12th International Urban Planning and Environment Association Symposium

Evaluating Meteorological Observation Network to Analyze Urban Thermal Environments

June 3, 2016.

Korea Institute of Civil Engineering and Building Technology

Hyomin Kim*, Seunghyun Jung, Hansaem Kim

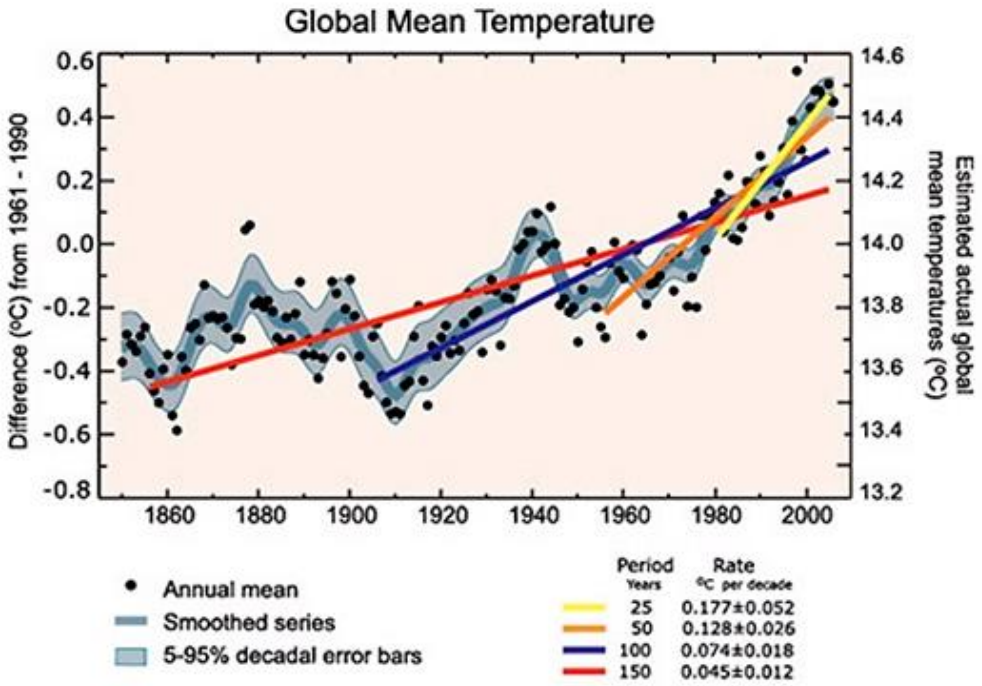
Contents

Ⅰ. Introduction

Background

- The earth has been warming rapidly.
- For the last 100 years, a mean temperature of the earth has been increased by 0.74℃.
- Temperature rise->climate change->natural disaster->loss of life and property

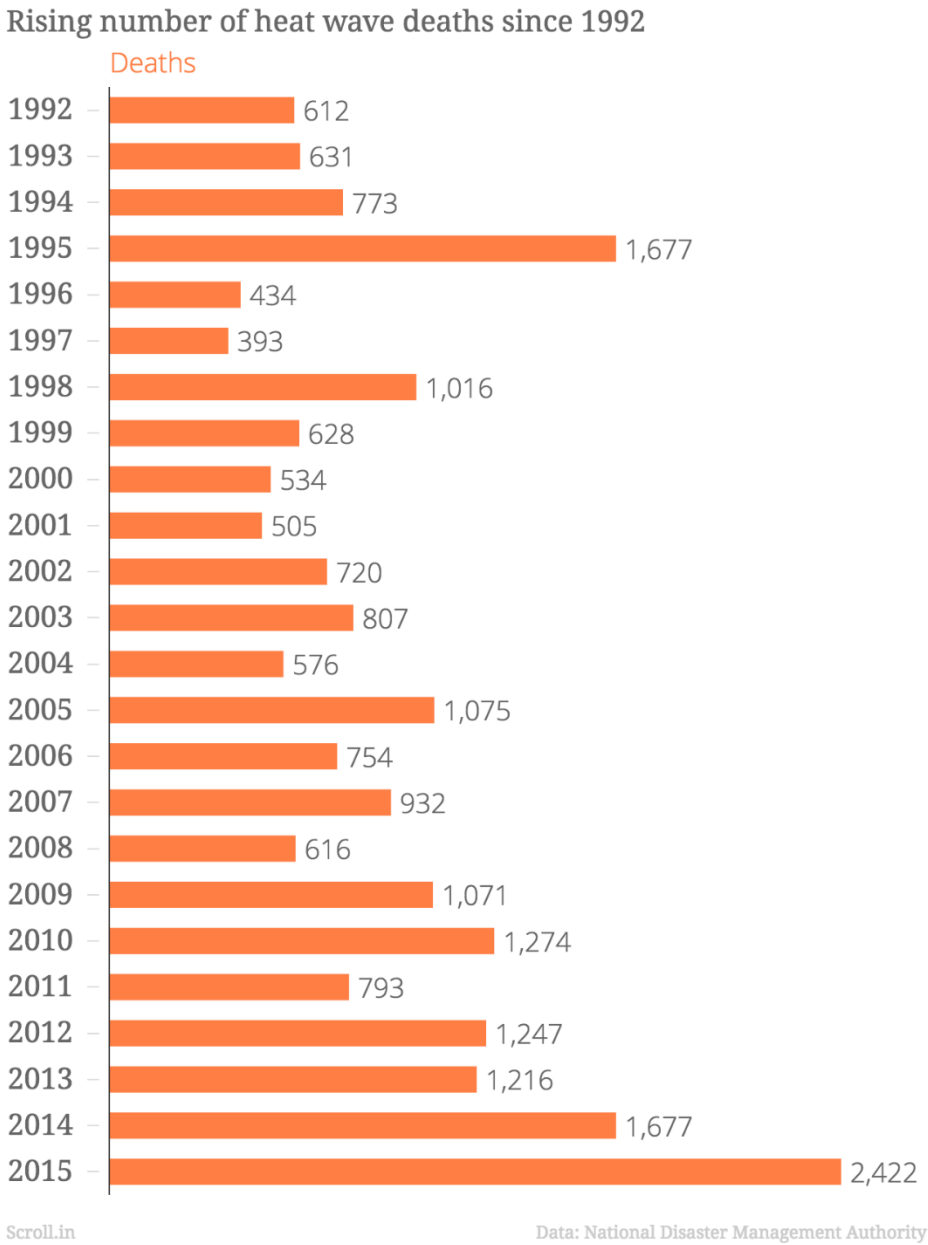
http://egloos.zum.com/rkrkrk22/v/296904



IPCC 제4차 평가보고서

Background

- Heat wave is one of the most fatal climate changes that cause a great damage.
- The number of casualties due to heat wave has been increasing continuously.
- A frequency of heat wave will be Once a 20-year -> Once a 2~5-year (ref. WHO)



Objectives

- Therefore, it is now necessary to analyze and predict the urban thermal environment accurately to cope with the problem.
- Nonetheless, the number of the temperature observatories in Seoul is not enough
- An effective range of each observatory shall be identified before additional installation of the automatic weather system(AWS).

1) Evaluating Meteorological Observation Network to Analyze Urban Thermal Environments

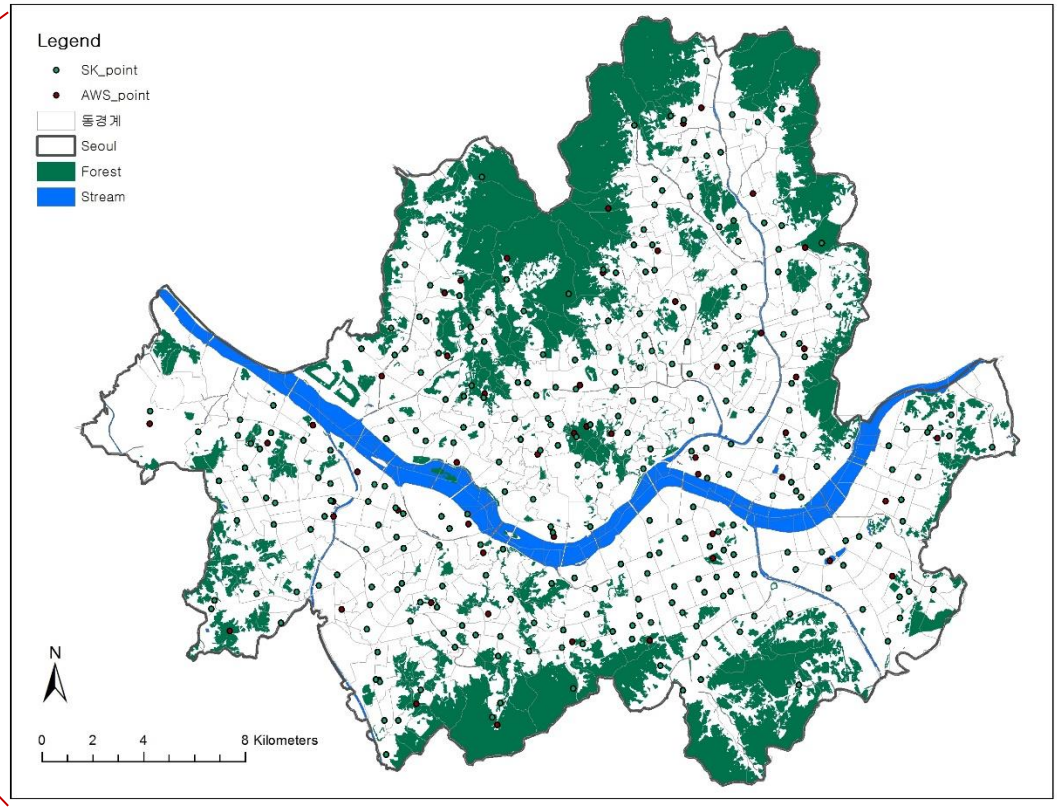
2) Selecting Suitable area for Installation of Automatic Weather System

Ⅱ. Method

1. Spatial scope

- Seoul city, Korea(Area : 605.41km^2)

- 45% of Seoul is more than 70% of an impermeable pavement ratio
- Green/open space : 30% of Seoul



2. Evaluating Meteorological Observation Network

Identify data scope

- July 7th, 2014
- (without rain, cloud, weak wind)

Select of data source

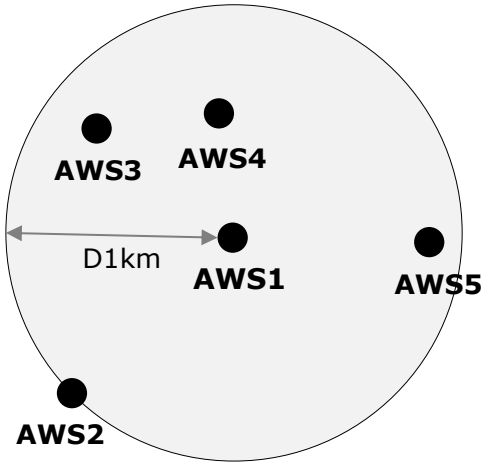
- Korea Meteorological Administration(KMO)
- SK techx

Spatial autocorrelation analysis

Deduction of Correlation coefficient

Calculation of Effective range(radius)

Identity of suitable installation spacing



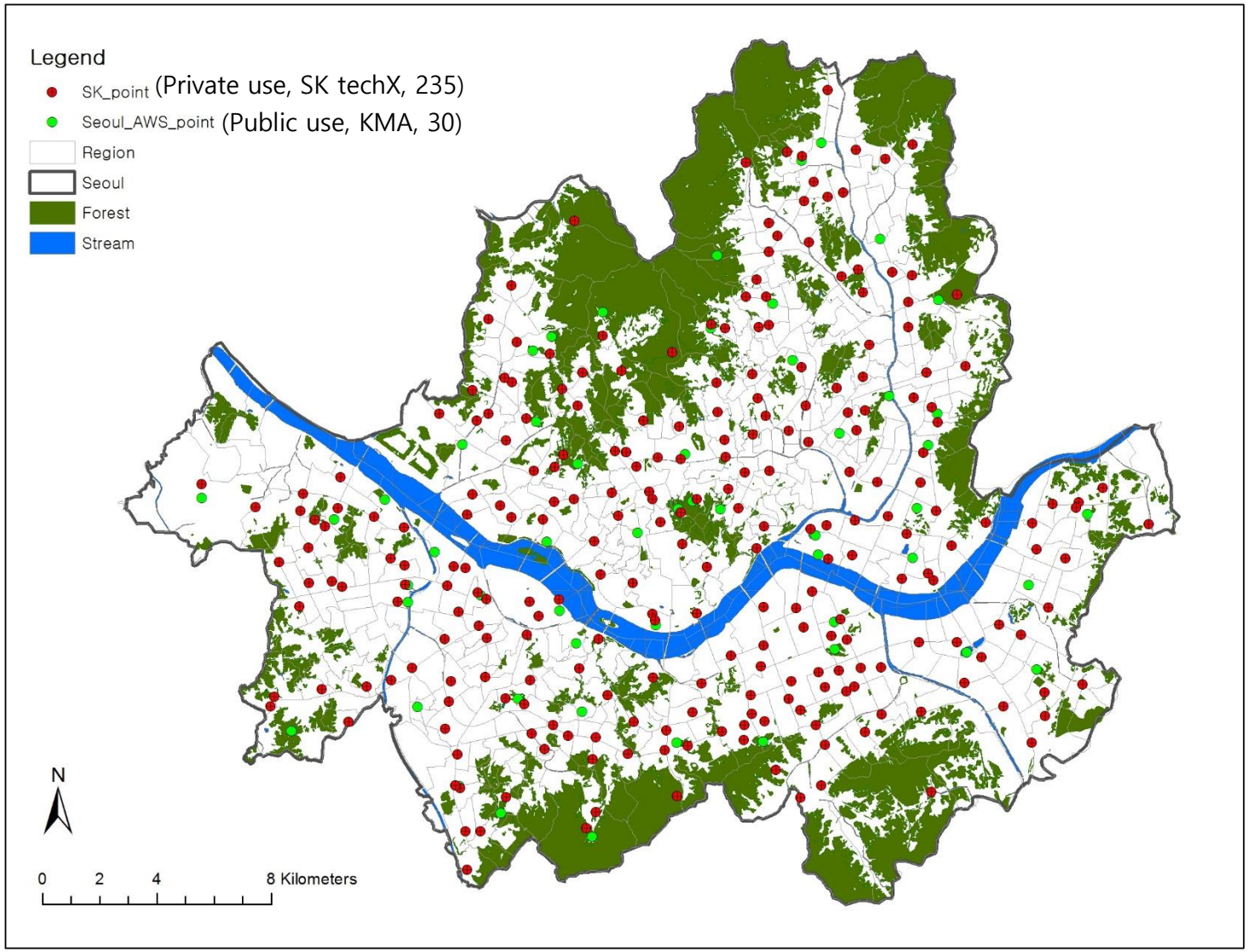
<Location of the AWS diagram>

$$R = \sqrt{\frac{(\frac{l_c}{2})^2}{\pi}}$$

<Function of calculating the effective range>

2. Evaluating Meteorological Observation Network

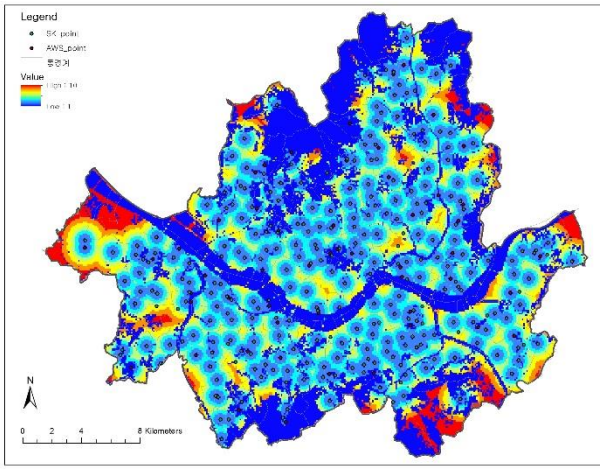
Distribution of meteorological observation



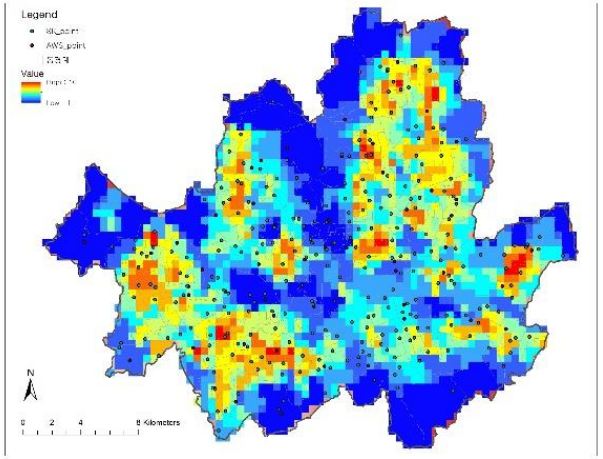
3. Selecting Suitable area for Installation of AWS

Criteria of priority installation of AWS

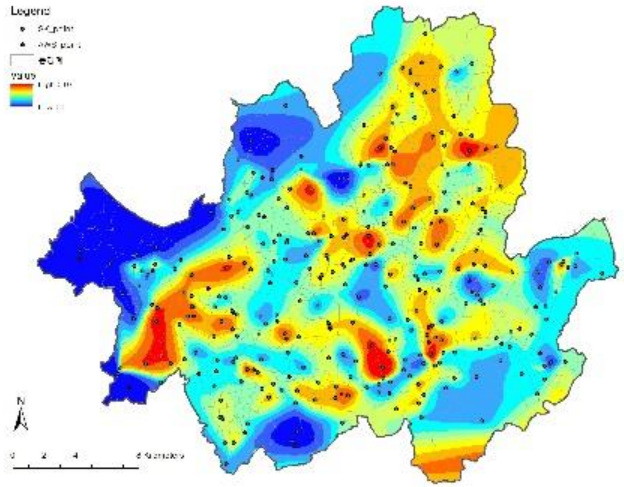
1) A place far away from existing meteorological observatory
2) A region affected much by the urban heat island due to dense population
3) A region where urban heat island occurs frequently
4) Mountain, river and streams are excluded.
5) Public facilities such as schools or community centers



Distance from the AWS



Population density

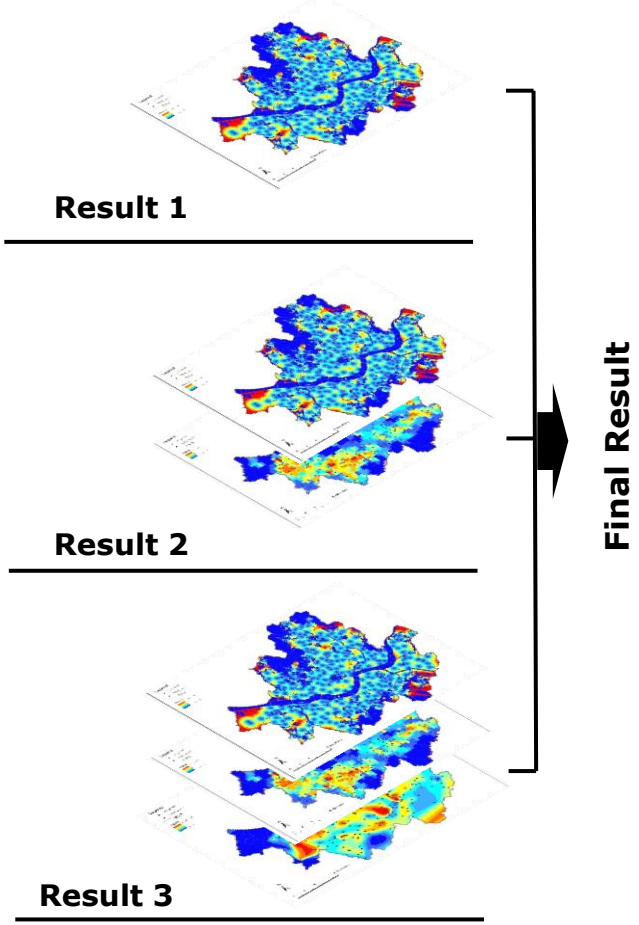


temperature

3. Selecting Suitable area for Installation of AWS

Integration of the variables

- Parameters was scored into 10 categories using a natural breaks
- The scored parameters were overlaid step by step on the basis of a variable of distance from the AWS.
- Extracting a region whose score was high from the three drawings
- Selecting by iterating the process more than twice.



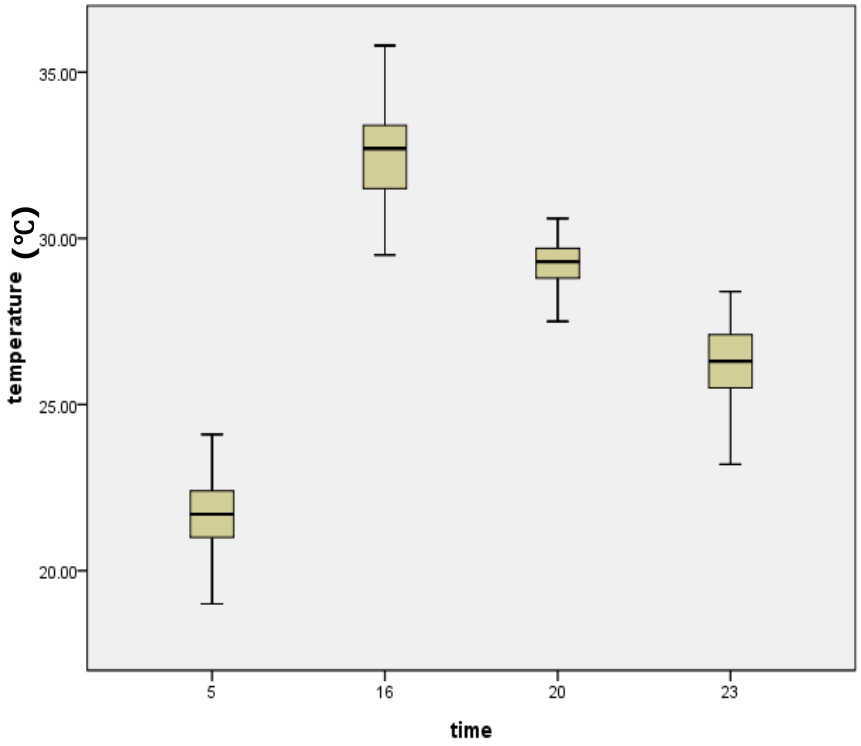
Variables		Analysis unit	Reference	-
Distance from AWS	Seoul city	100m	KMA	Excluded in mountain, stream
	SK TechX	100m	SK TechX	
Population density		1km	NSO	Data processing
Temperature		100m	SK TechX	Average July 7th, 2014 12-15 pm

Ⅲ. Results

1. Evaluating Meteorological Observation Network

1) Temperature dispersion of target time

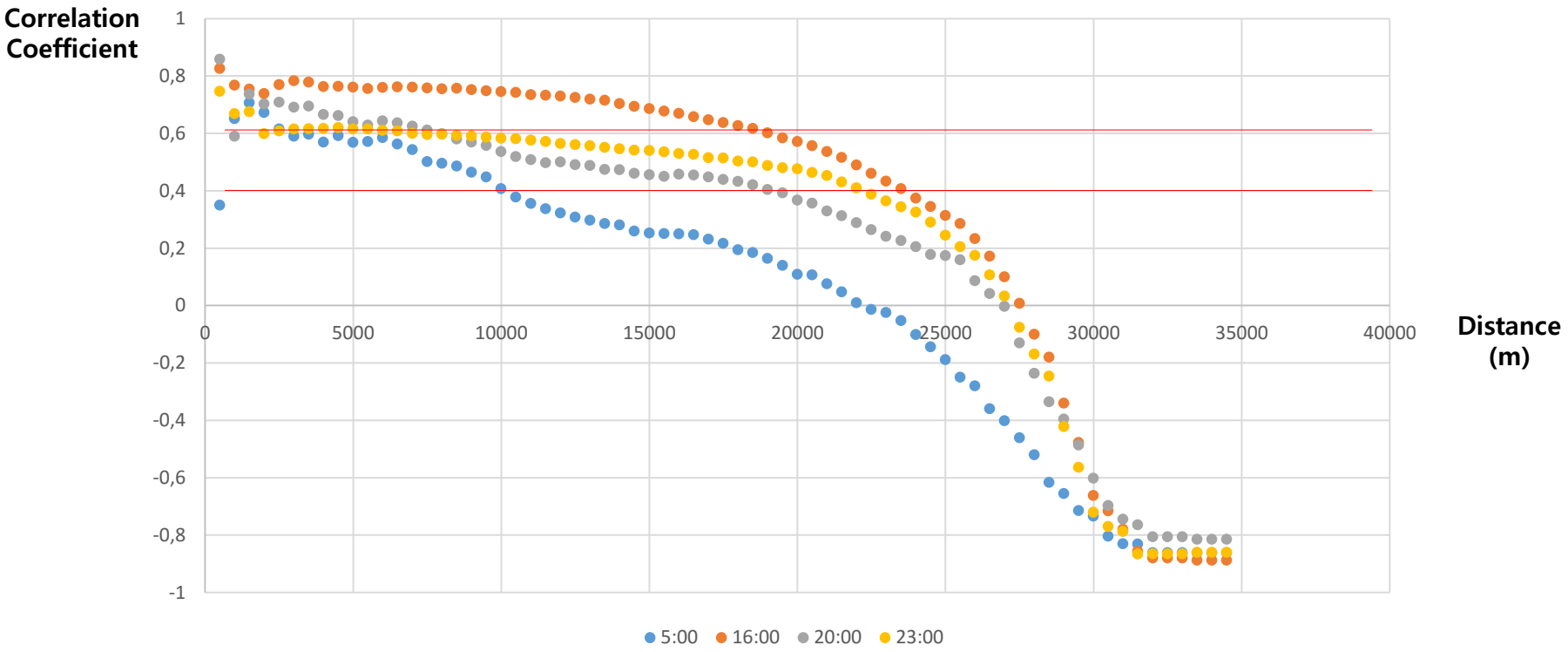
- 5 am : prior to the sunrise, lowest temperature in a day
- 4 pm : highest temperature in a day, most vulnerable time to heat
- 8 pm : just after the sunset, heat island is most noticeable
- 11 pm : 3hr after the sunset, heat island is most noticeable



	N	average	SD	Median	Min	Max
5am	246	21.68	0.97	21.7	19.00	24.10
4pm	244	32.49	1.25	32.7	29.50	35.80
8pm	247	29.22	0.6	29.3	27.50	30.60
11pm	249	26.23	1.1	26.3	23.20	28.40

1. Evaluating Meteorological Observation Network

2) Correlation distance and effective radius of temperature



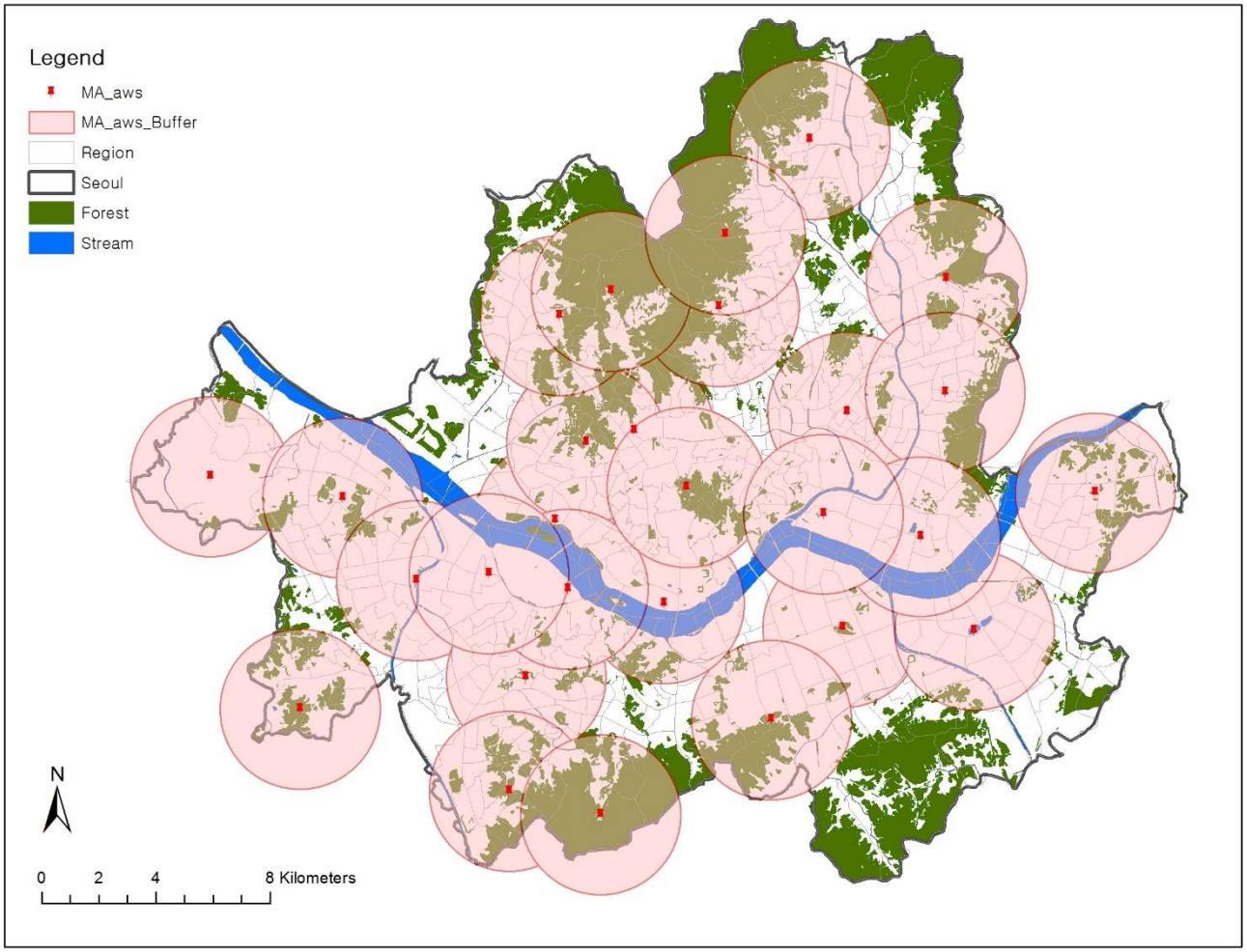
Time	Correlation coefficient > **0.6**	
	Correlation distance	Effective radius
5am	**2.6km**	**0.73km**
4pm	**19.0km**	**5.36km**
8pm	7.7km	2.17km
11pm	6.5km	1.83km

Time	Correlation coefficient > **0.4**	
	Correlation distance	Effective radius
5am	**10.0km**	**2.82km**
4pm	**23.5km**	**6.63km**
8pm	19.0km	5.36km
11pm	22.0km	6.21km

1. Evaluating Meteorological Observation Network

3) Effective radius of Meteorological observation network

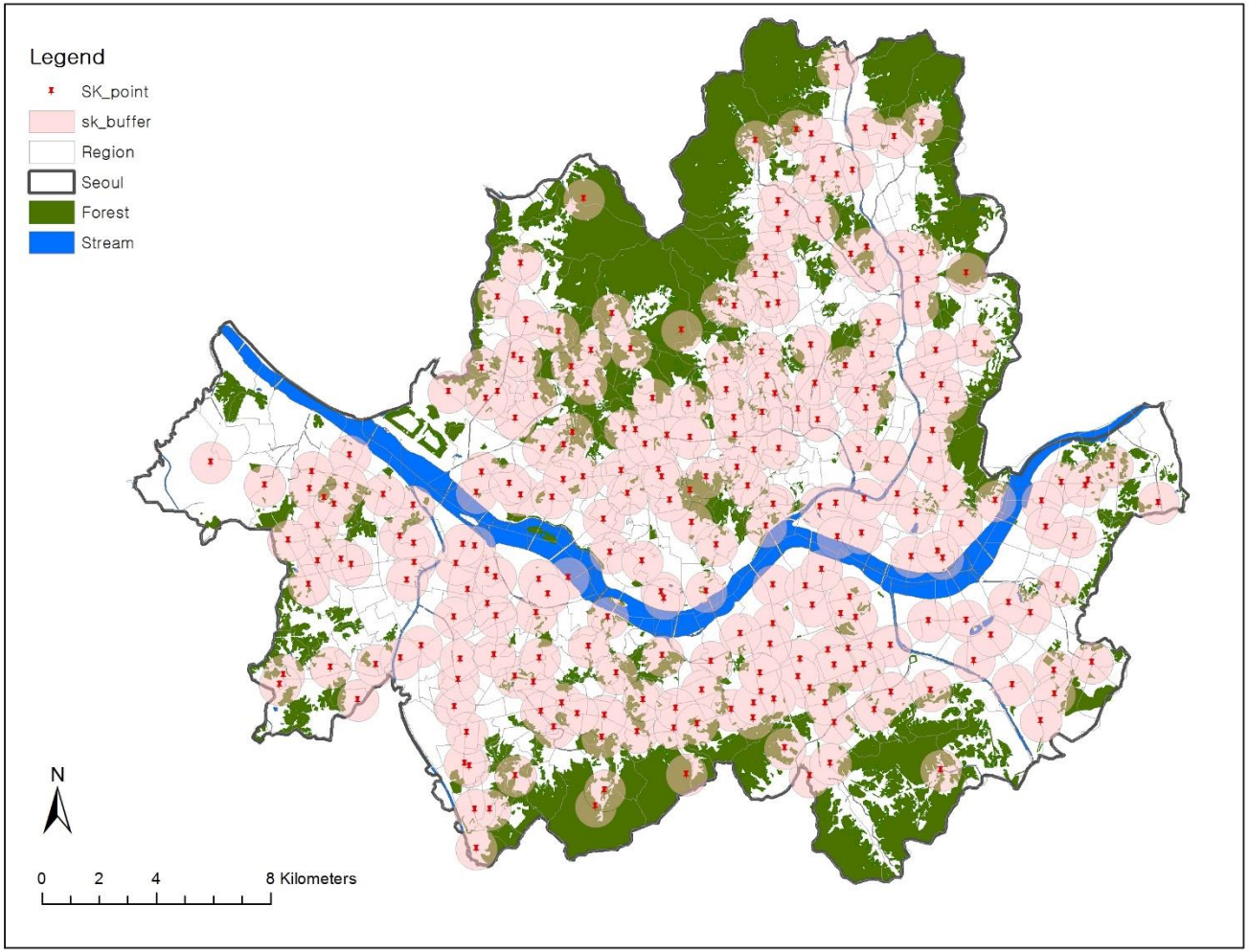
- Based on the meteorological agency AWS, Effective radius **2.8km (ρ>0.4)**



1. Evaluating Meteorological Observation Network

3) Effective radius of Meteorological observation network

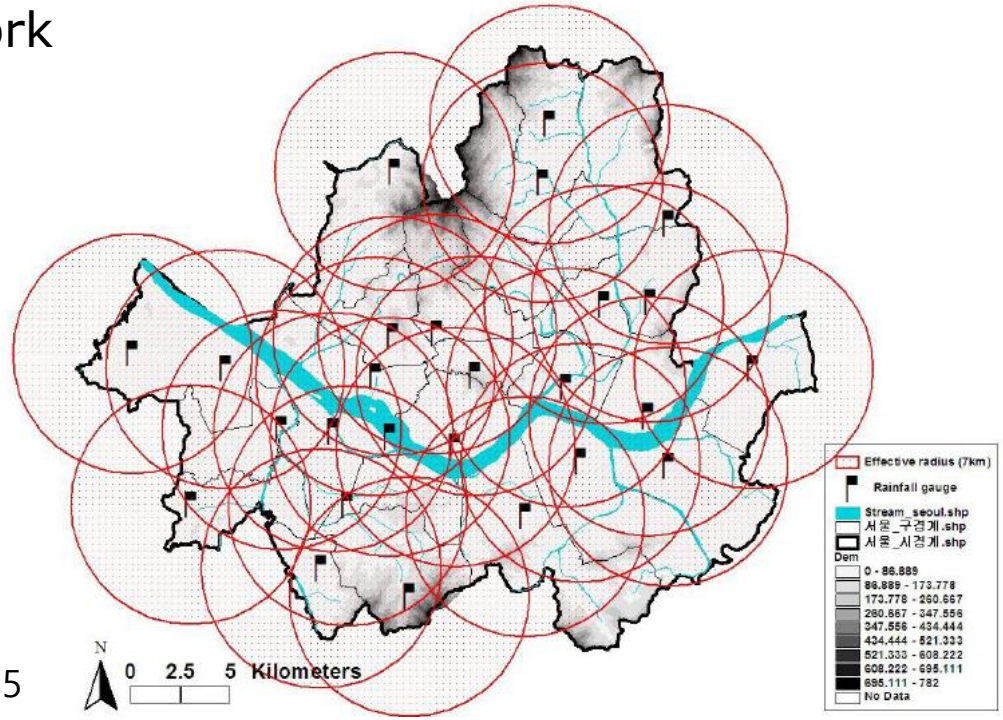
- Based on the SK TechX, Effective radius **730m(ρ>0.6)**



1. Evaluating Meteorological Observation Network

4) Comparison to Rain-gauge observation network

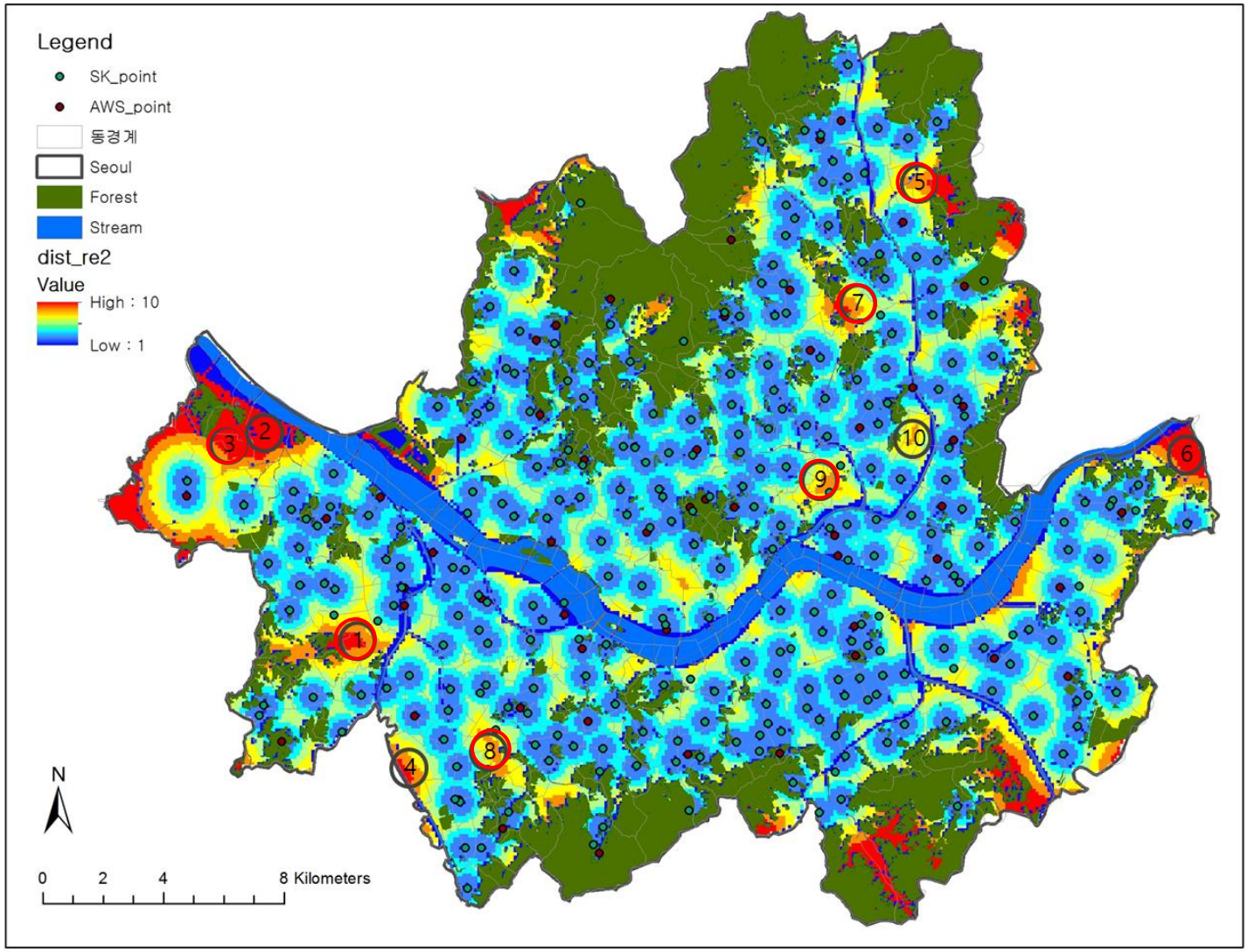
- According to Park et al.(2015), effective radius of the rain-gauge network in Seoul was 7 km.
- Effective radius of the temperature was 2.8 km
- An effective radius of the temperature network was smaller than that of the rain-gauge network



Park et al., 2015

2. Selecting Suitable area for Installation of AWS

1) Distance from the AWS

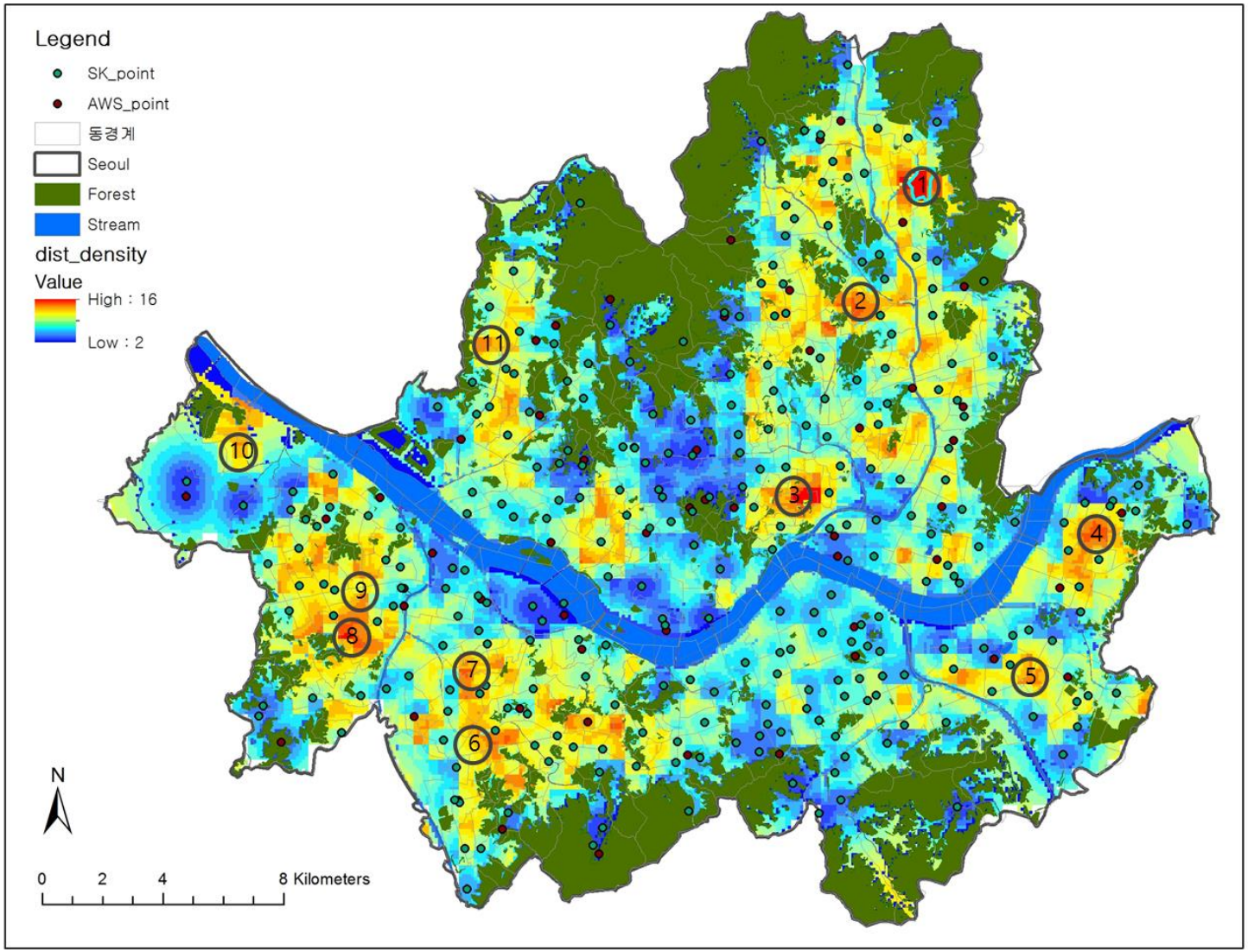


1. Sinjeong7
2. Gayang1
3. Banghwa1
4. Gasan
5. Joonggye1
6. Hail
7. Jangwee1
8. Shillim8
9. Doseon
10. Jangan4

* The red color indication means at least two highest scores among the next three results

2. Selecting Suitable area for Installation of AWS

2) Distane from the AWS + Population density

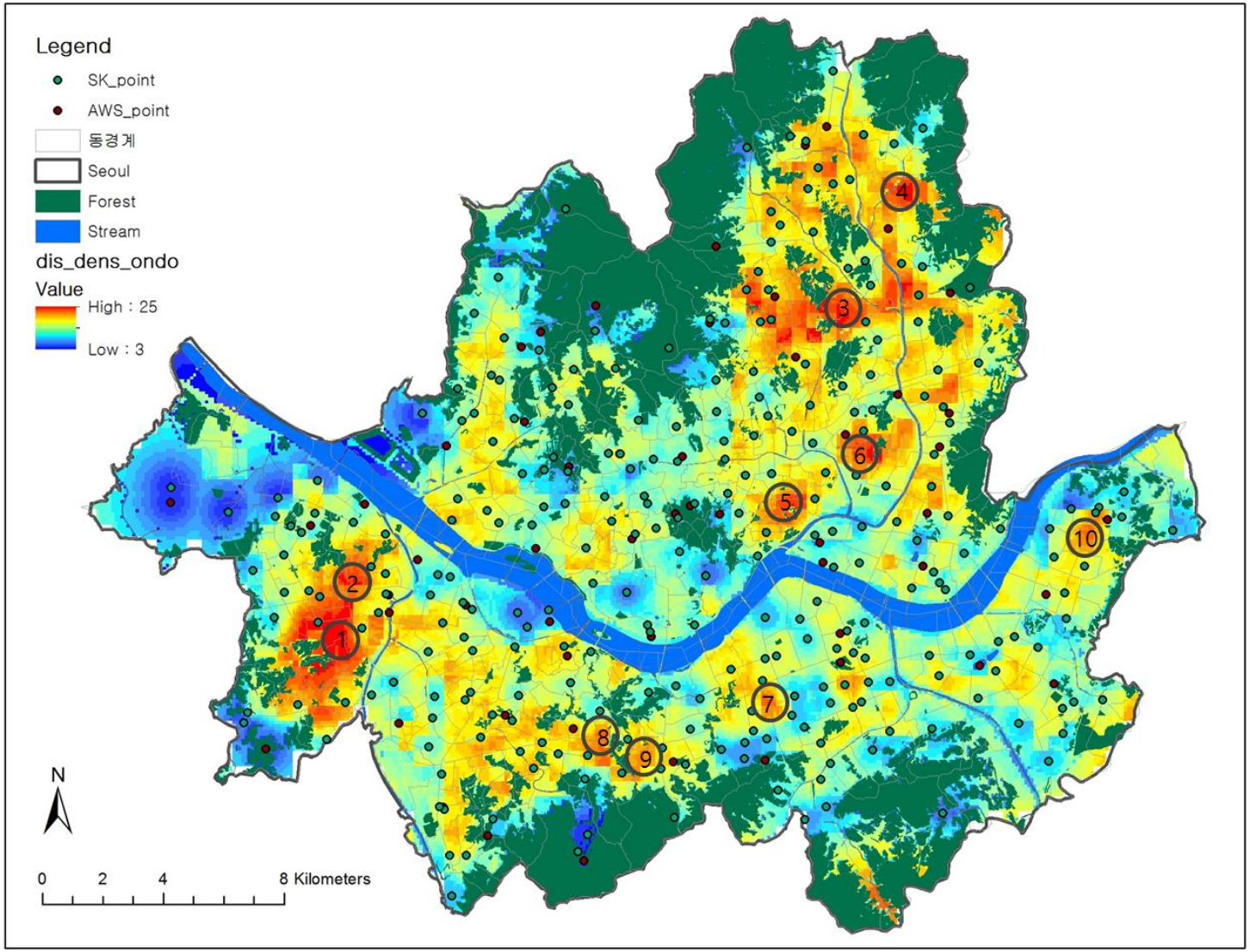


1. Joonggye1
2. Jangwee 1,2
3. Hangdang1
4. Cheonho1
5. Songpa2
6. Shillim4,8
7. Singil3
8. Sinjeon 1,7
9. Mock4
   Hwagock4
10. Banghwa1

* The red color indication means at least two highest scores among the next three results

2. Selecting Suitable area for Installation of AWS

3) Distane from the AWS + Population density+Temperature

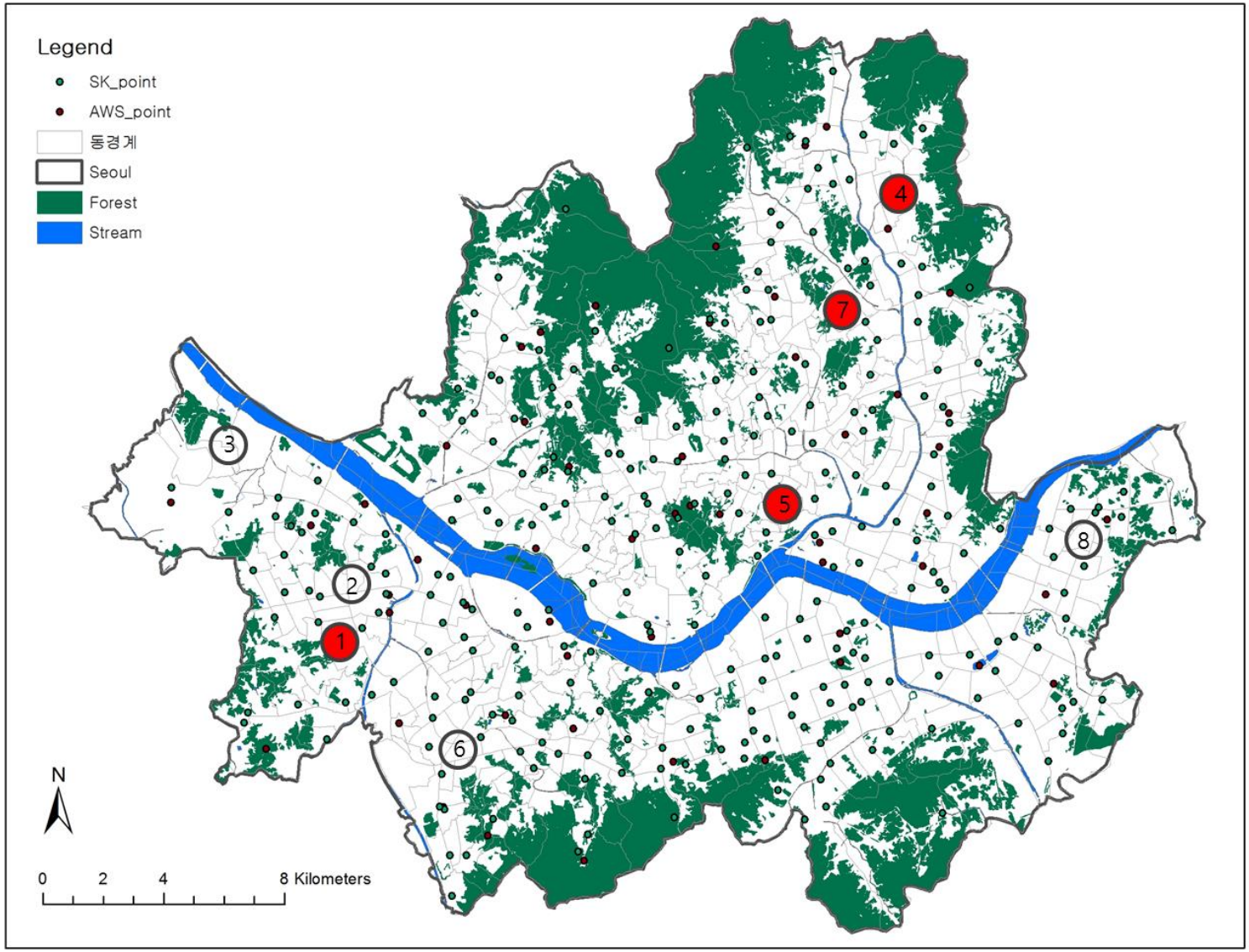


1. Sinjeong1,4,7
2. Mock4
3. Jangwee1,2
4. Joonggye1
5. Hangdang2
6. Dapsiplee1
7. Seocho4
8. Bongcheon3,6
9. Sadang4
10. Cheonho1

* The red color indication means at least two highest scores among the next three results

2. Selecting Suitable area for Installation of AWS

4) Selecting suitable area

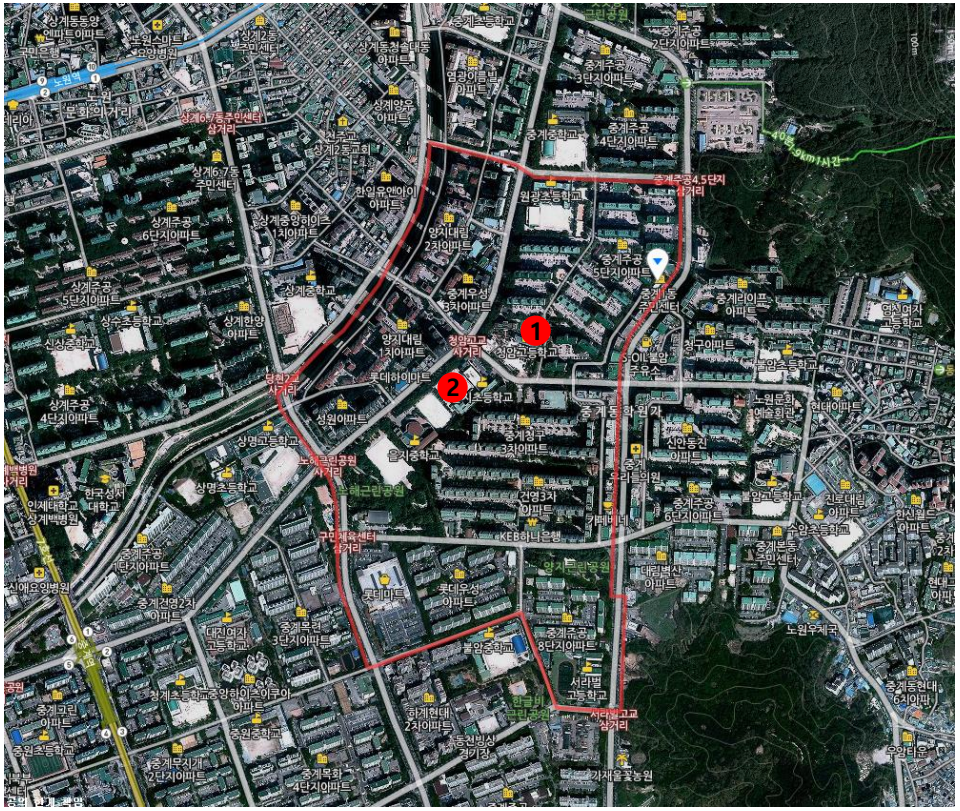


1. Sinjeong1,7
2. Mock4
3. Banghwa1
4. Joonggye1
5. Hangdang1
6. Shillim8
7. Jangwee1,2
8. Cheonho1

* The red color indication means highest scores over three among the previous results

2. Selecting Suitable area for Installation of AWS

5) Location for installation (1)



Region	Facility		coordinate	Characteristics
Joonggye1	1	Cheongam high school	37.651732, 127.074478	Surrounded by apartment
	2	Eulji elementary school	37.651023, 127.073013	

2. Selecting Suitable area for Installation of AWS

5) Location for installation (2)

Region	Facility		coordinate	Characteristics
Jangwee3	1	Jangwee fire center(119)	37.615556, 127.058247	Housing redevelopment complex
	2	Jangwee3 community service cneter	37.616794, 127.056631	Adjacent road

Ⅳ. Conclusion

Conclusion

- Spatial autocorrelation structure of temperature in Seoul showed that a spatial relative distance between temperature observatory was 10–23.5km and an effective range was 2.82–6.63 km.
- To have accurate temperature analysis, an appropriate effective range of the temperature network is within 2.8 km radius.
- Current AWS network in Seoul City installed by the KMA does not comply with this effective range.

- For Seoul City, more dense observatory shall be additionally installed to cope with heat waves and heat island.
- Since the temperature network shall be installed more densely than the rainfall network, it is not necessarily needed to install both sensors at all regions simultaneously.

Implication

- Contribute to improvements on efficiency and economics of the meteorological network by minimizing unnecessary regions in the sense of limited budget.

- Ultimately, a level of the disaster warning system can be improved through the appropriate deployment and design of the temperature network so that citizen's properties and casualties can be reduced significantly.

THANK YOU

E-mail : hyominkim@kict.re.kr

This research was supported by a grant(16AUDP-B102406-02)from Architecture & Urban Development Research Program(AUDP) funded by Ministry of Land, Infrastructure and Transport of Korean government.