Green Infrastructure

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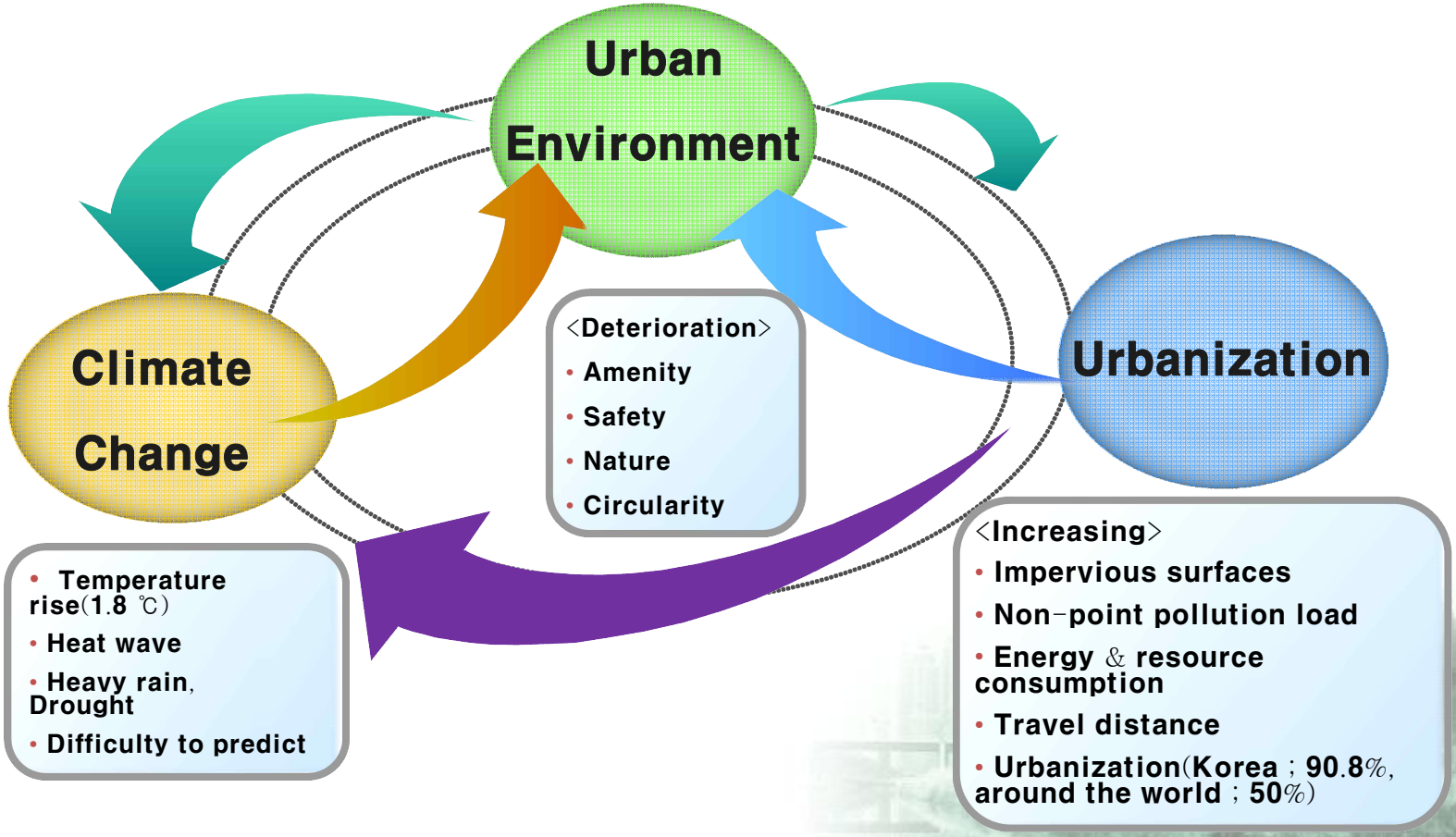
1. Current problems

Energy, resource-consuming cities



* In 1950 about 65% of the population worldwide lived in rural settlements and 35% in cities and this number will be reversed by 2050, where 70% will be urban and 30% rural

(UN, 2014, World Urbanization Prospects, 2014 available at : http://esa.un.org/unpd/wup/highlights/wup2014-highlights.pdf)

1. Current problems

Energy, resource-consuming cities

- **Urban infrastructure such as building, transportation**
  - ⇒ High level of dependence on fossil energy
- **Increase in impervious surface in urban areas**
  - ⇒ Lack of soil moisture, decrease in evapotranspiration rate, increase in heat island and fine dust
  - ⇒ Safety issues and flooding derived by reduced time of travel of stormwater
  - ⇒ Problems of river ecosystem disturbances and water quality safety due to increases in inflow of viruses, bacteria and xenobiotic
  - ⇒ Impervious area ratio of urban(48%, ; 2005, ROK MOLIT)
    Non-point source pollution load(72%, 2020) in South Korea
- **Linear Metabolism without circulation between Input and Output**
  - ⇒ 2/3 of energy and 60% of the drinking water have been consumed in cities around the world

1. Current problems

Climate Change

- **Heavy rain days of more than 80mm have doubled in the 1970s**

  ⇒ Rainfall has been increased by 17% over the past 100 years but, 18% reduction in number of rainy days

  - 2010.9.21, Hyoja Area(75mm/hr, 202mm/3hr)
  - 2011.7.27, Gangnam Area(65mm/hr, 103mm/3hr)

- **Increase of 1.8 ℃ in Korean cities (Seoul, Gangneung, Incheon, Daegu, Mokpo, Busan) from 1911 to 2010. Meanwhile, average temperature rise in global temperature over the past 100 years was only 0.75 ℃**

  ⇒ Abnormal temperature such as heat wave threats life and health of vulnerable social group including the aged

- **Tropical night (70's 4.3 days -> 00's 7.8 days, Seoul)**
- **90% of the damage from the storm and flood has occurred in the city**

1. Current problems

Era of Climate Change, Risk Society ; Issues of Urban Safety

- **Socio-Economic Changes such as depopulation and aging population**
- **Impact amplified by chain reaction of urbanization and climate change**

⇒ Combination of climate change and rapid urbanization(increase in impervious surface) has great influences

– **adversely affects the overall urban environment such as increasing outflow, decreasing infiltration, water pollution, heat waves, urban flood inundation and ecosystem**

<Isolated citizens at the Cheonggye creek by 12mm rainfall; one side of risk society(12.10.11, JoonAng Iibo) >

❖ **New roles of urban infrastructure are needed**

1. Current problems

- Stormwater Management ; large scale facilities and high energy system

  ⇒ Deterioration of weakness regarding urbanization and climate change derived by absence of nature-based water cycle

- Sewerage ; Since it is only focused on sewage treatment it does not fulfil the production and recovery of energy and merging disposal of food waste and wastewater
- Road ; Since it is only focused on an environment for vehicles, it lacks of functions for rainwater cycle, urban thermal circulation, fine dust reduction and prevention of noise
- Greens of park ; solutions and designs are required to perform thermal circulation, rainwater cycle, fine dust reduction and prevention of flood

❖ Need of discussion for life-friendly infrastructure regarding safety, participation and living environment such as comfort and health

2. Urban Infrastructure

➢ **What about recycling of municipal wastewater treatment in urban areas?**

- **Source separation and treatment of sewage, Ecosan**
- **Use of rainwater, small-scaled and decentralized treatment, recycling of sewage and constructed wetland**
- **In 1ton/household sewage, about 25% of the sewage is low-polluted grey water and it is practicable to be treated and reused through constructed wetland with natural purification**(Kyoung Hak Hyun et al., A Study on the Development of Artificial wetland Treatment for Grey Water Recycling, 2006, Land & Housing Institute)

2. Urban Infrastructure

- **Are our cities safe?**
  - Safety issues including water-borne diseases and infections due to temperature rise by climate change
  - Doubt on safety of human-being and river due to increased amounts of chemicals followed by urbanization and improvement in living standards
  - Disturbed ecosystem and health issues due to non-degradable organic materials
  - Security of drinking water and water sources
  - Degradation of flood safety and inundation issues due to impervious surface
- **Need of integrated management of Green Infrastructure which is more am algamated than current infrastructure**
  - Need of disaster prevention planning and reduction of stormwater runoff by using building, roadway and school, etc
  - Introduction of LID Green Infrastructure is required over the existing drainage system

⇒ **Need of new methods in various aspects such as citizen participation and environmental welfare**

2. Urban Infrastructure

- Solutions for energy, environmental and safety issues such as a phase-out of nuclear power, fine dust and urban inundation ; Is it practicable in current infrastructure system?

⇒ **Current Priorities**

- **Functional performance of an individual infrastructure**
- **Smart City in a perspective of Smart Infrastructure with applications of ICT or IoT**
- **In terms of solutions for Smart City, urban regeneration and fine dust, considerations of infrastructure based on circulation of urban resources and energy are limited**
- **Nature-based solutions in urban area ; not be considered at all**

⇒ Hence, solutions for circulation and production of energy and resources using spatial interrelation and **multi-functionalized** infrastructures are required

2. Urban Infrastructure

New movements

- 123 floors tall Lotte World II ; Generating 10% of heating and cooling energy by using thermal difference energy of water from 50,000 tons/day(wide area waterworks supply) ; the same as 2,000 households' heating & cooling energy capacity

- Reserve Heat Energy derived from 9 billion tons/year of sewage(2010) in Kore a is estimated to be 3.2 million TOE; 8.8% in energy consumption of commerce and home sector

- Makuhari in Japan; Supplying heating and cooling energy generated by disposal of sewage to the local area of 48.9ha

2. Urban Infrastructure

Change in socio-technical system

New movements

- **Conversion theory for socio-technical system that has been studied in various countries such as Netherlands**

⇒ Conversion theory for socio-technical system focuses on fundamental causes such as social structure and culture, etc.

- pursuing fundamental changes rather than improvement of problems
- signifying the necessity of changes in technology, physical substructure, system, social values, perspectives, action and pattern of daily life

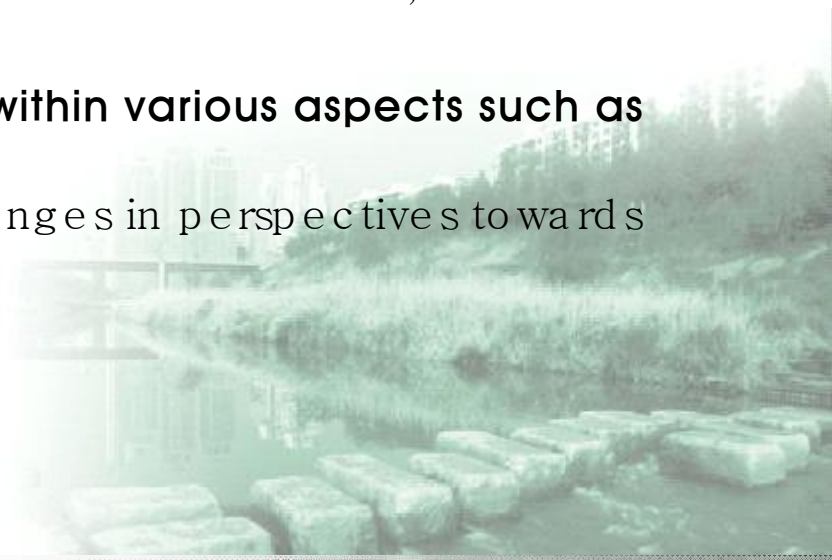
⇒ Hence, **new systems and methods** are required

2. Urban Infrastructure

New movements

❖ Movement towards **Green Infrastructure** of new paradigm is necessary, deriving decreases in urban energy resources consumption and efficient infrastructure system with spatial interrelation and multifunction

❖ For solutions to complexity of various issues occurred in cities, discussions for **Green Infrastructure** are required within various aspects such as **citizen participation**, living space and changes in perspectives towards technology and infrastructure



3. Green infrastructure of new paradigm

- Current paradigm ; Fast mostly underground water/wastewater conveyance and end-of-pipe storm and wastewater controls

- An attempt to design a new model is necessary

  ⇒ New model of urban planning and infra links to water, energy and resources

  ⇒ Singapore, Japan, Australia, UK, Germany, Sweden, Israel, UAE (Masdar), Canada (British Columbia, Toronto, Ontario)

  ⇒ MIT, Harvard and UC are conducting studies on the new model and, researches on planning sustainable community for the new model are being carried out in Milwaukee, Philadelphia and Portland of Oregon

- WWF(2008) insisted 50% reduction of water consumption especially in nations with huge water usage, aiming to sustainable development of future city by installation of water-saving facilities, isolating black and grey water and, recycling of grey water(Vladimir Novotny, 2013, Water-energy nexus: retrofitting urban areas to achieve zero pollution)

  ⇒ recovery of energy and nutrient are available from black water

3. Green infrastructure of new paradigm

LID, DRM, WSUD, NDS, NBS, GI, etc.

➢ **Green infrastructure**(GI, LID)(**USA**, **EPA**)

- **Natural Drainage**, **Circulational** stormwater management

- An approach that communities can choose to maintain **healthy waters**, provide multiple environmental benefits and support communities.

- **Unlike single-purpose** gray stormwater infrastructure, which uses pipes to dispose of rainwater, green infrastructure uses vegetation and soil to manage rainwater where it falls.

- By weaving **natural processes** into the built environment, green infrastructure provides not only stormwater management, but also **flood mitigation**, **air quality management**, **and much more**

➢ **Above all, GI offers us a smart, integrated way of managing our natural capital** (Building a green infrastructure for Europe, **European Commission**, **EU**, **2013**)

3. Green infrastructure of new paradigm

Green Infrastructure

➢ GREEN INFRASTRUCTURE AND THE SUSTAINABLE COMMUNITIES INITIATIVE

(2015.3, HUD, USA)

⇒ **Sustainable Communities Initiative(SCI) of HUD's Office of Economic Resilience**

- **Local community project to counter influences from climate change and disaster**

- **Green Infrastructure is very effective for economic management and investment on public infrastructures, rainwater management, water quality improvement and flood prevention**

- **Green Infrastructure is capable of reducing costs for future infrastructure management, promoting revitalization of community and providing resilience against climate change and extreme climate → Citizen participation, Urban regeneration, Environmental welfare**

3. Green Infrastructure of New Paradigm; LID

Green Infrastructure of New Paradigm
; LID stormwater Management

➢ Why is Green Infrastructure(GI)? Benefits of Green Infrastructure

- Economic solutions for development of both public and private sectors such as reduction of flood damage, improvement of water quality, reduction of CSOs

- Water usage reduction, heat island effect and reduced building energy consumption in urban areas through rainwater utilization and groundwater recharge
- Increases in discharge capacity of sewer, leading to job creation in construction and management fields
- Restoration and increase of wildlife habitats in urban areas
- Improvements of recreational amenities and public welfare in a local community
- Increase in property values followed by increase of green space
- Decrease in impervious surface and increase in amount of natural rainfall infiltration rate

-> benefits such as urban safety, welfare, employment, energy, ecosystem, resilience

4. Conclusions

Green Infrastructure & Switch of Socio-technology system

- **Green Infrastructure as a new solution to urban sustainability in the era of climate change, Worldwide urbanization rate is about 50%,**
  - Infrastructure determines competitiveness, livability and environmental welfare of city
  - Urban infrastructure plan, design and management need to be turned into eco-efficient and comprehensive to conclude living-friendly city with allure and competitiveness

- **Infrastructure that brings natural function into urban areas**

  ⇒ green infrastructure for future cities
  - firstly, including need of switch into **nature-based** water circulation infrastructure ; Circulating stormwater management
  - Keywords ; **Small, Smart, Natural, Multi, Decentralized**

- **Applying switching theory of socio-technology system**

4. Conclusions

Green Infrastructure & Switch of Socio-technology system

- The point is not to forget on the urban green infrastructure while developing a Smart City.
  Urban green infrastructure – as shown on the example of the urban heat island phenomenon – can provide solutions for the future city nevertheless green infrastructure is mostly“low-tech” and therefore not recognized as“smart”
  The urban green infrastructure approach – to see green structures equivalent to other “smart” infrastructures within a city – can help to fulfill this task.
  (Florian Reinwald et al., Urban Green Infrastructure Planning as a Contribution to the Smart “Green”City, Proceedings REAL CORP 2014)

- **Demonstration project for green infra**

Step 1 ; Restoration of natural stormwater circulation and water circulation of urban infrastructure(ecological environment, pollution purification, micro-climate and flood control contribution, etc.)

Step 2 ; Changeover of the existing Gray Infra to the green Infra for small-scale, decentralized community the convergence of resources, energy and land planning
Establishment of Green Infrastructure for Circulating Metabolism