“Innovative technology applications for urban disaster risk management”

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5. Wind generator capable of stable electric supply in case of disaster
Why LID Stormwater Management is Needed?
1. Why rainwater management is needed?

1. **Climate change**

- Higher temperature
- More rain
- Extreme weather
- Sea-levels are rising

- Average annual rainfall has slightly increased over the last century
- Variations in annual rainfall have significantly increased

1. Why rainwater management is needed?

2. Hydrologic characteristics

- **100% Green Ratio**
  - All Green, Natural Ground Cover
  - 10% runoff, 50% infiltration, 40% evapotranspiration
  - 100% Green Ratio

- **80~90% Green Ratio**
  - 80-90% Green
  - 20% runoff, 42% infiltration, 38% evapotranspiration

- **50~65% Green Ratio**
  - 35% evapotranspiration
  - 30% runoff, 35% infiltration

- **0~25% Green Ratio**
  - 55% runoff, 0% infiltration, 30% evapotranspiration
  - 0~25% Green Ratio
1. Why rainwater management is needed?

Urbanization

- Flooding
- Non-point source pollution
- Destruction in ecosystem
- Distorted water cycle
- Drought
- Dry stream
- Underground water level ↓

Energy for water management ↑

Energy consumption

Distorted heat cycle

Climate

Heat island

Tropical night
1. Why rainwater management is needed?

Examples of water-related problems:

- Flash flooding
- Water contamination
- Stream scouring
1. Why rainwater management is needed?

**5 Adaptation of climate change**

**Impacts of Climate Change**
- High Temperature
- Extreme Precipitation
- Shortage of Water
- Flash Flooding
- Heat Island
- Water Contamination

**Impacts of Urbanization**

**RWM**
- Produce a cooling effect
- Reduce stormwater runoff
- Provide an alternative water source

**Heat Control**

**Water Control**

**Water Supply**
Project description:
The Integrated Rainwater, Storm water and Wastewater Management Project in Cebu, Philippines
2. The Integrated Rainwater, Storm water & Wastewater Management Project in Cebu, Philippines

Introduction

◆ Project definition
  ▪ Pilot activity for the Philippines to develop and install in a public building a system capable of managing rainwater, stormwater and waste water treatment.

◆ International cooperation
  ▪ UN-ESCAP (Water Security Section of United Nations Economic and Social Commission for Asia and the Pacific),
  ▪ KOICA (The Korea International Cooperation Agency),
  ▪ KICT (The Korea Institute of Construction Technology),
  ▪ EREDE Co., Ltd.
  ▪ DOST7 (The Department of Science and Technology Region 7).

◆ Objectives of the project
  ▪ To strengthen the capacities of local government officials for the planning and management on the integrated rainwater and stormwater recycling system through the implementation of the pilot demonstration project
  ▪ To establish the model for integrated rainwater and stormwater recycling system in the selected building to demonstrate the eco-efficient approaches for water infrastructure
  ▪ To promote awareness and advocacy on eco-efficient water infrastructure development in the Philippines.
2. The Integrated Rainwater, Storm water & Wastewater Management Project in Cebu, Philippines

Outline of the project
• Site: DOST 7 Office Building, Cebu City, Philippines
• Project cost: US$45,000 from ESCAP
  ▪ Construction cost of the tanks supported by DOST 7
  ▪ MF system, MBR system, Remote controlling system
    donated by EREDE co. Ltd.
• Project duration: 2009-2010 (12 months)
• Information Source: http://www.ro7.dost.gov.ph/
2. The Integrated Rainwater, Stormwater & Wastewater Management Project in Cebu, Philippines

Application of Innovation Technology for the system construction

- **Design**
  - RainCity™ and Excel spreadsheet
  - Decision Support System

- **Techs**
  - Green filter
  - Storage tank
  - Micro-membrane filter system
  - MBR

- **Operate**
  - Ubiquitous Remote Management System

For rainwater & stormwater

For wastewater
2. The Integrated Rainwater, Stormwater & Wastewater Management Project in Cebu, Philippines

- Catchment area: 1,500 m²
- Rainwater tank: 60 m³
- Stormwater tank: 60 m³
- Treated water tank: 40 m³
- Supply tank on a roof: 9 m³
- First flush treatment device: W1,000 x L1,500 x H1,000 (Total 2set)
- MF system: 1 m³/hr (10 hr operation/day)
- Wastewater treatment (MBR): 10 m³/day (toilet flushing)
2. The Integrated Rainwater, Storm water & Wastewater Management Project in Cebu, Philippines

Pipe & Instrument Design (P&ID) of the system
2. The Integrated Rainwater, Storm water & Wastewater Management Project in Cebu, Philippines

Rainwater & stormwater harvesting system

Green filter (Applying innovation technology)

- Integrated system (Sedimentation and Filtration)
- No external power source is required
- Removal capability of nitrate, phosphate, and heavy metals as well as particles
- Filter media made of recycled wood: Environmentally friendly
- Patent No. 0516951 “Treatment facility and method for runoff from building rooftop”

Heavy Metals

```
F7 - Cu - Zn
```

```
Concentration (mg/L)
```

```
Time (min)
```

```
Fe  - Cu  - Zn
```

```
0  - 25  - 45  - 85  - 145
```

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Korea Institute of Construction Technology
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15
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2. The Integrated Rainwater, Storm water & Wastewater Management Project in Cebu, Philippines

Remote control and operating system (Applying innovation technology)
2. The Integrated Rainwater, Storm water & Wastewater Management Project in Cebu, Philippines

Reuse of stormwater and wastewater in the gardening of DOST 7

Plants and crops watered through the ISWM system.
Low Impact Development Technologies for Treatment of Stormwater Runoff
3. LID technologies for treatment of stormwater runoff

1 Definitions of the LID

Low Impact Development (LID) is a **stormwater management strategy** designed to maintain site hydrology and mitigate the adverse impacts of stormwater runoff and nonpoint source pollution. (U.S. Department of Defense, 2010)

Low Impact Development (LID) is an **ecologically-based stormwater management approach** favoring soft engineering to manage rainfall on site through a vegetated treatment network. (UACDC, 2010)

Low Impact Development (LID) is a land use planning approach **to reduce flood and water pollution considering infiltration, storage and water cycle system of stormwater or rainwater**. (Ministry of Land, Transport and Maritime Affairs, Guidelines on waterfront development, 2011. 11)
3. LID technologies for treatment of stormwater runoff

2 Technologies of LID

- **flow control**: The control of stormwater runoff flow rates
- **detention**: The temporary storage of stormwater runoff to reduce peak flow rates
- **retention**: The storage of stormwater runoff on site
- **filtration**: The sequestration of sediment from stormwater runoff
- **infiltration**: The vertical movement of stormwater runoff
- **treatment**: Process that utilize phytoremediation or bacterial colonies to metabolize contaminants in stormwater runoff

Ref.: UACDC(2010), LID a design manual for urban area
3. LID technologies for treatment of stormwater runoff

3 Facilities of LID

A : Vegetated filtration technologies
B : Infiltration technologies
C : Detention and retention technologies
D : Other technologies

From mechanical

A : Vegetated filtration technologies
B : Infiltration technologies
C : Detention and retention technologies
D : Other technologies

To biological

Increasing level of volume reduction
3. LID technologies for treatment of stormwater runoff

4 Multi-function (permeable-retentive-reflective) block

- Rainfall inflow to the block
- The material inside of block absorbed the rainwater

Runoff control

- Surface temperature control by evaporation and reflection of the block

Surface temperature control

- Rainfall
- Reflection
- Permeability
- Water-retention

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**Graph:**

- Normal block: Decrease → Maintain → Increase → Increase
- Permeable block: Decrease → Maintain → Increase → Increase
- Multi-function block: Decrease → Maintain → Increase → Increase

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3. LID technologies for treatment of stormwater runoff

5. Water retentive asphalt pavement

- Performance evaluation

<table>
<thead>
<tr>
<th>Pavement type</th>
<th>Daily Max. temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Summer (Aug)</td>
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<tr>
<td>Temperature</td>
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<tr>
<td>High density</td>
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<tr>
<td>Retentive</td>
<td>50.2°C</td>
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<tr>
<td>Natural ground</td>
<td>34.6°C</td>
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</tbody>
</table>
3. LID technologies for treatment of stormwater runoff

6. Water supply system for pavement

- Water supply system for retentive asphalt road

- Water supply system for multi-function block

Rain

Fair

Type 1

Type 2
3. LID technologies for treatment of stormwater runoff

7 Permeable hole block

- Surface
- Water Reserve wall
- High-density Porous Concrete
- Hole
- High Strength Concrete

Source: Mr. Baek, Daeil Tec. Co., Ltd.
3. LID technologies for treatment of stormwater runoff

8 Storage block

Differential settlement
Edge crack
Secure of Water Storage Space in block itself

Source: Mr. Choi, EcoTop Co., Ltd.
9. Tree box filter

3. LID technologies for treatment of stormwater runoff

Source: Dr. Heo, LID Solution Co., Ltd.
3. LID technologies for treatment of stormwater runoff

10 Infiltration street inlets

- Rainwater from the road ➔ street inlet ➔ infiltration chamber
- Overflow goes to the rainwater pipe
- The first flush inflow to the infiltration chamber and treated by materials

Source: Mr. Heo, LID Solution Co., Ltd.
3. LID technologies for treatment of stormwater runoff

**11 Infiltration lateral ditch**

- Reduce the water flow rate and infiltrate rainwater
- Crushed stone is put around ditch, rainwater is infiltrated through the side and bottom

Source: Dr. Heo, LID Solution Co., Ltd.
3. LID technologies for treatment of stormwater runoff

Rain garden

1. Pretreatment
2. After treatment, outflow to the rainwater pipe
3. After first flush, rainwater inflow
4. Reduce the pollutant by retention & filtration in the rain garden
5. Outflow from the rain garden goes to the storage tank
6. Rainwater use for gardening and cleaning

Source: Dr. Lee-Hyung Kim, Kongju National Univ
3. LID technologies for treatment of stormwater runoff

13 Tree protector & vertical infiltrators

- Tree protector and vertical infiltrator
- Function: Stormwater infiltration, non-point sources and soil erosion control

Source: Mr. Han, Earth Green Korea Co., Ltd.
3. LID technologies for treatment of stormwater runoff

14 First-flush treatment system

Basic system

Advanced System for High contaminant treatment
Korea National Green Infrastructure & Low Impact Development Center
4. Korea National Green Infrastructure & Low impact Development Center

National Smart GI and LID Research Group

Urban Green Water-Cycle Infrastructure Technology for Sustainable Low Impact Development

Smart Technology

GI
GREEN INFRASTRUCTURE

LID
LOW IMPACT DEVELOPMENT

Sustainable Water City

3H
High Efficiency
High Feasibility
High OPTIMALITY

3R
Reduction of flood
Reduction of pollution
Reduction of CO2

2C
Conservation of water
Conservation of energy

Korea Institute of Construction Technology
4. Korea National Green Infrastructure & Low impact Development Center

“SITE”  KOREA LID-VERIFICATION FACILITY

- Gyoungnam Yangsan-si 2nd Campus of Pusan National University

- The characteristics reflecting friendly water in Nakdong River

Site Condition

- Inside distributed national experimental facility complex
- Inside Pusan National University (offered by PNU)
- Completely furnished with infrastructure
4. Korea National Green Infrastructure & Low impact Development Center

LOCATION AND SITE PLAN
4. Korea National Green Infrastructure & Low impact Development Center

**LID OUTSIDE TEST-BED SITE (LID-TEST-BED)**

[Diagram of LID-TEST-BED site with zones labeled: Zone 1, Zone 2, Zone 3, Zone 4, Zone 5]
SITE STORMWATER SYSTEM (SS)

Outline
- Rainfall flow in test bed can be infiltrate and storage through LID or GI facilities.

LI D technologies
- Green Roof
- Porous Pavement
- Flow-Thorugh Planter
- Vegetated Filter Strip
- Rain Garden
- Bioretention
4. Korea National Green Infrastructure & Low impact Development Center (LID outside test-bed site)

ARCHITECTURAL LID TYPE

Outline
- Rain inflow: Rooftop, Road
- The rain inflow can be infiltrate and exclude through LID facilities.
- Infiltration water can be reuse

Key Map

Stormwater schematic diagram

Rain inflow: Rooftop, Road
Rain inflow can be infiltrate and exclude through LID facilities.
Infiltration water can be reuse
Eco-Efficient Water Infrastructure: LID & GI

4. Korea National Green Infrastructure & Low impact Development Center (LID outside test-bed site)

ROAD-LID ZONE

Asphalt Test pavement 1  Asphalt Test pavement 2  Concrete Test pavement 1  Concrete Test pavement 2

Pervious Asphalt  Pervious Concrete

Outline
• Road type LID facilities is to experiment for reduction effect of runoff, nonpoint source and heat island effect etc.
• The facilities is composed of pervious and impervious asphalt and pervious and impervious concrete
• Collection water can be reuse
4. Korea National Green Infrastructure & Low impact Development Center (LID outside test-bed site)

INDUSTRIAL LID ZONE

Outline
- Industrial LID facilities can be verify the effect of complex LID facilities
- Rain inflow in industrial LID facilities can be move to bioretention LID zone

Stormwater schematic diagram

Rainfall

IT-LID

Perforated pipe

MB 1 ~ 8

BR-LID

SD
4. Korea National Green Infrastructure & Low impact Development Center (LID outside test-bed site)

BIORETENTION-LID ZONE

Outline

- Bioretention LID zone collect the rain inflow from parking LID zone and industrial LID zone.
- Retention pond usually utilize landscape for park, but when the facility can be use exclude the rain inflow when it is raining.

Stormwater schematic diagram
Wind generator capable of stable electric supply in case of disaster
5. Wind generator capable of stable electric supply in case of disaster

Core Technology

- **Low Noise**
  - Proprietary blade shape restrains tip vortex and solves a noise problem.

- **Starts with Natural Wind**
  - Proved to self-start at a wind speed of 1.6m (w/o motoring).

- **Multiple Failsafes**
  - Self-stalling (driven by blade shpe)
  - Air Brake by centrifugal force
  - Wind pressure deflector
  - Electro-magnetic brake for forced shutdown

- **Low Speed, High Performance**
  - Achieves 43% power performance at a wind speed of 8m/h, in a wind tunnel
  - Generates twice the torque of conventional turbines at half the rotation speed.

- **Low Vibration**
  - Both ends of blades and axis connected to decrease vibration.
  - Internal vibration-proof system shuts out vibration of a generator.

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**Fail-safe Requirement**
Obligation to maintain a safe state of the wind power generator. (set by the Ministry of Economy, Trade and Industry, effective of April 1, 2005)
5. Wind generator capable of stable electric supply in case of disaster

<table>
<thead>
<tr>
<th>Content</th>
<th>Specification</th>
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</thead>
<tbody>
<tr>
<td>Rated Output</td>
<td>3 kw</td>
</tr>
<tr>
<td>Rotor Diameter</td>
<td>3.18 m</td>
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<tr>
<td>Cut-In-Out Wind Speed</td>
<td>2.5 ~ 17 m/s</td>
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<td>Voltage</td>
<td>220V / 50, 60Hz</td>
</tr>
<tr>
<td>Rated Wind Speed</td>
<td>12 m/s</td>
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<tr>
<td>Rated output speed</td>
<td>350rpm</td>
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<td>Blade material</td>
<td>Fiber Reinforced Plastics</td>
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<td>Generator type</td>
<td>Synchronous, gearless</td>
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<tr>
<td>Brake methods</td>
<td>Electronic control brake</td>
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<tr>
<td>Endurance Wind Speed</td>
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<tr>
<td>Weight (kg)</td>
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<tr>
<td>Tower Height</td>
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<td>Work temperature</td>
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<tbody>
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<td>Rated power</td>
<td>10kW</td>
</tr>
<tr>
<td>Rated Output</td>
<td>3 kw</td>
</tr>
<tr>
<td>Rotor diameter</td>
<td>7.1m</td>
</tr>
<tr>
<td>Cut-in-Out wind speed</td>
<td>3m/s - 25m/s</td>
</tr>
<tr>
<td>Grid tie type</td>
<td>Three phase 400V.50~60Hz.20A</td>
</tr>
<tr>
<td>Rated wind speed</td>
<td>10.5m/s</td>
</tr>
<tr>
<td>Rated output speed</td>
<td>180 RPM</td>
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<tr>
<td>Blade material</td>
<td>Carbon Fiber Composite</td>
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<tr>
<td>Blade Pitch Control</td>
<td>hydraulic pitch cylinder</td>
</tr>
<tr>
<td>Brake methods</td>
<td>Pitch and hydraulic disc brake</td>
</tr>
<tr>
<td>Weight (tower except)</td>
<td>1,850 Kg</td>
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<tr>
<td>rated frequency</td>
<td>50-60Hz</td>
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<tr>
<td>Total Tower height</td>
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<tr>
<td>Work temperature</td>
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<table>
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<td>Max. effect</td>
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<td>Rotor area</td>
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<tr>
<td>Operating area</td>
<td>3 - 25 m/s</td>
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<td>Output</td>
<td>3 x 400V / 50 Hz / 20 A</td>
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<td>Full effect from</td>
<td>8.5 m/s</td>
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<td>Speed regulation</td>
<td>Pitch via hydraulic</td>
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<td>Number of blades</td>
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<td>Tower height</td>
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5. Wind generator capable of stable electric supply in case of disaster

Grid-connected wind turbine generator system

Independent wind turbine generator system
Thank you

Joint Presenter

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