

The 9th AWCI ICG Meeting and the 2nd CCAA Study Workshop

Korea Report on CC Adaptation and Water Nexus

September 29, 2012

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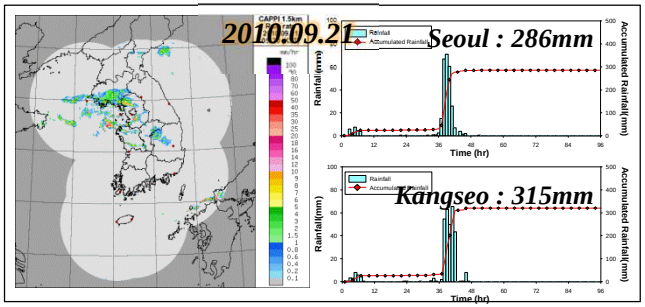
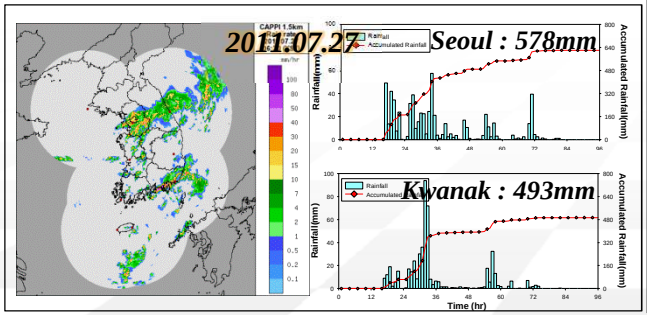
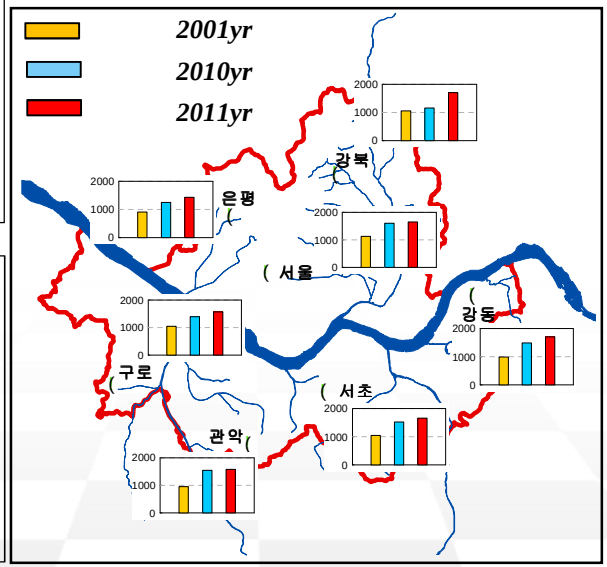
Recent abnormal heavy rainfalls

2010 & 2011years rainfalls in Seoul





Amount of Rainfall for Flood Season



Rainy days & total rainfall(July-Sept.)

Year	Rainy days (Rate, %)	Rainfall amount (mm)
2001	33 days (-)	981.1 mm
2010	56 day (69.70)	1394.6 mm
2011	47 day(42.42)	1640.1 mm

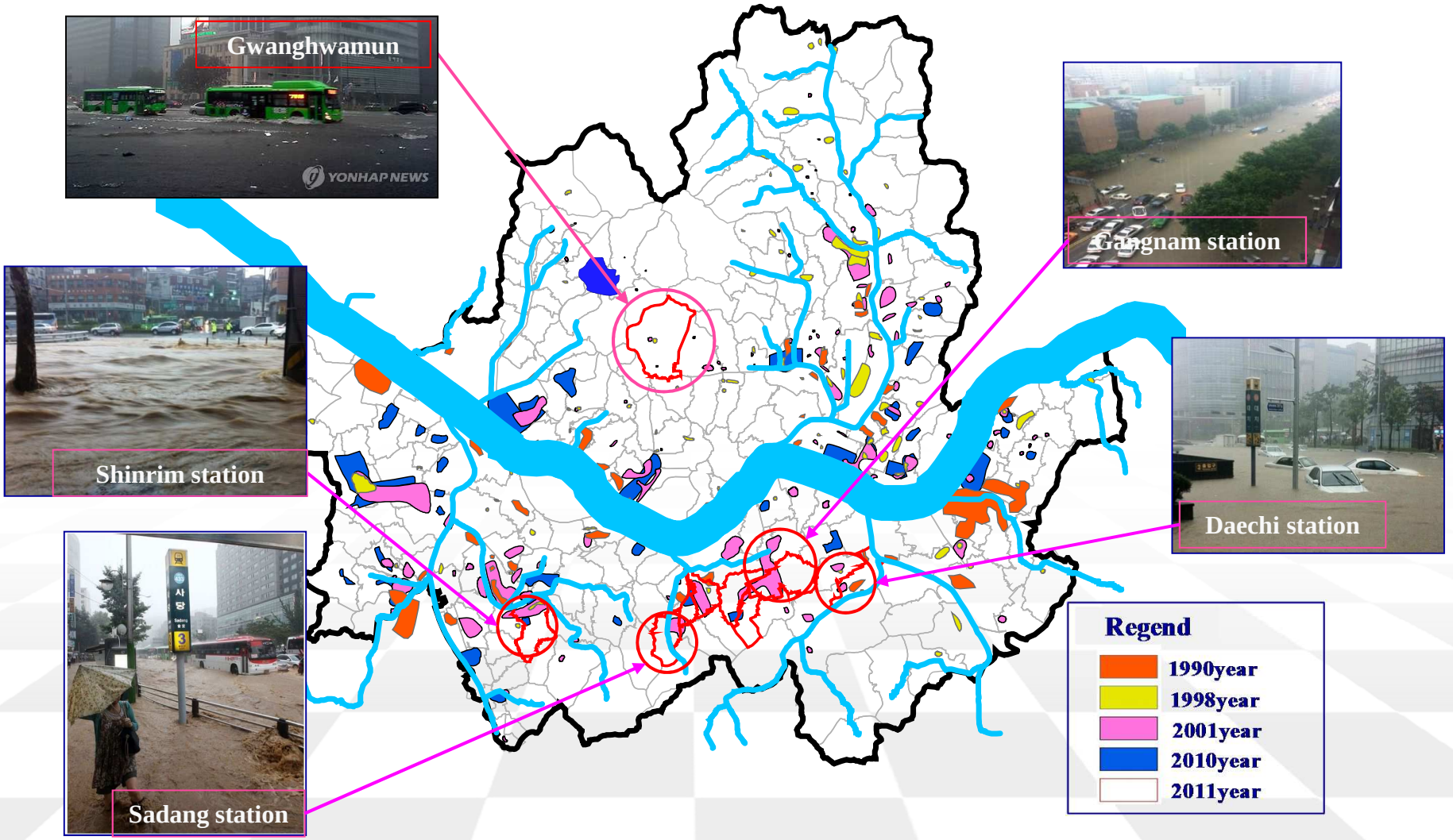
Max & Min Rainfall in Seoul

Year	3-hr max rainfall region	3-hr min rainfall region
2001	213.0 mm	155.0 mm
2010	198.5 mm	78.0 mm
2011	202.0 mm	100.0 mm

Remarks

1. Increase of rainy day
2. Increase of rainfall amount
3. Increase of 3-hr rainfall
4. Higher spatial difference in rainfall

➢ Flooding areas (2010, 2011 years)



Climate Change Impact Assessment in Urban Drainage System

High-Resolution Climate Chage (CC) Projection

- Simulation of precipitation for future design rainfall analysis

✓ Spatial resolution : 5km×5km, Temporal resolution : hourly

Climate Scenario

A2 Scenario
ECHO-G
400km×400km

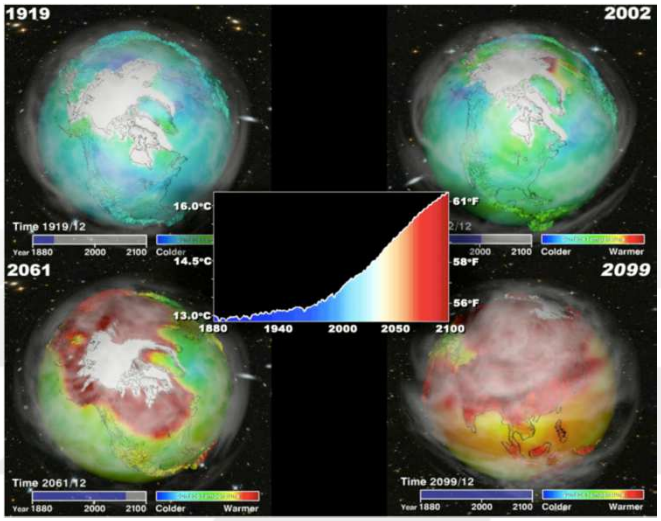
Downscaling

Dynamic
Downscailing
RegCM3
60km×60km

RegCM3 (60km)

20km
Atmosperic

5km
Landsurface

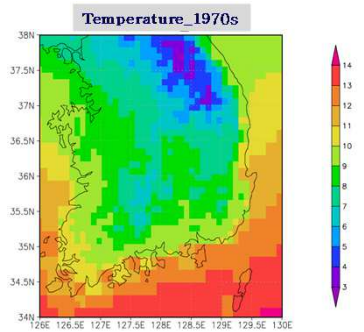


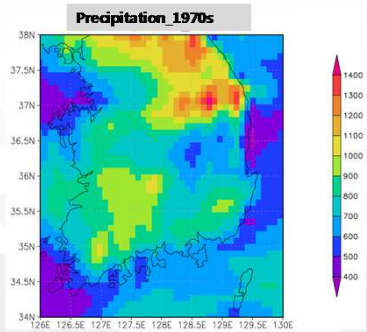
Results

Seoul
5km×5km

Analysis

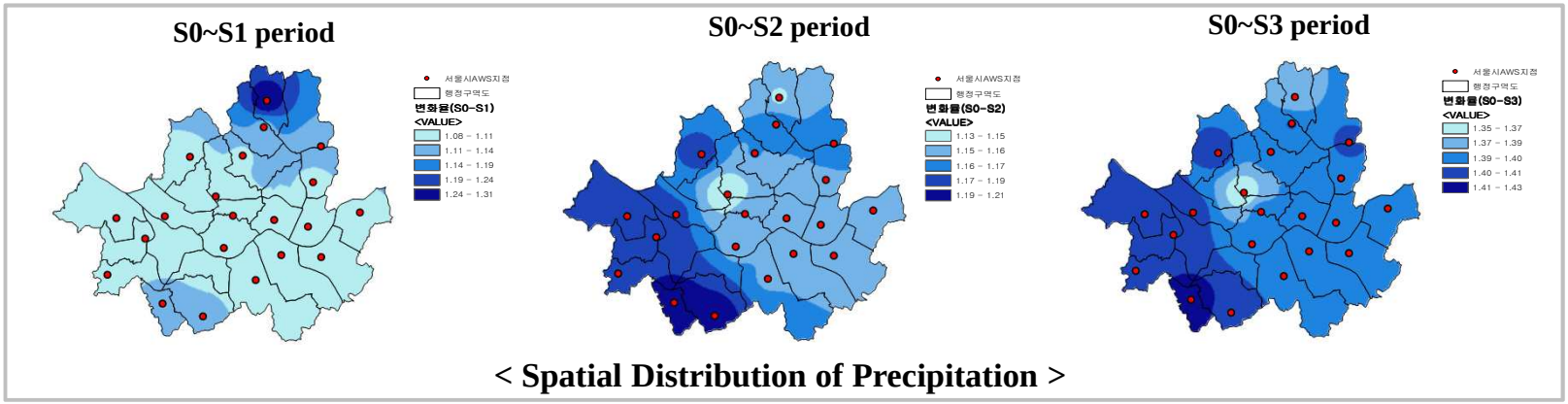
Climate
Prediction



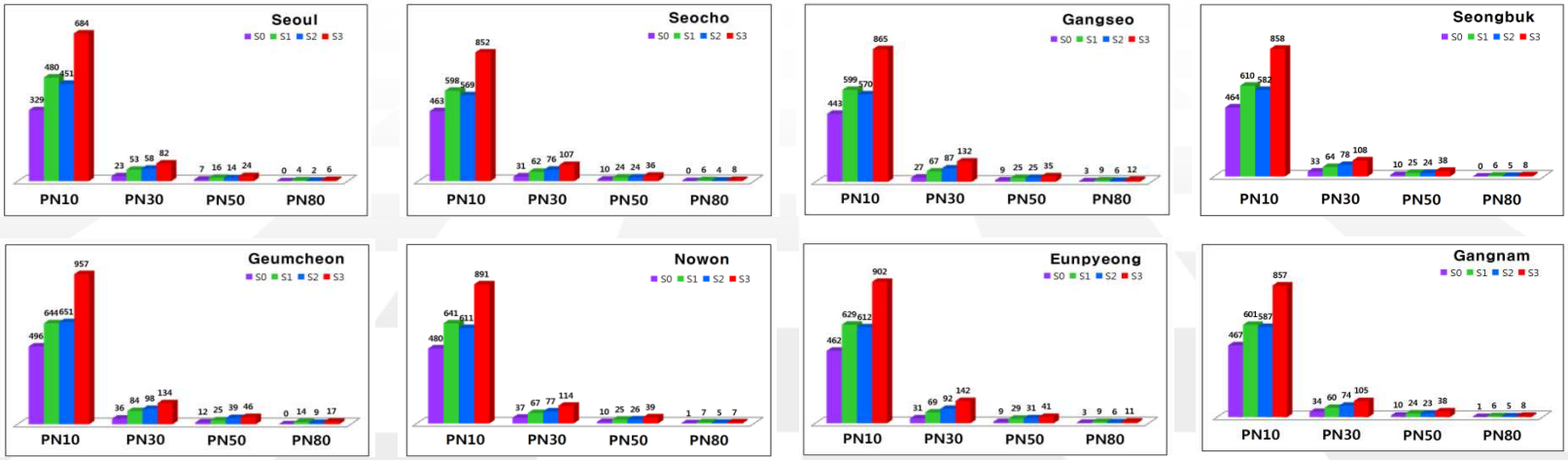


➢ Evaluation of future precipitation changes

- **Periods : S0(1971~2000), S1(2011~2040), S2(2041~2070), S3(2071~2100)**
- **Increase the spatial variability of precipitation**
- **The extreme rainfall event(over 80mm) is expected to be increase**



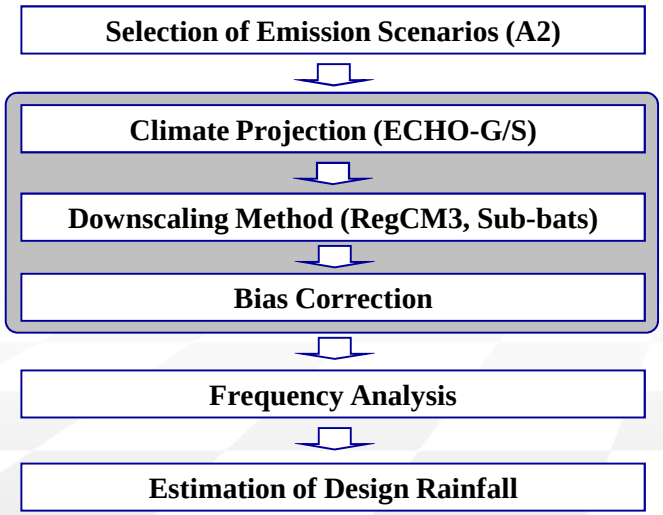
< Spatial Distribution of Precipitation >



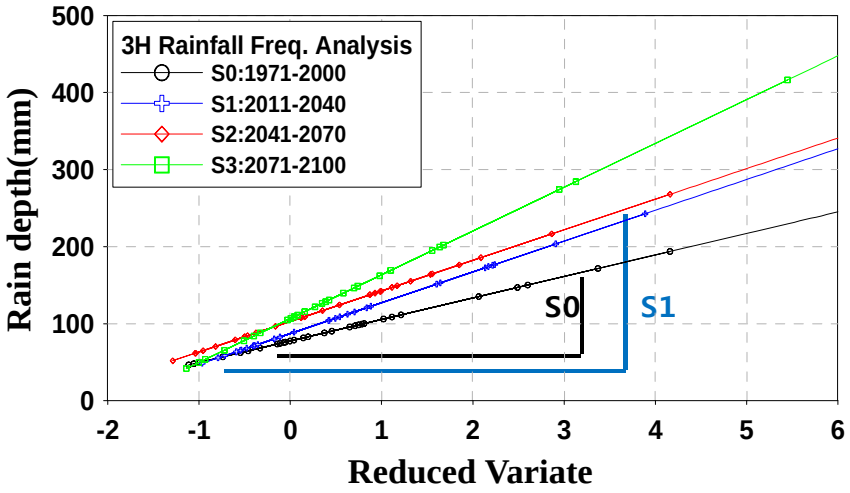
< Number of Rainy Days >

Estimation of future probability rainfall

- **Estimate the probability rainfall using Change Factor Method**
- **Increase the future probability rainfall**
  - ✓S1(30%↑), S2(38% ↑), S3(80% ↑) for 3hr duration



<Estimation Procedure of Future Probability Rainfall>



Return Period	Duration (180min)		
	2011-2040	2041-2070	2071-2100
30-year	1.31	1.38	1.77
50-year	1.31	1.38	1.79
100-year	1.32	1.39	1.82

<Increase of Probability Rainfall for the Future Preiods>

➢ Future design rainfall analysis

※ Currunt Design criteria of flood control facility (Seoul)

Facility	Classification	Design Criteria (frequency)
Stream	Main	100year
	Tributary	50year
Sewer	Main	30year
	Branch	10year
Pump	-	30year
....,	-	-

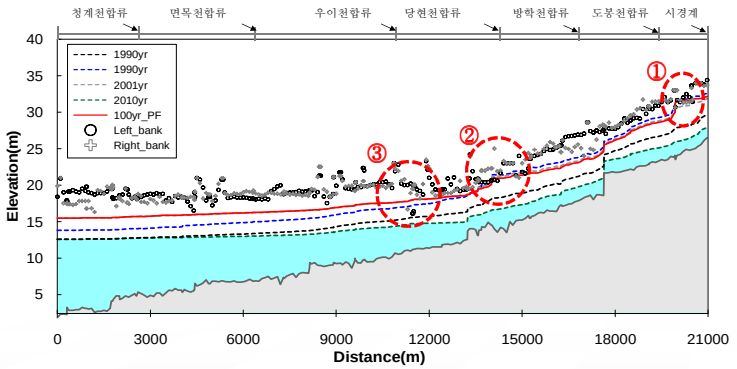
- ✓ In 60min design rainfall, 30-year rainfall of S0 is similar to 10-year rainfall of S1 period.
- ✓ In 240, 360min design rainfall, 100-year rainfall of S0 is similar to 50-year rainfall of S1 period.
- ✓ Need to increase the urban design rainfall

Return Period		Duration								
		1	2	3	4	6	12	15	24	48
S0	10yr	76.5	113.3	142.5	157.5	182.6	223	238.6	282.7	334
	30yr	93.5	139	176.7	195.6	225.4	273.9	294.7	354.5	419.5
	50yr	101.2	150.8	192.3	212.9	245	297.2	320.3	387.3	458.5
	100yr	111.7	166.6	213.3	236.3	271.3	328.6	354.8	431.5	511.1
	200yr	122.1	182.3	234.3	259.7	297.6	359.8	389.3	475.5	563.5
S1 (2020year)	10yr	87.1	125.8	161.4	161.3	195.7	232.9	251.3	307.2	367.9
	30yr	109.4	157.3	204.0	201.6	242.8	285.8	310.2	386.1	468.1
	50yr	119.7	172.0	223.5	219.8	264.5	309.9	337.0	422.0	513.7
	100yr	133.6	191.5	249.7	244.6	293.5	342.7	373.2	470.6	575.4
	200yr	147.4	210.7	275.8	269.4	322.5	375.1	409.3	518.7	636.8
S2 (2030year)	10yr	94.1	134.5	172.9	193.8	207.2	237.2	257.5	335.3	437.9
	30yr	119.4	168.9	219.8	248.4	259.7	291.5	319.2	428.0	567.9
	50yr	131.0	184.9	241.3	273.1	283.8	316.2	347.4	470.5	627.2
	100yr	146.7	206.2	269.9	306.5	316.1	349.8	385.2	527.5	707.3
	200yr	162.3	227.3	298.7	340.1	348.3	383.1	423.1	584.2	787.0

Estimation & evaluation of flood level in stream

- Evaluate the design flood level considering CC impact in main stream of Seoul
- Overflow areas are increased under current design frequency in almost all streams

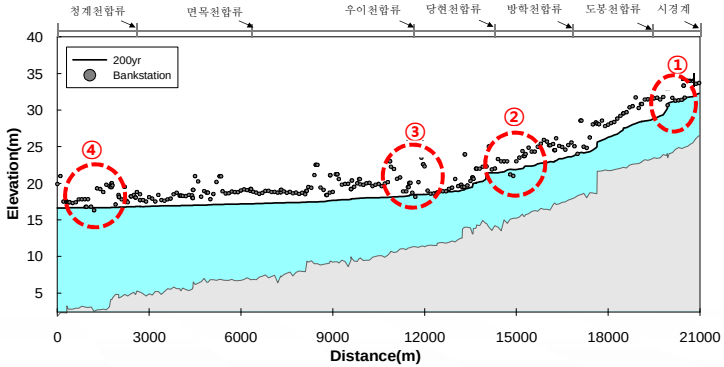
Current Design Frequency(S0, 100yr)



Flood Risk Analysis

Basin	Overflow height(m)	Risk level	Number
Jungrang Stream	h<0.5	△	6
	0.5<h≤1.0	□	1
	1.0<h≤1.5	○	-
	h>1.5	☆	-

Future Design Frequency (S1, 100yr)



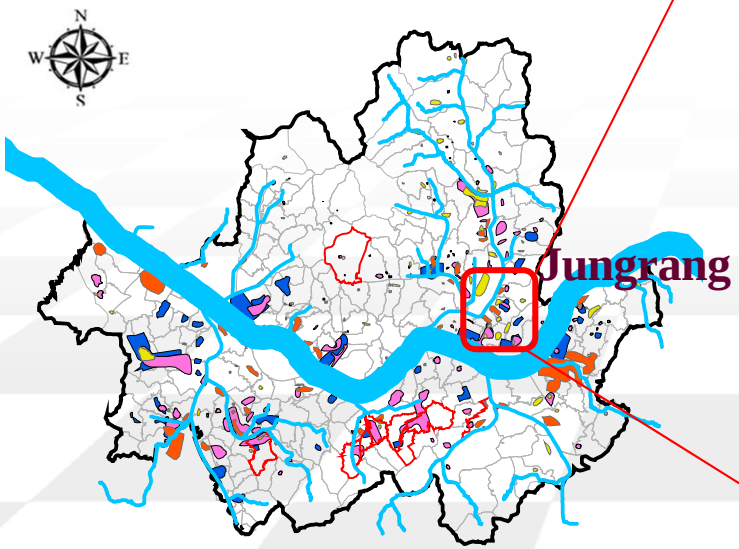
Flood Risk Analysis

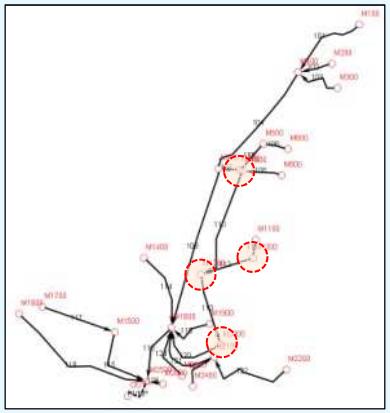
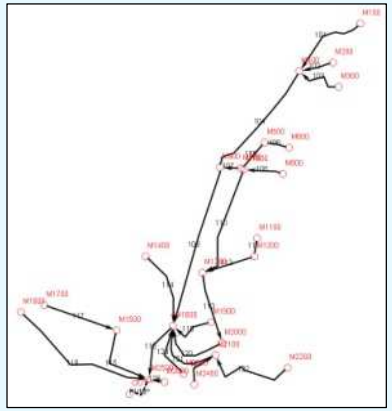
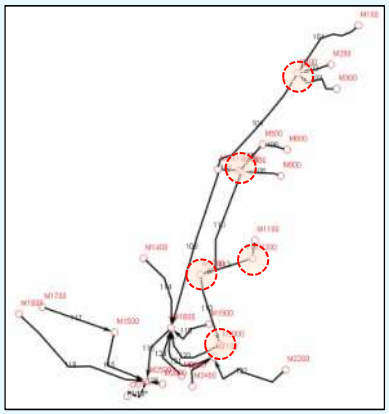
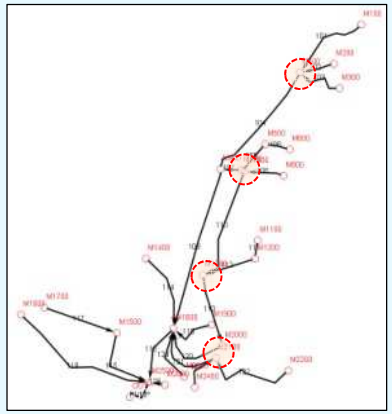
Basin	Overflow height(m)	Risk level	Number (existing)
Jungrang Stream	h<0.5	△	4(6)
	0.5<h≤1.0	□	3(1)
	1.0<h≤1.5	○	-
	h>1.5	☆	-

Evaluation of drainage capacity

➢ **Drainage capacity is evaluated before & after the investment plan of facilities**

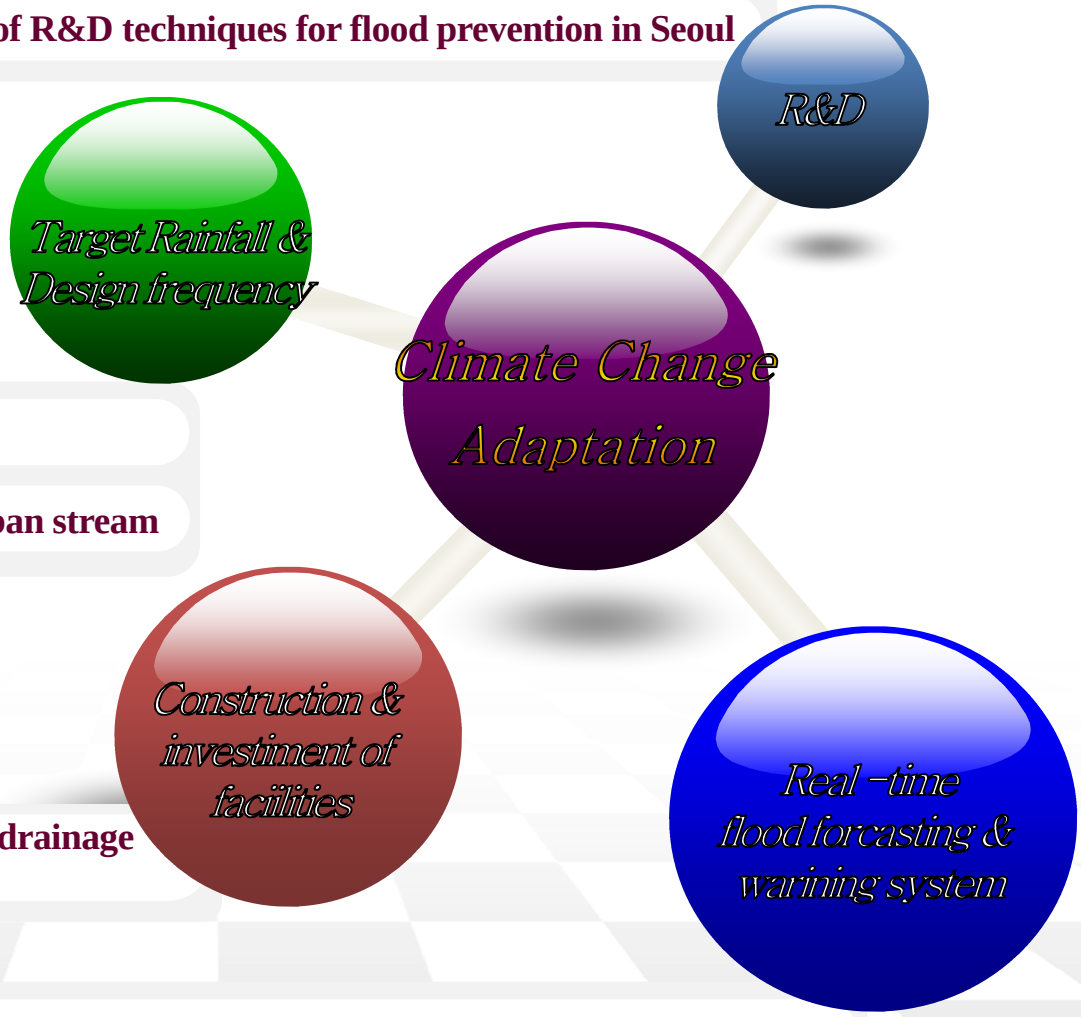
- **Evaluation event**
  - ✓ Sept.21, 2010 heavy rainfall
  - ✓ Target year : S2(2030yr)
- **Main facilities**
  - ✓ Sewer, Storage, Pump
- **Analysis model : SWMM**



Current Condition	After Investment
2010yr : 1hr maximum rainfall 71mm/hr	
	
Target year : 1hr maximum rainfall 94mm/hr	
	

Suggestions for Climate Change Adaptation

- ✓ Development of R&D techniques for flood prevention in Seoul



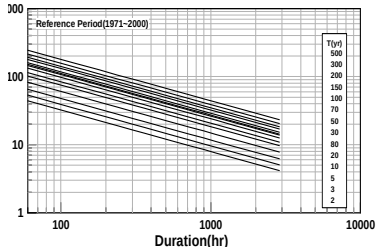
- ✓ Establishment of target rainfall
- ✓ Increase of design frequency for urban stream
- ✓ Consistent increase of investment for drainage facilities
- ✓ Research center of urban weather service for next generation
- ✓ Development of urban flash flood guidance system

Suggestion 1 : Establishment of Target Rainfall

Establishment of target rainfall for the climate change adaptation

Frequency Analysis

Rainfall data (over 30years) → Application of distribution function → Parameter Estimation → Determination of optimal distribution → Estimation of probability rainfall



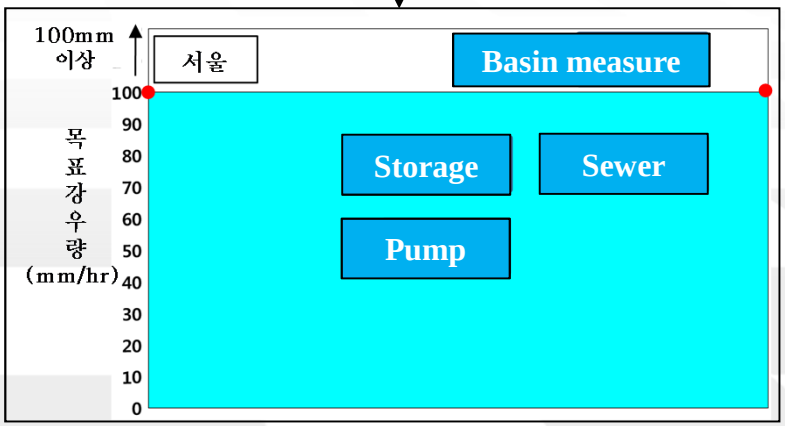
- Problem of design method based on frequency analysis
  - Annually, re-estimation of probability rainfall due to additional precipitation
  - Induction of different design frequency
  - Difficulties for integrated management of facilities [ex:sewer(10yr), pump(30yr), storage(30yr)]
- Need to estabilish the concept of integrated urban disaster prevention for CC adaptation

Application of target rainfall for Urban disaster prevention

- Determination of target rainfall that is able to do integrated disaster prevention performance of facilities
- Transformation of probability frequency criteria to disaster performance criteria

- The comporehesive flood prevetion plan
  - middle & upstream area : sewer, storage, infiltration facilities
  - Downstream area : observance of pump station & detention pond design criteria

Target Rainfall(100mm/hr)



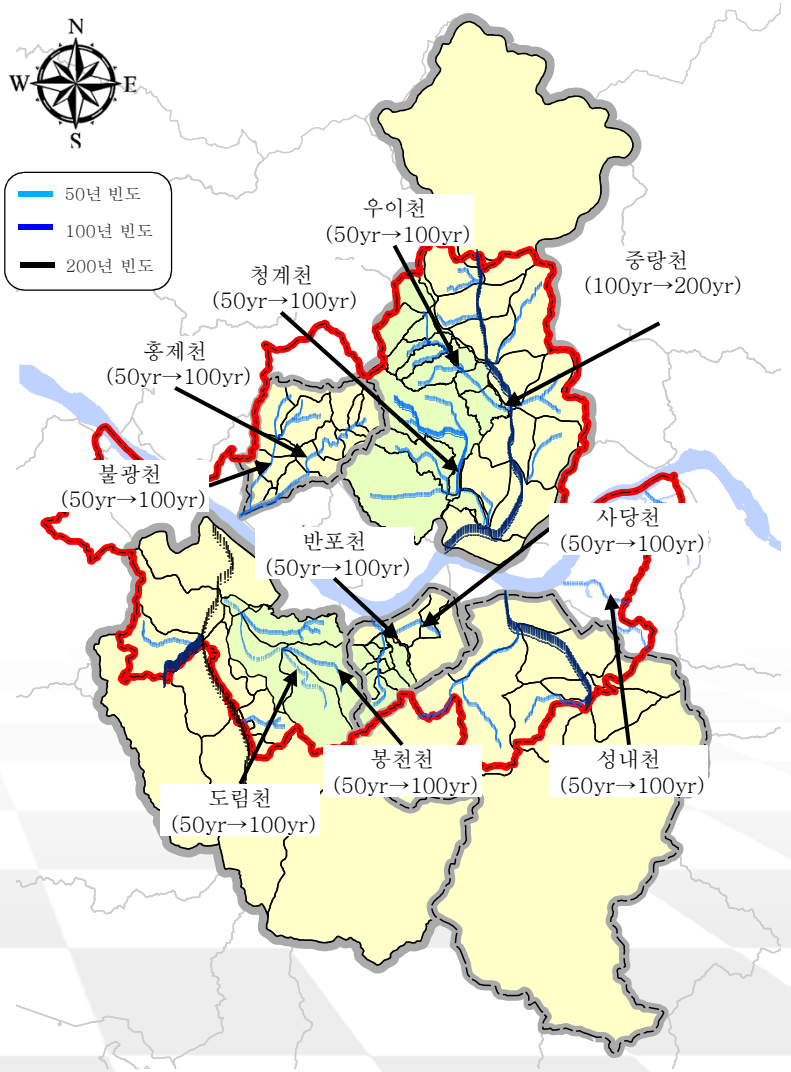
Suggestion 2 : Increase of Design Rainfall Frequency

Increase of design frequency for urban stream

- **Need to ensure the safety against inundation risk to adapt climate change**
- **Design frequency of Seoul stream : 50yr, 100yr, 200yr**
- **Need to enhance design rainfall frequency in urban streams**

<Proposal of Design frequency of urban stream in Seoul>

Basin	Current frequency (year)	New frequency (year)
Jungrang	100	200
Hongje	50	100
Banpo	50	100
Ui	50	100
Cheonggye	80	100
Dorim	50	100
...,	-	-



<Current and Suggested Design Frequencies>

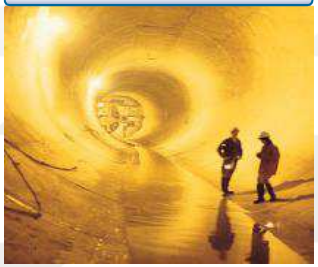
Suggestion 3 : Consistent Increase of Investment for Drainage Facilities

Underground facilities for flood management

- **Lack of space for constructing facilities of flood management on the ground in Seoul**
- **Expation & upgradation of current facilities is not feasible to overcome flood risk in the future**
- **Need to construct underground facilities for water management efficiently and stable**

Japan

U.S.A



Contry	Purpose	Capacity & Standard
Japen	▪ Improvement of water quality ▪ Eliminaion of flood risk	▪ (main line) D8.5mX2.2km ▪ (branch line) D3.0mX4.7km
Singapore	▪ Water reuse ▪ Improvement of drainage system	▪ D3.3~6.0mX45.7km
U.S.A (TARP)	▪ Improvement of water quality ▪ Eliminaion of flood risk	▪ D3.0~11.0mX176km ▪ Storage 3,783,000㎥
Spain	▪ Improvement of water quality ▪ Eliminaion of flood risk	▪ 10 retaining facilities ▪ Storage 2,634,000 ton
Malaysia	▪ Eliminaion of flood risk	▪ D11.8mX9.7km ▪ Storage 1,000,000㎥

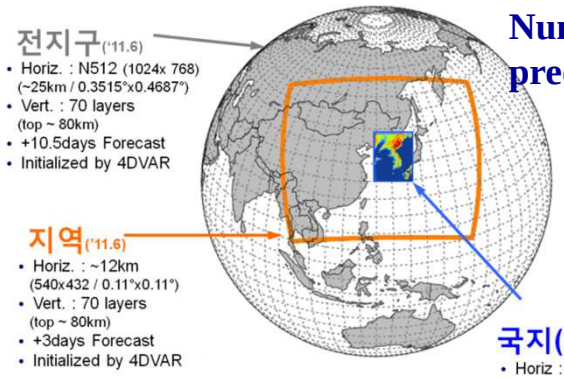
Plan to invest and construct

- **Selection of flood pron area**
- **Structural analysis for constructing of underground facilities**
- **Feasibility study**

<Ex: Planning Large scale drain tunnel(item)>

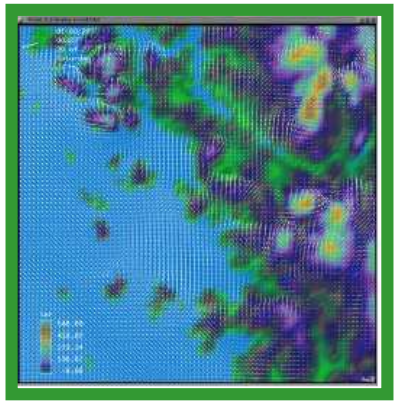
Suggestion 4 : Urban Weather Sevices for Next Generation

National Institute of Meteorological Research



Numerical prediction

국지(재해) ('12.6)
- Horiz : 1.5km (744x928)
- Vert. : 70 layers (top ~ 39km)
- + 12 hrs Forecast
- Initialized by 3DVAR (FGAT, IAU)



Development of weather prediction technique for urban area

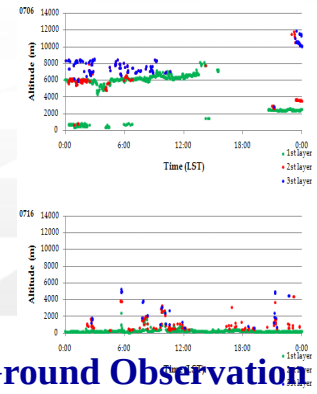
- **Service : +1hr~3hr forecast data every 20min**
- **Spatial resolution : 1km~200m**

Verification & Evaluation

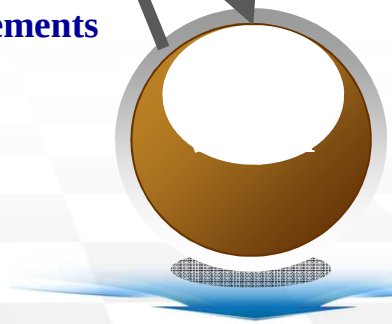
Insert

High resolution meteorological forecast

Customer requirements



Ground Observation



Development of state-of-the-art flood prevention system of urban area

Suggestion 5 : Development of Urban Flash Flood Forecasting System

Technique of urban flash flood guidance

- Urban flash flood is increaing by severe rain storm
- Flood forecast based on rainfall-runoff model is limited to forcast the flash flood occurence in advance
- Development of prediction method that is able to forcast flood using simple input data is required
- Flow nomograph that is useful to predict the flood is adopted

Set up the hydrological model

↓

Determination of Standard flood level at selected location

↓

Collection of weather forcast data

↓

Estimation of flood discharge

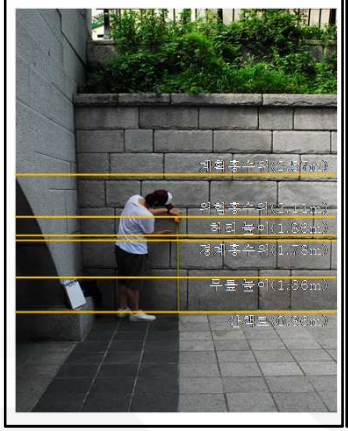
↓

Flotting Flownomograph

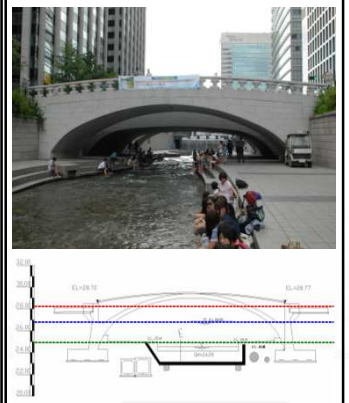
Station location

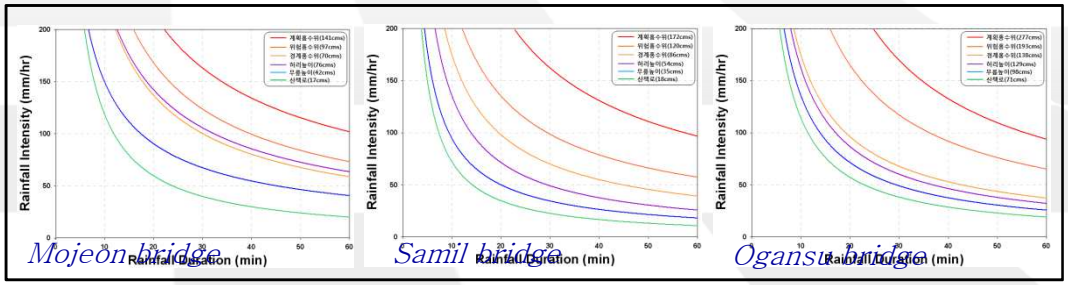
Cheonggye

Standard flow level



Channel section





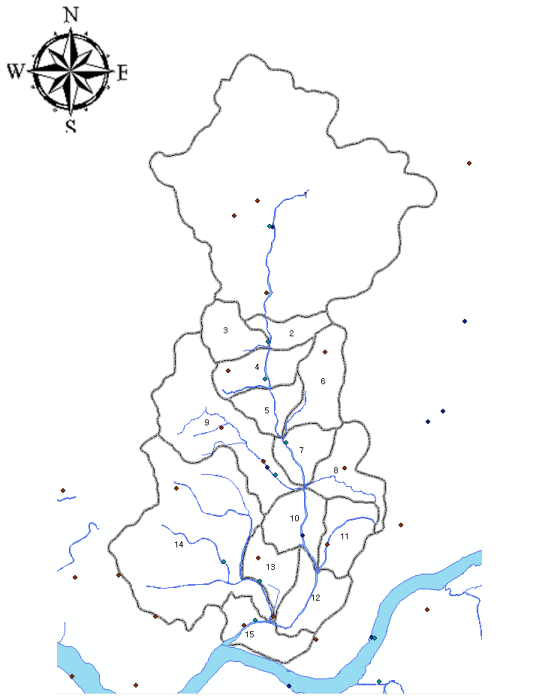
Mojeon bridge　Samil bridge　Ogansu bridge

Suggestion 6 : Development of R&D Techniques

Development of R&D techniques for flood prevention in Seoul

- Development of Urban flood design method for the Korea style through case analysis in and outside the country
- Development of technology for estimating design rainfall and quantity of flood in urban area
- Evaluation of flood risk and Development of technology for optimal division of basin flood
- Development of flash flood forecasting technique In Seoul city

The Operation of the Urban Experimental Basin



< Urban Experimental Basin : Junrang river>

Drawing up of Urban drainage control manual preparing for Climate change


Thank you for your attention!