Ecosystem Services, Human Well-Being and Quality of Life

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Consunji Room, Ang Bahay ng Alumni, Magsaysay Ave.,
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23 March 2017

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Well-being and Quality of Life

- Definitions are many and varied
- **Well-being**: State of being happy, healthy, capable and engaged
- In addition to feeling satisfied and happy, well-being means developing as a person, being fulfilled, and making a contribution to the community (Shah and Marks 2004) -> add up to quality of life

- **Quality of Life:** an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns (WHO, 1997)

- multi-dimensional construct -> hard to measure
  - Physical well-being
  - Economic well-being
  - Social well-being
  - Development and activity
  - Emotional well-being
  - Psychological well-being
  - Life satisfaction
  - Domain specific satisfaction
  - Engaging activities and work
- Indices developed to assess human well-being at different scales

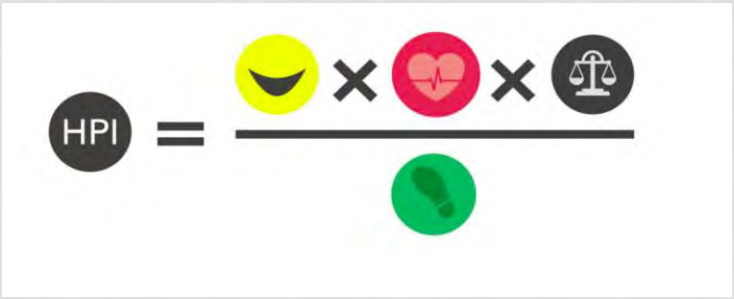
Example Indices

1. **Human Development Index (HDI)**

- supported by UN General Assembly
- Compositely summarizes a country's average achievements in 3 basic aspects of human development:
    a. health (life expectancy at birth)
    b. knowledge (adult literacy rate and the combined primary, secondary, and tertiary gross enrolment ratio
    c. standard of living (GDP per capita)
- Does not take into account cultural or social aspects, and considers security dimensions only insofar as they are reflected in economic and health outcomes.

2. Happy Planet Index (HPI)

- developed by the New Economics Foundation
- index of human well-being and environmental impact
- reflects the average years of happy life produced by a given society, nation or group of nations, per unit of planetary resources consumed.



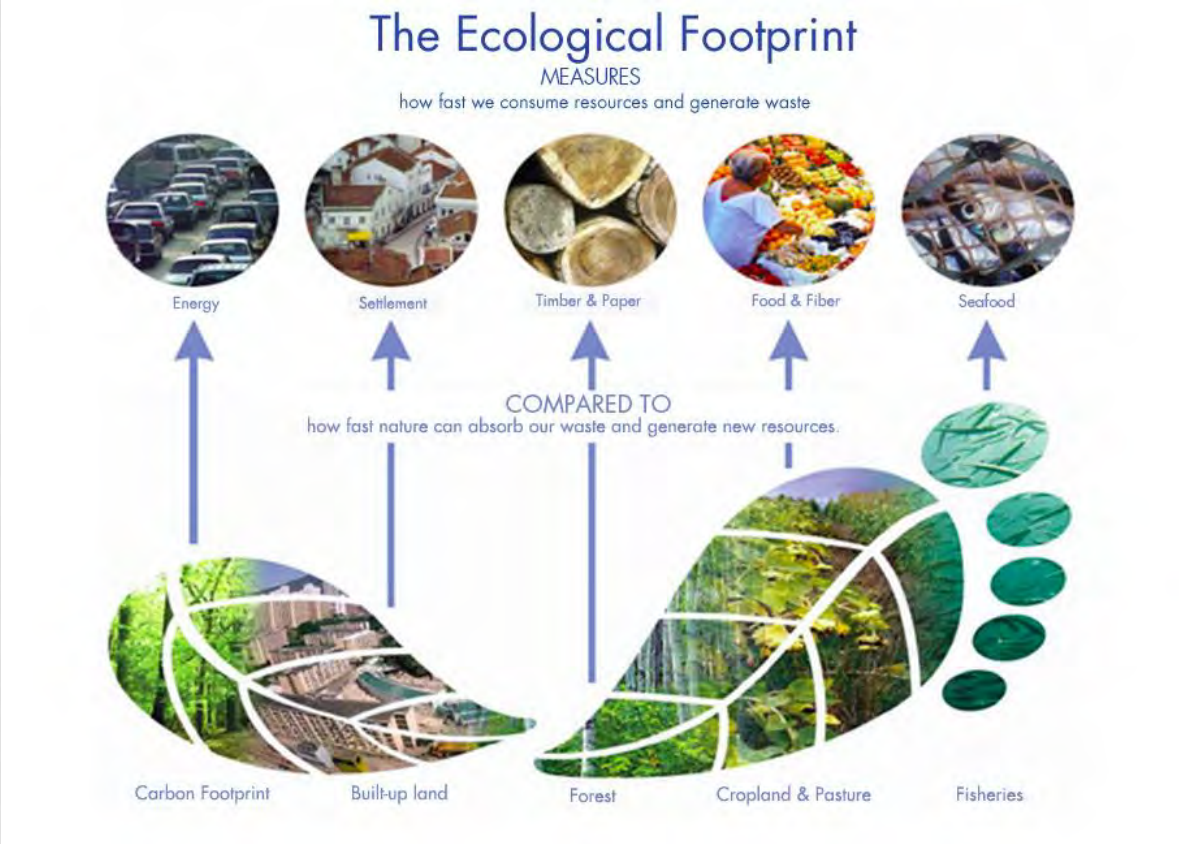
Life Satisfaction, on a scale From 0 to 10, Gallup World Poll

Life Expectancy, UN data

Social Inequality, inequalities between people within a country In terms of how long they live and how happy they feel, expressed as percentage

Ecological Footprint: Ave. impact placed on the environment , expressed as global hectares per person

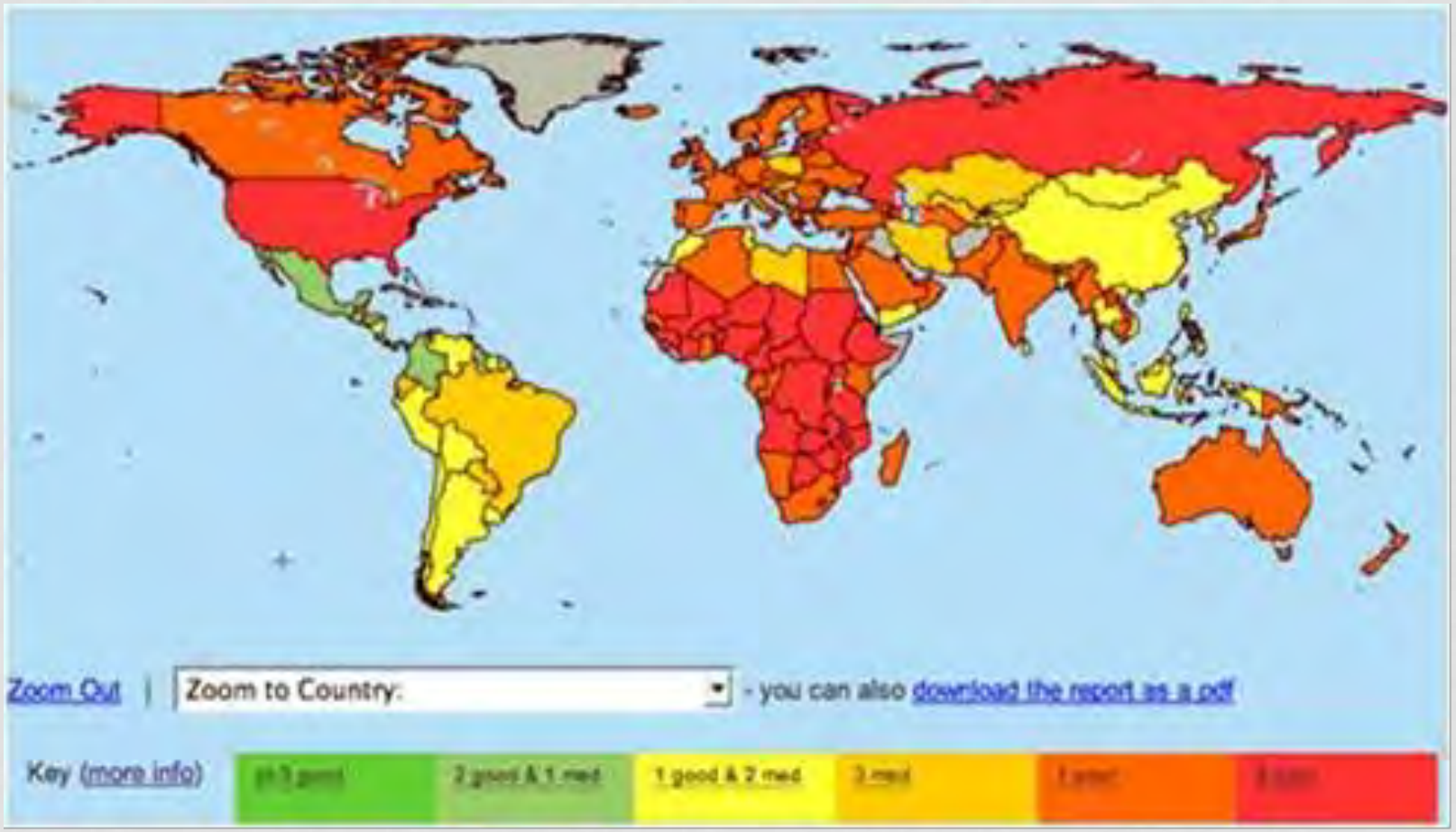
Source: New Economics Foundation



Source: Global Footprint Network

- Expressed in **global hectares**—globally comparable, standardized hectares with world average productivity
- If population's Ecological Footprint exceeds the region's biocapacity, that region runs an **ecological deficit – 80% of world population**
- We use the equivalent of 1.6 Earths to provide the resources we use and absorb our waste

Happy Planet Index for Different Countries



Source: Frąckiewicz, n.d.

- Wealthy Western countries do not rank highly on HPI but countries in Latin America and the Asia Pacific region instead
- **Top 10**: Costa Rica, Mexico, Columbia, Vanuatu, Vietnam, Panama, Nicaragua, Bangladesh, Thailand, Ecuador
- HPI provides a compass to guide nations and shows that it is possible to live good lives without costing the Earth much.

3. U.S. Well-Being Index

- Developed by US EPA
- Independent of time, place and culture and unifies the human and environmental domain
- Expands interpretation of ecosystem services indicators into an overall quality of life measurement
- Includes 4 sub-indexes:
  - human needs sub-index
  - happiness sub-index
  - economics sub-index
  - environmental sub-index

4. Australian Unity Personal Well-being Index

- Your health;
- Your personal relationships;
- How safe you feel;
-Your standard of living;
- What you are achieving in life;
- Feeling part of the community; and
- Your future security

Ecosystem Services

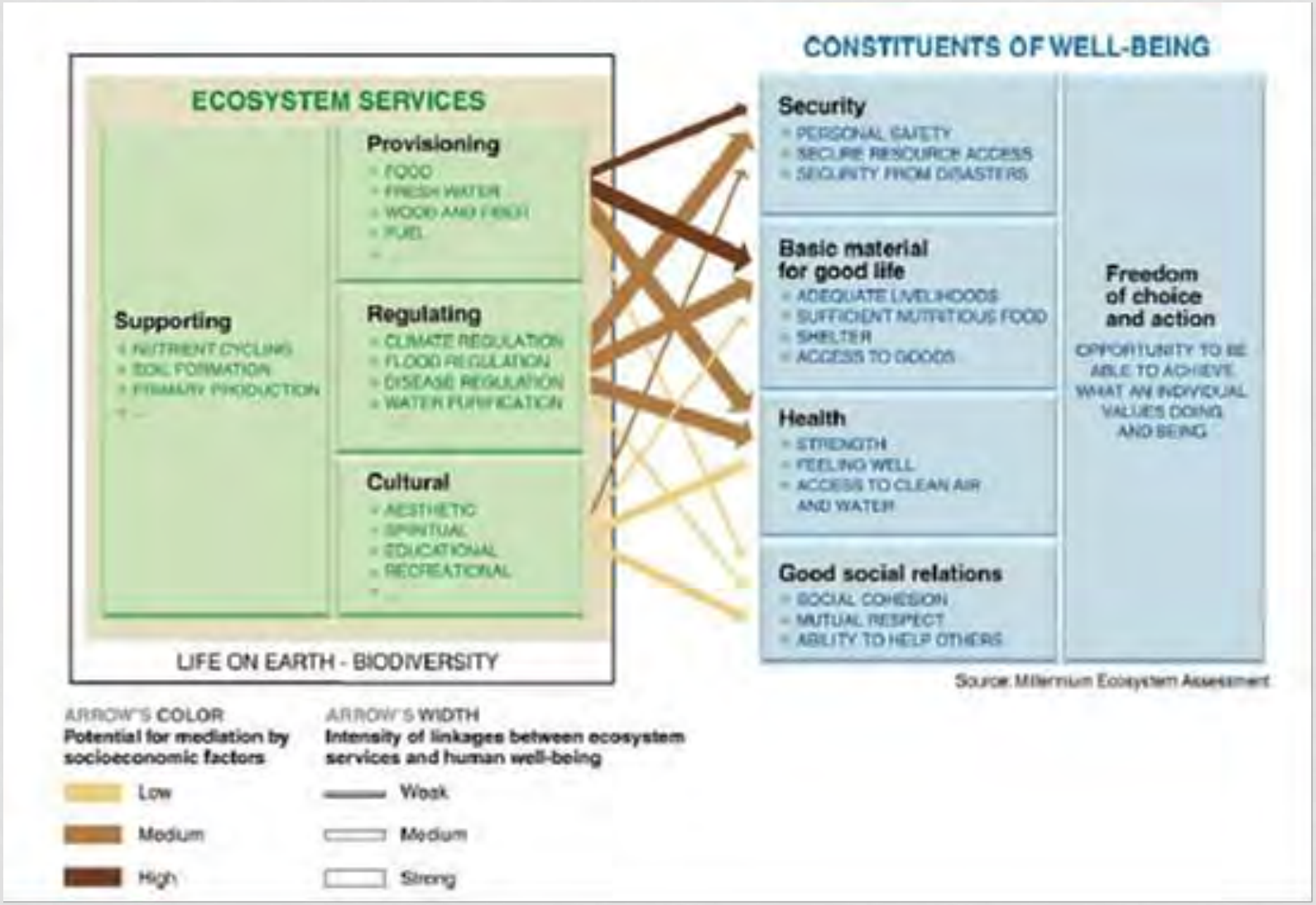
- US EPA definition: benefits derived from ecosystem processes and functions that directly or indirectly contribute to human well-being
- The Millennium Ecosystem Assessment (MA) definition: benefits people derive from ecosystems

The Millennium Ecosystem Assessment (MA)

- called for by the UN Secretary-General Kofi Annan in 2000 and initiated in 2001

- **Objectives**:
  - provide a state-of-the-art scientific appraisal of the condition and trends in the world's ecosystems and the services they provide
  - assess the consequences of ecosystem change for human well-being
  - provide the scientific basis for action to enhance the conservation and sustainable use of those systems

Key message: ecosystem services are strongly interlinked with different constituents of human well-being



Urban Parks as Green Infrastructure: Assesment of Flood Regulating and Other Ecosystem Services in Kinuta Park, Setagaya, Tokyo

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Main Research Questions

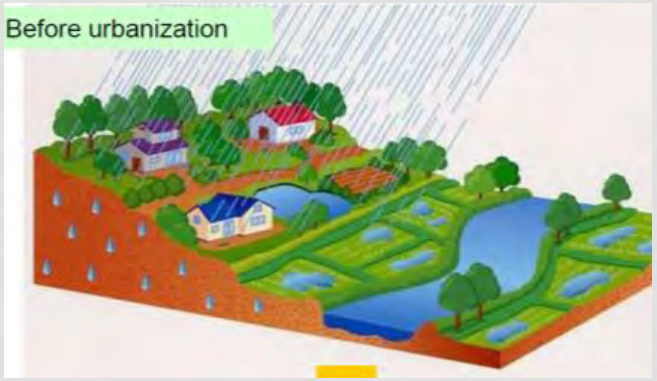
1. How does an urban park like Kinuta Park contribute to flood risk mitigation and by how much?

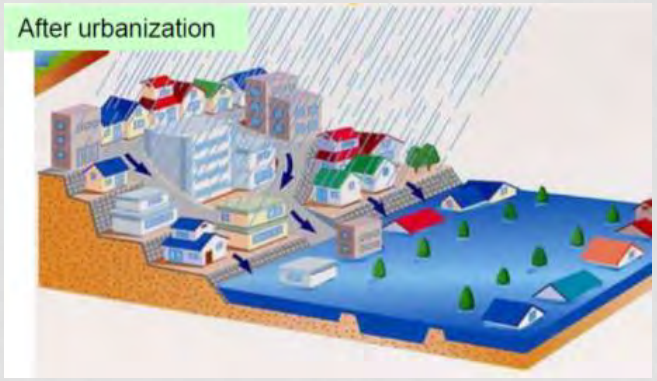
2. What other benefits can we derive from urban parks?

Urbanization and Climate Change: Effects on Flood Risks

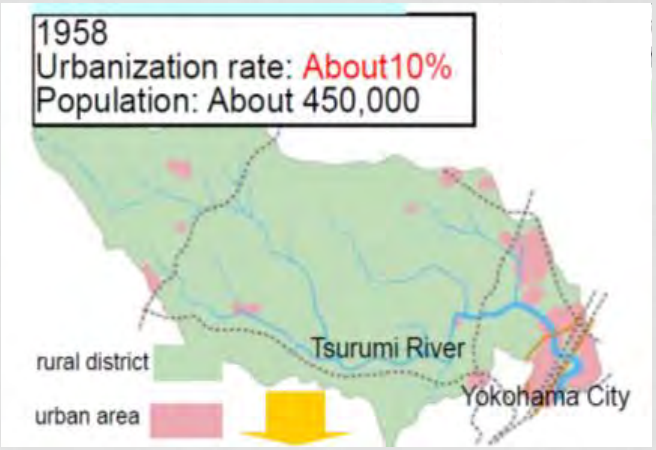
A. Rapid urbanization disrupts the hydrological cycle

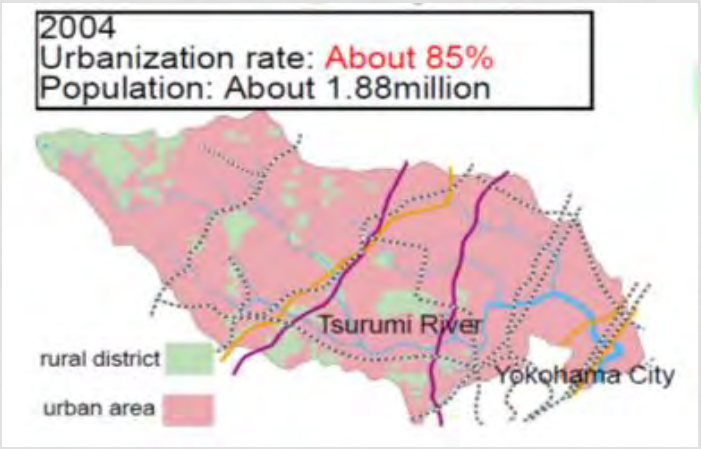
- increase of impervious areas
- removal of the porous surface and replacement with compacted layer
- reduction of the temporary retention by vegetation cover and soil layer





Sources: MLIT; Herath and Ngoc Mai, 2014



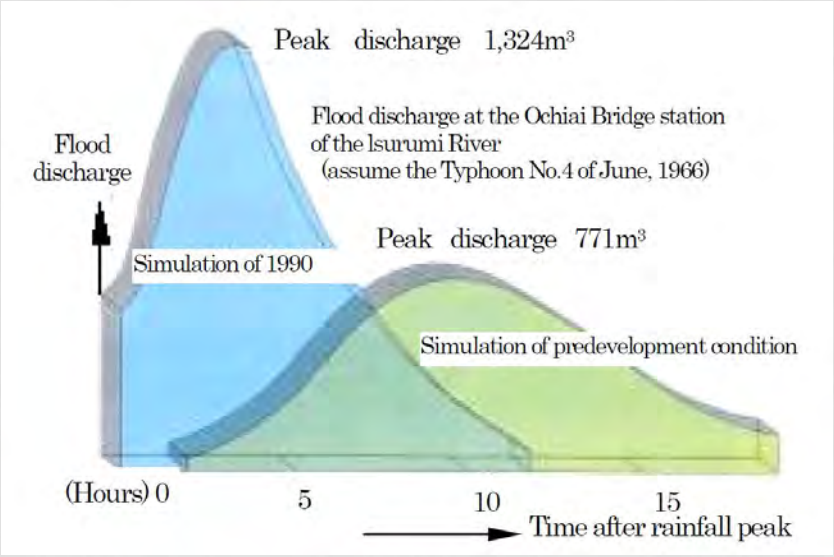


Urbanization in Tsurumi Watershed

Consequences:

- reduction of infiltration
- reduction of groundwater recharge
- increase in storm runoff

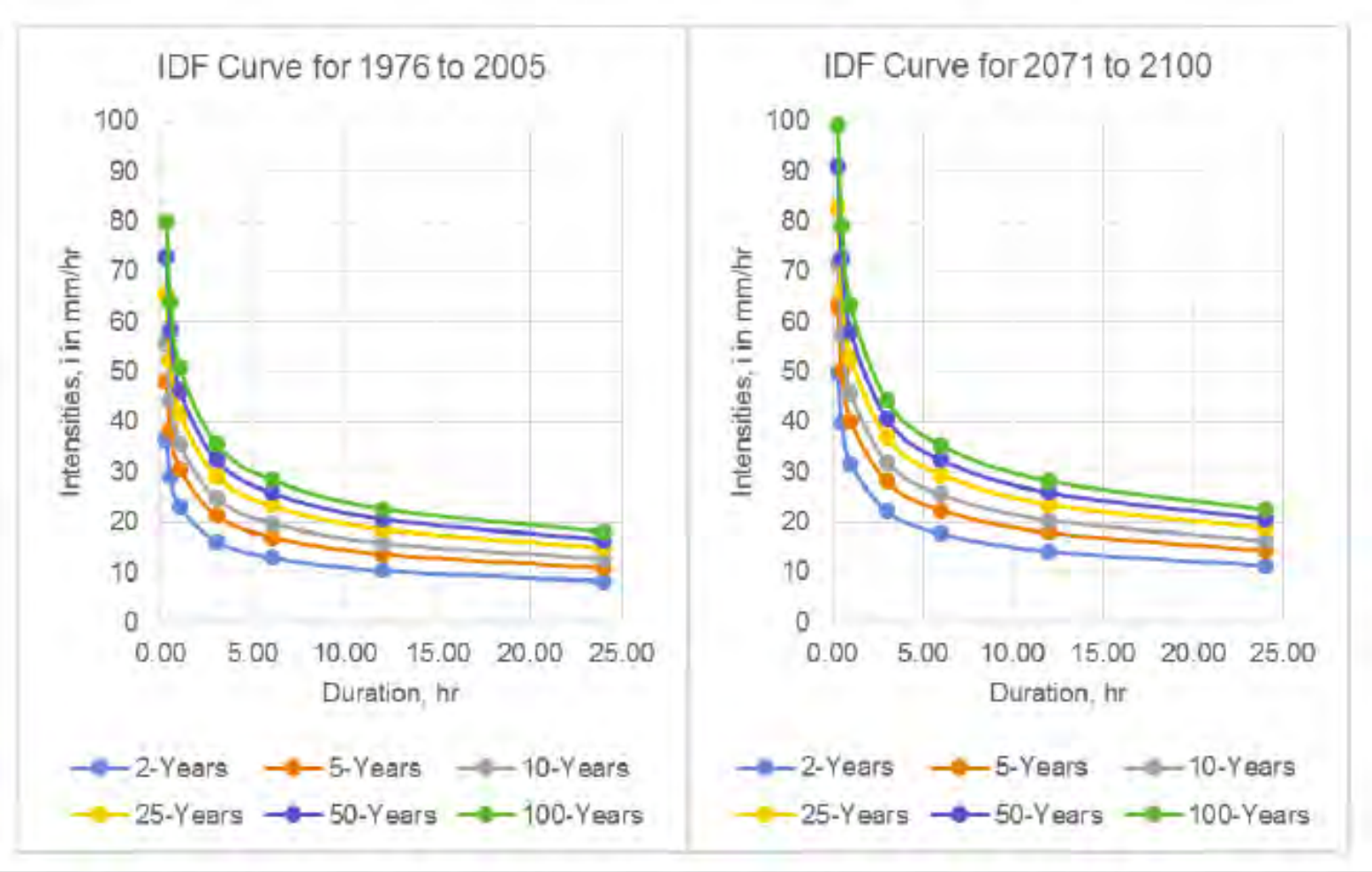
Thus,
runoff reaches its peak in shorter time;
peak runoff and runoff volume also higher



Before and after urbanization hdrograph
In Tsurumi River

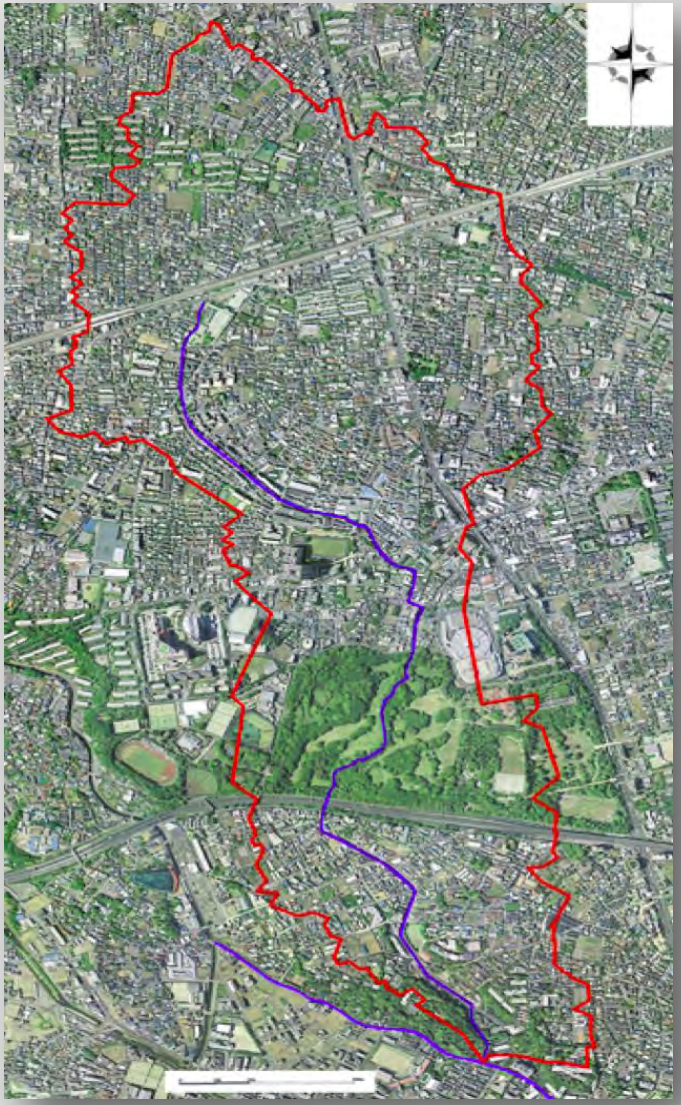
Source: MLIT, 2008

B. Climate change has changed the frequency and intensity of rainfall and consequently intensified flood damage and losses



Source: Mansoor, 2016

Study Area



Yato Watershed

- ~2.93 sq.km

- located in Setagaya ward (largest population, 2nd largest in area)

- southward flow; 3.3 km; concrete

- problems: riverine flooding; urban stormwater run-off

Kinuta Park

http://www.kensetsu.metro.tokyo.jp/kouen/kouenannai/park/english/kinuta.pdf

~ 0.39 sq.km., 0.24 sq.km grass

- facilities: baseball and soccer fields, 1,667m cycling course, bird sanctuary and the Setagaya Art Museum

- famous for cherry blossom viewing

Methodology

1. Tree Survey
   - data collection following i-tree protocol
   - data processing with i-tree eco

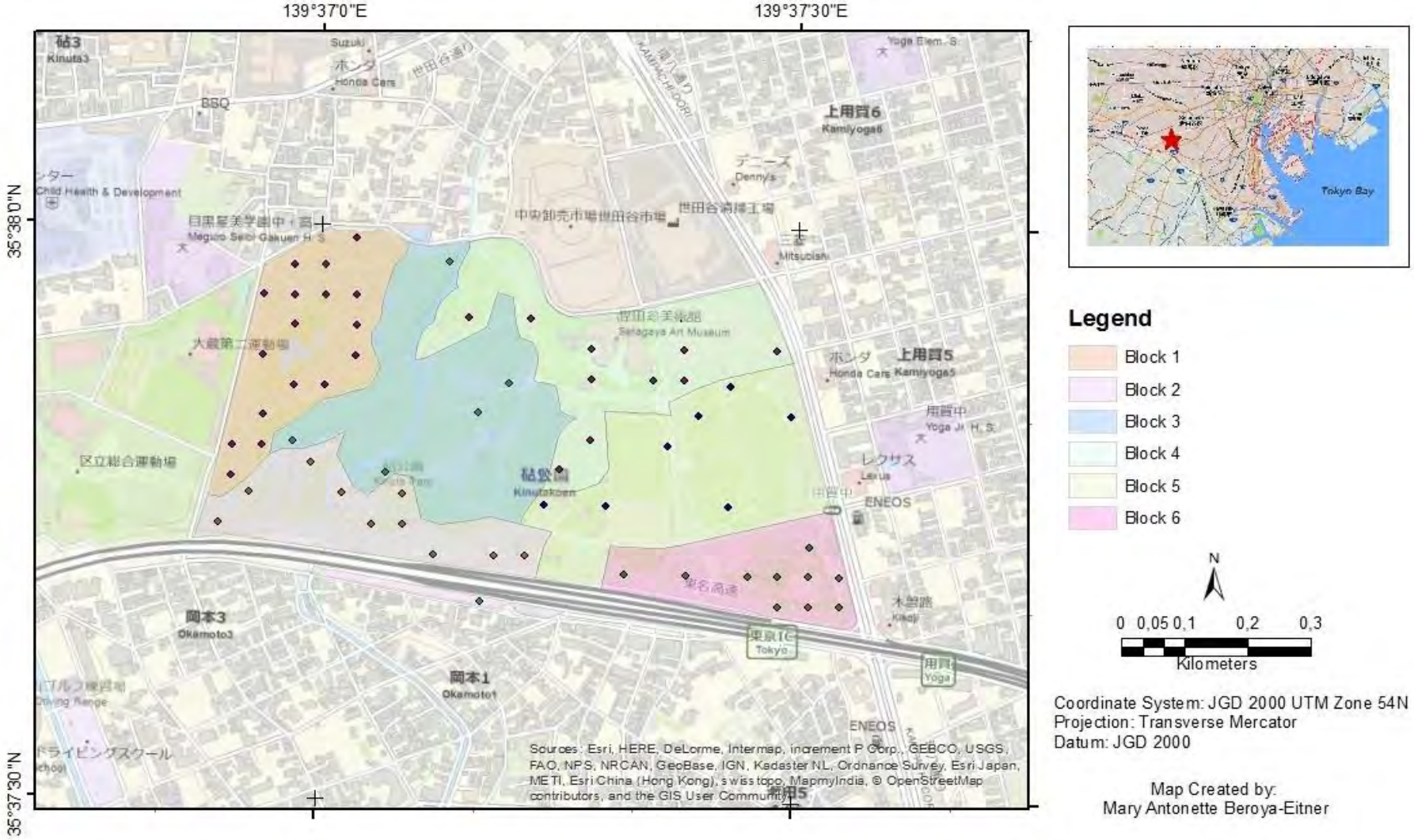
2. Hydrological Modelling (SHER Model) and GIS

3. Questionnaire Survey

4. Temperature Measurement Survey

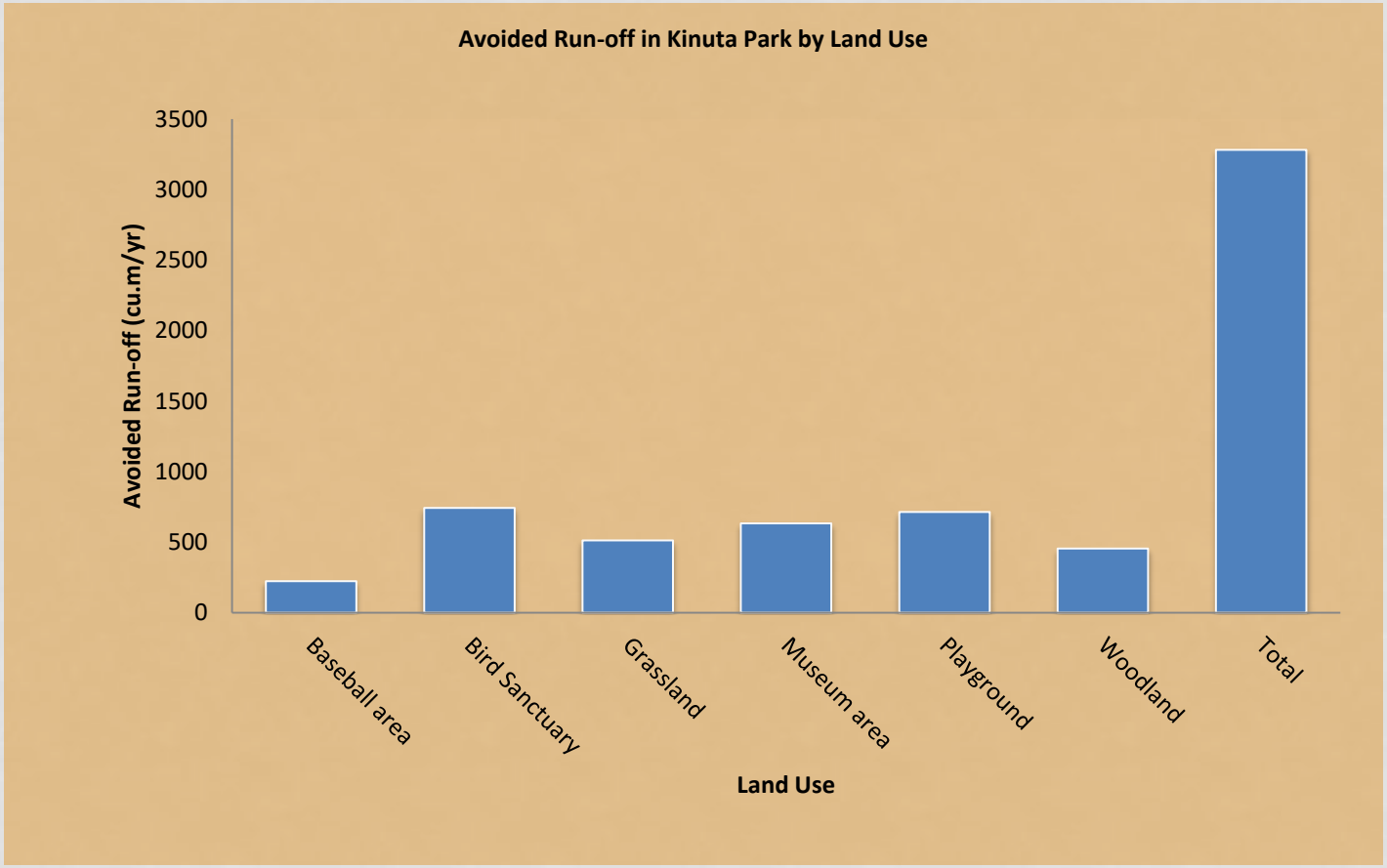
I. Tree Survey

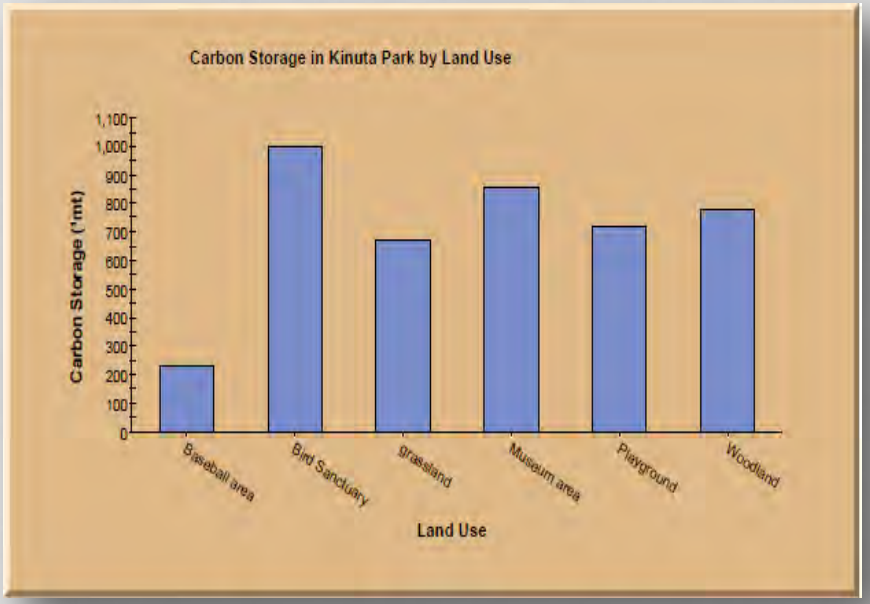
- Stratified Random Sampling
- No of plots: 60 (5% of KP)
- Plot size: 0.1 acre
- No. of trees: ~ 1000

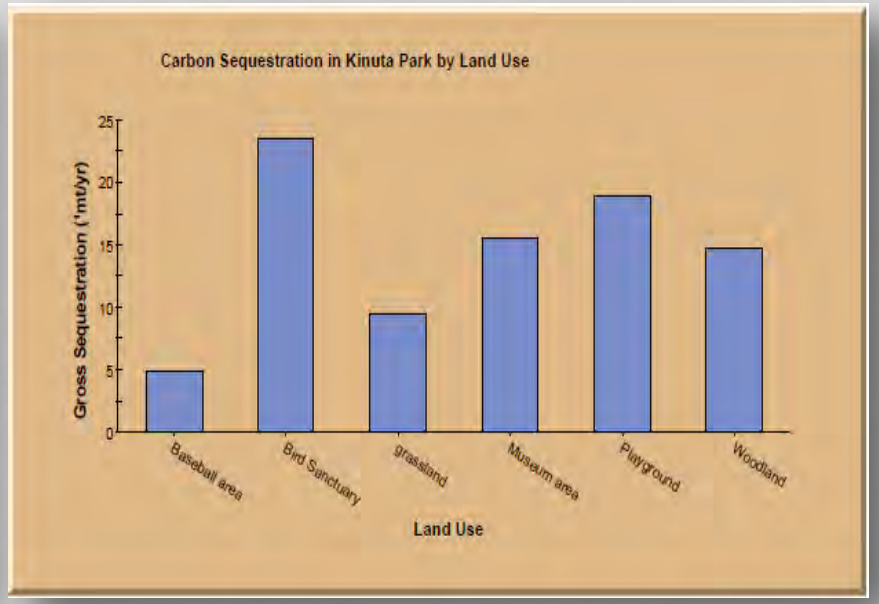


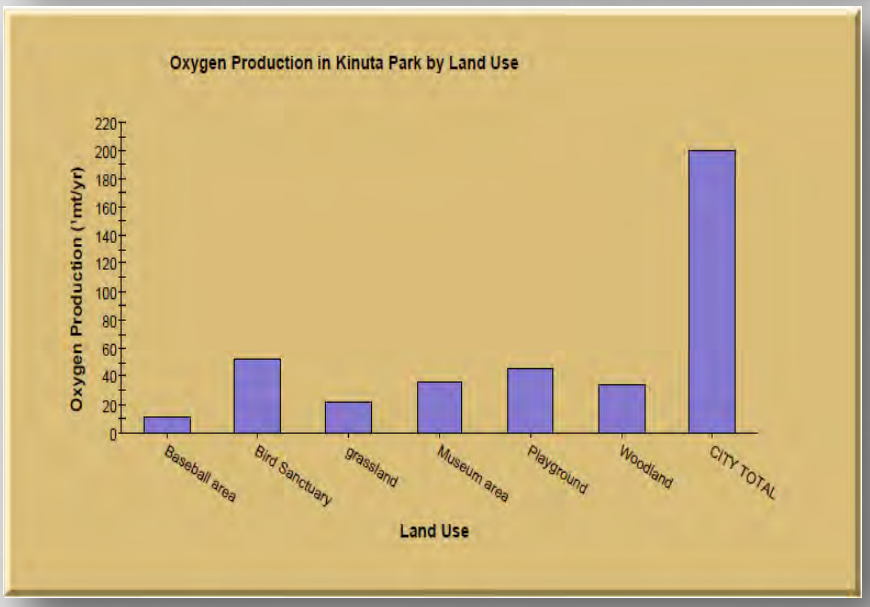
Coordinate System: JGD 2000 UTM Zone 54N
Projection: Transverse Mercator
Datum: JGD 2000

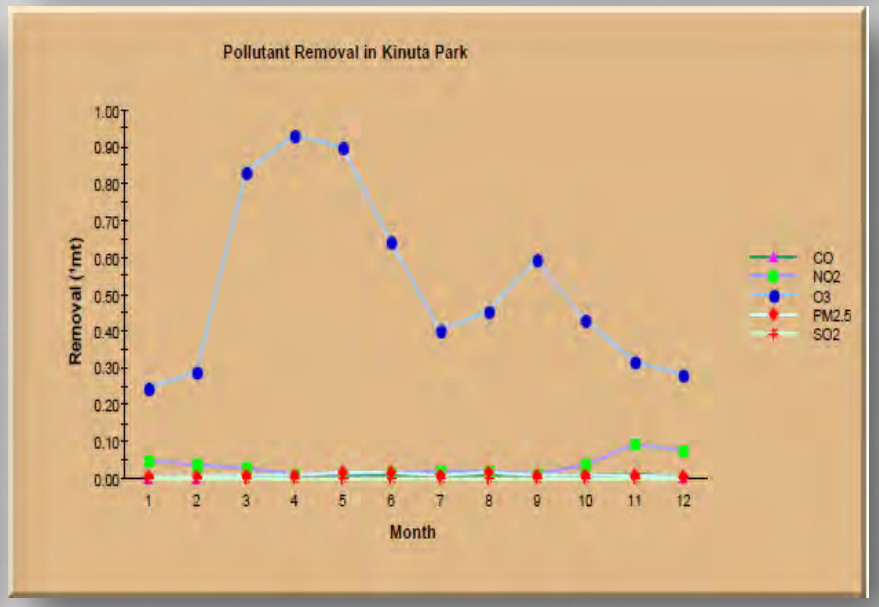
Map Created by:
Mary Antonette Beroya-Eitner


Avoided Run-off in Kinuta Park by Land Use
Avoided Run-off (cu.m/yr)
3500
3000
2500
2000
1500
1000
500
0
Baseball area
Bird Sanctuary
Grassland
Museum area
Playground
Woodland
Total
Land Use

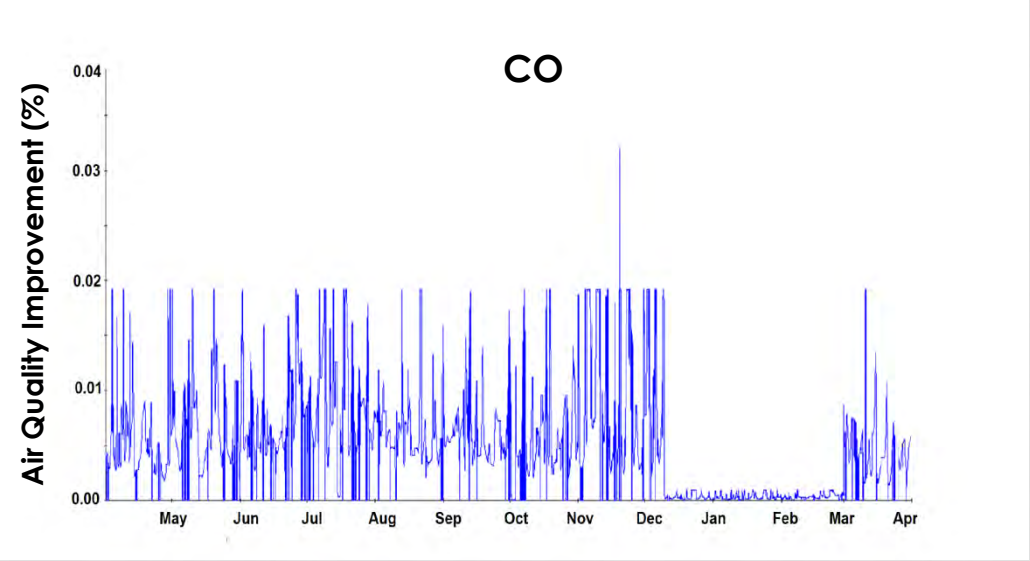

Carbon Storage in Kinuta Park by Land Use
Carbon Storage ('mt)
1,100
1,000
900
800
700
600
500
400
300
200
100
0
Baseball area
Bird Sanctuary
grassland
Museum area
Playground
Woodland
Land Use

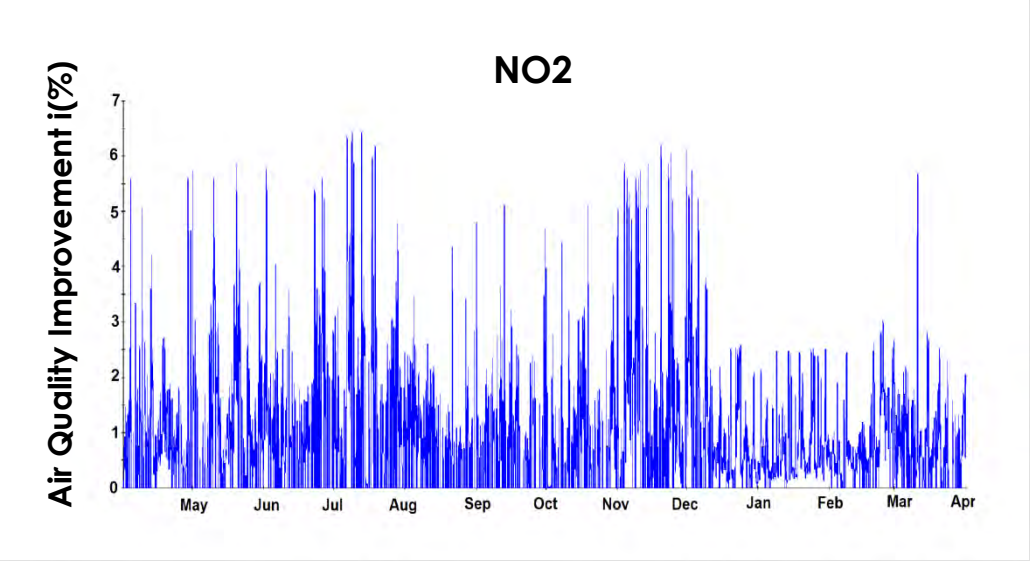

Carbon Sequestration in Kinuta Park by Land Use
Gross Sequestration ('mt/yr)
25
20
15
10
5
0
Baseball area
Bird Sanctuary
grassland
Museum area
Playground
Woodland
Land Use


Oxygen Production in Kinuta Park by Land Use
Oxygen Production ('mt/yr)
220
200
180
160
140
120
100
80
60
40
20
0
Baseball area
Bird Sanctuary
grassland
Museum area
Playground
Woodland
CITY TOTAL
Land Use

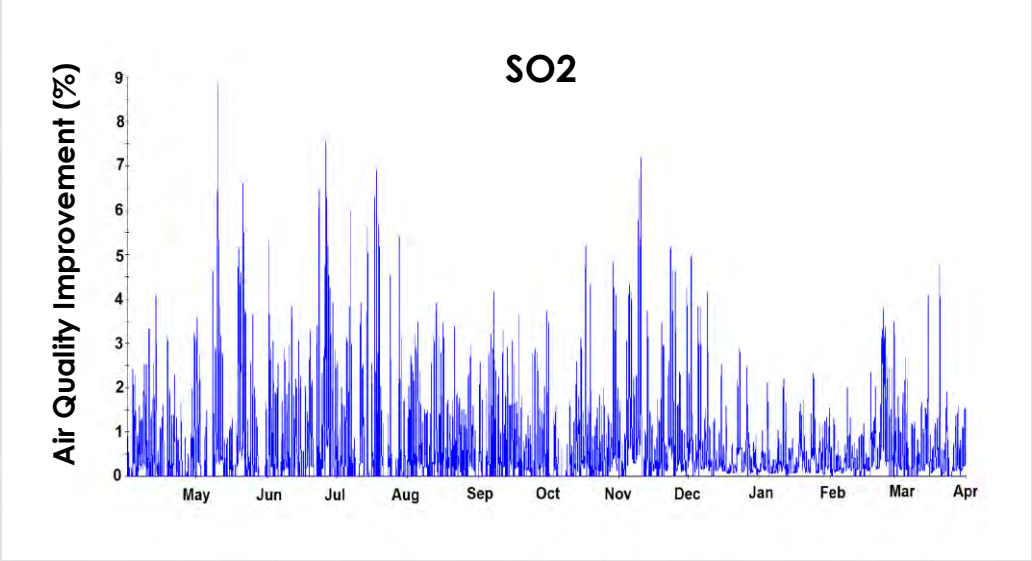

Pollutant Removal in Kinuta Park
Removal ('mt)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1
2
3
4
5
6
7
8
9
10
11
12
Month
CO
NO2
O3
PM2.5
SO2

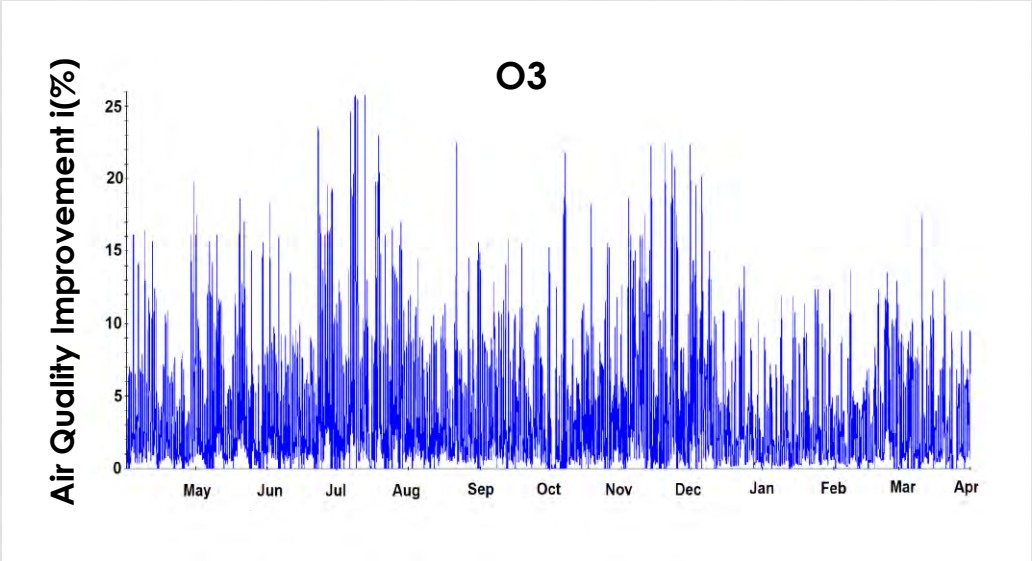
Monthly Air Quality Improvement for Total Tree Cover





Monthly Air Quality Improvement for Total Tree Cover





Summary of Tree Survey Results

1.Rainfall interception by trees are relatively small but together with ground interception (pervious cover in the park), they form a substantial amount of avoided run-off annually.

2. Carbon storage and carbon sequestration are substantial in absolute terms

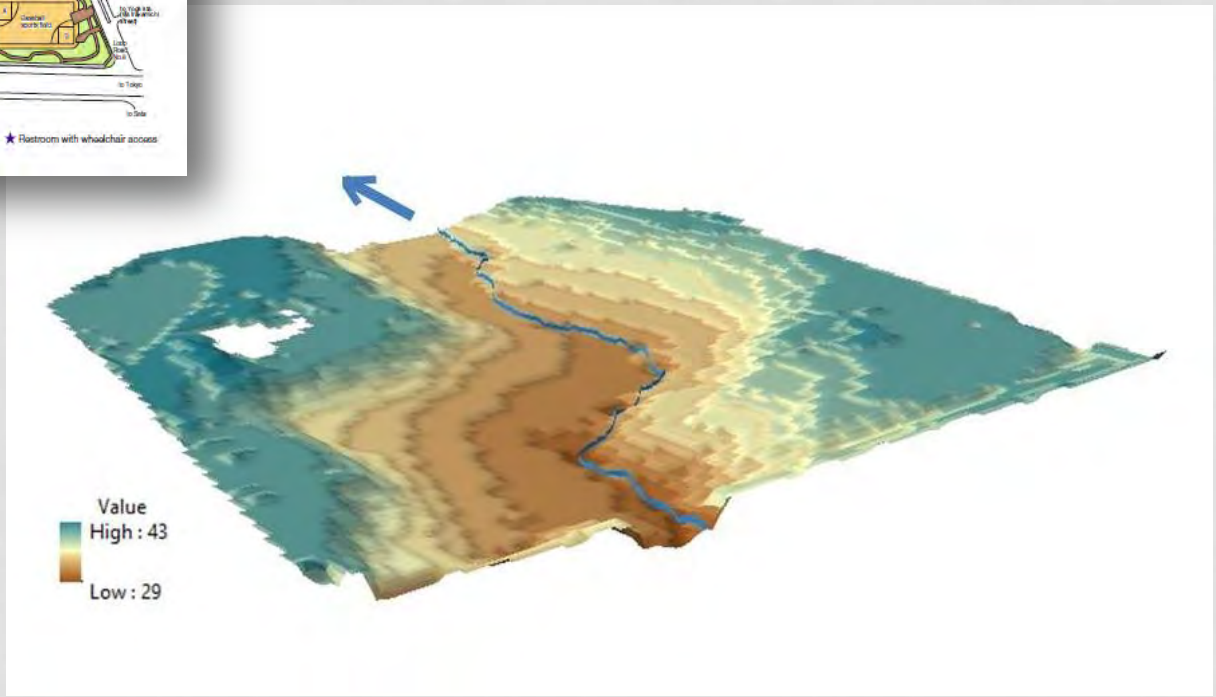
3. The park provides an important sink for tropospheric ozone (03), a major greenhouse gas, improving local air quality by as much as 25% in terms of this pollutant.

4. Carbon monoxide removal is insignificant, but considerable in terms of NO2 and SO2 removal, contributing to 9-11% improvement in local air quality.

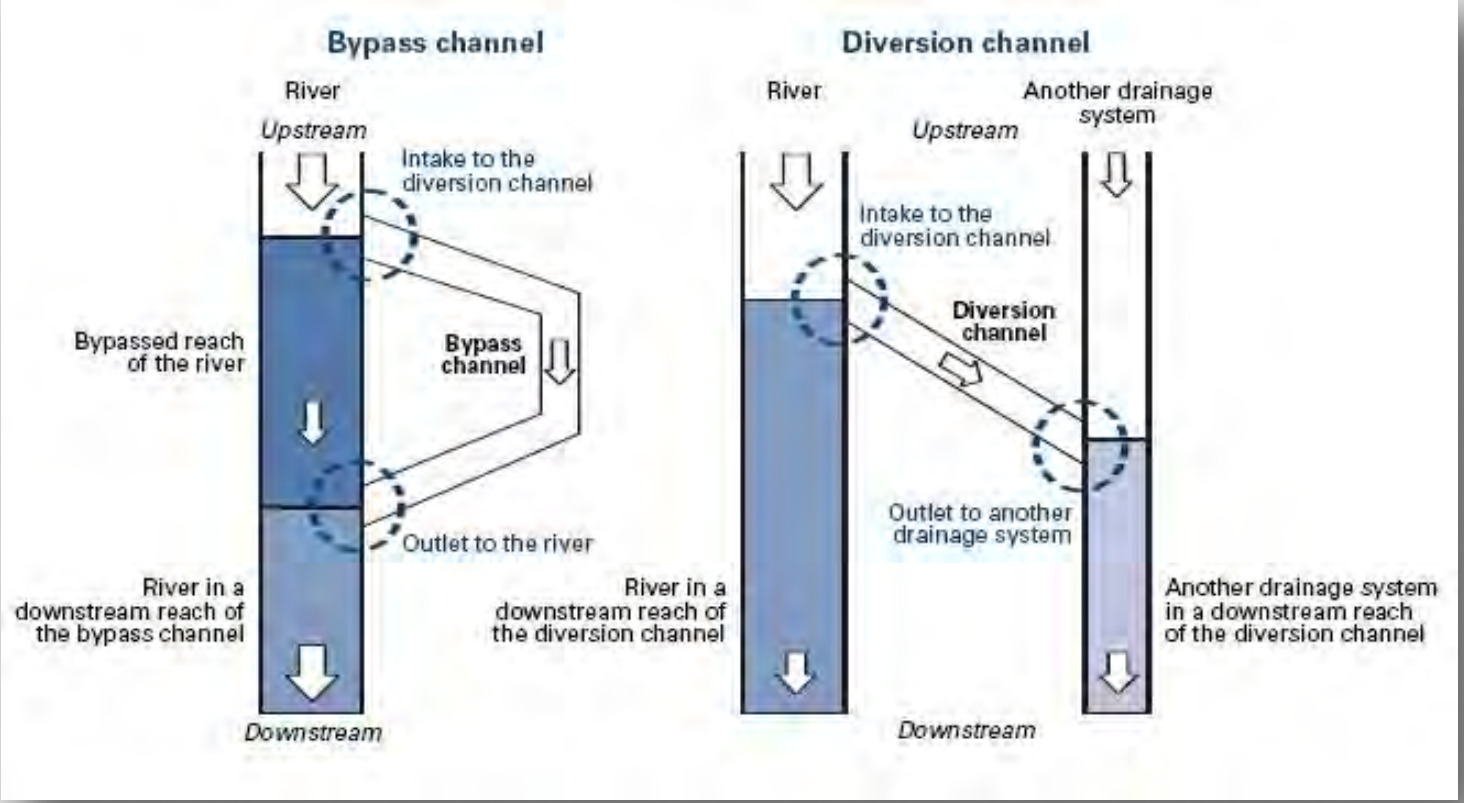
5. The park produces oxygen corresponding to the annual needs of 770 persons given an average human oxygen consumption of 0.26mT/yr.

II. Hydrological Modelling

- Kinuta Park as possible site of a bypass/detention basin



Bypass/Detention Basin



Source: http://daad.wb.tu-harburg.de

II. Hydrological Modelling

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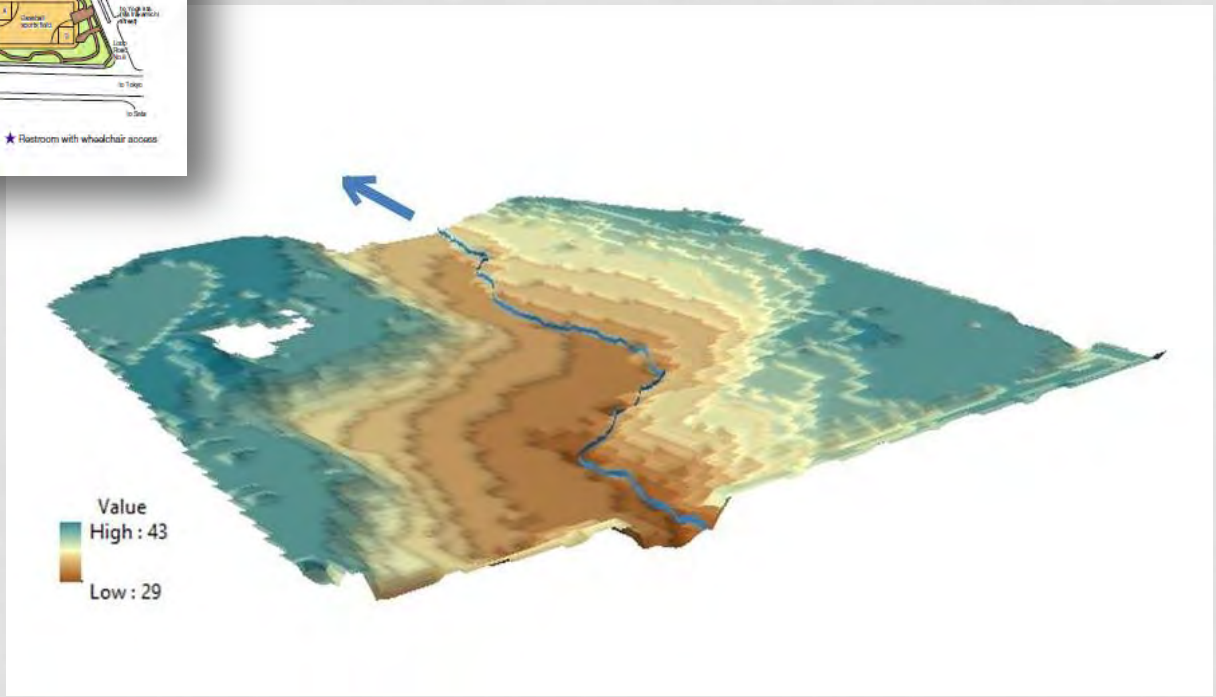
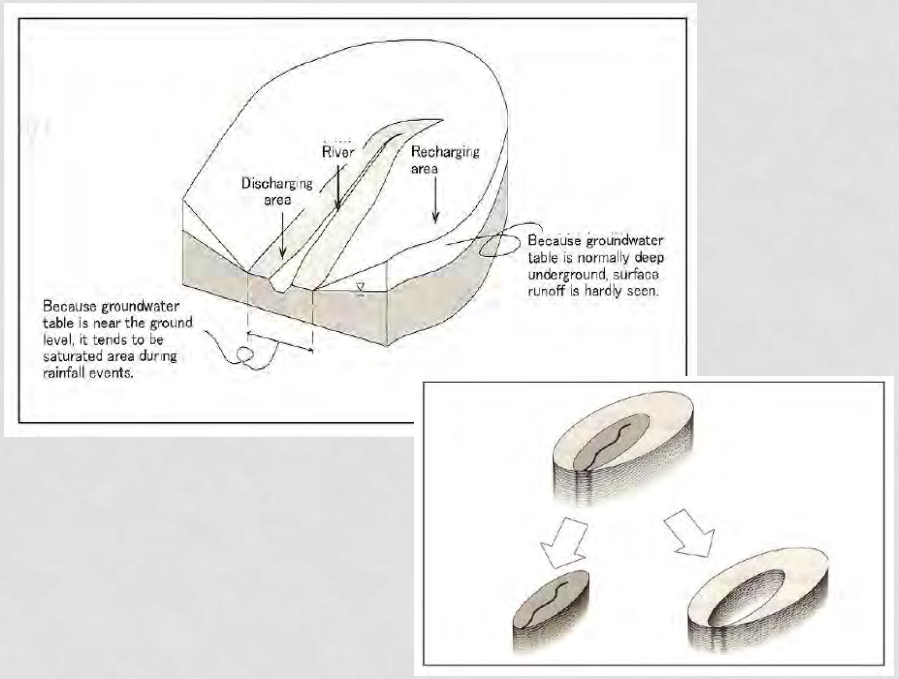
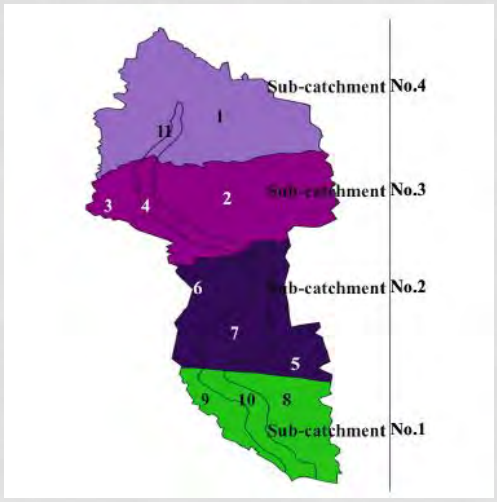


II. Hydrological Modelling

SHER (Similar Hydrologic Element Response) Model

- semi-distributed physically-based model developed by Herath and Musiake (1991) and Srikantha et al. (1992)
- used effectively in urban area where artificial water flow is significant
- has been used widely Japan
- Requires the subdivision of the catchment into sub-catchments, each of which is subdivided into discharging and recharging blocks.





Potential Bypass/Detention Basin Site

Legend

- Potential Detention Basin Site
- Yato River

N

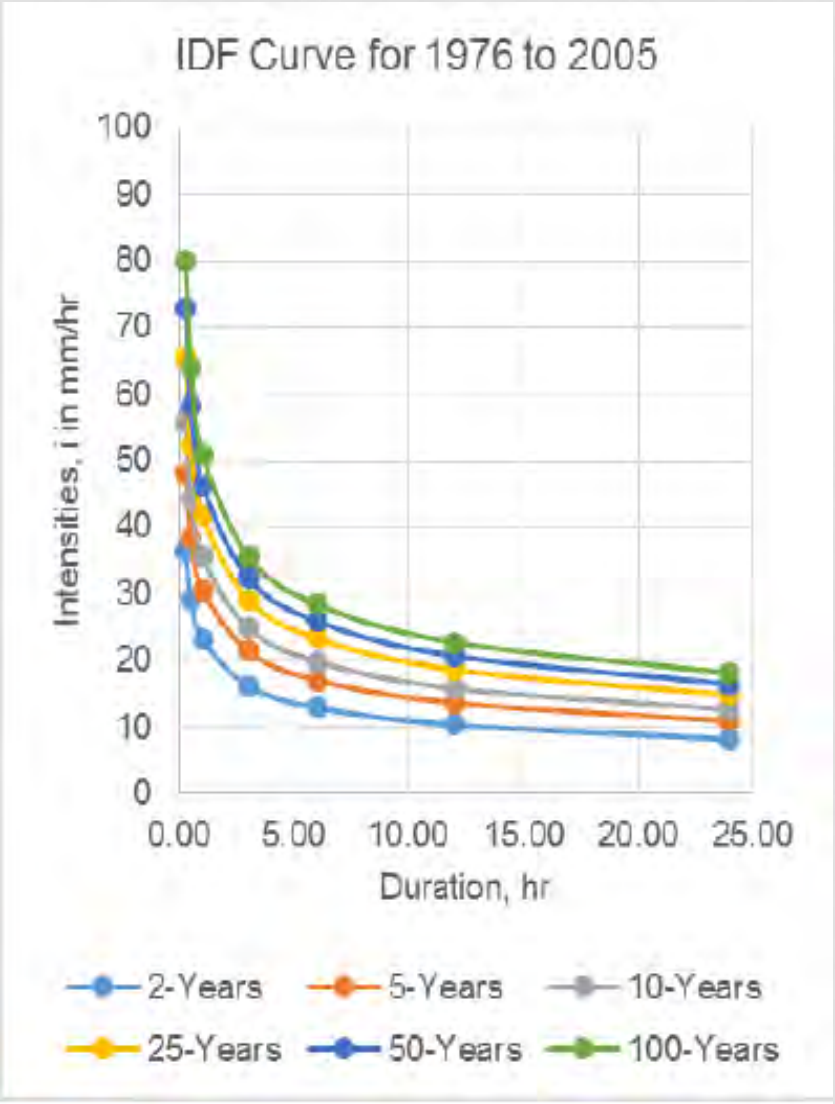
0 0,075 0,15 0,3

Kilometers

Coordinate System: JGD 2000 UTM Zone 54N
Projection: Transverse Mercator
Datum: JGD 2000

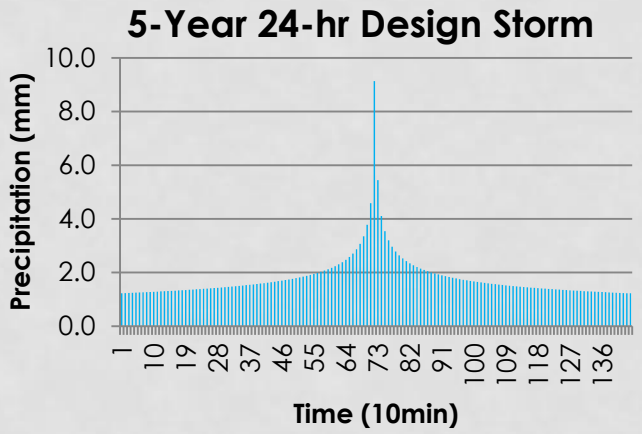
Map Created by:
Mary Antonette Beroya-Eitner

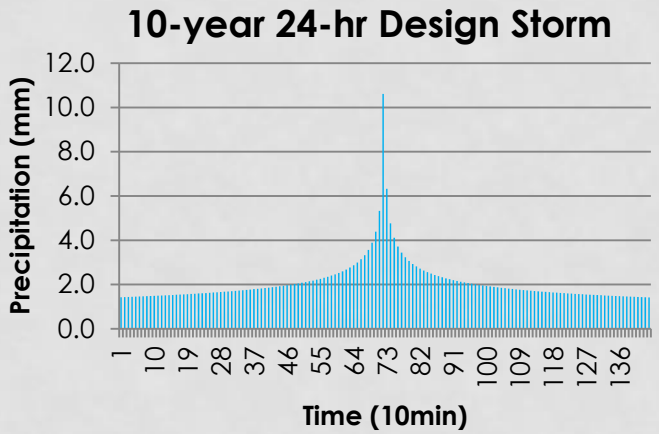
Volume : 160,530 cu.m

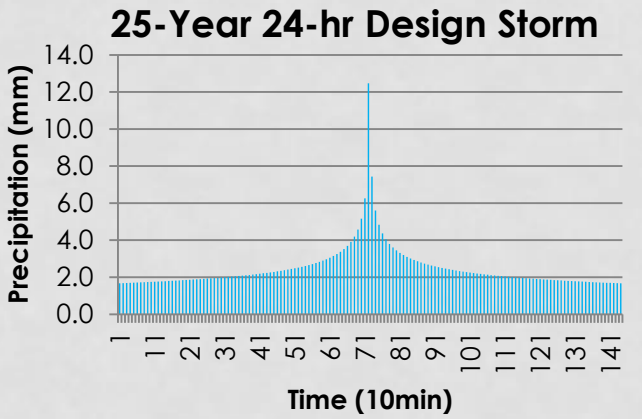


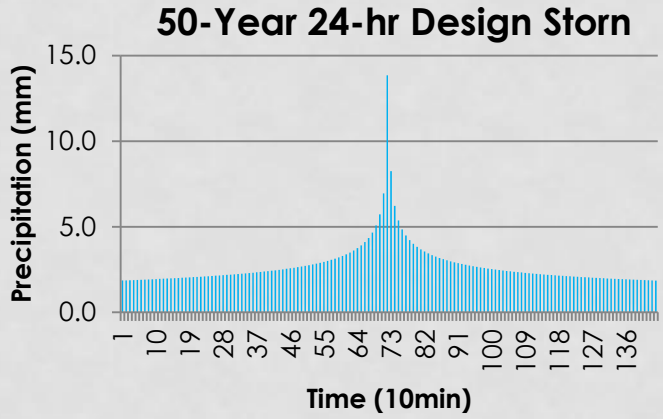
- Using the IDF curve, synthetic design hyetohgraph obtained for different return periods
- Event based modelling
- Discharge converted to volume
- Baseflow separation
- Runoff volume compared with available detention volume in KP

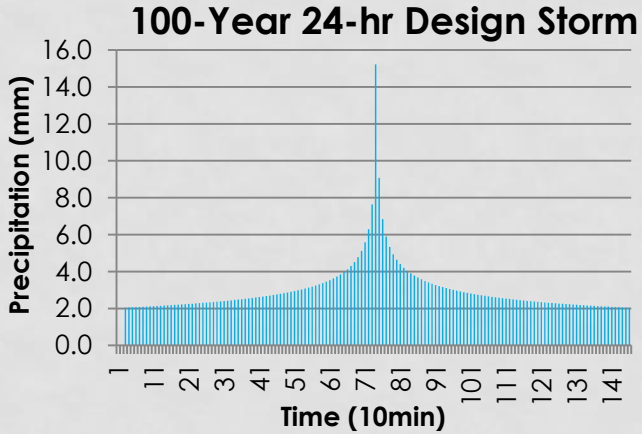
Mansoor, 2016

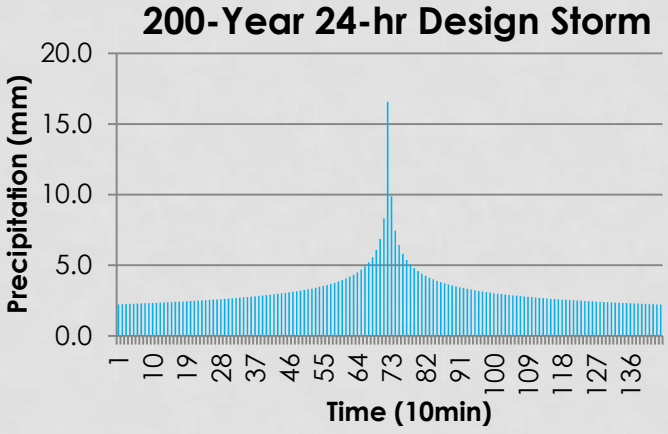

5-Year 24-hr Design Storm
Precipitation (mm)
10.0
8.0
6.0
4.0
2.0
0.0
1 10 19 28 37 46 55 64 73 82 91 100 109 118 127 136
Time (10min)


10-year 24-hr Design Storm
Precipitation (mm)
12.0
10.0
8.0
6.0
4.0
2.0
0.0
1 10 19 28 37 46 55 64 73 82 91 100 109 118 127 136
Time (10min)

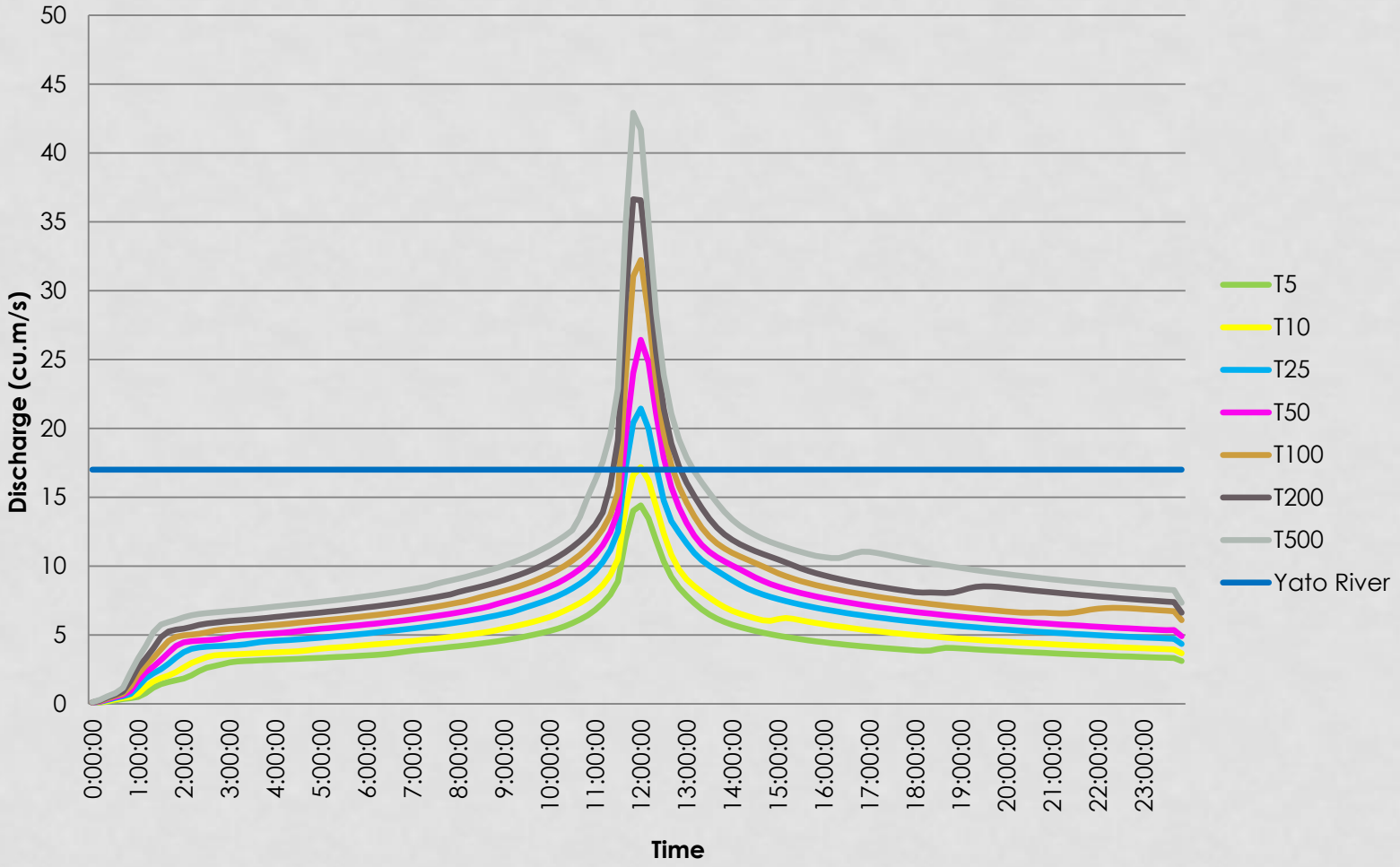

25-Year 24-hr Design Storm
Precipitation (mm)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
1 11 21 31 41 51 61 71 81 91 101 111 121 131 141
Time (10min)


50-Year 24-hr Design Storn
Precipitation (mm)
15.0
10.0
5.0
0.0
1 10 19 28 37 46 55 64 73 82 91 100 109 118 127 136
Time (10min)


100-Year 24-hr Design Storm
Precipitation (mm)
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
1 11 21 31 41 51 61 71 81 91 101 111 121 131 141
Time (10min)


200-Year 24-hr Design Storm
Precipitation (mm)
20.0
15.0
10.0
5.0
0.0
1 10 19 28 37 46 55 64 73 82 91 100 109 118 127 136
Time (10min)

Simulation Results for Different Return Periods



Summary of Hydrological Modeling Results

- Initial estimates show that the park as site for a bypass/detention basin is capable of accommodating the excess run-off from the design extreme rainfall events (i.e., 1 in 5, 10, 25, 50, 100, 200, 500, and 1000)

III. Questionnaire Survey

Why Socio-cultural values given particular focus:

1. Social dimension of urban parks technologically irreplaceable

2. Understand the role of urban parks in the lives of people in Tokyo, where the stresses of urban life are very high

3. Understand how social context and realities influence how people regard urban parks – use, function and meaning

Specific Research Questions:

1. What is the use of parks to the people?

2. What meaning do they derive from their experience of park?

3. What are the factors influencing such use and meaning?

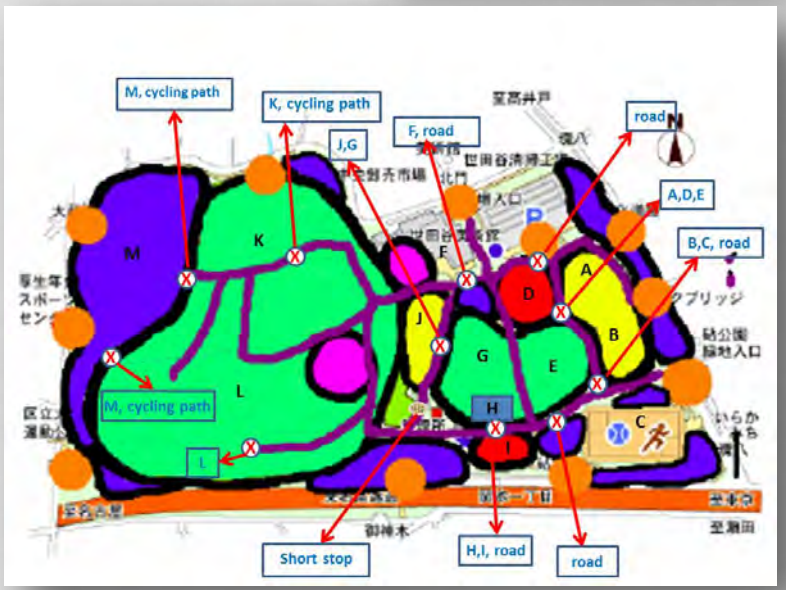
Methodology

I. Survey by Questionnaire Method

- Selection criteria: ≥ 16 yrs old; living in Japan
- 1 whole week at diff. hours of the day
- No. of respondents: 387 (85%),
- Statistical analysis in R
- Responses Format: closed (dichotomous, multiple choices) or in ranking scale

II. Visual Survey

- Direct observation of human activities in the park;
- Designated route

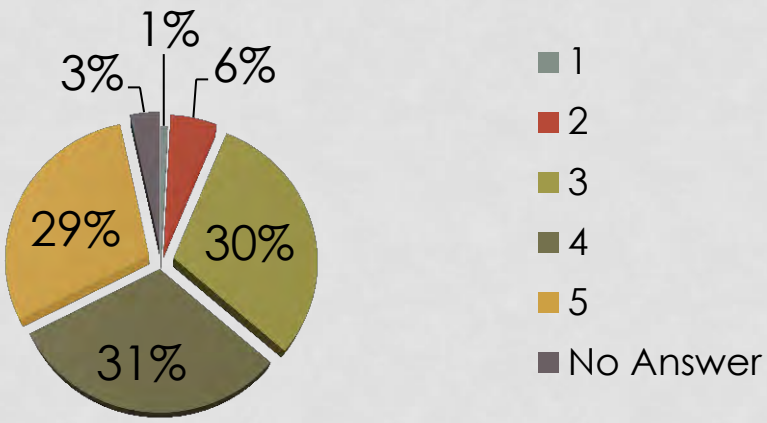


1. Use of Park

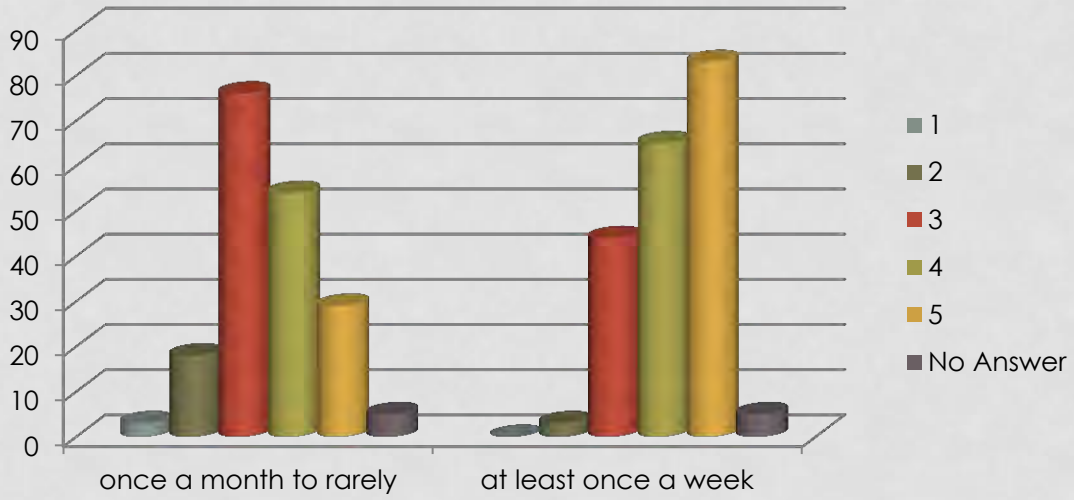
Frequency of Visit

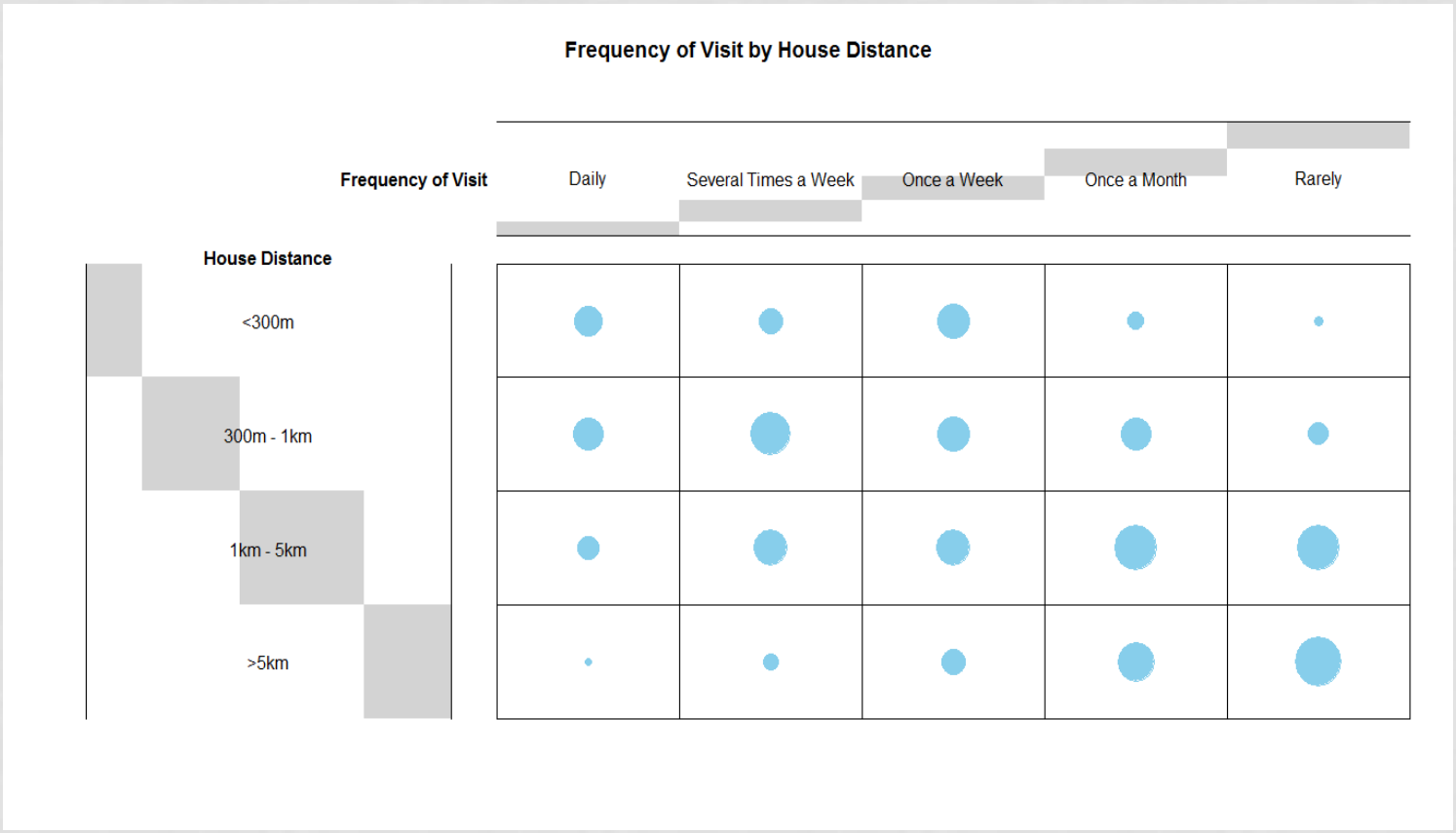
At least once a week – 51%, 12% daily users
Once a month - 24%
Rarely – 24%

Park Visit Contribution to General Well-Being



* On the scale of 1-5: with 1 as not important and 5 as very important




Frequency of Visit by House Distance
Frequency of Visit
Daily
Several Times a Week
Once a Week
Once a Month
Rarely
House Distance
<300m
300m - 1km
1km - 5km
>5km

Summary of Questionnaire Survey Results

1. The role of urban parks in Japan mainly lies in providing the following:

   – place for people's interaction with the nonhuman environment

   – disaster prevention zone

   – place for the environmental education especially of children

   – place of refuge for people in their old age.

2. Context-specificity of park use and meaning

   – non-relationship between the frequency of visit and self-evaluated health - Japanese generally live a long and healthy life

   – greater number of males engaged in exercise/sports and the greater number of females bringing their kids in the park, reflective of the gender roles in the country;

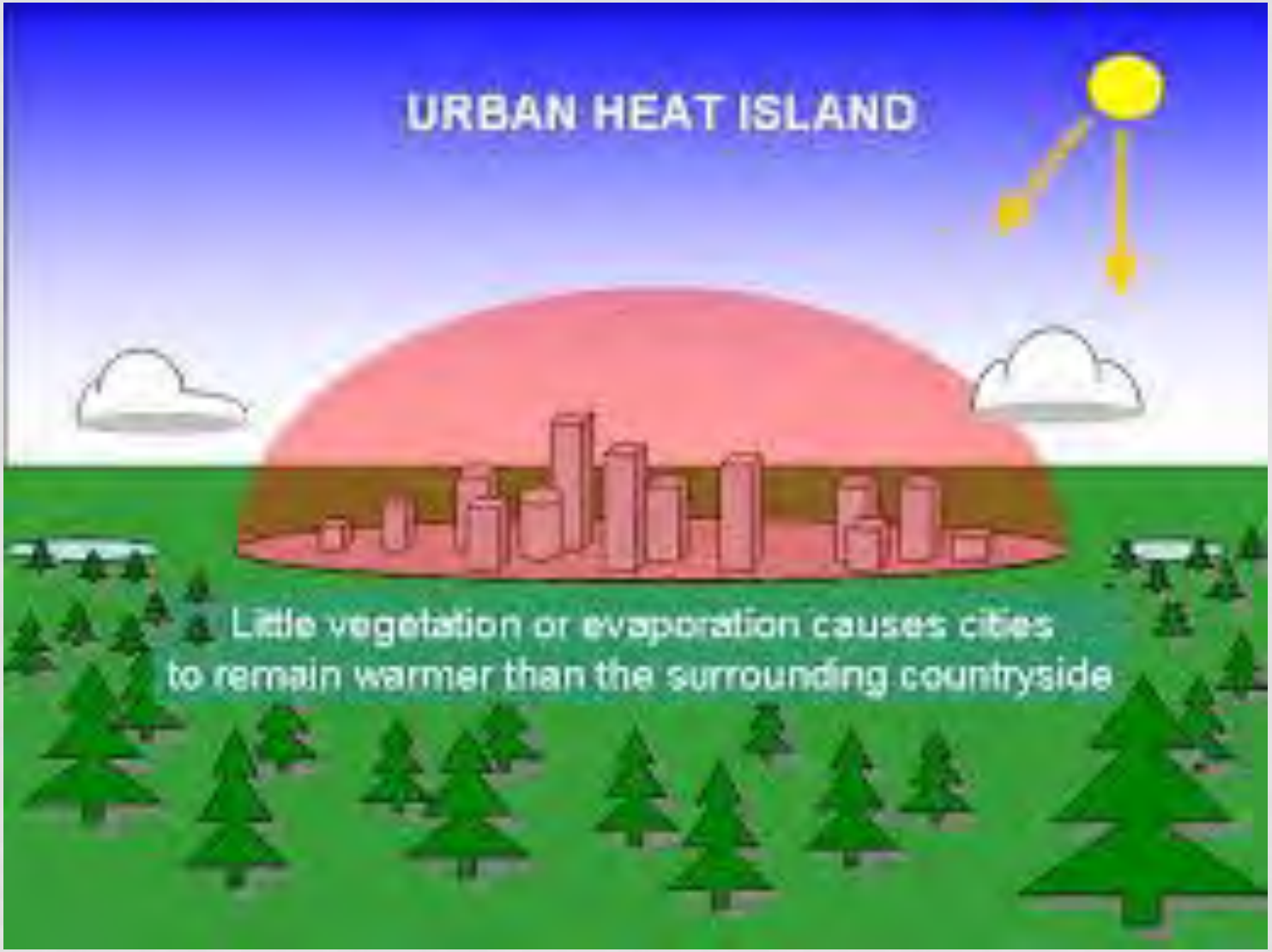
   – identification of suicide as a negative effect of the park, indicative of the extent and depth of suicide problem in the country

3. Some background variables and specific park-related factors affect park use and meaning

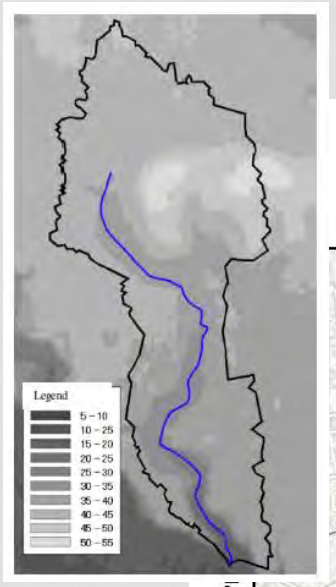
IV. Temperature Measurement Survey

- Series of temperature measurements to assess Heat Island Effect reduction

- Simultaneous and continuous measurement



http://www.weatherquestions.com



Legend

- A — Survey Station
- WS — Weather Station

N

0 0.25 0.5 1 1.5 2

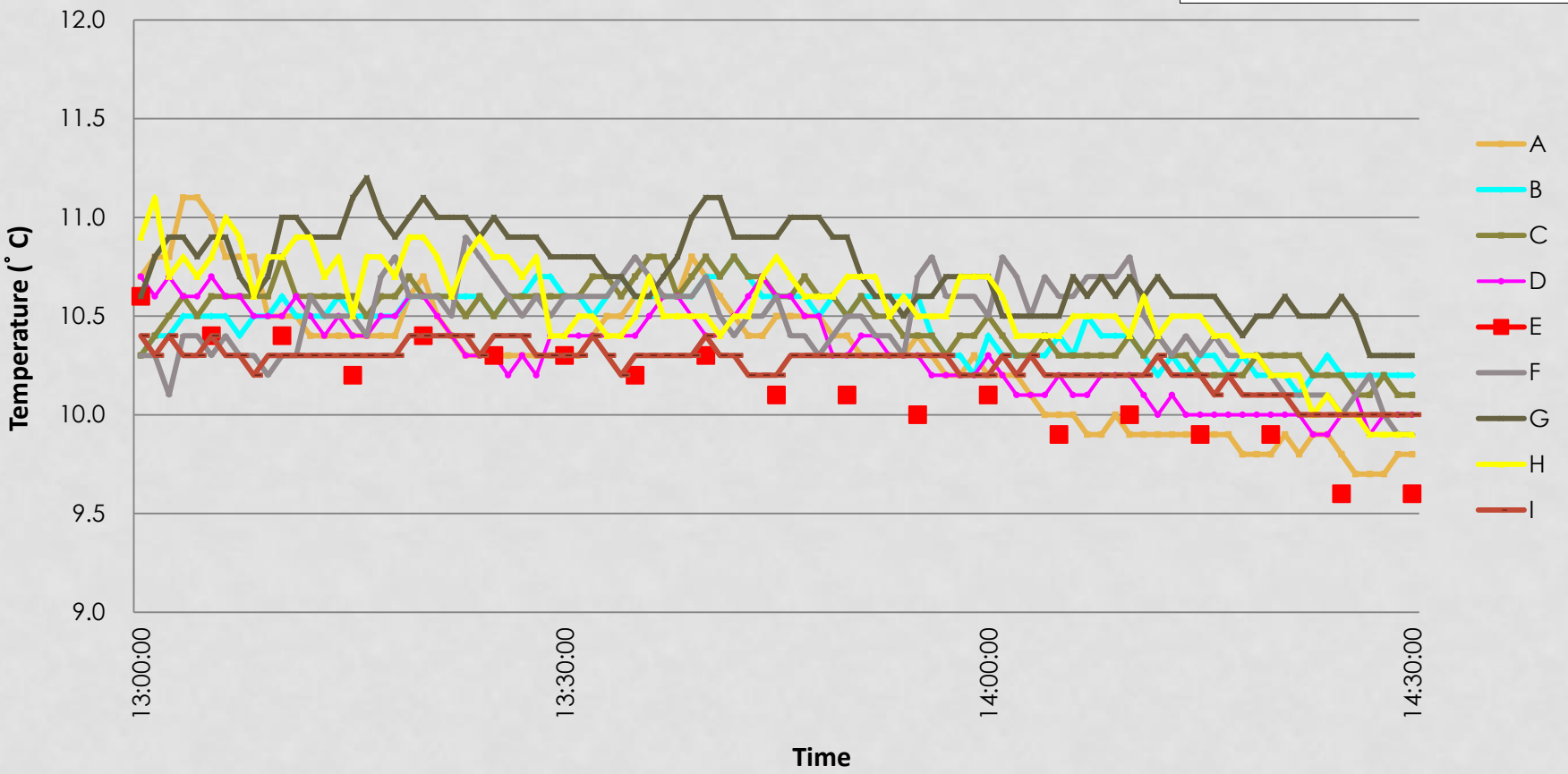
Kilometers

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree

Map Created by:
Mary Antonette Beroya-Eitner

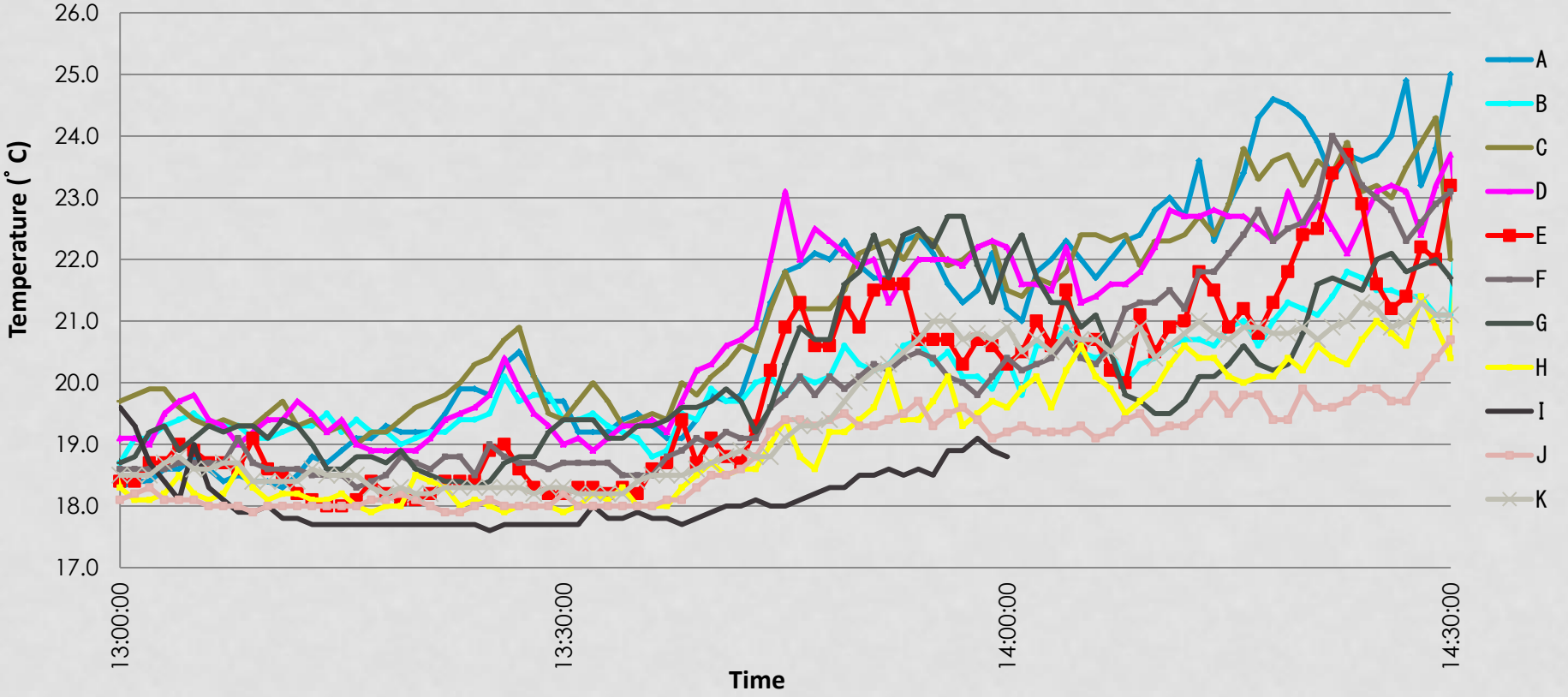
13December Temperature Survey Results

	Wind	
	Speed	Direction
13:00	0.4	W
14:00	0	W
15:00	0	W



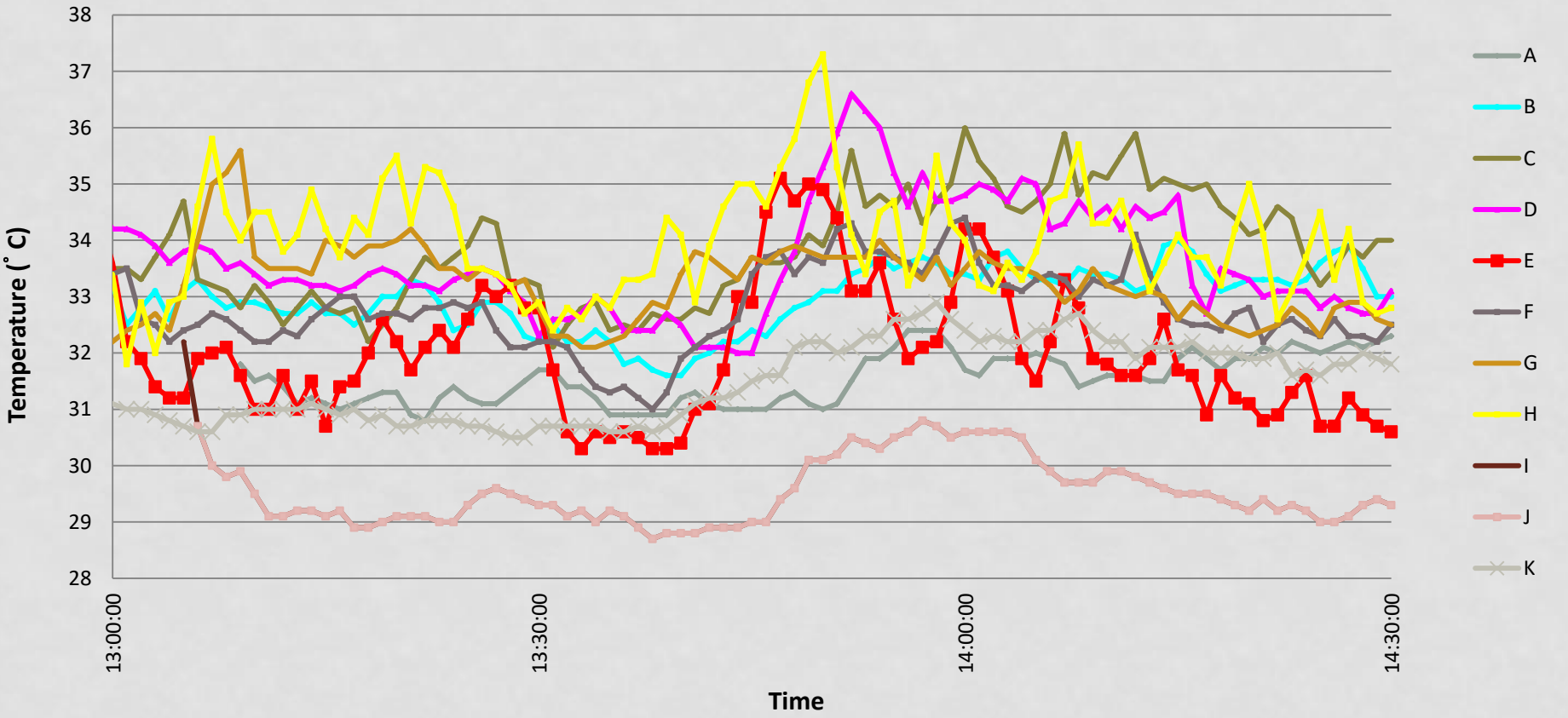
13April Temperature Survey Results

	Wind	
	Speed	Direction
13:00	0.9	S
14:00	0.9	SW
15:00	1.3	SSE



3August Temperature Survey Results

	Wind	
	Speed	Direction
13:00	0.4	SE
14:00	0.4	SE
15:00	0.9	SSW



Summary of Temperature Survey Results

- Heat Island Effect mitigation role is confirmed and shown to be most pronounced in summer; difference in temperature ~ 2-3 deg Celsius

- Elevation and wind important considerations

Concluding Remarks

- Clear link between ecosystem services and several components of human well being per MEA definition
- For the attainment of SDG goals, need for a thorough appraisal and mapping of ecosystem services -
- Value of ES usually hidden; need to make it explicit to make informed decisions about management of natural capital