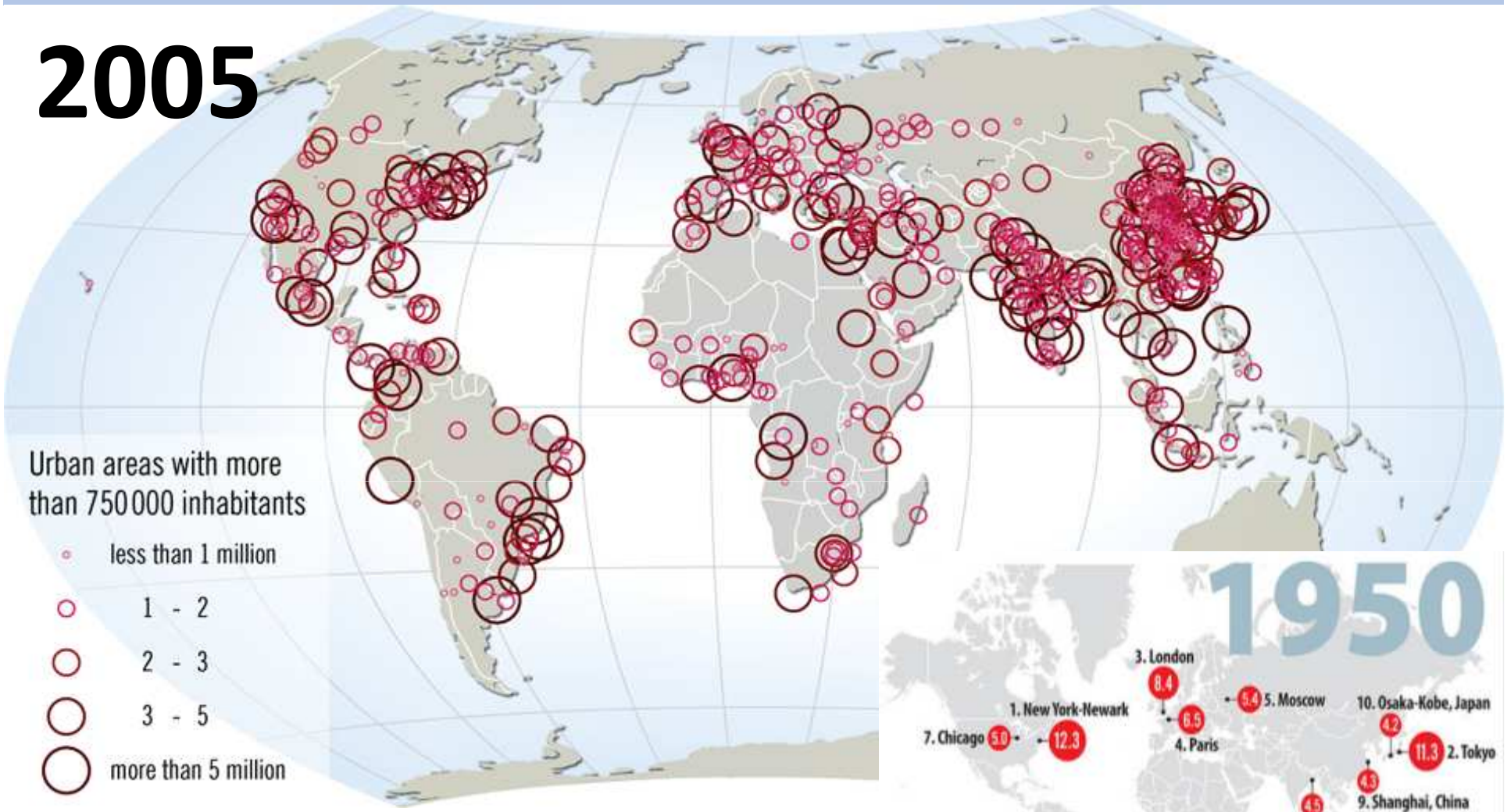
Urban Population

2005



Today, half of us live in cities, some of them in mega-cities

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Urban Population

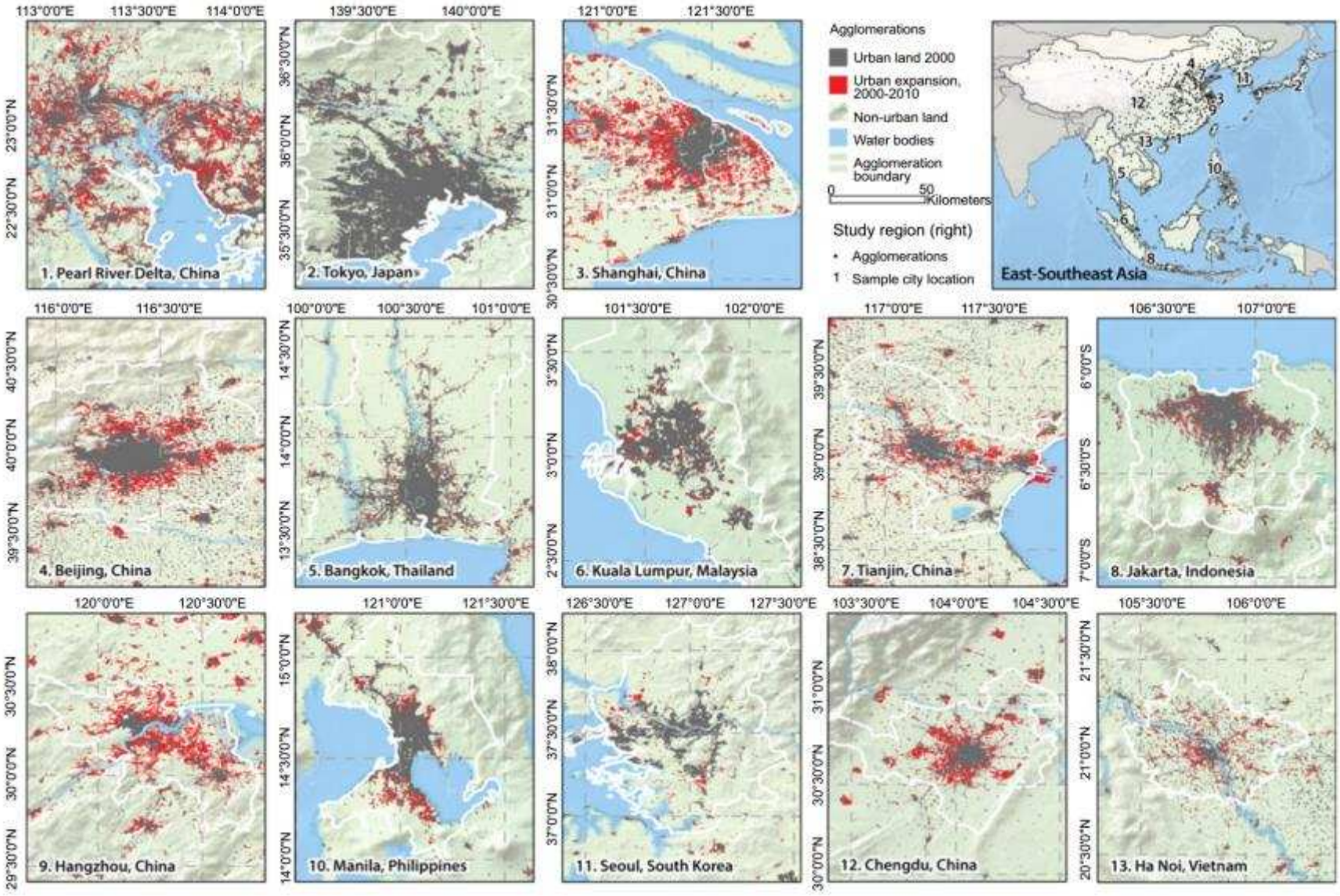
Half of the world's urban population reside in Asia

- Nearly doubled by the end of mid-21st century
- Resided in areas vulnerable to climate change

	Major area, region, or country	1950	1970	1990	2010	Projected for 2030	Projected for 2050
Urban population (millions of inhabitants)	**World**	745	1352	2281	3559	4984	6252
	More developed regions	442	671	827	957	1064	1127
	Less developed regions	304	682	1454	2601	3920	5125
	Least developed countries	15	41	107	234	477	860
	Sub-Saharan Africa	20	56	139	298	596	1069
	Northern Africa	12	31	64	102	149	196
	Asia	245	506	1032	1848	2703	3310
	China	65	142	303	660	958	1002
	India	63	109	223	379	606	875
	Europe	281	412	503	537	573	591
	Latin America and the Caribbean[a]	69	163	312	465	585	650
	Northern America	110	171	212	282	344	396
	Oceania	8	14	19	26	34	40

Revi, A. et al. 2014: Urban areas. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 535-612.

Urbanization – land use changes



Schneider et al. (2015), A new urban landscape in East–Southeast Asia, 2000–2010. Environmental Research Letters 10: 034002.

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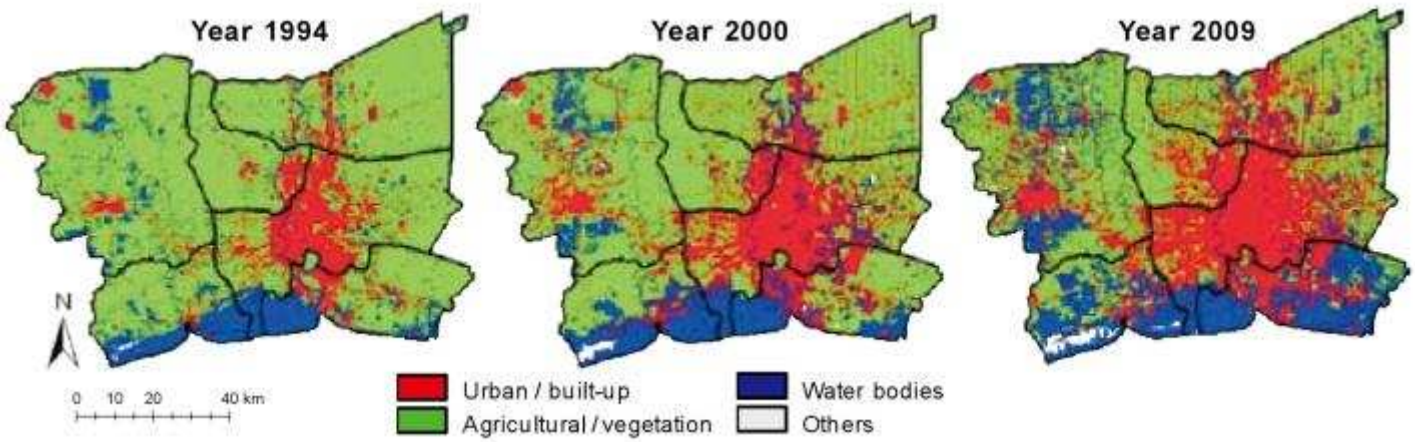
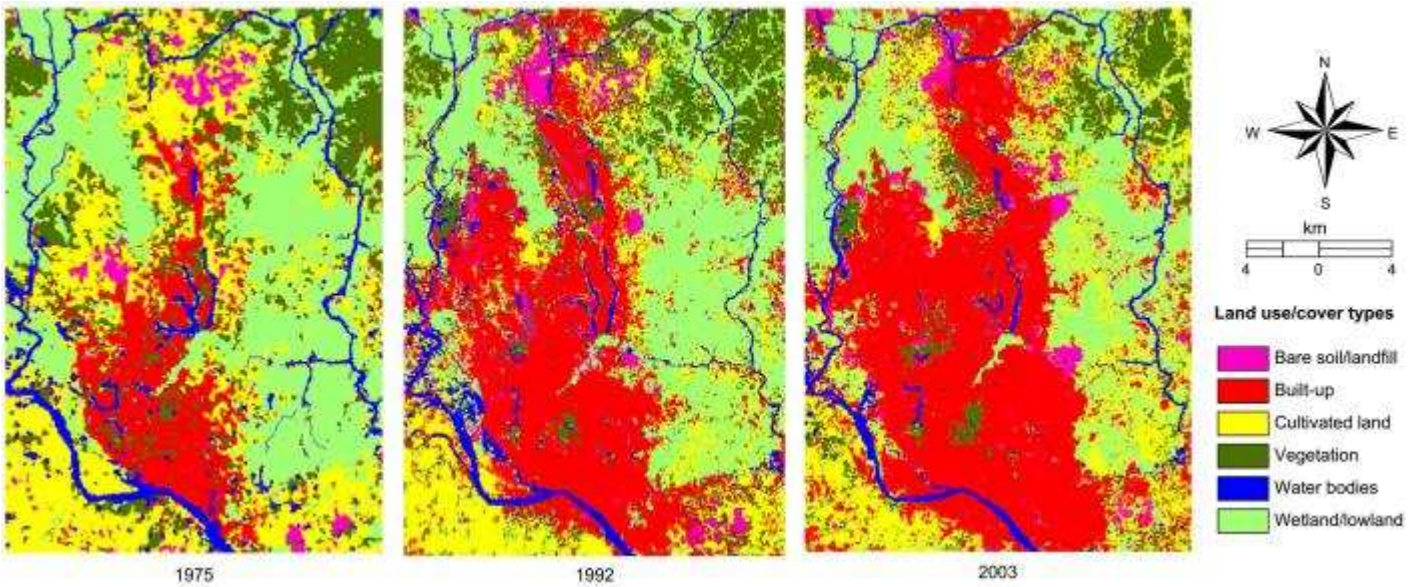
Fast Urbanization

Bangkok, Thailand





Dhaka, Bangladesh

Nagasawa et al. (2011), Urbanization and its influences on the suburban land use changes in Bangkok Metropolitan Region, Thailand. 32nd Asian Conference on Remote Sensing 2011, ACRS 2011, 1, pp. 103-108

Dewan and Yamaguchi (2009), Land use and land cover change in Greater Dhaka, Bangladesh: Using remote sensing to promote sustainable urbanization. Applied Geography 29(3): 390–401

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ARC3 – Adaptation strategies

LAND USE

Risks

Land sensitivity factors:

- Natural setting, Urban form, Built environment
- Extent of heat island effect
- Adaptive capacity -- urban land management system including: legal/political, planning, land regulations, infrastructures and urban services, land markets, and fiscal systems

Adaptation and Mitigation strategies

- Reduce sprawl, increase densities and mix uses to reduce auto use and increase public transit use
- Change in building codes to reduce energy use for heating and cooling
- Land use restrictions in areas subject to climate change impacts such as sea level rise
- Changes to building codes/land regulations to reduce damage from climate change hazards, e.g., elevating buildings in flood-prone areas
- Increase urban trees and vegetation to reduce the heat island effect

ARC3
First UCCRN Assessment Report on
Climate Change and Cities

Source: Marco Schmidt, 2003

Informal settlements on steeply sloped public land in Rio de Janeiro, Brazil

Key takeaway

Urban land strategies highly dependent on coordination and effectiveness of planning and management systems in politically fragmented metropolitan areas

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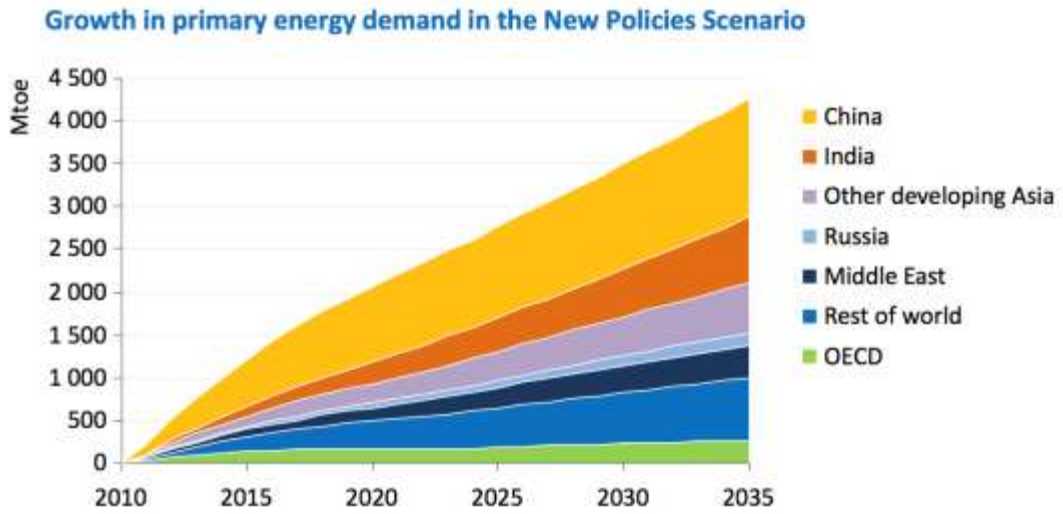
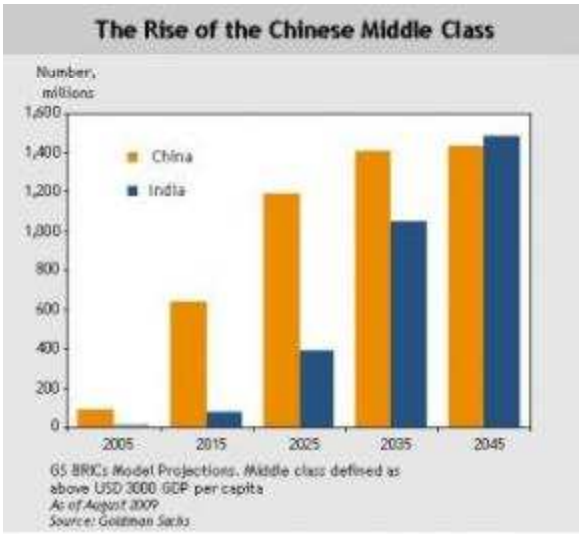
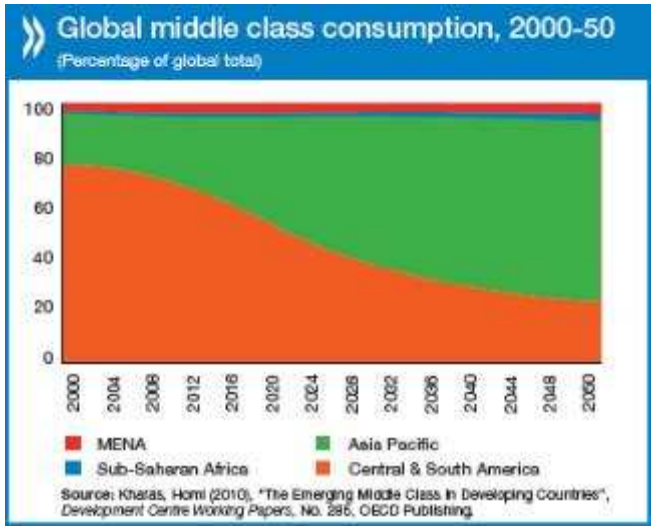
Rise of Middle Class







Top: http://www.peopleandtheplanet.com/index.html@lid=30091&section=36&topic=23.html
Bottom left: http://blogs.reuters.com/globalinvesting/2009/09/22/another-nail-in-the-malthusian-coffin/
Bottom Right: http://www.oecdobserver.org/news/fullstory.php/aid/3681/An_emerging_middle_class.html

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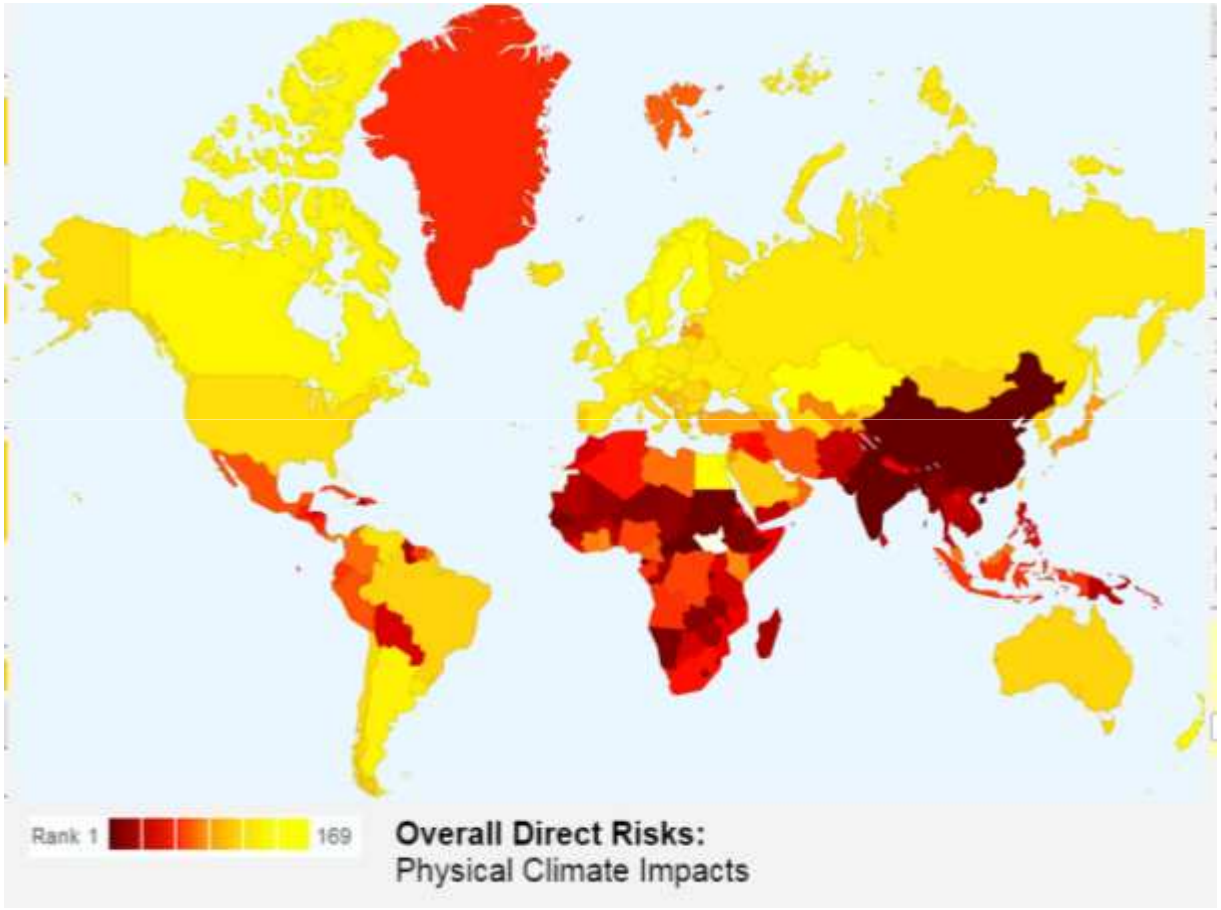
Adaptation strategies - China

Overall direct risks to Climate Change including Extreme Weather, Sea Level Rise, Agricultural Productivity Loss : China ranks No. 1



Source: http://www.cgdev.org/page/mapping-impacts-climate-change?utm_=

Adaptation strategies - China

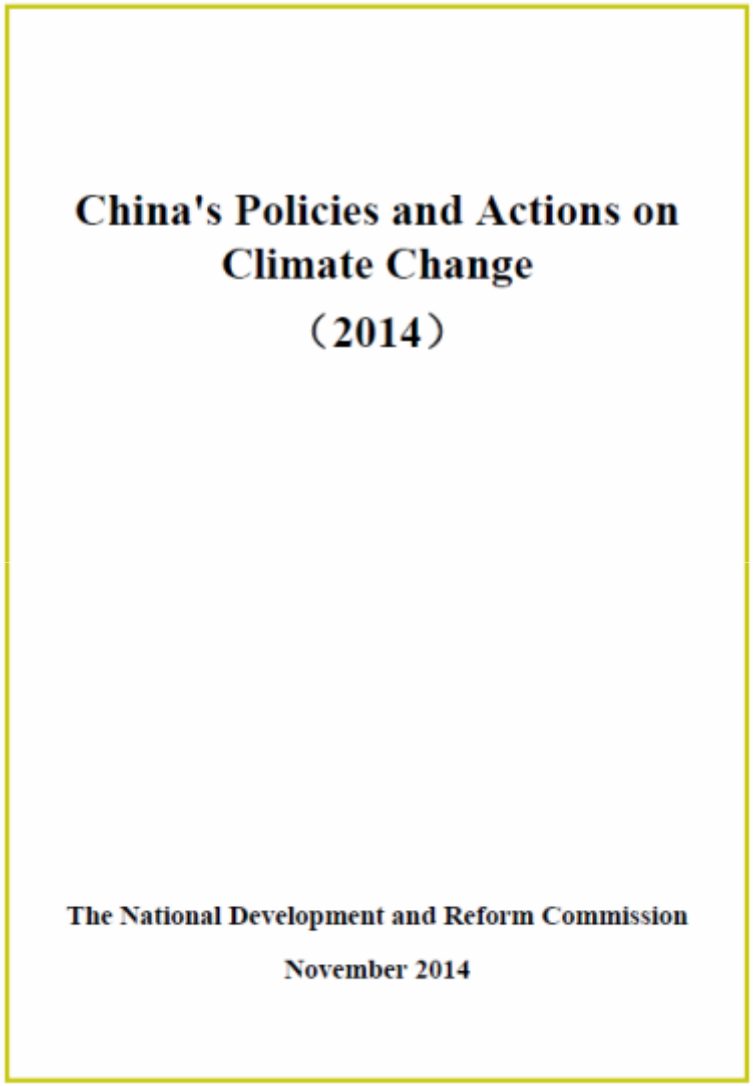
National Strategy of Climate Change Adaptation (2013)

Seven aspects:

- Infrastructure
- Agriculture
- Water Resources
- Coastal Areas
- Ecosystem
- Public Health
- Tourism and others

Source: National Development and Reform Commission , 2013 & Xinhua

Adaptation strategies - China


China's Policies and Actions on Climate Change

（2014）

The National Development and Reform Commission

November 2014

China issued the National Plan on Addressing Climate Change (2014-2020)

China has pledged to reduce its carbon emission intensity by 40-45% by 2020 compared with the 2005 level.

Source: National Development and Reform Commission

Source: http://www.ltaaa.com/post-1044.html

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Adaptation strategies - China

Technical guideline for climatic feasibility demonstration in urban overall planning

ICS 07.060
A47
备案号:

QX

中华人民共和国气象行业标准

QX/T XXXXX—XXXX

城市总体规划气候可行性论证技术导则

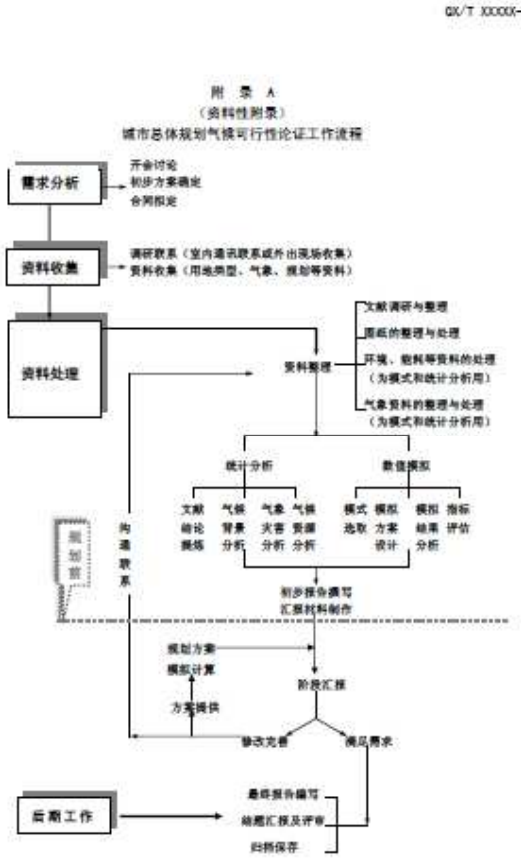
Technical guideline for climatic feasibility demonstration in urban overall planning

（征求意见稿）

（本稿完成日期：2011年8月）

XXXX－XX－XX 发布　　XXXX－XX－XX 实施

中国气象局　发布



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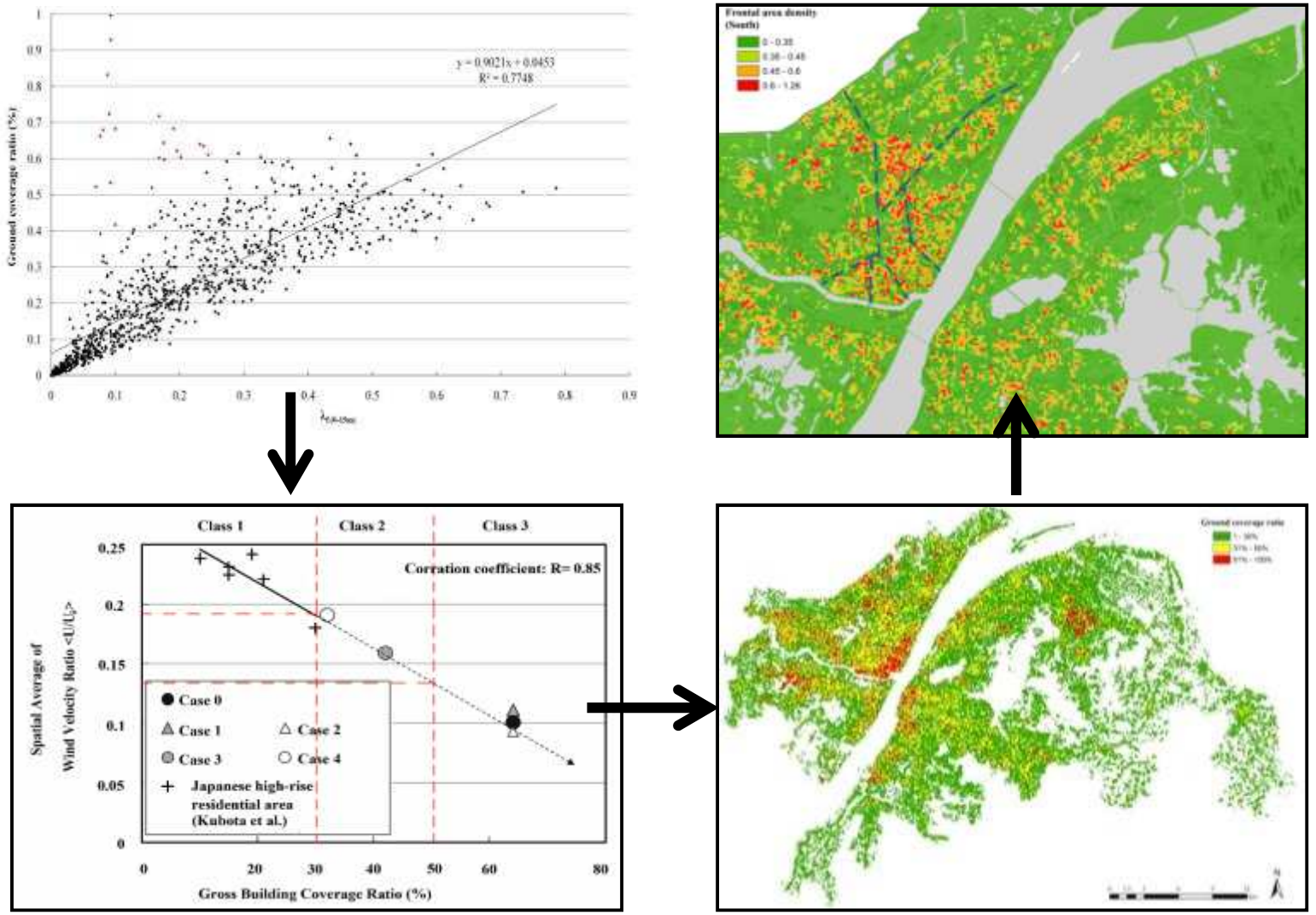
Adaptation strategies - China



Ng, E., Yuan, C., Fung, J.C., Ren, C., & Chen, L., 2011, Improving the wind environment in high-density cities by understanding urban morphology and surface roughness: A study in Hong Kong, Landscape and Urban Planning 101 (1) 59-74.

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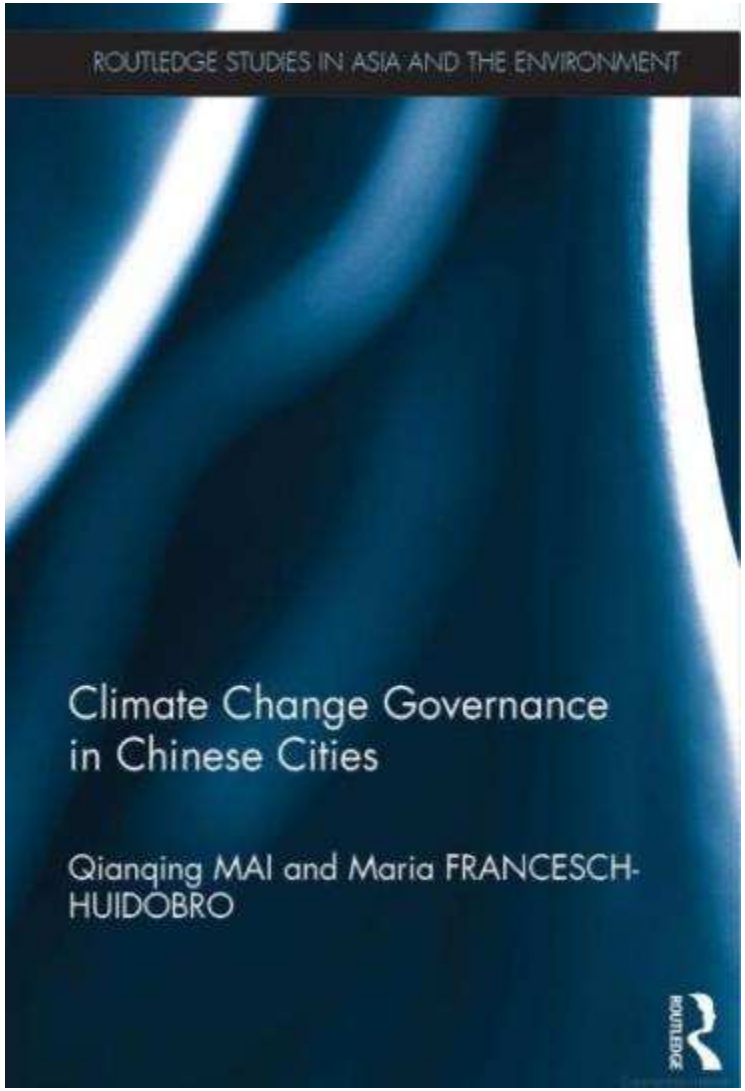
Adaptation strategies - China



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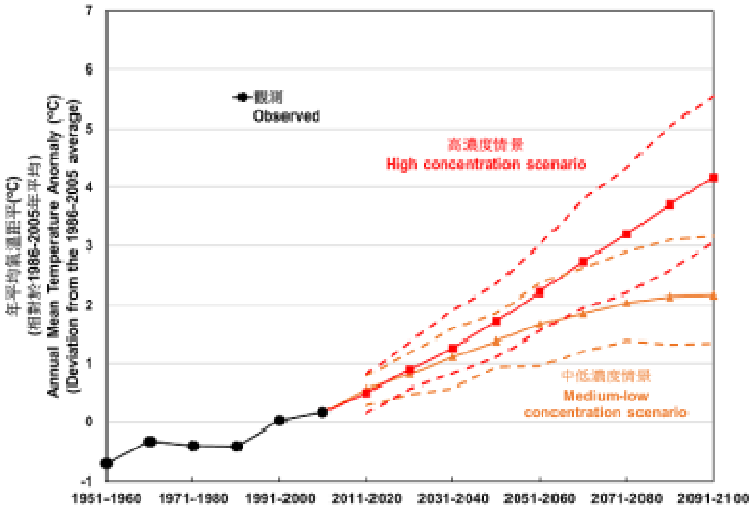
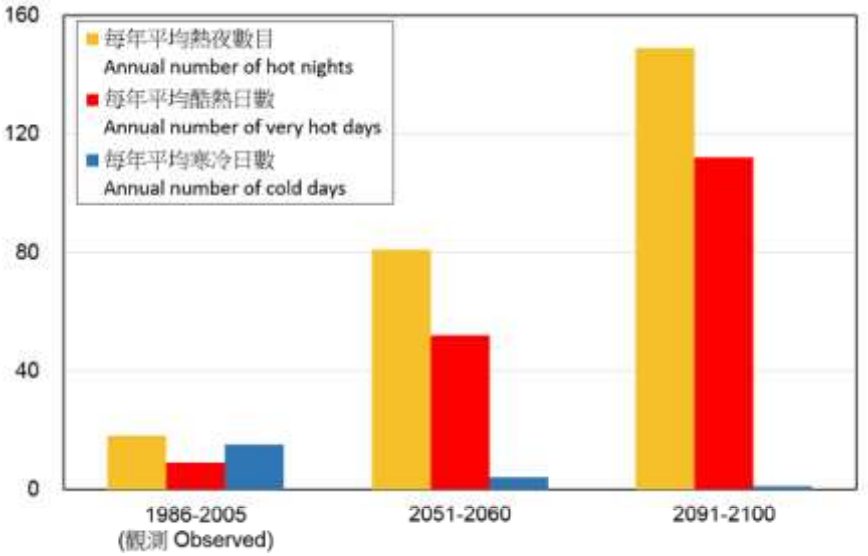
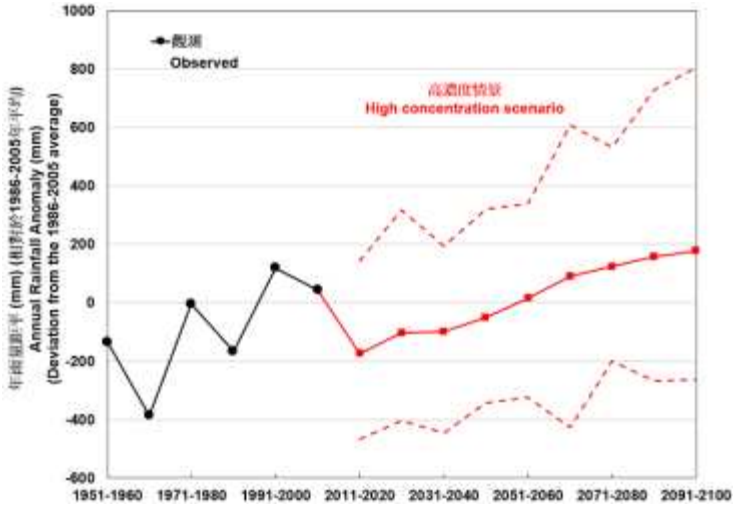
Adaptation strategies - Hong Kong

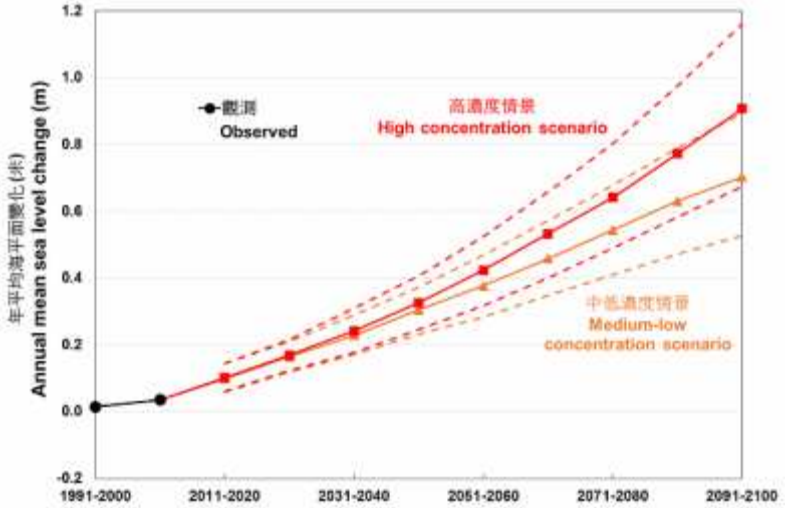
Risks of Climate Change:

Source: HKO









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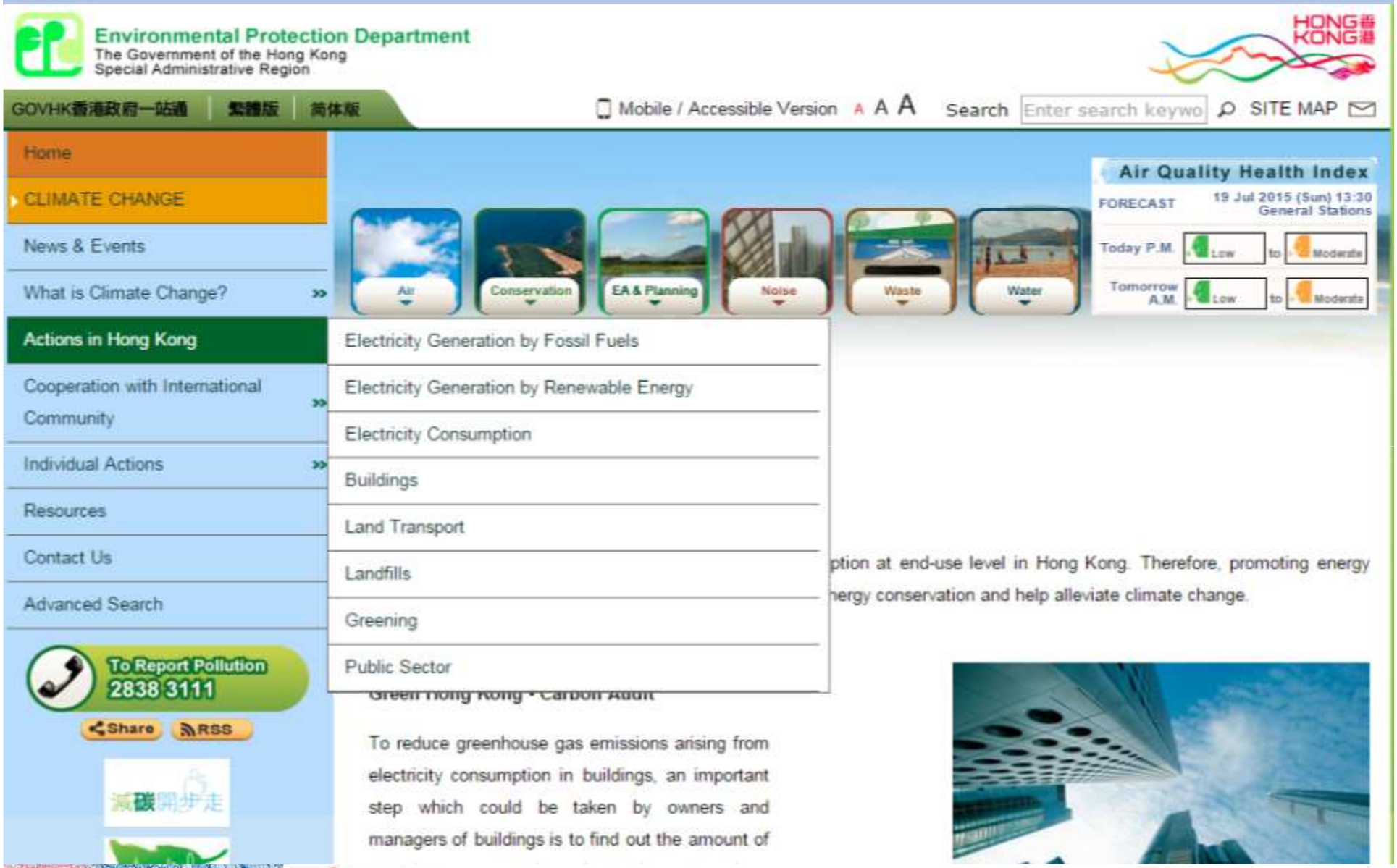
Adaptation strategies - Hong Kong



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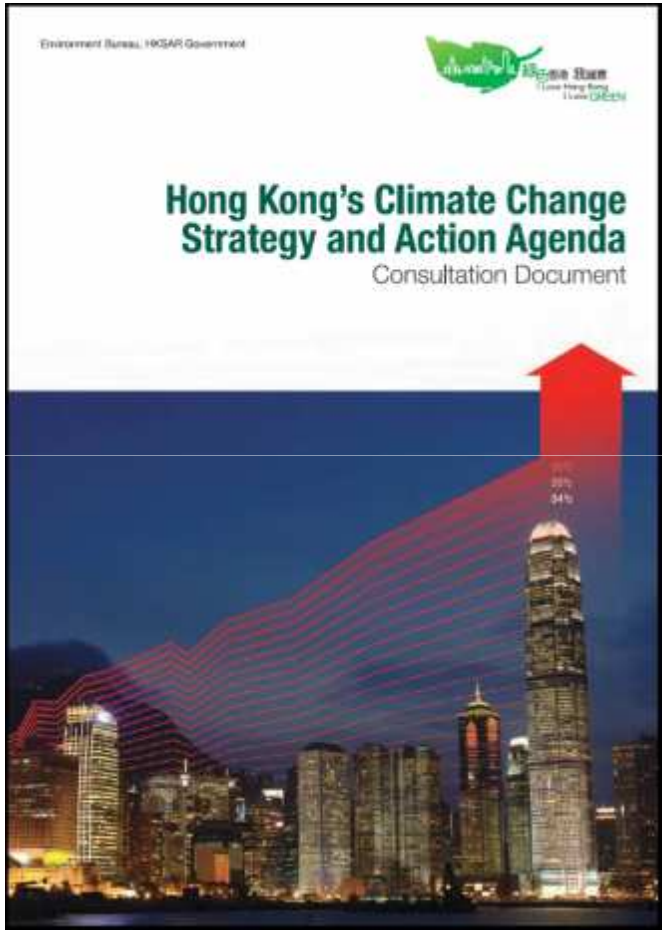
Adaptation strategies - Hong Kong

Hong Kong's Climate Change Strategy and Action Agenda (2012)

Adaptation Options and Measures:

- Monitoring
- Institutional Strengthening and Capacity Building
- Disaster Management and Emergency Planning
- Research and Investigation
- Education and Public Awareness



Source: Environment Bureau, 2010

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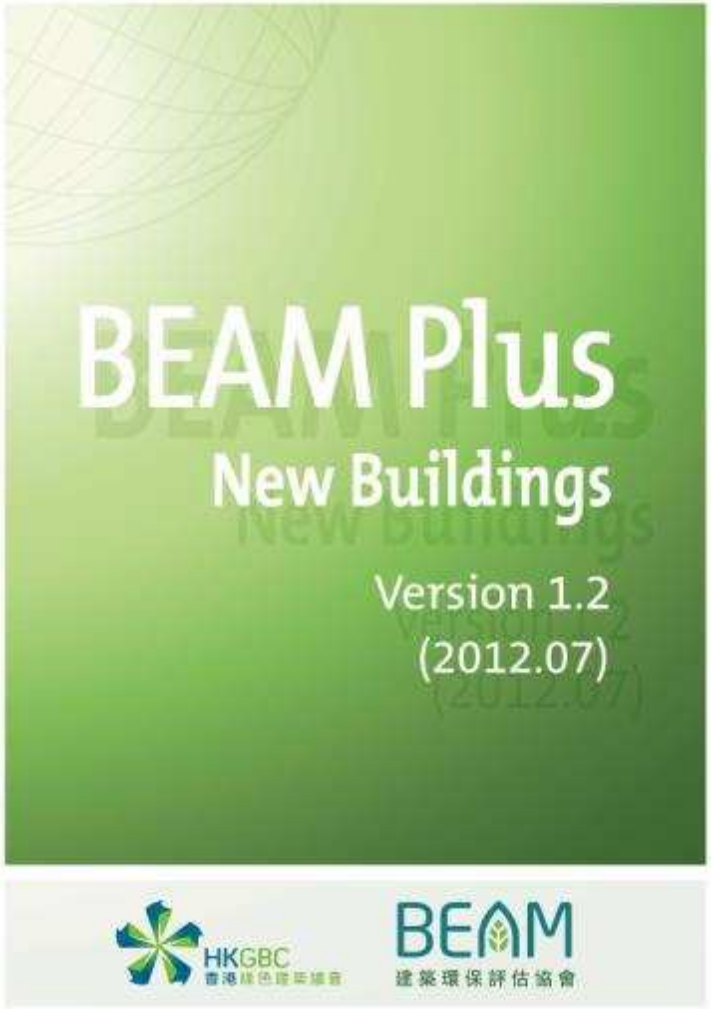
Adaptation strategies - Hong Kong

Actions:

- Site
- Energy
- Material
- Water
- IEQ

Urban environment and buildings



Source: HK EPD & HKGBC

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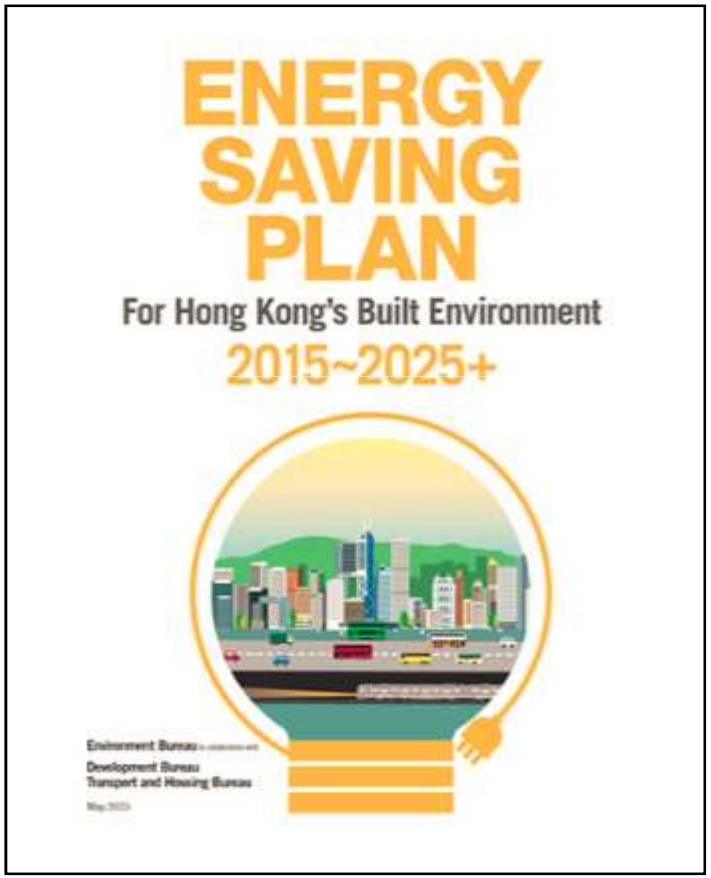
Adaptation strategies - Hong Kong

Actions:

- Energy intensity reduction
- Design summer year
- Benchmarking and monitoring
- Education and Public Awareness

Green Building blueprint



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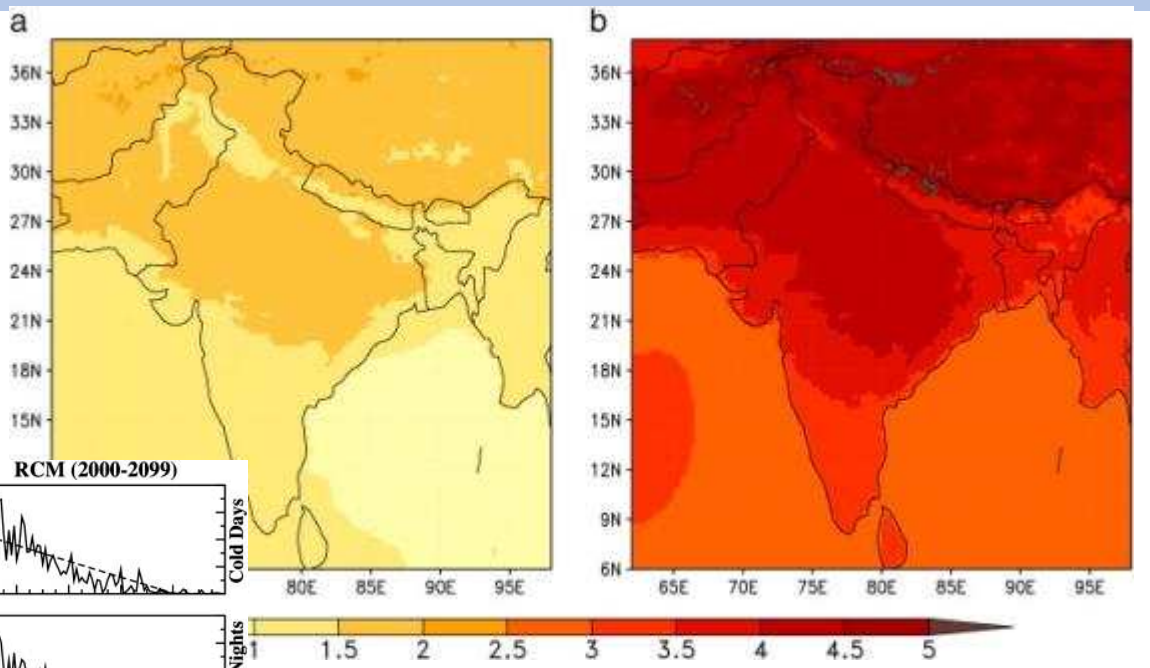
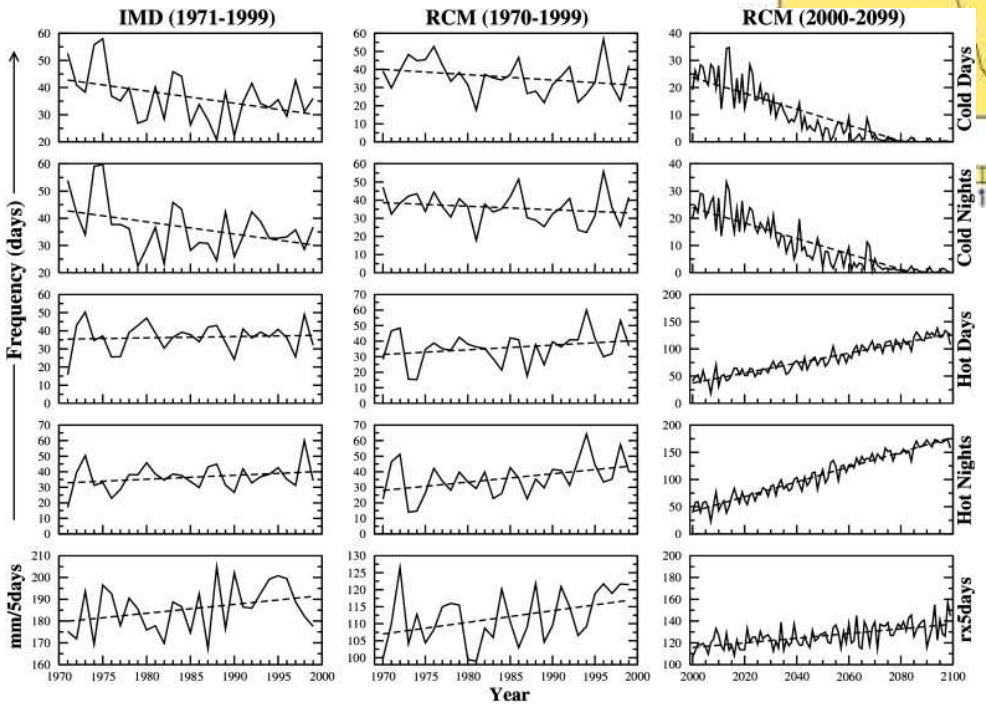
Adaptation strategies - India

Spatial plots for RCM EM for change in temperature (°C) to 1970–1999, 2020–2049 (left panel) and 2070–2099 (right panel) over south Asia (Kumar et al. 2013).





Trend and frequency (days) per year of the extreme temperature and precipitation indices for the control and future climate over India (Kumar et al. 2013).

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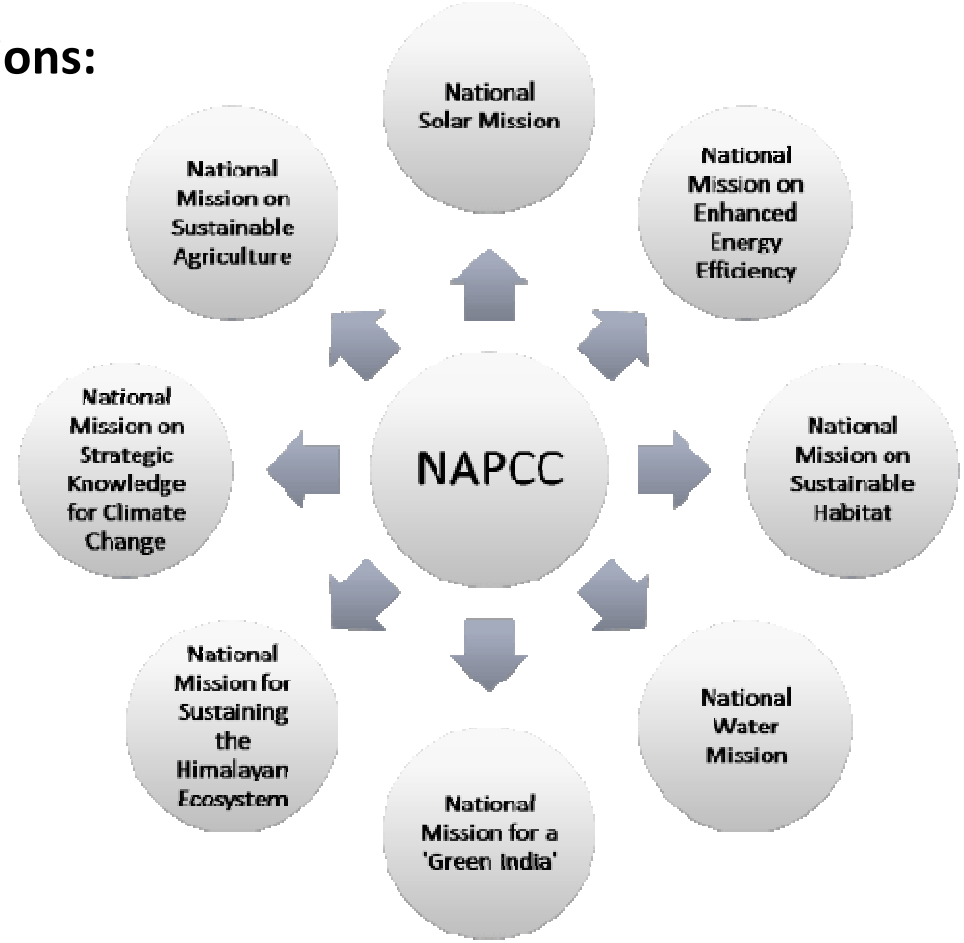
Adaptation strategies - India

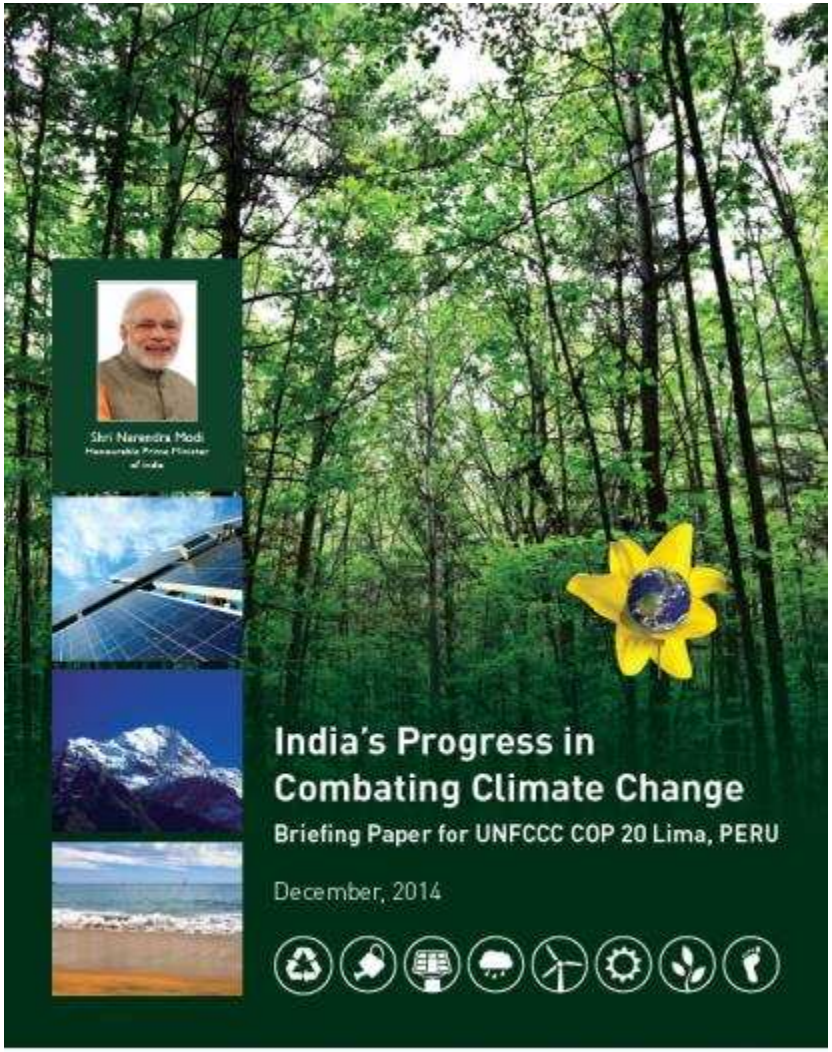
National Action Plan On Climate Change (NAPCC) (2008)

Eight Core National Missions:



Source: http://greencleanguide.com/2010/12/09/the-national-action-plan-on-climate-change/

Adaptation strategies - India



National Water Mission

Mission Objective

To conserve water, minimise wastage and ensure equitable distribution both across and within states through integrated water resources development and management.

Mission Targets and Timeline

To achieve its objective, the mission targets are:

- Development of comprehensive water database in public domain and assessment of impact of climate change on water resources
- Promotion of citizen and state actions for water conservation, augmentation and preservation
- Focused attention to vulnerable areas including over-exploited areas
- Increase water use efficiency by 20%
- Promotion of basin level integrated water resources management

Budgetary Requirements and Allocations

The mission requires budgetary support of INR 89,101 crore (approx. USD 14.4 billion) during the 11th (2007-2012) and 12th (2012-2017) five year plan periods. Proposals for INR 196 crore (approx. USD 31.6 million) have been approved.

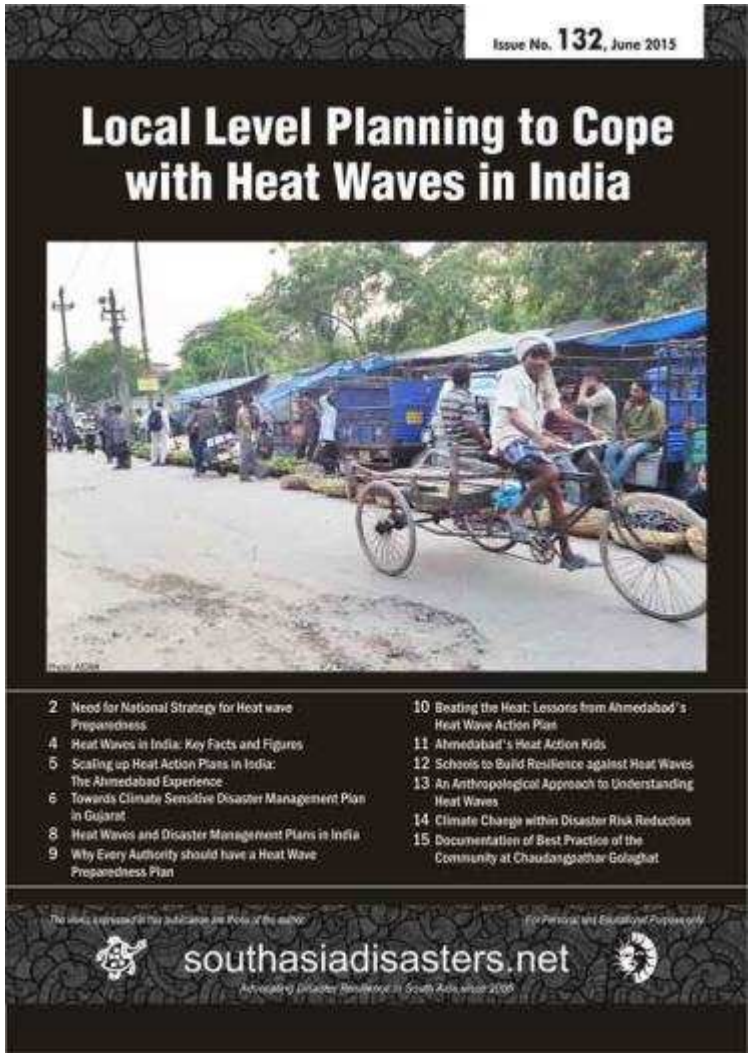
Implementation Status

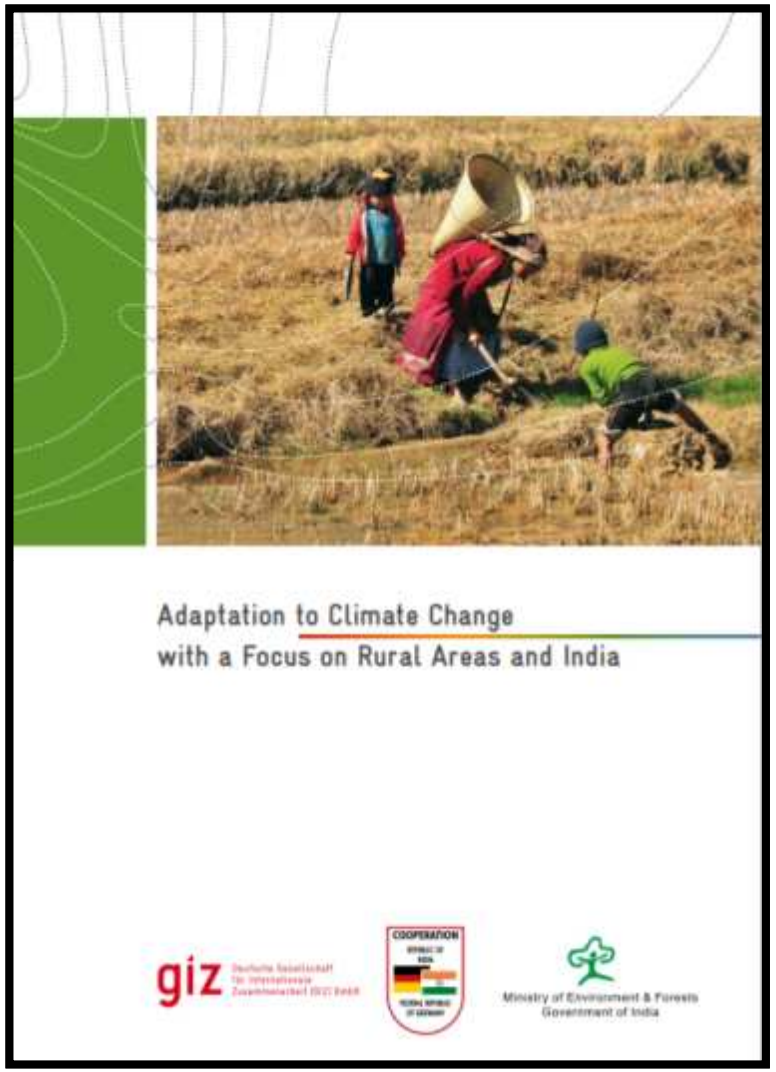
Key achievements to date:

- Revised National Water Policy (2012) adopted by National Water Resources Council
- Created 1,082 new Ground Water Monitoring Wells
- Several capacity building and training programmes are underway

Source:
http://envfor.nic.in/sites/default/files/pressreleases/Indian_Country_Paper_Low_Res.pdf

Adaptation strategies - India





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Adaptation strategies - Singapore

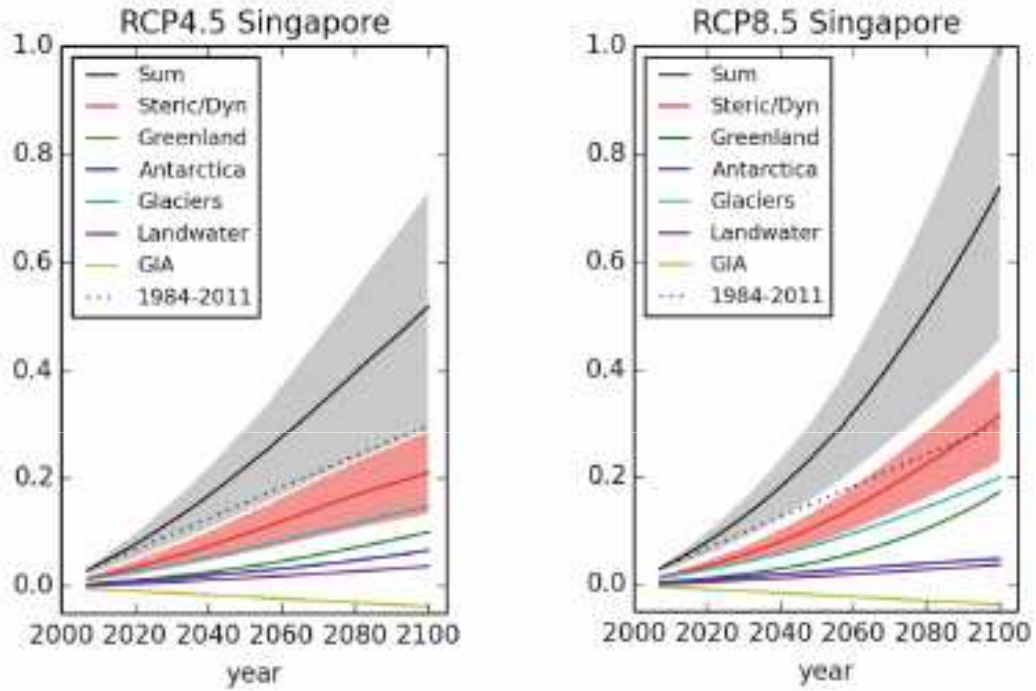
Projected ranges in the average daily minimum, mean and maximum temperature

		Mid-century (2040 - 2069)				End-century (2070 - 2099)			
Mean observed (1980 - 2009)		RCP4.5		RCP8.5		RCP4.5		RCP8.5	
Minimum Temp (deg C)	24.1	25.4	26.4	25.9	27.1	25.5	27.0	27.0	28.9
Mean Temp (deg C)	27.4	28.7	29.6	29.2	30.3	28.8	30.1	30.3	32.0
Maximum Temp (deg C)	31.8	33.1	34.5	33.8	34.9	33.3	34.6	34.9	36.7

Source: http://ccrs.weather.gov.sg/

Adaptation strategies - Singapore

Projections of sea level

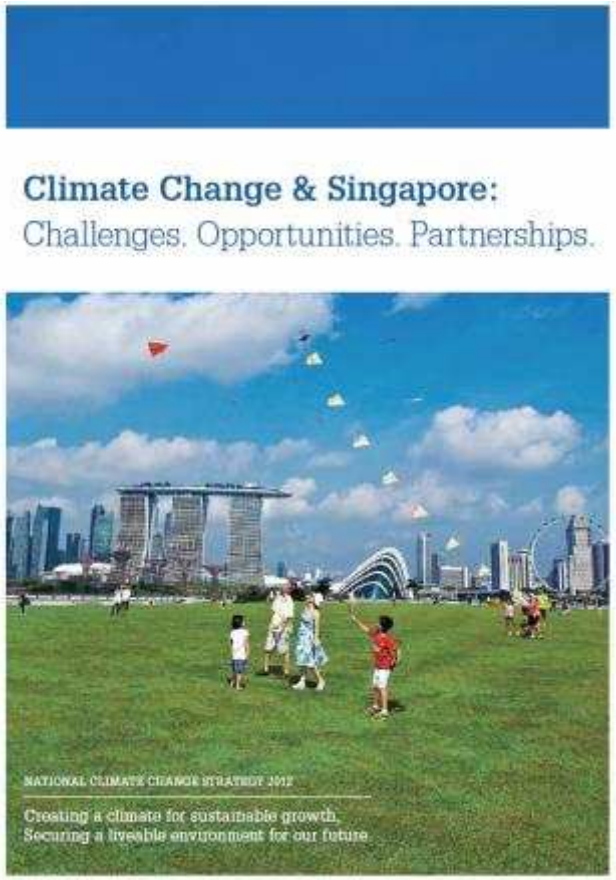


	2050			2100		
	Lower	Median	Upper	Lower	Median	Upper
RCP4.5	0.14	0.22	0.30	0.30	0.53	0.74
RCP8.5	0.17	0.25	0.32	0.45	0.73	1.02

Source: http://ccrs.weather.gov.sg/

Adaptation strategies - Singapore

National Climate Change Strategy 2012



Source: https://www.nccs.gov.sg/

Adaptation strategies - Singapore

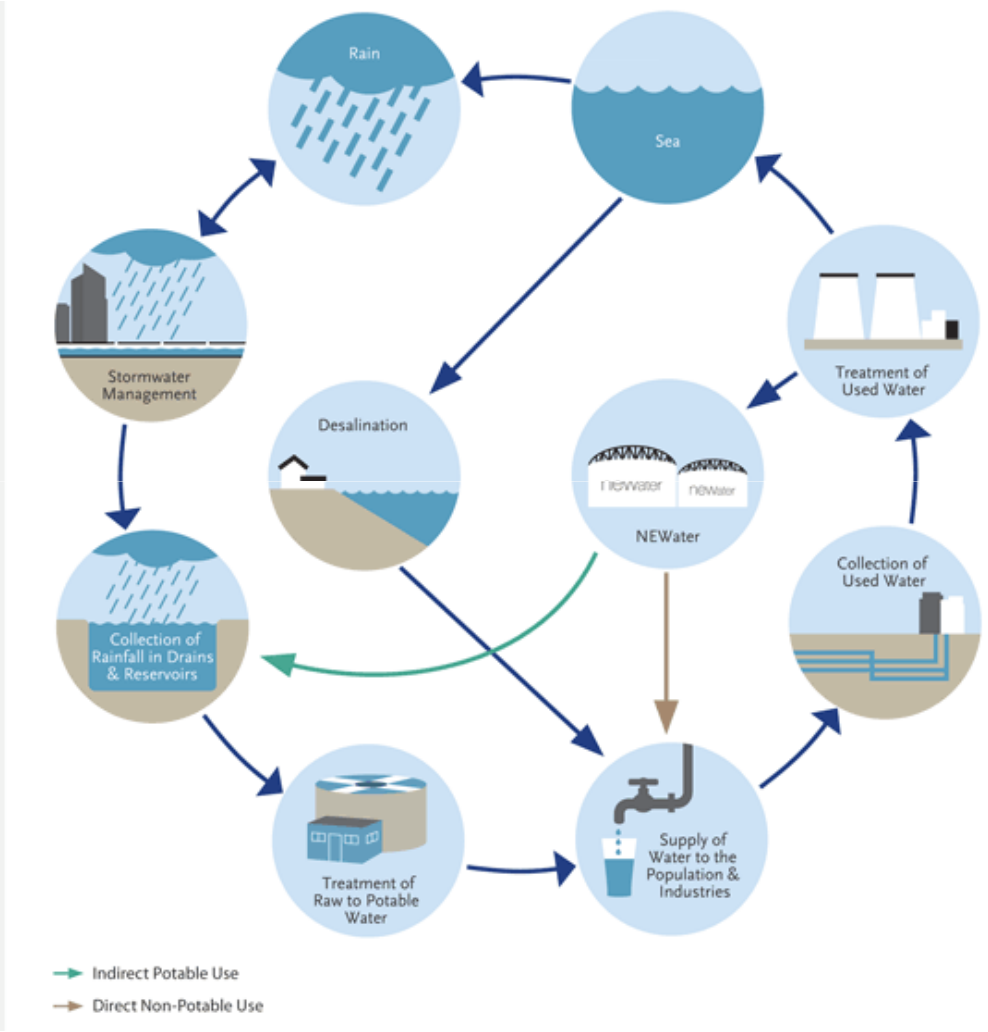
Coastal Protection

In anticipation of further rises in sea level, the minimum reclamation levels for newly reclaimed land have been raised to 2.25 m above the highest recorded tide level.

Source: https://www.nccs.gov.sg/

Adaptation strategies - Singapore

Water Loop Illustrating Singapore's Water Management



Source: https://www.nccs.gov.sg/

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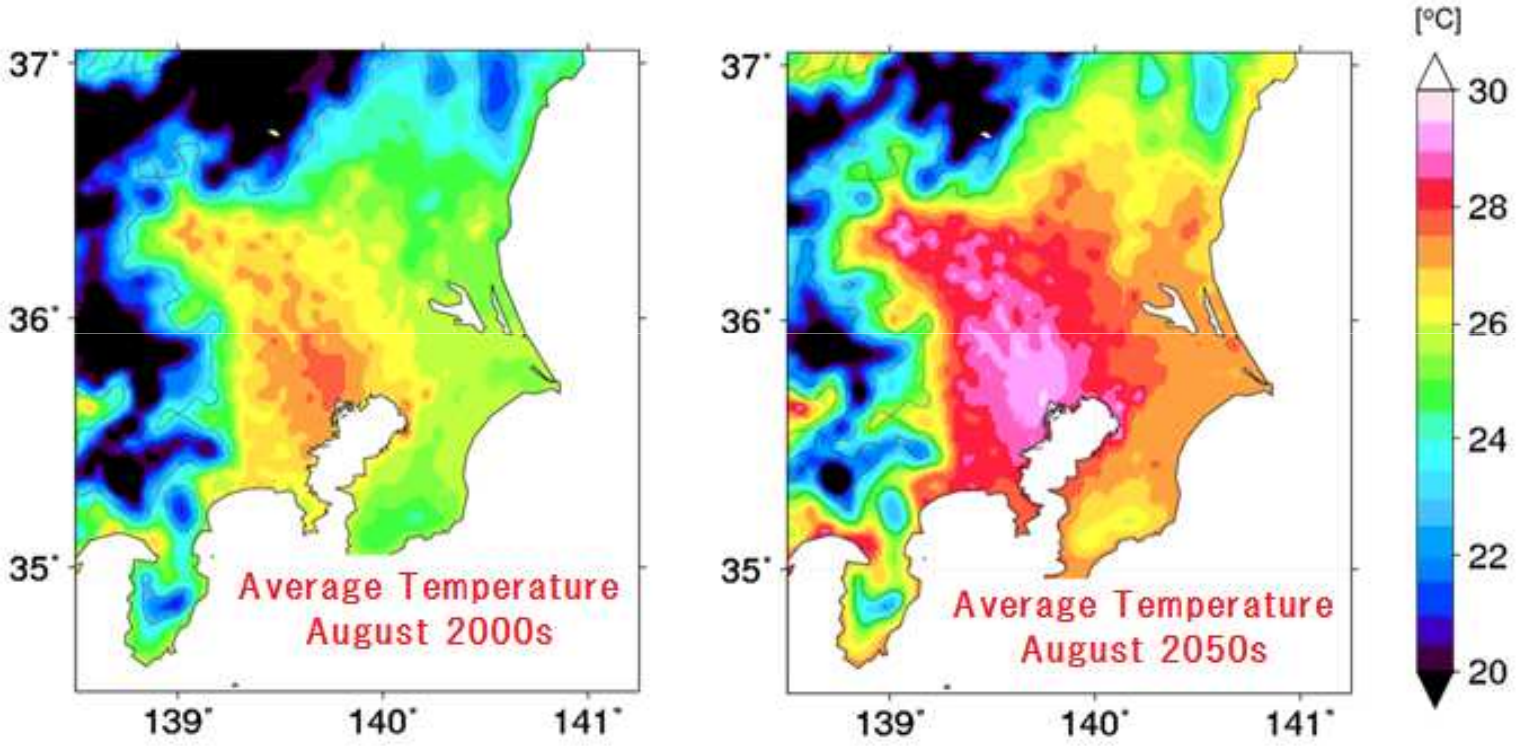
Adaptation strategies - Japan

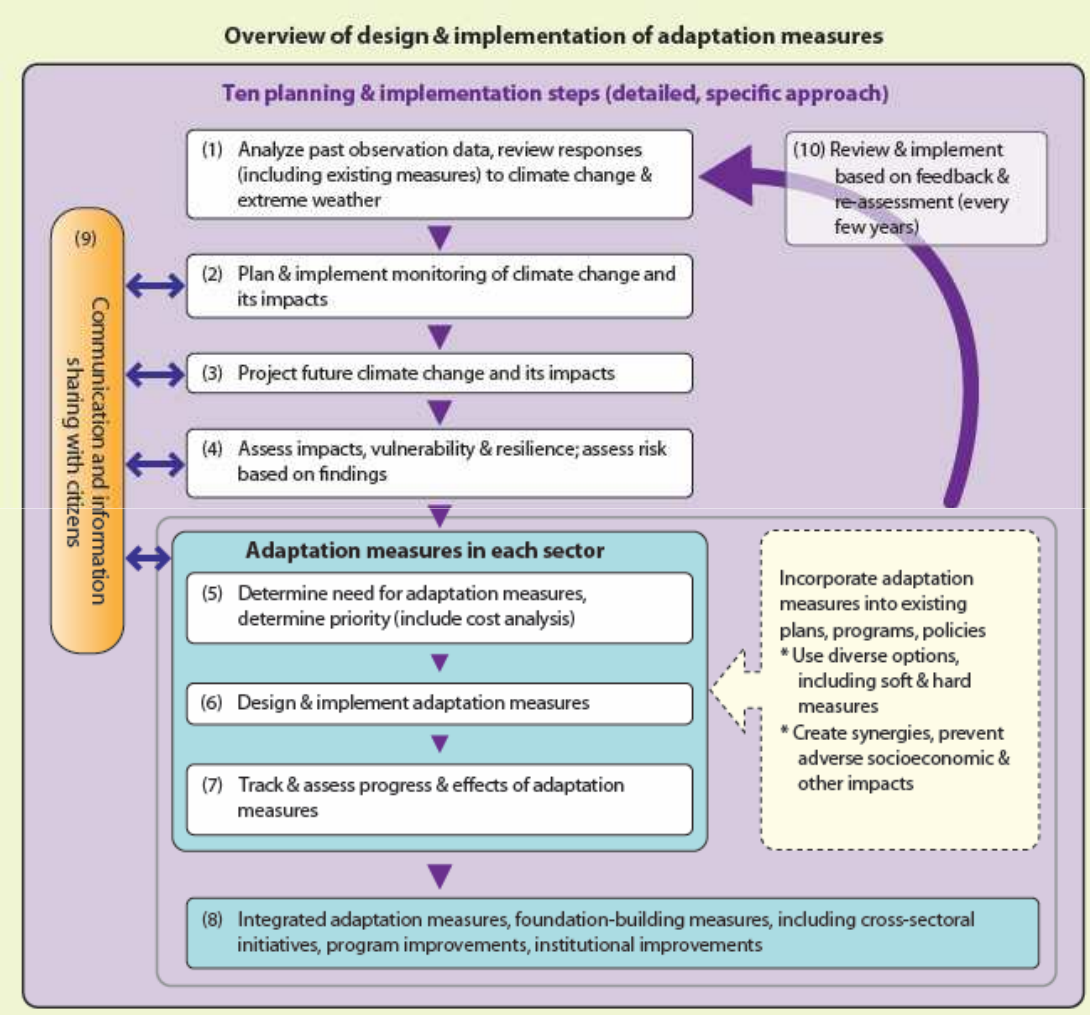
August average temperature calculated by WRF model of Tokyo



Source: Keiko FUJITA, 2011

Adaptation strategies - Japan

Approaches to Climate Change Adaptation (2010)

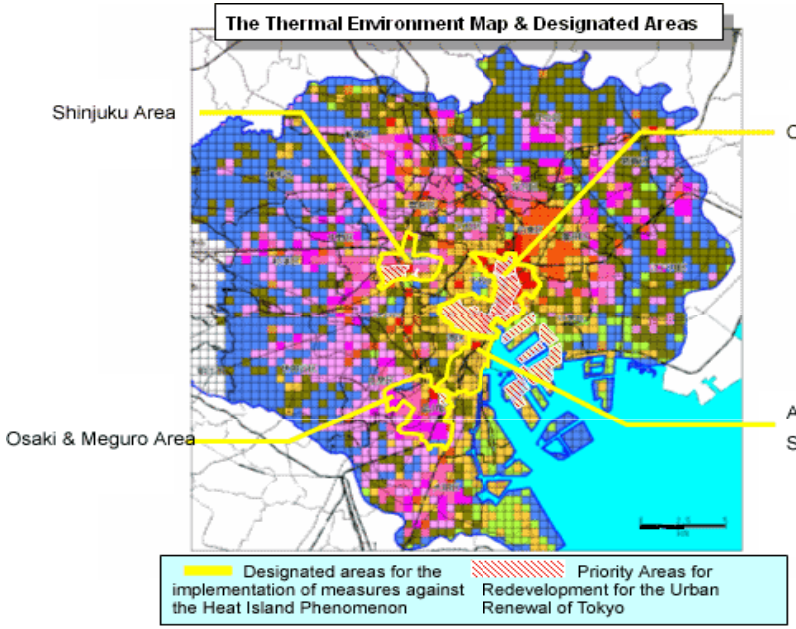


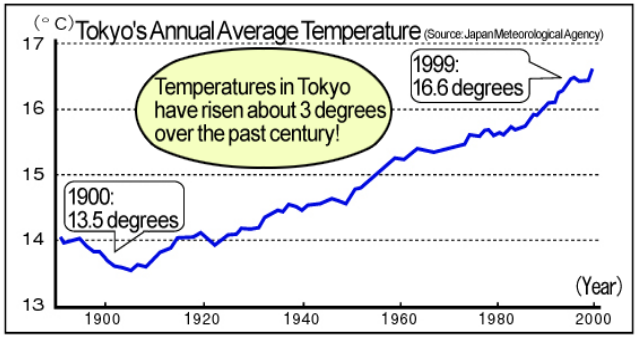
Source: http://www.env.go.jp/en/earth/cc/adapt_guide/pdf/approaches_to_adaptation_en.pdf

Adaptation strategies - Japan

Tokyo's Environmental Map heat map & tree programme

New Green Space: 1,000 ha + Double Roadside Trees to 1 M by 2016





Basic Policies for the 10-Year Project for Green Tokyo

– Regenerating Tokyo's Abundant Greenery –

Ideal Tokyo in 10 years envisioned by the 10-Year Project for Green Tokyo

- Formation of a "green road network" connecting large scale plots of greenery with roadside trees
- Creation of a green island in Tokyo as large as the Imperial Palace's grounds (Development of Umi-no-Mori)
- Creation of a green space with a size of 1,000 ha (equal to the total area of 1,500 football fields)
- To wage a "green movement," a Tokyo-wide campaign to gather momentum for greening and to encourage action
- To double roadside trees in Tokyo to 1 million

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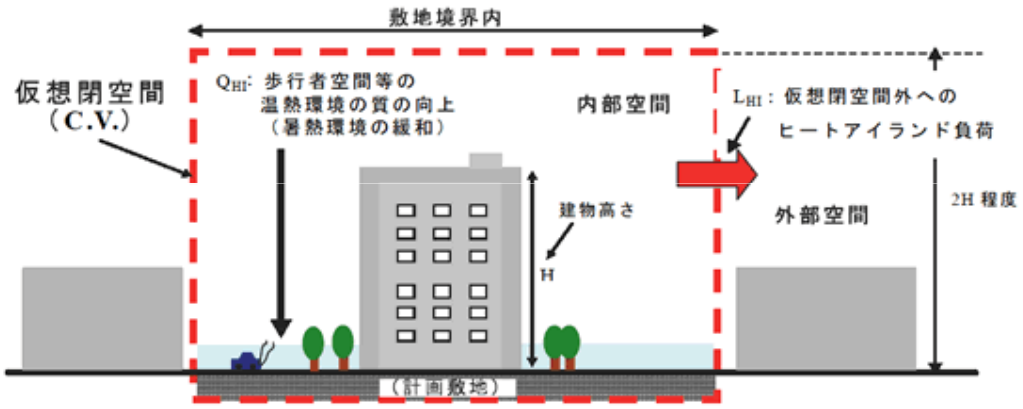
Adaptation strategies - Japan



Source: http://www.ibec.or.jp/CASBEE/cas_hi.htm

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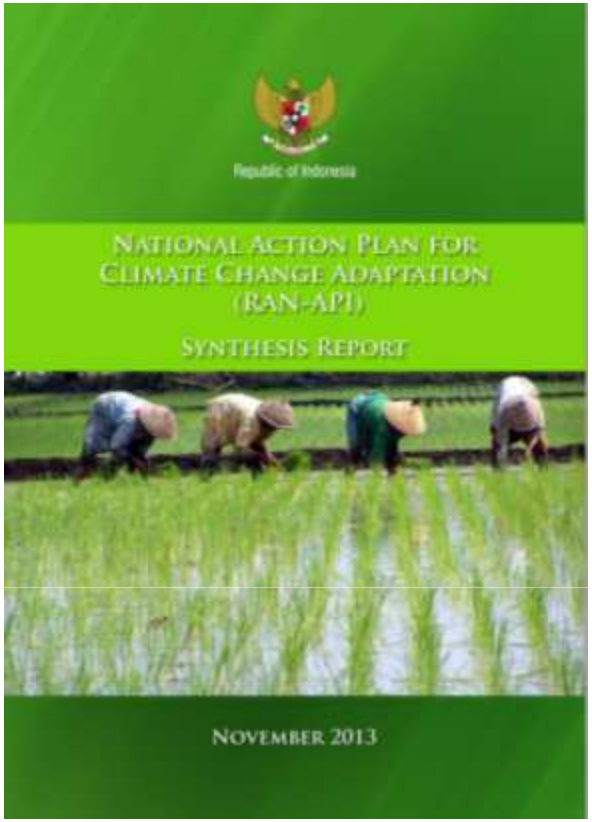
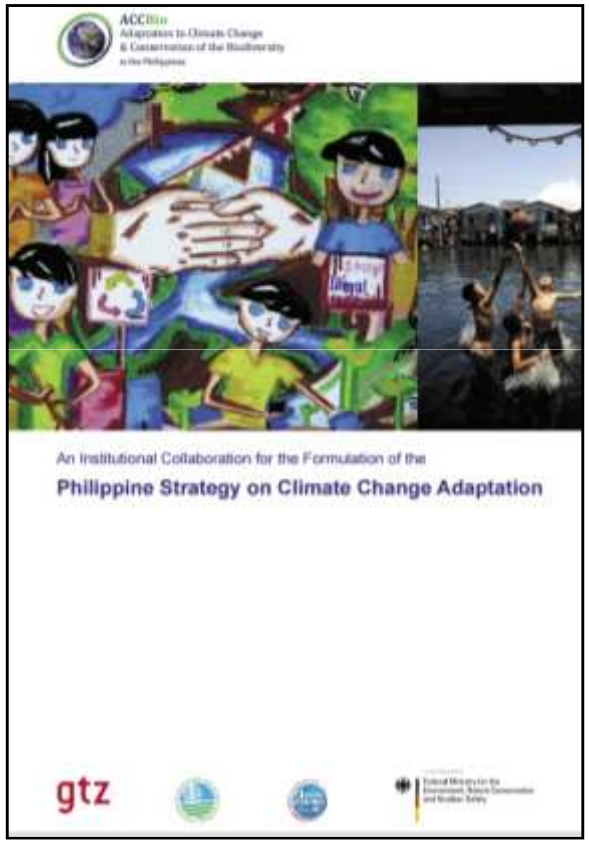
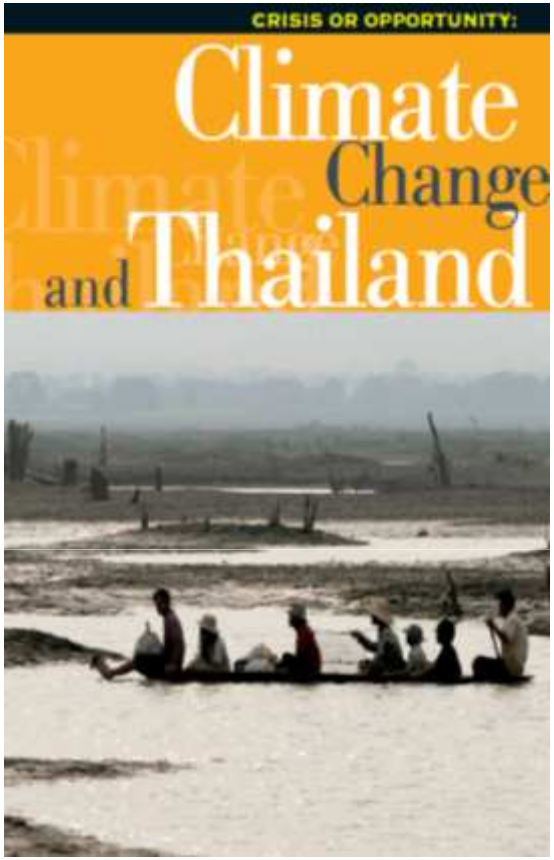
Adaptation strategies - … & etc







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Has the job been done?

National plan not filtered down and implemented strategically

Actions are slow, Piecemeal and not comprehensive

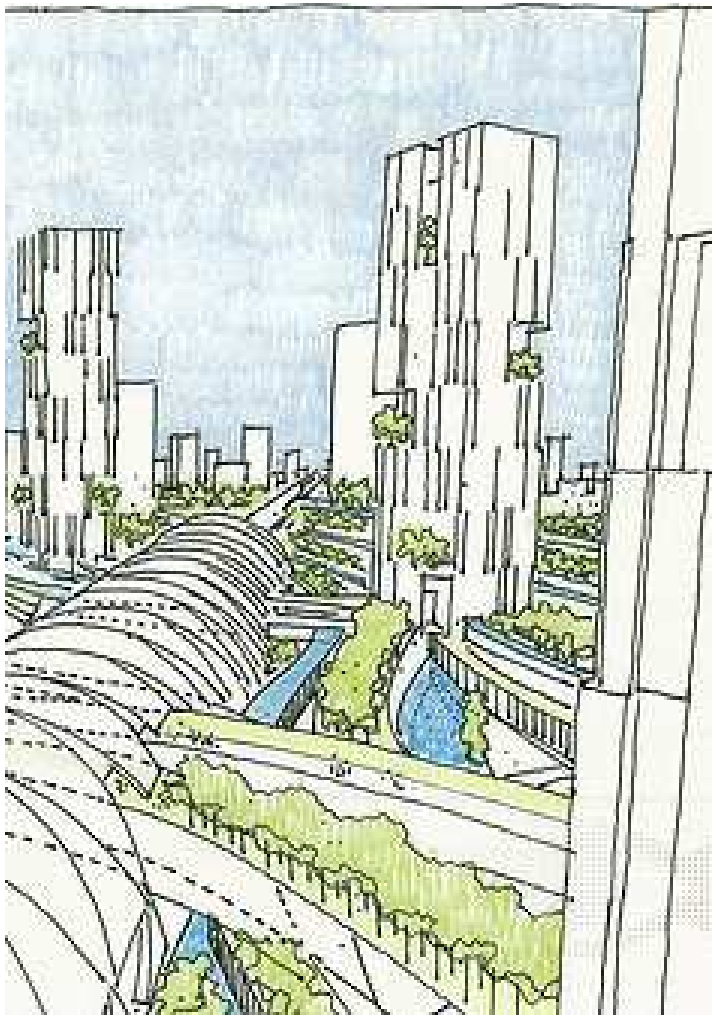
Not effective and long-lasting, short-termism

Not high up in the Govt's agenda, no sense of urgency, lack cost-benefit and evaluative assessment.

Reactive, not proactive

Enough? … what is next? OR what is missing?

Urban planning vs. Urban climatology



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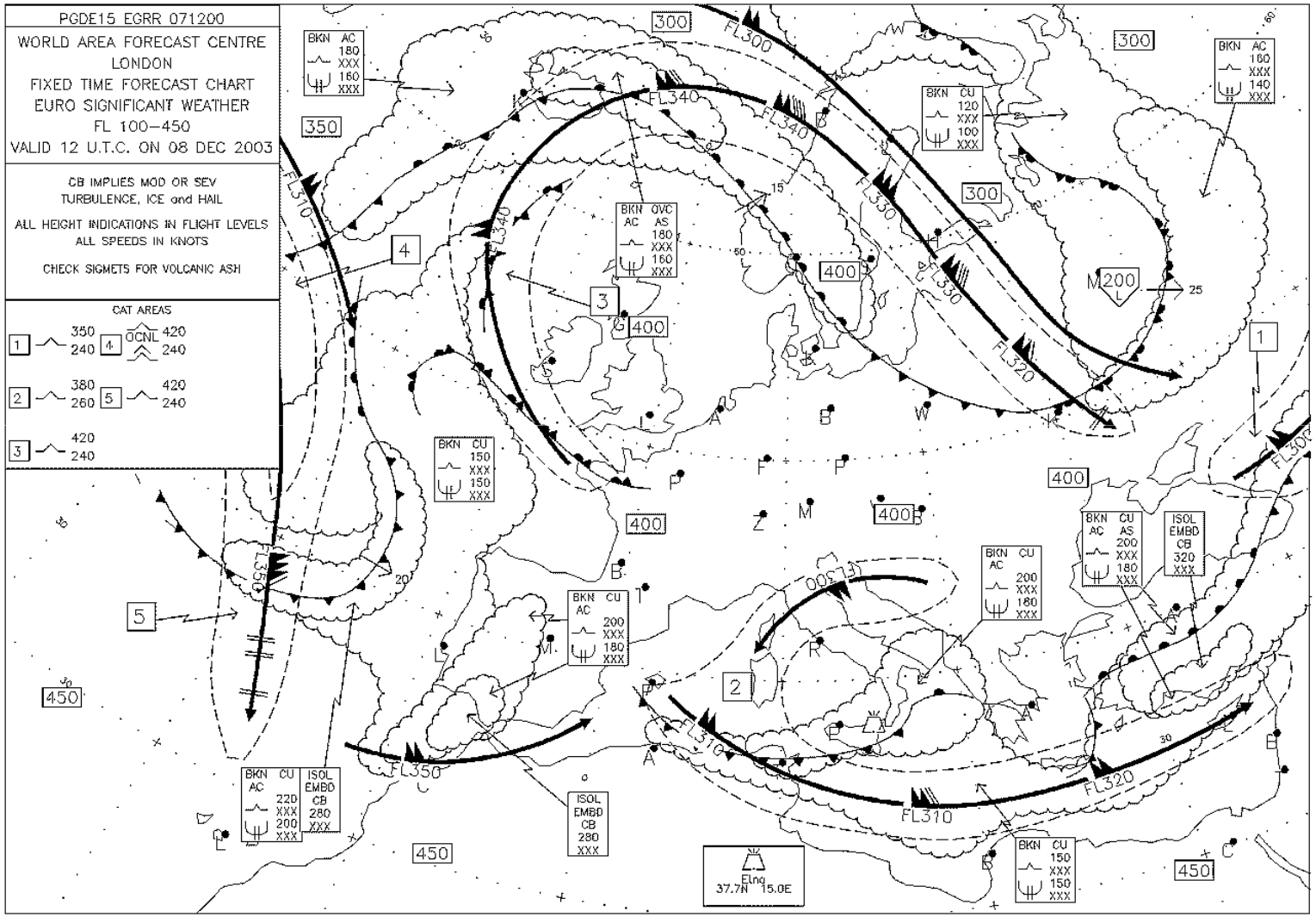
So, what is next? OR what is missing?

You know how to read this. Ask a planner if he knows …



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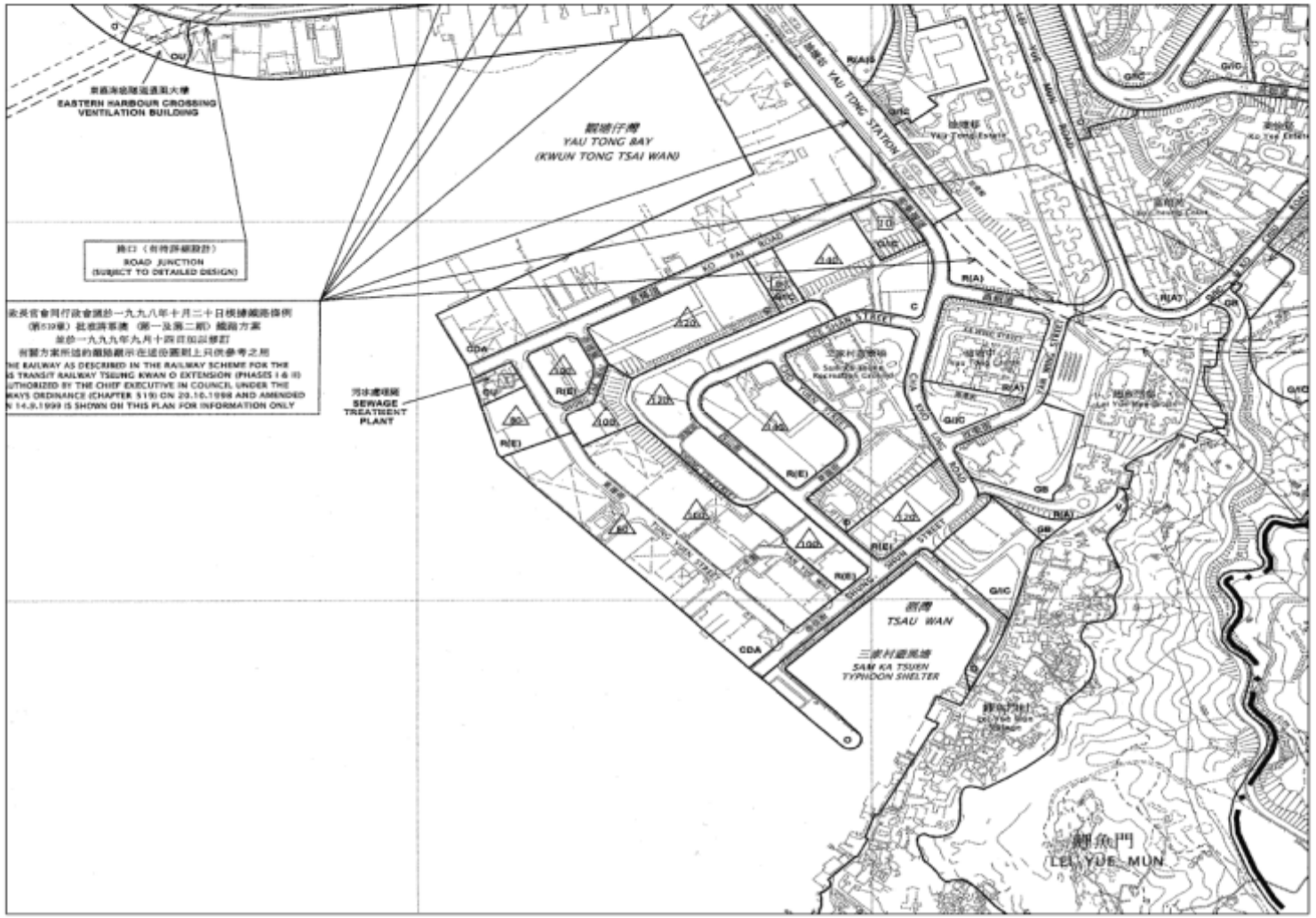
So, what is next? OR what is missing?

Planners know this. Can I ask you …

分區計劃大綱圖 OUTLINE ZONING PLAN



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London

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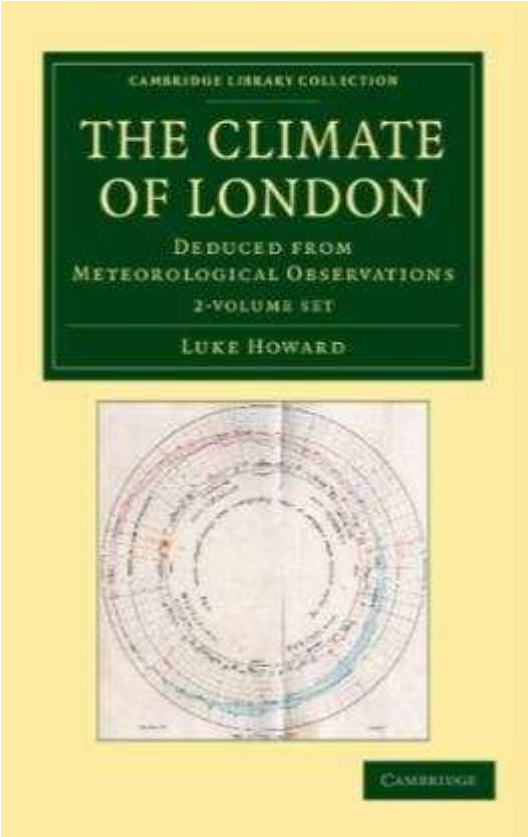
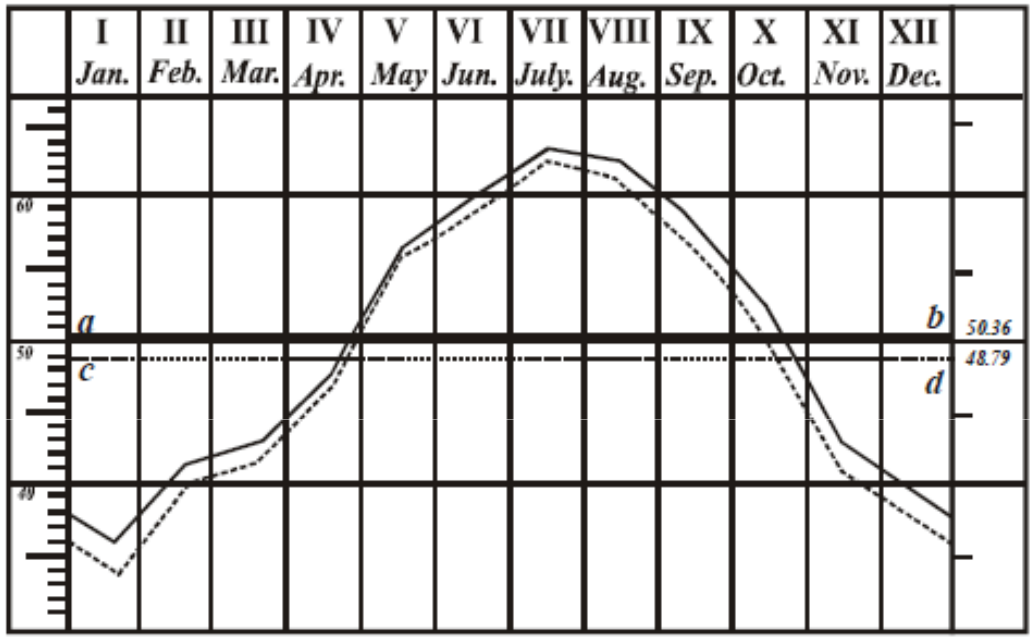
Luke Howard

City climate is not new science, Howard reported his observations on UHI in 1833





The Climate of London *2 Volume Set: Deduced from Meteorological Observations: 1-2 (Cambridge Library Collection - Earth Science) 1833 Luke Howard 1772–1864*

http://en.wikisource.org/wiki/Howard,_Luke_(1772-1864)_(DNB00)

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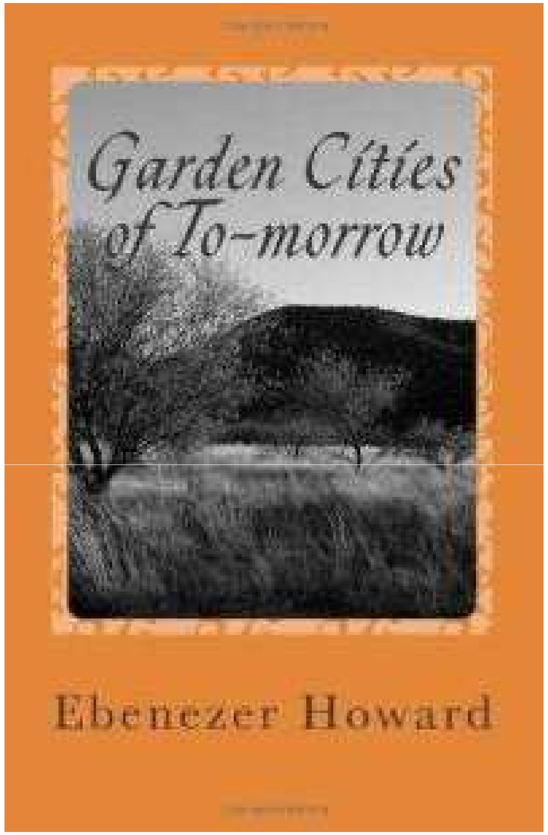
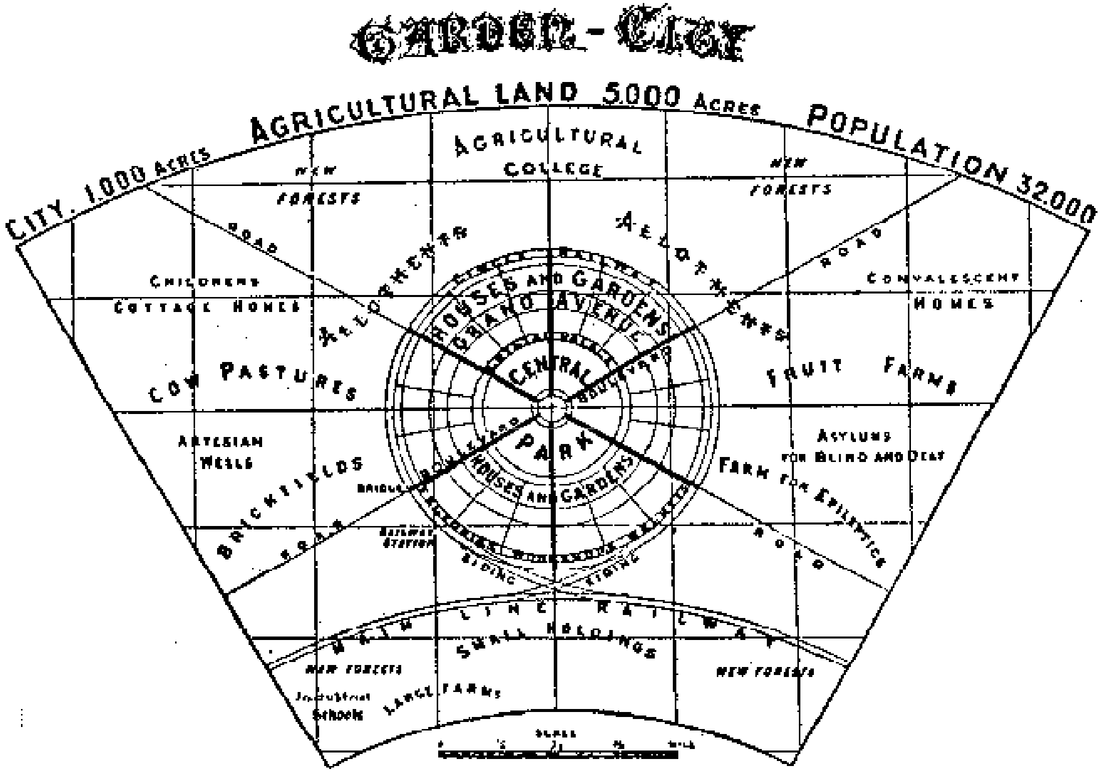
Ebenezer Howard

This was published by another Howard – a planner.

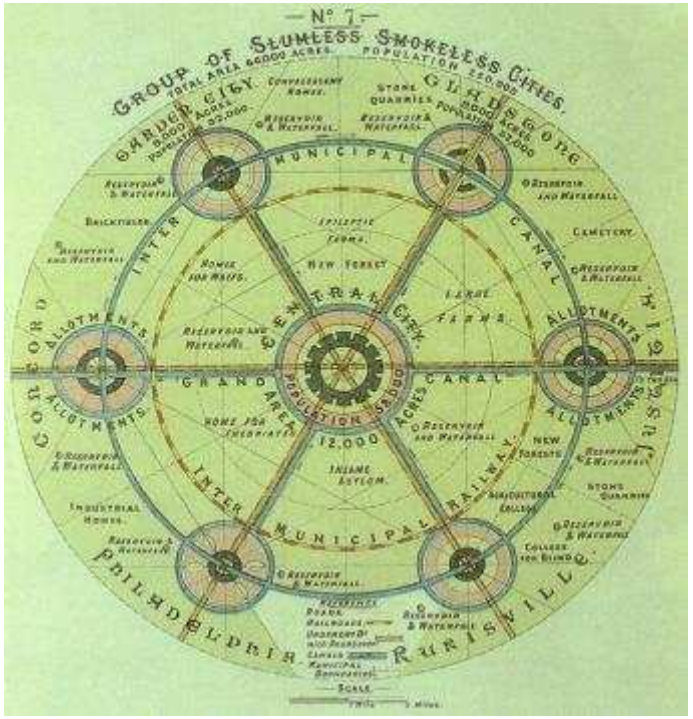


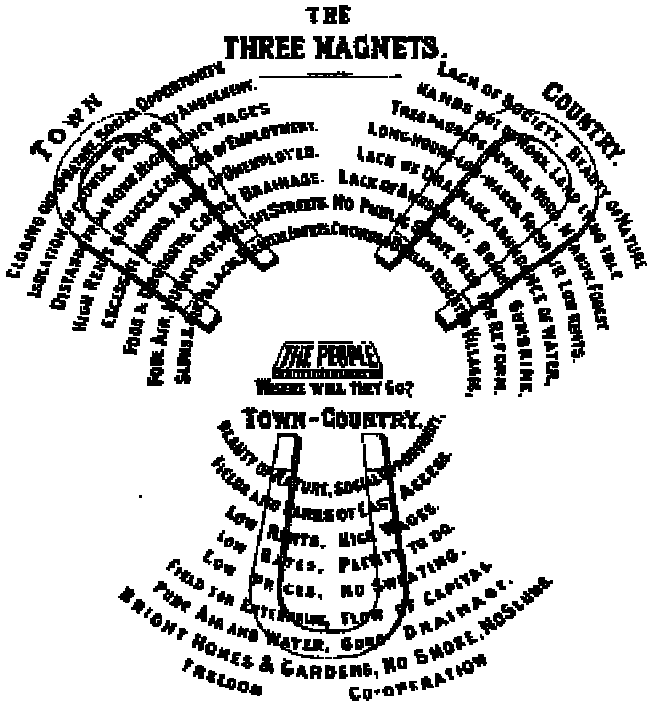


Garden Cities of To-morrow Create Space 1898 *Ebenezer Howard (1850-1926)*

So, what is next? OR what is missing?

He proposed a new way of planning taking into account our living environment





In 1909, he wrote *To-Morrow: A Peaceful Path to Real Reform*, which was reprinted in 1902 as *Garden Cities of To-morrow*. This book offered a vision of towns free of slums and enjoying the benefits of both town (such as opportunity, amusement and good wages) and country (such as beauty, fresh air and low rents). He illustrated the idea with his famous *Three Magnets* diagram (pictured), which addressed the question 'Where will they go?'

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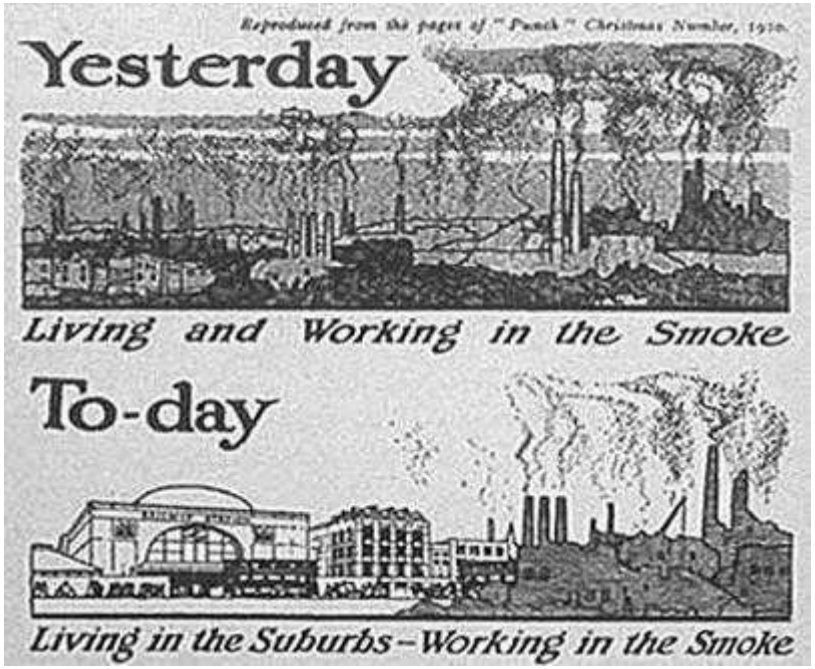
So, what is next? OR what is missing?

The Garden City Movement, living with light and air, was the key idea



"... by so laying. out a Garden City that, as it grows, the free gifts of Nature- fresh air, sunlight, breathing room and playing room- shall be still retained in all needed abundance“ … "It should be remembered that a sunny aspect for the main rooms is almost as important as ample air space.... “

So, what is next? OR what is missing?

How often you speak to each others?

Planners vs. **climatologists**

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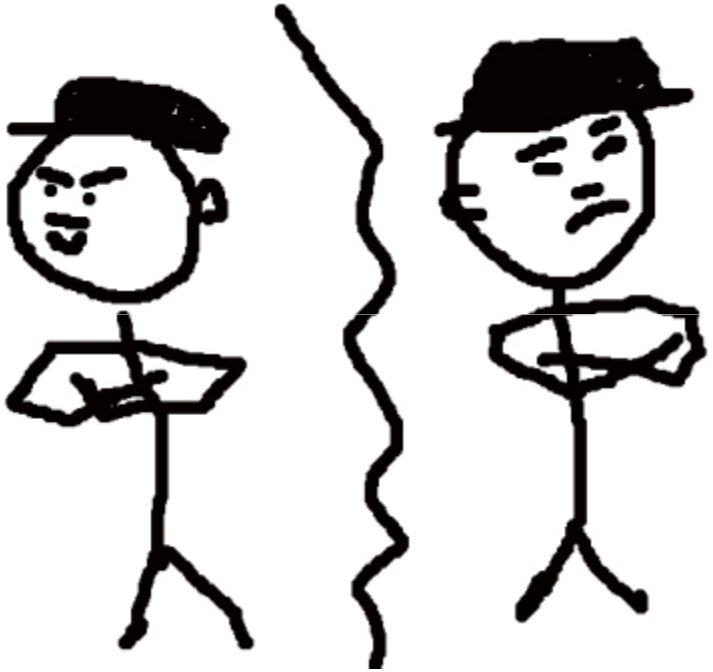
So, what is next? OR what is missing?

You don't hate each others? … But, do you speak the same language?

Planners vs. **climatologists**



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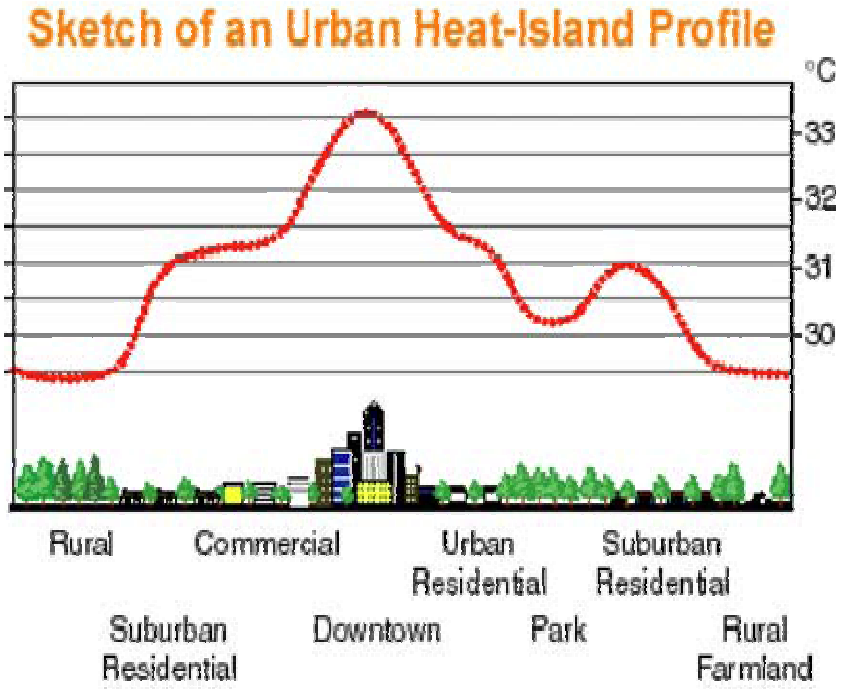
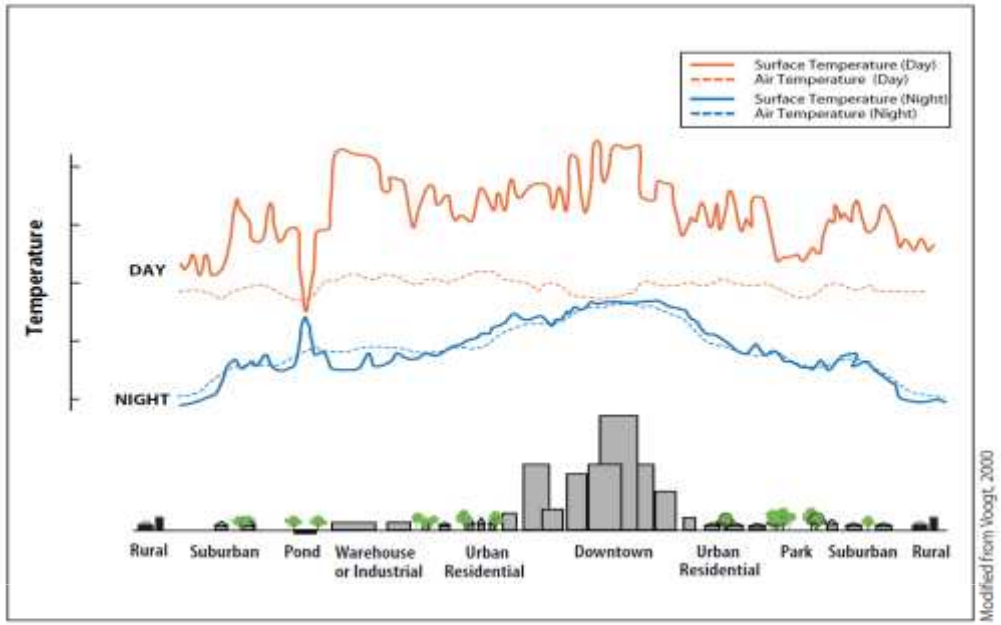
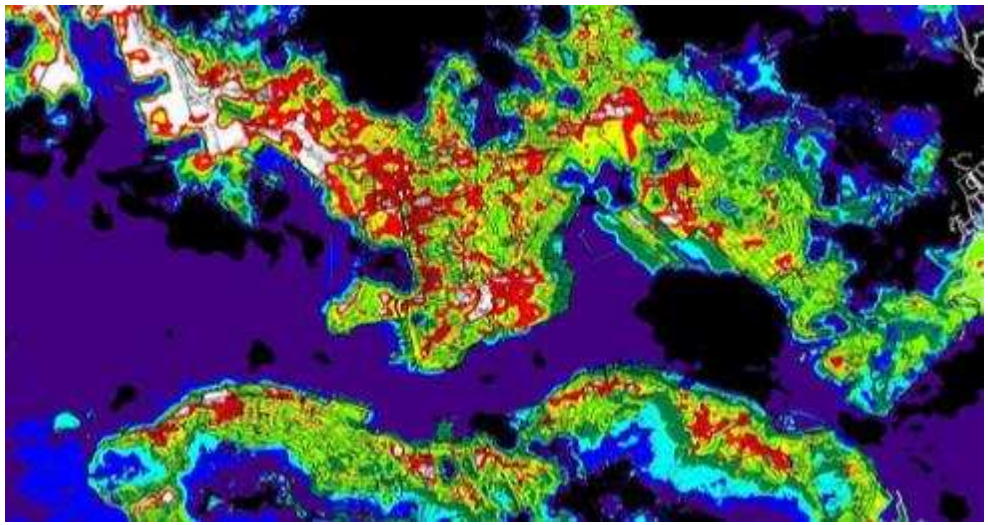
So, what is next? OR what is missing?







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So, what is next? OR what is missing?

ELSEVIER

Landscape and Urban Planning 48 (2000) 31–44

LANDSCAPE AND URBAN PLANNING

www.elsevier.com/locate/estoc

The use of climate knowledge in urban planning

Ingegärd Eliasson*

Conclusion

The low impact is a result of several constraints which could be related to five explanatory variables i.e. conceptual and knowledge based, technical, policy, organisational and the market. It is important that urban climatologists meet the planners demand-driven needs by providing them with good arguments, suitable methods and tools.

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So, what is next? OR what is missing?

Information & tools needed to address the importance of climatic aspects in the planning process

`Easily accessible literature is missing'
`Literature, handbook, education'
`Knowledge linked to specific projects. . .seminars with interdisciplinary discussions'
`Courses and seminars'
`Simple techniques/methods for an overstrained planner'
`Maps and models for climatic assessments'

Constraints on the influence of Climate Knowledge in the planning process

Climatic aspects are an integral part of environmental and comfort aspects
The planners feel uncertain about their own knowledge and lack arguments
Lack of knowledge
Communication problems: climatologist - planners and planners - decision makers
Lack of easily accessible techniques and literature
Other priorities such as traffic security and design aspects
Changed or unclear policy which results in predetermined projects
Fear of formal complaints from other stakeholders
Time, everything that prolongs the planning process increases costs
Limited budget, a climatic investigation increases costs
Status of the planning
Supply and demand in the housing market

(Eliasson, 2000)

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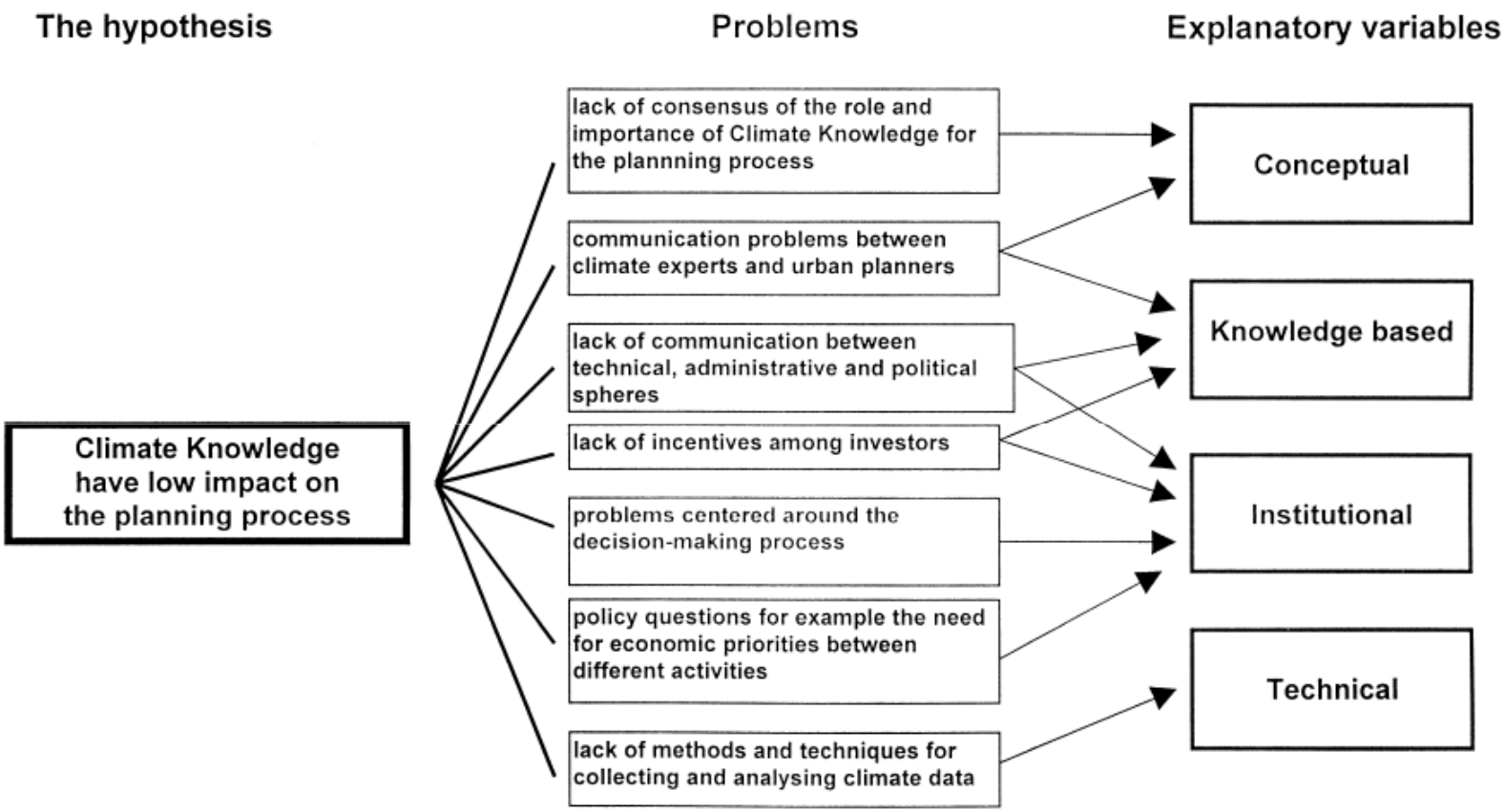
Prof Eliasson developed this framework of understanding



(Eliasson, 2000)

So, what is next? OR what is missing?

World Meteorological Organization

World Climate Conference · 3

Better climate information for a better future

Geneva, Switzerland, 31 August–4 September 2009

UN SYSTEM DELIVERING AS ONE ON CLIMATE KNOWLEDGE

2 important papers on urban climatology: capabilities and needs

ELSEVIER

Available online at www.sciencedirect.com

ScienceDirect

Procedia Environmental Sciences 1 (2010) 247–274

Procedia Environmental Sciences

Climate and More Sustainable Cities: Climate Information for Improved Planning and Management of Cities (Producers/Capabilities Perspective)

C.S.B. Grimmond[a,*], M. Roth[b], T.R. Oke[c], Y.C. Au[d], M. Best[e], R. Betts[e], G. Carmichael[f], H. Cleugh[g], W. Dabberdt[h], R. Emmanuel[j], E. Freitas[j], K. Fortuniak[k], S. Hanna[l], P. Klein[m], L.S. Kalkstein[n], C.H. Liu[o], A. Nickson[p], D. Pearlmutter[q], D. Sailor[r] and J. Voogt[s]

Climate Information for Improved Planning and Management of Mega Cities (Needs Perspective)

G. Mills[a,*], H. Cleugh[b], R. Emmanuel[c], W. Endlicher[d], E. Erell[e], G. McGranahan[f], E. Ng[g], A. Nickson[h], J. Rosenthal[i] and K. Steemer[j]

ICUC9 20th-24th July 2015 Toulouse France

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Observations and Data:

- (a) Place greater emphasis on gathering information on the tropical urban effect. In the absence of local research capacity there is a case for resources to be transferred to places where observations are needed.
- (b) Maintain existing urban meteorological stations and invest in good quality stations in and near the rapidly growing cities in less developed regions.
- (c) Develop research programmes that are designed to meet the requirements of urban decision-makers. These need data that shows the correspondence between the urban landscape and climate effects.
- (d) Acquire and maintain standardized information on city form. These data (at various scales) would be of benefit to modelling studies and would help urbanize existing meteorological data.

Understanding local, regional and global climate linkages:

- (a) Develop integrated hierarchal models that can provide useful predictions at urban planning scales.
- (b) Integrate urban climate knowledge into the practice of sustainable urban planning. Link urban climate effects with broader environmental effects and consider the effects within broader social and economic contexts.
- (c) Encourage cross-disciplinary research on urban climates and their effects and a dialogue between researchers, practitioners and decision-makers.

Tools:

- (a) Provide guidelines for good planning and design that are based upon evidence and supported by real world examples.
- (b) Integrate climate

(Mills et al, 2010)

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So, what is next? OR what is missing?

Theor. Appl. Climatol. 84, 69–76 (2006)
DOI 10.1007/s00704-005-0145-0

Theoretical and Applied Climatology
Printed in Austria

Department of Geography, University College Dublin, Ireland

Progress toward sustainable settlements: a role for urban climatology

G. Mills

Conclusion

The widespread inclusion of environmental objectives in urban plans at all scales provides an opportunity for the incorporation of urban climate knowledge into the planning process on a routine basis. Many of the stated objectives have both direct and indirect connections to climate. However, for this to happen, climate research and results must be linked more explicitly to the objectives of the sustainable settlement.

1. The needs of designer (e.g. existing built forms and individual building needs),
2. A range of outdoor urban spaces,
3. The links between indoor and outdoor air,
4. Outdoor levels of comfort,
5. Case-studies that link design decision to measurable impacts and,
6. A wider variety of climates.

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So, what is next? OR what is missing?

Landscape and Urban Planning 90 (2009) 56–65

Contents lists available at ScienceDirect

Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

Application of climatic guidelines to urban planning
The example of Lisbon (Portugal)

Maria-João Alcoforado*, Henrique Andrade, António Lopes, João Vasconcelos

Conclusion

As planners need spatialized guidelines, the mapping of Lisbon's physical features was carried out using a Geographical Information System. Based on a Digital Terrain Model and on data of urban roughness a "ventilation map" was produced. A "building-density" map was also prepared based on the analysis of a Landsat image and field work. By cross-tabulating these two layers, a final map depicting Lisbon's "homogeneous climatic-response units" was prepared. Finally, a series of climatic guidelines for planning were put forth for the different units.

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So, what is next? OR what is missing?

INTERNATIONAL JOURNAL OF CLIMATOLOGY
Int. J. Climatol. (2011)
Published online in Wiley Online Library
(wileyonlinelibrary.com) DOI: 10.1002/joc.2292

RMetS
Royal Meteorological Society

Towards planning and practical understanding of the need for meteorological and climatic information in the design of high-density cities: A case-based study of Hong Kong

E. Ng*
The Chinese University of Hong Kong, School of Architecture, Shatin, NT, Hong Kong

Conclusion

Urban climatic information must be presented sequentially to fit the hierarchal process of planning and land use decision making. For better transfer of knowledge and communication, '**prevailing**' and '**criticality**' should be observed; information overload must be avoided, and spatial information must be presented graphically whenever possible. Scholars have argued that instead of the need for precision and accuracy, most of the time planners need to make balanced and reasonable decisions. Simplicity is the key.

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So, what is next? OR what is missing?

Procedia
Environmental Sciences

Climate Information for Improved Planning and Management of Mega Cities (Needs Perspective)

G. Mills[a,*], H. Cleugh[b], R. Emmanuel[c], W. Endlicher[d], E. Erell[e], G. McGranahan[f], E. Ng[g], A. Nickson[h], J. Rosenthal[i] and K. Steemer[j]

Conclusion

Climate information must be appropriate to the task at hand. At the city scale, the planner needs to grasp general patterns and isolate critical issues. This type of information is descriptive in content, is not overly complex and is often available in synthetic form on a map. This allows planners a holistic appreciation of the urban climatic characteristics of the area. The map content itself may be the result of rigorous modelling and observation but it is the communication of the results that is the key to making planning decisions.

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Good examples

Berlin.de Senate Department for Urban Development and the Environment

Data for the Environment

*All texts are available in English. We thus enable a comfortable, **user-friendly access** to information about our city internationally. We have made it easier for all those interested in our policies, our planning, and our city of Berlin.*

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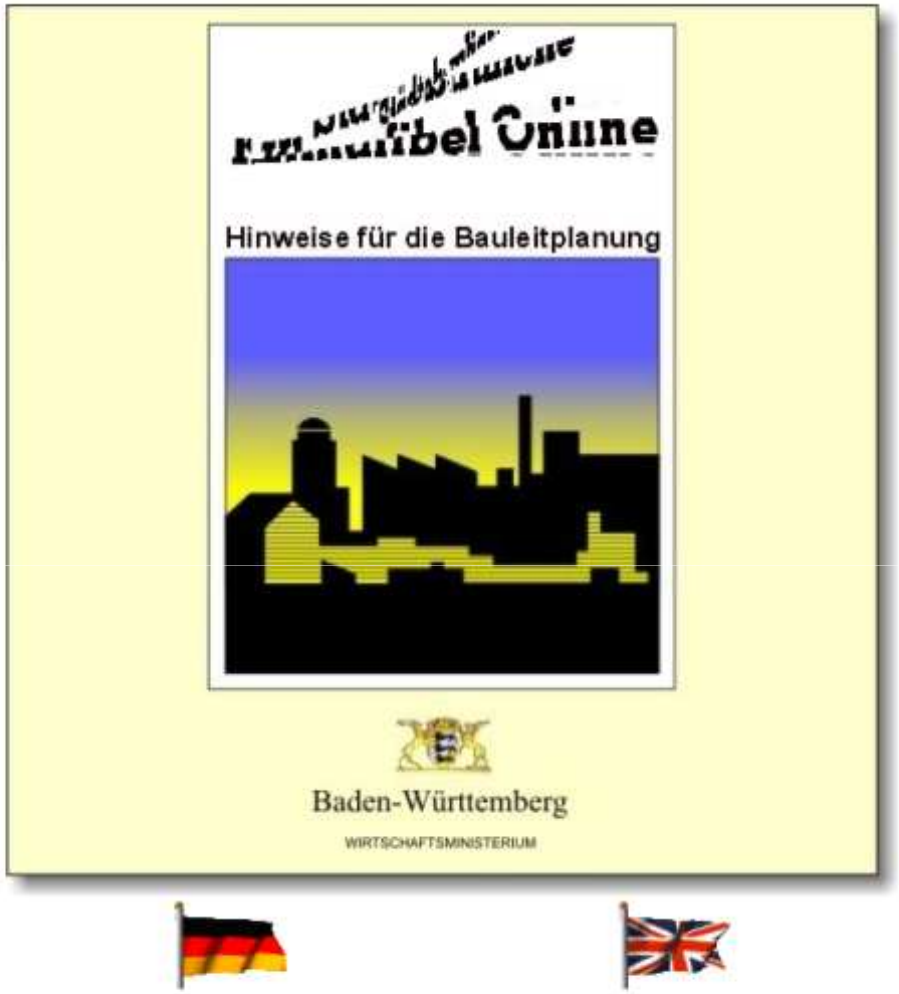
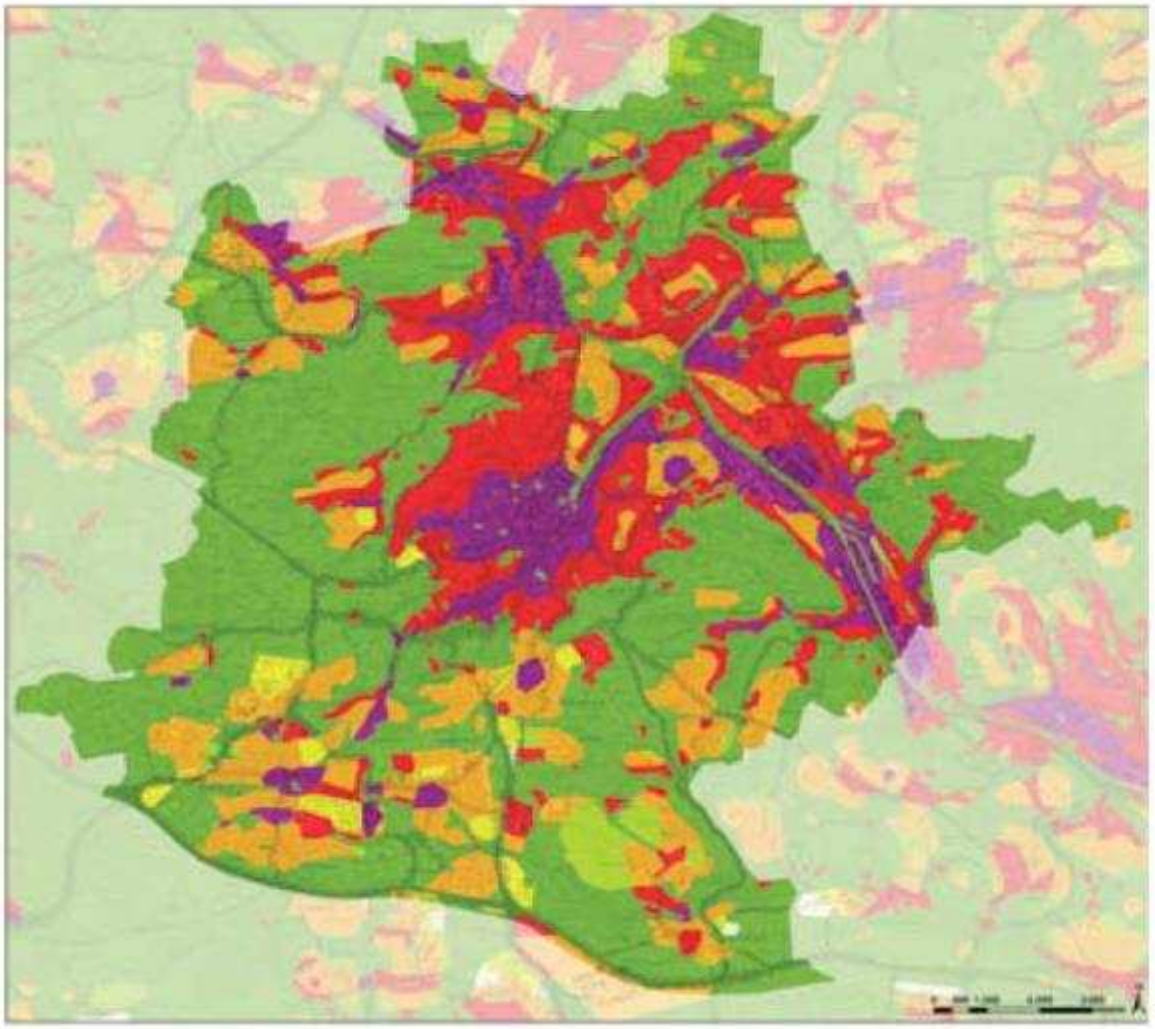
Good examples



http://www.staedtebauliche-klimafibel.de/

Good examples



Climate Analysis Map of the City of Stuttgart. Source: Verband Region Stuttgart (2008)

Planning Recommendation Map for the Region of Stuttgart. Source: Verband Region Stuttgart (Klimaatlas Region Stuttgart, Ed.: Verband Region Stuttgart 2008)

A good review paper

INTERNATIONAL JOURNAL OF CLIMATOLOGY
Int. J. Climatol. (2010)
Published online in Wiley Online Library
(wileyonlinelibrary.com) DOI: 10.1002/joc.2237

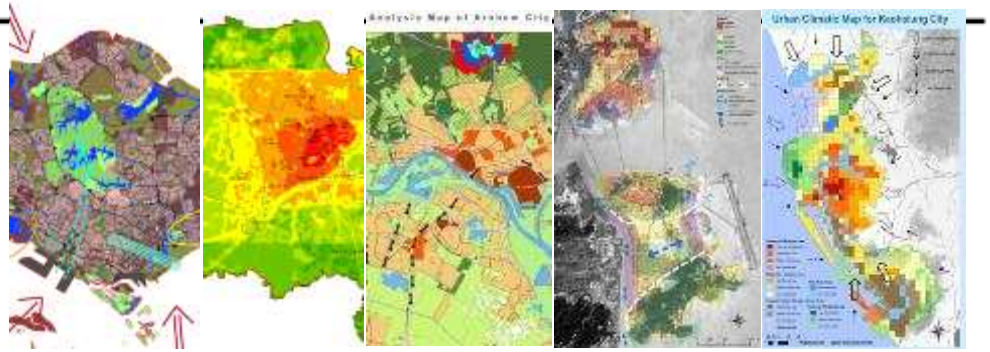
RMetS
Royal Meteorological Society

Urban climatic map studies: a review

Ren Chao,[a]* Ng Edward Yan-yung[a] and Katzschner Lutz[b]
[a] *School of Architecture, The Chinese University of Hong Kong, Shatin, New Territory, Hong Kong*
[b] *Department of Landscape and Urban Planning, University Kassel, Kassel, Germany*

Conclusion

Since their introduction 40 years ago, worldwide interest in urban climatic map (UCMap) studies has grown. Today, there are over 15 countries around the world processing their own climatic maps, developing urban climatic guidelines, and implementing mitigation measures for local planning practices.



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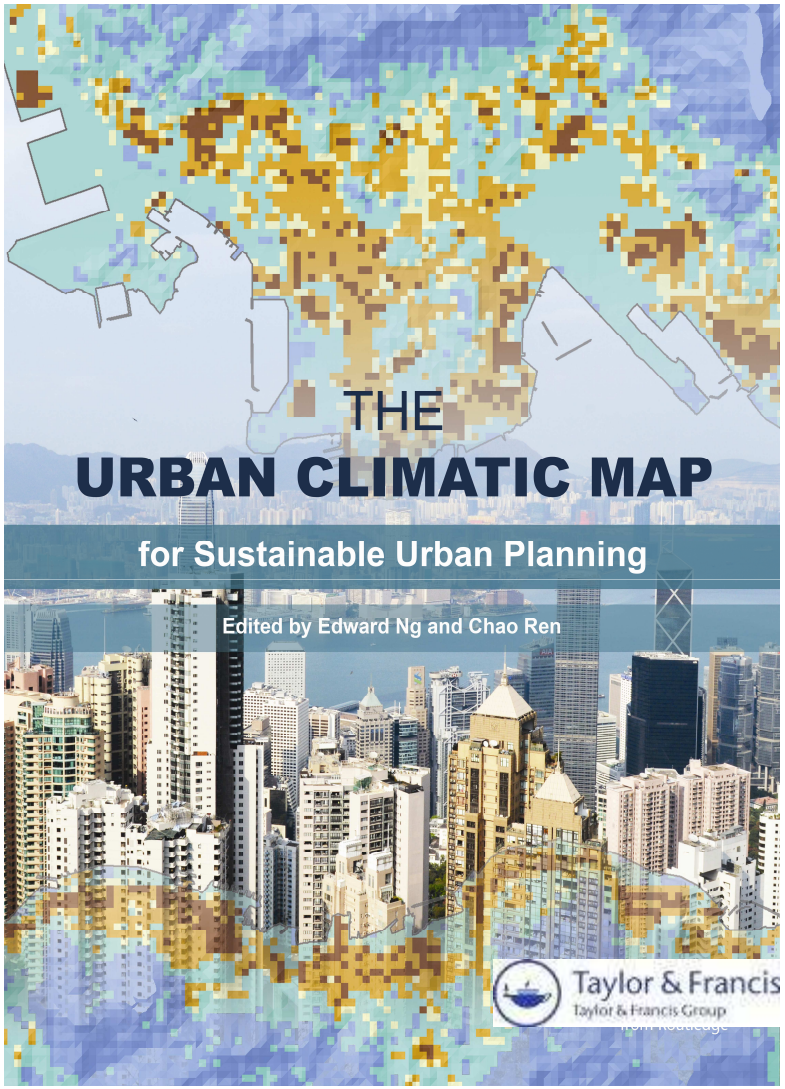
2 good books



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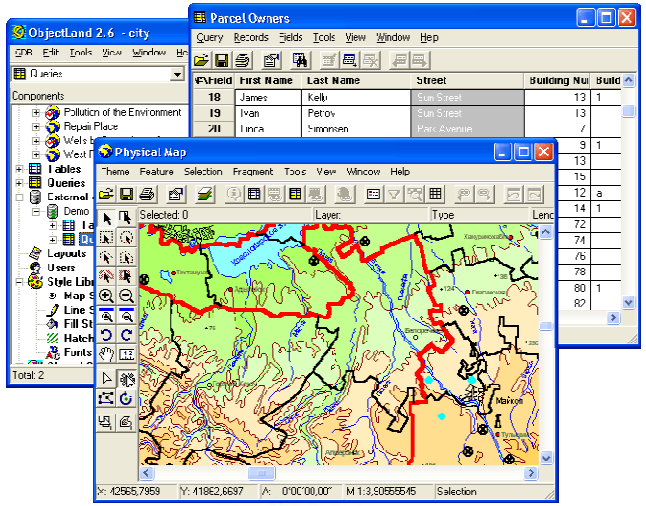
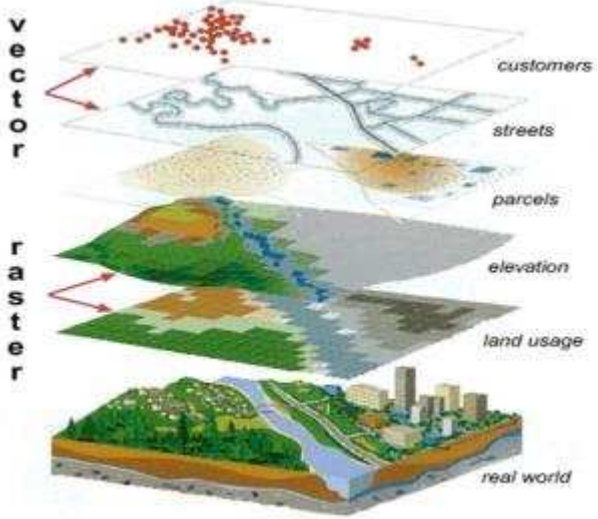
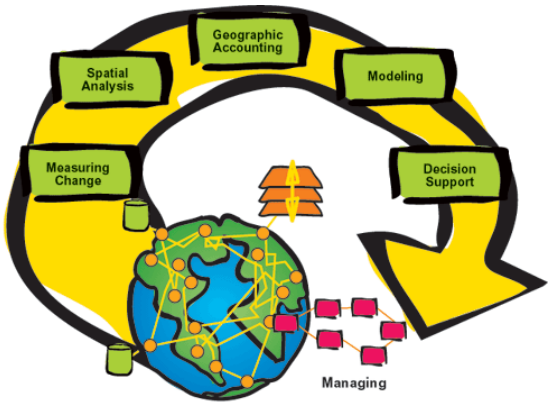
From urban climatic science to urban planning

Information embedding

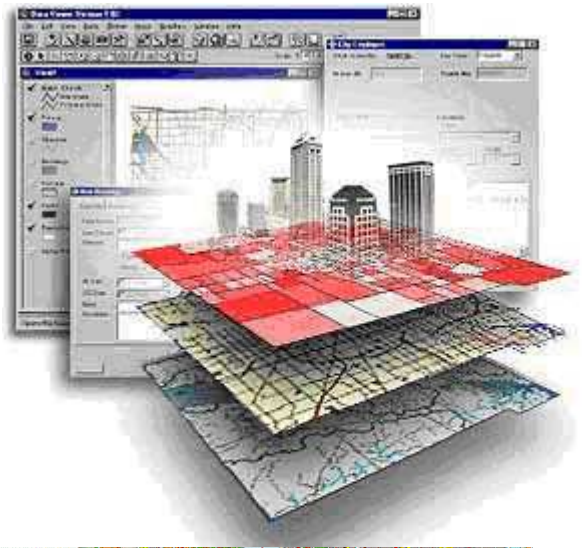


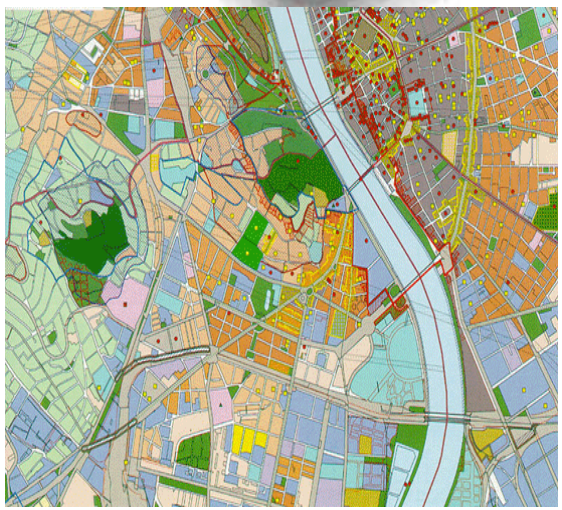


Assess and Process



Support and Decision





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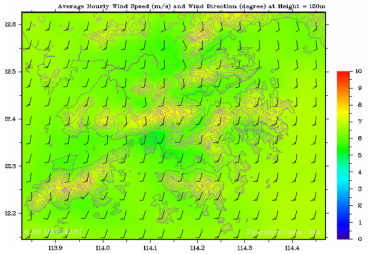
Planning for the future, urban climatically – Hong Kong

Urban Climatic Maps and HK's Planning Framework

Urban Climatic Analysis Map

+



Wind information

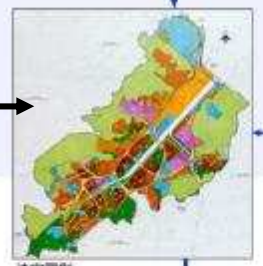
Urban Climatic Planning Recommendation Map

inform

Provide boundary conditions and background understanding for

Detail further additional studies: Micro-climatic and AVA

Territorial Development Strategy



Statutory Plan

Hong Kong Planning Standards & Guidelines

Outline Development Plan

Layout Plan

PLANNING APPLICATION

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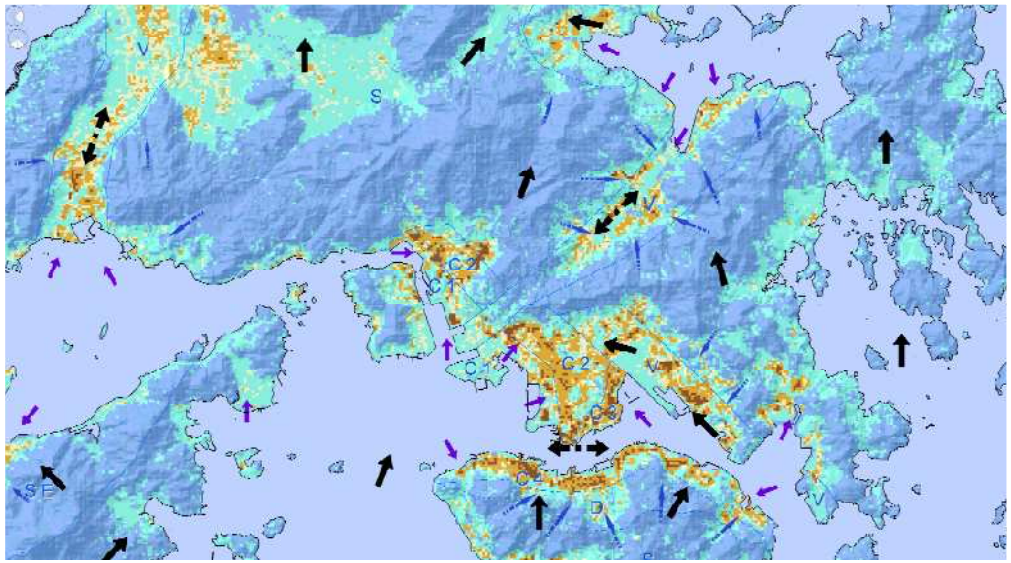
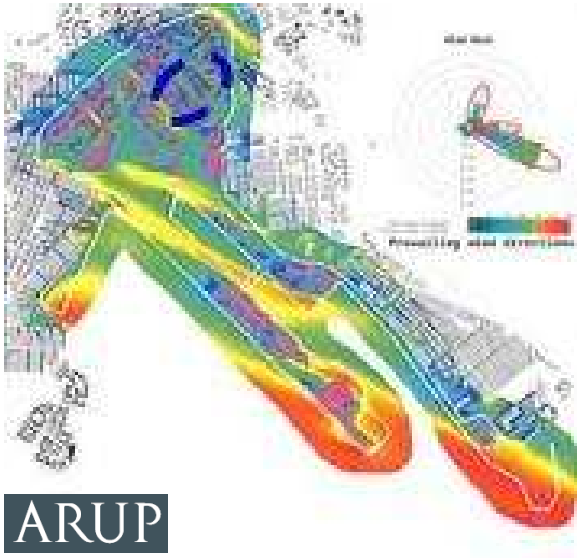
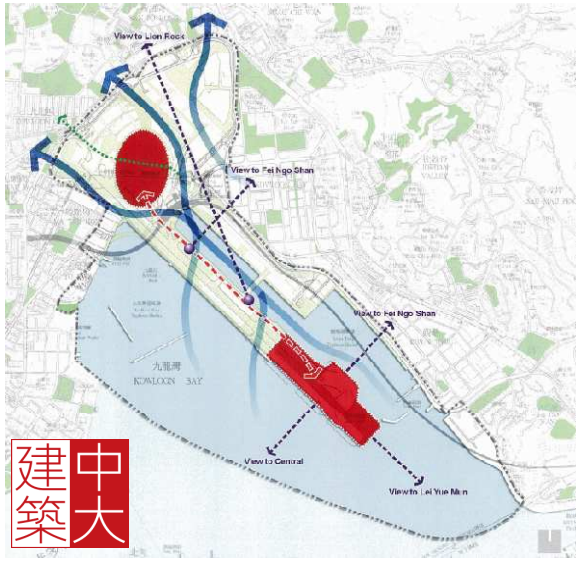
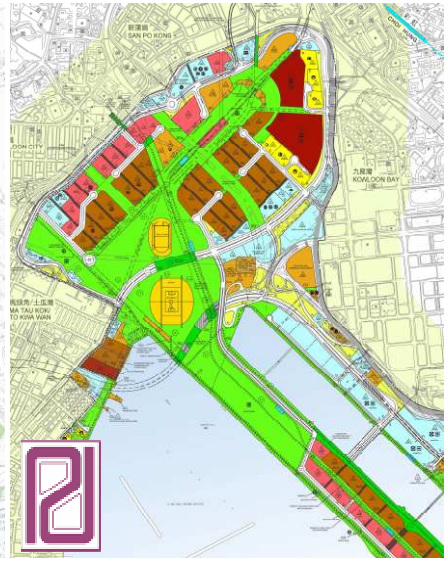
Legislative Council approved the old Kai Tak Airport site (300 ha) zoning plan (OZP) based on Air Ventilation Assessment and Urban Climatic recommendations









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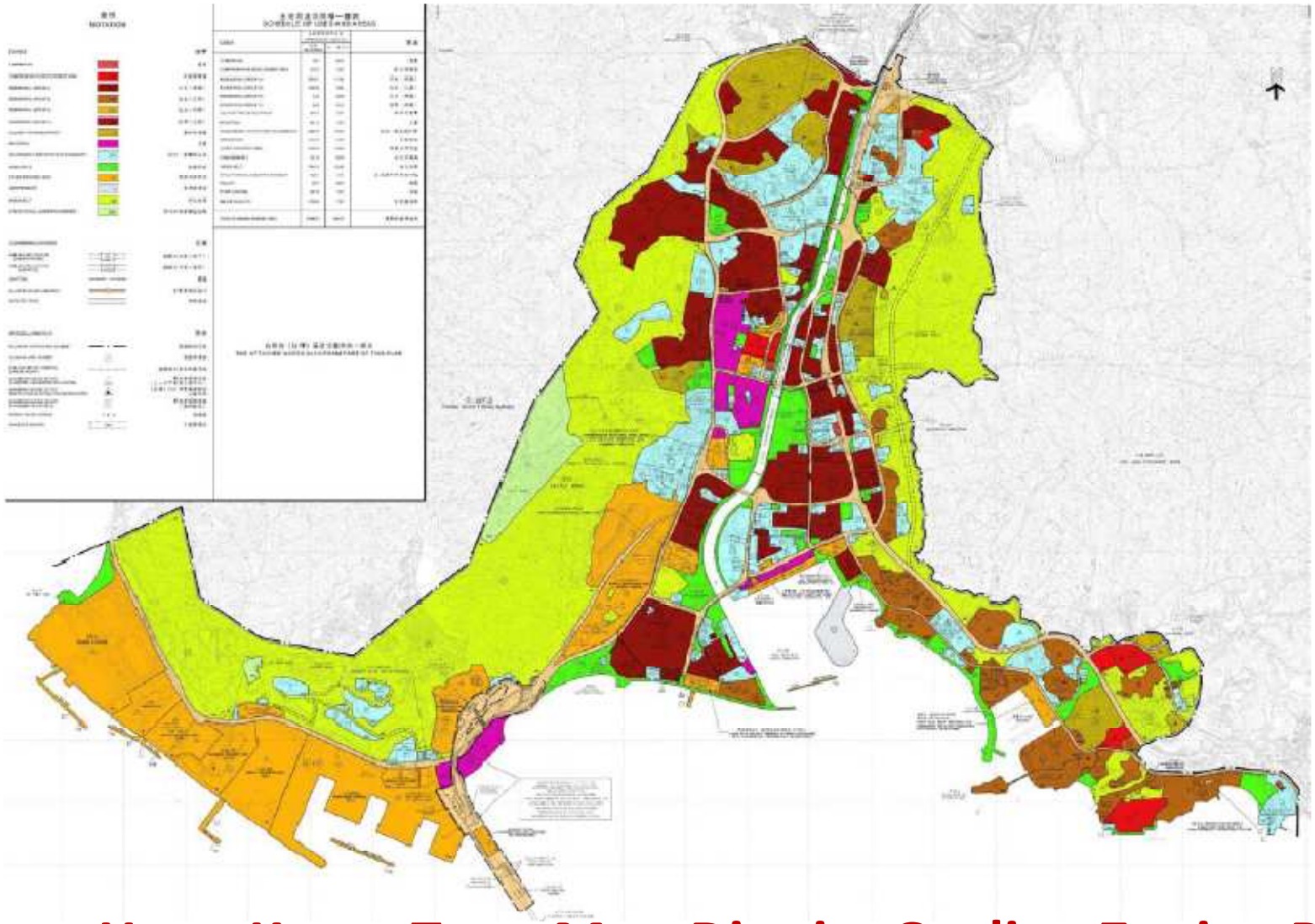

Hong Kong: Tuen Mun District Outline Zoning Plan

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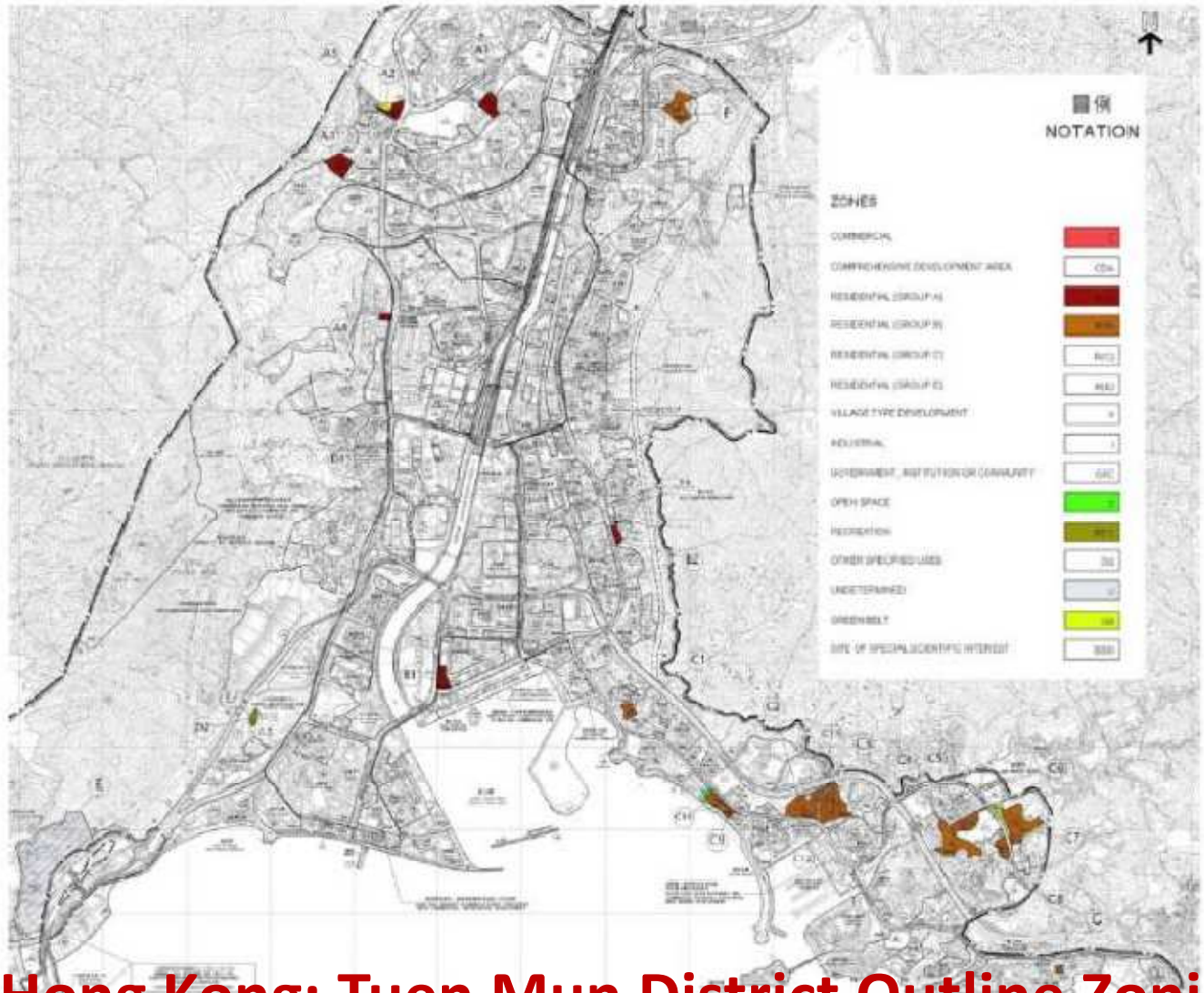

Hong Kong: Tuen Mun District Outline Zoning Plan

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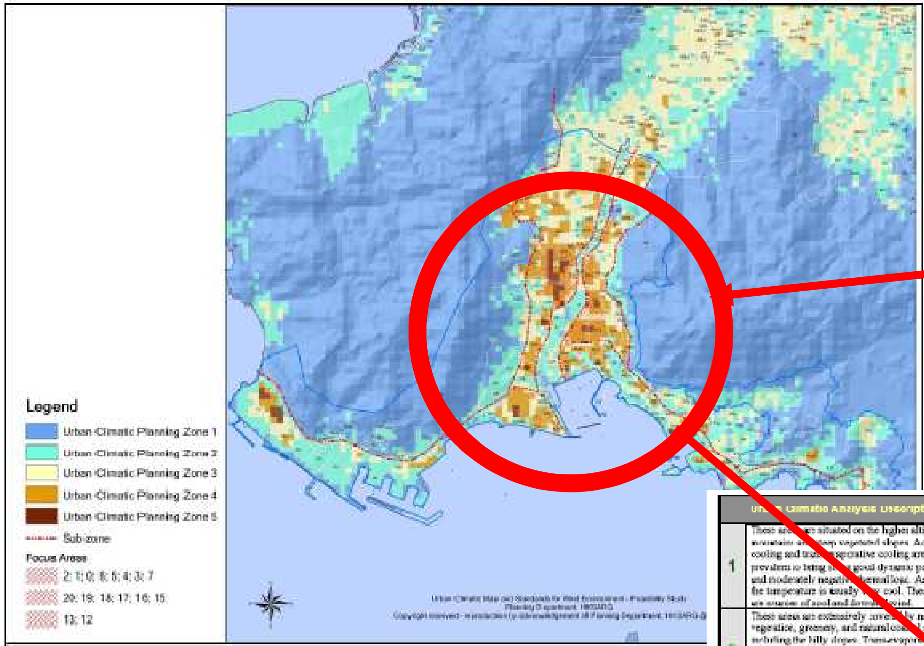
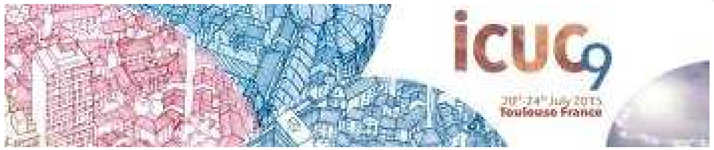


	Urban Climatic Analysis Description	Urban Climatic Classes	Impact on Thermal Comfort	Urban Climatic Value / Sensitivity Zone			Urban Climatic Planning Zones and General Planning Recommendations
1	These areas are situated on the higher altitudes of mountains and steep vegetated slopes. Adiabatic cooling and transpirative cooling are prevalent to bring good dynamic potentials and moderately negative thermal load. As a result, the temperature is usually very cool. These areas are sources of cool and fresh wind.	Moderately negative Thermal Load and Good Dynamic Potentials	•• Moderate	Urban climatically valuable area	Positive	1	1 Preserve 2 These areas are extensively covered with natural vegetation, at higher altitude and with few obstructions to wind. They can provide a cooler and more conducive thermal comfort environment. Their cool air production capability can also be beneficial to nearby urban areas. 3 Natural areas especially cold air production and drainage areas beneficial to other areas (e.g. vegetated hill slopes adjacent to urban areas) should be preserved. No sealing (paving) or development should be allowed. 4 Minor but essential development may be possible in areas other than natural areas identified in 3 above. Careful planning and design is necessary to minimize disruption. 5 Major but absolutely essential and necessary development (e.g. new town), other than natural areas identified in 3 above, may be exceptionally considered. Very careful planning and design is necessary to minimize disruption. Breezeways and air paths must be carefully designed. Street grids and building disposition must respect prevailing wind directions. Building Volume and Ground coverage must be kept low. Maximum greenery and open spaces and minimum sealing must be practised.
2	These areas are extensively covered by natural vegetation, greenery, and natural coastal areas including the hilly slopes. Transevaporative cooling is prevalent to bring about good dynamic potentials and slightly negative thermal load. As a result, the temperature is generally cooler. These areas are sources of cool and fresh air.	Slightly negative Thermal Load and Good Dynamic Potentials	• Slight				
3	These areas usually consist of more spaced out developments with smaller ground coverage and more open space very near the sea. As a result, the temperature is mild.	Low Thermal Load and Good Dynamic Potentials	- Neutral	Slightly urban climatically sensitive area	Neutral	2	1 Preserve and enhance 2 These areas are currently urban climatically "neutral" in terms of urban thermal comfort. It is important to maintain their urban climatic characteristics. Desirable features, like areas with lower building volume, open spaces and so on should be preserved. 3 Further development is possible. 4 Existing air paths must be identified and respected. The prevailing wind directions and air mass movement must be considered when buildings are positioned. 5 Higher Building Volume is permissible if item 4 above is respected. 6 Consider reducing ground coverage to improve ground level air volume; 7 consider greening to the open spaces.
4	These areas usually consist of low to medium building volumes in a developed yet more open setting, e.g. in the sloping areas with a fair amount of open space between buildings. As a result, the temperature is slightly warm.	Some Thermal Load and Some Dynamic Potentials	• Slight				
5	These areas usually consist of medium building volumes situated in low-lying areas further inland from the sea or in areas fairly sheltered by natural topography. As a result, the temperature is warm.	Moderate Thermal Load and Some Dynamic Potentials	•• Moderate	[illegible]	[illegible]	3	1 Some action encouraged 2 These areas are currently urban climatically "moderate" in terms of urban thermal comfort. Some impact on thermal comfort is expected. As such, it is encouraged to consider installing some mitigation measures. 3 Further development is possible and should be carried out with care. 4 Existing air paths must be identified, respected and enhanced. The prevailing wind directions and air mass movement must be considered when buildings are positioned. 5 Higher Building Volume is permissible if item 4 above is respected, and it is necessary to balance it with a reduction of ground coverage to improve ground level air volume; 6 Greening to the open spaces and streets is highly recommended.
6	These areas usually consist of medium to high building volumes located in low lying development areas with relatively less urban greenery. As a result, the temperature is very warm.	Moderately High Thermal Load and Low Dynamic Potentials	••• Moderately strong	High urban climatically sensitive area	High	4	1 Action desirable and recommended 2 These areas are already densely built. Thermal Load is high and Dynamic Potential is low. Some strong impact on thermal comfort is expected. 3 Further development is possible and should be carried out with care. A balanced consideration of adding Building Volume and reducing Ground Coverage must be considered so that at least a "no worse than existing" scenario could result. 4 Existing air paths must be identified, respected, enhanced and widened. The prevailing wind directions and air mass movement must be considered when buildings are positioned. 5 Greening to the open spaces and streets is essential. 6 Addition greenery and tree planting on streets in these zones is essential and is strongly recommended. Intensify greening in O and G/IC zones are also recommended.
7	These areas usually consist of high building volumes located in low-lying well-developed areas with little open space. As a result, the temperature is generally hot in these areas.	High Thermal Load and Low Dynamic Potentials	•••• Strong				
8	These areas usually consist of very high and compact building volumes with very limited open space and permeability due to shielding by buildings on many sides. Full and large ground coverage is prevalent and air paths are restricted from the nearby sea or hills. As a result, the temperature is very hot in these areas.	Very High Thermal Load and Low Dynamic Potentials	••••• Very strong	Very highly urban climatically sensitive area	Very high	5	1 Mitigation action necessary 2 These areas are already very densely built. Thermal Load is very high and Dynamic Potential is low. Very strong impact on thermal comfort is expected. A high frequency of occurrence of thermal stress is also anticipated. 3 No further adding of Building Volume and Ground Coverage should be allowed. 4 Existing air paths must be identified, respected, enhanced and widened. New air paths may need to be created. The prevailing wind directions and air mass movement must be considered when buildings are re-developed and re-positioned "to improve" the existing situation. Strategic mitigation measures (air paths, open spaces, urban greenery, street widening, building set back, and so on) must be considered "to improve" the existing situation. 5 A strategy to utilise all G/IC sites to relief the existing condition is recommended. No further infill structure is encouraged on all these G/IC sites. Intensify greening is recommended. 6 Addition greenery and tree planting on streets in these zones is essential and is essential recommended. Intensify greening in O zones is strongly recommended.

Based on the Urban Climatic Planning Recommendation Map of HK, the re-zoning sites were reviewed by the Town Planning Board.



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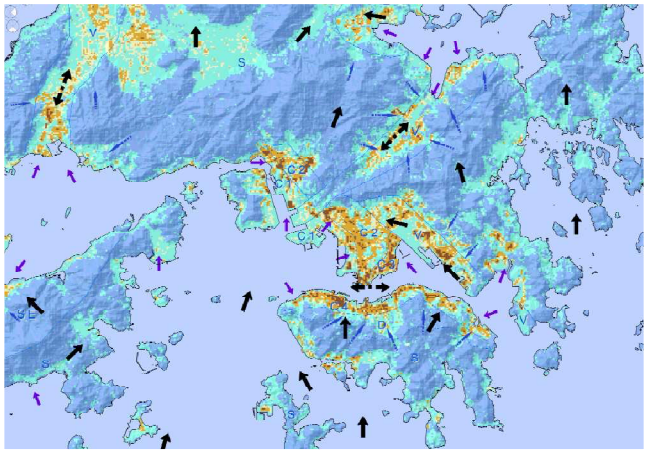

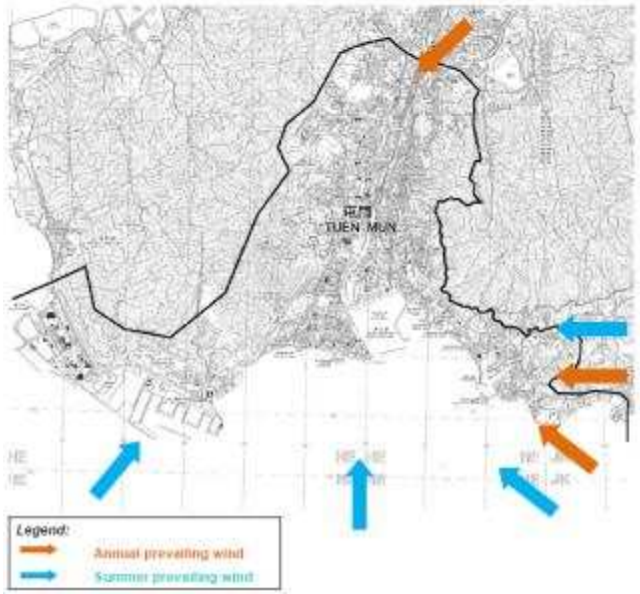

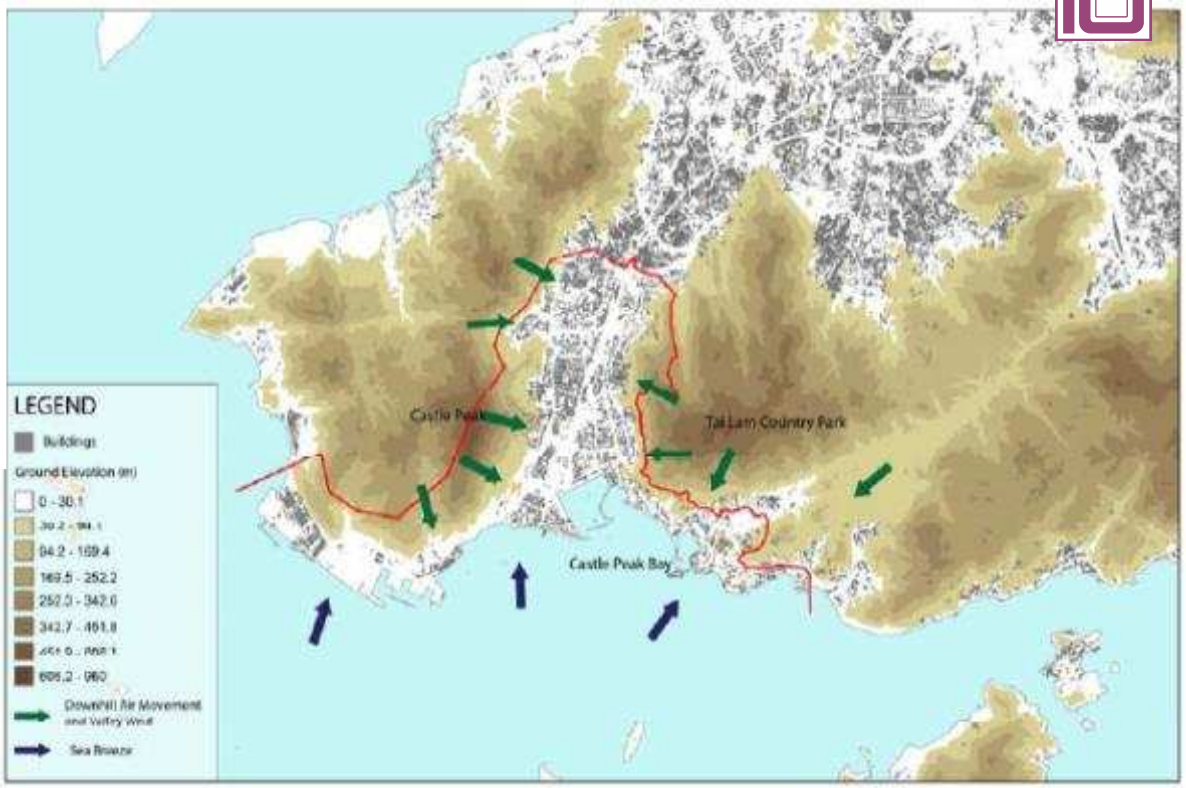

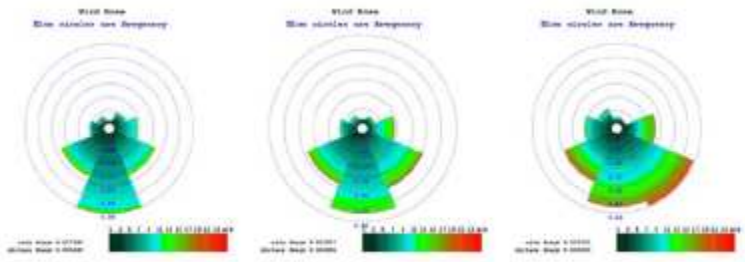

Figure 3.17 Summer Wind roses (2005) at A (left: 60 m; middle: 120 m; right: 450 m).

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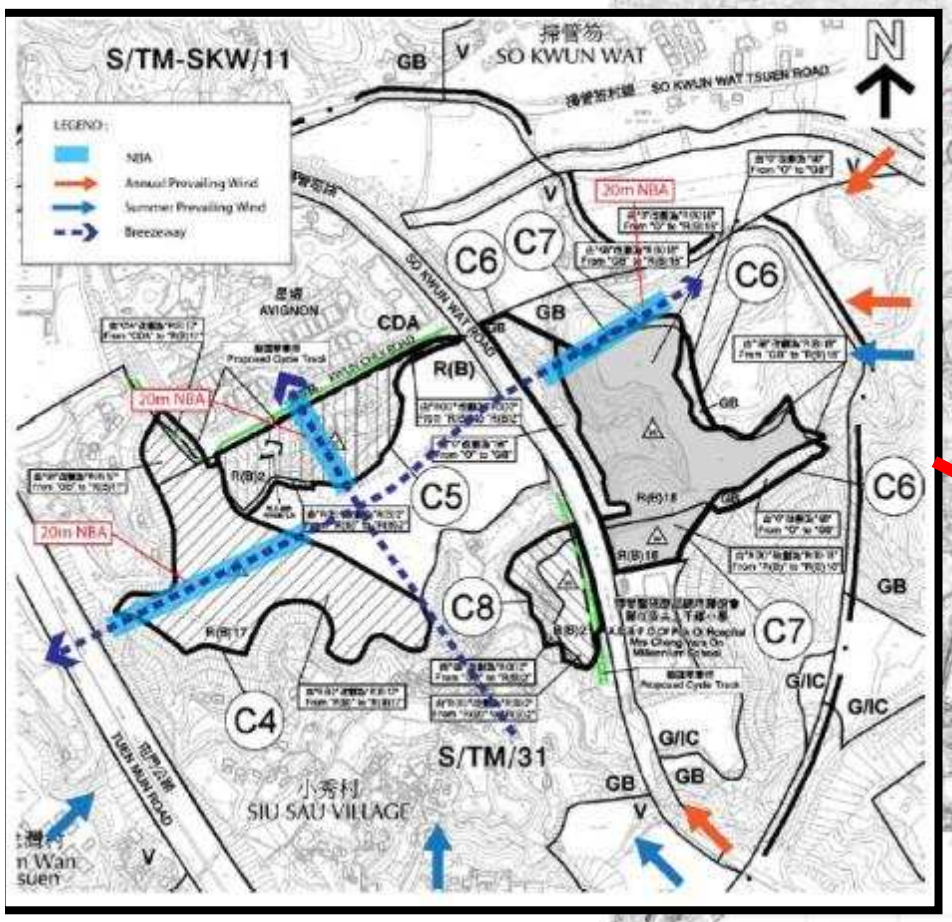
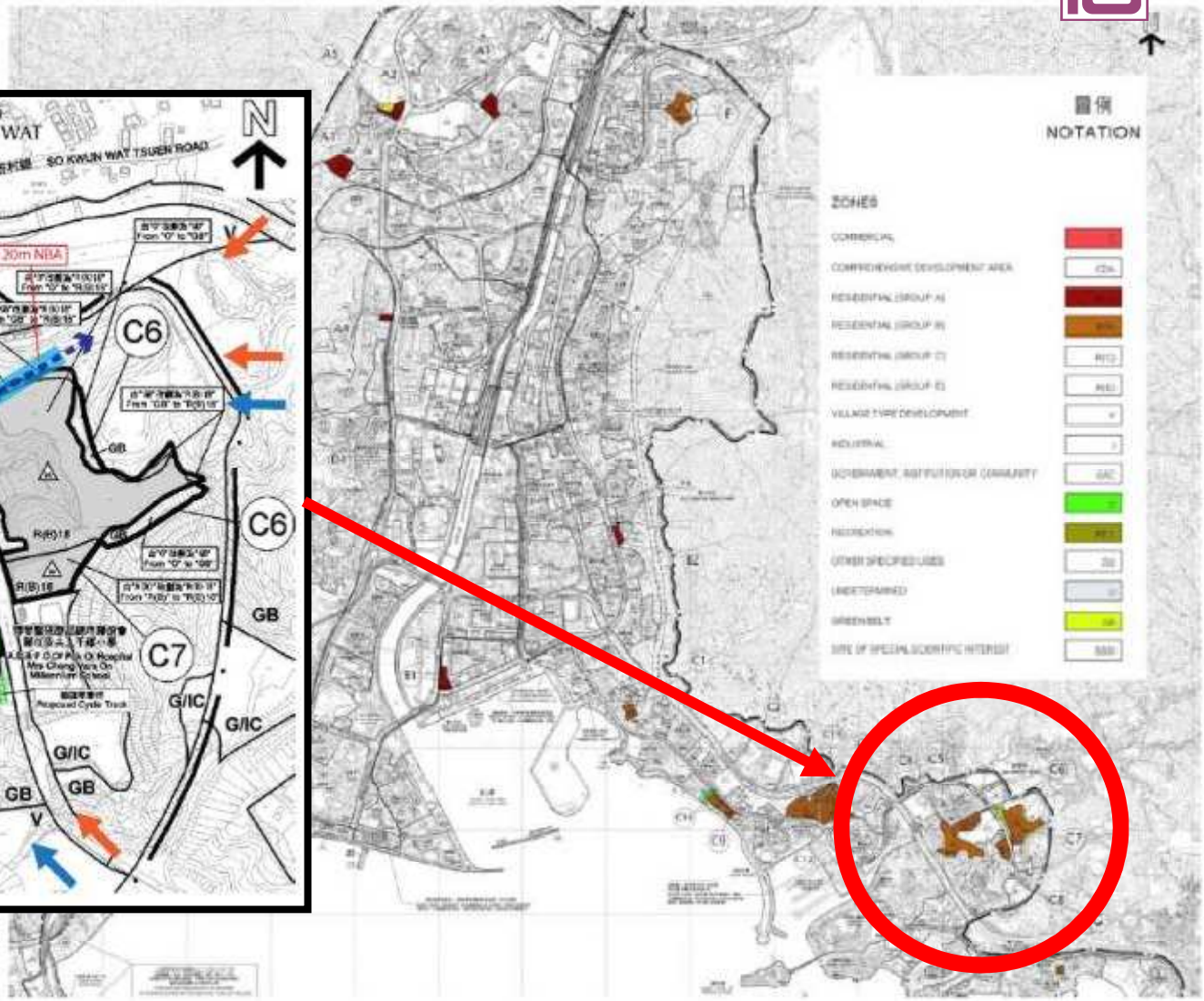
Planning for the future, urban climatically – Hong Kong





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Sustainable Building Development guidelines

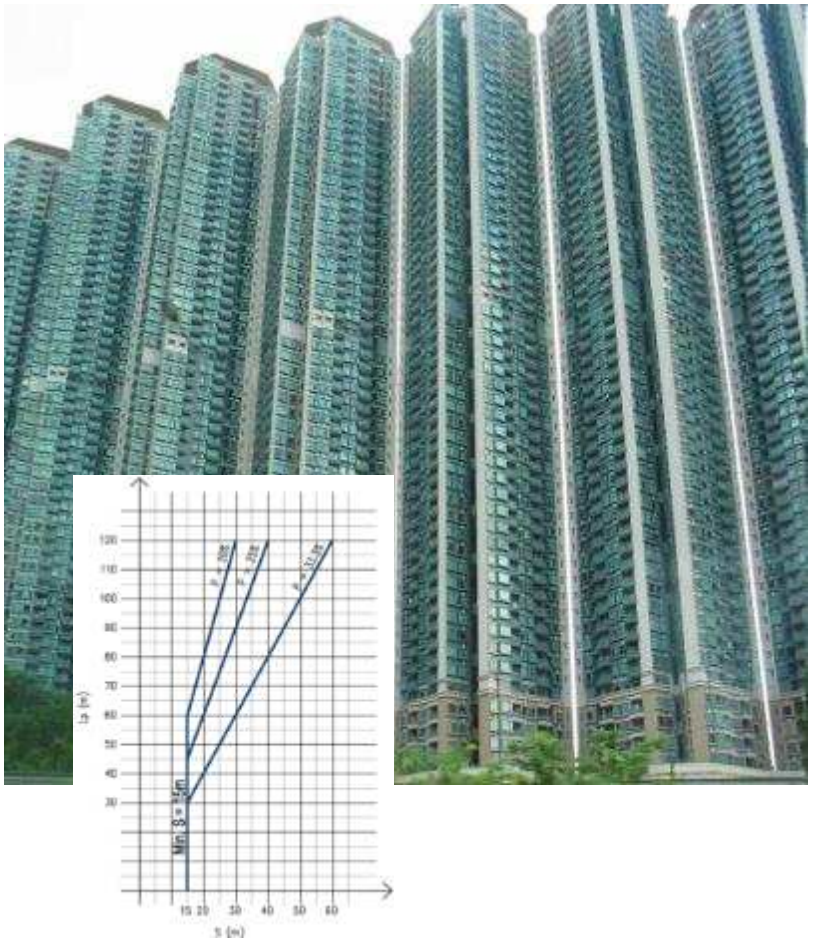
Building Separation and Design Guidelines

Buildings Department, HKSAR 香港政府屋宇署
Consultancy Agreement No. BA/01/2006

建築分隔 / 通風滲透性 Building Separation / Permeability

設計原則1: **建築分隔**
Design Principle 1: **Building Separation**

- 所需要的建築通風滲透性將首先通過調整**建築分隔**來實現。
  The required building permeability shall firstly be provided in form of **building separation (S)**
- 與相鄰立面長度成正比的分隔寬度應與所規定的建築滲透率標準相一致，**不小於15m。**
  The accountable width of which is proportional to the length of adjoining facades in accordance with the stipulated building permeability criteria and **in no case smaller than 15m**.
- 在相互緊鄰的條件下，從相鄰街道邊綫或中心綫測量的建築分割間距可以使用**1/2S**的標準。
  For the immediate context taken into account, the **1/2S** criteria can be applied to the facade ends with separation distance measured from the adjoining boundary line or the centerline of adjoining street.



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Sustainable Building Development guidelines

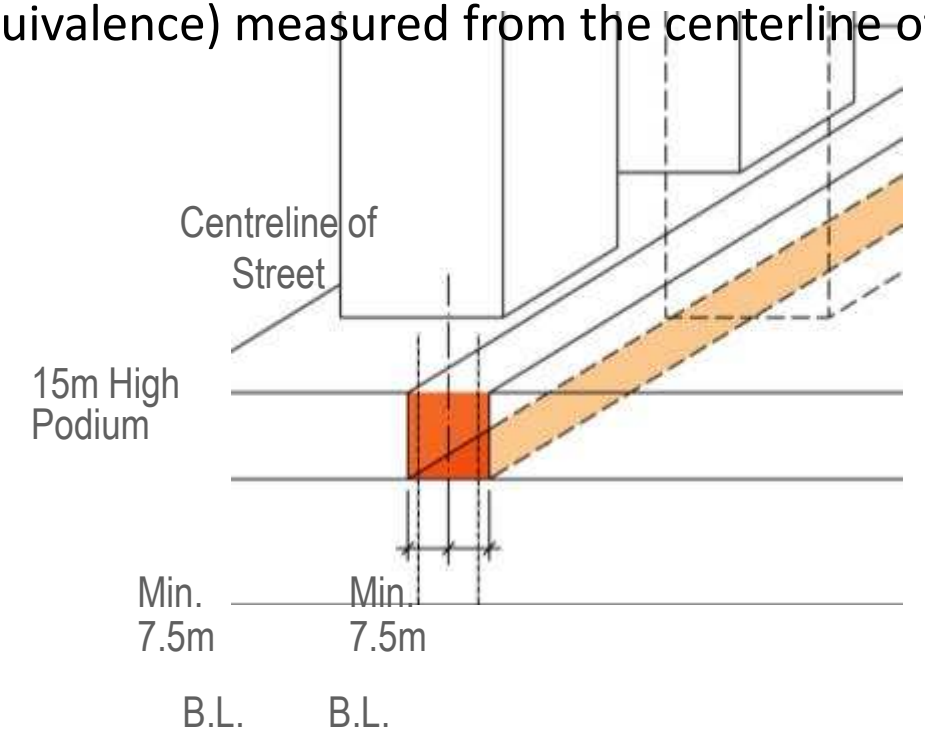
Buildings Department, HKSAR 香港政府屋宇署
Consultancy Agreement No. BA/01/2006

Street set back and non building areas

建築退讓 / 人行區域"峽谷式"街道的最小斷面面積
Building Setback / Minimum Sectional Area of Urban Canyon at Pedestrian Zone

在緊鄰開發用地的"峽谷式"街道中，為使人行空間獲得更充分的空氣容量，街道最小斷面面積不應小於**7.5m x 15m**（或等值面積）。

The minimum sectional area of urban canyon for better air volume at the Pedestrian Zone within the urban canyon abutting the development site should be not less than a **7.5m x 15m** sectional area (or the equivalence) measured from the centerline of the adjoining street.



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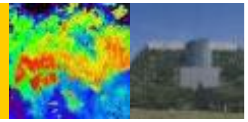
Sustainable Building Development guidelines

Buildings Department, HKSAR 香港政府屋宇署
Consultancy Agreement No. BA/01/2006

基地綠化覆蓋率 Site Coverage of Greenery

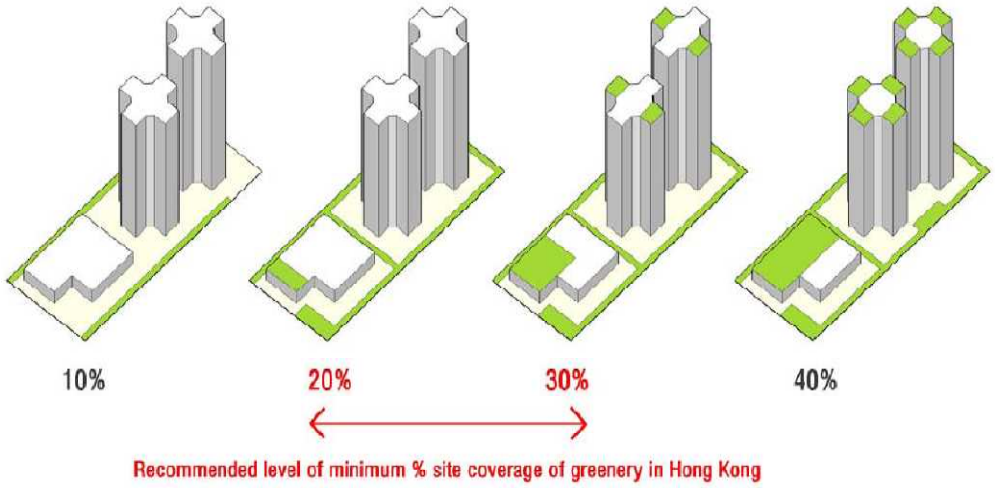


為加強城市綠化，新開發用地將根據基地面積的大小，提供以下最小綠化覆蓋率。

To enhance urban greenery, new development sites shall provide the following minimum site coverage of greenery, dependent on the site area:

Site Area	Site Coverage of Greenery
≥ 1,000 s.m.	Min. 20%
≥ 2 ha	Min. 30%

Site Area	Site Coverage of Greenery
≥ 1,000 s.m.	20%
≥ 2 ha	30%



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- No “wall” building
- Not 100% site coverage
- Greening Intensified at grade
- Setback from narrow streets
- Permeable podium
- Inner-site air corridor & air-path connectivity

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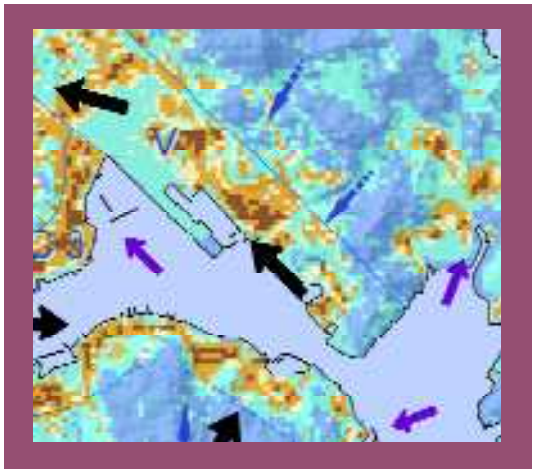
Sustainable Building Development guidelines



KWUN TONG
TOWN CENTRE PROJECT

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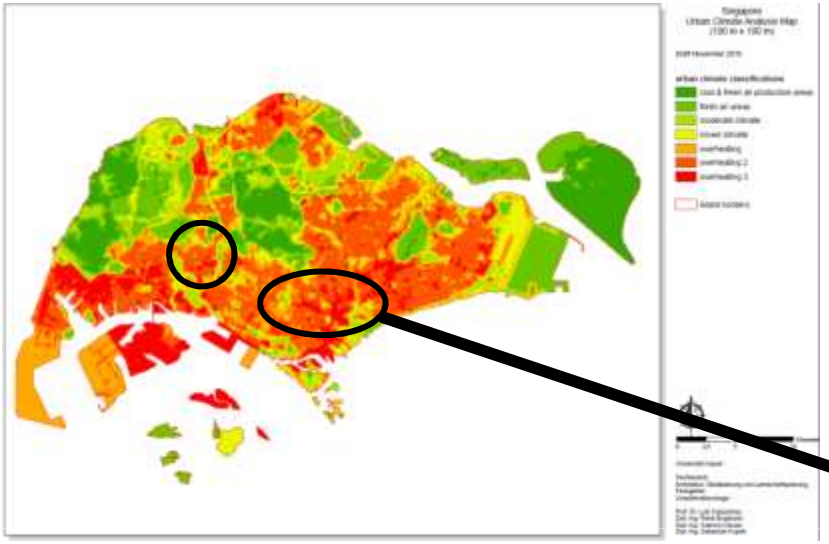
Planning for the future, urban climatically – Singapore

Singapore's heat map aligns with URA's Landscape Replacement Policy (2009)



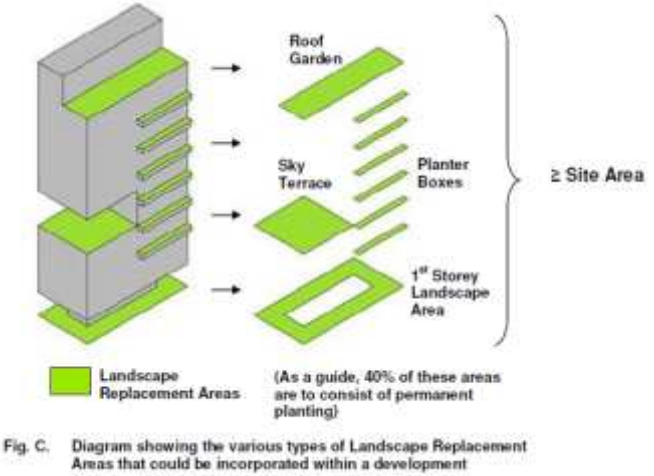
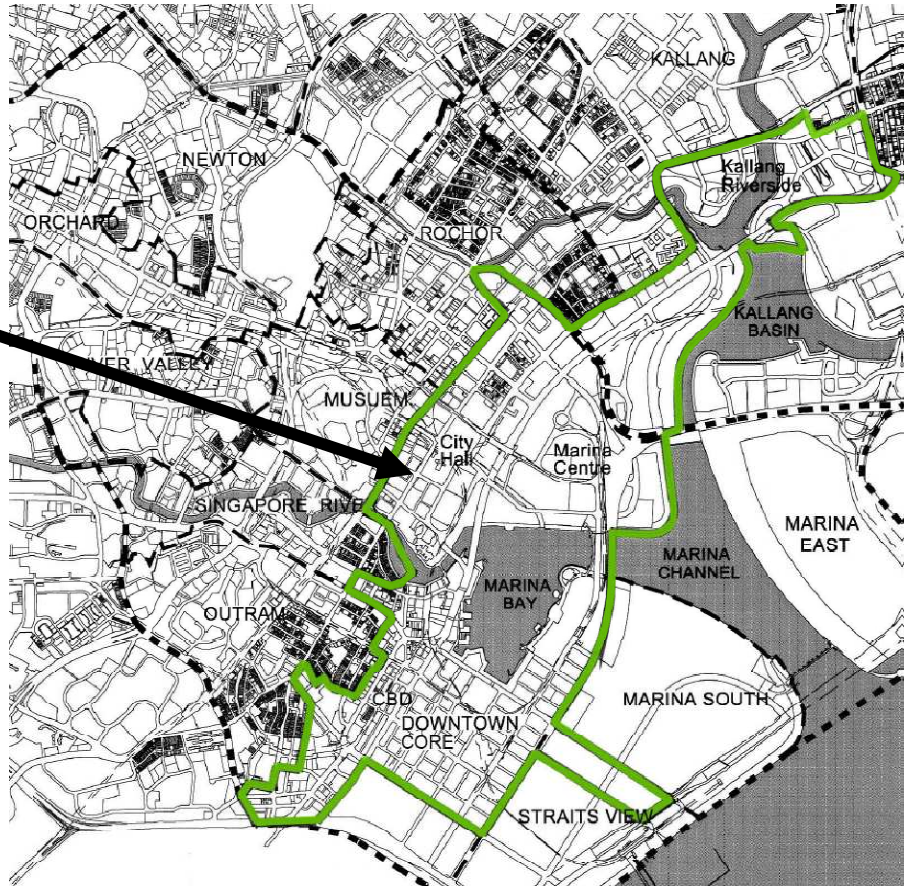


Fig. C. Diagram showing the various types of Landscape Replacement Areas that could be incorporated within a development

Areas where new developments will be providing Landscape Replacement Areas



URA landscape replacement policy http://www.ura.gov.sg/pr/graphics/2009/pr09-19a1.pdf
http://www.ura.gov.sg/circulars/text/dc09-09.pdf

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Planning for the future, urban climatically – Singapore

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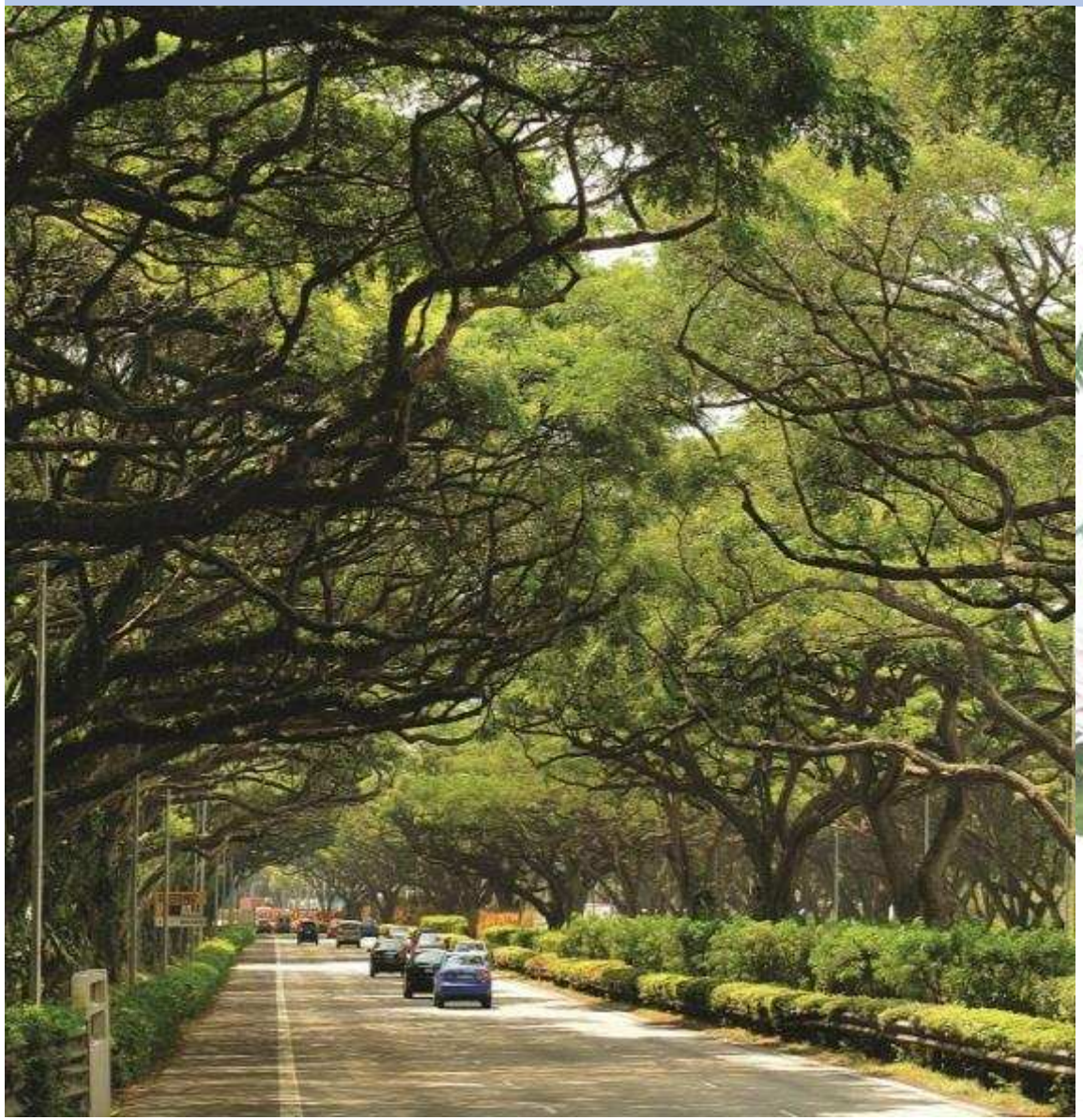

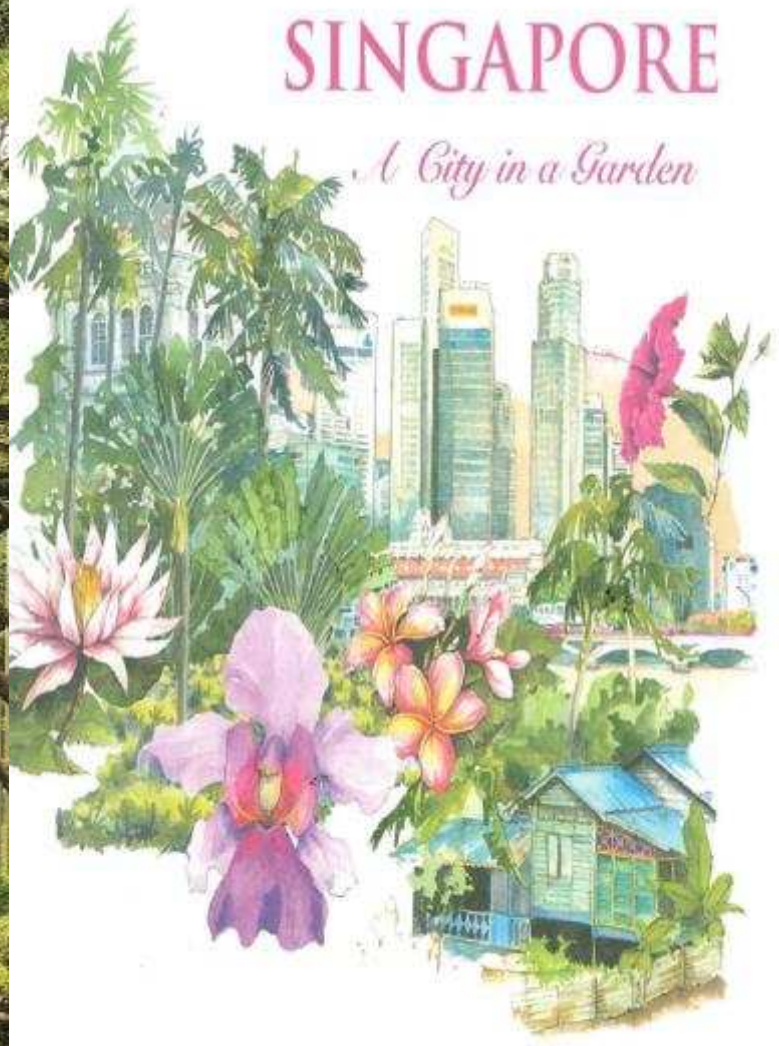

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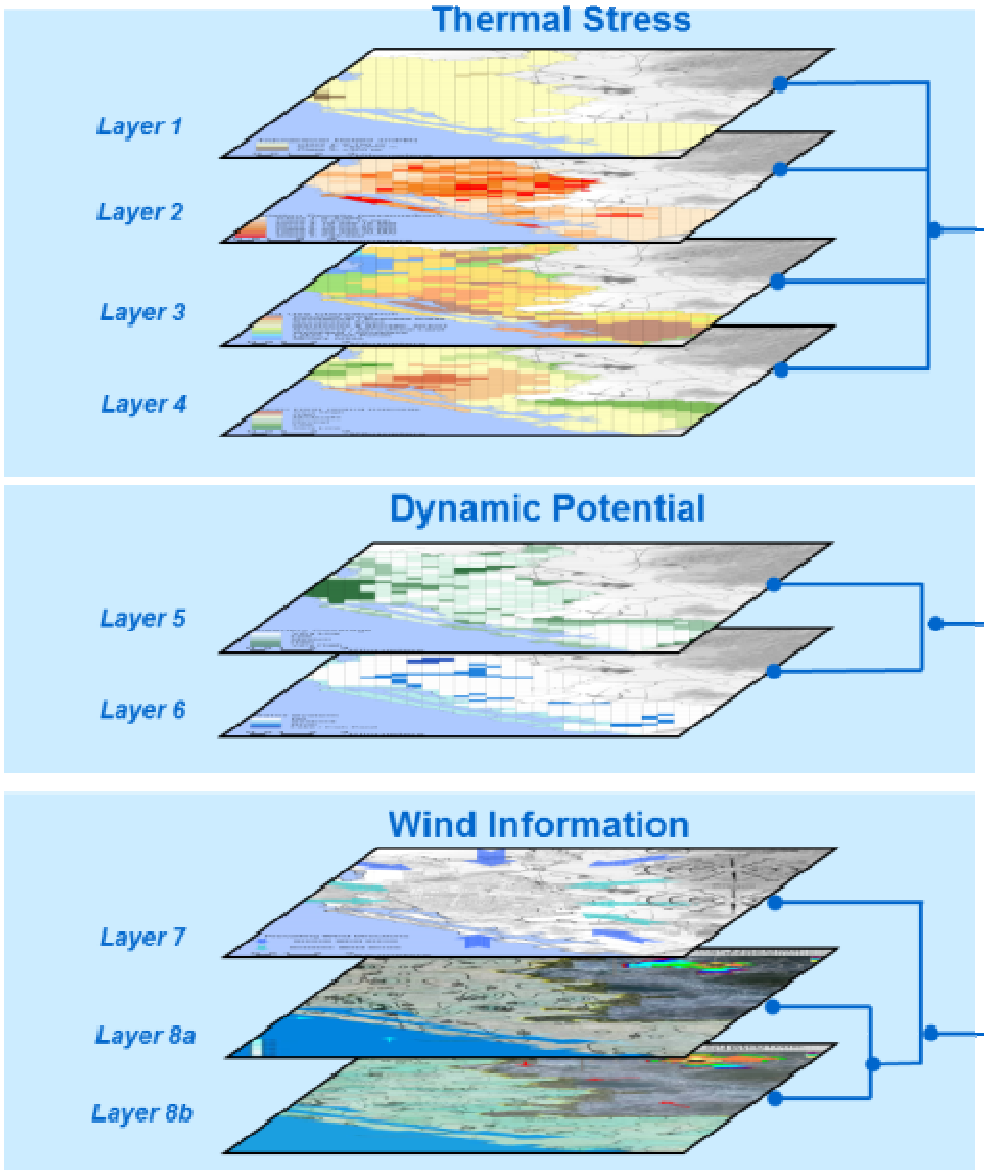

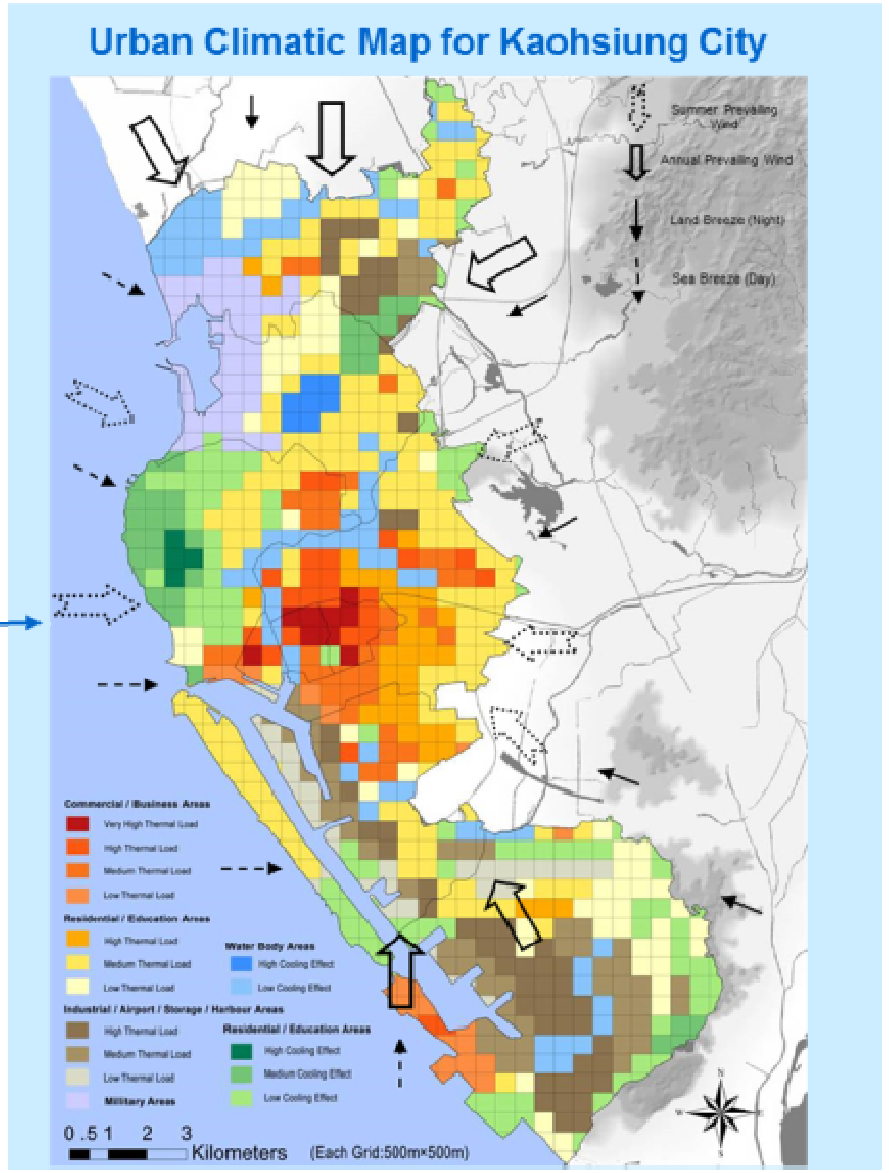

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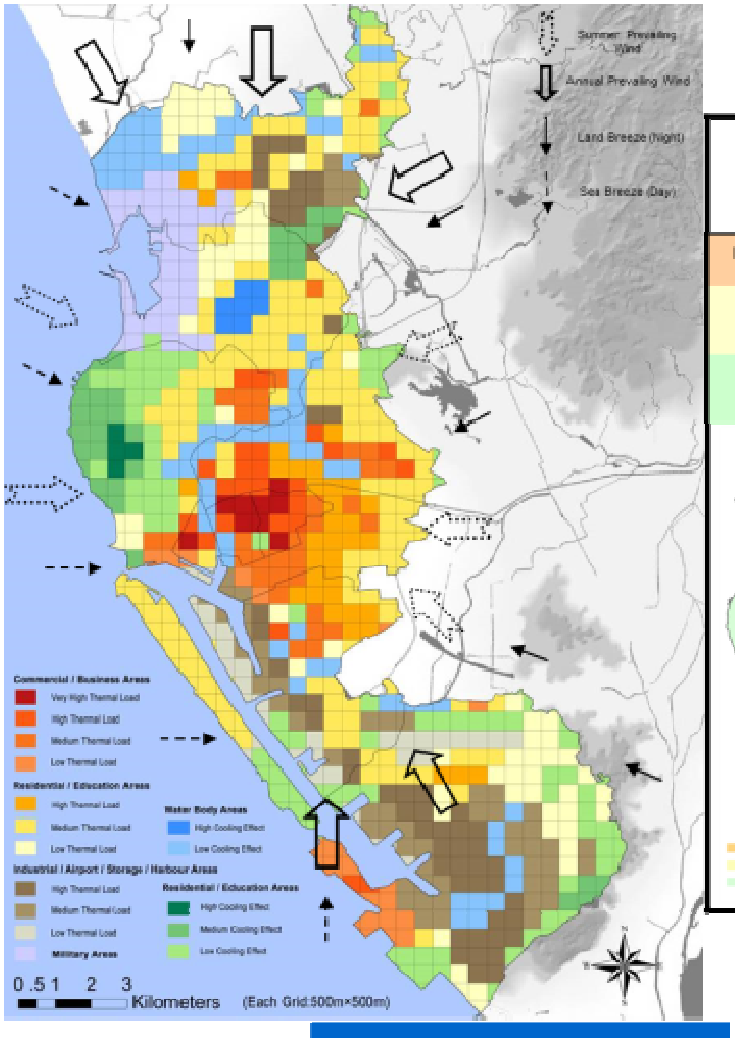
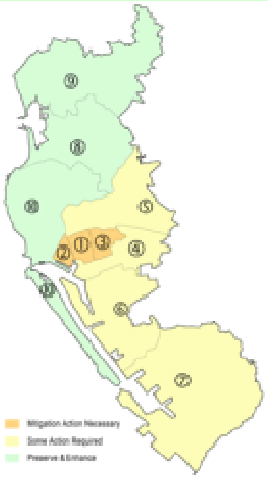


Urban Climatic Map & General Recommendations for 11 Districts

The Level of Plan Action	District Name	Urban Climatic and Environmental Characteristics	Menu of Effective Control Measures					
			Greenery	Stacking	Cool Albedo	An Heat Release	Air Exchange	Air Pollution
Mitigation Action Necessary	Cianjin	High to very high thermal stress and low dynamic potential due to high ground coverage, high Anthropogenic Heat (An-Heat) Release, various commercial activities and low greenery coverage;	▲▲	▲	▲	▼▼	▲▲	▼
Some Action Required	Yancheng		▲▲	▲	▲	▼▼	▲▲	▼
Preserve & Enhance	Sinsing		▲▲	▲	▲	▼▼	▲	▼
	Lingya	High to medium thermal stress and low to medium dynamic potential due to low to medium ground coverage, medium An-Heat Release, some commercial activities, lots of industrial activities and low greenery coverage;	▲▲	▲▲	▲	▼▼	▲▲	▼
	Sanmin		▲▲	▲	▲	▼	▲	▼▼
	Cianjhen		▲▲	▲	▲▲	▼▼	▲	▼▼
	Siaogang		▲▲	▲	▲▲	▼▼	▲	▼▼
	Zuoying	Medium to low thermal stress and medium to high dynamic potential due to low to medium ground coverage, low An-Heat Release, some commercial and industrial activities and medium to high greenery coverage;	▲	▲▲	▲	▼	▲▲	▼
	Nanzih		▲	▲	▲▲	▼▼	▲	▼▼
	Cijin		▲	▲	▲▲	▼	▲▲	▼
	Gushan		—	▲	—	—	▲	—



▲ Recommend to improve the existing condition
▲▲ Strongly recommend to improve the existing condition
▼ Recommend to degrade the existing condition
▼▼ Strongly recommend to degrade the existing condition
— Maintain the existing condition

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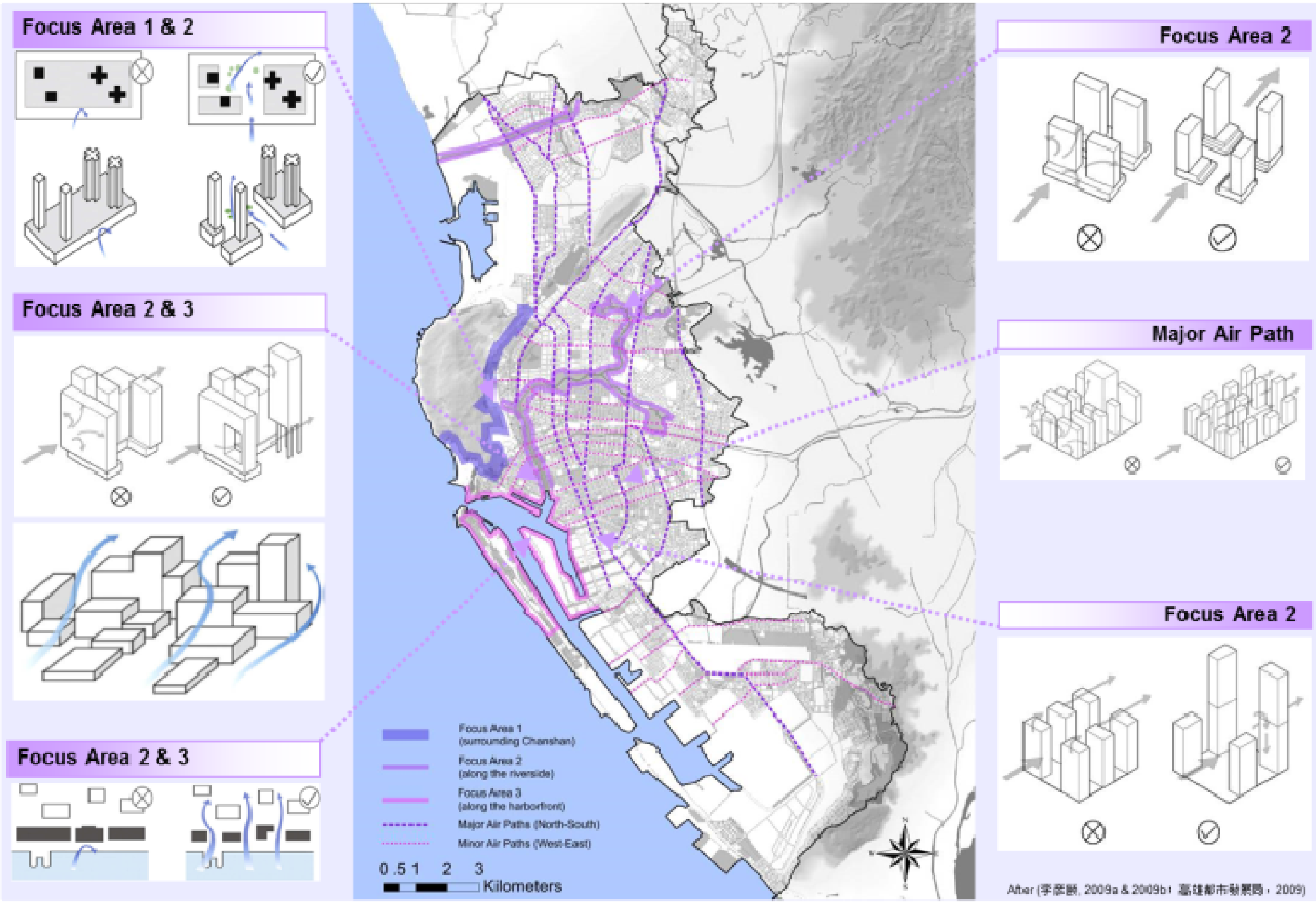
Recommendation on Wind Aspect

1. Respect the cooling effect from the Eastern Chanshan: minimize the development's impact; and form air path from hillside to downtown areas.
2. Respect the cooling effect from the river: Building blocks with various height to allow the penetration of cooling effect from riverside to inner urban areas;
3. Respect the sea breeze penetration: Do not form the Wall Effect Buildings at the harbour front;
4. N-S orientated main roads are important major air paths; Buildings should be orientated with respect to the major air paths (annual & summer)
5. W-E orientated main roads are important minor air paths esp in summer; Building should be orientated with respect to the minor air paths.



After (李彦頤, 2009a & 2009b; 高雄都市發展局, 2009)

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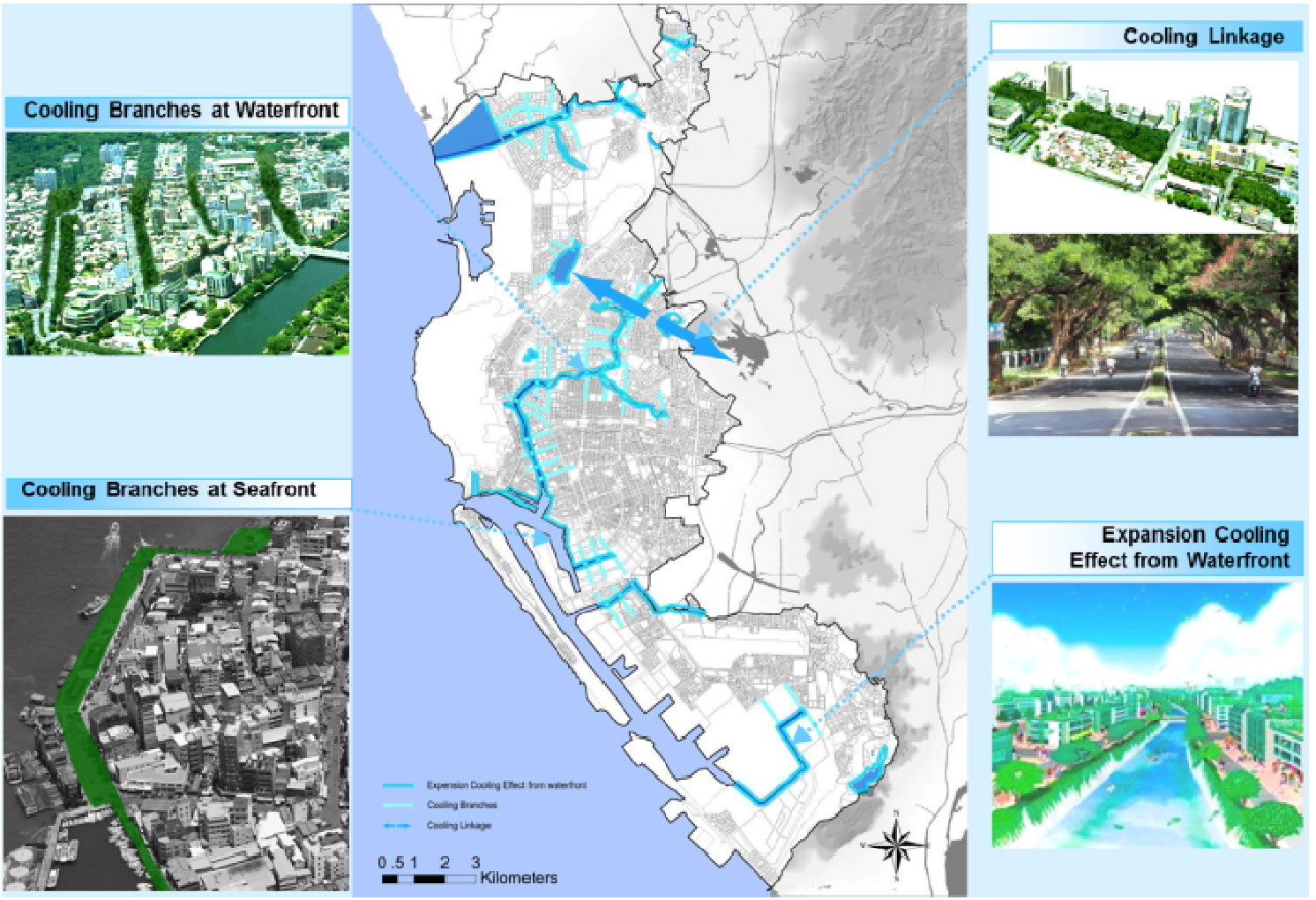
Recommendation on Water Aspect

1. Respect the cooling effect from water systems, including river, lake, ponds & seafront; minimize the development's impact at waterfront and landscape the waterfront.
2. Form cooling branches along major transportation links highlighted in light blue color in the right map appropriate greenery or landscape designs along these branches are strongly recommended.
3. Link the Lian Chih Pond Jhishih lake and Chengching Lake by using greenery or vegetations to benefit the surround areas of these water bodies and mitigate the urban heat island intensity;



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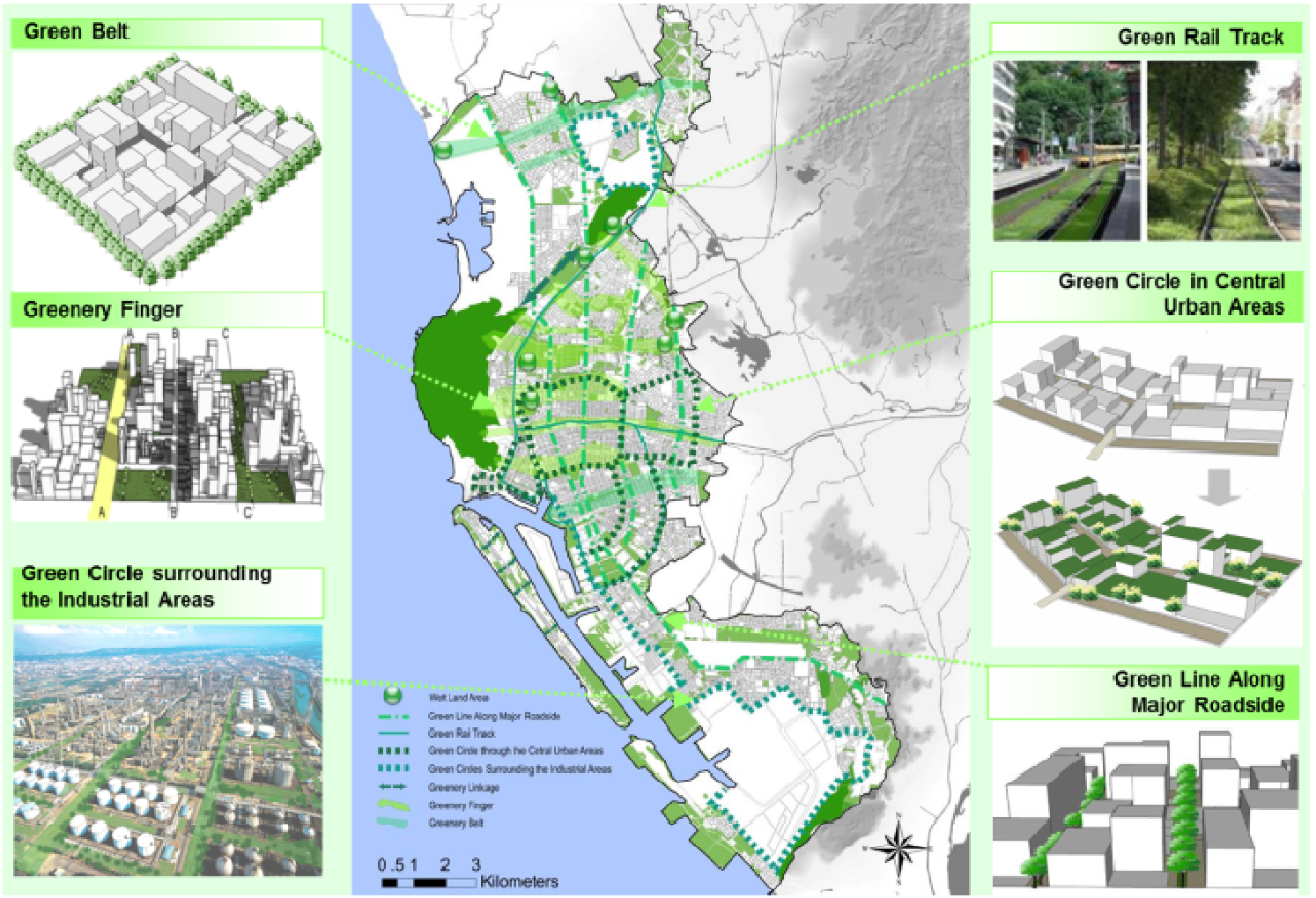
Recommendation on Greenery Aspect

1. Green rail track can be adopted to mitigate the anthropogenic heat release and air pollution along railways in dense urban areas;
2. Form green circles in the central urban areas to mitigate urban heat island intensity and anthropogenic heat releases. Provide shading at pedestrian level to create comfortable walking systems
3. Form green circles around the industrial areas to mitigate the distribution of air pollution.
4. Create Green linkage between Chanshan, Lianchih Pond and Banpinshan to maximize the cooling effect;
5. Develop Green Fingers to let the cooling effect from Chanshan East hillsides to high-dense centre urban areas;
6. Create Green Belt to bring sea breezes to inner areas and improve the air exchange;



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家園

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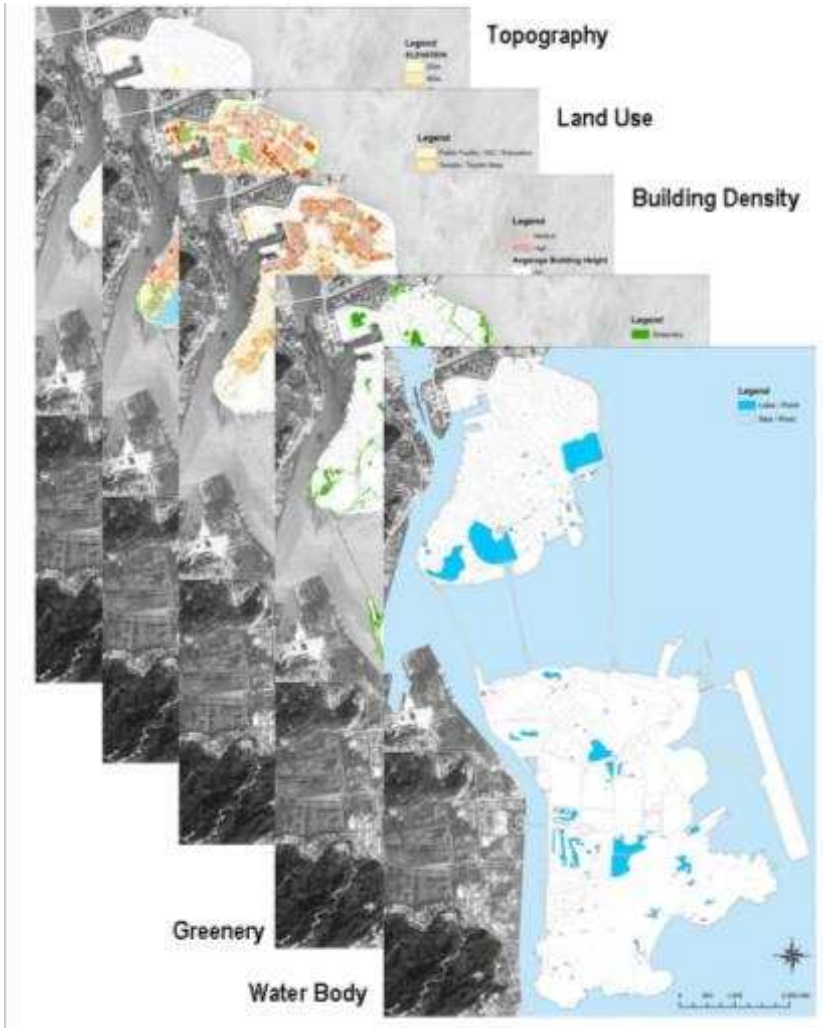
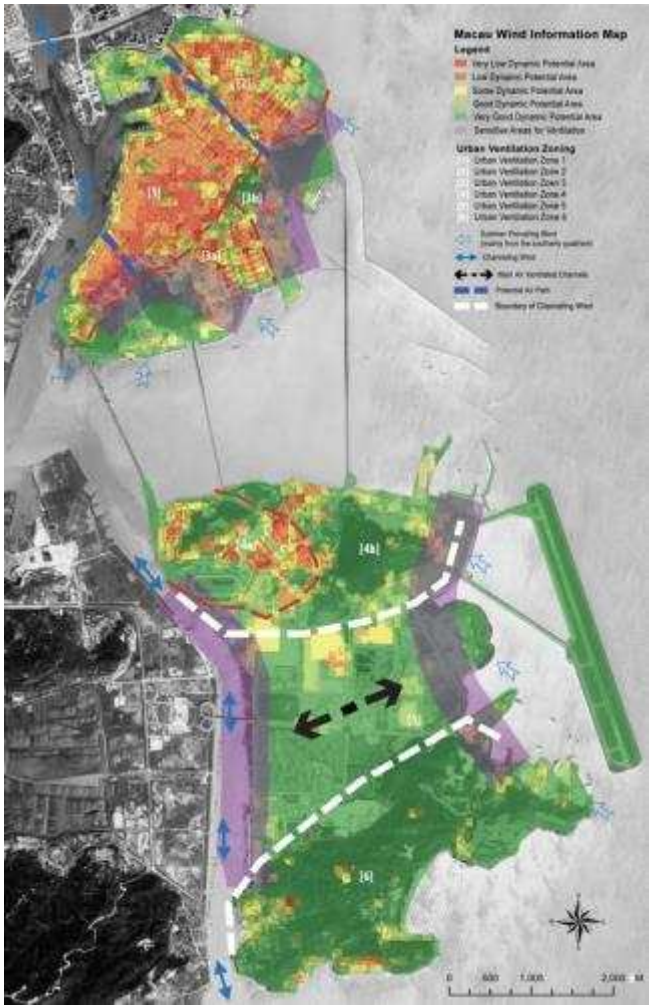
Planning for the future, urban climatically - Macau

Macau





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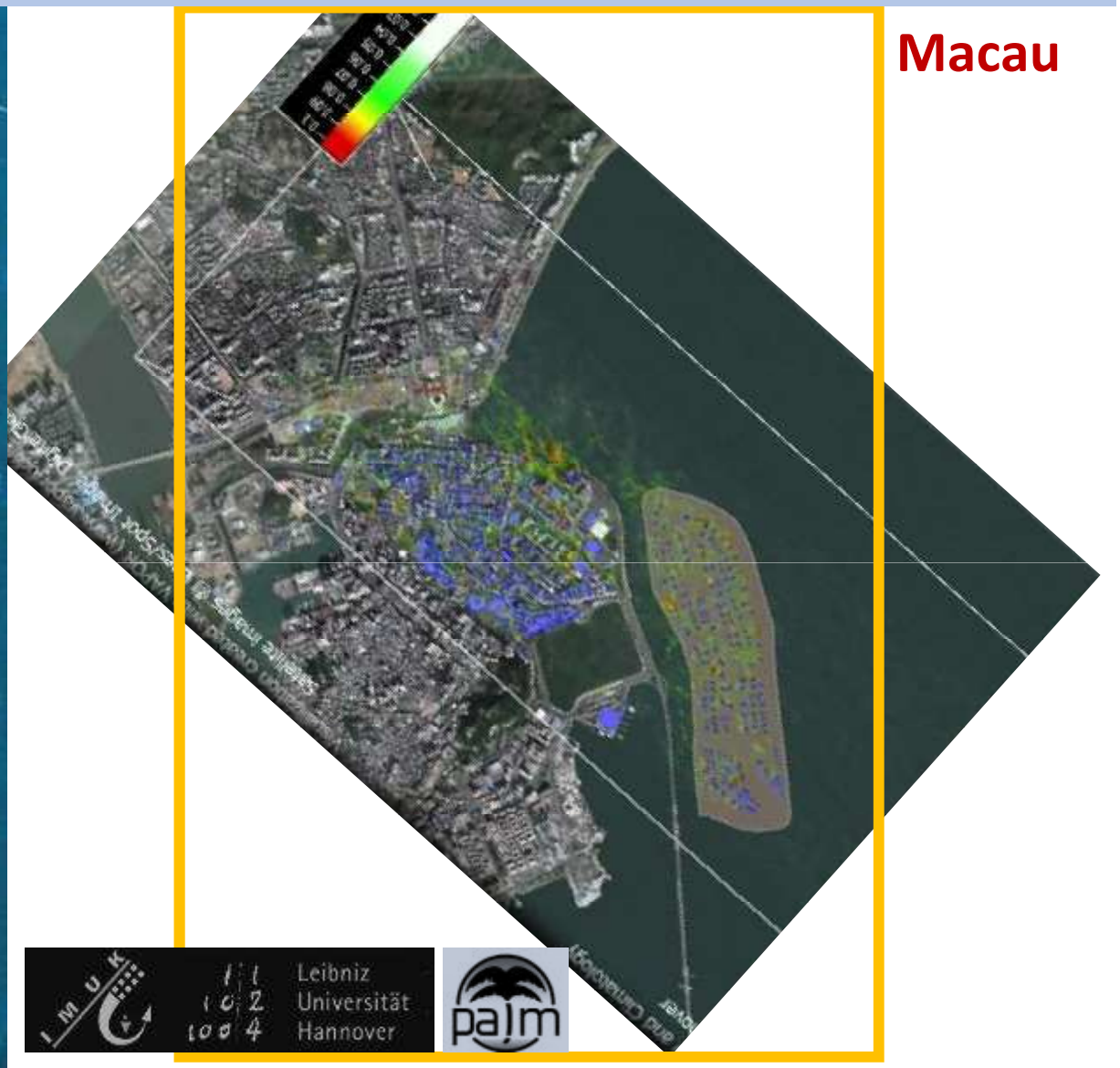

Macau

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Planning for the future, urban climatically - Macau

PALM simulations

Δ = 2m
5000*3000*500
grid points

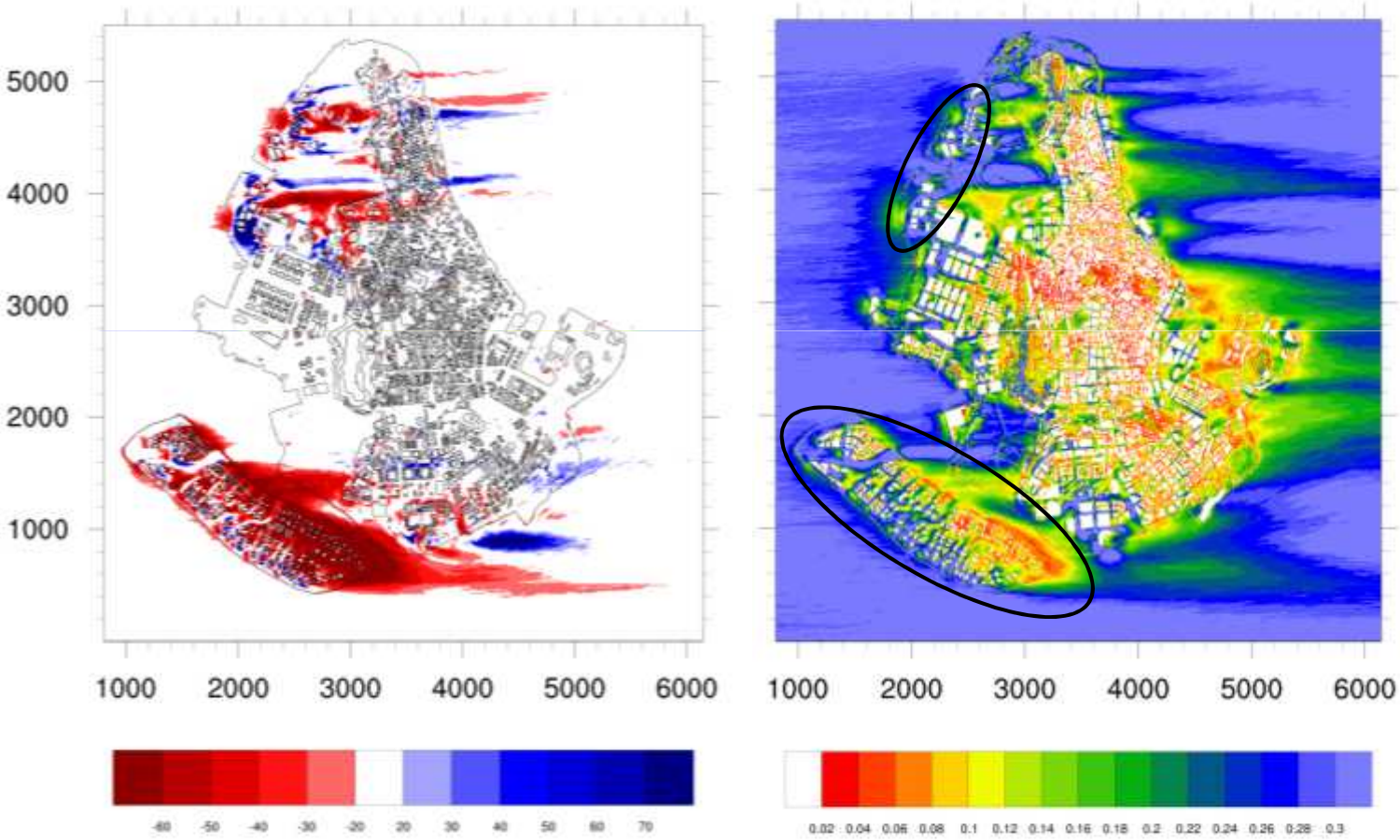
Macau

N

change of v_r in %

current conditions

with new reclamation areas



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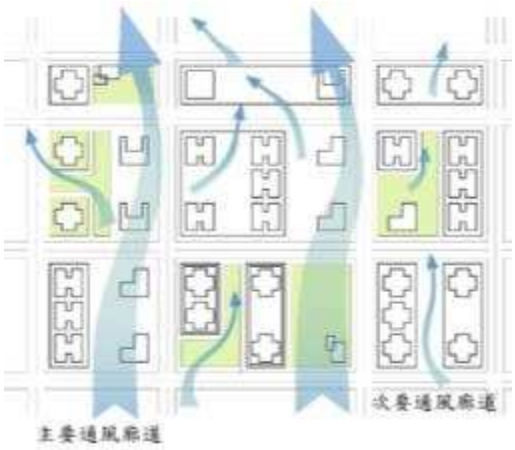
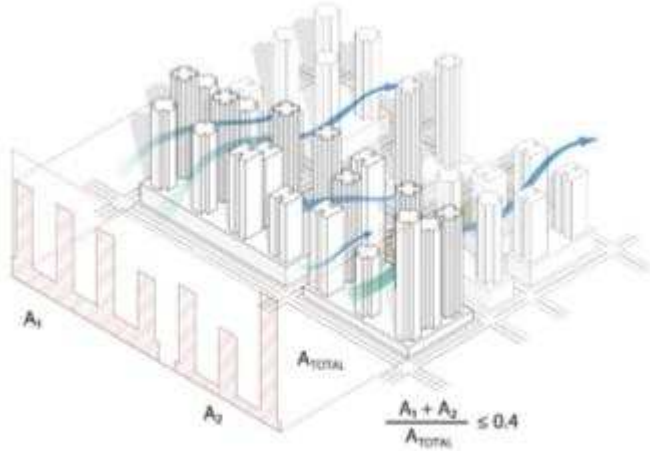
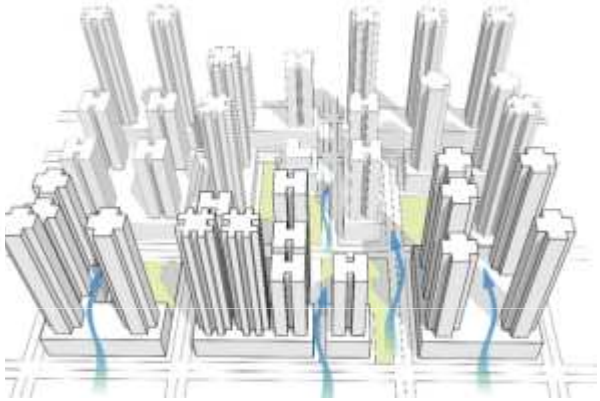
Planning for the future, urban climatically - Macau

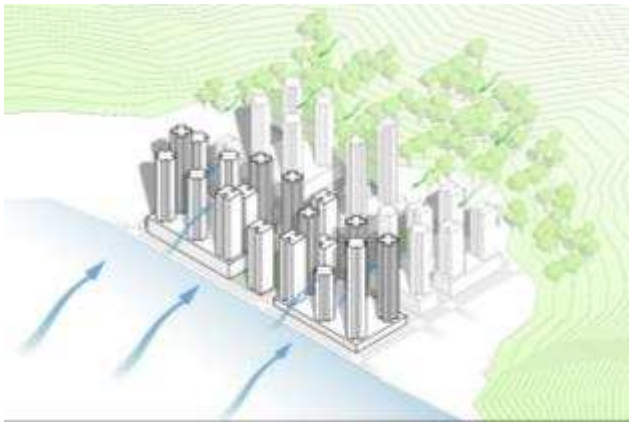
Macau

澳門風環境評估與風道設計策略









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The need to go beyond our boundaries, and communicate

We recommended the setting up of Urban Climate for Planning section

(*World Meteorological Organisation-WCC3*) **"The consideration of Urban climatology for planning is necessary"**

Planners must be assisted by and work with urban climatologists when interpreting and applying urban climatic considerations.

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My take home message

The giants of our disciplines Prof Tim Oke, Prof Bob Bernstein, and the like, and our predecessors have inspired us much on what we need to "know", now it is our turn to pay respect by making what we know "real".

Inspired by a friendly conversation in Carcassonne over a glass of wine.

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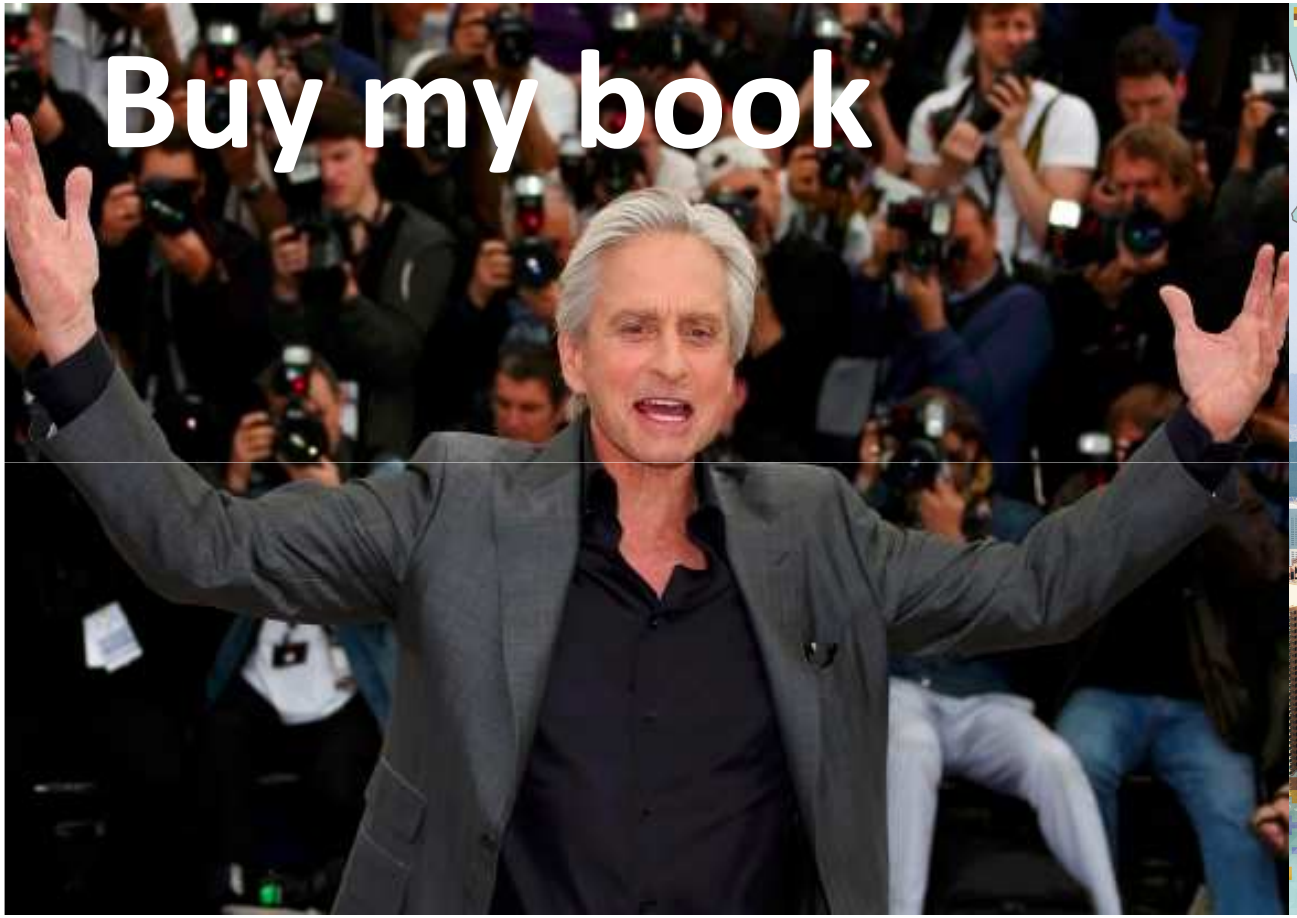
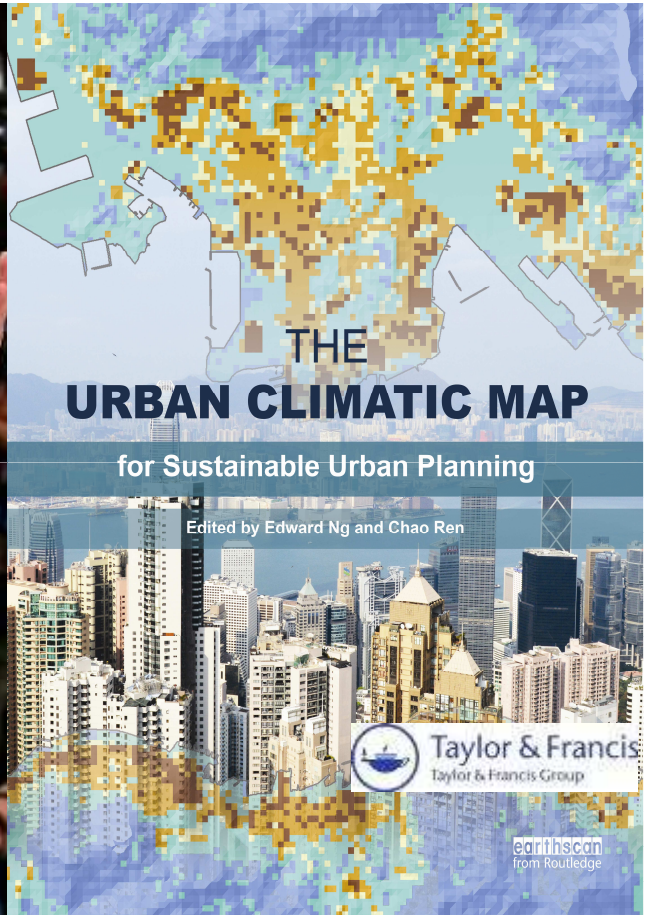
Another of my take home message, 3 words …





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Acknowledgement

Some members of my team. They do most of the hard work.

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International Conference of Urban Climate -- Toulouse

Thank you

Adapting Asian Cities to Climate & Urban Climatic Changes

Edward Ng

Yao Ling Sun Professor of Architecture

ICUC9 20th-24th July 2015 Toulouse France

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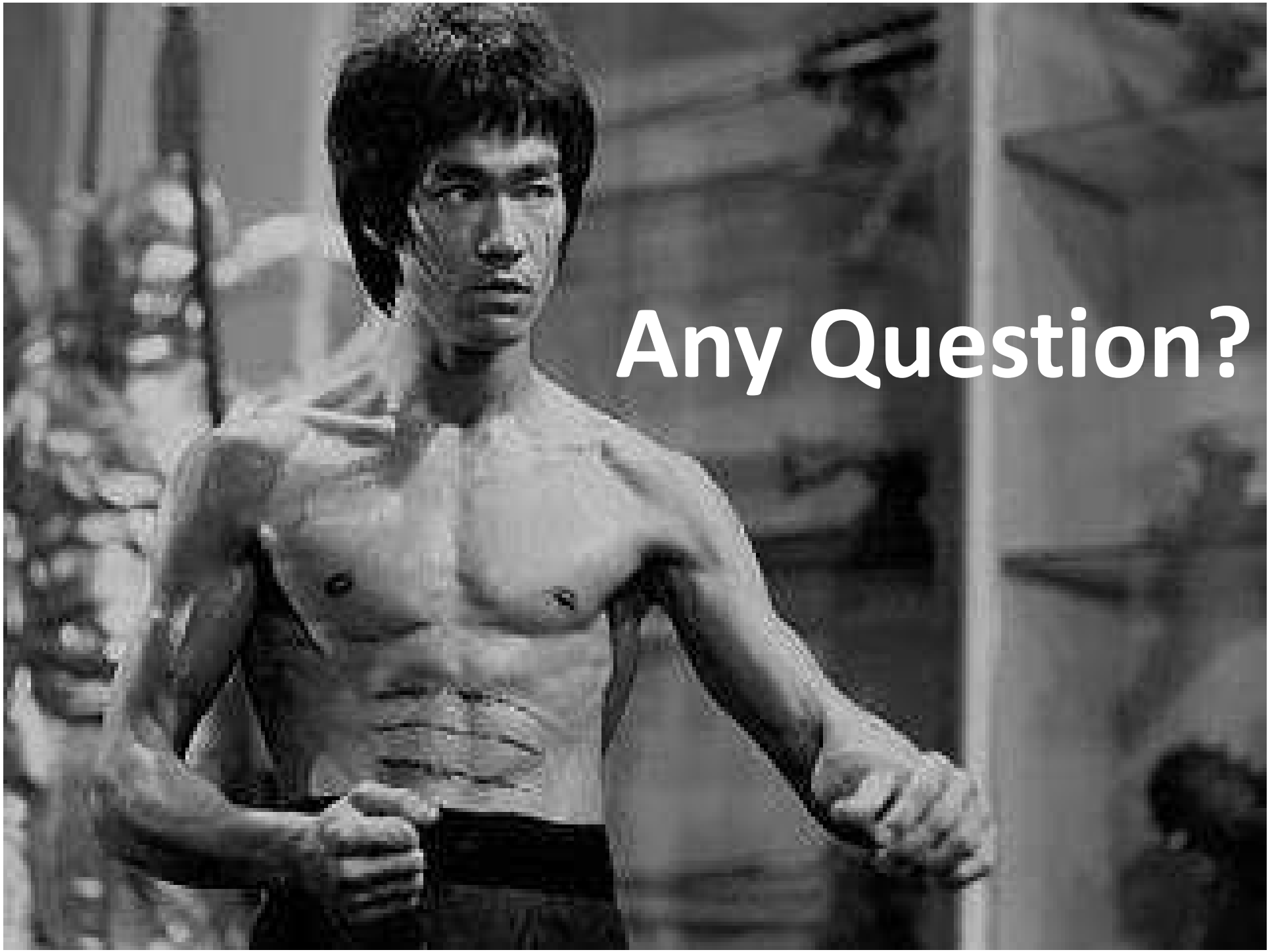
Any Question?