SMART CITIES

Complexity Science: Cities as Complex Systems

Gerhard Schmitt, November 9, 2015

Smart Cities

1 GS: Introduction	2 GS: Urban Systems I	3 PJ: Urban Systems II	4 GS: Urban Systems III	5 GS: Urban Research	6 GS: Urban Science	7 GS: Complexity Science	8 GS: Urban Governance	9 GS: Responsive Cities	10 GS: Final Critique
Principles of Information Architecture and Urban Simulation	Smart Cities	Methods and Tools for Urban Design	Stocks and Flows in Urban Systems	A Conversation: Measurements in the City	A Conversation: Citizen Design Science	Cities as Complex Systems	Participatory Design and Management	Cognitive Design Computing	Presentation of Results from 3 Courses
Exercise 1: Examples of Smart Cities			Exercise 2: Data Collection and Specification			Exercise 3: Energy and Mobility Data			Certificates

The story so far:

- 9.11.2015 Seeing cities as complex systems helps to understand and predict urban growth
- 2.11.2015 Citizen Design Science closes the gap between science and city
- 26.10.2015 Metrics of Smart Cities are basic instruments of urban research
- 12.10.2015 Stocks and Flows are fundamental concepts for understanding urban dynamics
- 5.10.2015 Methods and Tools for Urban Design can support the creative design process
- 28.9.2015 From smart houses to smart cities – emerging criteria for smart cities as urban systems
- 21.9.2015 Cities are complex systems. Ideally, they are sustainable, resilient, livable, smart, and finally responsive – from production machines to human habitat

Content

- Exercise 2 review
- Complexity Science
- Cities as complex systems
- Conclusions

LIVABILITY

The Stocks and Flows in Peking

LIVABILITY

Health

Ressource

Identity

STOCKS & FLOWS OF **POLLUTION**

Inflow
Great Smog now takes place in Peking, as well as sandstorm. Because of the industries around the city, also because of desertification in the nearby areas, where a great number of trees were cult down for money.

Problems
The folg and sandstorms are threatening everyone's health directly.

And even during the majority of time when there sees no folg, people still live under bad air conditions.

STOCKS & FLOWS OF **MEMORY**

Outflow I Collective Memories
Memories are disappearing in Peking. Everyday new houses are being built and old being torn down. Nothing seems to be able to stay stably for even seemly a short period, old buildings and architectures, neighborhoods and memories of the city. And even the historical areas can not survive.

Problems
Peking are losing its key characters as well as the identity.

STOCKS & FLOWS OF **PEOPLE**

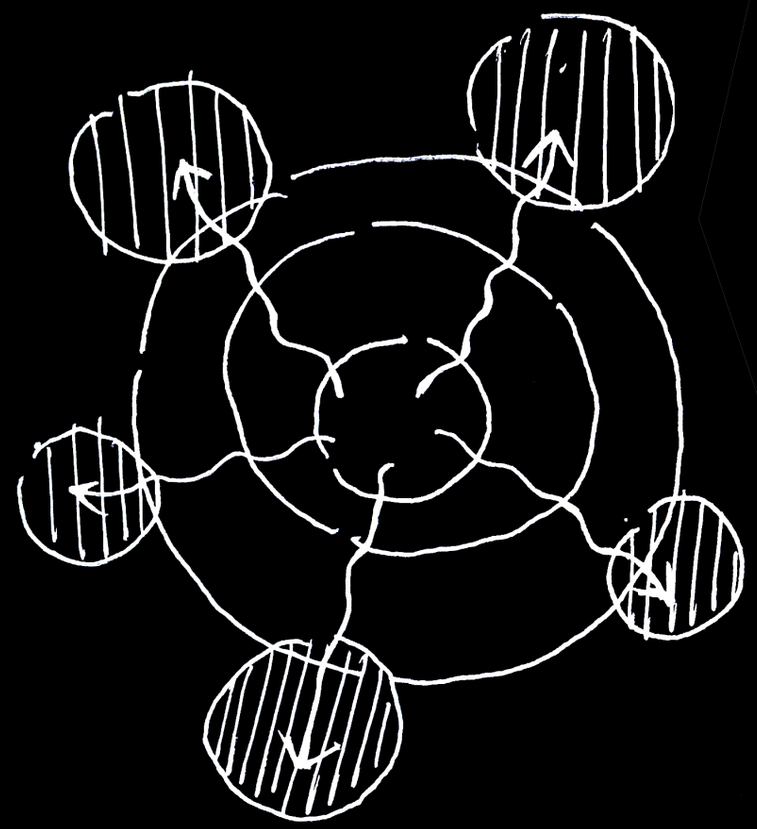
Inflow I Density
Because of a great contrast in resources and chances, a lot of Chinese people across the whole country flow into big cities like Peking, striving for a better life.

Problems
Peking gets more and more crowded,

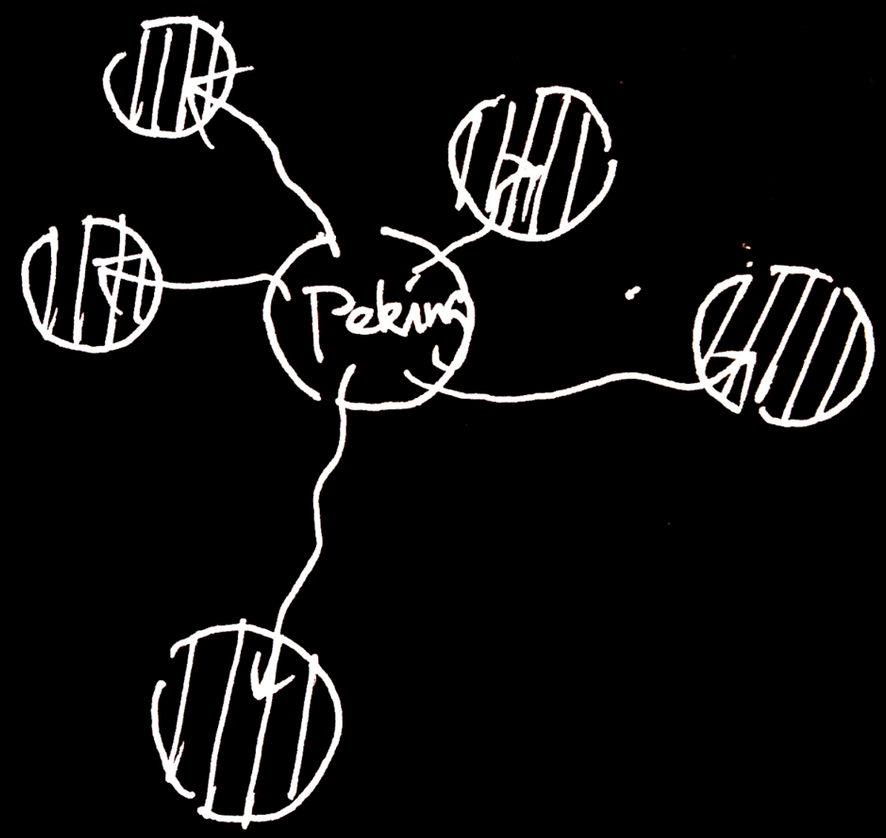
The public transport system is overloaded and commuting time gets longer and longer.

The house's price rises and rises, which becomes one of the hottest topics among Pekingers.

WHAT TO DO ?



New Towns



Own Towns

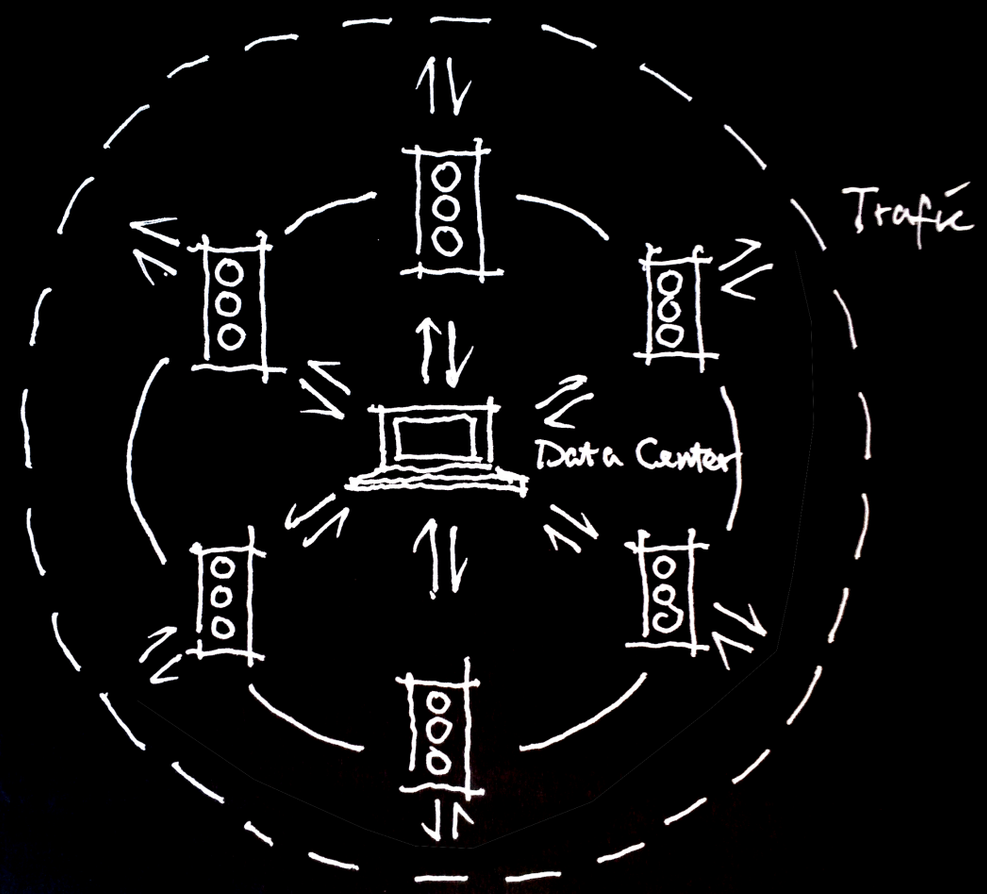
New Towns and own Towns
Investment in new towns around Peking or in the hometowns, where the migrants mostly come from to supply sufficient houses, infrastructures, work places.

Social Services
to guide the commercial and social services and events according to quantitive and structural changes of population

Data: Flow of Density

Data concerning the large-scale migration into the city, including where and how people are distributed

Census (both the latest and historical) and registration information from government to simulate population development in the future, and to predict the possible changes in demands on houses or other infrastructures in the city.



Smart Transport

Smart bus & metro routs and schedules to achieve the maximum use of the public transport capacity and to optimize the connection of different routs.

Smart traffic lights. Signals that utilize a buried induction coil to sense the presence of signals that adapt to information that is received from a central computer about the position, speed and direction of vehicles. The signals communicate with each other and adapt to changing traffic conditions to reduce the amount of time that cars spend idling.

Data: Flow of Position

Applies for the movement of the individuals within the city on a daily basis, depicting the daily movements of people between living, working and entertainment activities.

Sensors and monitors an the streets and in large building complexes to obtain the real-time statistics of the flow of people's positions, also, the real-time and historical density of a certain area of the city.

The use intensities in public transport system itself according to time and certain routs are also needed. Bei collecting and analyzing these statistics, the buses and metros can be better regulated with a sophisticatedly designed schedule.

serials of experiments about scale and boody

Minimum Dwelling
The rapidly increasing spatial density in Peking requires the individual acceptance of living and working even closer together with others. Therefore, ein dynamic spatial model in consideration of comfort is important for future designs and plans.

Data: Scales & Space
Sophisticated experiments concerning human bodies and scales from laboratory.

Questionnaires and feedbacks directly form residents to modify the analysis.

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https://en.wikipedia.org/wiki/Quality_of_life

https://en.wikipedia.org/wiki/Smart_traffic_light

RESPONSIVE CITIES
FUTURE CITIES
SMART CITIES

Lee Jing Han (15-908-171) : Mobility

SINGAPORE ‘LIVABLE’ CITY

Is Singapore really a liveable city?

Singapore has always been recognised as a very liveable city with its ease of business making and efficient infrastructure and transport systems. In recent rating systems by ECA (Employment Conditions Abroad), Singapore was ranked first as most liveable city globally. Its ranking was attributed to good air quality, solid infrastructure, decent medical facilities, low crime and health risks.

Despite this reputation, the checklist for liveability is more relevant to expatriates and does not account for the deep seated unhappiness among the citizens. Fissures are fractured in the seemingly liveable city when a survey conducted ranked Singapore as one of the unhappiest workforce in Asia.

Hence, is Singapore truly liveable or it is just a ‘checklist-approved’ city?

Top 20 most liveable locations globally for Asians

Global Rank 2015	Location	Country
1	Singapore	Singapore
2	Adelaide	Australia
2	Sydney	Australia
4	Osaka	Japan
5	Brisbane	Australia
5	Wellington	New Zealand
7	Canberra	Australia
7	Copenhagen	Denmark
7	Nagoya	Japan
10	Perth	Australia
11	Bern	Switzerland
11	Melbourne	Australia
11	Tokyo	Japan
11	Yokohama	Japan
15	Auckland	New Zealand
15	Dublin	Irish Republic
15	Luxembourg City	Luxembourg
15	The Hague	Netherlands
19	Antwerp	Belgium
19	Eindhoven	Netherlands
19	Geneva	Switzerland
19	Gothenburg	Sweden
19	Stavanger	Norway

‘Under Happy’ Singaporeans

A poll conducted by Gallup back in 2012 indicated that Singaporeans are the least likely to feel positive alongside war torn countries such as Iraq and Armenia. The rising social discontent could be due to climbing consumer prices and competition from an influx of foreign workers.

Much of this is reflected in election votes of the people 4 years ago. The government reacted to this issues but most of them remained as long term solutions.

In my opinion, there are 3 issues of stocks and flows pertaining to Singapore’s liveability.

- **Urban Canyon**
- **Food Waste**
- **Media Censorship**

GALLUP

Lowest Positive Emotions Worldwide

Percentage of adults who report experiencing all emotions asked about

	% Responding "yes"*
Singapore	46
Armenia	49
Iraq	50
Georgia	52
Yemen	52
Serbia	52
Belarus	53
Lithuania	54
Madagascar	54
Afghanistan	55
Azerbaijan	55
Haiti	55
Togo	55
Macedonia	55

Highest Positive Emotions Worldwide

Percentage of adults who report experiencing all emotions asked about

	% Responding "yes"*
Panama	85
Paraguay	85
El Salvador	84
Venezuela	84
Trinidad and Tobago	83
Thailand	83
Guatemala	82
Philippines	82
Ecuador	81
Costa Rica	81
Canada	80
Colombia	80
Malaysia	80
Netherlands	80

2011

*Did you feel well-rested yesterday? Were you treated with respect all day yesterday? Did you smile or laugh a lot yesterday? Did you learn or do something interesting yesterday? Did you experience the following feelings during a lot of the day yesterday? How about enjoyment?

Food Waste (stocks and flows of food/energy)

Due to the lack of primary and secondary industries in Singapore, we import many food products for our daily consumption, which embody much CO2 during transportation. Furthermore, the consumer culture has caused many to be disconnected from the process of production. Hence, people do not understand the implication of food waste when they decide to throw away unfinished or expired food (as the label dictates).

One of the most wasteful ways Singapore has is **cosmetic filtering**. Cosmetic filtering occurs in farms, wholesale and wet markets, supermarkets to homes, where food that looks “ugly”, damaged or less than perfect according to market or personal standards are discarded even if it’s edible. For supermarkets, a certain criteria must be met: products must be free of pest marks, be in the right shade of colour, not too ripe, etc. This process of filtering waste about 30% of what products just for not meeting the criteria.
Example: This scene is evident in Pasir Panjang wholesale market where 250 vegetable sellers spend the whole day trimming their vegetables to look ‘nice’.

Vegetable producer filtering his products for cosmetic approval by supermarkets and restaurants.

Another source of food waste is from our gastronomic culture: **buffets**. The all-you-can-eat concept often leads to sights of customers taking more food than they can finish. An estimated of 10-20% of the prepared food goes to waste. Also, practices such as doggie-bag leftover food is seen to be embarrassing and against social norms aggravates the situation.

Limitations: Difficulty in obtaining food waste data. It varies in places and time.

Media Censorship (stocks and flows of information)

The censorship of media in Singapore is one that targets mainly political, racial and religious issues. The government's justification is that censorship is necessary to avoid upsetting the delicate balance of Singapore's multi-racial society. Expression in any media that attempts to threaten such balance must be censored, otherwise the individual will be prosecuted.

In a recent incident regarding a teenage boy Amos Yee was imprisoned for criticising the late Prime Minister with deliberate intent to wound the racial and religious harmony in Singapore. His imprisonment invited much criticism, saying he is punished for exercising his right to freedom of expression.

In my opinion, such censorship is a **possible limitation to the stocks and flow of information**. Freedom of expression can give insights or affect how racial and religious group congregate or expand. A better spatial understanding of the city could possibly be developed. Furthermore, constructive criticism can also keep in check existing planning methods. They might be valuable data which informs the decisions we made.

Limitation: Censorship might be difficult to define and varies over time; eg. some shows that are accepted now may not be acceptable in the past.

An artwork showing censorship in Singapore.

Urban Canyon (stocks and flows of density)

With the urban population increasing rapidly, land in Singapore is rapidly decreasing. Building and physical density are not the only ones soaring, **perceived density** and one's evaluation of one's social relationships are also clearly linked. From interviews, well-being seems to be inversely proportional tov the feeling of overcrowding (**claustrophobic environment**) : the higher perceived density, the more people feel ill at ease with his environment.

An **urban canyon** is a place where the street is flanked by buildings on both sides creating a canyon-like environment. This formation has become a growing concern over the past decade due to the prevalence of **high-rise, high density** residential and commercial development. A possible solution could be identifying the various types of urban canyon and an ideal street design that would safeguard the **liveability** of today's environment.

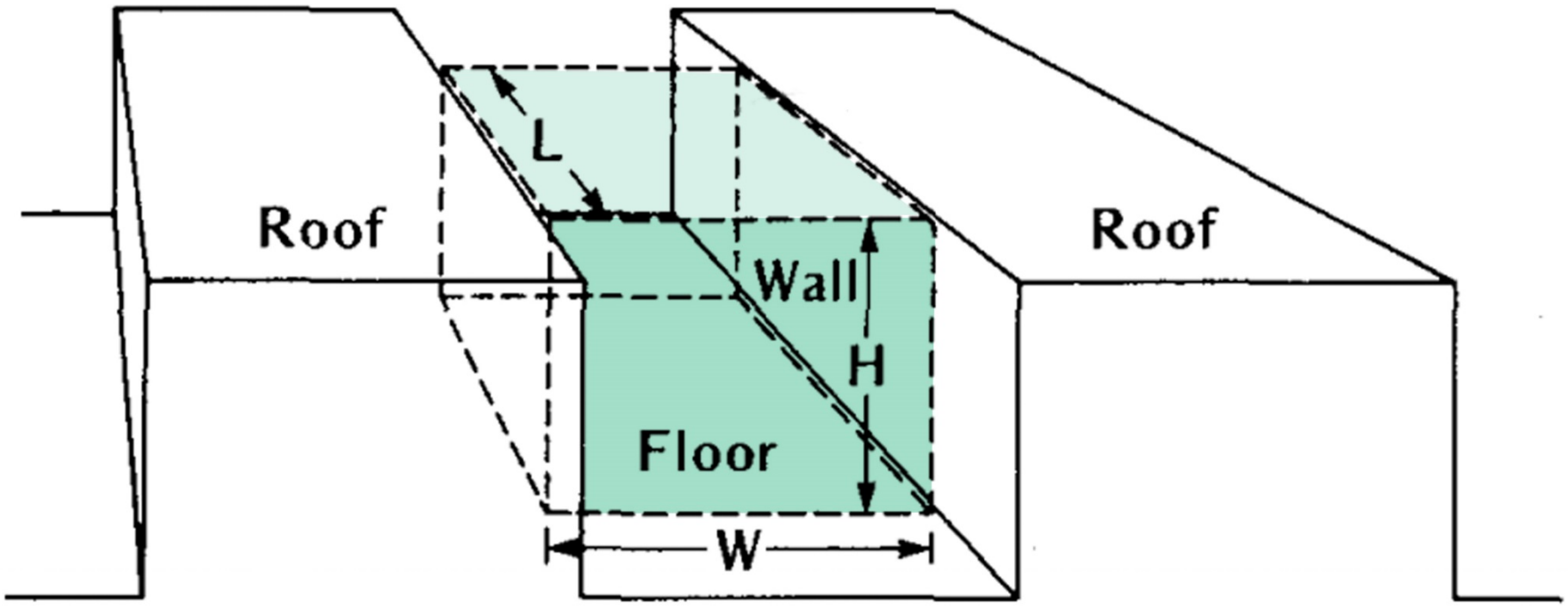
A better street environment will boost the well-being of people and debunk the negative connotation associated with dense high rise blocks.

Steps to improve the Urban Canyon

There are 2 key data sources required to assess the liveability of the urban canyons in Singapore. The first data source would be the **aspect ratios of existing building typologies**. This is a tangible analysis of the environment in spatial terms. The second data source would be the **sky view percentage at street level**. This assess the amount of sky visible at locations in-between buildings. The analysis is one which is intangible and relates more towards the feeling and atmosphere one gets when passing through the space. Through rigorous assessment of these data, one can gain a balanced insight towards liveable, less claustrophobic urban environment.

Aspect ratio metric

The aspect ratio is the ratio of the mean height of the buildings to the width of the street. The ratio is especially crucial when it comes to determining the visual comfort in the canyon.

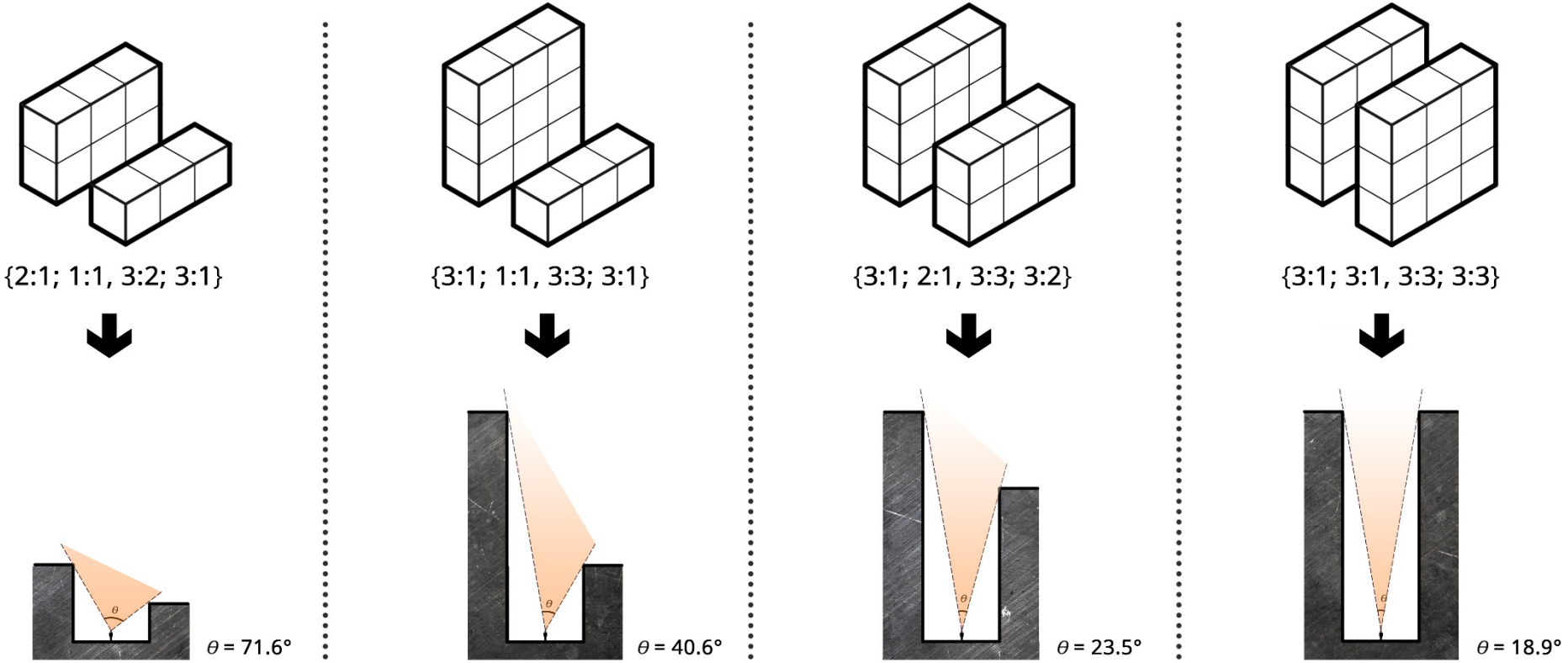


ASYMMETRY

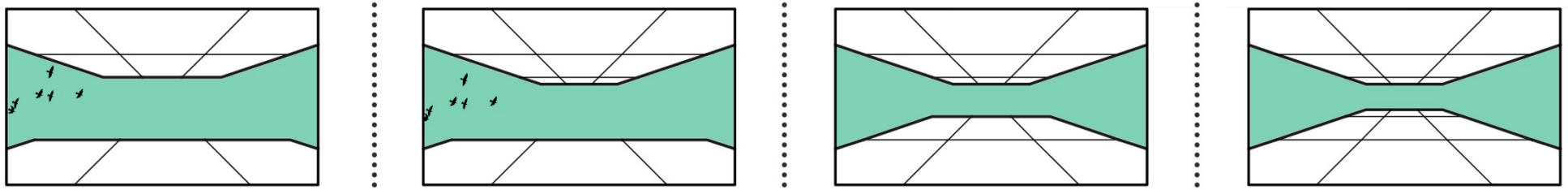
(Building to building spacing based on a 12x12M grid)

BUILDING TYPOLOGY

1. Aspect Ratio (h:w, l:h)



2. % of Sky View



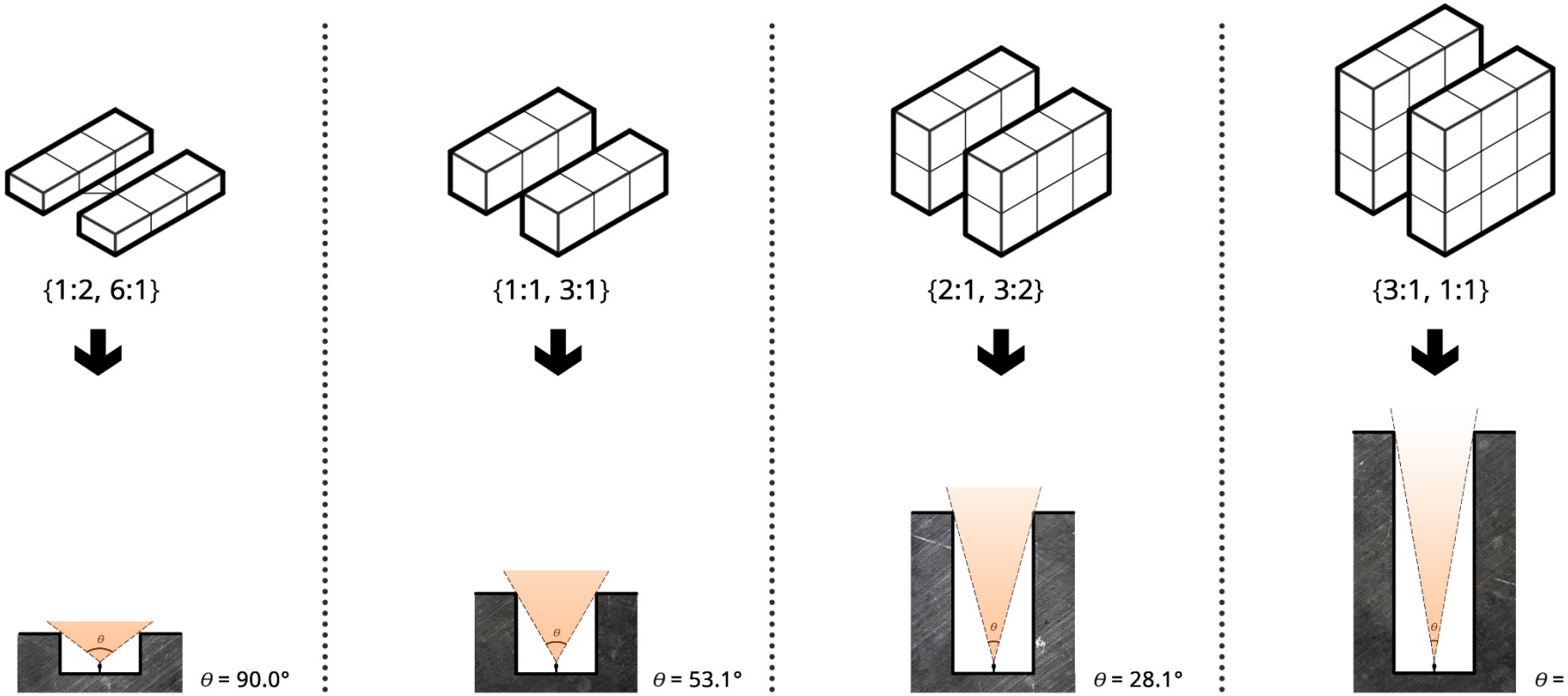
{41.6% Sky View} {40.4% Sky View} {32.6% Sky View} {31.3% Sky View}

OVERLAP

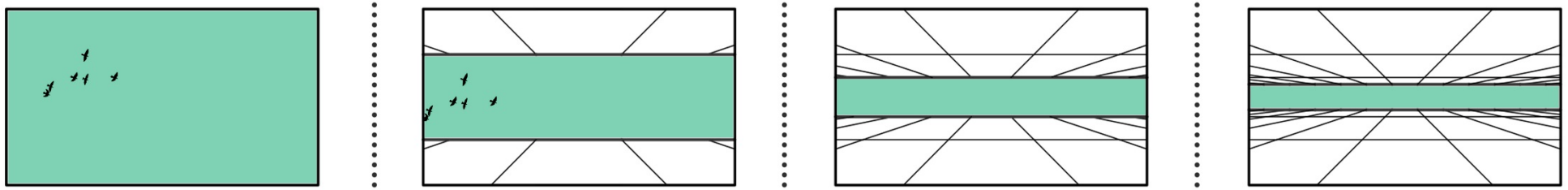
(Building to building spacing based on a 12x12M grid)

BUILDING TYPOLOGY

1. Aspect Ratio (h:w, l:h)



2. % of Sky View



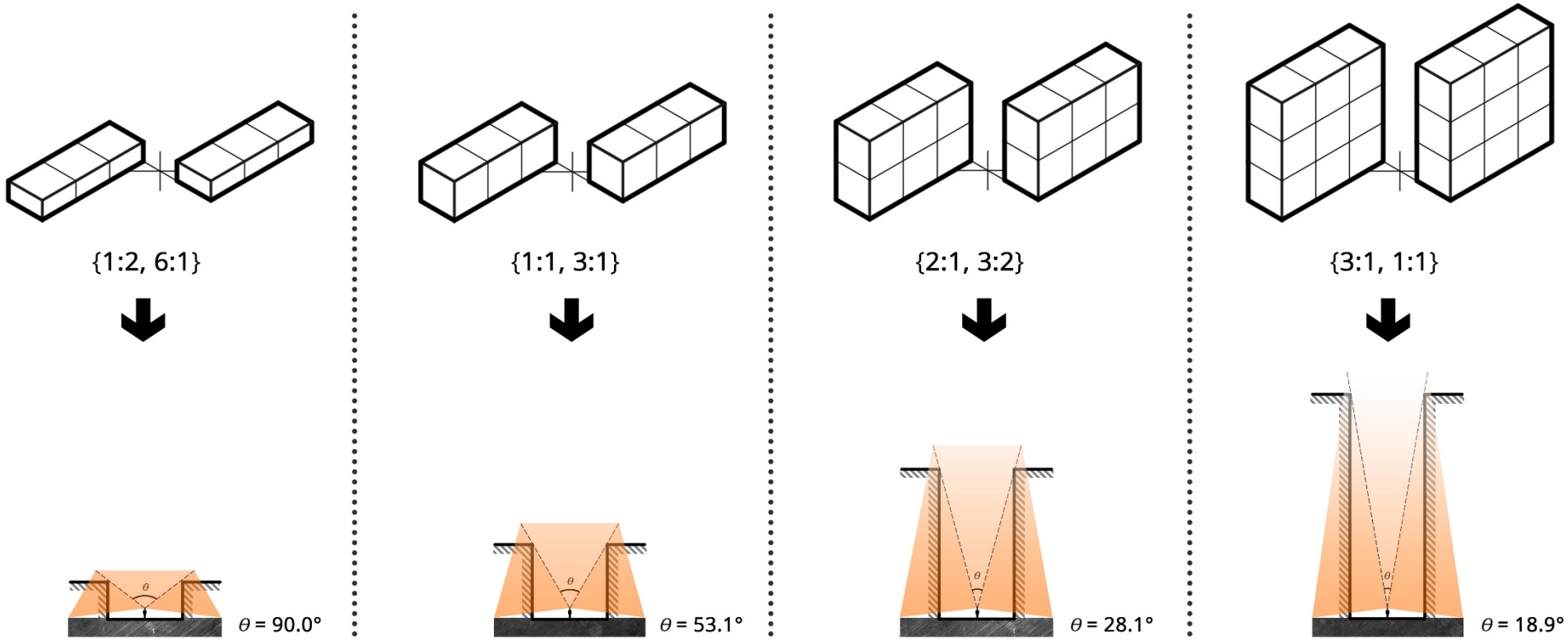
{100% Sky View} {48.5% Sky View} {22.4% Sky View} {14.6% Sky View}

NO OVERLAP

(Building to building spacing based on a 12x12M grid)

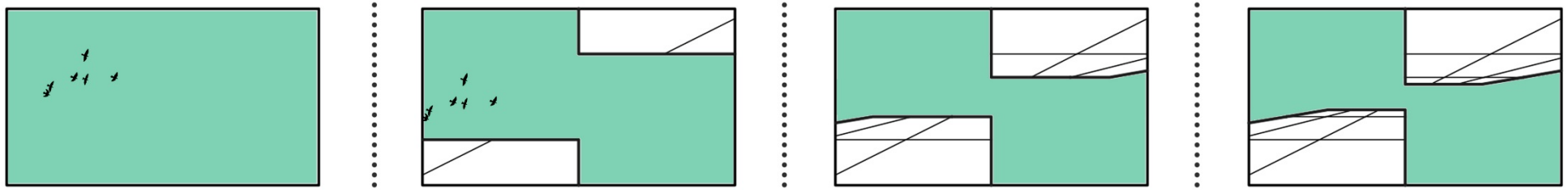
BUILDING TYPOLOGY

1. Aspect Ratio (h:w, l:h)



2. % of Sky View

= 90.0°



EXAMPLES

LINEAR GREEN @ BEDOK

TYPE: UNDULATING LINEAR PROFILE
HEIGHT: 51M (17 STOREYS)
WIDTH: 28-30M
LENGTH: 200M
% OF SKY VIEW: ≈ 38%
COMFORT LEVEL: TALL, CLOSELY SPACED LINEAR BLOCKS GIVES A DEEP CANYON EFFECT AND A CLAUSTROPHOBIC FEELING.

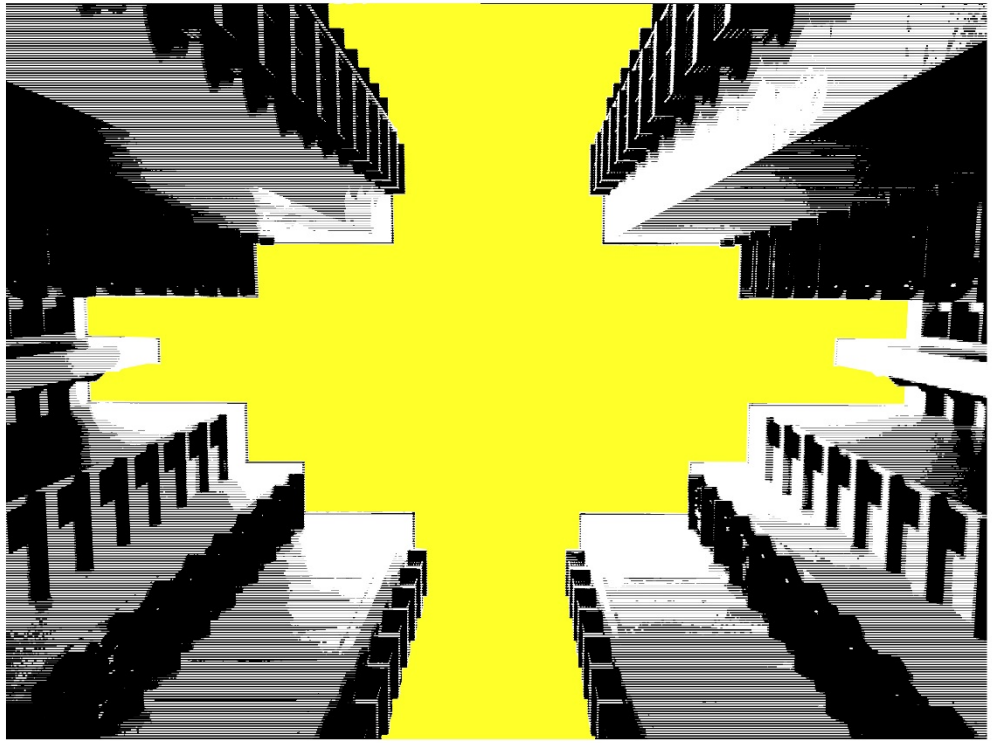
BEDOK TOWN CENTRE BLK 213 & 214

TYPE: LINEAR PROFILE
HEIGHT: 36M (12 STOREYS)
WIDTH: 35M
LENGTH: 150M
% OF SKY VIEW: ≈ 80%
COMFORT LEVEL: BUILDING BLOCKS SEEMS LESS INTIMIDATING A MORE SPACIOUS STREET TO TRANSVERSE IN.

EXAMPLES

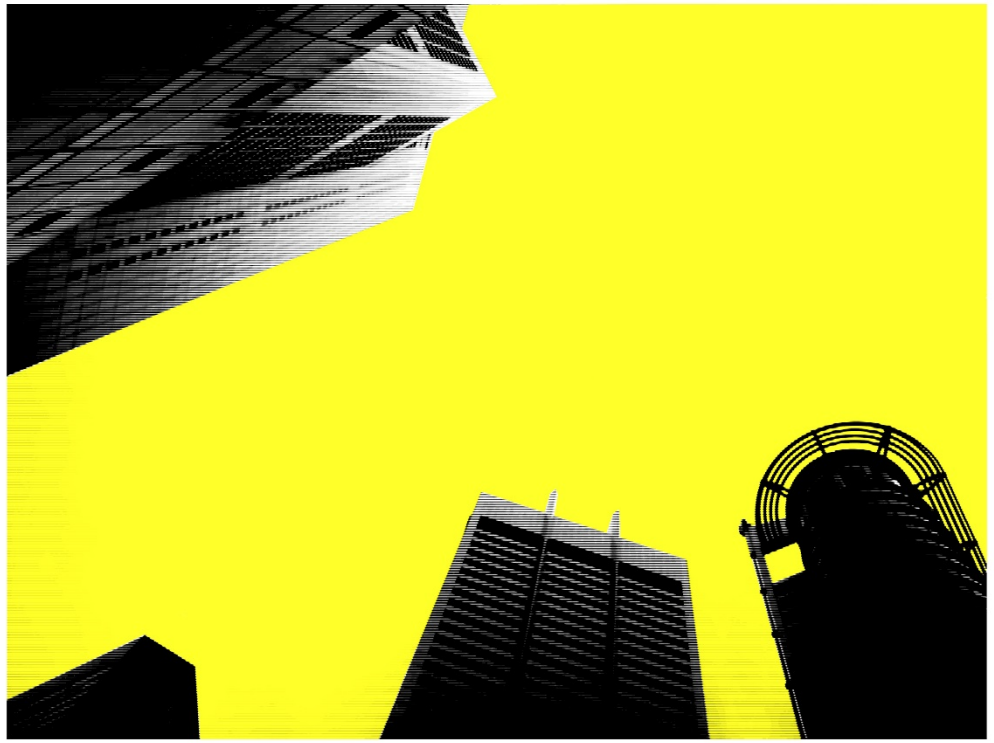
PUNGGOL RESIDENCES

TYPE: **LINEAR** PROFILE
HEIGHT: **48M** (16 STOREYS)
WIDTH: **8-10M**
LENGTH: **25M**
% OF SKY VIEW: ≈ **35%**
COMFORT LEVEL: **OVERCROWDED** AND **VISUAL DISCONNECTIVITY WITH THE SKY.**



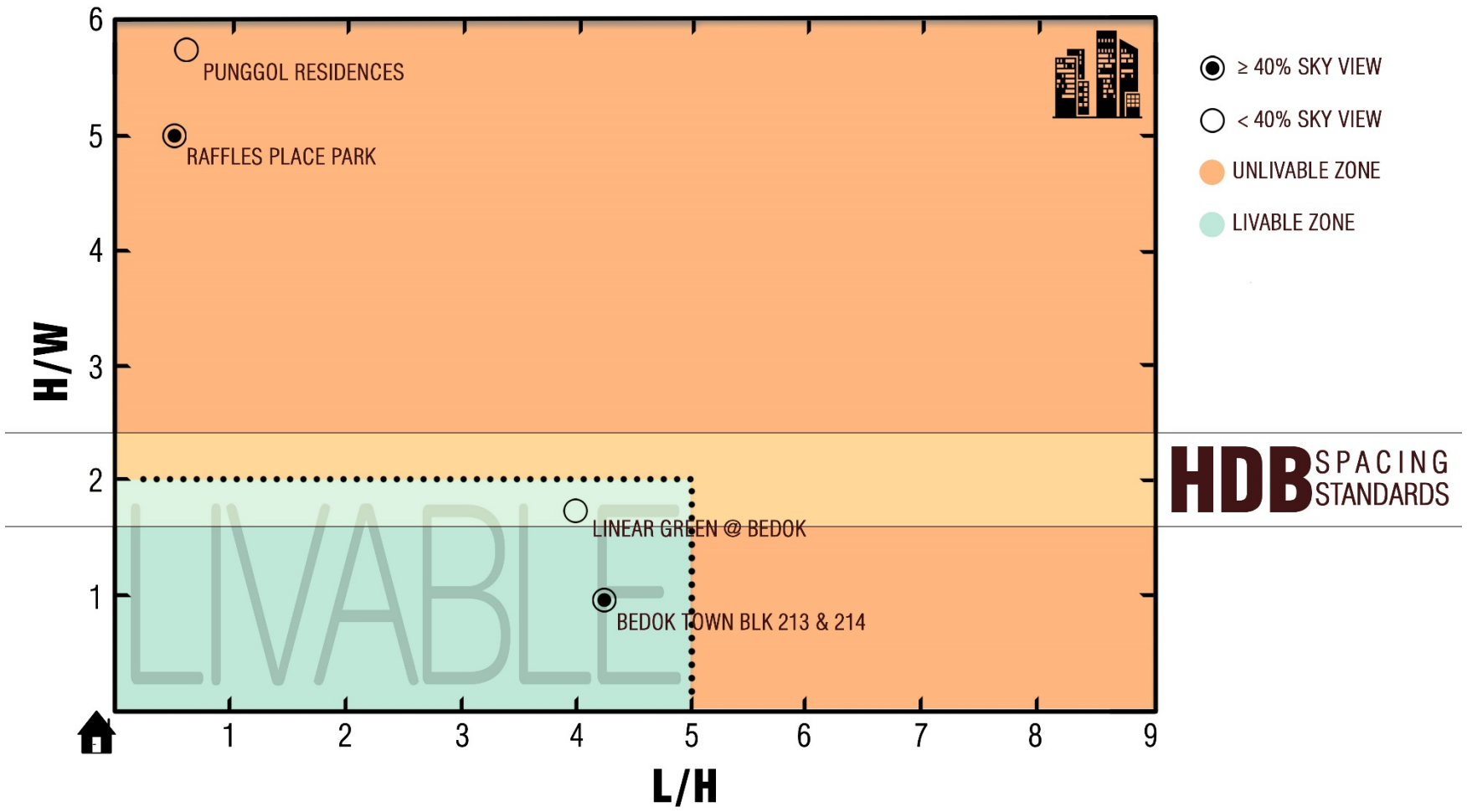
RAFFLES PLACE PARK

TYPE: **VARIED HEIGHT & SIZE PROFILE**
HEIGHT: **24-276M** (8-66 STOREYS)
WIDTH: **50M**
LENGTH: **120M**
% OF SKY VIEW: ≈ **55%**
COMFORT LEVEL: THE PLACEMENT OF SHORTER BLOCKS AT STREET FRONT DEFUSES A CLAUSTROPHOBIC ENVIRONMENT.



Formulation & Analysis

Natural light is crucial for its psychological effects on human productivity and well-being. Hence it is a crucial consideration that streets are exposed to natural light. % of sky view is dimensionless parameter to express this. Through various examples and an attempt to quantify liveable criteria, I concluded that there must be at least **40% sky view** between buildings and H/W & L/H should not exceed **2 & 5** to be liveable.



Limitations

The data for both aspect ratio and sky view percentage is currently not publicly available.

Aspect Ratio
This could be obtained through an estimation of a city 3D model or GIS.

Skyview Percentage
This data is difficult to collect as well as quantify. A scale could be developed based a an extensive survey done with the residents in different areas. Proximity sensors could also be installed in every street space to capture the amount of unobstructed view to the sky.

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EXERCISE TWO

BY ONG BAOLIN, JONATHAN
24.10.15

PREVIOUSLY…

Smart City Definition

- A smart city is one where there are **indices to measure stock and flows** of the city. The information is made public for analysis.
- Smart cities allow citizens **access to this information** so that they can **better inform their decision** for a better quality of life.
- Gathering of data either with the help of integrated digital technologies and information communication technologies is either **collected centrally** (e.g. goverments, corporations) or by **crowd-sourcing** (citizens).

2 EXAMPLES IN SINGAPORE, A SMART CITY:

PSI Indicator

PSI (With effect from 1 April 2014)

With effect from 1 April 2014, Singapore will move to an integrated air quality reporting index, where $PM_{2.5}$ will be incorporated into the current Pollutant Standards Index (PSI) as its sixth pollutant parameter. The PSI will therefore reflect a total of six pollutants – sulphur dioxide (SO_2), particulate matter (PM_{10}) and fine particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), carbon monoxide (CO) and ozone (O_3).

The 3-hr PSI will take into account $PM_{2.5}$ concentrations. In addition, NEA will also publish the 1-hr $PM_{2.5}$ concentrations every hour.

For past 24 hour PSI reading click here. For historical PSI reading click here.

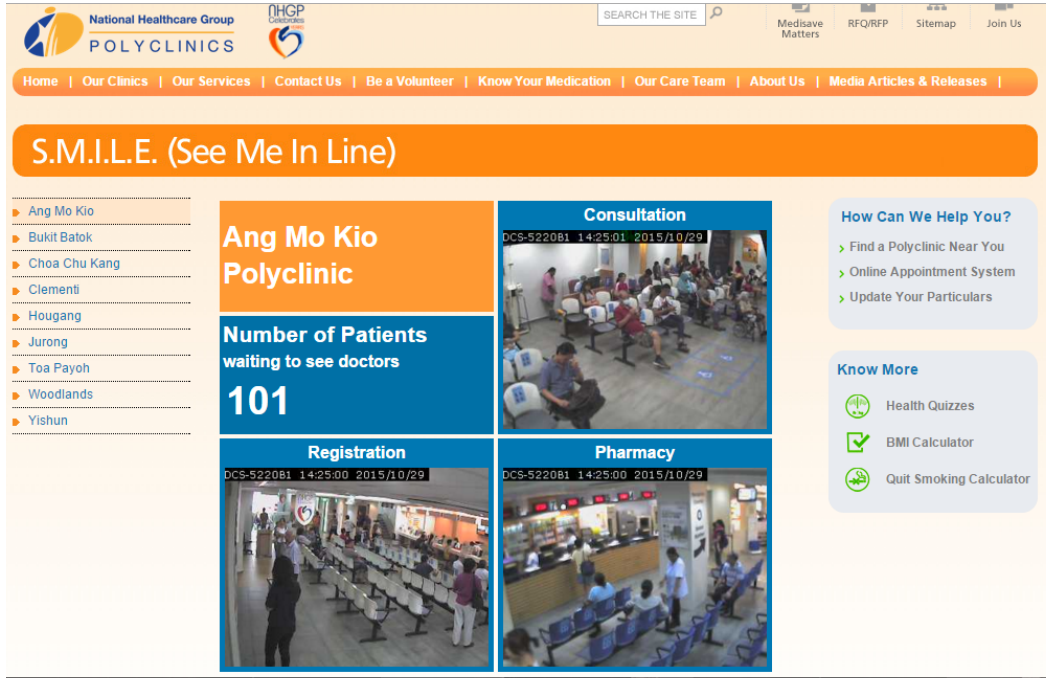
24-hr PSI: 132 - 161; 3-hr PSI: 135

Note: Air quality based on 24-hr PSI is as follows:

PSI Value	Air Quality Descriptor
0 - 50	Good
51 - 100	Moderate
101 - 200	Unhealthy
201 - 300	Very unhealthy
Above 300	Hazardous

PSI values of pollution is displayed on National Environmental Agency's website. Provides information on unhealthy levels of pollution and health advisory.

SMILE (See-Me-In-LinE)



SMILE System is a queue viewer that shows you the number of patients at each polyclinics for the day. Polyclinics visits and records are digital, thus crowd information at each clinic is readily available. Images are refreshed every five minutes. Citizens can access it online to plan their visit to the clinic.

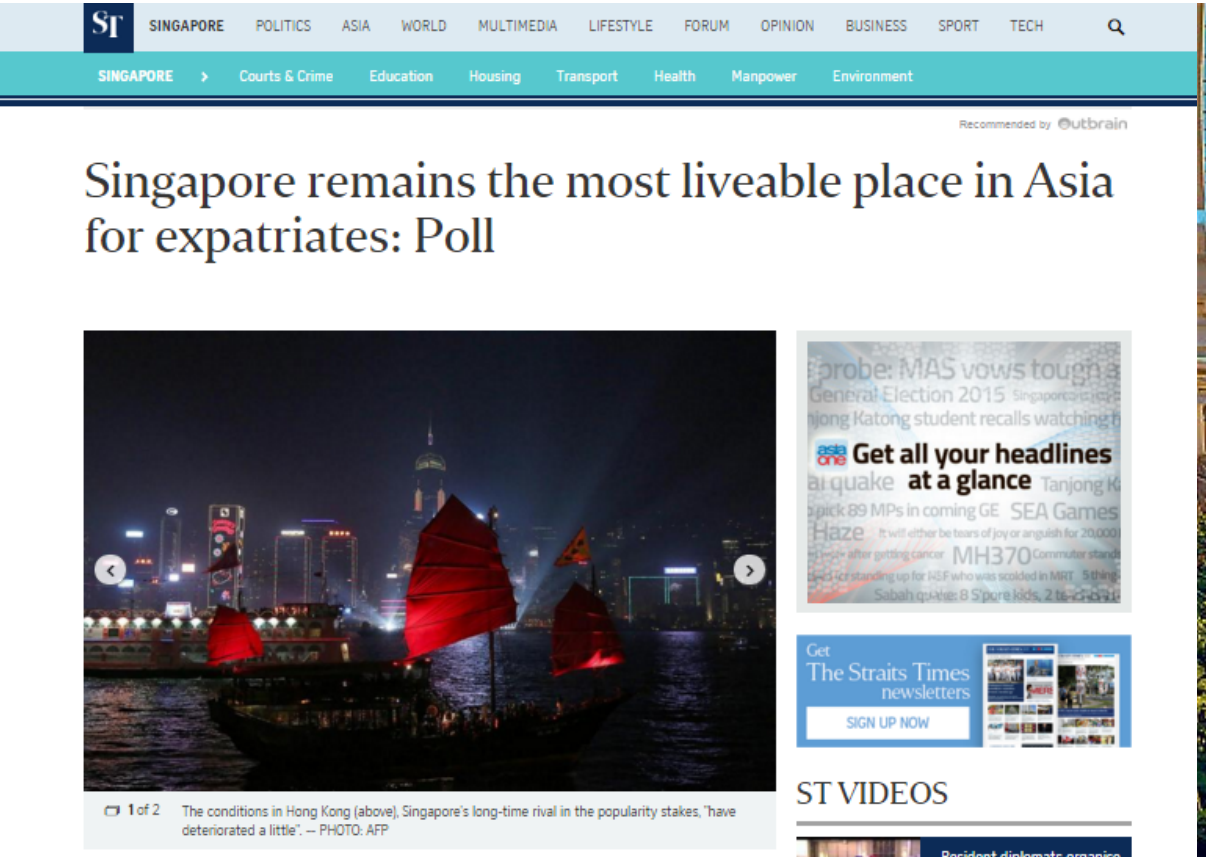
CONTENTS

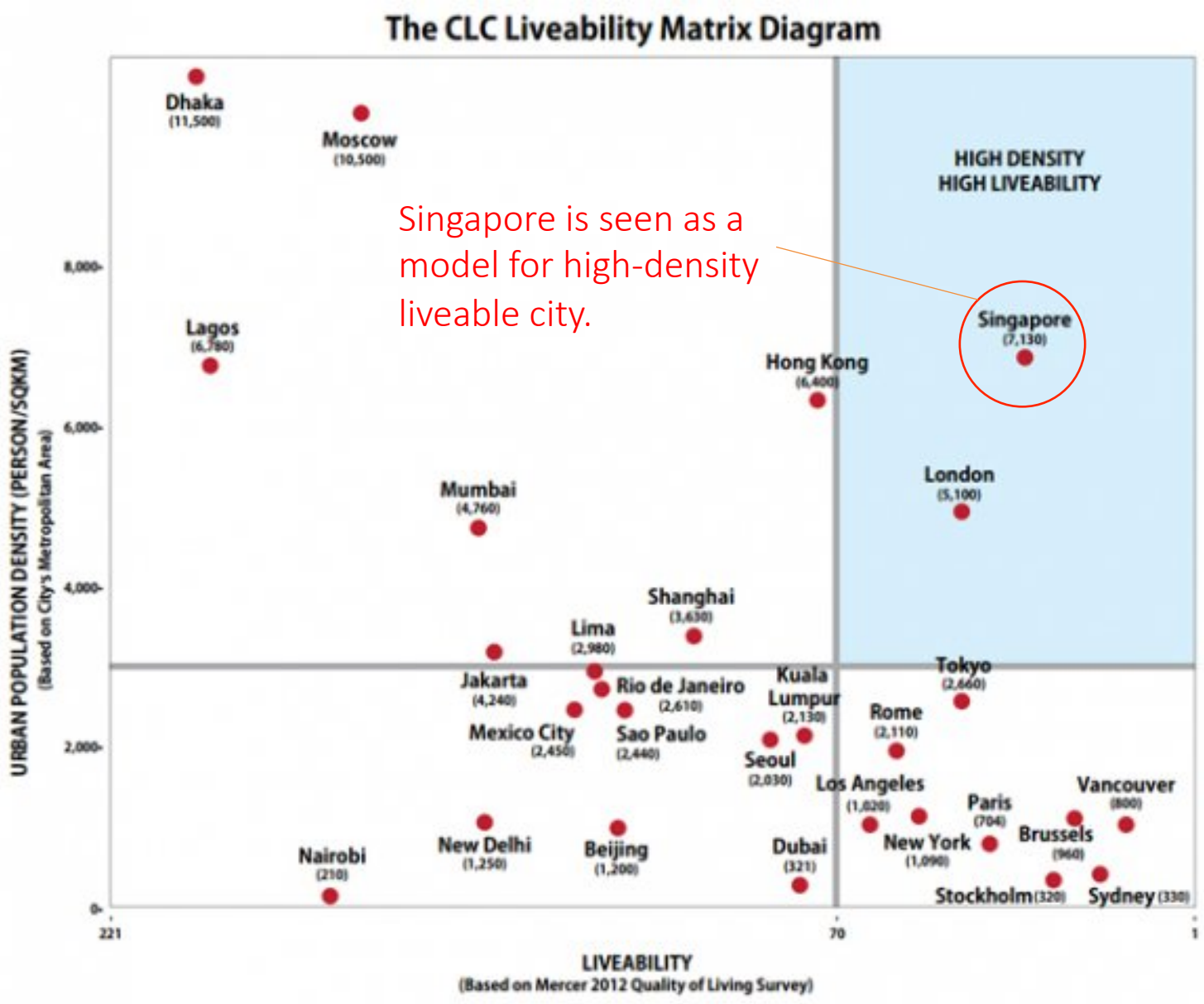
3 features on the architectural scale or on the urban district scale that in your opinion **decrease livability**

People, Material, Water, Energy, Space, Finances, Information

0. INTRODUCTION

Singapore: Model Liveable High-Density City





Current debates on the legitimacy of Singapore as the world's most liveable city centres very much around whether the yardstick used to measure its success has more to do with

- Economically-centered indicators (like GDP) than
- Quality of life

http://www.livablecities.org/articles/high-density-livability-question

Standard of Living = Quality of Life?

GDP vs intangible aspects (mental health, social integration etc.)

<u>The Subjective Yardstick:</u>

"Liveability" index is based on Mercer's 2012 "Quality of Living Survey", produced for the benefit of multinational firms. Compares standard of living metrics such as **"internal stability, law enforcement effectiveness, education, crime levels and the quality of health care".**

<u>In Europe:</u>

Quality of life would also include "the extent to which **social cohesion is deepened, social exclusion is diminished, and social capital is grown.**"

Rifkin, Jeremy.
The European Dream. 2004. New York: Jeremy P. Tarcher/Penguin. pp. 82

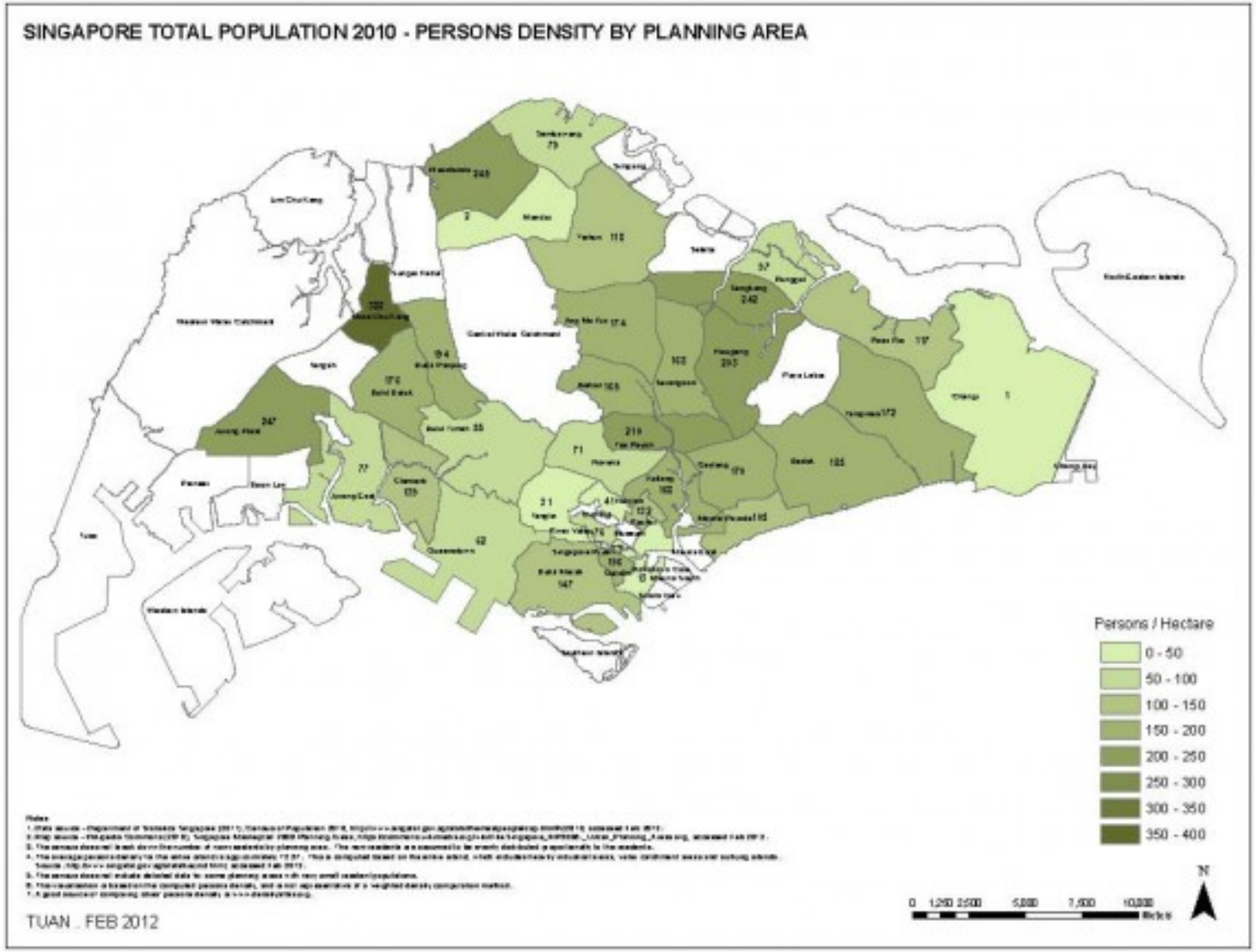
1. DENSITY High-Rise Residential & Sanitised Ground Plane

In her quest to house every growing population, even from the 60s, Singapore built many **modernist high-rise slab blocks** housing to house. As of 2013, 80% of the population live in such accommodation.

"literature suggests that high-rises are less satisfactory than other housing forms for most people, that they are not optimal for children, that ***social relations are more impersonal*** *and* ***helping behaviour is less*** *than in other housing forms, that crime and fear of crime are greater, and that they may independently account for some suicides"*

Robert Gifford

Environmental, Social and Personality Lab at the UVic Department of Psychology, *http://www.livablecities.org/articles/high-density-livability-question*

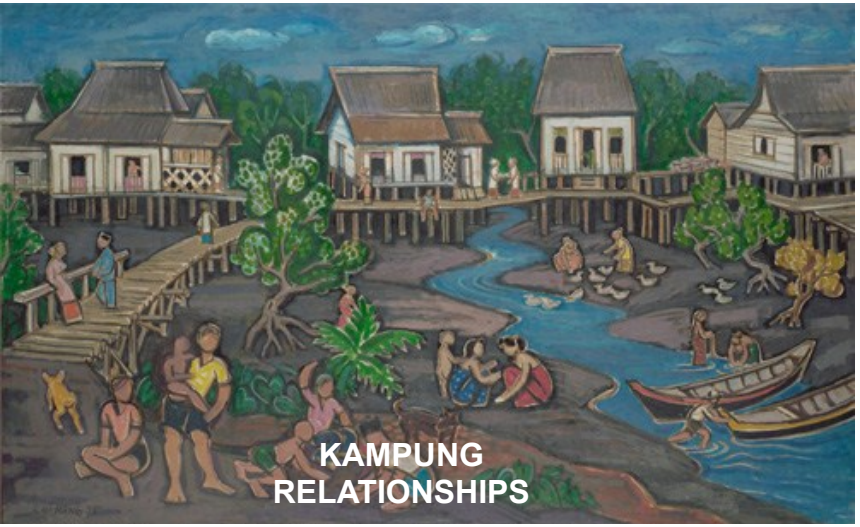


http://www.tuan-min.com/blog/wp-content/uploads/2012/02/SG_PersonsDensityByPlanningArea1-600x463.jpg

Old Mixed-Use Public Housing with store and street, Toa Payoh Town Centre

VER SUS

High-Rise Mono-use Public Housing, The Pinnacle @ Duxton



Life by the River, Painting, Artist: Liu Kang

Social integration is often romanticised as the **Kampung lifestyle** of early Singapore history. Painter Liu Kang captures the supposed close knitted communities where people knew each other

+

High-Rise Public Housing,
The Pinnacle @ Duxton

The Pinnacle @ Duxton is Singapore's highest public housing (HDB). Public spaces and streets are moved to the middle and top of the development as Sky Gardens. Sky garden is accessible for a fee, creating a **semi-gated community** of these 'public' facilities.

Unfortunately, this leaves behind a **sanitized ground** level devoid of life.

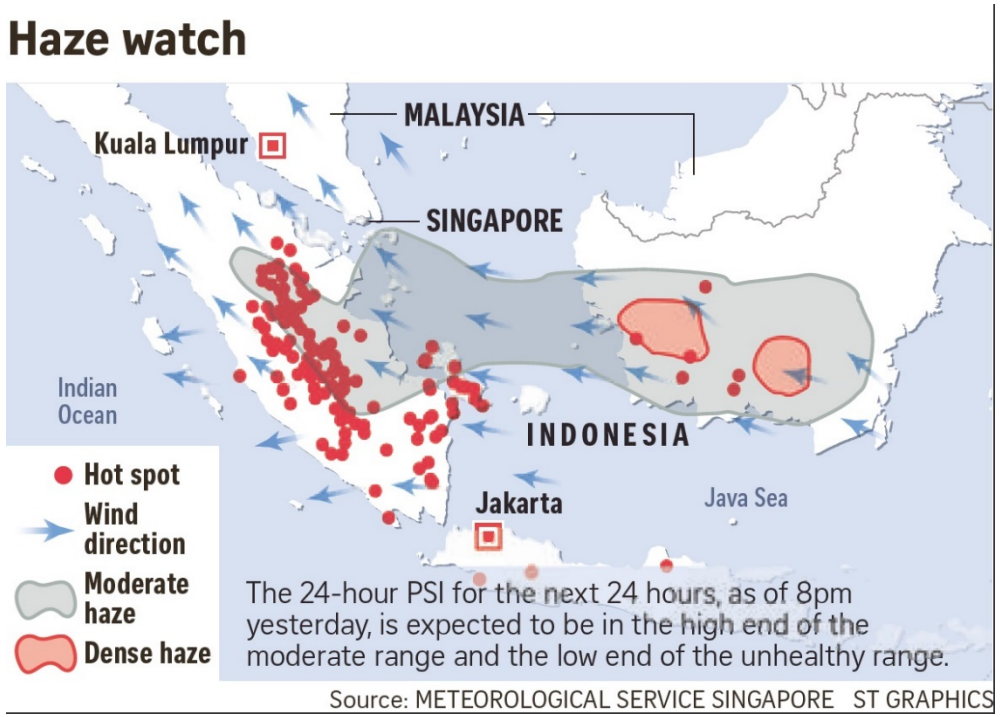
Fortunately, mixed-used project have developed across the island. The example of the New Punggol New Town:

Paris: human scale mixed-use

New Punggol Water-Town,
commercial on first few levels with connection to landscape

2. POLLUTION

Haze from slash & burn



http://news.asiaone.com/news/singapore/haze-singapore-back-unhealthy-levels-saturday

*"About 50 percent of palm oil companies operating in Indonesia are **owned by Malaysians and Singaporeans,**"*

Bogor Agricultural University professor Herry Purnomo to The Jakarta Post

*"But what's ironic is that many of the corporations, such as palm oil trader **Wilmar International** which has been known to source palm oil from companies involved in fire clearing and forest destruction, are also **based in Singapore**,"*

Greenpeace International Spokesman

PSI (With effect from 1 April 2014)

With effect from 1 April 2014, Singapore will move to an integrated air quality reporting index, where $PM_{2.5}$ will be incorporated into the current Pollutant Standards Index (PSI) as its sixth pollutant parameter. The PSI will therefore reflect a total of six pollutants – sulphur dioxide (SO_2), particulate matter (PM_{10}) and fine particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), carbon monoxide (CO) and ozone (O_3).

The 3-hr PSI will take into account $PM_{2.5}$ concentrations. In addition, NEA will also publish the 1-hr $PM_{2.5}$ concentrations every hour.

For past 24 hour PSI reading click here. For historical PSI reading click here.

24-hr PSI: 132 - 161; 3-hr PSI: 135

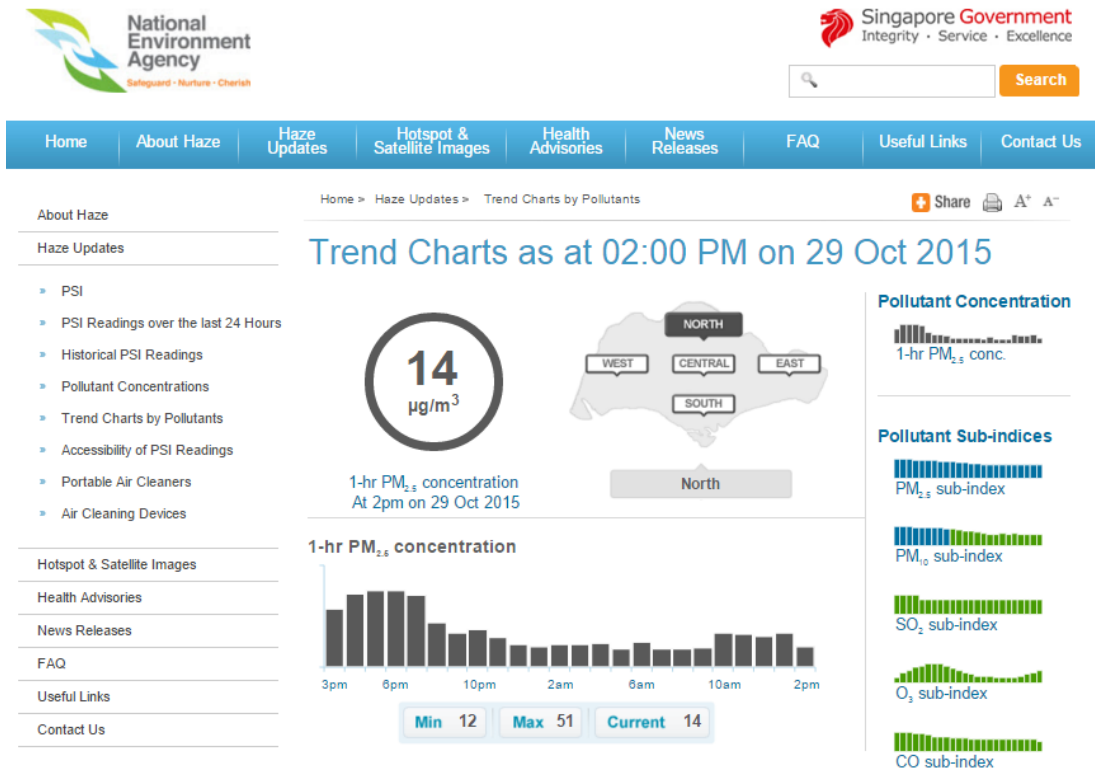
Note: Air quality based on 24-hr PSI is as follows:

PSI Value	Air Quality Descriptor
0 - 50	Good
51 - 100	Moderate
101 - 200	Unhealthy
201 - 300	Very unhealthy
Above 300	Hazardous

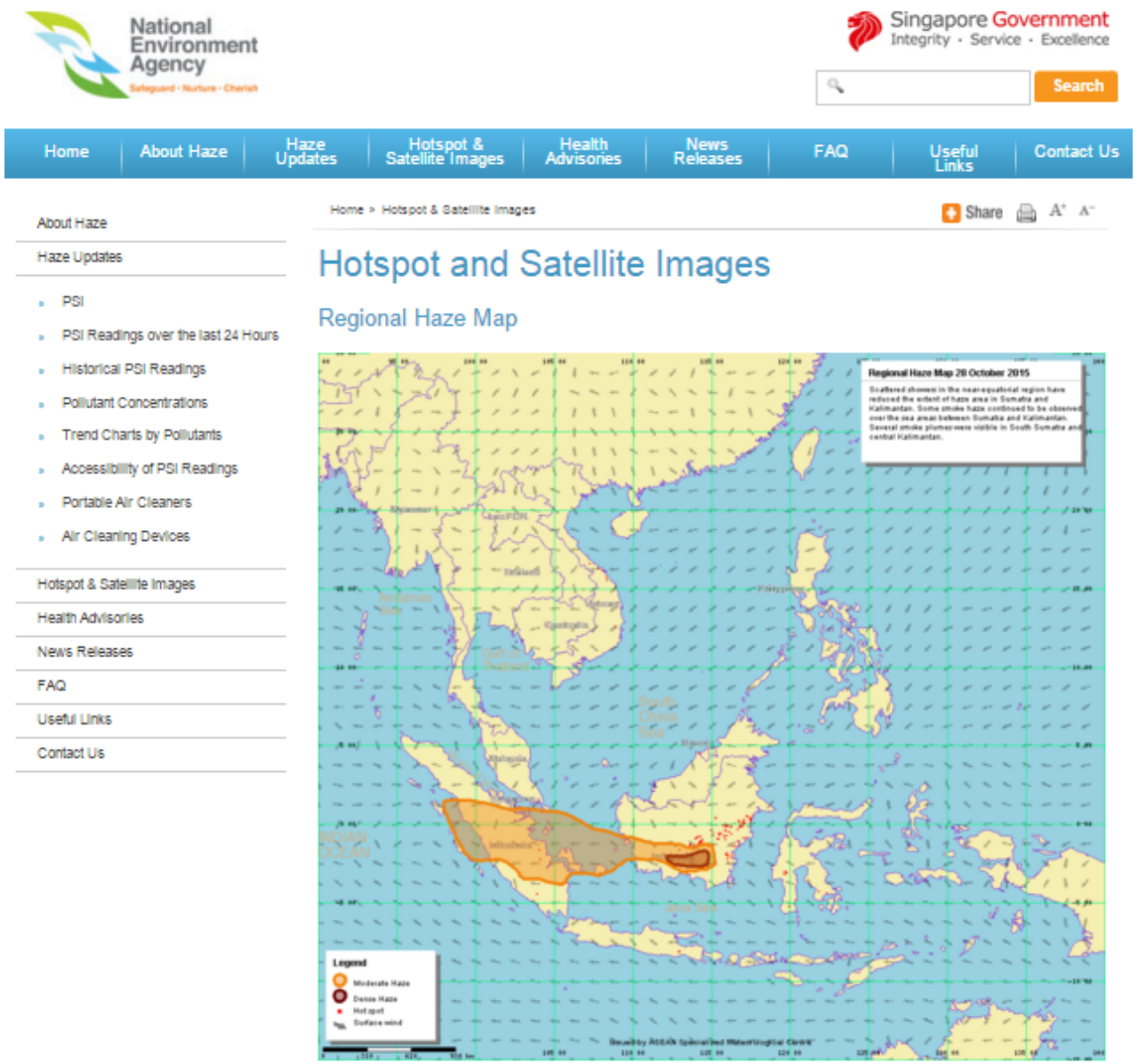
Retrieved from: http://www.nea.gov.sg/anti-pollution-radiation-protection/air-pollution-control/psi/psi

The National Environmental Agency provides a free service that displays PSI (of 6 pollutants) levels in 5 areas of the island. This information is accessible online and as an app.

It is accompanied by health advisory.



http://www.haze.gov.sg/haze-updates/trend-charts-by-pollutants



http://www.haze.gov.sg/hotspot-satellite-images

Other information can also be retrieved from NEA website:

1. **Historic Data** → Trend Charts
2. **Real-time Data** → Hotspot, Wind, Haze

3. FOOD Food Wastage

Every day, 250 vegetable sellers at the market spend dusk to dawn trimming, preening and discarding “ugly” vegetables to prepare them for sale to hawkers and wet market sellers.

*“…the market discards up to **30,000 kilos of unwanted** vegetable parts and blemished fruits every day.”*

Food waste recycling company, IUT Global

0.68 million tonnes

of food waste in 2011

130kg /yr

of food waste per person in a year

10%

of food waste recycled in 2011

30%

NEA's Green Plan 2012 Target of food waste recycled

Food From The Heart, a voluntary welfare organisation that channels **unwanted bread from hotels and bakeries to needy families** and individuals, collects approximately $150,000 worth of unsold bread and buns monthly.

The volume of bread collected fills up around 900 supermarket trolleys.

THE PROBLEM

FOOD COLLECTION AND DISTRIBUTION

LEARNING FROM THE SWISS

- COOP
  - Flexible order systems reduce food waste to a minimum. We also reduce the prices shortly before the expiration date or give the goods to a discount from our employees.
  - Foods that can no longer be sold, but are still perfect, we give free from at social institutions. 2011 to 2013 were the goods worth 42 million francs.
  - No longer suitable for consumption products are used as animal feed or used in biogas plants - these are already less than 1 percent of the food.
- Food Bike – Sells non-aesthetically pleasing farm produce to city at lower price
- AESS-bar - Sells old bread from other bakeries. If the price is right, the customer also buys products that are no longer fresh.

4. RECOMMENDATION

Figures from the Food Bank, Singapore:

70 000 food rations

Require per month

800 000 meals

Require per month

For the 130 member beneficiaries linked with the Food Bank. The food bank collects donated unused or unwanted food from companies or people to allocated to the needy in Singapore, via

family service centres

various types of homes

soup kitchens

other VWOs

http://www.foodbank.sg/index.php/the-big-issues/food-wastage-in-singapore

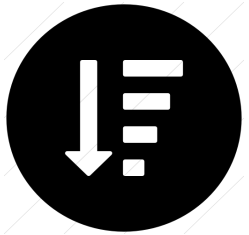
DATA SOURCE

From data sources from NEA and the government, there are lots of food wastage. Food priming (removal of unaesthetically pleasing food produce) is one of the reasons.

However, there are currently no indices to measure specifically the amount, location and time of disposal of such food priming produce.

By using apps as a way to **crowdsource** information of individual food wastage and **systems to connect** data of the amount of food priming produce at **wholesalers, supermarkets with the Singapore Food Bank.** The food bank can then use and analysis this information to increase their collection/delivery efficiency and thus benefit the needy.

DATA REQUIRED



Amount of Stunted Veg

Amount of Food Waste

REAL TIME

Frequency

HISTORIC

Location

SPATIAL &TEMPORAL

Price willing to pay

HISTORIC

DATA ACQUISITION

Quantities of deliveries and sales, and magnitude of pre-store waste and recorded in-store waste has to be daily registered by the supermarket, whole sellers etc. This real time data is **connected** to Food Bank SG for pickup.

Application to crowdsource real time data of location, frequency of individual food wastage by simultaneously providing a pick-up food service for such ‘waste’

THE DIGITAL FOOD BANK

Collection of aesthetically unpleasing but otherwise good farm produce from wholesalers and markets in the morning to food bank for consolidation.

1

Frequency

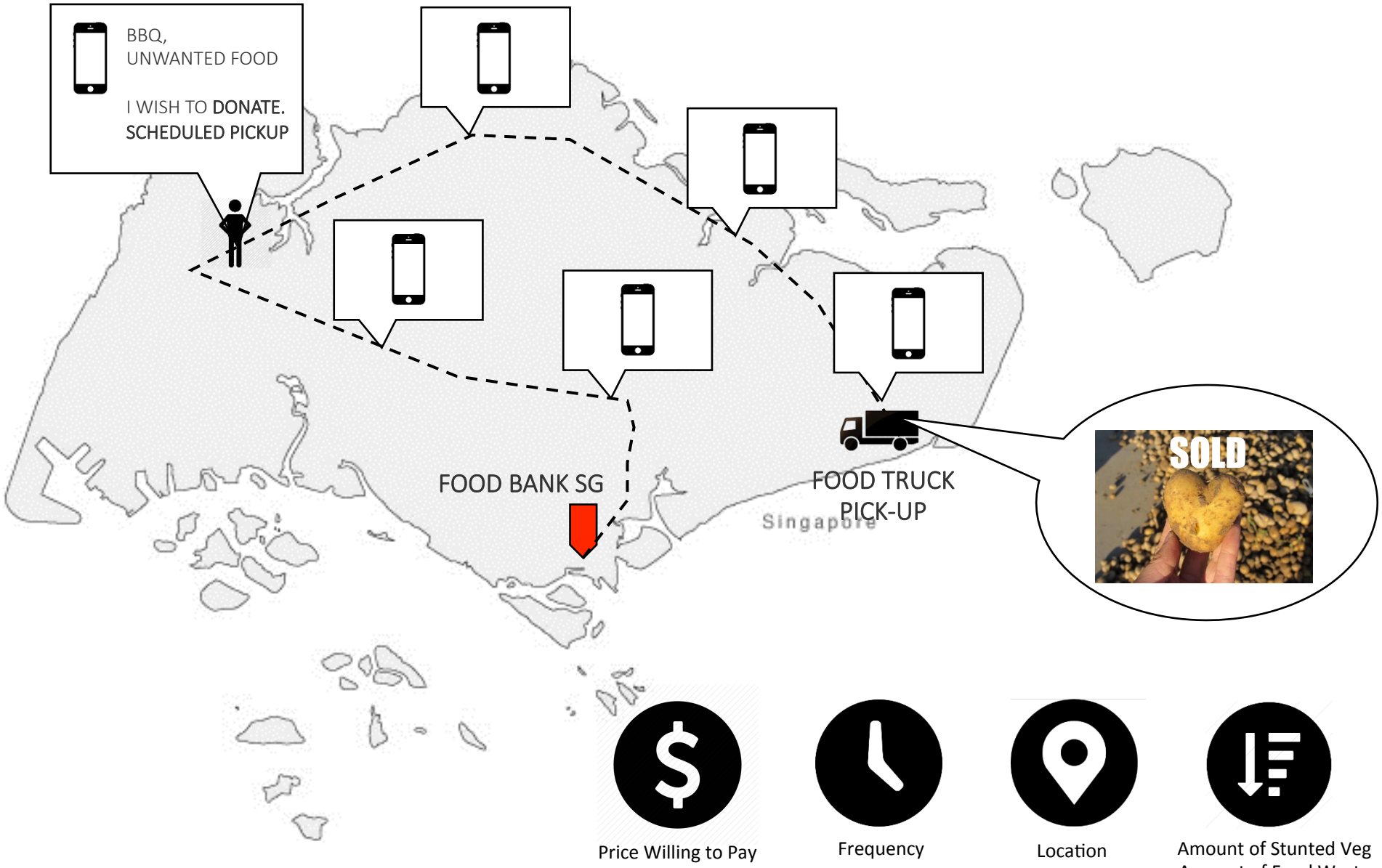
Location

Amount of Stunted Veg
Amount of Food Waste

Using an app on smart phone, what if we could plot where food wastages are. **INDIVIDUALS** who have unwanted food either due to excess or wastage, can indicate a pickup for a incentive like points.

Data of amount, location and time is thus collected. **Farm produce can be sold at lower prices along the pick-up route to communities and individuals.**

2



http://
www.tandfonline.com.libproxy1.nus.edu.sg/
doi/pdf/10.1080/10454446.2014.885863

TABLE 3 Multiple Discriminant Results

Predictor Variables	Group 1 Mean (more inclined to take effort to minimize waste)	Group 2 Mean (less inclined to take effort to minimize waste)	Sig.	Wilk's lambda	F
Throw fruits and vegetables whether cooked or not into the bin	4.026	3.477	0.01	0.96	6.33
Throw raw meat and fish into the bin	4.211	3.795	0.04	0.97	4.35
Throw processed meat and fish into the bin	4.193	3.773	0.04	0.97	4.26
Throw readymade meals and convenience foods into the bin	4.439	4.000	0.04	0.97	4.11
Throw food left on the plate after the meal	3.930	3.432	0.04	0.97	4.26
Throw food from the previous meal that you saved and was not eaten/finished the next day	4.096	3.568	0.02	0.96	5.79
Overall food that you waste	3.693	3.364	0.05	0.98	3.77
Thinking about when you have to throw uneaten food items away, to what extent, if at all, does it bother you?	2.088	3.114	0.00	0.88	21.58
To what extent, if at all, do you think about the cost of the uneaten food you throw away?	2.456	3.068	0.01	0.96	7.27
Food thrown away is not an issue as it is natural and biodegradable (lower means indicate stronger belief)	4.465	3.886	0.02	0.97	5.40

Note. Higher *F* indicates structural validity of the variables as predictor variables.

A NUS Study on types of food wasted by individuals. Highlighted in red are food waste with potential of redistribution or reuse (e.g. composting).

Real time data helps food trucks picks up food at allocated timing. It transport it to food bank SG for sorting before handing out to the needy.

3

HOME NURSING FOUNDATION 家护基金

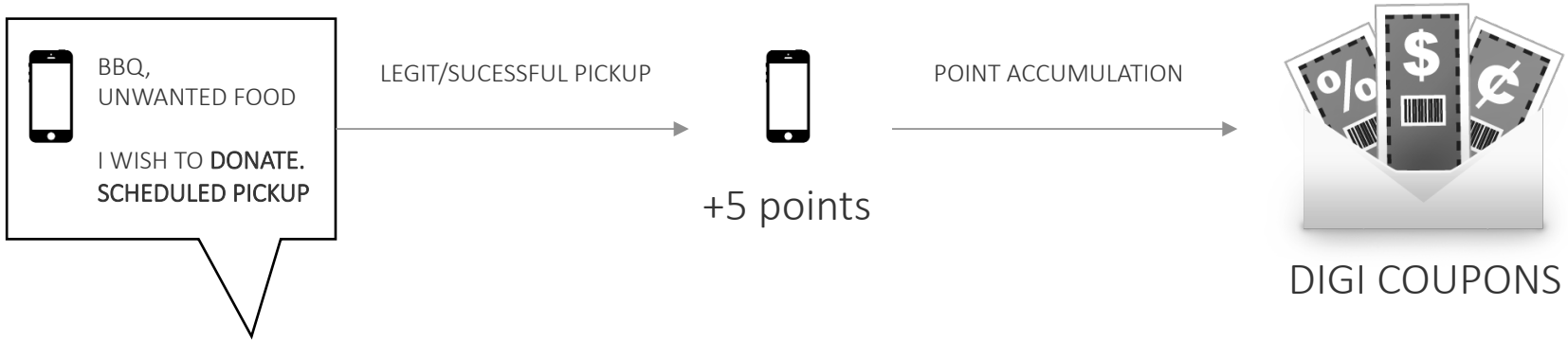
Marine Parade | FAMILY SERVICE CENTRE

Family Service centre

Real time data can be collected and stored to create predictive charts of season of high food donations/wastage. Food Bank SG can preempt and adjust operations for maximum returns.

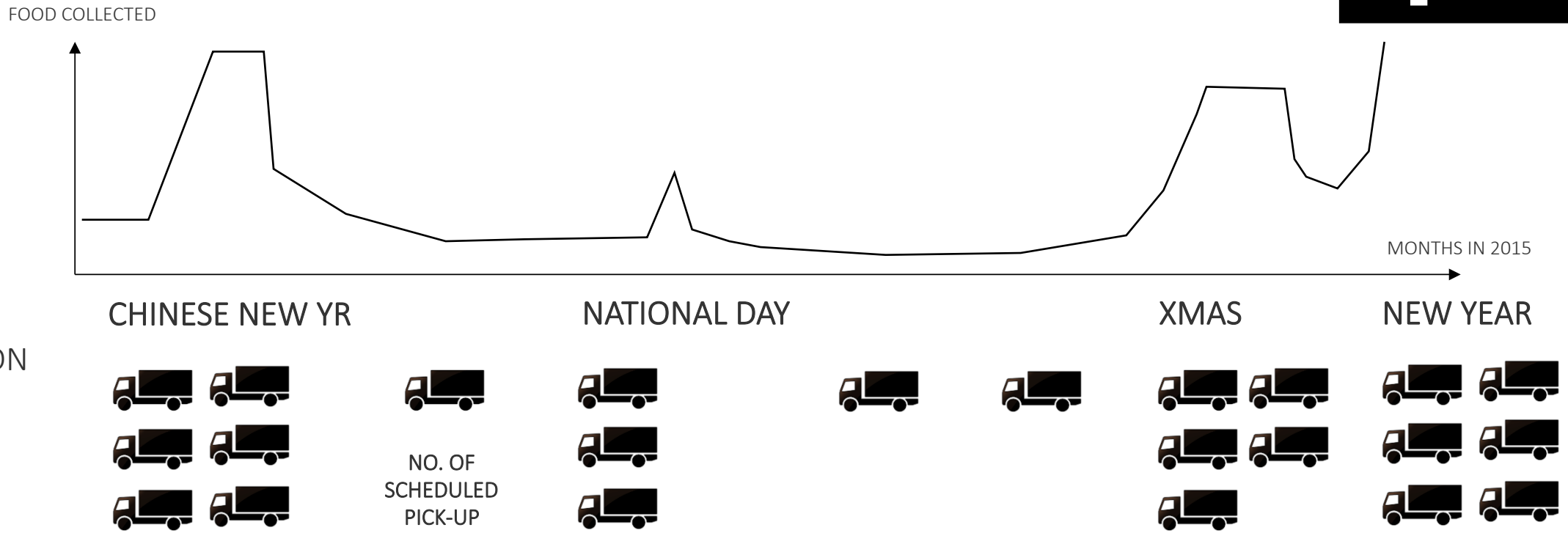
4

DONOR INCENTIVE



FOOD BANK SG

DATA COLLECTION AND ANALYSIS



Waste Problems

Glasgow makes it difficult to recycle. There are few recycling points to bring your recyclables, city collection comes infrequently, meaning that eco-tenants must stock pile their glass, paper and aluminium for weeks.

Surprisingly, there is **little infrastructure** and information surrounding waste management and recycling. Unlike in Switzerland, where high costs of rubbish bags can lead to waste reduction (personal experience), Waste collection in Glasgow is cheap and thus superfluous (fig. 2). **Unneccessary packaging** has become an art form in UK supermarkets adding excessive volume to waste (fig. 1).

The political backing behind enforced recycling schemes and **infrastructural support is weak** in the UK. The High Court judge **rejected a legal bid to enforce stricter recycling regulation**s which would require householders to separate their recycling into different bins.

The Daily Mail, the UKs most popular newspaper sympathised with their plight: "Millions of families were today **spared the threat of having to split up their household rubbish** into at least five separate bags and boxes." The social and political discourse surround recycling and waste management is suprisingly aggressive and negative.

What is more disappointing is that "much of the household waste collected for **recycling in fact goes to landfill"** - according to the Deparment for Environment, Food and Rural Affairs (fig. 3).

It seems that measures to incease recycling is being stunted at every step: from waste source to civic management.

1.http://www.dailymail.co.uk/news/article-2289220/Judge-rejects-bid-recycling-lobby-force-millions-families-sort-rubbish-separate-bins.html

1. Excessive packagin in UK supermarkets.

2. Rubbish sorting at source is not enforced allow for a laissez-faire domestic waste management.

3. UK not meeting the EU Waste Framework Directive for recycling. Additonally, much of the waste collected for recycling ends up in landfill

Waste Solutions

1. One man's waste is another's treasure. Offcut in Basel collects waste material and resells it cheaply - becoming the essential hot spot for the artist community and DIY enthusiasts.

2. Pfand system in Germany brings incentive to recycle.

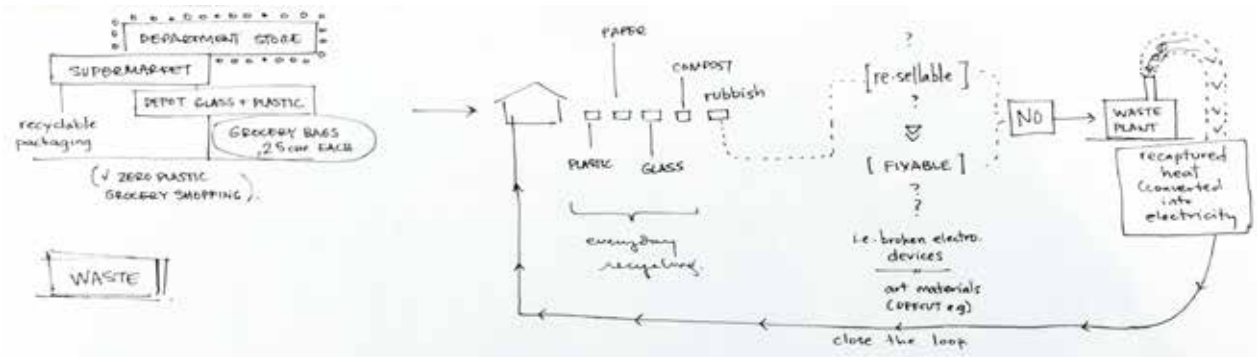
3. moo-ing recycle bins.

Recycling need not to be complicated. Though much of the world looks towards Copenhagen with recycling envy, simple measures can have large and positive implications on the mentality behind recycling.

Much of Scandanavia as well as other parts of Europe employ a **Pfand system** for bottles - meaning that a depot is already included at the purchase and the consumer receives that money back upon return of the bottle (fig. 2). Other creative schemes are being tried out to **encourage behavioural change** such as "moo-ing" recycling bins which moo when you open them. This is aimed for children with the hopes that the parents will develop recycling tendencies (fig. 3).

Resourceful young entrepreneurs are collecting usable material waste and reselling them with positive results (fig. 1). The **resourcing of material** is becoming a growing and valuable market. There is an emerging generation capitalising on re-use and recycling. This is made possible also through digital media where **sharing communities** can form easily and information and resources can be passed along through digital platforms.

Reduction in wastage can be managed in two ways: less production at the source, or **alternative ways to divert "expired" items from the landfill** through re-selling and re-use intiatives. There is a lunch food can at ETH selling sandwiches and salads made the day before at cafes around Zurich city, which would have otherwise been thrown away at the end of the evening.



More effective and efficient cycle flows need to be implemented

Transport Problems

Issues surrounding traffic in Glasgow are almost as notorious as the weather. Public transport is **inefficient** and **unreliable**. Pay stations are difficult to find and you have to pay with exact change on the buses. Timetables are loose interpretation of the movements of the buses. Most annoyingly however is the the **lack in connectivity** between stops and the different forms of public transport (rail, underground, bus).

In terms of private car usage and traffic, Glasgow wins the prize for ridiculousness. As part of a late 1960's (futuristic) plan to adopt the automobile as driving force of the modern city (no pun intended), the city placed an 8-lane M8 motorway, one of the busiest motorways in the UK, straight through the middle of the city (fig. 4). The repercussions have been catastrophic, cutting of parts of the city and **congesting downtown.** To deal with this the city implemented a **complicated one-way road system**. It does not work.

The provisions for pedestrians and cyclists are minimalistic. When cycling down the road the road a driver will swerve your direction and tell you to get off the road (cycling in the bus lane is illegal). Once on the pavement you have pedestrians shouting at you. What is clear as that no space has been clearly defined making **cycling dangerous and complicated** (fig.1,2). The **priority of the car** also makes crossing the city as a cyclist laborous. As for pedestrians, sidewalks, zebra crossings and other infrastructure are often optional planning after thoughts or simple just not considered (fig. 3)[1]

4. c. The M8 motorway cuts through the city, splitting it in two & causing unavoidable congestion in Glasgow

1. Creative approached to cycle paths

2. Urban planners do not have much sympathy for cyclists

3. An all too typical intersection void of pedestrian crossings

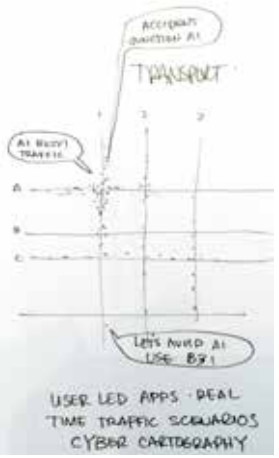
Transport

Solutions

1. City organised shared bike schemes located at public transport stops.

2. Start up Rickshaw schemes could increase connectivity and offer jobs. Other non-motorised and self-organised forms of local transport can be managed through digital platforms and applications.

3. Vancouver has clearely defined areas for pedestrians, cyclists and cars.



4. Potentials of cybercartography

4. Easy pay public transport with mobile phones

5. Real time traffic updates in Zurich

6. Water Taxis in Bangkok

7. Ferries in Basel connect the two sides of the city

Solutions: **Easy Pay public transport**. (fig. 4) Pay with your phone / oyster card facilities. More pay stations. **Proper real time timetables** (fig. 5), possible mapping of routes and streaming traffic updates. Mexico city utilises citizen led cybercartography to update real time traffic situations in the city which increases flexibility in traffic movements.

Emerging trends in the **sharing economy** could be encouraged through apps and service centres in regards to ride sharing, for example. Better yet - after the Napoli trend of "caffe sospeso[1]", the city could direct portions of ticket fines as a suspended fare for those unable to afford the public tranport.

The lack of connectivity between different transport systems within the city would require a huge infrastructural overhaul. However, there is already potential to link the light rail and bus networks better together, creating **better traffic cohesion** like we experience in Zurich.

In the mean time, **better cycle lanes and pedestrianised pathways** between stops and stations should be implemented, as well as bike-sharing points being set up at stops. Additionally, **apps for start-ups** like for rickshaws could be introduced[2] (many students have started offering their rickshaw services already).

The River Clyde was once one of the busiest rivers in the world. It has since become forgotten and a empty void slicing through another part of the city. Water taxis, like those used in Bangkok, or simple ferries like in Basel, would be a great way to **revive the river and reduce congestion.**

To simplify: **ease and efficiency of public transport** needs to be resolved. Cycle lanes and provisions for pedestrians need to be a priority. Both these elements would help **reduce car dependency.**

1. a tradition in Napoli where someone drinks an espresso but pays for two as a "suspended coffee" for the next person who can't afford one.

2. see: Sherazam Tiwana's futuristic rickshaw concept for London

Housing Problems

Livability goes hand in hand with quality of life and comfort. The quality of our home environments is important for well-being and in reducing unneccessary energy usage.

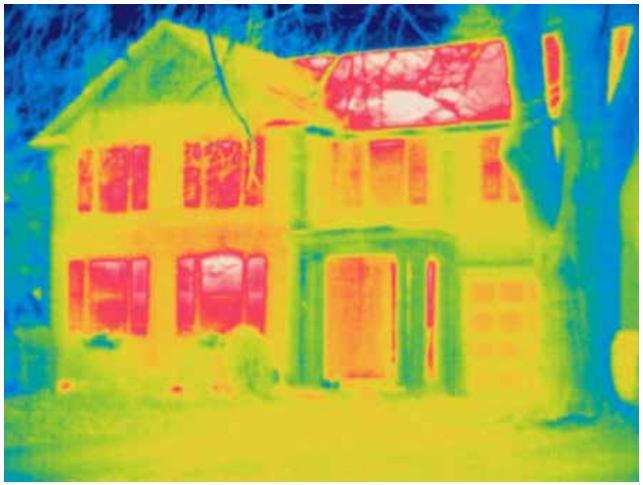
According to the UK government, about **1/3 of total energy consumption is gone is for residential use**[1]. Of this figure about 40% is lost in generation, transmission, and distribution. The rate of energy loss through unsuitable building fabrics is increidbly high (see fig. 1).

In a time of discussions surrounding peak oil and insecurities in the geo-politics of energy resources, rather than reducing dependency on such resources by building efficient and good quality housing stock, **fuel poverty is instead on the rise**[2]. More than one million people today in the UK can not afford to hearttheir homes[3], with up to 200 older people dying per day of cold-related diseases[4].

There is a housing crisis in the UK - Glasgow is famed for being the example of how not to build showcasing some of the worst housing stock in Britain. .

Single glazed and leaky windows, problems of moisture within the building fabric (interstitial condendation) and on surfaces (condensation - leading to rot) penetrate almost all housing stock in the UK (see fig. 2). Uninsulated piping further lead to heat loss and affects stable water temperatures. Simplified, much of the housing stock in the UK is badly built, **cold and damp**, and thus affects thermal comfort, well-bring and health - not to mention impinging on disposible incomes and energy consumption.

1. https://data.gov.uk/dataset/energy_consumption_in_the_uk
2. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/319280/Fuel_Poverty_Report_Final.pdf
3. http://www.theguardian.com/society/2015/jan/09/working-households-fuel-poverty-rising-energy-bills-policy-exchange
4. http://www.theguardian.com/society/2011/oct/22/older-people-cold-energy-bills

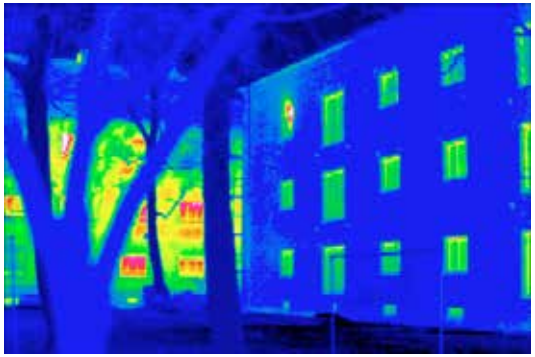


1. A thermal image of a typical house in the UK showing excessive heat loss.

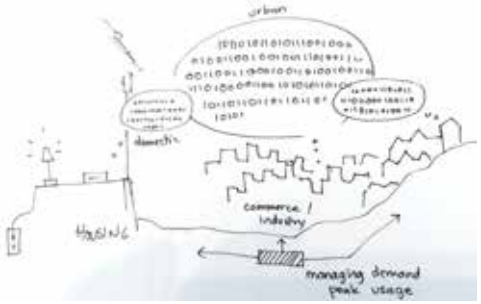
2. Single glazing results in condensation which forms on the glass and collects on the frame, leading to rot.

Housing Solutions

1. Smart meters enable two-way communication between device and a central system. It also serves to educate inhabitants on energy usage and fuel cost. Such data could be employed as a means to guaging energy efficient and thus livable housing.



2. Thermal imagine of a Passivhaus in Germany.



Smart meters allow for date to be collected from energy usage and collected in a larger data base. It is important that this data is then analysed and applied to predict future usage and demand, with an intention to reduce unnecessary energy consumption

Good news :: The housing crisis is quite straight forward to resolve. The sharing of building knowledge, systems and materials have become easier due to the globalised building market and internet (knowedge sharing).

What then is the next step?

Smart meters and similar **digital technologies** track energy consumption and can inform occupant of their energy usage. Studies show that this could lead to a 3-5% **reduction in energy consumption**[1]. Furthermore, this data could easily be collected and comprehended in real time to understand collective developments in energy demand and usage. Twenty years ago this would have been a time consuming, complicated and not totally accurate endevour taking a lot of time.

Refurbishment of existing housing stock must be a priority. Research in development in the field of **innovative insulation materials**, for example, are addressing how we can find insulation solutions for the range of stock (age, architectural constrains, monument status[2].

Knoweldge and interpretations of positive results from building strategies like Passivhaus are being mixed-and-matched to create **fusion building technologies and strategies**. Developments in modelling software for architects and planners allow for in-depth explorations in **building performance**.

Smart building management systems are able to assess and adjust the energy use of individual parts of buildings (heating management, automatic lighting), utilising the building properties as a whole. Smart building can be **connected to the grid** - this complete **flow of supply and energy demand** information allows for a more comprehensive structure for the stock and flow of district heating/cooling.

Indirectly the development, installation, management of smart systems could have a positive impacts: job creating, reduction in carbon emissions, and **improved health and well-being.**

1. "Energy informations for behaviorial change". Lossin, Felix · Loder, Allister · Staake, Thorsten in Computer Science - Research and Development (2014)
2. https://setis.ec.europa.eu/set-plan-implementation/technology-roadmaps/european-initiative-smart-cities

Content

- Exercise 2 review
- Complexity Science
- Cities as complex systems
- Conclusions

Complex systems

From Wikipedia, the free encyclopedia

See also: Complex system and Complex Systems (journal)

Complex systems present problems both in mathematical modelling and philosophical foundations. The study of complex systems represents a new approach to science that investigates how relationships between parts give rise to the collective behaviors of a system and how the system interacts and forms relationships with its environment.[1]

The equations from which models of complex systems are developed generally derive from statistical physics, information theory and non-linear dynamics and represent organized but unpredictable behaviors of natural systems that are considered fundamentally complex. The physical manifestations of such systems are difficult to define, so a common choice is to identify "the system" with the mathematical information model rather than referring to the undefined physical subject the model represents. One of a variety of journals using this approach to complexity is *Complex Systems*.

Such systems are used to model processes in computer science, biology,[2] economics, physics, chemistry,[3] and many other fields. It is also called *complex systems theory*, *complexity science*, *study of complex systems*, *sciences of complexity*, *non-equilibrium physics*, and *historical physics*. A variety of abstract theoretical complex systems is studied as a field of mathematics.

The key problems of complex systems are difficulties with their formal modelling and simulation. From such a perspective, in different research contexts complex systems are defined on the basis of their different attributes. Since all complex systems have many interconnected components, the science of networks and network theory are important aspects of the study of complex systems. A consensus regarding a single universal definition of *complex system* does not yet exist.

For systems that are less usefully represented with equations various other kinds of narratives and methods for identifying, exploring, designing and interacting with complex systems are used.

Complex systems

Topics

Emergence	[show]
Self-Organization	[show]
Collective Behaviour	[show]
Networks	[show]
Evolution & Adaptation	[show]
Pattern Formation	[show]
Systems Theory	[show]
Nonlinear Dynamics	[show]
Game Theory	[show]

V • T • E

Content

- Exercise 2 review
- Complexity Science
- Cities as complex systems
- An Example: Cooler Calmer Singapore
- Conclusions

Over time:

Cities as systems
Cities as hierarchical systems
Cities as complex systems

http://www.santafe.edu/research/cities-scaling-and-sustainability/

Cities as Complex Systems[†]

Scaling, Interactions, Networks, Dynamics and Urban Morphologies

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Abstract

Cities have been treated as systems for fifty year but only in the last two decades has the focus changed from aggregate equilibrium systems to more evolving systems whose structure merges from the bottom up. We first outline the rudiments of the traditional approach focusing on equilibrium and then discuss how the paradigm has changed to one which treats cities as emergent phenomena generated through a combination of hierarchical levels of decision, driven in decentralized fashion. This is consistent with the complexity sciences which dominate the simulation of urban form and function. We begin however with a review of equilibrium models, particularly those based on spatial interaction, and we then explore how simple dynamic frameworks can be fashioned to generate more realistic models. In exploring dynamics, nonlinear systems which admit chaos and bifurcation have relevance but recently more pragmatic schemes of structuring urban models based on cellular automata and agent-based modeling principles have come to the fore. Most urban models deal with the city in terms of the location of its economic and demographic activities but there is also a move to link such models to urban morphologies which are clearly fractal in structure. Throughout this chapter, we show how key concepts in complexity such as scaling, self-similarity and far-from-equilibrium structures dominate our current treatment of cities, how we might simulate their functioning and how we might predict their futures. We conclude with the key problems that dominate the field and suggest how these might be tackled in future research.

[†]in **The Encyclopedia of Complexity & System Science**, Springer, Berlin, DE, forthcoming 2008. Date of this paper: February 25, 2008.

Cities have been treated as systems for fifty year but only in the last two decades has the focus changed from aggregate equilibrium systems to more evolving systems whose structure merges from the bottom up. We first outline the rudiments of the traditional approach focusing on equilibrium and then discuss how the paradigm has changed to one which treats cities as emergent phenomena generated through a combination of hierarchical levels of decision, driven in decentralized fashion. This is consistent with the complexity sciences which dominate the simulation of urban form and function. We begin however with a review of equilibrium models, particularly those based on spatial interaction, and we then explore how simple dynamic frameworks can be fashioned to generate more realistic models. In exploring dynamics, nonlinear systems which admit chaos and bifurcation have relevance but recently more pragmatic schemes of structuring urban models based on cellular automata and agent-based modeling principles have come to the fore. Most urban models deal with the city in terms of the location of its economic and demographic activities but there is also a move to link such models to urban morphologies which are clearly fractal in structure. Throughout this chapter, we show how key concepts in complexity such as scaling, self-similarity and far-from-equilibrium structures dominate our current treatment of cities, how we might simulate their functioning and how we might predict their futures. We conclude with the key problems that dominate

(a) population density on a 200m grid from the 1991 Census of Population

(b) The evolution of the road network over the last 500 years from the centre outwards

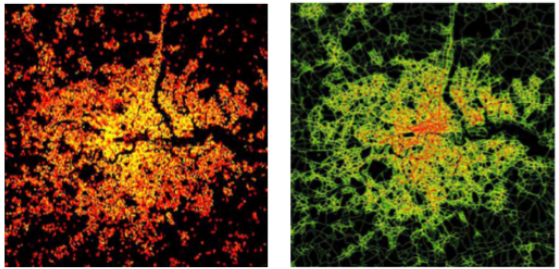


Figure 12: Greater London: Self-Similar Clusters and the Connectivity Network within the Sprawl

Future Directions

The biggest problems facing the development of complex systems models in general and those applied to cities in particular involve validation. The move from articulating systems as organized entities structured from the top down based on some sort of centralized control mechanisms to systems that grow in an uncoordinated way from the bottom up have also shifted our perspective from developing systems model in a parsimonious way to developing much richer models requiring more detailed data. In short, complexity theory has changed the basis for theory and model selection from an insistence that all models must be testable against data to an acceptance that if there is a strong reason why some non-testable propositions should be included in a model (as models with very rich behaviors and processes imply), then these should be included

even if they cannot be tested. This is consistent with the shift from aggregate to disaggregate modeling, from the focus on equilibrium to dynamics, and on processes and behaviors rather than simply outcomes.

Future Directions

The biggest problems facing the development of complex systems models in general and those applied to cities in particular involve validation. The move from articulating systems as organized entities structured from the top down based on some sort of centralized control mechanisms to systems that grow in an uncoordinated way from the bottom up have also shifted our perspective from developing systems model in a parsimonious way to developing much richer models requiring more detailed data. In short, complexity theory has changed the basis for theory and model selection from an insistence that all models must be testable against data to an acceptance that if there is a strong reason why some non-testable propositions should be included in a model (as models with very rich behaviors and processes imply), then these should be included

The Goal: Sustainable and Resilient Cities

Can a complexity science informed and evidence based planning process, using advanced simulation and design synthesis methods lead to more sustainable urban structures?

Resilience
of urban structures

Can a complexity science informed and evidence based planning process supported by advanced simulation and design synthesis methods lead to more resilient urban structures?

Development and Conflict

- Geometry driven planning
- Sequential planning
- Functional planning
- Urban Science
- Complexity Science informed design
- Big Data informed design

Design

Analysis
(Design 2.0?)

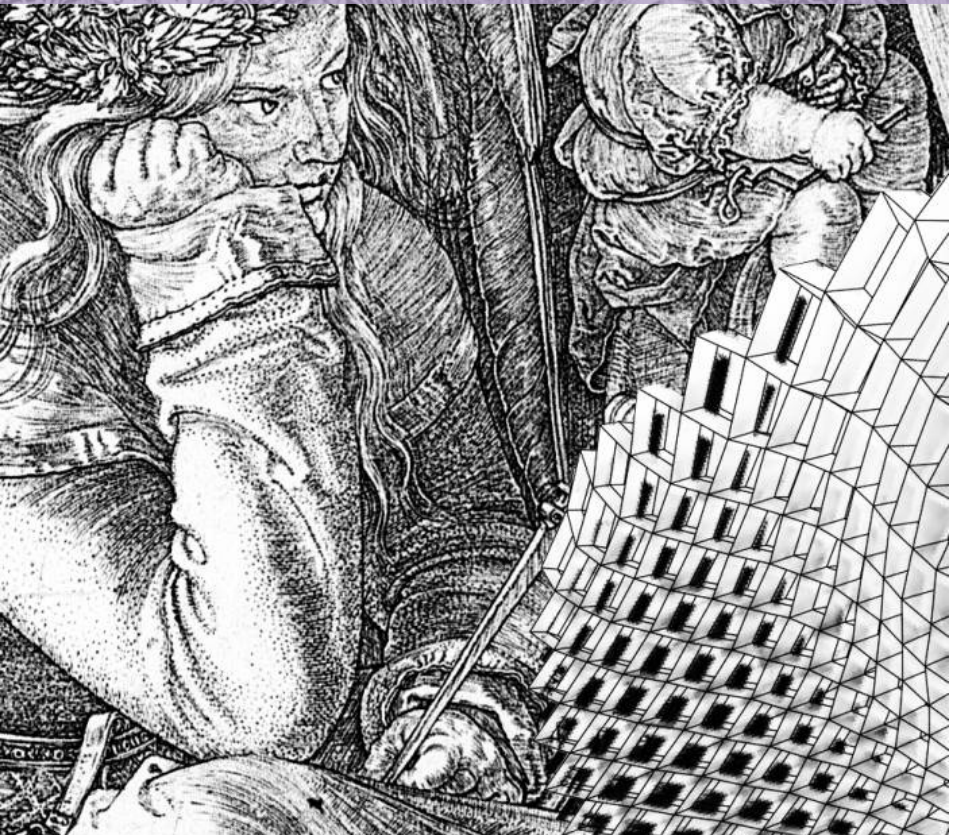
Urban Science, Complexity, Big Data

- Urban Science
  - Land use plannnig, generative design
- Complexity Science informed design
  - Stocks and flows, quantum city
- Big Data informed urban design
  - Citizen design science, cognitive design computing

Positivism

Crowdsourcing

Claims 2015



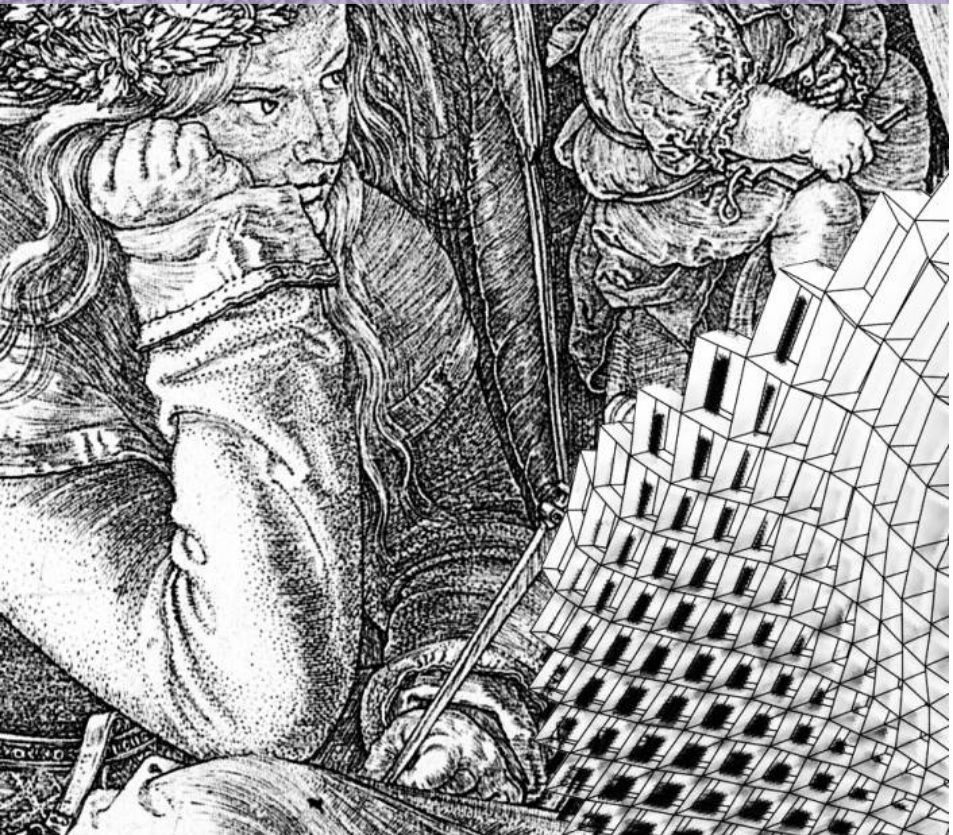
“Data-driven decisions are better decisions”

Using big data enables planners to decide on the basis of evidence rather than intuition.

For that reason data driven design has the potential to revolutionize planning and design.

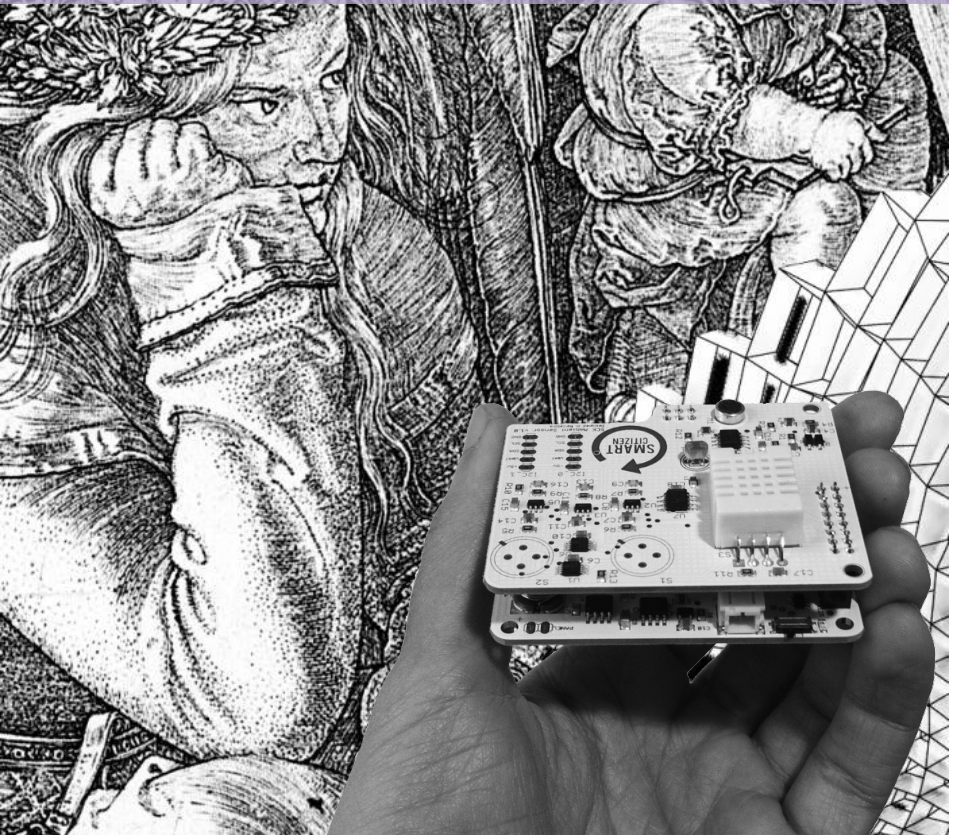
But
Big Data does not erase the need for vision or human insight.

Complexity, Big Data, Urban Planning



Once there was the idea that we can develop patterns, which represent good solutions for specific aspects of a planning…

Complexity, Big Data, Urban Planning

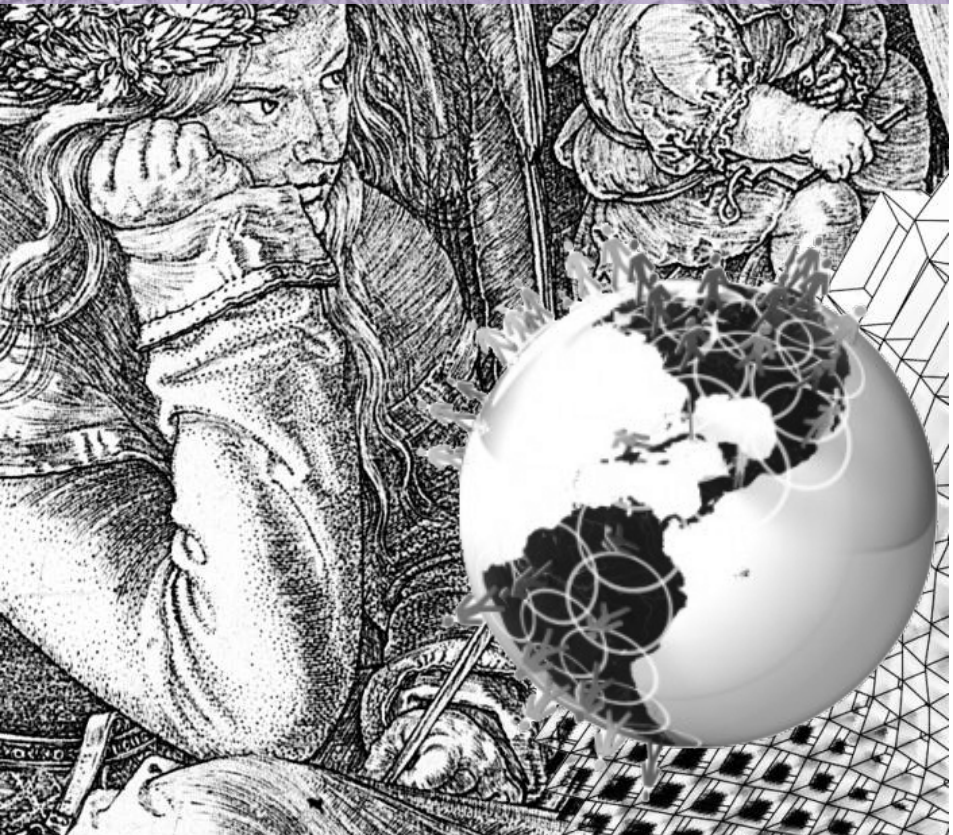


Once there was the idea that we can develop patterns, which represent good solutions for specific aspects of a planning…

… but we learned that it always depends on the context if a solution is good or not.

- Now, we have to look for a smarter, more pragmatic usage of **data and models**
- **Complexity Science?**

Complexity, Big Data, Urban Planning



From Big Data Analysis we learnt so far:

Future planning processes will be based on constantly changing truths.

Urban Science, Complexity, Big Data

Positivism

- Urban Science
  - Land use plannnig, generative design
- Complexity Science informed design
  - Stocks and flows, quantum city
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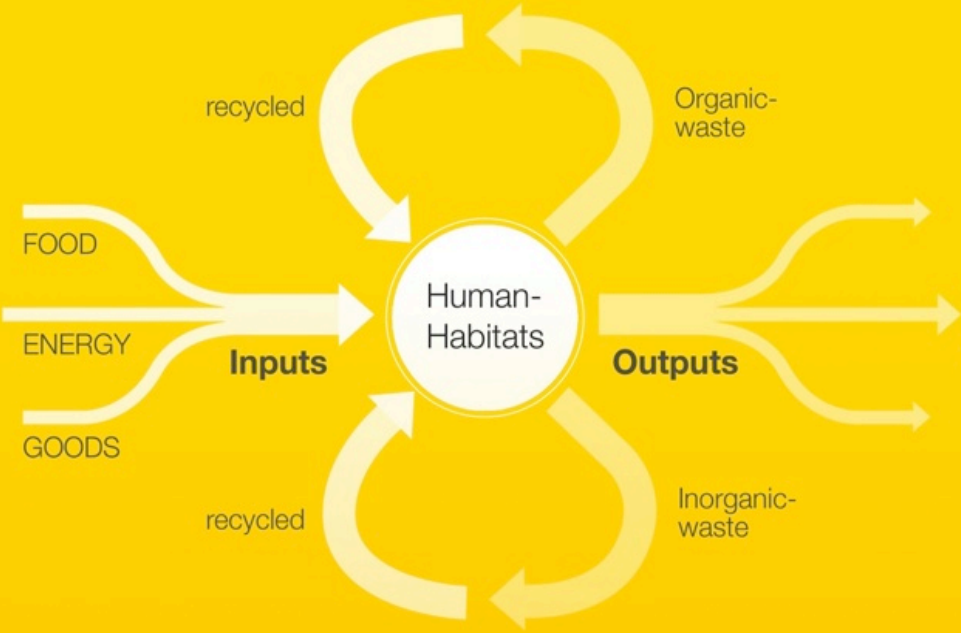
Crowdsourcing



Urban Metabolism

Understand the city as a dynamic and **complex system**

Read and model this system in terms of Stocks and Flows

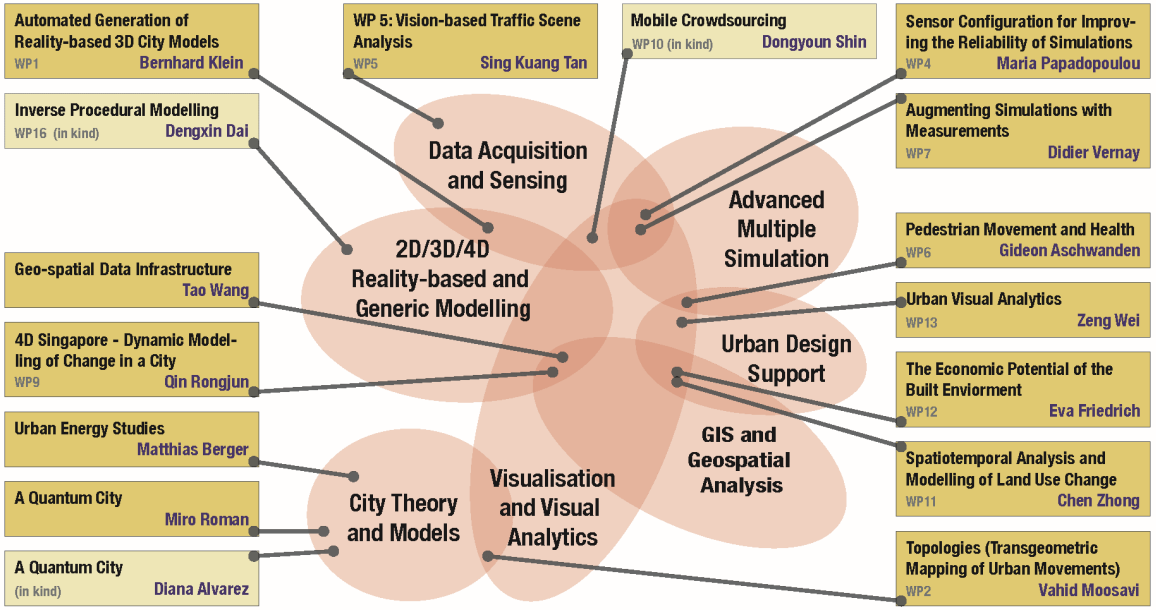
Recognise Urban Stocks as basic elements of the urban metabolism and as locally available resources

Examples for Urban Stocks and Flows

- People and Health
- Water and Capital
- Energy and Materials
- Space and Density
- Transportation and Information

Simulation Platform

Module IX



Module Leader:	Prof. Dr. Gerhard Schmitt
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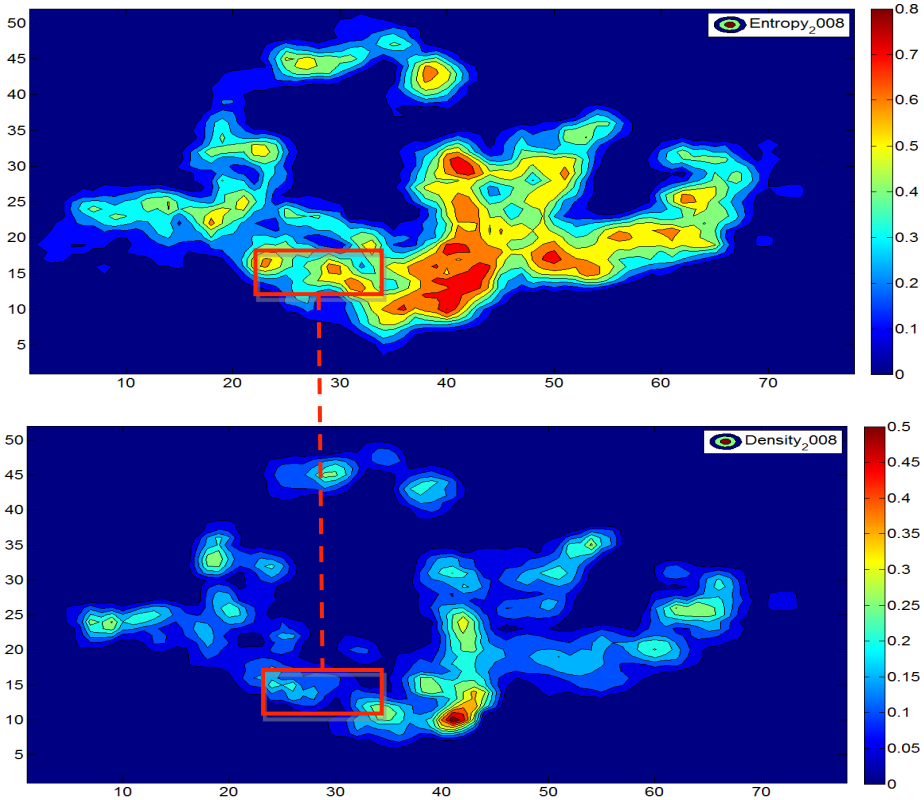
Postdoctoral Fellows:	Dr. Matthias Berger - Dr. Tao Wang - Dr. Bernhard Klein
System Specialists:	Daniel Sin - Rewell Dangoy

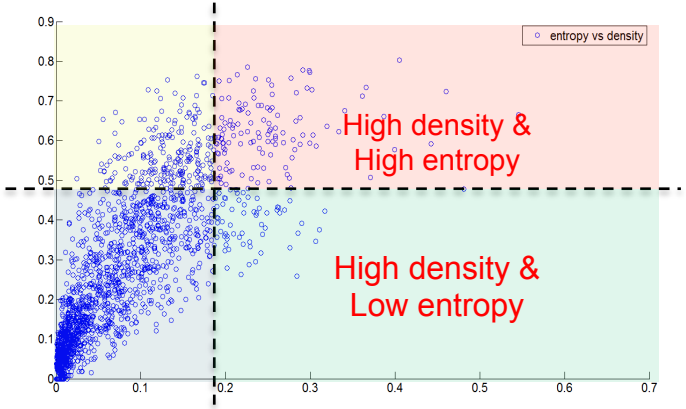
Urban Dynamics - Urban Transformation towards Polycentricity

The 20th century was the century of urbanization, and the 21st century is the century of urban transformation (Hall and Pfeiffer, 2002).

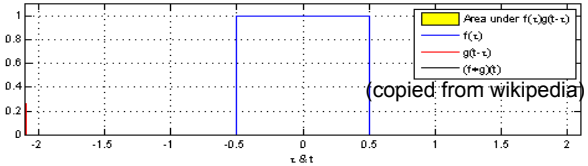
Managing the urban transformation is become prior as one of the central challenges of urban design and planning.

Method – Entropy, Density and Centrality





Convolution

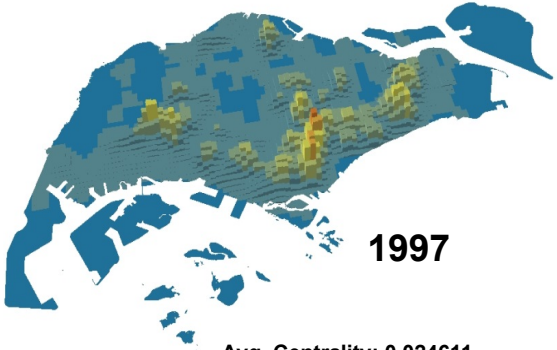


(copied from wikipedia)

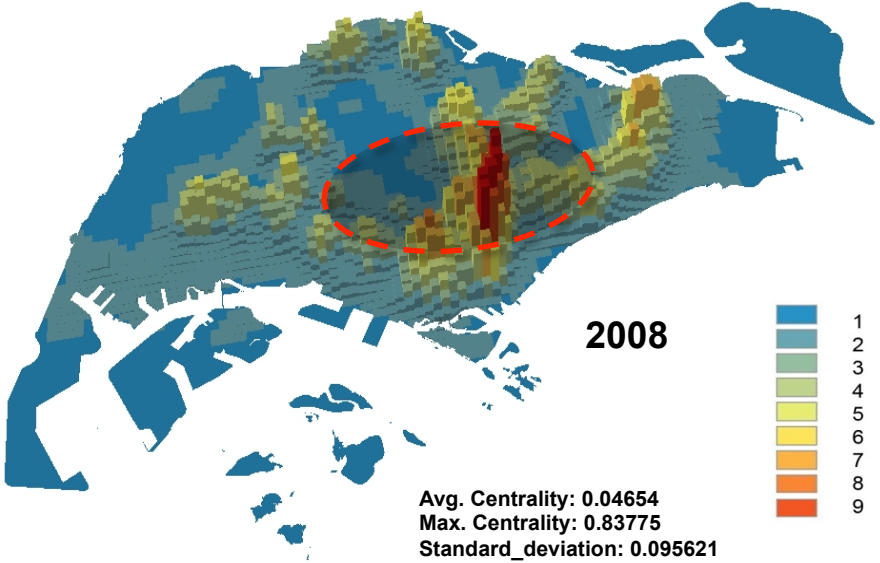
The joint probability dense function of two independent events is the convolution

$$C_{xy} = P_D(x,y) \otimes P_E(x,y)$$

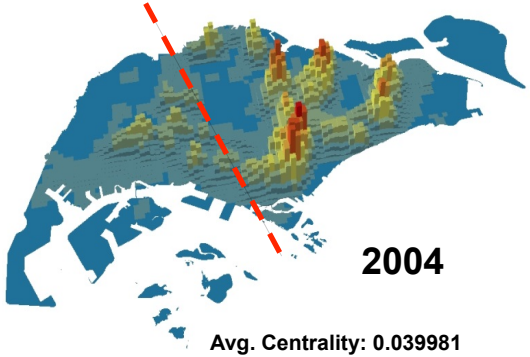
Result – Urban Centrality Map in 1997, 2004 and 2008



Avg. Centrality: 0.024611
Max. Centrality: 0.54349
Standard_deviation: 0.056668



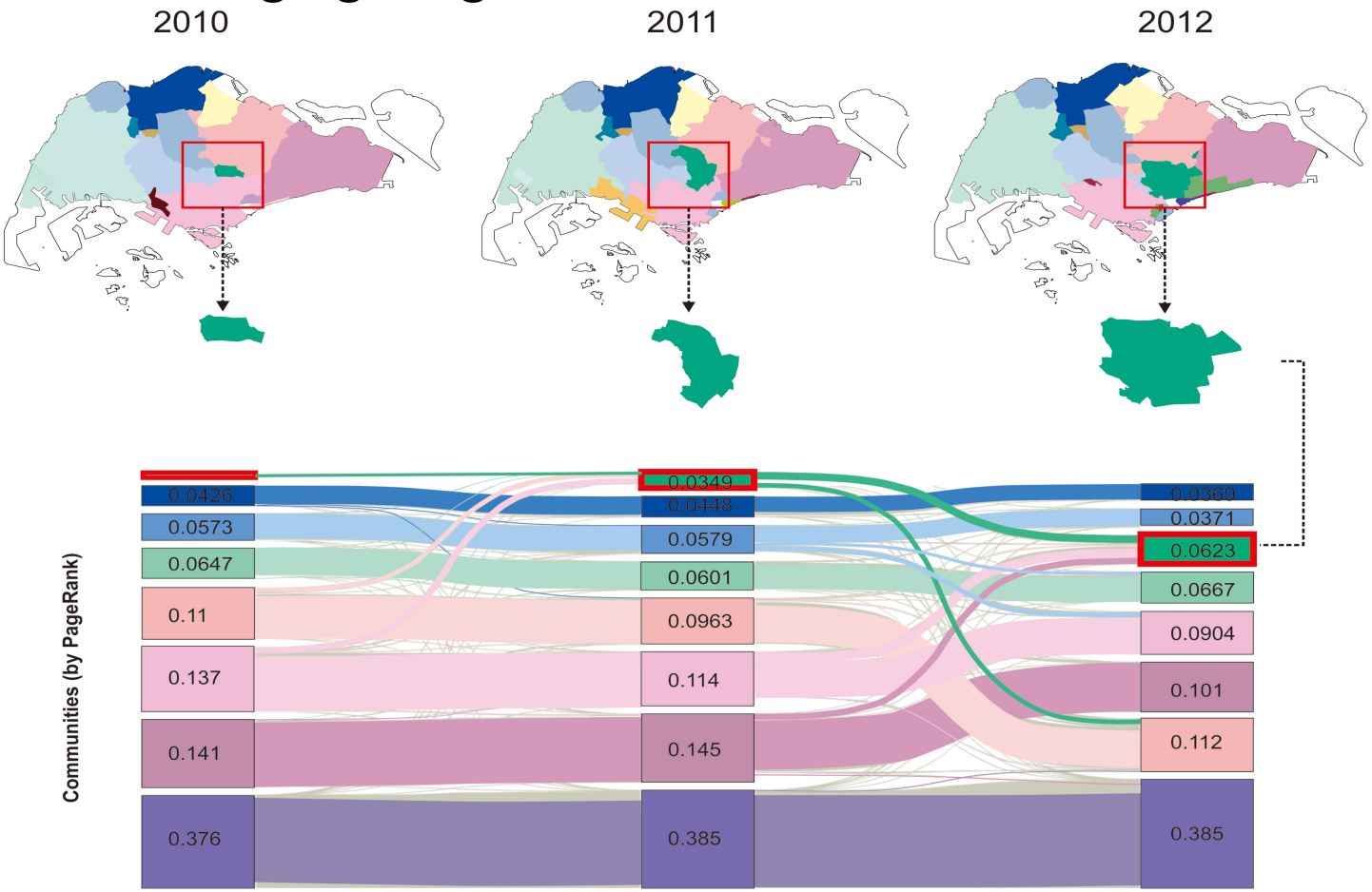
Avg. Centrality: 0.04654
Max. Centrality: 0.83775
Standard_deviation: 0.095621



Avg. Centrality: 0.039981
Max. Centrality: 0.7083
Standard_deviation: 0.090856

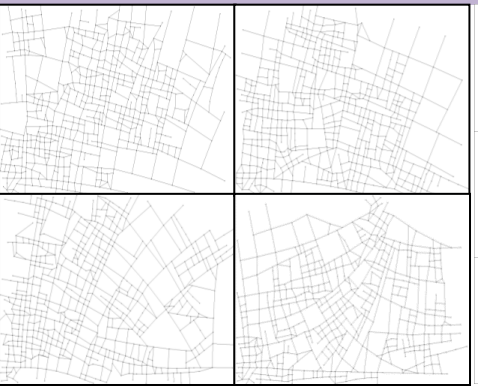
- The overall value of centrality was increasing.
- Distribution of centrality value turned more balanced between east and west regions.
- Anomalous increasing high centrality of the biggest centre

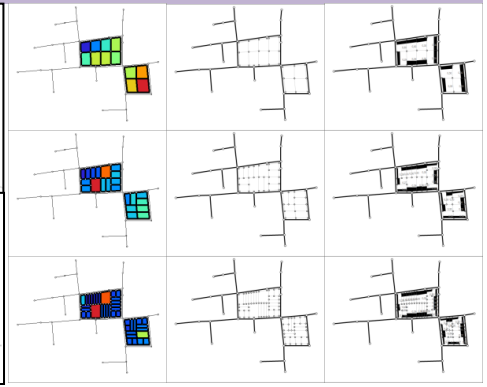
Result – Emerging Neighborhood

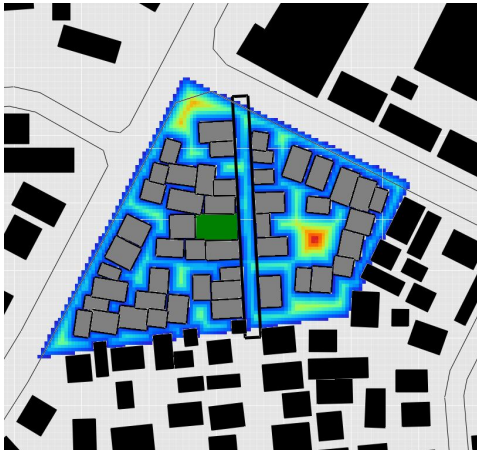


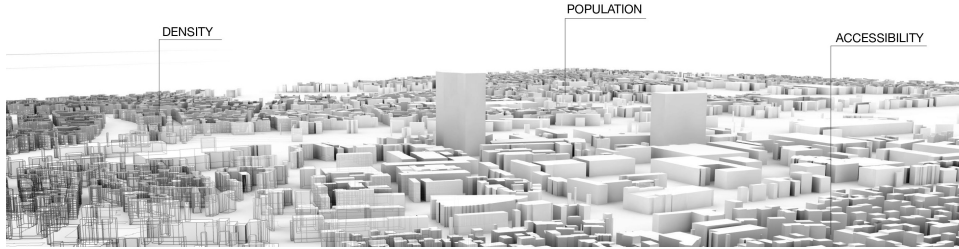
Making Cities

From data to urban planning









Top: Inverse Urban Design: Enhancement of urban environment at pedestrian scale (Anastasia Koltsova)

Koenig, R.: Software-Prototype, 2013

Left and top: Applicability of urban synthesis techniques for planning problems (Dr. Reinhard König)

Content

- Exercise 2 review
- Complexity Science
- Cities as complex systems
- Conclusions

Conclusions

- Complexity science helps to understand and predict urban systems behaviour
- The development began by seeing cities as systems, as top-down organised hierarchical systems (Cities as a tree), and more recently as complex systems
- While this view explains much post-factum, it re-enforces the essential role of the urban designer – or of citizen design scientists