RESILIENCE AS A FRAMEWORK FOR SUSTAINABILITY

Cities of the Future, resilience and sustainability

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THREE RECOMMENDATIONS

1. Leverage seismic resilience achievements to create city-wide resilience and sustainability
2. Plan for all kinds of change – sudden and long-term, residual risk and “Black Swan” events
3. Add city-wide resilience criteria to all planning and capital investments

OUTLINE

1. Cities of the Future must adapt
2. Uncertainty is high
3. Shift to incremental investments with a portfolio of options
4. Plan for resilience - both growth and disturbance
5. Learn from good examples and create more
6. Can we create a city that is resilient to all kinds of change?
7. Recommendations

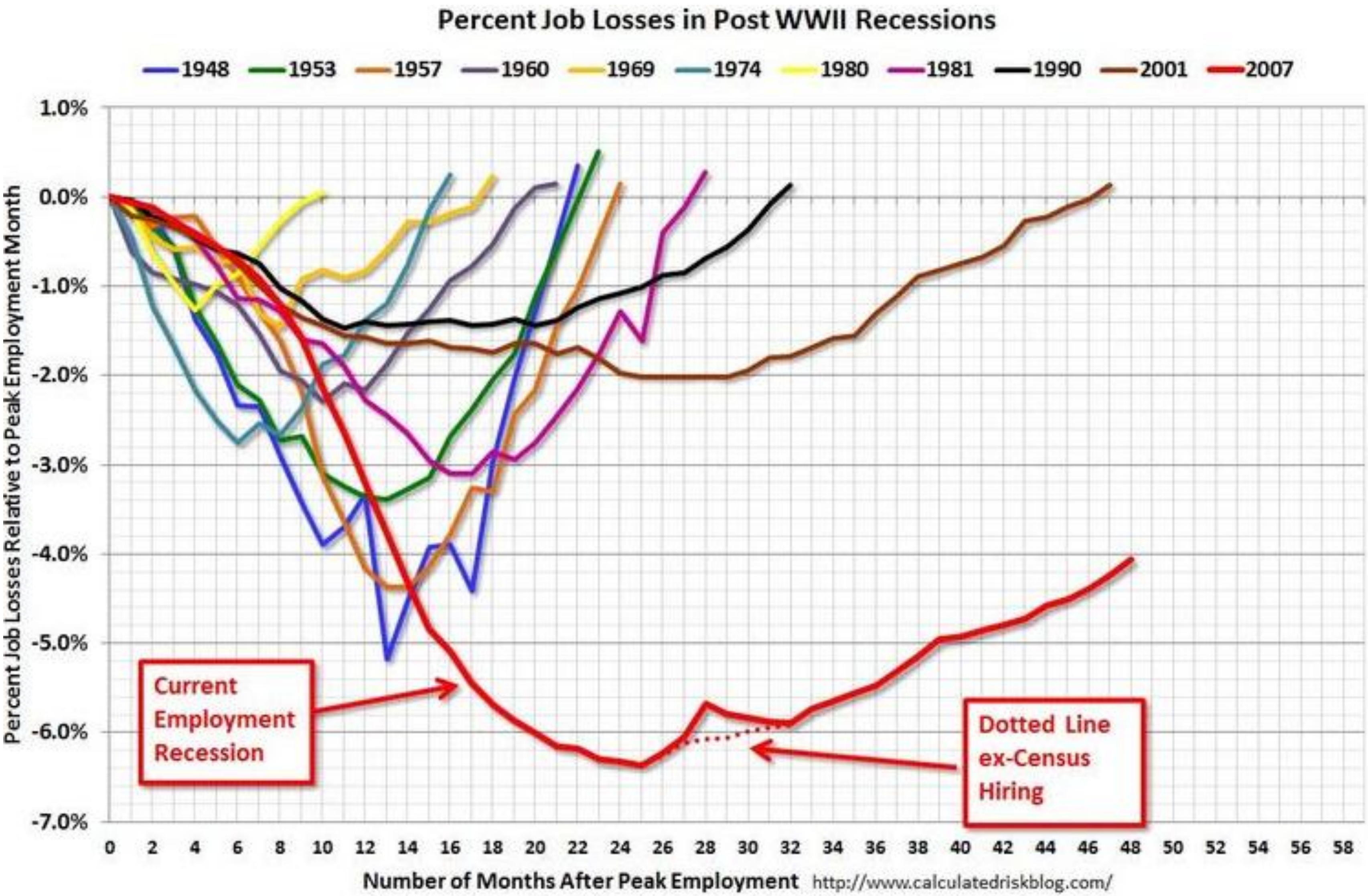
1. CITIES OF THE FUTURE

- The world has changed
  - Economic “reset”
  - Urbanization and growth
  - Climate change
  - Energy costs
  - Infrastructure costs
- Need to
  - Stop building brittle infrastructure
  - Start building adaptable and resilient infrastructure at multiple scales
  - Leverage current spending to create more value
  - Be strategic with our long range planning for land use, development and capital spending for infrastructure.

800,000

New people last week.
This week.
Next week.
Every week for the next 4 decades.

ECONOMIC RESET



DOES CLIMATE CHANGE = END OF RELIABILITY?

- Reliability is the standard that we use to design roads, bridges, water supply systems, wastewater systems, stormwater systems
- Reliability is based on the historic weather record
- Climate scientists tell us that the uncertainty of future weather is greater than ever before

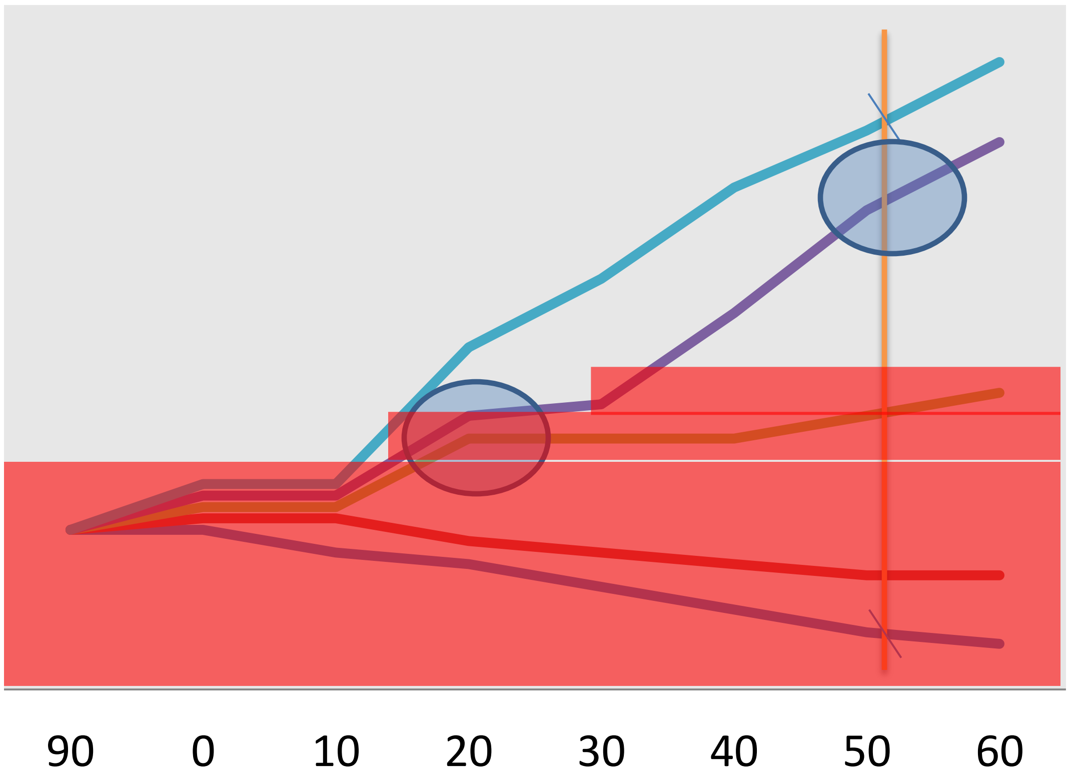
2. UNCERTAINTY

- Uncertainty is higher than we admit or recognize

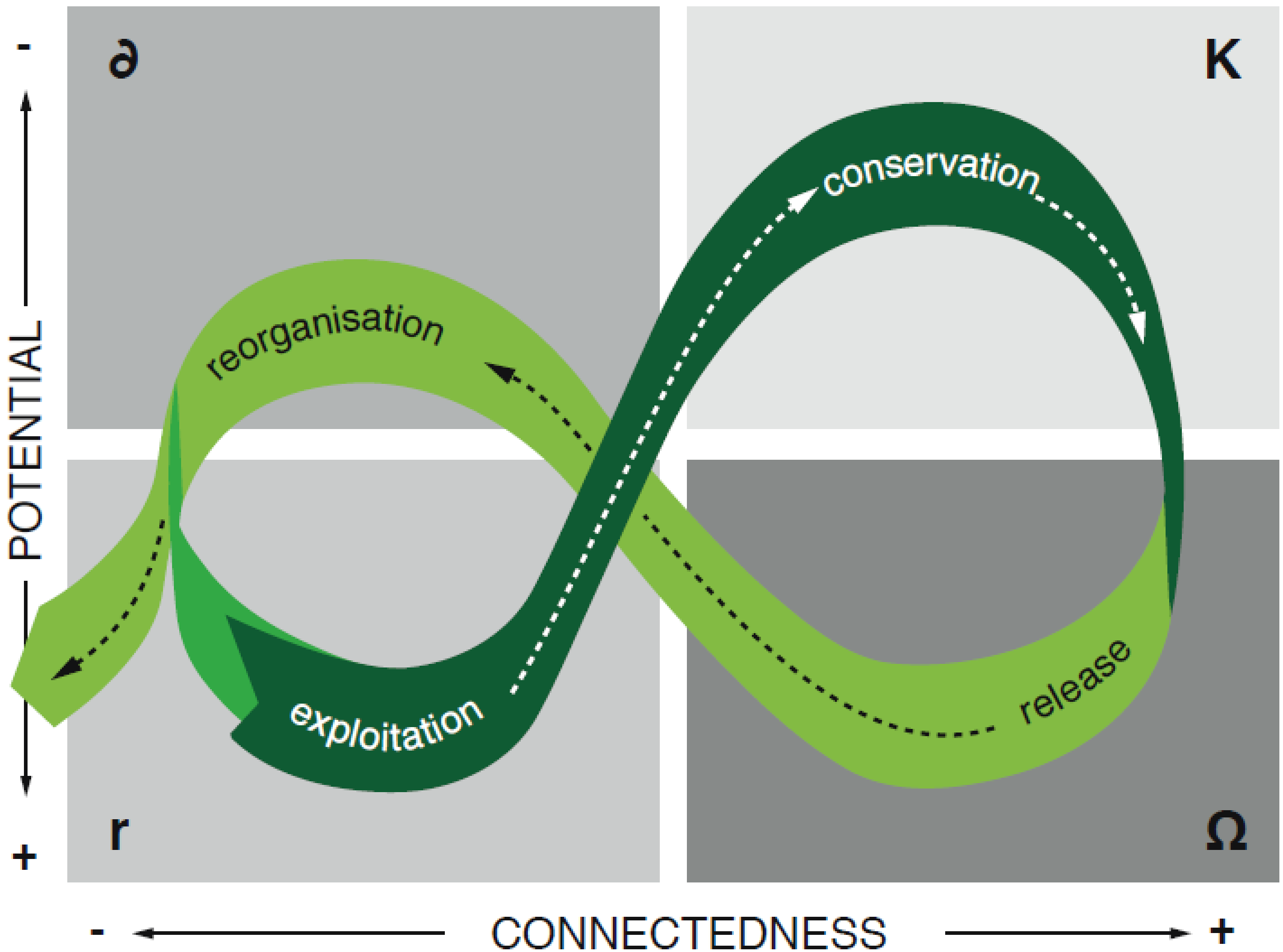
3. INCREMENTAL INVESTMENTS

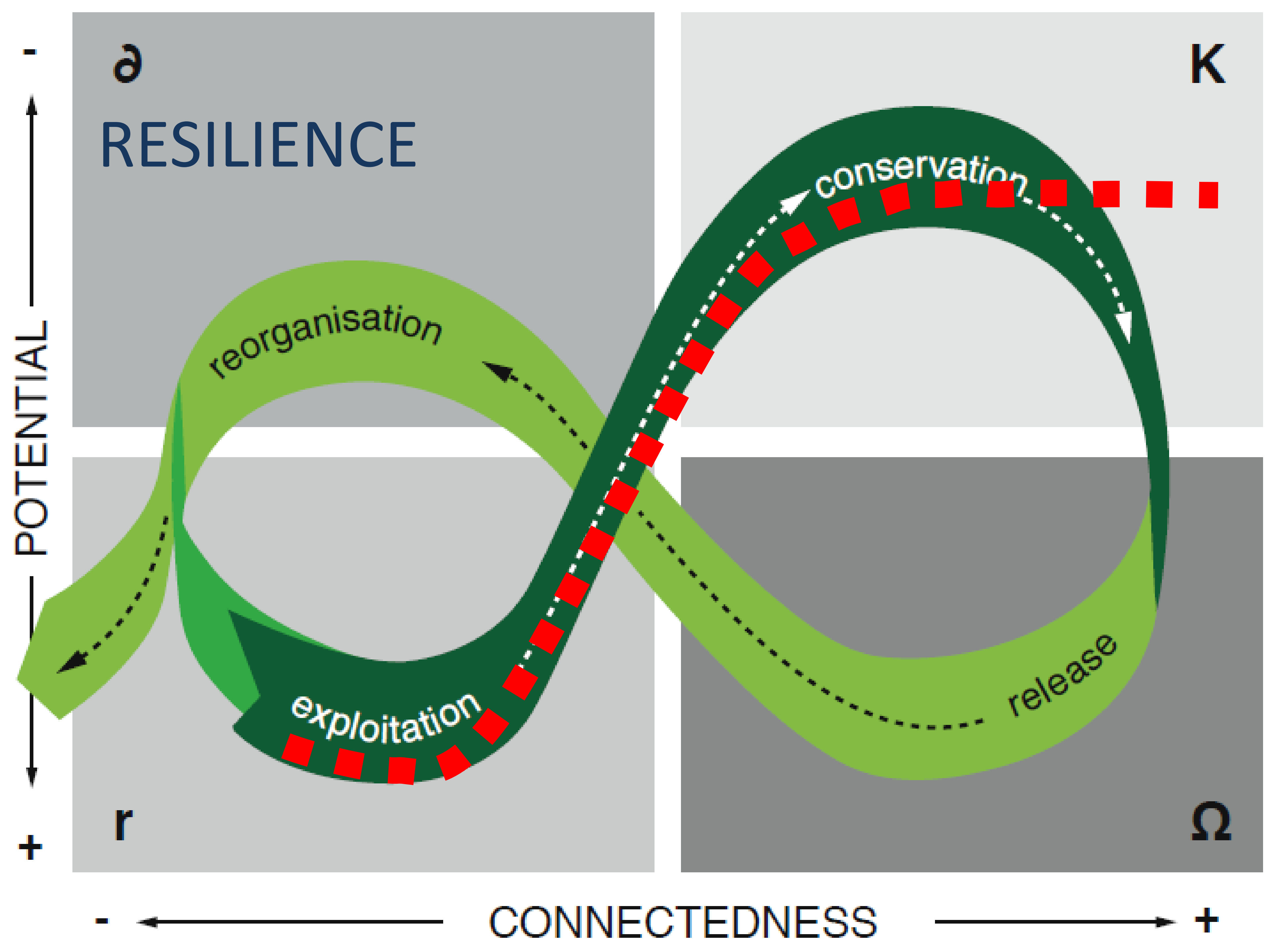
- When the range of possible futures is broad, make incremental investments that create flexibility and adaptability

Plausible worst case scenario

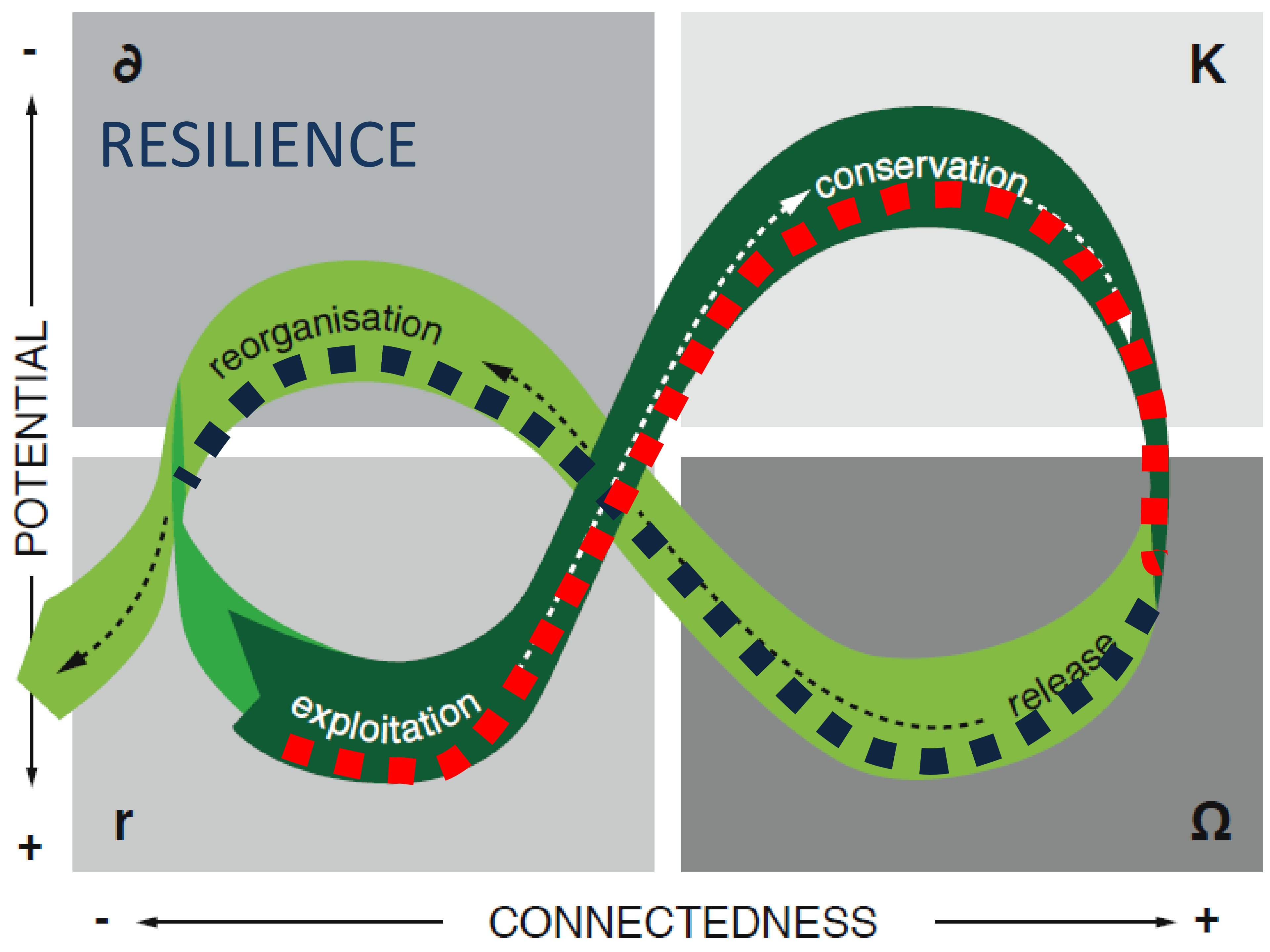


4. RESILIENCE IS BOTH GROWTH AND DISTURBANCE





-
∂
RESILIENCE
K
conservation
reorganisation
POTENTIAL
exploitation
release
r
Ω
+
-
CONNECTEDNESS
+



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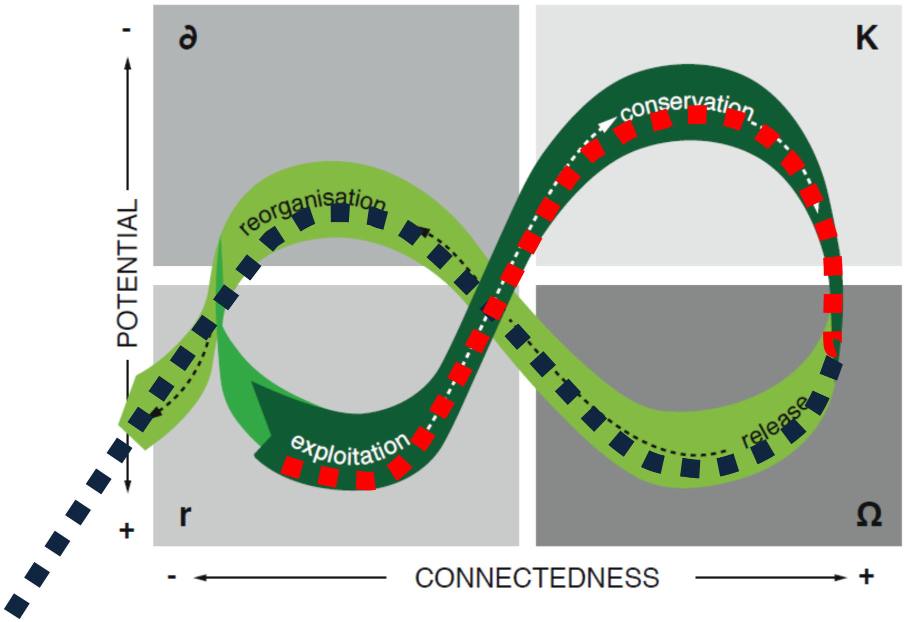
THE MEASURE OF RESILIENCE?

How quickly a system recovers

- Sometimes systems never recover and shift into a new "steady state"



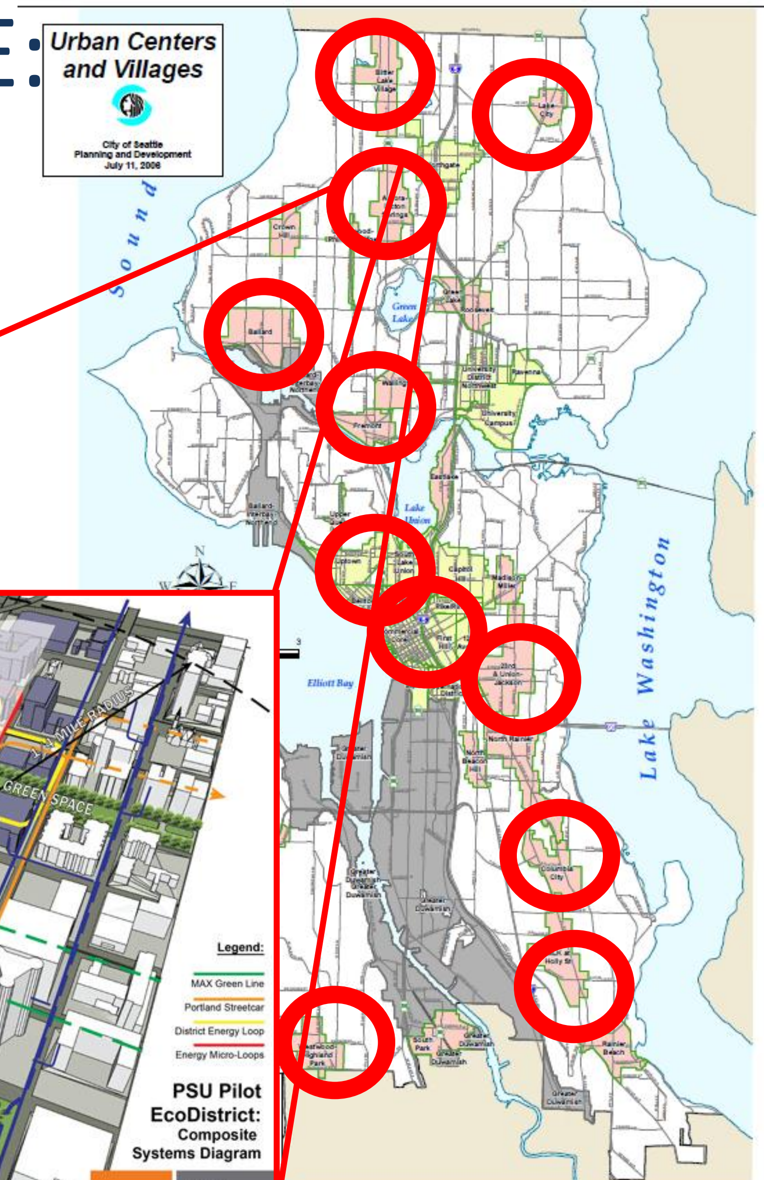
CHARACTERISTICS OF RESILIENT SYSTEMS

- Multiple scales
- Diversity
- Modularity
- Tightness of feedbacks
- Adapt to "slow variables"
- Portfolio of options

Image: USGS

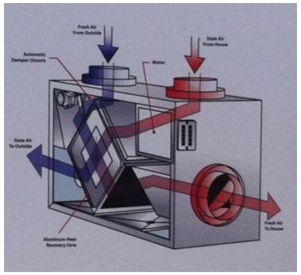
CITIES OF THE FUTURE: RESILIENT CITY

- Nested semi-autonomous
  - Buildings
  - Neighborhoods
  - Cities



SEMI-AUTONOMOUS BUILDINGS

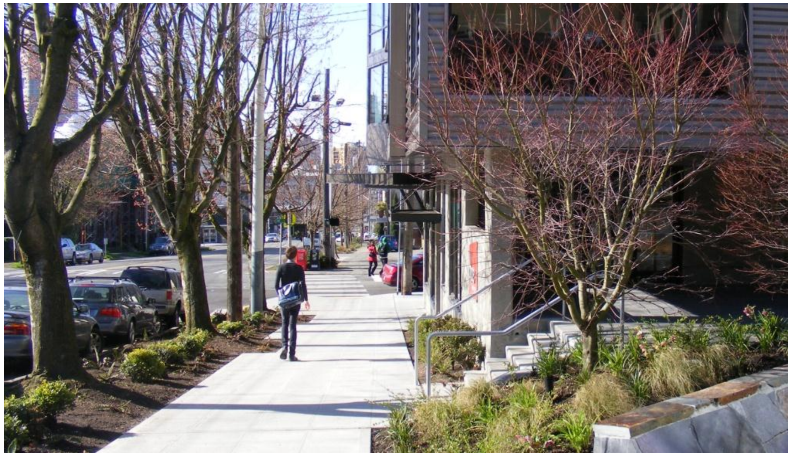
- Use renewable resources
  - Sun
  - Rain
  - Soils
  - Food
  - Shade
  - Vegetation
  - Wind
- Close loops
  - Air to air heat exchangers
  - Geo-exchange heat/cool
- Smart systems
  - Real time monitoring
  - Feedback loops



Zhomes, Issaquah photo by Moddemeyer

SEMI-AUTONOMOUS NEIGHBORHOODS

- Link together green semi-autonomous buildings
- Increase livability and resilience while reducing demand for outside services
- Design for recovery from quick or slow change and risks such as economic shifts, technological change and natural disasters
- Close loops and use onsite renewable resources
  - Sun
  - Rain
  - Soils
  - Shade
  - Vegetation
  - Food
- Install smart systems
  - Real time monitoring
  - Feedback loops
- Design places that people love and will care for over time



5. EXAMPLES: COMMONALITIES

- Use resilience as a framework to achieve real sustainability
- Join land use planning with infrastructure planning
- Emphasize multi-scale solutions/strategies
- Blend smart buildings with smart semi-autonomous districts into resilient eco-cites
- Design for multi-modal, multi-scale adaptability that add to resilience during extreme events
- Encourage technologies that create with multiple benefits instead of sector-only benefits

YESLER TERRACE

EXAMPLE: YESLER TERRACE

Seattle Housing Authority

38 acres

5,000 apartments

1 million sq ft of office

PROBLEM: Nearly $100 million in infrastructure costs

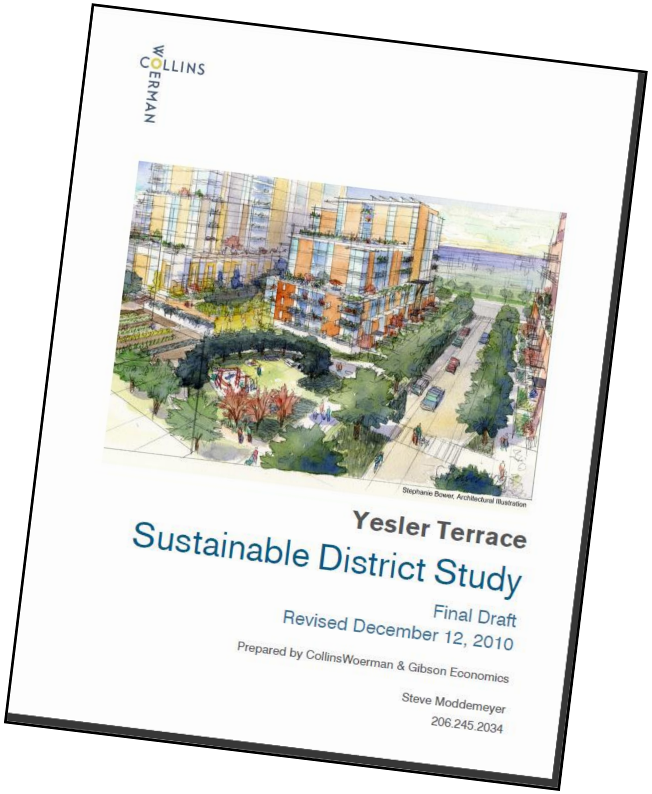
Lots of pressure to be a greenest of green

SOLUTION: Look at alternatives that meet or beat levels of service for the same or less cost

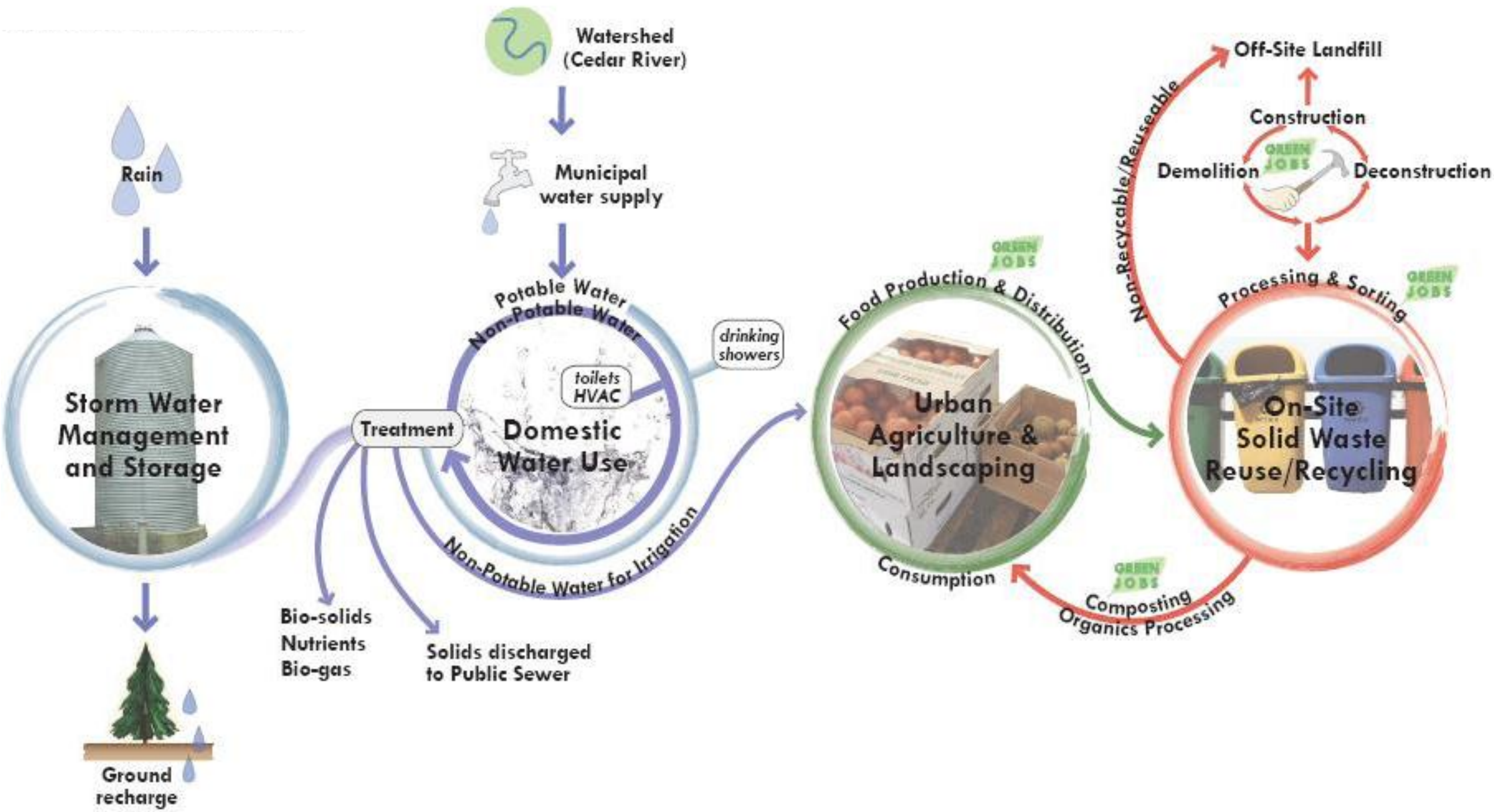
Seattle, USA Yesler Terrace

YESLER TERRACE SUSTAINABLE DISTRICT STUDY

- Evaluated district scale opportunities
- Meet or beat levels of service of business-as-usual … at the same or lower costs
- Measured benefit/cost and triple bottom line
- Emphasized designs that promote sustainability and resilience.



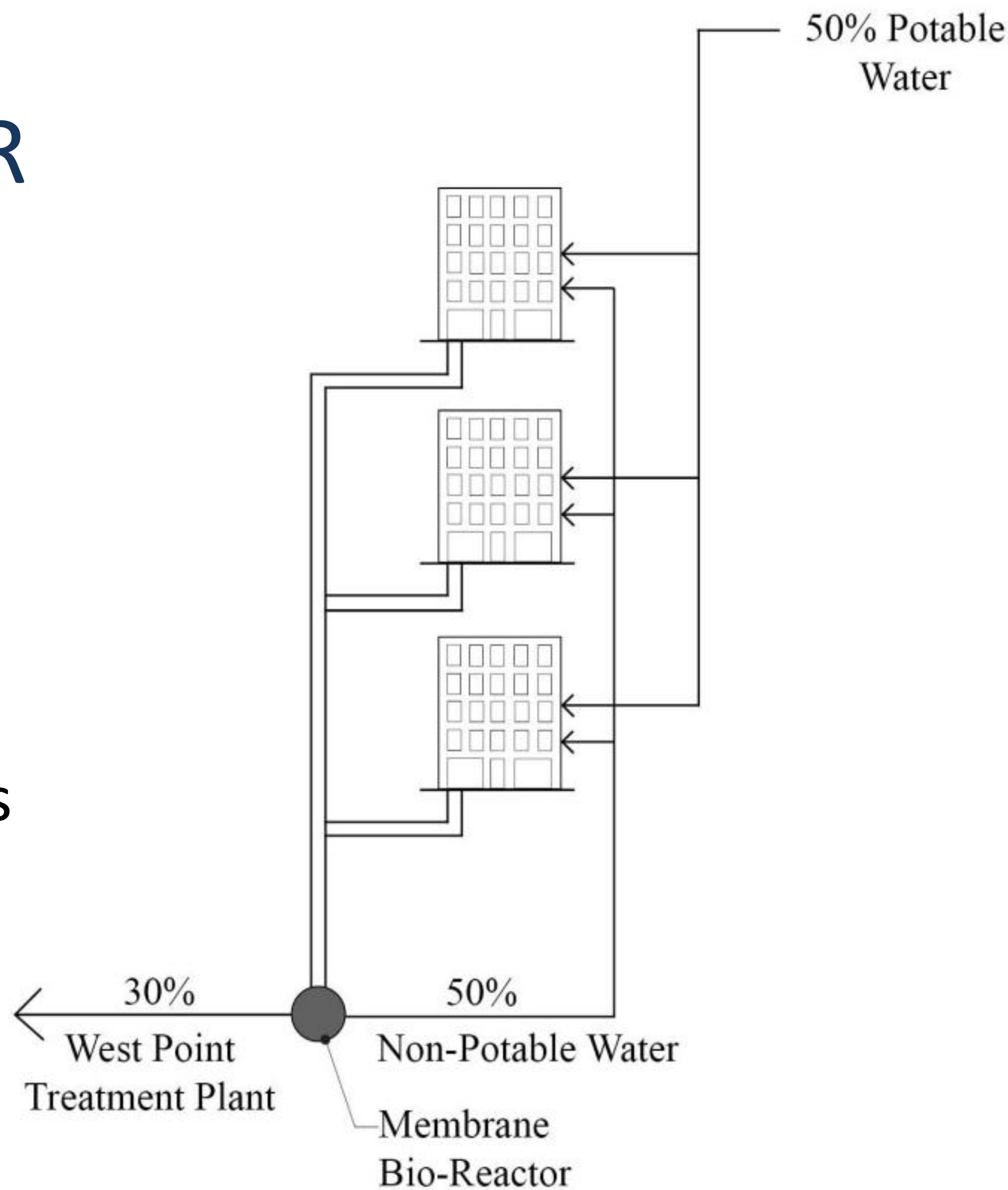
METABOLIC LANDSCAPE FLOWS



COLLINSWOERMAN SEATTLE, USA

RESULTS: WATER

- 45% reduction in potable water use
- 70% reduction in wastewater flows
- $300,000 per year lower than SPU rates
- Private capital available to build infrastructure




MEMBRANE
BACKWASH
STORAGE
TANK
ODOR
CONTROL
SYSTEM
SyncroFlo
RECYCLED
TO
TOILET
COOLING

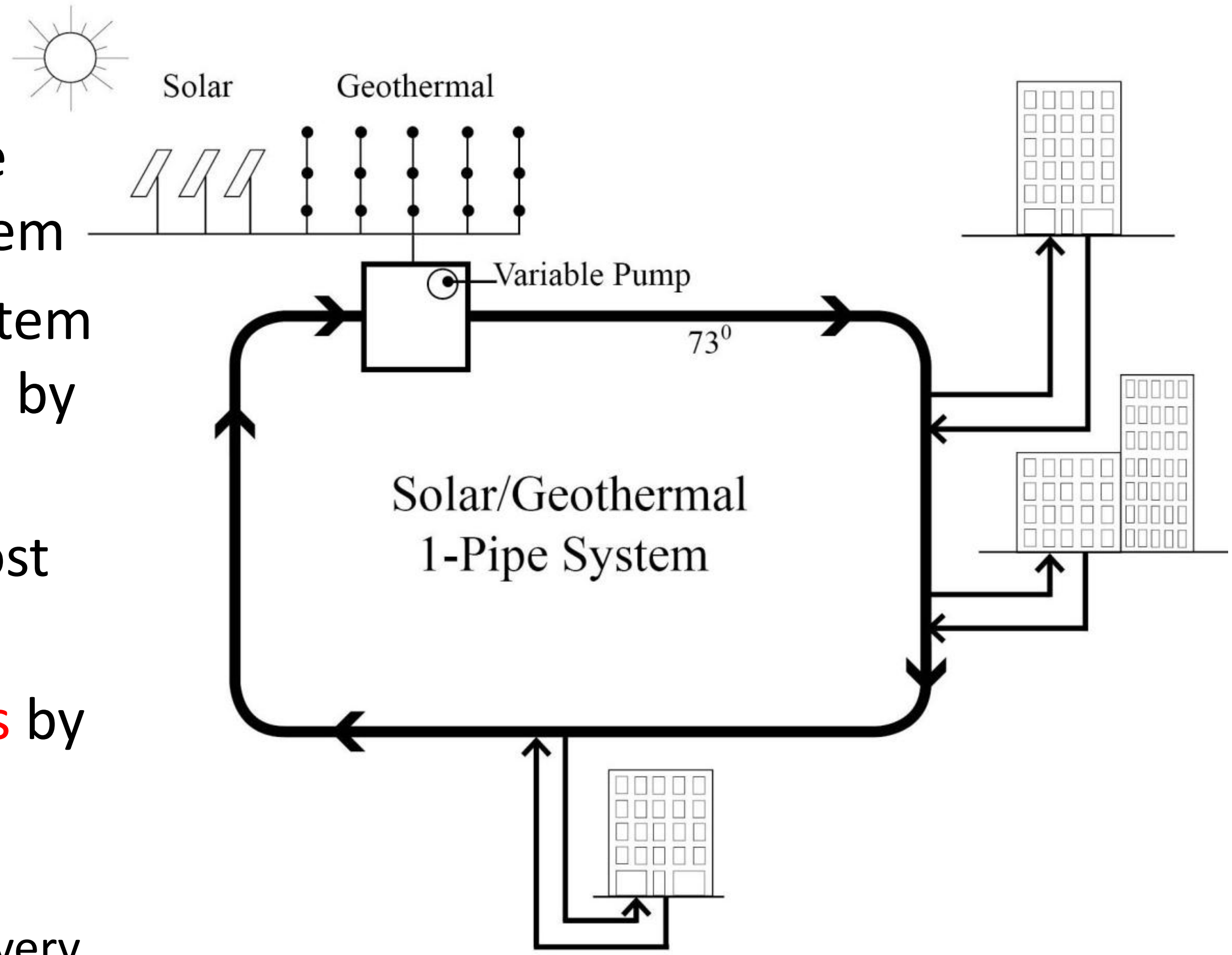
RESULTS: ENERGY

Geo-Exchange/Solar Hot Water System preferred:

- Over 90% of energy for heating and cooling from onsite renewable energy
- 25% reduction in energy from the grid
- 40% reduction in peak demand
- 4,200 metric tons reduction of CO_{2e}/
- Smallest land use requirement
- Least expensive
- Scalable over time

AMBIENT TEMPERATURE THERMAL LOOP

- Buildings balance uses between them
- Thermal loop system temp maintained by onsite energy
- Same or lower cost
- Decouple from energy price rises by using:
  - Solar hot water
  - Sewer heat recovery
  - Geo-exchange



MORE EXAMPLES

- Seoul
- Stockholm
- Qingdao
- Singapore
- Zhangjiawo, China
- Star City, Seoul

Chonggyechon Seoul, Korea

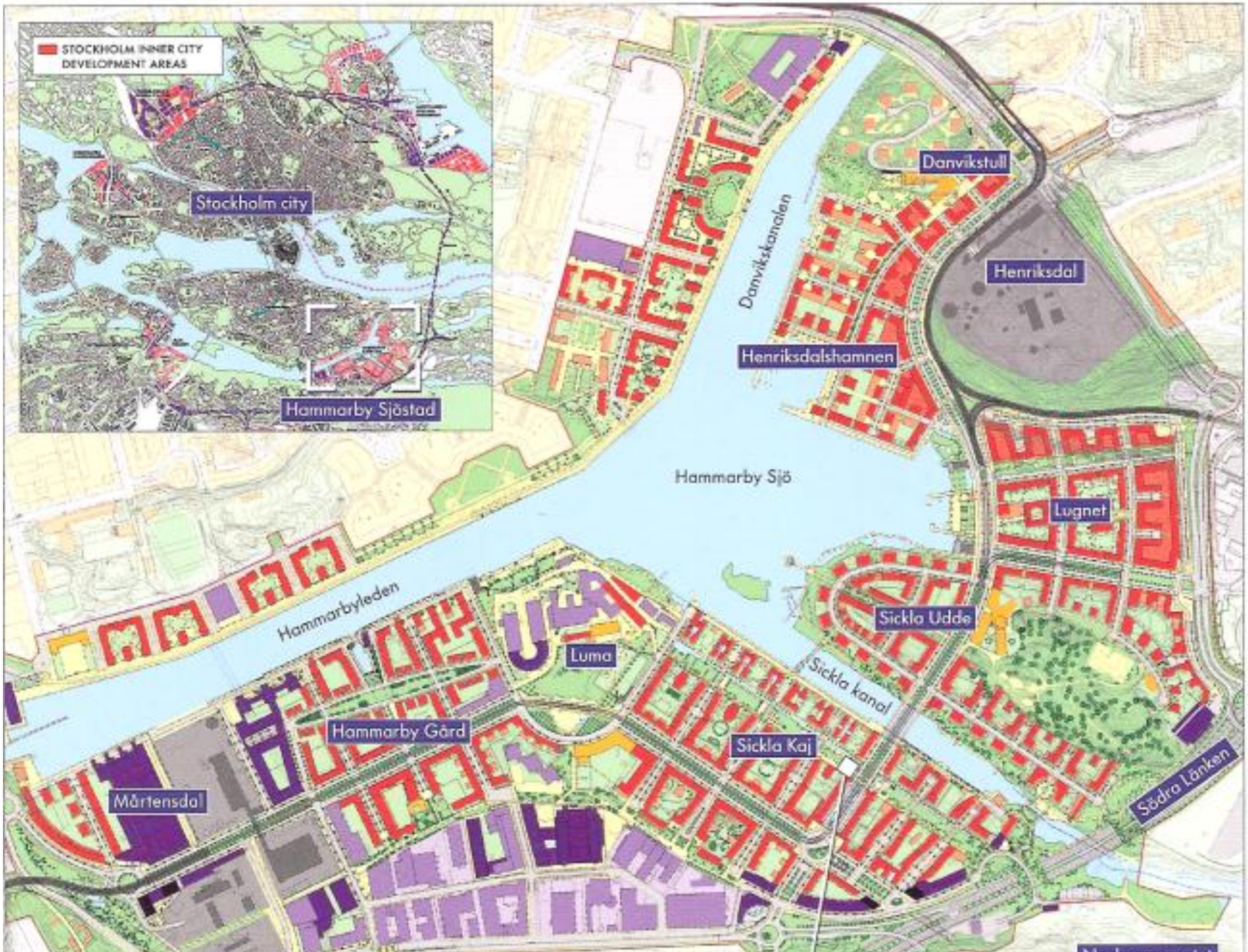
Chonggyechon Seoul, Korea

Chonggyechon Seoul, Korea


칼스버그 맥주

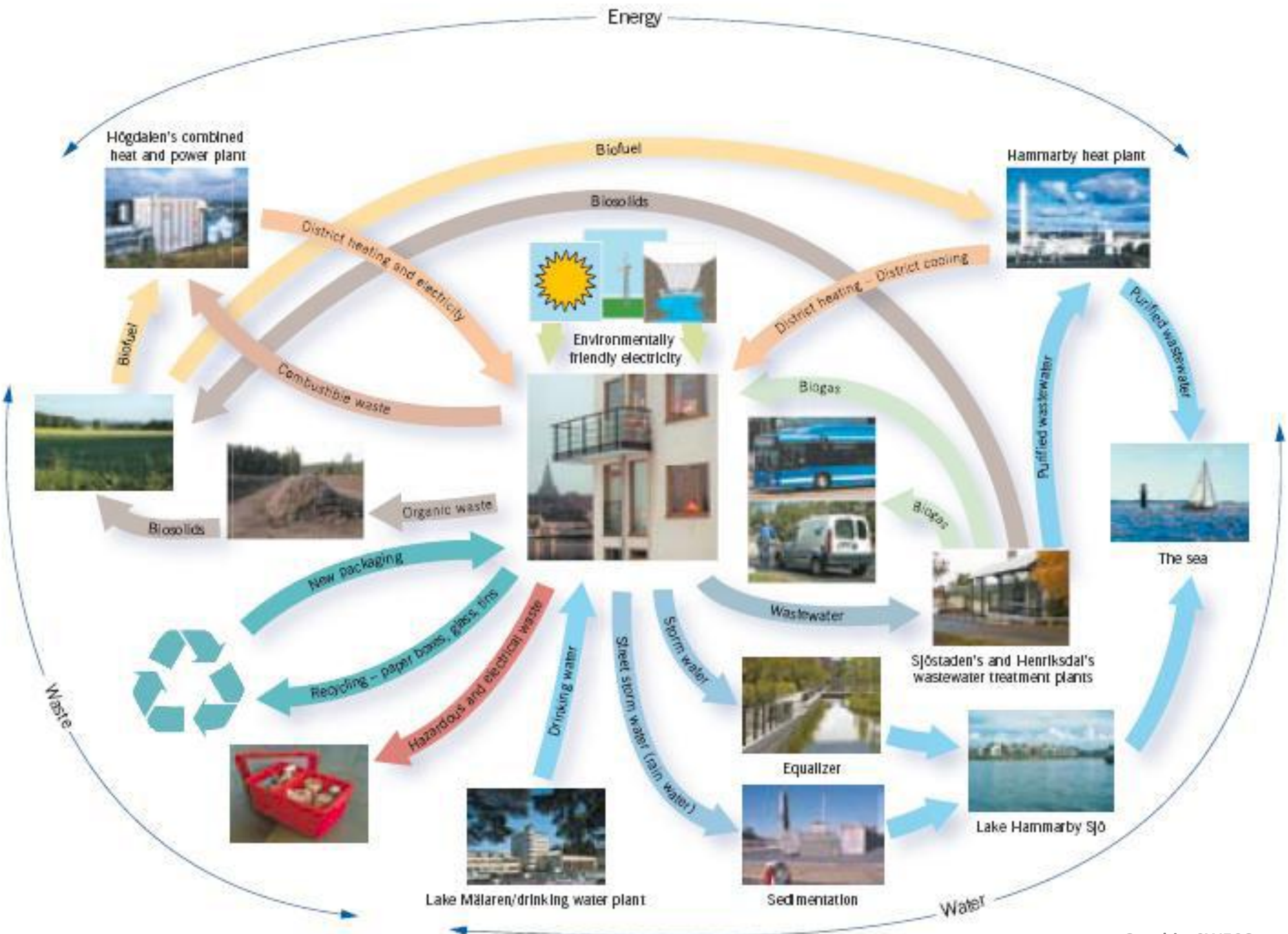
Chonggyechon Seoul, Korea

Hammerby Sjostad



HAMMARBY SJÖSTAD COMPREHENSIVE PLAN, PRODUCED BY STOCKHOLM CITY PLANNING DEVELOPMENT

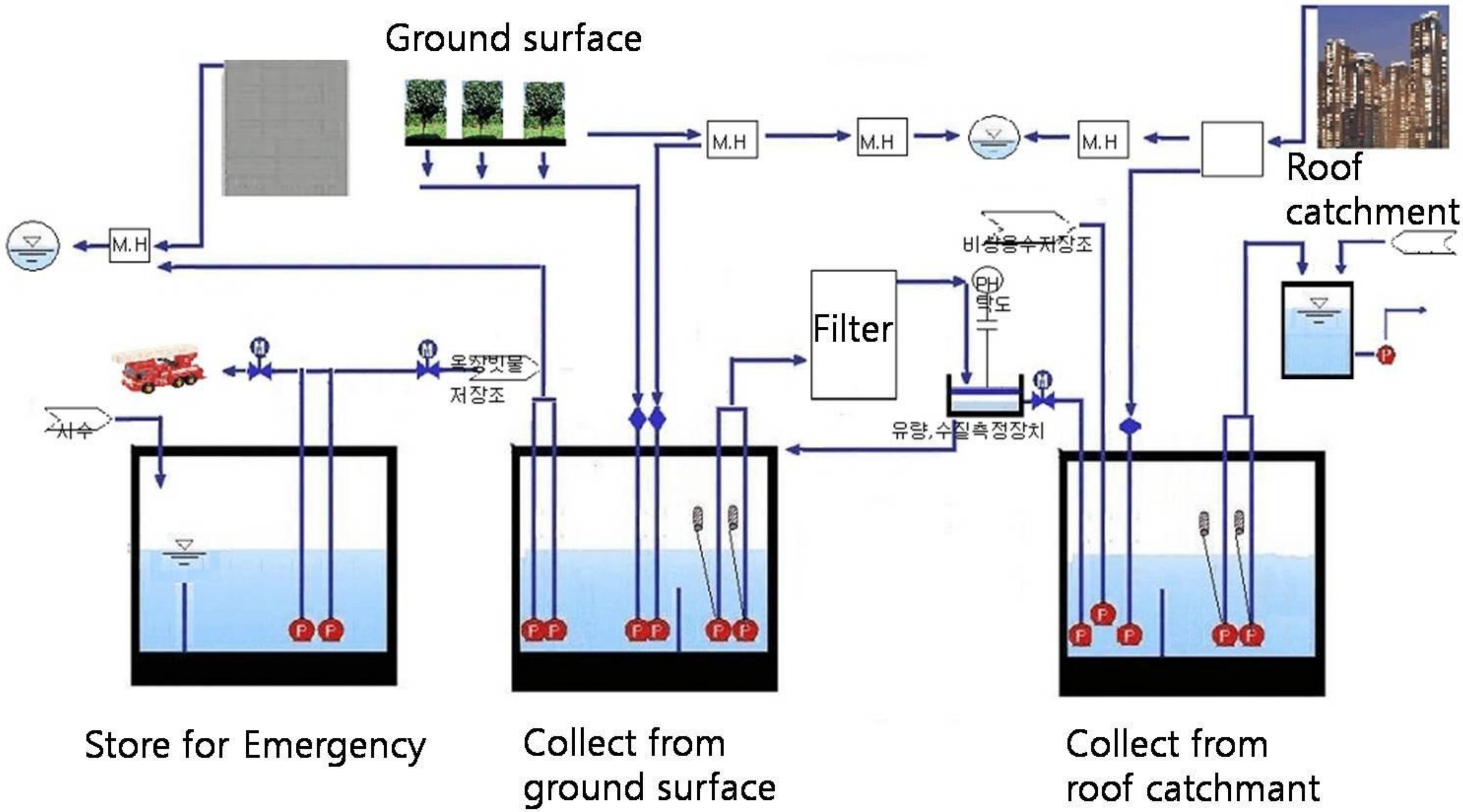
Hammarby Sjöstad has its own



Graphic: SWECO

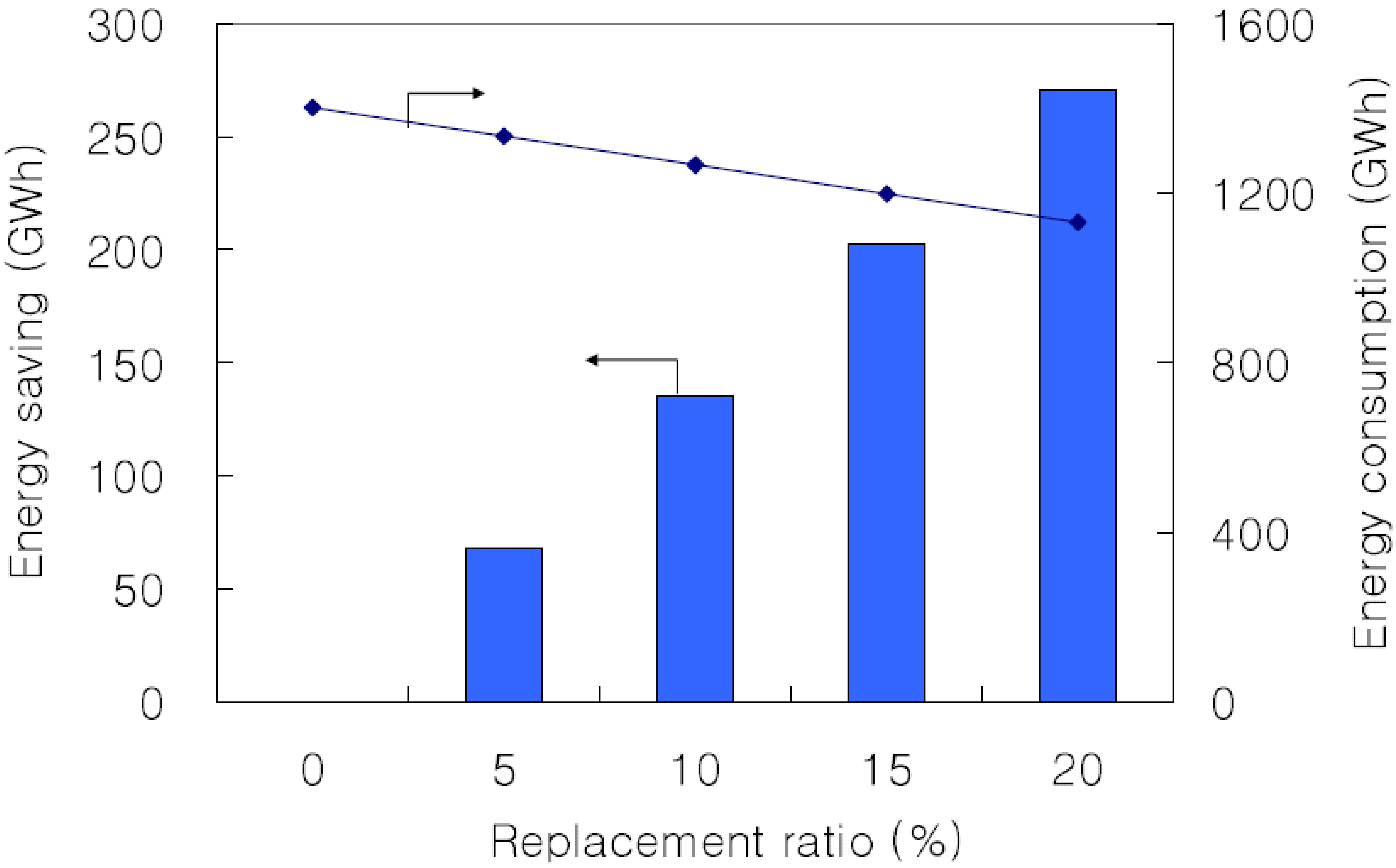
Star City, Gwangjin-gu, Seoul, Korea

Star City, Gwangjin-gu, Seoul,



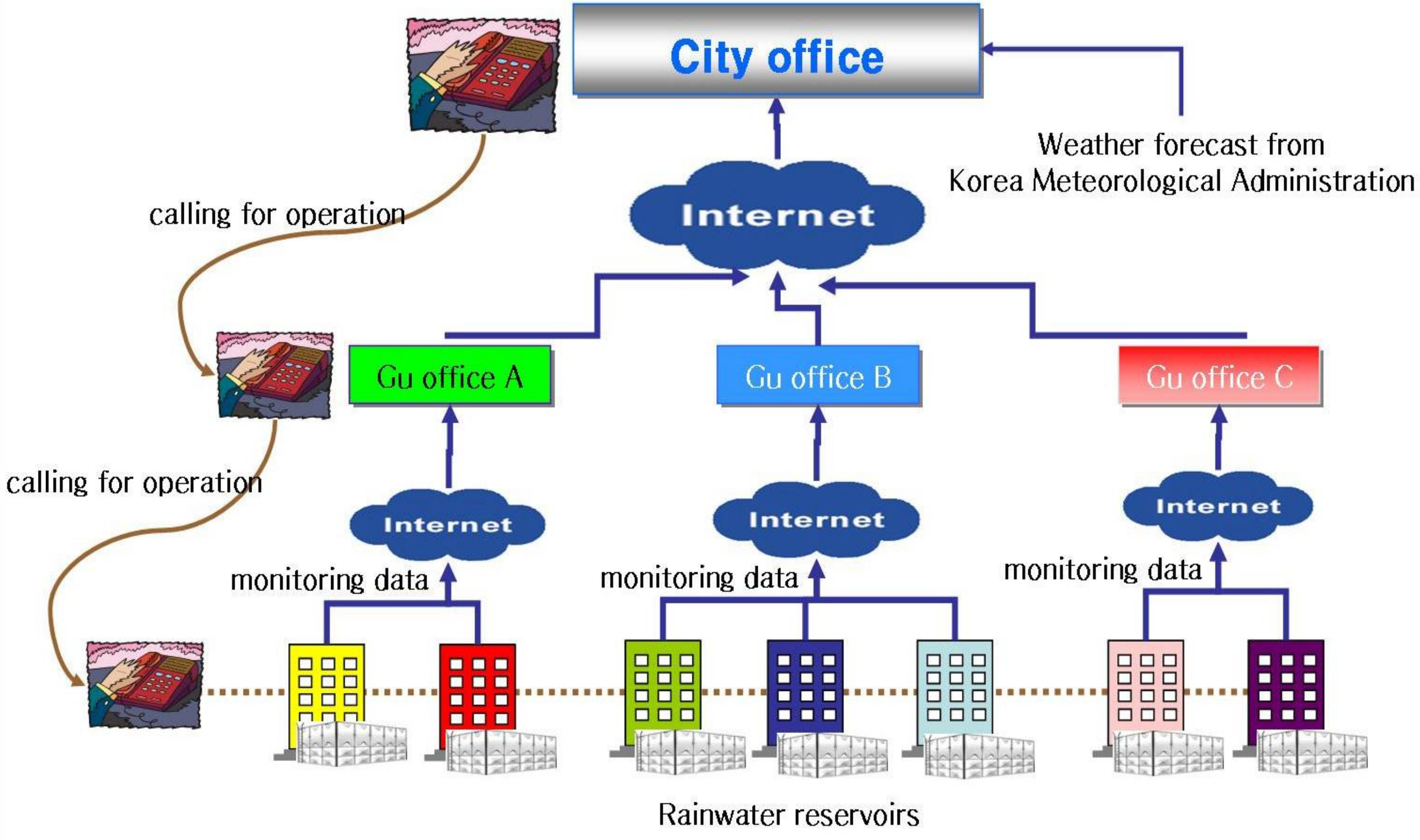
Graphic: Mooyoung Han, Seoul National University

Star City, Energy Savings



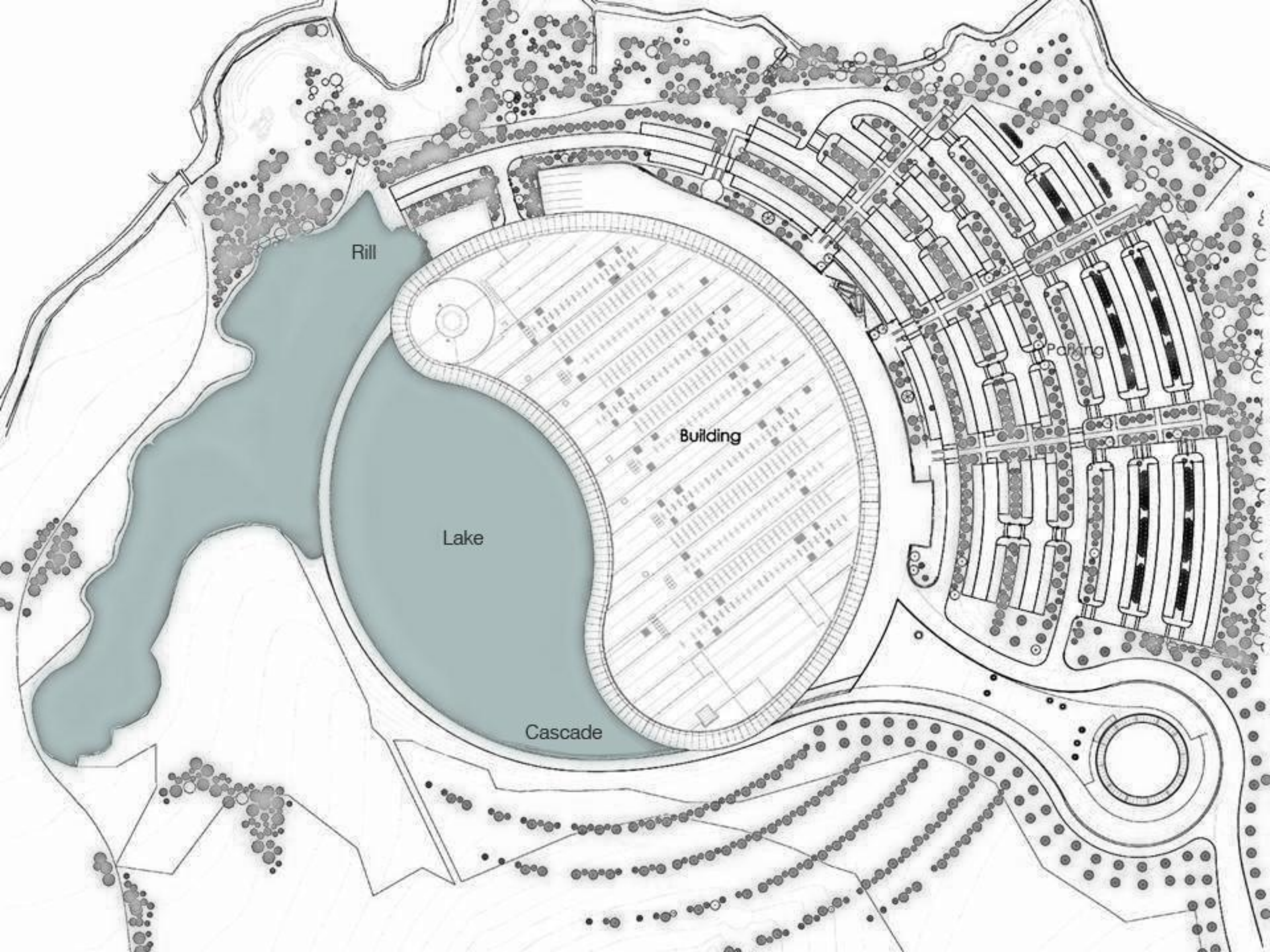
Graphic: Mooyoung Han, Seoul National University

Star City, Centralized Management of Rainwater Tanks



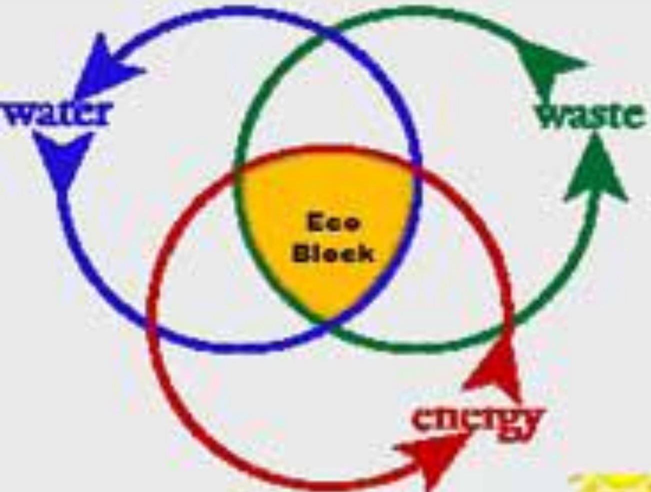
Graphic: Mooyoung Han, Seoul National University

Paragon research and design center, McLaren, London

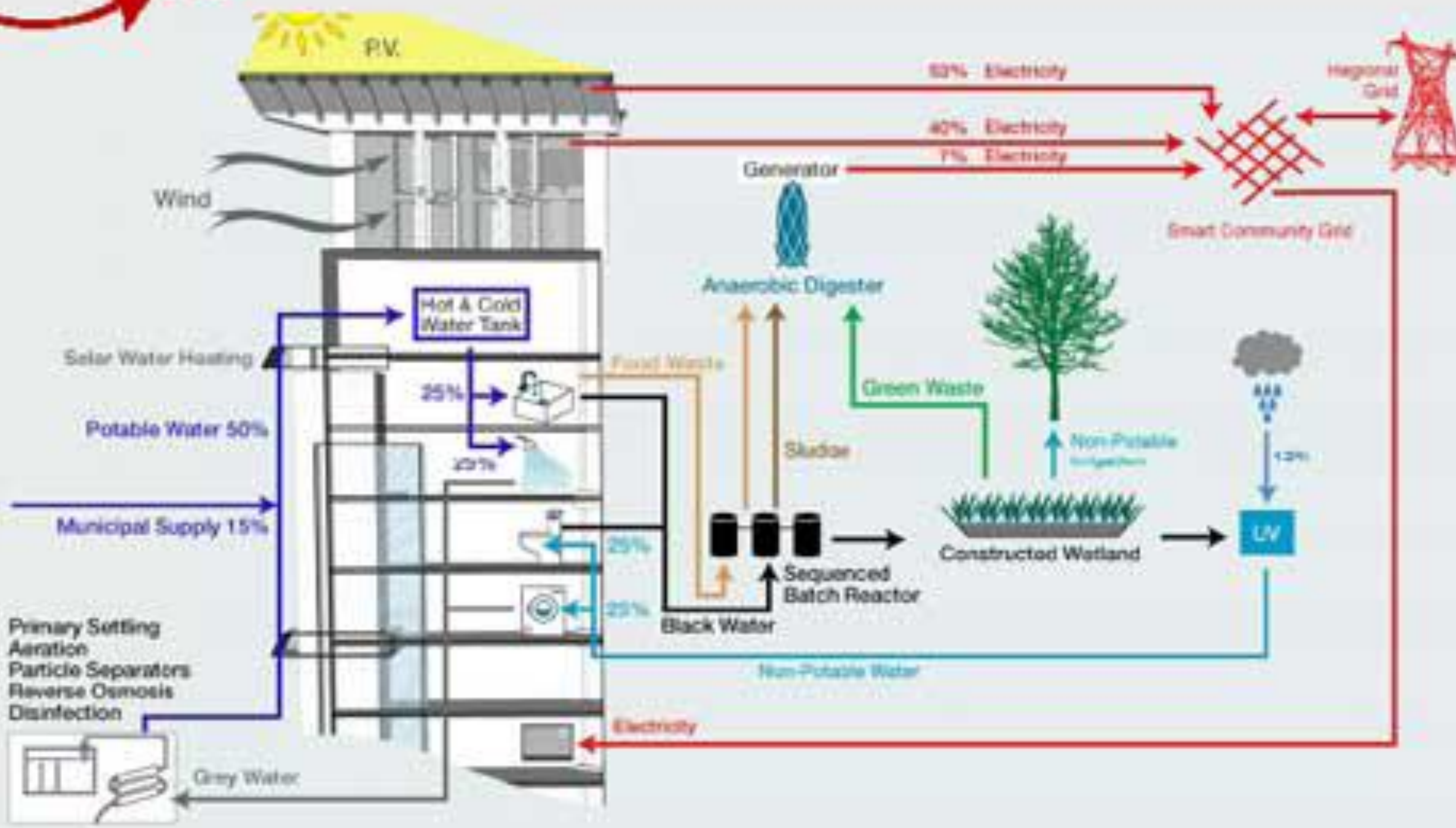


Rill
Building
Parking
Lake
Cascade


Qingdao, China (eco-blocks)



Whole Systems Design: integrated systems that are mutually beneficial



STOCKHOLM RESILIENCE CENTRE

image: Q-book Albano 4

STOCKHOLM RESILIENCE CENTRE

Photo: Q-book Albano 4

Image: Q-book Albano 4

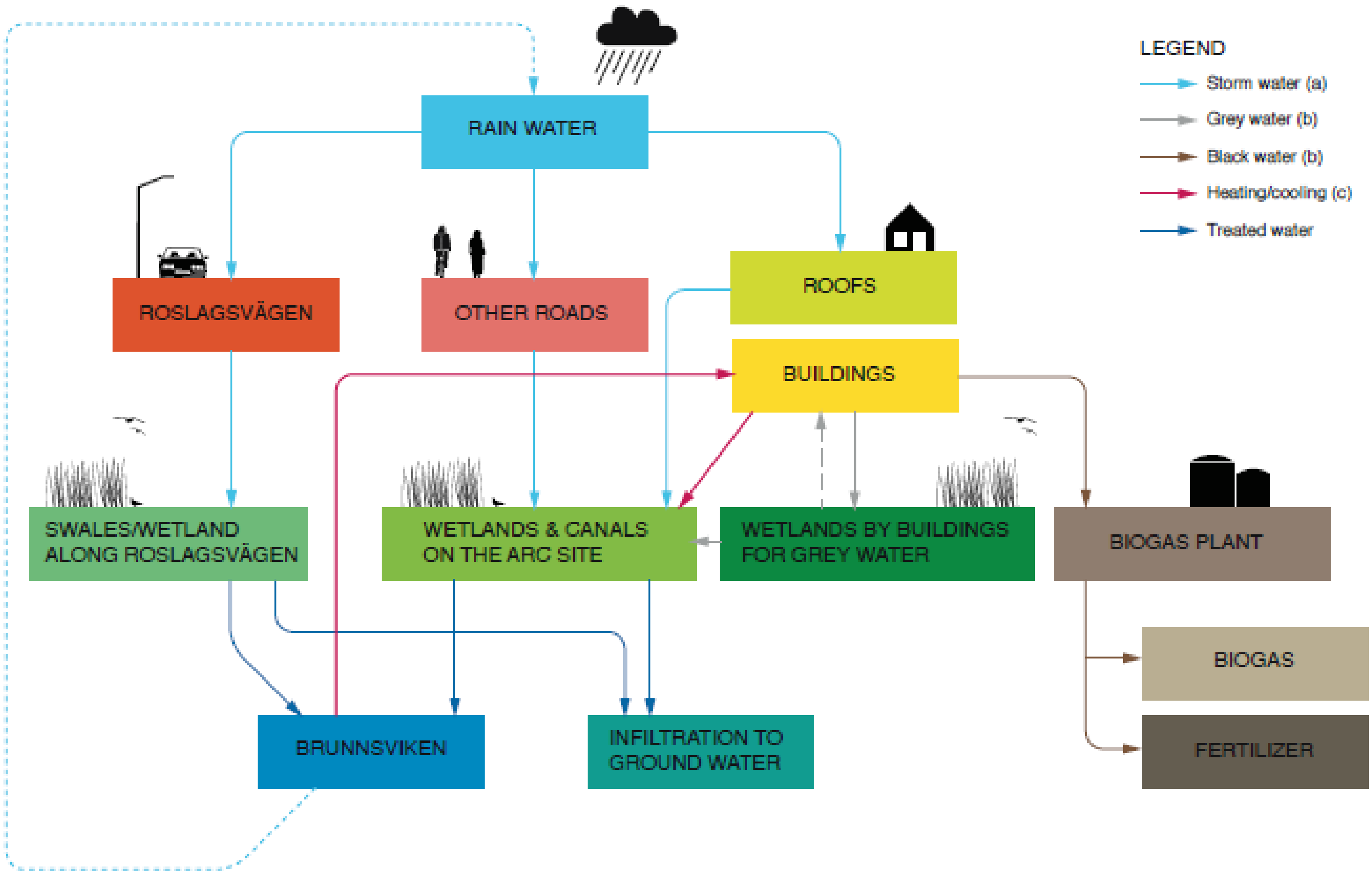
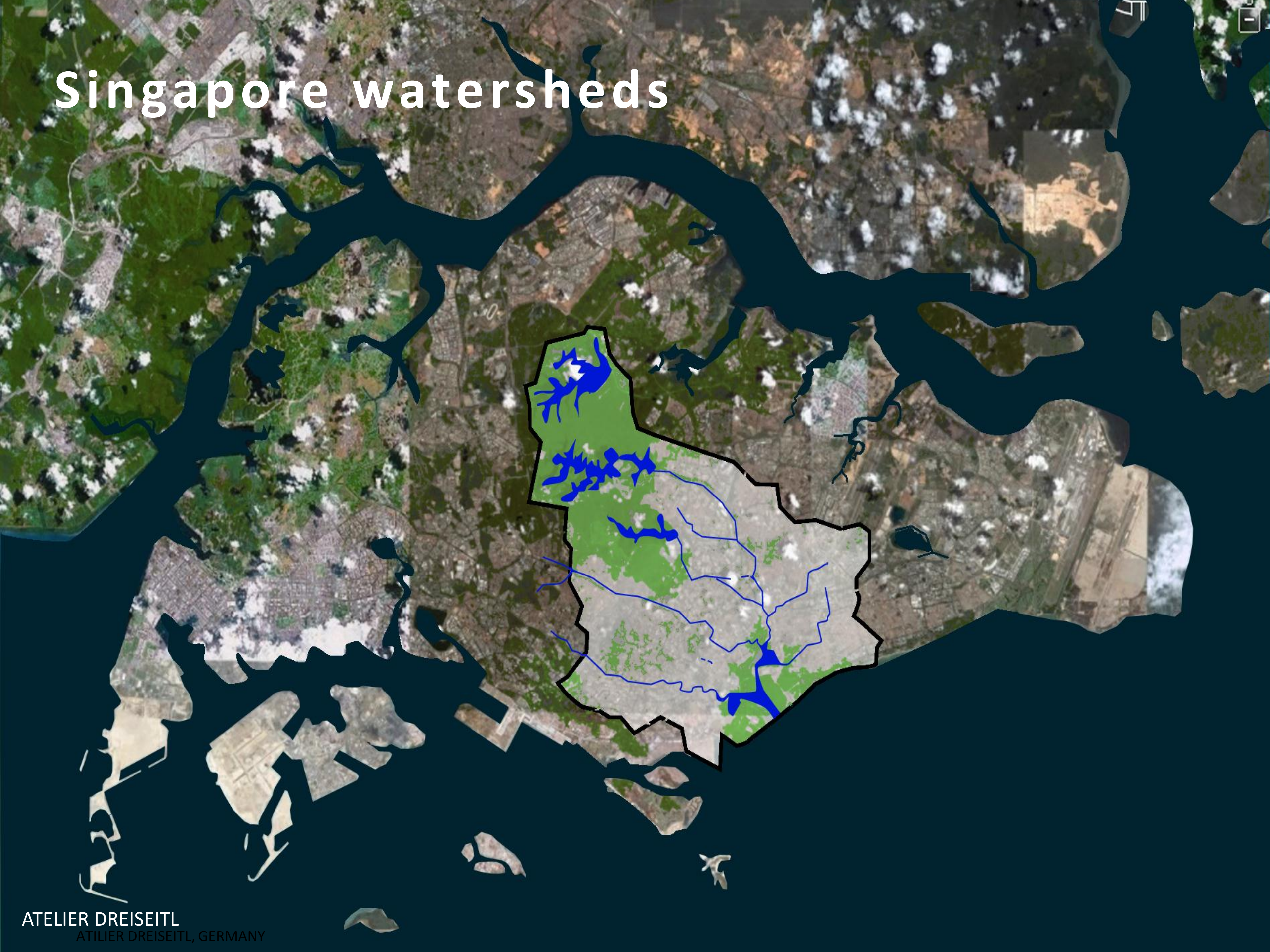


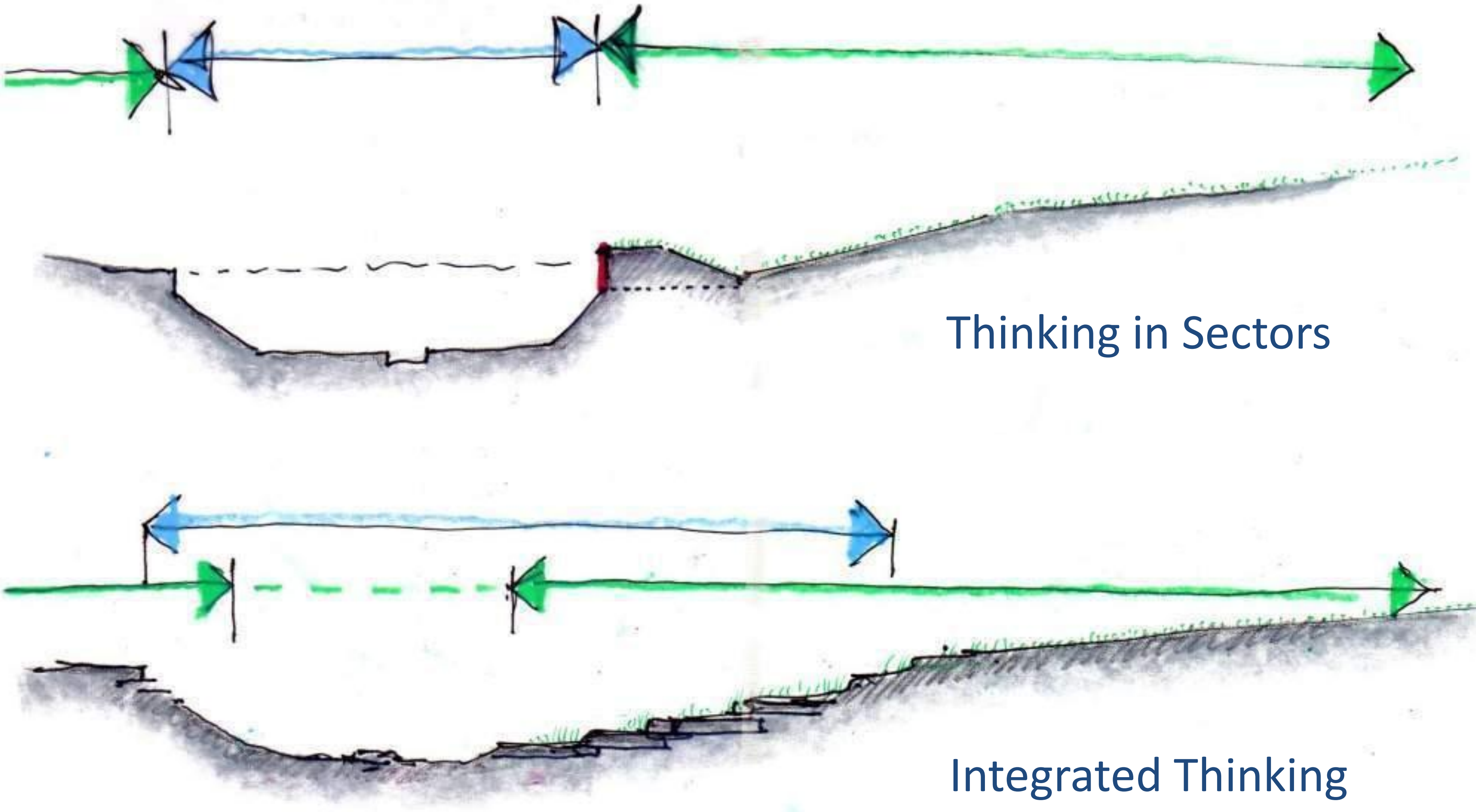
Image: Q-book Albano 4

Singapore Watersheds

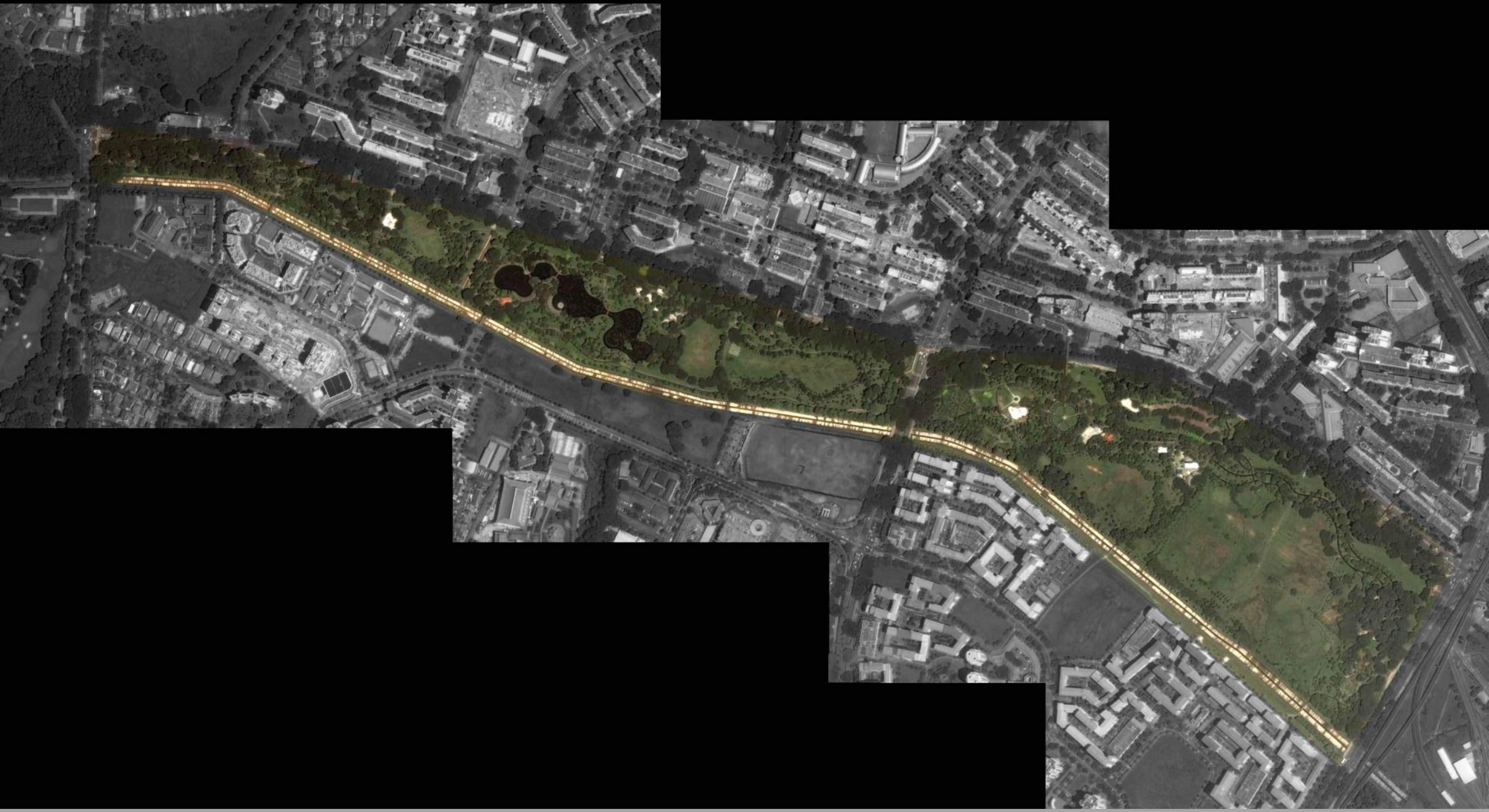
ATILIER DREISEITL, GERMANY


Singapore watersheds
ATELIER DREISEITL
ATILIER DREISEITL, GERMANY

Bishan Park



This means:
Overlapping of Territories River – Park
Overlapping of Responsibilities PUB - NP
Overlapping of Maintenance and Service PUB - NP



ATELIER DREISEITL

20 Years Later

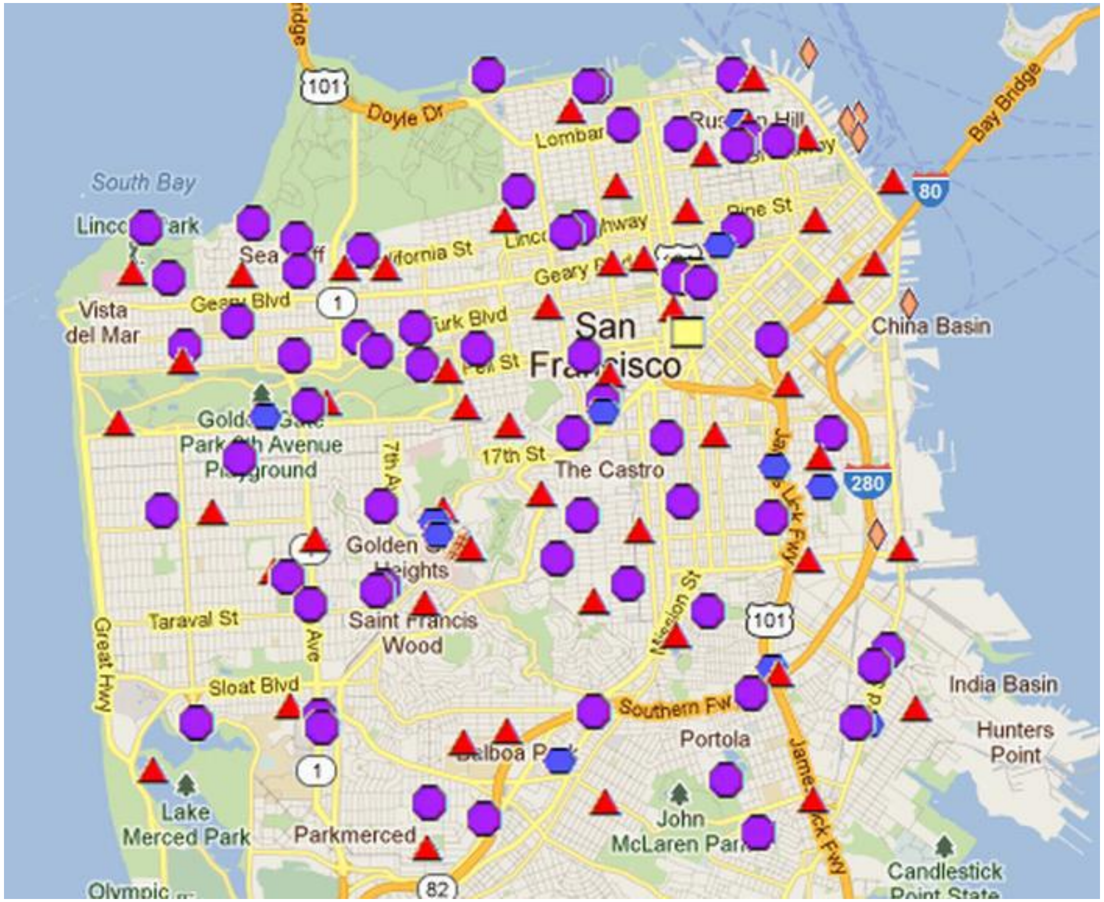
Today

Bishan Park 2031

ATELIER DREISEITL

6. CAN WE CREATE A CITY THAT IS RESILIENT TO ALL KINDS OF CHANGE?

CAN WE LEVERAGE SEISMIC RESILIENCE TO CREATE CITY-WIDE RESILIENCE TO ALL KINDS OF CHANGE?



LEVERAGING RISK-BASED STRATEGIES

RISK-BASED

- Identify and model risks
- Set a design standard (San Andreas M7.9 or sea level rise of x feet by xx date)
- Develop a range of mitigation strategies before, during and after an event

Keep driving towards city-wide resilience?

RESILIENCE-BASED

- Identify attributes of resilient systems
- Apply these attributes to all capital spending
- Include design risk *and* residual risks
- Use full array of risks to identify strategies that transcend any particular risk
- The Triple Bottom Line: Social resilience, ecological resilience, economic resilience

PROCESS APPROACH

Broader Alternatives

Develop broad integrated alternatives that meet criteria for resilience

Diversity

Multiple scales

Modularity

Tightness of feedbacks

Key to "slow variables"

Invest in building adaptability

Keep options open

Reduce costs of crisis management

Rigorous Evaluation

Calculate risk/ consequences cost

Conduct triple bottom line analysis

Compare net present values

Sensitivity analyses

Financing options

Public/private partnerships

Regulatory constraints

Strategies

Create cost-effective strategies that facilitate change towards resilience/ adaptability

RISK, DESIGN, AND RESIDUAL RISK

Create robust strategies that help to mitigate all kinds of risk and uncertainty:

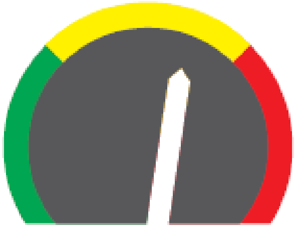
- *Climate change*
- *Sea level rise*
- *Earthquake*
- *Severe weather*
- *Landslide*
- *Liquefaction*
- *Disease outbreak*
- *Economic shifts*
- *Social instability*
- *Technological risk*
- *Systemic failures of any kind*
- *Obsolescence*

HOW TO PLAN FOR RESIDUAL RISK

RISK	RESPONSE	
0-1FT RISE: No changes necessary	• Monitor situation	
1-3FT RISE: Occasional flooding at high tide 1- 10x/yr; occasional disruption minor damage	• Consider enhanced drainage • Reinforce most vulnerable areas • Consider seawall height increase • Develop adaptive response strategies	

Design risk

Residual risk

RISK	RESPONSE	
3-6FT RISE Regular flooding at high tide 11-30x/yr; moderate damage to facilities and cargo	• Raise seawall • Raise operating areas • Consider elevated storage options • Routine flood warning sirens (like in venice)	
6FT+ RISE Major disruption to operations Major flooding of service and public roads	• Relocate port facilities • Increase throughput to minimize onsite storage • Raise operating area • Multi-level ship off-loading? • Floating facilities	

COMPARE STRATEGIES FOR VARIOUS RESIDUAL RISKS

Flooding

RISK	RESPONSE
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Earthquake

RISK	RESPONSE
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Disease outbreak

RISK	RESPONSE
0-1FT RISE: No changes necessary	• Monitor situation
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Sea level rise

RISK	RESPONSE
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Drought

RISK	RESPONSE
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Economic shifts

RISK	RESPONSE
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Storm surge

RISK	RESPONSE
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Occasional flooding at high tide 1- 10x/yr; occasional disruption minor damage	• Reinforce most vulnerable areas • Consider seawall height increase • Develop adaptive response strategies
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Landslide

RISK	RESPONSE
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Social instability

RISK	RESPONSE
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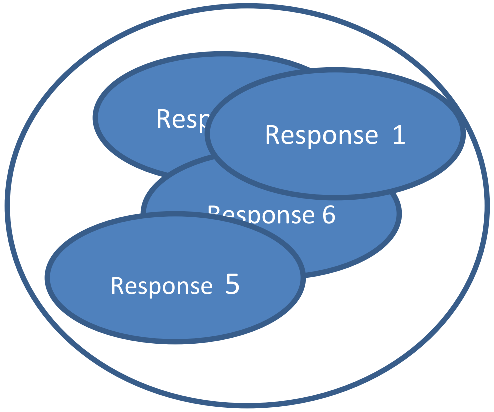
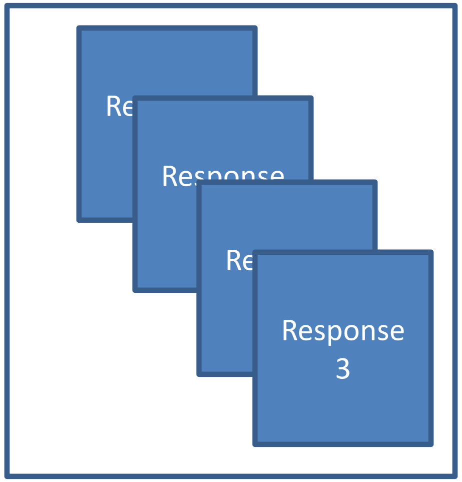
CATEGORIZE RESIDUAL RISK RESPONSES

- Assemble responses to residual risk into clusters based upon similar attributes
- Identify common attributes residual risk responses
- Turn these attributes into criteria to evaluate the robustness of near term risk mitigation strategies.



LIST OF COMMON ATTRIBUTES
A. ATTRIBUTE
B. ATTRIBUTE
C. ATTRIBUTE



LIST OF COMMON ATTRIBUTES
A. ATTRIBUTE
B. ATTRIBUTE
C. ATTRIBUTE

USE RESIDUAL RISK CRITERIA TO MAKE INCREMENTAL INVESTMENTS THAT KEEP OPTIONS OPEN

- Apply criteria developed in residual risk strategies to near-term incremental investments
- Prefer those incremental investments that do not foreclose responses to residual risk

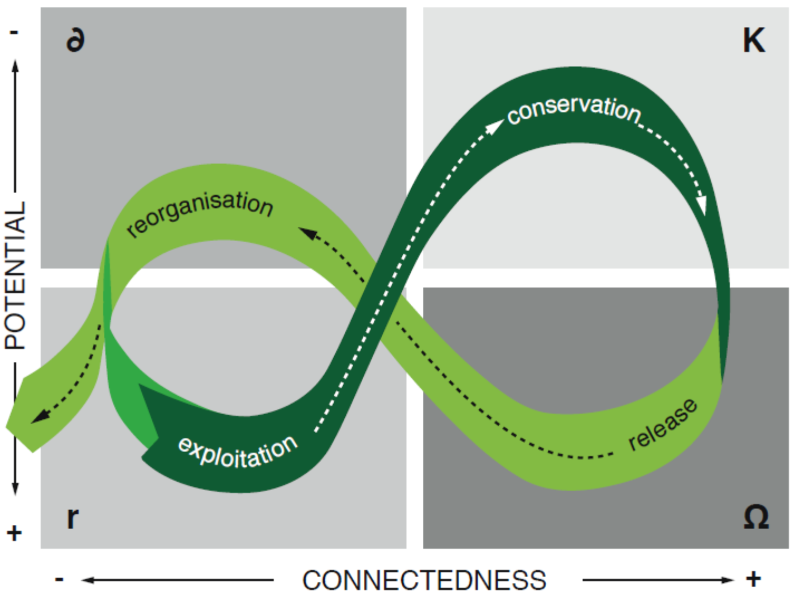
PLANNING FOR RESILIENCE AT THE LOCAL LEVEL

- Comprehensive plan updates
- Neighborhood plan updates
- Transit Oriented Development
- Disaster mitigation planning
- Campus planning
- Master planned developments
- Utility/infrastructure planning
- Climate change strategies
- Capital planning (10-year CIP)

COMP PLAN UPDATE

Add resilience:

- Show how we will accommodate growth AND how we will shorten the time for recovery
- Prioritize strategies that increase our capacity to bounce back



RESILIENT COMP PLAN GOALS & POLICIES

EXAMPLE

NEIGHBORHOOD GOAL	Increase the neighborhood's capacity to recover from sudden or long-term change
POLICY	Reduce demand for outside infrastructure services
POLICY	Encourage cost effective neighborhood systems that work with onsite renewable resources such as sun, rain, vegetation, and ecological habitats
POLICY	Encourage social networks
POLICY	Manage landscapes and install infrastructure in support of local food policies

RECAP

1. Cities of the Future must adapt
2. Uncertainty is high
3. Shift to incremental investments with a portfolio of options
4. Plan for resilience - both growth and disturbance
5. Learn from good examples and create more
6. Can we create a city that is resilient to all kinds of change?
7. Recommendations

THREE RECOMMENDATIONS

1. Leverage seismic resilience achievements to create city-wide resilience and sustainability
2. Plan for all kinds of change – sudden and long-term, residual risk and “Black Swan” events
3. Add city-wide resilience criteria to all planning and capital investments

DISCUSSION

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