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Urban church forests for local temperature regulation: Implications the role of managing and incorporating urban green space in urban planning

Tulu Tolla TURA[1,*], Teshome SOROMESSA[1], Seyoum LETA[1], Mekuria ARGEW[1] and Zewdu ESHETU[2]

1. Addis Ababa University, College of Natural and Computional Science, Center of Environmental Science, Addis Ababa, Oromia 1000, Ethiopia.
2.Addis Ababa University, College of Natural and Computional Science, Center for Climate Science, Addis Ababa, Oromia 1000, Ethiopia.
[*]Corresponding author Email: tulutollatura@gmail.com

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ABSTRACT: The global surface temperature shows an increment of 0.5±0.1°C per decade and 1.05±0.3°C per century from 1880-2014 with greater increases in cities than non-urban areas. Global communities are shifting towards urbanization due to various factors. Urbanization has caused lack of stable condition for dwellers due to environmental and anthropogenic factors such as land cover changes. Urban temperature rising is the main factors hindering urban dwellers at global level due to insufficient green areas. Social institutions are playing important role in urban greening and urban climate regulation. Ethiopian Orthodox Tewahido Church has long history in indigenous trees biodiversity conservation that plays largely greening role in urban and rural parts of the country. However, there is a research gap in Ethiopia regarding the role of urban green area in the church yards in regulating urban temperature and microclimate change. Therefore, the study evaluated the role of church managed forests in Addis Ababa in regulating surface temperature. Surface temperature inside four church forests at a buffer radius of 0–50 m, 50–100 m, 100–200 m and 200–500 m estimated using Landsat image thermal band 6 of 1986, 2000 and 2010 and ground measurement by ambient thermometer at 10:00 am, 12:30 am and 3:00 pm local time. The ground measurement was done in order to validate satellite image analysis. Plant species diversity, DBH, H, HC, BH and BA was measured. There were 1167 trees in the four studied churches. The mean temperatures of the studied sites were 22.5±0.1, 23.25±0.2, 24±0.6, 24.6±1.1 and 25.5±2.2°C on site,0–50 m, 50–100 m, 100–200m and 200–500 m respectively for 1986 images; 23.2±0.5, 23.3±1.0, 24.3±2.1, 24.8±2.2 and 25.5±1.8°C on site, 0-50 m, 50–100 m, 100–200 m and 200–500 m respectively for 2000 images and 23.2±0.3, 23.27±0.2, 23.7±1.6, 24±1.4 and 24.7±1.3°C on site, 0–50 m, 50–100 m, 100–200 m and 200–500 m respectively for 2010 images. The result illustrated a significant influence of green area on urban temperature in the buffering radius and implies the possibility of regulating urban temperature by planning urban green area in appropriate radius intervals. The study indicated that church forests in particular, social institution and urban green area in general have significant role in urban temperature regulation.

KEY WORDS: Church forests, Green area buffer, Urban green area, Urban planning, Urban temperature.

INTRODUCTION

The global surface temperature is increasing on average 0.5±0.1°C per decade and 1.05±0.3°C per century from 1880–2014 (NOAA, 2014). This increment is greater in cities than any terrestrial parts (Ackerman, 1985; Chandler, 1962; Oke, 1973; Moreno Garc´ıa, 1994). Natural climatic conditions of cities and other built up areas are altered due to changes in land use land cover changes and other anthropogenic activities (Krayenhoff and Voogt, 2010). These alterations have an effect on the absorption of solar radiation, surface temperature, evaporation rates, storage of heat, wind turbulence, modification in the near atmosphere over cities and causes temperature difference between urban and rural settings (Kleinzeller, 1960; Mallick J. *et al.,* 2008). The radical changing of urban land is increasing through time due to global community shifting towards urbanization (Smith *et al.,* 2009). Around half of the world's human population lives in urban areas and anticipation of urbanization will increased by 70% of the present world urban population by 2030 (Smith *et al.,* 2009).

Urban heat islands impact urban residents in several ways, including modify energy demand (higher in summer and lower in winter), causes thermal stress on inhabitants, and increase air pollution formation rates (Oke, 1997). Urban temperature is a concern because it causes health hazard such as heat syncope or fainting; heat edema or swelling of dependent parts such as the legs; and heat tetanus as a result of heat induced hyperventilation with other effects include heat cramps, heat exhaustion vomiting, weakness, and mental status changes (Frumkin, 2002). The most acute heat related conditions is heat stroke (Frumkin, 2002). Generally, temperature in excess of 23°C is associated with heat related stress and causes increase in summer deaths (WHO, 2008).

Land use planning and building strategies to regulate temperature within cities is influence the wellbeing as well as the environmental impact of heating and cooling of urban dwellers (Taha *et al.,* 1988; Saito, 1990; Saito, 1991). Therefore, studying urban green area role for local climate regulation is an important aspect in order to create sustainable and health ecosystem for the dwellers particularly, in the limited urban land social institutions. Therefore this study aims at generating baseline information on the role of church forests in urban greening and urban temperature regulation in Ethiopia.

MATERIALS and METHODS

Description of study site

The study area, Addis Ababa City, is located in the central part of Ethiopia. Addis Ababa has an elevation between 3023 and 2054 meter above sea level at geographical location of 09°05′N to 09°00′N altitudes and 38°45′E to 38°42′E longitude. The city receives annual mean rainfall of 1128 mm and mean monthly temperature of 16.25°C. Addis Ababa city is center of political and diplomatic mission with population of 3.5 million (CSA, 2007).

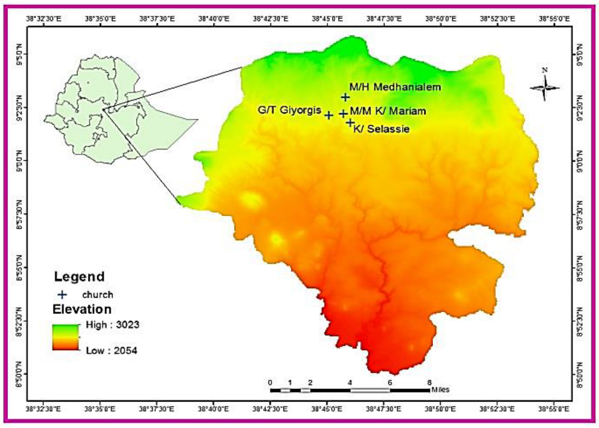

Fig. 1. Location map of Addis Ababa and studied churches.

Elevation classification of study sites

The elevation classification of Addis Ababa city at 100 m interval was categorized in eleven (11) classes with minimum 2054 m and maximum 3023 m above sea level. This elevation difference with other factors may induce a large temperature variation in the city. However, there is no significant temperature difference due to elevation in the selected studied sites. Because all the churches under studies were found in 2401 m–2500 m above sea level elevation range.

According to the digital model the study site land cover is classified as those sites with vegetation and without vegetation. The digital model illustrated that some parts of the city has better green area, while others have completely urban downtown (Fig 3).

The green color indicates green area and red color indicates urban downtown. The yellowish color is the jumble of sparse green area, building and other urban infrastructure. The appearance of varies color in the land cover digital model is due to reflectance of receiving objects during satellite image acquisition.

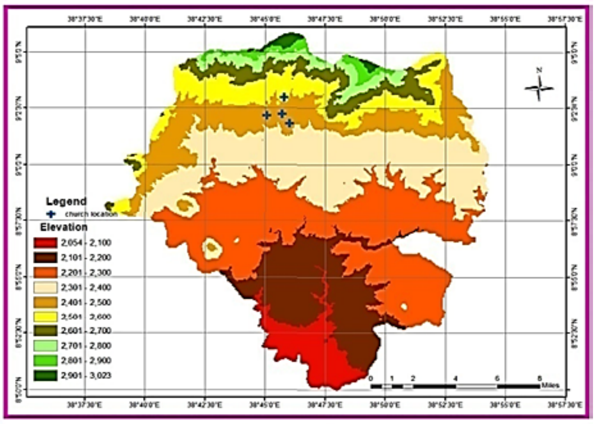

Fig. 2. Elevation Classification of Addis Ababa City.

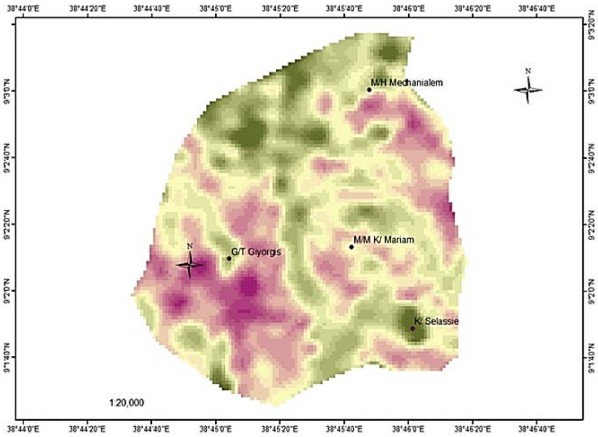

Fig. 3. Digital model of the study sites.

Sampling design

Sampling was designed based on elevation of the churches under investigation in order to control biasness due to temperature change along elevation variation. Four churches were selected in the similar elevation range with varying forest area coverage and tree species. (Table 1)

Table1. Elevation, area and location of the studied church.

Selected church	Elevation	Area	Location
Menbera Tsebaoti Kidist Selassie	2468	1.815	9°01'47"N and 38°45'57"E
Manbera Patriarch Kidisit Mariam	2470	0.2	9°02'11"N and 38°45'40"E
Miskaye Hizunan Medhanialem	2510	0.5	9°02'58"N and 38°45'43"E
Geneta Tsige Kidus Giorgis	2473	0.765	9°02'08"N and 38°45'02"E

Species identification

In order to investigate species diversity and growth impact on urban temperature regulation; the living trees in the studied churches were identified and reordered. Plant identification was done in the field using Flora of Ethiopia and Eritrea volume 2, part 1 and part 2 (Edwards *et al.*, 1995 and 2000); Flora of Ethiopia volume 3 (Hedberg and Edwards, 1989). For those species difficult to identify in the field, fresh specimens were collected and then pressed properly for identification at National Herbarium of Addis Ababa University.

Temperature measurement and land cover change analysis

Primary data were generated from extraction of satellite image and ground measurement. Ground field data collection was conducted inside the church compound and buffering 50 m, 100 m, 200 m and 500 m from the existing green spaces at 10:00 am, 12:30 am and 3:00 pm local time using ambient thermometer in order to validate thermal band satellite image.

Satellite imageries and ancillary data were collected in order to identify historical and recent land cover change. Land cover change analysis helps as to generate normalized difference in vegetation index and estimating surface temperature. Garmin GPS was used to verify the data generated from satellite image with ground. ERIDAS imagine2010; ArcGIS 10.2, Global Mapper 11, 3DEM and Easy GPS software was used for image processing and mapping purpose.

The image data was obtained from United State Geological Survey of Landsat thermal Band 6 1986, 2000 and 2010. The images has been acquired at the end of December and beginning of January between 10:00-11:00 am which is dry season in Ethiopia and high acquisition period with less environmental intrusion.

The images were selected in order to represent urban policy impact on urban green area and land cover change during the consecutive three political regime; 1986 Derg regime, 2000 Ethiopia People Republic Democratic Front (EPRDF) more focus on rural development and 2010 EPRDF focus on rural and urban development.

However, landsat 2014 image was not used due to the band width was smaller than that of landsat TM and ETM^+ images of 1986 and 2000 which may cause overstatement in normalized difference vegetation index and temperature estimation. In the meantime, study area visualization has been done using Ikonos 2006 and Google earth image at various times for detail analysis.

Digital elevation model (DEM) of the study area has been developed using 20 m horizontal and 16 m vertical absolute precision Shuttle Radar Topography Mission (SRTM) of NASA satellite image with 30 meter resolution.

Image precision test and validation

Band selection carried out toward the most precision information from remotely sensed data via analysis of reflectance properties of objects or features. Consequently, for the purpose of attaining accurate and validated image processing; Landsat images through ERDAS IMAGINE 2011 software, spectral reflectance curves and histogram behavior of the bands of satellite images were integrated an analysis of detailed feature records on the ground at the time of data acquisition and different vegetation types in the sites. Lillesand and Kiefer (1994) suggested that image interpreters should have good power of observations, imagination and careful understanding of the phenomenon being studied as well as knowledge of the geographic region under study. As a result, digital image enhancement and interpretation techniques were used.

True Color Composite and False Color Composite were produced to increase the visual interpretability of the images and the amount of information that can be visually interpreted from the data. Digital image enhancement techniques such as contrast stretching, band ratios and normalized difference vegetation index analysis were done. Finally, image analyses result were validated with ground measurement.

Data analysis

Thematic mapper and enhanced thematic mapper data process has been done through plunging ArcGIS remote sensing tool boxes in Landsat Thermal Band 6. The tool helps to estimate surface temperature of a given area and converts pixel values of thermal bands at spectral sensor radiance by conversion coefficient (Walawender *et al.,* 2012).

Step1. Conversion of Digital Number to Spectral Radiance (L_s)

L_s *=Gain *Digital Number + Bias*

Where

L_s *= Spectral Radiance*

Gain and Bias =Conversion coefficient

Inverted plank's law and specific calibration constant (K1 and K2) transforms spectral radiance to sensor brightness temperature (Walaweder *et al.,* 2012)

Step2. Conversion of Spectral Radiance to Temperature in Kelvin

$$T_B = \frac{K_2}{\ln\left(\frac{K_1}{L_s} + 1\right)}$$

Where

K1= Calibration Constant 1

K2 = Calibration Constant 2

TB = Surface Temperature in degree Kelvin And Temperature in degree Kelvin (°K) converted to degree Celsius (°C) (Walaweder *et al.,* 2012)

Step3. Conversion of Kelvin to Celsius TC = TB -273

Where

TB= Surface Temperature in degree Kelvin

TC= Surface Temperature in degree Celsius

273= Conversion factor from Kelvin to Celsius

Basal area of trees in the study sites were calculated with the formula:

BA = $0.785\ DBH^2$*, Where, DBH is the diameter of trees at breast height and 0.785 is conversion factors*

When the image processing completed the digital model images were displayed in the Arc Map software with applied color ramp scheme. Statistical software (R) was applied to analysis mean, standard deviation and correlation between temperature and different parameters considered in the study.

Table 2. Type, number and Growth characteristics of plant species in the study sites.

Study sites	Area	Species									
		Indigenous		*Exotic*		*Total*	*Growth characteristics*				
		Species	*Density*	*Species*	*Density*	*density*	H (m)	DBH (cm)	HC (m)	BH (m)	Basal Area
Menbere Tsebaot Kidist Silasse	1.8	9	355	7	58	413	32.6±5.12	58.3±14.2	15.4±12.4	7.4±6.5	0.27±0.01
Manbera Patriarch Kidisit Mariam	0.2	4	78	1	2	80	22.2±3.3	47.3±10.3	17.4±7.6	4.7±5.6	0.18±0.02
Miskaye Hizunan Medhanialem	0.5	8	280	4	25	305	20.7±6.7	35.7±25.2	12.3±12.5	8.2±5.8	0.10±0.05
Genete Tsige Kidus Giorgis	0.7	6	305	5	35	340	23.8±4.5	60.2±12.7	20.3±19.7	5.6±5.8	0.28±0.01

RESULTS AND DISCUSSION

Plant species and growth distinctiveness of study sites

The numbers of indigenous tree species were higher than exotic species in all the study sites. However, the numbers of exotic tree species are higher at *Menbere Tsebaot Kidist Silasse* than other study sites. The areas of green parts in the studied church compound were directly related with species density. As green area increase species density linearly increase. The number of exotic tree species increases as area of green space increase table 2. Increasing green area size is directly influence the radiance of temperature regulation (Jauregui, 1990 and 1991).

The influence of green area on urban temperature regulation is mainly based on the size of green area, types of plant species, diversity of plant species and growth stages of plants in the green area. It is directly related with absorption and transmission of a certain percentage of the incoming solar radiation, evapo-transpiration (movement of water to the air from different surfaces such as the soil, canopy interception, and water, and conversion of water within the leaf to water vapor which is then released to the atmosphere through the stomata); this cools the leaf and the surrounding local microclimate (Kotzen, 2003; Nakaohkubo and Hoyano, 2011; Hunter Block *et al.*, 2012; Berry *et al.*, 2013). This mechanism induces an important role in the water cycle, and contributes to the provision of ecosystem services by trees (Georgi and Dimitriou, 2010).

Trees produce oxygen, intercept airborne particulates, and reduce smog, enhancing a community's respiratory health and canopy directly contributes to meeting a city's regulatory clean air requirements (Emmanuel, 2005). This function is strongly influenced by type of species, diversity and growth stage of trees.

Trees in the study sites have a range of growth stage. The mean height of trees in each sites were 32.6±5.12 m, 22.2±3.3 m, 20.7±6.7 m and 23.8±4.5 m for *Menbere Tsebaot Kidist Silasse, Manbera Patriarch Kidisit Mariam, Miskaye Hizunan Medhanialem and Genete Tsige Kidus Giorgis* respectively. Trees height at *Miskaye Hizunan Medhanialem* church have highest standard deviation and *Manbera Mengisit Kidisit Mariam* church have lowest standard deviation than other study sites. This height variation indicates growth difference and diversity of species. Diameters at breast height (DBH) of trees in the study sites were illustrated analogous trends of height. Crown height (HC), basal height (BH) and basal area of trees in the study sites was designated irregular standard deviation table 2.

Temperature influence range of studied churches forest

The local surface temperature of the study sites looks like similar manifestation in visual. However, the surround environment is not similarly for the entire study site. Some of the study sites were interfaced with green area and the other urban down town. The interfacing environment of the study sites and buffering zone has impact on the green area temperature regulation range (Taha *et al.*, 1988; Saito, 1990; Saito, 1991).

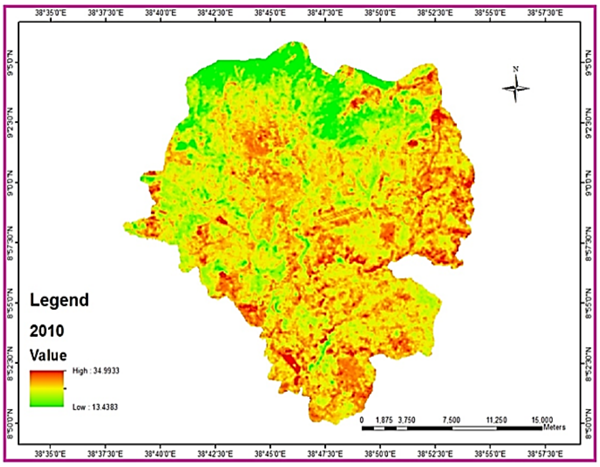

Fig. 3. Digital thermal model 2010 image of the study site.

The mean surface temperature of 2010L and sat Thermal Band 6 image of entire study sites illustrated 34.99°C highest and 13.44°C lowest respectively fig 3. The temperature variation designated the difference between green and non-green area entire study site with other environmental and anthropogenic factors. The green area appears green color in the digital thermal model with lowest temperature record and the red color indicates devoid of vegetation with highest temperature record.

The mean maximum and minimum surface temperature of 2010 Landsat Thermal Band 6 image on sites and buffering 0–50 m, 50–100 m, 100–200 m and 200–500 m was 30.6°C and 17.2°C respectively. There was significant difference between temperatures of entire city and buffering zone of studied sites fig 4.

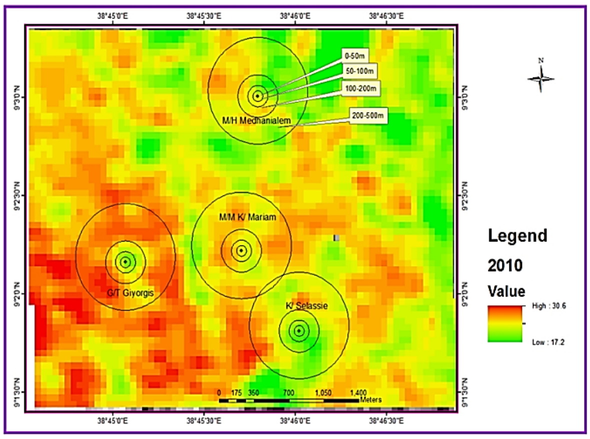

Fig. 4. Digital thermal model of 2010 image onsite and 0-500 m buffering zone of study sites.

The mean surface temperature of 2000 landsat thermal band 6 image of entire study sites illustrated 42°C highest and 13.5°C lowest respectively fig 5. The temperature variation designated the difference between green and non-green area on the entire study sites. The green area appears green color in the digital thermal model with lowest temperature record and the red color indicates devoid of vegetation with highest temperature record. The lowest temperature recoded at urban covered with green area and the highest temperature is observed in downtown.

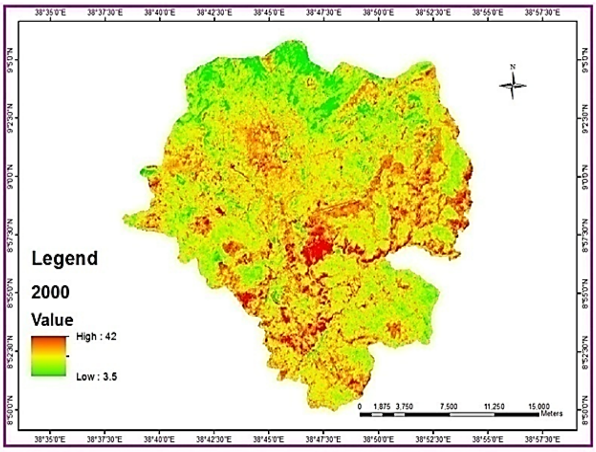

Fig. 5. Digital thermal model 2000 landsat image of the study site.

The highest mean temperature value is significantly differing from other regimes (2010 and 1986) considered satellite images. This might be due to varies factors related with image acquisition process which causes distinct values overall. However, lowest mean temperature was not significant differing from 2010 and 1986 images. The mean maximum and minimum surface temperature of 2000 Lands at Thermal Band 6 image on site and buffering 0–50 m, 50–100 m, 100–200 m and 200–500 m is 32.6°C and 16.1°C respectively. There was significant temperature difference between 2010 and 2000 image analysis both in lowest and highest point fig 6. But the temperature difference in the buffering zone was not significant for 2010 and 2000 images.

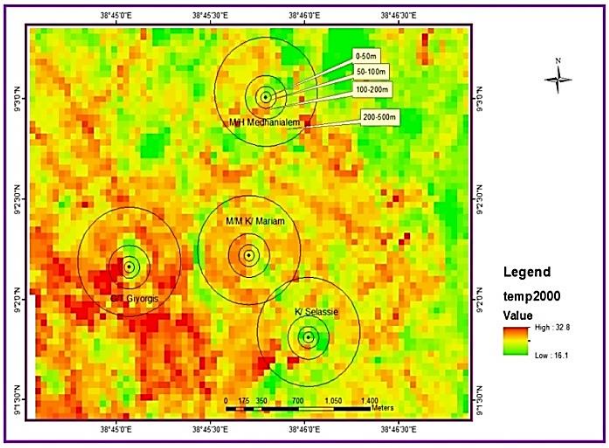

Fig. 6. Digital thermal model of 2000 image of onsite and 0-500 m buffering zone of study sites.

The mean surface temperature of 1986 landsat thermal band 6 image of entire study sites illustrated 36.6°C highest and 14.4°C lowest respectively fig 7. The temperature variation designated the difference between green and non-green area entire study site. The green area appears green color in the digital thermal model with lowest temperature record and the red color indicates devoid of vegetation with highest temperature record.

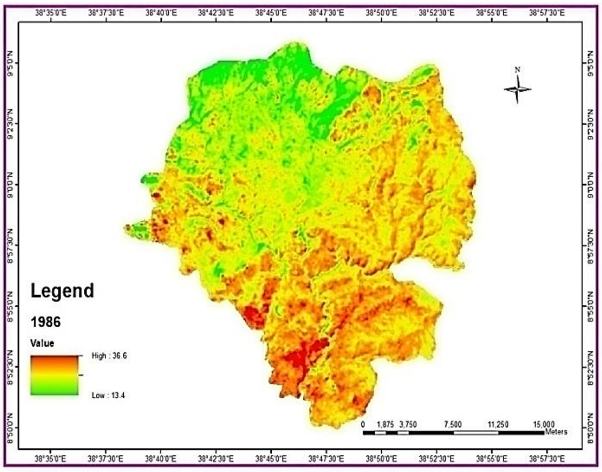

Fig. 7. Digital Thermal Model 1986 landsat Image of the study site.

The highest temperature acquired in 1986 image was greater than 2010 and lower than 2000. But the lowest temperature acquired was almost the same except very slight decimal point difference. The mean maximum and minimum surface temperature of 1986 Landsat Thermal Band 6 image on site and buffering 0–50 m, 50–100 m, 100–200 m and 200–500 m is 29°C and 17.6°C respectively. There was significant difference between temperatures of enter city and the buffering zone of studied sites fig 8.

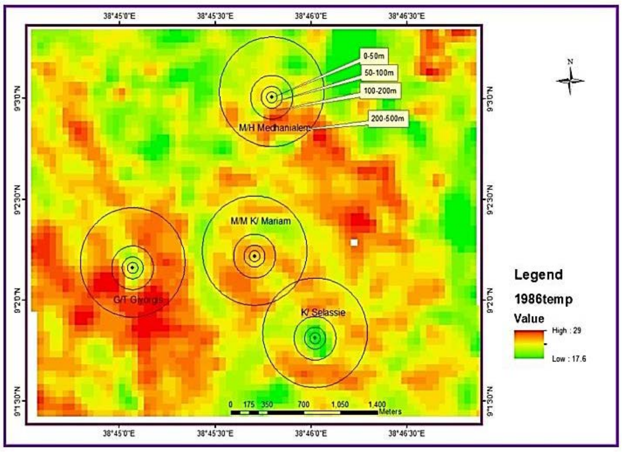

Fig. 8. Digital Thermal Model of 1986 image of onsite and 0-500m buffering zone of the study sites.

The mean entre city green area temperature ranges in the three political regimes were not regular trend. Even if the three political regimes were different police and strategies regarding urban, its impacts on studied churches forest were no significant. This indicates social institutions not significantly influenced by policy and strategy of political philosophy followed when compared with the rest urban green area table 3 and fig 9.

Table 3. Mean surface temperature (°C) in side churches compound and buffering zone of three political regimes.

Year	Onsite	0-50	50-100	100-200	200-500
1986	22.5±0.1	23.25±0.2	24±0.6	24.6±1.1	25.5±2.2
2000	23.2±0.5	23.37±1.0	24.3±2.1	24.8±2.2	25.5±1.8
2010	23.2±0.3	23.27±0.2	23.7±1.6	24±1.4	24.7±1.3

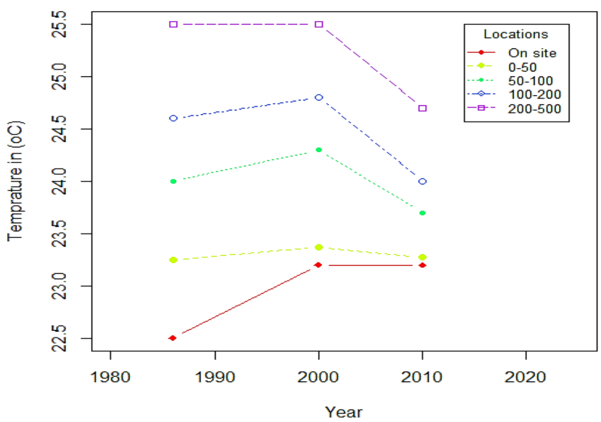

Fig. 9. Green area temperature influence range in the three political regimes

The mean temperature in each studied churches compound and buffering zone in the three political regimes were not uniform. *Menbera Tsebaot Kidisit Selassie* illustrates the lowest (19.3±0.01°C) in 1986 and highest (21.7±0.2°C) in 2010; *Menbera Patriarch Kidisit Mariam* lowest (24±0.4°C) in 2010 and highest (24.5±0.8°C) in 2000*; Miskaye Hizunan Medhanialem* lowest (22.8±0.1°C) in 1986 and highest (24.2±0.3°C) in 2010 and *Geneta Tsige Kidus Giorgis* lowest (23±0.3°C) in 2010 and highest in (24±0.6°C) in 2000 table 4 and fig 10. This illustrates green area size; type of tree species and growth stages of trees affect the temperature regulation range of green area in the three political regimes.

Table 4. Mean surface temperature (°C) of each studied church compounds of three political regimes

Selected church	1986	2000	2010
Menbera Tsebaot Kidisit Selassie	19.3±0.01	21±0.2	21.7±0.2
Menbera Mengisit Kidisit Mariam	24.2±0.2	24.5±0.8	24±0.4
Miskaye Hizunan Medhanialem	22.8±0.1	23.4±0.4	24.2±0.3
Geneta Tsige Kidus Giorgis	23.5±0.1	24±0.6	23± 0.3

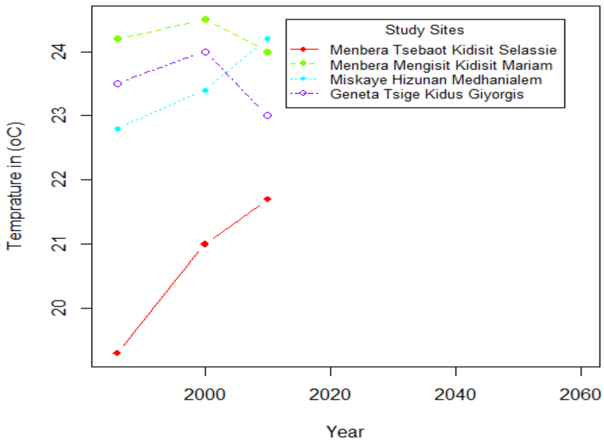

Fig. 10. Mean surface temperature (°C) of each studied church compounds of three political regimes.

The mean temperature recorded for Menbera Tsebaot Kidisit Silase and Geneta Tsige Kidus Giorgis was linearly increases as distance from green area increases. However, the mean temperature of Miskaye Hizunan Medhanialem and Menbera Patriarch Kidisit Mariamwas irregular it might be due to the neighboring environment in the buffering zone of study sites table 5 and fig 11.

Table 5. Mean surface temperature (°C) inside church compound and buffering zone of ground measurement using ambient thermometer.

Studied Churches	Site	0-50m	50-100m	100-200m	200-500m
Menbera Tsebaot Kidisit Selassie	20.50±0.2	21.80±0.2	22.70±0.5	24.20±1.2	25.3±2.1
Menbera Mengisit Kidisit Mariam	21.30±0.4	22.20±1.1	22.50±2.0	25.50±2.3	25.2±1.6
Miskaye Hizunan Medhanialem	20.7±0.3	22.00±0.3	22.90±1.3	25.70±1.4	24.8±1.3
Geneta Tsige Kidus Giorgis	20.80±0.3	22.10±0.1	23.00±0.4	25.90±1.1	25.3±2.3

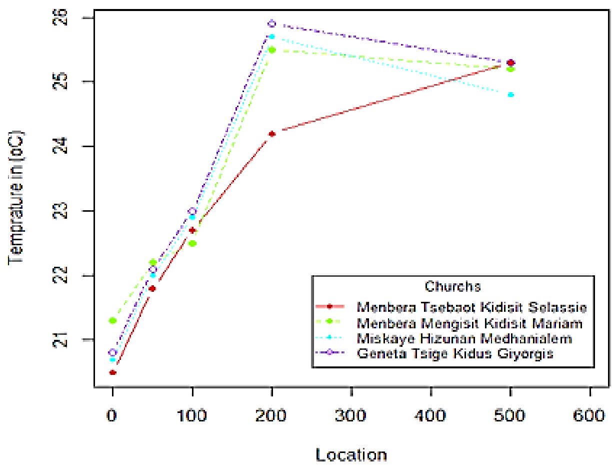

Fig. 11: Mean surface temperature (°C) inside church compound and buffering zone of ground measurement using ambient thermometer.

The mean surface temperature recorded in side studied churches compound and buffering zone of 0-50 m, 50-100 m, 100-200 m and 200-500 m landsat thermal band 6 images2010, 2000 and 1986 was increase as distance from green area increases. The mean surface temperature increment was not uniform for all images in the three political regimes. This indicates the neighboring land cover change in the three political regimes buffering of study sites table 6.

Table 6. Mean surface temperature (°C) with standard deviation of buffering zone in the three political regimes

Church	Year	0-50	50-100	100-200	200-500
Menbera Tsebaot Kidisit Selassie	2010	22±0.2	22.5±0.6	23.4±1	25±1.5
	2000	23.7±1	23.3±2.3	23.6±2.3	25±2
	1986	20±0.3	23.8±0.5	22.2±1.2	24.4±1.3
Menbera Mengisit Kidisit Mariam	2010	25±0	25.3±0.7	25.7±1	26±1
	2000	26.2±0.35	26.2±1.3	26.6±1.6	26±1.5
	1986	25±0	25.2±0.4	25±0.6	24.6±1
Miskaye Hizunan Medhanialem	2010	24.6±0	24.4±4	24.4±1.6	24.5±1.5
	2000	23±1	24.7±1.8	25±2	25±2
	1986	23.4±0	21±0.6	24.2±1.2	24±1.3
Geneta Tsige Kidus Giyorgis	2010	23.6±0.6	23.7±1	25.3±1.4	27±1.3
	2000	25.2±2.5	25.6±2.8	26.5±3	27.8±1.6
	1986	23.9±0.6	23.3±0.3	24.5±1.3	26±1.3

The correlation of temperature with area was strong negative which indicate strong relation. As green area increases temperature decrease in all buffering zone. Area and total trees in the study sites have positive relationship. As area increase numbers of total, indigenous and exotic trees are increases table 7.

The correlation of height with DBH, HC, BH and BA was positive. It was a linear relationship as height increases DBH, HC, BH and BA are increase. DHB was negatively correlated with BH and HC. It indicates weak correlation of DHB with BH and HC in the sites. The correlation of temperature onsite, 0–50, 50–100, 100–200 and 200–500 was negatively correlated with H, DBH, BH and BA except 200–500 with BA and DBH. This indicates the relationship of temperature with H, DBH, BH and BA was indirect strong relationship except 200–500 with BA and DBH. The correlation of temperature with crown height was positive which indicates as crow height increase temperature also increases. This was indirect negative relationship of crown height on temperature regulation. Trees having large crown height regulate less surface temperatures than short crown height table 8. The result illustrated strong relationship between species diversity, area of forest coverage and growth stages of plants temperature of urban. Therefore, urban green area role for urban temperature regulation was clearly visualized.

Table 7. Correlation of temperature (°C) with area, tree diversity and total species.

	Area	On Site	0-50	50-100	100-200	200-500	Total Trees	Indigenous	Exotic
Area	1	-0.8	-0.94	-0.7	-0.91	-0.24	0.84	0.78	0.9
On Site	-0.8	1	0.93	0.98	0.86	0.29	-0.98	-0.96	-0.95
0-50	-0.94	0.93	1	0.89	0.98	0.42	-0.91	-0.94	-0.93
50-100	-0.7	0.98	0.89	1	0.84	0.42	-0.92	-0.98	-0.87
100-200	-0.91	0.86	0.98	0.84	1	0.6	-0.81	-0.93	-0.82
200-500	-0.24	0.29	0.43	0.42	0.6	1	-0.11	-0.54	-0.1
Total Trees	0.84	-0.98	-0.91	-0.92	-0.81	-0.1	1	0.89	0.99
Indigenous	0.78	-0.96	-0.94	-0.98	-0.93	-0.54	0.89	1	0.86
Exotic	0.9	-0.95	-0.93	0.87	-0.82	-0.08	0.99	0.86	1

Table 8. Correlation of temperature (°C) with height (H), diameter at breast height (DBH), crown height (HC), basal height (BH) and basal area (BA).

	On site	0-50	50-100	100-200	200-500	H	DBH	HC	BH	BA
On site	1	0.93	0.98	0.86	0.29	-0.59	-0.21	0.35	-0.82	-0.25
0-50	0.93	1	0.89	0.98	0.43	-0.82	-0.3	0.37	-0.73	-0.33
50-100	0.98	0.89	1	0.84	0.42	-0.48	-0.01	0.51	-0.91	-0.05
100-200	0.86	0.98	0.84	1	0.59	-0.79	-0.15	0.52	-0.76	-0.19
200-500	0.29	0.43	0.42	0.59	1	-0.16	0.63	0.95	-0.7	0.61
H	-0.6	-0.81	-0.48	-0.79	-0.16	1	0.66	0.05	0.22	0.68
DBH	-0.21	-0.29	-0.01	-0.15	0.63	0.66	1	0.77	-0.39	0.99
HC	0.35	0.37	0.51	0.51	0.95	0.05	0.77	1	-0.81	0.74
BH	-0.82	-0.73	-0.91	-0.76	-0.7	0.22	-0.39	-0.81	1	-0.35
BA	-0.25	-0.33	-0.05	-0.19	0.6	0.68	1	0.74	-0.35	1

The result of this study coincides with studies conducted at different countries on different climatic zones. Spatial scales of cooling the surface temperature within a green space may be 15–20°C lower than that of the surrounding urban area giving rise to 2–8 °C cooler air temperatures and a cooling effect that extends out in to the surrounding area (Taha *et al.*, 1988; Saito, 1990; Saito, 1991). The mean near surface air temperature in the shade was less 0.8–1.7°C than the ambient air temperature (min 0.4, max. 4.5°C) depending on the background climate, measurement method and type of surface cover when measured at 25–35°C air temperature (Hodder and Parson, 2007; Thorsson *et al.*, 2007; Kántor *et al.*, 2013).

Susca *et al.* (2011) finding show that, New York City on average, those areas with less vegetation were hotter than those with more vegetation, the difference between the hottest and the coolest areas around 2°C. Chapultepec Park in Mexico City of 500 ha size was reduced temperature by 1.7°C in the radius of 2 km (Jauregui, 1990–91). A leeward breeze park of 60 ha size was reduced temperature by 1.5°C in the radius of 1 km (Asaeda and Abu, 1998). Benjamin Park in Haifa, Israel of 0.5 ha size was reduced temperature by 1.5°C in the radius of 150 m (Givoni, 1998). Green space Kumamoto City, Japan of 0.24 ha size was reduced temperature by 1–2°C in the radius of 20 m (Saito, 1990 and 1991). Honjo and Takakura (1990 and 1991) suggested that a 100 m wide green space cools to a distance of 300 m, 400 m wide green space cools to a distance of 400 m and recommended that green spaces should be no more than 300 m apart for optimum cooling within a neighborhood.

In addition to the role of green space size, the extent of the cooled area around a green space is influenced by the type and composition of vegetation in the green space. Potchter *et al.* (2006) found that high and wide canopy trees and higher tree/shrub coverage resulted in cooler parks compared to the surroundings. Similarly, Yu and Hien (2006) reported that the ambient temperature in a park was strongly correlated to the density of plants. Chang *et al.* (2007) showed that paved surfaces were equal or more than 50% of the land coverage parks were on average warmer than their surroundings. The other study result indicates wind strength and direction can affect the size of the cooled area around a green space (Yu and Hien, 2006; Zoulia, *et al.*, 2009).

In a hot summer the impact of direct radiation on human comfort has emphasized importance that can be described by mean radiant temperature value. Mean radiant temperature is the most important parameter in the human energy balance during summer conditions, since most human bioclimatic thermal indices have special interest in this parameter (Hodder and Parson 2007; Thorsson *et al.*, 2007; Kántor *et al*,. 2013). This fundamentally affects the energy balance of the body and thus the degree of physiological stress (Shashua-Bar *et al.*, 2010). Urban trees on the modification of urban human comfort especially in shading upshot by alteration of radiation energy balance and human bioclimatic impacts by reducing the short wave radiation impact of a human body (Ali- Toudert and Mayer, 2007; Lee *et al.*, 2013).

CONCLUSION AND RECOMMENDATION

The urban climate can be effectively modified by altering the amounts of heat energy absorbed, stored and transferred by adopting cooling strategies. The local climate regulation is a valuable service for the urban inhabitants by greening because it reduces the urban heat island effect. The green area size, plant density and plant growth stage have strong correlation with urban green area temperature regulation. The political regimes policy and strategy did not significant affect social institutions, however, it affects significantly the enter city green area. The green area influence range is not uniform for all study sites might be due to the influence of interlock environment in the buffering zone. However, the result strongly agrees with literature values in the different climatic zone with varying size of green area, plant density and growth stages. Therefore, researchers should consult urban managers/administration on how to develop sustainable and health urban with sufficient green in our vicinity.

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