The assessment of urban heat island effect and mitigation countermeasures

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ABSTRACT

Owing to the urban heat island effect, the urban design and planning have been encountered the severe plights. Based on our observational research show that each year in Taiwan during the summer season, the urban and rural area temperature difference of up to 3-8 °C; our numerical simulation results show the environmental thermal forcing effect is quite significant during the occurrence period of the urban heat island effect. And environmental wind field was forced to change (from the original northwest wind to southwest wind), a rapid increase in the moisture field (the relative humidity up to 90%), convergence was forced in the low level, upward motion derivative is excited, and result show the unexpected afternoon thunderstorms phenomenon occurred on the urban region.

On the vicinity of the architecture building or the urban construction region, planting the large arbor that the carbon sequestration force was strong (about 900 kg / m² / yr), by thinking about to adjust planting location, direction, height, area, density, and design, to guide the suitable environmental wind field, it will effectively mitigate the urban heat island effect.

Keywords: Climate change, the urban heat island effect, planting the large arbor

1.INTRODUCTION :

The so-called urban heat island effect, referring to the climate phenomenon associated with the process of urbanization generated, first appeared in 1820, Englishman Luke Howard's book "London Climate," a book. Urban heat island phenomenon refers to the city center's suburbs temperatures warmer than the high of the phenomenon, and so the whole temperature line sectional view of the spatial distribution of point of view, the high-temperature part form the shape of the island, which is called "heat island."

The main reason that the impact of the urbanized population is concentrated, and therefore some scholars related studies suggest that the number of urban population and urban heat island intensity has a significant relationship (Oke, 1973; Lee, 1993; Fukuoka, 1983). Oke (1989) and more particularly the heat capacity of the urban environment, the established model proposed, the city accounted for regenerative absorption surface of 15 to 30% of the net amount of radiation, while the suburbs only 5 to 15%, which was divided into urban and suburban areas in the heat storage capacity differences on. Akbari (2001,2002) have used DOE-2 energy simulation software to study how to reduce the impact of the heat island phenomenon Toronto area building energy consumption, and to try to come up with

effective techniques four kinds of outdoor environmental control.

Secondly, since the low-level heat island area, there is a suspension inversion layer that is not conducive to the spread of atmospheric pollutants. Urban air, smoke, fog, etc. under the sun, is likely to produce more harmful to human photochemical pollution, and even the formation of harmful dust cover chemical reaction. Watanabe's (1990) study of remote sensing analysis also showed that in September 1973 by the image analysis LANDSAT-5 satellite taken Tokyo area found that the high-energy region appears in the downtown area. Because people living in urban areas to improve their living and working environment, tend to use the air conditioning system can be adjusted. Meanwhile, the city gradually rising temperatures also reduce the efficiency of the air conditioning, air conditioning increases energy consumption. Yoshiyuki Shimada (2004) in the Osaka area in the range, investigate the effect of heat island phenomenon of building energy consumption. It was found that when the heat island intensity is about 2 °C when 33% of the cold room air conditioning electricity load Suburb 20%, greenhouse air conditioning electricity load reduction.

The urban heat island effect is not only likely to cause diffusion of atmospheric pollutants, resulting in harm to human pollution and dust cover; and to increase the building's air conditioning energy consumption, affecting the life of equipment and facilities, but also exacerbating global warming. For micro-climate changes in the environment, especially in urban and rural areas, differences in the spatial and temporal distribution of shade is very serious.

2.The research methods and research procedures :

This paper attempts from the viewpoint of climate statistics, gathered in Taipei, Taiwan from 1911 to 2016, a total of 106 years of meteorological data observed, respectively, in the month as the segment to identify temperature and rainfall Climate Change. Analysis of rainfall, weather station in Taipei are used within the statistical time from 1996 to 2015, a total of 15 stations (Figure 1).

Figure 1 、 Analysis of rainfall station in Taipei City

Second, the use of high-resolution meteorological satellite infrared remote sensing data, selected in 2008 as a case study, through the inversion calculation derived temperature difference in the spatial distribution of urban and rural areas to make it clear at the same time phase, differences of temperature distribution and quantitative data further illustrate the impact of urban heat island in Taipei, Taiwan.

Finally, Studies using mesoscale model WRF V3.3.1 version, the simulation time is 2008, July 5 0800 to 7 July 0800 a total of 48 hours, the initial field pattern and lateral boundary conditions using NECP / FNL global analysis of field data, spatial resolution of $1^{\circ} \times 1^{\circ}$, a time interval of 6 hours. Model simulations of the grid are set to 3 layers nested grids (Fig. 2), 3-layer nested horizontal grid resolve were D1: 27 kilometers, D2: 9 kilometers and D3: 3 kilometers. Cloud microphysical process model used is WSM3 (WRF Single-Moment 3-class) single-phase water particles Moments 3 program, the aqueous phase particle morphology of this parameter setting method comprising steam, water or ice, rain or snow, three simple cold cloud process; cumulus parameter method in D1 and D2 use Kain-Fritsch scheme, the innermost D3 net nest is no use of cumulus parameter set; boundary layer method using YSU boundary layer method; longwave radiation parameter method using RRTM program. Try to clarify when the urban heat island effect occurs, environmental conditions and weather events change and restore the entire development process.

Figure 2 、 Model simulations of the grid is set to 3 layers nested grids, 3-layer nested horizontal grid resolve were D1: 27 kilometers, D2: 9 kilometers and D3: 3 kilometers

3.The research results and suggestions :

According to 1911 to 2016, Taipei, Taiwan weather station data (Fig. 3), nearly 35 years, the average annual temperature generally rises higher than the average climate value 0.9°C , this phenomenon continues, the apparent global warming in Taiwan's influence is quite significant. From Figure 4, the average monthly temperature anomaly distribution point of view, the past 50 years, Taipei year-round warming, warming trend and more and more obvious, wherein the April-June 2016 than the temperature value is also climate high 2.5°C , obvious, the extent of global warming in Taiwan exacerbated.

Figure 3 、Year-Temperature anomaly distribution, according to 1911 to 2016, Taipei, Taiwan weather station data

Figure 4 、Month-Temperature anomaly distribution, according to 1965 to 2016, Taipei, Taiwan weather station data

Tables 1, respectively, from 1996 to 2005 and from 2006 to 2015, Taipei, Taiwan weather when the frequency statistics of rainfall from May to September, nearly 10 years the probability of occurrence of extreme rainfall is the last 10 years ago 2 to 7 times, especially in the afternoon of thermal effects and high-temperature environment, the most significant.

mm/ hr	鞍部	臺北	竹子湖	社子	大直	公館	木柵	內湖	士林	石牌	大崙 尾山	南港	天母	信義	次
20	229	157	199	87	115	180	55	139	111	105	91	157	149	53	1827
40	39	29	40	11	22	49	13	26	20	9	12	24	20	11	325
60	7	2	8	1	6	7	1	5	3	3	3	2	2	0	50
80	2	0	0	0	2	3	0	3	0	0	0	0	0	0	10
100	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1

Table 1 、From 1996 to 2005, Taipei, Taiwan weather when the frequency statistics of rainfall from May to September

mm/ hr	鞍部	臺北	竹子 湖	社子	大直	公館	木柵	內湖	士林	石牌	大崙 尾山	南港	天母	信義	次
20	177	137	206	58	103	185	198	125	95	86	63	129	115	142	1819
40	37	26	52	8	20	49	42	23	21	13	17	39	21	31	399
60	7	6	6	1	4	8	11	10	3	2	3	21	3	7	92
80	1	1	0	0	2	1	5	2	1	0	1	8	0	2	24
100	1	0	0	0	0	0	2	1	0	0	0	3	0	0	7

Table 2 、 From 2006 to 2015, Taipei, Taiwan weather when the frequency statistics of rainfall from May to September

To use of high-resolution meteorological satellite infrared remote sensing data, selected in 2008 as a case study(Fig. 5), through the inversion calculation derived temperature difference in the spatial distribution of urban and rural areas. Owing to the urban heat island effect, the urban design and planning have been encountered the severe plights. Based on our observational research show that each year in Taiwan during the summer season, the urban and rural area temperature difference of up to 3-8 °C (Fig. 6).

our numerical simulation results show the environmental thermal forcing effect is quite significant during the occurrence period of the urban heat island effect. And environmental wind field was forced to change (from the original northwest wind to southwest wind), a rapid increase in the moisture field (the relative humidity up to 90 %), convergence was forced in the low level, upward motion derivative is excited(Fig. 7), and result show the unexpected afternoon thunderstorms phenomenon occurred on the urban region.

Figure 5 、 The high-resolution meteorological satellite infrared remote

sensing data, selected in 2008 as a case study

Figure 6 、 Each year in Taiwan during the summer season, the urban and rural area temperature difference of up to 3-8 °C

On the vicinity of the architecture building or the urban construction region, planting the large arbor that the carbon sequestration force was strong (about 900 kg / m² / yr), by thinking about to adjust planting location, direction, height, area, density, and design, to guide the suitable environmental wind field, it will effectively mitigate the urban heat island effect.

Figure 7 、 Numerical simulation results, where (a) Convergence field, and (b) Vertical motion, Relational Humidity field, initial time is 2008.7.5.00Z

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