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Comparison of Air Temperature under Global Climate Change Issue in Gifu city and Ogaki city, Japan

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A B S T R A C T

Increases in air temperature indicate a global climate change. Thus, information in the change of temperature regional scale is important to support global data. The present research was conducted in Gifu city and Ogaki city located in Gifu prefecture, Japan. The results showed that, average air temperatures in both cities are quite similar with a difference value of under 1°C. Maximum air temperature in Gifu city is significantly higher than Ogaki city, whereas minimum air temperature in Gifu city is significantly lower than in Ogaki city. Daily range of air temperature in Gifu city significantly higher than in Ogaki city. In both cities, air temperature relatively increased in three decades. This is because of different in land characteristics in both cities.

A R T I C L E I N F O

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1. INTRODUCTION

Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. (Sturrock *et al.*, 2011). Climate changes serious effects on the planet and ecosystem (Crabbe, 2009), Therefore, climate change is one of the international environmental issues and getting ample importance from the part of the different stakeholders. Climate change and global warming, in many ways, have adverse effects on the environment and humankind (Ahmad & Hossain, 2015). Climate change can increase societies' propensity to conflict by changes in socio-structural conditions (e.g., resource scarcity, migration) (Fritsche *et al.*, 2012). Thus, climate change is an environmental problem with global causes and consequences. Human activities contribute to carbon dioxide (CO_2) emissions, which alter global climatic conditions and are likely to cause substantial harm to ecosystems and humans

in the future (Palmer *et al.*, 2009). One of the indications of climate change is increases in the temperature of earth surface temperature in global scale. Global warming is defined as the increase in the average temperature on the Earth. This includes both atmospheric and oceanic temperatures. Since the beginning of the twentieth century, the average global temperature has risen about 1.41 F, in which this is about two-third of that temperature rising since 1960. (Zuidhoff & Kolstrup, 2000).

Gifu Prefecture is a prefecture in the Chubu region of central Japan. Gifu Prefecture has 1 city with different land uses for each city. Gifu's climate varies from humid subtropical climate in the south, eventually making the transition to humid continental climate in the north. In the Mino region is surrounded by low mountains, the temperature fluctuates through the year, (from hot summers to cold winters). Total land area in Gifu prefecture approximately 10,621 square kilometers and can be approximated to be 2.81% of Japan's total landmass. In this area, approximately one quarter is made up of highlands in excess of 1,000 meters above sea level. Gifu has a rich natural environment, with 80.7% of the prefecture covered by woods and forests. Detailed data can be seen in the following Gifu Prefectural Government website: http://www.pref.gifu.lg.jp/English/info/statistics/index.data/geography.pdf, http://www.pref.gifu.lg.jp/English/info/statistics/index.data/facts.pdf, http://www.pref.gifu.lg.jp/English/info/statistics/index.data/hyousi.pdf, http://www.pref.gifu.lg.jp/English/info/statistics/index.data/geography.pdf.

Global climate change occurs in many places around the world, and the information in small region is needed to support global data. However, local/regional area have different characteristics of land surface indeed, this condition gives different responses in climate condition. In this paper, we explained effects of global climate change on local weather condition using air temperature data in Gifu Prefecture.

2. MATERIALS AND METHODS

Site description: Experiments were carried out in Gifu city (Latitude: 35°25.3746' N, Longitude: 136°45.6234'E) and Ogaki city (Latitude: 35°12' N, Longitude: 136°36'E) located in Gifu Prefecture Japan. Both cities were chosen because they located adjacent and had different land characteristics. Detailed information about the experimental site is shown in **Figure 1**, and the characteristic of the experimental site is shown in **Table 1**.

Air temperature data was measured in both cities using Automatic Weather Station (AWS) from Japan Meteorology Agency (JMA). To precisely compare air temperatures in Gifu city and Ogaki city, T-test 5% method was used.

3. RESULTS AND DICUSSIONS

Figure 2 shows that the average air temperature in Gifu city and Ogaki city are quite similar. The different temperatures in both cities are under 1^{o}C. Maximum air temperature is represented the air temperature in the afternoon, where the minimum air temperature is the air temperature in the morning.

Figure 3 shows monthly maximum air temperature (up: 2001-2005, middle: 2006-2010, bottom: 2011-2015), whereas **Figure 4** shows monthly maximum air temperature (up: 2001-2005, middle: 2006-2010, bottom: 2011-2015). Based on the t-test, the maximum air temperature in Gifu cities significantly higher than that in Ogaki city, minimum air temperature in Gifu cities significantly lower than that in Ogaki city. The different maximum air temperatures in

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both cities reached 2.6°C, whereas the different minimum air temperatures in both cities were around 2°C.

Figure 5 shows linear trend of air temperature in Gifu city from 1985-2015 (30 years), whereas **Figure 6** shows linear trend of air temperature in Gifu city from 1985-2015 (30 years). Both figures showed that both cities were indicated to have increasing air temperature in three decades. If we compared the temperatures in Gifu and Ogaki cities, we found that the daily range of air temperature in Gifu city is significantly higher than that in Ogaki city. Gifu city experienced the increase in temperature of about 0.75°C, whereas Ogaki city was about 0.5°C.

Figure 1. Gifu prefecture picture map

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Tabel 1. Land characterstic in Gifu and Ogaki cities

Land characteristics	Gifu City	Ogaki City
	ha	
Total land area	20289	20652
Forest area	6041	10843
Farmland	4060	3032
Dam	0	25
Pond	24	11
River	1262	820
Agriculture water way	223	208
Road	1999	1295
Residential area	5064	2398
Industrial site	115	256

Source: Gifu prefectural government 2013

Based on these figures, air temperature in Gifu city has a high R^2 value than that in Ogaki city, in which the potential increases in air temperature in Gifu city is higher than that in Ogaki city. Air temperature affected by several factors, such as latitude, altitude, ocean currents, surface characteristics. The surface characteristics that we considered are topography, surface color, distribution of land and water, and land cover/vegetation.

The main factor that is the most affected air temperature in both cities is surface characteristic or land characteristic. Carbon dioxide (CO_2) is the primary greenhouse gas emitted through human activities. The main human activity that emits CO_2 is the combustion of fossil fuels (coal, natural gas, and oil) for the energy and the transportation, although certain industrial processes and land-use changes also emit CO_2. In 2010, human population in Gifu city is 413.136 and in Ogaki city is 161.160. If we assumed one person to emit the same amount of CO_2, Gifu city emitters must be more than 2.5 of Ogaki city. These increases in CO_2 concentration in the atmosphere, especially in the last 60 years, correspond very well with increasing in air temperature. In other hands, forest area in Gifu cities only 6041 ha or 1/3 from a total forest area in Ogaki city.

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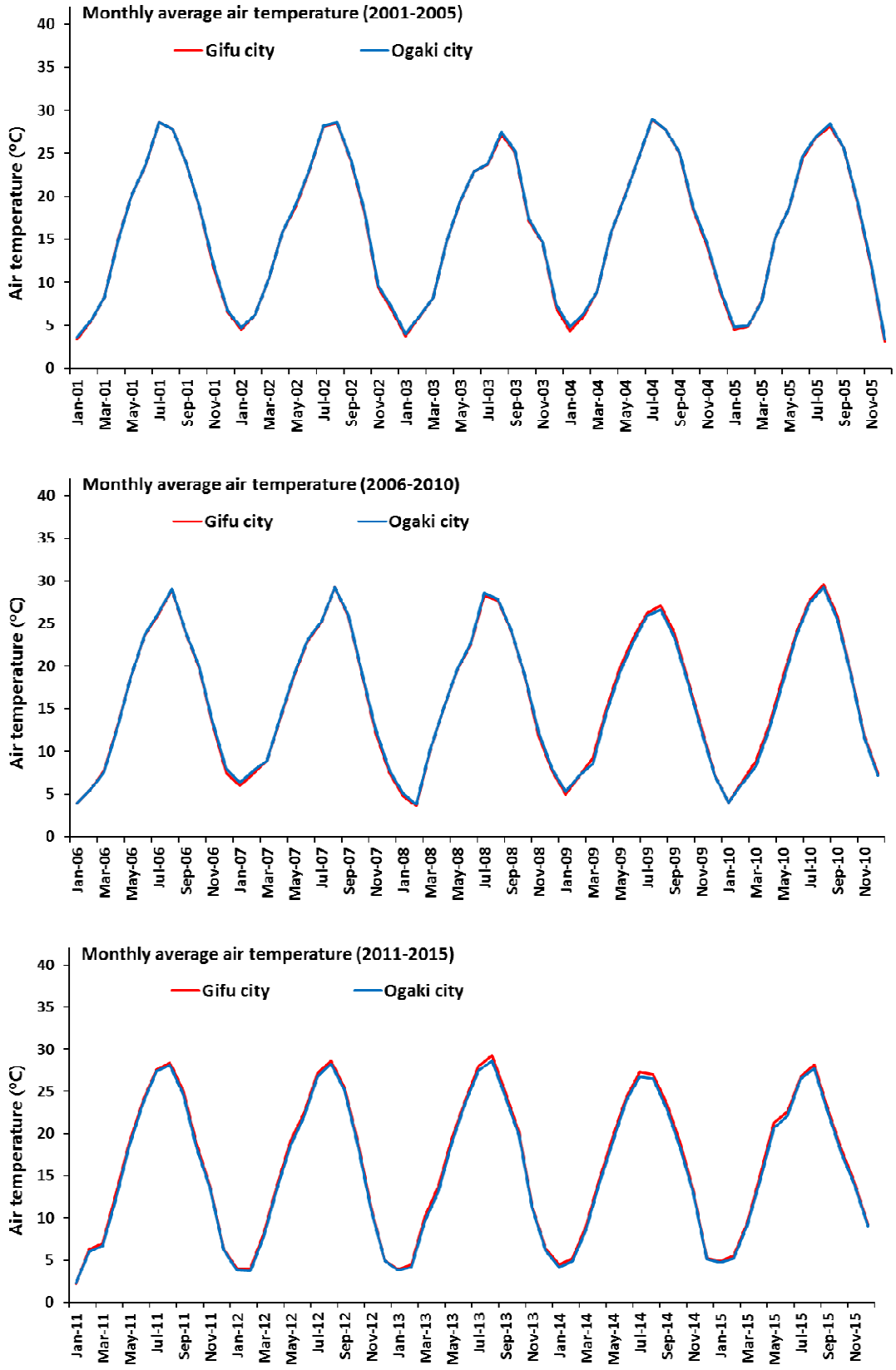

Figure 2. Monthly average air temperature (up: 2001-2005, middle: 2006-2010, bottom: 2011-2015)

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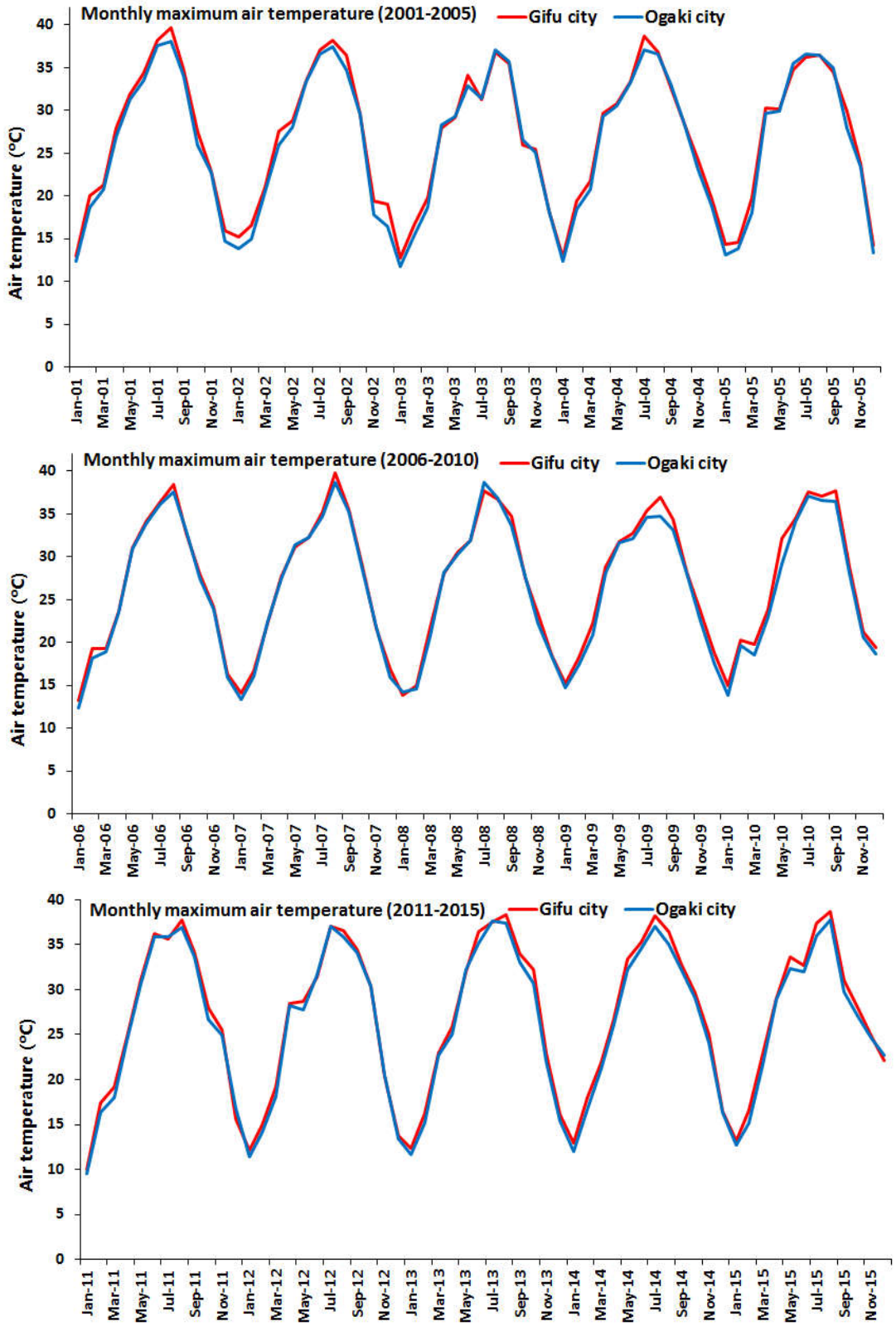

Figure 3. Monthly maximum air temperature (up: 2001-2005, middle: 2006-2010, bottom: 2011-2015)

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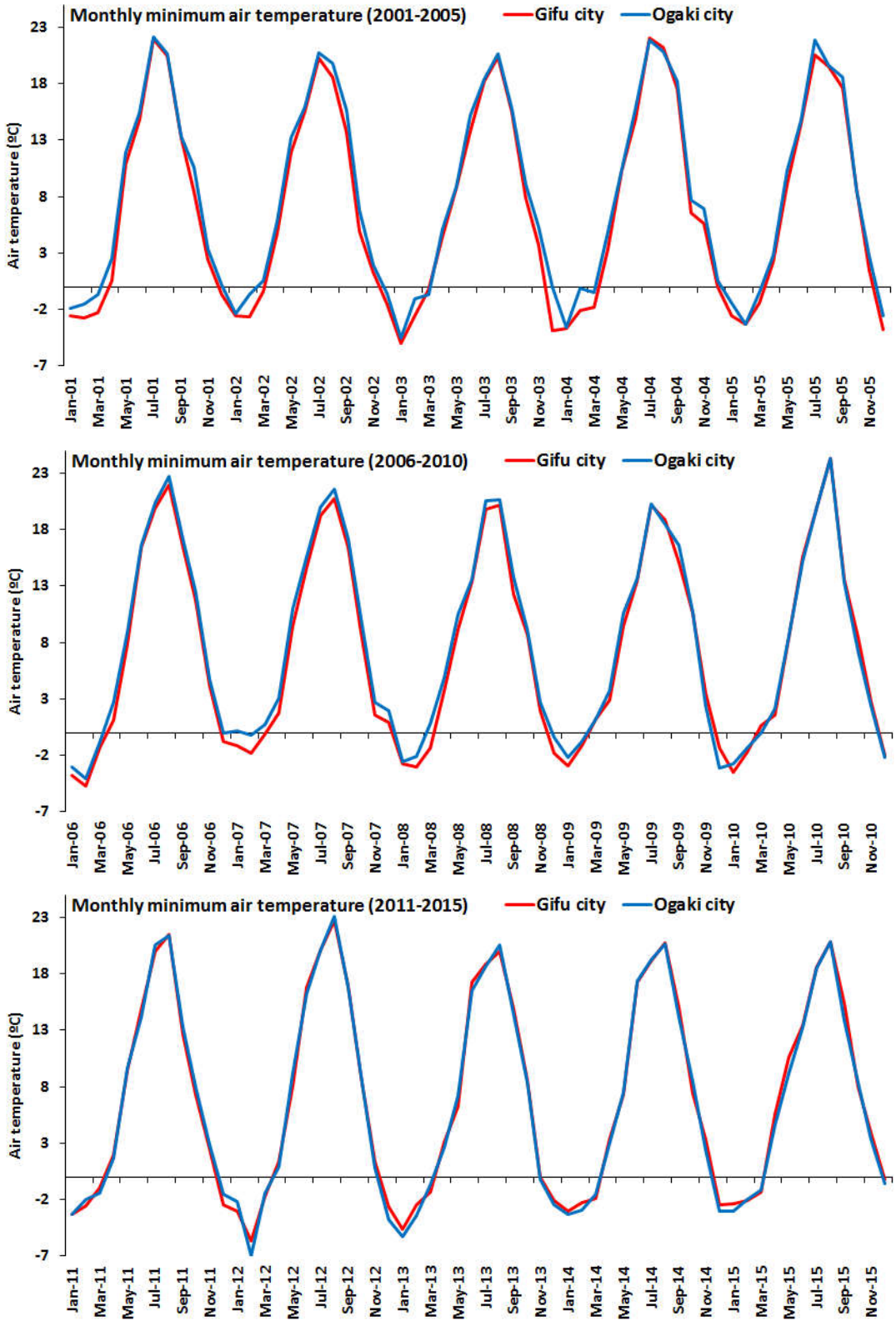

Figure 4. Monthly minimum air temperature (up: 2001-2005, middle: 2006-2010, bottom: 2011-2015)

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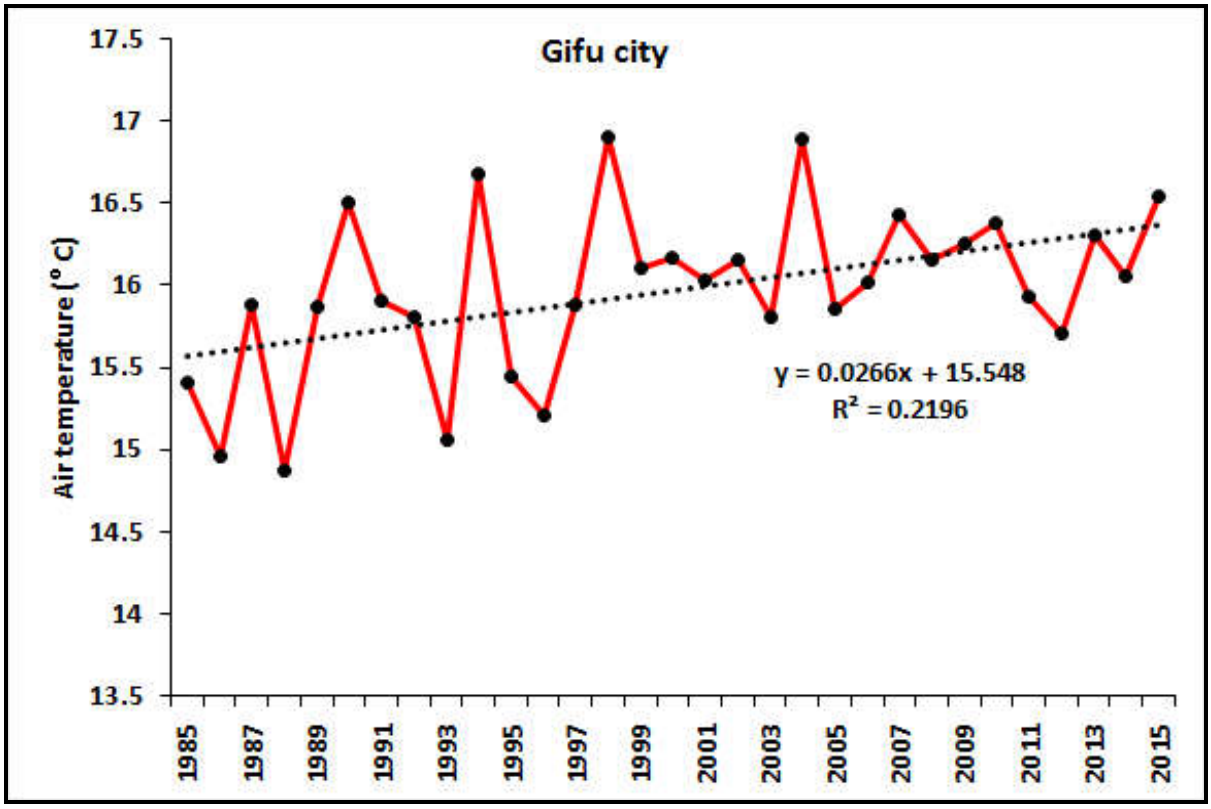

Figure 5. Linear trend of air temperature in Gifu city from 1985-2015 (30 years)

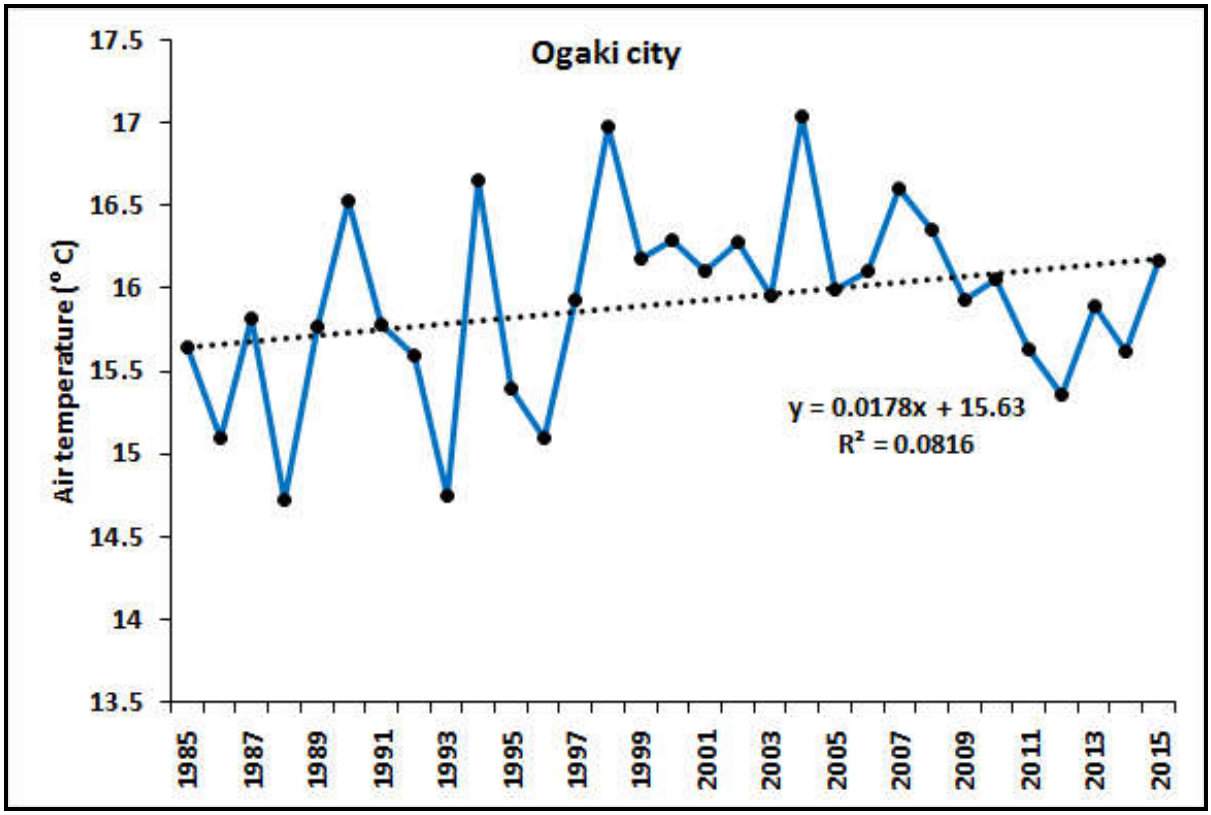

Figure 6. Linear trend of air temperature in Gifu city from 1985-2015 (30 years)

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Forest and trees have a function as a carbon sequestration. Tree or plants absorb more CO_2 than they release, and the trapped CO_2 is stored as a carbon in the biomass (foliage, branches, trunks, and roots) and soils. The carbon storage in the forest is about 50% of its biomass (Tuly *et al.*, 2005; Chang, 2013). Because forest area in Gifu city is lower than in Ogaki city, the function of carbon sequestration is lower and the greenhouse effects in Gifu city are more visible than in Ogaki city, clearly seen in maximum air temperature in Gifu city to be higher than that in Ogaki city. Temperatures remained are relatively cooler over natural cover due to evapotranspiration from vegetation. (Lin *et al.*, 2007), and forest/vegetation can be a buffer of air temperature in the morning.

Gifu city has a residential area larger than in Ogaki city. Residential construction materials as well as coating/paint are often colored in dark. Indeed, this type of color has a high specific heat capacity. Hence, this has a strong tendency to absorb and store heat energy. After sunset, the energy is released as a long-wave radiation In areas of high building density, the proportion of long-wave radiation is lost directly to the atmosphere. Then, the energy released from the building is less than that from the conditional rural environment (near with forest). The energy radiating to neighboring building is also absorbed and re-emitted to the local environment, causing heating (Source: http://www.forestry.gov.uk/pdf/FCRN012.pdf/$FILE/FCRN012.pdf). Besides CO_2 emission, the residential area is also the main reason why the air temperature in Gifu city is higher than that in Ogaki city.

In addition to the above factor, road must be also considered. Road is one component in city. Total road area in Gifu city is 1999 ha and in Ogaki city is 1.295 ha. Gifu city has 704 ha larger than in Ogaki city.

The roads are generally composed of cement, asphalt, brick, pebbles, or aggregates, which absorb and store radiation throughout the day and slowly release heat through the night (Buyantuyev & Wu, 2009). And, Gifu or Ogaki city usually has the road composed by asphalt. The main problem is the asphalt is relatively black. Indeed, this color absorbs a high-heat load (although the color of old asphalt road can be change). Road also can be also changed with age; in which this relates to the surface (becomes slighter over time). Darker materials generally absorb more heat than slighter materials, and rougher surfaces also tend to absorb more heat as their surface area increases (Doulos *et al.*, 2004). Average surface temperatures varied between all the materials. Asphalt (40.0°C) and brick pavers (37.3°C) were the warmest materials, and grass (25.4°C) was the coolest material (Guan, 2011).

4. CONCLUSIONS

The average air temperatures in both Ogaki and Gifu cities are relatively similar. The daily range of air temperature in Gifu city is significantly higher than that in Ogaki city because minimum air temperature in Gifu city is lower than that in Ogaki city and maximum air temperature in Gifu city is higher than in Ogaki city. The air temperature in Gifu city and Ogaki city increases in three decades. This increasing relates to the forest/vegetation area, population, residential area, and road area in Gifu city. Because the population, the residential area, and the road area increased with the time, the excellent strategies on how to against the climate change (specifically temperature) must be found as soon as possible.

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6. AUTHOR'S NOTES

The author(s) declare(s) that there is no conflict of interest regarding the publication of this article. Authors confirmed that the data and the paper are free of plagiarism.

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