MICROCLIMATE VARIATION OF URBAN HEAT IN PRIMARY SCHOOL ENVIRONMENTS: EVIDENCE FROM TIRANA

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Approval sheet of the Thesis

This is to certify that we have read this thesis entitled **“Microclimate Variation of Urban Heat in Primary School Environments: Evidence From Tirana”** and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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ABSTRACT

MICROCLIMATE VARIATION OF URBAN HEAT IN PRIMARY SCHOOL ENVIRONMENTS: EVIDENCE FROM TIRANA

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Urbanization inherently disrupts the climate of cities, which results in localized zones of elevated temperatures and thermal discomfort. This phenomenon is known as the Urban Heat Island Effect (UHI) and often has adverse effects on urban inhabitants. This study examines UHI from the eye-level perspective in two elementary schools in Tirana, Albania. The analysis focuses on identifying driving forces behind urban microclimates in school environments to inform potential solutions for more sustainable design and construction practices. UHI mitigation strategies are modeled and tested through software simulations on the most ubiquitous paving materials employed in Albania, solar exposure analysis, air pollutant dispersion, building physics, and green and blue technologies.

Keywords: *UHI, Urban Microclimate, Eye-level, Mitigation Strategies, Ubiquitous Paving Material, Building Performance Simulation, Solar Analysis, Air Pollutant Dispersion*

ABSTRAKT

VARIACIONI MIKROKLIMATIK I NXEHTËSISË URBANE NË MJEDISET E SHKOLLËS FILLORE: DËSHMI NGA TIRANA

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Urbanizimi në mënyrë të natyrshme prish klimën e qyteteve, gjë që rezulton në zona të lokalizuara të temperaturave të ngritura dhe shqetësimit termik. Ky fenomen është i njohur si Efekti i Nxehtësisë Urbane (ENU) dhe shpesh ka efekte të pafavorshme mbi banorët e qytetit. Ky studim shqyrton ENU nga këndvështrimi i nivelit të syrit në një shkollë fillore në Tiranë, Shqipëri. Analiza përqendrohet në identifikimin e forcave lëvizëse pas mikroklimave urbane në mjediset shkollore për të informuar zgjidhjet e mundshme për dizajne dhe praktika ndërtimi më të qëndrueshme. Strategjitë e zbutjes së ENUI-së janë modeluar dhe testuar përmes simulimeve të softuerëve në materialet më të kudondodhura të shtrimit në Shqipëri, analiza e ekspozimit diellor, shpërndarja e ndotësve të ajrit, fizika e ndërtesave dhe teknologjitë e gjelbërta dhe blu.

Fjalët kyçe: *ENU, Mikroklima Urbane, Niveli i syrit, Strategjitë e Zbutjes, Materiali i Plotësueshëm i Asfaltimit, Simulimi i Performancës së Ndërtesës, Analiza Diellore, Shpërndarja e Ndotësve të Ajrit*

Dedication

I dedicate my dissertation work to my family and Nicola. A special feeling of gratitude to my sisters, Daniela and Ana for their infinite support.

I dedicate this work and give special thanks to Nicola A.Verdho for being there for me throughout the entire thesis process and everyday. You have been my best cheerleader.

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ABBREVIATIONS

UHI	Urban Heat Mitigation
ITC	Infant,Toddler and Caregivers
ITCN	Infant,Toddler and Caregivers Neighborhood
SM	Servete Maci School
AR	Asphalt with red coating
LC	Light Concrete
GC	Grey Concrete
SC	Scenario
PT	Potential Temperature
MRT	Mean Radiant Temperature
RH	Relative Humidity
WS	Wind Speed
WD	Wind Direction
SR	Sun Radiation

CHAPTER 1

INTRODUCTION

1.1 Overview

Most cities have substantially greater air temperatures than rural areas. This phenomenon, commonly known as Urban Heat Island (UHI), causes issues for city dwellers. Luck Howard, a meteorologist who measured the climate in the London region for forty years, was the first to identify UHI (1801-1841). [1] Some of the foremost challenges of today's economies embrace speedy pace of urbanization and handling the potential impacts of climate change. Today, quite half the globe population lives in urban areas. Cities of developing countries, wherever 70% of urban population lives, are possible to borne the severe impacts for dynamical climate. [2].

Urbanization is presently a global issue. According to the World Organization, the current 55 percent of the world's population living in urban areas will increase to 68 % by 2050, with the majority of the urban expansion taking place in developing nations. This expansion endangers our natural system by raising outdoor air temperatures and, as a result, causing the UHI phenomena. It is critical in terms of landscape design and building energy performance in urbanized areas, and it causes significant human discomfort, particularly in town centers. [3]

The overlaying weather is influenced by urban areas, resulting in variations in cloud cover, precipitation, temperature, wind speed, and wind direction. [4]UHI intensifies the harmful impact of heat days and heatwaves and its effects are additional profound within the sub-surface layer. Its impacts are well related to human health, thermal comfort, environmental quality and energy efficiency. [5]

With the fast develop of urbanization, the depth and bad outcomes of the urban heat island (UHI) impact may be significant. In the city climate, building heights, vegetation, and the geometrical houses of city surfaces have an effect on warmness absorption and radiation traits and additionally create the UHI impact. The excessive temperature in city regions impacts the wellbeing, financial development, leisure activities, and welfare of residents. The elderly and youngsters are more vulnerable to the UHI effect, which ends up in health issues. Urban warming also can enhance air pollution, such as elevated surface ozone concentrations, which impacts human wellbeing. [6] Hence, research on influencing factors and mitigation strategies are crucial in order to achieve convenient development. It is important to understand the microclimatic issues, what causes them and how they affect the surrounding environment. The study of this phenomenon during summertime is of specific importance particularly in dense urban areas due to severe influencing factors. [7]

1.2 Motivation

Being an issue across the world acknowledged and studied via previous researchers, UHI is nowadays a completely crucial issue for the cities in development. Motivated through worldwide efforts to enhance the city microclimate to reduce the UHIs phenomenon to enhance the city microclimate this paper incorporates a literature evaluation of the UHI impact on different places of the world, which data might assist on helping to build sustainable elementary school buildings and surroundings urban spaces in Tirana.

UHI is considered one of the crucial issues in the twenty-first century due to human civilization's expansion and automatization. The city systems generate a large quantity of warmth from sun radiations and different assets, including anthropogenic heat. This situation is even worse in towns with excessive density and large populations, and vast monetary activities. Tirana, a densely urbanized city, is significantly going through this problem.

The implementation of research-informed and context-appropriate UHI mitigation strategies can reduce the negative impacts of environmental hazards in elementary schools, such as overheating due to elevated temperatures, unhealthy levels of air pollution, and associated public health effects. Potential strategies consist of increasing tree and vegetative cover, installing green roofs, installing calm and mainly reflective roofs, using cool pavements either reflective or porous and utilizing smart vegetation growth practices. [8] UHI mitigation strategies can reduce the demand for air-conditioning-related energy production, lessen adverse UHI effects, and ultimately improve the quality of school learning environments. [9]

Limited urban vegetation and ubiquitous materials of building structures are considered the main contributors to the UHI effect. However, these priors have not been systematically tested in the context of elementary schools in Albania. Buildings with limited open space for tree planting and green areas are more susceptible to heat absorption. With global warming and climate change, these buildings face the more significant challenge of the interactions between existing UHI effects and the lack of climate mitigation strategies. [8]

1.3 Thesis Aim and Objectives

Under this paper's studies, the essential question is to understand how children are affected by thermal comfort in preliminary school amenities. Being able to answer correctly, firstly, we need to address further questions. The main problem is, the meaning of thermal comfort. This question permits us to understand the study's essential aspect and give some general information.

Another outstanding sub-question is the correlation between thermal comfort and youngsters' studying environment and why schools. These two questions are substantial because they will lead us to discover the principle concept approximately the study. Thus, the significance of thermal comfort in primary schools could be determined and emphasized through this study.

The subsequent query issues how does the UHI impact affects the indoor thermal factor. The query offers a few benefits to focus on an important aspect to apprehend the elements that influence the UHI. However, the mitigation techniques are also considered an excellent way to comprehend the well-being of the youngsters. This question provides opportunities to reach the study's main idea and discover the pros or cons that both UHI and thermal comfort have on child development.

Hence the aim is to evaluate the conseqeuences of UHI at the eye-level in primary schools in Tirana (Albania). The research can provide original contributions to the body of knowledge by addressing the following research gaps and identifying potential areas for further improvements in the simulation, outlined by the following literature review. Examining UHI-associated factors and advocate capability answers for a more significant sustainable layout. The primary consciousness is to discover architectural form in UHI mitigation via expertise in the impact of city warmness in current school buildings and children's well-being in the school environment and in the neighbourhood scale.

1.4 Organization of the thesis

This thesis organization consists of 8 chapters. It is organized as the following: Chapter 1,the introduction which presents the thesis motivation and objectives. Chapter 2 describes the theoretical background of Urban Heat Island phenomenon, its influencing factors and mitigation strategies. It is followed by case studies which focus on youngsters development and the impact of urban spatial design and the case of Tirana's school neighborhoods is introduced.. Chapter 3, consists of the methods and data used in this study. In Chapter 4 the data analysis are depicted. Chapter 5 consists of scenario results of ENVI-met simulations are presented and discussed. Chapter 6 consists of optimization scenarios. In Chapter 7 results and discussions are presented. Optimization results and mitigation techniques are discussed. In Chapter 8 conclusions, limitations and recommendations for further research are stated.

CHAPTER 2

LITERATURE REVIEW

The purpose of this chapter is to provide information about microclimate problems, causes and consequences. The Urban Heat Island is addressed and examined, as well as mitigating strategies for obtaining enhancements. The literature review begins by looking into the concept of urban heat island and the factors that contribute to it ***Table 1.***

2.1 Urban Heat Island Phenomenon Description

An Urban Heat Island (UHI) is a metropolitan region with higher surface and near-surface air temperatures than its encompassing rural and country regions. [10] This issue is also worsened by the expanding length of the metropolis inhabited by the human population and the rising cost of power usage. According to studies, cities currently use 60-80 percent of the world's total power usage. It was also discovered that distance from UHI is a major factor impacting heating and cooling costs, as well as the influence of urbanization on energy consumption. Because the ratio of global city population to total population is anticipated to increase from 54 percent in 2016 to 60 percent in 2030, UHI is likely to become a major initiative in the future city living. [11] [12] [13]

The UHI effect is caused by the greater warmth maintenance of structures and man-made surfaces such as cement and black-top, which are ubiquitous in urban areas, compared to the poorer warmth maintenance and cooling qualities of more abundant vegetation in the open country. Its impact stems from a variety of factors, including the accelerated absorption of daylight through the use of dark-colored building surfaces, the bodily houses of commonly used substances in city areas, the imposition of warmth within the city area due to city morphology, which affects shading and air movement, and the city compactness, which stems from density, plot ratio, and land-use ratio. It also has an impact on the weather above it, causing changes in cloud cover, precipitation, temperature, humidity, wind velocity, and wind direction. [12] [2]

Incredible possibilities exist inside towns for tackling weather change. Urban Heat Island (UHI) impact is a phenomenon wherein tremendous temperature distinction among a metropolis's internal micro-climates and neighboring microclimates may be perceived. Mitigation of UHI outcomes can make contributions to relieve detriments of weather change. The UHI impact is a phenomenon wherein a considerable distinction in temperature may be located among a city and its surrounding rural regions or particular city components. The areas of maximum temperature may be found in the densest part of the city area, illustrated in ***Figure 1.*** [9]

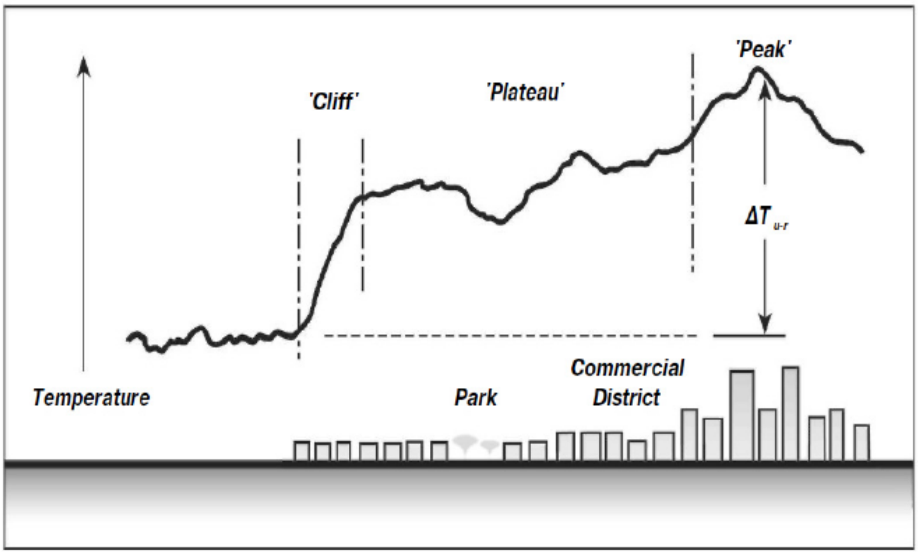


Figure 1.Urban Heat effect in the city

Urban roads typically have more miniature trees and other vegetation to conceal structures and cool the air by evapotranspiration. Subsequently, the urbanized land cover tends to hold less surface water from precipitation than the regular land cover. The metropolitan warmth island temperature impact can be estimated as far as the metro covering layer, which alludes to space underneath the housetops of structures, and the mesoscale, which alludes to local temperature estimation Fig. 2 is a prevalently utilized portrayal of an "average" heat island impact on near-ground temperature.***Figure 2*** [10] [12] [7]

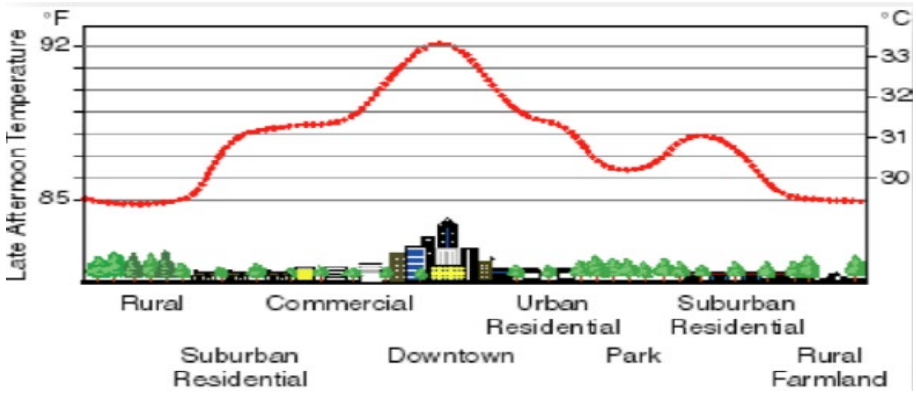


Figure 2.Urban Heat Island Phenomenon

The UHI is a global problem that jeopardizes the functioning and habitability of our cities and built environments. The concept of UHI has been well explored and recorded; nevertheless, information on the issue is scarce. Due to increased awareness of global warming and weather consequences, warmer cities, and changes in the generation for size and analysis, this has changed in recent years. The warmth island effect is defined by our cities experiencing much higher temperatures than the nation-state that immediately surrounds them. [14]

2.2 UHI Influencing Factors

The UHI is a worldwide phenomenon that affects thousands of people. [14] In the previous several centuries, the world has witnessed considerable industrialization and urbanization. The natural environment is altered by rapid urbanization, which transforms it into man-made structures and artificial landscapes. These changes are widely known for contributing to the formation of urban heat islands by boosting local temperatures in cities (UHI). [15]

Its influence is seen as one of the most serious problems confronting humanity in the twenty-first century. Across 3 billion people living in urban areas around the world are immediately exposed to the problem, which is expected to rise significantly in the near future. [16] Expansion and growth of cities, as well as anticipated climatic change The risk of temperature degradation in extremely hot cities, as well as the risks to human health that this poses. These issues highlight the importance of comprehending the influence of the built environment on heat exposure to tiny particles, which has an impact on the health, well-being, and productivity of city dwellers through thermal comfort. [14]

UHI is a well-known mesoscale phenomenon caused by many factors related to land cover, energy use, and human factors. Heat, and the configuration and size of buildings with high heat dissipation materials that collect heat during the day and radiate heat at night. Although it is important to understand the meteorological differences in the environment from the impenetrable natural surface, the surface characteristics of arcs are temperature and albedo play an important role in the absorbed radiation by a human and the total thermal stress on a person. Previous studies have shown that emissions from traffic and road traffic have a significant impact on urban temperature rise. [17] Previous studies have shown that emissions from traffic and road traffic also have a significant impact on urban temperature rise. [15]

The temperatures in city regions than the encompassing geographical area have tremendous results for humans' health and wellness residing in cities. The improved use of human-made substances and improved anthropogenic warmness manufacturing are the primary reasons for the UHI. This has led to the knowledge that enhanced urbanization is the number one motive of the city's warmness island. The UHI impact also results in improved power wishes that contribute to the heating of our city landscape and the related environmental and public fitness results. Pavements and roofs dominate the city floor uncovered to sun irradiation. [14]

2.3 Mitigation Strategies

Mitigation strategies were aiming to counterbalance the UHI phenomenon cope with the extensive utilization of inexperienced spaces, the utility of distinctly reflective substances, substances having excessive thermal resistivity, lower the anthropogenic heat, sunlight hours of open spaces, use of environmental warmness sinks, and expansion of the wind go with the drift withinside the cover layer. Though substances having excessive thermal resistivity do now no longer at once mitigate the UHI impact. However, upon using them as constructional substances, the buildings end up relaxed, which reduces the anthropogenic (waste) warmness from the homes, thereby mitigating the UHI impact. [16] Due to the continuing worldwide warming, warmth mitigation techniques have become applied via exercise and simulations. These efforts intended to make the towns that might be handling the city warmth island extra livable. [18]

Effective mitigation techniques consist of increasing materials albedo intracity, vegetation, trees, and ponds inside city areas. Also lowering the launch of anthropogenic the warmth internal constructing canopies, and designing shelters and buildings. [19] The results show that building volume, orientation, and location are one of the most commonly used strategies to mitigate UHI risks. Trees, shrubs, grass (TSG), and excessive albedo materials (HAM) in outside construction surfaces are indicated as effective measures whose achievement depends on constructing form. All assessed mitigation strategies (TSG, HAM, UIWB) are proven to have a comparable resilience stage. These can be advanced if well future-proofed towards the next changes. Accordingly, a few practical guidelines supply to assist the resilience of examined UHI mitigation strategies. [9] Natural airflow is a not unusual approach to keep away from overheating in buildings. [20]

In order to offset the effects of urban warming, special mitigation and adaptation technologies have been proposed. Two major promising clusters of mitigation techniques have been identified and researched Increasing solar Reflectance: technology to reduce the absorption of solar radiation in the urban environment. This is mainly achieved by using materials with high solar reflection (and high heat radiation) to cool the surface. These materials are called cold materials and can be used for building exterior walls, ceilings and floors. Use of cool materials decreases the surface temperature of the urban areas and minimizes the corresponding release of sensible heat to the atmosphere; and Increasing evapotranspiration: Technologies aiming to increase evapotranspiration in the urban environment. This can be achieved through the intensive use of urban vegetation, such as urban parks and green roofs, and the use of permeable sidewalks. [7] [6] [21]

2.2.1. Urban Water Sources

Urban waters, including rivers, lakes, and reservoirs, are one of the most important ecological spaces in urban areas. Water bodies are usually rich in natural elements and characterized by complex natural processes; as such, urban water bodies are significant Elements of urban ecosystems. As we all know, water has high heat capacity and low thermal conductivity, and its evaporation is the main cooling mechanism. These characteristics of water lead to a significant decrease in the apparent heat exchange capacity, which leads to changes in heat transfer methods. This effect is expected to contribute to a more constant climate, including decreasing maximum temperature and increasing minimum temperatures.

It is generally believed that water bodies can significantly reduce the impact of UHI due to the mentioned physical properties. Studies have also shown that size and shape are positively and negatively related to the cooling effect. For instance, a study indicated that relatively large water bodies presented a higher cooling effect, as compared to equally distributed small water bodies. Moreover, studies also found that the location, wind direction, and the specific landscape pattern around the waterbody play a significant role in the cooling effect, but the contributions of such factors to the cooling effect of the waterbody are still unclear. In order to most effectively alleviate the UHI effect, proposed an idealized spatial pattern of blue-green space within a city – hierarchical hexagonal structure model.

In addition, the evaporation from water bodies may lower the temperature; however, this process would increase the humidity around the water bodies, which reduces the positive effect of water bodies on thermal comfort. The latitude of the city also affects the cooling intensity of the water body, and the cooling intensity is generally stronger in lower latitude cities than in high-latitude cities. [22]

2.2.2 Vegetation

Various forms and functions of vegetation utilization in urban areas are getting more and more attention as a tool to mitigate the UHI effect and improve indoor and outdoor thermal comfort. The aim of previous researchers has been to investigate the use of vegetation as a strategy to reduce the urban heat island effect and to improve the thermal comfort of indoor and outdoor environments. [12] [23] [7]

Urban green space includes forests, grasslands, shrublands, and street vegetation which are important. The type of land cover that maintains the health and balance of the urban ecosystem. Through shade (trees), urban vegetation affects the physical environment of the city. Selectively absorb and reflect incident radiation and adjust latent heat and sensible heat transfer. These mechanisms form the basis of the cooling effect of the green space. The cooling effect of green space differs according to, for example, the size and type of green space (tree-covered and grass-covered), the structural features of plants, and the spatial patterns of the green space. [22] [23]

The UHI phenomenon will increase additionally because of the declining quantity of flowers and evapotranspiration withinside the towns which results in absorption of sun electricity at some point of the day. The presence of tall flowers decreases the absorption of sun electricity for this reason greenery performs a essential position for the towns. [7] The shape of the green space also affects the cooling effect. Urban vegetation can reduce surface roughness, improve evapotranspiration, reduce environmental temperature, and improve human thermal comfort. Due to its additional benefits for ecology, urban greening has gained popularity worldwide. [22] [23]

2.2.3 Surface Materials

The use of man-made materials rather than natural materials is some other purpose for the emergence of UHI. The characteristics of urban surface materials together with albedo (reflectively of sun energy) and warmth ability have an effect on the urban heat island. Materials with low albedo and excessive warmness ability can keep massive quantities of sun warmness and launch it once more overnight. [14]

Reflective coatings have higher sunlight reflection (albedo) than traditional dark coatings. This is achieved by either using surfacing materials of light color or applying light color coating on dark surfacing materials. The reported albedo range of simple sidewalks is 0.2/0.3 for red/green surfaces to 0.6/0.7 suitable for gray or cream colored surfaces, and the albedo value of fresh black asphalt t is usually less than 0.1. Increasing the solar reflectivity of the pavement reduces its surface temperature and the However, the increased radiation reflected from complex urban areas can be guided and absorbed by surrounding buildings. This will increase the surface temperature and may have a negative impact on the air temperature and energy consumption in the building.

Permeable coverings contain more pores than traditional impermeable coverings, and their design makes to allow water to drain into the sub-layers and then down into the groundwater. Compared with traditional coatings, permeable coatings have many environmental advantages, including reduction of rainwater runoff, replenishment groundwater, reduce pollutant emissions, improve air quality and reduce road and highway noise. In addition to these advantages, their relatively high porosity allows the permeable coating to retain moisture when wet. This water can be used to evaporate during the hottest time of the day, using evaporative cooling to lower the surface and air temperature. Evaporation converts part of the pure downstream radiation into latent heat keeps the surface temperature low and reduce underground heat storage, thereby reducing sensible heat exchange between the surface of the earth and the atmosphere.

However, as the pore size increases, the permeable coating can more easily drain water into deeper layers due to gravity. This means that less water is left on the surface to evaporate, which reduces the possible cooling effect. Although a significant amount of work has been done in order to correctly design porous pavements to avoid stormwater run-off and to characterize their saturated properties and thermal performances, only a limited amount of work has been found on the characterization of the unsaturated hydraulic properties of porous pavements , which is essential to correctly understand their drying behavior, and the impact of these properties on the cooling response. [24] [25]

Darker floor materials are generally the sorts that have better albedo subsequently soak up much less sun energy. One of the largely used paving substances round the arena is Asphalt Concrete subsequently it's miles essential contributor to UHI. Asphalt concrete is a dark pavement as a result it's miles essential contributor to UHI. Asphalt concrete is a dark pavement as a result it has low reflectivity of sunlight. Fresh Asphalt Concrete absorbs 95% of sunlight. Therefore paving material in summer season reaches very excessive ranges this means that a massive quantity of warmth is saved in maximum elements of the city. [14]

2.4 Children Development and Thermal Discomfort

Thermal comfort is especially crucial for children's development because it influences how youngsters analyze withinside the classroom. [26] Climate alternate elevates the nice and cozy season's duration and depth within the academic year, with a completely tremendous effect on indoor study room conditions. Increasingly common episodes of intense warmth negatively impact college activities, whose length may also need to be shortened or tempo slackened. Fitting centers with aircon does now no longer continually remedy the hassle and may also even make contributions to soreness or get worse fitness conditions, frequently due to insufficient airflow. Users have historically followed measures to conform to those situations, mainly in heat climates wherein mechanical refrigeration is absent or unavailable. However, implementation of such actions or herbal airflow is not continually viable, or their efficacy is constrained in college environments. [27]

2.4.1 Children Development

Today, high-quality education is essential to the development of society, the intelligence of citizens, and social development. In order to solve this problem, it is necessary to improve the quality of the learning environment, including the classroom environment. Some studies link student performance with thermal comfort and indoor air quality. [28] Since students spend about one-third of their time in school every day, they also need to address health and well-being issues related to the indoor environment. [29]

Several international studies have been conducted to evaluate student performance and the factors that affect them the most, including the thermal comfort of the classroom. However, some differences were found between the student's perception and the results of the thermal comfort model. [28] Most research on the thermal comfort of classrooms is conducted in mechanically heated and ventilated rooms. In free-movement areas, the expectations of residents are usually different, and the lack of information becomes obvious. [30] [31]

As primarily public assets as discussed in other studies, urban schoolyards comprise a high percentage of open space and a large and diverse urban population. In addition they are usually widely distributed geographically, but relatively small on the individual level .These factors enable decision makers to innovate and have sources to achieve multiple benefits that work towards the goals of a given neighborhood or community. [28] According to green schoolyards can be defined as multi-functional school grounds that reduce non-porous surfaces by With green elements such as gardens, plants, trees, grass and other porous surfaces. Green parks better can better respond to extreme weather events, help reduce the impact of climate change, and become a natural resource for students, teachers, parents and communities. [32] Planners are tasked with creating great communities for all and greening schoolyards can be a multi beneficial A way to promote community participation and social cohesion, climate change mitigation and adaptation, and improved health outcomes. [33]

The recorded growth within the typical global temperature during the last century has raised worries about overheating in buildings without mechanical cooling.

Furthermore, warm waves have become more common and intense. The first-rate situation as studies proves that children ″are much more likely to be related to heat-associated morbidity.″ Schools are mainly susceptible to elevated temperatures because of the younger age of occupants, excessive occupancy densities, and restrained possibilities for behavioral changes to improve classroom thermal consolation. There are bodily and physiological variations among kids and adults, explaining their exclusive thermoregulation and stated thermal sensation. Besides these, different surface area-to-mass ratios, extra metabolic warmth manufacturing according to kg frame mass, and decrease sweating rate.

Under experimental situations (***Figure 3***) in U.K. schools and workout levels, kids were observed to have decreased evaporative sweat loss and better pores and skin temperature through 3oC than adult men. The kids' high body surface area to weight ratio and their poorly developed sweat mechanism led to a similar heat mechanism that brought about comparable warmness dissipation of 51% through evaporation and 44% through radiation and convection. For adult men, the corresponding changes have been 65% and 33%, respectively. However, sports in the study room are much less extensive than the bodily workout. This test highlights that kids depend more on dry warmness loss (thru radiation and convection) than adults. This indicates that kids' cooling ability is greater sensitivity to the bodily residences in their surrounding area. They decide the radiant and convective warmness losses, highlighting the importance of the college constructing layout to keep away from warmness soreness in kids. [34]

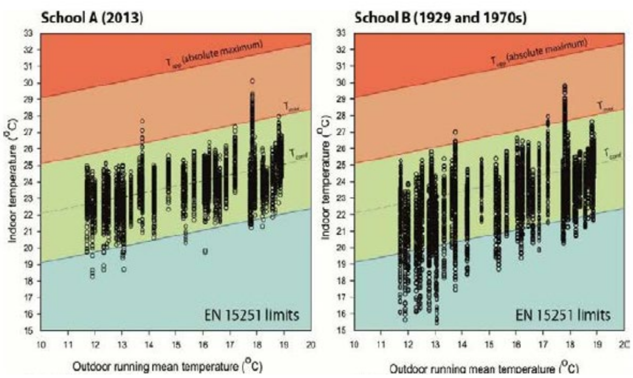


Figure 3.Measured hourly air temperatures during occupied hours in each school against the outdoor running mean temperature

Development in unexpectedly developing city-regions can affect neighborhood weather. This micro-weather alternate may also affect the surroundings, which include schools. However, the observation of comfort withinside the coaching and gaining knowledge of surroundings may be minimal, especially for schools. Thermal comfort is described as "that circumstance of mind, which expresses pride with the thermal surroundings." Thermal comfort was suffering from warmness, convection warmness, radiation, and warmness loss absorption (evaporative warmness loss). It retained the warmth produced with the aid of using the human metabolism may be removed. This will maintain thermal equilibrium with the surroundings. Any profits or losses outdoor this range, the warmth will purpose discomfort. Many research performed indicates thermal consolation can affect occupants in it. Several researches has proven these days that the global consolation requirements for homes and the associated predictions fashions file a hotter sensation than the occupants' file withinside the case of obviously ventilated homes in heat climates. [35]

Gaining proceeds for all time from the beginning to the furthest limit of life. During this period, there are numerous components that help learning. Considering the learning cycle in the youth, play is the best correspondence and the most regular learning climate for youngsters. Play perceives and builds up kid's abilities and inventive potential; increments languistic, mental, social, passionate, and engine abilities; gives learning openings through preliminary information and experience that will be needed all through their lifetime. Thusly, learning can be acknowledged for all time. Open air spaces are the best play conditions for youngsters. These territories offer freedoms that are not found in indoor spaces and actual climate adds to kids' learning with possessed affordances. In this way, open air spaces intended for youngsters are vital. These open air spaces will be more significant and helpful when they add to kids' learning.

In the event that we take a gander at it according to instructive perspective, this absence of data and disposition might be originating from the deficiencies in the educational plans, or from the way that exercises are not functional yet hypothetical, or from the insufficiencies in the instructing strategies. In any case, this ought not be viewed as an insufficiency stemming just from the arrangement of training in schools.

The cooperation among youngsters and climate in the out-of-school times is likewise significant.

Since numerous examinations stress the significance of playing in open air spaces in youth, encountering the climate, learning by seeing, contacting, hearing and feeling. Experience and data acquired along these lines about existence and climate are likewise crucially significant. In this way, on the off chance that you take a gander at the issue according to the perspective of scene engineering, which is the current creator's space of specialization, the significance of outside play spaces to be intended for youngsters is showed. The significant thing in such territories is to add to youngsters' learning while addressing their need of play.

It is important to focus on the accompanying three constituents when planning kids' surroundings - youngsters' discernment and understanding of the climate, the impacts of the actual climate on kids' conduct, and the inspirations driving kids' ecological associations.

In the outside spaces that are intended for youngsters as ideal regions, and of these territories, the mental domain and social domain halfway cover, and this covering part may make the most liked, significant and much utilized zones. For this, one should know the youngster, what he needs, and what he can do in distinctive age gatherings. After this, the information about the space to be planned and the chances that the space offers ought to be assessed. The subsequent stage is, contingent upon the sorts of action that kids will do, to make spatial associations nearby to be planned. Now, the creator should mull over the sorts of commitment that the exercises to be recommended and the gear and materials for these exercises will make. Moreover, youngsters can likewise be fused into the plan interaction. [36]

Children are mainly at risk of warm ambient environments and warmth strain in comparison to adults because of numerous age-associated factors. [37] They also are greater prone to sunburns and burn accidents on playgrounds due to the fact their pores and skin is greater sensitive [38] to air temperatures up to 32 °C. [39] An infant is susceptible to a burn while a floor exceeds 50ºC and while the pores and skin is heated to 45ºC for an extended period. At floor temperatures extra than 50ºC, gentle younger pores and skin may be burned seriously inside seconds and can require surgery. Many playground surfaces and equipment (consisting of plastic parts) can exceed those temperatures while there may be low humidity, bright, sunny day withinside the excessive twenties. [39] [40]

2.5 Infant, Toddler and Caregivers (ITC)

Infants, toddlers, and caregivers or "ITCs" are a grouping of at least two people, the youngest of whom is under five years old (***Figure 4)***. ITCs have specific needs that ITC planning responds to. For example, a breastfeeding mother is able to spend more time in a park when it has safe, clean, and comfortable bathrooms with a diaper changing station, and when it is less than a ten-minute walk from home.

Figure 4.ITC Group

2.6 What is an ITC Neighborhood?

An ITC Neighborhood is a network of urban design features and places, specially supportive of infant, toddler, and caregiver wellbeing, centered around a large park. Here, ITCs can safely access play, learning, and public services, while breathing clean air, all in a ten-minute walk from home

Tirana has a shortage of neighborhood parks. Tirana provides roughly 2 m^2 of green space per capita, well below the recommended minimum by the World Health Organization of 9 m$^{2.}$ But through planning and design interventions, we can harness existing open spaces and make them accessible to the community, free of air and noise pollution and playable for everyone. Moreover, we can make it easy and safe to get there, by improving walkability of key routes within neighborhoods.

Caregiving while doing daily errands is hard work and usually requires a lot of coordination. Multiple caregivers may switch duties throughout the day; e.g. a mother dropping off a child to the grandfather so that she may work in the afternoon. The ITCN clusters basic services and high-quality play, with safe access, within a 300m radius shown in ***Figure 5***.

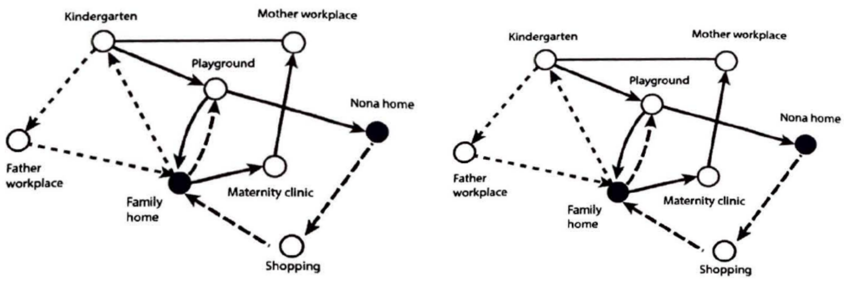


Figure 5.The ITCN clusters basic services and high-quality play, with safe access, within a 300m radius

Building the ITC neighborhood is everyone's job. For example, a healthy street requires action from national policy makers to reduce auto emissions, in coordination with the municipal streets team to widen sidewalks and calm traffic, and residents who become local leaders in applying for temporary street closures, to organize festivals and inspire collective care of the street and parks. Together, the Tirana municipality, school principles, teachers, health experts, designers, caregivers and children can work to ensure that every neighborhood thrives. The ITC neighborhood is a place that we can all rally around. [41

Table 1.List of reviewed literature

Contribution area	***Authors***	***Description***
UHI Phenomena and influencing factors	[10] Rosenthal J et al. (2008) [9] O'Malley, 2014 [14] Mohajerani, 2017) [16] Kandya, 2018 [7] Aflaki, 2017 [12] Aram, 2019 [2] Kotharkar, 2019 [17] Hardin, 2018 [15] Wong [11] Vardoulakis, 2015	UHI phenomena investigation and heat island evaluation.
UHI Mitigation Techniques (UHMT	[20] Palme, 2017 [9] O'Malley, 2014 [16] Kandya, 2018 [18] Taleghani, 2018 [21] Deilami, 2018 [22] Yu, 2020 [23] Jinda Q. [25] Reza, 2015 [6] Xiao, 2018 [7] Aflaki, 2017 [27] Domínguez-Amarillo, 2020 [41] Center,2019	Investigating strategies for mitigation and reduction of an UHI — urban context, vegetation, building materials.
Children Development	[36] Ac ar, 2014 [28] Almeida, 2016 [29] Barbhuiya, 2013 [32] Flax, 2020 [30] Heracleous, 2020 [33] Vanos, 2016 [31 Katafygiotou, 2014	A detailed study regarding the youngsters needs and development within their neighborhood

2.7 Case Studies

This section focuses on various projects that address topics closely related to infant, toddler and caregivers development. Detailed information is provided on the precautions taken in each project and the implementation ideas. The projects taken into consideration in this section are organized in a structural order such as shown in ***Table 2***.Each of the projects also gives guidelines on how and what could be improved in relation to youngsters and their parents, to strengthen their relationship and even more - what can be done for living in sustainable neighborhoods nowadays.

Table 2.Reviewed case studies list

No.	**Project Name**	**Location**	**Key Elements**
1	[42] Green Blue Schoolyards	Rotterdam, Netherland	Youngster agreeableness, Metropolitan Greening and Environment Variation
2	[43]Services For Children And Family In Istanbul District Municipalities	Istanbul,Turkey	Data Collection (Mapping,Survey,Interactive Website)
3	[44]Parque 6 de Junio	Quito,Ecuador	Native Veggetations,Infiltration Ditches,Tree Shade,

2.7.1 Green Blue Schoolyards

Rotterdam's *Green Blue Schoolyards* program tends to kid benevolence and environment variation plans with a typical arrangement: more nature in schoolyards. The program upholds schools to change their open-air spaces into common play territories for open air instructive tasks and local area use. The program centers around five or six schools in territories with less open green spaces and higher financial weaknesses, chosen to cover various spaces of the city.

Green Blue Schoolyards is an appropriation and specialized help program by the city of Rotterdam for 2019–2022. It sits at the crossing point of a few techniques: youngster agreeableness, metropolitan greening and environment variation. It plans to build the quantity of green spaces (like stops) and blue spaces (like lakes, trenches or waterfronts) to address the issues of families living in neighborhoods with not many alluring characteristic play openings, and the dangers related with environmental change. It takes on a value focal point while choosing zones for subsidizing.

Green and blue spaces are known to give compound advantages to inhabitants and city specialists: dynamic and better ways of life, lower feelings of anxiety and better psychological wellness; and better stormwater the board, decreased warmth island impacts, and expanded land esteems. The execution cycle is driven by the schools. They should be in neighborhoods with less normal spaces and can get financing to participate in a huge common makeover of their outside spaces. The plan cycle is participatory (kids, guardians, neighbors) and should prompt the schoolyard being available to all inhabitants outside school hours.

2.7.2 What functioned distinctively

A solid vision that puts youngster's prosperity and advancement at the middle is at the times difficult to keep up when budgetary limitations emerge, or profoundly hazard loath propensities win. The Green Blue Schoolyards program demands a solid common vision, which has assisted schools with overseeing obstruction in their areas. This likewise assists with building versatility and supportability, and to change the outlook of training staff, the executives, development organizations and guardians. This common vision should be continually kept up and revived among partners to remain pertinent and viable.

By tending to a few themes imperative to Rotterdam's authority through a solitary intercession, the Green Blue Schoolyards program permits subsidizing streams to be consolidated, subsequently opening bigger measures of spending plan. For this situation, it empowers youngster well disposed drives to be added onto existing ventures from the broad environment transformation endeavors that are in progress and have effectively gotten political endorsement.

Every candidate school goes through a determination interaction that utilizes models identifying with qualities of the area (half) and the inspiration of the school, written in an undertaking plan (half). Information for the primary portion of the evaluation is quantitative and comes from the city of Rotterdam, like the territory's extent of green surfaces, spaces for play, weakness to flood or metropolitan warmth, and financial pointers. The other half is subjective and includes meeting with the school's authority, understanding their inspiration, surveying their vision, commitment and limit with regards to support, programming and preparing. The choice group, which additionally deals with the program, incorporates staff individuals from different city offices like schooling, wellbeing, spatial arranging. It can likewise draw on other aptitude when required.

The main partner is the school. This permits the undertaking to be secured around there, nearer to occupants. The schools administer support and movement programming and hold responsibility for new green and blue spaces. They can adjust each undertaking to their own personality – particularly in the programming of exercises. Changes inside the school's authoritative culture are driven by their own vision, instead of by hierarchical course from city lobby. This methodology further improves neighborhood proprietorship and the drawn out supportability of the venture.

2.7.3 What did not function distinctively

Green Blue Schoolyards requires the collaboration of numerous partners, from city offices to schools, to guardians, kids, and neighborhood associations, each with their own dreams and targets for the task. It is now and again testing to keep everybody adjusted around the prosperity and improvement of youngsters. Every schoolyard redesign project needs to manage different degrees of hazard avoidance and different imperatives, for example, spending cutoff points or development conventions. It likewise faces various suppositions inside the local area identified with open air training, neighborhood exercises, support principles, or resilience of clamor created by youngsters. To relieve these challenges in execution, the program administrator attempts to give a lot of time to vision building, fortifying and arrangement among partners prior to jumping into execution. This has demonstrated much more significant as the program is taking a gander at changing conditions as well as evolving outlooks.

Deciding to have schools start to lead the pack in carrying out the program is advantageous for fitting tasks to their areas, however implies that general coordination is more divided. This can demonstrate trying for quality affirmation no matter how you look at it, and guaranteeing that tasks are following conventions and conditions for execution. Different urban areas, for example, Amsterdam or Paris have comparative projects for greening schoolyards, however have settled on the choice to oversee them midway from inside the regional government to stay away from this issue. In Rotterdam, the test is tended to by having Speeldernis, the master nature jungle gym association, go about as a specialized help and commentator, and as a center point for schools to meet and gain from one another, and get the preparation they need to do quality execution.

When carrying out Green Blue Schoolyards projects, schools are stood up to by a progression of conventions, guidelines and settled in rehearses identified with hazard, obligation, development rules, sterilization and instruction that occasionally clash with the goals of the venture. This stems from public level guidelines and laws that have not yet developed to mirror the new outlook on play and hazard that Rotterdam is embracing with this program. For instance, the public strategy for schoolyards doesn't allow a lot of independence from the rat race for schools to start to lead the pack in getting sorted out their own schooling programming and conditions for youngsters, a circumstance that makes it hard for schools in Rotterdam to adjust their financial plan to their kid focused vision. This error expects work to be done at the public level to adjust thinking, systems and guidelines. [42]

2.8 Planning Administrations for Kids and Families in Istanbul Region Districts

Fast urbanization and the issues that join it have progressively drawn ideas like the privilege to the city, admittance to the city, also, nature of metropolitan life to the focal point of conversation during the time spent distinguishing metropolitan strategies. Reacting to two significant calls - the creation and estimation of nearby pointers, and then again advance public, TESEV *(Turkish Economic and Social Studies Foundation)* as of late has moved in examinations expecting to produce information driven metropolitan strategies.

This case study sums up how the TESEV created an intuitive guide of administrations for youngsters and families across 39 locale regions in Istanbul, related with information about the kid populace and financial pointers, as a team with the Kadir Has University Istanbul Studies Center and with subsidizing from the Bernard van Leer Foundation. Planning the area of existing administrations for children, babies and guardians, and contrasting their area with where the most families in need reside, permits chiefs to center mediations in regions where they will have the best effect. The point is to create administrations and openings for youngsters younger than 8 who have grown up under troublesome social and financial conditions.

2.8.1 Data Collection Process

The Urban95 Program has a couple of segments. In this section, the first of these parts, that is contemplates which intend to help information driven dynamic cycles are clarified. This part plans to improve the nature of administrations in the city that are situated towards small kids and their peers, which either as of now exist or which can be made with basic techniques considering new information that will be delivered.

This project is divided into three main phases. In the main phase of the three organized undertaking, the locale of Istanbul have been planned by age gathering and land esteems on a neighborhood scale by the *Kadir Has University Istanbul Studies Center*. The intervention scale is city-wide. The program gives vigorous information to activity on youth needs (instruction, wellbeing, stops and green spaces, and social guide) and administrations all through the entirety of Istanbul's 39 regions. In the last stage, the outcomes and guides that arose in the initial two phases have been joined on an intuitive advanced stage, making a social administrations map until now one of a kind in extension and scale.

In the principal phase of the undertaking, the Istanbul area and its locale have been planned utilizing neighborhood underlays legitimate on a geographic data framework (GIS) medium as per age gathering and pay. The current and definite guides that arose plainly uncover the dispersion of kid populaces in areas and pay separation among regions and neighborhoods.

The neighborhoods in which kid populaces are amassed in these guides may not relate to neighborhoods in which the best youngster populaces live. Neighborhoods that have a high portion of populace inside the all out locale populace normally likewise have a high kid population (***Figure 6***). Neighborhoods have been hued by the grouping of age bunches inside them comparative with the region normal. For instance,in the event that the 0-4 matured kid populace is appeared as exceptionally amassed in a neighborhood, the extent of the 0-4 matured kid populace inside the complete populace of the area is higher than in other neighborhoods. When arranging administrations and frameworks focused on explicit areas, it is vital for leaders to be ready to see the high number of kids, however the extent of the kid populace comparative with other age bunches in that particular area. For regardless of whether the quantity of youngsters in a single area is higher than in another, the old populace rate for instance may be higher than the pace of the youngster populace. In such a case, the prioritization of social administrations coordinated at the old populace would be more exact when arranging social administrations. Another benefit of maps, which show the portrayal of all age bunches with this rationale is that it permits seeing the synchronous presence of various age gatherings. Subsequently, notwithstanding administrations to be created for kids, the guides have the engineered nature of giving direction to administrations for other age bunches too.

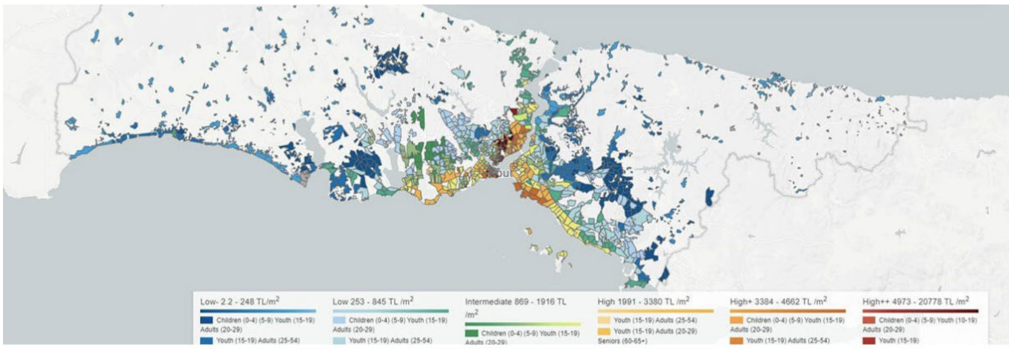


Figure 6.Planning administrations in Istanbul region districts

2.8.2 The Interactive Website Groundwork

The yields procured toward the finish of the initial two phases of the venture ("Separation of Neighborhoods concerning Age and Mean Real Estate Values" guides and information accumulated in hands on work) have been joined to make an intuitive site intended to be a definitive item of the undertaking. A roundtable gathering occurred with members from pilot regions at the advancement phase of the site, for which the reasons and types of use by region staff and area inhabitants are summed up underneath. The draft form of the site was introduced to people who were educated about the task and who were remembered for the readiness of the study and the information gathering measure (***Figure** 7*). Conversations were done with members in regards to the use and improvement of the site, and the chances for keeping it state-of-the-art later on also.

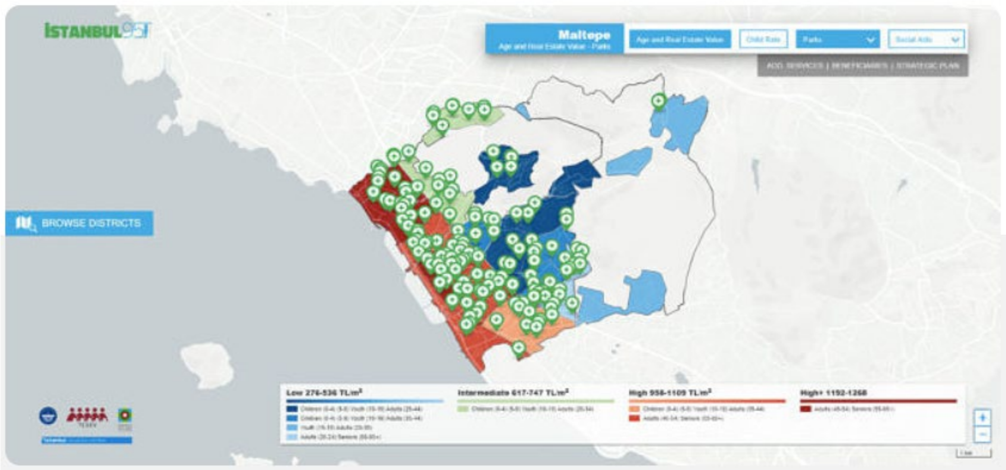


Figure 7.The interactive website

2.8.3 Conclusion

It will be productive to assess the reason for which the site delivered because of the undertaking will be utilized for region laborers furthermore, locale occupants independently.

From the viewpoint of districts, it should initially be expressed that the site gives freedoms to simpler admittance to existing circumstance investigations and leading of circumstance appraisals. District laborers will actually want to peruse the imagined type of information on age and land esteems as to neighborhoods and information on administrations and help plans gave through intelligent guides by entering the site.

The advantage to laborers of being educated about exercises led outside of their own units should likewise be considered in districts which have inadequate correspondence between their various directorates or which don't have a typical data set.

Notwithstanding appraisal of the current circumstance, the site presents real information in a justifiable arrangement to leaders so that they can create information driven dynamic and solid arrangement proposition. The presentation of administrations gave by the region to youngsters and family on underlay maps made with age and land values information on a local premise can make following these administrations which ought to be moved in neighborhoods where generally low pay families with youngsters are exceptionally addressed, simpler.

Moving from this reason, chiefs will actually want to settle on better choices in regards to which neighborhoods they will coordinate the administrations or help plans they need to create. It is in this sense workable for the site that was delivered to be utilized as a device in the essential arranging cycle of regions. In any case, one issue that should be underlined is that since the guides have been delivered on neighborhood premise, they don't have road level subtleties; the districts should make a more definite investigation while choosing the road on which they plan to offer the types of assistance. Since neighborhoods likewise separate inside themselves, a few roads might be much higher than the area normal, and a few roads might be a great deal lower.

To sum up, the intuitive stage that was delivered is a device that makes it simpler for Istanbul district laborers and chiefs to follow existing region administrations in their own and in different areas also, to create systems for administrations that they intend to give in the future. From the point of view of region inhabitants, it should be underlined that the site will give point by point data on the administrations and help plans given by regions. Local occupants will actually want to access data on which administrations and help plans are given where they reside, if the administrations convey a charge, the sum of the charges where material, opening and shutting hours, nature of administration, and standards for qualification for the administrations and help plans, on a single site. In this sense, the site will make it simpler to pass on service.

2.8.4 Nurseries and Daycare Centers

Of the 39 districts of Istanbul, 16 give nursery or childcare focus administrations. The districts that give nursery or childcare focus administrations are Ataşehir, Avcılar, Bağcılar, Bakırköy, Beşiktaş, Beyoğlu, Çatalca, Esenyurt, Kadıköy, Kağıthane, Kartal, Maltepe, Sancaktepe, Sarıyer, Şişli and Tuzla districts. The districts with the most noteworthy number of nurseries are Sancaktepe (15), Beyoğlu (14), Kartal (11) furthermore, Esenyurt (10) districts shown in ***Figure 8.***

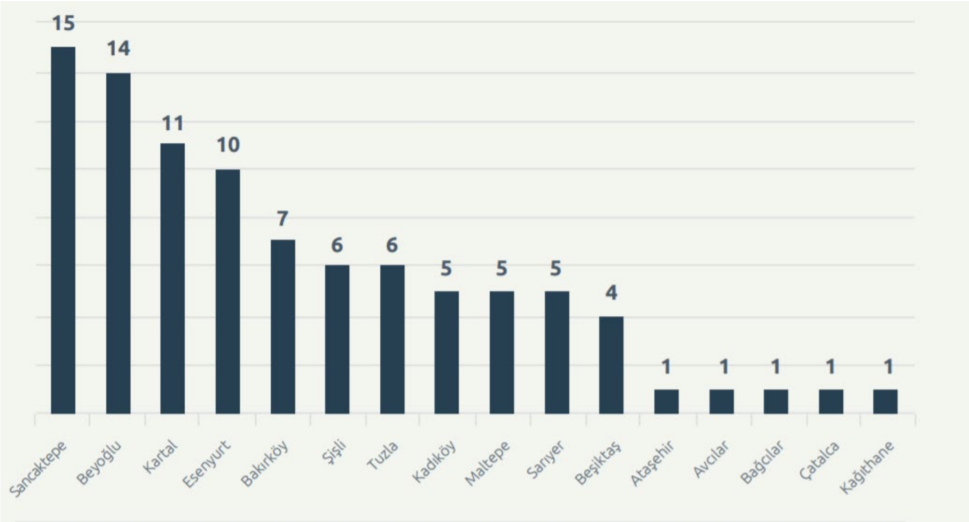


Figure 8. The districts with the most noteworthy number of nurseries

Similar four districts are again at the front line with regards to the quantity of kids profiting by nurseries or childcare focuses. Be that as it may, when the quantity of instructors and the quantity of understudies per instructor are thought of, the low number of educators with deference to the quantity of kids who utilize the help in Sancaktepe sticks out. Beside that, ignoring the nurseries of the Tuzla district, the quantity of understudies per educator in different regions range from 4 to 20.

The times of the youngsters which the nurseries or childcare focuses serve start from 3 (three years) besides in Maltepe, Avcılar and Sancaktepe districts. Offspring old enough 2 (two years) can profit by the nurseries of the Maltepe region. Youngsters between ages 4-6 are ready to profit by nurseries in Avcılar, and just kids that are 5 a long time old in Sancaktepe. What is perceptible here is that the nursery administrations of regions beside the Maltepe region don't cover youngsters in the 0-3 age bunch. In the Maltepe district on the other hand, youngsters can start going to nurseries after at least 2 years old. The nursery administrations of the Sancaktepe, Beyoğlu, Tuzla what's more, Avcılar regions are for nothing. Expenses in different districts change between 220 to 700 TL.

The arrangement of nursery or childcare focus administrations by the regions appeared over, the low number of understudies per instructor other than a few exceptions, the low expenses contrasted with private nurseries and that some of them have award openings are positive. Regions should think about both expanding the quantity of nurseries and supporting them as far as quality while deciding their procedures with respect to administrations for youngsters and family. Endeavors should likewise be made to give the nursery administrations given to youngsters matured 3 or more to offspring of lower ages too.

2.8.5 Other Service Units

Other than nurseries/childcare focuses, wellbeing units and mental advising units, information has additionally been assembled on other district administration units for youngsters and family inside a similar extension. These help units comprise of administrations like kids' habitats, data houses and youngsters' libraries which are coordinated exclusively at kids, or professional courses, exile focuses, coordination habitats for the handicapped, culture focuses and libraries which envelop youngsters or guardians. The site contains nitty gritty data on each help unit.

2.8.6 Green Areas

The aggregate and per-individual measures of dynamic green space which is the obligation of both area regions and the Istanbul Metropolitan Municipality are appeared in the table beneath on a region premise. Shockingly, the measure of green space in the territory of Istanbul in general is at a low level. The aggregate sum of dynamic green space of the territory is 2081 hectares, and the region wide measure of dynamic green space per individual is 1.44 m2. The measure of dynamic green space per individual remaining parts underneath the all around low 1.44 m2 (when contrasted with different nations) in 21 of the 39 regions (***Figure 9***). It is fundamental for the wellbeing of the people living in the city that both the region regions and the metropolitan district play it safe on this point and take part in like manner endeavors with the point of expanding the measure of green space.

Belediyeler Municipalities	Toplam aktif yeşil alan (ha) Total active green space (ha)	Kişi başına düşen yeşil alan (m^2/kişi) Green space per person (m^2/person)	Toplam park sayısı Total number of parks	Çocuk oyun alanlı park sayısı Number of parks with children playground
Adalar	6	3,7	veri yok / no data	veri yok / no data
Arnavutköy	39	1,7	125	108
Ataşehir	32	0,8	192	116
Avcılar	57	1,4	56	49
Bağcılar	20	0,3	154	154
Bahçelievler	17	0,3	109	81
Bakırköy	161	7,2	97	80
Başakşehir	88	2,6	veri yok / no data	veri yok / no data
Bayrampaşa	45	1,7	74	54
Beşiktaş	77	4,1	127	81
Beykoz	65	2,6	veri yok / no data	veri yok / no data
Beylikdüzü	25	0,9	124	102
Beyoğlu	45	1,9	57	46
Büyükçekmece	34	1,5	187	155
Çatalca	9	1,3	78	76
Çekmeköy	16	0,7	98	90
Esenler	11	0,2	veri yok / no data	veri yok / no data
Esenyurt	51	0,7	66	66
Eyüp	88	2,4	veri yok / no data	veri yok / no data
Fatih	156	3,7	105	69
Gaziosmanpaşa	18	0,4	veri yok / no data	veri yok / no data
Güngören	15	0,5	veri yok / no data	veri yok / no data

Figure 9.Dynamic green space per Municipality

Expanding the quantity of available and walkable parks would normally prompt an increment of the measure of green space. Youngsters' jungle gyms for different age bunches should be worked, as per needs, into these parks which exist in the middle of local locations in the city. Another proposition with respect to parks is to make an investigation of requirements as indicated by populace and age gatherings and to guarantee the homogenous dispersion of parks around there. The geographic disseminations of existing parks for each area might be seen on the site.

2.8.7 Recommendations

Another impression they had about the information during the review cycle was that districts don't keep spending information independently for each administration and that thusly what amount is spent on youngsters and family isn't available. Separate arranged and genuine spending information was mentioned for actual foundation, faculty and extra administrations for each sort of administration (nursery/childcare focus, wellbeing units, mental guiding units and so on). Furthermore, information on the quantity of families with offspring of ages 0-8 who utilize social guide was likewise independently mentioned. It was seen that most regions don't keep information on the quantity of offspring of families as well as information on their ages.

The missing information thusly makes computing the spending plan doled out for administrations coordinated at youngsters and correlations between regions incomprehensible. As an end, one suggestion made on the premise of venture discoveries is that regions keep information on actual framework, work force and extra assistance spending plans for every sort of administration independently and that they accumulate the information on number of kids in families and their ages for families that get social guide.

Most information on administrations should likewise be opened to locale occupants according to the standard of straightforwardness. Social affair of the information utilizing the configuration arranged inside the extent of The Project for Analyzing and Mapping Administrations for Children and Family in Istanbul District Municipalities can become an instrument that makes both information dividing among units and the show of information to area occupants simpler. In the event that the review design of this task can turn into a guide for districts on the issues of which information ought to be recorded for the estimation of the nature of administrations of regions, which kinds of information about the recipients of administrations and their techniques with respect to administrations ought to be delivered available, and how information ought to be coordinated, we can take it that our project has accomplished its most significant objective.

2.8.8 What functioned Distinctively

When specialized staff verified that pay information was conflicting or inadequate, they changed direction to utilize land esteems as an intermediary for money. This course amendment permitted the undertaking to accomplish its target without requiring the exorbitant and unwieldy assortment of new populace wide information.

Likewise, working with regions to recover land esteems permitted the scientists to utilize this immediate relationship with government to effortlessly accumulate precise information on the area of administrations.

The accessibility of vigorous and straightforward information on existing administrations and regions most in need has provoked locale districts that are put resources into Urban95 to make a move by dispatching public space and different activities in focused regions.

All mediations focus on the families and areas recognized in the examination as most out of luck. Four region regions additionally dispatched non-spatial intercessions, for example, home-visiting projects to prepare key abilities of guardians with infants and little children under 3.

The created site is available to and offers some benefit to civil staff and occupants the same. It is both a valuable instrument for dynamic for the Urban95 drive, and an incredible support device for more spotlight on youth in Istanbul and all around the world.

The guides consolidated information from region districts (land esteems and area of administrations) and information delivered by the Turkish Statistics Institute (age bunches by neighborhood). Albeit both informational indexes are open and open, consolidating those information has empowered the nearby groups to more readily target administrations.

2.8.8 What did not function distinctively

A dynamic apparatus open to everything is both an accomplishment and a test. TESEV and ISC created those guides by gathering information from various organizations, anyway the guide' utility won't be supported except if the Istanbul Metropolitan Municipality takes responsibility for d evice and guarantees upkeep and update. The TESEV and ISC groups are tending to the issue by guaranteeing that any new guide created is claimed straightforwardly by the metropolitan government. [43]

2.9 Parque 6 de Junio – Safe Public Space

The "Parque 6 de Junio" is a project (***Figure 10***) completed with a technique that means to underscore the socio-ecological states of the spot. The goal is to change this public space into an apparatus to battle instability, brutality, confusion and awfulness. This park expects to turn into a space of interruption for the local area, with every one of the offices for individuals, all things considered. The recreation center will profit 16,000 inhabitants of the area.

Figure 10.Parque 6 de Junio Masterplan

The recreation center plan measure had the cooperation of the local area, who were called to various exercises to build up the issue and needs of the space to intercede. Socializations, exploratory walks and workshops were important for the exercises that were completed before the development of this public space, these thus created a beginning stage of appointment of the undertaking project.

As a plan technique and in acknowledgment of the particularities of the site as shown in ***Figure 11*** (geography and vegetation), it utilizes the little geographical reliefs of the recreation center, of an old cycling circuit to produce various encounters in the client. This previous condition permits the improvement of little slopes that create diversion spaces like slides, tarabitas and climbing dividers. [44]

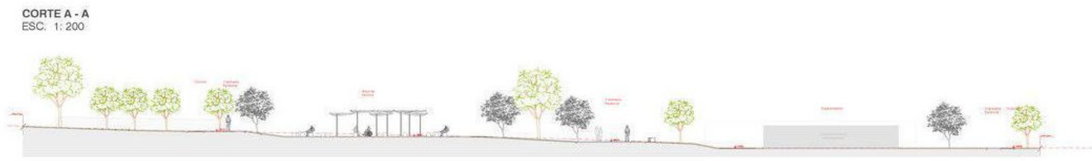


Figure 11.Section A-A, Terrain and Vegetation

2.9.1 Playground Inclusive Design

This project utilizes various assets to safeguard the climate. The fuse of characteristic streets, not just regards and reviews old path utilized by park clients, yet in addition permits the activity of a characteristic seepage framework, where surface overflow waters get back to the ground. The utilization of local vegetation, invasion ditches, low utilization clean batteries, sun based lighting and the preservation of existing trees are essential for this present venture's commitment to the climate. It features key plan mediations and tells the best way to meet the goals of making a neighborhood for ITCs such as playful,inclusive,green,safe and accessibility as shown in ***Figure 12***, ***Figure 13*** and ***Figure 14*** [44]

Figure 12.Greenery (Photo on the left) and Inclusive Design (Photo on the right)

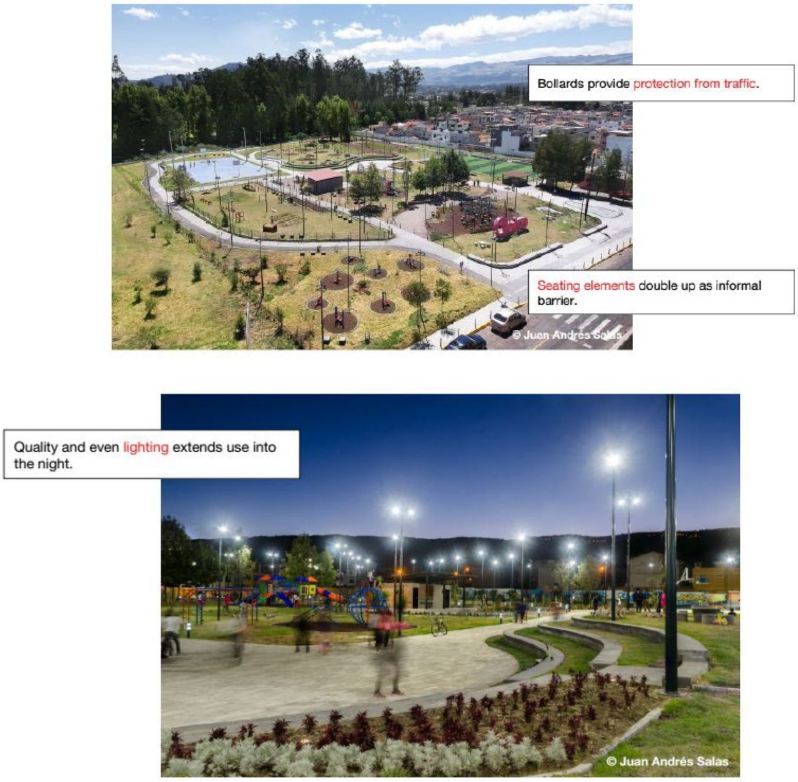


Figure 13.Safety (Photo on the Left) and Accessibility (Photo on the Right)

Figure 14.Playful Design

2.9.2 What functioned distinctively

Allowing occupants to take an interest in the design cycle engages them. Through a synergistic interaction, residents can demonstrate precisely what their need are and which issues are to be tended to. In Quito this has brought about a protected park for all age gatherings, including little kids and their parental figures.

2.10 ITC Objectives

2.10.1 Objective 1-Playful and Inclusive

Overall urbanization has transformed urban areas into places where millions are conceived, grow up and live, highlighting a need to extend the meaning of the city past its financial advantages. Notwithstanding, even 'reasonableness' files set forward during the 1980s are basically utilized simply as markers of monetary achievement.

In a nutshell, urban communities have become the environment of the human species and of youngsters and need to react to the requirement for play.

For a youngster, being outside is a significant way to become acquainted with the world and to improve her abilities. Neighborhoods that permit youngsters to investigate, experience new things and play, assist them with learning by perception and socialization.

It is essential to comprehend if jungle gyms, the essential public space intended for kids, do trigger their creative mind, energize their parental figures for perky cooperation. Play is a willful activity. It is anything but an obligation. It's impermanent. Play makes its own reality yet it isn't separated from the real world. It doesn't look for its own advantages. Play doesn't need to be helpful. It has rules and guidelines. On the off chance that rules are disregarded, the play closes. Truth be told, in light of the fact that it has such countless structures, it is a troublesome word o characterize. What's more, Play is the most genuine endeavor of a youngster. Play is characterized as a fundamental requirement for offspring, all things considered, and is ensured under Article 31 of the United Conventions on the Rights of the Child.

Youth is the period when people grow up and get familiar with the quickest. Current research shows that 85% of our mind creates inside our initial 1000 days. Indeed, it has been seen that the minds of children who have been disregarded, who have not had adequate correspondence or haven't been played with during this basic period, don't develop.

Blissful connection with infants is significant for their mental health. Touchy and caring discussions, play, and conditions that empower play are significant. Neurotransmitters - associations between neurons in the cerebrum liable for various abilities - are more grounded in the mind of a kid that experiences childhood in a climate rich with incitement. These associations give the establishment to a youngster's intellectual abilities like acquiring, consideration, and memory. Playgrounds are metropolitan outside spaces intended for kids, however even playgrounds are frequently planned without considering the most youthful. Youngsters games themselves are and action that have no material benefits and will not bring any profit. It continues inside its own appropriate limits of reality as indicated by fixed guidelines and in a systematic way. It advances the arrangement of social groupings which will in general encircle themselves with mystery and to stretch their distinction from the basic universe of camouflage or different methods. [45]

There are unlimited opportunities for casual play along roads and paths. With cautious arranging and basic articles, youngsters can be animated to utilize their creative mind to change any item or space into an ideal jungle gym. It is dependent upon fashioners to give kids the privilege innovative instruments cap to make their own play-world.

Metropolitan furniture in broad daylight spaces or essentially along roads, if all around picked and set, can become energetic components for little children and babies.

The equivalent applies to ordinary items like the line of a tree grower or various advances, which can give new play encounters for the youngsters. For instance, a basic bus station concealing rail may bend over as a spot to set up a spring up swing for the little youngsters, basic, brilliant seats can become energizing components to climb, slither, and have diverse fun loving encounters.

There a couple of things which should be viewed as while picking open air furniture as shown in ***Figure 15***:

1. Consider the road furniture through the eyes of a little kid. Consider how they would see and utilize it.

2. Low seats and seating with level tops, ergonomic, so kids can utilize them without any problem.

3. Colorful road furniture

Edging along grower that railings that are low and wide enough for little feet.

Figure 15. Playful furniture

Sidewalk games, then again, are an amazing illustration of how youngsters can utilize their creative mind to make a universe of play inside the limits of an asphalt region. As an initial step, fashioners need just give kids an unfilled and secured space and some animating pointers, to fire the creative mind and keep them rethinking and intrigued for quite a long time.

Sidewalk games (***Figure 16***) can be stimulated by :

1. Introducing designed asphalt over a little segment of the asphalt region.

2. Providing a smooth level space of pavement,where youngsters can draw their own asphalt figures.

3. Painting basic lines or squares onto asphalt regions.

4. Drawing the beginnings of a game or a few shapes on the asphalt for youngsters to fill in. Using relevant games for simple and general arrangement. [46]

Figure 16.Sidewalk games

2.10.2 Objective 2-Green Space

The nature of the air we inhale, our openness to the sun, clamor or vehicle exhaust, and numerous other ecological factors radically influence the manner in which small kids act, live, and create. Green roads give climatic security to ITC and support from clamor and contamination, and brutal climatic conditions.

Planting is imperative to make conceal and cooling on roads. They establish a wonderful climate (security from glare and warmth). In a retrofit setting, there are freedoms to add green in the public domain which doesn't need numerous spaces, for example, window boxes or climbing plants against the exterior and arbors across little roads. These don't need incredible measures of time for development before solid measures of shade are given.

Planting zones, whenever put close by streets go about as a cushion between the road and the asphalt bend over as insurance. Whenever put along veneers, alleviate heat retained and emanated from the structures (cooling factor). Plans let little youngsters interact with nature. Underground utilities can discourage root development: It is imperative to consider how utilities are put according to trees.

2.10.2.1 Guidelines for Green Areas

Use planting at various stature -trees for concealing and lower plants at the size of little youngsters. Plants can be set in different zones in the road: against veneers, in a zone among traffic and people on foot. On the off chance that there is no space for planting on the asphalt, think about planting between left vehicles.

Where roads are extremely limited like in downtown regions, think about utilizing climbing plants against the veneers. Spot pruned plants along a veneer. Notwithstanding, guarantee that there is still sufficient asphalt width for a parental figure pushing a pram. Utilize native plants and neighborhood species.

Try to hold existing trees while retrofitting a road. Enormous trees add moment character to a road.

2.10.2.2 Shading and Cooling Elements

A very much utilized road is a road that gives an agreeable climate to its users. This implies insurance from outrageous warmth during most of the year (***Figure 17***). Giving concealed regions on asphalts, making coverings along all around utilized courses is pivotal for little youngsters and their minders. Resting and seating regions ought to be concealed from warmth and downpour for all year utilization.

In metropolitan plan and arranging the accompanying concealing components ought to be thought of:

- Ideal concealing is characteristic concealing, where conceivable: use trees, shrubberies, and climbers.
- Give consistent shade on very much utilized area courses.
- Other than constructed overhangs, consider lattices congested with climbing plants. These give conceal while likewise having a cooling factor.

- Give concealed where kids and their parental figures need to stand by: at transport stops, at occupied traffic intersections, and in play regions.

- Ensure that resting components like seats have conceal. [46]

Figure 17.Tree Canopy

2.10.3 Objective 3-Safety

Caregivers are less inclined to send kids on a segregated road. The presence of individuals and action along a road goes about as a methods for inactive control, and structure the éyes on the street'. Vandalism and wrongdoing episodes can be decreased by informal, latent control of the public domain. This is given by occupants or passers-by having an unhindered perspective in the city. In the event that roads or seating regions are encircled by structures with windows looking onto them and dynamic, open veneers on the ground floors, at that point individuals feel more secure.

Inactive control can be accomplished by:

- Ensuring that all edges of a road are apparent from the encompassing structures.
- Planning passerby courses alongside structures that have open and dynamic veneers.
- Keeping away from structures in the public domain that impede sees.
- Present painstakingly positioned neighborhood conveniences like food merchants.

Other than open action, the interface between the private area of the home and the public road should be painstakingly overseen. Right now, homes turn their backs towards roads that are edged with high limit dividers. A permeable and dynamic private edge ought to be stayed away from or kept at a low tallness. Gatekeeper lodges assuming any, ought to be in the private space, looking outwards. Sitting at your doorstep, permitting youngsters to play there permits local area holding and a more secure area.

2.10.3.1 Lightning

Great lighting assumes an indispensable part in the impression of wellbeing, as shown in ***Figure 18***. It additionally keeps little youngsters from stumbling over snags lying on the asphalt or lopsided clearing. Sufficiently bright courses along roads will draw in more individuals, be more secure, and consider expanded utilization of the road into the evening hours. Very much picked light-shafts and armatures can add to the personality of a road and cause them to feel agreeable.

Figure 18. A varied use of lightning fixtures,at Liverpool Ropewalks,Landscape by BDP

Consider the accompanying for a sufficiently bright region:

- Pick a lightning type to mirror the utilization of the public domain being lit: High unadorned lights to sparkle onto street surfaces, and lower, appealing armatures to light trails and asphalts.

- Add low-level lightning where clearing is lopsided, or where there are steps to enlighten these snags better.

- Spot lighting components for asphalt regions at continuous spans. When in doubt of thumb, no less than each 30m.

- No shadow zones or dull spots ought to be left while setting lighting alongside a pathway.

- Have a lightning master ascertain the degree of lighting along the entire road. Preferably, the lightning level along the whole length of the asphalt region ought to be consistent at min 6-8 lux level.

- Keep away from huge changes in lighting levels along a road.

- Think about the situation of trees and different plants. Ensure that branches don't hinder any light.

- Continuously remember that, aside from wellbeing, lighting can give increased the value of a spot from multiple points of view.

2.10.3.2 Defensive Elements From Traffic

Traffic, even sluggish traffic, can perpetrate a lot of mischief on a little kid and subsequently structure a critical risk to kids.

Little youngsters will in general follow up without much forethought, and a small kid, ignorant of these threats could, for instance, suddenly pursue out a ball onto a street. Where well known strolling courses go across roads, additional actions are expected to shield youngsters from approaching traffic. Measures should be taken to keep kids from coincidentally running onto the street. The vehicle at 30kmph necessities 8m to respond to stop and 5m to stop; an aggregate of 13m.

These incorporate security bollards (see ***Figure 19***), low fences, or presenting a green path with trees between the home and the road. As far as possible on shared roads in areas ought to be 15 kmph and on different roads be a limit of 30 kmph.

Figure 19. Security Bollards (Photo on the left) and Crossing (Photo on the right)

ITCs are particularly powerless at intersections since they move more slow than grown-ups or more seasoned kids. Also, the perspectives on youngsters in age bunch 0-5 can without much of a stretch be obstructed by low planting or left vehicles. The interface between the street and the intersection should be thought of. Exploring high controls without check cuts is a snag for little kids and furthermore when their parental figures in pushing a pram. [46]

2.10.4 Objective 4-Accessibility

Likewise with a recreation center or a little neighborhood square, the asphalt region can likewise be where individuals wish to wait thus make roads more reasonable and energetic. To make roads open for ITCs, it is imperative to consider segments like inclines for buggies, low check stones that permit a little youngster to scale, ground cover, and safe resting gear.

2.10.4.1 Groundcover Materials and Colors

Ground cover materials shown in ***Figure 20*** utilized for asphalts ought to be painstakingly chosen. Little youngsters stagger and fall effectively where clearing is lopsided, and wheels of prams could stall out on unpleasant surfaces. Simultaneously, various sorts of clearing may likewise unpretentiously show zones where it is protected to walk. change in the clearing design around a lively piece of road furniture could demonstrate this casual playing region on the asphalt. Similarly, tones can be utilized to demonstrate zones on asphalt for kids. For instance, yellow-painted asphalts at every traffic intersection will make these conspicuous for kids.

Figure 20.Groundcover Materials and colors

It is basic to have locally accessible, sturdy, savvy ground covers and clearing materials. Whatever models are underneath:

2.10.4.1.1 Tendency Ramps

ITCs have exceptional necessities in the public domain where level contrasts are concerned. A little level distinction, like control of only 10 cm high, is a hindrance for a little youngster and pram. Checks ought to be slanted at all road intersections, to guarantee a protected and simple intersection.

Steps in the public domain could represent a difficult issue for a guardian pushing a pram and a little youngster (***Figure 21***). Adding an incline where there are bigger level contrasts in the open arena will guarantee that all youngsters, wheelchair-clients, and parental figures with carriages can approach the full degree of the public domain.

Figure 21.Steps and Ramps in Public Spaces

2.10.4.1.2 Continuous Borders

Casual seating can be furnished by structures alongside asphalt regions like fabricated edges for grower or holding dividers where there are level contrasts. This for the most part gives along persistent seating surfaces and could turn out to be little source gathering spaces for a gathering of guardians.

2.10.4.1.3 Seat Types

Resting hardware, especially along roads, give the way to newborn children and babies, and parental figures to invest more energy outside. The opportunities for a parent conveying his offspring of resting for a couple of moments under a decent shadow, while doing some staple goods, can be an exceptionally esteemed quality if the asphalt region.

2.10.4.1.4 Flip Down Divider Seat

In regions where space is restricted, for e.g,a limited asphalt, flip-down seats can be a space-productive technique to give resting spaces.

2.10.4.1.5 Wide Seat for a Creeping Child

Where there is space, introduce extra wide seats. This gives parental figures a spot to securely put down a child.

2.10.4.1.6 Tallness Split Seat

Where there is additional room, seats can be tallness parted, to permit little children to climb onto them without any problem. This can be very much joined with an extra-wide seat plan.

'Found' or incorporated components for seating. Seating ought to be coordinated into public space however much as could reasonably be expected. It doesn't need to be an introduced seat in that capacity.

2.11 ITC in Tirana

This section contains the results of a prior study conducted in conjunction with the Municipality of Tirana and Qendra Marredhenie (Relationship Center). The first round of data collection began in the summer of 2019. It entails assessing the physical features of the city using the Maps Plus program, which allows data collectors to map every data point for each indication. A total of 56,000 data points have been mapped, and over 5000 geotagged photographs have been collected over the course of fifteen days by eight data collectors. GIS was used to import the mapped data. In addition to compiling a comprehensive indicator database, data was gathered by visiting over fifty-five villages and meticulously recording precise information (i.e., traffic, humidity, light emission, and acoustic noise).

Other data collection methods included utilizing an AirBeam2 device to measure air quality in the city's neighborhoods. This gadget connects via Bluetooth to the data collector's phone and sends a signal with the air quality reading every second to its application and the AirCasting open-source database. Three times a day, at 8:00, 13:00, and 20:00, a preset path was walked in the area.

These are the times of day when children are walking to and from school, allowing us to assess the air quality in the vicinity of school streets. The length of the path was dictated by the physical constraints of the area, although it was usually between 1.5 and 3 kilometers each cluster. The data was then analyzed in GIS to map the air quality at the chosen location.

2.11.1 School Park

Infants and toddlers require sensory-rich settings as they learn about their role in the physical world. Within the ITC neighborhood, both the routes and the destinations should provide opportunities to pause, study, and marvel. As a result, schoolyards ***(Figure 22***) are underutilized green space that, if opened to the public, has the potential to become community gathering spaces.

Increasing the number of ITCs available at the school park and for longer periods of time indicates the recreation center's worth and desirability, and serves as a reliable mediator to pass judgment on the nature of its plan. As school grounds are converted into parks, more families with small children should be made available gradually. The popularity of the recreation facility is an important indicator of the city's program's success. In Tirana, the trash depicted in figure no longer serves as parks, nor do they possess the necessary components to be regarded as ITC pleasant. There are several schools that serve as public venues and are mostly used by understudies to play on the gaming zones.

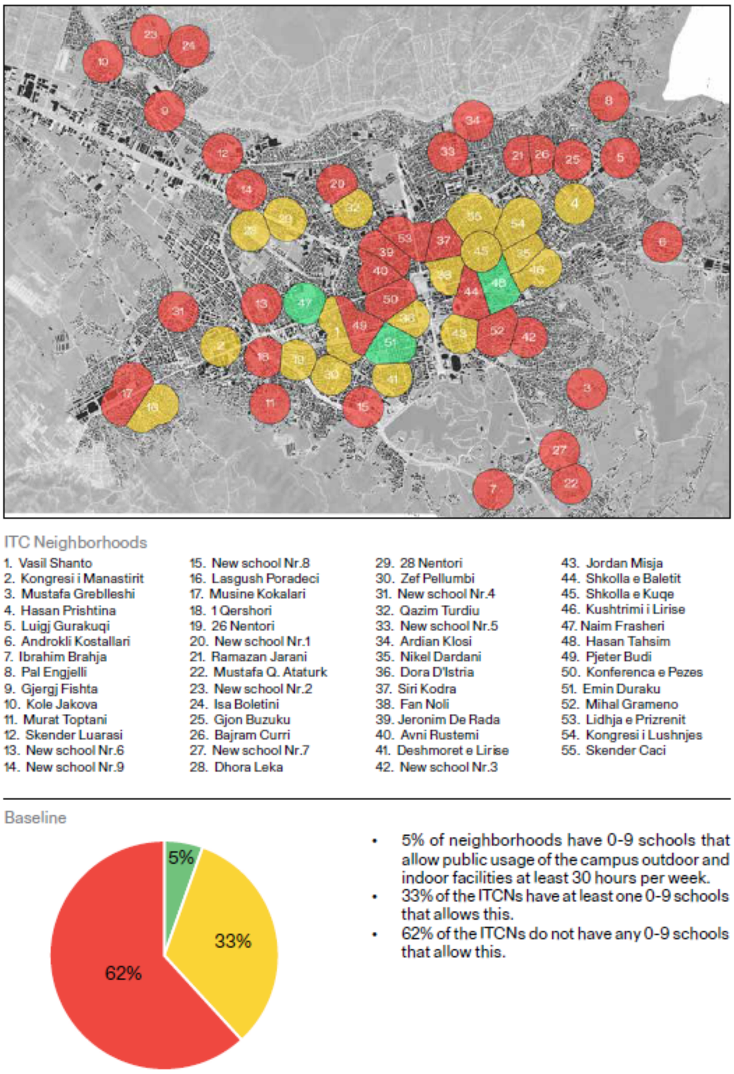


Figure 22.Number Of Primary Schools With Campus Joint-use Agreements, By Administrative Unit

2.11.2 Average Amount of time per week caregivers engage with their 0-5 year old in outdoor green spaces

Outdoor, unstructured play is extremely important for the healthy development of babies and toddlers. Caregivers should engage very young children in play in green spaces on a regular basis to build habits and familiarity with natural play. The city should be interested to know the changes in these habits over time, as a proxy for the mental and physical health of citizens. The school park provides a convenient place for this engagement to happen and its existence should be expected to help increase the indicator year by year. In ***Figure 23*** is shown that only 56% of caregivers engage with their 0-5 year old in outdoor green spaces at least one hour per week. 24 % of caregivers spend at least 30 min with their 0-5 year old in outdoor green spaces. Only 20% of caregivers spend less than 30 minutes with their 0-5 year old in outdoor green spaces.

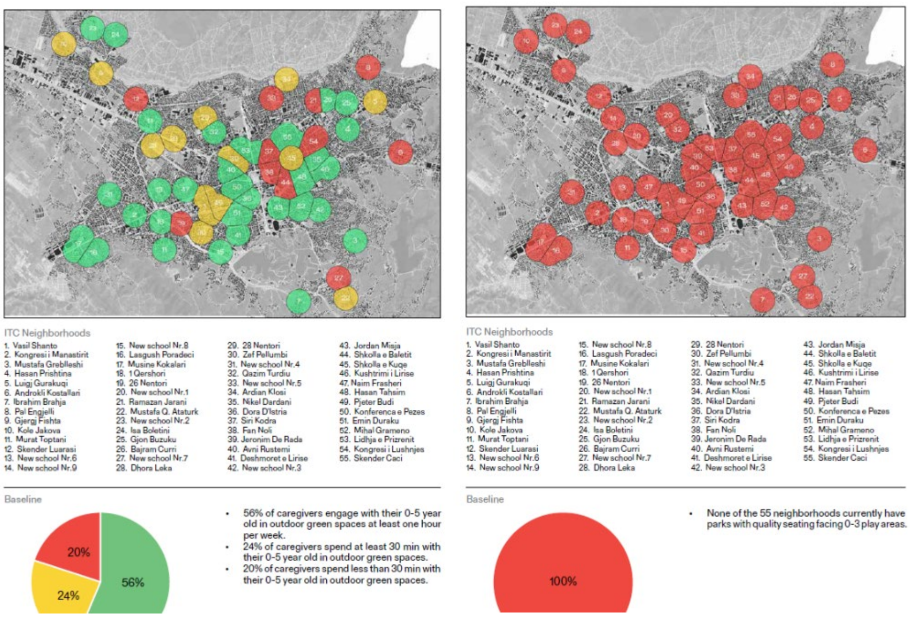


Figure 23.Basemap of the average amount of time per week caregivers engage with their 0-5 year old in outdoor green spaces (on the left) and Percentage basemap of daily trips by non-motorized means (on the right)

2.11.3 Percentage of Streets with Decibel Levels Above Standard 55 Db

Infants and toddlers are very sensitive to noise. The World Health Organization has set the good enough noise restrict at fifty five dB throughout the day and forty five dB throughout the night (***Figure 24***). Evidence suggests that better levels of noise can result in emotional distress at infants and toddlers. Neighborhood streets have to offer safety from noise and the important intimacy from visitors. As the city calms traffic in neighborhoods noise levels have to lessen over time.

Benchmark Score

THRIVING	STRIVING	SURVIVING
There is less than 5 percent of streets with decibel levels above 55 dB.	There is less than 15 percent of streets with decibel levels above 55 dB.	There is less than 25 percent of streets with decibel levels above 55 dB.

Images

Traffic as a factor of unpleasant urban noise.

One of the major contributors to harmful urban noise is construction sites.

Figure 24.Construction Site next to Servete Maci School (Photo on the right***)***

2.11.4 Frequency of Large Tree Canopy

The street tree canopy cools in summer time season with shade, it blocks wind, it captures carbon dioxide and releases oxygen. Street bushes play a function in stormwater management, they offer habitat for creatures, and their root structures make contributions to healthful soils. The town desires to realize the amount and fine of its tree cover with a view to successfully control it for long-time period viability. It compels the town to plant large bushes instead of most effective extra bushes.

Street trees are planted on an average of less than 30 m apart on center. As shown in ***Figure 25*** the average canopy diameter of street trees in the ITCN is not greater than 4m.

Figure 25.Tree Canopy and average planting distance at SM Site

2.11.5 Daily Concentrations of PM2.5

PM2.5 refers to atmospheric particulate matter (PM) which have a diameter of much less than 2.5 micrometers, which is set 3% the diameter of a human hair. High levels of publicity to PM2.5 have a number public fitness effects, contributing in general the breathing and cardiovascular complications. Infant, toddlers, and the aged are the maximum affected city dwellers from its effects. The PM2.5 levels at SM area not higher than 30 mg/m^3 in 24-hour mean as shown in **Figure 26.**

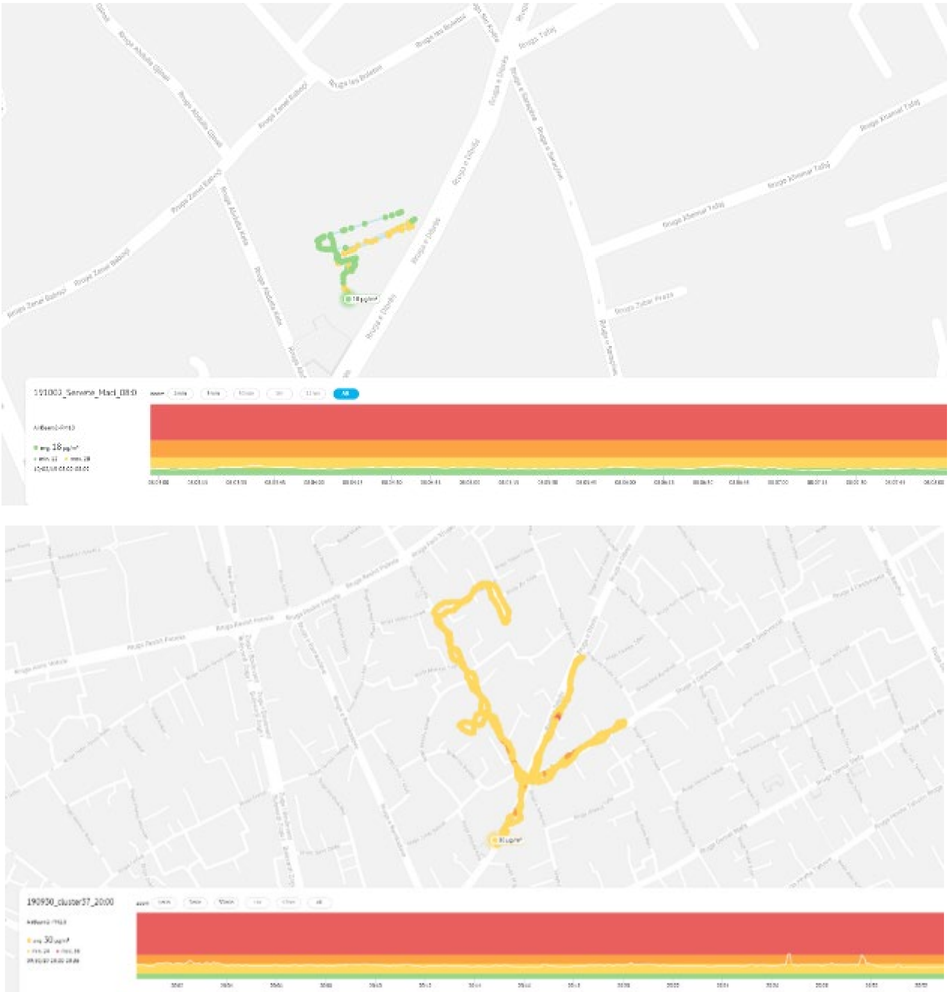


Figure 26.Daily concentration of PM2.5 at 8:00 AM and 20:00 PM

2.11.6 Daily Concentrations of PM10

The daily concentration of airborne fine particulate matter of 10 microns or less in width. Common sources of PM10 particles area sea salt, pollen, and combustion processes, such as automotive and industrial processes. Road dust is also the main source of PM10 particles. PM10 affects city dwellers' respiratory and cardiovascular systems, with infants and toddlers being the most vulnerable to its effects. The PM10 levels are between 30 mg/m^3 and 50 mg/m^3 in a 24-hour mean (***Figure 27)***.

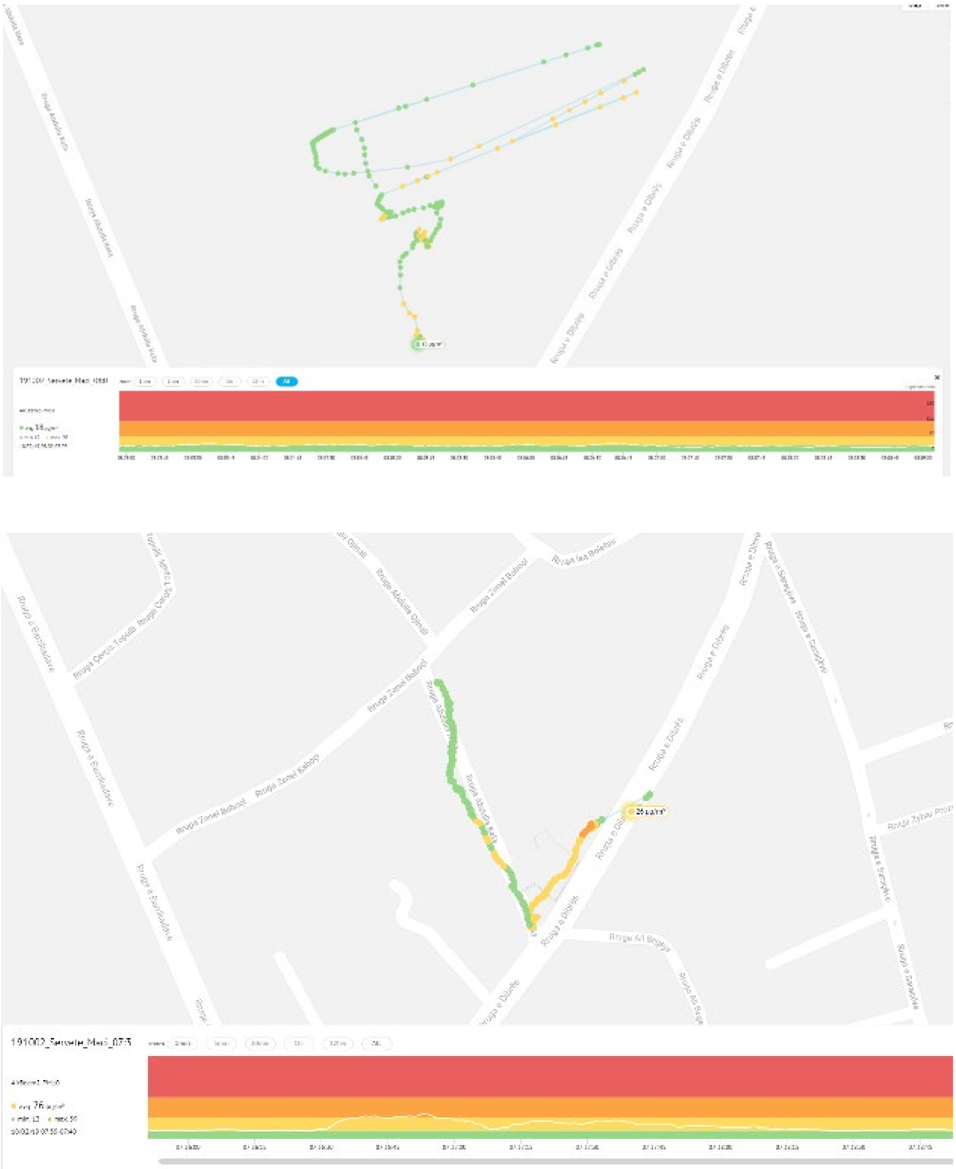


Figure 27.Daily concentration of PM10 at 8:00 AM and 20:00 PM

CHAPTER 3

METHODOLOGY

3.1 Overview

Even though there have been various studies on the UHI phenomenon, its influencing factors and causes the continuation of research is yet important. This dissertation combines theoretical approach and software solutions to examine and apply mitigation techniques in school neighborhood in Tirana. This chapter consists of two sections: urban scale diagnostics and meteorological data analysis and the computation simulations (***Figure 28***). Meteorological evaluation (hourly temperatures and humidity) was done based on internet records from a weather platform called weather underground. Other environmental data such as temperature, humidity and sound levels (see ITC in Tirana, page 50) was done on an open-source environmental data visualization platform called Air Casting Maps. The data gathered from analysis of SM are used for ENVI=met simulations to analyze the local climate issues around SM school. For model adjustment and verification, after completing the analysis with ENVImet, comparisons between the measures of current conditions of the built environment and simulation scenarios are conducted.

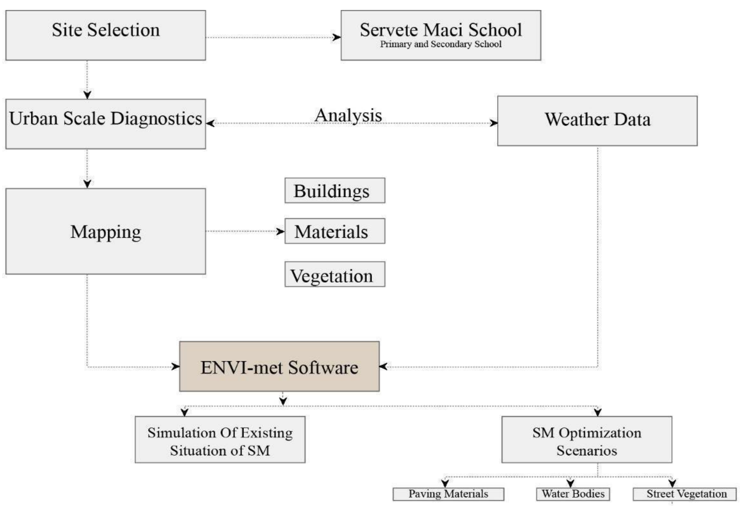


Figure 28.Illustrative Description of Methodology

3.1.1 Albanian Climate

Albania has a typical Mediterranean climate, with mild winters, heavy rainfall, and hot and dry summers. The average annual temperature in this area varies greatly, from 7°C in the highest areas to 15°C in the coastal areas. In the southwest, the temperature reaches 16°C.In the lowlands, the average annual temperature is almost stable (from 12 to 14 °C).The lowest temperature measured was 25.8°C and the highest was 43.9°C. The average annual rainfall in Albania is about 1485 mm. In the southeastern part of the country, there is less precipitation (up to 600 mm of annual precipitation).The Albanian Alps have the highest precipitation, with values ranging from 2,800 to 3,000 millimeters per year. Another area with heavy rainfall is the southwest mountainous area, with a total rainfall of 2200 mm. The amount of precipitation corresponds to a clear annual process, with the largest in winter and smallest in summer . [47]

3.1.2 Air Temperature Changes

In the eastern Mediterranean, the intensity, duration and number of heat waves have increased six to eight times since the 1960s . [48]

The climate change scenario in Albania predicts that the temperature will rise as high as 1°C, 1.8°C, 3 each year.6°C respectively by 2025, 2050 and 2100.Seasonal changes in temperature and rainfall indicate a shift towards milder winters, warmer springs, drier autumns, and drier, warmer summers. The projected ranges of temperature increase for all seasons are shown in ***Table 3*** [49]:

Table 3. The projected ranges of temperature increase

Season	**Increase 2025**	**Increase 2050**	**Increase 2100**
Annual	0.8-1.1 °C	1.7-2.3 °C	-16.2 to - 8.8 %

Winter	0.7-0.9 °C	1.5-1.9°C	-8.4 to -4.6 %
Spring	0.7-0.9 °C	1.4-1.8°C	-5.8 to -3.2 %
Summer	1.2-1.5°C	2.4-3.1 °C	-54.1 to -29.5 %
Autumn	0.8 – 1.1°C	1.7-2.2°C	-14.2 to -7.7 %

Possible changes in other climate parameters [49]:The daily minimum temperature rises more than the maximum; In 2025, 2050 and 2100, the number of frost days in high-altitude areas (temperature ≤5°C) will be reduced from 4 days to 5 days, 9 days and 15 days respectively; The frequency and intensity of heat waves increase. It is estimated that by 2100, the number of days in the highlands will increase from 5 to 6 days, and the number of days in the lowlands will increase to 8 days.

3.1.3 Precipitation Changes

The climate change scenarios for Albania project an annual decrease in precipitation up to -3.8%, -6.1%, -12.5% respectively by 2025, 2050 and 2100 [49].Seasonal changes in temperature and precipitation indicate a shift towards milder winters, warmer springs, drier autumns, and hotter and drier summers. The forecast area of rainfall changes in all seasons is shown in ***Table 4*** [49]:

Table 4.Forecast area of rainfall changes

Season	**Increase 2025**	**Increase 2050**	**Increase 2100**
Annual	-3.4 to -2.6 %	-6.9 to -5.3 %	-16.2 to -8.8 %
Winter	-1.8 to – 1.3 %	-3.6 to -2.8 %	-8.4 to – 4.6 %

Spring	-1.2 to - 0.9%	-2.5 to -1.9 %	-5.8 to - 3.2 %
Summer	-11.5 to 8.7 %	-23.2 to – 17.8 %	-54.1 to – 29.5 %
Autumn	-3.0 to – 2.3 %	-6.1 to 4.7 %	-14.2 to - 7.7 %

It is estimated that the total annual precipitation in the southeast is the lowest (approximately 570 mm) by 2050.The Myzeqe area in the west of the country is 950 mm, and the southwest area is 2,100 mm.The highest value is about 2 650 2850 mm, which is expected to be recorded again in high mountain areas.It is expected that the same distribution may occur in 2100 [49].

Possible changes in other climate parameters [49]:

- There is more precipitation than snow in winter;
- More frequent heavy rain events.
- One to two days before 2025, two or three days before 2050, and three to five days before 2100.

3.2 Site Selection Criteria

SM area has been selected to study the urban heat phenomenon in Tirana (***Figure 29***),. The primary selection benchmark is based on the presence of weather station in Tirana which are accessible through Weather Underground (wunderground.com), a weather platform which is used to publish climate related data from weather stations arranged by meteorologists . The other criteria consists of urban morphology. Hence, it includes building heights ,paving materials and street vegetation on this site to understand and identify the UHI effect.

Figure 29.Orthophoto of Servete Maci School location, Tirana,Albania

3.3 Urban Scale Analysis and Diagnostics

It is located 376.29 m from the city center, in Rruga e Dibres more precisely in coordinates 41°19'56.9"N 19°49'19.0"E (***Table 5***) Based on orthophotos and site visits the plan is updated with the actual building footprints and heights, with the vegetation types, paving materials and roads. To analyze the urban scale conditions. The analysis of SM begin with the site visit to document the building environment and its surrounding in a 150m radius from the school. Hence, during the site visit information related to street vegetation, green areas, paving materials and building typologies were investigated. Servete Maci site is mainly characterized by mixed building typologies as shown in ***Figure 30***. The school is easily accessed by vehicles from the main road 'Rruga e Dibres' and by pedestrians from the pathways (***Figure 31***). The used materials in site landcover are mostly masonry, brick and concrete in buildings. Streets and sidewalks are mainly covered by dark asphalt and dark concrete bricks in streets and sidewalks as shown in ***Figure 32***. Satellite images extraction from ASIG [50] were used to provide more precise analysis of the urban context. This analysis require exact mapping of the site features with correct dimensions which are used to calculate the accurate demonstration of urban features, surface materials and their respective percentages.

Table 5.SM Site parameters

Coordinates	41°19'56.9"N 19°49'19.0"E
Area (m2)	90000 m2
% Built Area	33.6%
% Street Area	14.3%

Figure 30.Building Heights

Figure 31.Circulation Map

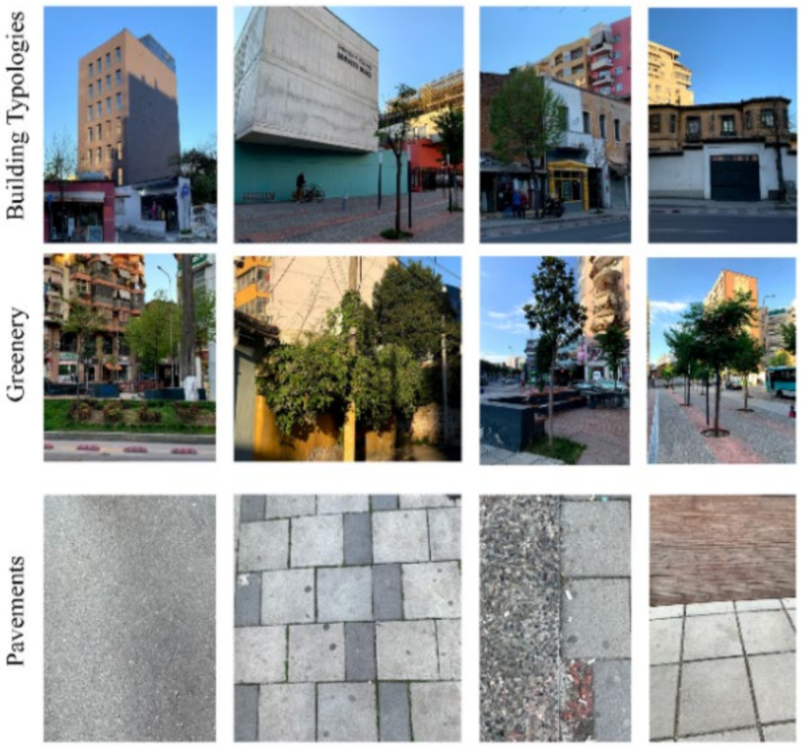


Figure 32.Landcover and Buildings Materials

3.3.1 Street Vegetation

Studies show that being associated with the natural world outcomes in physical and emotional well-being benefits, for example, lower paces of weight, misery, stress and consideration problems.

Caregivers of youngsters who aren't yet in school frequently need to travel through the city bringing the youngster along. These are regularly multi-stop stumbles on a commonplace work day. It's significant for the cerebrum improvement of a little child that that involvement with the city is as animating and protected as could really be expected.

Trees and plants are a fundamental component of a solid metropolitan domain. In warm environments a thick tree overhang or a plant structure keep roads in conceal during summer. A cooler ground temperature makes an excursion simpler, and benefits the city from various perspectives as well, from holding more water in soil, to blunting wind speeds, what's more, even to diffusing unnecessary commotion. To the kid, the capacity to contact, press, pull, and bat at normal material is a wondrous learning experience.

A cross sectional investigation in the U.S. showed lower asthma predominance among youngsters living in regions with more road trees. Planting zones, whenever put close by streets act as a cradle between the road and the asphalt, bend over as insurance. Road planting acquires little children contact with nature. [41]

Trees ought to be decided on primarily based totally on form, mature size, color, and texture to mirror the city layout desires of a road. Also, careful interest is needed to the mature tree cover and the way it is able to have an effect on road and pedestrian lights or perspectives of signage and constructing fronts. An element regularly unnoticed is the capacity for root structures to have an effect on sidewalks, curbs, and utilities, developing issues in road circulation, in particular for ITCs.

It is vital to choose a various combination of evergreen and perennial trees,in order that there's a wealthy palette of green year round. Vegetation have to include trees for shading and lower plant life at the dimensions of small kids. Plants may be located in diverse zones in the road which include in opposition to facades, in an area among traffic and pedestrian. However, toddlers' view of the road must be minimally obstructed with the aid of using low planting so as for them to preserve a feel of passing activity, especially on streets with frequently transferring site visitors as SM.

At lower levels, use of herbs or colorful/blooming groundcovers might be considered. The trunk diameter of trees to be planted have to be no less than 5cm at 250cm of height. The minimum tree length at planting is a 60cm field; 40cm field specimens and smaller caliper sizes have to be allowed for volunteer efforts and assets owner-initiated replacement. Tree branches that increase into the course of tour should preserve 2m of vertical clearance.

Evergreen tree species have to be selected in instances whilst it's far needed foliage through the winter months or to decorate ecological overall performance with the aid of using permitting leaves to slow storm water at some point of the rainier season. To permit daylight in winter months, and supply a higher experience walking through the sidewalk, deciduous trees have to be considered. Trees and different planting have a super affect withinside the private safety of people. Personal safety is enhanced through trees and shrubs that don't obstruct views, intervene with avenue and pedestrian lighting, or block ability break-out routes. This is especially proper in children and impacts their behavior.

A variety of local and exclusive natural world species employ trees and landscaping withinside the city. Street trees and landscaping offer corridors for the motion of these species and serve as hyperlinks among parks and open spaces throughout the city. It also can have an added educational value for youngsters. Except for the aesthetic look and mixing with the streetscape, flowers have to be decided on primarily based totally on overall performance withinside the city environment, inclusive of drought tolerance and hardiness. Before planting, contemporary soil situations have to be tested to create the maximum useful developing situations

The following tree matrix (***Table 6)*** is produced from a list provided by the Agency of Parks and Recreation of species known to fare well in public spaces and in the Tirana climate. [41] Meanwhile in ***Figure 33*** are shown the identified street vegetation at SM site.

*Table 6.*Tirana's Tree Matrix List

Scientific Name	View	Dimension
Acacia Dealbata Mimoza Silver Wattle Blooms: Feb-Apr Soil: Moist soil Water need: Low		Maximum Height: 12 m Maximum Crown Diameter: 5m
Acer obtusatum Panja fletë gjerë Spring maple Blooms: Apr-May Soil: Moist Soil Water need: Medium		Maximum Height: 20 m Maximum Crown Diameter: 20m
Acer platanoides Panja fletë rrapi Norway maple Blooms: May Soil: Dry soil Water need: Low		Maximum Height: 25 m Maximum Crown Diameter: 15m

Acer pseudoplatanus

Panja e malit

Sycamore

Blooms: May-June

Soil: Sandy, Moist

Water need: Medium

Maximum

Height: 30 m

Maximum

Crown

Diameter: 20m

Albizia julibrissin

Albicia

Pink siris

Blooms: June-July

Soil: Tolerates all

Water need: Medium

Maximum

Height: 10 m

Maximum

Crown

Diameter: 15m

Catalpa bignonioides

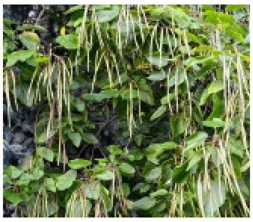
Katalba

Walter indian bean

Blooms: June-July

Soil: Moist soil

Water need: Medium



Maximum

Height: 15 m

Maximum

Crown

Diameter: 12m

Ilex aquifolium

Ashja

Maximum

Height: 8 m

Common holly

Blooms: May

Soil: Tolerates all

Water need: Low

Maximum

Crown

Diameter: 4m

Laburnum anagyroides

Ajdesi

Common laburnum

Blooms: May-July

Soil: Well-drained soil

Water need: Medium

Maximum

Height: 9m

Maximum

Crown

Diameter: 5m

Liriodendron tulipifera

Druri tulipan

Tulip tree

Blooms: May-June

Soil: Well-drained soil

Water need: Medium

Maximum

Height: 30 m

Maximum

Crown

Diameter: 8m

Magnolia denudata

Manjola kineze

Lily tree Blooms: Feb-Mar

Soil: Moist soil

Water need: Medium

Maximum

Height: 15 m

Maximum

Crown

Diameter: 8m

Magnolia grandiflora

Manjola lule-madhe

Evergreen Magnolia

Blooms: Apr-June

Soil: Moist soil

Water need: Low

Maximum Height: 30 m

Maximum Crown Diameter: 8m

Malus sylvestris

Molla e egër

Wild aple tree

Blooms: Apr-May

Soil: Tolerates all

Water need: Low

Maximum Height: 10 m

Maximum Crown Diameter: 8m

Ceratonia siliqua

Xhixhibanozi

Bean tree

Blooms: Aug-Oct

Soil: Moist to dry soil

Water need: Low

Maximum Height: 10 m

Maximum Crown Diameter: 15 m

Cercis siliquastrum

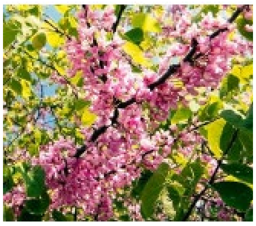
Lofata

Common Judas

Blooms: Apr-May

Soil: Moist soil

Water need: Medium



Maximum Height: 10 m

Maximum Crown Diameter: 8m

Cinnamomum camphora

Kamfora

Camphor tree

Blooms: Apr-May

Soil: Moist, Sandy

Water need: Medium

Maximum Height: 40 m

Maximum Crown Diameter: 50 m

Crataegus monogyna

Murrizi

Common hawthorn

Blooms: May-June

Soil: Tolerates all

Water need: Medium

Maximum Height: 10 m

Maximum Crown Diameter: 10 m

Ginkgo biloba L.Ginkgo

Gingo

Maximum Height: 50 m

Maidenhair tree

Blooms: Apr-May

Soil: Well-drained soil

Water need: Medium

Maximum
Crown
Diameter: 20m

Gleditsia triacanthos

Gledicia

Honey locust

Blooms: June

Soil: Moist Soil

Water need: Medium

Maximum
Height: 20 m

Maximum
Crown
Diameter: 8m

Myrtus communis

Mersina

Common myrtle

Blooms: Apr-June

Soil: Tolerates all

Water need: Low

Maximum
Height: 5 m

Maximum
Crown
Diameter: 3m

Paulownia imperialis

Paulonja

Empress tree

Maximum
Height: 10 m

Blooms: Apr-June

Soil: Well-drained soil

Water need: Medium

Maximum

Crown

Diameter: 12 m

Pittosporum tobira Dryand

Pitosporë

Japanese pittosporum

Blooms: Apr-June

Soil: Tolerates all

Water need: Low

Maximum

Height: 10 m

Maximum

Crown

Diameter: 5m

Prunus avium

Qershia e egër

Wild cherry

Blooms: Apr-May

Soil: Sandy, loamy

Water need: High

Maximum

Height: 20 m

Maximum

Crown

Diameter: 8m

Pyrus amygdaliformis

Gorrica

Wild pear

Blooms: Apr-May

Soil: Well-drained soil

Maximum

Height: 10 m

Maximum

Crown

Diameter: 8m

Water need: Low

Pyrus pyraster

Dardha e egër

Wild pear

Blooms: Apr-May

Soil: Tolerates all

Water needed: Low

Maximum

Height: 20 m

Maximum

Crown

Diameter: 10m

Quercus ilex

Ilqe

Holm oak

Blooms: Mar-June

Soil: Well-drained soil

Water need: Low

Maximum

Height: 52 m

Maximum

Crown

Diameter: 8m

Robinia pseudoacacia

Robinia

Locust tree

Blooms: May-June

Soil: Moist soil

Water need: Low

Maximum

Height: 30 m

Maximum

Crown

Diameter: 10m

Sophora japonica

Sofora

Japanese pagoda

Blooms: Aug-Oct

Soil: Well-drained soil

Water need: Low

Maximum Height: 20 m

Maximum Crown Diameter: 10m

Sorbus aucuparia

Vadhja e eger

Mountain-ash

Blooms: May-June

Soil: Moist soil

Water need: Medium

Maximum Height: 15 m

Maximum Crown Diameter: 8m

Tilia argentea Desf.

Bliri

Silver Lime

Blooms: July-Aug

Soil: Moist soil

Water need: Medium

Maximum Height: 35 m

Maximum Crown Diameter: 20m

Tilia platyphyllos Scop.

Maximum Height: 30 m

Bliri fletëgjerë Large-leaved Lime Blooms: June Soil: Moist soil Water need: Medium	Maximum Crown Diameter: 20m

Figure 33. Tree Canopy and average planting distance at SM Site

3.4 Meteorological Station

Weather Underground [51]is a commercial weather service that provides real-time weather information through the Internet. Weather Underground provides weather reports for most major cities in the world for weather forecasts for the website and local newspapers and third-party websites. The collected records from the station are analyzed through professional meteorologists to be able to deliver greater reliable information.

In Tirana four weather stations have been localized in wundermap, but at the moment only one is yet available on website. Analysis of this study were conducted through the data gathered from personal weather station ITIRANA7 (***Figure 34***) on the left). The weather station is located at Rruga Andon Zako Cajupi, 1.63 km from SM. In figure 33 on the right are shown the personal weather station features.

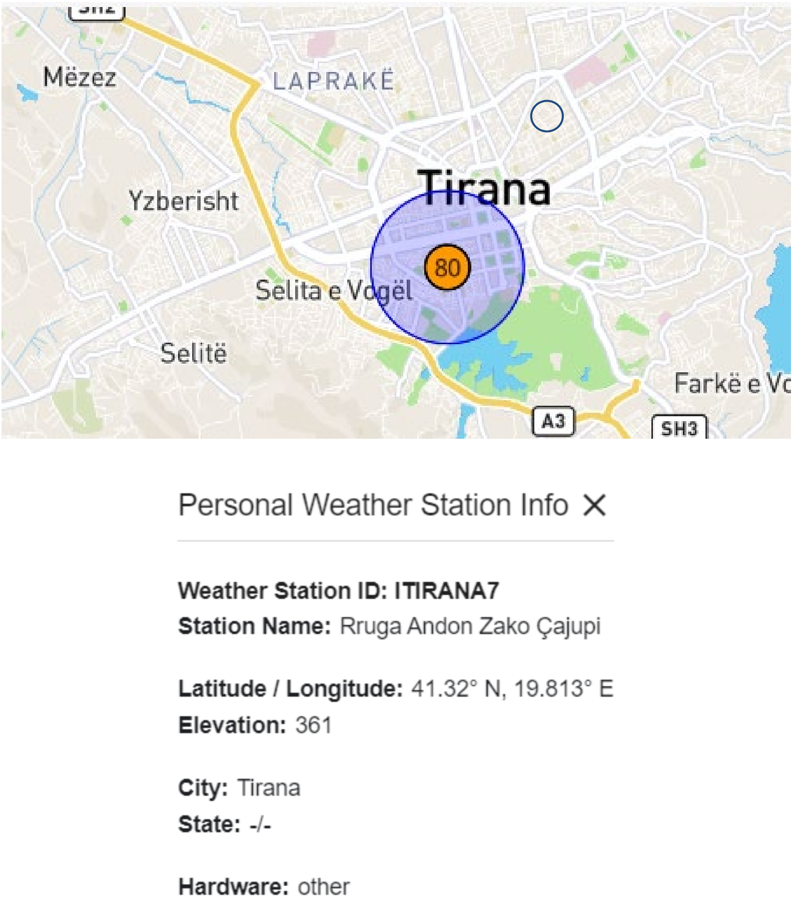


Figure 34.ITIRANA 7 Personal Weather Station location

3.5 Meteorological Data

Albania has a typical Mediterranean climate, with mild winters, heavy rainfall, and hot and dry summers. Meteorological data required for the study are of Tirana only. ***Table 7*** shows the monthly meteorological data throughout a year on variables of temperatures and humidity during summer time 2019 and 2020 near SM. ***Table 8 shows*** the temperature and humidity data separated into the highest variables, the lowest and their average. June, July and August have been selected as three months with the highest recorded temperatures. ***Table 8*** shows the hourly temperature data of August 2019 and 2020 as the warmest day of the month throughout the summer time.

In the following ***Table 9*** the humidity percentage data are shown for both years, as in the previous table of temperatures. As defined from the data collected from the ITIRANA7 station, in 13th of August 2019 was recorded the highest temperature 38 °C at 14:00 hour. ***Figure 35*** shows the comparison chart of humidity percentage data compared to the 2020 data. ***Figure 36*** shows the comparison of temperature between 2019 and 2020 year in August 13th.

Table 7.Temperature and humidity monthly meteorological data throughout a year

Year	***Month***	***Temperature °C***			***Humidity %***		
		High	**Low**	**Average**	**High**	**Low**	**Average**
2019	January	14.7	-1.7	7.4	100	32	67
	February	22.3	2.7	11.5	95	20	51
	March	26.7	5.2	15.2	88	15	51
	April	28.8	11.1	16.7	100	29	63
	May	27	10.8	17.8	100	42	73
	June	36.1	15.3	26.3	98	24	61
	July	35.8	19.1	27.5	92	32	56
	August	38.9	21.3	29	79	27	51
	September	34.8	17	24.8	97	25	59
	October	31.5	14.3	21.1	91	33	64
	November	23.1	11.2	16.2	100	45	76
	December	17.1	2.2	11.7	100	0	70
2020	January	15.5	1.6	9.1	100	0	65

February	21.4	3.9	11.7	94	27	63
March	24.5	4.2	14	100	0	62
April	26.3	4.4	16.4	92	0	55
May	33.1	12.4	20.7	100	0	55
June	33.9	14	22.8	96	34	66
July	37.7	18.5	27.2	81	33	54
August	37.9	20.5	28	88	29	57
September	37.6	14.9	26.1	87	24	54
October	32.9	12.1	19.1	100	30	67
November	24	8.4	15.3	94	33	62
December	20.4	7.3	13	97	41	74

Table 8.13 August 2019-2020,hourly humidity values

	August 13,2019	**August 13,2020**
Time (h)	**Humidity (%)**	**Humidity (%)**
12:00 AM	49	62
2:00 AM	46	65
4:00 AM	46	64
6:00 AM	41	64
8:00 AM	43	63
10:00 AM	37	59
12:00 PM	33	50
2:00 PM	32	44
4:00 PM	35	43
6:00 PM	33	52
8:00 PM	34	53
10:00 PM	48	60

Table 9.13 August 2019-2020,hourly temperature maximum values

Time (h)	August 13,2019 Temperatures (°C)	August 13,2020 Temperatures (°C)
12:00 AM	30.2	26.7
2:00 AM	30.2	25.4
4:00 AM	30.2	24.8
6:00 AM	29.7	24
8:00 AM	31.1	24.8
10:00 AM	33.5	28.1
12:00 PM	37.1	32.5
14:00 PM	38.9	35.1
16:00 PM	38.4	34.1
18:00 PM	35.4	31
20:00 PM	34	29.4
22:00 PM	32.5	28

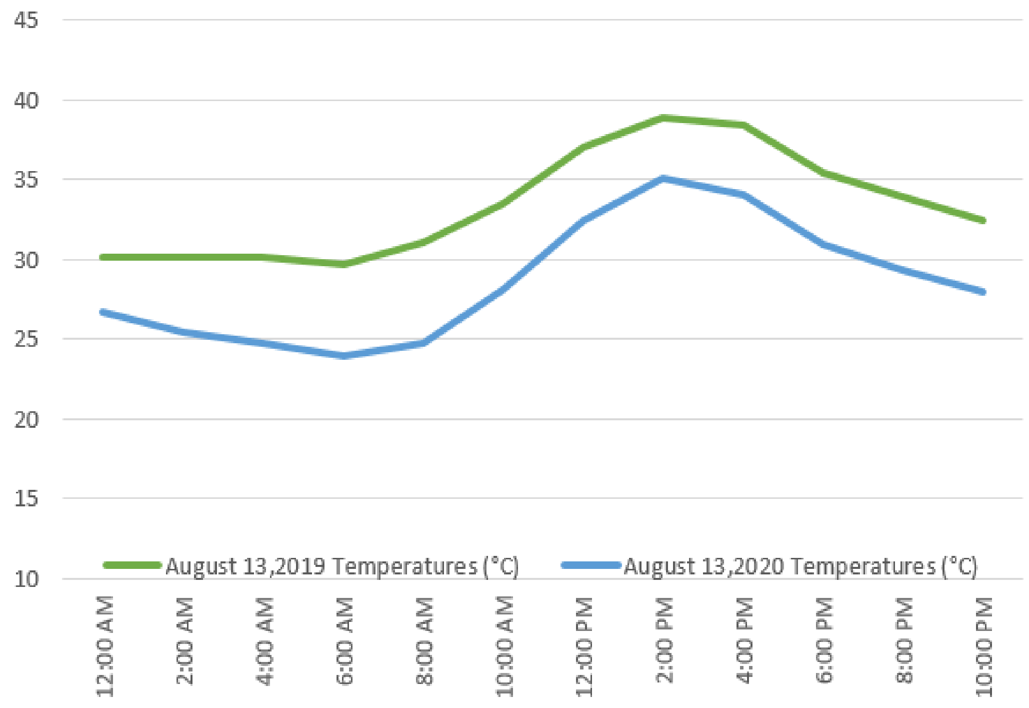


Figure 35.Comparison chart of humidity percentage

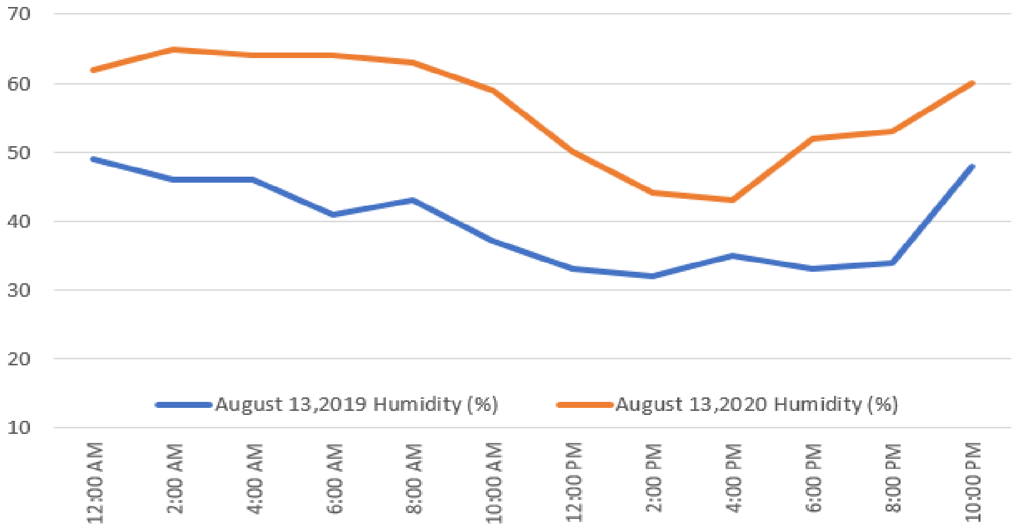


Figure 36.Comparison chart of temperature changes

CHAPTER 4

DATA ANALYSIS

4.1 Software and Simulations

The data processing and integration into simulation programs are the most notable phases. ENVI-Met is the program used in this investigation [52] (ENVI-Met, n.d.). It's utilized to go further into the urban scale in order to improve simulation and knowledge of UHI effects. It examines the assessment of layout impacts at the chosen location. The study covers the specification of ground-floor pavement materials, building construction materials, and vegetation in any possible configuration to minimize aspects such as city heat stress. The program includes a variety of applications (***Figure 37***), including:

- Headquarter
- ENVI-met
- Monde
- Spaces
- Leonardo
- BioMet

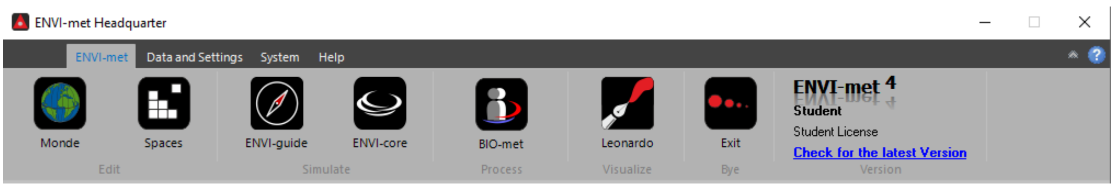


Figure 37.ENVI-met Headquarter

In a continuously changing environment, ENVImet software enables for the creation of sustainable living circumstances. Create chances to immerse yourself in all elements of the microclimate complex and assess the performance of your project by using ENVImet's interactive tools. The programming model is utilized all across the planet, from the tropics to the poles. With almost 3,000 research conducted independently. ENVImet is the most popular climate model available. It has shown that it can precisely replicate the exterior microclimate of any location on the planet. The software's features enable users to assess a project's influence on the local environment, decide regional planning and building materials, and apply green on walls or ceilings in any possible arrangement to minimize environmental issues.

The 4.4.6 Version of ENVI-met License Student (Summer21 Release) is used for the simulations of this study. It is used to simulate the reciprocity between all the urban features on microscale. It analyzes the soil properties, atmosphere, vegetation, buildings and surface materials. Even though the software offers a variety of features, the student version is used for this study, therefore many features are not available or limited.

The main advantage of the student version is that the grid structure is not limited to 50x50x30 grid, even though a greater grid would be translated into greater amount of time to get the simulation results. The simulation time, depends not only on the grid size but on the inserted inputs on the software as well.

In Figure x are shown the process steps that ENVImet follows. Firstly, a bitmap file is inserted in Spaces Application to help as a basemap for building the model and its urban features. Next steps consists of climate data input which are inserted through ENVIguide Aplication to the .inx map created previously in Spaces. The final phase consists of the .simx , the simulation file, which is calculated in ENVI-met for several hours (sometimes even days) until the simulation is finished.

Leonardo is used as the final phase, to visualize all the data gathered from the simulation.

4.2 ENVI-met Computation Simulations

The site analysis are done through the simulations via ENVI-met. Several steps take place until the simulation file. The modeling of the site was performed using

Spaces. For modeling of the site the 60x60x30 grid is used. Each grid represents 2x2x2m on x, y and z direction. For easier calculations the site dimensions are decided 120x120m. The map location was set to Tirana, Albania updated with it respective geographic coordinates

4.3 Site Modeling Scenarios

The satellite image of SM area extracted from ASIG was inserted in AutoCAD (***Figure 38***)to update the selected area urban features properly. The updated map, focused on SM school and its surroundings, was used as bitmap for modeling SM site in Spaces (***Figure 39***). Buildings, street vegetation and green spaces, soil and paving materials were added in each file according to the site analysis done in the first phase of the study. The building envelope materials were set to concrete with moderate insulation material (building default material on ENVI-met).

Figure 38.Satellite Image from ASIG and AutoCAD Updated Map

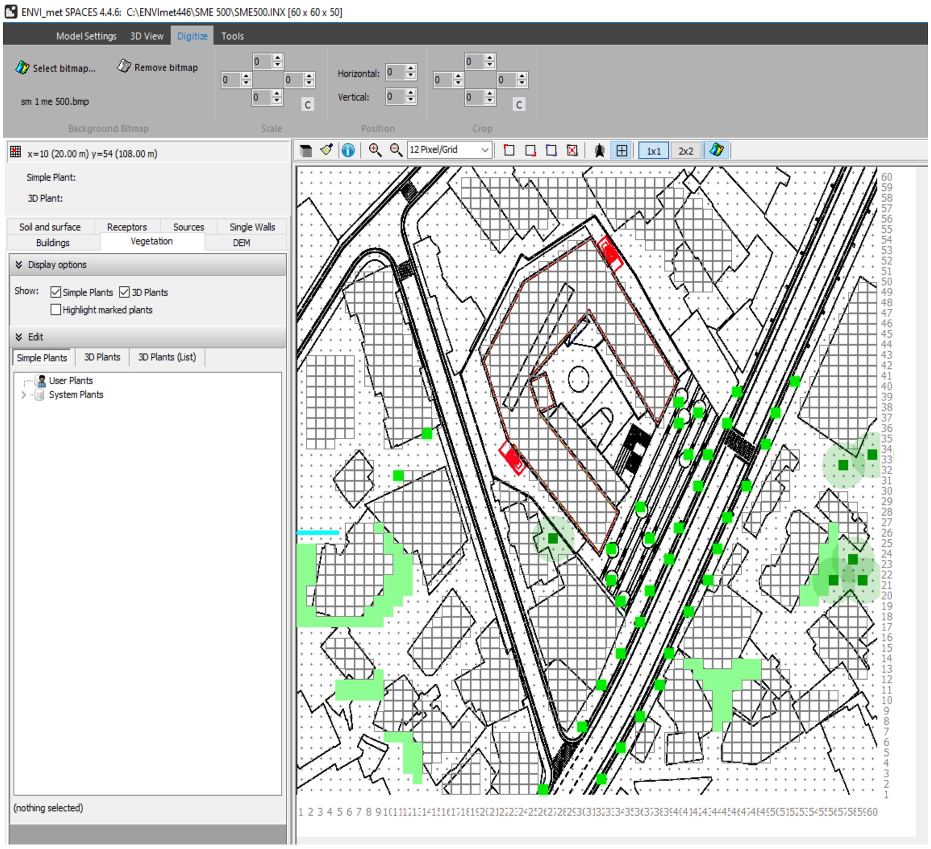


Figure 39.ENVI-met Spaces Application, SM modeling

4.4 Simulations

The following phase is focused on creating the .inx (simulation) file (***Figure 40***). ENVIGuide application is used before running the simulation via the software. The creation of . INX file consists on the following steps :

1.Start date and time of the simulation

2.Total simulation hours

3.INX file loading

4.Input of metorological data collected prior to the beginning of this study.

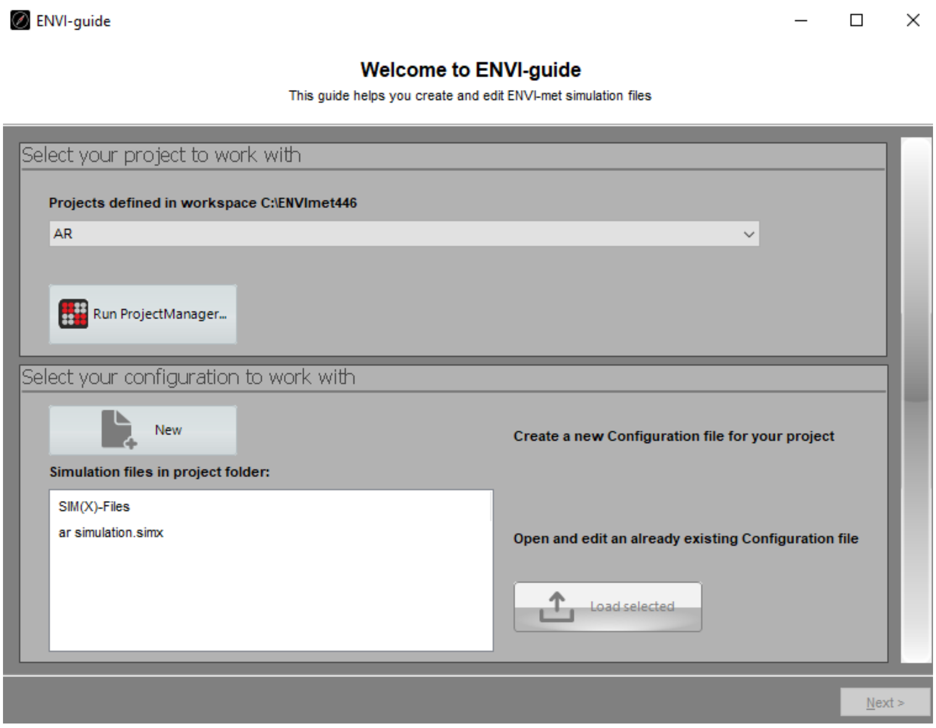


Figure 40.ENVIGuide Application

Envimet offers two options of simulation at this phase: Full Forcing and Simple Forcing. Fullforcing is not supported in student license,therefore Simple forcing is used in this phase over the total duration of 24hours. Advanced settings were not added in the simulations of this study. SM computer simulations via ENVImet software have lasted within a range of 30 to about 48 hours. ***Table 10*** below shows the input parameters used for all the simulations during summer time simulations which are based on the data collected from the ITIRANA7 weather station.

Table 10.13 August 2019 Simulation Input Data

Date	*Temperature (°C)*		*Humidity (%)*		*Wind Speed (m/s)*
13th August	Min	Max	Min	Max	-
2019	29.7	38.9	32	49	3.8

4.5 Leonardo 4 Application

ENVI-met allows to load simulation result files and display output 2D or 3D analysis maps using Leonardo 4.4.4 (***Figure 41***).In Leonardo the simulation results are analyzed and visualized in 2D and 3D output maps . When opening Leonardo, the simulation results can be opened and accessed through Data Navigator. As previously mentioned, the software allows to choose between 2D and 3D maps to display the simulation results and editing in terms of visualization, view plan heights for the chosen analysis. After uploading the simulation files in Data Navigator, the application opens hourly simulated data files for each selected variable.

Leonardo offers various number of data available to analyze and visualize. The data for this study is as the following:

Air Temperature (°C)

Mean Radiant Temperature (°C)

Potential Temperatures

Relative Humidity (%)

Wind Speed (m/s)

Wind Direction (deg)

Solar Radiation (W/m2)

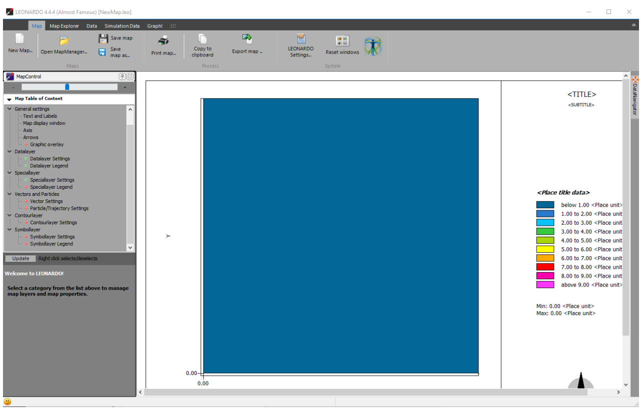


Figure 41. ENVI-met Leonardo 4.4.4 Application

CHAPTER 5

SM SCENARIOS

5.1 Site Modeling Scenarios

The satellite image of SM area extracted from ASIG was inserted in AutoCAD (***Figure 42***)to update the selected area urban features properly. The updated map, focused on SM school and its surroundings, was used as the bitmap basemap for modeling SM site in Spaces. Buildings, street vegetation and green spaces, soil and paving materials were added in each file according to the site analysis done in the first phase of the study. The building enevelope materials were set to concrete with moderate insulation material (building default material on ENVI-met).

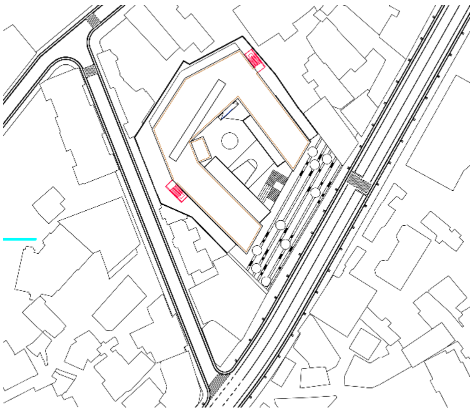


Figure 42.Satellite image from ASIG and AutoCAD Updated Map

Scenario 1 (SC1) in ***Figure 43*** consists of the current conditions of the SM. The street tree typologies consist of 5m tree height and 3-4m crown width in the streets and other height and crown width trees and 25 cm grass in private courtyards. Soil and paving materials involve loamy soil, dark asphalt roads and pathways, and sidewalks covered in grey concrete pavements.

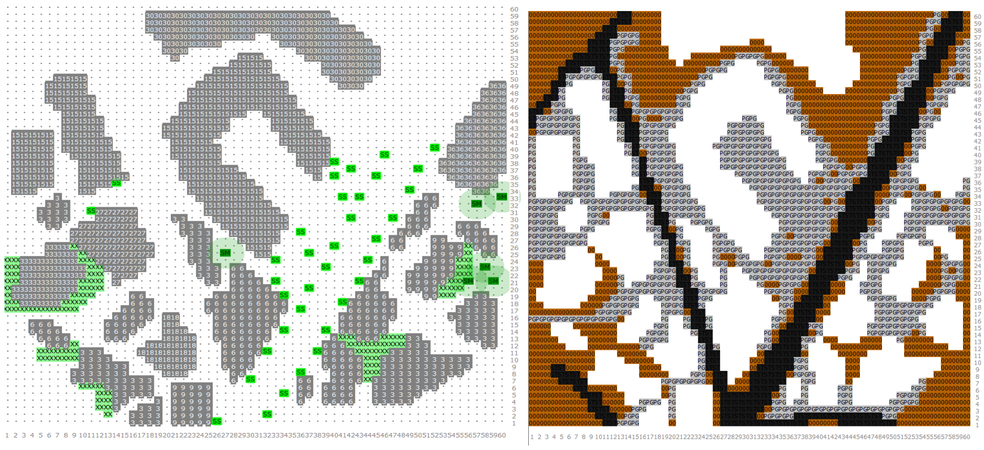


Figure 43.SC1 Greenery and Buildings SC1 Soil and Surface Materials

In second scenario (SC2) shown in Figure 43 change are made in sidewalk paving materials. Light Concrete material (LC) is used in this scenario instead of grey concrete.

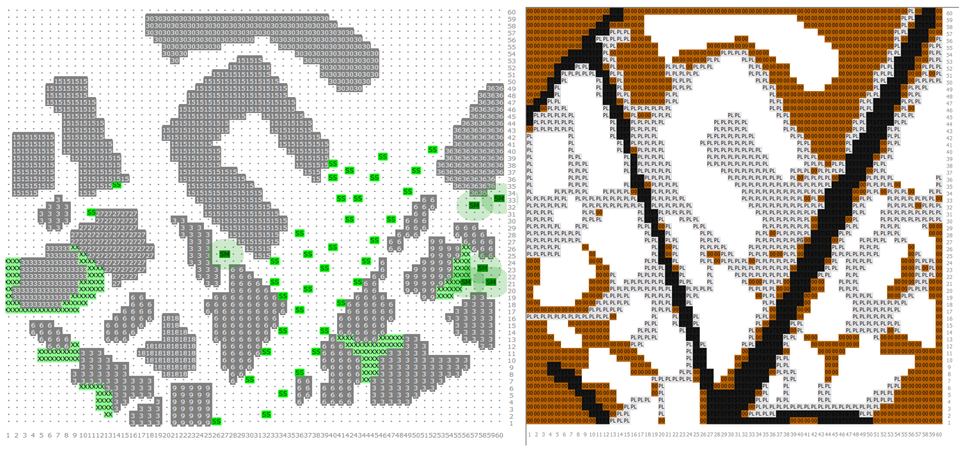
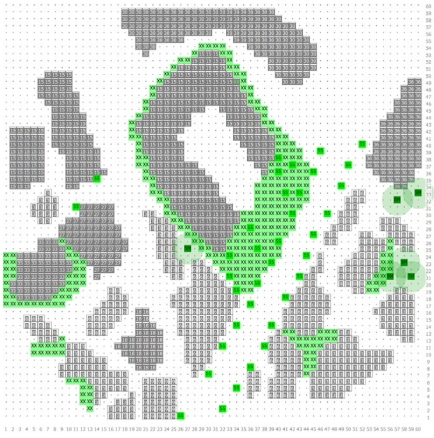
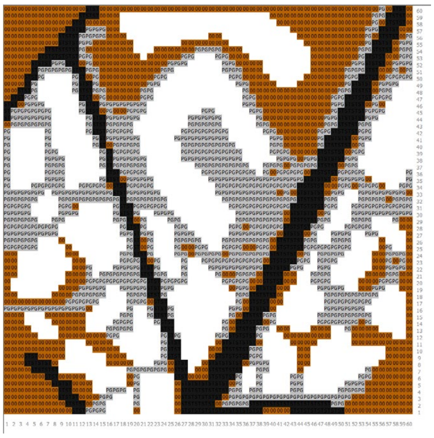


Figure 44.SC2 Greenery and Buildings SC2 Soil and Surface Materials

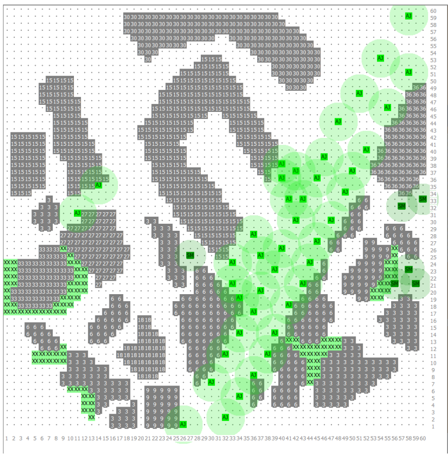
In the third scenario (SC3) provides different vegetation typologies (**Figure 44**). It presents the following greenery: low plants (25 cm grass), medium height trees of 12m height and 9m crown width and 12m tree height with 11m tree crown width and high tree consisting of 20 m height and 13m tree canopy.





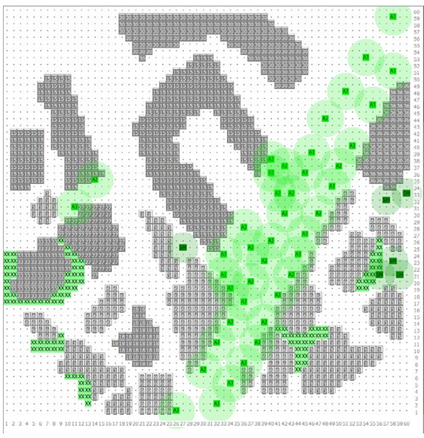
Grass 25 cm

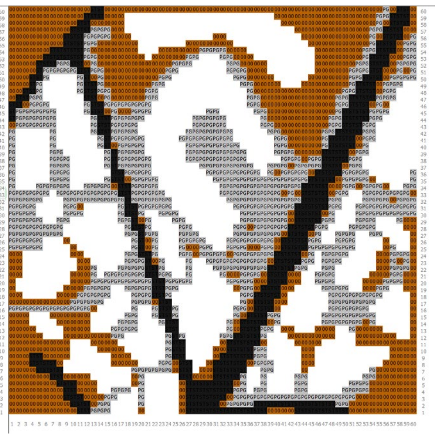
Current Soil and Surface Materials



Tree 12m height and 9m canopy

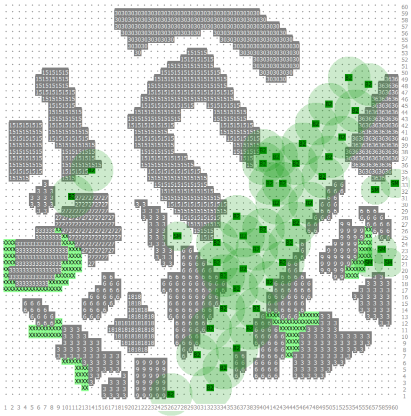
Current Soil and Surface Materials

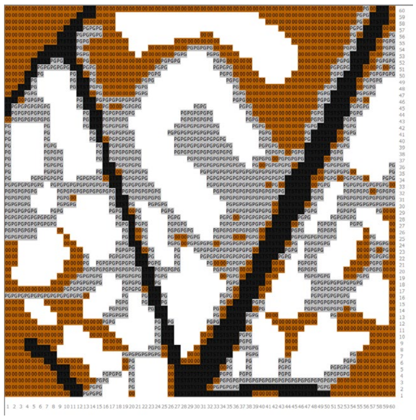




Tree 12m height and 11m canopy

Current Soil and Surface Materials

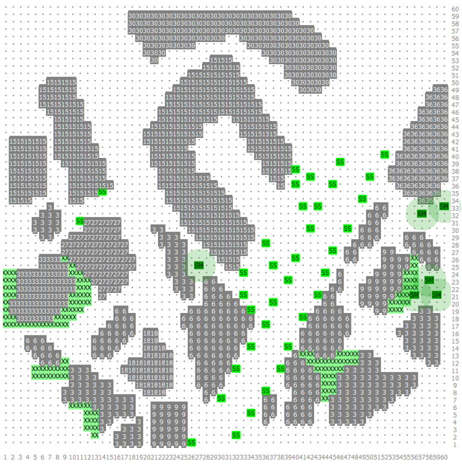




Tree 20m height and 13m canopy   Current Soil and Surface Materials

Figure 45.SC3 Scenarios on Spaces Application

The scenario (SC4) consists of replacing the black asphalt material with AR ***(Figure 46)***.



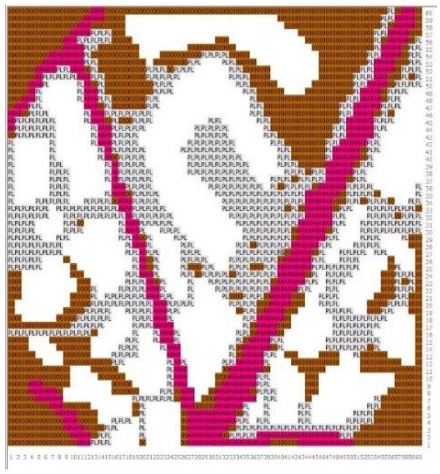


Figure 46.SC4 Greenery and Buildings   SC4 Soil and Surface Materials

CHAPTER 6

RESULTS AND DISCUSSIONS

6.1 Simulations – Base Case Scenarios

After running the simulation files using ENVI-met and the input settings specified in the first meteorological analysis, the files are imported into Leonardo 4. The SM site characteristics examined are air temperature, direct shortwave radiation, relative humidity, mean radiant temperature, and wind speed and direction.

The simulated outside air temperature of 13th August 2019 at 12:00 is depicted in ***Figure 47.*** The temperature distribution in the area is depicted, as well as the lowest and highest values. The impact of site characteristics is examined and recognized in these graphs.

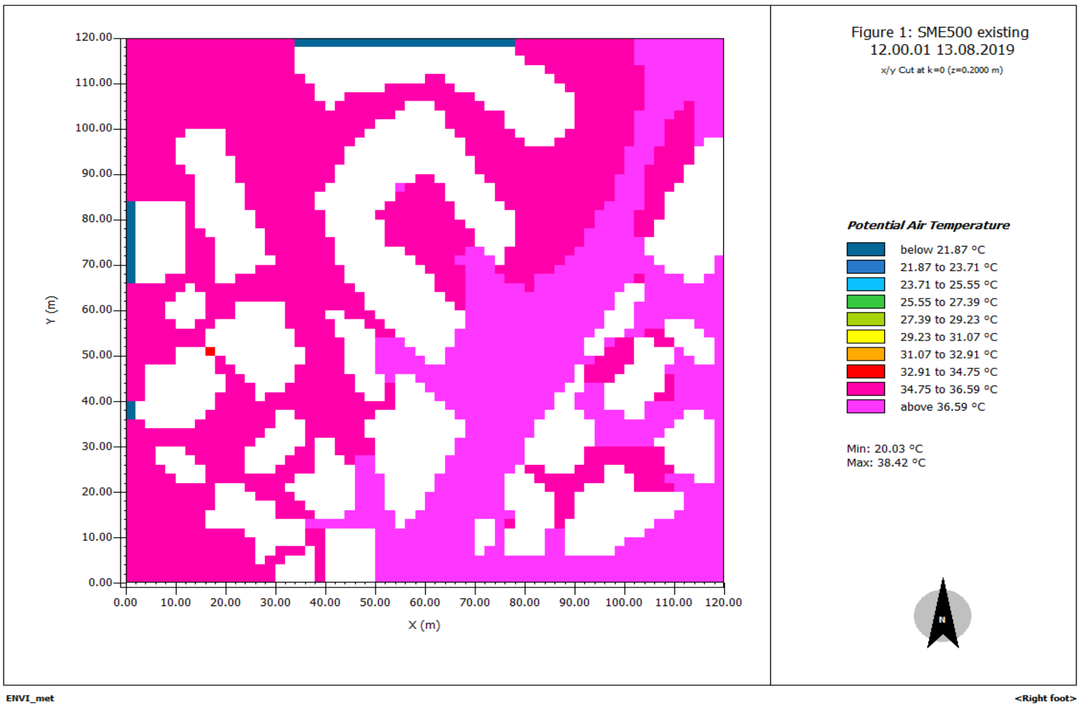


Figure 47.SM Simulation of Outside Air Temperature at 12:00 p.m. on August 13th, 2019

The simulated outside humidity at 12:00 is depicted in Figure 46. The graphs in ***Figure 48*** depict how this parameter impacts the site's UHIs.

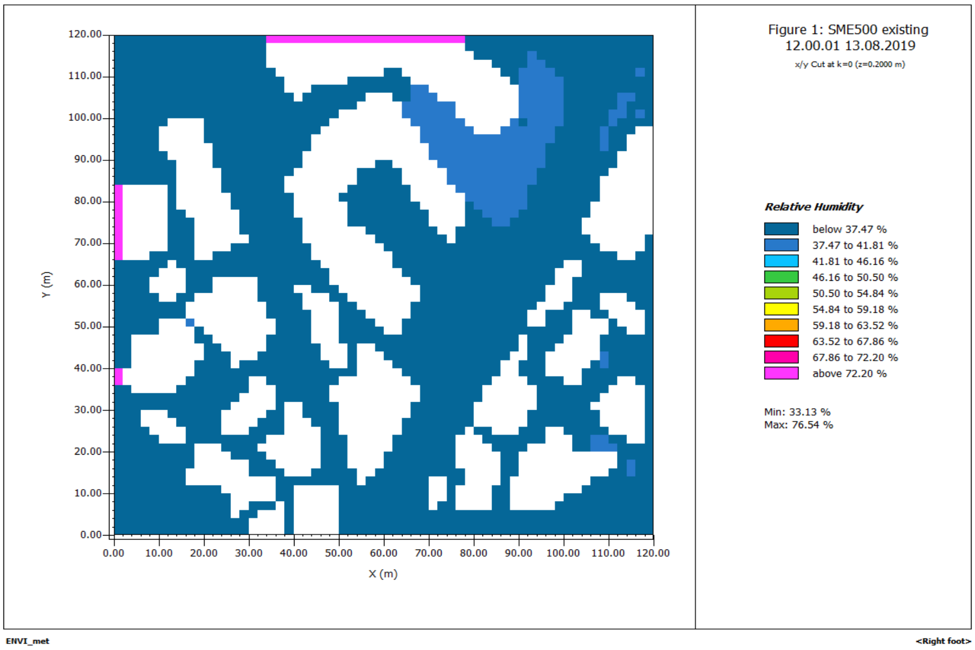


Figure 48.SM Simulation of Relative humidity at 12:00 p.m. on August 13th, 2019

The simulated direct shortwave radiation, mean radiant temperature, and wind speed are depicted in ***Figure 49***,***Figure 50***, and ***Figure 51***, respectively. The influence of solar radiation on surface temperature and the change in wind speed owing to building density and street vegetation are depicted in these graphs.

Figure 52 depicts the minimum and highest simulated air temperatures, as well as the mean radiant temperatures, for the SM region for the 24 hours of August 13th (See *APPENDIX A* for hourly simulation graphics of MRT and Table of hourly air temperatures values).

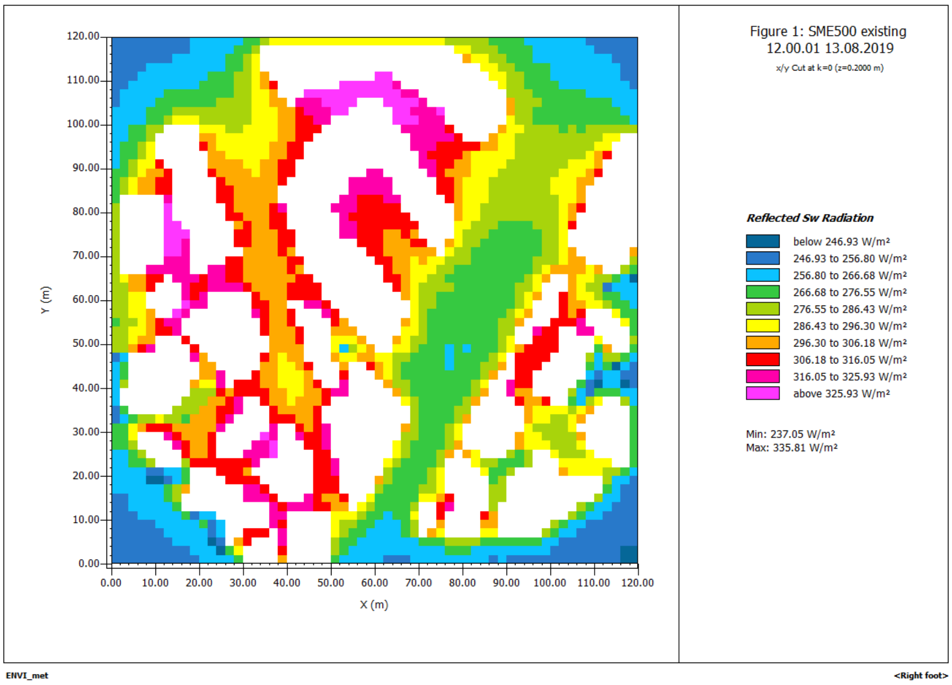


Figure 49.SM at 12:00 p.m. on August 13th, 2019, the shortwave radiation simulation.

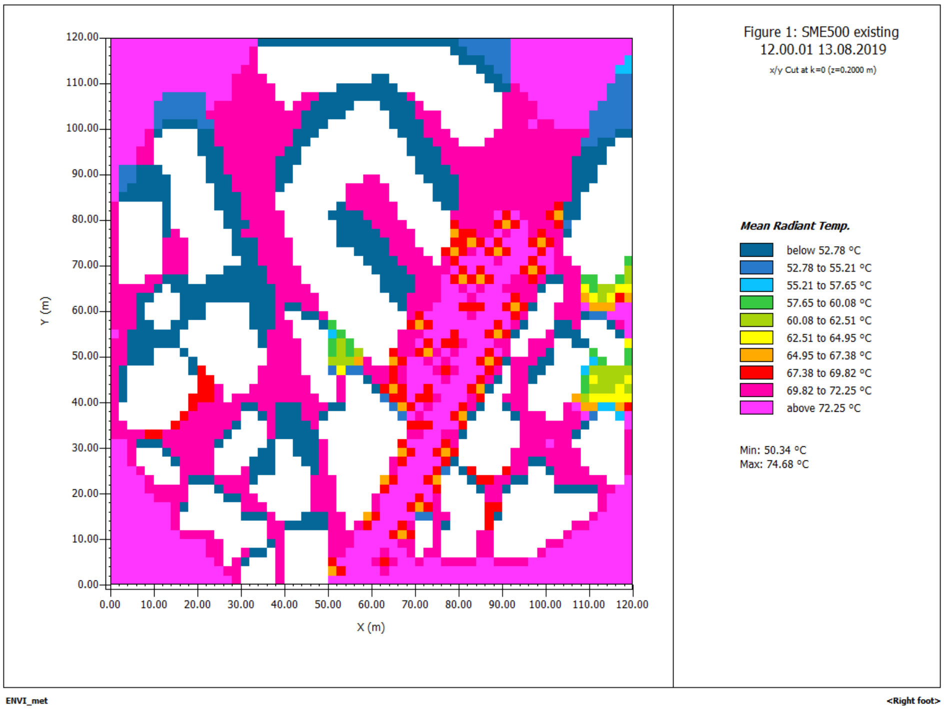


Figure 50.SM at 12:00 p.m. on August 13th, 2019, the mean radiant temperature simulation

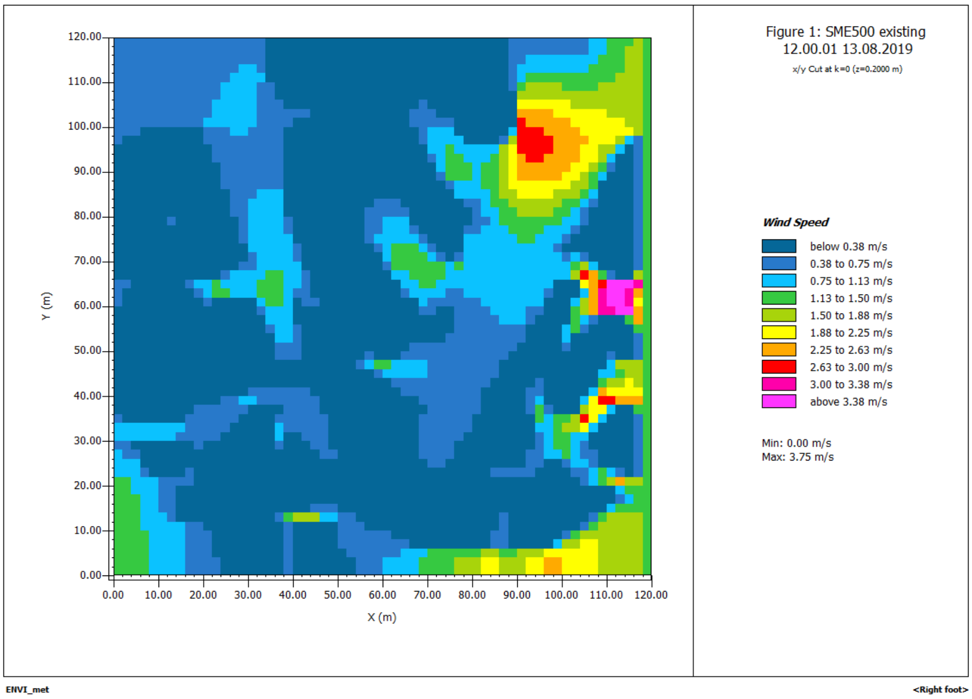


Figure 51. SM at 12:00 p.m. on August 13th, 2019, the wind speed simulation.

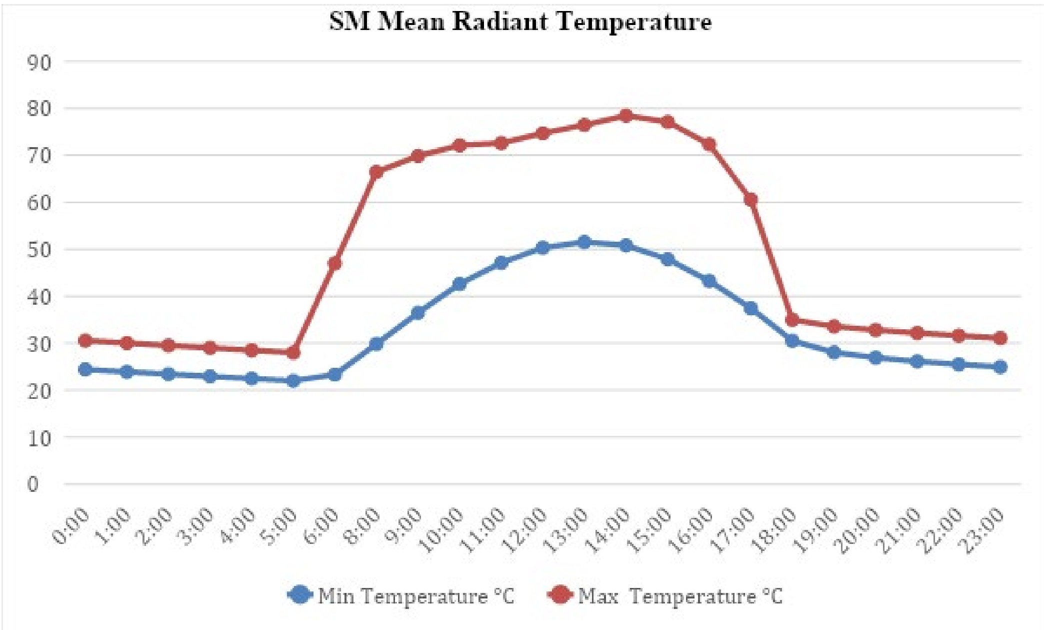


Figure 52.At 12:00 p.m. on August 13th, 2019, 24 hour graph of simulated lowest and highest mean radiant temperatures

Temperatures fluctuate throughout the 120x120 m site area, according to the simulation results. Although the site is mostly made up of buildings, the presence of paving materials has had an impact on the temperature distribution across the zone. It can be seen from the findings that air temperature (AT) values are lower in regions with natural soil and foliage, and higher in areas with grey concrete pavement, black asphalt roads, and no flora (see figure 45 simulated AT at 12:00). The figures extracted from Leonardo indicate that when there are no shadows available, temperatures rise, and when there are shadows available, temperatures tend to fall.

The analyzed results in 12:00 show a very noticebale effect of usage of asphalt as surface materials for roads as asphalt increase the air temperature much more than the other surface materials present in the site. High temperature values are also noticed in the areas of concrete pavement,but slightly lower than in areas covered with asphalt. (See *APPENDIX B* for 24 hour air temperature illustrations). ***Figure 53*** shows the 24 hour maximum and minimum values of air temperature at SM site.

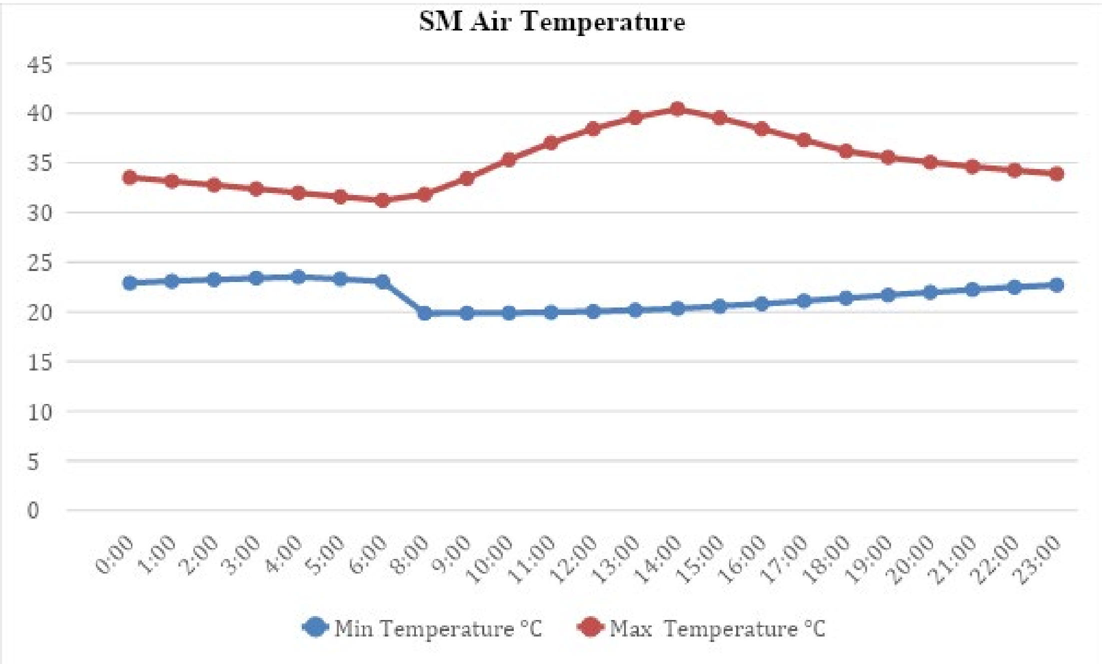


Figure 53.24 hour maximum and minimum values of air temperature at SM site

The temperature results do not only depend on the physical characteristics, they also occur due to its relation with the other climatic parameters. From the meteorological analysis due to weather station a noticeable relationship between temperature and humidity was observed. The analysis extracted from simulations also show that relationship occurs in the same manner. The humidity values decrease as the temperature values increase (***Figure 54***) (Refer to *APPENDIX C* for 24 hour simulation graphics of relative humidity values.) The simulation results illustrate that the presence of vegetation increases humidity values and decreases the temperature values and that results in making the environment thermally appropriate for inhabitants.

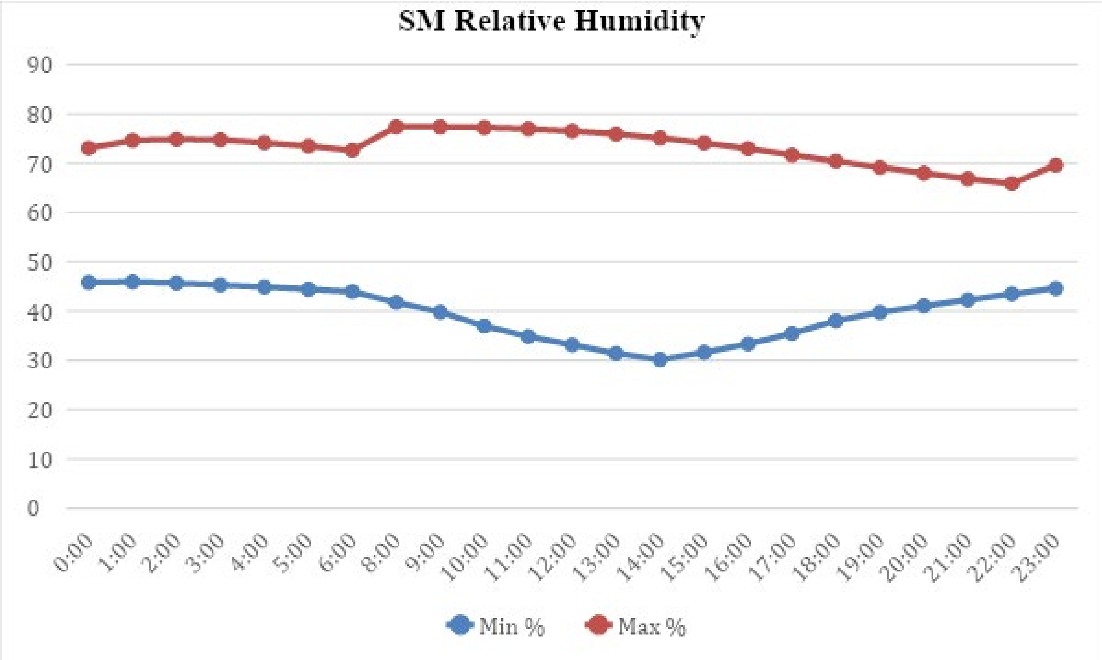


Figure 54.SM Relative Humidity 24 hour simulation at 12:00,August 13th 2019

The strong association between MRT values and direct shortwave radiation is found while examining the MRT values. The MRT surface temperatures are quite high, hitting 74.68 °C at 12:00 p.m. and continuing to rise throughout the day (see *APPENDIX A* for hourly graphs of MRT at Scenario 1,SM)

CHAPTER 7

OPTIMIZATION

7.1 Optimization Scenarios

As the research demonstrates, several techniques are used to reduce the UHI phenomenon. The Servete Maci school in Tirana was chosen to test and assess their effect on site temperatures in order to examine their effects in the actual surrounding environment of school buildings. According to the review literature, simulation scenario requirements are based on physical and thermal properties:

- Buildings Density and Typology
- Paving surface materials
- Vegetation Presence

This study suggests several optimization options. Each scenario is updated in the modeling application (Spaces) and simulated using ENVI-met with the same input parameters as the present scenario to ensure accurate portrayal of findings. The findings are evaluated using the Leonardo4.4.4 software. Among the mitigating techniques examined are modifications in surface materials as well as changes in the amount and kind of vegetation. The following characteristics have changed: 1.Paving, and 2. Vegetation. Among average values, certain regions because the schoolyard and paving beneath tree shade had been decided on to research the adjustments in air temperatures and imply radiant temperatures.

7.2 Optimization – Street Vegetation

To successfully reduce urban microclimates, optimization scenarios based on plant kinds are examined. According to the literature, four scenarios are offered for greenery properties (***Table 11***) :

1. Scenario 1 - Lower plant usage (Grass 25 cm)

2. Scenario 2 – Use of Medium Tree (*Albizia Julibrissin*) with a height of 12m and a crown width of 9m

3. Scenario 3 – Use of Medium Tree (*Albizia Julibrissin*) with a height of 12m and a crown width of 11m.

4. Scenario 4 – Use of High Tree (*Fagus Sylvatica*) with a height of 20m and a crown width of 13m.

Table 11.Proposed Greenery on Simulated Vegetation Scenarios

Name	***Image***	***Height (M)***	***Canopy (M)***
Eremochloa Ophiuroides		0.25	-
Albizia Julibrissin		12	9
Albizia Julibrissin		12	11
Fagus Sylvatica		20	13

7.2.1 Street Vegetation

Scenario 2 is illustrated in ***Figure 55***. Figure 56 illustrates the simulated average air temperatures for scenario 2 at 12:00 August 13,2019. From the ***Figure 55*** it is noticeable that the air temperatures have slightly increased (See *APPENDIX D* for hourly AT simulations). As air temperature increases, the relative humidity values decrease (see *APPENDIX E* for RH hourly simulation). Implementation of grass has resulted to slight changes in the UHI phenomenon. The UHI improvements can be slightly denoted in ***Figure 56***, ***Figure 57*** and ***Figure 58*** where the simulated MRT graphs show the differences compared to the existing conditions (see *APPENDIX F* for MRT hourly simulations). In ***Figure 59*** are shown the selected areas from Leonardo4 for comparison, respectively the grid 30,39 (the schoolyard) and 36,24 (paving under the tree shade) for 24 hours simulation. Figure 60 depicts the air temperatures compared in the schoolyard (30,39 grid) for SC1 and SC2 . As shown in the ***Figure 61*** and ***Figure 62*** AT has slightly decreased and MRT (***Figure 63** and* ***Figure 64***) has increased compared to the SC1 and the standard temperatures of ITC .

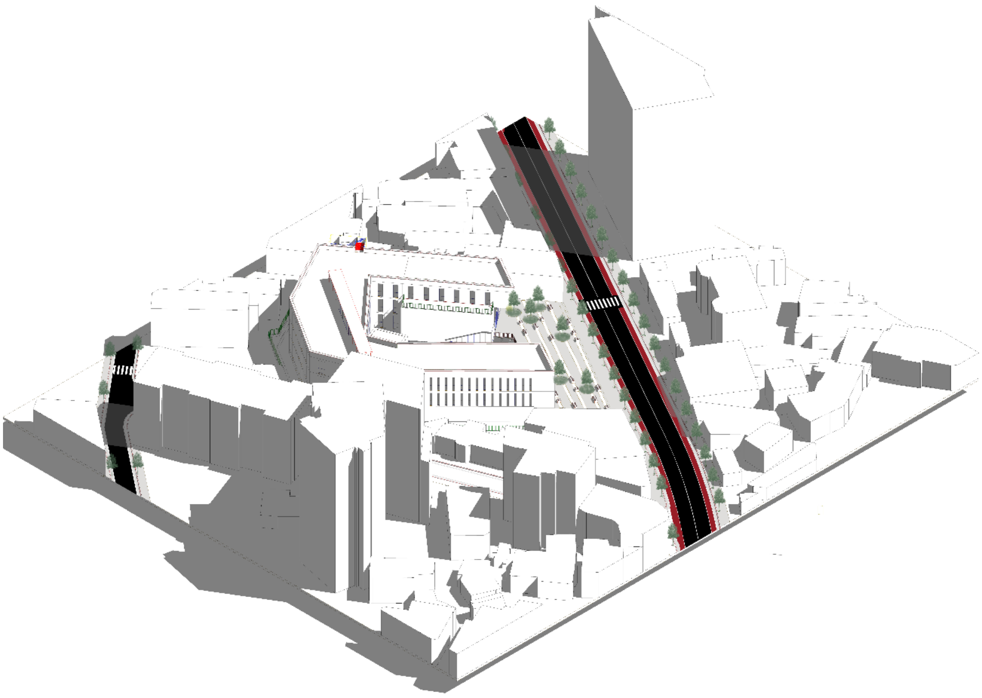


Figure 55.Schematic Illustration of Scenario 2

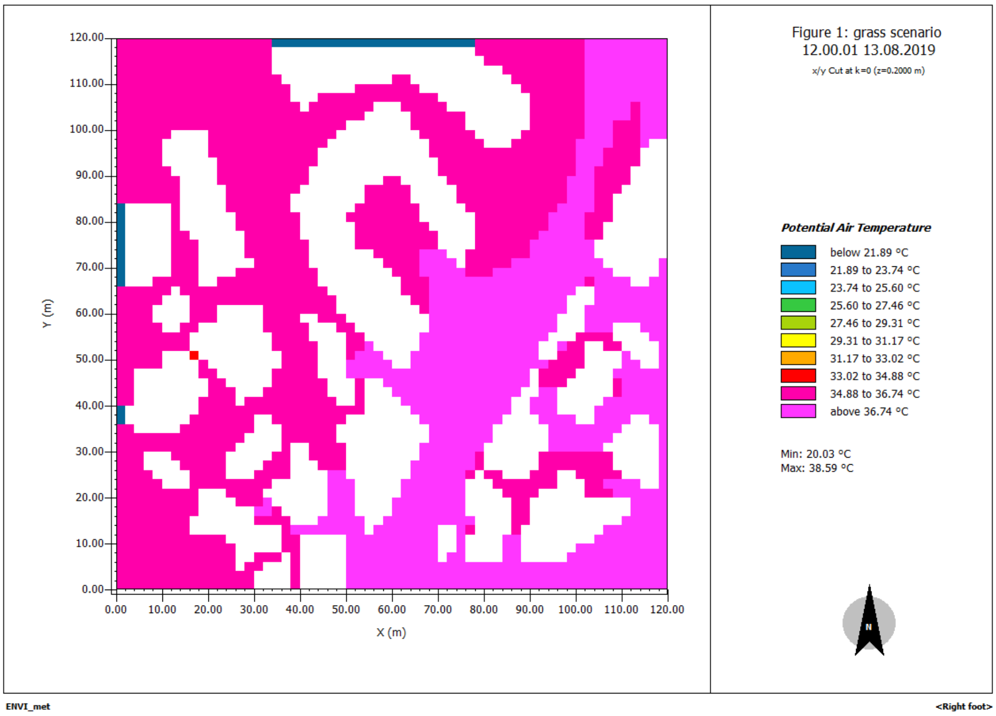


Figure 56.Simulated air temperatures for scenario 2 at 12:00 August 13,2019

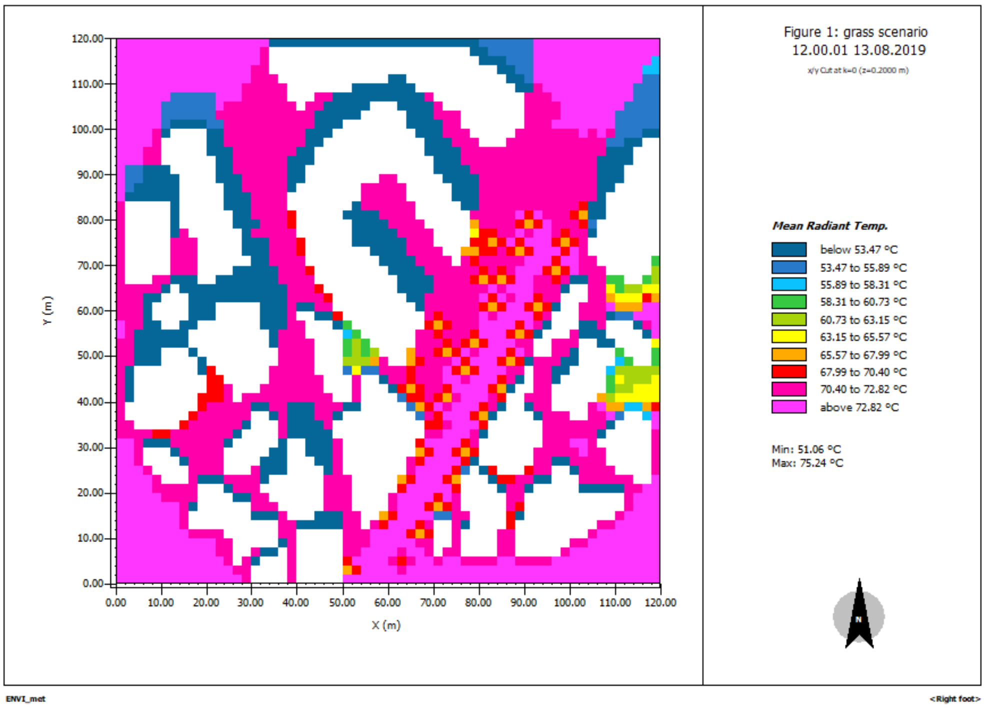


Figure 57.Simulated mean radiant temperature for scenario 2 at 12:00 August 13,2019

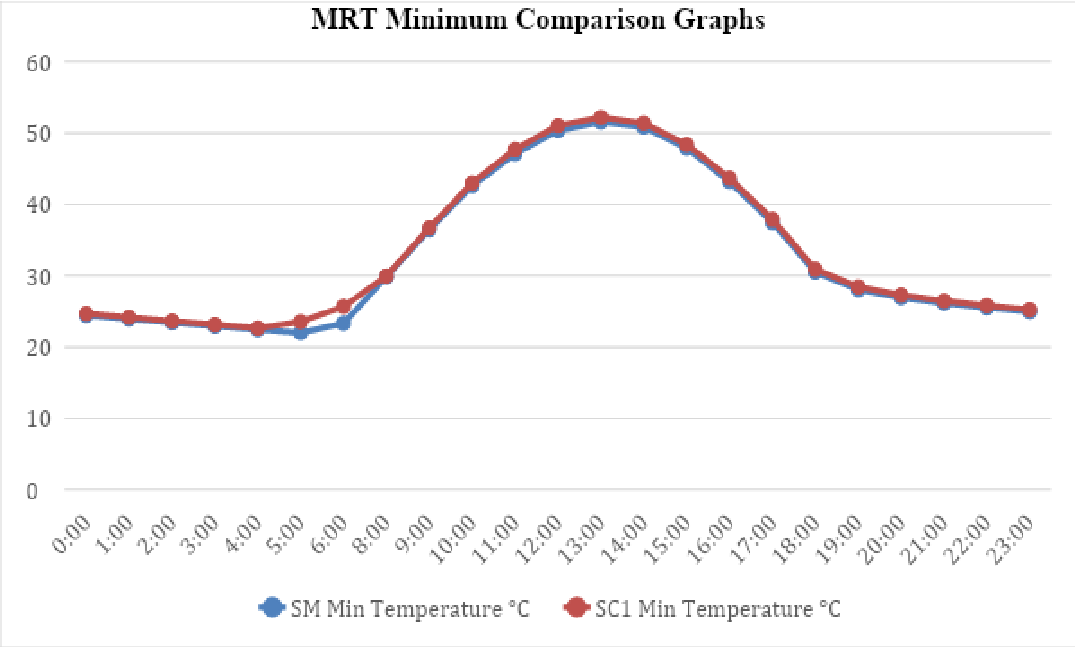


Figure 58.24 hour Comparison simulated graph of minimum MRT values between SM and SC2 August 13,2019

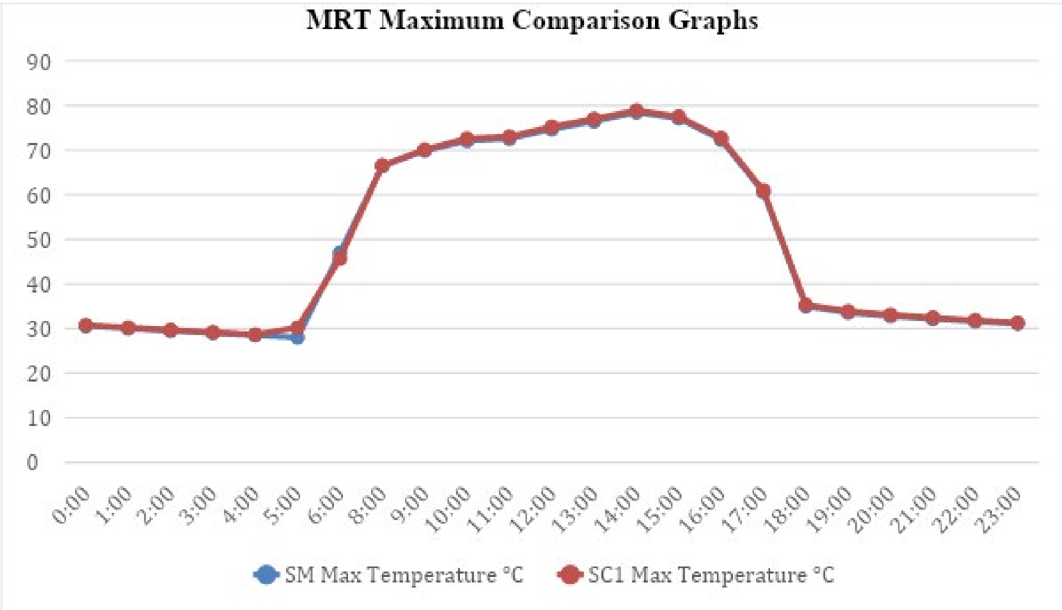


Figure 59.24 hour simulated comparison graph of maximum mean radiant temperature values for existing conditions and scenario 2 August 13,2019

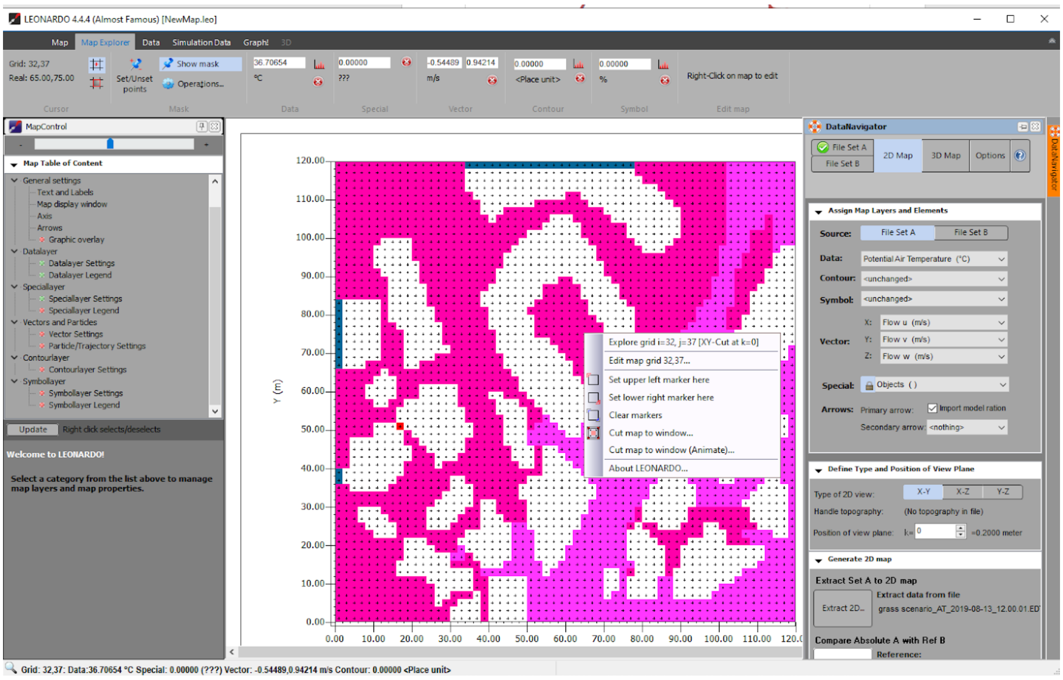


*Figure 60.*Leonardo Selected Grid 30,39

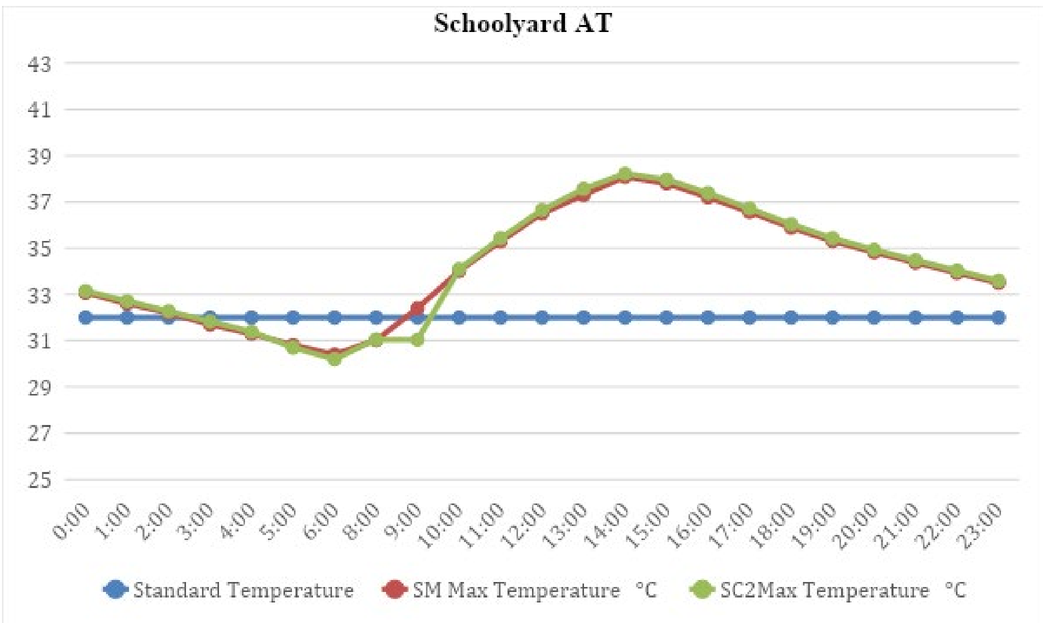


*Figure 61.*Air Temperature Comparison Graphs at 30,39 Grid between Scenario 1 and 2 in August 13,2019

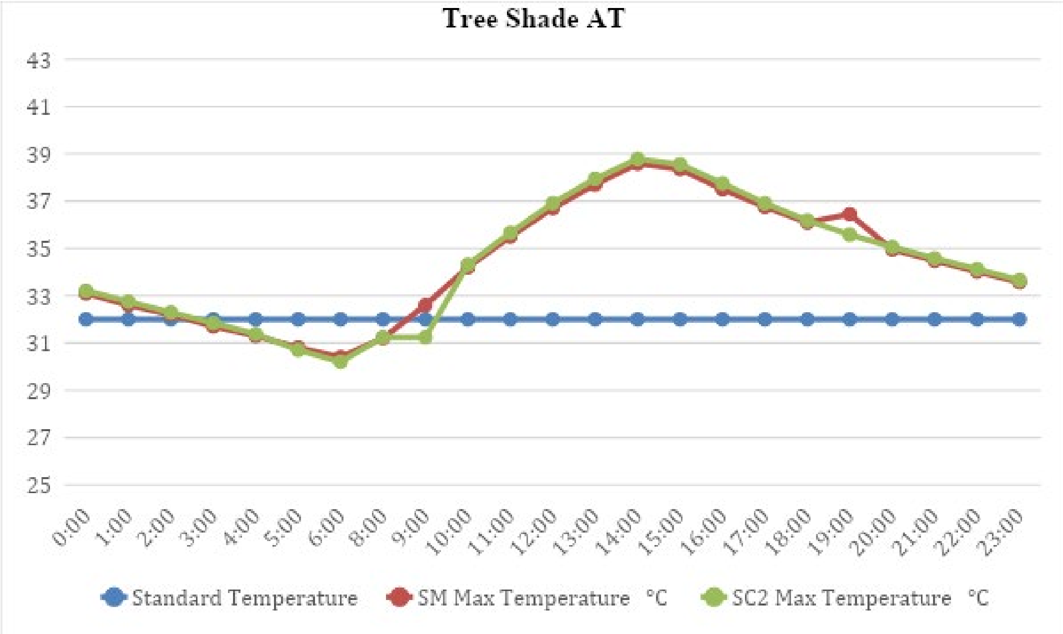


Figure 62.Air Temperature Comparison Graphs at 36,24 Grid between Scenario 1 and 2 in August 13,2019

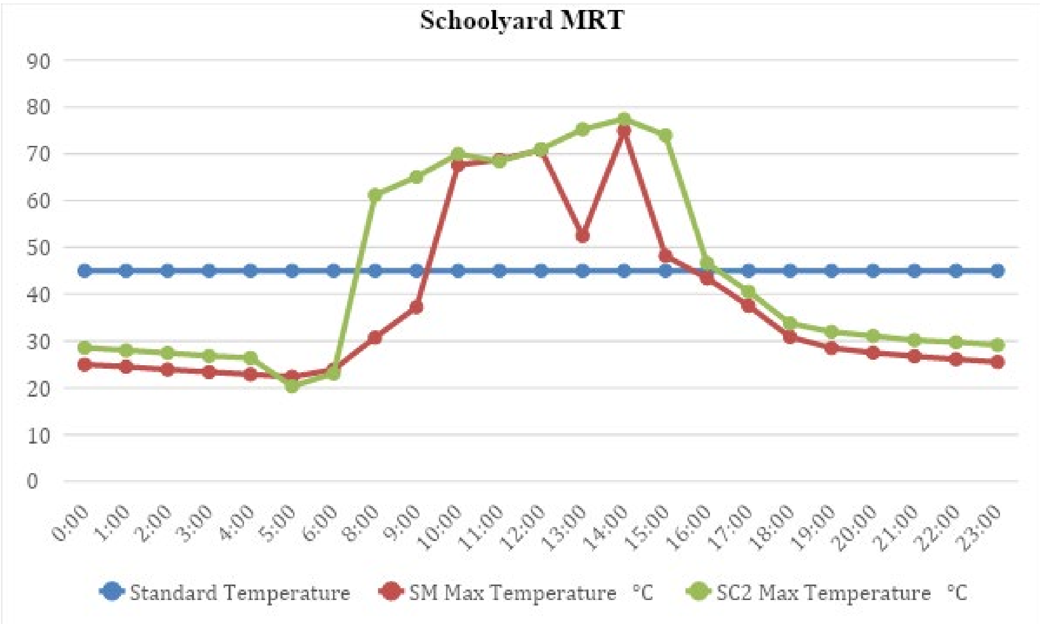


Figure 63. Mean Radiant Temperature Comparison Graphs at 30,39 Grid between Scenario 1 and 2 in August 13,2019

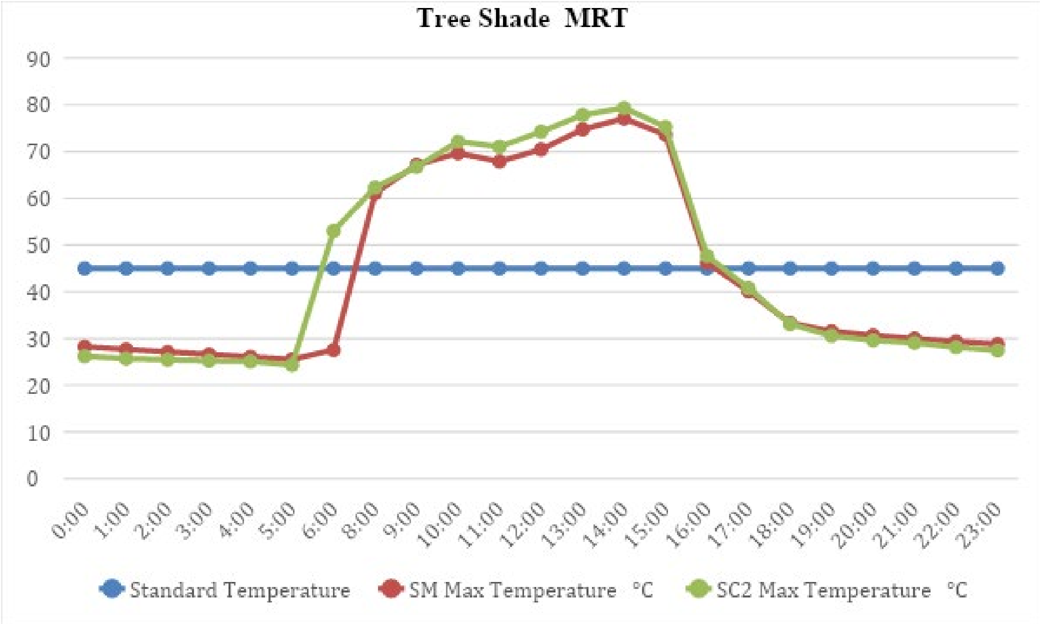


Figure 64.Mean Radiant Temperature Comparison Graphs at 36,24 Grid between Scenario 1 and 2 in August 13,2019

7.2.2 Scenario 3 – Medium Tree (12m Height, 9m Crown Width)

The simulated air temperatures for SC3 *(*see ***Figure 65*** are depicted in Figure 66. The graph depicts the notable variations in air temperature from 38.42°C to 37.81 °C. ***Figure 66*** depicted the 1.14 °C temperature changes in MRT at 12:00 , between SC3 and the present circumstances MRT values. (Refer to *APPENDIX G* and *APPENDIX H* and *APPENDIX I* for hourly simulation of AT, MRT and RH of SC3) In ***Figure 67***,***Figure 68, Figure 69*** and ***Figure 70*** are respectively shown the simulation values of relative humidity, direct sw radiation, wind speed and wind direction. It is noticed that wind direction and wind speed have an impact on temperature distribution of the site. Measurements of AT in the schoolyard (30,39) and paving under tree shade (36,24) result in +1.79°C lower temperatures in the grid 36,24 at 12:00 AM shown in ***Figure 70*** and ***Figure 71*** As a result, SC2 allows the ITC to be outdoors till 10:00 AM to continue their day-to-day activities. In ***Figure 72*** and ***Figure 73*** noticeable changes have been illustrated in MRT. In 36,34 grid the MRT have resulted in temperature changes up to 20°C at 12:00 AM in shaded areas (Figure 74,Figure 75).

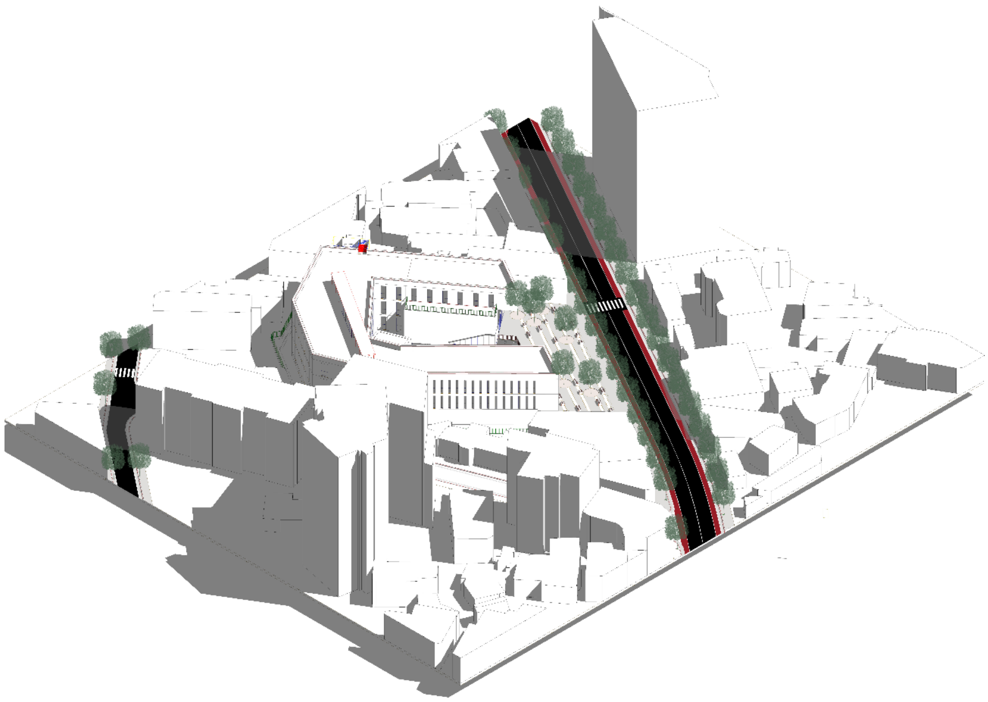


*Figure 65.*Scenario 3 Schematic Illustration

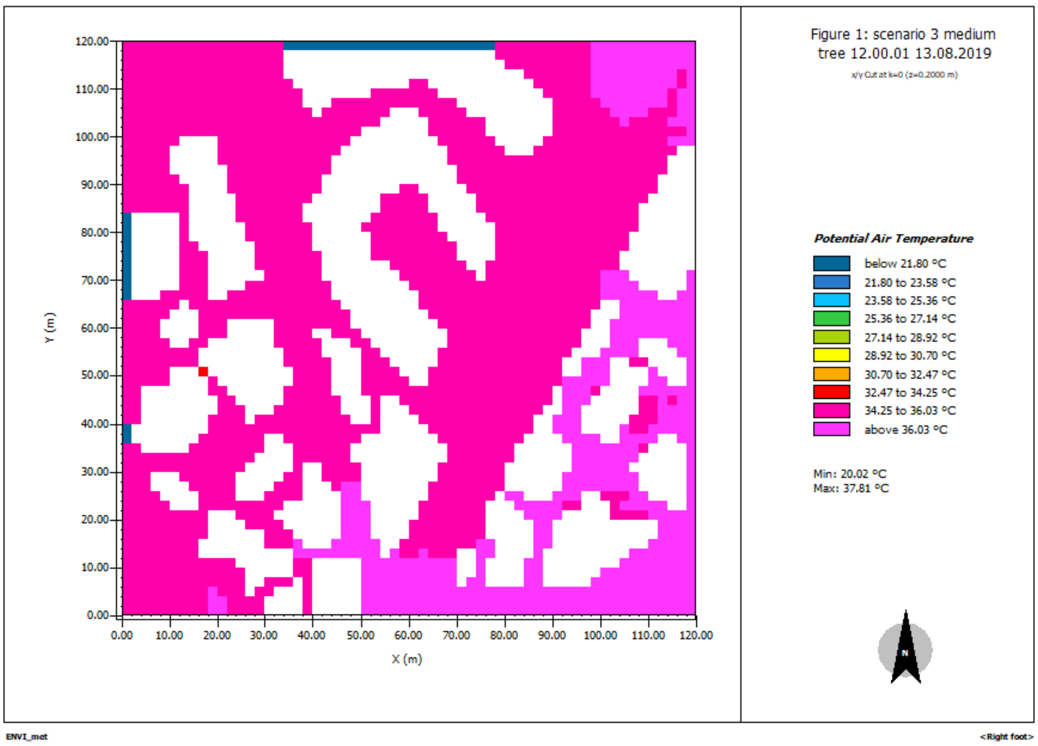


*Figure 66.*SC3 simulated air temperatures at 12:00 13 August 2019.

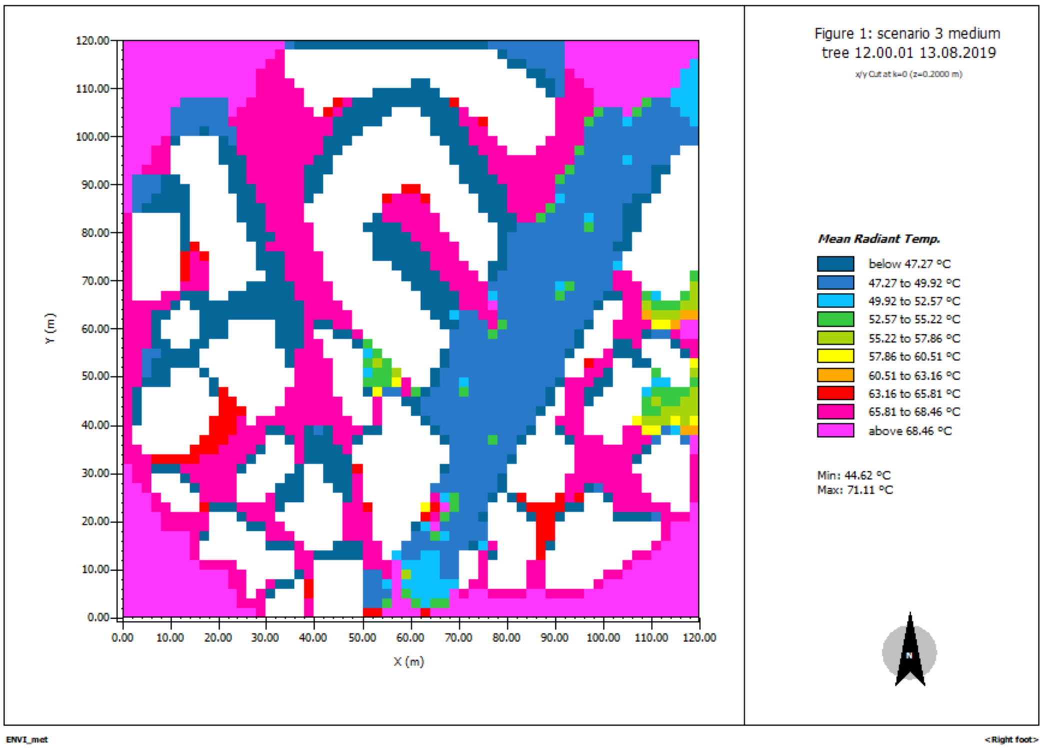


Figure 67.SC3 simulated mean radiant temperatures at 12:00 13 August 2019.

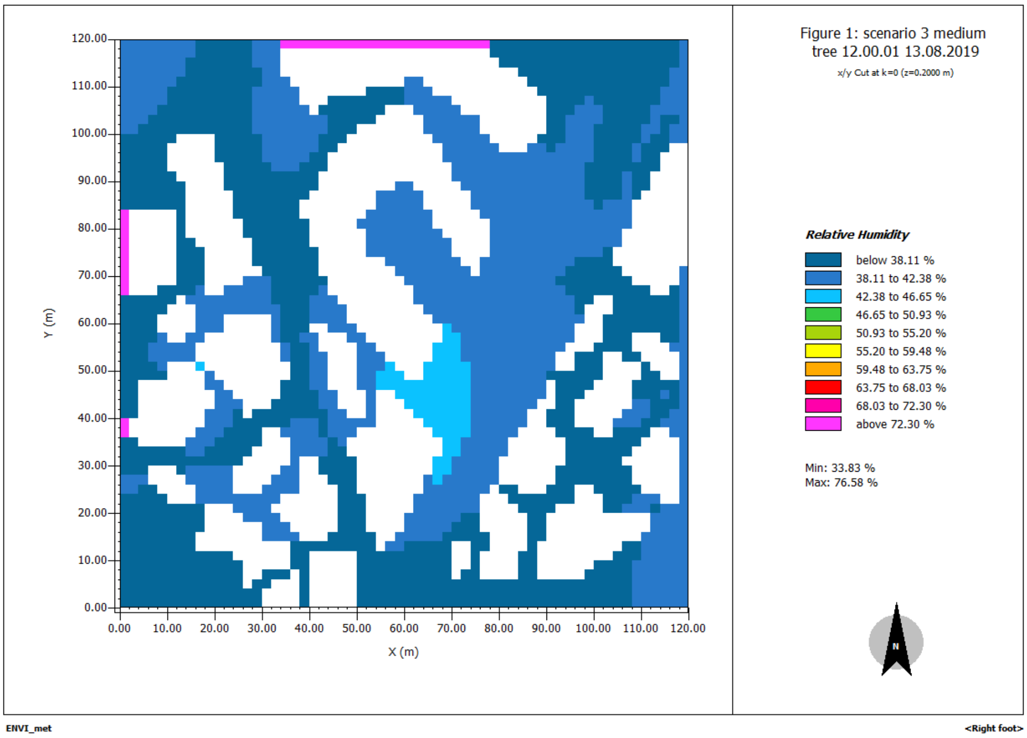


Figure 68.SC3 Simulated Relative Humidity at 12:00 13 August 2019.

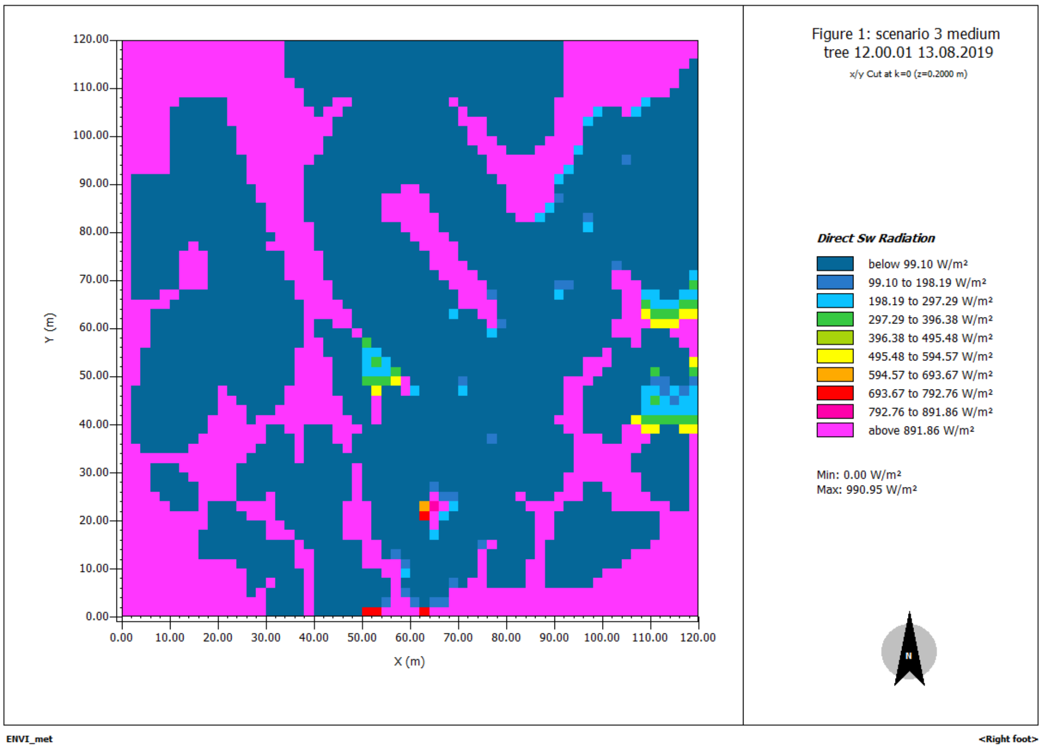


Figure 69.SC3 Simulated Direct Sw Radiation at 12:00 13 August 2019.

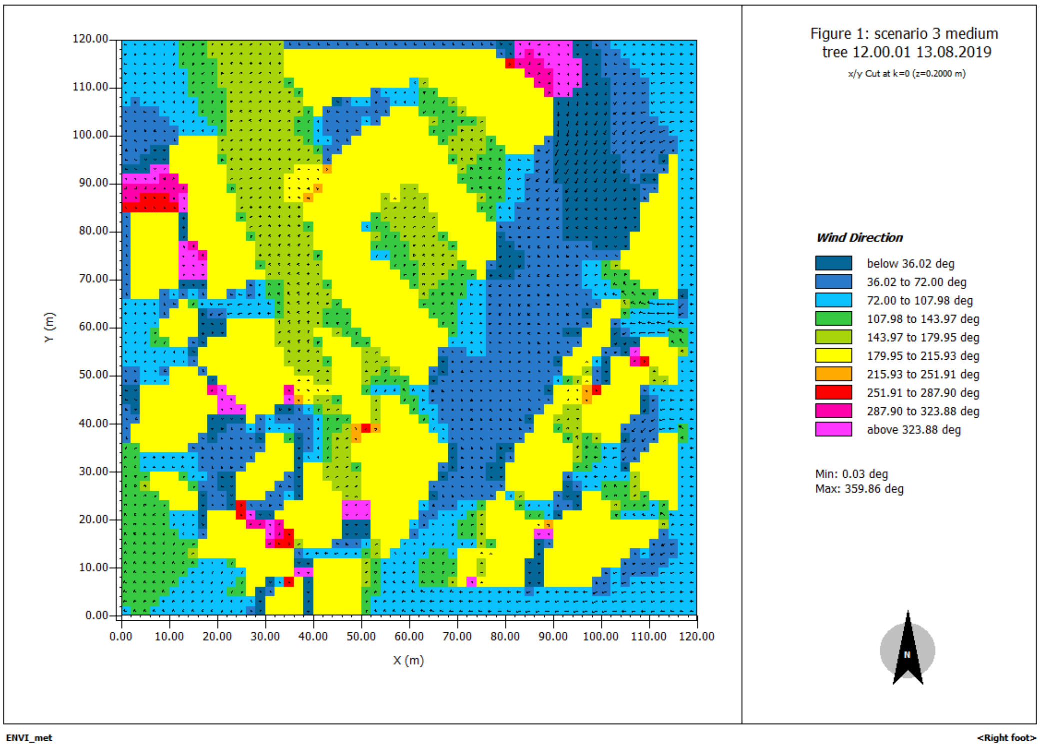


Figure 70.SC3 Simulated Wind Direction at 12:00 13 August 2019.

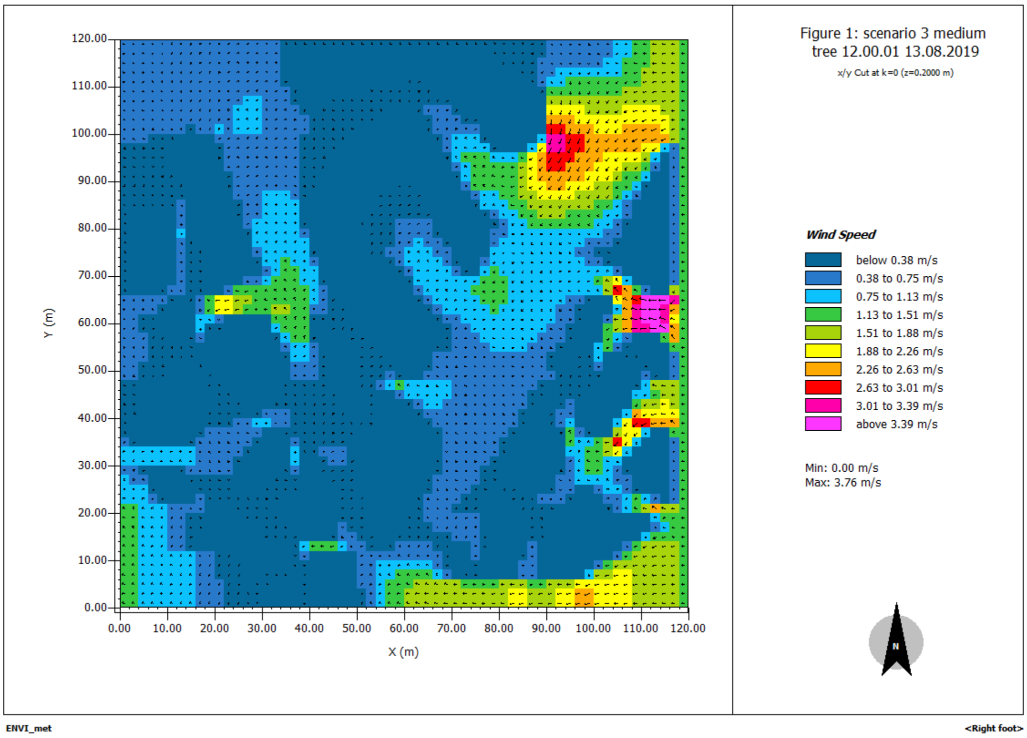


Figure 71.SC3 Simulated Wind Speed at 12:00 13 August 2019.

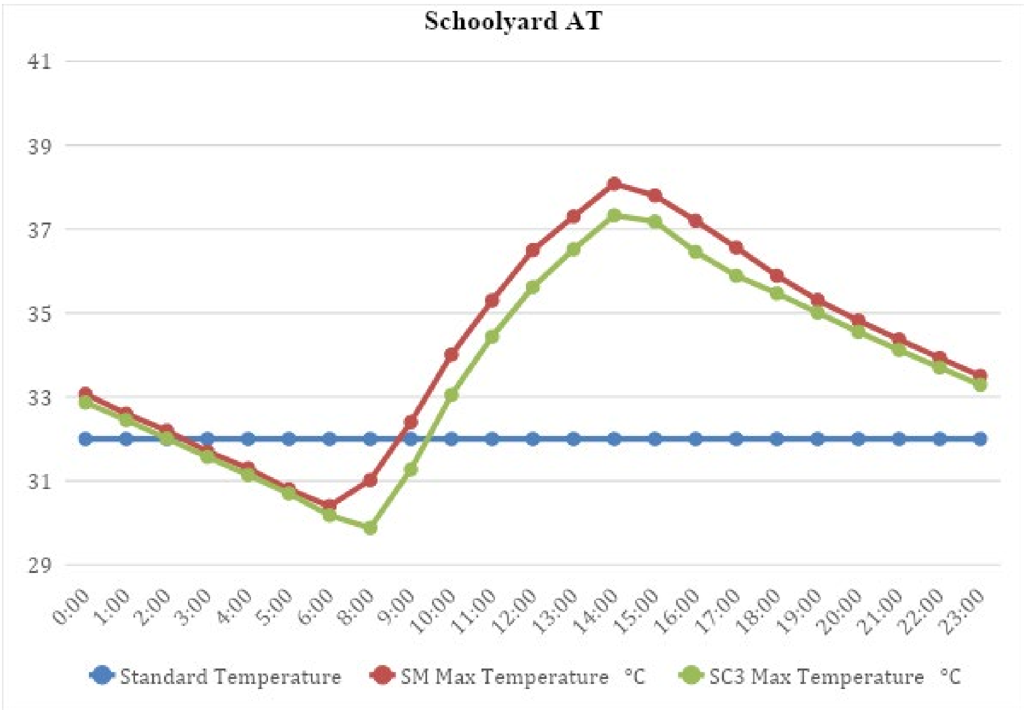


Figure 72.Air Temperature Comparison Graphs for SC3 at 30,39 Grid between Scenario 1 and 2 in August 13,2019

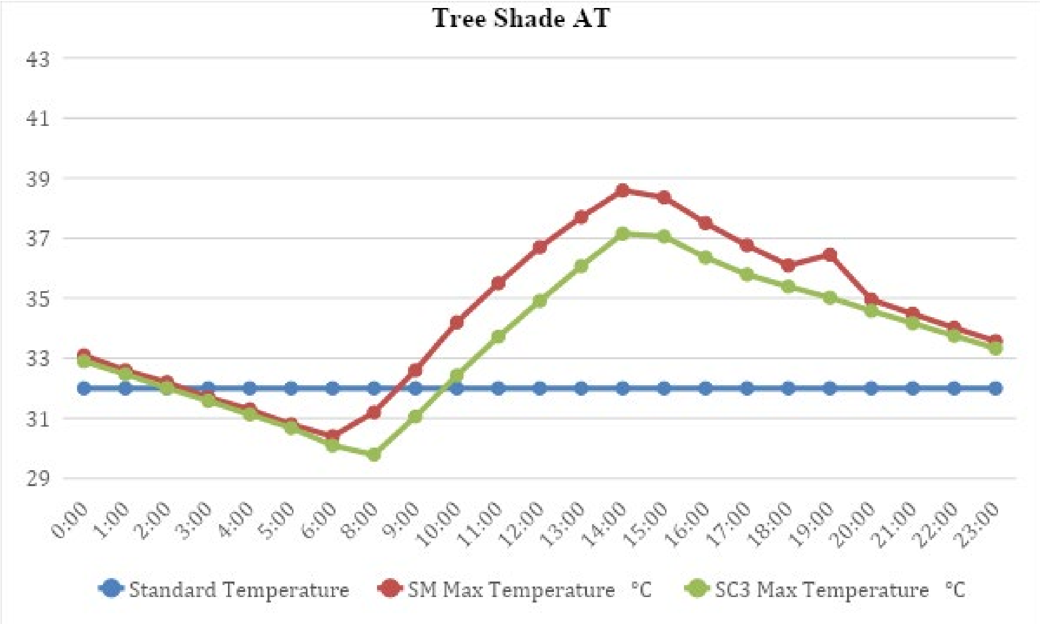


Figure 73.Air Temperature Comparison Graphs for SC3 at 36,24 Grid between Scenario 1 and 2 in August 13,2019

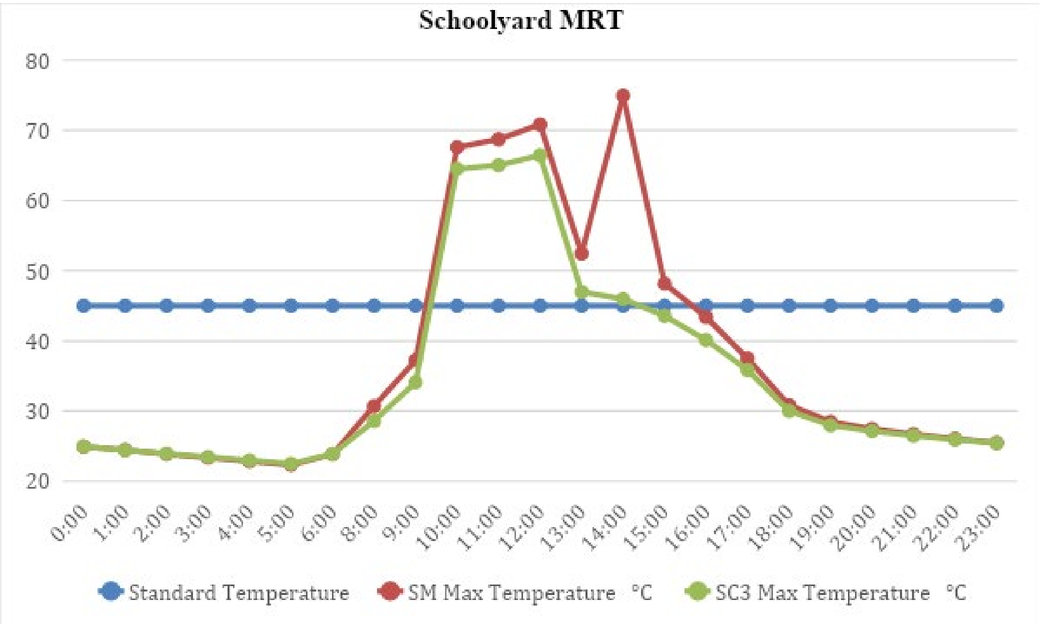


Figure 74.Mean Radiant Temperature Comparison Graphs for SC3 at 30,39 Grid between Scenario 1 and 2 in August 13,2019

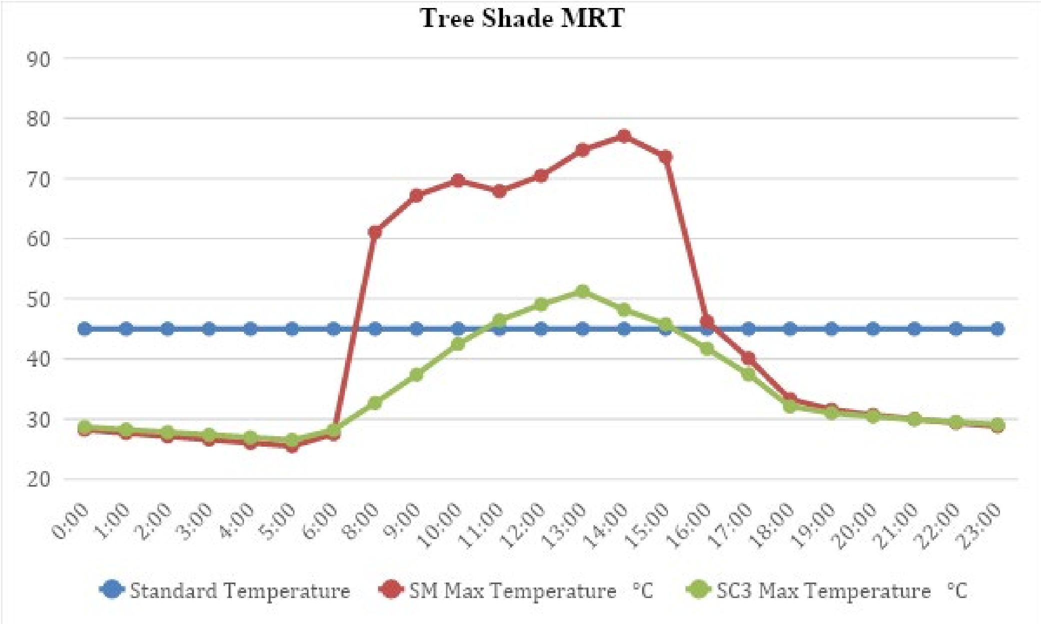


Figure 75.Mean Radiant Temperature Comparison Graphs for SC3 at 36,24 Grid between Scenario 1 and 2 in August 13,2019

7.2.3 Scenario 4 – Medium Tree (12m Height, 11m Crown Width)

Scenario 4 is shown in ***Figure 76***.In ***Figure 77*** is illustrated the simulated air temperatures for this scenario. The air temperatures have decreased from 38.42 °C to 38.24 °C. Meanwhile the mean radiant temperature has changed from 74.68 °C to 73.11 °C ***(Figure 78)***. As demonstrated from the results implementation of SC4 trees has resulted to highly noticeable improvements to the site. In ***Figure 79***, ***Figure 80***, ***Figure 81*** and ***Figure 82*** are respectively shown the simulation values of relative humidity, direct sw radiation, wind speed and wind direction. It is noticed that wind direction and wind speed have an impact on temperature distribution of the site. (Refer to *APPENDIX I, APPENDIX J* and *APPENDIX K* for hourly simulation of AT , MRT and RH of SC4). AT changes, illustrated in ***Figure 83*** and ***Figure 84*** have resulted in reduction of +2°C at 12:00 AM. MRT values are depicted in ***Figure 85*** and ***Figure 86***. As shown in ***Figure 85*** the MRT values have highly decreased compared to the unshaded schoolyard area from 8:00 AM to 15:00 PM.

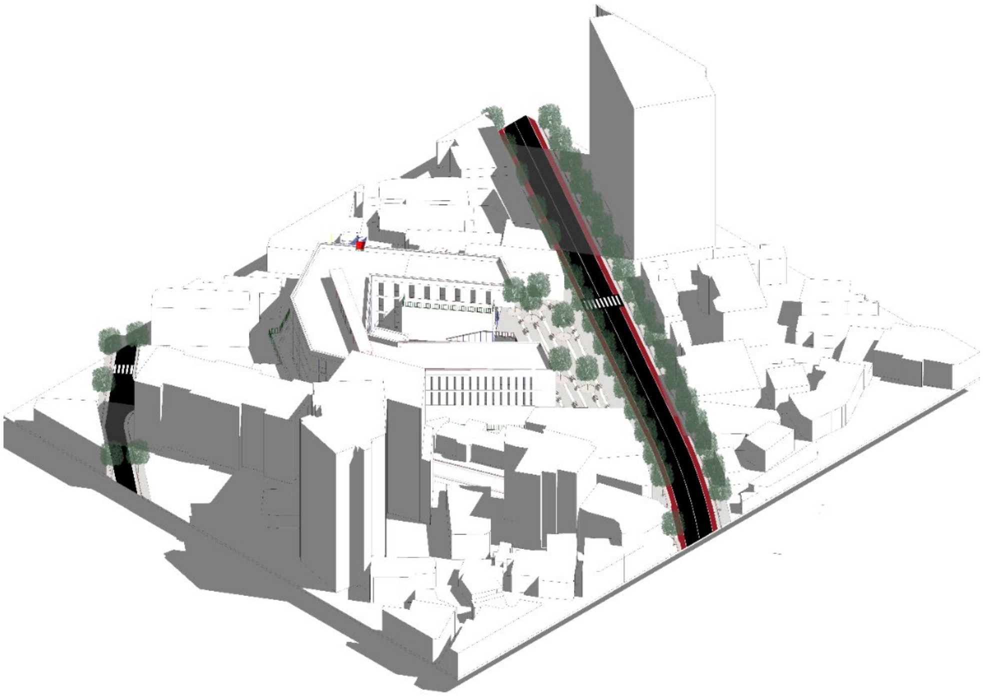


Figure 76.Scenario 4 Illustration

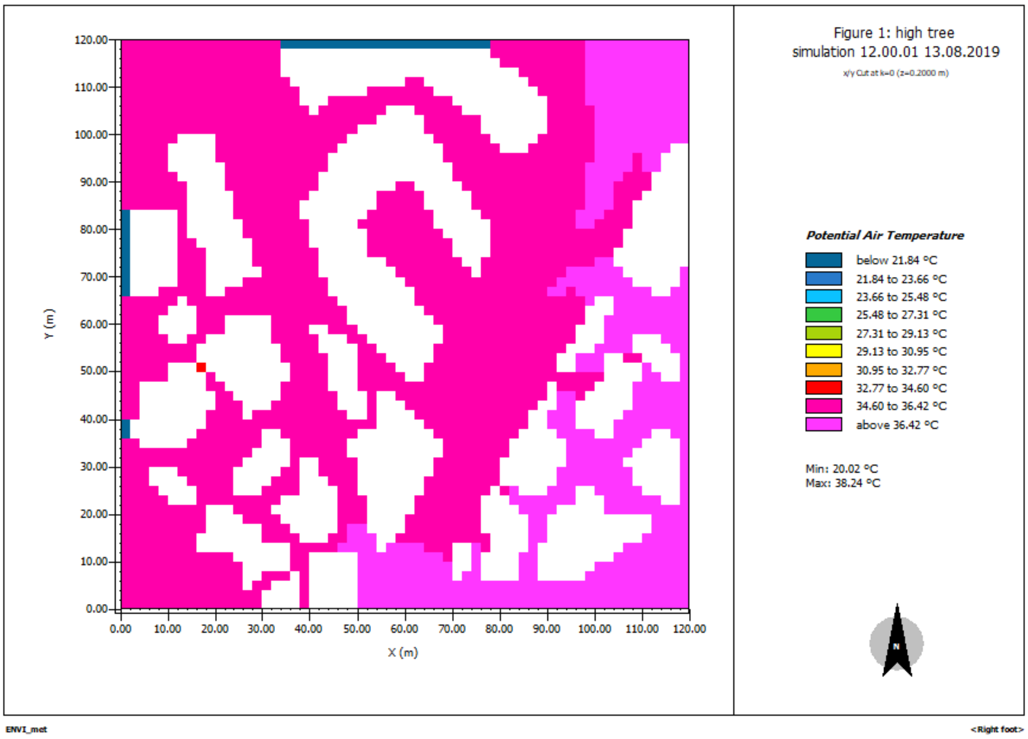


Figure 77.SC4 simulated air temperatures at 12:00 13 August 2019.

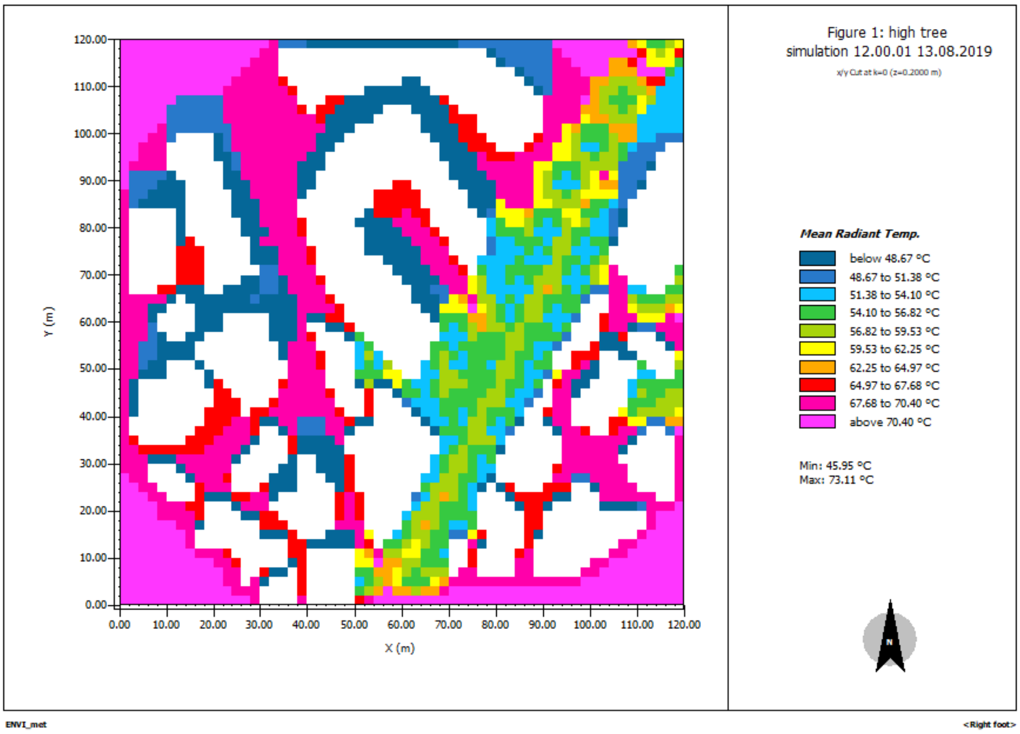


*Figure 78.*SC4 simulated mean radiant temperatures at 12:00 13 August 2019.

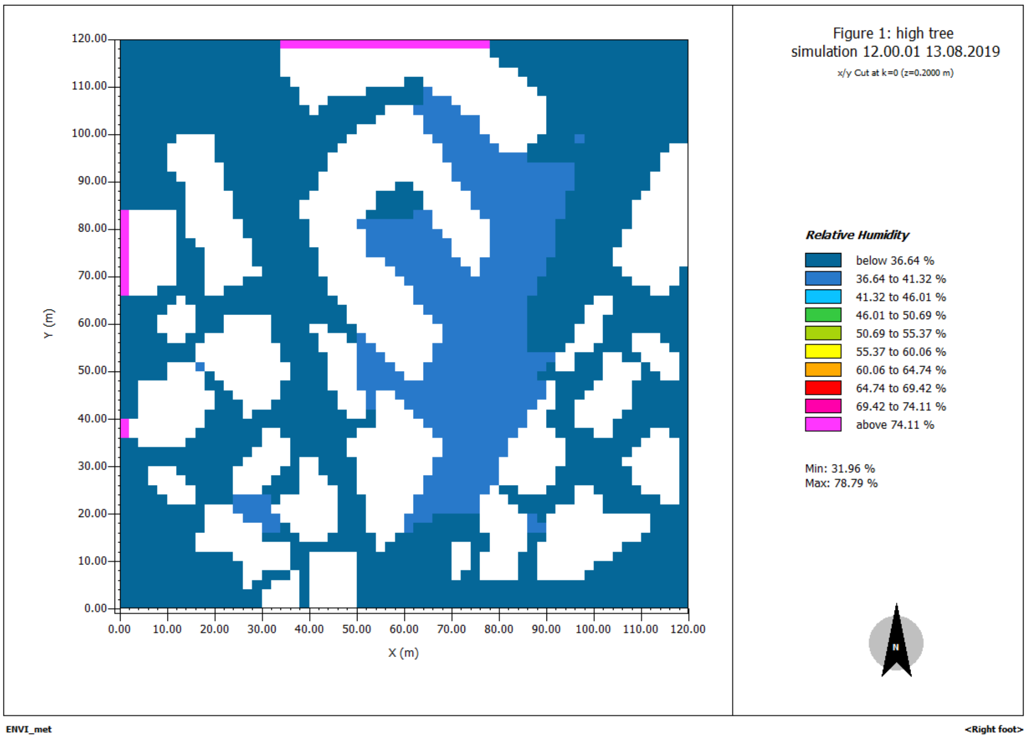


*Figure 79.*SC4 simulated relative humidity at 12:00 13 August 2019.

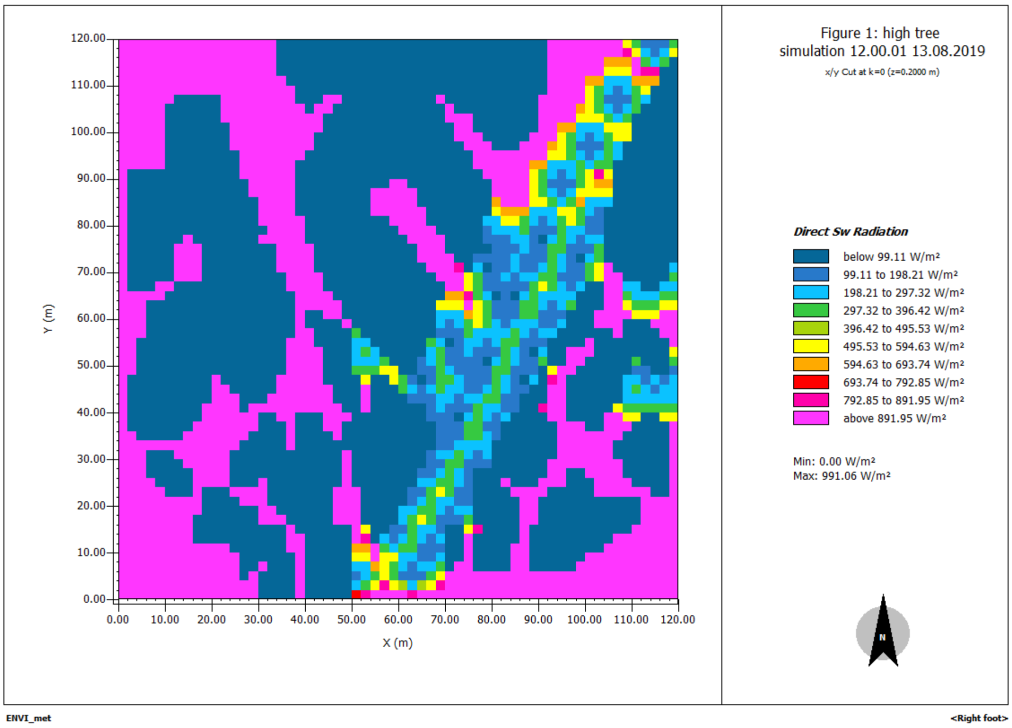


Figure 80. SC4 simulated Direct Shortwave Radiation at 12:00 13 August 2019.

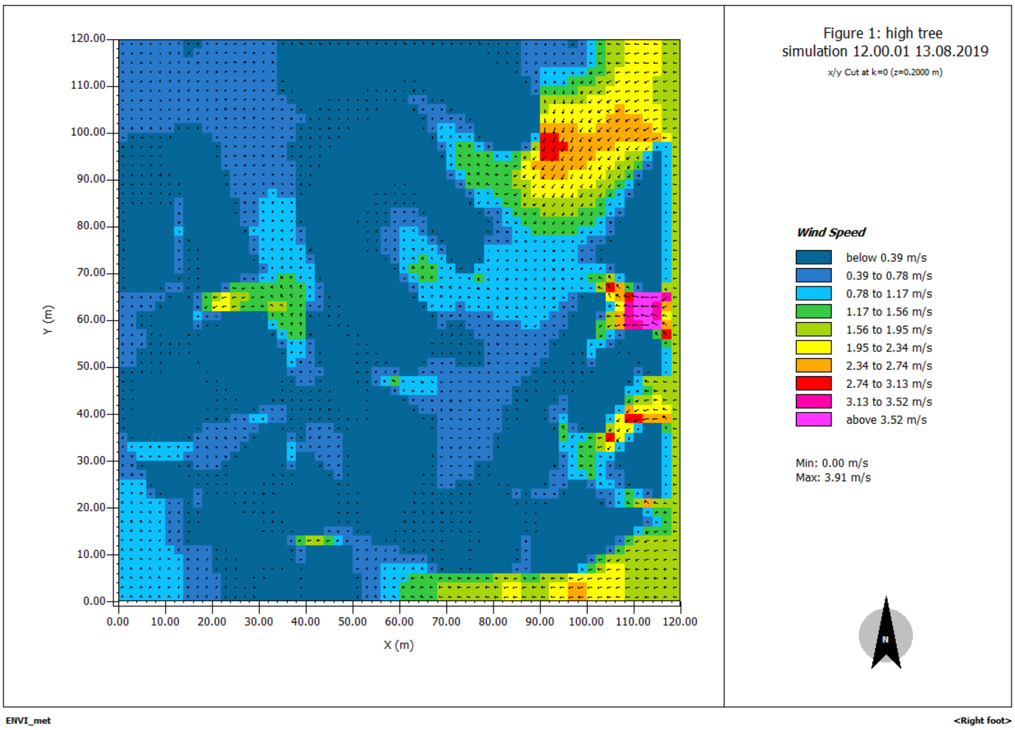


Figure 81.SC4 simulated wind speed at 12:00 13 August 2019.

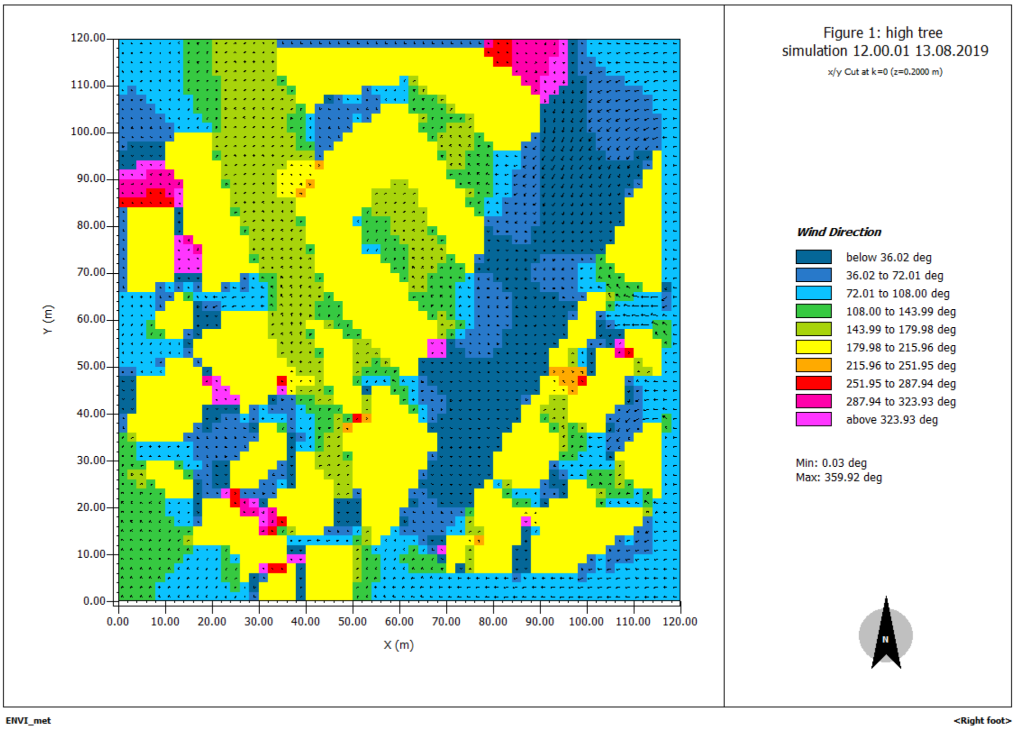


Figure 82.SC4 simulated wind direction at 12:00 13 August 2019**.**

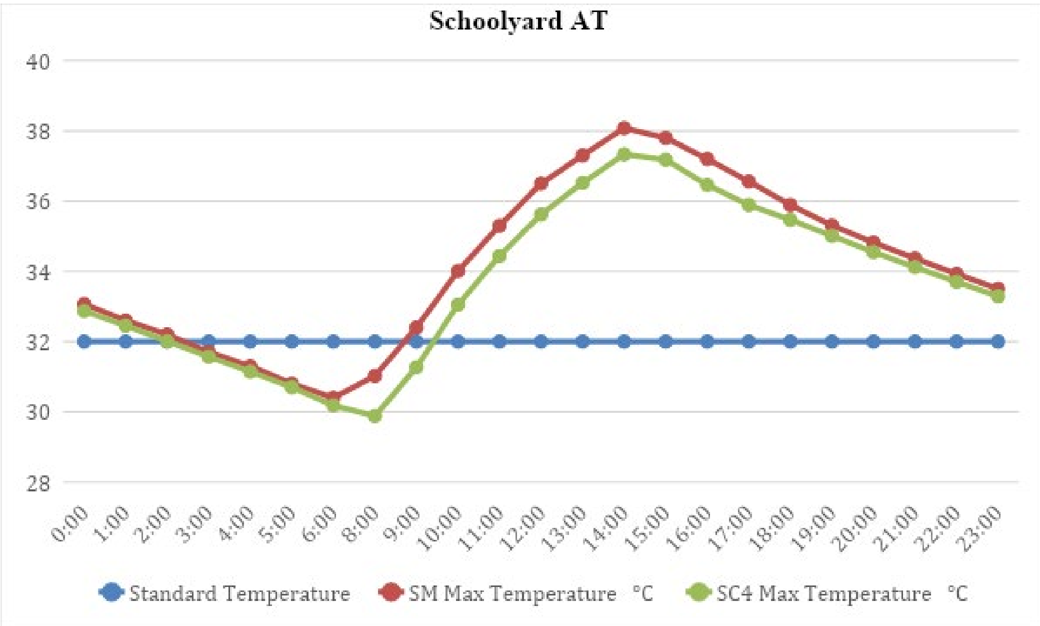


Figure 83.Air Temperature Comparison Graphs at 30,39 Grid between Scenario 1 and 2 in August 13,2019

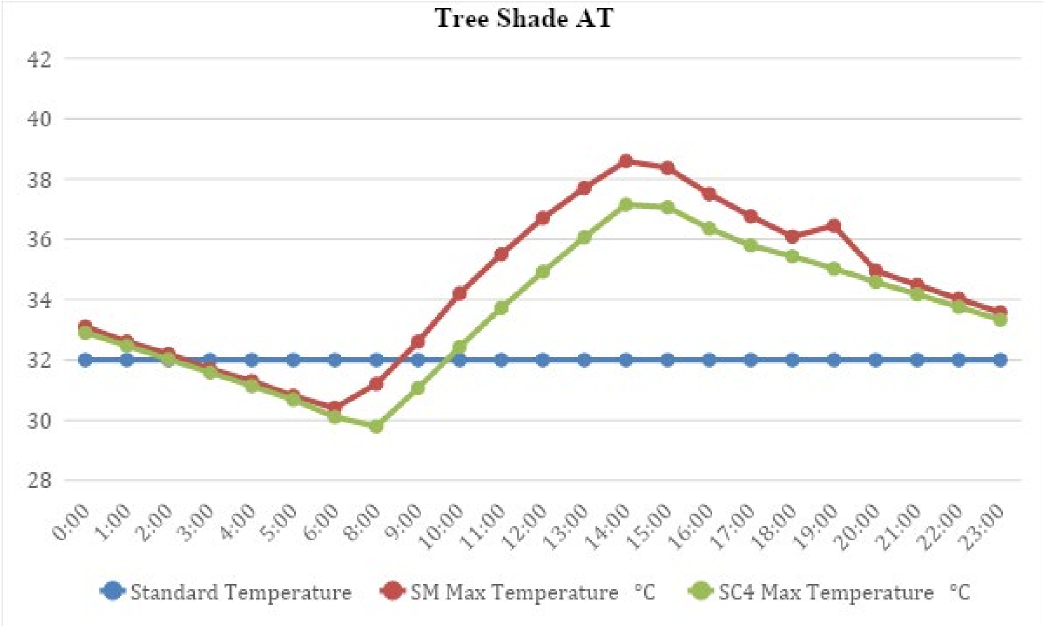


Figure 84.Air Temperature Comparison Graphs at 36,24 Grid between Scenario 1 and 2 in August 13,2019

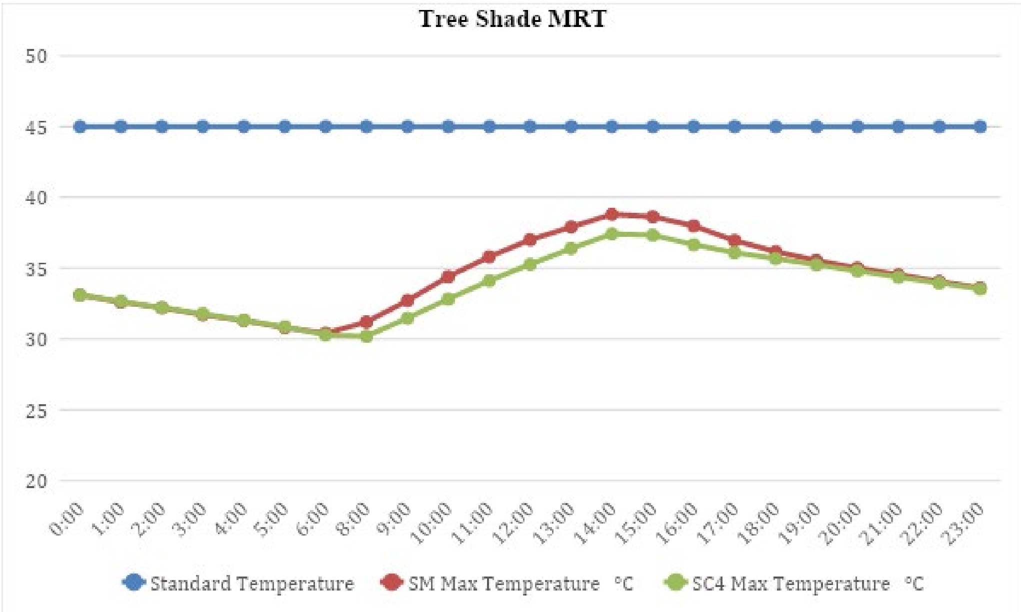


Figure 85.Mean Radiant Temperature Comparison Graphs at 36,24 Grid between Scenario 1 and 2 in August 13,2019

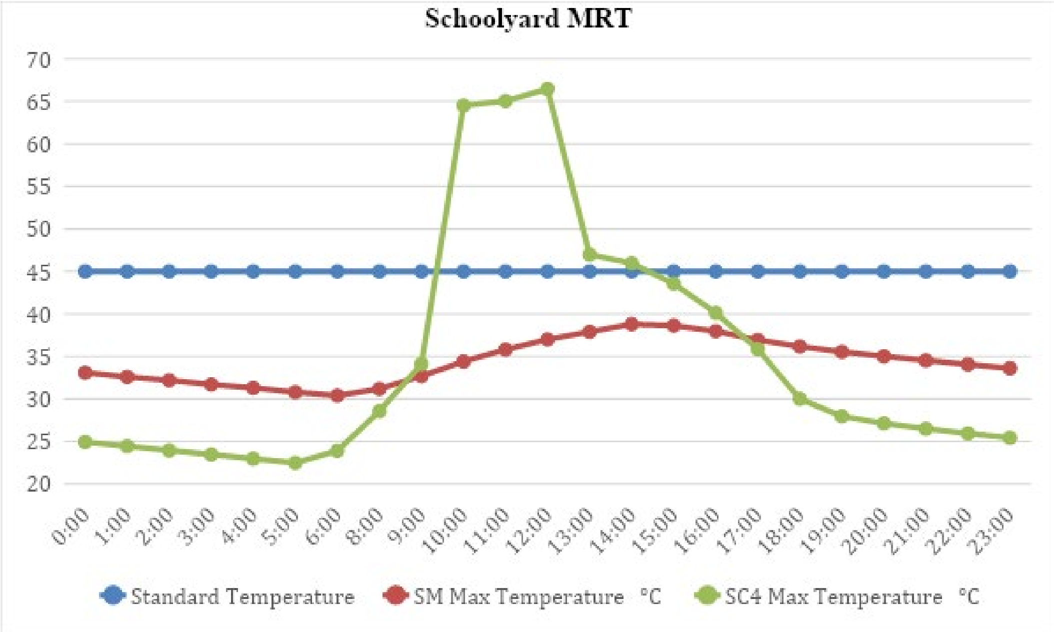


Figure 86.Mean Radiant Temperature Comparison Graphs at 30,39 Grid between Scenario 1 and 2 in August 13,2019

7.2.4 Scenario 5 – High Tree (20m Height, 13m Crown Width)

Scenario 5 is shown in **Figure 87**. In ***Figure 88*** illustrated the simulated average air temperatures for this scenario. The air temperatures have decreased from 38.42 °C to 38.07 °C. *(***Figure 89***)*. Meanwhile the average mean radiant temperature has changed from 74.68 °C to 71.08 °C ***(Figure 90)***. As demonstrated from the results the 13m tree canopy has resulted to highly noticeable improvements to the site. It is important to mention that RH has reduced from 76.54% of the existing conditions to 72.57% (***Figure 91****)*. As well as direct shortwave radiation has highly reduced from 891.31 W/m^2 to 99.28 W/ m^2 . Changes have also been noticed in wind speed and wind direction as shown in ***Figure 92*** and ***Figure 93***. (Refer to *APPENDIX M, APPENDIX N*, and *APPENDIX O* for hourly simulation of AT, MRT and RH of SC5). ***Figure 94*** and ***Figure 95*** show the minimum and maximum simulated air temperatures and mean radiant temperature values on 13th August 2019. Illustration graphs in ***Figure 96*** and ***Figure 97*** show the air temperatures changes In the schoolyard and under tree shade. The simulated results show that the air temperatures are lower under tree shade but continue to be high after 10:00 AM. Meanwhile ***Figure 98*** comparison graph shows that the simulated MRT values for 24 hour under tree shade areas are highly acceptable for ITCs throughout the whole day compared to the schoolyard (***Figure 99***).

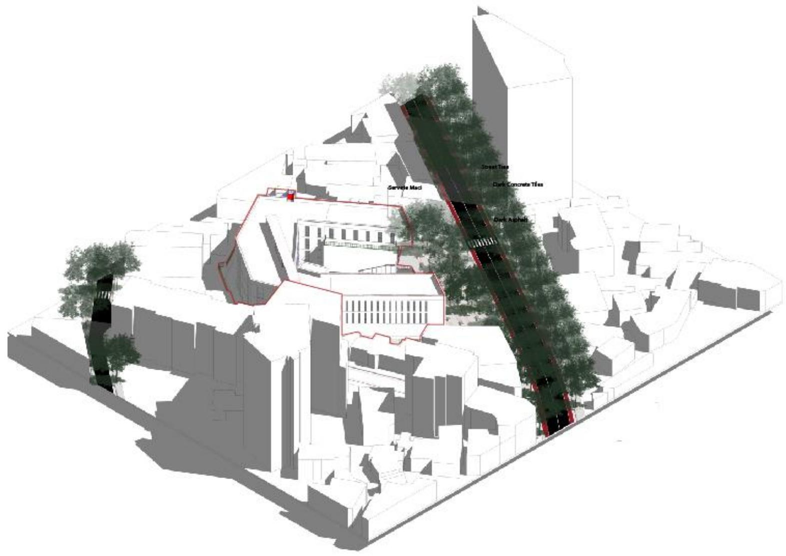


Figure 87.Scenario 5 - 20 m Height and 13m crown width

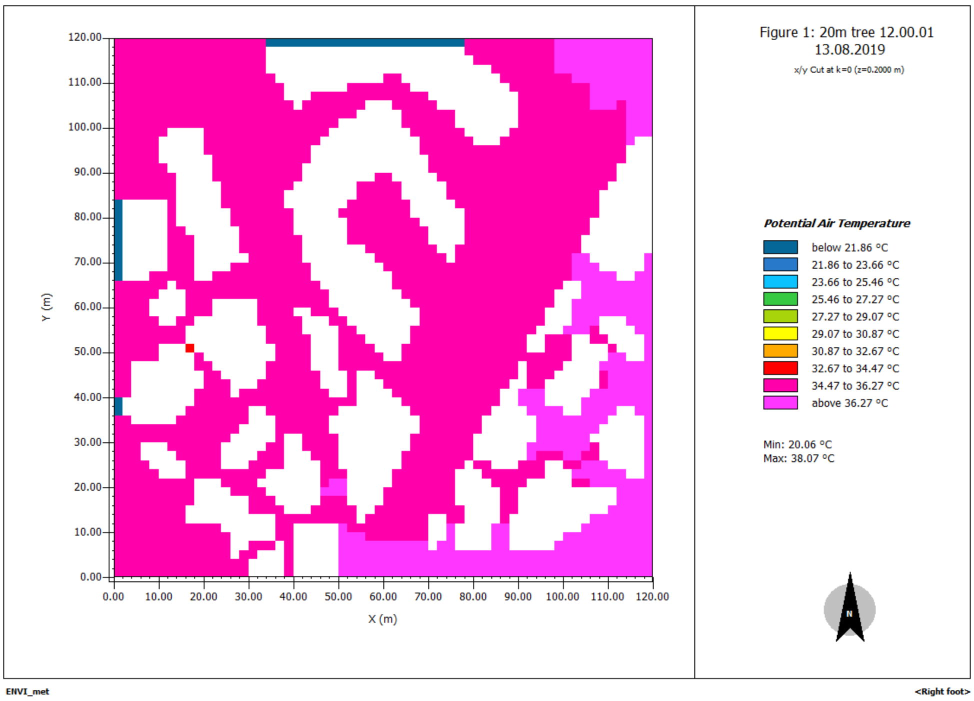


Figure 88.SC5 air temperatures at 12:00 13 August 2019.

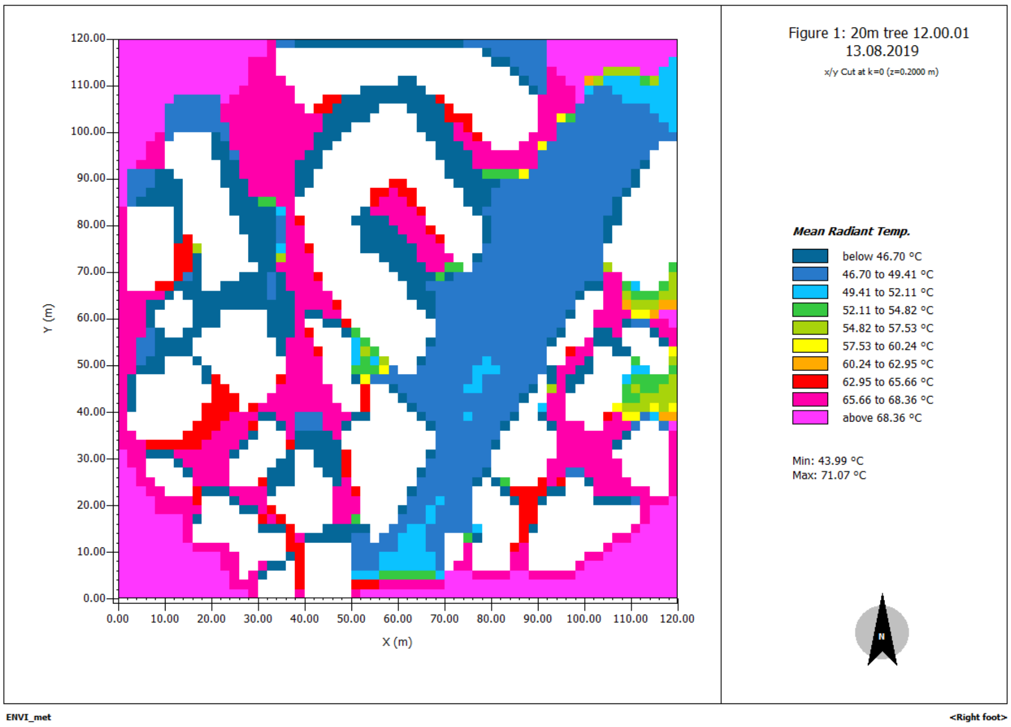


Figure 89.SC5 mean radiant temperatures at 12:00 13 August 2019.

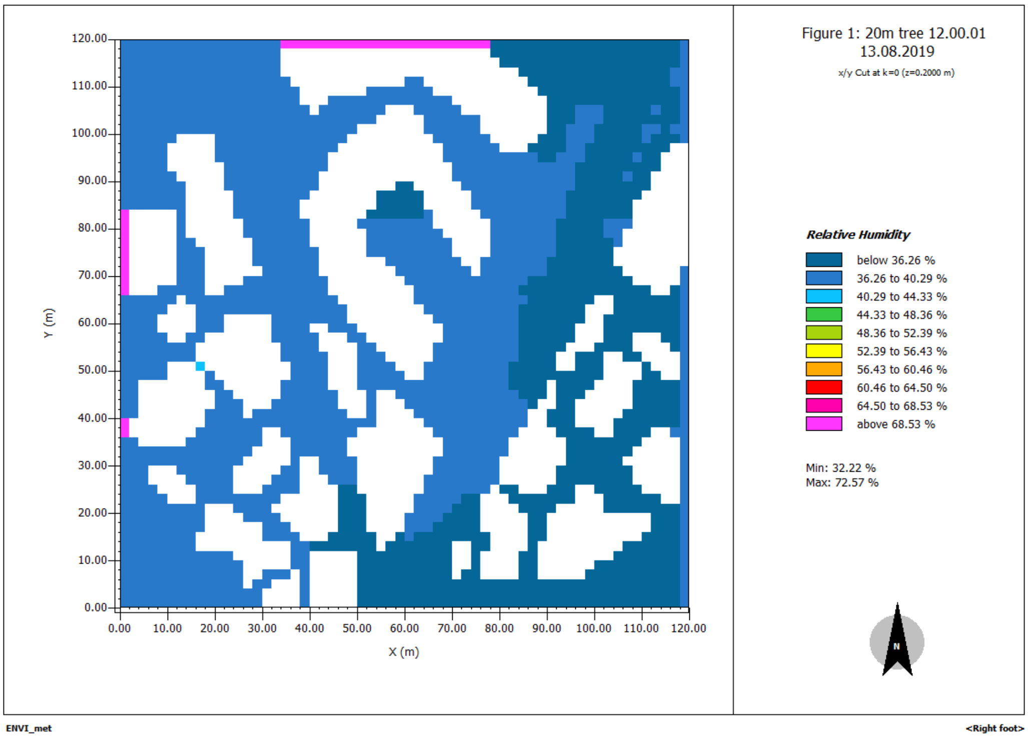


Figure 90. SC5 Relative Humidity at 12:00 13 August 2019

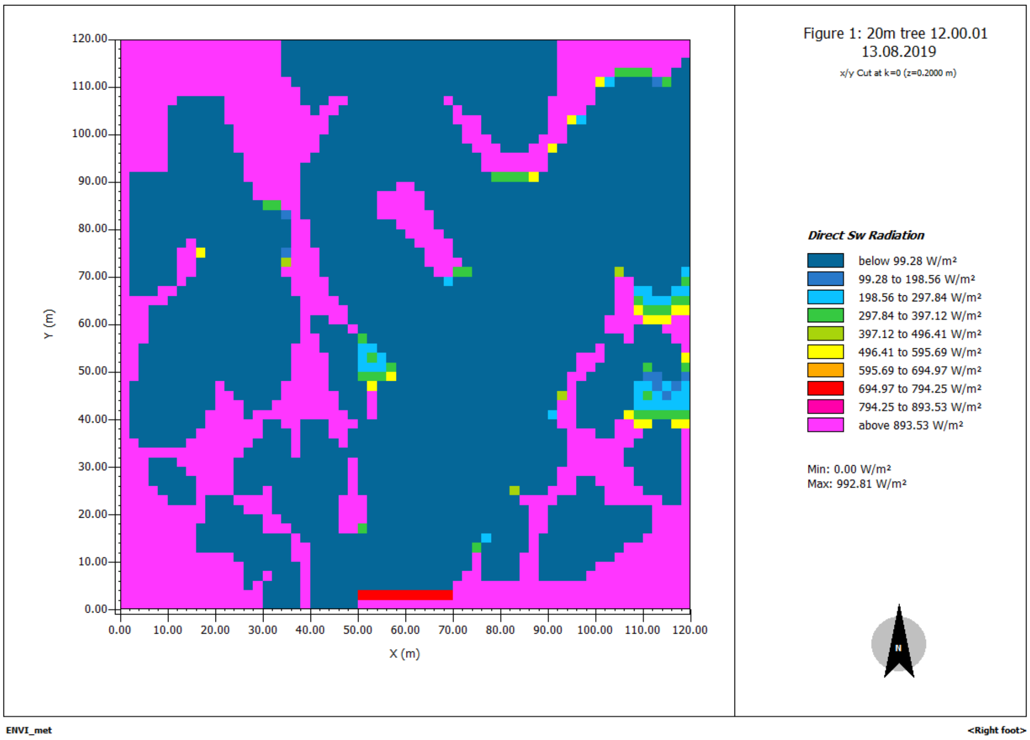


*Figure 91.*SC5 Direct sw radiation at 12:00 13 August 2019

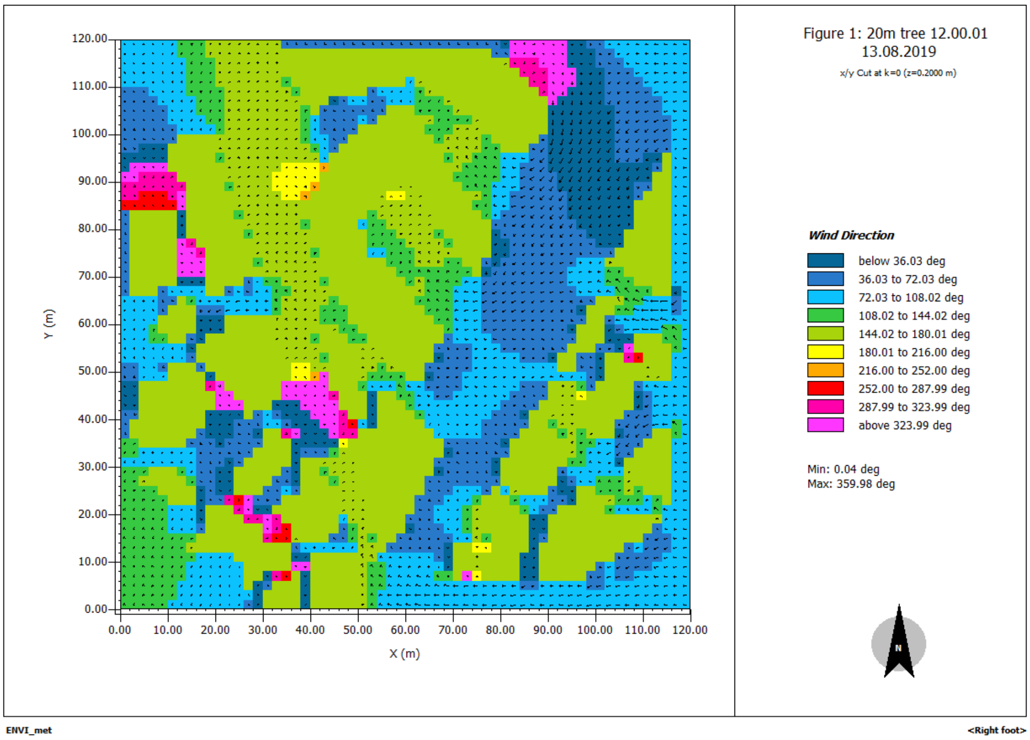


*Figure 92.*SC5 Wind direction at 12:00 13 August 2019

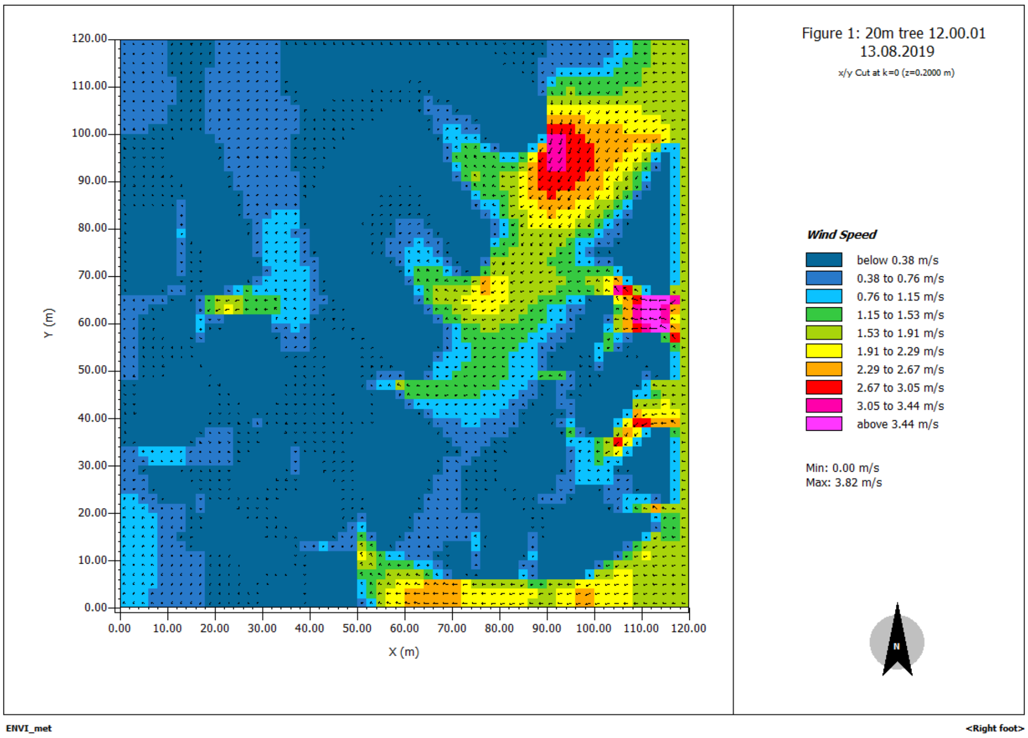


Figure 93.SC5 Wind Speed at 12:00 13 August 2019

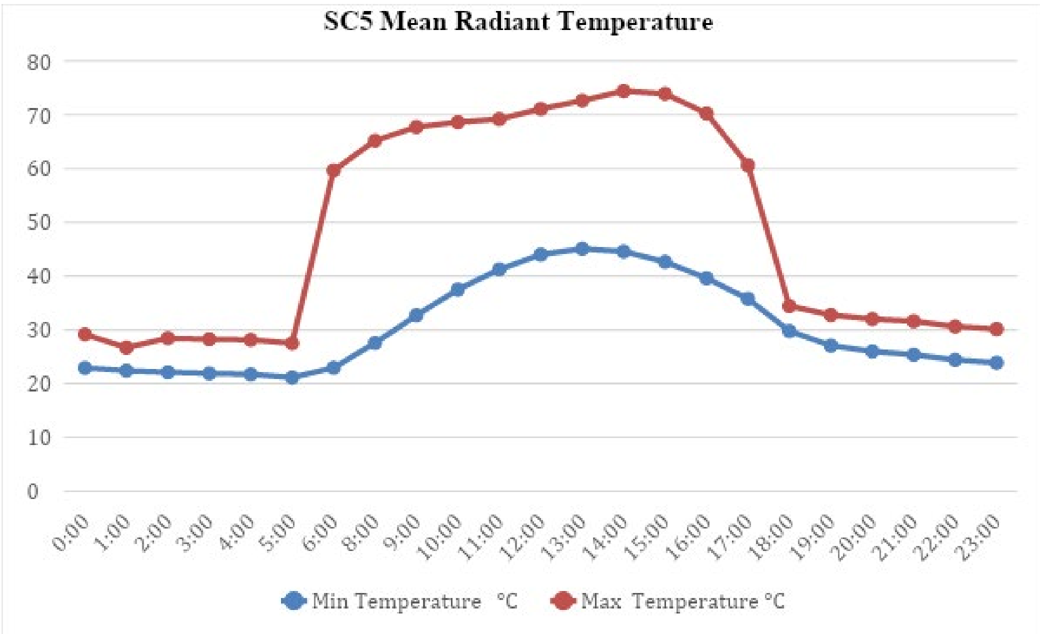


Figure 94.24 hour simulated graph of minimum and maximum mean radiant temperature values for scenario 5, August 13,2019

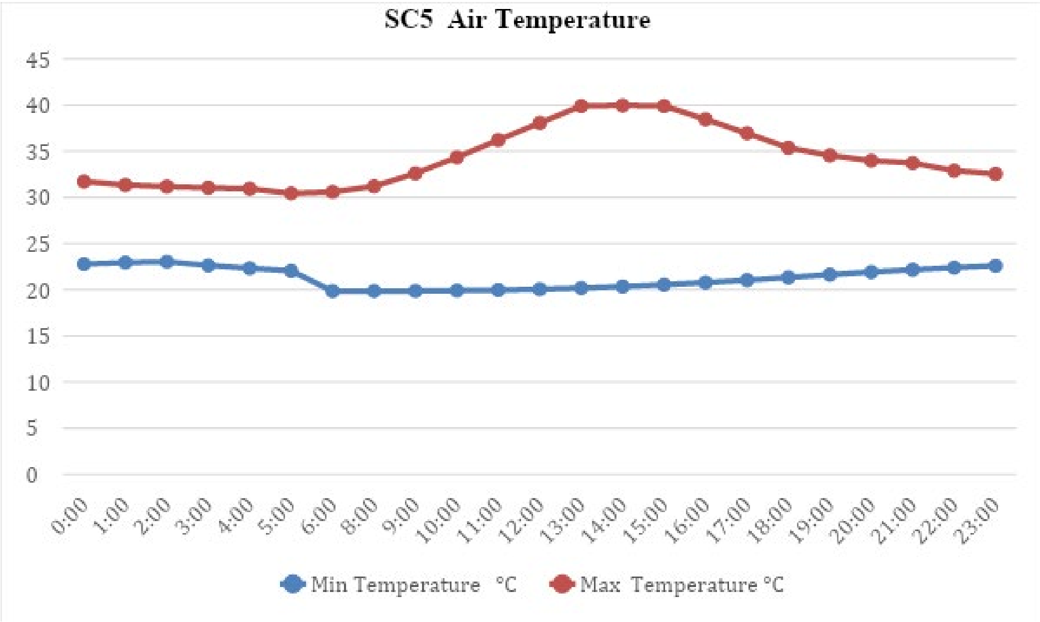


Figure 95.24 hour simulated graph of minimum and maximum air temperature values for scenario 5, August 13,2019

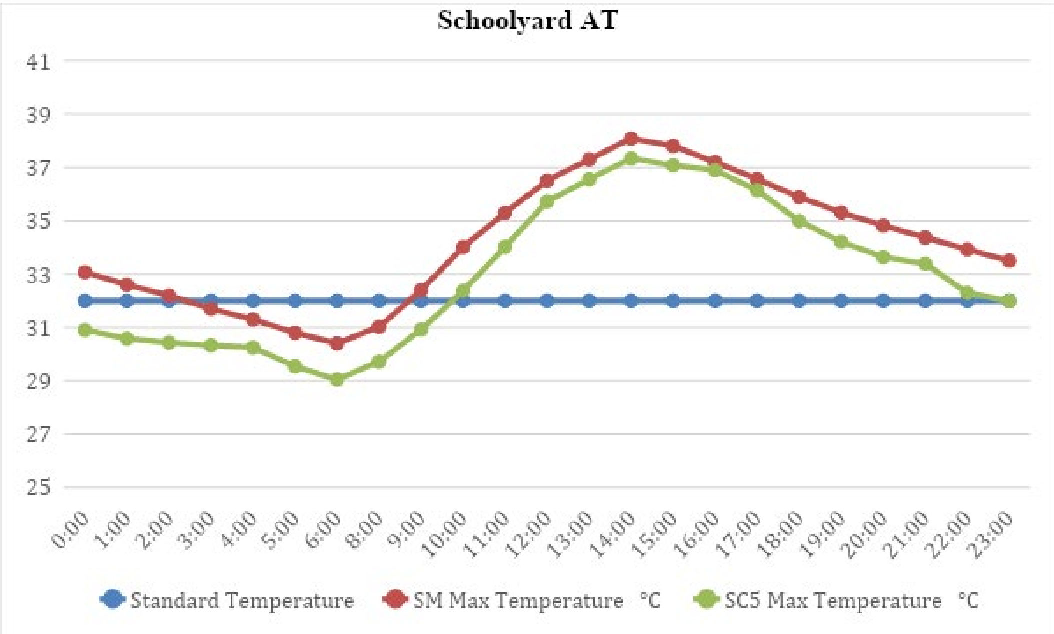


Figure 96.Air Temperature Comparison Graphs at 30,39 Grid between Scenario 1 and 2 in August 13,2019

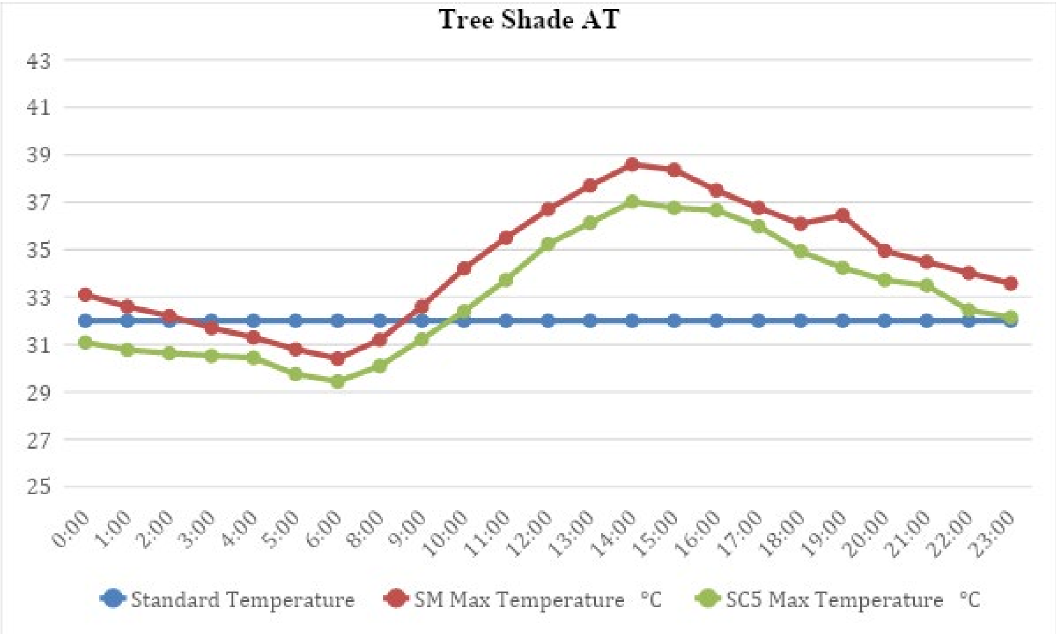


Figure 97.Air Temperature Comparison Graphs at 36,24 Grid between Scenario 1 and 2 in August 13,2019

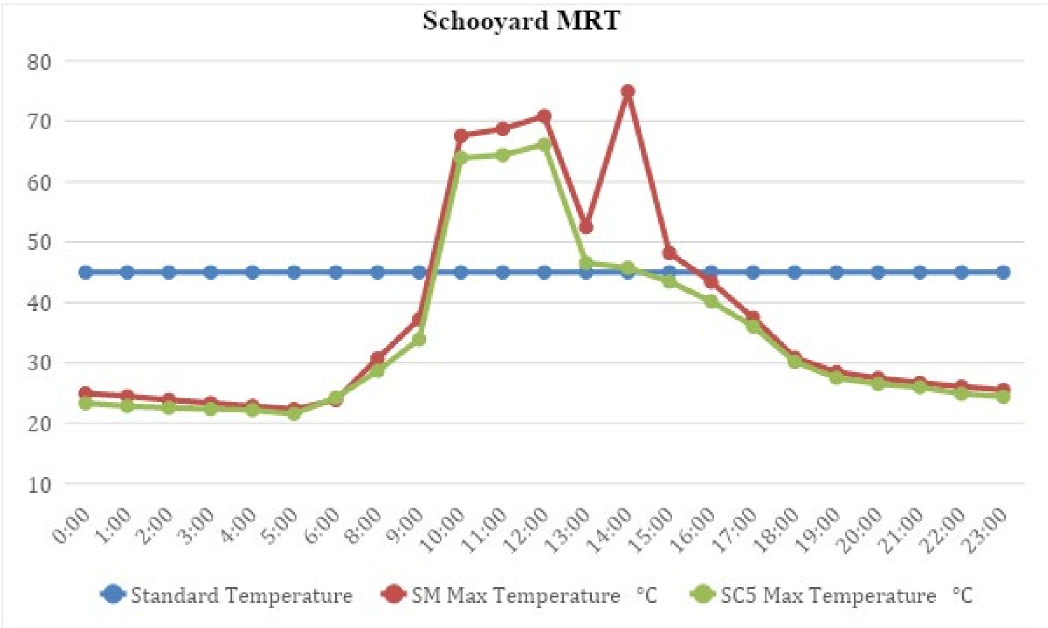


Figure 98.Mean Radiant Temperature Comparison Graphs at 30,39 Grid between Scenario 1 and 2 in August 13,2019

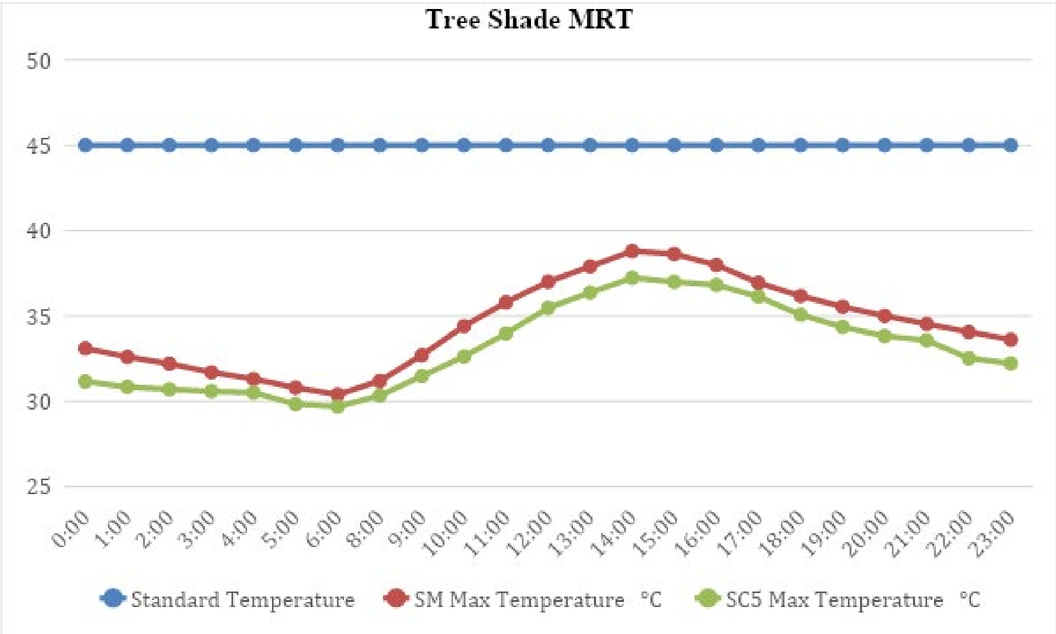


Figure 99.Mean Radiant Temperature Comparison Graphs at 36,24 Grid between Scenario 1 and 2 in August 13,2019

7.2.5 Optimization by Vegetation

Figure 100 depicts the average air temperature comparison data for the four vegetation scenarios and the current region conditions. The graph shows the improvements generated by different scenarios by displaying values throughout the day and illustrating the optimal vegetation situation. The comparison graph demonstrates that each suggested vegetation scenario reduces the UHI effect surrounding the school in varying degrees. The presented scenarios show that vegetation typologies and features are an effective mitigation method for improving the site's current circumstances. The SC5, which comprises of trees with a larger tree canopy, has shown to be the most successful scenario. This is due to the characteristics of the tree canopy breadth, which serves to lower air temperatures during the summer and increase the thermal comfort of the ITC group.

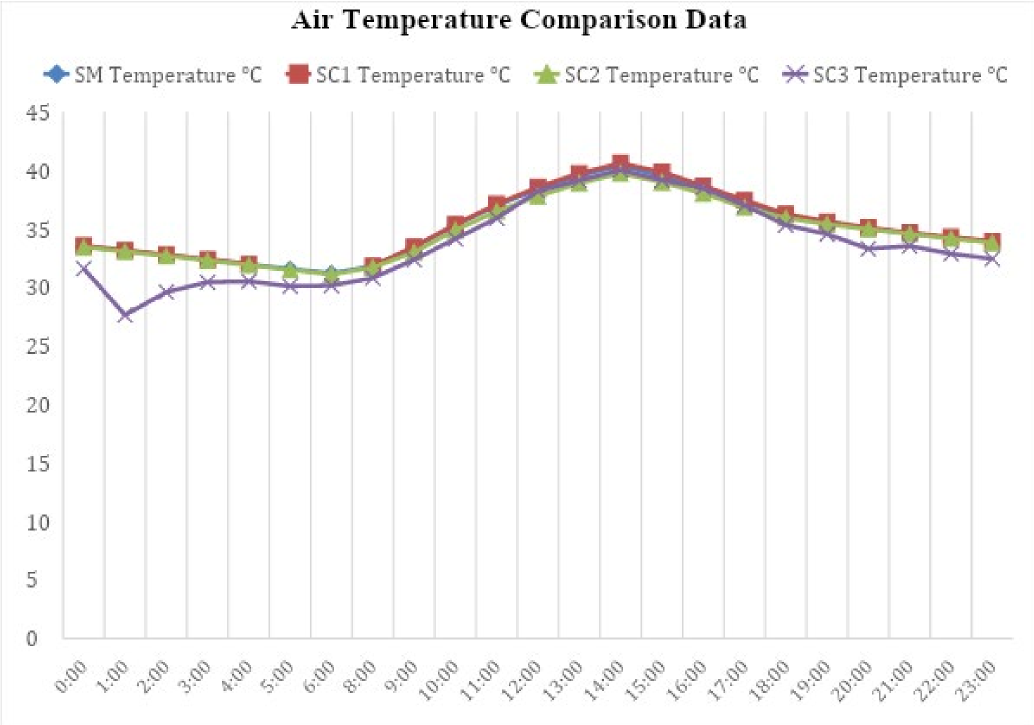


Figure 100.Comparative air temperatures on vegetation implementation of SC1,SC2, SC3, SC4 and SC5 at 12:00, 13 August 2019

7.3 Scenario 6 – Sidewalk Paving

Scenario 6 (SC6) consists of changing the grey concrete tile pavement of the sidewalk and school surrounding areas with light concrete material (See ***Figure 101***and ***Figure 102***). The air temperatures have decreased from 38.42 °C to 37.01 °C (***Figure 103)*** (See *APPENDIX P* for AT hourly simulations). Meanwhile the mean radiant temperature has changed from 74.68 °C to 73.53 °C **(*Figure 104*** and ***Figure 105) (***See *APPENDIX Q* for MRT hourly simulations*)*. In ***Figure 106*** and ***Figure 107*** are respectively shown the simulation values of relative humidity *(*See *APPENDIX R* for RH hourly simulations). and direct sw radiation. It is also noticed that wind direction and wind speed have an impact on temperature distribution of the site (See ***Figure 108*** and ***Figure 109)***. ***Figure 110*** and show the minimum and maximum values for 24 hours of AT and MRT simulated values of SC7. Comparison graphics in ***Figure 111*** and ***Figure 112*** show the air temperatures changes as in previous scenario in the schoolyard and under tree shade. The simulated results show that the air temperatures are lower under tree shade but continue to be high after 10:00 AM. Meanwhile ***Figure 113*** comparison graph shows that the simulated MRT values for 24 hour at the schoolyard are acceptable for ITCs till 9:00 AM due to the shade provided from the building and the LC paving material compared to the tree shade MRT values (***Figure 114***).

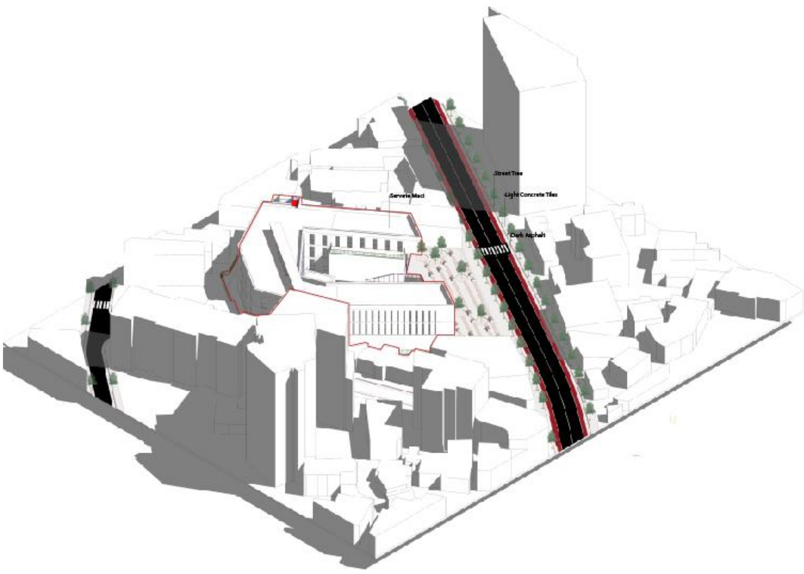


Figure 101.Schematic 3D of SM site with light concrete pavement zones

Figure 102. SC6 Light Concrete Pavement on Spaces Application

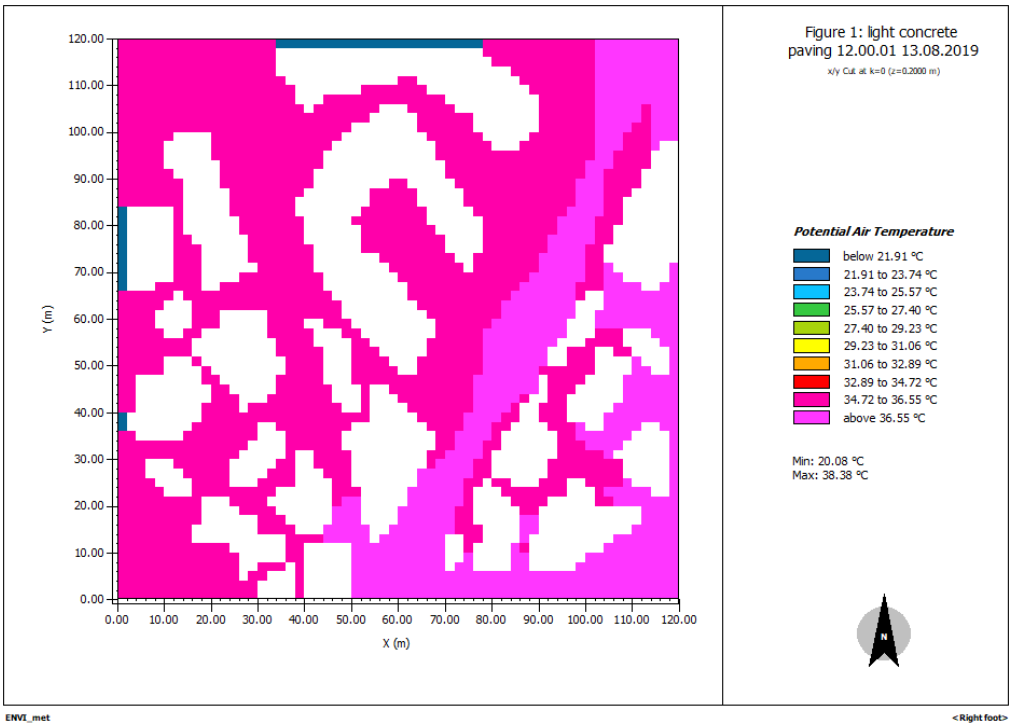


Figure 103.SC6 simulated air temperatures at 12:00 13 August 2019.

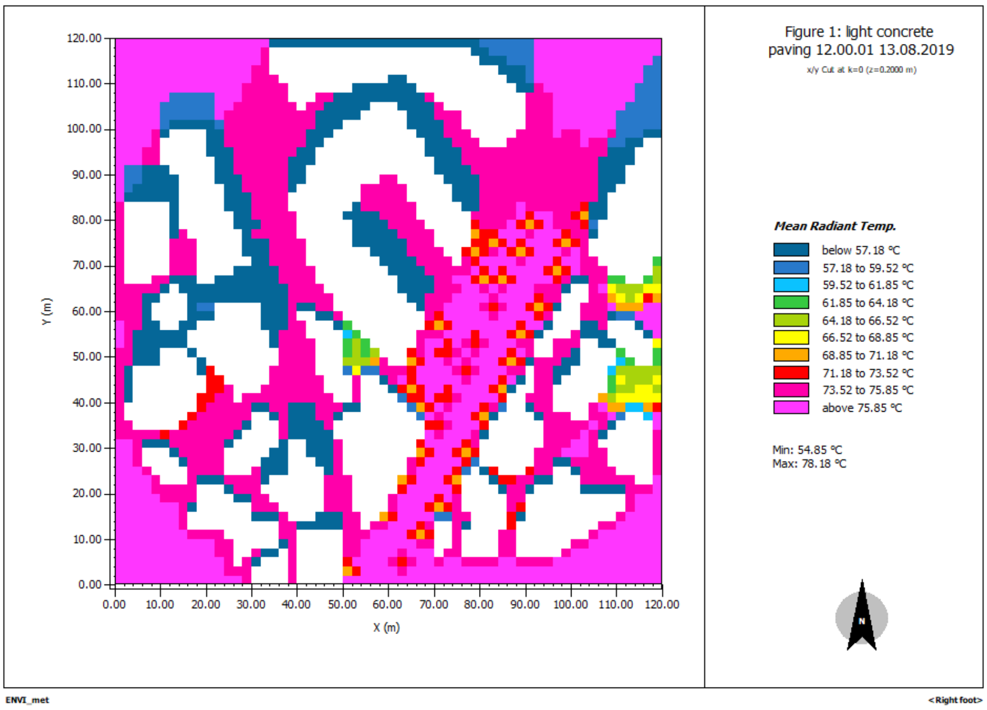


Figure 104.SC6 simulated mean radiant temperatures at 12:00 13 August 2019.

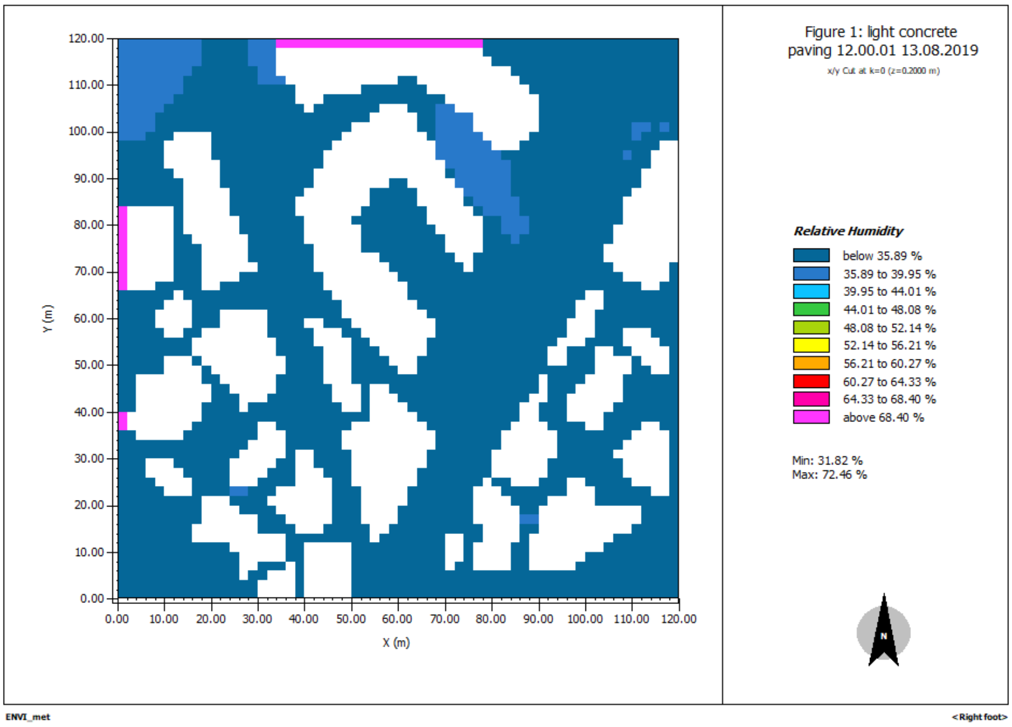


Figure 105. SC6 Simulated Relative Humidity at 12:00 13 August 2019.

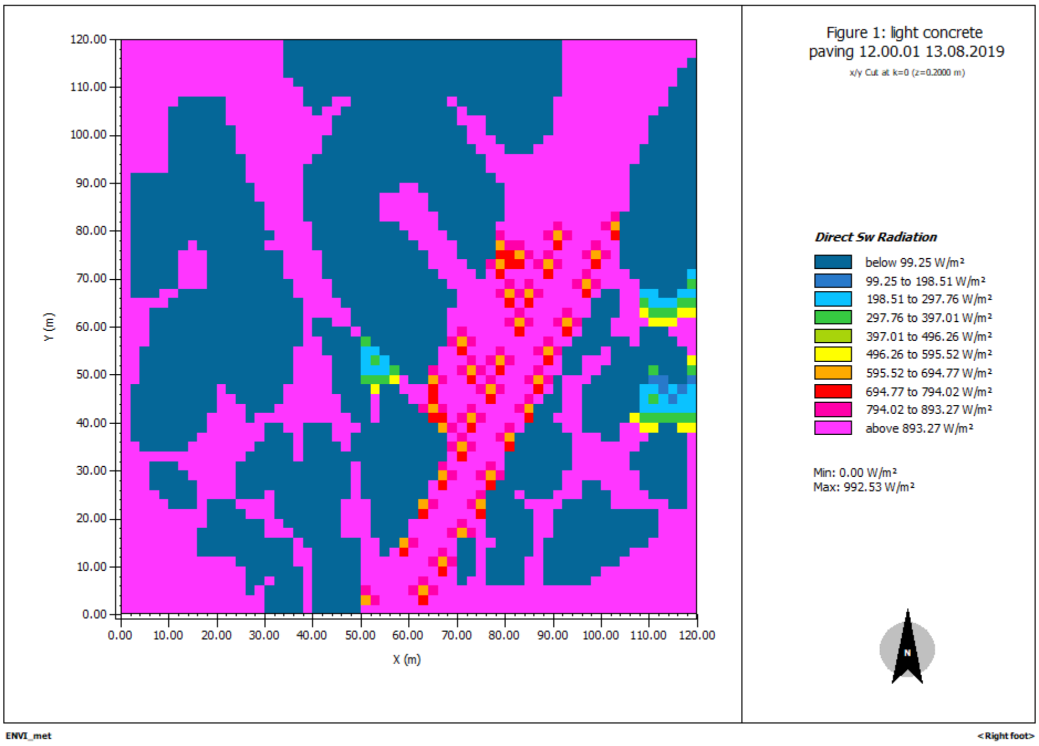


Figure 106. SC6 Simulated Direct Sw Radiation at 12:00 13 August 2019.

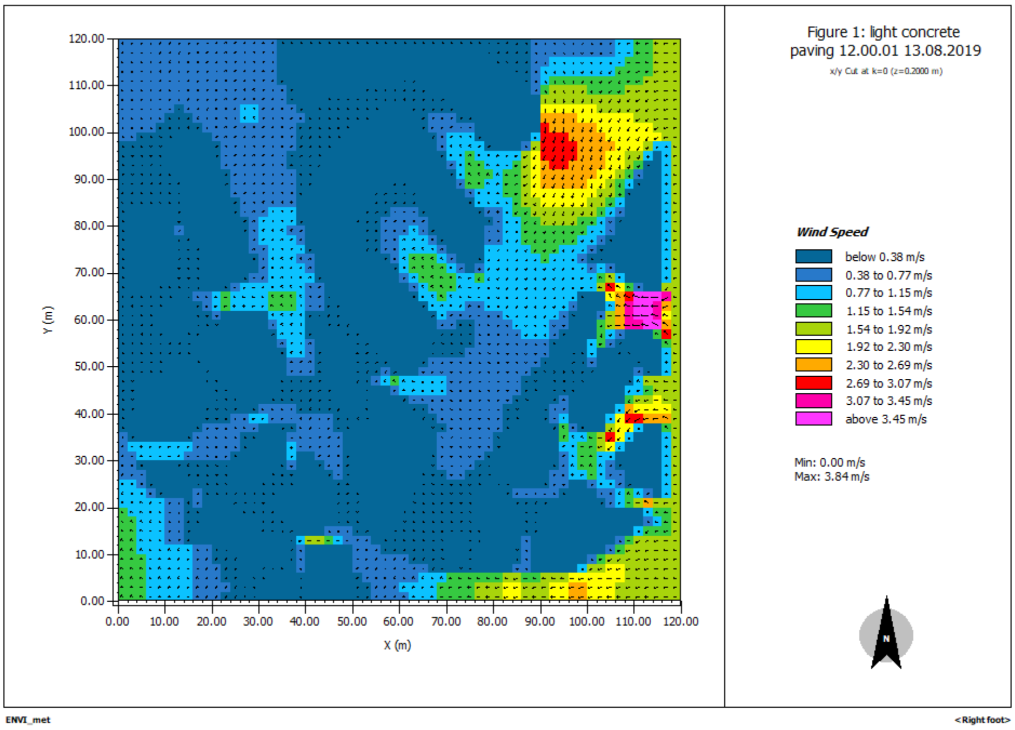


*Figure 107.*SC6 Simulated Wind Speed at 12:00 13 August 2019.

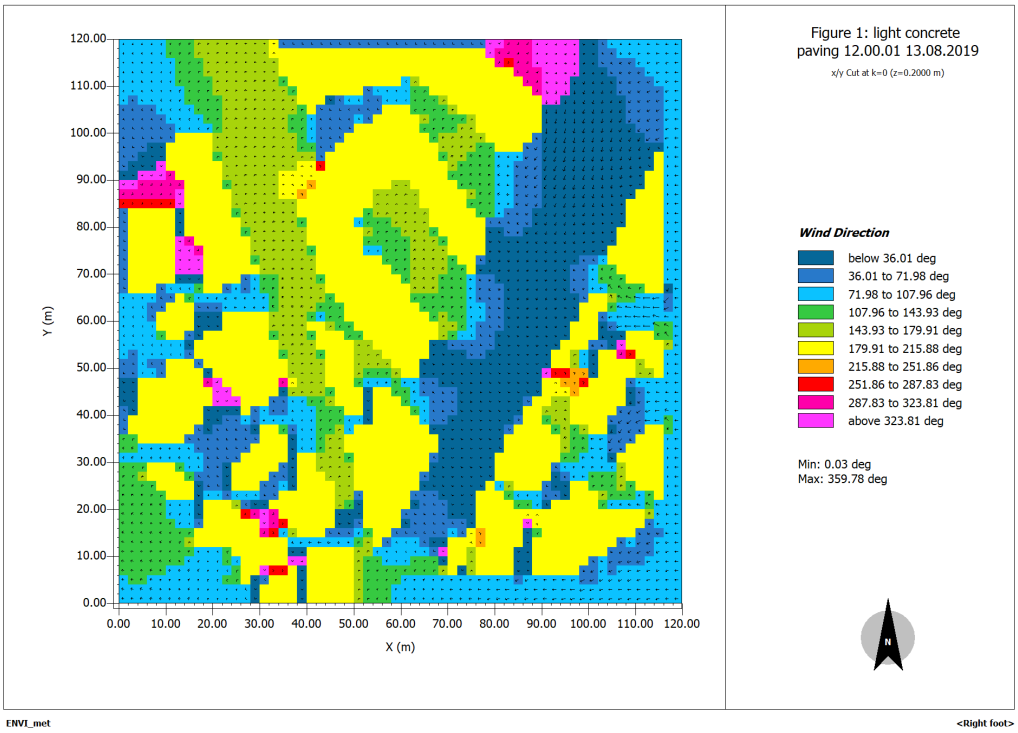


*Figure 108.*SC6 Simulated Wind Direction at 12:00 13 August 2019.

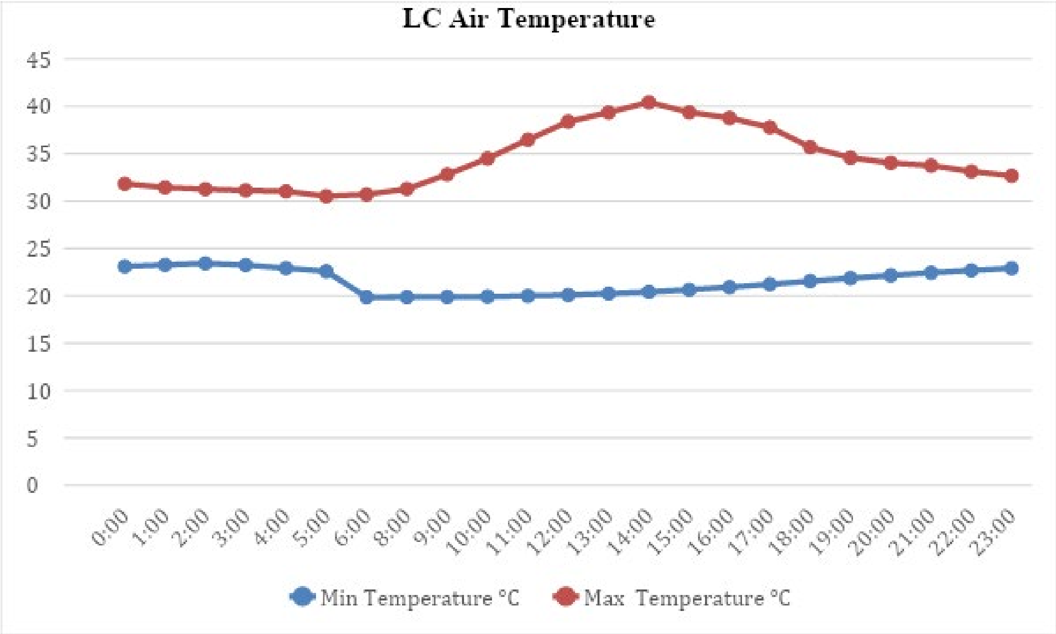


Figure 109.24 hour simulated graph of minimum and maximum air temperature values of SC6, August 13,2019

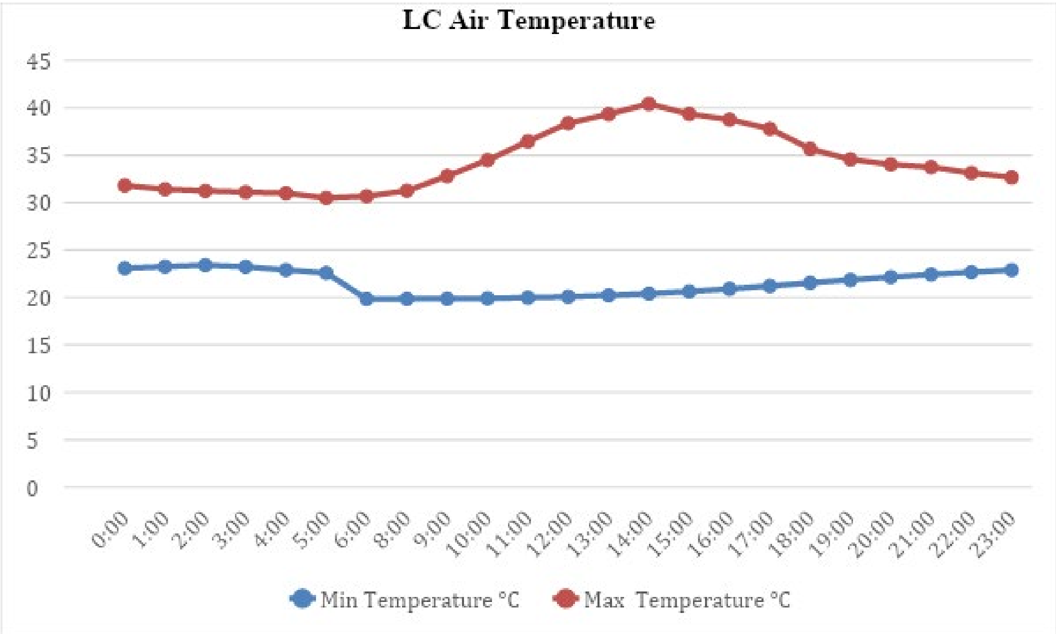


Figure 110.24 hour simulated graph of minimum and maximum mean radiant temperature values of SC6, August 13,2019

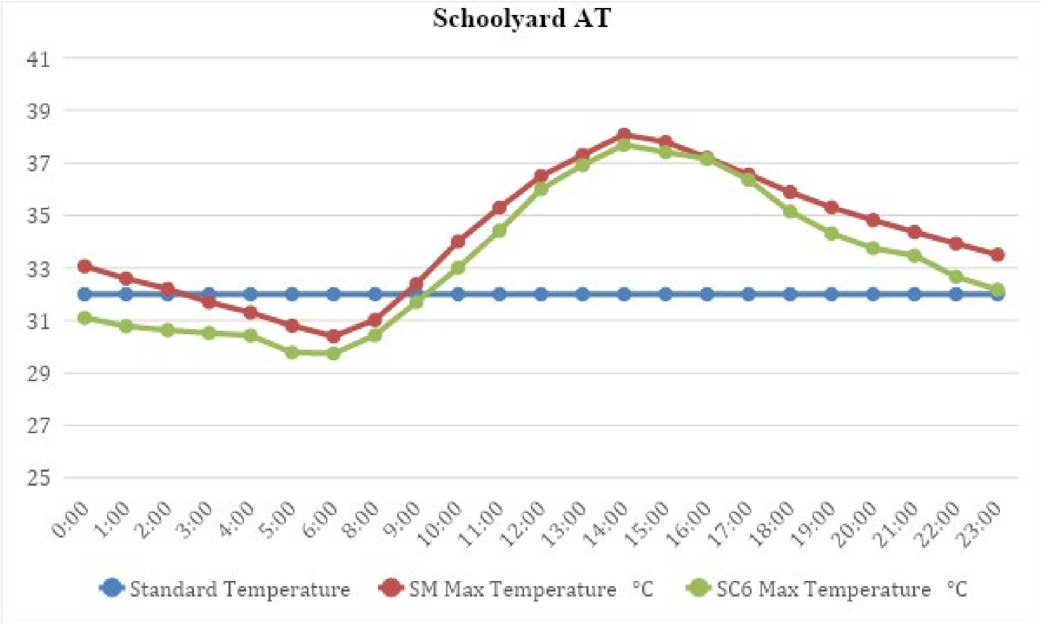


Figure 111.Air Temperature Comparison Graphs at 30,39 Grid between Scenario 1 and 6 in August 13,2019

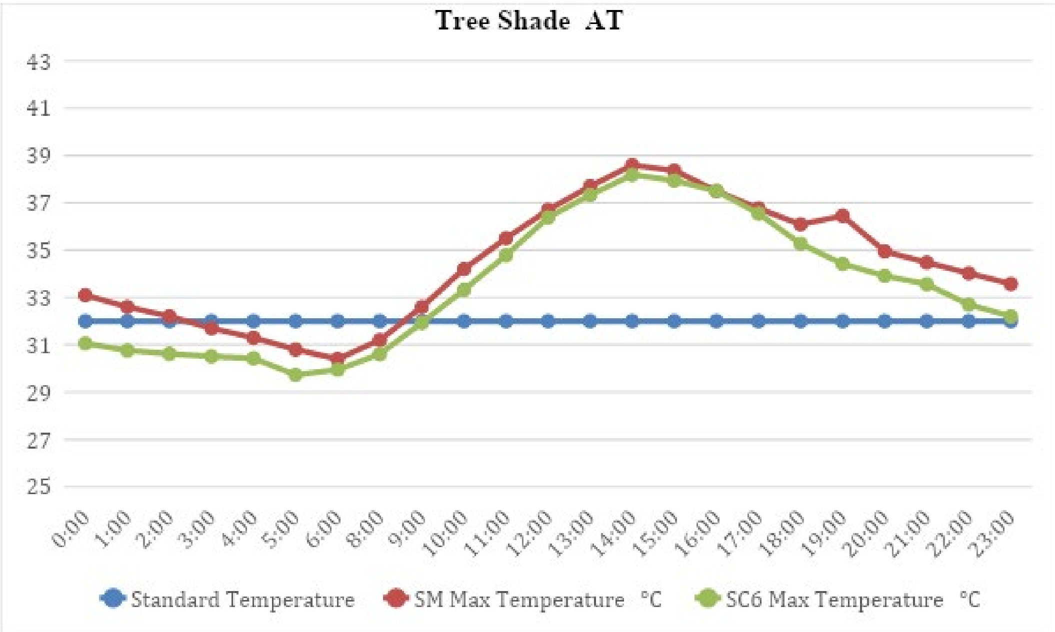


Figure 112. Air Temperature Comparison Graphs at 36,24 Grid between Scenario 1 and 6 in August 13,2019

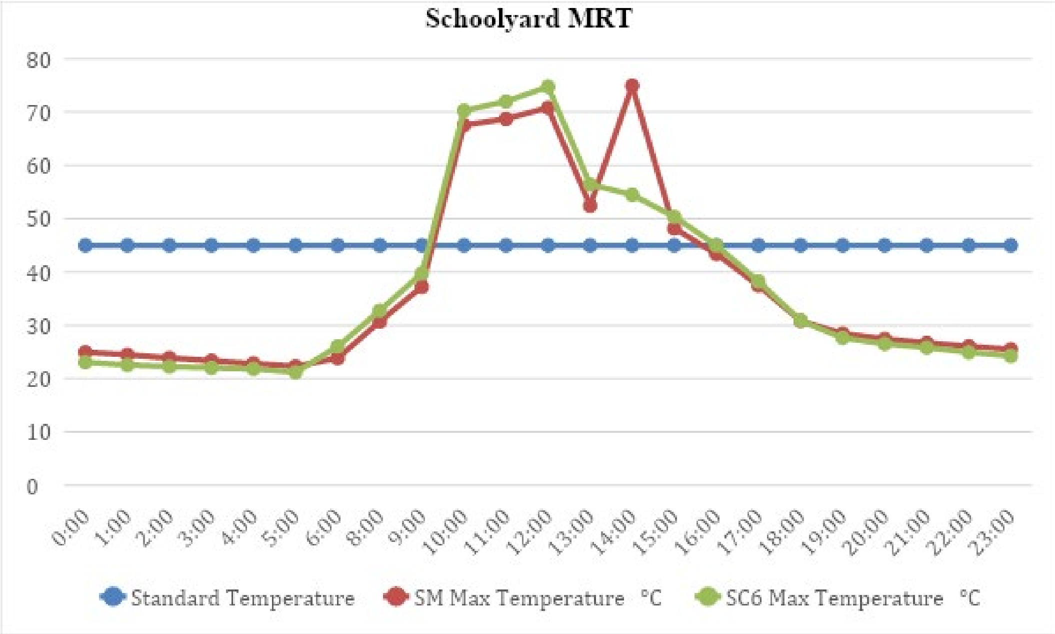


Figure 113.Mean Radiant Temperature Comparison Graphs at 30,39 Grid between Scenario 1 and 6 in August 13,2019

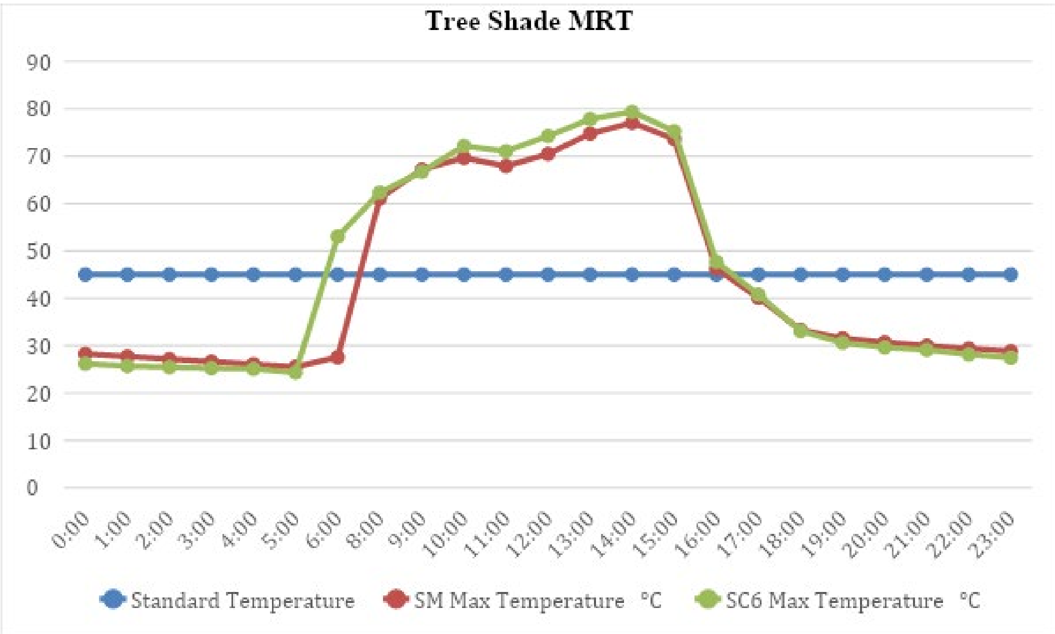


Figure 114.Mean Radiant Temperature Comparison Graphs at 36,24 Grid between Scenario 1 and 6 in August 13,2019

7.4 Scenario 7 – Road Paving

Optimization ways based on roads are considered to effectively mitigate urban microclimates. Due to the previously discussed properties of asphalt pavements its proposed to replace it with red coating asphalt (***Figure 115)***. Colored surfaces are able to reduce the heat absorbed by the materials and the surrounding elements.

Figure 115. Space Modeling with red coating asphalt.

Figure 116 illustrates the simulated temperatures after the implementation of SC7. The air temperatures shown in Figure 116 change from 38.42 °C to 36.75 °C (See *APPENDIX S* for Air Temperature 24 hour simulations). Changes are also seen on mean radiant temperature values as the ***Figure 117*** indicates (See *APPENDIX T* for Mean Radiant Temperature 24 hour simulations). ***Figure 118*** *and* ***Figure 119*** depict the changes of relative humidity (RH) and Wind Speed values (WS). The comparison shows that AR material has e very high impact on UHI mitigation and temperatures have reduced up to 1.67 °C (See ***Figure 120*** and ***Figure 121***). Measurements of AT in the schoolyard (30,39) and paving under tree shade (36,24) result in +2.86°C lower temperatures in the grid 36,24 at 12:00 AM. As a result, SC6 allows the ITC to be outdoors till 11:00 AM to continue their day-to-day activities. Noticeable changes have been noticed in MRT. In 36,34 grid the MRT have resulted in temperature changes up to 6°C at 12:00 AM in shaded areas.

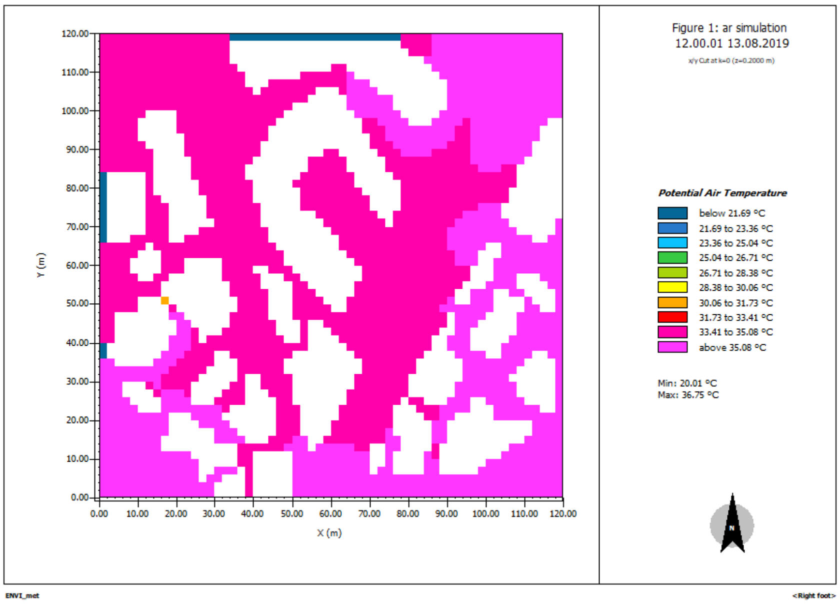


Figure 116.SC7 Air Temperature simulation at 12:00 13 August 2019.

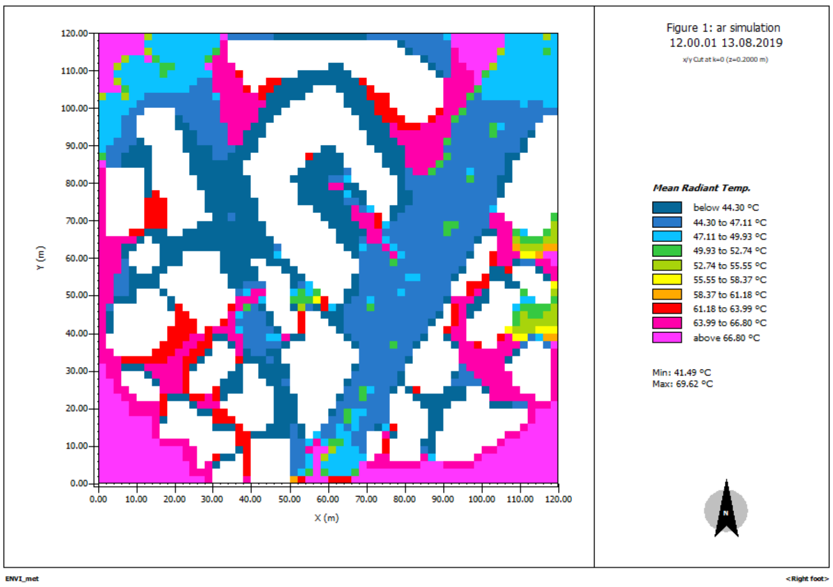


Figure 117.SC7 Mean Radiant Temperature simulation at 12:00 13 August 2019.

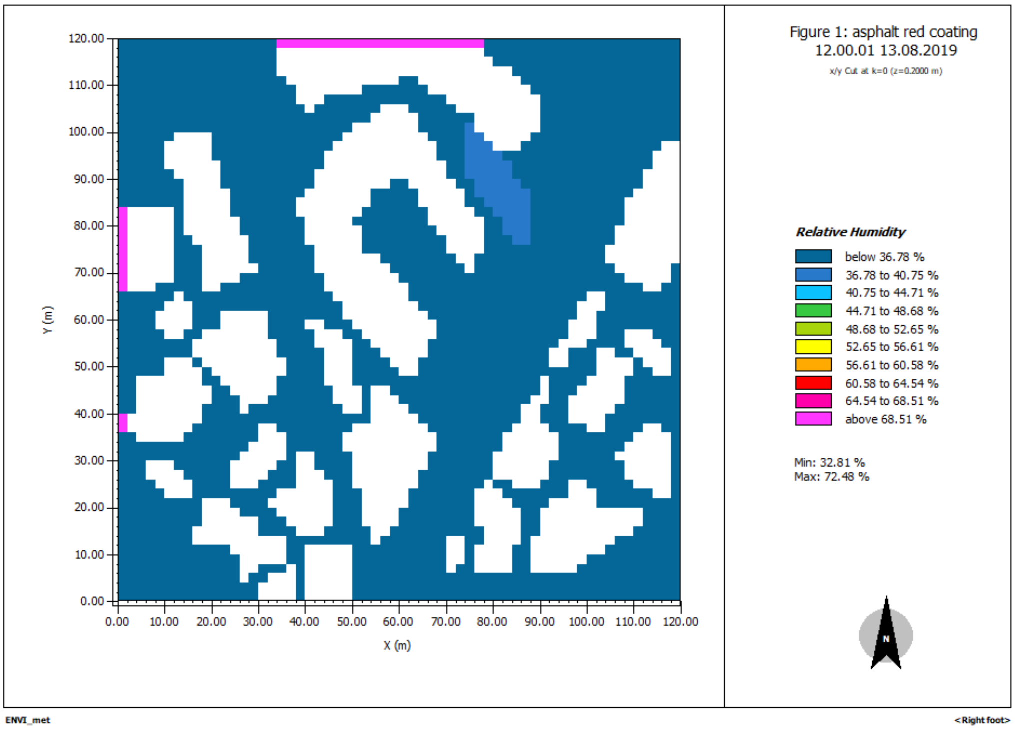


Figure 118.SC7 Relative Humidity simulation at 12:00 13 August 2019

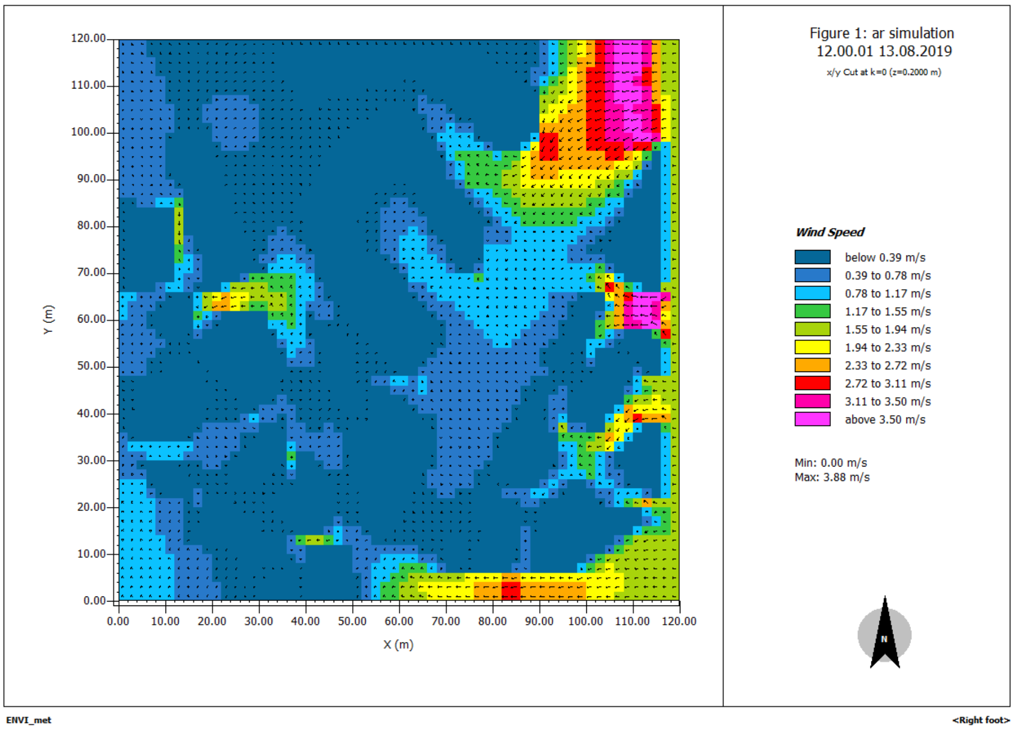


Figure 119.SC7 Wind Speed simulation at 12:00 13 August 2019

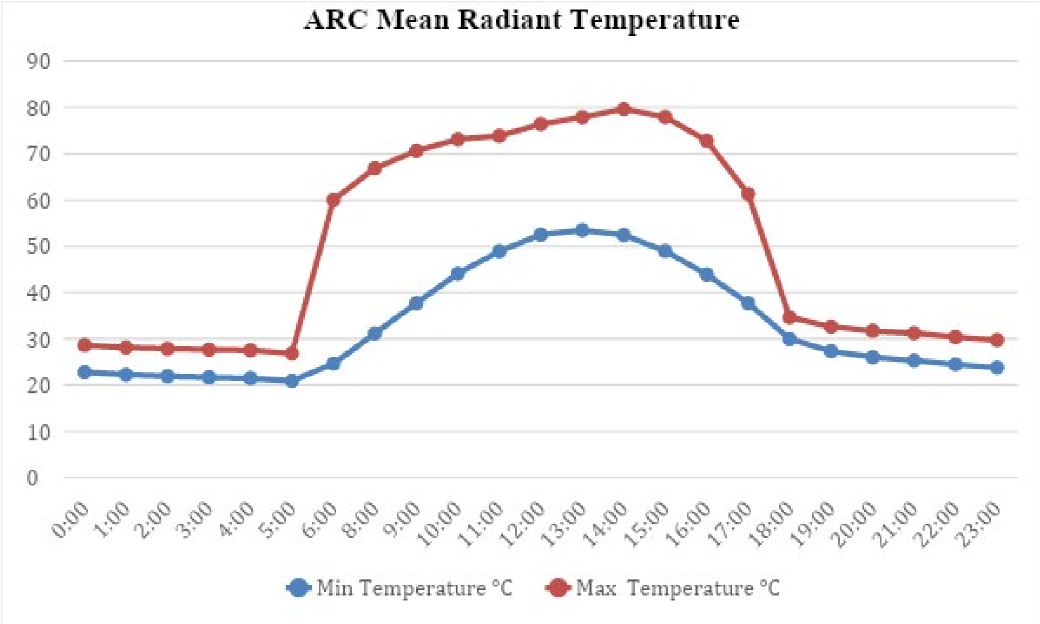


Figure 120.24 hour simulated graph of minimum and maximum mean radiant temperature values of SC7, August 13,2019

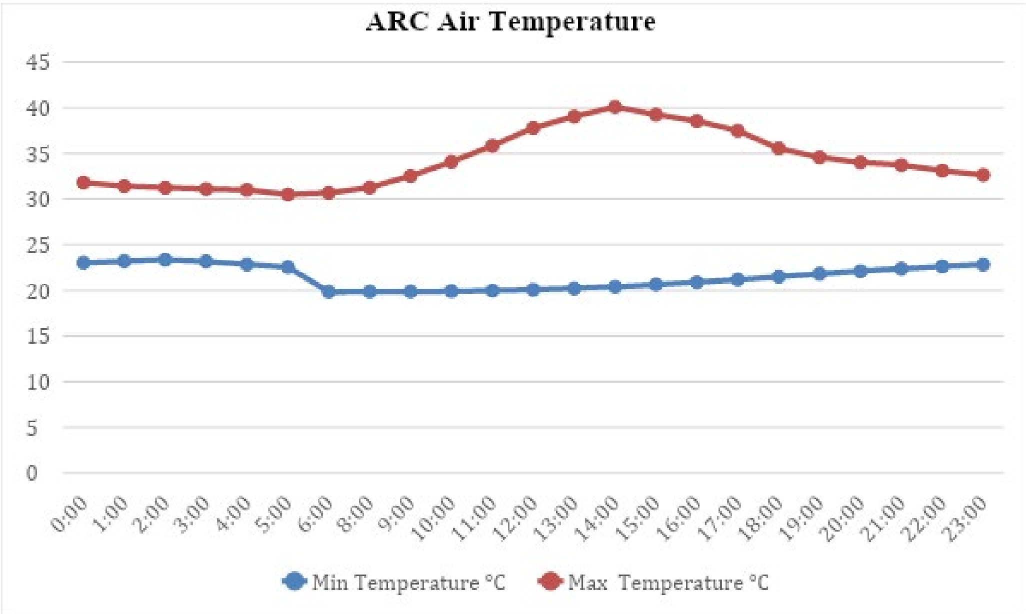


Figure 121.24 hour simulated graph of minimum and maximum air temperature values of SC7, August 13,2019

7.5 Optimization Scenario

The final Scenario (Optimization) is shown in ***Figure 122*** and Spaces modelling in ***Figure 123***.

Figure 122.Schematic 3D of Optimization Scenario

It consists of replacement of dark asphalt material with red coating asphalt, light concrete sidewalk tiles, 20 high trees and 13m tree canopy. The results in ***Figure 124*** show a decrease of air temperature up to 3 °C in the shaded areas (See *APPENDIX V* for 24 hourly simulations of AT).***Figure 125*** demonstrated changes of 1.15 °C – 3.86 °C of mean radiant temperature values *(*See *APPENDIX W* for MRT hourly simulations). Changes noticed in simulations of Relative Humidity, wind speed, wind direction and direct sw radiation are shown respectively in ***Figure 126, Figure 127, Figure 128*** and ***Figure 129*** (See *APPENDIX X* for 24 hourly simulations of RH). Minimum and maximum values graphics of air temperature and mean radiant temperature in 24 hours are shown *in* ***Figure 130*** and ***Figure 131***. Comparison graphics between existing conditions of Servete Maci site and proposed optimization scenarios are shown in ***Figure 132*** for air temperatures and ***Figure 133*** demonstrates the mean radiant temperature decreased values. (See *APPENDIX Y* for Comparison Graphs between SC1 and all other scenarios for AT values and *APPENDIX Z* for MRT compared values graphics). Illustration graphs in ***Figure 134*** and ***Figure 135*** show the air temperatures changes in the schoolyard and under tree shade. The simulated results show that the air temperatures have decreased under tree shade. Meanwhile ***Figure 137*** comparison graph shows that the simulated MRT values for 24 hour under tree shade areas are highly acceptable for ITCs throughout the whole day. The schoolyard MRT temperatures also are ideal for the youngsters, as the best temperatures are in among the timeline which is recommended as now no longer a right motion timeline of being exterior for children, and maintain to lower after 15:00 PM.(***Figure 137***).

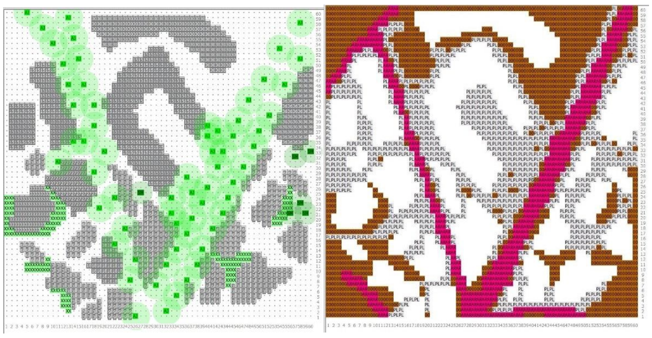


Figure 123.Optimization Scenario on Spaces Application, ENVI-met

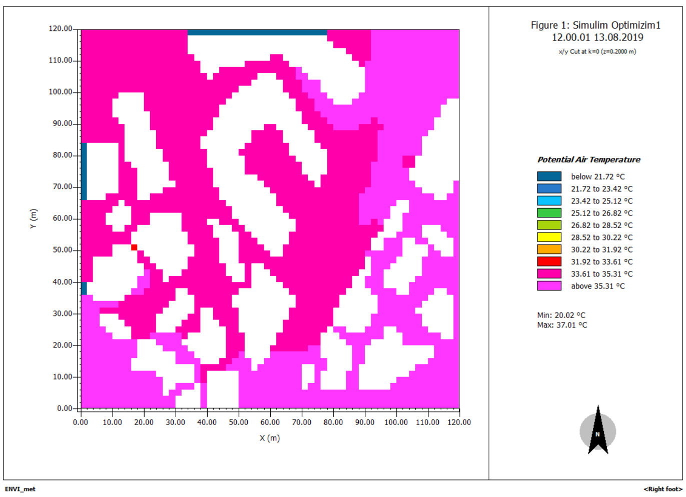


Figure 124.Optimization Scenario, Air Temperature simulation at 12:00 13 August 2019

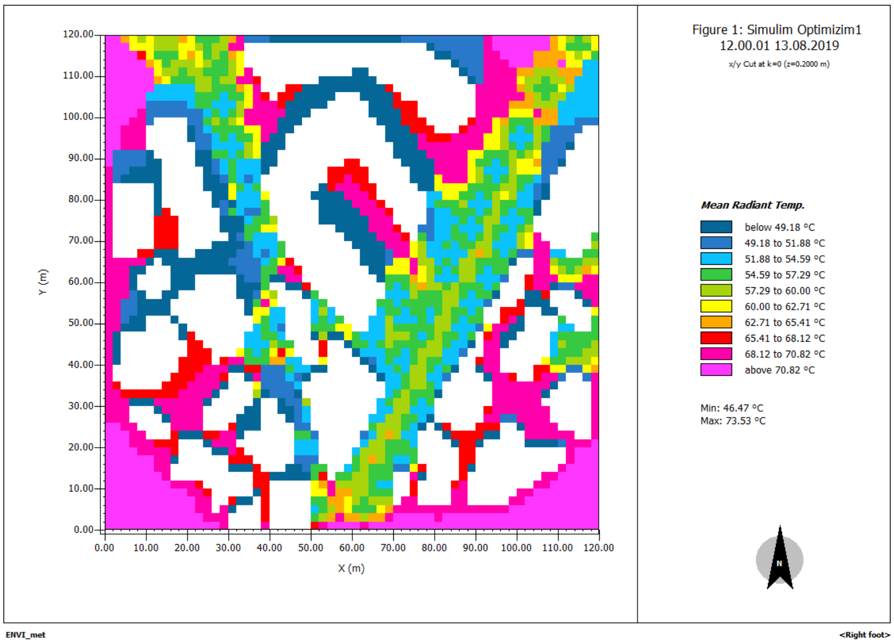


Figure 125. Optimization Scenario, Mean Radiant Temperature simulation at 12:00 13 August 2019

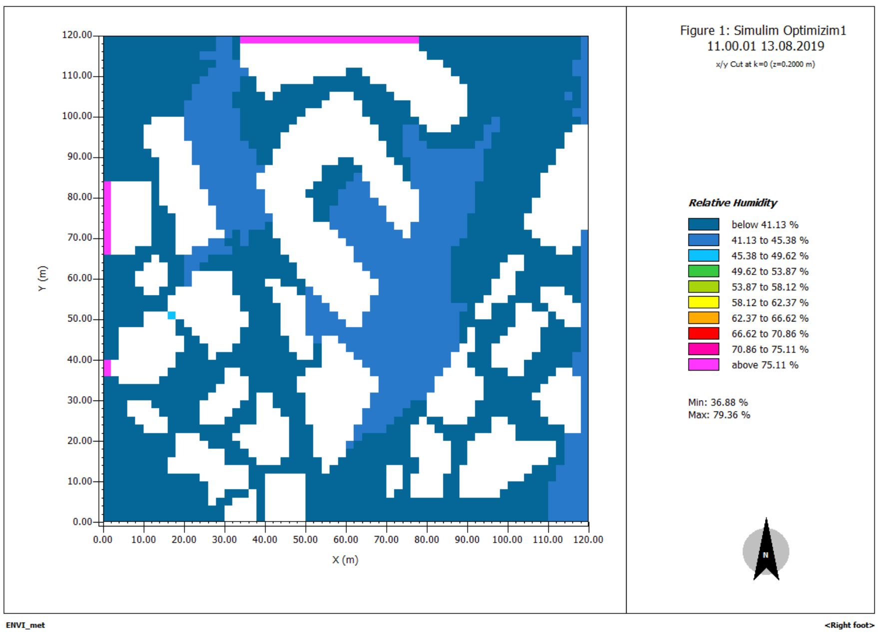


Figure 126. Optimization Scenario, Relative Humidity Simulation at 12:00 13 August 2019

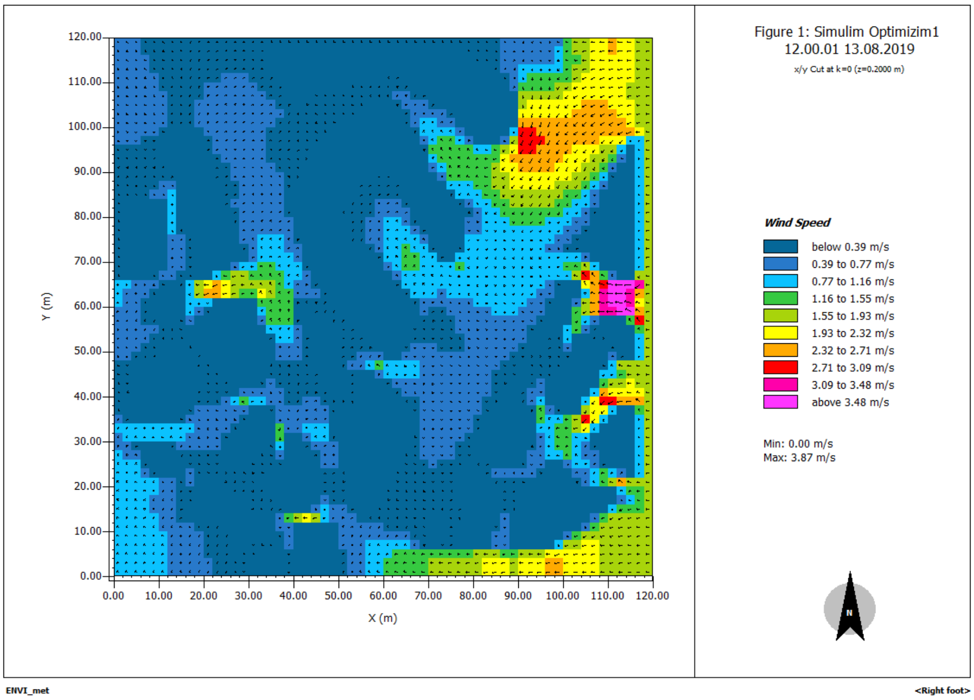


Figure 127.Optimization Scenario, Wind Speed simulation at 12:00 13 August 2019

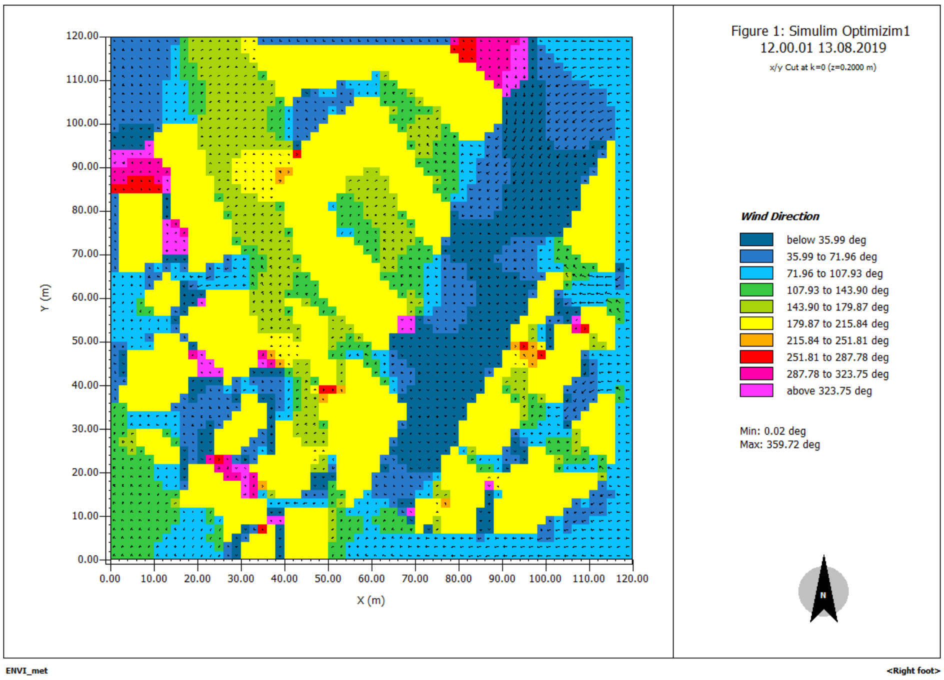


Figure 128.Optimization Scenario, Wind Direction simulation at 12:00 13 August 2019

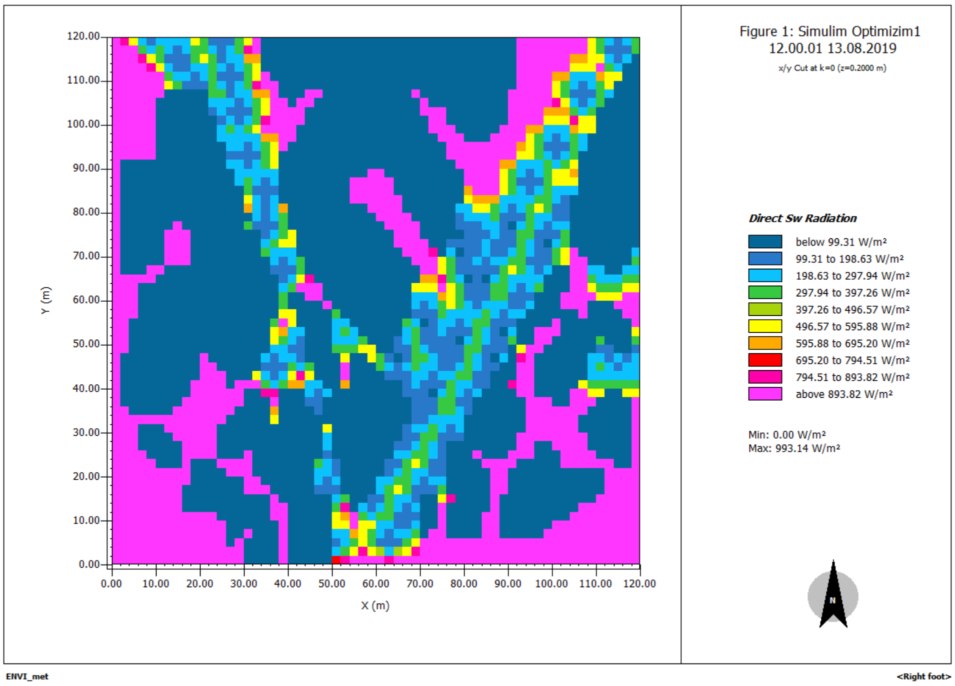


Figure 129.Optimization Scenario, Direct ws Radiation simulation at 12:00 13 August 2019

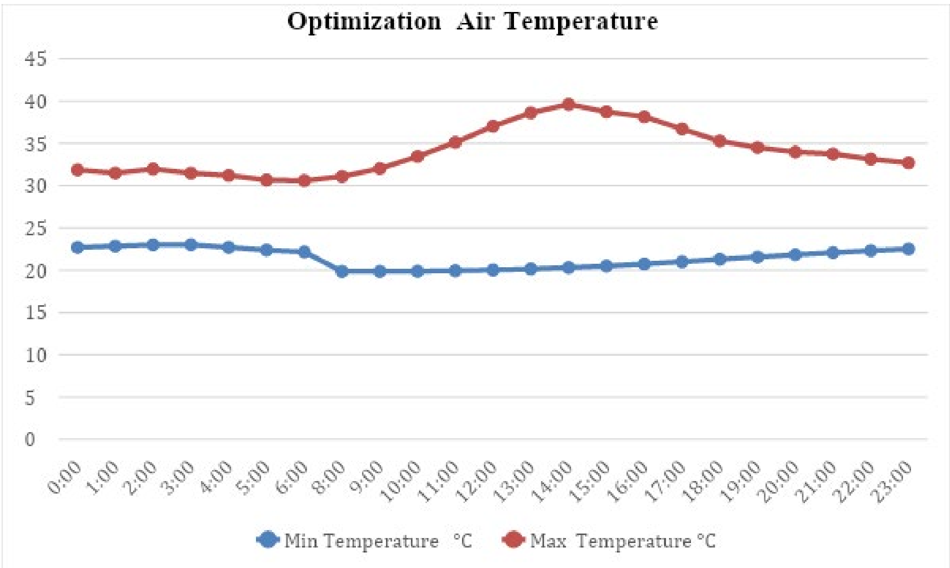


Figure 130.Minimum and Maximum Simulated Air Temperature values of Optimization Scenario, 13th August 2019

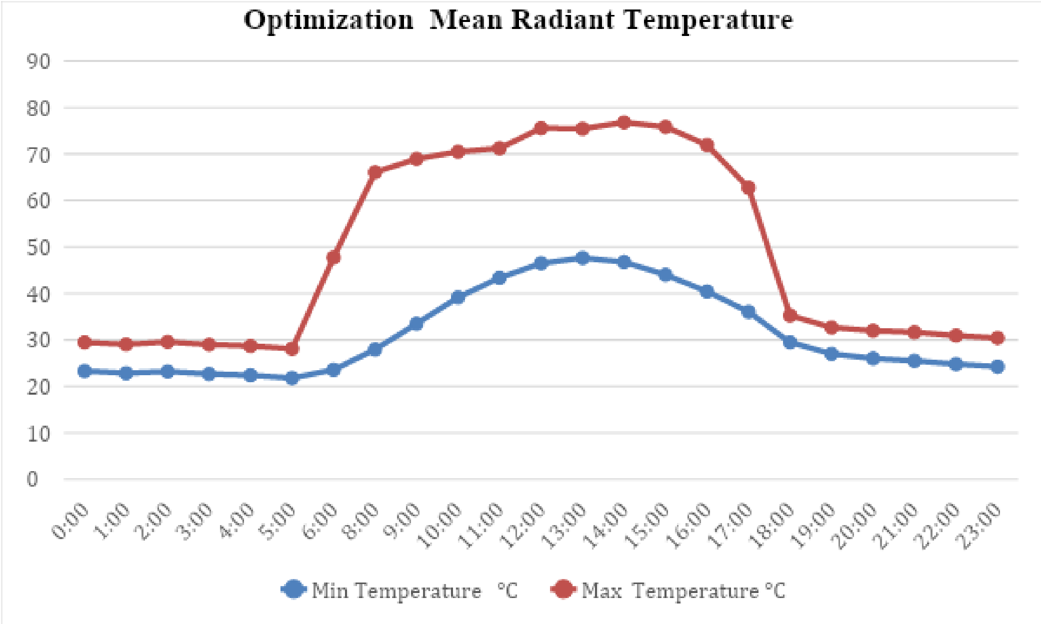


Figure 131.Minimum and Maximum Simulated Mean Radiant Temperature values of Optimization Scenario, 13th August 2019

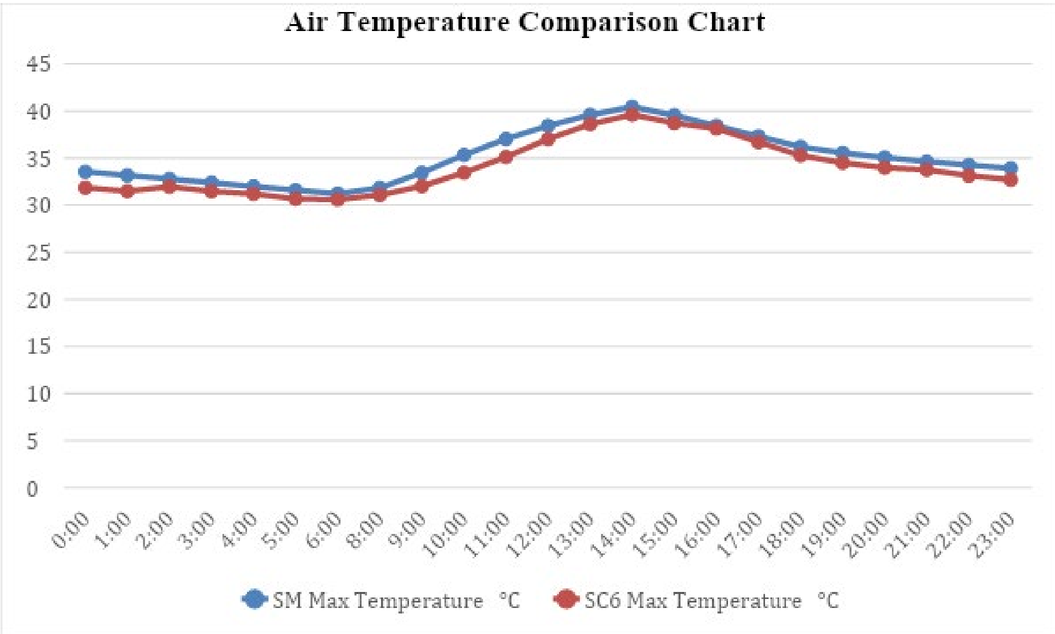


Figure 132.24 hour Comparison simulated graph of Maximum Air Temperature values between SM and SC8, August 13,2019

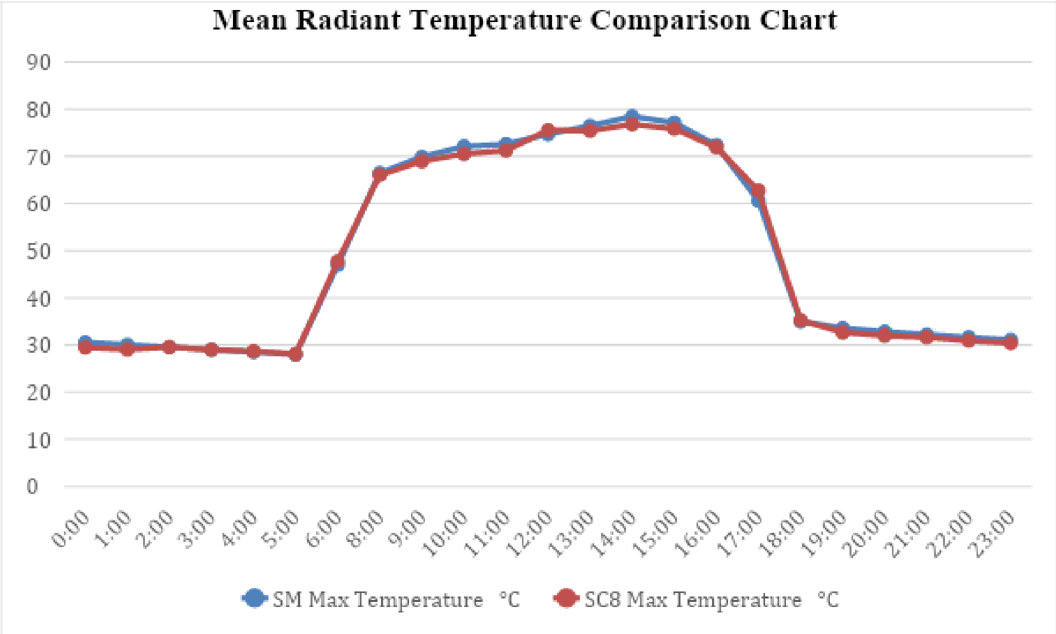


Figure 133.24 hour Comparison simulated graph of Maximum Mean Radiant Temperature values between SM and SC8, August 13,2019

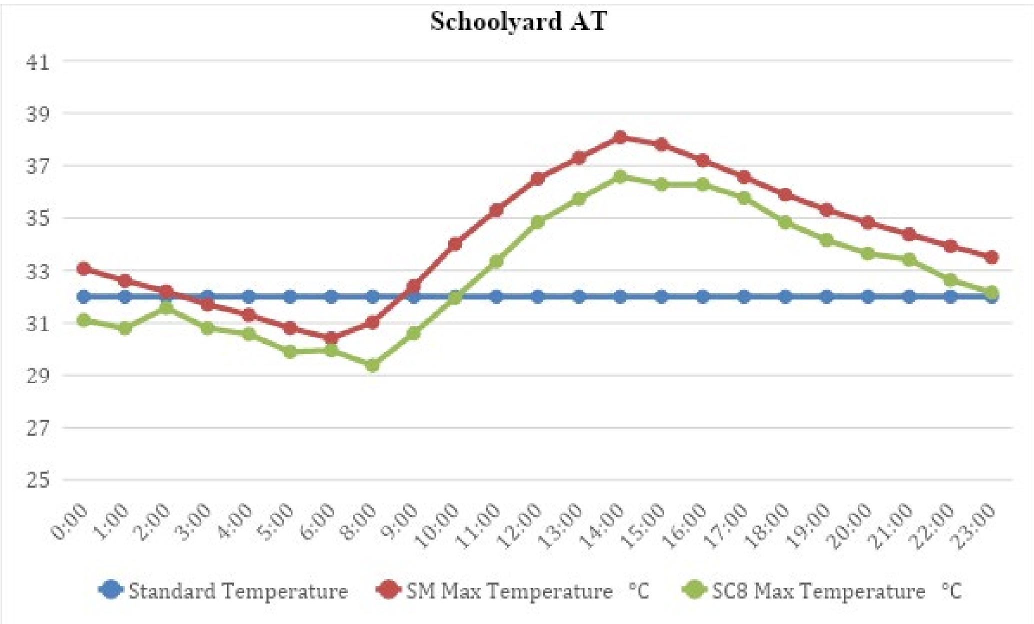


Figure 134.Air Temperature Comparison Graphs at 30,39 Grid between Scenario 1 and 8 in August 13,2019

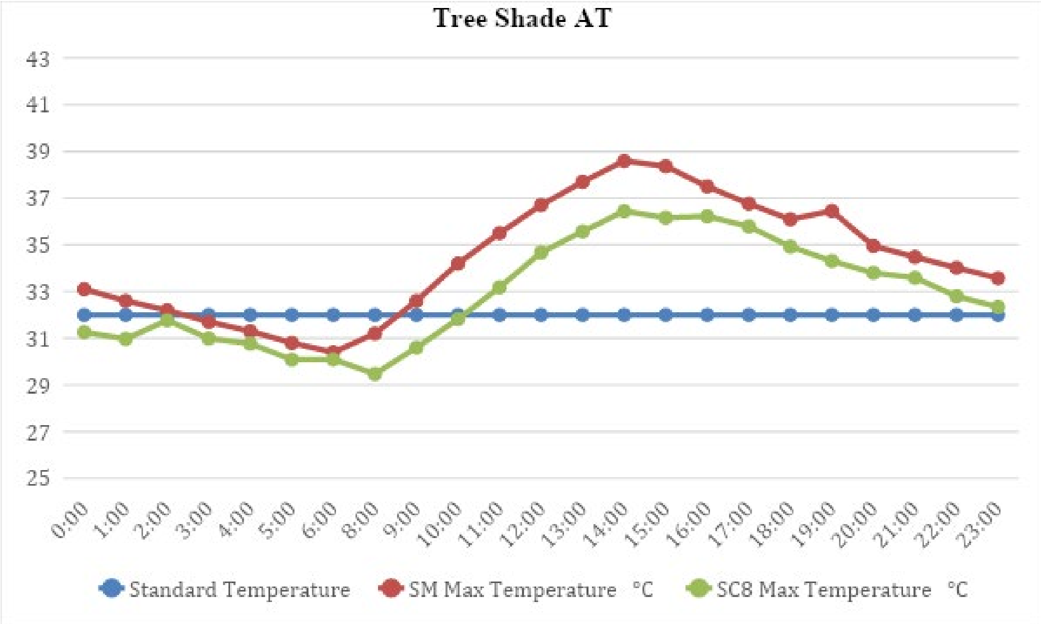


Figure 135.Air Temperature Comparison Graphs at 36,24 Grid between Scenario 1 and 8 in August 13,2019

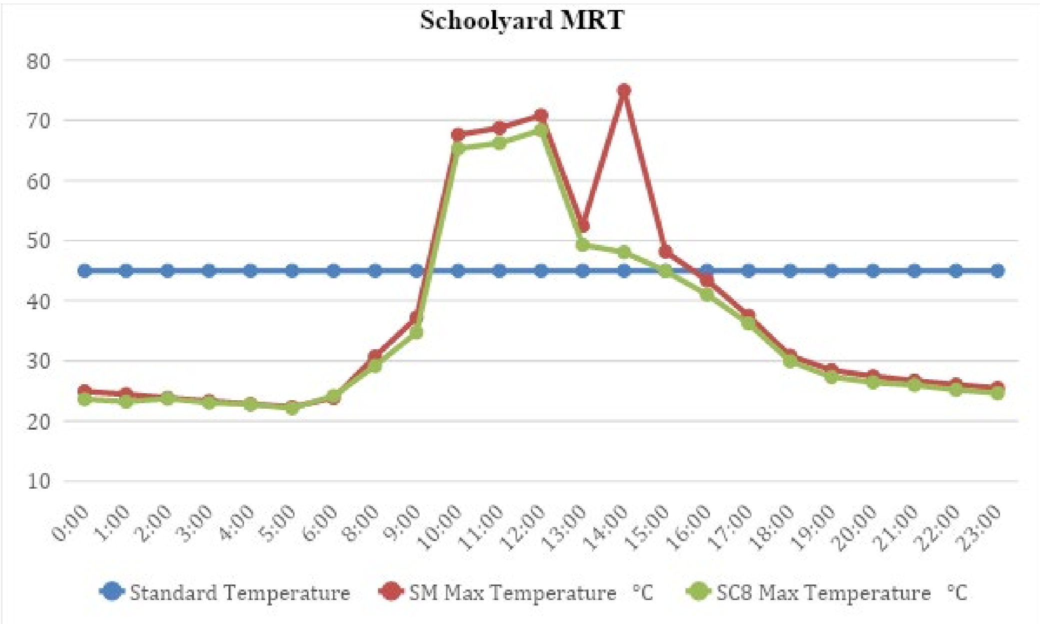


Figure 136.Mean Radiant Temperature Comparison Graphs at 30,39 Grid between Scenario 1 and 8 in August 13,2019

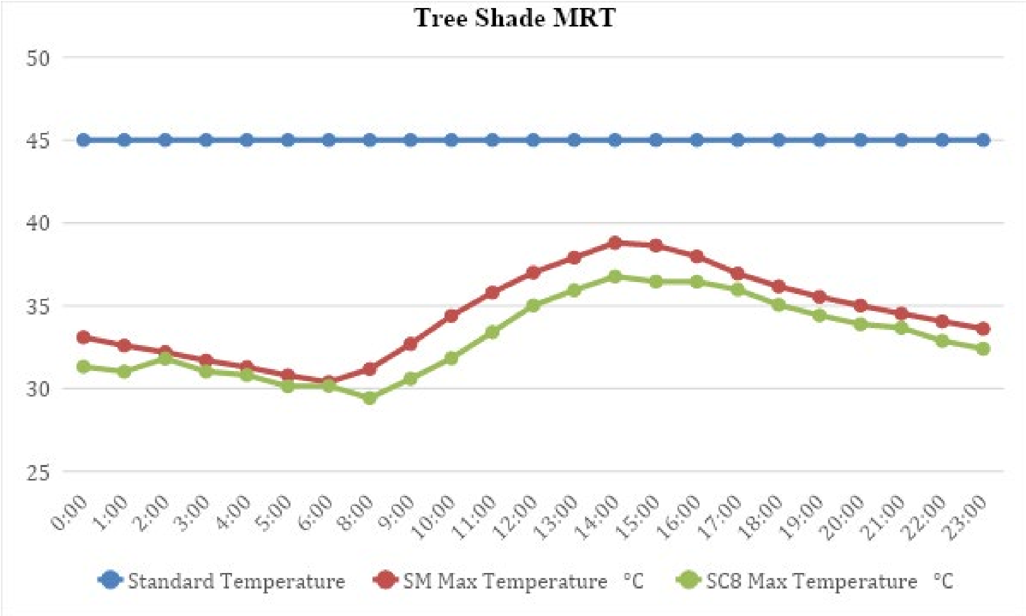


Figure 137.Mean Radiant Temperature Comparison Graphs at 36,24 Grid between Scenario 1 and 8 in August 13,2019

CHAPTER 7

CONCLUSIONS

7.1 Conclusions

This thesis investigates and expands on the UHI phenomenon, its contributing factors, repercussions, and mitigation measures. Because the impact of UHI is most widespread in disadvantaged countries, this study focused on Tirana, Albania. The thesis' primary target group was babies, toddlers, and caregivers, who are today the world's most vulnerable population.

Only one site, a modern primary and secondary school in the heart of Albania's capital city, was chosen for study to obtain the most precise information. The first step was to collect data from appropriate resources in order to acquire precise study results.

The meteorological data for the given area were gathered during the warmest summer month, August 2019, and then uploaded to the ENVI-met software. The collected data were compared in order to get a better understanding of the factors that impact the UHI phenomenon and which mitigation techniques operate best. The sidewalk area and the main vehicular highway near to the school were chosen for testing optimization scenarios because the thesis focuses on the ITC group.

Finally, this study concentrated on the UHI phenomenon in a school building and its surroundings. This study was carried out by assessing and modeling existing and ideal scenarios of UHI influencing factors in order to recommend mitigation measures for this newly increasing issue in Tirana.

Because no earlier studies of the UHI phenomenon had been conducted in Tirana, the school building was highlighted in the thesis. According to the findings, UHI is present everywhere and must be minimized by increasing the number of suitable vegetation and reflecting surface paving materials, which lessen the intensity of the UHI. As a consequence, babies, toddlers, and caregivers live in a healthier environment.

7.2 Limitations of the study

A variety of issues hindered the study's results, restricting the research technique and conclusions. Temperature measurements within classrooms in the school building, a lack of surveys with students, a paucity of weather measuring equipment, and the computer tools used for simulations are all drawbacks of this study.

Meteorological stations were required to collect appropriate analyses of the related issue. Tirana had a modest number of meteorological stations, the most of which were personal and located a great distance from the designated location. As a result, the data cannot be considered entirely accurate.

The ENVI-met software was the second constraint. This software's Student Version was utilized, which resulted in a general limitation of capabilities for providing more comprehensive simulation results. The primary restriction was the grid size, as larger gride sizes took too long to finish the simulation or stopped the runs.

Another significant constraint was the Co-Vid19 pandemic situation, which made it difficult to access the school building premises to obtain more detailed data and conduct surveys with children to understand the thermal comfort inside the school setting. Given that the thesis's focus was on infants, toddlers, and caregivers, both data collection and questionnaires would have had a significant influence on reducing UHI occurrences and assessing ITC thermal comfort.

7.3 Recommendations for future research

Future recommendations on this issue might concentrate on incorporating new UHI mitigation methods and surface paving materials that are available in Albania.

A cost-benefit analysis of the mitigating impact of each approach utilized is a required future strategy in order to properly control expenses given Albania's low revenue.

To summarize, future study can focus on the building size by expanding more on the thermal comfort of ITC inside the school premises, taking into account the relevance of UHI. As a result, it is critical to comprehend the link between the outside and inside environments, as well as how UHI influences both.

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APPENDIX A

Table 12. Scenario 1 hourly simulation values of Mean Radiant Temperatures on 13 August 2019

Mean Radiant Temperature		
Hour	Min Temperature °C	Max Temperature °C
0:00	24.43	30.56
1:00	23.92	30.04
2:00	23.43	29.52
3:00	22.94	29.01
4:00	22.47	28.51
5:00	22	28
6:00	23.32	46.97
8:00	29.84	66.43
9:00	36.46	69.85
10:00	42.6	72.1
11:00	47.09	72.57
12:00	50.34	74.68
13:00	51.55	76.46
14:00	50.84	78.46
15:00	47.88	77.12
16:00	43.22	72.31
17:00	37.44	60.58
18:00	30.51	34.97
19:00	28.05	33.57
20:00	26.93	32.8
21:00	26.14	32.17
22:00	25.51	31.61
23:00	24.96	31.08

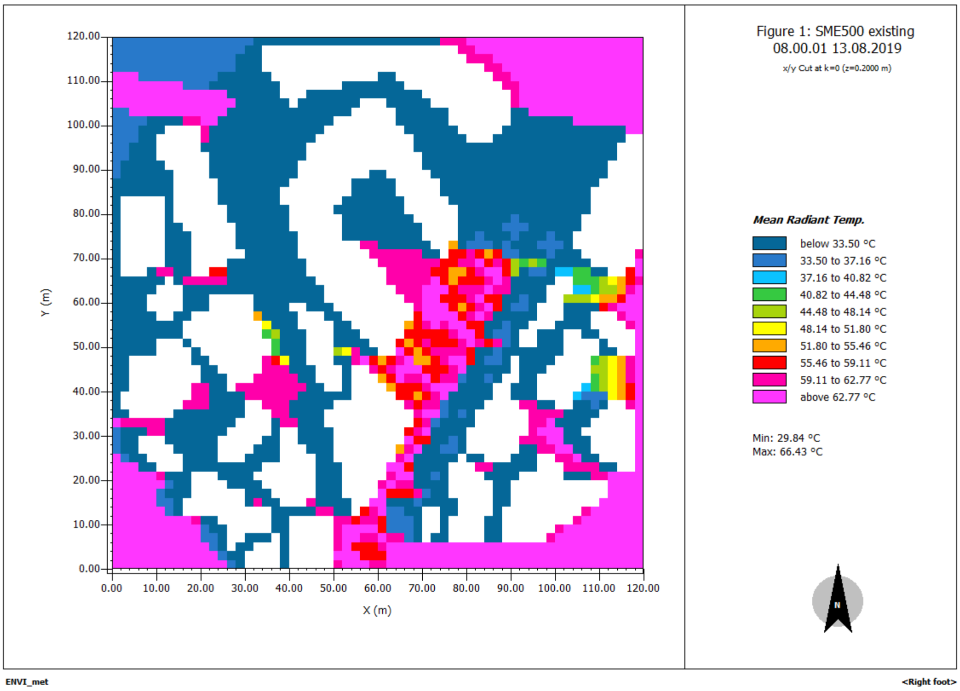

Figure 138.Simulated mean radiant temperatures for scenario 1 at 8:00 AM August 13, 2019

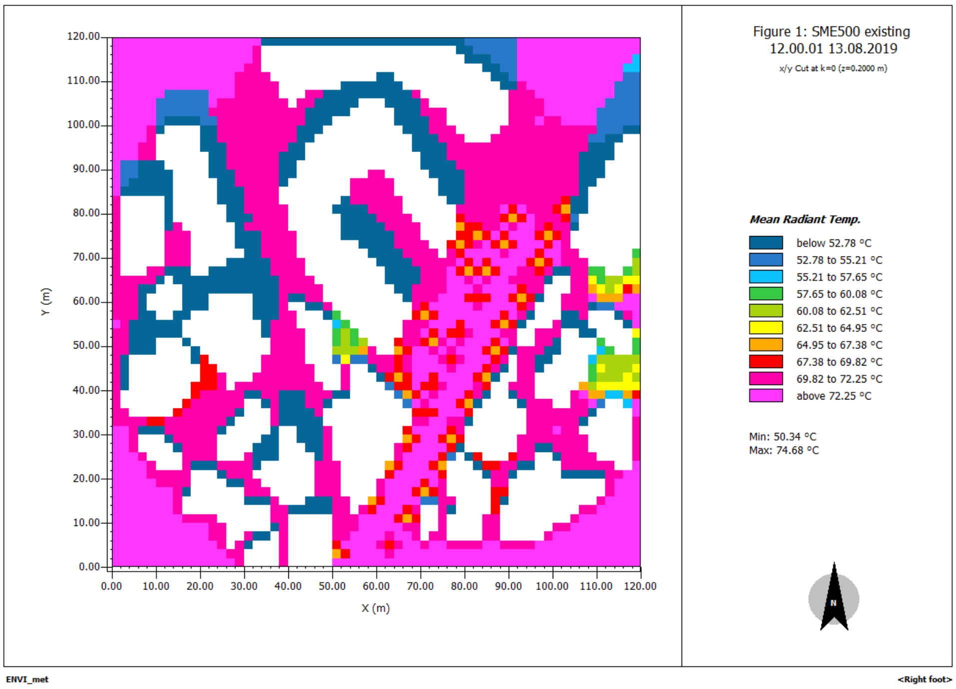

Figure 139.Simulated mean radiant temperatures for scenario 1 at 12:00 AM August 13, 2019

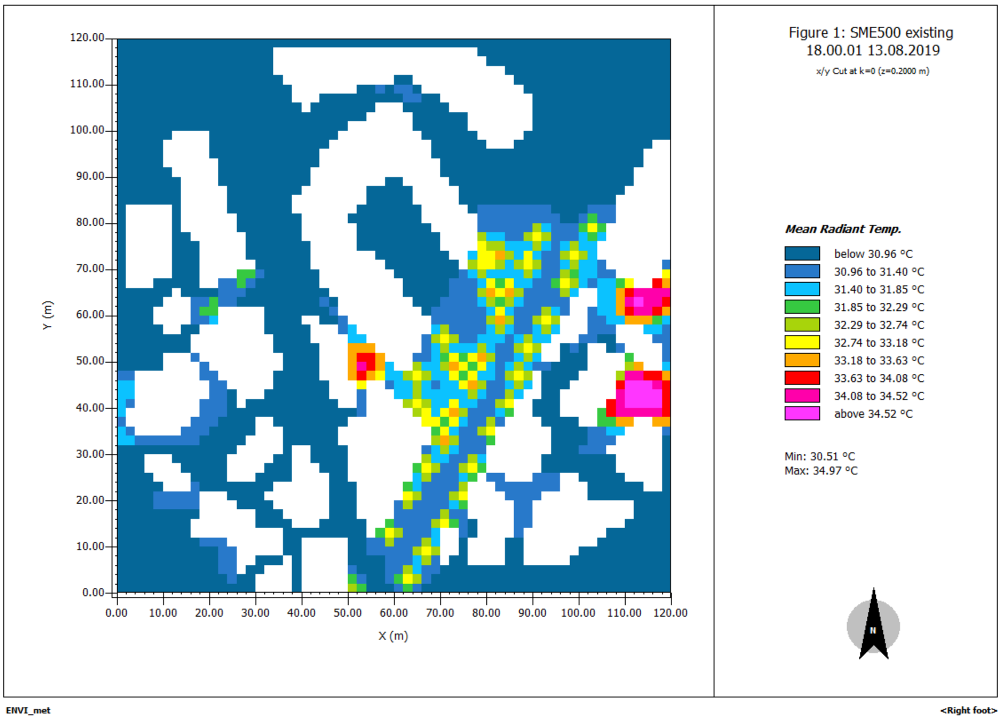

Figure 140.Simulated mean radiant temperatures for scenario 1 at 18:00 PM August 13, 2019

APPENDIX B

Table 13. Scenario 1 hourly simulation values of Air Temperatures on 13 August 2019

Air Temperature		
Hour	**Min Temperature °C**	**Max Temperature °C**
0:00	22.9	33.53
1:00	23.08	33.15
2:00	23.24	32.77
3:00	23.39	32.38
4:00	23.51	31.98
5:00	23.3	31.59
6:00	23.03	31.22
8:00	19.85	31.82
9:00	19.86	33.43
10:00	19.88	35.32
11:00	19.94	37.02
12:00	20.03	38.42
13:00	20.16	39.57
14:00	20.33	40.43
15:00	20.55	39.53
16:00	20.8	38.42
17:00	21.09	37.3
18:00	21.38	36.18
19:00	21.68	35.55
20:00	21.96	35.06
21:00	22.23	34.62
22:00	22.48	34.25
23:00	22.7	33.9

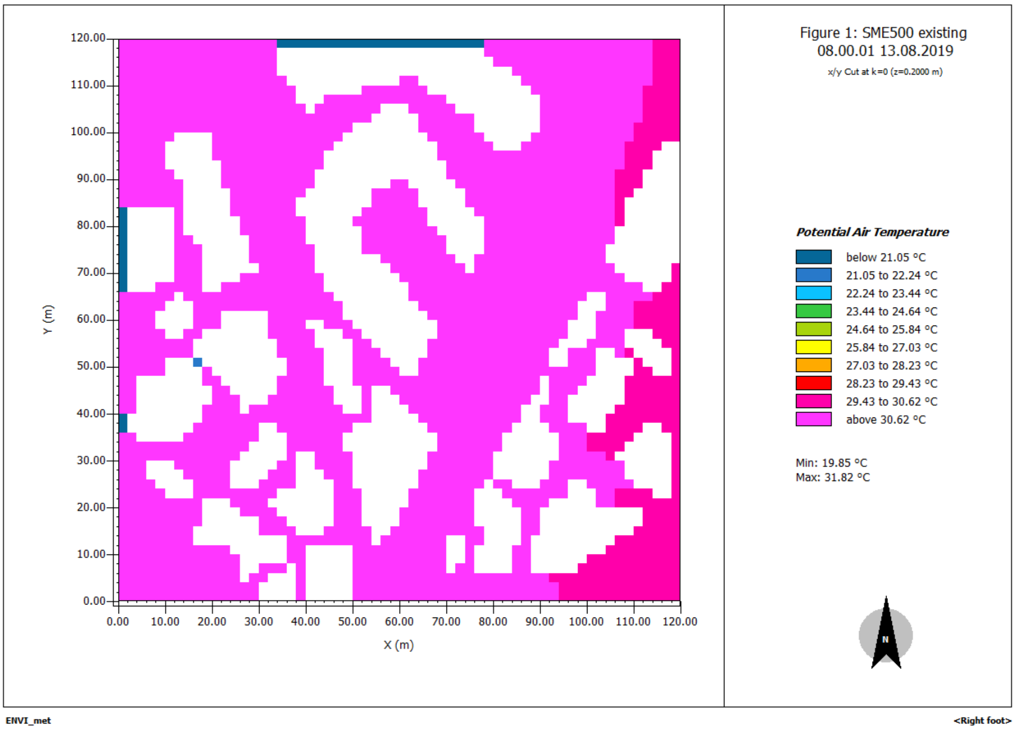

Figure 141.Simulated air temperatures for scenario 1 at 08:00 AM August 13,2019

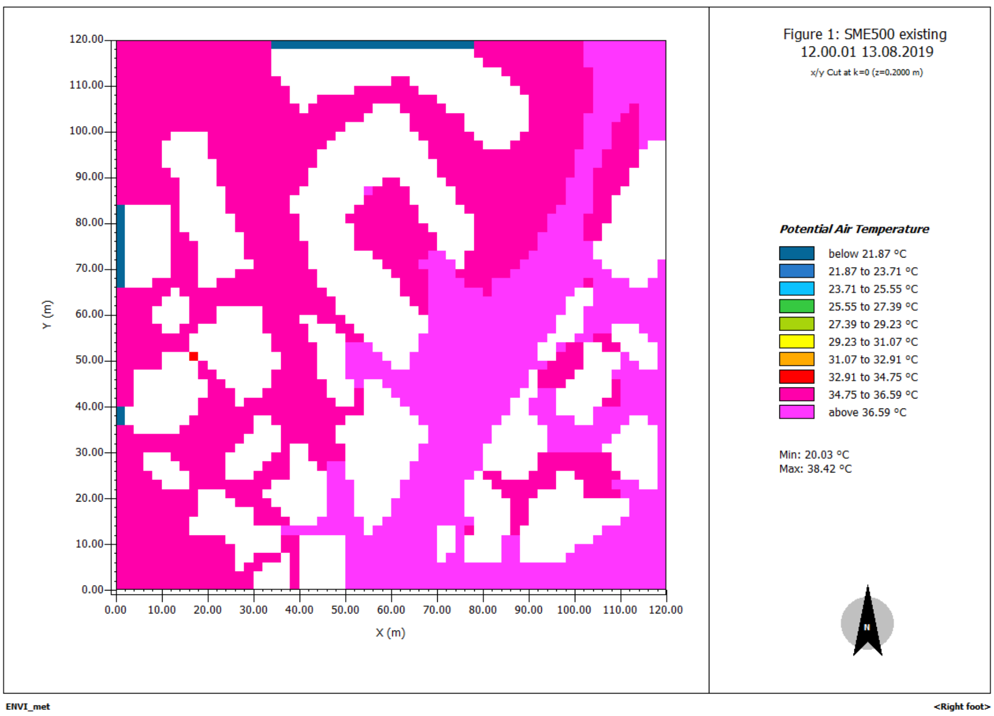

Figure 142.Simulated air temperatures for scenario 1 at 12:00 PM August 13,2019

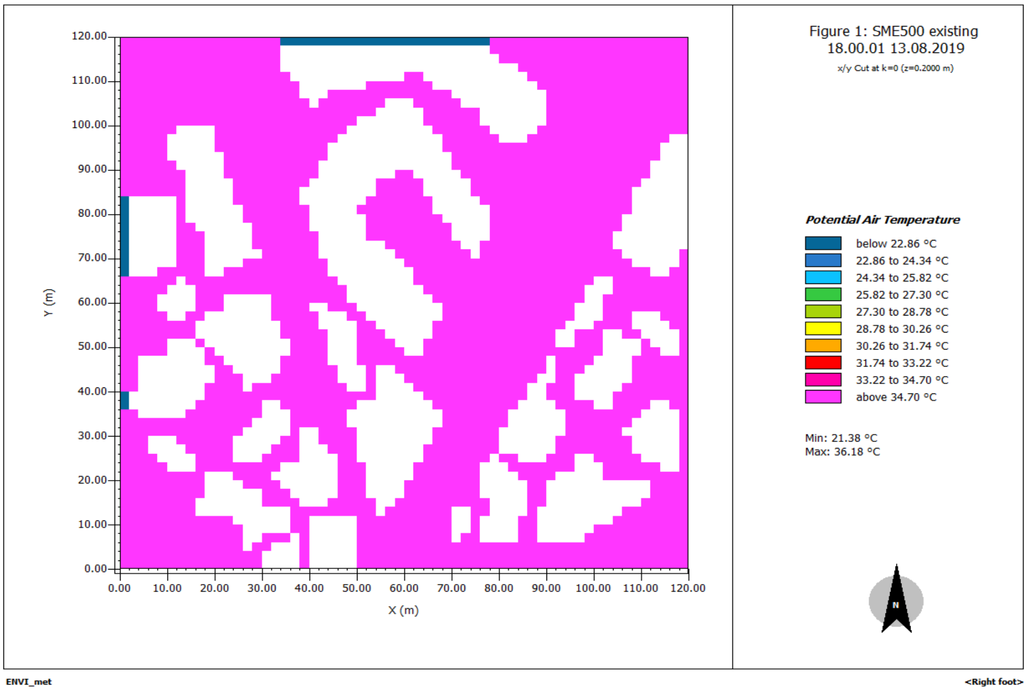

Figure 143.Simulated air temperatures for scenario 1 at 18:00 PM August 13,2019

APPENDIX C

Table 14. Scenario 1 hourly simulation values of Relative Humidity on 13 August 2019

	Relative Humidity	
Hour	**Min %**	**Max %**
0:00	45.79	73.08
1:00	45.91	74.64
2:00	45.65	74.86
3:00	45.3	74.76
4:00	44.9	74.17
5:00	44.44	73.5
6:00	43.94	72.62
8:00	41.76	77.39
9:00	39.82	77.36
10:00	36.97	77.23
11:00	34.85	76.97
12:00	33.13	76.54
13:00	31.4	75.93
14:00	30.18	75.12
15:00	31.59	74.13
16:00	33.32	72.98
17:00	35.45	71.7
18:00	38.05	70.41
19:00	39.78	69.15
20:00	41.06	67.95
21:00	42.28	66.85
22:00	43.47	65.86
23:00	44.62	69.59

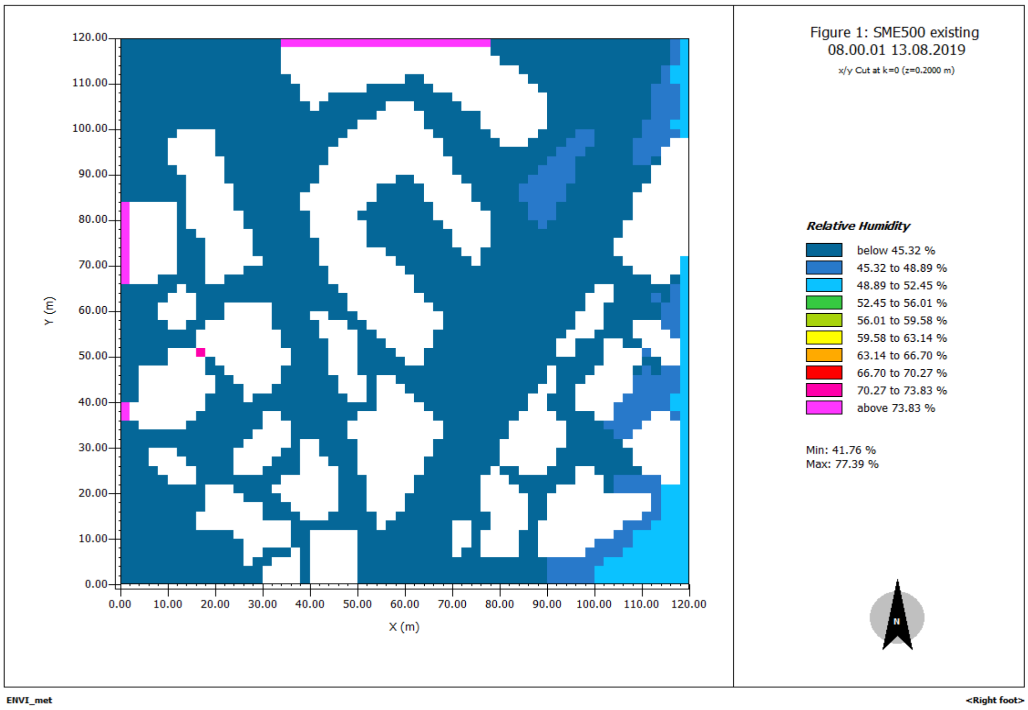

Figure 144.Simulated relative humidity for scenario 1 at 08:00 AM August 13,2019

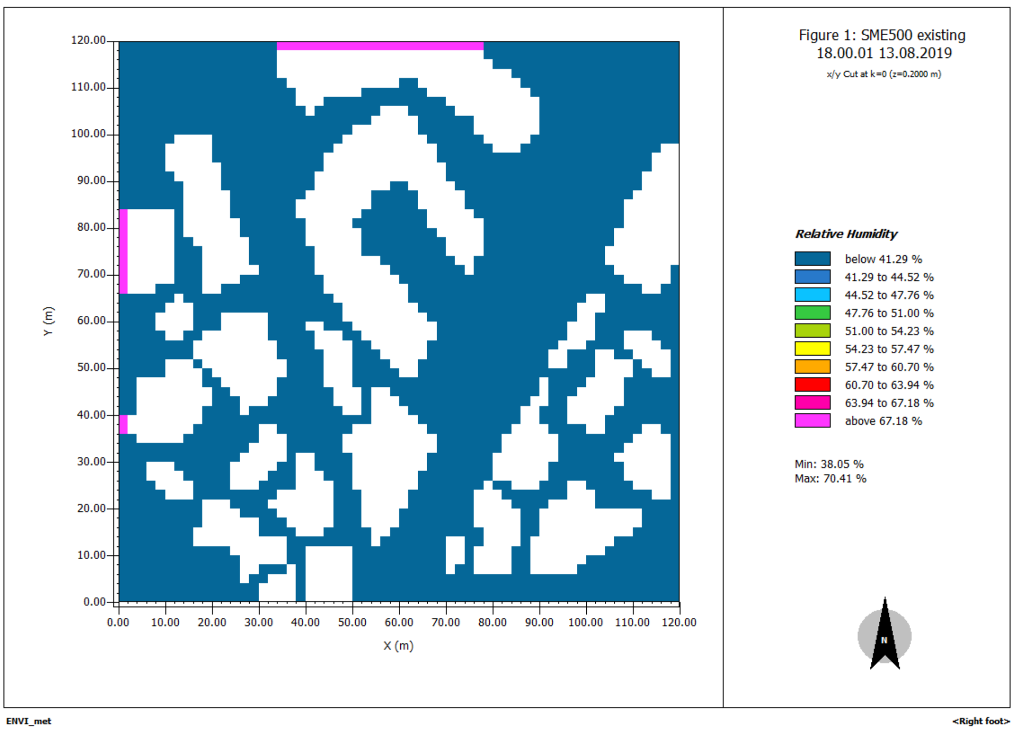

Figure 145. Simulated relative humidity for scenario 1 at 18:00 PM August 13,2019

APPENDIX D

Table 15. Scenario 2 hourly simulation values of Air Temperature on 13 August 2019

Air Temperature		
Hour	**Min Temperature °C**	**Max Temperature °C**
0:00	22.93	33.58
1:00	23.11	33.2
2:00	23.28	32.81
3:00	23.42	32.42
4:00	23.56	32.02
5:00	23.5	32.5
6:00	20.5	31.9
8:00	19.85	31.84
9:00	19.86	33.49
10:00	19.88	35.4
11:00	19.94	37.13
12:00	20.03	38.59
13:00	20.16	39.77
14:00	20.34	40.64
15:00	20.55	39.88
16:00	20.81	38.71
17:00	21.1	37.48
18:00	21.4	36.3
19:00	21.7	35.64
20:00	21.99	35.13
21:00	22.26	34.69
22:00	22.5	34.32
23:00	22.73	33.96

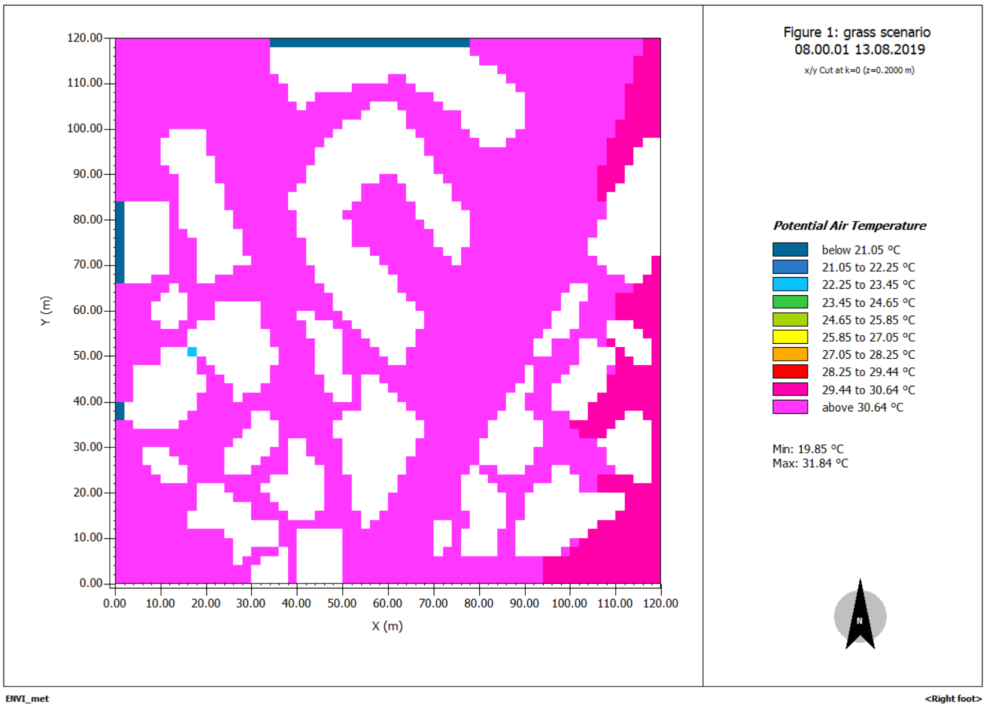

Figure 146.Simulated air temperatures for scenario 2 at 08:00 AM August 13,2019

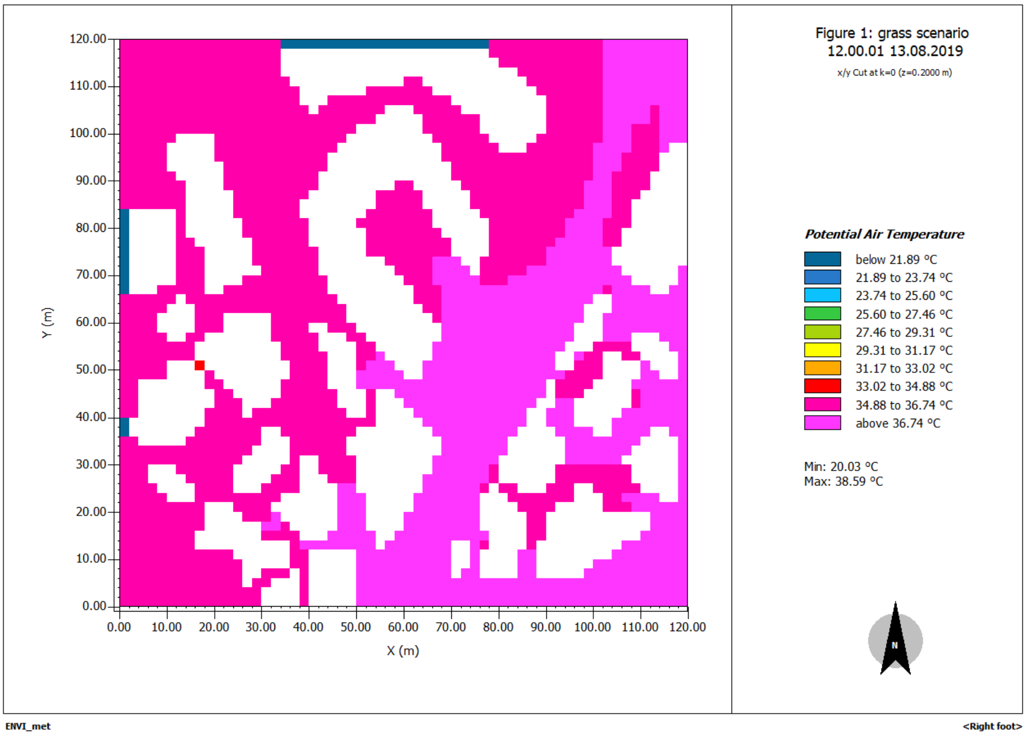

Figure 147.Simulated air temperatures for scenario 2 at 12:00 AM August 13,2019

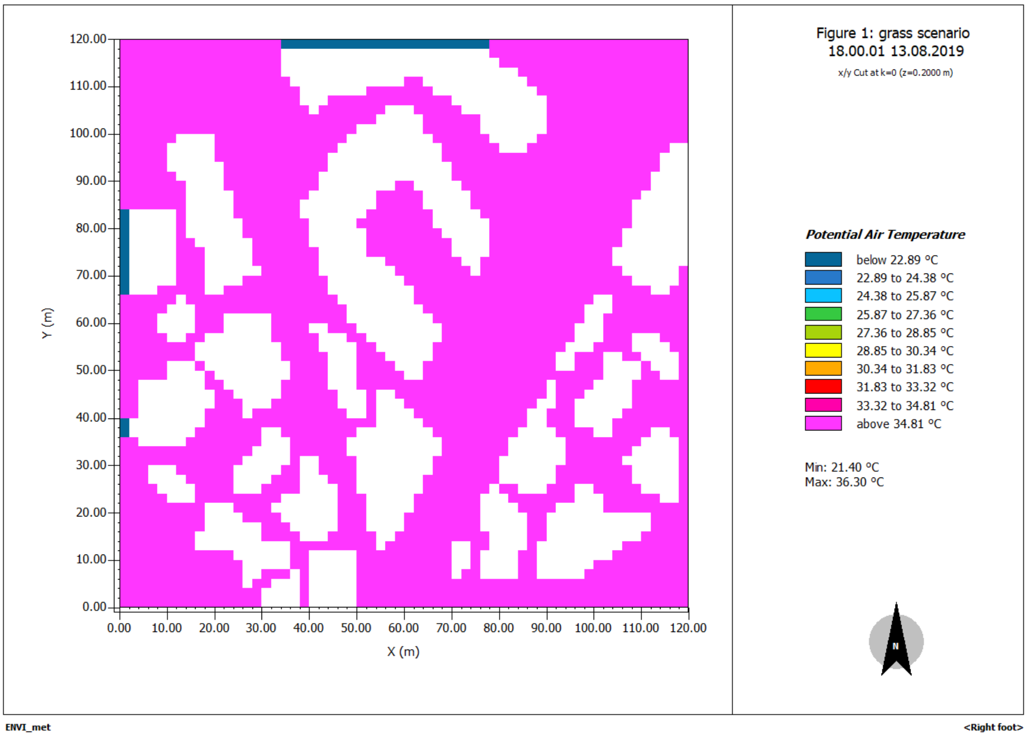

Figure 148.Simulated air temperatures for scenario 1 at 18:00 PM August 13,2019

APPENDIX E

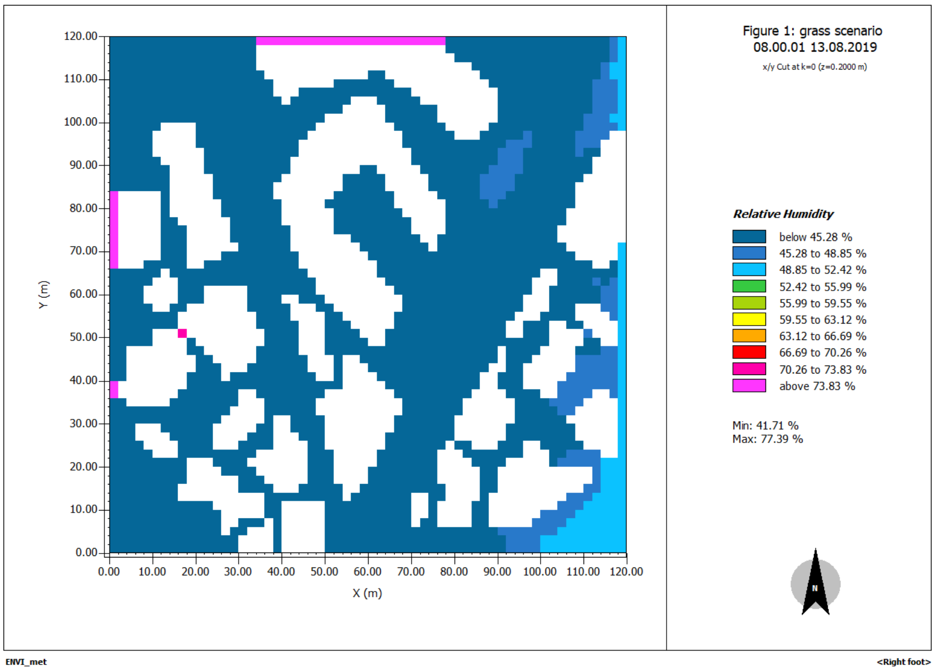

Figure 149.Simulated relative humidity for scenario 2 at 08:00 AM August 13,2019

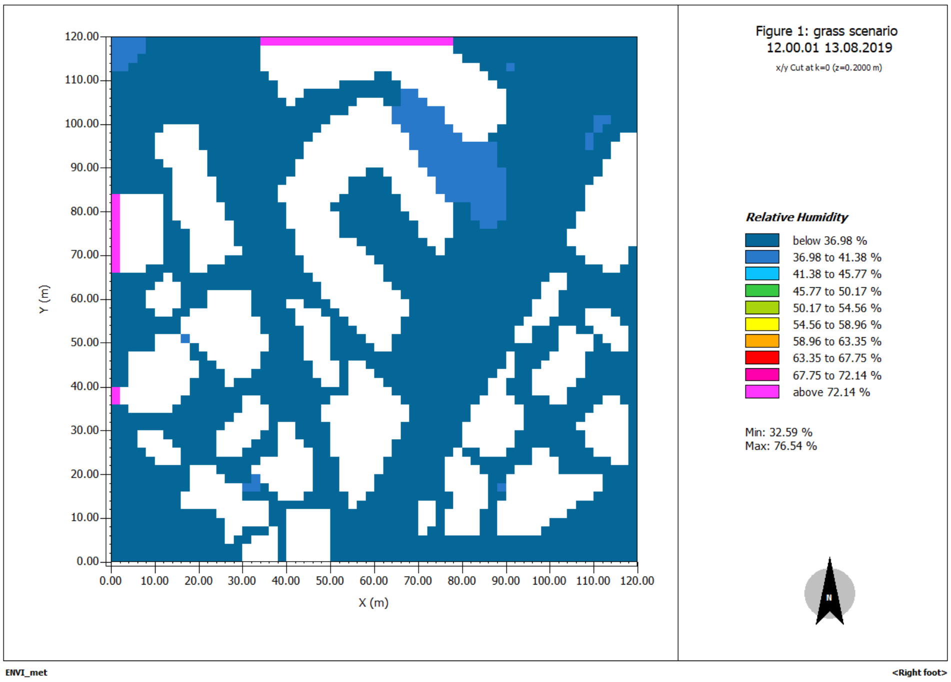

Figure 150.Simulated relative humidity for scenario 2 at 12:00 AM August 13,2019

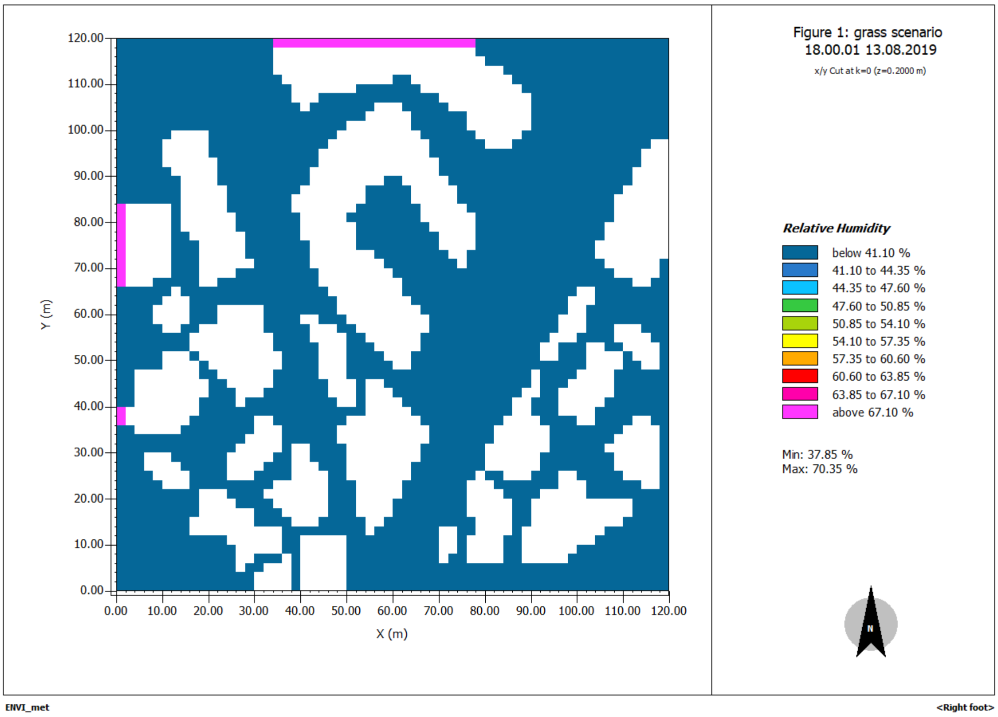

Figure 151. Simulated relative humidity for scenario 2 at 18:00 PM August 13,2019

APPENDIX F

Table 16. Scenario 2 hourly simulation values of Mean Radiant Temperatures on 13 August 2019

Mean Radiant Temperature		
Hour	**Min Temperature °C**	**Max Temperature °C**
0:00	24.69	30.75
1:00	24.16	30.21
2:00	23.65	29.68
3:00	23.15	29.15
4:00	22.66	28.63
5:00	23.55	30.2
6:00	25.67	45.67
8:00	29.95	66.55
9:00	36.71	70.11
10:00	43.04	72.6
11:00	47.71	73.02
12:00	51.06	75.24
13:00	52.22	77.01
14:00	51.4	78.9
15:00	48.38	77.53
16:00	43.71	72.71
17:00	37.93	60.95
18:00	30.91	35.34
19:00	28.44	33.89
20:00	27.29	33.09
21:00	26.48	32.44
22:00	25.82	31.85
23:00	25.24	31.3

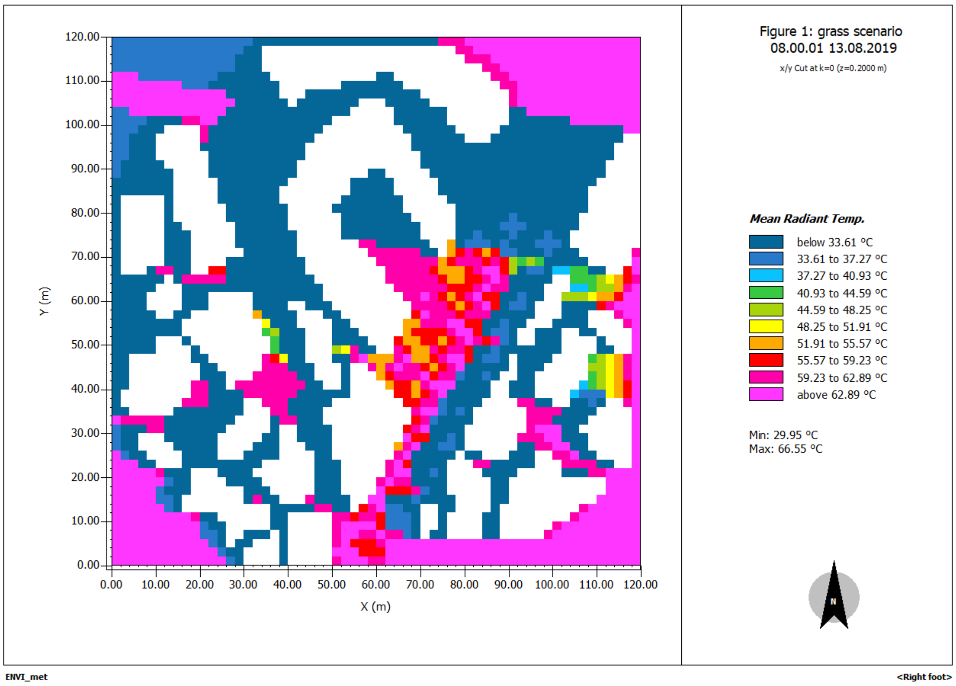

Figure 152. Simulated mean radiant temperatures for scenario 2 at 08:00 AM August 13

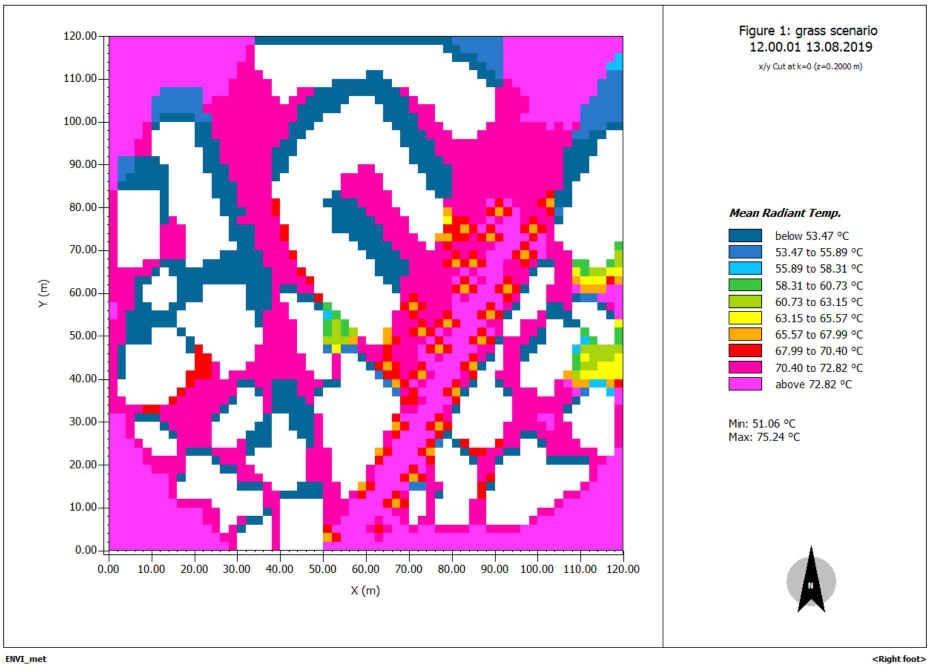

Figure 153. Simulated mean radiant temperatures for scenario 2 at 12:00 AM August 13

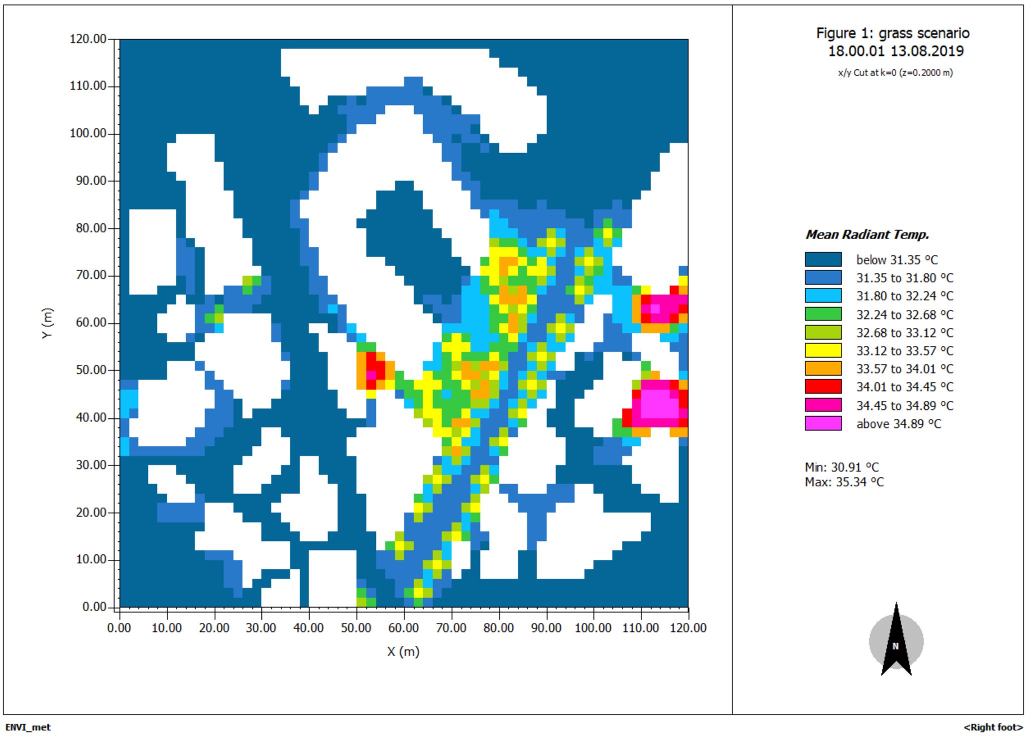

Figure 154.Simulated mean radiant temperatures for scenario 2 at 18:00 PM August 13

APPENDIX G

Table 17. Scenario 3 Hourly simulations of Air temperature on 13 August, 2019

Air Temperature		
Hour	**Min Temperature °C**	**Max Temperature °C**
0:00	22.72	34.46
1:00	22.9	33.09
2:00	23.05	32.71
3:00	23.19	32.32
4:00	22.99	31.92
5:00	22.61	31.52
6:00	22.33	31.13
8:00	19.85	31.72
9:00	19.86	33.02
10:00	19.88	34.91
11:00	19.94	36.52
12:00	20.02	37.81
13:00	20.14	38.91
14:00	20.3	39.76
15:00	20.5	39.01
16:00	20.74	38.05
17:00	21	36.84
18:00	21.29	35.95
19:00	21.57	35.42
20:00	21.84	34.99
21:00	22.09	34.59
22:00	22.32	34.18
23:00	22.53	33.83

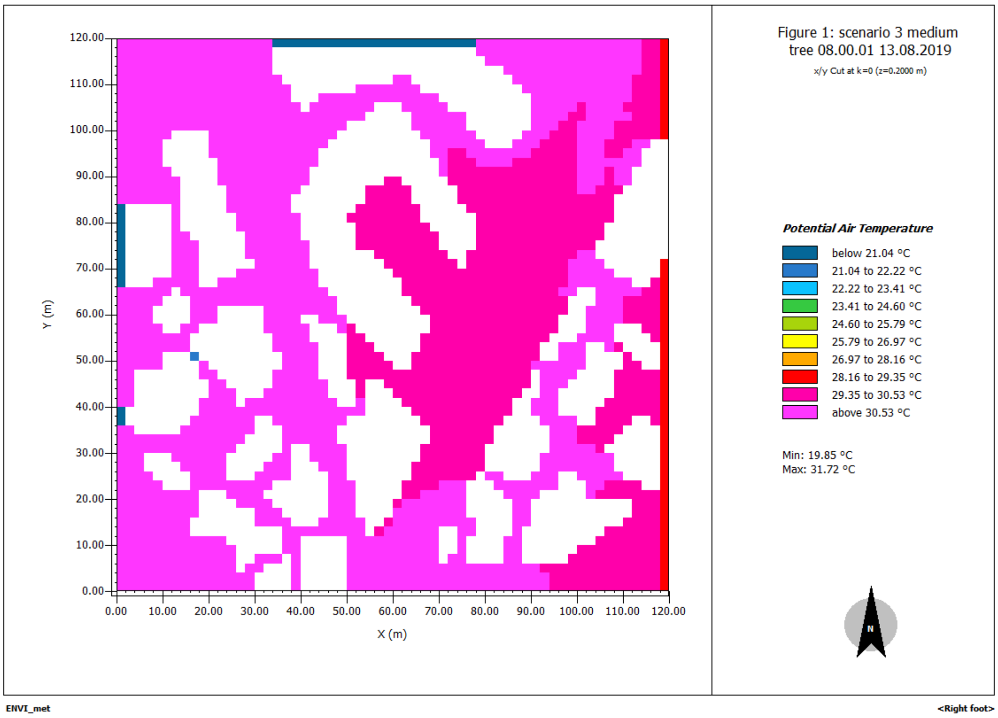

Figure 155.Simulated air temperatures for scenario 3 at 08:00 AM August 13

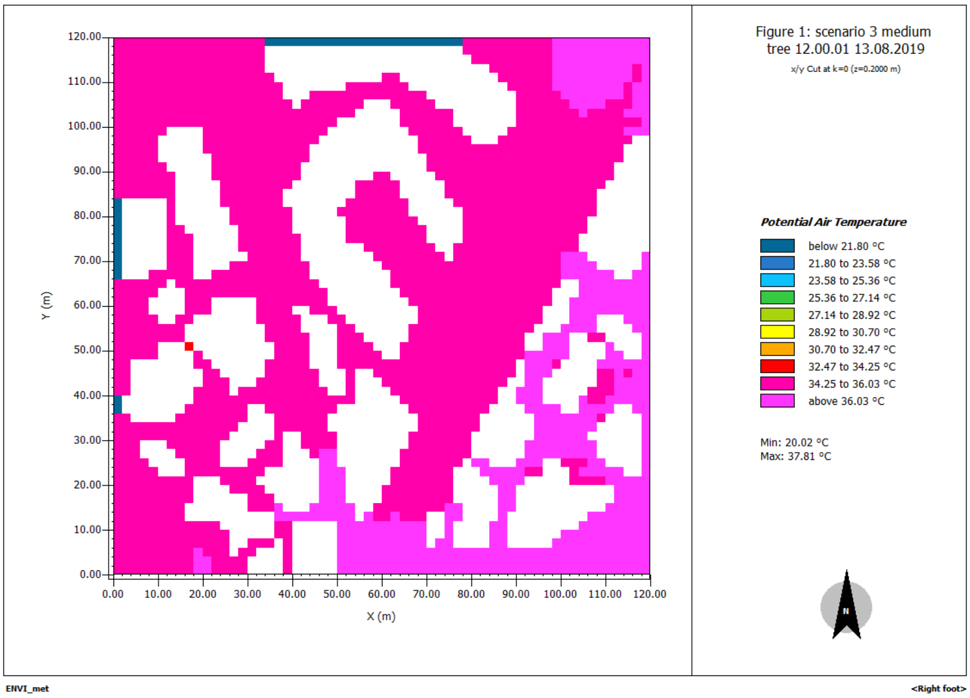

Figure 156.Simulated air temperatures for scenario 3 at 12:00 AM August 13

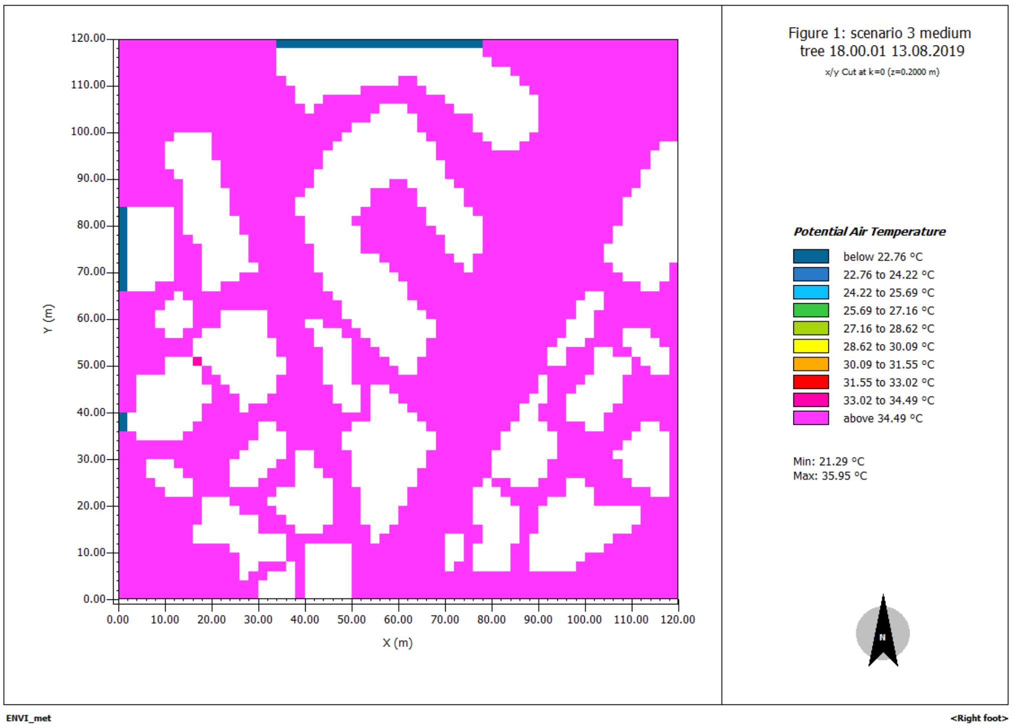

Figure 157.Simulated air temperatures for scenario 3 at 18:00 PM August 13

APPENDIX H

Table 18. Scenario 3 24 hours simulated Mean radiant temperatures on 13 August 2019

Mean Radiant Temperature		
Hour	**Min Temperature °C**	**Max Temperature °C**
0:00	24.35	30.84
1:00	23.89	30.36
2:00	23.43	29.88
3:00	22.98	29.4
4:00	22.54	28.92
5:00	22.08	28.45
6:00	23.27	47.33
8:00	27.41	65.23
9:00	33.11	67.83
10:00	38.46	69.11
11:00	42.25	69.66
12:00	44.62	71.11
13:00	45.71	72.8
14:00	45.03	74.38
15:00	43.02	74.03
16:00	39.69	69.87
17:00	35.67	59.77
18:00	29.85	34.5
19:00	27.43	33.4
20:00	26.5	32.78
21:00	25.85	32.26
22:00	25.31	31.78
23:00	24.82	31.31

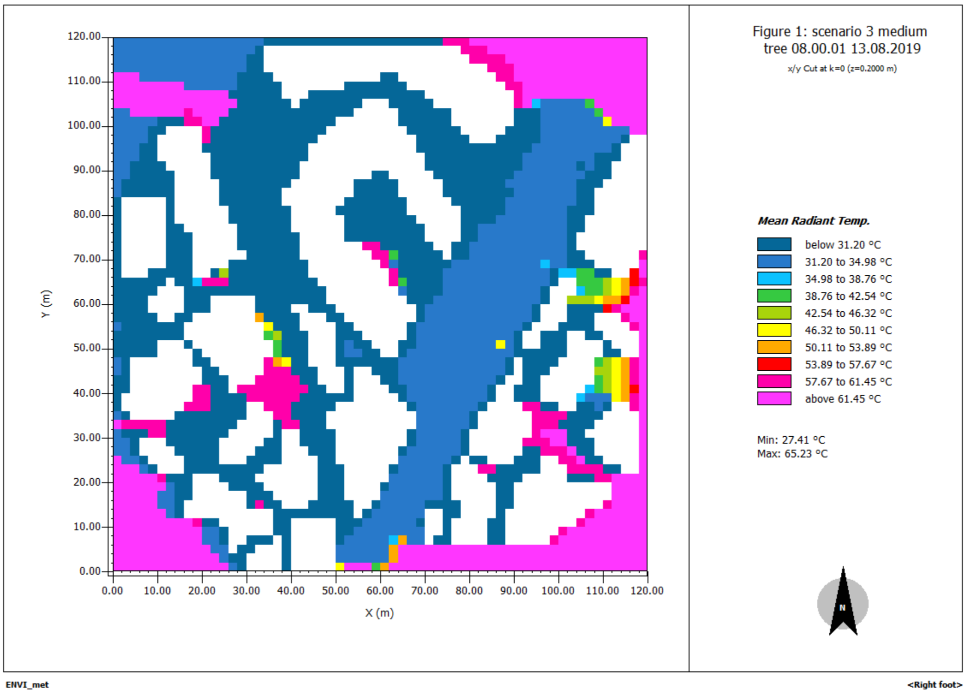

Figure 158.Simulated mean radiant temperatures for scenario 3 at 08:00 AM August 13,2019

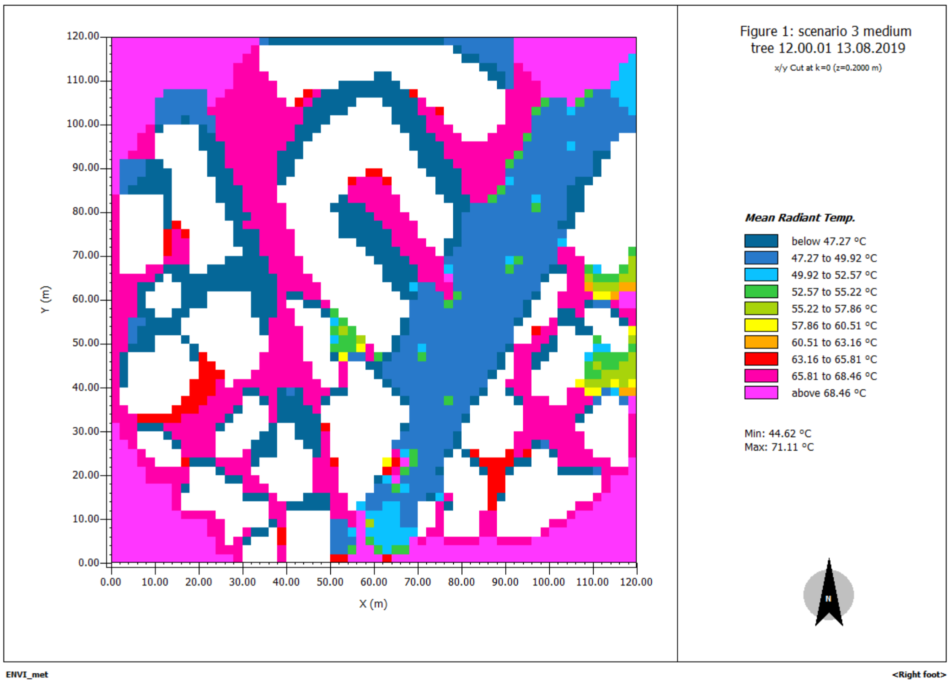

Figure 159.Simulated mean radiant temperatures for scenario 3 at 12:00 AM August 13,2019

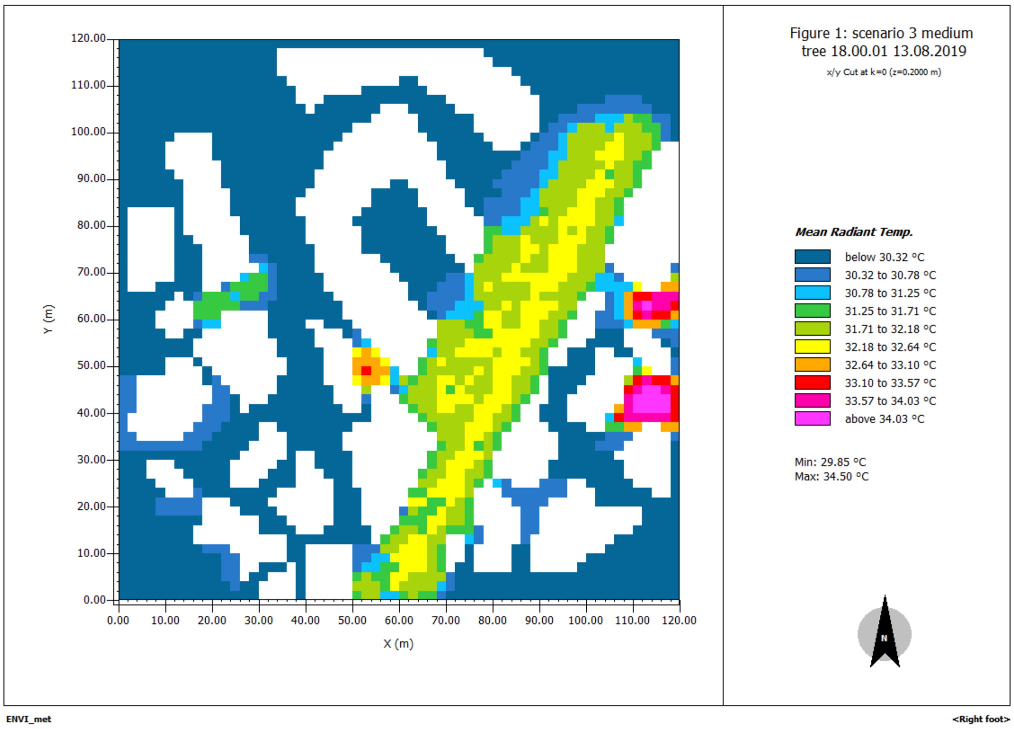

Figure 160.Simulated mean radiant temperatures for scenario 3 at 18:00 PM August 13,2019

APPENDIX I

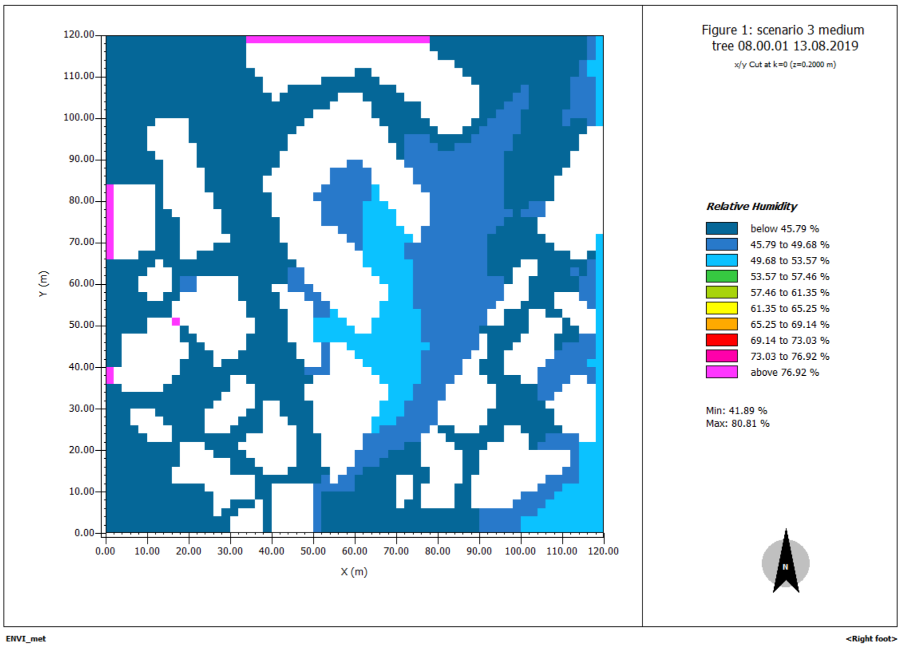

Figure 161.Simulated relative humidity for scenario 3 at 08:00 AM August 13,2019

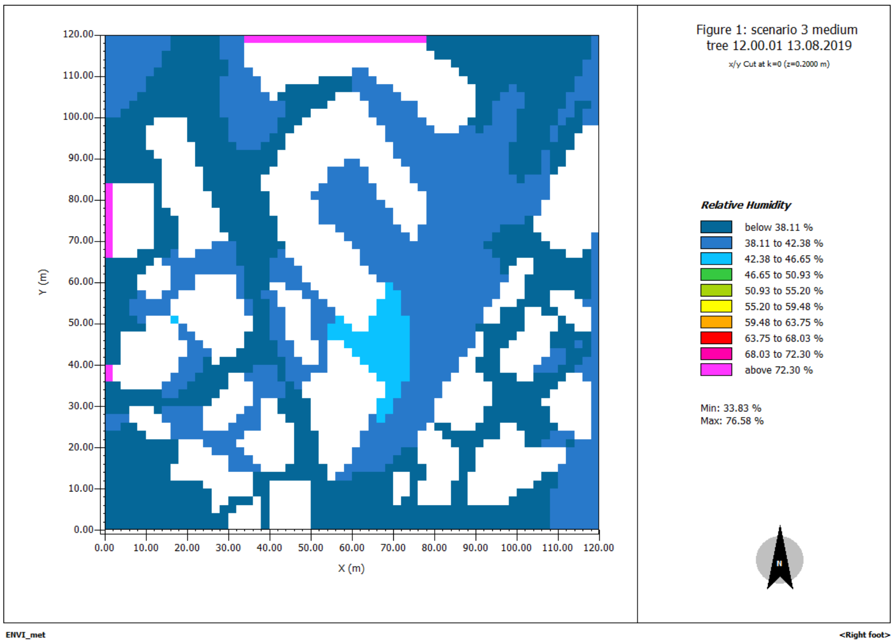

Figure 162.Simulated relative humidity for scenario 3 at 12:00 AM August 13,2019

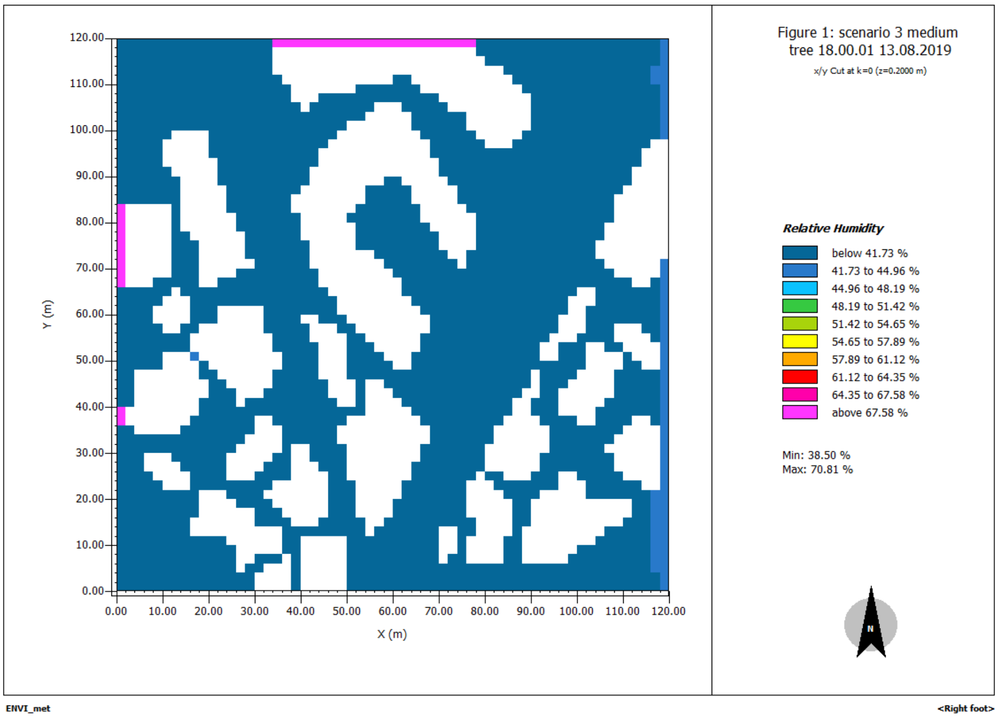

Figure 163.Simulated relative humidity for scenario 3 at 18:00 PM August 13,2019

APPENDIX J

Table 19. Scenario 4 24 hour simulated air temperature values on 13 August 2019

Air Temperature		
Hour	**Min Temperature °C**	**Max Temperature °C**
0:00	22.71	31.63
1:00	22.71	27.65
2:00	22.27	29.61
3:00	21.87	30.46
4:00	21.66	30.53
5:00	21.49	30.11
6:00	21.4	30.17
8:00	19.85	30.82
9:00	19.86	32.38
10:00	19.88	34.17
11:00	19.93	35.92
12:00	20.02	38.24
13:00	20.14	39.16
14:00	20.29	40.05
15:00	20.49	39.18
16:00	20.72	38.52
17:00	20.99	37.03
18:00	21.28	35.34
19:00	21.56	34.57
20:00	21.83	33.32
21:00	22.08	33.56
22:00	22.31	32.89
23:00	22.52	32.46

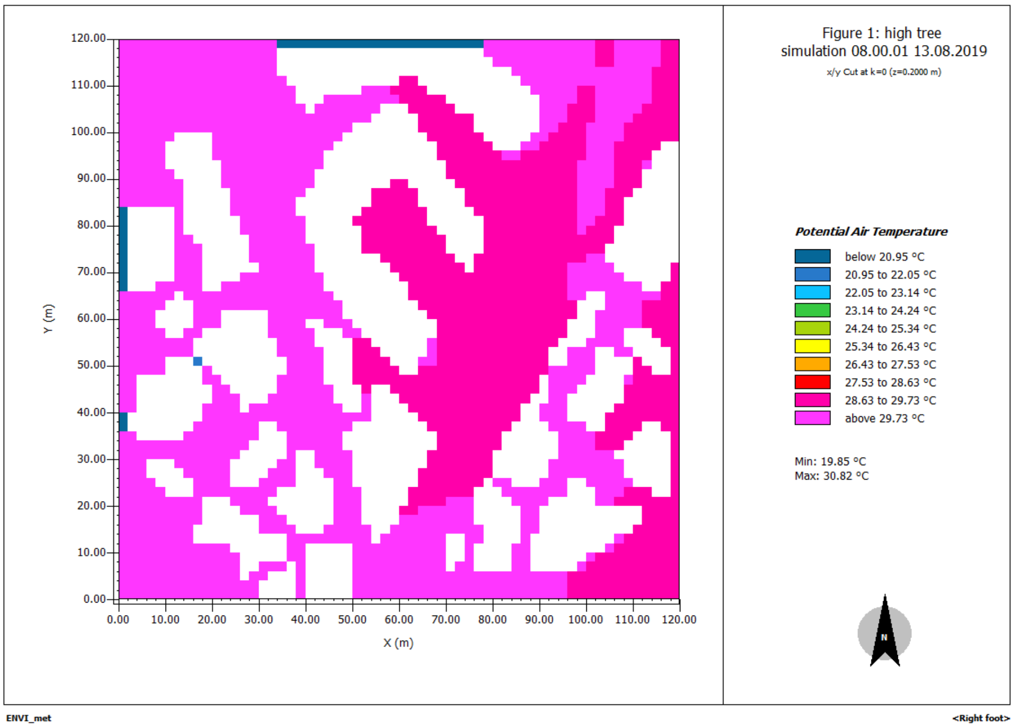

Figure 164.Simulated air temperatures for scenario 4 at 08:00 AM August 13,2019

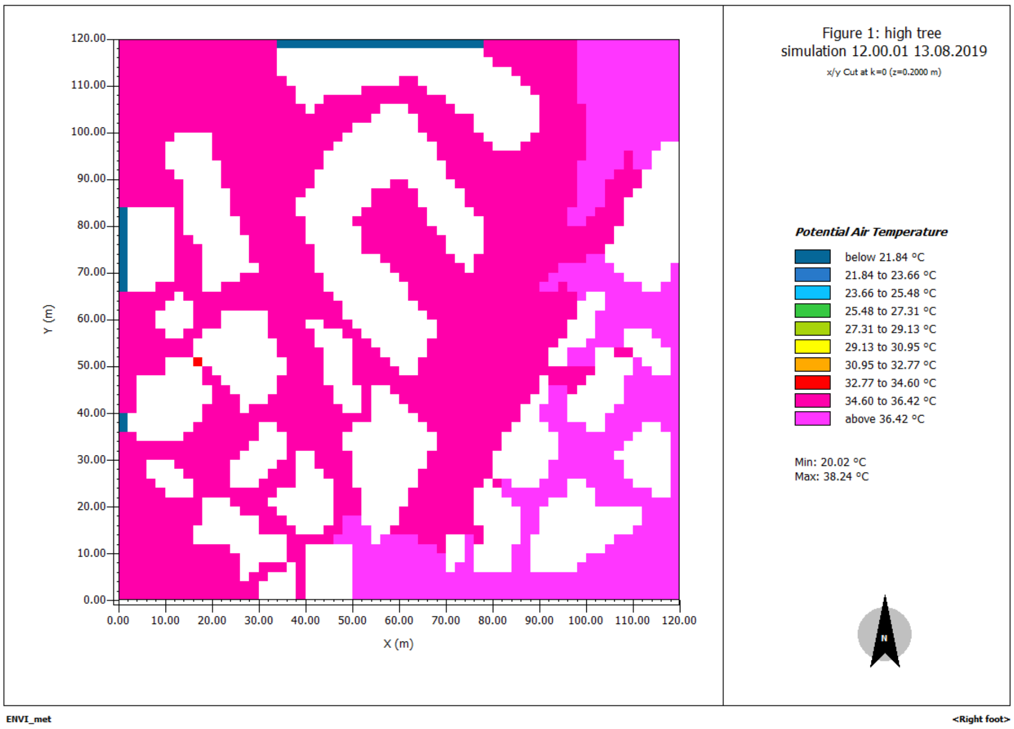

Figure 165.Simulated air temperatures for scenario 4 at 12:00 AM August 13,2019

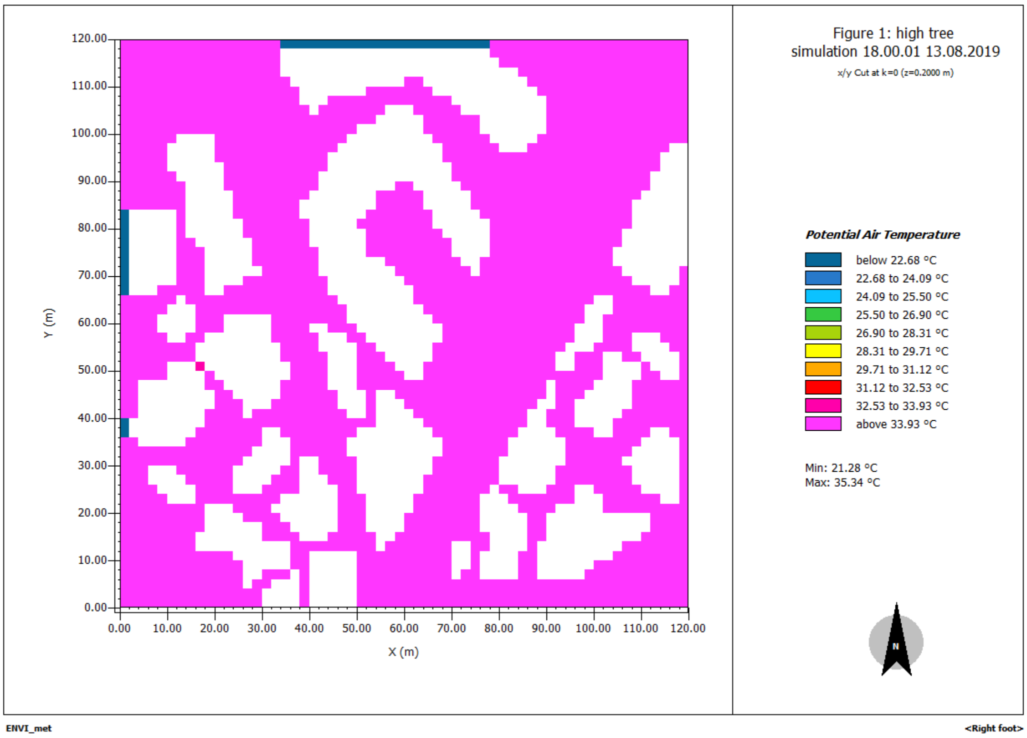

Figure 166.Simulated air temperatures for scenario 4 at 18:00 PM August 13,2019

APPENDIX K

Table 20. Scenario 4 MRT Values, 24 hours on 13 August 2019

Mean Radiant Temperature		
Hour	**Min Temperature °C**	**Max Temperature °C**
0:00	23.1	29.3
1:00	16.09	24.8
2:00	20.69	26.84
3:00	21.28	27.78
4:00	21.37	27.83
5:00	20.95	27.32
6:00	22.71	47.18
8:00	27.32	65.71
9:00	33.17	68.7
10:00	38.8	70.34
11:00	42.93	71.08
12:00	45.95	73.11
13:00	46.99	74.78
14:00	46.19	76.22
15:00	43.93	75.02
16:00	40.68	70.67
17:00	36.58	62.86
18:00	29.94	35.11
19:00	27.34	33
20:00	25.69	31.54
21:00	25.33	31.52
22:00	24.66	30.88
23:00	24.09	30.31

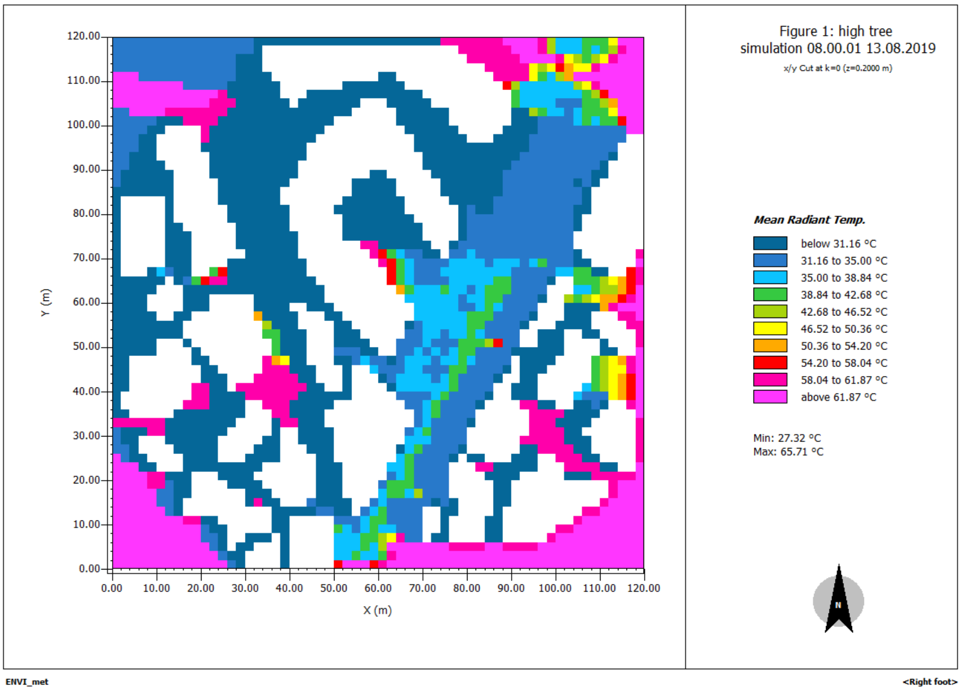

Figure 167.Simulated mean radiant temperatures for scenario 4 at 08:00 AM August 13, 2019

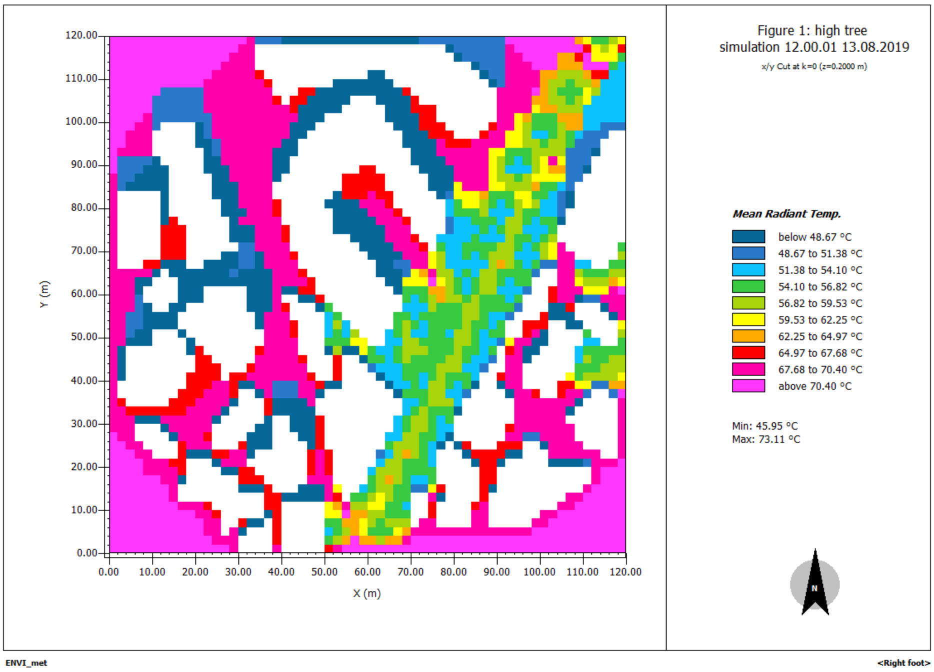

Figure 168. Simulated mean radiant temperatures for scenario 4 at 12:00 AM August 13, 2019

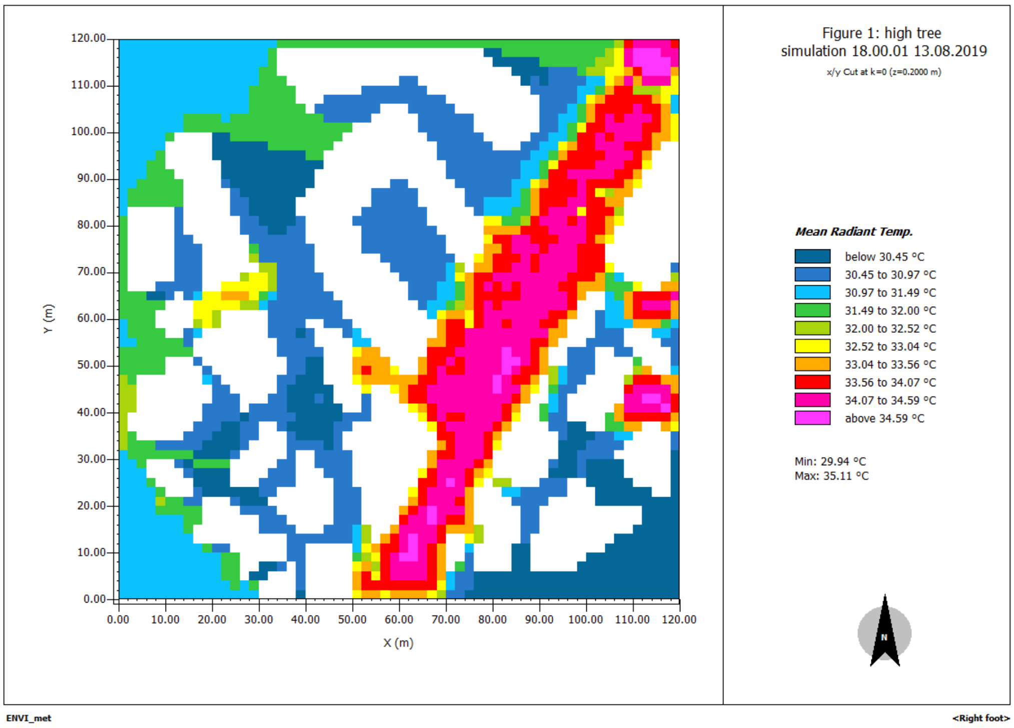

Figure 168. Simulated mean radiant temperatures for scenario 4 at 18:00 PM August 13, 2019

APPENDIX L

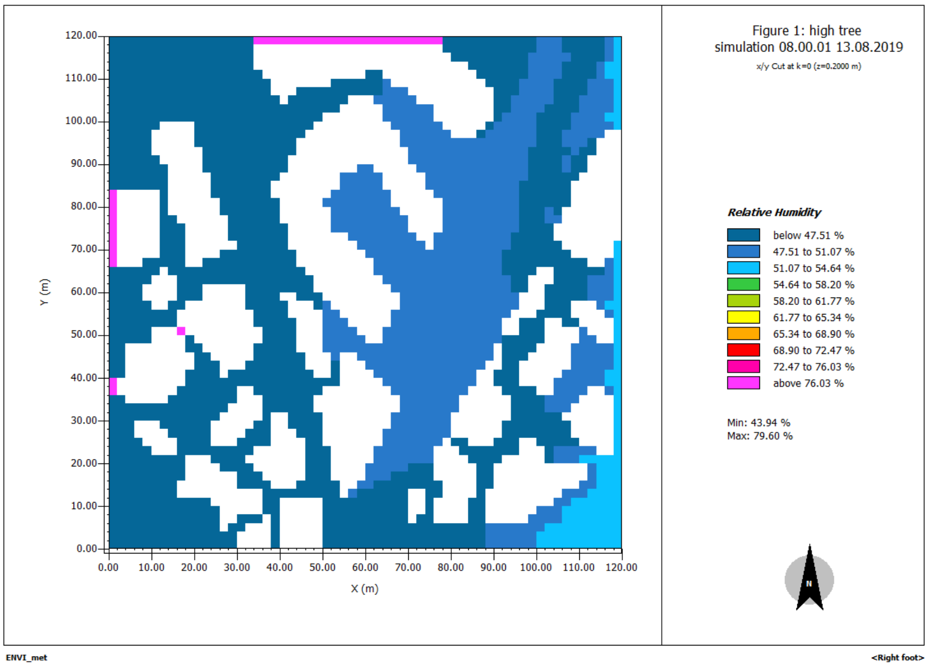

Figure 169.Simulated relative humidity for scenario 4 at 08:00 AM August 13, 2019

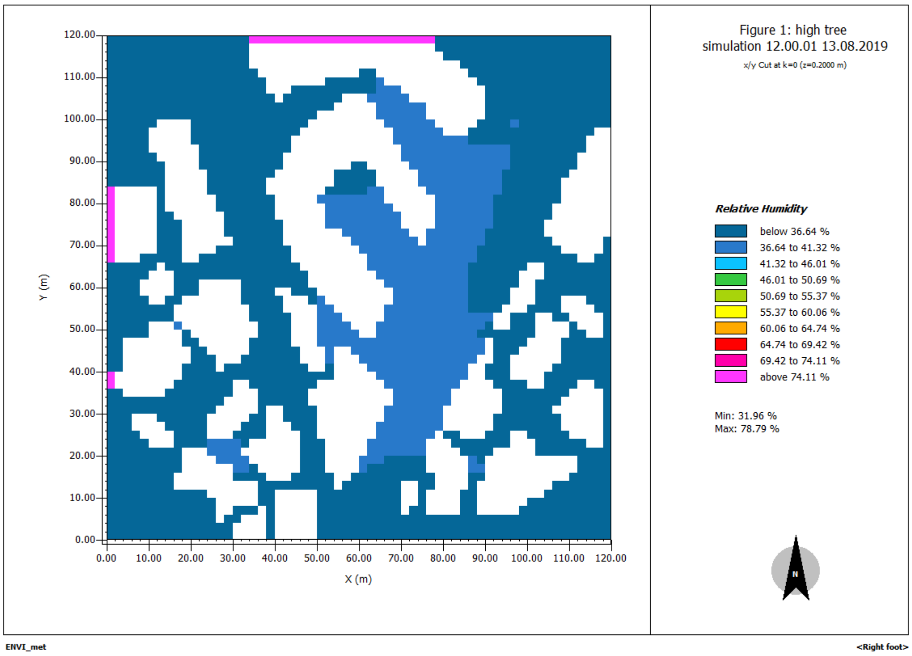

Figure 170.Simulated relative humidity for scenario 4 at 12:00 AM August 13, 2019

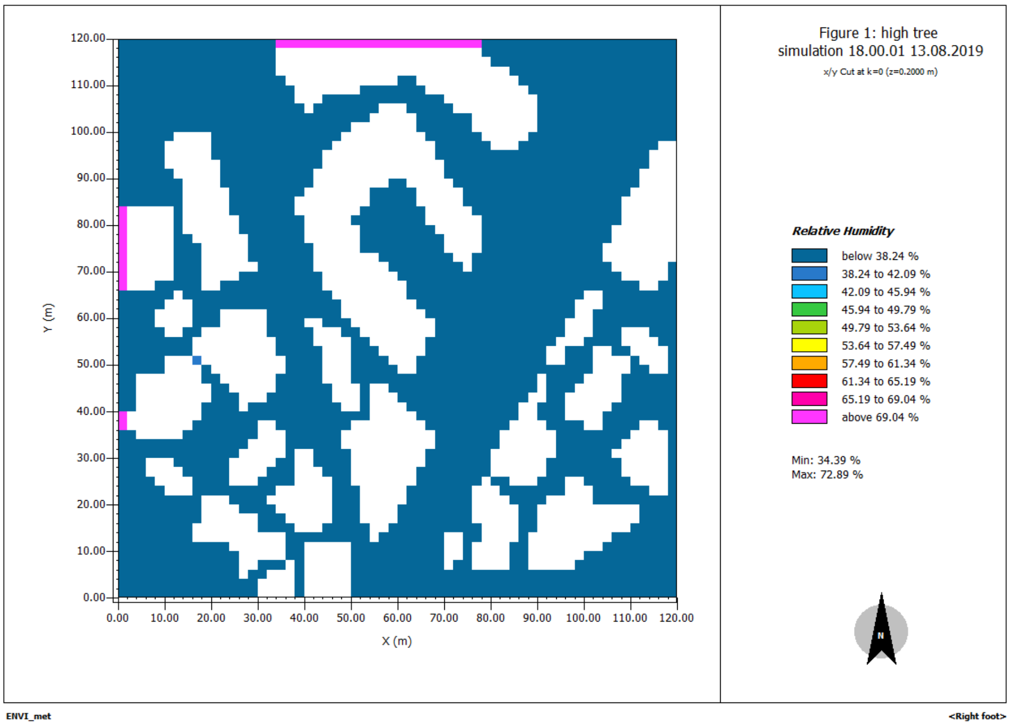

Figure 171. Simulated relative humidity for scenario 4 at 18:00 PM August 13, 2019

APPENDIX M

Table 21. Scenario 5 Simulated air temperature values on 13 August 2019

Air Temperature		
Hour	**Min Temperature °C**	**Max Temperature °C**
0:00	22.78	31.72
1:00	22.94	31.35
2:00	23.03	31.18
3:00	22.63	31.05
4:00	22.32	30.95
5:00	22.04	30.44
6:00	19.85	30.6
8:00	19.86	31.21
9:00	19.87	32.6
10:00	19.91	34.34
11:00	19.97	36.22
12:00	20.06	38.07
13:00	20.19	39.9
14:00	20.35	39.96
15:00	20.55	39.9
16:00	20.78	38.46
17:00	21.04	36.95
18:00	21.33	35.37
19:00	21.63	34.55
20:00	21.91	33.98
21:00	22.16	33.72
22:00	22.39	32.89
23:00	22.59	32.54

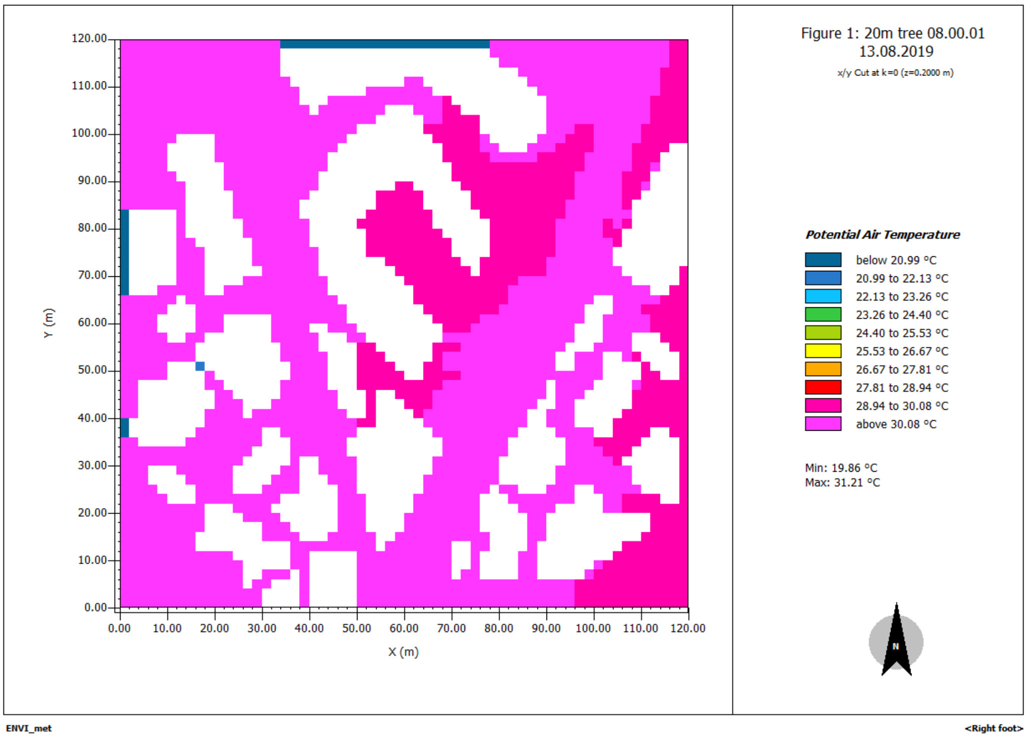

*Figure 172.*Simulated air temperature for scenario 5 at 08:00 AM August 13, 2019

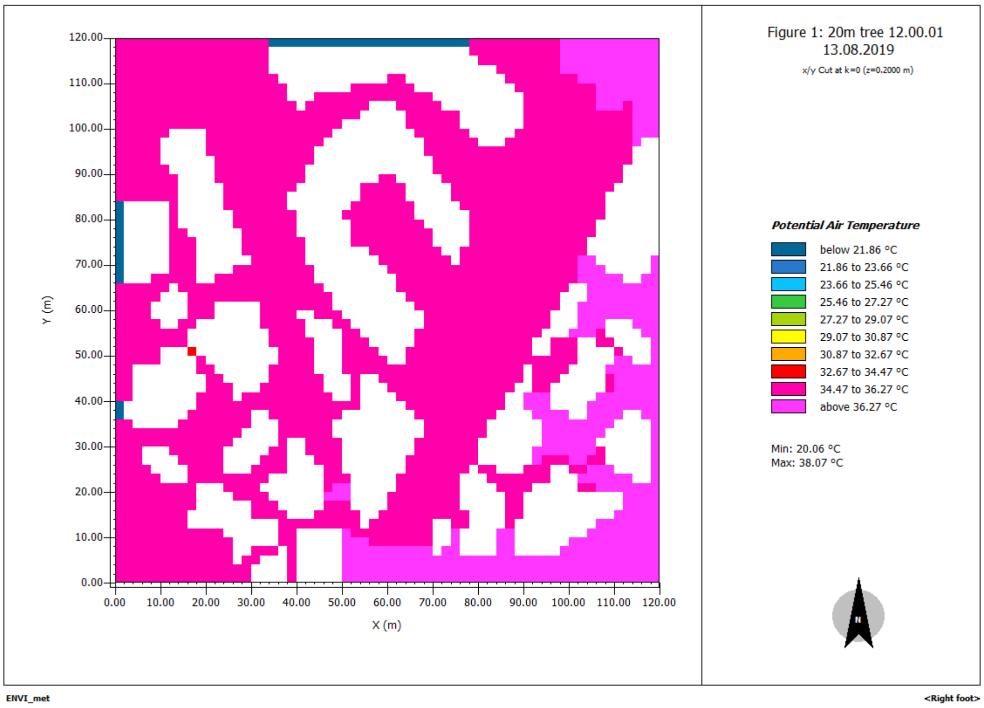

*Figure 173.*Simulated air temperature for scenario 5 at 12:00 AM August 13, 2019

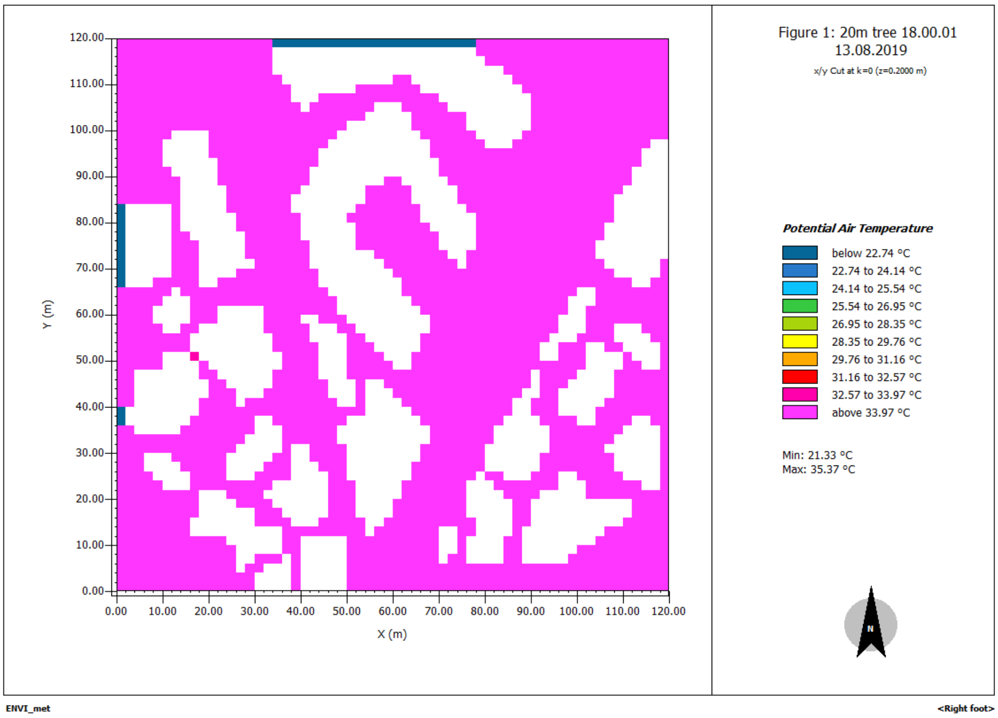

Figure 174.Simulated air temperature for scenario 5 at 18:00 PM August 13, 2019

APPENDIX N

Table 22. Scenario 5 hourly simulation values of Mean Radiant Temperatures on 13 August 2019

	Mean Radiant Temperature	
Hour	**Min Temperature °C**	**Max Temperature °C**
0:00	22.92	29.15
1:00	22.41	26.68
2:00	22.11	28.44
3:00	21.89	28.26
4:00	21.72	28.13
5:00	21.13	27.5
6:00	22.94	59.65
8:00	27.55	65.17
9:00	32.71	67.74
10:00	37.49	68.62
11:00	41.25	69.19
12:00	43.99	71.07
13:00	45.08	72.64
14:00	44.56	74.43
15:00	42.66	73.91
16:00	39.59	70.24
17:00	35.77	60.61
18:00	29.77	34.42
19:00	27.06	32.75
20:00	25.98	32
21:00	25.37	31.6
22:00	24.42	30.62
23:00	23.88	30.16

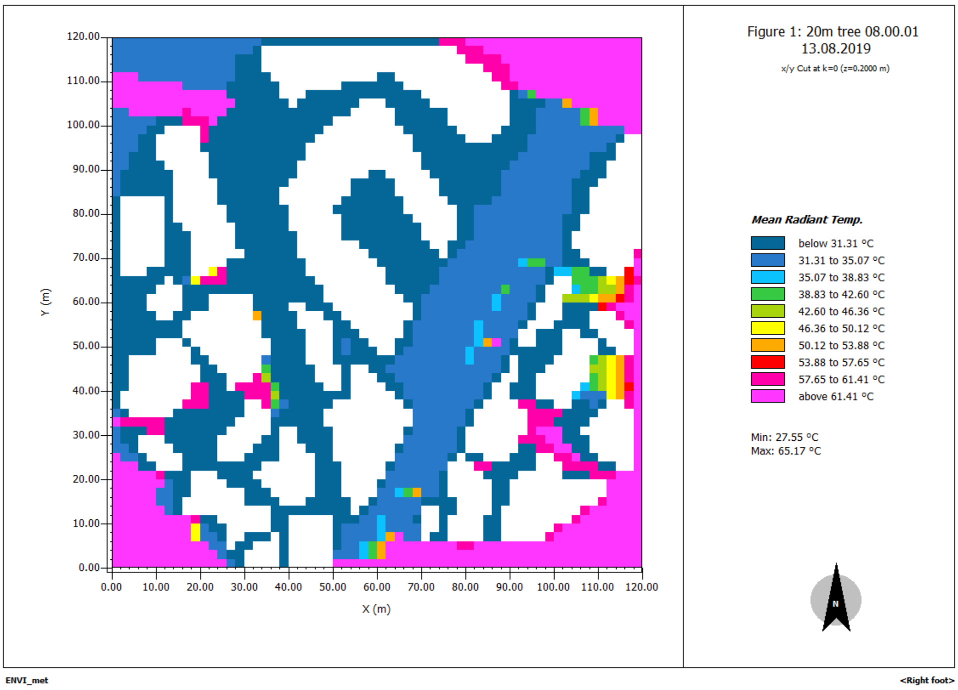

Figure 175.Simulated mean radiant temperature for scenario 5 at 08:00 AM August 13, 2019

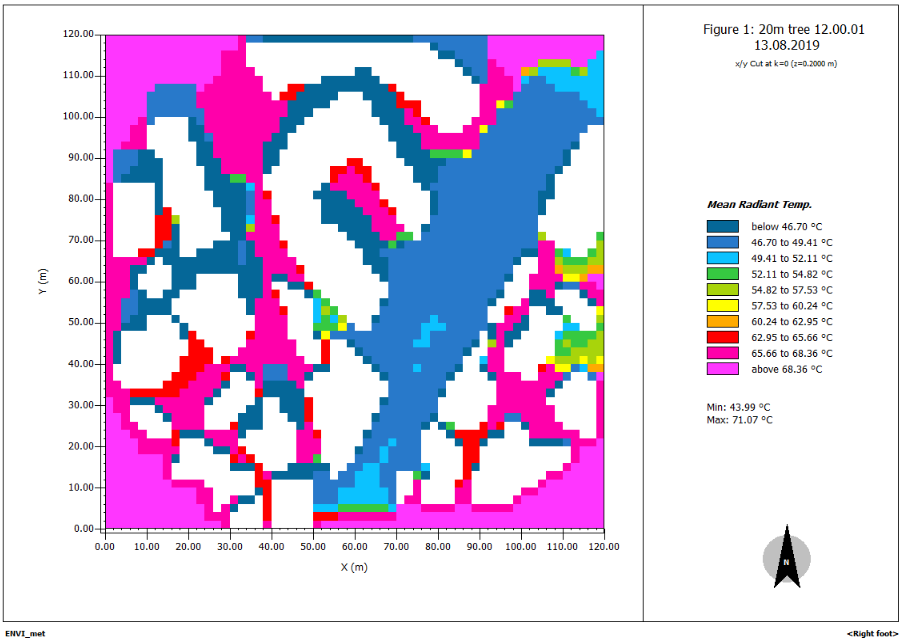

Figure 176.Simulated mean radiant temperature for scenario 5 at 12:00 AM August 13, 2019

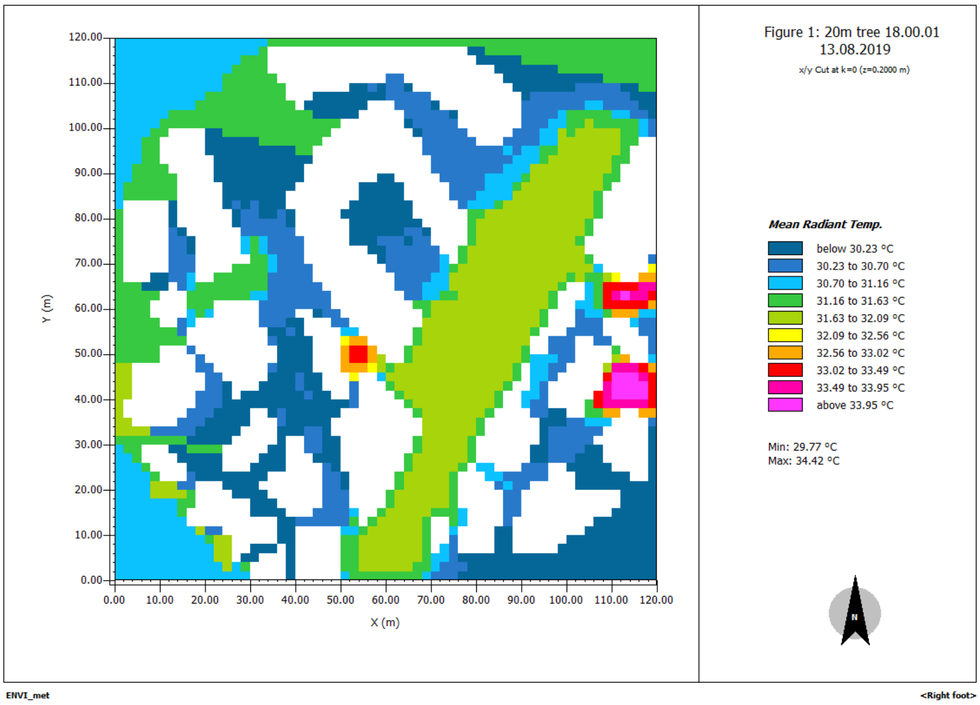

Figure 177.Simulated mean radiant temperature for scenario 5 at 18:00 PM August 13, 2019

APPENDIX O

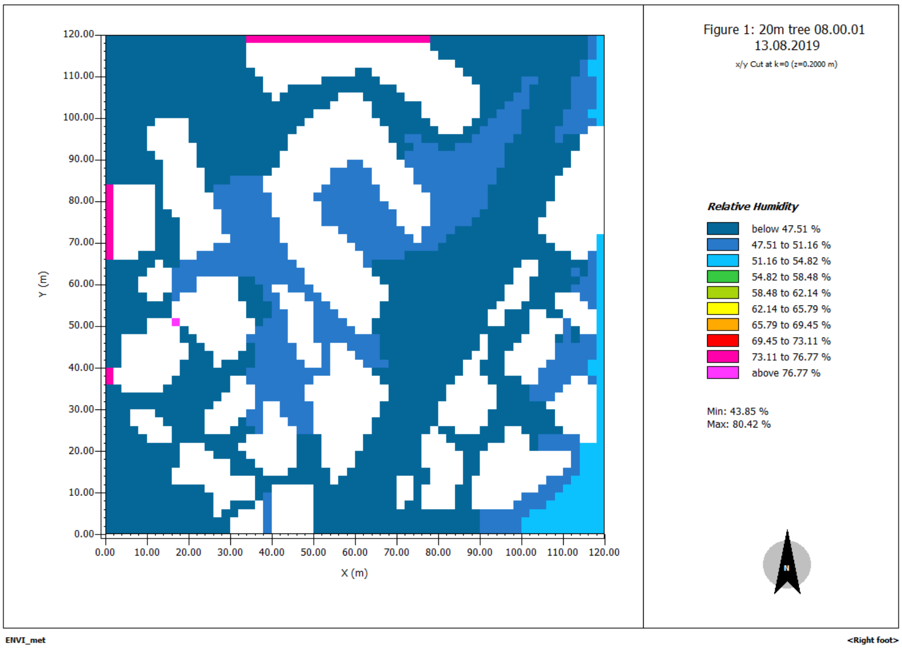

Figure 178.Simulated relative humidity for scenario 5 at 08:00 AM August 13, 2019

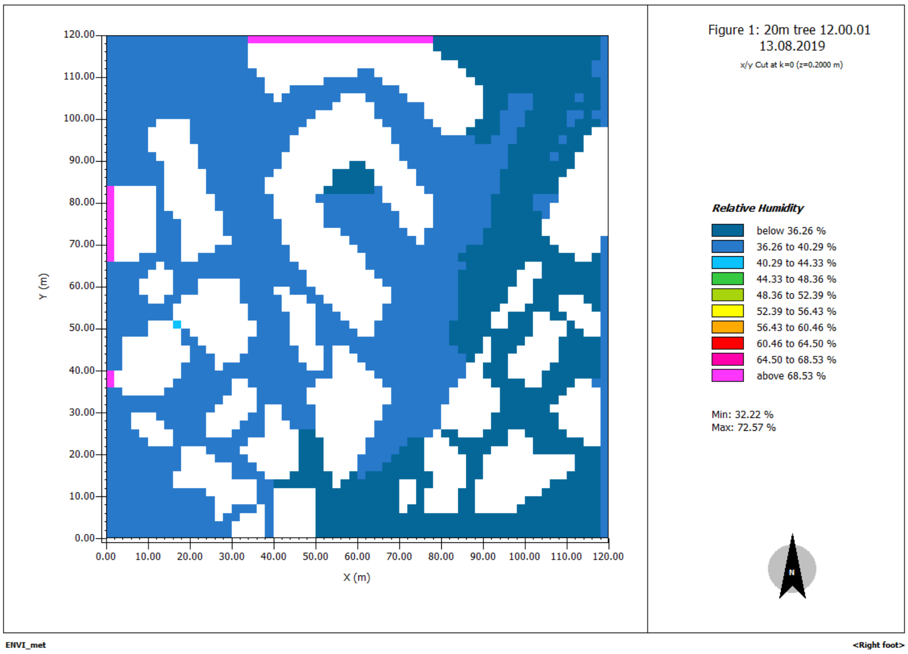

Figure 179.Simulated relative humidity for scenario 5 at 12:00 AM August 13, 2019

APPENDIX P

Table 23. Scenario 6 hourly simulation values of Air Temperatures on 13 August 2019

Air Temperature		
Hour	**Min Temperature °C**	**Max Temperature °C**
0:00	23.08	31.81
1:00	23.25	31.42
2:00	23.41	31.24
3:00	23.23	31.11
4:00	22.9	31
5:00	22.58	30.5
6:00	19.85	30.68
8:00	19.86	31.26
9:00	19.87	32.8
10:00	19.91	34.49
11:00	19.98	36.46
12:00	20.08	38.38
13:00	20.23	39.33
14:00	20.41	40.41
15:00	20.64	39.35
16:00	20.91	38.76
17:00	21.21	37.78
18:00	21.54	35.67
19:00	21.85	34.56
20:00	22.14	34.02
21:00	22.42	33.74
22:00	22.66	33.12
23:00	22.89	32.66

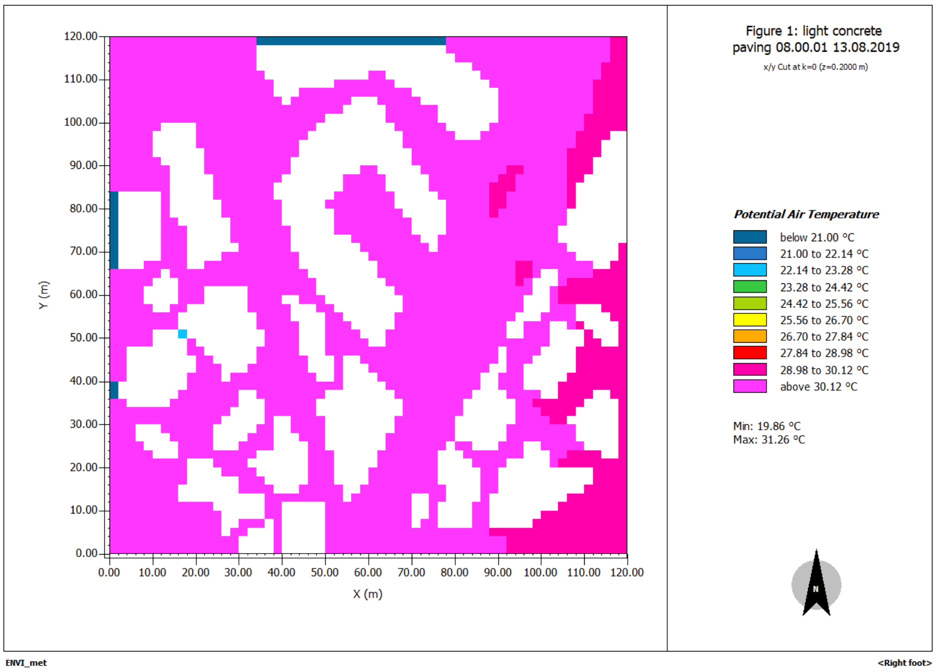

Figure 180.Simulated relative humidity for scenario 6 at 08:00 AM August 13, 2019

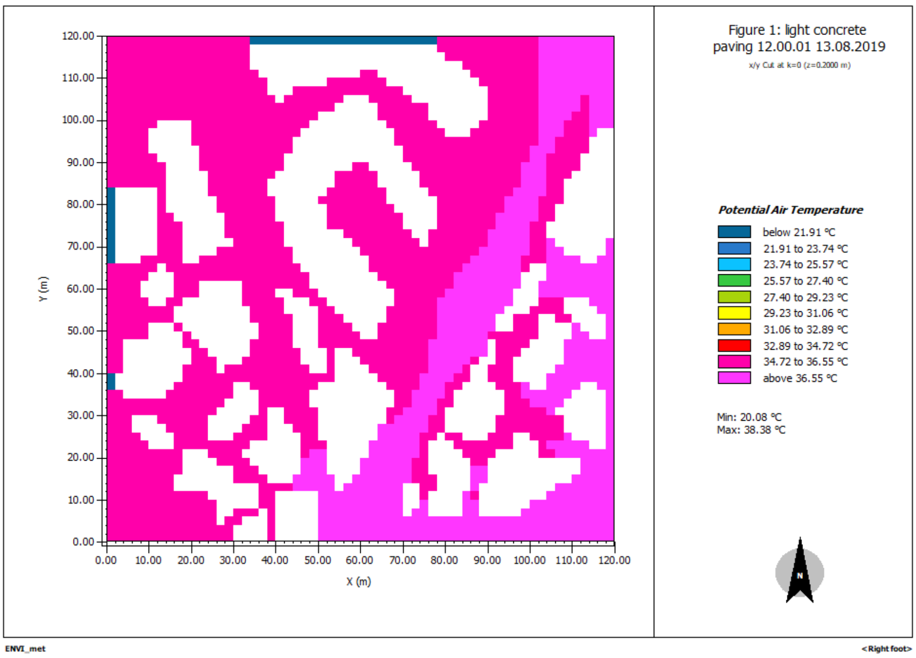

Figure 181.Simulated relative humidity for scenario 6 at 12:00 AM August 13, 2019

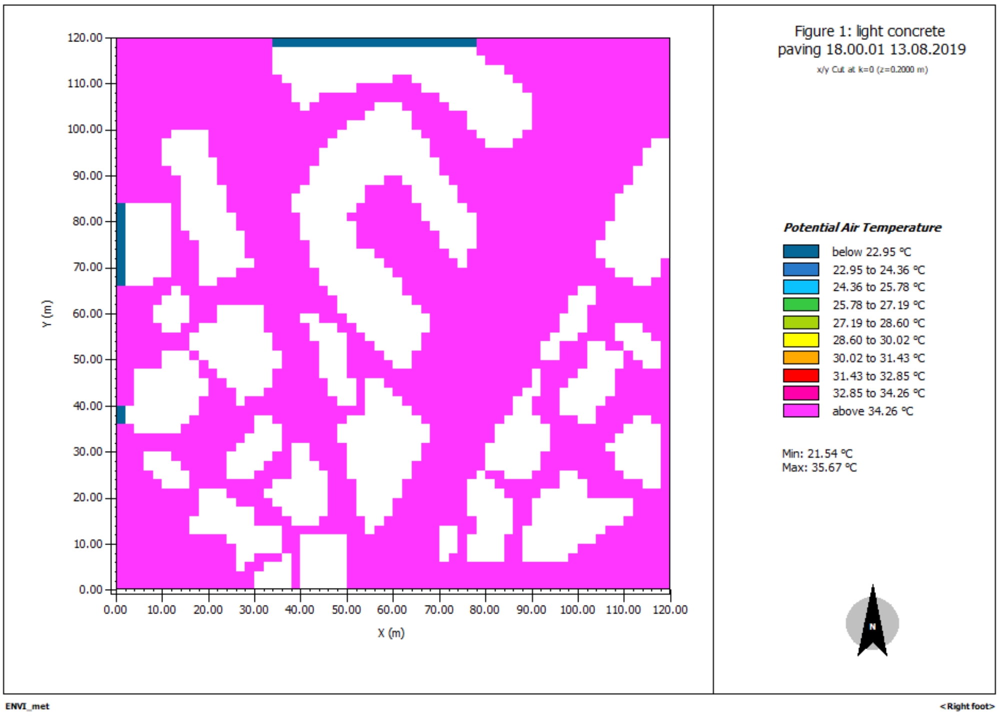

Figure 182. Simulated air temperature for scenario 6 at 18:00 PM August 13, 2019

APPENDIX Q

Table 24. Scenario 6 hourly simulation values of Mean Radiant Temperatures on 13 August 2019

	Mean Radiant Temperature	
Hour	**Min Temperature °C**	**Max Temperature °C**
0:00	22.82	28.65
1:00	22.28	28.15
2:00	21.94	27.9
3:00	21.69	27.7
4:00	21.49	27.55
5:00	20.91	26.87
6:00	25.21	60.46
8:00	32.12	63.52
9:00	38.97	71.61
10:00	45.81	74.57
11:00	50.9	75.22
12:00	54.85	78.18
13:00	55.37	79.37
14:00	53.74	80.56
15:00	49.93	78.61
16:00	44.72	73.42
17:00	38.19	61.64
18:00	30.1	34.76
19:00	27.42	32.65
20:00	26.13	31.77
21:00	25.4	31.29
22:00	24.53	30.43
23:00	23.86	29.79

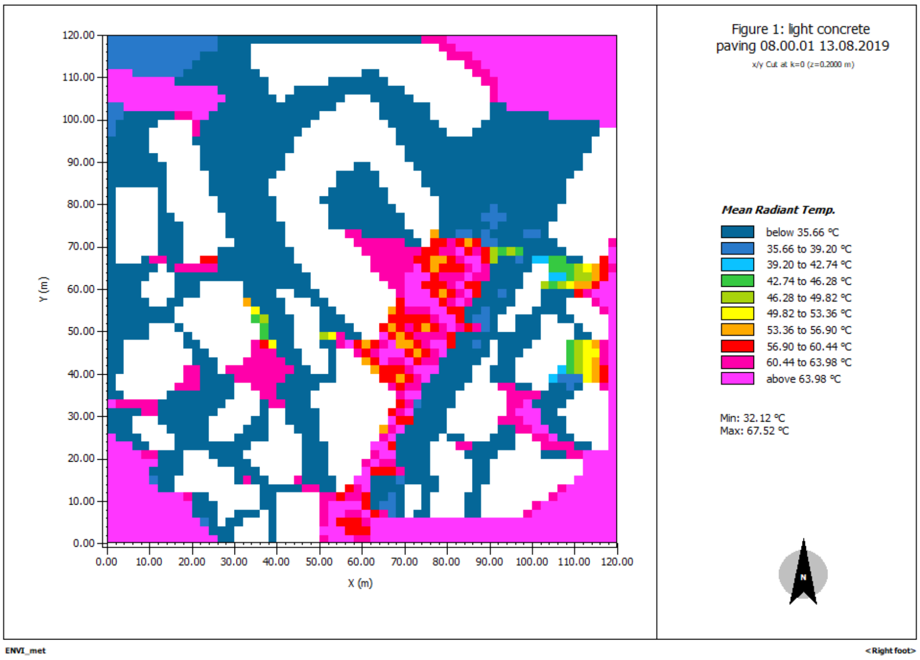

Figure 183. Simulated mean radiant temperature for scenario 6 at 08:00 AM August 13, 2019

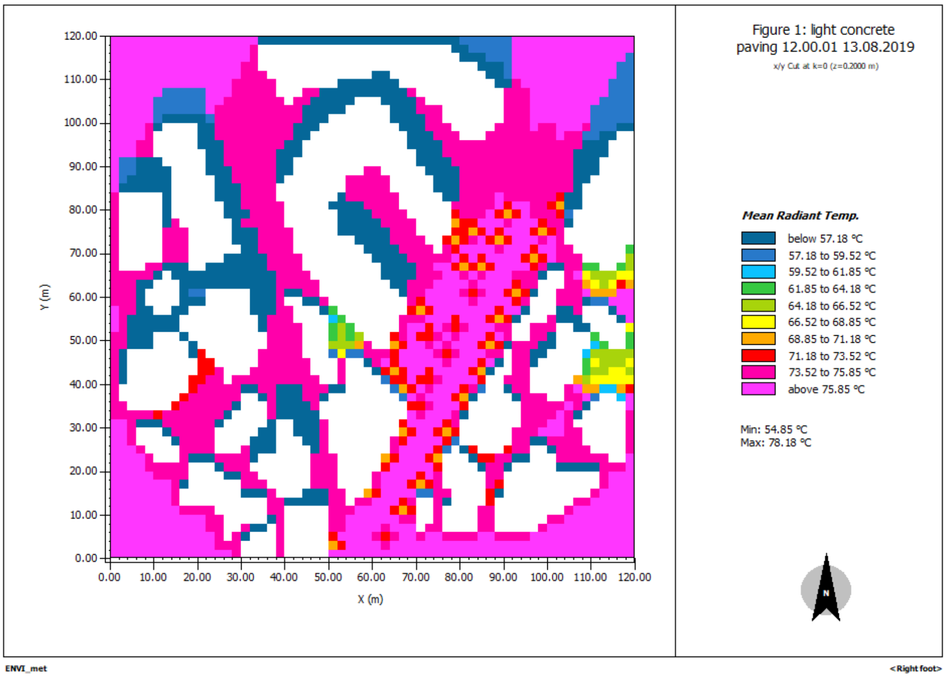

Figure 184. Simulated mean radiant temperature for scenario 6 at 12:00 AM August 13, 2019

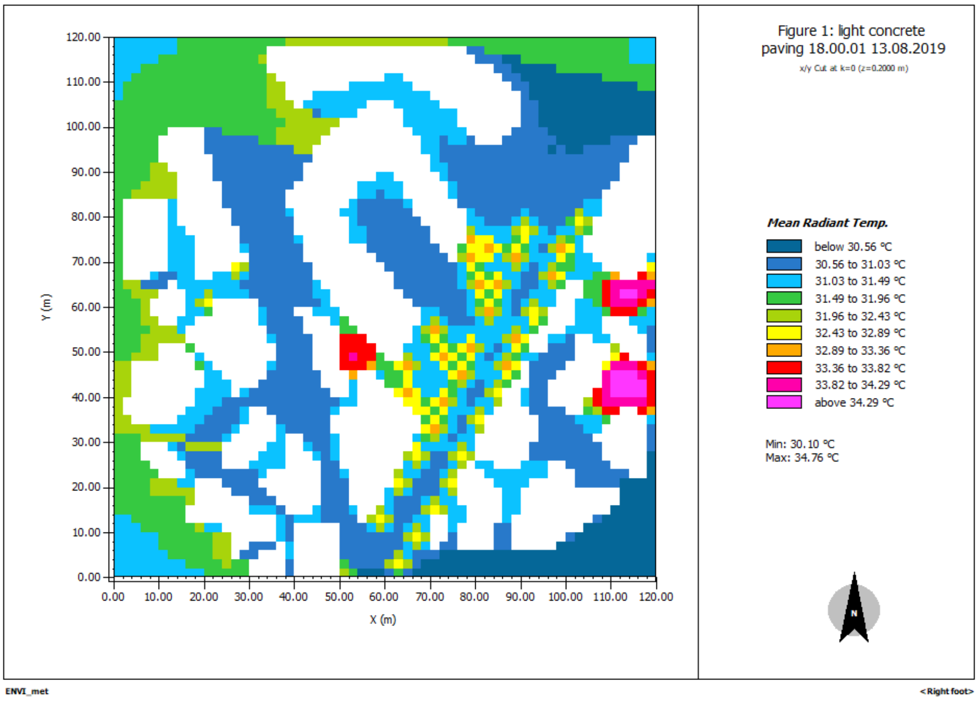

Figure 185.Simulated mean radiant temperature for scenario 6 at 18:00 PM August 13, 2019

APPENDIX R

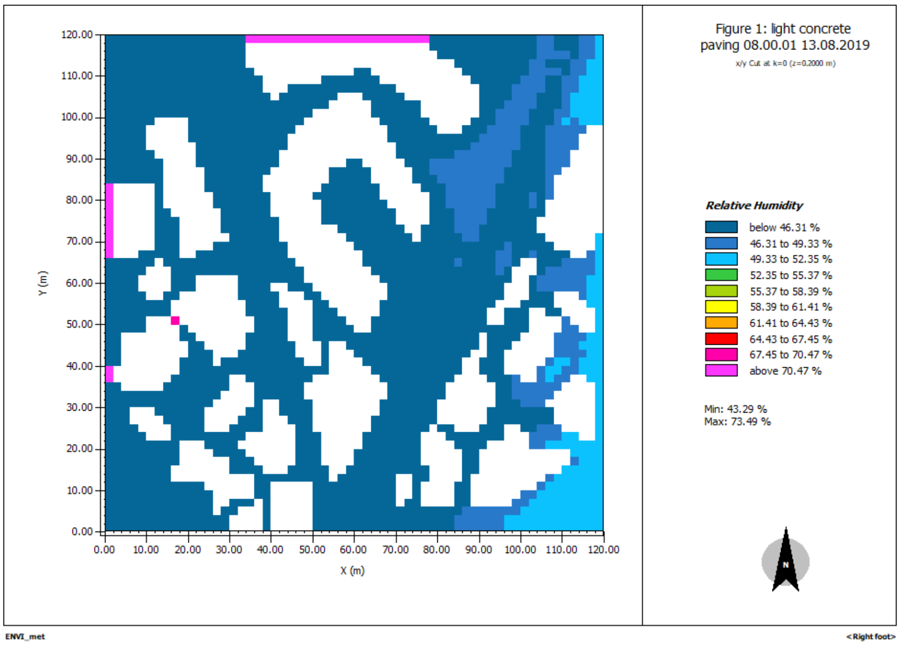

*Figure 186.*Simulated relative humidity for scenario 6 at 08:00 AM August 13, 2019

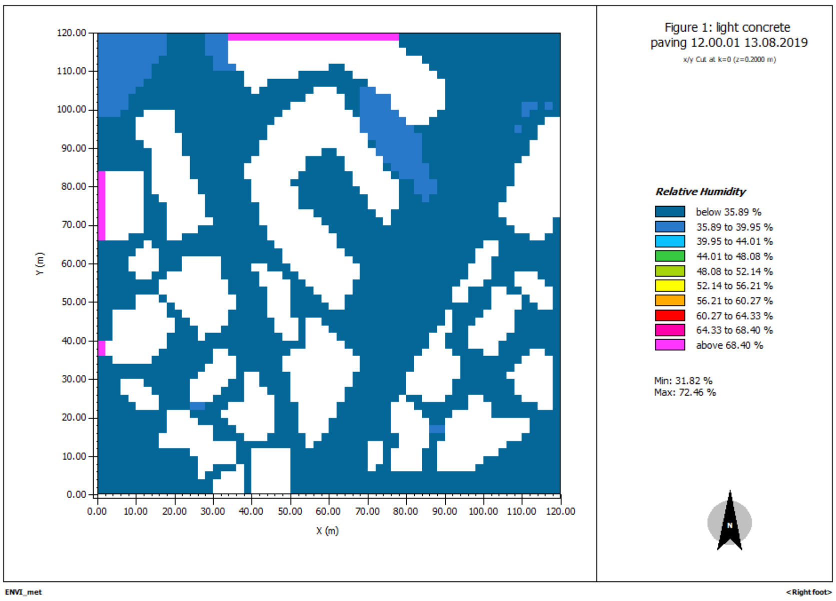

Figure 187.Simulated relative humidity for scenario 6 at 12:00 AM August 13, 2019

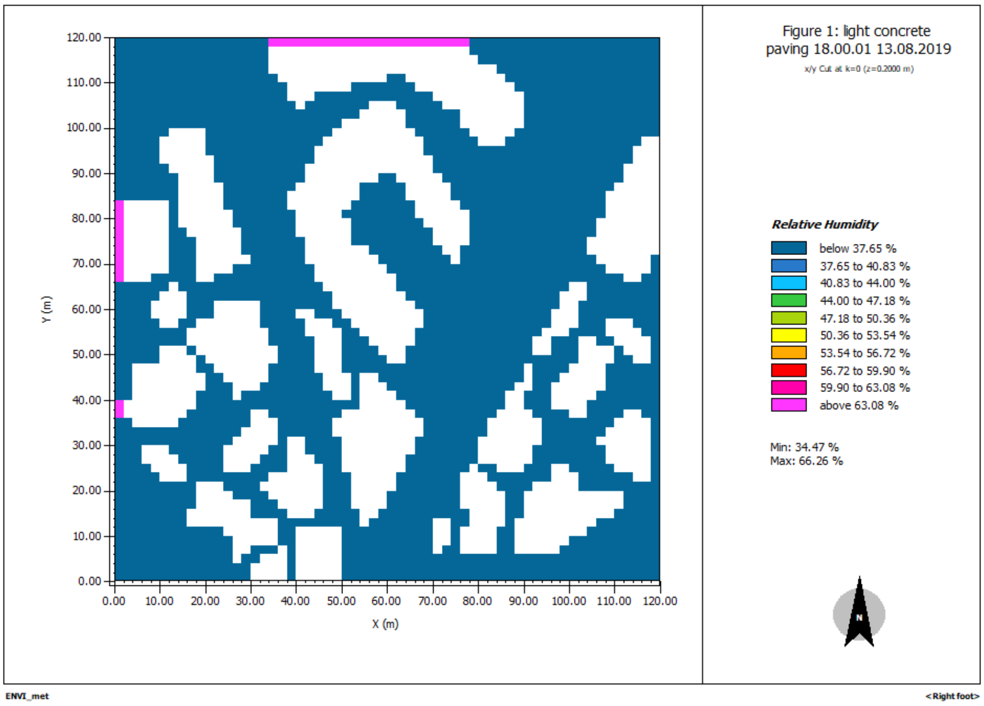

Figure 188. Simulated relative humidity for scenario 6 at 18:00 PM August 13, 2019

APPENDIX S

Table 25. Scenario 7 hourly simulation values of Air Temperatures on 13 August 2019

Air Temperature		
Hour	**Min Temperature °C**	**Max Temperature °C**
0:00	23.03	31.8
1:00	23.2	31.42
2:00	23.35	31.24
3:00	23.17	31.1
4:00	22.84	31
5:00	22.54	30.49
6:00	19.85	30.67
8:00	19.86	31.26
9:00	19.87	32.53
10:00	19.91	34.07
11:00	19.98	35.84
12:00	20.08	37.78
13:00	20.22	39.04
14:00	20.4	40.08
15:00	20.63	39.24
16:00	20.89	38.54
17:00	21.18	37.47
18:00	21.5	35.53
19:00	21.81	34.57
20:00	22.1	34.01
21:00	22.37	33.72
22:00	22.62	33.1
23:00	22.83	32.64

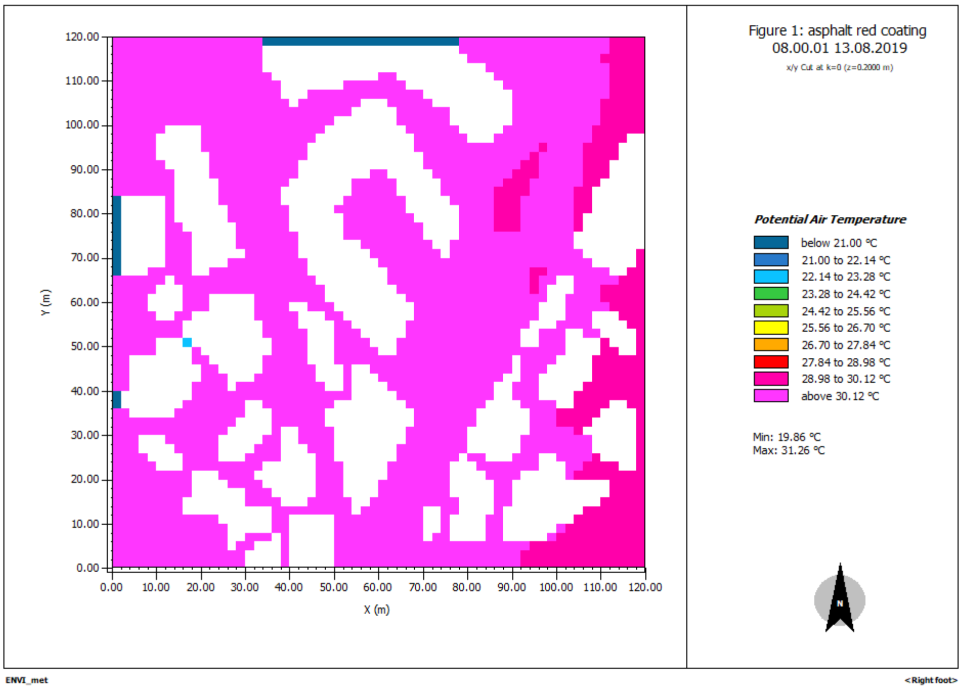

Figure 189.Simulated air temperature for scenario 7 at 08:00 AM August 13, 2019

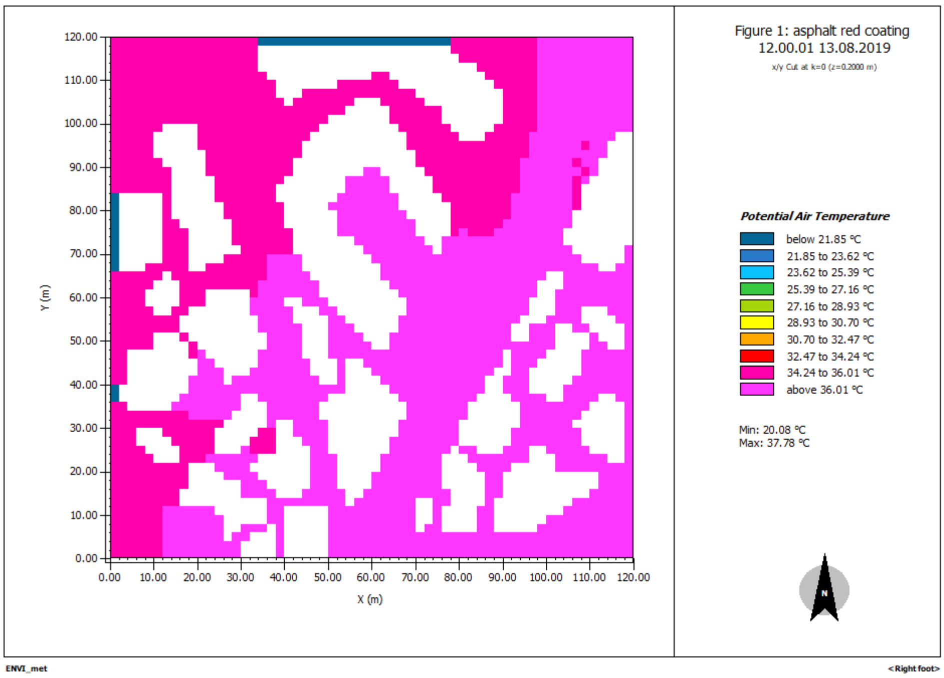

Figure 190.Simulated air temperature for scenario 7 at 12:00 AM August 13, 2019

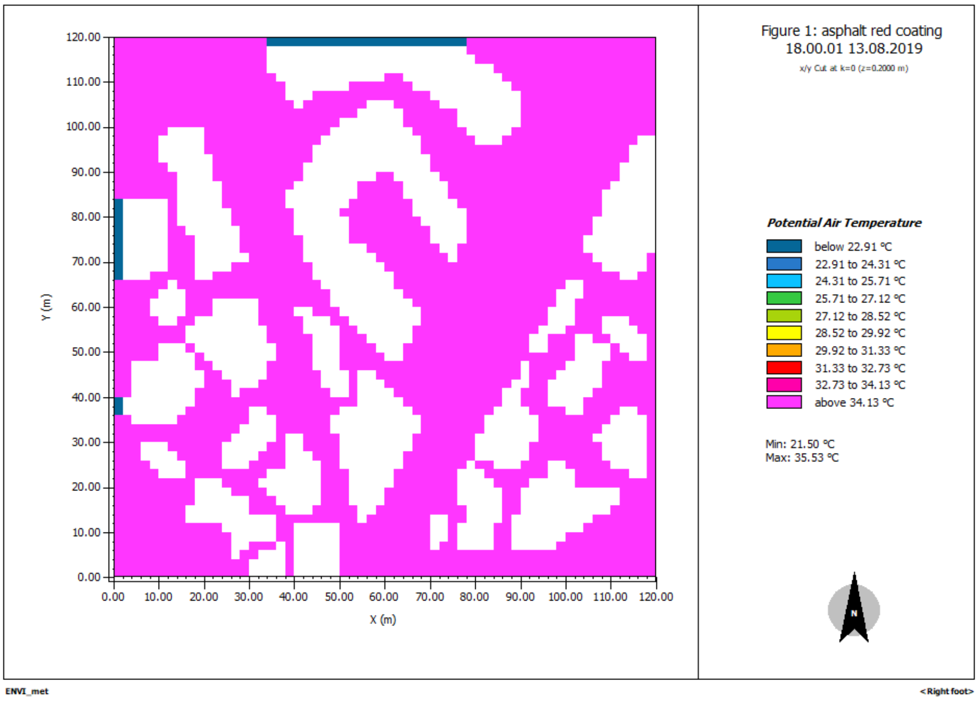

Figure 191.Simulated air temperature for scenario 6 at 18:00 PM August 13, 2019

APPENDIX T

Table 26. Scenario 7 hourly simulation values of Mean Radiant Temperatures on 13 August 2019

	Mean Radiant Temperature	
Hour	**Min Temperature °C**	**Max Temperature °C**
0:00	22.8	28.63
1:00	22.26	28.14
2:00	21.92	27.89
3:00	21.67	27.7
4:00	21.48	27.54
5:00	20.9	26.87
6:00	24.63	60.04
8:00	31.15	66.82
9:00	37.72	70.63
10:00	44.1	73.12
11:00	48.91	73.84
12:00	52.52	76.39
13:00	53.45	77.86
14:00	52.43	79.6
15:00	48.97	77.91
16:00	43.91	72.81
17:00	37.73	61.33
18:00	29.96	34.61
19:00	27.34	32.61
20:00	26.05	31.71
21:00	25.32	31.23
22:00	24.47	30.38
23:00	23.81	29.75

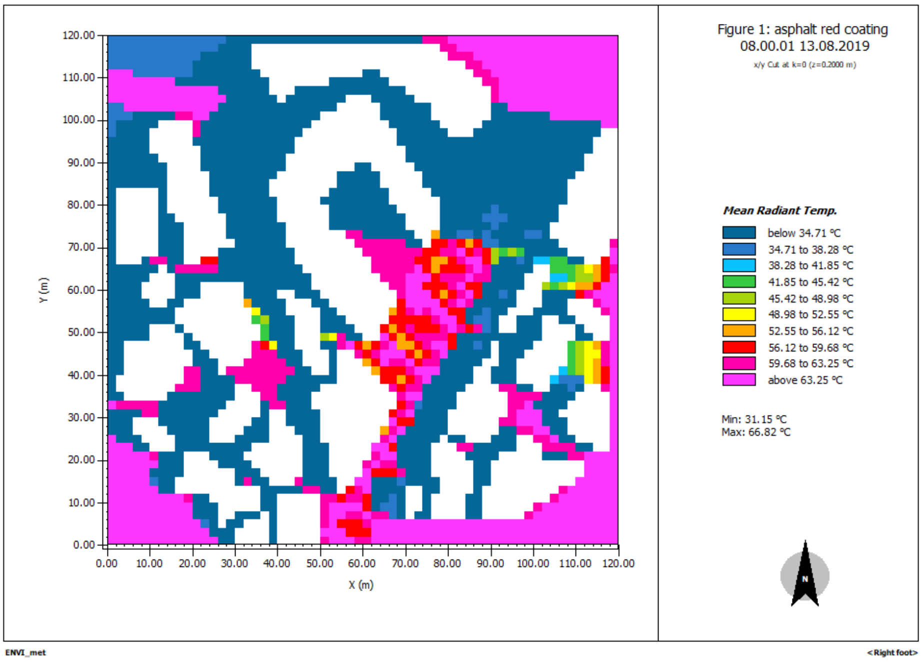

Figure 192.Simulated mean radiant temperature for scenario 7 at 08:00 AM August 13, 2019

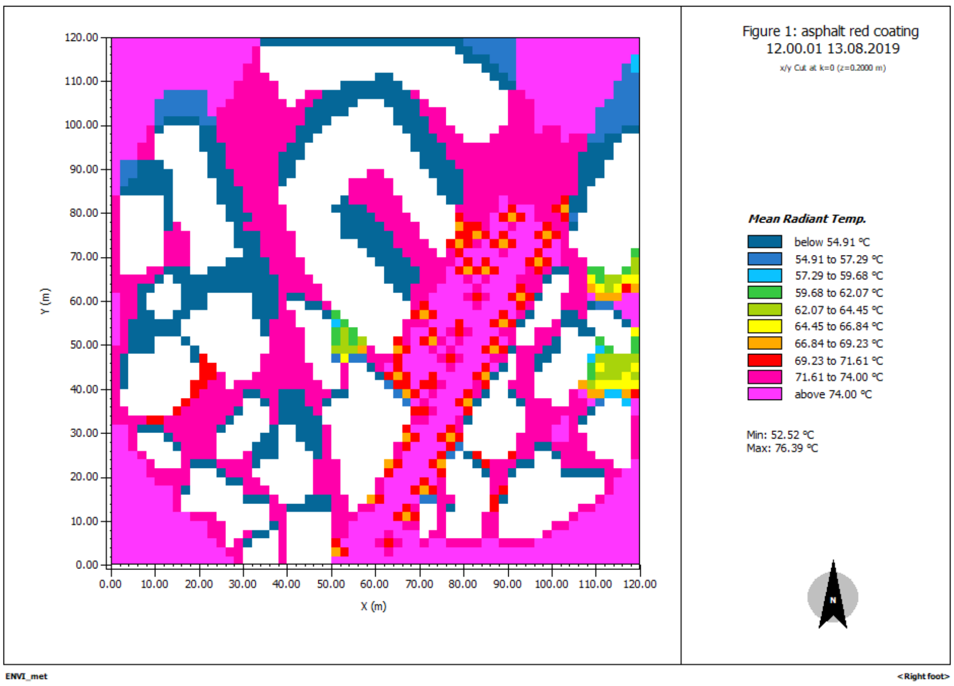

Figure 193.Simulated mean radiant temperature for scenario 7 at 12:00 AM August 13, 2019

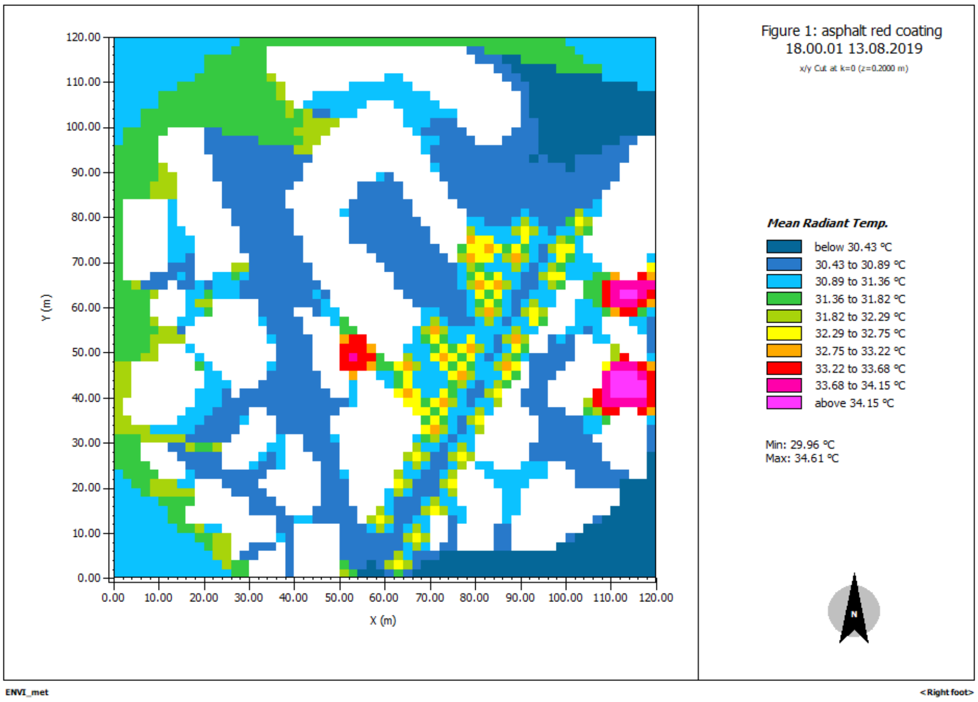

Figure 194.Simulated mean radiant temperature for scenario 7 at 18:00 PM August 13, 2019

APPENDIX U

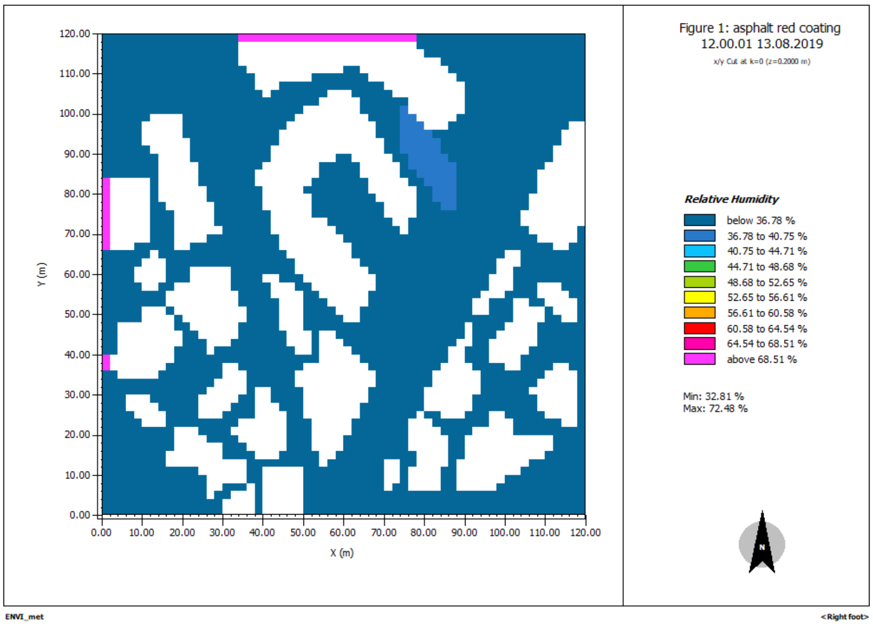

Figure 195.Simulated relative humidity for scenario 7 at 08:00 AM August 13, 2019

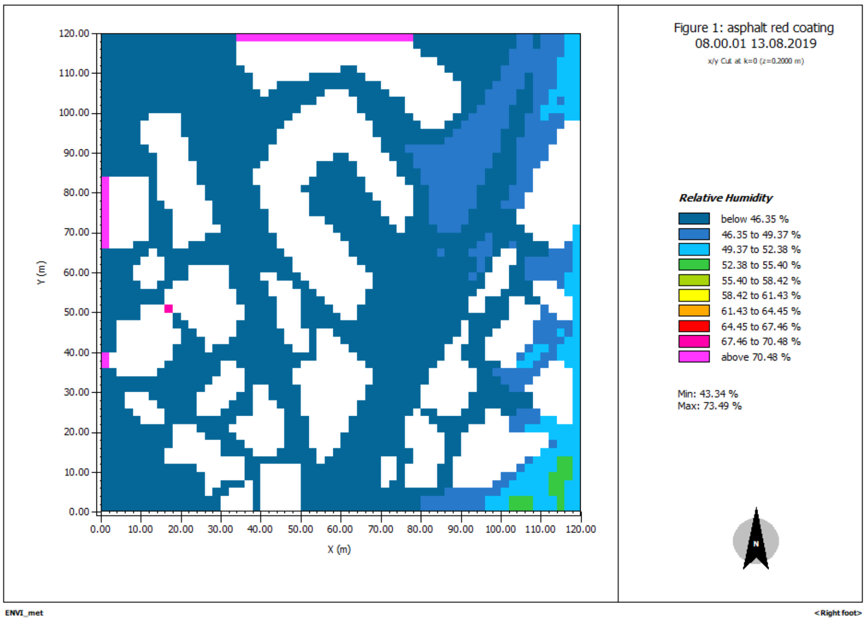

Figure 196.Simulated relative humidity for scenario 7 at 12:00 AM August 13, 2019

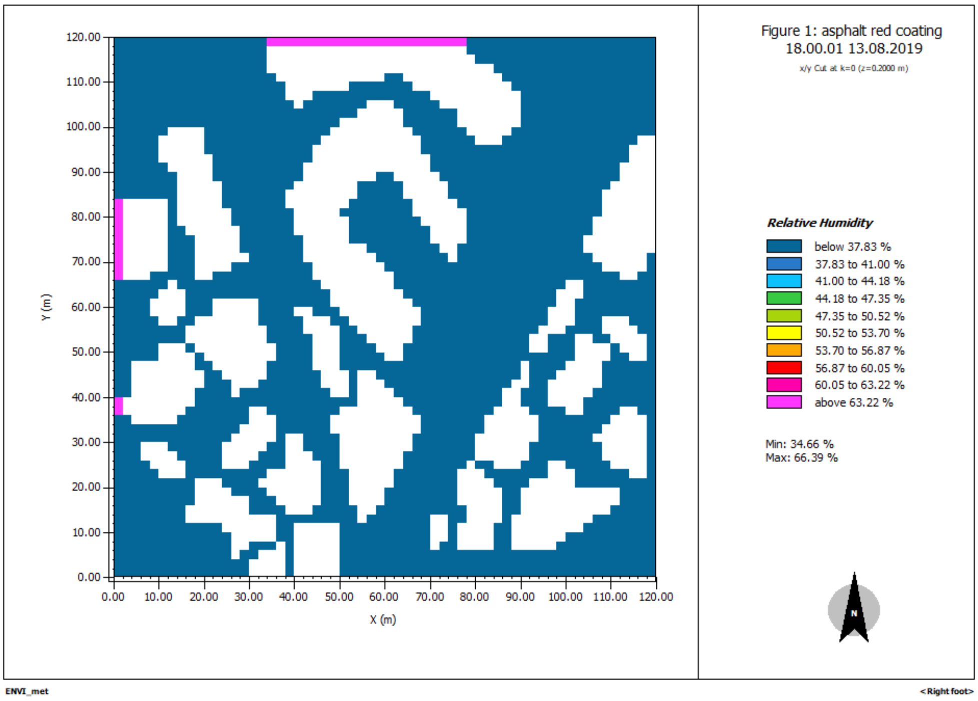

Figure 197.Simulated relative humidity for scenario 7 at 18:00 PM August 13, 2019

APPENDIX V

Table 27. Scenario 8 hourly simulation values of Air Temperatures on 13 August 2019

	Air Temperature	
Hour	**Min Temperature °C**	**Max Temperature °C**
0:00	22.69	31.85
1:00	22.85	31.48
2:00	23	31.95
3:00	23.02	31.47
4:00	22.69	31.19
5:00	22.37	30.66
6:00	22.15	30.59
8:00	19.85	31.07
9:00	19.86	32.01
10:00	19.88	33.43
11:00	19.93	35.11
12:00	20.02	37.01
13:00	20.14	38.59
14:00	20.3	39.6
15:00	20.49	38.71
16:00	20.73	38.13
17:00	20.99	36.69
18:00	21.28	35.27
19:00	21.55	34.49
20:00	21.82	33.97
21:00	22.07	33.74
22:00	22.3	33.12
23:00	22.5	32.69

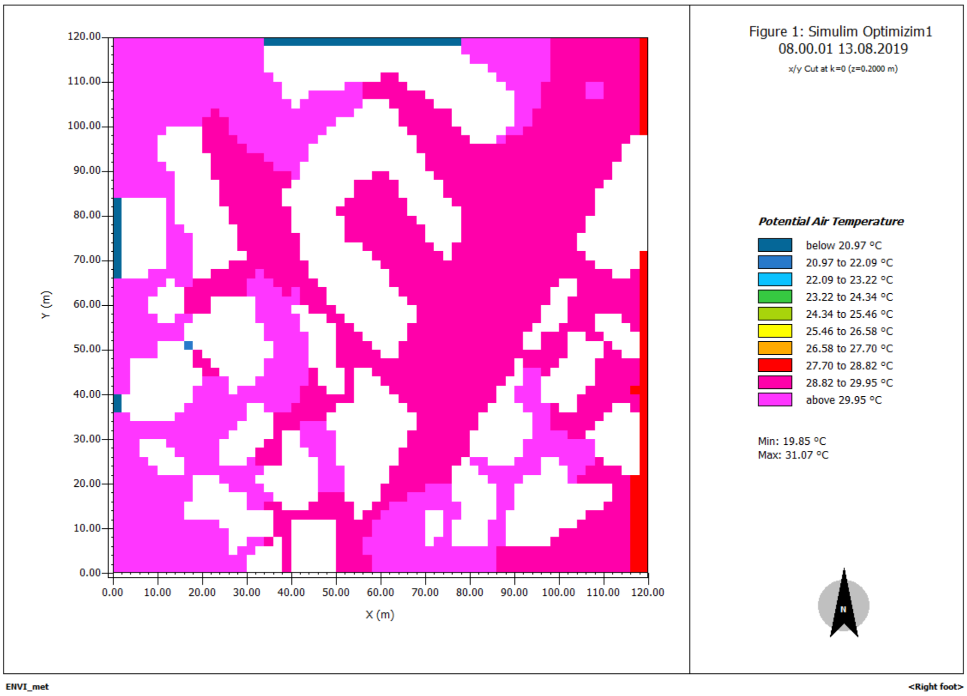

Figure 198. Simulated air temperature for scenario 8 at 08:00 AM August 13, 2019

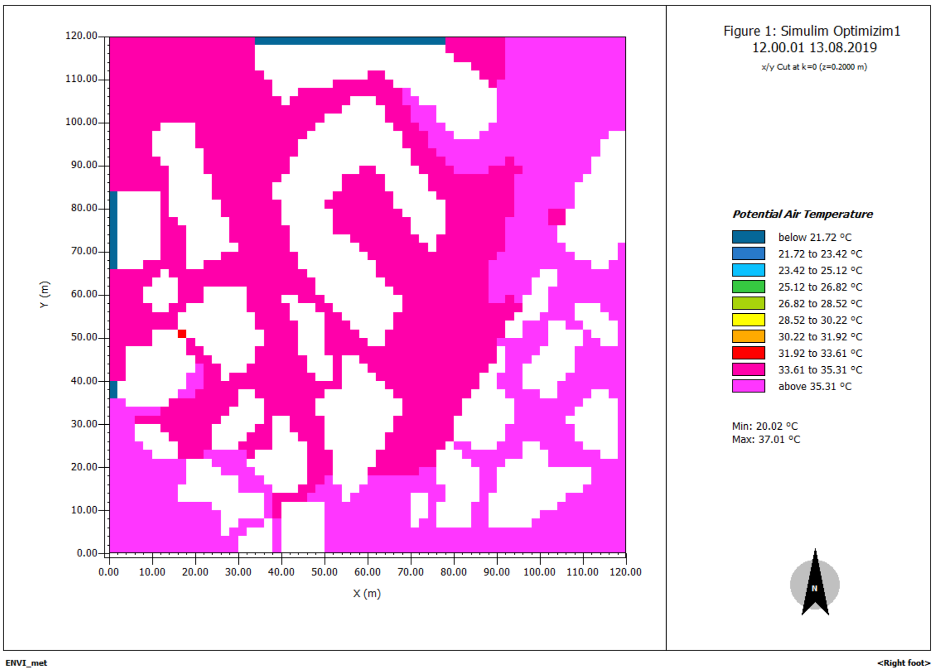

Figure 199. Simulated air temperature for scenario 8 at 12:00 AM August 13, 2019

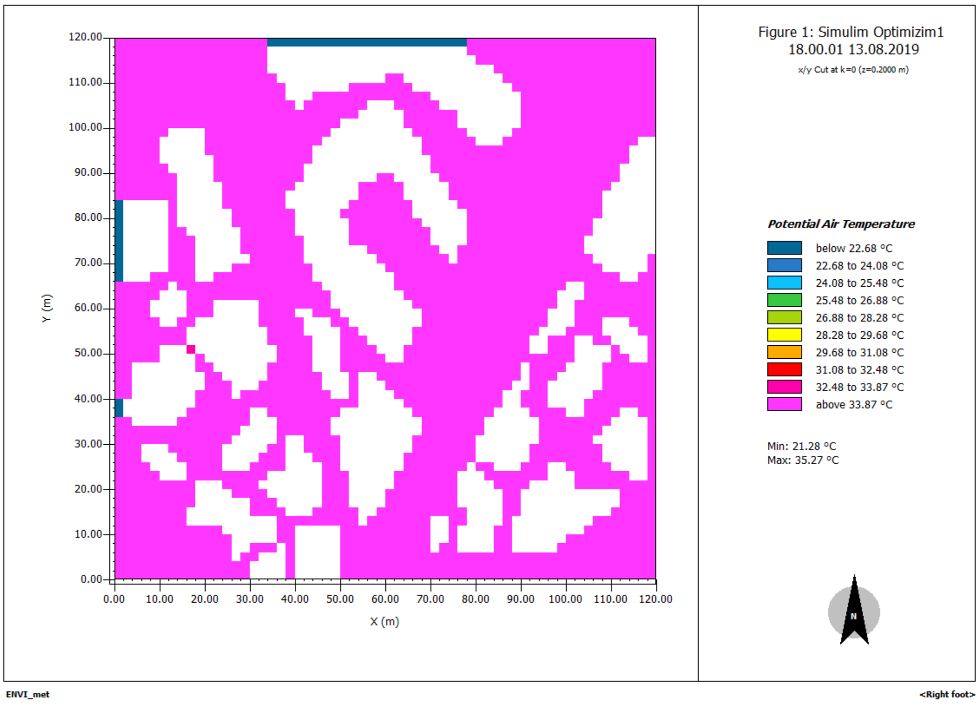

Figure 200.Simulated air temperature for scenario 8 at 18:00 PM August 13, 2019

APPENDIX W

Table 28. Scenario 8 hourly simulation values of Mean Radiant Temperatures on 13 August 2019

Mean Minimum Radiant Temperature		
Hour	**Min Temperature °C**	**Max Temperature °C**
0:00	23.28	29.46
1:00	22.82	29.02
2:00	23.17	29.55
3:00	22.65	28.97
4:00	22.37	28.66
5:00	21.77	28.06
6:00	23.54	47.72
8:00	27.9	66.05
9:00	33.48	68.95
10:00	39.12	70.49
11:00	43.35	71.22
12:00	46.47	75.53
13:00	47.62	75.4
14:00	46.74	76.78
15:00	44.01	75.81
16:00	40.38	71.92
17:00	36.02	62.74
18:00	29.45	35.24
19:00	26.95	32.66
20:00	25.98	31.98
21:00	25.46	31.64
22:00	24.76	30.93
23:00	24.22	30.4

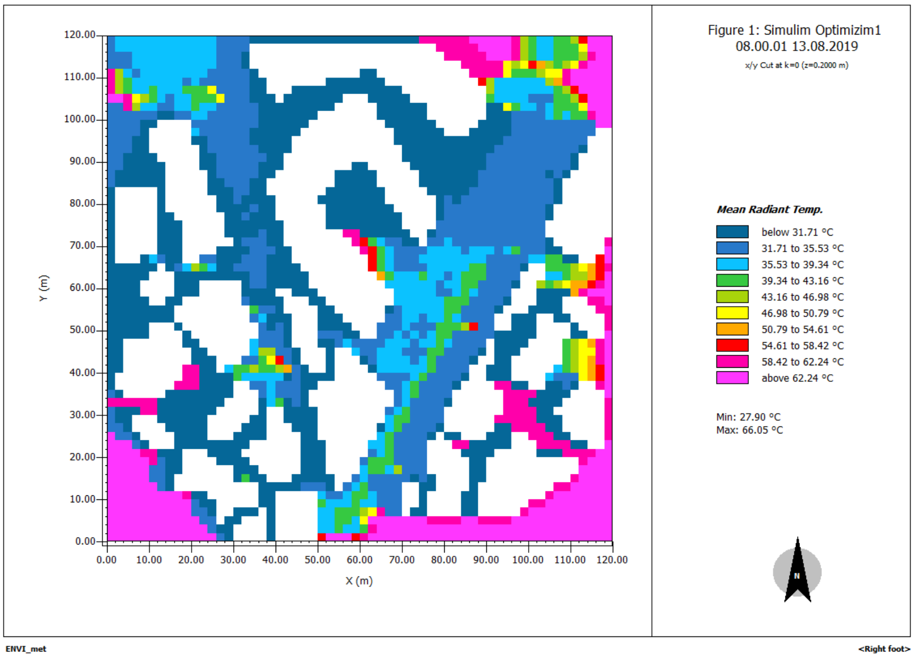

Figure 201.Simulated mean radiant temperature for scenario 8 at 08:00 AM August 13, 2019

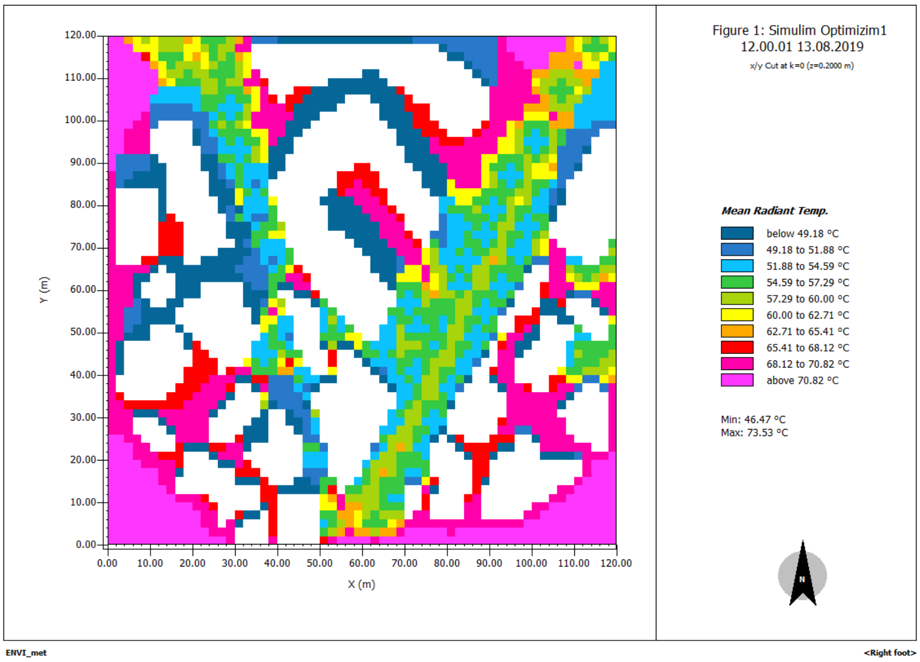

Figure 202.Simulated mean radiant temperature for scenario 8 at 12:00 AM August 13, 2019

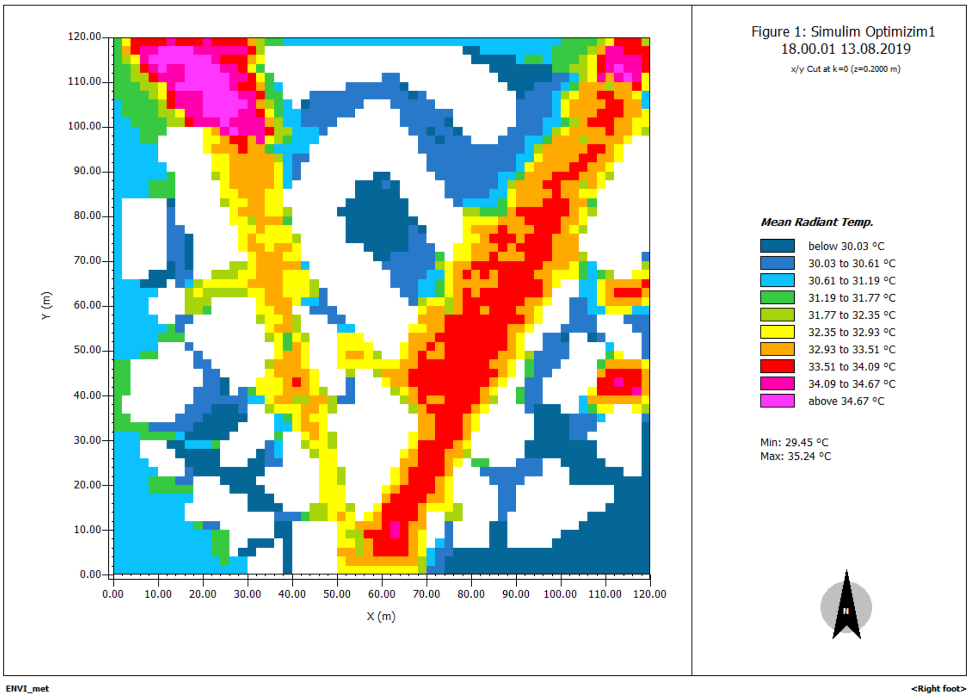

Figure 203.Simulated mean radiant temperature for scenario 8 at 18:00 PM August 13, 2019

APPENDIX X

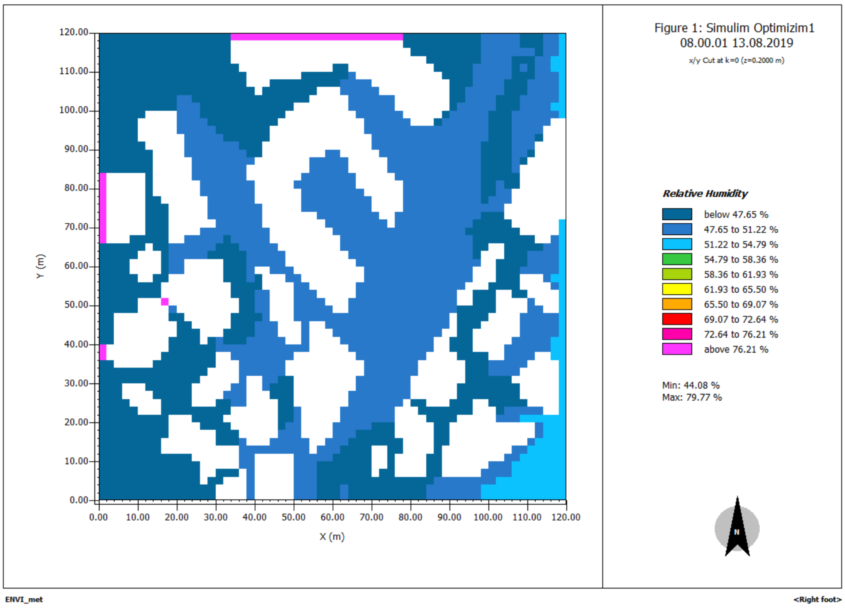

Figure 204.Simulated relative humidity for scenario 8 at 08:00 AM August 13, 2019

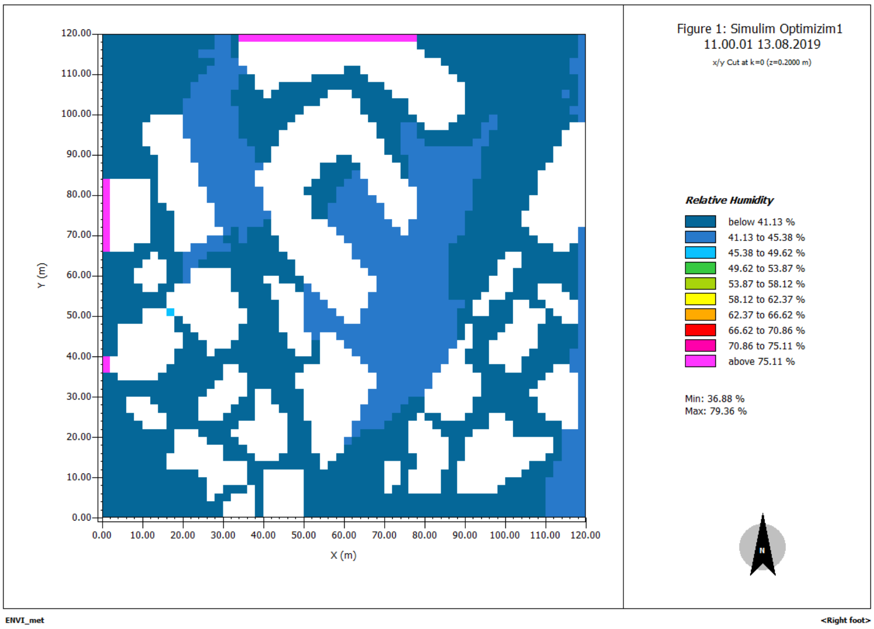

Figure 205.Simulated relative humidity for scenario 8 at 12:00 AM August 13, 2019

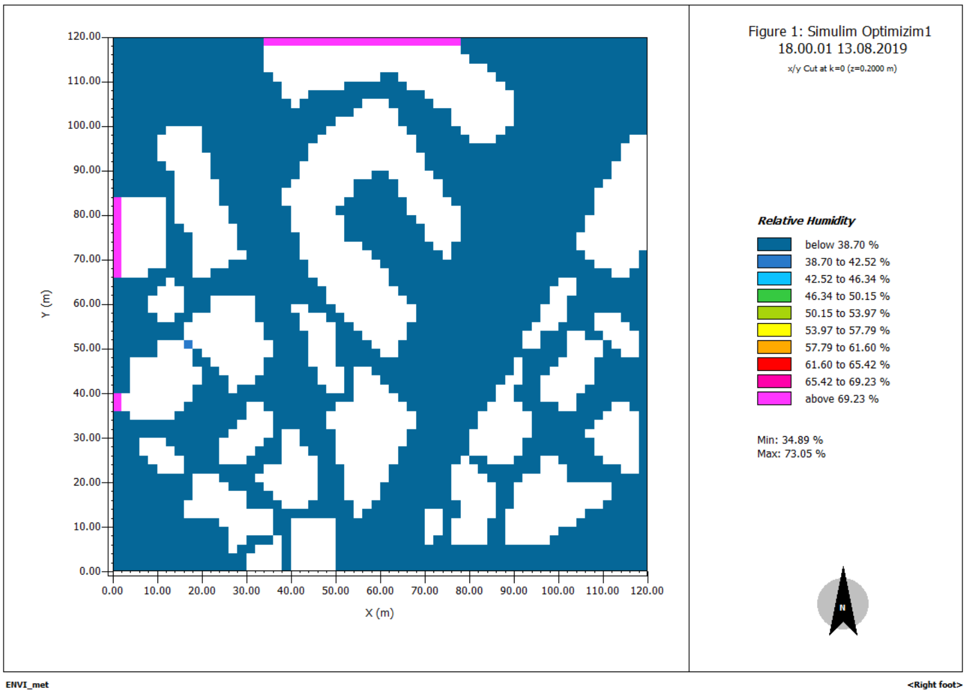

Figure 206. Simulated relative humidity for scenario 8 at 18:00 PM August 13, 2019

APPENDIX Y

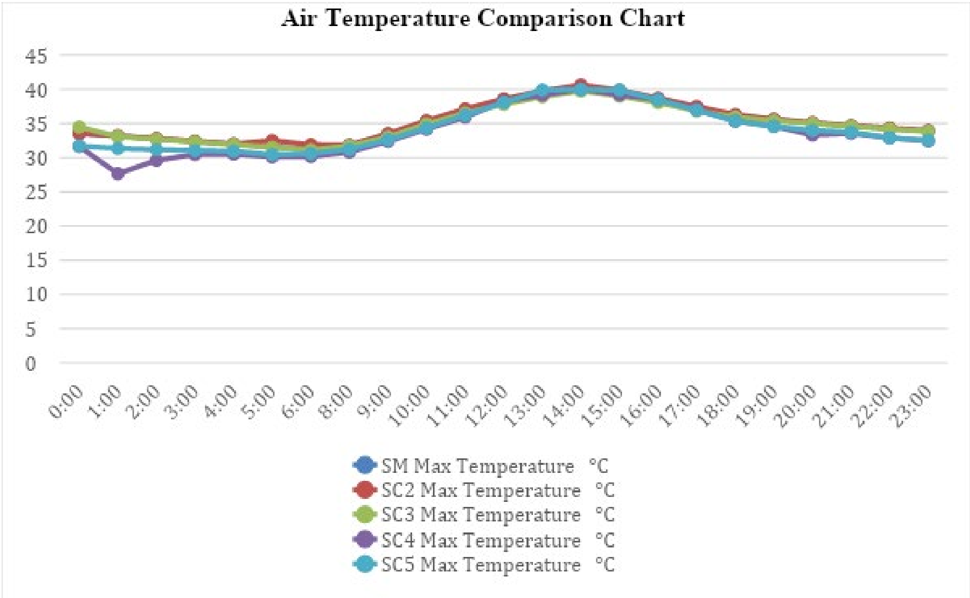

Figure 207.Air Temperature Comparison Graphics of SC1,SC2,SC3,SC4,SC5

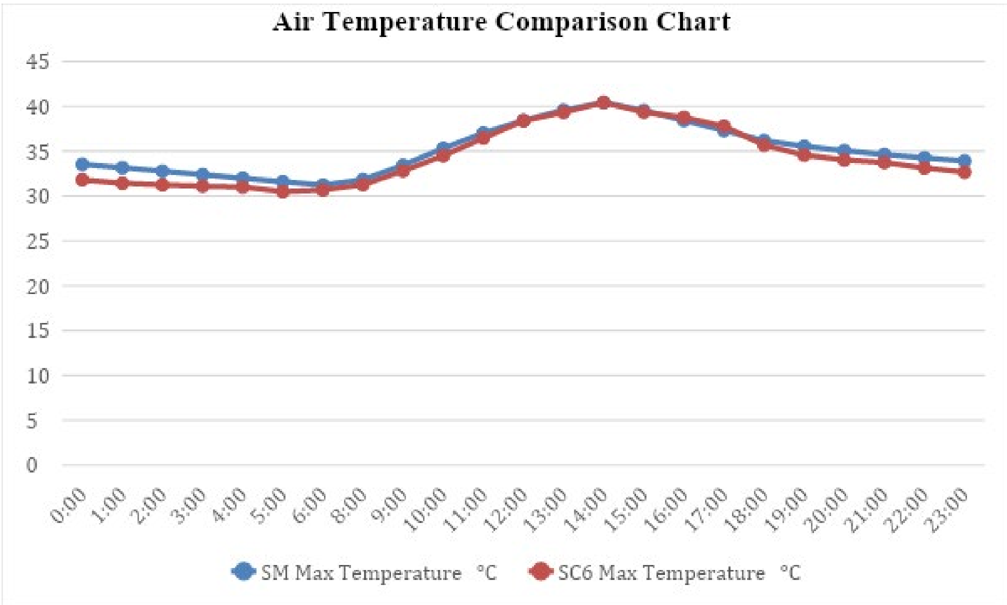

Figure 208. Air Temperature Comparison Graphics of SC1-SC6

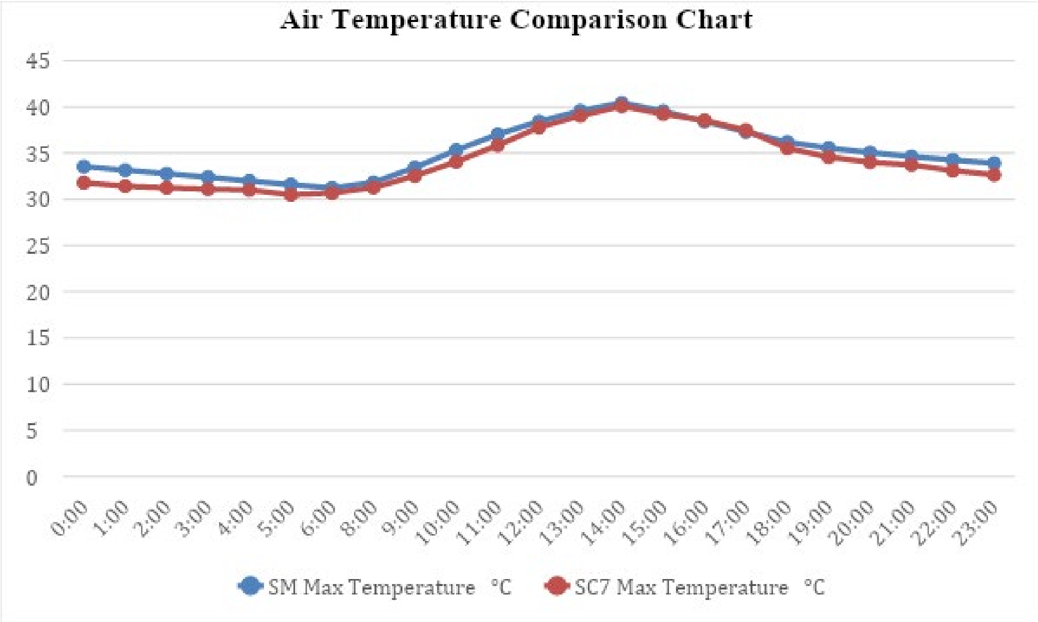

Figure 209.Air Temperature Comparison Graphics of SC1- SC7

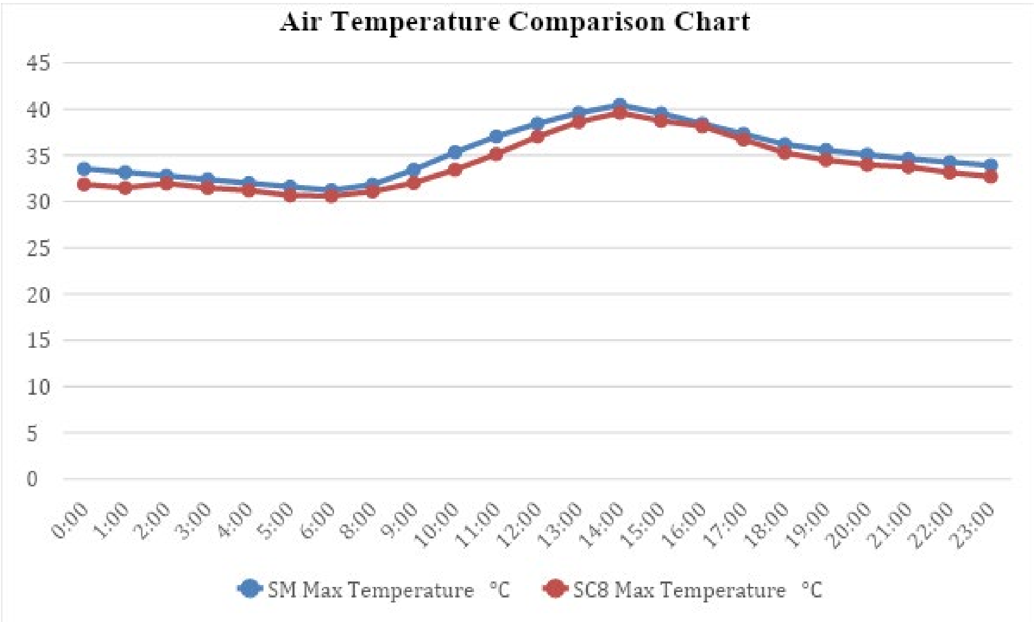

Figure 210.Air Temperature Comparison Graphics of SC1- SC8

APPENDIX Z

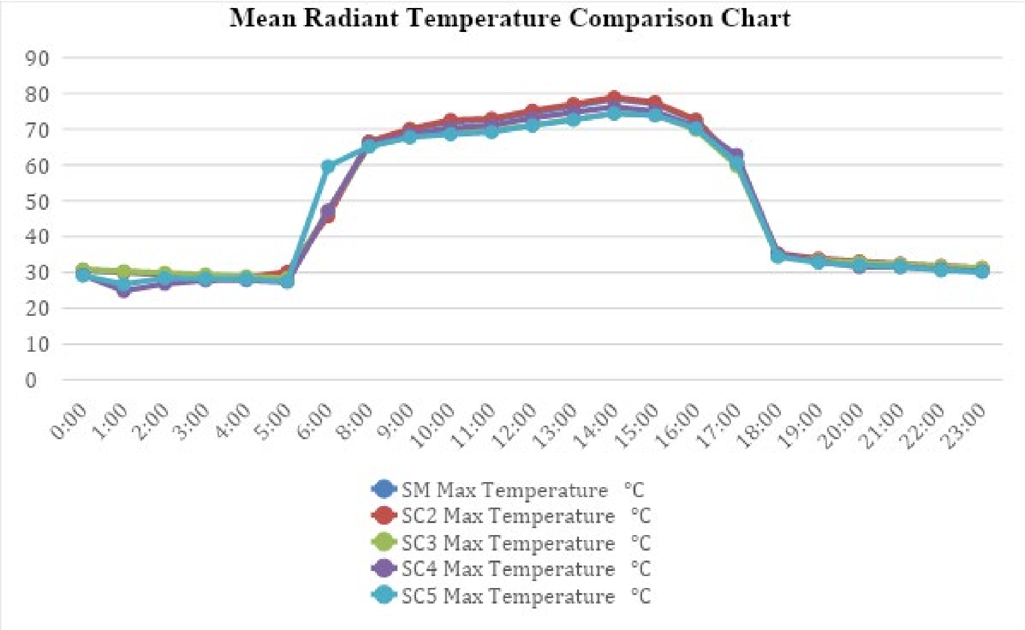

Figure 211.Mean Radiant Temperature Comparison Graphics of SC1-SC5

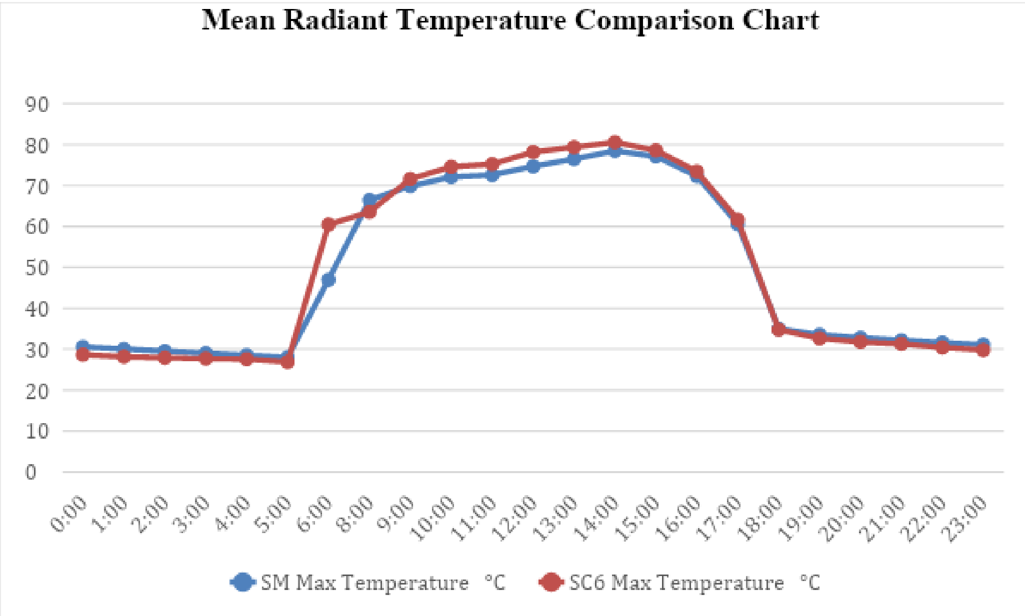

Figure 212.Mean Radiant Temperature Comparison Graphics of SC1-SC6

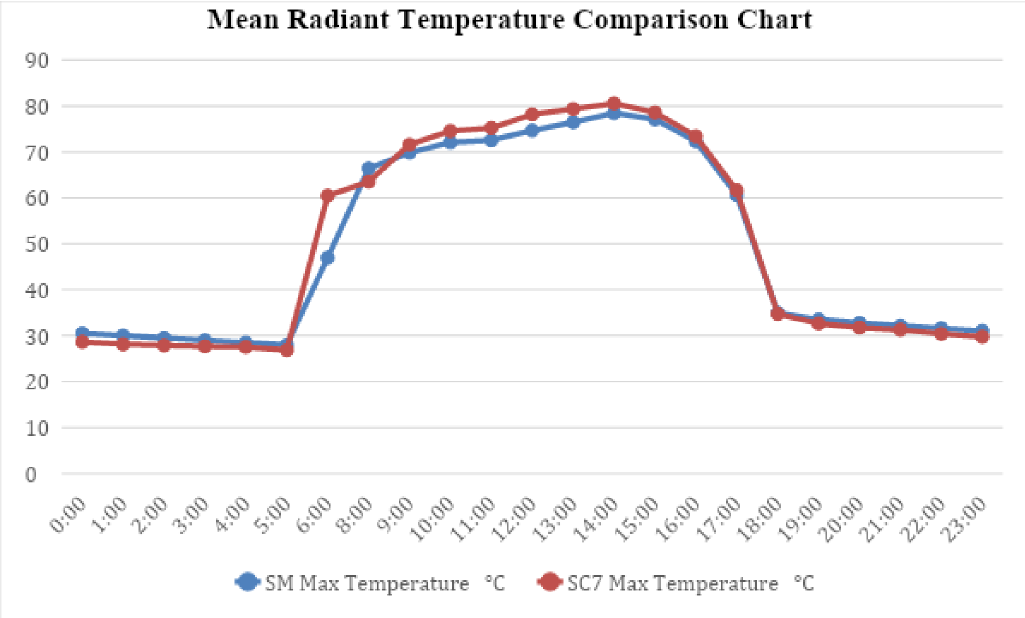

Figure 213.Mean Radiant Temperature Comparison Graphics of SC1-SC7

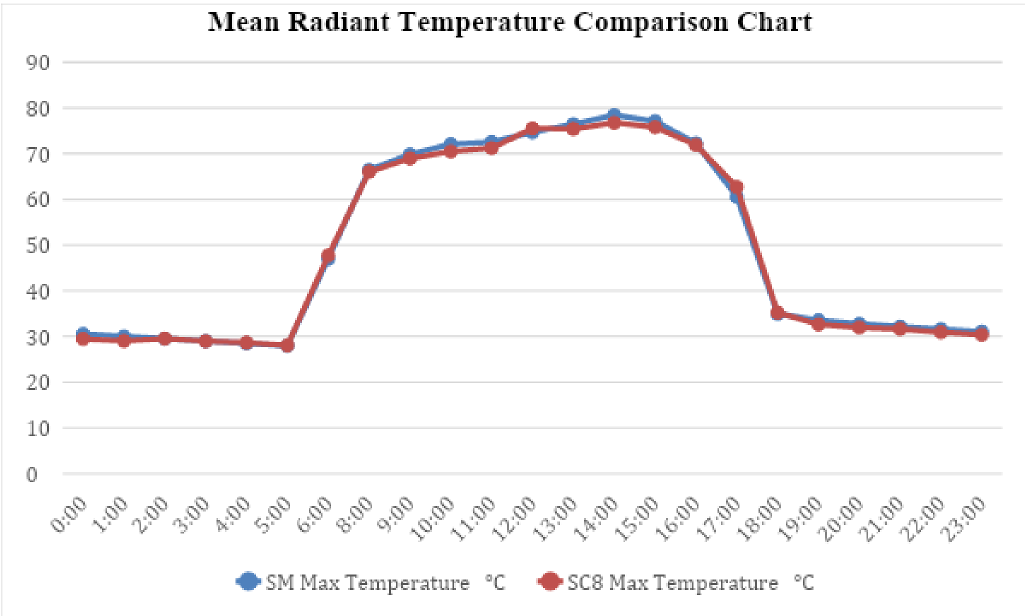

Figure 214.Mean Radiant Temperature Comparison Graphics of SC1-SC8

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