Crisisonomy Vol.14 No.4, 27-40
ISSN 2466-1198 (Print) ISSN 2466-1201 (Online) https://doi.org/10.14251/crisisonomy.2018.14.4.27

Crisisonomy

A Study on Development of Environmentally Friendly Urban Air Environment in Response to Residential Environment Crisis

- Focusing on Cheongju and Daejeon City -

Seol A Kwon+, Seung Hyeon Shin

National Crisis & Emergency Management Research Institute, Chungbuk National University, 1 Chungdae-ro, Seowon-gu, Cheongju, Chungbuk, Korea

Abstract

This research conducted a comparative analysis of Daejeon and Cheongju City which are geographically adjacent and have similar topography but different air environment in order to suggest an urban planning framework for environmentally-friendly urban air environment. It is found that the Cheongju City has a higher level of air pollution than Daejeon since the industrial complex is located in the downtown basin and thus high fine dust concentration is not circulated well. The suggested alternatives for inducing air flow for environmentally-friendly urban air environment are as follows. First, it is necessary to construct natural areas in urban outskirts, large green zones inside the city, and sufficient pond area as they are creating cold air. Second, there is a need of areas to accumulate cold air. Third, it would need a passage area allowing air flow.

Key words: wind corridor, urban forest, fine dust, urban air environment, life environment

Ⅰ. Introduction

According to evaluation of United Nations Environment Program(UNEP), 60% of overall ecosystem service provided by the earth was already disappeared or reduced. Also, we can know the speed of risk on environment by Environmental Doomsday Clock, and this Environmental Doomsday Clock has been presented annually from the year of World Summit on Sustainable Development in Rio in 1992 as environment pollution and its damage was accelerated, in order to arouse attention on environment and environmental foundation is also presenting Korean Environmental Doomsday Clock (Jang, 2017; Korea Meteorological Administration Homepage).

Environmental Doomsday Clock means when the hands of clock goes to 12, all lives on earth disappear. The hour from 0 to 3 means ‘good’, 3 to 6 means ‘average’, 6 to 9 means ‘bad’ and 9 to 12 means

+ Corresponding author: Seol A Kwon, Tel. +82-43-261-3337, Fax. 82-43-272-5798, e-mail. seolakwon@chungbuk.ac.kr

'danger'. Based on 2016, global Environmental Doomsday Clock points 9:31, so we can know that environment crisis is in danger stage(Korea Meteorological Administration Home page).

Korea's Environmental Doomsday Clock is 9:47 based on 2016, so we can know that Korean environmental risk is proceeding in higher speed than global environment risk. The most critical environmental risk factor is climate change and former climate change was one of natural phenomena and it proceeded slowly. On the contrary, current climate change was proceeded too fast due to result of human behavior and it creates lots of disaster and confusion(Jang, 2017).

Recently, as Beijing is expressed as 'airpocalypse (apocalypse due to air pollution)'. many foreigners residing in Beijing leave Beijing. Airpocalypse is new word combining 'air' and 'apocalypse' and western media use this word alluding critical air pollution status in Beijing. But, this issue due to fine dust comes to the fore as big social problem and cause of crisis in Korea not only the problem of China(Ban, 2014).

Especially, Cheongju City in Chungcheongbuk-do claiming pure, clean and elegant life culture city, became the city having the highest fine dust concentration in Korea and it is threatening health of citizens, now. Especially, as Cheongju City has basin type topography, when fine dust occur, the air quality become worse due to disadvantage of topography of dead air and industrial complex located in the city(Yonhapnews, 4. 14).

The city is making best effort to make pleasant environment by conducting special inspection for business sites where fine dusts can be occurred such as inspection of large-sized dust scattering and illegal open-air incineration activity as countermeasure for fine dusts, but still there is limitation to reduce fine dust directly(Gukjenews, 2017. 11. 3).

Air pollution due to fine dust in Cheongju City can be considered differently from other regions' air pollution in several aspects. Vertically constructed high apartments and buildings, factories form uneven ground surface and interrupt natural flow of air and wind. This polluted air of Cheongju City will be polluted more in critical because heated air due to urban heat island phenomena becomes the shape of dust roof and interrupts solar energy ground heating and vertical flow of air will be reduced. In order to improve air environment of Cheongju City, we need to review structure, economic environment and ecology of Cheongju City and understand it as one organic system(Kim & Jung, 2005).

Cheongju City is combined with rural and urban communities where 840,000 people are residing. In 1989, Cheongju Industrial Complex was completed as 1·2·3·4 complex with the size of 4,098,000㎡ and it became an industrial city exporting fiber, ceramics, home appliances to 108 countries in the world including USA, Japan and EU. Especially, land utilization of Cheongju City was made in high density and therefore, the environment of the city became poor(Cheongju homepage).

On the contrary, there is a city located in same Chungcheong-do but having lower fine dust concentration than other cities. This city is Daejeon and it shows the lowest fine dust concentration in Chungcheong-do area and showed the lowest figure in annual average fine dust pollution level among large cities in Korea in 2016. Daejeon has no

industrial complex and has lots of green zones differently from Cheongju, so urban environment of Daejeon is considered as better than Cheongju (Daejonilbo, 2017. 04. 02)

In general, wind lowers sensible temperature of citizens and takes role of improving pleasant air of urban environment by transporting urban air pollution materials to suburb, so it is very important to make space for creation of wind and secure wind corridor for passing of wind, in order to create environment-friendly and clean environment city.

This research is a proposal research on urban planning for environmental-friendly urban air environment, so the purpose of this research is to propose necessary policy direction for creating clean and environment-friendly environment of Cheongju and provide fundamental data on urban planning by utilizing urban environment. By conducting comparative analysis of urban environment of Cheongju City and Daejeon City, we would like to understand structure system of reducing fine dust concentration and green space of the area and analyze urban green connection system considering the flow of wind. We would like to propose direction of urban planning considering environment based on this and proper policy direction to relieve air environment problem of Cheongju City in the future(Kim & Jung, 2005).

II. Theoretical discussion

1. Crisis and type of life environment

Life environment means 'environment related to daily life of social members such as air, water, soil, wastes, noise · vibration, stench, sunshine, artificial illumination' and crisis is an incident occurred under unpredictable situation and in case of wrong corresponding to this, it may become critical threat giving harmful influence to organization or industry. Then, life environment crisis can be considered as 'generic term of threatening and unstable status occurred under environment related to daily life'(Framework Act on Environmental Policy, Article 3; Lee, 2001; Kown, 2017).

Life environment crisis appeared together with climate change according to industrialization and development of science technology. And these causes of crisis are not occurred to specific people but they are occurred in ordinary lives of ordinary social members(Chung, 2003).

Types of life environment crisis mean the status that environment such as air, soil, wastes, noise · vibration, stench, sunshine, artificial illumination is threatened, and also it can be used as the term 'air pollution', 'water pollution', 'soil pollution', 'waste pollution', 'noise', 'vibration', 'stench', 'damage on right to enjoy sunshine'.

Characteristic of ordinary life environment crisis appears in daily life and this is not occurrence of threat to specific target but this is threatening health and property of ordinary social members in life. But, in order to understand the types of this life environment crisis, very specialized knowledge is necessary. For example, damage, such as air pollution, soil pollution and radioactivity leak, does not cause injury to human body immediately and it is difficult to check visually, we should rely on expert's analysis. Therefore, life environment crisis causes damage to majority of ordinary social member, but it is an item requires very specialized knowledge and there is possibility of damage due to knowledge on risk, so it is worth

discussing sufficiently.

2. Urban air environment

Dust which influences to urban air pollution is divided into total suspended particles, fine dust(diameter below 10㎛), ultra-fine dust(diameter below 2.5㎛, hereinafter referred to as PM 2.5) and yellow dust from China in spring according to size of particle. In Korea, for management and measurement of fine dust, particle, whose diameter is below 10㎛(PM10), was classified as fine dust and managed pursuant to Framework Act on Environmental Policy in 1995. Since 2015, particle whose diameter is below 2.5㎛ (PM2.5) was classified as ultra-fine dust and being measured and managed, and now the government announced that fine dust(PM10) is changed to airborne dust and ultra-fine dust(PM2.5) was changed to fine dust in March 2017 pursuant to international standard, according to comment that the term for fine dust used in Korea and internationally. Also, the government decided the term calling airborne dust and fine dust together as 'respiratory dust' and decided to hold the expression 'ultra-fine', which had been used for PM2.5 so far, to use for PM1.0 or PM0.1 in the future(Korea Meteorological Administration Home page).

Yellow dust, airborne dust whose diameter is below 10㎛ and fine dust whose diameter is below 2.5㎛ have difference in particle size and also in the cause and ingredient. Yellow dust is consisted of soil ingredient flew from dry desert zone in China or Mongolia but fine dust is air pollution material occurred while chemical fuel is burning which is used in factory, house or automobile(Korea Meteorological Administration Home page).

The reason why it is more harmful as particle of fine dust is smaller is that it gives critical influence to human body when it is exposed for short period differently from big dust, so it can lead to early death in critical case. In addition, it cannot be filtered in airway, but permeates into alveolus and causes cardiac disease and respiratory disease(Doosan Encyclopedia).

Therefore, we would like to conduct this research focusing on measuring smaller and more harmful particle, fine dust, whose diameter is below 2.5㎛, which is the smallest measurement unit in Korea.

This research would like to cover problems on fine dust which appeared as urgent issue among types of life environment crisis. Other types of life environment crisis are risky as well, but fine dust is the 1st carcinogen group selected by WHO, so it was selected because WHO also warned deep concern and severity of risk due to fine dust in Korea. Especially, damage due to occurrence of fine dust also gives damage to neighboring area and nation, so countermeasure plan for this is necessary internationally from various angles.

3. Urban environment-friendly plan

Urban environment-friendly plan can be divided into formation of wind corridor and urban forest. Above all, concentration of population through urbanization, industrialization through industrial complex and increase of chemical material caused emission of harmful air material, and consequently it gave fatal influence to health of citizens residing in the city. So, recently appeared urban planning field started to consider several factors, which gives influence to urban environment for improvement of citizen health and quality of life,

as important. Due to this reason, the term 'wind corridor' appeared for the first time in the field of urban planning in Germany(Lee, 2012).

Wind corridor appeared first in the urban planning of Stuttgart, the capital of Land Baden-Württemberg of Germany, and Stuttgart had serious air pollution because it is basin type city and had slower wind speed compared to other cities and finally it had high emission rate of air pollution material due to characteristic of industrial city. Considering this spatial characteristic, a plan was devised to bring air into downtown through proper flow of created cold air and improve condition of air circulation within the city. Since this concept was introduced to Korea, the concept of wind corridor is being understood to bring cold air, which was created in the outskirt of city, to downtown(Go, 2010).

When we utilize wind corridor, we can bring fresh air from outskirt of city into downtown and reduce air pollution of downtown, and when urban air environment is improved, several advantages will be accompanied such as improvement of environment of collective residential area and rapid removal of air pollutant material of interior environment of each buildings(Lee, 2012).

Subsequently, formation of urban forest means 'any forest and trees created and managed in any city for recreational, emotional development, and activity-based programs, etc. for citizens' pursuant to Article 2 clause 4 of Creation and Management of Forest Resources Act, and its purpose is to create forest and solve urban environment pollutant material as part of urban planning facility. Hwang(2016) found out the correlation with reduction of fine dust concentration by creating forest in buffer zone on wayside.

When we review most research results, urban forest is measured lower than other cities and considered to be efficient to reduce fine dust concentration and also it is judged to be utilized as shelter from fine dust to vulnerable groups to fine dust in the downtown area (Yoo, *et. al.*, 2017).

4. Review on preceding researches

Among cases of life environment crisis, review result on preceding researches for air pollution and introduction of wind corridor in urban planning, which was suggested as solution for this is as follows.

Kim, *et. al.*(2014) analyzed overseas advanced cases of Delft in the Netherlands in order to improve urban air pollution due to traffic system and suggest sustainable city type. Kim & Chun(2014) analyzed the relation between air pollution level pursuant to characteristic of city targeting capital area and urban development pattern.

Cho, *et. al.*(2016) analyzed measurement of air quality pursuant to air environment criteria in Chungbuk area and trend change by years. And, Lee(2017) analyzed reduction policy of fine dust from viewpoint of international studies and suggested alternative for creation of organization having legal force for solving air environment and climate change problem between Korea, China and Japan.

Chung(2015) studied on improvement plan for management system of air pollution quality emission amount in small and medium-sized cities in Korea, and Kim & Kwon(2016) selected and developed optimum location of urban air pollution measurement network by utilizing GIS.

Seo & Chung(2017) analyzed fluidity of wind corridor pursuant to characteristic of Daegu city as basin type and contended that it would be effective to reduce heat island phenomena and air pollution of the city when proceeding urban planning by understanding wind corridor pursuant to topographic characteristic.

Wong(2010), Cha(2007), Jun(2014), Arain(2007), Jacobson(2009) and Chandrasekar(2003) studied on improvement plan of urban air pollution pursuant to wind corridor.

Nowak, *et. al.*(2006), Escobedo, *et. al.*(2009), Brack(2002) and Scott(1998) studied on improvement plan of urban air quality pursuant to forming urban forest.

Ⅲ. Research design

1. Research model

Research model is as follows. As this is a basic study for improvement of urban air environment, it investigated topographic characteristic of Daejeon city and Cheongju city and analyzed the flow of wind on selected 10 days when PM2.5 concentration recorded the highest result in 2016. Based on analyzed basic study result, we would like to propose urban planning for improvement of air environment.

2. Analysis method

This research is to investigate topographic status, urban characteristic and air flow at the time of fine dust warning of Cheongju city and Daejeon city, and then predict the flow of wind under urban air environment for reduction of fine dust by utilizing data from the Meteorological Administration.

Ⅳ. Analysis result

1. Topographic analysis of Cheongju city and Daejeon city

Daejeon is basin topography surrounded by mountains and the center forms valley. Daejeon forms typical basin topography surrounded by Gyeryong Mountain area, Gyejok Mountain area, Sikjang Mountain area and Manin Mountain area, and hill area between alluvion in stream · Yoodeung stream · Daejeon stream(piedmont) and alluvion near 3 streams(Daejeon homepage).

And, when we divide topography of Daejeon into

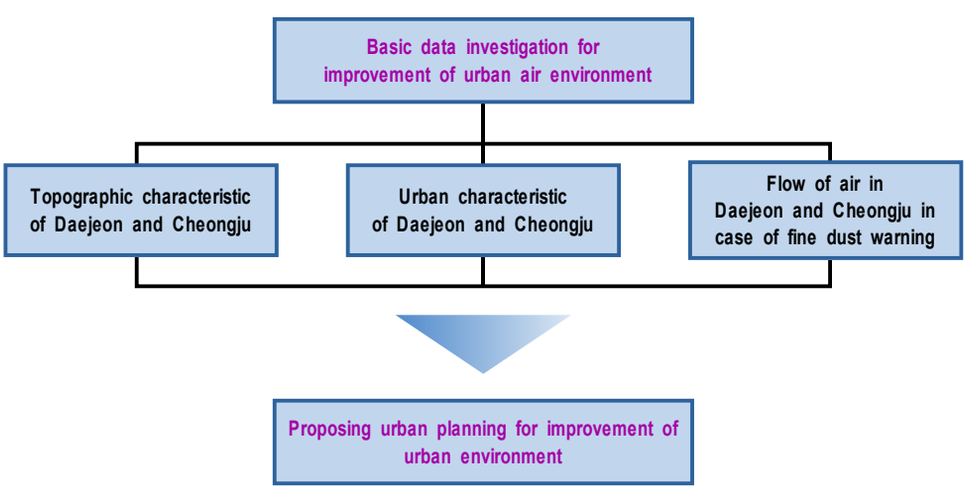


Figure 1. Research model

the area over altitude of 50m, over altitude of 100m and over altitude of 300m, it is distinct from east, west, south and north direction surrounding Daejeon basin. Eastern mountain area is started from Secheon-dong, Dong-gu to the north including Gobong Mountain(304.3m), Gyejok Mountain(398.7m), Gaemeori Mountain(365m), Hamgak Mountain(314.5m) are connected to Okcheon-gun and Boeun-gun in Chungbuk. In Western mountain area, Gyeryong mountain chain such as Woosan peak(573.8m), Gabha Mountain(469m), Dodeok peak(534m), Bingye Mountain(415m), Siru peak(435m), Jogae peak(342m) are connected to Dooma-myun, Nonsan-gun(Daejeon homepage).

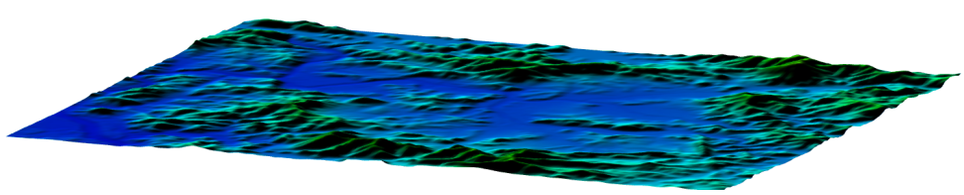
Southern mountain area forms highlands including the highest mountain in Daejeon, Sikjang Mountain(597.4m), Mangdeok Mountain(439m), Manin Mountain(537.1m), An Mountain(264.1m), Myungmak Mountain(330.5m), Jojoong peak(333.5m), Anpyung Mountain(470.2m), Janggoon peak(268.2m) (Daejon homepage).

Northern mountain area is extension of Noryung Mountain Range and connected to Seodae Mountain, the highest mountain in Chungnam(903.7m), and Daedoon Mountain(877.7m) at the boundary with Jeollabukdo province(Daejeon homepage).

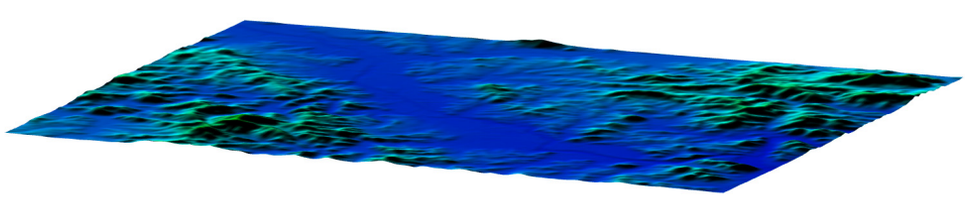
Cheongju forms basin topography developed from west slope of Sobaek Mountains and south slope of Charyung Mountains. Topography of Cheongju forms mountain area in east connected to Sangdang Mountains, hill area which is not mountain and not field in west and south part, and to the northwest part, plains are developed. Especially, Cheongju basin is developed near Miho stream of Geum River and Musim stream area. Miho stream area is the largest plain in Chungcheongbukdo province spread wide in Jeungpyung, Jincheon, Jochiwon and Bugang area(Cheongju homepage).

According to topographic analysis in Cheongju city and Daejeon city, we can know that two regions are surrounded by mountain from four directions and the rivers flow in the cities. In detail, we can find out through 〈Figure 2〉 and 〈Figure 3〉.

When we review digital elevation model of Daejeon and Cheongju city, we can know that these two cities are basin area and also we can know that Cheongju city has more visible basin type basin characteristic than Daejeon city.



※ Source: National geographic Information Institute homepage
Figure 2. Digital Elevation Model(DEM) in Daejeon Metropolitan City



※ Source: National geographic Information Institute homepage
Figure 3. Digital Elevation Model(DEM) in Cheongju City

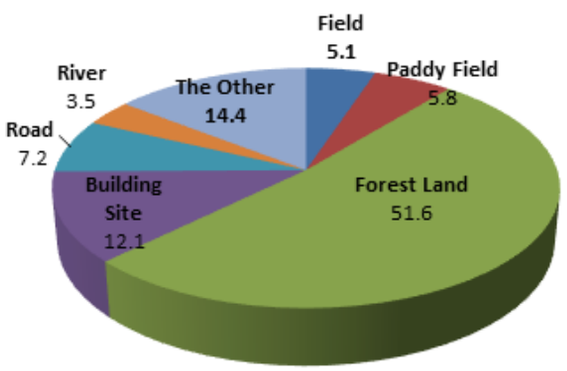
2. Analysis of urban system of Cheongju city and Daejeon city

From the analysis result of urban system pursuant to Cheongju city and Daejeon city's topography, forest land area is occupying over 50%. This forest land is located focusing on outskirts of city. When we check 〈Figure 4〉 and 〈Figure 5〉 in detail, building site of Daejeon city occupies 12.1% and building site of Cheongju city occupies 5.3% lower than Daejeon city.

When we review status of land area for use purpose through 〈Figure 4〉 and 〈Figure 5〉, the ratio of forest land is similar, but Daejeon city has wider area in building site and road area than Cheongju city.

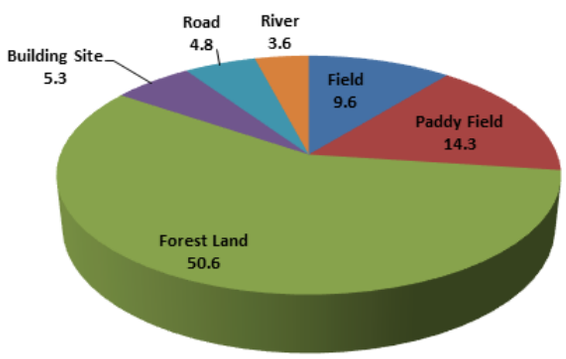
When we review land edit drawing for use district in 〈Figure 6〉 and 〈Figure 7〉, Cheongju city and Daejeon city has business district and residence area located in the center of city and both cities have industrial zones. And, plain area is widely located in outskirts of both cities.

The biggest difference of two cities is that Cheongju city has industrial zone in downtown applicable to basin type, but Daejeon city has industrial zone in outskirts of city.



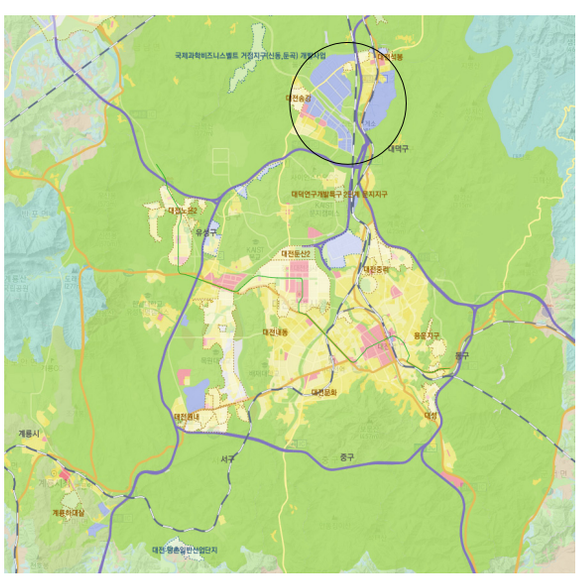
※ Source: Land Registration Statistical Yearbook(2016)

Figure 4. Status of land area for use purpose in Daejeon city



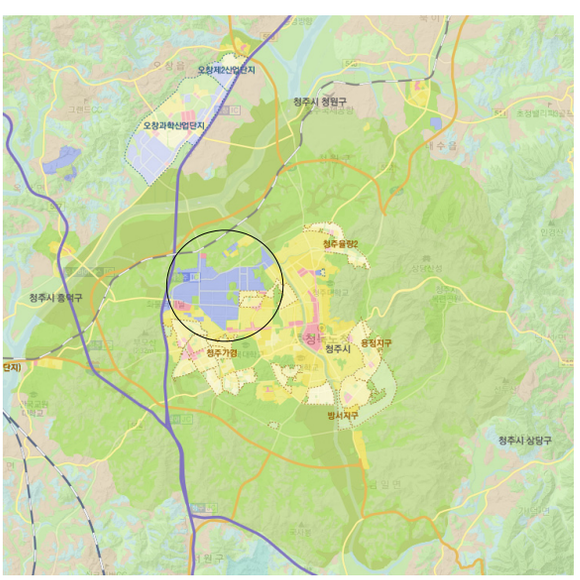
※ Source: Land Registration Statistical Yearbook(2016)

Figure 5. Status of land area for use purpose in Cheongju city



※ Source: National Geographic Information Institute

Figure 6. Land edit drawing for use district in Daejeon city



※ Source: National Geographic Information Institute

Figure 7. Land edit drawing for use district in Cheongju city

3. Comparative analysis of environment for the case of fine dust warning in Cheongju city and Daejeon city

Based on 2016, monthly PM2.5 pollution level result of Cheongju city and Daejeon city is same as 〈Table 1〉.

When we review comparison result of air pollution level of Cheongju city and Daejeon city in 〈Table 1〉, Cheongju city has higher concentration of PM2.5 fine dust in every month and annual average concentration was also 8$\mu g/m^3$ higher than Daejeon city.

In order to investigate urban air environment change, we arranged flow of wind direction and wind speed based on 10 days recording high fine dust pollution level in Cheongju city and Daejeon city as 〈Table 2〉.

When we review 〈Table 2〉, first of all, Cheongju city shows basically 120$\mu g/m^3$ higher concentration result than Daejeon city, and Daejeon city shows lower concentration result than Cheongju city with average value 90$\mu g/m^3$. Singularity is that Cheongju city has 2 calm(no wind) days among high fine dust concentration days and Daejeon city shows slightly higher wind direction and wind speed than Cheongju city. And, in case of wind speed, Daejeon city has slightly higher wind speed than Cheongju city, so we can find out that air circulation is occurring through flow of wind.

V. Conclusion

Fundamental meaning of environment-friendly urban air environment development is to enhance quality of life local residents in order to improve sustainability of urban development and improve life space of citizens by creating clean and pleasant urban environment in our city.

Table 1. Monthly PM2.5 pollution level result by city(2016)

2016year(Unit:$\mu g/m^3$)

City	1	2	3	4	5	6	7	8	9	10	11	12	Monthly average
Daejeon	31	26	30	25	25	22	13	15	17	16	25	25	21
Cheongju	39	32	39	32	29	25	12	14	21	25	38	39	29

※ Source: Air Korea Homepage

Table 2. Information on 10 days recording high fine dust pollution level by city

(Wind speed unit: m/s)

Measured date	Daejeon PM 2.5	Daejeon wind direction	Daejeon wind speed	Measured date	Cheongju PM 2.5	Cheongju wind direction	Cheongju wind speed
2016010409	113	North-north-west	1.5	2016052706	176	Calm	0.2
2016020903	98	Northwest	2.5	2016010407	158	West-north-west	0.8
2016052708	98	Northwest	1.0	2016101924	160	North-north-west	0.9
2016041020	90	Northwest	3.1	2016120814	160	West-south-west	2.1
2016022616	89	Southwest	0.9	2016111820	136	Northeast	1.9
2016111803	87	West	0.5	2016102014	134	North-north-east	1.3
2016031401	86	North	0.9	2016120421	130	Calm	0.4
2016022811	85	South	1.4	2016112613	130	North-north-east	2.2
2016011612	84	South-south-east	1.0	2016040310	128	North-north-east	1.8
2016042220	82	West	1.6	2016011712	128	North	1.8

※ Source: Rearrangement of data from Air Korea and Meteorological Administration Homepage

This research is basic investigation study in order to prepare alternative for reducing fine dust concentration and pleasant urban environment by forming wind flow proper to worse air environment due to fine dust concentration. In this research, we conducted comparative analysis on cases of Daejeon city and Cheongju city which have similar topography and located closely, but have different air environment. The contents of analysis result are as follows.

First, from the analysis result of digital elevation model and topography data of Daejeon city and Cheongju city, we can know that both cities are basin topography and based on the model, Daejeon city has more visually basin type topography than Cheongju city. Considering that basin type topography has a structure of difficult air circulation, Daejeon city should have more difficult air circulation than Cheongju city, but actually real urban air environment result showed that Cheongju city has worse air environment than Daejeon city.

Second, from the analysis result of urban system in Daejeon city and Cheongju city, we can know that two cities have similar rate of forest land area but Daejeon city has wider area of building site and road area than Cheongju city. Also, from the review result of land edit drawing for use district, Cheongju city and Daejeon city have business district and residence area located in the center of city and both cities have industrial zones. The biggest difference of two cities is that Cheongju city has industrial zone in downtown applicable to basin type, but Daejeon city has industrial zone in outskirts of city.

Third, singularity of air environment in Cheongju city and Daejeon city is that Cheongju city has calm(no wind) days or lower wind speed among high fine dust concentration days and Daejeon city shows slightly higher wind speed than Cheongju city, so we can find out that air circulation is occurring through flow of wind.

Based on analysis result, Cheongju city and Daejeon city all have basin type topography and forest land area occupies high rate in outskirts of cities. But, in case of Cheongju city, industrial zone is located in the center of basin type city and therefore air pollution level is higher due to bad air circulation on the days having high fine dust concentration.

Therefore, alternatives for inducing air flow for environment-friendly urban air environment development is as follows. First, it is necessary to construct nature district in the outskirts of city, large-sized green zone and sufficient pond area in and the city as region to create cold air. In addition, it is considered to be appropriate to locate industrial zones in the outskirts of city, in case of basin type city.

Second, a region to accumulate cold air is necessary. It is necessary to make the status to accumulate clean air in the city through creating green zone in the city such as countryside area in the outskirts of city.

Third, it is necessary to have passageway where air flow is possible. Especially, in case green zone is insufficient inside the city with basin type, it is certain that passageway of air flow can be cut. Then, even though it possesses nature green zone in the outskirts of city, air accumulation and passageway connecting clean air to inside of city is not distributed well, so there is difficulty to secure passageway for air

flow. (Kim & Chung, 2005).

The purpose of this research is fundamentally to construct urban environment for clean and pleasant local society by developing environment-friendly urban air environment, and improve and continuous development of overall urban environment, and counterplan for this is to prepare plans for occurrence and inflow of cold air and make urban forest.

In order to achieve this purpose, we compared data on topographic characteristic, urban fine dust distribution and wind flow environment between Cheongju city and Daejeon city which have similar geographic environment but different air environment, and suggested fundamental data necessary for inflow of wind corridor and urban forest creation.

We would like to aim at local society with pleasant environment through reduction of fine dust concentration by trying to improve urban air environment through inflow of wind to city and appropriate urban forest planning, as a tactic strategy for future pleasant urban environment (Kim & Chung, 2005).

감사의 글

This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2017S1A5B8059946)

References

Arain, M. A., R. Blair, N. Finkelstein, J. R. Brook, T. Sahsuvaroglu, B. Beckerman, and M. Jerrett. 2007. The use of wind fields in a land use regression model to predict air pollution concentrations for health exposure studies. *Atmospheric Environment.* 41(16): 3453-3464.

Ban, Gi Sung. 2014 . *Climate and weather*. Seoul: planetmedia

Brack, C. L. 2002. Pollution mitigation and carbon sequestration by an urban forest. *Environmental pollution.* 116: S195-S200.

Cha, J. G., E. H. Jung, J. W. Ryu, & D. W. Kim. 2007. Constructing a green network and wind corridor to alleviate the urban heat-island. *Journal of the Korean Association of Geographic Information Studies.* 10(1): 102-112.

Chandrasekar, A., C. R. Philbrick, R. Clark, B. Doddridge, and P. Georgopoulos. 2003. Evaluating the performance of a computationally efficient MM5/CALMET system for developing wind field inputs to air quality models. *Atmospheric Environment.* 37(23): 3267-3276.

Cho, Sung Rul, Yoon Hyeong Cho, Sun Hee Park, Pil Sik Shin, Eun Kyeong Jang, Yeong Sang Song, and Tea Gwang Sek. 2016. Air Quality Analysis in Chungbuk Area 2015. *Chungcheongbuk*.

Chung, Sung Ik. 2017. *Citizens' Movement for Environmental Justice.* Seoul: pulbit.

Daejonilbo. 2017. 04. 02.

Escobedo, F. J. and D. J. Nowak. 2009. Spatial heterogeneity and air pollution removal by an urban forest. *Landscape and urban planning.* 90(3): 102-110.

Gukjenews. 2017. 11. 3.

Hwang, Gwang Il. 2016. A Study on Decreasing Effects of the Ultrafine Particles(PM2.5) by Structures in Roadside Buffer Green. Master's Thesis. University of Seoul.

Jacobson, M. Z. 2009. Review of solutions to global warming, air pollution, and energy security. *Energy & Environmental Science.* 2(2): 148-173.

Jeoung, Doo Hee. 2015. (A)study on the improvement of air pollutants management system in domestic small medium city. Master's Thesis. Hoseo University.

Jun, L., and Y. Rong. 2014. Urban Design Control For Wind Corridor: Wuhan Case. *Planners.* 30(8): 115-120.

Kim, A Young and Chang Hee Kwon. 2016. Study on Optimal Location of Air Pollution Monitoring Networks in Urban Area Using GIS : Focused on the case of Seoul City. *Journal of the Society of Disaster Information.* 12(4): 358-365.

Kim, Hee Jae and Myung Jin Jun. 2014. Analysis on Relationship between Urban Development Characteristics And Air Pollution level: A Case of Seoul Metropolitan Region. *JKPA*. 49(7): 151-167.

Kim, In Soo, Choong Heon Yang, Hye Jeong Hur, and Jung Gon Sung. 2014. Emission Dispersion Analysis based on the Development Density associated with Urban Planning (a case study of the Delft city on Netherlands). *Int. J. Highw. Eng*. 16(3): 21-33.

Kim, Soo Bong and Eung Ho Jung. 2005. A Basic Study on Introduction of Wind Path for Eco-friendly Urban Construction. *Daegu Gyeongbuk Institute*.

Ko, Eun Ah. 2010. Wind Simulation and Optimal Building Allocation Wind Simulation and Optimal Building Allocation. Master's Thesis. Hanbat National University.

Lee, Hyeon Woo. 2001. *Crisis Management communication*. Communication Books.

Lee, Jae Eun. 2012. Study on the Wind Road of the Urban residential area: In the Case of Eunpyeong-Gu Newtown in Seoul. Master's Thesis. Konkuk University.

Lee, Soo Cheol. 2017. Japanese Measurement on Fine Particles(PM2.5) Emission Pollution and Cooperation of Korea-China-Japan to Reduce Fine Particles Pollution. *Environmental and Resource Economics Review*. 26(1): 57-84.

Nowak, D. J., D. E. Crane, and J. C. Stevens. 2006. Air pollution removal by urban trees and shrubs in the United States. *Urban forestry & urban greening*. 4(3): 115-123.

Scott, K. I., E. G. McPherson, and J. R. Simpson. 1998. Air pollutant uptake by Sacramento's urban forest. *Journal of Arboriculture* 24: 224-234.

Seo, Bo Yong and Eung Ho Jung. 2017. Comparative Analysis of Wind Flows in Wind Corridor Based on Spatial and Geomorphological Characteristics to Improve Urban Thermal Environments. *Journal of the Korean Association of Geographic Information Studies*. 20(2): 75-88.

Wong, M. S., J. E. Nichol, P. H. To, & J. Wang. 2010. A simple method for designation of urban ventilation corridors and its application to urban heat island analysis. *Building and Environment*. 45(8): 1880-1889.

Yonhapnews. 2017. 4. 14.

Yoo, So Yeon, In Koo Nam, Hak Oh Jung, and Yeol Park Chan. 2017. Characteristics of fine dust concentration change in urban forests. KENSS.

環境政策基本法.

Korean References Translated from the English

고은아. 2010. Envi-met에 의한 바람길 해석 및 건물배치 계획. 한밭대학교 석사학위논문.

국제뉴스. 2017. 11. 3일자

국토지리정보원 홈페이지

기상청 홈페이지

김수봉, 정응호. 2005. 친환경적 도시건설을 위한 바람길 도입 기초연구. 대구경북연구원.

김아영, 권창희. 2016. GIS를 이용한 도심지 대기오염 측정망 최적위치 선정에 대한 연구: 서울특별시를 대상으로. 한국재난정보학회논문집. 12(4): 358-365.

김인수, 양충헌, 허혜정, 성정곤. 2014. 도시계획에 따른 개발밀도에 근거한 도시 대기오염 확산분석: 네덜란드 Delft시를 사례로. 한국도로학회 논문집. 16(3): 21-33.

김희재, 전명진. 2014. 도시 특성과 대기 오염 수준과의 관계 분석 연구: 수도권을 사례로. 대한국토계획학회지. 49(7): 151-167.

대전광역시 홈페이지.

대전일보. 2017. 04. 02일자.

반기성. 2014. 기후와 날씨, 건강 토크토크. 서울: 프리스마

서보용, 정응호. 2017. 도시 열환경개선을 위한 공간지형적 특성에 따른 바람길 유동 비교 분석. 한국지리정보학회지. 20(2): 75-88.

에어코리아 홈페이지

연합뉴스. 2017. 4. 14일자

유소연, 구남인, 오정학, 박찬열. 2017. 도시숲 내 미세먼지 농도 변화 특성. 한국환경과학회.

이수철. 2017. 일본의 미세먼지 대책과 미세먼지 저감을 위한 한중일 협력. 자원·환경경제연구. 26(1): 57-84.

이재은. 2012. 도시주거지역의 바람길에 관한 연구: 서울시 은평구 뉴타운 사례를 중심으로. 건국대학교 석사학위논문.

장성익. 2017. 환경정의. 서울: 풀빛

정두희. 2015. 국내 중소도시 대기오염물질 배출량 관리의 체계 개선에 관한 연구. 호서대학교 석사학위논문.

조성렬, 조윤형, 박선희, 신필식, 장은경, 송영상, 석태광. 2016. 충북지역 대기질 분석결과, 2015년. 보건환경연구원.

청주시 홈페이지

충청북도 홈페이지

통계청. 2016. 지적통계연보. 통계청.

통계청홈페이지.

환경정책기본법.

황광일. 2016. 도로변 완충녹지의 식재구조에 따른 초미세먼지(PM2.5)농도 저감효과 연구. 서울시립대학교 석사학위논문.

Received: Jan. 19, 2018 / Revised: Mar. 15, 2018 / Accepted: Mar. 27, 2018

생활환경위기 대안을 위한 친환경적 도시대기환경 개발 연구

– 청주시와 대전시를 중심으로 –

국문초록 본 연구는 친환경적 도시대기환경을 위한 도시계획 제안연구로서 유사한 지형을 띄고, 지리적으로도 인접하지만 대기환경은 차이가 있는 대전시와 청주시의 지형요인, 도시특성요인, 대기요인을 토대로 비교분석해 보았다. 2016년 기준 미세먼지농도 상위 10일간 공기의 흐름을 비교분석한 결과 청주시는 대전시보다 미세먼지농도 상위 10일간 대기의 흐름이 정체되어 있음을 알 수 있었다. 이는 분지형 도시중심에 공업단지가 위치해있어, 외부의 미세먼지와 도심의 미세먼지가 지형적 영향으로 대기가 순환하지 못하고 정체되어, 대기의 오염도가 더 높게 나타나는 것을 알 수 있었다. 따라서 친환경적 도시대기환경 개발을 위한 공기 흐름 유도에 대한 대안은 다음과 같다. 첫째, 찬 공기 생성지역으로서 도시외곽의 자연지역, 도시 내의 대규모 녹지대 그리고 충분한 면적을 가진 수공간 지역을 조성하는 것이 필요하다. 둘째 찬 공기를 축적할 수 있는 지역이 필요하다. 셋째, 공기의 흐름이 가능한 통로지역이 필요하다.

주제어 : 바람길, 도시숲, 미세먼지, 도시대기환경, 생활환경

Profiles **Seol A Kwon :** She received her Ph.D. from Chungbuk National University, Korea in 2017. She is Community Life Safety Research Team Leader from National Crisis & Emergency Management Research Institute, Chungbuk National University. Research interests include life environment crisis, crisis management, organization theories, and risk communication (seolakwon@chungbuk.ac.kr).

Seung Hyeon Shin : He is researcher from National Crisis & Emergency Management Research Institute, Chungbuk National University(shshin0317@naver.com)