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Prof. Dr. Latif Gürkan KAYA

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CONTENTS

CHAPTER 1

ENHANCING ENVIRONMENTAL QUALITY WITH VERTICAL GREENERY SYSTEMS

Tuğçe PEKDOĞAN[1]

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1. Introduction

As people spend more time indoors, indoor air quality has become an increasingly important aspect of modern building designs. Governments, organizations, and individuals have extensively discussed the importance of improving indoor environmental quality, resulting in various regulations and decision-making processes. Indoor air quality has become even more important after the pandemic. Awareness of the indoor spread of particulates has prompted policymakers and building owners to prioritize measures that can effectively reduce the risk of contamination in confined spaces. Therefore, innovative solutions and technologies have emerged to address and improve indoor air quality. An important emerging technology is heating, ventilation, and air conditioning (HVAC) systems. HVAC technology has evolved to include advanced air filtration systems that reduce allergens and pollutants indoors. In addition, the interest in technological solutions in which UV rays are used in the systems to destroy pathogens in air handling units is also increasing (Pekdogan et al. 2021).

Monitoring of air quality indoors is very important. Therefore, air quality monitoring systems and real-time sensors detect and measure various parameters such as temperature, humidity, CO_2 levels, and volatile organic compounds. Continuous indoor air quality monitoring allows users to quickly identify potential problems and take appropriate action to improve air quality. Adopting building materials and furniture with low levels of indoor emissions is also important for improving indoor air quality. Volatile organic compounds (VOCs) released from certain materials can adversely affect indoor air quality. Therefore, understanding the different building materials and how they affect indoor air quality is key to maintaining a healthy environment. Various building materials in the indoor environment can adversely affect indoor air quality. For example, wood is a common building material that releases PM (particulate matter) over time. Building materials such as concrete, mortar, and stone emit these PMs over time. Another innovative solution for indoor air pollution prevention is green wall systems. Living walls and vertical gardens include growing plants vertically on the walls using various systems and modules while saving energy and reducing indoor air pollution. These green walls are crucial in improving indoor air quality by acting as a natural air filter. Plants absorb carbon dioxide and release oxygen, helping to regulate oxygen levels indoors. The presence of these green walls can significantly reduce airborne pollutants and contribute to a healthier indoor environment.

This paper aims to examine the impact of green wall systems on indoor environmental quality through environmental, economic, and social benefits such as thermal performance, air pollution, noise reduction, social and visual effects, and psychological benefits. This research primarily

examines vertical greenery systems and makes a literature review of the benefits of these systems.

2. Greenery Systems: Definition and Classification

In recent years, the problems caused by climate change have led architects and city planners to sustainable building designs that have the potential to reduce energy demand, minimize environmental impact, and reduce the heat island effect (Radić, Dodig, and Auer 2019). Adding green walls, green facades, and living walls to buildings is part of an urban design approach that addresses current problems with the built environment (Pekdogan 2022b). In addition to increasing the aesthetic appeal of buildings, these systems have many benefits, such as increasing urban biodiversity, providing thermal comfort, reducing the urban heat island effect, and improving air quality.

2.1. Green Walls

They are self-contained systems in which vegetation is supported on vertical structures. These walls typically comprise a framework or panels holding plants, growing media, irrigation, and drainage systems. These green walls can be used not only outdoors but also indoors. These systems can be applied to a wooden, concrete, or metal structure.

According to Kohler (Köhler 2008), green walls have greater potential than green roofs. This is because facade greening can be applied in more areas in city centers. Green walls contribute to the sustainability performance of buildings as a passive solution. While it can be used as an insulation layer to improve thermal performance, it causes lower losses in surface temperatures with the evaporation-sweating effect of plants. In the summer, it causes it to be cooler. Therefore, it is used as a system to help minimize heat losses and gains. As shown in Fig. 1, green wall technology is divided into two classes according to its construction characteristics. The first is green facades, and the other is living walls. While the green facades system is applied directly and indirectly, living walls are implemented as continuous and modular.

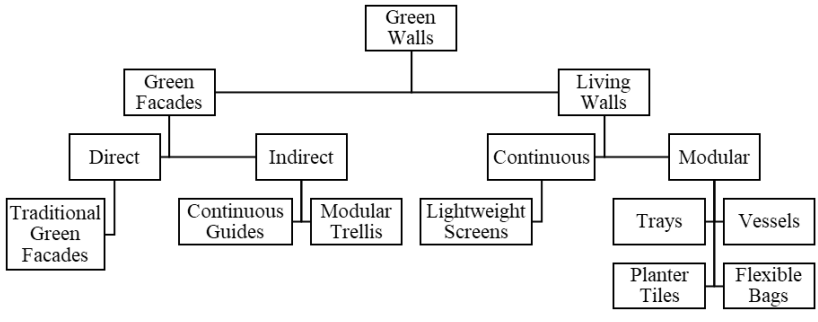

Figure 1. Classification of the green walls

2.1.1. Green Facades

A vertical garden system creates different types of vegetation, climbing plants, or cascading vegetation. The general feature of this system is that it can be installed as an independent structure on existing walls or buildings with fences and columns. Green facade systems can be created as flowerpots and rewind walls differently. In this system, plants form green facades by wrapping and climbing a modularly constructed trellis panel system or Grid and wire-rope net systems (Timur and Karaca 2013).

Green facades can improve the thermal performance of buildings, reduce air pollution, and provide habitat for wildlife, as buildings have vertical surfaces covered with vegetation and add beauty and character to buildings with improved aesthetic appeal. Despite the maintenance, weight, and water requirements challenges, green facades are a way to improve the environmental performance of buildings in general for sustainable design. As the demand for green buildings increases, green facades will likely become more common in the coming years.

2.1.2. Living Walls

Living walls are called biological walls of living plants or vertical gardens. Plants are grown in a wall-mounted environment in vertical gardens with living walls. The most important advantages of living walls are that they can be grown without soil and applied in various climatic environments. Sand, peat, vermiculite, and perlite are the most preferred growing media materials. Living walls can be applied by contacting the façade, or they can be applied separately and independently from the façade. They can also be applied as potted plants, pre-production with foam or mineral wool layer, or on-site production with a felt layer (Fig. 2) (Erdoğdu and Çetiner 2014).

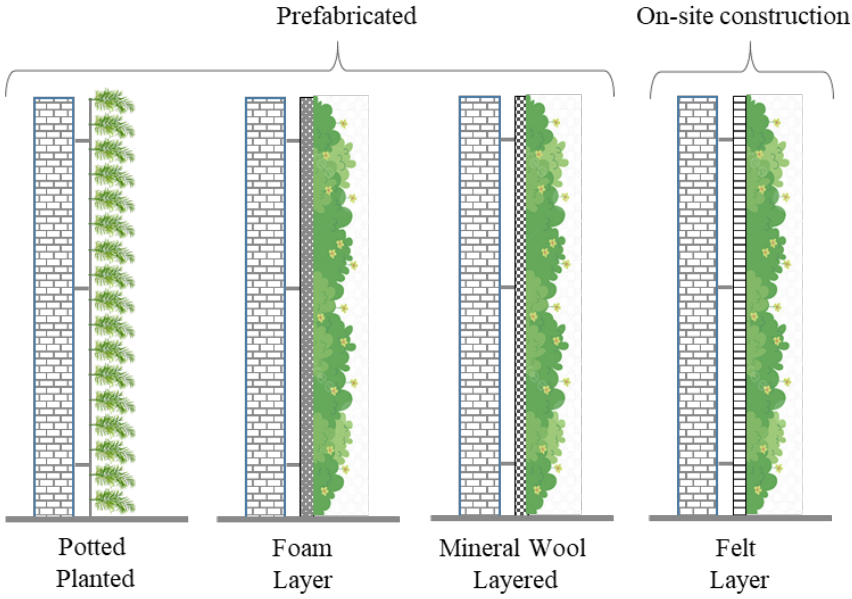

Figure 2. Living Walls Section

In parallel with technological advances, it also allows the use of different techniques and materials, especially in modular systems.

Living walls, like green roofs, also have environmental benefits, such as preventing air and environmental noise pollution and protecting the building surface from harmful effects such as sun rays and acid rain. It has positive sociological and psychological effects on aesthetics and human psychology. Especially in high-rise buildings, when the environmental contributions of green roofs and walls are examined, it is seen that green walls provide 20 times more environmental contribution than green roofs due to their large surface areas. (Erdoğdu and Çetiner 2014).

3. Benefits of Greenery Systems

The Industrial Revolution and the technological developments after it led to the emergence of new urban models, where people moved away from nature and crowded settlements increased. The rapid increase in city life and the intense migration to cities have caused the rapid consumption of non-renewable traditional energy sources, and widespread environmental problems have occurred because of this uncontrolled use. These negativities have increased the importance of environmental and human health, and it has been understood that sustainability can only be solved by planning sustainable living spaces.

Sustainable spaces have a balance with the environment, and their economic contribution is also very important regarding their effects on energy efficiency. In addition, space designs made with durable, easy-to-maintain materials that can provide recycling because of re-production are effective in terms of being beneficial to environmental health (Pekdogan 2022a).

Greening systems can improve air quality through living walls inside and outside the building, reduce air pollution levels, lower temperatures inside and outside buildings, reduce building energy use and provide soundproofing, contribute to biodiversity, and help improve people's physical and psychological health (Beecham et al. 2019).

3.1. Environmental Effects

Living walls can be applied in any area where all the requirements for the survival of plants are met and their infrastructures are planned and implemented correctly. Living walls, designed using living plants, provide spiritual and mental benefits to people trying to survive in the harsh conditions of urban life. Modern architecture with diversified construction techniques can apply this system to all spaces. Living vegetation on building surfaces provides many environmental advantages (Abdullahi and Alibaba 2016). Although there are some disadvantages, such as construction and maintenance costs, irrigation and nutrition system requirements of plants, the environmental effects of living walls, which greatly contribute to the solution of various negativities brought by urbanization, are examined below.

3.1.1. Thermal Performance

The need for new buildings is directly proportional to the increasing urban population. Therefore, urban green spaces are decreasing, and urban temperatures, also known as the urban heat island effect, are increasing daily. Many studies are now focusing on finding solutions to this issue, and living walls are emerging as a potential answer to reduce urban temperatures and combat climate change.

Green walls act as a heat insulator by reducing the amount of heat lost or gained through the walls of the building. Plants in a green wall absorb solar radiation, which helps keep the wall cooler in summer. Plants also release water vapor into the air, which helps create a humid microclimate around the wall. This humid microclimate helps to reduce heat transfer through the wall through conduction and convection. Green walls also help regulate the temperature inside the building. In summer, green walls keep the building cooler by absorbing solar radiation and releasing water vapor. In winter, green walls trap heat and keep the building warmer.

A façade covered with green plants also protects from intense solar ra-

diation, as a large amount of solar radiation can be converted into latent heat, preventing heat build-up. Depending on the amount and type of vegetation, it can reflect or absorb between 40% and 80% of solar radiation. The warm air rising on the surface of the existing material on the facade is replaced by fresh air from above, naturally reducing the heat island effect. For this reason, the existing temperature on the façade surface tends to be lower than the surrounding temperature. Green wall vegetation becomes a potential insulating tool, almost like a barrier, preventing radiation transfer inside (Çerçi 2018).

Perini et al. stated that the air gap formed in green walls could affect the wind speed of the existing envelope in the building and act as a buffer that improves thermal performance (Sheweka and Mohamed 2012).

A heat transfer coefficient of 2.9 W/m2K can be achieved with a 5 cm fixed buffer air pocket between the vegetation and the building. Depending on the desired effect, solar radiation and wind can be controlled with a green plant layer or deciduous vegetation depending on the summer and winter seasons (Krusche, Althaus, and Gabriel 1982).

It shows that using living walls in semiarid climatic conditions can reduce the wall surface temperature by up to 30°C compared to conventional wall surfaces. However, this effect may vary depending on the plant species and wall structure (Victorero et al. 2015).

According to Stav and Lawson's study in a subtropical climate zone, annual cooling energy savings can reach 25% (Stav and Lawson 2012), 489-500. In his green façade experiment for a hot-dry climate zone, Laurenz found that a glass curtain wall in an office building saved 45% of energy in summer and 23% in winter (Laurenz et al. 2005). According to Bakhshoodeh's comprehensive literature review on the thermal performance of green facades, it has been observed that when the external wall temperatures are compared, independent facades reduce the wall surface more than the combined facades during hot periods (Bakhshoodeh, Ocampo, and Oldham 2022).

Djedjig et al. found that an innovative green wall system in a building in France reduced the peak temperature of the building's exterior surface by up to 12°C in summer and reduced the building's annual energy demand by up to 37% (Djedjig et al. 2017).

Studies on green walls' thermal effects generally indicate that they considerably impact a building's thermal performance. They can also improve thermal comfort in urban settings by reducing heat gain in the summer and heat loss in the winter. Additionally, it is important to remember that the thermal effects of green walls might change based on the type of green wall, the environment, and the building's orientation.

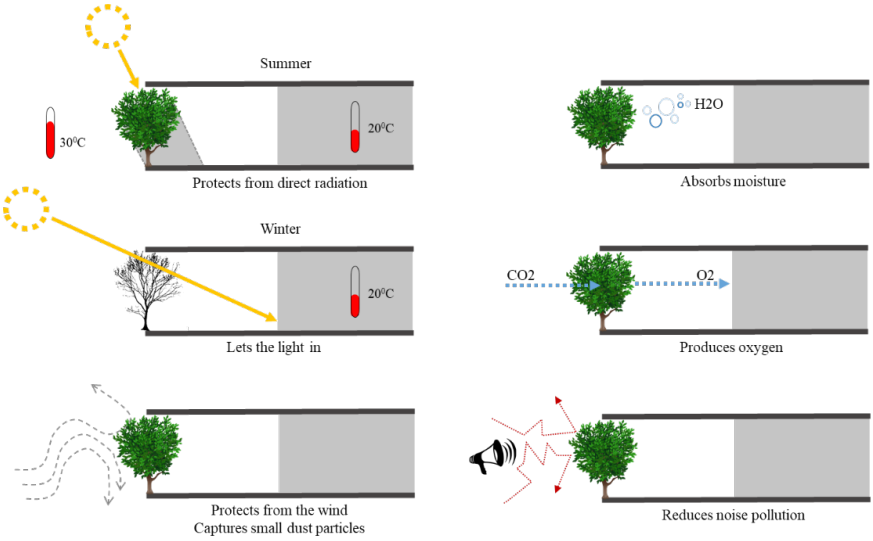

Figure 3. Thermal effects of green walls

3.1.2. Air Pollution

Oxygen is the main source of life on Earth for humans and all other living things. The importance of clean air in places where people live or work has come to the fore with the sick building syndrome that emerged in the United States in the late 1970s (Wolverton, Johnson, and Bounds 1989).

Plants are natural filters that take carbon dioxide from the air and replace it with much-needed oxygen. Therefore, they can filter pollutants from indoor and outdoor air. In order to reduce urban atmospheric pollution in semiarid climates, vegetation on green roofs and living walls can be used Viecco et al. (Viecco et al. 2018) studied the deposition of particulate matter (PM2.5 and PM10) and concluded that it could make a significant contribution to reducing air pollution at the urban scale in general.

The existing green wall in the building acts as a biological filter and oxygen generator. For this purpose, 27 g of oxygen can be produced per hour from a green wall with 25 m2 of leaf surface. This production is equal to human consumption. A green wall with 150 m2 of leaf surface can produce the oxygen humans need for a year (Peck et al. 1999). While a small leaf can produce this amount of oxygen, the production effect is greater if the plant is large enough. In addition, a 60 m2 green wall can filter 40 tons of harmful gases and 15 kg of heavy metals (Ecosystems 2011). Green wall plants inside the building filter and remove VOCs, benzene, toluene, and other toxic fumes (Darlington, Dat, and Dixon 2001). People suffering from respiratory diseases such as asthma can benefit from these beneficial

aspects of green walls. This can save 3.5 kW per person during peak seasons (Cooney et al. 2004).

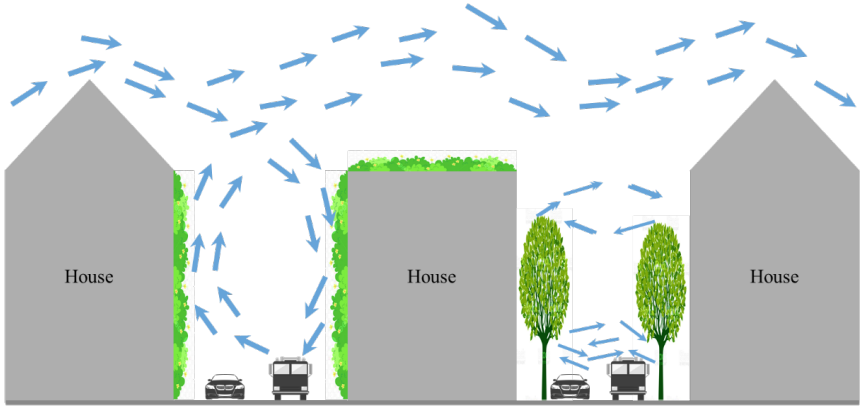

Figure 4. Airflow schema

Vertical gardens improve the flow of polluted air at street level compared to a narrow street covered with eaves of trees (Fig. 4) (Ottelé 2011).

3.1.3. Noise Reduction

There are many studies in the literature suggesting that vertical greenery systems can be a solution to urban noise pollution. Studies have shown that more greenery coverage leads to an increase in the sound absorption coefficient. Green walls may minimize noise in two distinct ways. The first of these is absorption. Plant leaves and stems absorb sound waves from the environment and convert them to heat energy. The total amount of noise absorption varies according to the type, density of the planting, and frequency of the sound waves. Diffusion is another mechanism. Plants spread sound waves in diverse directions by diffusing them via their leaves and stems. The noise level can be decreased because of the disruption of sound waves going in a straight path.

The degree of noise reduction that a green wall can achieve is determined by various factors, including the height of the wall, the type of plants utilized, and the distance between the wall and the noise source. In general, taller walls and denser plants provide more noise reduction.

Green walls are particularly important for reducing low-frequency noise, such as traffic noise. This is because low-frequency noise is more difficult to block with conventional soundproofing materials.

A roof garden experiment measured that a large green roof blocks 5-13

dB of noise (Connelly and Hodgson 2008). According to the experiment conducted by Wong et al. on the sound absorption coefficient, it was observed that it increases in direct proportion to the area of the green facade system. It can also be said that it generally causes noise loss between 2-8 dB (Wong et al. 2010).

3.2. Economic Effects

In addition to aesthetic and environmental benefits, green walls have several economic impacts. Financially, green walls perform poorly, quite often negatively. However, the economic evaluation improves when ecological and social benefits are added. Studies show that balancing costs against benefits is important in implementing green walls (Teotónio, Silva, and Cruz 2021).

The heat island phenomenon in cities is increasing with the spread of concrete buildings. During the day, the building absorbs heat, and the temperature rises compared to its surroundings, creating a heat island. The green wall is a natural cooler due to vegetation and plant evaporation. Evapotranspiration (evaporation and transpiration) creates a cooling effect due to the evaporation of water from the leaves. For example, 2.5 MJ of energy is required to evaporate 1 kg of water (Ottele 2010). A green wall can reduce wind impact by 75% and heating demand by 25%, depending on various conditions (Peck et al. 1999).

The biggest economic gain of green walls comes from the energy savings they provide through their thermal performance. This issue is important today when energy costs and global warming are increasing.

3.3. Social and Psychological Effects

Since people living in urban environments have less interaction with nature, this can lead to depression and anxiety (Darlington et al. 2001). Studies show that plants help reduce stress, cure diseases and increase disease resistance (Sheweka and Magdy 2011). Gardening and plant gardening is a therapeutic field that regulates the relationship between humans and plants to reduce stress, fear, anger, blood pressure and muscle tension (Başdoğan and Arzu 2016). For this purpose, living walls attract attention like a natural environment and change negative thoughts like meditation. (Peck et al. 1999).

Many studies have been conducted to analyze the benefits of green walls in work environments and schools. One study showed that green plants in vertical gardens used in workplaces reduced employee absenteeism by 5-15%. Natural green plants in classrooms were found to reduce students' stress levels and increase their productivity by 12% (Butkovich et al. 2008).

According to an experiment conducted in an office in Finland, it was observed that green walls remove volatile organic compounds as well as balance the humidity in the air and that living walls that circulate air change the microbiome and positively modulate the immune system of office workers (Soininen et al. 2022).

The Drew School in San Francisco (Fig. 5), designed by Patrick Blanc, uses green walls on the building façade. While the green wall helps the school's students with their educational research, it also attracts birds to the neighborhood because of the natural environment it creates. It has been observed that the birds carry tomato seeds, and thus, tomato plants start to grow on the surface. The contribution of the human-made green wall system to sustainability is seen in this example. In this way, the school building received a gold LEED certificate (Morrison 2018).

Figure 5. Drew School San Francisco

The many buildings that make up cities surround the city and create a cold, artificial, and unaesthetic appearance. Weathered and worn building surfaces, gray facades, and structures built with different techniques negatively affect the aesthetics of the city. Sustainable green walls can reduce these undesirable effects on sociologically and psychologically affected people. With green wall applications, the aesthetics of the city can be increased, worn building surfaces can be covered with green plants, and the city's image can be renewed.

4. Discussion and Results

Increasing urban life due to developing technology brings out the concept of sustainability to transfer limited and non-renewable resources to future generations. The concept of a sustainable city necessitates the harmonization of green building/smart city approaches with the city. In addition, reasons such as increasing migration, the negativities created by technology in living conditions, increased vehicle traffic, increased consumption

and decreased production negatively affect urban life and reduce the quality of life. Increasing air and water pollution, climate changes caused by heat islands, increasing global climate change on a large scale, and deterioration of bioclimatic comfort cause a decrease in green areas in cities. In order to maintain sustainable urban life, vertical greening systems contribute ecologically to the quality of life in large cities by isolating noise, creating habitats for birds and insects, increasing biodiversity, reducing the heat island effect and creating opportunities for urban agriculture practices. They leave positive psychological effects on people and improve aesthetic perception.

When analyzed economically, vertical gardens increase energy efficiency and can also provide water efficiency, especially if it is planned to use rainwater for irrigation. The cornerstone of the sustainable city model is economic contribution. In this case, economic contributions are also important in green wall applications. The maintenance costs, water and light expenditures, external supply of nutrients and additives of the preferred applications contradict the concept of sustainability. Therefore, in vertical garden designs and applications, priority should be given to projects that utilize rainwater for irrigation, provide light naturally and minimize external dependency and maintenance needs.

The factors that should be considered in designs that are desired to be sustainable can be listed as follows.

- Good analysis of climatic conditions in terms of sun position, wind, humidity and temperatures before the project,
- Good articulation of design objectives in terms of energy performance expectations, heat island effect, indoor air quality, noise reduction, etc.,
- Selecting materials that are suitable for budget planning and will serve the purpose, determining their advantages and disadvantages and obtaining technical information from experts,
- By analyzing the climatic conditions well, determining the plant species suitable for the selected materials and determining their needs,
- Determining the type, thickness, composition and maintenance needs and requirements of the appropriate layer for the growth and survival of the plant,
- Pre-planning additional improvement measures, such as using solar panels and rainwater storage systems, will directly impact the sustainability of green walls.

Periodic maintenance of these systems will ensure their longevity in the space where they are located and will contribute positively to the livable environment in terms of energy efficiency, providing acoustic comfort, reducing water consumption and noise pollution, improving indoor-outdoor air quality, supporting biodiversity, and increasing aesthetic comfort.

REFERENCES

Abdullahi, Muhammad Shamsuddeen, and Halil Zafer Alibaba. 2016. "Facade Greening: A Way to Attain Sustainable Built Environment." *International Journal of Environmental Monitoring and Analysis* 4(1):12–20.

Bakhshoodeh, Reza, Carlos Ocampo, and Carolyn Oldham. 2022. "Thermal Performance of Green Façades: Review and Analysis of Published Data." *Renewable and Sustainable Energy Reviews* 155:111744.

Başdoğan, Gülçinay, and Çığ Arzu. 2016. "Ecological-Social-Economical Impacts of Vertical Gardens in the Sustainable City Model." *Yuzuncu Yıl University Journal of Agricultural Sciences* 26(3):430–38.

Beecham, Simon, Mostafa Razzaghmanesh, Rosmina Bustami, and James Ward. 2019. "The Role of Green Roofs and Living Walls as WSUD Approaches in a Dry Climate." Pp. 409–30 in *Approaches to water sensitive urban design*. Elsevier.

Butkovich, Kent, Jeffrey Graves, Jenn McKay, and Marlene Slopack. 2008. *An Investigation into the Feasibility of Biowall Technology*.

Çerçi, Serpil. 2018. "Bitkilendirilmiş Cephelerin Çevresel ve Ekolojik Etkileri." *Ulusal Çatı & Cephe Sempozyumu, Nisan, Istanbul* 12–13.

Connelly, Maureen, and Murray Hodgson. 2008. "Sound Transmission Loss of Green Roofs." *Proceedings of the 6th Annual Greening Rooftops for Sustainable Communities. Baltimore, MD. April*.

Cooney, Erin, Sarah Deller, Leanne Michie, and Duran Wedderburn. 2004. "A Research Study of the Feasibility of Implementing a Living Wall into the Environmental Studies 2 Building." *University of Waterloos*.

Darlington, Alan B., James F. Dat, and Michael A. Dixon. 2001. "The Biofiltration of Indoor Air: Air Flux and Temperature Influences the Removal of Toluene, Ethylbenzene, and Xylene." *Environmental Science \& Technology* 35(1):240–46.

Djedjig, R., M. El Ganaoui, Rafik Belarbi, and R. Bennacer. 2017. "Thermal Effects of an Innovative Green Wall on Building Energy Performance." *Mechanics \& Industry* 18(1):104.

Ecosystems, Vertical. 2011. "Vertical Garden Benefits." *Retrieved from Vertical Ecosystems*.

Erdoğdu, Elif, and Ikbal Çetiner. 2014. "Düşey Yeşil Sistemlerin Enerji Etkinliklerinin Değerlendirilmesi." *Ulusal Çatı & Cephe Sempozyumu*.

Köhler, Manfred. 2008. "Green Facades-a View Back and Some Visions." *Urban Ecosystems* 11(4).

Krusche, Per, D. Althaus, and D. Gabriel. 1982. "Okologisches Bauen Herausgegeben Vom Umweltbundesamt." *Wiesbaden Und Berlin: Bauverlag*.

Laurenz, Jon, I. Paricio, J. Alvarez, and F. Ruiz. 2005. "Natural Envelope. The

Green Element as a Boundary Limit." Pp. 4653–60 in *The 2005 World Sustainable Building Conference, Tokyo*.

Morrison, K. 2018. "Softening Concrete and Metal with Native Plants." *Flora California's Plants, People, Places* 33.

Ottele, M. 2010. "Vertical Greened Surfaces and the Potential to Reduce Air Pollution and the Improvement of the Insulation Value of Buildings." *Delft University of Technology*.

Ottelé, Marc. 2011. "The Green Building Envelope." *Civil Engineering and Geosciences; SiecaRepro: Delft, The Netherlands*.

Peck, Steven W., Chris Callaghan, Monica E. Kuhn, and Brad Bass. 1999. "Greenbacks from Green Roofs: Forging a New Industry in Canada."

Pekdogan, Tugce. 2022a. "Design of Learning Spaces in the Post-Pandemic Era." *International Journal of Sustainable Building Technology and Urban Development* 13(4):500 – 513.

Pekdogan, Tugce. 2022b. "Yapılı Çevrede Akıllı Kent Kavramında 'Yeşil Bina.'" Pp. 127–43 in *Mimarlık, Planlama ve Tasarım Alanında Güncel Tartışmalar*. Duvar Yayınları.

Pekdogan, Tugce, Ayça Tokuç, Mehmet Akif Ezan, and Tahsin Başaran. 2021. "Experimental Investigation of a Decentralized Heat Recovery Ventilation System." *Journal of Building Engineering*.

Radić, Mina, Marta Brković Dodig, and Thomas Auer. 2019. "Green Facades and Living Walls-A Review Establishing the Classification of Construction Types and Mapping the Benefits." *Sustainability (Switzerland)* 11(17).

Sheweka, Samar, and Arch Nourhan Magdy. 2011. "The Living Walls as an Approach for a Healthy Urban Environment." *Energy Procedia* 6:592–99.

Sheweka, Samar Mohamed, and Nourhan Magdy Mohamed. 2012. "Green Facades as a New Sustainable Approach towards Climate Change." *Energy Procedia* 18:507–20.

Soininen, Laura, M. I. Roslund, Noora Nurminen, Riikka Puhakka, O. H. Laitinen, Heikki Hyöty, and Aki Sinkkonen. 2022. "Indoor Green Wall Affects Health-Associated Commensal Skin Microbiota and Enhances Immune Regulation: A Randomized Trial among Urban Office Workers." *Scientific Reports* 12(1):6518.

Stav, Yael, and Gillian Lawson. 2012. "Vertical Vegetation Design Decisions and Their Impact on Energy Consumption in Subtropical Cities." *The Sustainable City VII: Urban Regeneration and Sustainability [WIT Transactions on Ecology and the Environment, Volume 155]* 489–500.

Teotónio, Inês, Cristina Matos Silva, and Carlos Oliveira Cruz. 2021. "Economics of Green Roofs and Green Walls: A Literature Review." *Sustainable Cities and Society* 69:102781.

Timur, Özgür Burhan, and Elif Karaca. 2013. "Vertical Gardens." in *Advances in*

Landscape Architecture. IntechOpen.

Victorero, Felipe, Sergio Vera, Waldo Bustamante, Felipe Tori, Carlos Bonilla, Jorge Gironás, and Victoria Rojas. 2015. "Experimental Study of the Thermal Performance of Living Walls under Semiarid Climatic Conditions." *Energy Procedia* 78:3416–21.

Viecco, Margareth, Sergio Vera, Héctor Jorquera, Waldo Bustamante, Jorge Gironás, Cynnamon Dobbs, and Eduardo Leiva. 2018. "Potential of Particle Matter Dry Deposition on Green Roofs and Living Walls Vegetation for Mitigating Urban Atmospheric Pollution in Semiarid Climates." *Sustainability* 10(7):2431.

Wolverton, Bill C., Anne Johnson, and Keith Bounds. 1989. *Interior Landscape Plants for Indoor Air Pollution Abatement*.

Wong, Nyuk Hien, Alex Yong Kwang Tan, Puay Yok Tan, Kelly Chiang, and Ngian Chung Wong. 2010. "Acoustics Evaluation of Vertical Greenery Systems for Building Walls." *Building and Environment* 45(2):411–20.

CHAPTER 2

EXAMINATION OF CLIMATE FICTION CINEMA IN THE CONTEXT OF CLIMATE CHANGE

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1. Introduction

As a social and cultural entity, human beings and their natural environment are closely interconnected and have a complex relationship. In the context of globalization, environmental problems increase in direct proportion to the increase in human activities, and its impact on ecological degradation varies due to its unique characteristics. For example, economic globalization has been found to have both positive and negative consequences for environmental degradation, with some studies showing that it reduces ecological degradation (Jahanger, 2022; Tang, 2022). In contrast, social and political globalization does not impact environmental degradation significantly (Usman et al., 2022). Furthermore, trade, income growth, and ecological quality interconnections exhibit variations between developed and developing nations. In developed countries, commerce and income growth typically enhance environmental quality, whereas, in most developing countries, they have a detrimental impact on environmental quality (Karaduman, 2022). Globalization is known to significantly impact environmental issues, although with varying effects depending on the level of development and the extent of globalization in a given country. In light of these emerging environmental challenges, there has been a growing emphasis on adopting climate-friendly and innovative solutions. It is possible to see clues about what kind of future awaits us without studies and sensitivity toward solutions to environmental problems in post-apocalyptic climate fiction cinema Climate Fiction (Cli-Fi). Climate fiction cinema examines the interrelation between film and the natural world, focusing on climate change. In post-apocalyptic climate fiction cinema, initiatives to solve global environmental problems and the importance of sensitivity are emphasized. Fictional stories depict how climate change affects agriculture, rural lifestyles, and urban environments, emphasizing social, political, and economic consequences (Akyol, 2020; Brereton, 2020). In addition, these films can encourage the participation of a wider audience through creative audiovisual storytelling (Panda, 2020). Audiovisual narratives and fictional films can captivate audiences, evoke emotions, generate awareness, and facilitate positive action and behavioral change (Schneider-Mayerson, 2018; Svoboda, 2016). Moreover, they can contribute significantly to our comprehension of the future and aid in formulating strategies necessary for establishing a sustainable world (Michael, 2019). Examining climate change films can offer researchers valuable insights into the potential consequences of environmental concerns, allowing for a multifaceted approach to addressing these issues (Lindenfeld & Mcgreavy, 2015). Nevertheless, it is imperative to critically evaluate the portrayals depicted in climate change films, as certain representations may not align with sustainable development objectives (Bina et al., 2017). As a result of

literature research, it has been determined that climate fiction cinema needs to be examined in the context of global environmental problems and that there is a lack of studies in this field. In this context, while examining environmental problems and climate scenarios in the study, their reflections on the silver screen were categorized, and solution methods were examined in terms of their feasibility, threats, potentials, positives, and negatives in today's conditions and media environment. Thus, it was tried to investigate how it could contribute to our future. In order to examine these problems and solutions, it is first necessary to explain concepts such as S.S.P. scenarios and resilient cities.

2. Shared Socioeconomic Pathways (S.S.P.)

Shared Socioeconomic Pathways (S.S.P.s) play a crucial role in the examination and evaluation of global transformations. The primary objective is to generate comprehensive scenarios that encompass socioeconomic and environmental factors influencing climate change and policies. Within this framework, S.S.P.s serve as reference trajectories that depict potential alternative trends in societal and ecological development, assuming no climate change or policies. These scenarios are employed to comprehend the future trajectory of greenhouse gas emissions under diverse climate policies. (Kriegler et al., 2014; Nakicenovic et al., 2014; O'Neill et al., 2014; van Vuuren et al., 2014) S.S.P.s represent an indispensable instrument for gaining insights into the future state of the Earth. Their purpose is to inform the formulation of policies and actions aimed at enhancing the livability of our planet. They are constructed based on five distinct pathways, which consider the potential evolution of global challenges such as climate change, social inequality, and technological advancements. The intention is to capture the potential evolution of global challenges that may shape future societies (O'Neill et al., 2017);

SSP1, A world of sustainability-driven growth and equity. Climate change and other global challenges can be rapidly addressed in this scenario.

SSP2, The middle path, is where the world continues to evolve similarly to its historical course throughout the 21st century. In this scenario, global environmental problems are moderately reduced. The world maintains a mix of economic growth and prosperity.

SSP3, A fragmented and resurgent nationalist world (regional competition, a nationalist world). In this scenario, global environmental problems increase significantly. The world becomes a place of inequality and conflict.

SSP4, A world of ever-increasing inequality (inequality). In this scenario, world population and consumption overgrow. The world becomes a

place of environmental stress and social tensions.

SSP5, A world of rapid and unlimited growth in economic output and energy use (carbon-intensive energy use). In this scenario, technological development slows down. The world maintains a mix of economic growth and prosperity, but global environmental problems increase significantly.

The conceptual framework for the design and use of S.S.P.s requires the development of global pathways that define the future evolution of crucial aspects of society, which together will mean a set of challenges for climate change mitigation and adaptation; (O'Neill et al., 2014) propose a conceptual framework for identifying and developing Shared Socioeconomic Pathways (S.S.P.s). This framework envisages combining future radioactive forcing pathways and associated environmental issues with alternative socioeconomic development pathways to research climate change impacts, adaptation, and mitigation. (O'Neill et al., 2017) address the development of S.S.P.s that describe future changes in demography, human development, economy and lifestyles, policies and institutions, technology, environment, and natural resources. (Kriegler et al., 2014) Addresses issues such as the development of concentration pathways for climate change projections.

3. Urban Resilience

The term resilience was first introduced into scientific research associated with ecological systems by Holling (1973, p. 17): *"Resilience/ Durability determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes in state variables, driving variables, and parameters and still persist. In this definition, resilience is the property of the system, and the possibility of permanence or extinction is the outcome*." (Ribeiro & Pena Jardim Gonçalves, 2019). Urban Resilience refers to the capacity of a city to withstand, adapt, and recover from shocks and stresses while maintaining its vital functions and overall well-being (Cao, 2023). Social cohesion, inclusiveness, economic diversity, sustainable infrastructure, environmental sustainability, effective governance, and community participation affect urban Resilience (Yamagata & Maruyama, 2016). Measures to increase urban resilience include conducting risk assessments, incorporating resilience into urban planning, investing in resilient infrastructure, promoting social cohesion and community participation, supporting economic diversity and sustainability, leveraging technology and innovation, and strengthening governance structures and partnerships (Galderisi, 2014). Urban resilience is critical for designing and operating cities that withstand significant threats such as natural disasters and economic downturns (Roméro, 2022). Urban resilience plans are necessary for cities to ensure livable conditions and recover from de-

stabilizing factors such as extreme weather events, infrastructure failures, and refugee problems. Resilience is also important in engineering contexts, particularly concerning communities and urban network systems recovering from natural disasters. When the literature on the subject is examined, it is seen that urban resilience is discussed under different headings.

In this context, when the studies within the scope of creating urban resilience are examined, (Irani & Rahnamayiezekavat, 2021) In his study, he examined the literature on urban resilience. He investigated the various definitions of the concept as well as its social, economic, and institutional dimensions as components of a dynamic system. (Godschalk, 2003), It proposes a comprehensive strategy for creating resilient cities that withstand natural hazards and terrorism. (Dobbelsteen et al., 2013), - Modern cities are highly dependent on fossil fuels and are not self-sufficient, making them vulnerable to energy crises. - Therefore, the study discusses the need for resilient cities and the approach to making cities resilient to energy crises. (Weichselgartner & Kelman, 2014), Examines some of the theoretical foundations and basic assumptions of the concept of resilience and highlights some difficulties with practical application. (Spaans & Waterhout, 2017), Evaluates the concept of urban resilience, introduces the Rockefeller Foundation's efforts to build city resilience worldwide, and illustrates this with the case of Rotterdam. (Etinay et al., 2018) Differently, in the context of urban resilience for Disaster Risk Management (DRM) and Disaster Risk Reduction (D.R.R.), 2015-2030 Sustainable Development Goals (S.D.G.s) for the built environment, and the Sendai Disaster Risk Reduction Framework. It aims to define common principles to create consistency among (S.F.D.R.R.).

When studies that propose methodological approaches regarding urban resilience are examined (Roméro, 2022), a methodological proposal is discussed for elaborating urban resilience plans, one of the most critical issues concerning cities today. (Bautista-Puig et al., 2022a) Examines publications within this scope between 1998 and 2020. (Yamagata & Maruyama, 2016), Urban resilience focuses on how cities can be designed, operated, and recovered to withstand significant threats such as natural disasters and economic downturns. (Ribeiro & Pena Jardim Gonçalves, 2019), Builds a conceptual framework based on existing literature to support the production of urban resilience tools to prepare and develop strategies and plans to improve urban planning and management in response to disruptive events that may affect the city's functioning.

(Bulkeley & Tuts, 2013), Focuses on how we can understand and respond to the challenges of urban vulnerability, adaptation, and resilience in the context of climate change through collaboration between academia and UN-Habitat's Urban Planning and Design Branch, taking climate change

together with the concept of urban resilience. It was observed that studies on this topic were mostly at the regional scale.

When studies on the resilience of ecological systems are examined, (Holling, 1974), Over the last decade, he has developed various models of ecological processes, population interactions, and ecological community structure. By examining these models, researchers can learn about the underlying mechanisms that drive ecological processes and interactions. They can also use their knowledge to develop more effective strategies for managing and protecting natural resources. (Gunderson, 2000), Reviews the concepts and multiple meanings of resilience given in the literature, examples of modeling and field experiments that enrich our understanding of ecological change, and finally includes a review of how ecological resilience is vital to managing complex human and natural systems. (Wu & Wu, 2013), Cities are complex adaptive systems that face unforeseen problems. The study emphasizes that cities need to provide various strategies to withstand unforeseen challenges, diversify their economy, invest in infrastructure, promote social cohesion, and protect natural resources (the city's structure, function, and identity).

When the relationship between urban resilience and sustainability is examined, it reveals that interrelated paradigms focus on a city's ability to withstand and recover from hazards as it moves towards desirable development pathways. (Zeng et al., 2022). Urban sustainability encompasses social, economic, and environmental dimensions and aims to protect social health and well-being in the context of environmental change (Bautista-Puig et al., 2022b). The urban resilience literature is growing into more practical research, but its direct contribution to sustainability is limited and focuses on environmental and social perspectives (de la Cal & García, 2018). Therefore, resilience is critical for cities to address uncertainties related to global environmental challenges, deindustrialization, unemployment, poverty, and terrorism. In sum, designing resilient cities requires a holistic approach that considers the linkages between different systems and stakeholders and involves the collaboration and participation of a wide range of actors.

4. Global Environmental Issues and Related Films

This part of the study discusses global environmental problems such as global warming and drought, melting of glaciers and sea level rise, global cooling and ice age, and finally, the deterioration of the atmosphere. In this context, the silver screen products analyzed were categorized according to predetermined event patterns. By giving a piece of preliminary information about these categories, it was tried to examine the current situation, the predicted situation, and the post-apocalyptic situation in the cinema and to determine the basis on which the solution proposals are

based and whether these solutions are possible with today's technological possibilities. The evaluation of the films was based on the parameters of SWOT analysis and analyzed under the themes of strengths, weaknesses, opportunities and threats.

4.1. Global Warming and Drought

According to NOAA's Annual Climate Report 2021, the global average temperature has risen rapidly since 1981. The amount of future global warming will depend on what level of carbon dioxide and other greenhouse gases humans emit over the next decade (Url.6, 2022) Global warming will significantly impact drought dynamics, including severity, intensity, area, and duration changes. Studies show drought is expected to increase non-linearly with global warming, with the highest growth rate under 3 °C scenario (Ji et al., 2023). Sudden droughts are expected to increase globally, especially under scenarios of high solar radiation and increased fossil fuel use (Christian et al., 2023). Achieving the Paris Agreement's long-term temperature target of limiting warming to 1.5°C above pre-industrial levels is projected to reduce the risk of severe droughts in many countries significantly (Price et al., 2022).

Figure 1. An animation showing the change in global surface temperatures between 1884 and 2022. Dark blue indicates areas colder than average. Dark red indicates warmer-than-average regions, and the effects of global warming over the years are seen (Url.9, 2023).

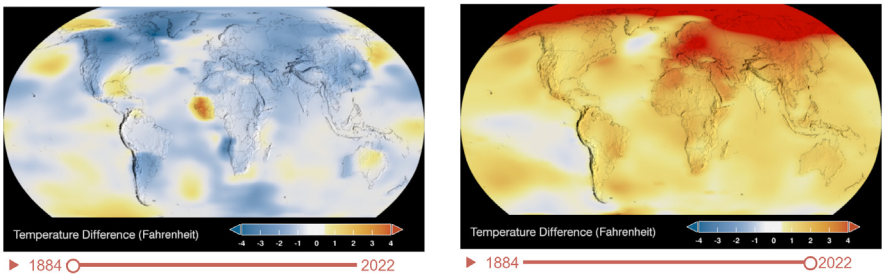

Figure 1. 1884-2022 Global Surface Temperature Visualizations (Url.9, 2023).

Films about global warming and drought often fall into the category of environmental films or documentaries that highlight the effects of climate change on the planet. These films shed light on the environmental challenges posed by global warming and drought and the need for action to address these issues. Films on global warming and drought, one of the biggest crises of our time, have been analyzed, and the film "Intersteller-2014" (Figure 2) was analyzed in this study.

Figure 2. Interstellar 2014 Movie Poster (Url. 1, 2014; Url. 2, 2014).

Interstellar-2014 (Url. 1, 2014; Url. 2, 2014), It is a science fiction film directed by Christopher Nolan. It tells the story of people in the middle of the 21st century trying to cope with problems such as increasing drought, food shortages, and dust storms that endanger daily life and cause lung diseases. It also deals with space exploration and the search for planets. When the movie is evaluated under the themes of strengths, weaknesses, opportunities, and threats within the scope of SWOT analysis parameters in Table 1:

Table 1. SWOT Analysis of the Movie "The Interstellar" in the Context of Climate Change

Strengths	• Raising awareness the importance of addressing environmental issues on Earth, depicting a future where global warming, drought, and famine reach a critical point. • It highlights space exploration as a potential solution to the problem of finding new habitable planets when Earth's resources are depleted. • It informs the audience about scientific concepts (such as black holes, relativity, and time dilation). • The visual effects are pretty successful.
Weaknesses	• There have been criticisms that the movie portrays some scientific concepts as incomplete and fanciful. • While the movie explores space migration as a solution to environmental problems, it spends less time exploring Earth-based solutions. • The movie makes no mention of greenhouse gases and average global temperature.
Opportunities	• With the increasing importance of agriculture, automated production on farms has become widespread, and agricultural equipment controlled by artificial intelligence has come to humanity's aid. • In this way, the film encourages us to think about how technology and scientific advances can be used to reduce drought and famine.
Threats	• Instead of emphasizing the importance of combating environmental problems, the film can promote the idea of escaping from the Earth's problems.

4.2. Melting of Glaciers and Sea Level Rise

Glaciers cover about 10% of the Earth's surface and store 69% of freshwater (Singh & Singh, 2015). Glaciers have been melting since the Little Ice Age, and the melting rate accelerated after the second half of the 20th century (Zemp et al., 2019). Unlike the Greenland and Antarctic ice sheets, glaciers caused global mean sea level rise of 27 ± 22 millimeters from 1961 to 2016 (Zhang & Moore, 2015). Glaciers are the second largest contributor to sea level rise after the thermal expansion of the oceans (Kerr, 2013). As long as global warming continues, sea level rise will be inevitable. The level at which it happens depends on the future greenhouse gas emissions rate. About every four to five years, NOAA publishes reports on likely and unlikely scenarios for future sea level rise (Figure 3). According to research, the global average sea level has risen by about 21-24 cm since 1880 due to glaciers and ice sheets melting. The 2022 report concluded that even with the lowest possible greenhouse gas emissions and warming, the global average sea level will rise by at least 0.3 meters (1 ft) by 2100. However, the global sea level could rise by up to 2 meters (6.6 feet) by 2100 if high emissions cause the ice sheet to collapse rapidly. (Url.3, 2022)

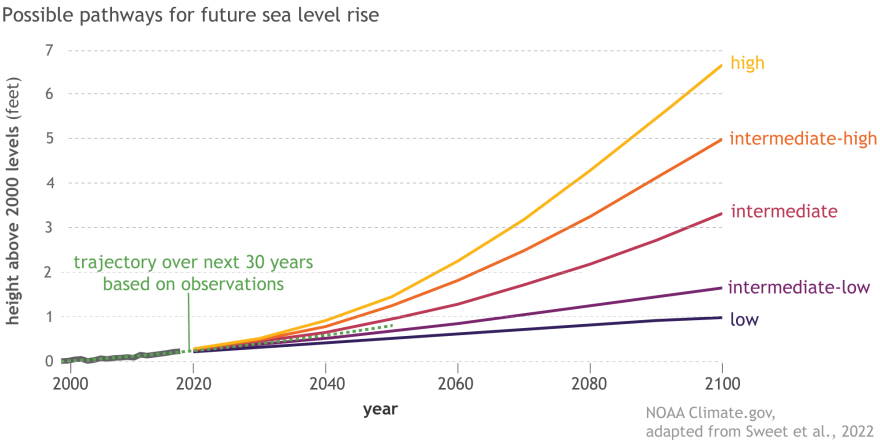

Figure 3. Future Sea Level Change (Url.3, 2022).

Films with the theme of melting glaciers and rising sea levels have been analyzed, and the film "The Reminiscence-2021" (Figure 4) has been considered within the study's scope.

Figure 4. The Reminiscence-2021 Movie Poster (Url.4, 2021).

The Reminiscence-2021 (Url.4, 2021), It is a science fiction movie directed by Lisa Joy. It depicts a dystopian future where the sea level in Miami rises due to climate change, and the city is partially flooded. When the movie is evaluated under the themes of strengths, weaknesses, opportunities, and threats within the scope of SWOT analysis parameters in Table 2:

Table 2. SWOT Analysis of the Movie "The Reminiscence" in the Context of Climate Change

Strengths	• The film has the potential to raise awareness and mobilize people by highlighting the devastating effects of rising sea levels on coastal cities. • The film highlights flooded cities, degraded ecosystems, and lost lives. • The film emphasizes that people should consume less energy and adopt a more sustainable lifestyle to combat climate change. • To protect against rising water levels, coastal protection walls/ barriers and dams were built. Underwater life has begun, and migration to higher areas away from underwater has begun.
Weaknesses	• The film needs to sufficiently emphasize the fact that climate change is a result of human activities. • The movie shows the devastating effects of environmental problems but does not give hope for the future as it does not offer a concrete solution.
Opportunities	• It can encourage viewers to seek more information about real-world environmental issues. • In the film, as the city is flooded, alternative means of transportation are proposed, using boats, submarines, water motorcycles, and water bikes, and these vehicles are updated in line with climate change.
Threats	• As the water level continues to rise, the measures taken are expected to be insufficient. • Coastal protection walls and dams may erode or collapse over time. • Migration to flooded areas may cause problems in infrastructure and transportation systems. • Living underwater can pose health and safety risks.

4.3. Global Cooling and Ice Age

Literature reviews show that a combination of factors influences global cooling and ice ages. The amount of future warming depends on how much carbon dioxide and other greenhouse gases humans emit in the coming decades. According to NOAA's 2021 Annual Climate Report, the global average temperature has risen by an average of 0.8 °C per decade since 1880 but has risen more than twice as much since 1981, averaging 1.8 °C (Url.5, 2022). Projections of future climate conditions use various scenarios (Figure 5). Consistent with previous practice, this assessment is based on scenarios created for the Intergovernmental Panel on Climate Change (I.P.C.C.) (Url.6, 2022). In line with the data, global warming is increasing, and global cooling is becoming impossible.

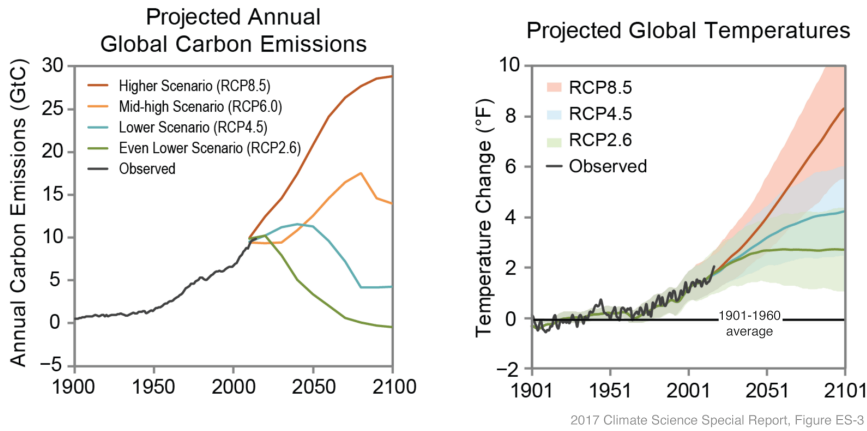

Figure 5. Past and Future Change in Global Temperature (Url.6, 2022).

Films with the theme of Global Cooling and Ice Age were analyzed, and the movie "The Day After Tomorrow-2004" (Figure 6) was considered within the study's scope.

Figure 6. The Day After Tomorrow 2004 Movie Poster (Url.7, 2004).

The Day After Tomorrow-2004 (Url.7, 2004)**,** In the movie, the city is flooded by a big wave, and after the city is flooded, the Northern Hemisphere transitions into an ice age due to sudden cooling. As a result, migration to the south began. In summary, it is a science fiction movie about

extreme weather events such as storms, hurricanes, and extreme cold triggered by climate change, dragging the world into a new ice age, and a group of people's struggle to survive in these conditions. When the movie is evaluated under the themes of strengths, weaknesses, opportunities, and threats within the scope of SWOT analysis parameters in Table 3:

Table 3. SWOT Analysis of the Movie "The Day After Tomorrow" in the Context of Climate Change

Strengths	• The movie presents the devastating effects of climate change and natural disasters with powerful visual effects. • By drawing attention to climate change and environmental problems, it can contribute to raising social awareness on these issues. • It gives important messages showing how people can help in the face of climate disaster.
Weaknesses	• The movie is based on a scientifically unrealistic scenario.
Opportunities	• This is a crucial opportunity to raise awareness about climate change and global cooling. • Governments and international organizations have created a joint action plan in response to the melting of the Arctic ice caps and the resulting global cooling wave. The plan aims to reduce the use of fossil fuels while increasing investments in renewable energy sources.
Threats	• The film may lead to misunderstandings among viewers about the scientific facts of climate change and global cooling. • At a time when even the levees built for tsunamis reaching a few meters high have failed, the structure and materials needed to meet a wave of water hundreds of meters high are beyond today's conditions.

4.4. Deterioration of The Atmosphere

Air pollution has serious consequences for the environment and people. It can cause illness and death in humans, as well as damage food products and the natural and built environment (Melnichenko, et. al., 2022). Chemical pollution of the atmosphere can be predicted using mathematical models that consider meteorological parameters, deposition sites, and chemical properties (Fitzgerald & Stockwell, 2022; Makra, 2009). Atmospheric pollution impacts climate change, including the greenhouse effect and changes in the ozone layer.

Films on atmospheric destruction and environmental degradation have been analyzed, and the film "The WALL-E 2008" (Figure 7) is considered in this study.

Figure 7. WAAL-E 2008 Movie Poster (Url.8, 2008)

The WALL-E-2008 (Url.8, 2008)**,** Produced by Pixar Animation Studios, written and directed by Andrew Stanton, the movie is set in the year 2805, in a future where the Earth has been rendered uninhabitable by human pollution and abandoned as humans flee into space. WALL-E, the movie's main character, is a robot designed to clean the Earth. One day, a search robot named EVE arrives on Earth, tasked with looking for plant seeds. He delivers the plant seed to humans, and WALL-E and EVE work together to convince humans to return to Earth and make it habitable again. When the film is evaluated under the themes of strengths, weaknesses, opportunities, and threats within the parameters of SWOT analysis in Table 4:

Table 4. SWOT Analysis of the Movie "WALL-E" in the Context of Climate Change

Strengths	• The film shows that excessive consumption of natural resources by humans leads to problems such as deforestation, pollution of water resources, and depletion of soils. The Earth can become uninhabitable due to behaviors such as not disposing of waste properly. Therefore, it raises awareness that climate change and the destruction of the atmosphere are severe environmental problems. • By depicting a future in which the Earth is covered with garbage and vegetation disappears, the problem is presented strikingly. • It emphasizes measures such as using natural resources more efficiently, disposing of waste in an environmentally appropriate way, and adopting a sustainable lifestyle.
Weaknesses	• The movie presents a fictional solution to the problems of climate change. • It does not accurately reflect scientific facts.
Opportunities	• It provides an opportunity to educate and raise awareness, especially among younger generations, about environmental issues and the importance of sustainability. • It can inspire people to adopt environmentally friendly lifestyles.
Threats	• It promotes the idea of escaping Earth and migrating to space. • In the movie, people are shown to be obese and lazy. Therefore, it shows that environmental pollution can negatively affect people's health. • Animals are also shown to be extinct. This shows that environmental pollution can destroy nature.

5. Evaluation and Conclusion

In recent years, "climate fiction cinema" has rapidly developed as a new category focusing on global environmental problems and solutions. This category maintains the essential elements of traditional science fiction cinema. However, it focuses on today's and tomorrow's environmental concerns and puts their resolution on the agenda. In today's world, when the consequences of climate change are rising, and natural catastrophes are becoming more common, such films and television programs directly impact the audience, presenting them with pertinent issues and emphasizing the gravity of the problems. In this way, they offer viewers the opportunity to reflect on the future of the world and their future. In this study, global environmental problems such as global warming and drought, melting of glaciers and sea level rise, global cooling, ice age, and finally, the deterioration of the atmosphere are discussed, and brief information is given within the scope of the information in the literature. Then, silver screen products that incorporate these themes into climate fiction films are categorized according to their plots, and the selected films are analyzed under the headings of challenges, weaknesses, opportunities, and threats, mainly based on the parameters of SWOT analysis. Thus, through the films, the

current state of the relevant environmental problem, its projected state, and its post-apocalyptic state in cinema are examined, and based on this, the basis on which the solution proposals are based and whether these solutions are possible with today's technological possibilities are interpreted.

Considering today's global climate crisis, it is known that global warming and drought problems, covered quite consistently in the movie Interstellar, have started to manifest themselves and pose an increasing threat. The study will raise awareness by emphasizing the assumption that these problems will reach a critical point in the future and may lead to severe problems. It may mobilize people to take the necessary measures.

Melting glaciers and rising sea levels are another problem we are beginning to see the effects of. Additional factors, such as endangered species and the impact on animal habitats, contribute to a deeper understanding of the problem. The films presented in this context are more fictionalized works that are partially more distant from reality and are dealt with in a dimension that will not be realized in the short term. This is also the case with the movie Reminiscence. However, the situations represented have the potential to become reality soon if measures are not taken. Therefore, science fiction works serve as a warning for those interested in such scenarios.

Global cooling and ice age is a situation that may develop as a result of humanity's excessive measures against global warming. However, in today's conditions, it is unlikely that this problem will occur suddenly. Therefore, more research and evaluation is needed on the applicability of such scenarios in the real world. The Day After Tomorrow is also based on a scientifically unrealistic scenario.

Finally, more abstract and complex problems, such as the deterioration of the atmosphere, are generally less emphasized in fiction films. In this study, the movie WALL-E, prepared to raise awareness that climate change and the destruction of the atmosphere are serious environmental problems, was analyzed. In this context, what is emphasized is the necessity of taking measures such as using natural resources more efficiently, disposing of waste in an environmentally appropriate way, and adopting a sustainable lifestyle. These solutions should be considered and adopted in all environmental issues to struggle with climate change.

As a result, climate fiction cinema serves as a crucial resource for comprehending environmental issues, as it extends the confines of the science fiction genre and visually portrays the quest for solutions to these problems. Such studies have the capacity to shed light on the future implications of contemporary environmental challenges, thereby fostering social consciousness, engendering global sensitivity, and promoting aware-

ness. Consequently, when engaging with fictional works that tackle climate change, it is imperative to contemplate their underlying messages and the gravity of the environmental predicaments they depict, and subsequently take proactive measures. However, when the results of these fictional products are taken into account and the solutions offered are followed, it is a fact that a high amount of resources, technological development, labor force, and economic development will be needed. Even if this situation is questioned in today's conditions, the possibility of realization will be high with future developments.

Kaynakça

Akyol, Ö. (2020). Climate change: An apocalypse for urban space? An ecocritical reading of "Venice drowned" and "The Tamarisk hunter." *Folklor/Edebiyat*, *101*(1), 115–126. https://doi.org/10.22559/FOLKLOR.1137

Bautista-Puig, N., Benayas, J., Mañana-Rodríguez, J., Suárez, M., & Sanz-Casado, E. (2022a). The role of urban resilience in research and its contribution to sustainability. *Cities*, *126*, 103715. https://doi.org/10.1016/J.CITIES.2022.103715

Bautista-Puig, N., Benayas, J., Mañana-Rodríguez, J., Suárez, M., & Sanz-Casado, E. (2022b). The role of urban resilience in research and its contribution to sustainability. *Cities*, *126*, 103715. https://doi.org/10.1016/J.CITIES.2022.103715

Bina, O., Mateus, S., Pereira, L., & Caffa, A. (2017). The future imagined: Exploring fiction as a means of reflecting on today's Grand Societal Challenges and tomorrow's options. *Futures*, *86*, 166–184. https://doi.org/10.1016/J.FUTURES.2016.05.009

Brereton, P. (2020). Cultural and Visual Responses to Climate Change: Ecological Reading of Irish Zombie Movies. *Palgrave Studies in Media and Environmental Communication*, 185–201. https://doi.org/10.1007/978-3-030-47587-1_11

Bulkeley, H., & Tuts, R. (2013). Understanding urban vulnerability, adaptation and resilience in the context of climate change. *Local Environment*, *18*(6), 646–662. https://doi.org/10.1080/13549839.2013.788479

Cao, H. (2023). Urban Resilience: Concept, Influencing Factors and Improvement. *Frontiers in Business, Economics and Management*, *9*(1), 343–346. https://doi.org/10.54097/fbem.v9i1.8777

Christian, J. I., Martin, E. R., Basara, J. B., Furtado, J. C., Otkin, J. A., Lowman, L. E. L., Hunt, E. D., Mishra, V., & Xiao, X. (2023). Global projections of flash drought show increased risk in a warming climate. *Communications Earth and Environment*, *4*(1). https://doi.org/10.1038/S43247-023-00826-1

de la Cal, P., & García, M. (2018). Urban resilience: Towards a global sustainability. *Urban Visions: From Planning Culture to Landscape Urbanism*, 227–236. https://doi.org/10.1007/978-3-319-59047-9_22/COVER

Dobbelsteen, A. V. D., Keeffe, G., & Tillie, N. (2013). *Cities ready for energy crisis: Building urban energy resilience*.

Etinay, N., Egbu, C., & Murray, V. (2018). Building Urban Resilience for Disaster Risk Management and Disaster Risk Reduction. *Procedia Engineering*, *212*, 575–582. https://doi.org/10.1016/J.PROENG.2018.01.074

Fitzgerald, R. M., & Stockwell, W. R. (2022). Editorial for the Special Issue "Advances in Air Pollution Meteorology." *Atmosphere 2022, Vol. 13, Page*

2081, *13*(12), 2081. https://doi.org/10.3390/ATMOS13122081

Galderisi, A. (2014). *Urban resilience: A framework for empowering cities in face of heterogeneous risk factors*.

Godschalk, D. R. (2003). Urban Hazard Mitigation: Creating Resilient Cities. *Natural Hazards Review*, *4*(3), 136–143. https://doi.org/10.1061/(ASCE)1527-6988(2003)4:3(136)

Gunderson, L. H. (2000). Ecological Resilience—In Theory and Application. *Annual Review of Ecology, Evolution, and Systematics*, *31*, 425–439. https://doi.org/10.1146/ANNUREV.ECOLSYS.31.1.425

Holling, C. S. (1974). *Resilience and Stability as Shown by Models of Ecological Systems*. 93–95. https://doi.org/10.1007/978-3-642-45455-4_11

Huang, Y., Guo, M., Bai, P., Li, J., Liu, L., & Tian, W. (2023). Warming intensifies severe drought over China from 1980 to 2019. *International Journal of Climatology*, *43*(4), 1980–1992. https://doi.org/10.1002/JOC.7957

Irani, M., & Rahnamayiezekavat, P. (2021). An overview of urban resilience: dimensions, components, and approaches. *Acta Scientiarum Polonorum Administratio Locorum*, *20*(4), 305–322. https://doi.org/10.31648/ASPAL.7054

Jahanger, A. (2022). Impact of globalization on CO2 emissions based on EKC hypothesis in developing world: the moderating role of human capital. *Environmental Science and Pollution Research*, *29*(14), 20731–20751. https://doi.org/10.1007/S11356-021-17062-9/TABLES/3

Ji, Y., Fu, J., Lu, Y., & Liu, B. (2023). Three-dimensional-based global drought projection under global warming tendency. *Atmospheric Research*, *291*. https://doi.org/10.1016/J.ATMOSRES.2023.106812

Karaduman, C. (2022). The effects of economic globalization and productivity on environmental quality: evidence from newly industrialized countries. *Environmental Science and Pollution Research*, *29*(1), 639–652. https://doi.org/10.1007/S11356-021-15717-1/TABLES/9

Kerr, R. A. (2013). Melting glaciers, not just ice sheets, stoking sea-level rise. *Science*, *340*(6134), 798. https://doi.org/10.1126/SCIENCE.340.6134.798/ASSET/9ECF0A13-ED10-49E8-A318-93920CDF8EB0/ASSETS/SCIENCE.340.6134.798.FP.PNG

Kriegler, E., Edmonds, J., Hallegatte, S., Ebi, K. L., Kram, T., Riahi, K., Winkler, H., van Vuuren, D. P., Kriegler, E., Edmonds, J., Hallegatte, S., Ebi, K. L., Kram, T., van Vuuren, D. P., Riahi, K., & Winkler, H. (2014). A new scenario framework for climate change research: the concept of shared climate policy assumptions. *Climatic Change*, *122*, 401–414. https://doi.org/10.1007/s10584-013-0971-5

Lindenfeld, L., & Mcgreavy, B. (2015). Entertaining our way to engagement? Climate change films and sustainable development values. *Article in Inter-*

national Journal of Sustainable Development, *17*(2), 123–136. https://doi.org/10.1504/IJSD.2014.061766

Makra, L. , K. H. (2009). Special Issue on air pollution. *International Journal of Environment and Pollution*. https://www.researchgate.net/publication/278374591_SPECIAL_ISSUE_AIR_POLLUTION

Melnichenko, A. , K. M. , B. O. Y. , T. o. , B. O. , K. M. , P. O. Y. , P. T. , K. O. I. , S. N. Y. ,. (2022). Devising a procedure to forecast the level of chemical damage to the atmosphere during active deposition of dangerous gases. *Eastern-European Journal of Enterprise Technologies*, 31–40. https://doi.org/10.15587/1729-4061.2022.251675

Michael, K. (2019). Films from the Future [Book Review]. *IEEE Technology and Society Magazine*, *38*(4), 9–10. https://doi.org/10.1109/MTS.2019.2948418

Nakicenovic, N., Lempert, R. J., Janetos, A. C., Nakicenovic, N., Lempert, R. J., & Janetos, A. C. (2014). A Framework for the Development of New Socio-economic Scenarios for Climate Change Research: Introductory Essay A Forthcoming Special Issue of Climatic Change. *Climatic Change*, *122*, 351–361. https://doi.org/10.1007/s10584-013-0982-2

O'Neill, B. C., Kriegler, E., Ebi, K. L., Kemp-Benedict, E., Riahi, K., Rothman, D. S., van Ruijven, B. J., van Vuuren, D. P., Birkmann, J., Kok, K., Levy, M., & Solecki, W. (2017). The roads ahead: Narratives for shared socio-economic pathways describing world futures in the 21st century. *Global Environmental Change*, *42*, 169–180. https://doi.org/10.1016/J.GLOENVCHA.2015.01.004

O'Neill, B. C., Kriegler, E., Riahi, K., Ebi, K. L., Hallegatte, S., Carter, T. R., Mathur, R., & van Vuuren, D. P. (2014). A new scenario framework for climate change research: The concept of shared socioeconomic pathways. *Climatic Change*, *122*(3), 387–400. https://doi.org/10.1007/S10584-013-0905-2/TABLES/2

Panda, P. (2020). Green cinema: Reading the context in select Indian cinematic texts. *Handbook of Research on Social and Cultural Dynamics in Indian Cinema*, 23–34. https://doi.org/10.4018/978-1-7998-3511-0.CH003

Price, J., Warren, R., Forstenhäusler, N., Wallace, C., Jenkins, R., Osborn, T. J., & Van Vuuren, D. P. (2022). Quantification of meteorological drought risks between 1.5 °C and 4 °C of global warming in six countries. *Climatic Change*, *174*(1–2). https://doi.org/10.1007/S10584-022-03359-2

Ribeiro, P. J. G., & Pena Jardim Gonçalves, L. A. (2019). Urban resilience: A conceptual framework. *Sustainable Cities and Society*, *50*, 101625. https://doi.org/10.1016/j.scs.2019.101625

Roméro, M. A. (2022). *Urban Resilience: A Methodological Approach.*

Schneider-Mayerson, M. (2018). The Influence of Climate FictionAn Empirical Survey of Readers. *Environmental Humanities*, *10*(2), 473–500. https://doi.org/10.1215/22011919-7156848

Singh, M. K., & Singh, B. R. (2015). Modeling of Future Sea Level Rise Through Melting Glaciers. *SAMRIDDHI : A Journal of Physical Sciences, Engineering and Technology*, *5*(1), 47–56. https://doi.org/10.18090/SAMRIDDHI.V5I1.1517

Spaans, M., & Waterhout, B. (2017). Building up resilience in cities worldwide – Rotterdam as participant in the 100 Resilient Cities Programme. *Cities*, *61*, 109–116. https://doi.org/10.1016/J.CITIES.2016.05.011

Svoboda, M. (2016). Cli-fi on the screen(s): patterns in the representations of climate change in fictional films. *Wiley Interdisciplinary Reviews: Climate Change*, *7*(1), 43–64. https://doi.org/10.1002/WCC.381

Tang, J. (2022). Combing Effects of Economic Development and Globalization Towards Energy Efficiency and Environmental Degradation: Fresh Analysis From Energy Efficient Resources. *Frontiers in Energy Research*, *10*, 847235. https://doi.org/10.3389/FENRG.2022.847235/BIBTEX

Url. 1. (2014). *Yıldızlararası (Interstellar) Filminin Bilimsel Analizi - Evrim Ağacı*. https://evrimagaci.org/yildizlararasi-interstellar-filminin-bilimsel-analizi-2977?ysclid=lmvti95kru331958953

Url. 2. (2014). *Recensione Interstellar (2014) - Movieplayer.it*. https://movieplayer.it/articoli/recensione-interstellar-2014_13685/

Url.3. (2022). *Climate Change: Global Sea Level | NOAA Climate.gov*. https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level

Url.4. (2021). *Reminiscence (2021) - Plot - IMDb*. https://www.imdb.com/title/tt3272066/plotsummary/?ref_=tt_ov_pl

Url.5. (2022). *Annual 2022 Global Climate Report | National Centers for Environmental Information (NCEI)*. https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202213#gtemp

Url.6. (2022). *Climate Change: Global Temperature | NOAA Climate.gov*. https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature

Url.7. (2004). *The Day After Tomorrow (2004) - Plot - IMDb*. https://www.imdb.com/title/tt0319262/plotsummary/

Url.8. (2008). *WALL·E (2008) - Plot - IMDb*. https://www.imdb.com/title/tt0910970/plotsummary/

Url.9. (2023). *Global Temperature | Vital Signs – Climate Change: Vital Signs of the Planet*. https://climate.nasa.gov/vital-signs/global-temperature/

Usman, M., Jahanger, A., Makhdum, M. S. A., Balsalobre-Lorente, D., & Bashir, A. (2022). How do financial development, energy consumption, natural resources, and globalization affect Arctic countries' economic growth and environmental quality? An advanced panel data simulation. *Energy*, *241*, 122515. https://doi.org/10.1016/J.ENERGY.2021.122515

van Vuuren, D. P., Kriegler, E., O, B. C., Ebi, K. L., Riahi, K., Carter, T. R., Edmonds, J., Hallegatte, S., Kram, T., Mathur, R., Winkler, H., van Vuuren, D. P., Kram, T., Kriegler, E., Ebi, K. L., Riahi, K., Hallegatte, S., Mathur, R., & Winkler, H. (2014). A new scenario framework for Climate Change Research: scenario matrix architecture. *Climatic Change*, *122*, 373–386. https://doi.org/10.1007/s10584-013-0906-1

Weichselgartner, J., & Kelman, I. (2014). *Challenges and opportunities for building urban resilience*.

Wu, J., & Wu, T. (2013). *Ecological Resilience as a Foundation for Urban Design and Sustainability*. 211–229. https://doi.org/10.1007/978-94-007-5341-9_10

Yamagata, Y., & Maruyama, H. (2016). Urban Resilience: A Transformative Approach. *Urban Resilience*. https://doi.org/10.1007/978-3-319-39812-9

Zemp, M., Huss, M., Thibert, E., Eckert, N., McNabb, R., Huber, J., Barandun, M., Machguth, H., Nussbaumer, S. U., Gärtner-Roer, I., Thomson, L., Paul, F., Maussion, F., Kutuzov, S., & Cogley, J. G. (2019). Global glacier mass changes and their contributions to sea-level rise from 1961 to 2016. *Nature*, *568*(7752), 382–386. https://doi.org/10.1038/S41586-019-1071-0

Zeng, X., Yu, Y., Yang, S., Lv, Y., & Sarker, M. N. I. (2022). Urban Resilience for Urban Sustainability: Concepts, Dimensions, and Perspectives. *Sustainability 2022, Vol. 14, Page 2481*, *14*(5), 2481. https://doi.org/10.3390/SU14052481

Zhang, Z., & Moore, J. C. (2015). Glaciers and Sea Level Rise. *Mathematical and Physical Fundamentals of Climate Change*, 441–455. https://doi.org/10.1016/B978-0-12-800066-3.00013-9

CHAPTER 3

CONTEMPORARY BUILDING SOLUTIONS IN HOT DRY CLIMATE REGIONS

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1. Introduction

The relationship between nature and humans changes with the land decisions taken at the building design stage. To minimize damage to the natural environment, to inherit existing resources to future generations, and to create sustainable living spaces, plans must be made taking into account climatic characteristics. In today's conditions, design approaches that consider ecological balance, benefit from natural resources, and evaluate climatic conditions are preferred. In this way, areas compatible with the city and ecological environment can be designed under the supervision of sustainability principles (Adil, 2010). To maintain ecological balance, criteria such as climate elements, wind strength in the current region, and availability of renewable energy resources should be observed (Karaca, 2008).

Stopping carbon emissions in the construction field is no longer an option but a necessity. As countries strive to reduce greenhouse gases by 2050, it is becoming clearer that existing building norms are not enough to create real change. Achieving climate goals requires economies to advocate for measures that support carbon neutralization and effectively manage associated spending.

Today, zero-carbon buildings are both technically feasible and economically feasible. Although they have high initial costs, these buildings provide many economic benefits that provide a return on the initial investment. It is noticed that sustainability in the construction industry is beneficial in every field. The notion that greens construction requires a lot of initial investment is wrong because reducing embodied carbon is a low-cost way to unlock many economic opportunities (Lechner, 2014).

2. Energy Efficient Design Criteria in Hot Dry Climate Region

Ground and Settlement Texture:

- A low-rise, compact arrangement should be designed to protect from sunlight and wind during the hottest periods. Wind should be used if it has a humidifying effect.

- In hot, dry climate regions, wind does not provide a comfort-enhancing effect in summer due to humidity. However, it increases humidity by passing through moist areas such as lakes and forests. Buildings cool down at night due to cold air lakes. For this reason, the valley floor becomes the most suitable settlement point for hot dry climate regions (Figure 1) (Özdemir Bahar, 2005).

Figure 1. Suitable Settlement in the Hot Dry Climate Region (Koçlar Oral, 2010).

- Trees should not be planted on the north and south facades of the residential area, and on the east and west facades (their location may vary), fences, vines wrapped around the walls and deciduous trees should be used (Lechner, 2014).
- In hot seasons, direct reflected sunlight should be prevented and maximum shading should be provided. Cooling through evaporation should be encouraged.
- Existing settlement patterns and street networks can be of three different types: cross grids positioned on the east-west axis, narrow and zigzag streets, and streets blocked by buildings (Figure 2) (Okeil, 2010).

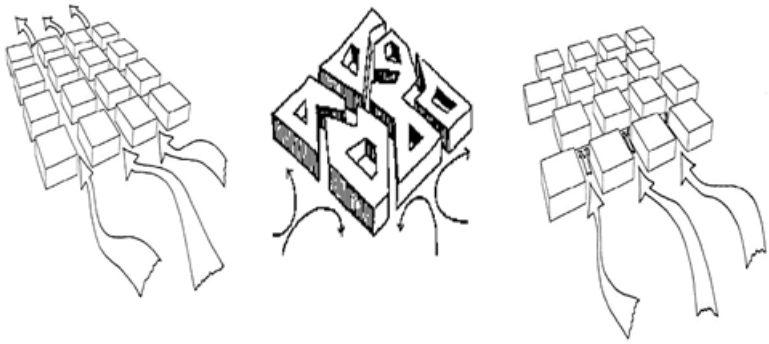


Figure 2. Energy Efficient Building Forms with a Holistic Approach (Okeil, 2010).

Orientation:

- Sun rays falling in different directions are effective in building orientation. They are positioned in clusters to make the most of shading opportunities and heat absorption. The largest building in size should be oriented north-south.

- Maximum cross ventilation should be provided in rooms. Windows and walls should be in the direction of the prevailing wind. The best positioning aims to create minimum heat gain in summer and maximum heat gain in winter.

Shading:

- In a hot dry climate, shading must refract direct sunlight. Shading can be provided by creating protrusions on buildings, positioning buildings close to each other, and choosing deciduous trees.

- Natural ventilation and passive cooling methods should be preferred.

Building Form:

- Living spaces in hot dry climate regions should be protected against dust and wind. For this reason, compact and courtyard designs may be preferred. A clustering method called carpet planning can be used. Underground buildings can be built with different solutions.

- It is important to gain heat during the winter months. It is difficult to meet climatic comfort in buildings with different functions. Considering the volumetric functions, the "passive house" concept appears to be the most appropriate form. It is thought that passive houses can benefit from the microclimatic effect of the cool air in the courtyards during the summer. Especially in residential areas without slopes, traditionally introverted and compact designs with inner courtyards should be used (Figure 3).

- In buildings with a courtyard building form, windows should be positioned to provide shading. Air movement should be ensured at small intervals. Large exposed external surfaces should be avoided. Large exterior surfaces should be painted in light colors.

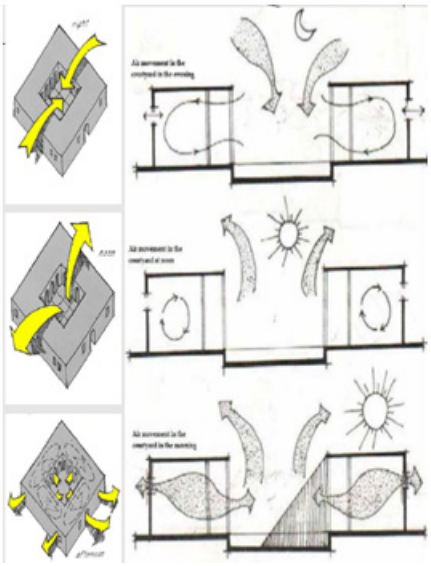


Figure 3. Climatic Characteristics in Buildings with Courtyards (Alqatrani, 2020).

Sustainability:

- Sustainable design is designing with the future in mind. It is necessary to protect our natural resources and maintain living diversity. Sustainability means living in a way that meets the needs of today's generation while ensuring that tomorrow's generation can meet their own needs (Lechner, 2014).
- There is a 4 R approach to sustainable design. These are reduced, reused, recycled and renewed (Figure 4).

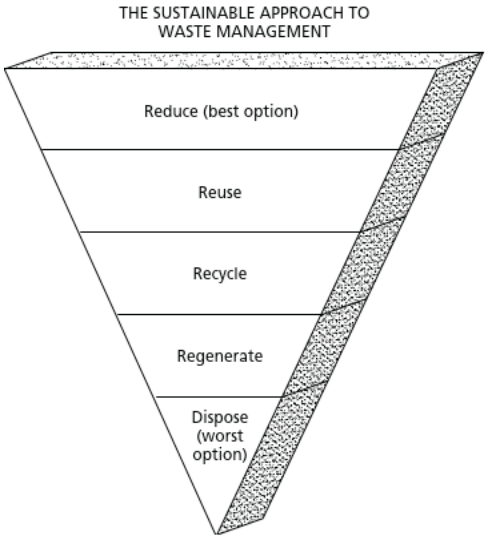


Figure 4. The 4 Rs in Sustainable Design (Lechner, 2014).

Construction materials:

- Buildings in hot arid climates generally consist of thick walls, roofs and very small windows. Internal heat storage capacity is needed to reduce temperature fluctuations in summer by "carrying the night coldness to the day" and to benefit from increased ventilation at night.

- Materials that do not conduct heat are best. Thermal insulation is necessary to reduce changes in surface temperature. Cold and light colors should be preferred indoors to create a refreshing contrast against the intense outdoor temperature and to spread natural light.

Passive Ventilation:

- Choosing passive or natural methods for ventilation of the junction is a very popular and common practice to both reduce operating costs and improve interior spaces. Systems that combine low-energy ventilation and heat recovery provide high-cost savings for building owners. In addition, it is also interesting for automation that reduce the damage caused and increase greenhouse gas emissions. It is seen that the processes carried out for heating and cooling of buildings consume the most energy in buildings during the hot seasons and cold seasons, while at the same time, many opportunities are offered to minimize the need. Natural ventilation can regulate heat control in the building, but this requires that the temperature

level between the area outside the building and the area inside the building be different. When the temperature range inside and outside is close, the possibility of the environment cooling in the summer range and thermal options being selective decreases (O'Connor, 2016).

3. Building Complex Investigations in the Hot Dry Climate Region

3.1. Dano Secondary School :

- Dano city of Burkina Faso, was built in 2007. Burkina Although Faso has a dry tropical climate, it goes into a long dry period after a short rainy season. Soil was used as the material in the building.

- The school, which consists of three separate blocks, has an oval amphitheater opening to the outside. The structure, covered with a sloping roof cover, is laminated with 30 cm thin layers of cement. Long windows placed at regular intervals are painted in bright colors that vary according to activities (Figure 5).

(Figure 5). Dano Secondary School (Url 1).

- existing schools with an L plan type (Figure 6), and sustainable materials that can respond to climate restrictions were used. The building is positioned in an east-west orientation, covering the angle to the south. The building is protected from the sun by wave-like canopies (Figure 7).

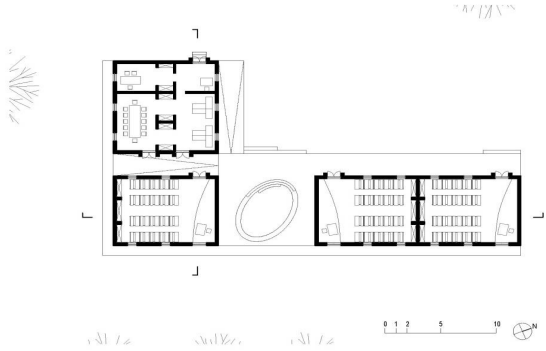


Figure 6. Dano Secondary School Plan Type (Url 1).

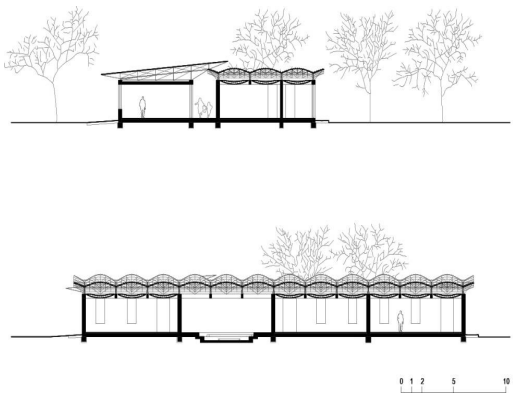
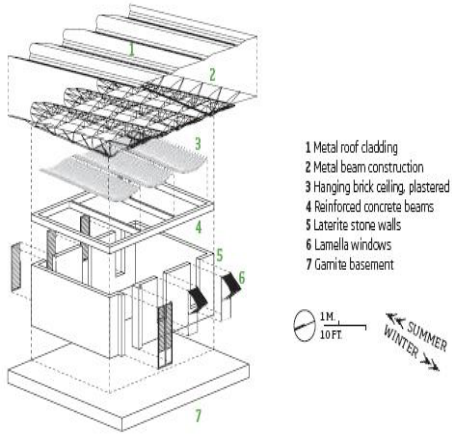


Figure 7. Dano Secondary School Sections (Url 1).

- The building is positioned in an east-west direction. Long eaves were used on the roof to reduce sunlight (Figure 8). Natural ventilation within the building is achieved through perforated suspended ceilings and slatted shutter windows that provide airflow. The building consists of three classrooms, a computer room and office space. Fine processing of laterite stones and laminating them with very thin cement joints were considered unusual techniques in the region. In addition, suspended ceilings and narrow-angle roof structures designed to suit the climatic conditions are considered unique methods in the region. Although the building was built entirely with local materials, it is recognized as a very innovative structure in the country and stands out with its advanced ventilation system.

(Figure 8). Dano Secondary School Canopies (Url 1).

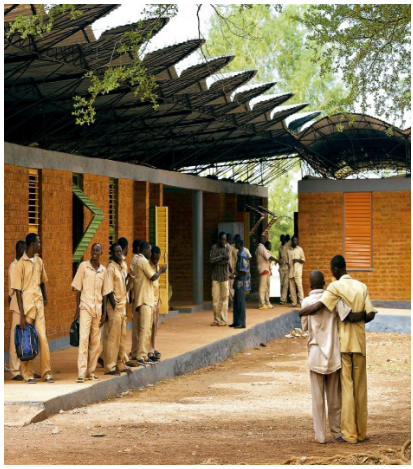
- The roof of the building is designed as 3 m wide modules assembled by welding from 14 mm and 16 mm diameter iron rods. The corrugated sheet material covering the roof creates an aesthetic appearance by giving the building a wavy shape (Figure 9). Rainwater is removed from the building thanks to the channels located at the bottom of these waves.



(Figure 9). Dano Secondary School System Section (Url 1).

- Corrugated roofing is an assembly system that protects the building from external factors. The suspended ceiling has a wavy shape that blends into the exterior structure and separates the classrooms with 3-meter sections. The openings in the ceiling help the natural ventilation of the

building by allowing hot air to escape (Figure 10).



(Figure 10). Dano Secondary School Roof (Url 1).

- Sustainability:

Thanks to the permeable suspended ceiling that allows natural airflow, the inclined corrugated sheet roof and the windows that provide shade, there is no need to artificially cool the rooms. This method is a more sustainable alternative to traditional construction methods at a time when energy costs are high and fossil fuels are decreasing. This is especially important for a country like Burkina Faso, which is at the bottom of the UN poverty list and must provide all its energy needs from abroad. In this construction concept, only laterite stone, a local material, was used.

- Building materials:

The unique construction materials used in this project include locally available laterite stone for the walls, insulation materials that increase the durability of the roof, corrugated sheet metal for the roof surface, and cement for the concrete parts. The walls are made of hand-hewn and recycled laterite stones (Figure 11).

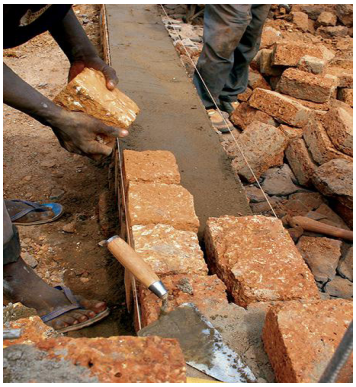
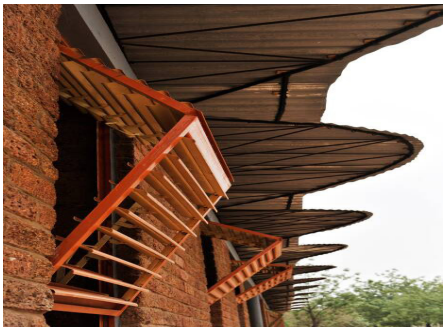



Figure 11. Dano Secondary School Building Material (Url 1).

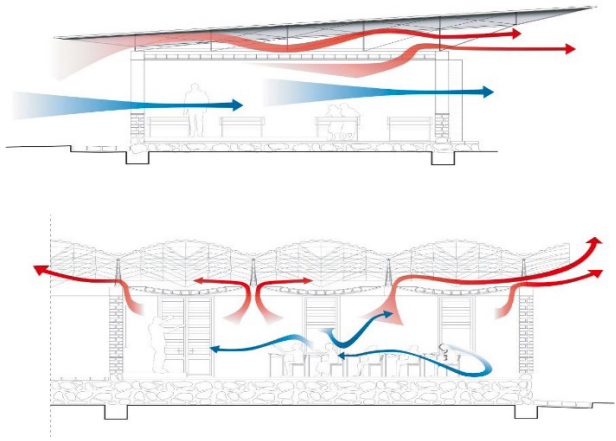
- Passive Ventilation:

Gaps are placed on the side walls to provide airflow. All suspension elements are covered with plaster. The lower retractable, shaded windows are painted bright colors to spread light evenly throughout the classroom (Figure 12).



(Figure 12). Dano Secondary School Windows (Url 2).

The roof design of the building is designed to provide passive ventilation (Figure 13).



(Figure 13). Passive Ventilation (Url 1).

3.2. Salim Habib Educational Complex

- Toba Tek Singh City, Pakistan, was built in 2020. Although Toba Tek Singh has a tropical desert climate, the annual temperature in the region is 10.9% higher than in central Pakistan. Approximately 48 days a year are rainy.

- The building complex, located among tangerine trees, serves as an information center and college building in the region. Figure 14 shows the plan of the building.

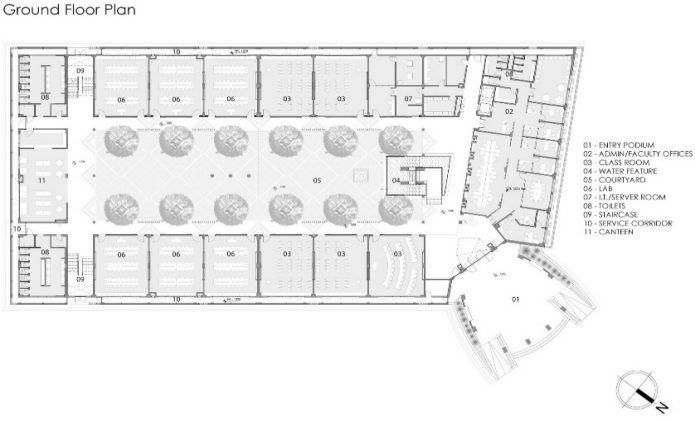


Figure 14. Salim Habib Education Complex Plan (Url 3).

- Sustainability:

The project is a multifunctional building consisting of lecture halls, computer and science laboratories, a two-story library building and two different meeting rooms, as well as administrative units and training rooms organized around a courtyard. Vegetation was adopted as a concept. A growing tree of knowledge is embodied.

- Building materials:

In the facility located in a rural town, prefabricated and terrazzo floors were frequently used alongside the red brick façade. Mostly locally produced materials were preferred in the building to reduce the overall carbon footprint. These materials allow architects to use local architecture and traditional language.

Due to extreme temperatures, the light entering the spaces had to be insulated without compromising its quality. For this purpose, a double-skinned facade was designed on the west and southeast facades of the building complex (Figure 15). The designed façade system significantly reduces temperatures inside the building by reducing sunlight absorption and making the educational complex have a different feature from other buildings. Built with red bricks, this perforated screen was created to respond to intense local climatic conditions. The facade section related to the structure is shown in Figure 16.

Figure 15. Salim Habib Education Complex Exterior (Url 4).

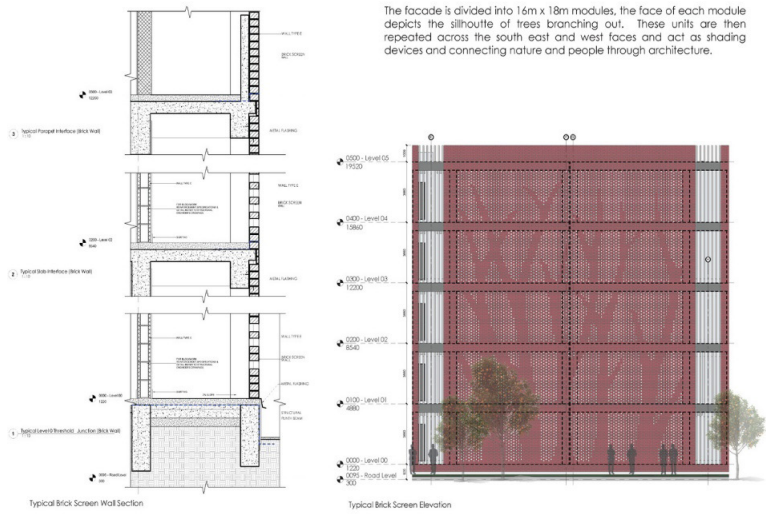


Figure 16. Salim Habib Education Complex System Section (Url 4).

- Passive Ventilation:

The northern entrance departs from the regular form of the building, creating an ostentatious space by elevating the meeting hall, which is equipped with a large wind-capturing structure that allows for natural ventilation. It facilitates natural airflow throughout the courtyard-shaped structure, which rises vertically to establish a visual relationship between all floors. The shade system, which is a semi-transparent fabric in the courtyard, protects against direct sunlight (Figure 17). Connection elements extending throughout the courtyard regulate the relationship of all floors with each other and offer resting, working and gathering areas. The passive ventilation system in the building is shown in Figure 18.

Figure 17. Salim Habib Education Complex (Url 4).

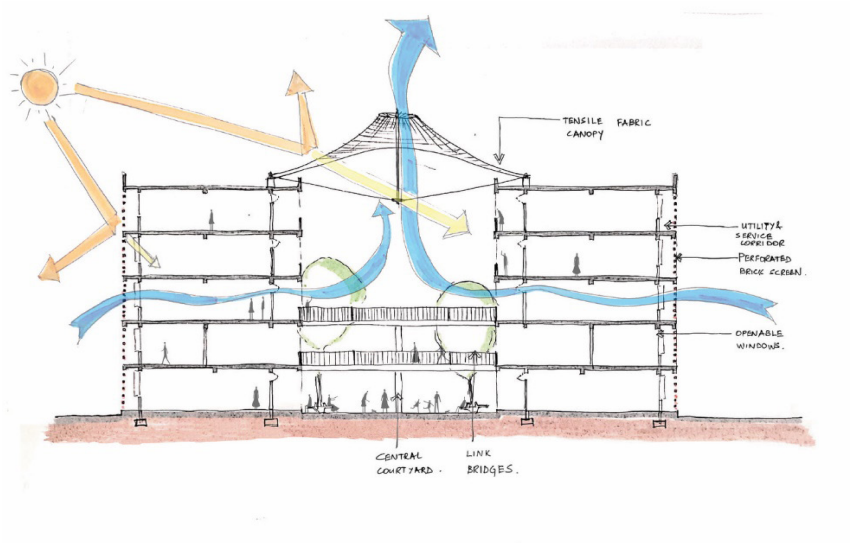


Figure 18. Salim Habib Education Complex Passive Ventilation (Url 4).

3.3. Rudrapur Community Center and Workshop Complex

- The building, located on an area of 253 m² in Rudrapur, Bangladesh, was built in 2019. Since the average annual temperature in Rudrapur is 24.3 °C, it has a subtropical climate. The average temperature in the hottest month is 40°C. The temperature in the coldest month is 14.9°C.

- There is a therapy center for the disabled on the ground floor of the two-story building and a textile production workshop on the first floor (Figure 19). The design is made by combining energy sources and local materials.

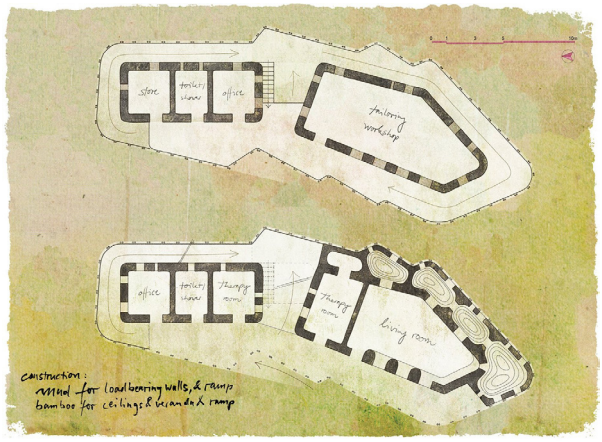


Figure 19. Rudrapur Community Center and Workshop Complex Plan (Url 5).

- Sustainability:

Energy efficiency and the use of locally sourced materials have come to the fore in local design. By using the properties of mud, the building was given a more impressive feature. Mud is seen as a poor quality and non-modern product, inferior to brick. But it is not important how old the material is, the main thing is our creativity to use it in an up-to-date way. To reveal the aesthetics and potential of mud, it is necessary to use it in a way that shows its best side and not just as a cheaper alternative to brick. This unique clay method, called cob, does not require any formwork and folds can be made as easily as straight walls.

- Building materials

cob ', a special clay technique, the construction of curves has become as easy as straight walls without the need for any formwork (Figure 20). This method has been achieved by using existing materials with a true respect for culture, people and land to create a sustainable structure.

Figure 20. Rudrapur Community Center and Workshop Complex Materials (Url 6).

Compressed soil made of mud obtained from ponds was used for structural elements (Figure 21).

Figure 21. Rudrapur Community Center and Workshop Complex Structural Elements (Url 5).

- Passive Ventilation:

Offering a panoramic reflection of the environment, bamboo walls allow for a wide range of indoor movement. The frame construction on the upper floor of the building was added to protect and stabilize the building against the wind coming from below. It also increases airflow. Passive ventilation is provided thanks to the gaps made by the construction of the roof added to it.

4. Evaluation

Today, increasing environmental problems have made the concept of sustainability more important in the design and construction of buildings. Sustainability means building design and construction that is sensitive to environmental impacts, depletion of natural resources and energy efficien-

cy. In this context, local building materials and passive ventilation are the cornerstones of sustainable building design. The projects examined within the scope of the study are shown in Table 1. Training and workshop complexes in tropical regions with hot dry climates were evaluated. Sustainability features, building materials and passive ventilation systems were compared in buildings using passive design principles.

Sustainability has been tried to be achieved through the preferred local materials, traditional methods, permeable suspended ceilings and shaded windows used in Dano Secondary School. The use of laterite stone, one of the local building materials, is one of the prominent movements in the building. Thanks to the passive ventilation system, the natural circulation of air is ensured. Local materials specific to the region were also preferred in the Salim Habib Education Complex. It meets sustainability criteria with its double-skinned facade, wind catchers and vegetation concept. Red brick, terrazzo floor covering and fabric shades were preferred as building materials. Passive ventilation is facilitated with the help of the fabric canopy over the courtyard created in the building. Attention has been paid to energy efficiency in the Rudrapur Community Center and Workshop Complex. Sustainability was tried to be achieved through the selection of local materials, bamboo walls, and the cob method and cob technique used. The different techniques used in the building complex attract attention in the region where it is located. The use of mud, a local building material, with a modern technique is an important example of the transformation of traditional material into contemporary building material. Passive ventilation is provided with the help of bamboo construction added to the roof. The most important common feature seen in the structures examined is the preference for local building materials. Designs were made considering sustainability criteria. The climate zones in which existing building complexes are located have been decisive in design studies.

Project	Year	Country-City	Sustainability	Building materials	Passive Ventilation
Dano Secondary School	2007	Burkina Faso- Dano	➢ Permeable Suspended Ceiling ➢local material ➢Window with Shade ➢traditional method	➢Soil ➢Laterite Stone ➢Iron bar ➢Corrugated Sheet ➢Cement	Available
Salim Habib Education complex	2020	Pakistan-Toba Tek Singh	➢Vegetation Concept ➢Double Skin Facade ➢Wind Catcher ➢Local Material	➢Red Brick ➢Terrazzo Floor ➢Fabric Canopy	Available
RudrapurSociety Central And Workshop Complex	2019	Bangladesh-Rudrapur	➢Local Material ➢Energy Efficiency ➢Bamboo Walls ➢Cob Method ➢Cob Technique	➢ Compressed Earth ➢Mud ➢Bamboo ➢Ceramic	Available

Table 1. Comparison of the Structures Examined (by the Author)

5. Conclusion

Hot dry climate zones are regions with high temperatures and low humidity levels throughout the year. Such climatic conditions present some challenges and opportunities in contemporary building design. Several important factors need to be carefully considered for buildings to be efficient, sustainable and comfortable in hot dry climates. Due to high temperatures, buildings must have good thermal insulation. Good insulation can help control indoor temperature. Roofs, walls and windows should be designed to block solar radiation and reduce temperature. Thermal mass is also important; Buildings should use materials that can store cold air at night and maintain coolness during the day. Solar energy potential is high in hot dry climates. Buildings can save energy by using solar panels and other renewable energy sources. In addition, the shading mechanisms used and building designs that regulate sunlight effectively can contribute to better directing the indoor temperature.

Since water resources are not unlimited, it is necessary to use water economically in hot dry climates. Wind can provide natural cooling in hot dry areas. During the building design phase, designs were made to support natural ventilation. Opening windows and cross-channel ventilation systems can increase air movements in the interior of buildings. Shading systems to be used in the building can reduce the hot effects of the sun. Open areas such as verandas and courtyards can create a cooling and resting environment for the residents of the building.

Choosing local building products in sustainable building design stages is considered an important way to reduce environmental impacts. The use of local materials reduces transportation costs and contributes to the econ-

omy. Additionally, the use of these materials ensures less consumption of environmental resources. For example, materials such as local wood, stone or soil can reduce the carbon footprint of buildings. At the same time, the use of these materials can encourage respect for local culture and traditions. Passive ventilation systems are an important design criterion that ensures energy efficiency. Natural ventilation systems of buildings provide more energy savings than mechanical ventilation. Passive ventilation design optimizes air circulation within the building and provides coolness during hot weather periods. This helps control the indoor temperature and provides comfort to the occupants. Positioning windows, considering wind paths and using shading systems in building design ensure that the passive ventilation system works efficiently. Sustainable building design must be compatible with the local environment, economy and society. Using local building materials helps preserve natural resources and support the local economy, while passive ventilation promotes energy savings and increases indoor comfort. Adhering to sustainability principles to reduce the environmental impact of buildings is of critical importance in terms of both meeting the needs of current generations and considering the needs of future generations. Therefore, building design should combine local materials and sustainable methods that include passive ventilation, thus making the buildings of the future more environmentally friendly and livable.

The importance of studies carried out in line with passive design principles is increasing. Particular attention is drawn to sustainability, building materials and passive ventilation. The use of local materials, energy-efficient orientations and climatic comfort parameters are decisive at the design stage. Designs should be made by the climatic conditions in the region. Traditional local materials and architectural styles can be adapted for use in hot dry climates. These materials and designs can contribute to the construction of environmentally compatible and energy-efficient buildings. In hot dry climates, contemporary building solutions are of great importance in terms of energy efficiency, sustainability and comfort. Building design and construction in these regions should be sensitive to climatic conditions and local resources. Additionally, new technologies and design methods need to be considered to increase residents' comfort and reduce energy costs.

Source

Adil, S. (2010). *Examination of ecological urbanization and ecological planning approach in mass housing in the example of Başakşehir 4th Stage* (Master's thesis, Institute of Science and Technology).

Alqatrani, FSA (2020). the historical Dimension oath physical Characteristics of Al- Al-Shanasheel

Heritage Buildings in the Old City of Basra (Iraq). *Journal of Basra researches for Human Sciences*, *45* (2).

Karaca, M. (2008). *Energy efficiency in mass housing; An examination of Mass Housing Administration (TOKİ) mass housing projects.* (Master's thesis, Science Institute).

Koçlar Oral, G., Solar Energy and Construction, Diyarch Bulletin (Diyarbakır Chamber of Architects Bulletin), Issue 1, p.11, Diyarbakır, 2010

Lechner, N. (2014). Heating, cooling, lighting: Sustainable design methods for architects _ John Wiley & Sons.

O'Connor, D., Calautit, J. K. S., & Hughes, B. R. (2016). A review of heat recovery technology for passive ventilation applications. *Renewable oath Sustainable Energy Reviews*, *54*, 1481-1493.

Okeil, A. (2010). A holistic approach to energy-efficient building forms. *Energy and Buildings*, vol. 42, pp. 1437-1444, 2010

Özdemir Bahar B., (2005). *Buildings as Energy-Efficient Passive Systems for a Sustainable Environment Design* (Master's thesis, Institute of Science and Technology).

Url 1. https://arquitecturaviva.com/works/escuela-secundaria-de-dano-9 _ _

Url 2. https:// divisare.com/projects/83616-kere-architecture-dano-high-school

Url 3. https://www.archdaily.com/949942/salim-habib-education-complex-ali-arshad-associates/5f8eea9a63c017ec6f0000cd-salim-habib-education-complex-ali-arshad-associates-plan

Url 4. https://www.archdaily.com/949942/salim-habib-education-complex-ali-arshad-associates

Url 5. https://www.archdaily.com/950681/anandaloy-center-studio-anna-heringer

Url 6. https://www.avontuura.com/anandaloy-by-anna-heringer/

Url 7. https://www.kerearchitecture.com/work/building/dano-secondary-

Url 8. https://archello.com/project/secondary-school-dano

Url 9. https:// www.archilovers.com/projects/19569/school-at-dano.html

Url 10. https://csis.myclimateservice.eu/node/5182

Url 11. https://www.solaripedia.com/13/257/dano_school_passively_cool_(burkina_faso). html

Url 12. https:// www.architecturalrecord.com/articles/6600-secondary-school

Url 13. www.artsy.net/artwork/kere-architecture-kere-architecture-dano-secondary-school-burkina-faso

Url 14. https://medium.com/@ bioclimatologiafavip/an%C3%A1lise-do-projeto-dano-secundary-school-de-francis-ker%C3%A9-fdea7f4eac65

Url 15. https:// www.researchgate.net/figure/Primary-School-Gando-High-School-Dano-Burkino-Faso-

Url 16. https://www.designboom.com/architecture/anna-heringer-anandaloy-mud-bamboo-community-center-bangladesh-10-21-2020/

Url 17. https://www.designandarchitecture.com/article/anandaloy-by-studio-anna-heringer-enables-the-disabled-to-participate-in-community-life.html

Url 18. https://www.designandarchitecture.com/

Url 19. https://arquitecturaviva.com/works/anna-heringer-edificio-anandaloy-en-rudrapur-banglades-gye86-5

Url 20. https://www.dezeen.com/2020/10/23/obel-award-anna-heringer-rammed-earth-therapy-centre-bangladesh/

Url 21. https://www.architectural-review.com/buildings/houses-in-bangladesh-by-anna-heringer-with-basehabitat-brac-university-and-dipshikha

CHAPTER 4

LOCAL HOUSING ARCHITECTURE AND CONSERVATION PROBLEMS IN IZNİK-İNİKLİ VILLAGE

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1. INTRODUCTION

Housing types differ from region to region in local architecture shaped according to social life, traditions and customs, production and consumption habits, climatic and topographical conditions. Unlike modern architecture, the care shown to human dimensions in local houses expresses respect for human beings and their lives (Çekül 2012: 7). In recent years, one of the most neglected issues in the conservation discipline is the protection and sustainability of local architectural identity. As seen in many rural settlements of Anatolia today, the unconscious use of today's building materials and the failure to design the new buildings built in the empty areas of the rural environment in accordance with the local identity have caused the loss of local building characters and the deterioration of local architectural elements. In addition, the fact that large and prestigious monumental buildings are taken into consideration more in the culture of conservation has led to less attention being paid to local dwellings, which are the transmitters of local knowledge (Rudofsky 1965: 1-2). This unidirectional perspective has accelerated the destruction of local architectural examples, making these structures more in need of protection over time (Ovalı and Delibaş 2016: 516). In order to control the factors that cause deterioration in rural areas, important studies are carried out in many countries to protect and document cultural values related to local architectural identity and to ensure sustainability. Especially in Europe, the processes developed in the context of the protection of rural architectural heritage can be briefly defined as valuing, documenting, drawing attention for protection and producing policies for protection (Eres 2016: 10). In our country, the studies carried out to date on revealing and protecting the local housing architecture in different regions of Anatolia have been quite inadequate and at the same time delayed. For this reason, it is seen that the local texture and rural houses that constitute local architecture in many regions have disappeared without being documented. Despite the inadequacy of the studies on this subject, there are a small number of important settlements in our country such as Cumalıkızık, Safranbolu, Yörük village, Şirince where local architectural heritage and life culture are under protection. These areas are also special examples where a rural settlement has turned into an open-air village museum in its own place. The interest that has grown in recent years with the guidance of some sensitive people and some coincidences has led to the production of more planned and sustainable conservation policies for the protection of settlements with rural architectural heritage.

İnikli Village of İznik district of Bursa province, which was selected as the research area, is one of the rare rural areas that have survived to the present day with its local housing architecture values and original settlement texture. Except for a few Ottoman period houses built in the mid-19th

century, the remaining local houses in the original village texture were built in the 1940s. Although these houses were built by local builders, they are the continuation of the Ottoman period rural housing architecture in terms of spatial design, façade features, materials and construction techniques. The houses that constitute the local housing culture in İnikli have faced the danger of extinction due to reasons such as abandonment and neglect caused by social, economic and technical inadequacies. For this reason, it is necessary to urgently carry out guiding studies for the identification and protection of rural architectural principles that will contribute to the documentation and sustainability of the local housing building tradition, which is changing under different conditions and rapidly disappearing today (Eminağaoğlu and Çevik 2007: 157).

In order to protect and sustain the local houses, which are the center of life and production in rural village settlements such as İnikli, and the identity values specific to the culture in which they are located, in addition to determining the architectural features of the houses within the texture, the importance of discussing the reasons for not being protected and the necessity of integrating rural heritage into contemporary life should be emphasized in the studies to be carried out. In this context, it should be ensured that the local houses, which are in danger of extinction in İnikli village, which has a unique rural architectural identity, are protected, kept alive and transferred to the future with their original values. In this context, identification studies based on field research were carried out to determine the current status and architectural features of İnikli houses. Based on the field research, the original street texture and settlement characteristics of the region were analyzed, and as a result of the detailed studies carried out, the local houses built in the 1940s in the wooden frame system were examined in terms of space fiction, facade features and construction techniques and documented with drawings and photographs. In addition, the deterioration of the houses and the reasons why they could not be preserved were investigated and suggestions were developed for the protection and sustainability of the existing texture and the local houses within the texture.

2. REGIONAL ARCHITECTURE AND TRADITIONAL HOUSING CULTURE

The most important of the basic components in the formation of architectural identity is vernacular architecture. Local architecture includes all kinds of buildings organized by the tribe, people, peasants and built with the planning understanding of local craftsmen without an expert designer (Oliver 1978: 4). According to Kuban, vernacular architecture is the natural and organic construction of one's own dwelling with the help of local craftsmanship in common understanding (Kuban, 1995: 12). All forms of

vernacular architecture are designed to meet the values, economies, lifestyles and special needs of the cultures that produce them (Vellinga et al. 2007: 13). Regional architecture, which forms cultural bridges between generations, constitutes a harmonious pattern of architectural/spatial solutions developed by humanity in line with centuries of life experiences around the common mind, reflecting traditional construction practices and local identity with local materials and techniques (Icomos 2013: 3, http://www.icomos.org.tr). Each region harbors unique examples of rural settlements within its own conditions. In Anatolia, rural settlements gain their unique identities with local solutions developed in line with regional conditions, and reveal effective appearances together with the natural environment (Eminağaoğlu and Çevik 2006: 32). Climate conditions, geographical location, landforms, vegetation, traditions and customs, community life, production-consumption patterns and beliefs determine the process of shaping rural structures. Local solutions diversify in the interaction of social, cultural, religious, economic and physical factors and change from place to place (Rapoport 1969: 46-47). Despite the diversity that emerges in local buildings, there is an integrity, order and harmony as if they were created by the same master. This is the result of the traditional master-apprentice relationship formed over centuries. The basic construction principles, which are passed down from generation to generation without changing, ensure the texture integrity in the settlement (Hersek 2000: 33). In this context, the shaping process of local buildings is a process that is learned by doing what they see from their grandfathers, fathers and masters, and developed by experimenting (Aran 2000: 12-15). Especially every element taken into consideration in the creation of houses is designed and produced according to the lifestyle and economic activities of the inhabitants of the house. For this reason, functionality takes precedence over form and aesthetics in rural buildings (Çekül 2012: 7-8). On the other hand, local houses are located on plots of different sizes with different plans and façade views, far from uniformity in terms of layout. The most common country house plan is similar to the buildings known as the "Turkish House", which were seen in Anatolia and the Balkans during the Ottoman period, with a masonry floor and a wooden roof on the upper floor (Çekül 2012: 14-15).

The Turkish house, which constitutes the traditional housing culture, is defined as the type of house in which Turks have lived throughout history, showing typological differences according to various climatic and topographical conditions reflecting the Turkish life culture (Günay 1998: 16). Although they were built in regions far away from each other, they have similar spatial relationships (Orhun 1999: 259). In the Turkish house, the rooms are arranged on the sofa and open to separate sofas, making the sofa the center of movement. At the same time, the sofa is a place of passage,

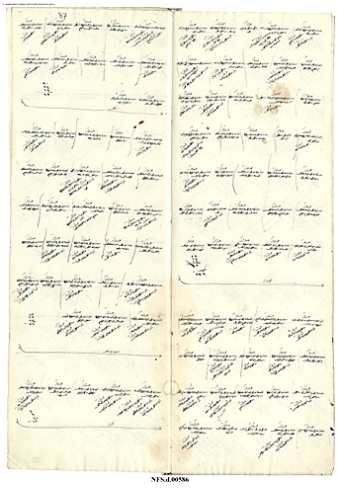
a place of production and a social space. It is a place where the people of the house gather for entertainment, even weddings and henna ceremonies, and in some regions where silkworm cocoon production is carried out. In the Turkish house, the main floor is always single. Even in houses with several floors, the main floor is always at the top (Eldem 1986: 16). From the 17th century onwards, the rooms began to project onto the street. The main floor overhangs the street above the ground floor. Living spaces are on this floor (Günay 1998: 42-43). The ground floors of the houses of this period mostly contain service spaces and warehouses. The kitchen is on the ground floor and overlooks the garden (Orhun 1999: 259). From the 18th century onwards, the roofing method with wooden materials began to be widely used in houses. In this period, rooms were arranged around a central sofa. There is an iwan between two rooms. As the number of iwans increased in the houses, the sofa became in the form of a "T" shaped open or closed inner sofa. The rooms grew larger and had two-way projections, thus providing mobility on the facade (Günay 1998: 59). The sofa, which is the space where the rooms are arranged in the Turkish house, is the most determining element of the Turkish house plan type, although it is variable. The plan types of the Turkish house with sofas are divided into 3 main sections according to the order of development (Eldem 1986: 17). These are; outer sofa, inner sofa and middle sofa plan types. In this context, local houses, which are the concrete evidences of rural life culture that have survived to the present day, reflect the culture of life, behavioral patterns, environmental preferences and space typologies that constitute the characteristic features of the local identity to which they belong. However, recent social and cultural erosions in the characteristics of the local identity formed over time have led to significant changes in the context of lifestyle, personality and culture (Gür 2000: 11). Along with these changes, local houses, which are the most important component of local identity, have also entered a process of rapid disappearance due to abandonment or economic and technical inadequacies.

3. INIKLI VILLAGE LOCATION, HISTORY and CURRENT SITUATION ANALYSIS

Inikli is 11 km. away from Iznik District of Bursa province in the Marmara region. Inikli, which is adjacent to historical settlements such as Elbeyli town and Ömerli village, was established in a forested area on the slope of the Samanlı Mountains facing Iznik Lake (Figüre 1).

Figüre 1. *Location of Iznik in the Marmara Region (www.eokulbilgi.com/marmara-bolgesi-haritasi)*

There is no precise information about the dates of the first settlement in and around İnikli Village. However, it is known that İnikli had a settlement area where rural life was maintained during the Ottoman period. In the population and dividend registers of 1845, the earliest of the archival sources that provide information on this subject, 56 male inhabitants were recorded (Document 1). In addition, the same dated dividend book indicates that there were 34 households in İnikli Village (Document 2).



Document 1. *İnikli Population Book dated 1845*

Document 2. *İnikli Temettuat Book dated 1845*

In the 1845 dated dividend book, these households are stated as Çakıroğlu Ahmet Ağa oglu İbrahim, house number 1, Çakıroğlu Ahmet Ağa oglu İbrahim, house number 2 Yarıyolcu Karaca Hüseyin bin Ali, and all movable and immovable assets belonging to these individuals were recorded together with the amount of taxes they paid. As it can be understood from this, since one house was recorded as one household, it can be said that there were 34 houses in İnikli in 1845. When the 1908 Hüdavendigar provincial salnament is analyzed, it is seen that 34 households were again registered in İnikli (Document 3). It is understood that there has been no increase in the number of households and thus the number of houses in Inikli in the 63 years that have passed. In the 1927 salnamas, 306 people, 145 women and 161 men, lived in Inikli (Document 4).

Document 3. *Inikli 1908 yearbook*

Document 4. *Inikli 1927 yearbook*

While 361 people lived in İnikli in 1990 and 328 people lived in 1997, today there are 87 households and it is recorded that a total of 300 people, 143 men and 157 women, live in the houses. In the rural texture, apart from the existing 34 houses belonging to the Ottoman period, in parallel with the increase in the number of households over time, especially between 1940-1950, 53 houses were built in the wooden frame system and in accordance with the traditional architectural character instead of some of the Ottoman period houses, and the number of houses became 87. Today, there are 87 houses in İnikli and some of these houses have recently been demolished and replaced by new buildings in reinforced concrete style. It is also understood from the construction dates written on the triangular pediments on the balconies of some houses that the local houses in İnikli were built in the 1940s (Figüre 2).

Figüre 2. *Plate showing the date of construction in the triangular area on the balcony of local houses*

The general view of the settlement texture of Inikli Village is given in Figüre 3.

Figüre 3. *General view of the settlement texture of Inikli Village*

The houses within the existing rural texture of Inikli are divided into 3 groups according to their periods. These are;

a) Mid-19th century Ottoman houses, which were built in the mid-19th century and few of which have survived to the present day,

b) Between 1940-1950; local houses built in wooden frame system with traditional character in terms of plan schemes, facade features, use of local materials and construction techniques.

c) After the 1980s, Ottoman houses were replaced by reinforced concrete houses built in violation of the original texture and local architecture.,

d) Houses that have been removed from their original features as a result of interventions made in local houses with today's materials.

Today, the distribution of houses in the rural texture according to construction periods and construction systems is given in Figüre 4.

Figüre 4. *Distribution of houses according to construction periods*

Figüre 5. View of buildings built in reinforced concrete style within the texture

As can be seen in Figure 2, there are 87 houses in the existing texture today. 29 of the 34 Ottoman houses built in the mid-19th century were demolished after the 1980s without any documentation work, and some of them were replaced by new buildings in reinforced concrete system (Figüre 5).

Since 1 of the 5 houses that survived from the Ottoman period was recently demolished due to lack of maintenance, there are 4 historical houses remaining from the Ottoman period (Figüre 6).

Figüre 7. *Examples of houses belonging to the Ottoman period in the Inikli local housing texture, which are not in use today and remain in a dilapidated state*

On the other hand, the houses in the local texture have 2 and 3 storeys. The analysis sheet showing the number of storeys of the houses is given in Figüre 8.

Figüre 8. *The number of storeys of the houses in the local texture (In the analysis of the number of storeys, the present Ottoman period houses and other local houses are processed, and the new houses in reinforced concrete style are not processed.)*

In addition, in the village square within the rural fabric, there are the Hacı Mehmet Mosque, built in 1943 in a wooden frame system in accor-

dance with the local architectural character, and a new mosque built recently in reinforced concrete system, small-scale commercial units such as grocery stores, grocery stores and barbershops, and a primary school built in reinforced concrete style on the slopes but not in use (Figüre 9).

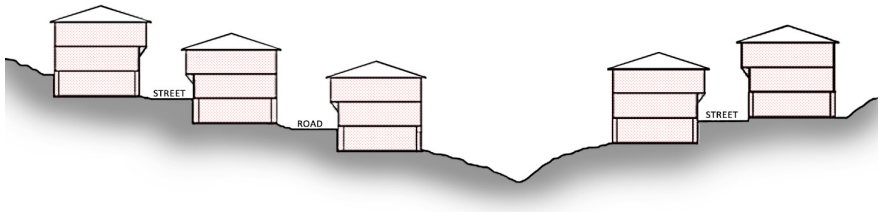
Figüre 9. *View of Hacı Mehmet Mosque (Old Mosque) and Primary School within the texture*

4. INIKLI LOCAL HOUSING ARCHITECTURE and FEATURES

When the surviving Ottoman period houses and the local houses produced in the 1940s in İnikli settlement texture are interpreted in terms of plan types, space distributions, façade features, use of local materials and construction techniques, it is seen that they reflect the 19th century Ottoman period rural housing architecture with inner sofas that emerged with the closure of the outer sofas. The original houses within the local texture of Inikli were analyzed and evaluated in terms of layout, plan types, façade features and construction techniques..

4.1. Settlement Analysis

The streets in Inikli, a typical village settlement, are organically shaped. The streets within the village are not named. Since İnikli Village is a mountain village built on opposite slopes descending towards the valley, there are streets rising parallel to the slope. Therefore, the houses are built on terrace arrangements on two opposite slopes facing each other. For this reason, there is usually a one-story difference between the lower level and the upper level in the living arrangement of the houses (Figüre 10).

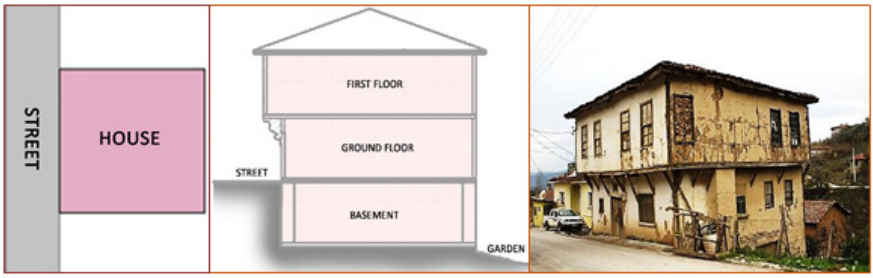


Figüre 10. *The layout of the houses on two opposite slopes*

As can be seen in the figure, the first floors entering the house from the street vary according to the settlement status. Almost all of the houses located in a split-order layout face the street (Figüre 11).

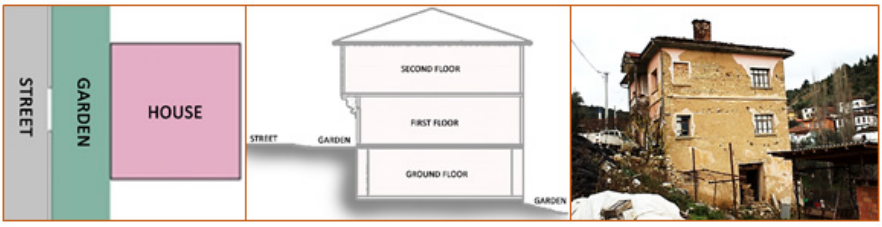
Figüre 11. *The arrangement of houses facing the street in the local texture*

Although each house in İnikli has a garden, the street-garden-home relations of the houses are different from each other. For this reason, the relationships between the buildings are not regular. In the local fabric, street, garden and house come together in two ways. The first is entering the house directly from the street (Figüre 12).



Figüre 13. *Direct entrance to the house from the street; plan, section and view*

In these houses, since the facade is located on the street line, the entrance is provided directly from the street. In this type of settlement, the street boundary is determined by the house. Direct entrance from the street is the most common type of entrance. The second is the entrance from the street to the garden and the entrance from the garden to the house (Figüre 14).



Figüre 14. *Entrance to the garden and house from the street; plan, section and view*

In this type of settlement, the front garden defines the street boundary. When entering the house from the garden, the entrance door is again on the facade facing the street. Although some of the houses entering the garden from the street have garden boundary walls made of mudbrick or stone, most of the houses have no boundary wall between the front garden and the street. In the houses located on the slope descending towards the valley, the first floor is the ground floor. These houses have a 2-storey appearance from the street façade where the entrance is provided and a 3-storey appearance from the backyard. Since the basement floors and side and back gardens of these houses are below the road level, the exit to the garden is provided from the basement floor. In the houses located towards the upper levels of the slope, the entrance is provided from the basement floors. These houses have a 3-storey appearance from the street and a 2-storey appearance at the upper level (Figüre 15).

Figüre 15. *2-storey view from the upper level of the 3-storey house on the street facade*

Gardens are important environmental assets for houses in Inikli. Almost every house has gardens of different sizes and used for different purposes. The gardens located in the front, side and rear parts of the houses according to the entrance layout from the street are generally used as small agricultural areas where fruits and vegetables are grown. In the front and back gardens of some houses, there are ovens made of mudbrick and covered with shed roofs (Figüre 16).

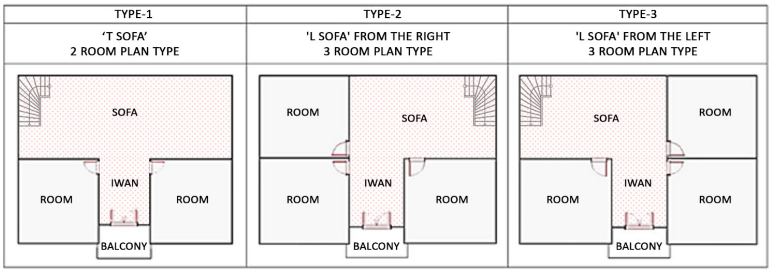
Figüre 16. *Examples of hearths made of adobe material in local texture*

4.2. Plan Features

The houses that constitute the local residential architecture in the urban fabric of İnikli are 3-storeyed and 2-storeyed. The three-storey houses are predominantly designed as basement floor + first floor + second floor, while the others are basement floor + ground floor + first floor. View from the street The ground floors of the 2-storey houses are designed as living spaces. There are at least 2 rooms with kitchen on the ground floor. In the basements below the ground floor, there are service volumes such as storages and cellars. In the houses with a 3-storey view from the street, service volumes such as kitchen, pantry and storage are located on the first floor where the entrance is provided. In these houses, the first and second floors after the first floor are the living floors. Houses with 2 floors are ground

floor + first floor. The first floor, which is entered from the street or garden, is the ground floor, and while there are kitchens and rooms on this floor, the main floor, the upper floor, has rooms opening to the living room. In İnikli, each house has overhanging projections overflowing onto the street or garden. The projections called cumba are on the top floor, which is the main floor.

Inikli houses have different plan types where the rooms are arranged around the sofa. In some houses, the rooms opening to the sofa are arranged as three rooms and in others as two rooms. The number of rooms on the ground or first floor, which is defined according to the entrance layout from the street, is the same on the upper floor. In the local houses within the texture, the number of rooms has been the most important factor in the shaping of the living room. In houses with 3 rooms on the floor, the sofa has an "L" plan, while in houses with 2 rooms on the floor, the sofa becomes a "T" plan with the iwan opening between the two rooms. On the other hand, "L" planned sofas are divided into two as "L" planned sofas from the left and "L" planned sofas from the right. In this context, the typological plan schemes of houses are divided into two groups according to the number of rooms on the floors and into three groups according to the shape of the sofa (Figüre 17).



Figüre 17, *Room and sofa configurations in Inikli houses*

In İnikli houses, the sofas are the converted inner sofas by closing the front of the outer sofas, which are classified in the Turkish house plan types. As in the Ottoman period houses, in the houses of İnikli with a local character, the sofa is not only a place of passage, but also a social space where the household gathers for entertainment, even weddings and henna parties, as well as a production area used to grow silkworms in the region. In the houses, the iwans formed between two rooms on the top floor from the inner sofa open onto balconies overhanging the street (Figüre 18).

Figüre 18. *View of the iwan leading to the sofa and balcony*

There are no overhangs on the ground floors of the 3-storey houses after the basement. On the facades of the iwan on the ground floor of these houses facing the street, there are generally windows in the width of the wall, and these windows are complemented with arches in some houses (Figüre 19).

Figüre 19. *View of the arch-shaped end windows over iwanönü on the ground floor*

The balconies that open from the iwan and overhang onto the street in İnikli houses are the most prominent feature that distinguishes these houses from the plan scheme of Ottoman period houses. The understanding of open space overhanging the street, which has been shaped as a unique façade character, is influenced not only by environmental and functional conditions, but also by new assumptions in the culture of life that aims to open up to the outside. Along with the balconies in the houses, the room overhangs, which overhang the street and form a bay window, are arranged on the main floor and on the front facades facing the street. Since the rooms on the main floor project onto the street, they are larger than the rooms on the lower floor by the width of the projection. In some houses, the rooms are enlarged in both directions compared to the lower floor by projecting on the side facade as well as the street facade. The room overhangs over-

hanging the street are made to the width of the room on the right and left sides of the facade according to the entrance axis, and there is a balcony overhang in the center of the facade, on the entrance door axis. The balcony bay are slightly more prominent than the room bay, providing mobility on the façade. In most of the houses, balconies and rooms, as well as the entire front façade, have overhangs overhanging the street, while in some houses, balcony overhangs overhanging the street or the front garden were constructed only on the entrance door axis on the front façade. The widths of the room overhangs to the street generally vary between 30 - 50 cm. and the widths of the balcony overhangs to the street are between 50 cm. and 100 cm.

On the other hand, in the living floors of the houses, there are usually additions such as stoves, cupboards and gusulhane in a room that are aligned with each other, and in some houses, these additions are located only in a room on the main floor. In particular, the room with a hearth on the main floor is also defined as the bride's room. In these houses, as in the Ottoman period houses, every room with a stove is also a cooking space. Although there is a separate kitchen on the ground floor of the houses, the presence of a stove in the rooms called bridal rooms, hence the design with two cooking spaces, stems from the father's desire to prepare his son for an independent life under his supervision. The hearth has a wooden sliding shutter mechanism on its front face that moves up and down. On the other hand, the hearths and gusulhanes located inside the rooms usually protrude from the side and rear facades of the house into the garden (Figüre 20).

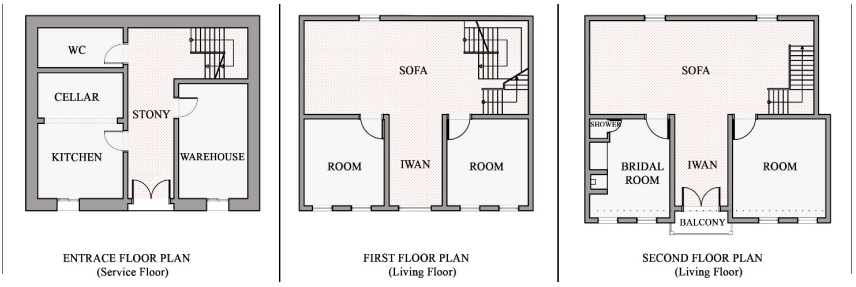
Figüre 20. *Hearth and Gusülhane extensions in the room on the main floor and overhangs to the garden*

In the houses, the exit stairs that provide vertical circulation between floors are made of wood. The stairs are located on the narrow side of the hall in almost all houses. The stairs from the ground floor to the first floor and the stairs from the first floor to the second floor do not have the same axis and layout. While the staircase from the ground floor to the first floor

is located on the right narrow edge of the hall, the staircase from the ground floor to the second floor is located on the left narrow edge of the hall or from the same wall edge to the upper floor hall in the form of a different stair arm.

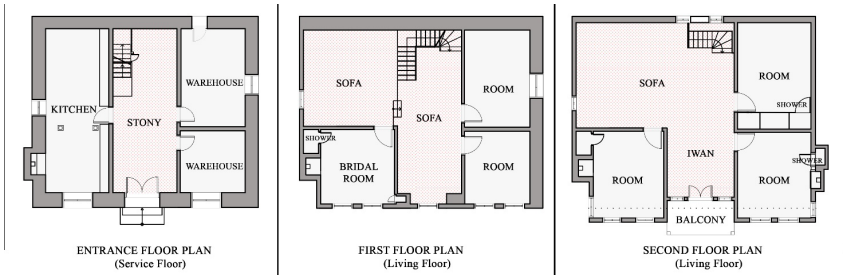
The houses that constitute the local residential architecture of Inikli have 5 different plan typologies according to the entrance layout from the street, the shape of the sofa, the number of rooms on the floor and the way they overflow to the street on the upper floors.

The houses with the 1st plan typology have 3 floors and 2 rooms on each floor. This type of houses are entered into the basement from the street. There are service spaces and kitchens in the basement floors where the entrance is provided. In the plan of this type of houses, the doors of the rooms open to the hall and there are iwans opened between the two rooms. On the top floor, which is the main floor, the bride's room with a stove with a gusulhane and the other rooms open out to the street in width. In addition, in this plan typology, there is a balcony between the two rooms on the top floor that overhangs the street from the iwan opening to the hall (Figüre 21).



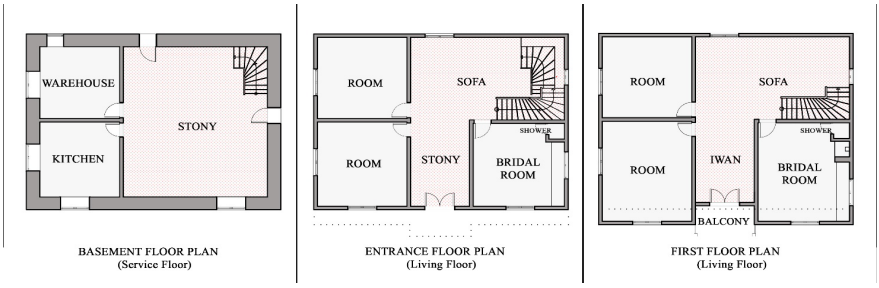
Figüre 21. *1. Plan schemes of houses with typology*

In the 2nd plan typology houses, the entrance is also directly from the street. These houses have 3 floors and the first entrance floor is the basement floor with service spaces. The houses with this plan have 3 rooms on each floor. Two of the room doors open to the hall and one to the iwan. On the upper floor, there is also a bride's room with a hearth, gusulhane and cupboard niches (Figüre 22).



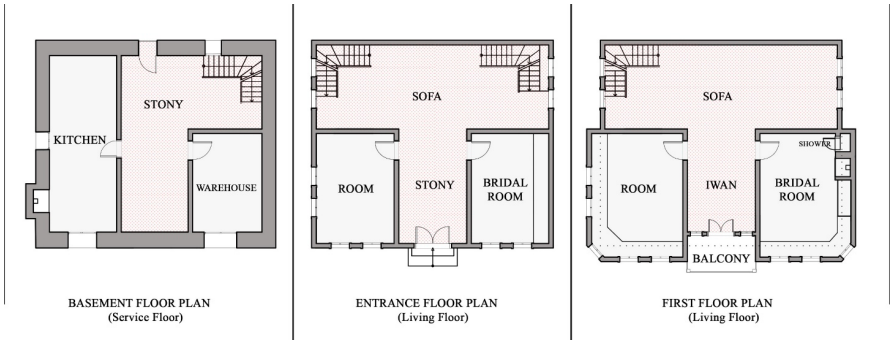
Figüre 22. *2. Plan schemes of houses with typology*

Although the 3rd plan typology houses have 3 storeys like the others, they have basement floors since they were built in areas with high land slopes. The basement floors open to the garden. In these houses, the garden is entered before the street and the 1st floor is entered by climbing a staircase of approximately 1.00 m. from the garden. From the 1st floor, a staircase leads to the basement floor and another staircase leads to the main floor. There are also service spaces in the basement floor and a door leads to the lower garden. On the first and main floors, there are three rooms, two of which open to the hall and one to the iwan. The houses with this plan type have wooden poles placed on the entrance landing under the balcony ledge. There are no posts carrying the balcony under the balcony, and the balcony is carried on the buttresses on the handrails together with the room exits. The rooms on the main floor do not have projections to the garden (Figüre 23).



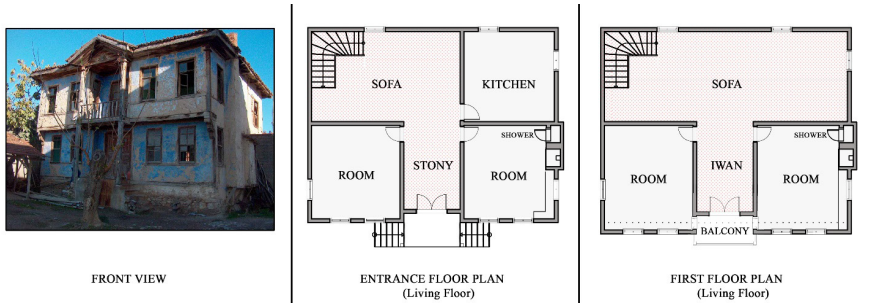
Figüre 23. *3. Plan schemes of houses with typology*

The houses with the 4th plan typology have 3 storeys and are accessed from the street first to the garden and then to the basement. The most important feature that distinguishes the houses with this typology from the others is that the rooms on the main floor have projections in both directions. In the projections in both directions, there are examples where the corners intersect perpendicularly, as well as examples where the corners make a 45° angle (Figüre 24).



Figüre 24. *4. Plan schemes of houses with typology*

The houses with the 5th plan typology have 2 storeys and the houses are entered from the garden as well as from the street. The entrance of the houses is usually raised around 1.00 m. There are two rooms and a kitchen on the first ground floor, while the main floor, the upper floor, has two rooms opening to the living room (Figüre 25).



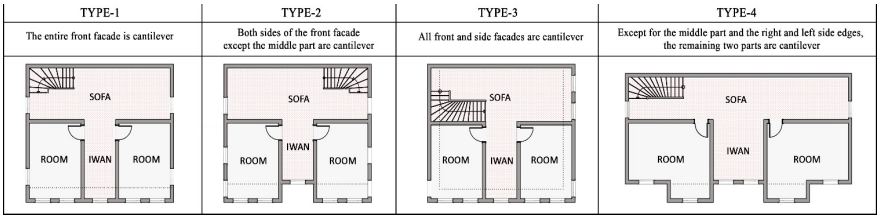
Figüre 25. *5. Plan schemes of houses with typology*

The service requirements of the houses with two storeys such as storerooms and cellars were generally solved with outbuildings built in the garden. In these houses, there is a balcony carried by two wooden poles from the iwan opened between two rooms on the upper floor. The balcony poles continue at the top and carry the triangular pediment on the roof..

Since there were no balcony projections facing the street in the Ottoman period houses, the projections on the top floor were room projections. Two of the few houses from the Ottoman period in İnikli have similar plan schemes, while the other three have different plan schemes. Existing houses in the local texture are classified according to plan types;

- The entire front facade must be removed,
- Both sides of the facade should be projecting without a central part,
- The front and side facades should be completely removed,
- The central part and the right and left side edges are divided into four parts: the middle part and the right and left side edges without projections, and the two parts in between with projections.

The plan typologies of the existing Ottoman period houses in the local texture are given in Figüre 26.



Figüre 26. *Plan typologies of Ottoman period houses in the local texture*

4.3. Facade Features

The main characteristic feature of the street-facing front facades of the houses forming the local architecture in İnikli is that they are designed in a symmetrical order. Overhangs on the top floors and symmetrically arranged windows are the most prominent features of the façade. Within the original texture, all of the houses, except for the Ottoman houses, have balcony overhangs in the middle of the façade and at the level of the upper axis of the entrance door, which are shaped as a unique façade character and protrude onto the street or the front garden. Balcony overhangs are slightly more prominent than room overhangs, providing mobility on the façade. A small number of houses have room projections both to the street and to the side gardens. In some houses with two-way projections in the rooms, the projections overhanging the front and side faces of the room intersect perpendicularly, or their corners do not intersect perpendicularly, but are broken at a 45-degree angle, forming a narrow surface with a window opening. In all of the houses, there are no overhangs on the front facades facing the street on the mezzanine floors.

Since the projections on the front and side facades of the top floors of houses vary, they can be classified into three different types.

1. Houses with balconies on the upper axis of the entrance door on the top floor and overhangs from the rooms on both sides of the balcony to the street or front garden along the facade (Figüre 27)

Figüre 27. *Examples of houses with balcony overhangs on the middle axis of the facade on the top floor on the front facade and room overhangs on both sides of the balcony*

In all of the houses with this façade character, the balconies on the central axis protrude forward more than the rooms. This feature provides mobility on the front facades.

2. Houses on the top floor with only a balcony projection on the upper axis of the entrance to the street or garden, and no projections in the rooms on either side of the balcony (Figüre 28),

Figüre 28. *Examples of houses with only balcony projections on the front facade*

3. Houses with room overhangs on the side facades along with the overhangs on the front facade are divided into two types: overhangs that intersect each other at right angles and overhangs whose corners meet at an angle of 45 degrees (Figüre 29).

Figüre 29. *Examples of houses with protrusions on the street and side façades, joining each other at right angles or at a 45-degree angle*

In addition, the façade views of the houses in the local fabric with different room projections belonging to the Ottoman period are given in Figüre 30.

Figüre 30. In the local texture, examples of houses from the Ottoman period where the front facade is completely projected, the front and side facades are projected, the middle axis of the front facade is not projected, and both sides are projected

The projections on the street façades of the houses resulted from the desire to dominate the view. In almost all of the houses, the projections organically related to the street texture give different perspectives on the street. On the other hand, the wooden poles on both sides of the balconies, which overhang the street more than the room projections, carry the flat or gable roof pediments on the balcony (Figuüre 31).

Figüre 31. *View of the roof eaves on the balcony, complete with flat or gable pediment*

The balustrades on the balconies, which were originally wooden, have been replaced with wrought iron balustrades in some houses, which appear to have been added later. Under the balconies and room overhangs, there are eliböğründe or furus for load-bearing support. Depending on the width of the balcony overhangs, the width of the overhangs is 0.50 m. - 1.00 m. and the heights are 0.90 m. - 1.10 m. and 1.20 m. The eliböğründeler under the room projections are generally between 0.30 m. - 0.50 m. wide and 0.60 m. - 0.70 m. high. The types of eliböğründe containing the characteristic features of the facades are given in Figüre 32.

Figüre 32. *Eliböğründe sample view*

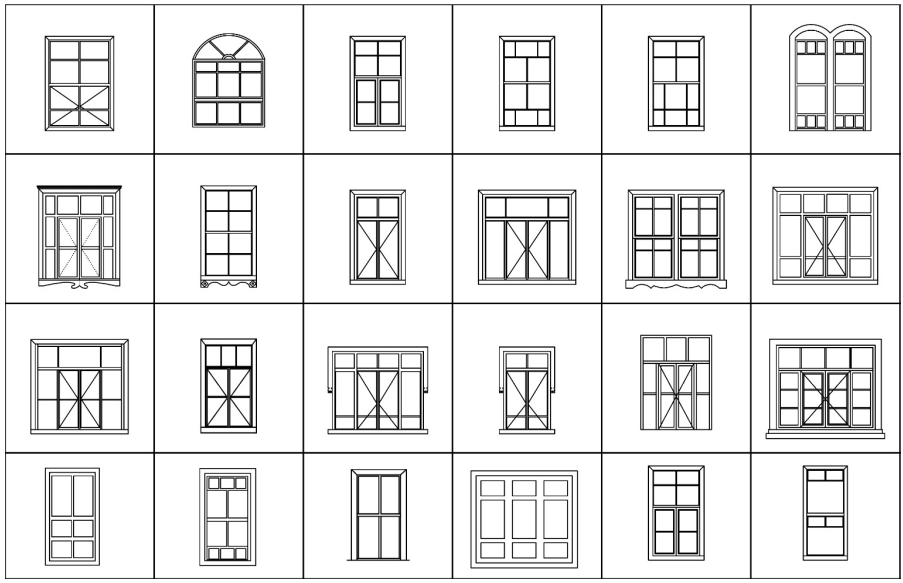
4.3.1. Window Features

Windows with different functions were used in Inikli local housing architecture. Despite this diversity, there is not much change in the way of window production. The main material used is wood. Wooden windows started to be used in Turkish houses after the mid-18th century with the widespread use of glass. Before the 18th century, since large-sized glass

was not produced, skylights were arranged above the lower row of windows to provide light to the space (Uluengin et.al 2001: 175). At the end of the 19th century and the beginning of the 20th century, as a result of the westernization movement, which greatly affected the traditions, movable furniture started to enter the dwelling, and as a result of this, sitting instead of sitting cross-legged, eating at the table instead of eating on the floor affected the height of the ottoman and eliminated the ottoman element over time. In the 17th and 18th century Turkish house, the window parapet height, which was 42-50 cm. depending on the height of the cedar, was raised to 60-70 cm. depending on the height of the furniture in the 19th-20th century house, and the solution of the double layout in a single window reduced the wall and thus the room to a single dimension and eliminated the horizontal line, and the change in the internal layout constituted the change in the exterior (Uluengin 2000: 210). In traditional Turkish houses, the ratio of width to height in window dimensions is usually 1/2. Since the window sizes were kept narrow and long, two rows of windows were arranged side by side in a space. Due to the lack of large-sized glass, divided glass surfaces were used instead of large glass elements in the Traditional Turkish house. This provides privacy from time to time and is a very successful solution in terms of different external perspectives.

In Inikli, the windows of the house show a typical example of the window design in the traditional Turkish house with the thickness of the registers and the texture that emerges with the registers. Wooden railings and wooden shutters with multiple functions, of which we can see different examples in traditional Turkish houses, are not encountered in İnikli houses. The use of the window element with different intervals and periods has a great effect on people who are deeply rooted in geometric and numerical values (Yüksek 2005: 19). From this point of view, as in traditional Turkish houses, windows in İnikli houses are arranged in a certain rhythm and this rhythm is followed on the same floor and between floors. Window rows formed groups on the façade and window groupings were made as 1/1, 2/2 by arranging them on the same axis between floors. Windows are generally located on the inside of the wall cavity. In this way, rainwater is prevented from reaching the joinery and some protection is provided. The frames of the window frames are fixed on a wooden covering arranged in the thickness of the wall in almost all examples. The facade groupings of the windows are mostly in pairs, with two on the upper floor and two on the lower floor. This result indicates that there were at least two windows in a room. This number increases to four in double-fronted rooms. The width and height dimensions of the windows in groupings of two are generally 90/180 cm. On surfaces where the window width exceeds 90 cm, the windows are in groups of one. In the part of the mezzanine corresponding to

the upper axis of the door, there are square or rectangular windows in the width of the door, as well as windows with arched ends. On the ground floor, 2 small rectangular or square windows are used, usually to the right and left of the façade. The opening shape of the window sashes is mostly lateral, but there are also examples of vertical sliding sashes. In characteristic examples, two rows of sashes are arranged on top of each other. One of these pairs of sashes is the main sash and the other is the ventilation sash. The ventilation wing at the bottom provides ease of use. While the ventilation sash at the top makes it difficult to open and close in terms of height, it provides a healthier air circulation like today's applications. The window edge ratios in İnikli houses are 1/2 as in traditional residential architecture. In some windows, this ratio is 1/1.5. The narrow and long 1/2 ratio windows allow light to enter to the lowest point of the room. The window edges have wooden jambs. Examples of windows found in Inikli local houses are given in Figüre 33.



Figüre 33. *Examples of windows in local houses in İnikli*

4.3.2. Door Features

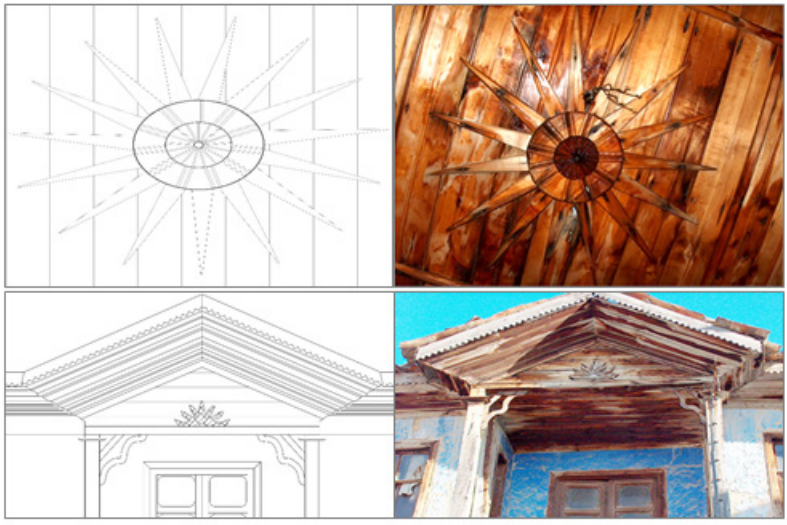
In İnikli Houses, the room doors facing the sofa face are surrounded by moldings on three sides and a wooden threshold at the bottom. The exterior doors facing the street are also framed with wooden moldings on three sides and stone thresholds on the lower side. Room doors are single-leaf and usually have three cores. Although the upper and lower cores

are longer, the middle core is narrower. Room doors generally measure 0.90/2.30 m. Exterior doors opening to the street have two wings in all houses, and each wing has three cores with a narrow center, as in the room doors. The widths of the exterior doors are 1.25-1.40-1.60 m. and their heights vary between 2.30-2.60 m. Narrow windows were made on some doors to illuminate the entrance space. Examples of entrance doors of houses are given in Figüre 34.

Figüre 34. *Door examples of houses in the local texture*

4.3.3. Ornaments:

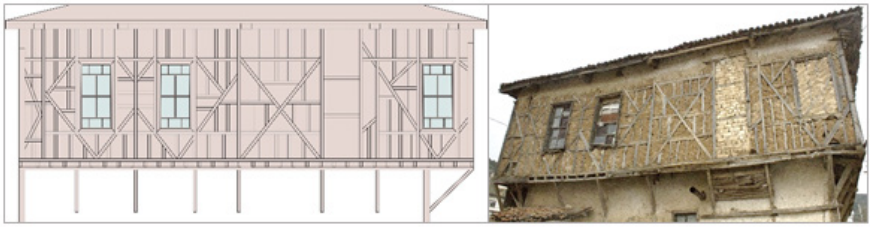
It is possible to trace the effects of art on old Turkish architectural spaces, especially in architectural decoration. The walls, built-in cupboard doors and ceilings of the sofas and rooms in the central part of traditional houses are decorated with rich wooden ornaments (Günay 1998:318). In Inikli houses, although not as seen in more qualified architectural examples, there are wooden decorations on the ceilings of the rooms and on the triangular pediments on the balcony exits (Figüre 35).



Figüre 35. *Examples of wooden ornamentation on room ceilings and gable ends above balconies*

4.4. Construction Technique

The building materials used in local buildings that constitute rural architecture are generally wood, adobe, stone and brick. The materials used in these buildings vary depending on the location and climate of the region. As in every region, since İnikli settlement was established in a forested area, the carrier material of the original houses in the local texture is wood. The construction technique of the houses is wooden carcass roof system (Figüre 36).



Figüre 36. *Appearance of the wooden frame construction technique of the houses*

The spaces between the wooden carriers were filled with adobe bricks placed in the sword and covered with adobe plaster. The adobe bricks are 9 cm thick, 12 cm wide and 28 cm long. In order to prevent the wooden car-

rier system and mudbricks from being affected by water, the houses were raised by building a stone wall of 1.00 m. on average from the ground. The basements, which remain in the soil due to the slope, were built entirely of stone masonry walls. The floor slabs in the houses are made of floor beams placed on horizontal wooden beams placed on pole heads. The floor beams are covered with wooden boards. The roofs of the houses are wooden hipped roofs and covered with alaturka tiles.

In this context, stone and adobe, which are easily accessible materials, were widely used in İnikli village. Stone, obtained from the stream bed and the quarries in the vicinity, was generally used in the foundations and basement walls of the houses, while mudbrick, obtained from the soil taken from the village, was used in the first and second floor walls. The basement floors were built with a masonry construction system using natural and cut stone. Mud was used as mortar between the joints. These stone walls, which have an important place in the formation of the traditional texture, were also preferred for the garden walls. Although adobe, which is used as filling material between wooden frames in the upper floors, is a material that needs constant maintenance, it is a preferred material because it forms thick walls and protects the building against heat in summer and cold in winter (Sözen et al. 1996). Yürekli et al. (2005) interpreted the construction of ground floors with masonry system and upper floors with wooden frame system as "The unity of settlement and nomadism in the Turkish House is expressed by the lightness of the upper floors as opposed to the full and heavy lower floors". Two different forms of timber frame construction system were used in the upper floor walls. The first is the "hımış construction system", whose skeleton is obtained by placing wooden poles of various lengths and diameters vertically and diagonally, and the other is the "bağdadi construction system". In Bağdadi structures, uprights, intermediate uprights and diagonals are connected to each other with laterally nailed Bağdadi slats. These laths cover the wall surface while at the same time helping to insulate and hold the filling material.

It is a fact that a great deal of knowledge, tradition, custom and a system are hidden within the apparent ordinariness of all these modest, simple traditional rural houses. Most of the craftsmen who worked on the construction of these houses are no longer alive, and those who are alive are passing away one by one. Unfortunately, they take their construction methods, traditions and customs with them. As Aran (2000: 120) states, "rural construction masters keep their methods in mind. They transfer their knowledge materials based on sensory data and the thought patterns and actions locked on them from one generation to another verbally in a master-apprentice relationship, and continue them within the common culture with traditions and customs. The method of rural builders is an unwritten

design method. In this method, traditional knowledge is not recorded as written documents or drawings." For this reason, the information to be obtained from the masters who are still alive and from these houses that are still standing but with little time left is very valuable.

5. PROTECTION ISSUES

Local architectural products, which are the most concrete examples of human-nature interaction, should be preserved and kept alive together with all the values of rural life. However, the fact that life in rural areas is not continued as in the old periods leads to the destruction of local houses and their surroundings (Eres 2016). Many rural settlements in our country, which have failed to utilize their cultural and economic potential, are dominated by the image of neglect, abandonment and neglect. Traditional houses, which are the most important elements of the local environment, are the elements most affected by this neglect. In this context, the most prominent preservation problem in the local houses in İnikli is that, as in other rural areas, due to different reasons, the houses cannot be used due to different reasons and they fall into the process of dilapidation and destruction (Figüre 37).

Figüre 37. *Examples of neglected and dilapidated houses*

The main problem here is the decline in production in the village due to changing agricultural and livestock policies and the consequent decline in economic power. This situation has caused especially the young population in İnikli not to want to stay in the village. The lack of adequate initiatives to support life in the village and the lack of financial support from local governments have accelerated the migration of people living in the village to Iznik or Bursa, an industrialized city. As a result of these factors, most of the houses, especially in the upper parts of the slope, have been completely abandoned and some of them are used seasonally. In the houses that are permanently inhabited in the village and located close to the village center,

large families have been replaced by nuclear families over time, or elderly members of the family living alone have remained. Since the traditional large family life style could not be maintained, only the spaces on the first floors of the building are used and the spaces on the upper floors have become dysfunctional. On the other hand, it is observed that the changes in social taste are also an important problem in the failure to preserve the local houses in İnikli. A significant portion of the people living in İnikli do not take any initiative to protect the village and the local houses without thinking that they have any value. On the other hand, instead of repairing their old houses, there is a tendency to demolish these houses and rebuild them in a reinforced concrete system. Therefore, houses built in the past using wood, mudbrick or stone materials and requiring constant maintenance are no longer appreciated. In this context, the important fact, which is also valid for local houses in other rural areas of Turkey, is that the traditional rural architectural environment no longer fits the lifestyle of modern people and more importantly, it is not yet acceptable in terms of social psychology. As a result, the local houses in the village settlement are abandoned and the traditional texture disappears over time. Another important problem that arises in the preservation of local houses in İnikli is that the owners of the houses that remain in the village and continue to be used by the elderly population, whose number is decreasing day by day, face economic difficulties when they want to maintain and repair their houses. The decrease in income sources and the lack of any funds or grants allocated by local governments for conservation are among the main obstacles faced by the villagers in İnikli. In addition to the lack of willingness to make repairs and economic problems, technical implementation problems are also among the problems that arise in the conservation of houses. As it is known, structures built with natural building materials such as stone, soil and wood require constant maintenance like a living organism (Eyüpgiller et.al 2016: 155). In İnikli, it is imperative to repair the earthen plaster on the exterior wall surfaces of the houses every year in order to increase the resistance of the structure against climatic conditions. Failure to plaster the facades of the buildings, and as the earthen plaster on the surface falls off, stone walls with mud mortar and wooden frame walls filled with mudbrick are exposed, causing them to become dilapidated and lose their load-bearing qualities in a short time. Preparing adobe soil and repairing plaster are difficult and labor-intensive tasks. When the owner of the house wants to repair the house built with traditional techniques and materials or inherited by him, it is not possible in today's conditions to supply materials and find a master to work with that material. For this reason, the facades of some houses have been plastered with today's cement-based mortars, and the old and dilapidated wooden frames have been replaced with plastic-based windows and the houses have been removed from their original appearance.

In this context, the problems that arise in the failure to preserve Inikli houses are generally;

1. Abandonment, neglect, neglect and indifference as a result of economic and technical inadequacies,

2. Changes in social taste, as a result of which it is perceived as a low level of social perception for young people, especially those living in the village, to live in houses they consider old. Therefore, the desire to demolish the original house and replace it with a new building in reinforced concrete style or to renovate the house with interventions using today's modern materials,

3. Insufficient understanding of the historical and cultural value of local houses and lack of awareness about the need to protect cultural heritage,

4. Lack of adequate guidance for conservation, valorization, attention and policies for conservation.

Therefore, the first thing to be done for the conservation of the local houses in İnikli is to prepare an inventory of local houses, which has not been done to date. Once the inventory has been prepared and the available potential has been identified, rehabilitation projects for conservation integrated with socio-cultural development policies should be prepared and these projects should be implemented immediately.

6. CONCLUSION and RECOMMENDATIONS

The construction and living codes of the local heritage, which are obtained through centuries of experience and whose validity is tested by living, constitute the equal parts of a whole with the environmental, socio-cultural and socio-economic dimensions of sustainability. In this study, which aims to determine the information of the original values of local constructions that can be transferred to today's sustainable architecture, some basic conclusions have been reached from the analysis of İnikli Village. These are:

- Staggered placement of the houses built in a discrete order, organic and in accordance with the topography
- Space and facade organization suitable for the climate, settlement on slopes that protect the natural landscape and are compatible with the landscape, street formations where the difference in elevation is not felt,
- The front facades or garden walls of the houses define the street boundary,
- Houses are shaped in the closed outer sofa plan type and rooms are arranged around the sofa,,

- On the top floor there is an iwan between two rooms and a balcony from the iwan,
- 2 to 3 storeys,
- Use of the first floors as service spaces such as storerooms, cellars and kitchens,
- The main floor is the top floor and is used as the main living space,
- The presence of room overhangs on the main floor overhanging the street. Even if the house is two-storey or three-storey, the projection is located on the top floor,
- The presence of balcony projections on the top floor, which overhang the street a little more than the room projections and are located in the middle of the façade, differentiates these houses from the plan scheme of the Ottoman period houses,
- Symmetrical street façade layout based on the entrance gate axis,
- The windows are arranged in a certain rhythm and this rhythm is observed on the same floor and between floors,
- The use of local materials, the fact that they were built with a timber frame construction system, and that the spaces between the load-bearing systems were filled with adobe bricks.

It is understood from the construction dates inscribed on the triangular pediments on the balconies of some of the houses that the Inikli local houses, which were examined with their architectural features based on typological classification, were built in the 1940s. Although these houses were built in recent years, they are the continuation of the Ottoman 19th century rural housing architecture in terms of plan schemes, use of local materials, space design and construction techniques. As seen in the İnikli example, it is seen that in many rural areas of Anatolia whose settlement dates back to the Ottoman period, the housing culture of the previous period was continued for a while with its general characteristics.

İnikli is one of the rare local examples that have survived intact. However, the studies carried out here show that these houses and the original texture, which have survived until today, are in danger of disappearing due to reasons such as abandonment and neglect. It is necessary to repair these houses, which were built by rural builders with a design approach whose method is not written and drawn, as soon as possible, and to carry out studies that will enable them to continue their lives with their original function or by re-functionalizing them. In addition, all measures identified as reasons for the lack of preservation should be taken and implemented immediately. For this purpose, it is possible to list the necessary actions to

be taken based on the analysis and determinations as follows.

- The region should be declared a protected area and conservation zoning plans should be prepared. In the conservation plans; besides the preservation of the street texture and residences, works such as squares, street sanitization, landscaping arrangements along the stream should be carried out. Local and economic vitality should be ensured by designing open and closed spaces with functions such as sitting, resting, dining, shopping where local products are exhibited.

- An inventory of the civil architecture buildings that constitute the local architecture should be made, and all original houses should be registered and taken under protection.

- Buildings should be evaluated as cultural assets, structurally strengthened, and all necessary resources should be mobilized to transfer them to the future with their original features through radical repair works.

- For this purpose, survey drawings and restoration projects based on identification and documentation of the houses should be prepared. Designs for re-functionalization such as local product sales, restaurants and accommodation should be made for the houses. A cultural road should be created from İznik to İnikli, and touristic programs and organizations for sightseeing, food and accommodation should be organized in order to ensure that visitors coming to İznik also come here.

- Reinforced concrete houses built in violation of the texture should be expropriated and demolished and rebuilt in a wooden frame system in accordance with the local texture,

- In addition, necessary restoration works should be carried out to restore the houses that have lost their original form as a result of interventions made with today's materials,

- Efforts should be made to reveal and keep alive the food, clothing and other local cultures.

Although İnikli has a rural life atmosphere that seems to be far from the city today, it can contribute to the development of local tourism with a bridge between it and İznik. On the other hand, as seen in the example of İnikli village, when the houses in different rural regions of Anatolia are examined, it is seen that each of them has its own unique local character. It is a cultural necessity to preserve the rural architectural building stock, which is a document that conveys the socio-economic structure of the period in which it was built, common cultural values formed by traditions and customs, neighborhood relations, local architectural solutions transferred from one generation to another in a master-apprentice relationship,

and many other information, and to transfer it to the future together with its local values. For this reason, the number of similar studies should be increased in order to protect and document rural architectural heritage and to ensure the sustainability of identity values specific to local culture. Due to the lack of conservation awareness on the one hand and the lack of attention to such studies in the context of architectural research on the other, this rich cultural accumulation has entered the process of extinction without being comprehensively learned. It can be said that today, it is an important task for scientists not only to ensure the preservation of historical villages and rural houses, but also to document the last examples reflecting this architectural culture in detail and turn them into usable information. Therefore, as in the case of İnikli, local houses and life culture should be preserved and kept alive with all their values.

REFERENCES

1. Aran, K., (2000). *Barınaktan öte Anadolu'da kır yapıları,* Ofset Publishing, 12-15

2. Çekül Vakfı, (2012). *Anadolu'da Kırsal Mimarlık.* http://library. atilim.edu.tr/shares/library/files/e-kitap/AnadoludaKirsalMimarlik- E book.pdf, Date of Access: 14 March 2022.

3. Eldem, H. S. (1986). *Türkevi.* Volüm 1, TAÇ Foundation, İstanbul.

4. Eminağaoğlu , Z., Çevik, S. (2006), Doğa-Kırsal Yerleşmeler Birliktelikleri, Kafkas University Artvin Faculty of Forestry Journal 7(1), 28-40.

5. Eminağaoğlu , Z., Çevik, S. (2007). Kır¬sal Yerleşmelere İlişkin Tasarım Politikaları ve Araçlar, Gazi University Faculty of Engineering and Architecture Journal,22 (1), 157- 162.

6. Eres, Z. (2016). Türkiye'de Geleneksel Köy Mimarisini Koruma Olasılıkları. *Journal of Ege architecture,* January, 8-13.

7. EOKUL, (2014). www.eokulbilgi.com/marmara-bolgesi-haritasi, E.T. Date of Access: 15 April 2023,

8. Eyüpgiller, K.K. Topçubaşı, M. Yaylalı, İ. (2016). Darende'de Geleneksel Ev Mimarisi ve Korunması.Arkeoloji ve Sanat Publishing, 159-166.

9. Günay, R. (1998). *Türk Ev Geleneği ve Safranbolu Evleri.* Yem Publishing, İstanbul.

10. GÜR, Ş.Ö. (2000). Doğu *Karadeniz Örneğinde Konut Kültürü.* Yapı Endüstri Merkezi Publishing, İstanbul.

11. Hersek, Can M. (2000). *Safranbolu Yörük Köyü, Geleneksel Yaşam Biçimi ve Evleri.* Yörük Foundation, Kuban Publishing, Ankara.

12. ICOMOS (2013). Türkiye Mimari Mirası Koruma Bildirgesi 2013. http://www.icomos.org.tr/Dosyalar/ICOMOSTR_ 0623153001387886624.pdf , Date of Access: 11 March 2022.

14. Kuban, D. (1995). The Turkish Hayat House. Eren Publishing. İstanbul.

15. Oliver, P. (1978). Why Study Vernacular Architecture. "Built to Meet Needs Cultural Issues in Vernacular Architecture, Elsevier Ltd., UK, 3-16.

16. Orhun, D. (1999). Türk Evi mi Yaşamada Tümleşik Ev mi, TMMOB Chamber of Architects Osmanlı Mimarlığının 7 yüzyılı, YEM Publishing, İstanbul.

17. Ovalı, K. P., Delibaş, N. (2016). Yerel Mimarinin Sürdürülebilirliği Kapsamında Kayaköy'ün Çözümlenmesi, *Megaron Journal* 11(4), 515-529, DOI: 10.5505/megaron, 2016.44711.

16. Rapoport, A., (1969). *Housa Form and Culture.* Foundations of Cultural Geography Series, Englewood Cliffs, N.J.: Prentice Hall. USA, 46-47.

18. Rudofsky, B. (1965) *Architecture Without Architects: A Short Introduction to Non-Pedigreed Architecture.* Newyork, Doubleday&Company, Inc.

19. Sözen, M., Eruzun, C., Anadolu'da Ev ve İnsan, Real Estate Bank Publishing, 1996.

20. Uluengin, N.Y. (2000). *Osmanlı -Türk Sivil Mimarisinde Pencere Açıklıklarının Gelişimi.* YEM Publishing, İstanbul.

21. Uluengin, F. Uluengin, B. H. Uluengin, B.H. (2001). *Osmanlı Anıt Mimarisinde Klasik Yapı Detayları.* YEM Publishing, İstanbul.

22. Vellinga, M., Oliver, P., Bridge, A. (2007). *Atlas of Vernacular Architecture of the World.* New York, Scotprint.

23. Yüksek, İ. (2005). Kırklareli Geleneksel Konutlarında Pencerelerin Karakteristik Özelliklerine Yönelik Bir Çalışma. Trakya University Journal of Science, 6 (2), 17-26

24. Yürekli, H. Yürekli, F. (2005). Türk Evi, Gözlemler-Yorumlar. Yapı Kredi Publishing, İstanbul.

ARCHIVE DOCUMENTS

Document 1. BOA. NFS-D. 86/43.

Document 2. BOA. TMT-D. 08280

Document 3. Hüdavendigar vilayeti salnamesi, 1907-1908, sf:140

Document 4. Hüdavendigar vilayeti salnamesi, 1927, sf:156

Author Note: Architectural drawings and photographs not cited in the study were made by the author.