University of West Attica

School of Administration, Economic, and Social Sciences

Department of Accounting & Finance

M.Sc. in Public Economics and Policy

Combating Climate Change: An Evaluation of Municipal Plans in Greece's most Densely Populated Regional Unit

Filippos Eleftherios Priniotakis

Master Thesis submitted to the Dept. of Accounting & Finance of the University of West Attica in partial fulfillment of the requirements for the degree of M.Sc. in Public Economics and Policy

Aigaleo, Greece, 2024

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Πανεπιστήμιο Δυτικής Αττικής

Σχολή Διοικητικών, Οικονομικών και Κοινωνικών Επιστημών

Τμήμα Λογιστικής & Χρηματοοικονομικής

Π.Μ.Σ. Δημόσια Οικονομική & Πολιτική

Καταπολέμηση της Κλιματικής Αλλαγής στην Αθήνα: Αξιολόγηση των Δημοτικών Σχεδίων στην πιο πυκνοκατοικημένη Περιφερειακή Ενότητα της Ελλάδας

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Διπλωματική Εργασία υποβληθείσα στο Τμήμα Λογιστικής & Χρηματοοικονομικής του Πανεπιστημίου Δυτικής Αττικής για την απόκτηση Μεταπτυχιακού Διπλώματος Ειδίκευσης στη Δημόσια Οικονομική και Πολιτική

Αιγάλεω, 2024

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In honor of the remarkable women and men who have passed and who, with imagination and courage, dedicated their lives to protect the environment and unite people.

Acknowledgments

My deepest gratitude goes to the brilliant people who supported me throughout my Master's journey and beyond. Without their unwavering support this thesis would not have been possible. I am especially fortunate to have had Dr. Andreas Alexopoulos as my supervisor. His invaluable support and insightful guidance were instrumental throughout my Master's journey. I am also immensely grateful to Dr. Alina Hyz, the program director, whose constant encouragement propelled me forward on my academic journey, inspiring me all along the way. A heartfelt thanks to the exceptional staff and faculty of the Department of Accounting and Finance.

I would also like to express my appreciation to my fellow classmates for the stimulating discussions that challenged my thinking and pushed me to excel. My sincere gratitude goes to my friends outside of class- Foti and Pano you've inspired me to become a better person and pursue my dreams.

To my family, Giorgos, Dimitra, Natalie, Efraim- thank you for allowing me to grow and change. Every aspect of my life is enriched by your unconditional love. Heg. Macaria- thank you for always believing in me.

“Combating Climate Change in Athens: An Evaluation of Municipal Plans in Greece’s most Densely Populated Regional Unit”

Abstract

. Climate change is a major challenge of contemporary societies. High population density and rapid urbanization serve as a significant driver that fuels climate change. This study evaluates the quality of municipal climate change action plans in Greece, a country facing heightened vulnerability to the impacts of climate change. Greece is increasingly threatened by its effects, with prolonged floods, devastating wildfires, suffocating air quality, high temperatures and extreme weather events that severely affect the quality of life of the urban setting. Additionally, the Athenian context incorporates the second most densely populated region in Europe. Climate change action plans serve as a substantial initiative for addressing the issue for local governments. However, plan quality evaluation is a relatively new concept for the Greek context, with no prior studies practicing the discipline in the specific field. This paper stands as the first plan quality evaluation for municipal climate change plans in Greece. Utilizing content analysis and a binary scale, the paper adopts certain criteria and identifies the absence and presence of the relevant indicators. Consequently, the strengths and weaknesses of the plans are revealed and a comprehensive comparison through literature review suggest that there are various areas for improvement concerning the Greek climate change action plans, such as a weak factual foundation and an emphasis of mitigation at the expense of adaptation strategies.

Keywords: Climate Change, Sustainability, Climate Change Action Plans, Plan Quality Evaluation, Indicators, Population Density, Urbanization.

“Καταπολέμηση της Κλιματικής Αλλαγής στην Αθήνα: Αξιολόγηση των Δημοτικών Σχεδίων στην πιο πυκνοκατοικημένη Περιφερειακή Ενότητα της Ελλάδας”

Περίληψη

Αυτή η ερευνητική εργασία αξιολογεί την ποιότητα των δημοτικών σχεδίων δράσης για την κλιματική αλλαγή στην Ελλάδα, μια χώρα που αντιμετωπίζει αυξημένη ευπάθεια στις επιπτώσεις της κλιματικής αλλαγής. Η κλιματική αλλαγή αποτελεί μια από τις σημαντικότερες προκλήσεις της σύγχρονης κοινωνίας. Η υψηλή πληθυσμιακή πυκνότητα και η ταχεία αστικοποίηση είναι κινητήριες δυνάμεις που τροφοδοτούν την κλιματική αλλαγή. Η Ελλάδα απειλείται ολοένα και περισσότερο από τις επιπτώσεις της, με παρατεταμένες πλημμύρες, καταστροφικές πυρκαγιές, ασφυκτική ποιότητα του αέρα, υψηλές θερμοκρασίες και ακραία καιρικά φαινόμενα που επηρεάζουν σοβαρά την ποιότητα ζωής του αστικού περιβάλλοντος. Επιπλέον, οι περιφερειακές ενότητες της Αθήνας χαρακτηρίζονται ως οι πιο πυκνοκατοικημένες περιοχές στην Ευρώπη. Τα σχέδια δράσης για την κλιματική αλλαγή χρησιμεύουν ως ουσιαστική πρωτοβουλία για την αντιμετώπιση του ζητήματος από τις τοπικές κυβερνήσεις. Ωστόσο, η αξιολόγηση ποιότητας σχεδίων είναι μια σχετικά νέα έννοια για το ελληνικό πλαίσιο, δίχως να υπάρχουν προηγούμενες μελέτες για τον συγκεκριμένο τομέα. Η παρούσα εργασία αποτελεί το πρώτο σχέδιο αξιολόγησης ποιότητας δημοτικών σχεδίων για την κλιματική αλλαγή στην Ελλάδα. Χρησιμοποιώντας ανάλυση περιεχομένου και δυαδική κλίμακα, η εργασία υιοθετεί ορισμένα κριτήρια και εντοπίζει την παρουσία και απουσία των προκαθορισμένων δεικτών. Κατά συνέπεια, αποκαλύπτονται τα δυνατά και αδύναμα σημεία των σχεδίων. Η διεξοδική σύγκριση των αποτελεσμάτων της ανάλυσης περιεχομένου με τα ευρήματα της βιβλιογραφίας αποκαλύπτουν διάφορους τομείς που χρήζουν βελτίωσης στα ελληνικά σχέδια δράσης για την κλιματική αλλαγή, όπως η αδύναμη τεκμηρίωση και η έμφαση σε στρατηγικές μετριασμού σε βάρος των στρατηγικών προσαρμογής.

Glossary

UN	United Nations
GHG	Greenhouse Gas
UN DESA -	United Nations's Department of Economics and Social Affairs
WCED -	Western Cape Education Department
UNCED	United Nations Conference on Environment and Development
MDGs	Millennium Development goals
SDGs	Sustainable Development Goals
kWh	Kilowatt-hours
US	United States
PPM	Parts Per Million
GDP	Gross Domestic Product
UHI	Urban Heat Island phenomenon
EU	European Union
CO2	Carbon Dioxide
$CH4$	Methane
$N2O$	Nitrous Oxide

OECD	Organization for Economic Cooperation and Development
LMIC	Low Middle Income Countries
ELSTAT	Hellenic Statistical Authority
ECNs	Electronic Communication Networks
DG CNECT	Directorate-General for Communications Networks, Content and Technology
DG JRC	Directorate-General for Joint Research Team
ISO	International Organization for Standardization
ETI	European Telecommunication Institute
ITU	International Telecommunications Agency
U4SSC	United for Smart Sustainable Cities
ICTs	Information and Communication Technologies
LEED	Leadership in Energy and Environmental Design
UCI	Urban China Initiative
MGI	McKinsey Global Institute
IUCN	International Union for Conservation of Nature
CR	Endangered

EN	Endangered
VU	Vulnerable
NT	Near Threatened
LC	Least Concern
DD	Data Deficient
NE	Not Evaluated
RLI	The Red List Index
IAS	Legislation Targeting Invasive Alien Species
SWOT	Strengths Weaknesses Opportunities Threats
HFCs	Hydrofluorocarbons
ΣΠΑΥ	Ymittos Protection and Development Association

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CHAPTER 1

Introduction

"Don't be boggled by totality: We're here to save the world without exception. it will serve"

Heather McHugh

1.1 Background and Context

Climate change stands as a defining challenge of our time, impacting life on Earth across the globe. It is not merely the prosecutor of devastating events that severely disrupt Earth's delicate ecological equilibrium. Calamitous floods, biodiversity loss and a cascade of irreversible consequences are not distant threats, but potential realities fueled and amplified by climate change (VijayaVenkataRaman *et al.*, 2012).

Despite not always being the case (Ones and Dilchert, 2012), decades of research from around the world categorically defend the presence and severity of climate change and the fact that human activity significantly accelerates its pace. While being relatively new to the earth's ecosystem, humanity's brief tenure has been profound (VijayaVenkataRaman *et al.*, 2012).

Sustainable urbanization and development has emerged as a prominent research area in recent years. This surge in interest is primarily driven by unprecedented population shifts, with people rapidly migrating from rural areas towards larger urban settings (Michalina *et al.*, 2021). According to the 2018 Revision of World Urbanization Prospects document, published by the United Nations, an approximate 55% of the world population lives in urban areas. The urban population surpassed the number of 751 million people in 1950, secured a percentage of 4.2 billion people in 2018 and it is now believed to reach 6.7 billion or 68% of the world population by 2050 (United Nations, 2018). By the end of 2018, humanity reached a milestone where more than half of the population inhabited urban areas (World Health Organization, 2019). However, recent scientific evidence overturn previous assumptions, showing the 2018 data significantly underrepresents

reality. The new estimations reveal a surprisingly high level of urbanization around the world. According to this new standard, a staggering 76,5% of the global population was already living in urban centers in 2015 (Hellenic Republic, 2021)- a number significantly higher than the previous estimates which placed the urbanization rate approximately at 55%. Thus, it is a common realization, among the relative researchers, that the 21st century is going to be characterized as an urban century (Nazarian *et al.*, 2022).

Urbanization, particularly high population density and rapid growth patterns, are recognized as a primal driver of climate change (De León Barido and Marshall, 2014; IPCC, 2014). This trend is projected to continue to accelerate, with estimates suggesting a potential 25% increase in global emissions at the end of the century (O'Neill *et al.*, 2010).

However, the socioeconomic potential of urbanization cannot be ignored. There are several researchers defending the positive impact of urban development in major cities by highlighting the potential health benefits compared to the rural areas (Jiang *et al.*, 2021; Zhang, 2012). The researchers argue that cities can provide the opportunity of higher quality of life by their ability to concentrate resources and infrastructure that lead to improved access to healthcare, education and essential services (Phillips, 1993; Kabisch *et al.*, 2017; Zhou, *et al.*, 2015).

Greece, as a mediterranean country with a vast coastline, faces significant vulnerabilities due to climate change (OECD, 2020) and is particularly susceptible to rising temperatures and increased frequency and intensity of extreme weather events (Koundouri, 2023). Greece faces major issues such as rapid urbanization and urban sprawl which exacerbate the challenge (Valavanidis and Vlachogianni, 2011; OECD, 2020).

Athens is now characterized as one of the most densely populated cities in Europe. According to Eurostat, Central Athens Regional Unit is the second most densely populated region in Europe (Eurostat, 2020), with 11.796,14 inhabitants per square kilometer (ELSTAT, 2021), following Paris. According to Athens's official climate change plan (Municipality of Athens, 2021), the city is characterized by dense, haphazard construction compromising the quality of life of the citizens in many aspects. More specifically, the Athenian climate action plan identifies that high population density along with unsustainable urban development has led to the emergence of the urban heat island phenomenon that has detrimental effects in the society and is estimated to significantly lower the quality of life more intensely in the following years.

The implementation of decentralization strategies in Greece has empowered regional authorities to become key actors in developing action plans. This enhanced role is critical for achieving any form of sustainability (OECD, 2020).

In contrast, after a thorough literature review, it appears that there is no plan quality evaluation for the Greek context.

Constant evaluation and assessment of government plans is regular practice in the global context (Berke *et al.*, 2006). The establishment of robust evaluation criteria is a prerequisite for considering planning a bona fide discipline. Such criteria would enable the differentiation between high-quality plans who demonstrate effectiveness in achieving their objectives, and those which fall short (Alexander and Faludi, 1989).

It is a broad consensus that a successful execution of an adopted plan possesses the inherent capacity to significantly impact the community's well-being across various dimensions, ultimately resulting in an enhanced quality of life. After all, for planners, effective planning constitutes a cornerstone tool that allows the jurisdiction to strive for growth and development (Dalton *et al.*, 1989).

The evaluation of plan quality has emerged as a prominent area of research, with a notable expansion in the scope and sophistication of methodologies employed in recent years (Horney *et al.*, 2016; Stevens, Lyles and Berke, 2014). Seminal works by Berke & Godschalk (2006), Baynham & Stevens (2013) and Baer (2007) have been particularly influential in shaping the field of plan quality evaluation.

1.2 Purpose, Research Problem Statement, Hypothesis and Objectives

Climate change action plans are increasingly crucial for municipalities worldwide. However, there isn't a single study that evaluates the quality of climate change municipal plans within the Greek context. This study aims to bridge the gap by conducting the first comprehensive evaluation of the quality of climate change municipal plans for the Central Athens Regional Unit. By analyzing these plans through a rigorous framework, this research seeks to identify the strengths, weaknesses and areas of improvement, ultimately contributing to the development of more effective climate change action plans. Consequently, the research is designed to answer the following central research question:

- How do the municipal climate change plans within the Central Athens Regional Unit measure up against established criteria for plan quality?

Greece is defined by heightened vulnerability in climate change. At the same time, the Central Athens Regional Unit boasts the highest population density in Greece and ranks second in the entire Europe. Scientific evidence suggests that high population density is one of the substantial drivers that fuel climate change. This research identifies population density as a primal factor that contributes to climate change (as shown in the literature review) and aims to detect whether the Athenian context offers satisfiable public awareness on the matter.

This study investigates the following research sub-questions:

- To what extent do the municipalities of the Central Athens Regional Unit foster public awareness regarding the impacts of population density?

To effectively reach a comprehensive and well-supported conclusion, this study pursues the following objectives:

I. Literature Review
   A. Examine the involving concept of environmental sustainability and its significance in contemporary society.
   B. Analyze the environmental and socio-economic impacts of climate change.
   C. Investigate mitigation and adaptation strategies for addressing climate change.
   D. Identify specific vulnerabilities of climate change in the Greek context.
   E. Explore the benefits and drawbacks of population density and urbanization from various aspects.
   F. Examine the demographics and administrative divisions of Greece.
   G. Probe the plan quality evaluation framework.
   H. Create a synopsis of the most cited characteristics of the plan quality evaluation framework.
   I. Investigate the most cited quantitative indicators for climate change.

II. Framework Development
   A. Develop a plan quality evaluation framework tailored to the Central Athens Regional Unit.

B. Adopt a well-established set of qualitative indicators for plan quality evaluation.
C. Design additional quantitative indicators to address specific gaps relevant to the Central Athens Regional Unit context.

III. Plan Quality Evaluation
A. Gather the municipal climate change plans of the Central Athens Regional Unit.
B. Evaluate the municipal climate change plans within the Central Athens Regional Unit using the developed framework.
C. Analyze the plans to identify strengths, weaknesses and areas of improvement.
D. Compare the plans of different municipalities within the region to assess consistency and effectiveness in addressing climate change and population density challenges.

Finally, the paper is based on the following hypotheses:

I. Municipalities with larger populations are more likely to incorporate a plan dedicated to climate change than municipalities with lower population numbers due to the fact that the effects of climate change are more present in urban settings (as discovered in the literature review).
II. Municipalities with higher population numbers may have more robust climate change plans due to greater urgency to address climate change as well as the availability of resources in the specific context.
III. The examination of quantitative indicators can provide the research with a more comprehensive set of qualitative indicators.

1.3 Methodology

The research consists of two main steps. The first one is to identify the key urban environmental and climate change challenges. In order to achieve that- a comprehensive literature review of scientific literature and gray literature will be carried out. Consequently, the key urban environmental and climate change challenges are going to

be identified and finally, the connection between the densely populated cities and environmental unsustainability is going to be addressed.

The second main step is to conduct the evaluation of the municipal climate change plans. After outlining the eight main plan evaluation characteristics used, relevant climate change indicators will be gathered from existing studies. In order to ensure a comprehensive evaluation, these indicators are going to be carefully analyzed in a previous section of the literature review, ensuring a selection of the most appropriate ones. Moreover, additional indicators are going to be designed in order to cover possible gaps and align the research with the Central Athens Regional Unit context and the paper's framework. Finally, the coding and analytical techniques of the research will be established, paving the way for a thorough evaluation of the municipal climate change plans.

For the establishment of a coding protocol, this study will employ a binary scoring system to evaluate the quality of municipal climate change plans (Berke *et al.*, 2006; Guyadeen, Thistlethwaite and Henstra, 2018; Stevens, 2013; Donoghue and Katz-Rosene, 2023; Horney *et al.*, 2016b). Each indicator within the evaluation framework will be assigned a score of "0" if absent and "1" if present.

Following the initial coding, an overall score will be calculated for each characteristic. This is going to be achieved by summing the individual scores for each indicator and then normalizing them with the total number of indicators (n) within the characteristic. The process will result in a score ranging from 0,00 to 1,00, where a value closer to 1,00 will signify a more comprehensive characteristic than the one closer to 0,00.

Finally, the overall score for each municipal plan will be determined. The calculation refers to the summation of the scores of each characteristic and then the normalization of the result to the total number of characteristics (8). The final score will measure the strength and comprehensiveness of the plan.

Consequently, each plan will receive three scores: scoring for each indicator, scoring for each characteristic, overall score of the plan. The *Results* section will present the findings and the data analysis and the *Discussion* section will provide deeper insights.

1.4 Structure of the Thesis

The paper will be divided into the following sections:

Chapter 1. Introduction

The first chapter provides the essential background information and existing knowledge in the field. Furthermore, it clearly identifies the research problem and outlines the specific question the research seeks to answer and the hypotheses it aims to test by providing detailed goals and objectives. Subsequently, the chapter provides a short description of the methodology that the paper aims to employ and finally, the chapter addresses the organization of the report and offers a brief overview of the remaining chapters.

Chapter 2. Sustainability and the Environment

The second chapter delves into the core ideology of sustainability. It begins by exploring the three fundamental cornerstones that underpin this concept. Upon completion, the chapter specifically investigates environmental sustainability, a critical element that lays groundwork for the analysis of climate change in the following chapter.

Chapter 3. Climate change

The third chapter investigates the multifaceted challenges of climate change. It systematically categorizes the environmental and economic effects of the issue and identifies a certain gap in between the disciplines. Subsequently, it analyzes the mitigation and adaptation strategies and finally, it outlines the environmental challenges and public policy in the Greek context.

Chapter 4. Densely Populated Cities and Urbanization

The fourth chapter addresses the impacts of population density and urbanization. It provides a comprehensive review of various existing studies exploring both the potential benefits and drawbacks of high population density and urbanization. Finally, it outlines the environmental implications of high population density.

Chapter 5. Demographics and Administrative Divisions

The fifth chapter explores the geographic data and the demographic makeup of the Greek context. Finally, it outlines the administrative divisions and focuses specifically on the regional units within the Attica region.

Chapter 6. Plan Quality Evaluation Framework

The sixth chapter investigates the plan quality evaluation as a discipline. It provides a synopsis of the most cited characteristics. Finally, it establishes the difference between the qualitative and quantitative climate change indicators and specifically examines and summarizes the quantitative indicators.

Chapter 7. Summary of the Literature

The seventh chapter provides a summary of the literature review and presents a concise overview of the key findings. Consequently, it discusses the implications of each finding and paves the way for the research to be conducted.

Chapter 8. Methodology

The eighth chapter establishes the research area and presents the sampling strategy and data collection. Finally, it provides an extensive analysis of the research approach.

Chapter 9. Analysis and Findings

The ninth chapter begins by systematically presenting the results. Furthermore, it lays out a comparative analysis of the performance of each municipality and establishes a critical bridge between the research questions, hypotheses, literature review findings and the municipal plan performances. Finally, the chapter acknowledges the limitations of the current research and provides potential avenues for further exploration.

Chapter 10. Conclusion

The tenth and last chapter culminates the entire thesis and draws together the key findings and broader significance. Finally, the conclusion presents a concise, yet impactful statement.

CHAPTER 2

SUSTAINABILITY AND THE ENVIRONMENT

"The way in which we experience and interpret the world obviously depends very much indeed on the kind of ideas that fill our minds. If they are mainly small, weak, superficial, and incoherent, life will appear insipid, uninteresting, petty and chaotic."

E.F. Schumacher

2.1 Sustainability

Sustainability is a major concept of today's way of thinking. It certainly makes the argument to be considered an ideology (Thiele, 2016) or a movement (Caradonna, 2022), while being almost worldwide accepted, endorsed and embraced amongst the greatest ideals, such as democracy and human rights. In a time when civilisations fall and economies decline, in the age where global climate change rapidly increase (European Commission, 2021) and basic human rights cease to exist, sustainability aims to tackle the world's most crucial issues and learning to leave sustainable becomes the biggest challenge of our times, demanding groundbreaking and revolutionary science (Thiele, 2016).

Sustainability touches many different fields and can be studied, explained and be used in a plethora of ways. An important fact to consider while studying or analyzing the term is that the main areas of sustainability are interrelated, support one another and simultaneously co-exist in each other's favor or failing in each other's behalf (Placet, Anderson and Fowler, 2005; Caradonna, 2022). At the same time, it is worth noting that although it is crucial and sometimes mandatory to consider numerous areas at the same time, it is arguably complicated and most of the time, the related research fields lack evidence and data. Despite the fact that high-level quality evidence does exist and can be found occasionally, there is still much uncertainty surrounding categories such as urban green, income inequality, well-being, (physical or other) health etc. (Ahlfeldt and Pietrostefani, 2019).

In recent years, the term "sustainability" has been widely used by global society (Caradonna, 2022). Sometimes the meaning of sustainability has been misinterpreted, addressing a product (whether that means a material, a business or a city) exclusively for its environmentally friendly behavior (Heinberg, 2010). Some argue that the concept of defining sustainability lacks accuracy as it misdirects the reader and forms the problem as definitional, rather than a prediction of what will actually last in an undefined period of time. Concurrently, it misses to account the range of interrelated time and space that a preferred etymology needs to address (Costanza and Patten, 1995).

Understanding the word as it is- should be quite straight-forward. The term originates from the Latin word "sustinere" which literally means "to sustain". Thus, the idea should be simple: *a sustainable system is one which survives or persists* (ibid). For the researchers Constanza & Patten b. (1995), the definition raises three questions.

A) When?

To be precise, in order to evaluate if a system is sustainable today, one must wait until tomorrow. That can give us a more comprehensive understanding of the term as it implies that in a perfect state the product should complete its life cycle in order to be assessed and be characterized for its sustainability. That is not what most available research shows us. To that end, a more accurate theory is that what is assumed as the definition of sustainability, is simply a prediction of actions that are applied today, hoping that they will eventually lead to sustainability.

B) How long?

The researchers argue that when one characterizes a system as sustainable, it should be under an analysis that takes into consideration the time span involved. An organism, whether that is a living organism, a strategic plan, a city or the whole universe, could never be infinite. Therefore, sustainability has a life span that is consistent with the system's time and space scale. For example, a human being has a life expectancy which can be estimated by numerous criteria. There are health systems developed with a prospect of expanding this life span. Those systems are acknowledging the time range and space scale. With this knowledge, a system can have the necessary information that is needed before being assessed for its sustainability.

C) What system?

As previously mentioned, sustainability does not answer to one thing exclusively. Indeed, there are many areas of sustainability that are interrelated and have fundamental influence to each other but still, when evaluating a system for its sustainability, there is a

need for focus. That being said, a system that aims to be sustainable, whether it's an economic, ecological, political or social system (etc.) needs to be addressed and be given focus, respectfully to other related areas.

But why is the term so present in today's society? Although it may look like sustainability is an invention of our times that was crafted in order to solve or minimize mistakes made by humanity, the truth lies somewhere within. The urge to live sustainably does not originate from today's society, but rather from ancient times (Thiele, 2016). Despite the fact that, the term has gained form, recognition and a place in our vocabulary, in no more than three decades ago, the motivation to live effectively and valuably while providing the opportunity for the next generations to thrive and prosper, stems from the human nature, biologically and spiritually since the beginning. In recent years sustainability has been embedded directly or indirectly in culture, economy, policies, innovations within businesses, lifestyles, ideologies and has received global endorsement (ibid.)

Considering that, and while examining historical records, we can identify several behaviors that pointed towards sustainable practices. More specifically, there were indigenous tribes living in upper New York, such as the Iroquois Confederacy, that implemented the "Gayanashagowa", or the better known as the "Great Law of Peace", where the chiefs were obligated to take into consideration up to the seventh generation to come, before taking any major decision (Heinberg, 2010). Studies seem to agree that the the word "Nachhaltigkeit" or sustainability in english, was publicly addressed for the first time in 1712, by the German forester and researcher Hans Carl von Carlowitz, in his book "Sylvicultura Oeconomica", in his effort to scientifically describe the ways that forests should be maintained in the long run (Scoones, 2007). Consequently, there were several reports that were focused on sustainability, without necessarily using the term, such as Thomas Malthus in 1798, who published his paper about mass starvation, or Harold Hotelling in 1931, who formed a theory about the exploitation of non-renewable resources (Hotelling, 1931), or Donella H. et al. who published the book "The limits to growth", successfully predicting that several resources, fundamental for our survival, would be exhausted in no more than two generations time (Meadows *et al.*, 2018). The latter led to the vastly known report, entitled "Our common future", from the (United Nations) UN' World Commission on Environment and Development, chaired by the former Norwegian Prime Minister, Gro Brundtland, in 1987. The report has been a source of influence for researchers and environmentalists throughout the world but it has also been criticized for

its lack to address issues such as the disadvantages of utilizing non-renewable resources and issues of population growth (Heinberg, 2010). The report is known for giving a definition to sustainability as following (World Commission on Environment and Development, 1962):

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development contains within it two key concepts: the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs."

UN DESA, in 2002, made the decision to evolve the definition, due to the fact that WCED's interpretation was solely focused on the environmental element of sustainability, arguably overlooking the other two or failing to consider the importance of the separation of the three cornerstones. The new, improved definition is as follows:

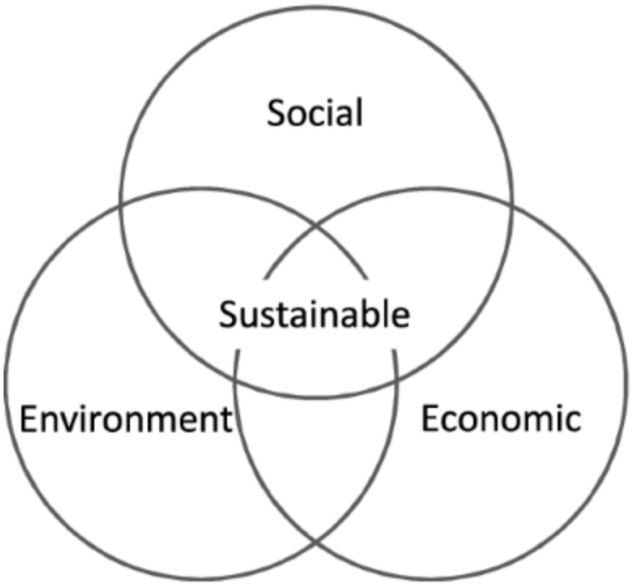
Underlying the economic component is the principle that society's well-being would have to be maximized and poverty eradicated through the optimal and efficient use of the natural resources… The social component refers to the relation between nature and human beings, uplifting the welfare of people, improving access to basic health and education services, fulfilling minimum standards of security and respect for human rights. It also refers to the development of various cultures, diversity, pluralism and effective grassroots participations in decision-making. The issue of equity, i.e., the distribution of benefits and access to resources remains an essential component of both the economic and social dimensions of sustainable development. The environmental component, on the other hand, is concerned with the conservation and enhancement of the physical and biological resource base and eco-systems.

Since this WCED report was published, there has been a global explosion of academic research and political debate towards sustainability, as well as milestone events (Scoones, 2007b), such as the one organized by the United Nations Conference on Environment and Development (UNCED) in Rio in 1992, the Millenium Development goals (MDGs) in 2000, the United Nations Conference on Sustainable Development in

2012 in Rio, the United Nations Sustainable Development Summit in 2015 who published the highly influential 17 Sustainable Development Goals (SDGs) and the Paris Agreement, which was adopted by nearly every nation worldwide, Greece included. There are numerous papers trying to enhance the definition of sustainability, such as Holling's and May's, who supported that sustainability can be understood by its ability to bounce back from shocks and stresses and adapt accordingly (Holling, 1973; May, 1977) or others who focus on "critical natural capital" (Pearce and Atkinson, 1993) or even green politics.

A growing consensus among researchers suggests a theory with a utopian dimension (instead of an exclusively environmental one) that describes the key areas of sustainability and how those areas are interconnected. Specifically, the theory posits the cornerstones of sustainability, which are environmental stewardship, social responsibility, economic prosperity (Placet, Anderson and Fowler, 2005b) and some argue that political ideals should be equally measured (Caradonna, 2022). The environmental sector (environmental sustainability), which is the one this paper aims to cover, refers to the protection of the ecosystems, the land, water, air and the sustainable management of the earth's natural resources. The social sector (social sustainability), sometimes written only as "equity", aims to improve the quality of life, equity between race, genders (etc.), equal and balanced work culture etc. The economic sector (economic sustainability), describes the economic opportunities, the systems, the strategies and the connections between stakeholders (ibid.).

We can identify this pattern by the numerous theories the aforementioned researchers have given us. Precisely, the UN World Summit endorsed a Venn diagram back in 2005 and since then the same one has appeared frequently throughout the research community and media (see Figure 2.1) (ibid.).



Source: https://link.springer.com/article/10.1007/s11625-018-0627-5

Figure 2.1

The three E's

The diagram illustrates the environmental sphere, the social sphere and the economic sphere, where only through their interconnectedness- sustainability can be achieved.

Another example is the diagram inspired by the economists Peter Victor and Herman Valy, who aspire to lay emphasis on the importance of the environmental sector which fuels the other two (see Figure 2.2).

Source: https://link.springer.com/article/10.1007/s11625-018-0627-5

Figure 2.2

The foundation of sustainability

For those economists, the only way through which the social and economic sectors are able to thrive is via the environmental one and so, the latter one needs to receive substantial acknowledgement (Hayden, 2022).

The "five axioms of sustainability", created by the leading expert Richart Heinberg, have also drawn a considerable degree of attention. The axioms are portrayed as following (Heinberg, 2010):

1) "Any society that continues to use critical resources unsustainably will collapse".
2) "Population growth and/or growth in the rates of consumption or resources cannot be sustained".
3) "To be sustainable, the use of renewable resources must proceed at a rate that is less than or equal to the rate of natural replenishment".
4) "To be sustainable, the use of nonrenewable resources must proceed at a rate that is declining, and the rate of decline must be greater than or equal to the rate of depletion".
5) "Sustainability requires that substances introduced into the environment from human activities be minimized and rendered harmless to biosphere functions".

The idea for the second axiom originates from Albert Bartlett's book "Reflections on Sustainability, Population Growth and the Environment" where the researcher addressed the issue behind population growth and unsustainability (Bartlett, 1994). Richard Heinberg respectfully adopted the idea and completed the important "five axioms". The second axiom is also crucial for this paper, as it addresses topics relevant to the issues faced by densely populated cities, such as Athens (further discussion in later chapters).

2.2 Environmental Sustainability

Humanity must harmonize with the fact that life should be within the limitations of the biophysical environment (Goodland, 1995). There has been a lot of research in the last decades focused on changing political will and human behavior in order to address the challenge of adapting to biophysical limitations to ensure long-term societal, ecological and economic well-being. It is true that countries who make progress on achieving sustainability, instead of liquidating their resources, are expected to be more peaceful than the ones who do not sustain themselves. On the contrary, countries who are unable to

sustain their strategies, liquidating their own natural capital or even, relying on the supply of other countries who liquidate their own capital, are more prone to wage wars than the sustainable economies (ibid.)

Environmental sustainability as an ideal is non-negotiable and hard to debate for the academic society (Goodland and Daly, 1996). The fact that earth's resources are limited is a recognized principle and the acknowledgment of scarcity is a pillar to the economic studies (Sowell, 2015). Thus, the degradation and unsustainable consumption of non-renewable resources, as well as the exhaustion of renewable resources to a degree higher than the regeneration rates will undoubtedly deplete the natural resources to their limits- if not in the near future, then unquestionably in the long term (Ones and Dilchert, 2012). The reality is that the earth's natural resources, water, air, energy, arable land, biodiversity and raw materials are elements vital to our existence, our survival and well-being (ibid.). Nonetheless, recent economic behavior shows us that being "green" leads to successful business and should be adopted and applied to public and private businesses, strategic plans, economic and management thinking and households (Holme and Watts, 2000).

According to Robert Goodland, environmental sustainability "seeks to improve human welfare by protecting the sources of raw materials used for human needs and ensuring that the sinks for human wasting are not exceeded, in order to prevent harm to humans". The researcher approached the concept of environmental sustainability by acknowledging the fact that economic sustainability and environmental sustainability are closely related and tried to give a definition by emphasizing the distinction between the environmental sustainability and the social sustainability. He explained that, although the cornerstones overlap with each other, it may be found useful to give separate definitions to each, in order to understand the concept of global sustainability. He focused on environmental sustainability and hoped that future research will achieve a level where all three aspects can be examined together. He explained that environmental sustainability seeks sustainable consumption as well as sustainable production and gave a definition by presenting "the source and the sink functions" as the two fundamental environmental services that are stipulated by the four major activities of the human economic subsystem (Goodland, 1995). Specifically:

- For the sink function: The waste and pollution emissions that are the aftermath of human activity need to be balanced in a way that can be assimilated by the environment without causing damage.
- For the source function:

A) It is a widely known fact that non-renewables cannot be sustained. Hence, their depletion rates should be kept to a degree where renewable substitutes can be produced.
B) The consumption of renewables should be kept to a degree at least equal to the regeneration rates.

The depletion rate measures the percentage of recourse that is being extracted and used annually, compared to the total remaining amount (Heinberg, 2010).

We can say that Daly shares the same vision as Goodland, highlighting the same three operational rules (Daly, 1990). However, despite the fact that these operational rules have paved the way to understand environmental sustainability, they lack specificity and are not explicitly quantitative (Little, Hester and Carey, 1986).

Holdren et al. explored the concept of environmental sustainability by analyzing its biogeophysical aspects (Munasinghe and Shearer, 2018). By "biogeophysical aspects" the researchers referred to the preservation and enhancement of the life supporting systems of the earth. Achieving biogeophysical sustainability ecompasses the social and economic prosperity of present and future generations, featuring cultural and biological diversity, as well as the biochemical integrity of the biosphere using sustainable practices and the correct management of water, air and land resources (Moldan, Janoušková and Hák, 2012).

"Current Opinion in Environmental Sustainability", which is a journal that gathers research and focuses specifically on concepts hovering around environmental sustainability and change, outlined the six main areas that need to be studied when analyzing the term (ibid.).

A) "Climate Systems": This area focuses topics related to climate change, mitigation, adaptation and climate risk management
B) "Human settlements and habitats": This area centers topics such as urbanization, urban and suburban sprawl, transportation and everything around cities
C) "Energy systems": This area concentrates on the many corners of energy, such as renewable energy, bioenergy, energy conservation and efficiency
D) "Terrestrial systems": This area covers the ecosystems services, the biodiversity, the food system, the natural and the managed ecosystems and the forestry

E) “Carbon and nitrogen cycles”: This area targets the sources and sinks functions
F) “Aquatic systems”: This area investigates water ecosystems fisheries and biodiversity

Our paper recognizes the six main areas suggested by the aforementioned journal and aims on addressing them via the utilization of relevant indicators. In cases where indicators that cite every of the six main areas cannot be found in the literature review, new ones will be designed. To be precise, the second area which refers to “Human settlements and habitats” had not been addressed by the scientific synopsis. Thus, our paper crafted new ones which aimed to detect urban sustainability, urban sprawl and population density. Further information can be found in the *Indicator* section of the *Methodology* chapter.

Additionally, there is research which makes progress on the concept of environmental sustainability without necessarily using the term, such as the Millennium Ecosystem Assessment Project who built on the idea and formed four categories (World Health Organization, 2005; Moldan, Janoušková and Hák, 2012b):

1) Provisioning: Within this category there is fuel, food, freshwater, wood etc.
2) Regulatory: This category describes the water purification, climate flood and disease regulation etc.
3) Cultural: This category encompasses the cultural, recreational, educational aspects etc.
4) Supporting: This category describes the soil formation, the nutrient cycling etc.

Ultimately, the scientific evidence shows us that human consumption has already exceeded earth’s regenerative capacity (Wackernagel *et al.*, 2002). In previous years, opinions were divided, with some not fully convinced about climate change and the imminent scarcity of the earth’s vital natural resources. A robust body of scientific evidence supports a clear understanding of these events- endearing a significant argument unlikely. The degradation of the natural environment, the loss of natural habitat and biodiversity, climate change, water scarcity, population growth, natural disasters, agricultural problems (e.g., loss of soil and availability of arable land), agricultural activity on local ecosystems, the declining fossil fuel reserves and the pollution data

shows us that undoubtedly, human economic activity is responsible for the large-scale degradation of the natural environment (Ones and Dilchert, 2012).

CHAPTER 3

CLIMATE CHANGE

"Adults keep saying: "We owe it to the young people to give them hope." But I don't want your hope. I don't want you to be hopeful. I want you to panic. I want you to feel the fear I feel every day. And then I want you to act. I want you to act as you would in a crisis. I want you to act as if our house is on fire. Because it is."

Greta Thunberg, at the 2019 World Economic Forum

3.1 Environmental effects of climate change

Climate change is a major issue that affects life on earth worldwide. By definition, climate change is the alteration in the long-term weather patterns that epitomize the regions of the world. The phenomenon can be observed in numerous different situations and places, such as the melting of the snow and ice, the increasingly dangerous rising of sea levels, extreme weather and other changing weather patterns (VijayaVenkataRaman, Iniyan and Goić, 2012c). Such situations can be the precursors of serious, life threatening incidents and foreshadow catastrophic events, such as devastating, major floods and the destruction of biodiversity, which ultimately, disrupt earth's ecological equilibrium and have the potential to be the prelude that triggers a cascade of irreversible consequences. Despite not always being the case (Ones and Dilchert, 2012), today science categorically defends the fact that climate change is a serious global issue that has been drastically accelerating in our age.

Scientific evidence coming from numerous parts of the world shows that human activity has tremendously worsened the rising threat of climate change and that natural climate variability alone could never provide an incentive explanation. While being relatively new to the earth's ecosystem, humanity's brief tenure has already left a devastating mark and has become a major disruptive force in earth's delicate ecological balance (VijayaVenKataRaman, Iniyan and Goić, 2012c).

Human activity has affected climate change mainly by increasing the concentration of heat-trapping gasses in the atmosphere, such as the burning fossil fuels (e.g., gas, coal, oil etc.). Unequivocal scientific data demonstrates that the relentless worsening of climate

change and the earth's rising temperature- project an acceleration at a rate that is directly linked to the continuous activity of releasing these gasses in the atmosphere. Scientific evidence and observation over the last fifty years prove that human activity is-by-far-the main source that triggers climate change. There is a belief that natural events such as volcanic eruptions, have the potential to counteract some of the anthropogenic emissions by weakening or slowing the temperature rises but evidently, natural variations would only result in temporary solutions and that only mitigation strategies of the greenhouse gas emissions (GHG) and carbon dioxide can provide long-lasting results (U.S. Global Change Research Program, 2009). Notwithstanding the fact that climate change and earth's rising temperatures have taken a possible irreversible turn and the fact that this destructive situation cannot be avoided entirely, it is humanity's duty to make a substantial effort on reducing the factors that trigger the phenomenon and tackle the primary culprit human-made greenhouse gas emissions, while striving to live and operate as sustainable as possible (VijayaVenkataRaman, Iniyan and Goić, 2012; Goodland, 1995).

That being said, the temperature rises of this century are far greater than the ones that occurred in previous centuries with the global average temperature rising by 1,5℃ since 1900 (U.S. Global Change Research Program, 2009). It is estimated that anthropogenic emissions will lead to 1,5℃ of global warming above the pre-industrial levels by the time period 2030-2050 (Ipcc, 2022), or even a rise by 2,78℃ to 6,11℃ by 2100 (U.S. Global Change Research Program, 2009), affecting a number of sectors, such as the economy, the ecosystems and health. Scientific research shows us that in order to achieve mitigation we have to follow a strategic reduction plan focused on global carbon dioxide (*CO2*) and greenhouse gas emissions (Crispino and Loberto, 2024).

It is crucial to assess the rational and communicative perspectives of climate change between the government (local or national) and the citizens (Hossu *et al.*, 2020) due to the importance of guiding public policy and influencing social trends (Crispino and Loberto, 2024). Thus, this study aims to evaluate the quality of municipal climate change plans in the context of the Central Athens Regional Unit, the most dense regional unit of Greece and the second denser region in the European Union (Eurostat, 2020b).

This paper aims on adopting indicators that will cover the main climate change challenges. According to the frequency of indicators mentioned in some of the most influential studies, the following encompass the main climate change challenges (see Table 3.1). This paper acknowledges these six main climate change challenges and will

later (in the Methodology chapter) modify them to serve as indicators for the evaluation of the climate change municipality plans of the Central Athens Regional Unit.

It is also important to mention that some of the greatest environmental challenges, such as noise pollution, are not directly related to climate change and thus, including them in this paper would be a lack of coherence. At the same time, there are other critical environmental issues, such as *marine areas degradation*, which are not related to the Central Athens Regional Unit context and will be excluded as well.

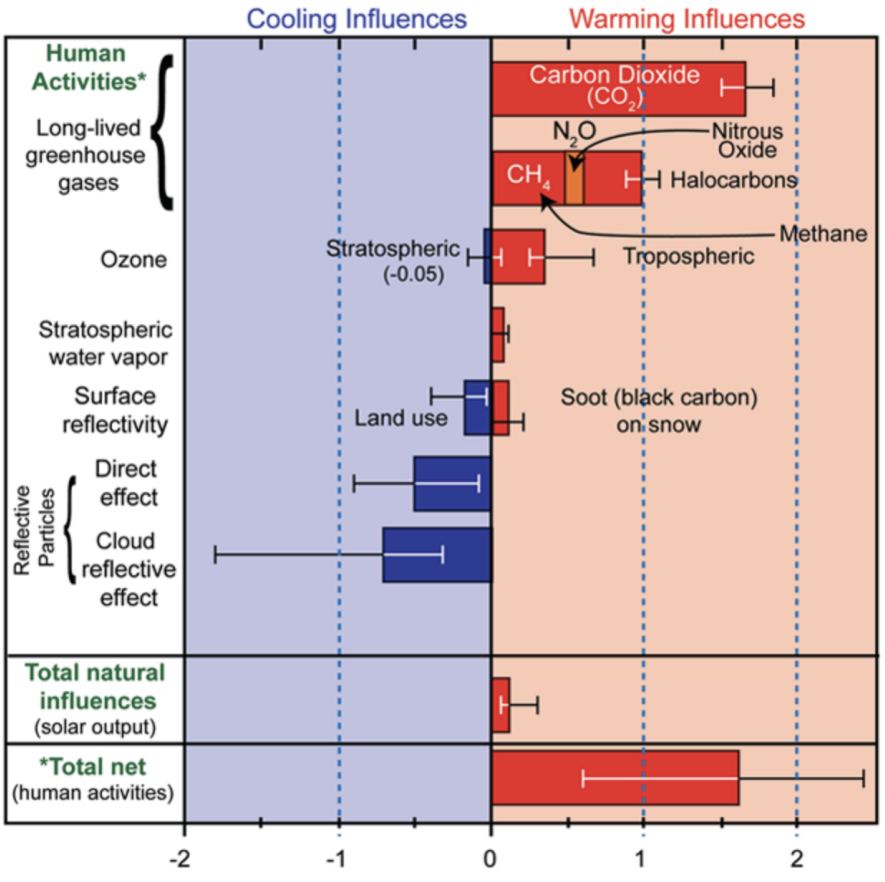
Table 3.1

Main Climate Change Challenges

Direct Climate Change	**Greenhouse gas emissions in general**
Biodiversity Loss and Natural Degradation	Land-use conversion fragments, which were once havens of biodiversity are now transforming into human-dominated landscapes. This alteration imbalances the natural biodiversity and makes them more vulnerable to extinction. At the same time, invasive alien species further disrupt the balance and natural harmony. Finally, anthropogenic unsustainable practices, such as deforestation are worsening the situation (Ayyad, 2003).
Air Pollution	A mix of chemicals and particles coming from various sources, such as vehicle fuels, forest fires. industrial facilities etc. and affecting both indoor and outdoor environments. Air pollution raises major public health concerns and contains particulate matter, carbon monoxide, ozone, nitrogen dioxide and sulfur dioxide. A considerable degree of air pollution is triggered by GHG emissions

	(World Health Organization: WHO, 2019a).
Freshwater Pollution	An estimate of 2 billion tons of contaminants enter water every day. There are several drivers of freshwater pollution, such as industrial waste, raw sewage, car usage, agricultural runoff etc. Both human life and ecosystem are heavily affected by this major issue. Each year, millions of people, particularly children, succumb to waterborne diseases. At the same time, excessive nutrients trigger algal blooms which consequently, significantly reduces the oxygen within the water and suffocates aquatic life (UN Environment Programme, 2022).
Waste Management	A holistic oversight of waste lifecycle, including every activity involved since its creation, such as the handling, processing, storaging, and transportation of waste (UN Environmental Programme, 2020).
Energy Consumption	The estimated amount of energy used. The most common way to measure it is in units like kilowatt-hours (kWh) for electricity, or even oil equivalent for numerous other energy sources (Repsol, 2023). Greece's total energy consumption is 46,18 billion kWh of electric energy, annually (Worlddata.info, 2024). The estimation shows an average of 1,9 toe per capita, annually (20% below the EU average)

	(Enerdata, 2024).



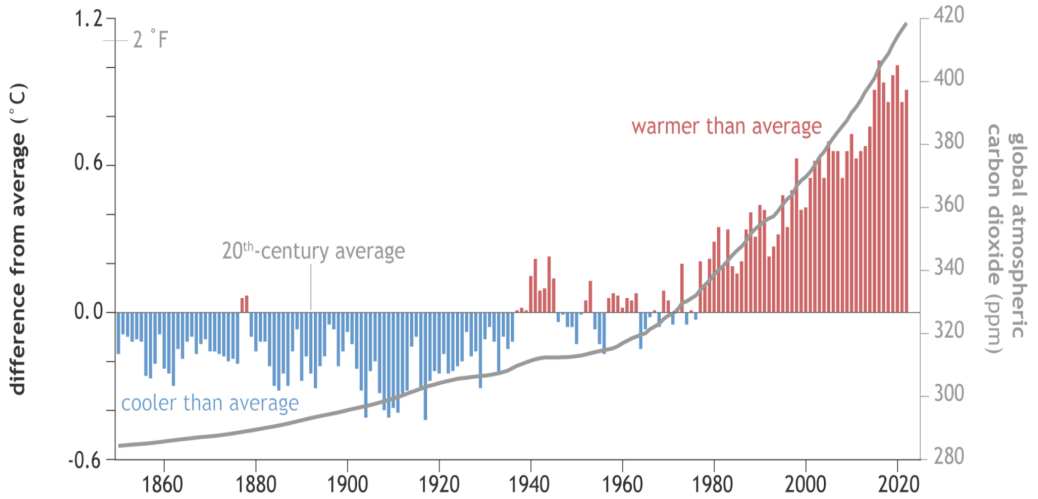
Source:https://nca2009.globalchange.gov/major-warming-and-cooling-influences-climate/index.html

Figure 3.1

Major Warming and Cooling Influences on Climate Change 1750-2005

The US Global Change Research Program published a figure (see Figure 3.1), illustrating the cooling and warming influences of the major factors of Earth's temperature disbalances over the industrial age of 1750-2005. The red bars demonstrate the warming influences, while the blue bars portray the cooling ones. The further the bar stretches-the bigger is the influence. The findings are in watts per square meter. The figure is split in three parts where the first one refers to the human activities that contribute to changes in the temperature, the second one points to the total natural influences, which is only the sun and the third one calculates the total net effect, where one can easily observe that the warming influences are dominating the graph. For the second part, there are other natural influences that can contribute to temperature changes, such as volcanic eruption,

but as we previously mentioned, these natural variations can only have temporary effects and thus, they have been purposely excluded from the graph (U.S. Global Change Research Program, 2009).



Source: https://www.climate.gov/media/13840

Figure 3.2

Yearly Global Surface Temperature and Atmospheric Carbon Dioxide 1850-2022

As we can see in Figure 3.2, the major factor of temperature changes is carbon dioxide and greenhouse gasses. Figure 4 shows us the yearly global surface temperature and atmospheric carbon dioxide in 1850-2022. The blue bars demonstrate the temperature below the average and the red bars the ones above it. The stretch of the bars provides the estimation and the black line portrays the atmospheric carbon dioxide (*CO2*) concentration in parts per million (ppm) (U.S. Global Change Research Program, 2009). It is clear that carbon dioxide emissions have been accelerating at a dangerous rate. There are sharp shifts in the graph that originate from natural processes.

It is substantial to seek improved climate change awareness strategies and ways to influence citizens to adopt such ideals and be actively involved, in order to achieve a successful implementation on both mitigation and adaptation policies. Researchers state that shaping effective communication strategies and building a global alliance against climate change are essential keys to effectively approach the issue (Dechezleprêtre *et al.*, 2022; Crispino and Loberto, 2024c). Due to the fact that the effects of climate change have not been fully upfolded, there is a genuine reluctance on how to foster proper policies

in order to tackle the phenomenon. The level of public awareness and concern, as well as the all-encompassing effects of climate change remain a subject of ongoing research, not fully developed and not yet attained (ibid.).

3.2 Economic Effects of Climate Change

At the same time, the public unfamiliarity on the subject can be found decisive, not only in the ways people tend to operate but on asset prices in the financial market too (Zhang *et al.*, 2024), whereas the GHG emissions represent the biggest market failure this world has seen, imposing substantial negative externalities on a global scale (Stern, 2008). Climate change is the origin of all externalities, which are considerably larger, more complex and uncertain than any other environmental issue (Tol, 2009). Despite that most scientific research coming from different expertise is convinced on investing in GHG emission reduction strategies, there seems to be a concerning gap deriving from the economists.

In order to estimate the total economic effect of climate change, Tol. R. (2009), made a synopsis of the studies of Nordhaus (1994a), Nordhaus (1994b), Fankhauser (1995), Tol (1995), Nordhaus and Yang (1996), Plambeck and Hope (1996), Mendelsohn, Schlesinger and Williams (2000), Nordhaus and Boyer (2000), Tol (2002), Maddison (2003), Rehdanz and Maddison (2005), Hope (2006) and Nordhaus (2006) (see Figure 3.3).

Study	Warming (°C)	Impact (% of GDP)	Worst-off region (% of GDP)	Worst-off region (Name)	Best-off region (% of GDP)	Best-off region (Name)
Nordhaus (1994a)	3.0	−1.3				
Nordhaus (1994b)	3.0	−4.8 (−30.0 to 0.0)				
Fankhauser (1995)	2.5	−1.4	−4.7	China	−0.7	Eastern Europe and the former Soviet Union
Tol (1995)	2.5	−1.9	−8.7	Africa	−0.3	Eastern Europe and the former Soviet Union
Nordhaus and Yang (1996)[a]	2.5	−1.7	−2.1	Developing countries	0.9	Former Soviet Union
Plambeck and Hope (1996)[a]	2.5	2.5 (−0.5 to −11.4)	−8.6 (−0.6 to −39.5)	Asia (w/o China)	0.0 (−0.2 to 1.5)	Eastern Europe and the former Soviet Union
Mendelsohn, Schlesinger, and Williams (2000)[a,b,c]	2.5	0.0[b] 0.1[b]	−3.6[b] −0.5[b]	Africa	4.0[b] 1.7[b]	Eastern Europe and the former Soviet Union
Nordhaus and Boyer (2000)	2.5	−1.5	−3.9	Africa	0.7	Russia
Tol (2002)	1.0	2.3 (1.0)	−4.1 (2.2)	Africa	3.7 (2.2)	Western Europe
Maddison (2003)[a,d,e]	2.5	−0.1	−14.6	South America	2.5	Western Europe
Rehdanz and Maddison (2005)[a,c]	1.0	−0.4	−23.5	Sub-Saharan Africa	12.9	South Asia
Hope (2006)[a,f]	2.5	0.9 (−0.2 to 2.7)	−2.6 (−0.4 to 10.0)	Asia (w/o China)	0.3 (−2.5 to 0.5)	Eastern Europe and the former Soviet Union
Nordhaus (2006)	2.5	−0.9 (0.1)				

Note: Where available, estimates of the uncertainty are given in parentheses, either as standard deviations or as 95 percent confidence intervals.

[a] The global results were aggregated by the current author.

[b] The top estimate is for the "experimental" model, the bottom estimate for the "cross-sectional" model.

[c] Mendelsohn et al. only include market impacts.

[d] The national results were aggregated to regions by the current author for reasons of comparability.

[e] Maddison only considers market impacts on households.

[f] The numbers used by Hope (2006) are averages of previous estimates by Fankhauser and Tol; Stern et al. (2006) adopt the work of Hope (2006).

Source: https://pubs.aeaweb.org/doi/pdfplus/10.1257/jep.23.2.29

Figure 3.3

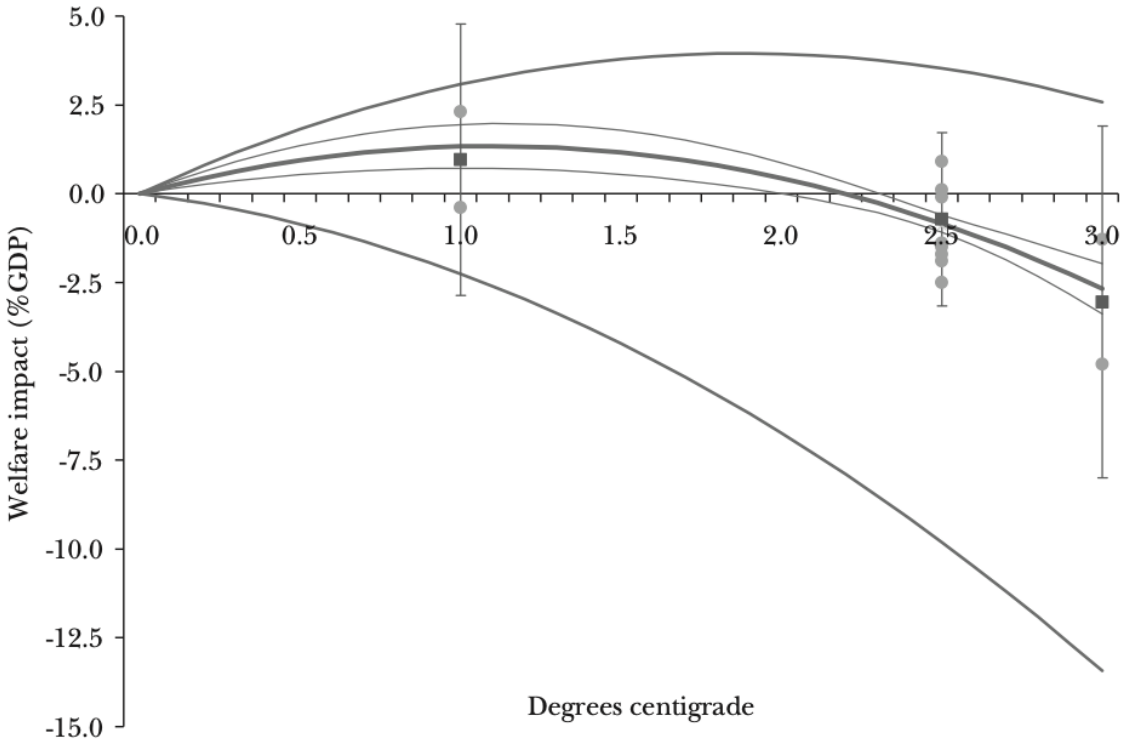
Estimates of Welfare Impact of Climate Change

The conduction of the research obligated the scientists mentioned above to use two different methodological approaches. Tol (1995, 2002a,b), Nordhaus (1994a) and Fankhauser (1994,1995) used the *enumerative method*. This method involves gathering individual estimates of climate change's tangible consequences from natural science papers. These scientific studies use a variation of other approaches, such as computer simulations (climate models), predictions of future outcomes (impact models) and last but not least, controlled laboratory experiments. In this way, the physical impacts are gathered and then assigned by financial values, which are later added up, calculating the total cost.

On the other hand, Mendelsohn, Schlesinger, Morrison and Andronova (2000), as well as Mendelsohn, Schlesinger and Williams (2000) used the *statistical approach*. By using this method, the researchers estimated the impact of climate change on well-being while using observed variations within different regional spaces of one country in prices and expenditures (Tol, 2009). The findings of this synopsis of studies are the following (ibid.):

1. The majority of the studies agree on the fact that given the current economic output, doubling the current level of GHG in the atmosphere wouldn't necessarily result in major economic impacts. In fact, it is estimated to have a limited direct impact, disbalancing the Gross Domestic Product (GDP) by only a few percentage points.
2. An unexpected outcome comes with the second finding, gathered by several studies, including those by Hope (2016), Mendelsohn, Schlesinger, Morrison and Andronov (2000) and Tol (2002b). Those studies argue that there will be initial short-term advantages after the temperature rises but those benefits will later be outweighed as the temperatures continue to accelerate (see Figure 6).
3. Despite the fact that high-income developed countries have higher percentages of GHG emissions per person, the larger-scaled climate change impact is placed on the shoulders of low-income countries.
4. The economic forecast of these studies regarding the aftermath of the GHG emissions reveals that the estimates shifted towards a more optimistic behavior, expecting less severe economic impacts.
5. The final finding of the synopsis is that most of the analyzed scientific papers are characterized by uncertainty and the author of the synopsis identifies and justifies it.

To summarize, there is a concerning gap emerging from the economic sector. Despite the fact that most scientific evidence supports an investment on the reduction of GHG emissions and that the government is prepared to spend enormous amounts of capital in order to achieve it, the economists cannot estimate confidently the scale of such an investment and whether it is expected to be a decision that makes sense from an economic perspective (Tol, 2009).



Source: https://pubs.aeaweb.org/doi/pdfplus/10.1257/jep.23.2.29

Figure 3.4

Global Economic Impact of Climate Change

There is uncertainty surrounding the economists about the economic impacts of climate change, leading to confusion and issues when it comes to formulating clear-cut economic decisions.

3.3 Mitigation and Adaptation

Scientific research suggests that the private, public and non-profit organizations have begun to realize that there are only three available options regarding climate change: mitigation, adaptation and suffering. The mitigation of climate change necessitates the reduction and subsequent sequestration of GHG emissions. Adopting a mitigation plan would serve as a factor in order to impede further atmospheric concentration increases or ideally, to achieve a reduction to levels deemed less hazardous compared to the ones prevailing since the Industrial Revolution (Chen, Suzuki and Lackner, 1982). More precisely, meaning the reduction of the emissions of heat-trapping gasses and particles or the removal of heat-trapping gasses from the atmosphere.

The primal focus of mitigation strategies usually hovers around carbon dioxide emissions, whether that means achieving energy efficiency while using energy sources that do not abuse the production of carbon dioxide, or even capturing and storing carbon dioxide from fossil fuel use etc. (U.S. Global Change Research Program, 2009). The adaptation on the other hand, signifies the adjustment to the effects of climate change, whether those are already happening or are estimated to be happening in the future.

An adaptation strategy on the other hand, aims at minimizing the damage and reducing the impact of climate change on society, economy and the places that people live, whether those places are rural agricultural areas and villages or large-scaled urbanized cities that produce the major amount of energy consumption and carbon emissions (Chen, Suzuki and Lackner, 1982). To elaborate, an adaptation strategy aims to improve our ability to adjust and avoid harmful impacts while taking advantage of beneficial ones in the present and in the long-term (U.S. Global Change Research Program, 2009). Anything else apart from those strategic choices will eventually end up to the third option: suffering.

3.3.1 Mitigation Of Climate Change

Central and local governments, alongside researchers, extensively utilize mitigation strategies in order to combat climate change, due to their quantifiable nature and their ability to allow monitoring and measurable progress in emissions reduction. This facilitates data-driven policy adjustments and fosters an effective approach to climate change.

Mitigation strategies contain the analysation of the key components of the GHG reduction policies, as well as the technological options focused on reducing those emissions (see Figure 3.5). The main components of the greenhouse gas emissions usually refer to the key areas of energy, transport, industrial processes, agriculture, land-use change and forestry and wastes, while their policies vary focusing on tackling those areas by the formation of strategies, such as an economically efficient supply and use of energy, air quality management, energy security, afforestation and deforestation strategies in order to increase sink capacity, the minimization of wastes etc. (U.S. Global Change Research Program, 2009).

Following the analysis of the key components of the GHG reduction policies, a mitigation strategy should provide the technological options in order to achieve those

reductions. Those options are usually split between the sectors: The main issues and the technological options and suggestions. The sectors of the technological options are addressing the energy supply and infrastructure, the use of energy and the non-$CO2$ GHG (UNFCCC, 2004) . The main issues usually divide the sectors into focuses. For instance, the Energy Supply and Infrastructure sector's focuses are (see Figure 3.5):

- Renewable energy and fuels
- Energy infrastructure
- Low emission, fossil based power and fuels
- Hydrogen
- Nuclear
- Buildings
- Methane emissions from energy and waste

KEY COMPONENTS OF GREENHOUSE GAS REDUCTION POLICIES		TECHNOLOGY OPTIONS FOR REDUCING GREEN HOUSE GAS EMISSIONS		
		SECTORS	MAIN ISSUES	*TECHNOLOGY*
ENERGY	Economically efficient supply and use of energy	Energy Supply and Infrastructure	Renewable energy and fuels	*wind energy*
				solar buildings
				concentrating solar power
				biochemical conversion of biomass
				thermochemical conversion of biomass
				biomass residues
				energy crops
				photoconversion
				advanced hydropower
				geothermal energy
			Energy infrastructure	*high-temperature superconductivity*
				transmission and distribution technologies
				distributed generation and CHP
				energy storage
				sensors, controls and communications
				power electronics
			Low emission, fossil based power and fuels	*zero-emission power, hydrogen and other value-added products*
				high-efficiency coal/solid feed stock
				high-efficiency gas fuel cell/hybrid power systems
			Hydrogen	*hydrogen production from nuclear fission and fusion*
				integrated hydrogen energy systems
				hydrogen production
				hydrogen storage and distribution
				hydrogen use
				hydrogen infrastructure safety
			Nuclear	*existing plant research and development*
				next-generation fission energy systems
				near-term nuclear power plant systems
				advanced nuclear fuel cycle processes
				nuclear fusion
		Use of Energy	Buildings	*building equipment, appliances and lighting*
				building envelope(insulation, walls, roof)
				intelligent building systems
				urban heat island technologies
		Non-CO2 GHGs	Methane emissions from energy and waste	*advances in coal mine ventilation air systems*
				advances in coal mine methane recovery systems
TRANSPORT	Sustainable development in the sector		Transportation	*light vehicles-hybrids, electric and fuel cell vehicles*
	Air quality management			*intelligent transportation systems infrastructure*
	Congestion management			*aviation*
	Energy security			*encouragment of public transportation*
INDUSTRIAL PROCESSES	Reduction of gases emitted as by-products	Non-CO2 GHGs	Emissions of high global warming potential gases	*semiconductor industry: abatement technologies*
				semiconductor industry:substitues for industrial GHGs
				aluminium industry: HFC emissions
				electric power systems and magnesium:substitues for SF_6
				supermarket refrigeration:HFC emissions
AGRICULTURE	Greater sustainability through, among other things, improved food quality, rural development, organic farming and land-use planning	Non-CO2 GHGs	Methane and nitrous oxide emissions	*advanced agricultural systems*
				options for manure management
				enteric emissions reduction
LAND-USE CHANGE AND FORESTRY	Protection and sustainable management of forests Conservation of biodiversity, wildlife, soil and water Afforestation and deforestation to increase sink capacity			
WASTES	Recycling of wastes	Non-CO2 GHGs	Methane emissions from energy and waste	*conversion of methane gas in wastewater treatment plants*
	Minimizing wastes			*electricity generation technologies for landfill gas*

Source: https://keneamazon.net/Documents/Publications/Virtual-Library/Impacto/157.pdf

Figure 3.5

Mitigation Of Climate Change

The mitigation strategies signify that every single one of the main issues should be accompanied by technological suggestions, such as solar buildings, high-efficiency gas fuel cells and hybrid power systems, advances in coal mine methane recovery systems, high-temperature superconductivity, biochemical conversion of biomass and so on.

3.3.2 Adaptation of Climate Change

Researchers Chen W., Suzuki T. and Lackner M. acknowledged the fact that research data can drive people into the conclusion that "less mitigation today can be balanced by more adaptation in the future" but characterized it as misleading as it projects the two approaches as substituted to each other. Indeed, the deferral of the mitigation strategies today will translate to the greater resilience of adaptation strategies in the future. That led the aforementioned researchers to put more emphasis on the long-term resilience of adaptation strategies, as well as the severity that surrounds them. The truth can be unveiled by the realization that even reduced GHG emissions will continue to contribute to the atmospheric buildup and that the destruction that follows them is cumulative. The frequency and severity of the heatwaves, the droughts and the floods will continue to accelerate, reshaping and eroding the economic well-being and requiring an even greater assembly of resources in order to balance the aftermath of climate change. The researchers then stressed the importance of mitigation and adaptation and claimed that the two strategies should be treated as complements, as well as a package that is shaped in a way that will prevent catastrophe (Chen, Suzuki and Lackner, 1982).

On the same note, it is crucial to appreciate the importance of adaptation strategies. An unfortunate but realistic fact is that despite a potential aggressiveness of mitigation strategies that humanity may choose to use in order to tackle the issue, the impact and aftermath of climate change will unequivocally continue to cause suffering due to the years of abuse of GHG emissions releases. The issue will not be resolved overnight and at best it will cease to exist after causing centuries of pain and suffering (U.S. Global Change Research Program, 2009).

There are several reasons explaining this situation and the truth lies within. Firstly, there are numerous gasses that have been released in the atmosphere. The lifespan of some of these gasses are so long that the level of atmospheric heat-trapping gasses will remain elevated for many centuries. Secondly, the heat-trapping gasses have altered the

temperature of the oceanic system, to an extent where the ocean has absorbed so much heat and will maintain it for at least several decades. The third reason comes from a social and technical background and supports the fact that the factors that determine those emissions, such as energy-supply systems, could not endure socially or technically a dramatic change (U.S. Global Change Research Program, 2009). It is unrealistic to expect global understanding and cooperation between nations, when human history has repeatedly shown us that the tendency for human power can extend to a reach where abuse and exploitation becomes a common tactic, whether that points towards other races, ideologies, social groups or even the place that we all live in, earth. But at the same time, we have a duty and should be making unanimous and single-handed efforts to find ways to coexist and protect the gift of life, whether that means sustaining ourselves from overconsumption or finding new ways to cover our needs.

3.3.3 Issues of Mitigation and Adaptation Strategies

The issue that follows the adaptation and mitigation strategies is that the "safe" level of GHG concentrations remains fiercely debated and will most likely result in an accurate estimation after the irreversible aftermath of climate change. This stems from our incomplete understanding of how earth's systems and human activity will interact with each other under unprecedented levels of these gasses. The threshold that will determine the "safe level" and the "danger level" is not yet to be projected, due to the fact that scientific evidence is not present yet and the borderline of GHG concentrations could not be accurately estimated before the developments in the global biochemical system have exceeded the true unknown rate that will result in an irreversible situation (U.S. Global Change Research Program, 2009).

This irreversible situation may refer to the melting of cryospheric reservoirs or ice sheets that will eventually result in the release of vast quantities of long-sequestered methane and carbon dioxide from sub permafrost soils, meaning a major acceleration of global warming and changing weather patterns. Another catastrophic situation may affect the oceanic ecosystem by altering the patterns of the oceanic circulatory system. These circulatory patterns are transporting vital nutrients and are responsible for heat balance. Such a catastrophe will end up in a chain of marine deoxygenation and an overall ecosystem collapse. These phenomena, as well as the change in weather and temperature patterns, will have crucial effects on agricultural systems, challenging the abilities of the

global food system to handle the food demand of the growing human population (Chen, Suzuki and Lackner, 1982).

Although mitigation and adaptation strategies are certainly the key to reducing the effect of climate change, human activity has already surpassed a threshold which will force a struggle of decades of temperature changes and centuries of sea level rise. There are numerous reports showing that choices and actions taken around climate change will have long-lasting and possible detrimental consequences to life on earth and by weakening the main source, meaning the GHG emissions, both the magnitude and the rate at which climate change appears will be considerably lessened (U.S. Global Change Research Program, 2009).

These phenomena will trigger a chain of reactions that will greatly affect or shape the biophysical and socioeconomic environment and will lead to the acceleration of the frequency and severity of extreme weather events. The change of biophysical conditions will eventually enter a loop where it will fuel destruction and be revitalized by it, challenging the productivity of managed forests and croplands and altering the distribution of pests and diseases. This catastrophe will have irreversible consequences and will lead to a life of suffering and pain, determining the livelihood and longevity of humanity and disbalancing the population (Chen, Suzuki and Lackner, 1982).

3.7 Environmental Challenges and Public Policy in Greece

3.7.1 Climate change

Greece, a mediterranean nation with thousands of islands, is highly vulnerable to the impacts of climate change. For the Greek context, which is estimated to undergo temperature rises and declining precipitation, issues such as rising sea levels and water scarcity play a critical role and are estimated to have devastating consequences to the Hellenic environment. The country is fortified with public policies and institutional frameworks formulating adaptation strategies, but the reality is that action plans are yet to take place. Greece's decentralization strategies have enabled regional authorities to play a pivotal role in the development of action plans, which is crucial in order to achieve sustainability of any kind (OECD, 2020).

Scientific evidence (N.E.C.C.A., 2018) reveals that according to anthropogenic effects on climate, it is estimated that by the end of the 21st century rainfall will be reduced by 19% on a national level. Additionally, there will be an increase of the air

temperature between 3,0°C and 4,5°C, respectively, as well as shifts in various climatic parameters such as humidity, cloud covering, wind speed and the income shortwave radiation. Scientific studies estimate that the mean maximum summer temperature is going to increase by another 5% in 2071-2100. The population of urban areas are already suffering in the summer, where days have temperatures higher than 35°C. It is expected that the coolest temperatures of the summers of 2071-2100 will match with the warmest temperatures of our times (ibid.)

Greece exhibits heightened vulnerability to rising temperatures with a growing frequency and intensity of extreme weather events. Recent years have witnessed a national rise in natural disaster linked to extreme weather, exemplified by devastating wildfires, prolonged periods of droughts and exceptionally high temperatures (Koundouri, 2023).

A study by Diakakis et al. (2010) revealed a disturbing event in Greece's flooding history (Diakakis, Mavroulis and Deligiannakis, 2012). The analysis of the events from 1880 to 2010 projected 54 floods causing over 686 casualties. Notably, the deadliest ones were concentrated in Attica who bear the brunt of the damage (Diakakis, 2013). The Mandra flash flood on November 15, 2017, tragically exemplified this pattern. Statistically considered a 1-in-150-year event (Stamou, 2018), it caused 24 deaths and widespread devastation, following a similar deadly flood in 1977 and another "warning flood", both in the same region (Mitsopoulos *et al.*, 2022).

Another catastrophic event in recent years, storm "Daniel", a hybrid storm with traits of both mid-latitude storm and a tropical cyclone, caused devastating floods in Greece in September 2023. The severity of the situation was induced by the enormous amount of rain that dropped in a considerable small timeframe. To be precise, the area received 18 months worth of rain in just 24 hours. Greece's agricultural heartland, Thessaly, underwent significant economic losses, environmental destruction and tragically, many deaths. The event led the scientists to believe that far more extreme weather events are coming as the temperatures rise, with flooding likely to have more devastating impacts (Adamopoulos, Frantzana and Syrou, 2023).

3.7.2 Urbanization challenges

The Greek context has undergone various changes in major sectors. Developments in economic growth have put increased pressure on the environment. Urbanization, energy, agriculture, tourism, construction of houses, infrastructures and roads and the

development of coastal areas, had a significant impact on Greece's environment, triggering environmental pollution and the degradation of natural resources (Valavanidis and Vlachogianni, 2011).

Greece has been troubled with unplanned urbanization, urban and suburban sprawl, housing construction in forested areas and coastal zones, further worsening the air quality, energy consumption and the excessive use of water. The most high-level inspections reveal constant violations. Illegal construction remains a major environmental issue for Greece (OECD, 2020).

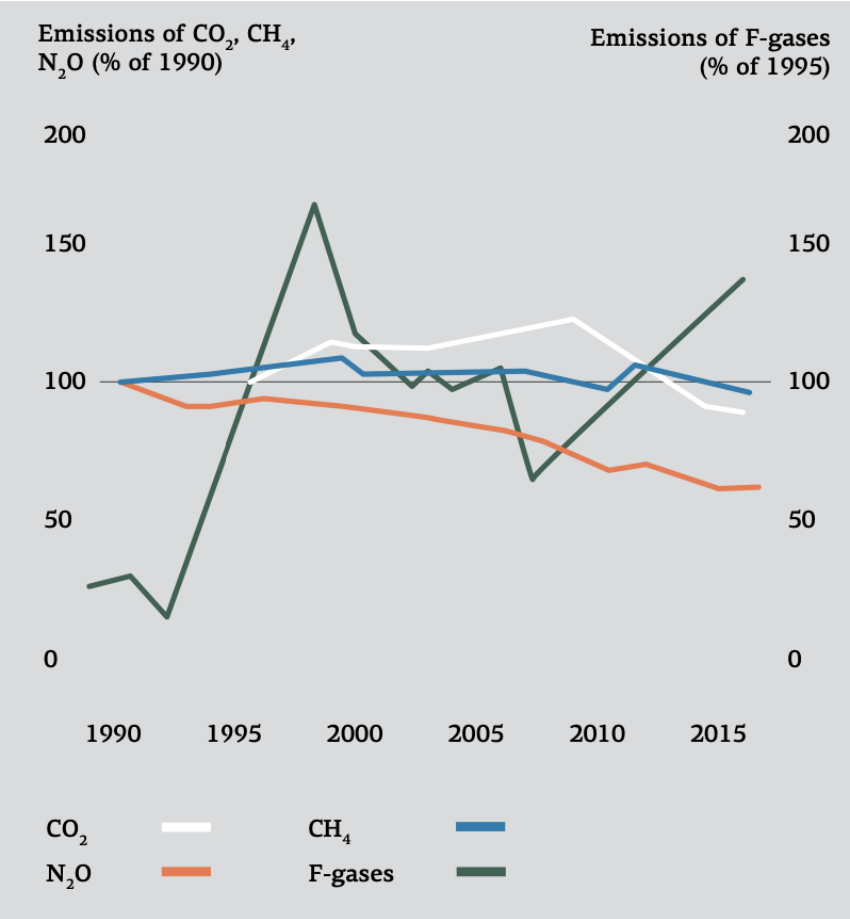
Rapid urbanization, mainly due to post war situations (Municipality of Athens, 2021), led to high population density in the city of Athens, which is now characterized as one of the most densely populated cities in Europe (Eurostat, 2020). At the same time, the relentless pressure of urban congestion, traffic, noise and air pollution triggered a mass unplanned exodus of Athenians from the city centers towards the suburbs since 1980 that resulted in urban sprawl and unsustainable urbanization. According to Athens's official climate change plan, the city is characterized by dense, haphazard construction compromising the quality of life of the citizens in many aspects (Municipality of Athens, 2021).

More specifically, the Athenian climate action plan identifies that high population density along with unsustainable urban development has led to the emergence of the urban heat island phenomenon that has detrimental effects in the society and is estimated to significantly lower the quality of life more intensely in the following years (ibid.).

The Urban Heat Island phenomenon (UHI) refers to the higher temperatures experienced in urban cities compared to the rural areas and is triggered majorly by high population density (Georgakopoulos, 2021). The Athenian context is significantly impacted by UHI and the issue of extreme heat, particularly during the night. The western Athenian neighborhoods exhibit a 8°C temperature difference compared to the rural areas, especially during heatwaves. At night, the heat absorbed by the concrete urban structure gets released, causing significant discomfort to the citizens. The overheating of buildings, along with increased air pollution and a dense urban setup is severely stressing Athenians, leading to severe consequences in health and well-being, particularly for the vulnerable populations (Municipality of Athens, 2021).

3.7.3 Air quality

Despite the fact that the major cities such as Athens, Thessaloniki and Patra have shown considerable progress in urban air quality by investing in environmental-protective mediums, such as cleaner high-quality fuels and public transportation, the country lacks a dedicated program to handle the significant health impacts (OECD, 2020). Additionally, there is a reduction of 7,1% GHG emissions since 1990, touching 95,7 Mt of *CO2* eq, in 2015. Thus, Greece successfully fulfilled the first period of the Kyoto protocol and is preparing for the EU target (N.E.C.C.A., 2018).



Source:https://old.necca.gov.gr/wp-content/uploads/2019/10/Greece-State-of-the-Environment-Report-Summary-2018-English-Version_WEB.pdf

Figure 3.6

Emissions of CO_2,CH_4 and N_2O (1990-2015)

There is a 10,1% reduction of *CO2* since 1990, which is still comparatively higher than the *CH4* emissions, which have been reduced by 6,3% (see Figure 3.6). Moreover, there is a significant increase of fluorinated gasses by 42,7% since 1990 and a

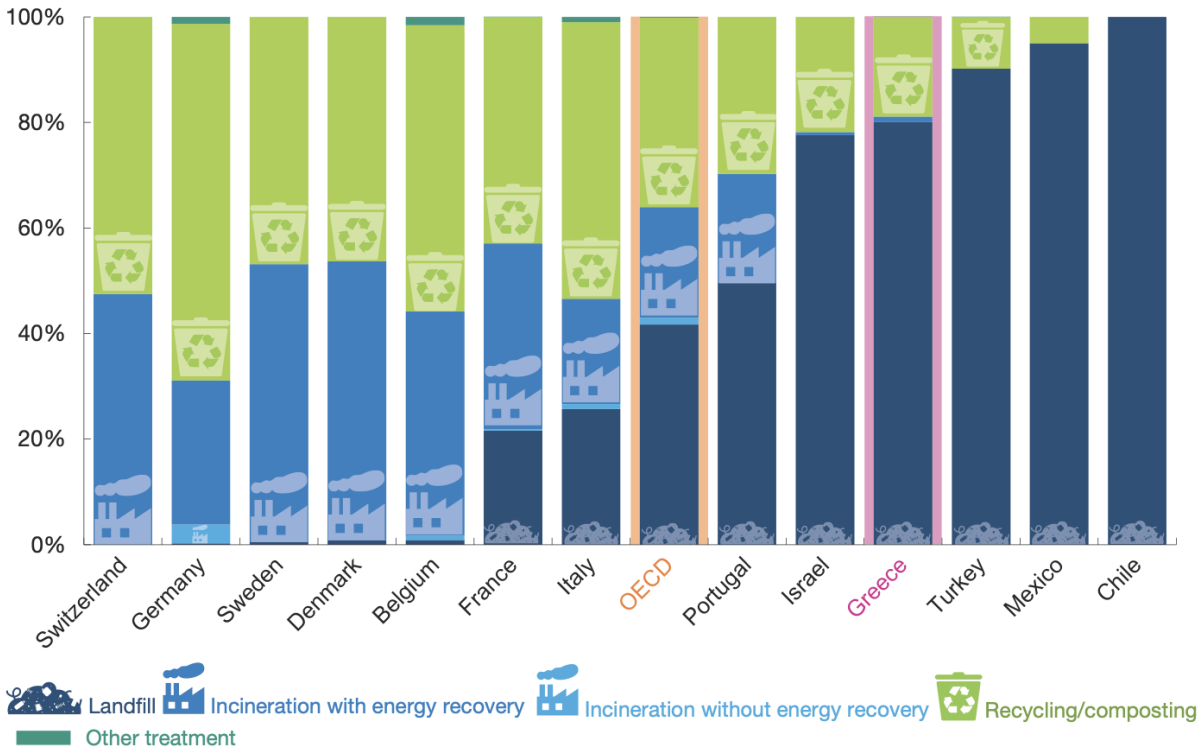
considerable decrease of *N2O* by 39,3%. However, the decrease in greenhouse gas emission is an aftermath of the economic crisis which reduced the energy demand (OECD, 2020).

3.7.4 Waste management

There is obvious progress in the public policy system- a National Circular Economy Strategy, as well as a tax on single-use plastic bags were adopted. On the contrary, energy consumption, municipal waste generation and pesticide use have accelerated faster than economic growth since 2013. Greece is still grappling with major challenges, such as waste management. Municipal waste still ends up in landfills as the primary destination, the majority of which doesn't comply with EU requirements. The country also lacks a resilient hazardous waste management strategy. There is a growing need for the implementation of a robust treatment infrastructure, as well as application and utilization of economic instruments to achieve average sustainability levels (OECD, 2020).

It is estimated that around 80% of Greece's municipal waste ends up in landfills (see Figure 3.7). The country's performance is completely disproportionate to the EU agreements and is unlikely to meet even 50% of the EU reuse and recycling target, set to be evaluated by 2020. Additionally, 2018 assessments showed that more than 50 dumb

sites did not comply with EU regulations (OECD, 2020).



Source:https://www.oecd.org/greece/oecd-environmental-performance-reviews-greece-2020-cec20289-en.htm

Figure 3.7

Municipal waste in the EU

The illegal and unregulated disposal of waste led to the EU court's implementation of penalty fines of 24.520.000 euros in 2014. According to the latest evaluation of the EU Commission there is still uncontrolled disposal of waste and infringements happening. The country's inexpediency continued regarding hazardous waste management. Greece failed to adopt a specific plan, a proper network of disposal facilities and failed to address existing stockpiles, such as "historical waste" according to the EU regulations. The EU court applied a second series of fines for the aforementioned violations regarding hazardous waste management, resulting in a total of 18.916.000 euros (N.E.C.C.A., 2018).

3.7.5 Water Management

Scientific evidence claims that water scarcity will keep deteriorating-aligning with climate change. There is a high level of freshwater abstraction, mainly due to irrigation and leakage. It is crucial to establish a system of collection and disposal of pesticide containers in order to tackle the environmental impact of agriculture (OECD, 2020). At the same time, the legal framework also lacks a comprehensive biodiversity system, allowing rapid urbanization, pollution, invasive alien species and habitat fragmentation to disbalance the natural environment (ibid.).

However, from an ecological status point, the coastal waters seem to project a high/good status, the rivers a good/moderate status and the lakes and transitional waters a moderate/unknown status, due to the fact that there is lack of data and evidence. Additionally, from a chemical status point, the majority of Greece's water encompasses high/good status, while a small number can be considered as lower/unknown. Finally, almost every kind of groundwater body ranks as good qualitative (85%) or qualitative (80%) status (ibid.)

3.7.6 Environmental related taxes

Greece reaffirmed its dedication to sustainable development through their Voluntary National Review, published in 2018, for the implementation of the 2030 Agenda. These documents, while not binding on the members of the UN, are of critical importance in order to measure and evaluate the success of a country involved. At the same time, they provide specific data to show the source of the problem as well as in which areas the country lags behind (European Union, 2022).

The country undergoes a critical rise in environmentally related tax revenue as a share of GDP, with main driver- the increase of energy taxes. Greece implements effective taxes on *CO2* emissions from energy use but on the other hand, carbon pricing is discrepant. Unfortunately, over a quarter of Greece's tax revenue ends up advocating fossil fuel consumption- completely undermining the environmental advantage that could be attained through these taxes (OECD, 2020).

Additionally, the country ranks among the countries with the highest prices and taxes in petrol within the OECD, but in contrast, the taxation on diesel- which is a far more polluting fuel- remains lower in comparison. At the same time, the country holds one of the oldest, most polluting vehicle fleets among the EU countries. The country's legal and

public policy framework introduced a new law on tax reform, in 2019, with environmental criteria further restricting the personal use of company cars and commuting expenses by taxation (OECD, 2020).

CHAPTER 4

DENSELY POPULATED CITIES AND URBANIZATION

"You said I'll go to another country, go to another shore, find another city better than this one…"

C.P. Cavafy (1863-1933)

Sustainable urbanization and development has been a topic of research for several years. There is a great deal of research on that field and it is mainly caused due to the growing population that is continuously leaving the more rural areas in order to inhabit the larger scale, urban cities (Michalina *et al.*, 2021). According to the 2018 Revision of World Urbanization Prospects document, published by the UN, an approximate 55% of the world population lives in urban areas. The urban population surpassed the number of 751 million people in 1950, secured a percentage of 4.2 billion people in 2018 and it is now believed to reach 6.7 billion or 68% of the world population by 2050 (United Nations, 2018). By the end of 2018, humanity reached a milestone where more than half of the population inhabited urban areas (World Health Organization, 2019). However, recent scientific evidence overturn previous assumptions, showing the 2018 data significantly underrepresents reality. The new estimations reveal a surprisingly high level of urbanization around the world. According to this new standard, a staggering 76,5% of the global population was already living in urban centers in 2015 (Hellenic Republic, 2021)- a number significantly higher than the previous estimates which placed the urbanization rate approximately at 55%. Thus, it is a common realization, among the relative researchers, that the 21st century is going to be characterized as an urban century (Nazarian *et al.*, 2022).

At the same time, urbanization, density and rapid urban growth are considered as significant contributors that drive the GHG emissions (De León Baridó and Marshall, 2014). There is scientific evidence supporting that urbanization and density, at a global level, have led to the rise of greenhouse gas emissions over the past decades (IPCC, 2014).

This trend is expected to continue with a rapid pace, indicating a potential increase of 25% in global emissions during this century (O'Neill *et al.*, 2010).

The Greek word *στεναχώρια* (stenahoria) which means *sadness* in today's vocabulary, has not always been always used with the same motives. To be specific, the Greek word underwent an evolution, leading to the alteration of its definition, where Greeks use it to express different emotions or describe different situations compared to its original meaning. For instance, the Athenian historian and general Thucydides analyzed the tactics of Gylippus, the Spartan general who led the Syracusans to victory against the fifth-century BC Athenian expedition. In his texts 7.49.2 and 4.30.2, Thucydides uses twice the word *στενοχωρία* in order to describe the tactic of leading the enemy in narrow places so that the schemer could benefit from the advantages (Thucydides, 431 BC). In the second century, an alternate definition can be observed where the text written in an inscription in Sestus, used the same word (in lines 100-106) to express feelings of sadness (Unknown Sestos Writer, 133-120 BC). An additional example can be given, sharing the historical context of the same era, where the Pauline epistles B' verse 12.10 in the New Testament use the word with the new definition, expressing emotions of sorrow (Letters of Paul, 2022). It is obvious that the Greek word *στενοχωρία* which in today's context is altered to *στεναχώρια* and translates to *sadness* and *sorrow*, was once used to describe narrow, tight and dense places.

It appears to be a variation of divided opinions with conflicting results of scientific research when analyzing the subject. On the one hand, the critics, opposed to the linear way of urbanization and economic growth, claim that rapid urbanization and densely populated cities are leading to numerous socioeconomic and environmental issues. For example, Wang et al. (2013) examined the impacts of urbanization and concluded that urban sprawl, a common consequence of rapid urbanization and densely populated cities, has led to numerous threatening issues, such as *CO2* increase, traffic congestion, loss of farmland and higher crime rates. B. Schultz (Schultz, 2006) investigated the extensive urbanization and verified the concerning aftermaths of urbanization and industrialization in those dense, flood-prone areas. Additionally, the United Nations (2011), on the Global Report for Cities and Climate Change, published by the UN Human Settlements Program, stated that cities are responsible for a number greater than 70% of the global greenhouse gas emissions (United Nations, 2011).

The Global Report for Urban Health, published by the World Health Organization (ibid.), disagrees on the matter that urbanization is associated with an overall health

improvement and points out that the health of the citizens may vary due to different circumstances. Specifically, in the dense city of London, the citizens of Westminster live an approximate of seventeen years longer compared to those, a few streets further the Underground. Additionally, there are people living in the same city of Baltimore, United States, whose life expectancy differs significantly and is estimated to have a twenty-year-gap difference between them. According to the World Health Organization (ibid.), the same citizens of Baltimore have a life expectancy analogous to the People's Republic of Korea, which are approximately thirty times poorer than the average citizen of the US. The same study shows that, obviously, the low or middle income large scale countries (LMICs) offer worse conditions for health compared to smaller cities and at the same time, makes clear that the National wealth level does not always set the boundaries for its cities health conditions. The point is that as urbanization and climate change are progressing rapidly and simultaneously, the populations that are located in dense urbanized cities will be threatened at a much greater rate regarding climate change, as well as, other societal and environmental issues (ibid.).

On the other hand, there are numerous researchers that are emphasizing the socioeconomic power of urbanization. Philips (1993), states that urban development in major cities is a great way to improve human health, compared to the more rural areas, since cities have the ability and the flexibility to fulfill the indicator requirements by providing more sustainable, ecological and cultural services to the citizens. At the same time, Philips (ibid.) adds that despite the fact that life expectancy may be higher in the larger scale urban cities, compared to that of the citizens of the more rural areas, there are serious health issues that define those inhabitants. N. Kabisch et al. (Kabisch & Lafortezza, 2017), backs up that statement by explaining that urban cities, compared to the rural areas, are capable of building and supporting green areas, ecological changes, sustainable methods and cultural services, which are fundamental assets, leading to a healthy and sustainable city. A milestone for creating healthy, sustainable cities and at the same time, keeping the citizens safe and happy is medical resources. Zhang et al. (2021), (Zhang, 2021, 2012), underlined the fact that, in most cases, the cities have more advanced and progressive health systems, resources, equipment and available human capital. In general, urbanization has been widely known, amongst city planners, researchers and politicians (Shen & Zhou, 2014), for being a powerful tool in order to establish better job opportunities and income increase, as well as for making possible for

health services and cultural/social infrastructure to take place (Zhou, Zhang, 2015; Shen and Zhou, 2014; Larson *et al.*, 2015).

There is a wide variety of research examining the effects, the benefits, the drawbacks or the general concept of urbanization and sustainability (Shi *et al.*, 2019) but as the population grows in the, already, highly-dense populated cities, there is need for further investigation regarding the sustainable development on a regional level for the pursuit of healthy and sustainable cities.

The analysis of the "city" as a phenomenon began very early in human history. Amongst the great Greek philosophers that examined the vision of an ideal city, Aristotle, on the third page of *Politics*, points out that "every city exists by nature". This statement is later defended, in book 1, chapter 2, by explaining that the "city" phenomenon is the natural and social evolution of a family. Due to that realization, as well as the fact that humans are social beings, Aristotle states that a person is naturally tied to inhabit a city and one who does not feel the need of doing so, is either foul or a being greater than humans. The philosopher continues by saying that everything that exists has a cause and its cause is always to be perfected. At the end, Aristotle concludes by accentuating that the development of a city is critical and it strives for the "eudaimonia", which literally means "good spirit" and the "autarkeia" of the citizens, which translates to self-sufficiency. Regarding the last statement, it's obvious that Aristotle's ideal city is focusing on the combination of the spiritual health and material sufficiency of the citizens for the overall pursuit of their happiness since, for Aristotle, happiness is the only cause a human is supposed to strive for (*Aristotle's: POLITICS*, 384 BC).

According to several researchers, highly dense urbanized cities offer better healthcare compared to the more rural areas, resulting in the overall improvement of the citizen's healthLiuLiu *et al.* (2016), measured the ways urbanization affect the health of the citizens, using a logistic model and the findings of the research suggested that areas which undergo high levels of urbanization are more likely to have better health status and systems, opposed to the low density areas which are more prone to health system issues. (Brueckner, 2019), while exploring adult mortality and urbanization in Sub-Saharan, Africa, came to the conclusion that the level of urbanization and the death rate of a city, have an inversely proportional relationship and that the value of one increases with respect of the other's decline and vice-versa. Biadgilign et al. (2019), acknowledged the concerning drawbacks of extensive urbanization but underlined that an effective government can measure and reduce the health issues, resulting in a lesser death rate.

The hypothesis that dense urbanized cities are the actual cause of public health is supported by plethora of research but it is yet to be confirmed (Jiang *et al.*, 2021). There are several researchers that endorse the belief that urbanization leads to high-fat, unhealthy diets and, in extent, to long-term health problems. Eckert and Kohler (2014), claim that compared to the more rural areas, in developed countries, highly populated cities are, in fact, resulting in chronic diseases and overweight citizens, while in developing countries, extensive urbanization often treats malnutrition. Poel et al. (2012), published a detailed case study in China, analyzing the health drawbacks that urbanization has caused and concluded by stating that the higher the presence of urbanization in a city, the higher the impact on poor health will be (mainly caused from high consumption of cigarettes and fat). Miao and Wu's (2016) research confirm the last statement, by using data from the China Health and Nutrition Survey, but at the same time, while examining the complex mechanism that outlines the health and income-health relationship, the researchers suggest that effective and sustainable urbanization has the ability to minimize the health drawbacks. P.W.G. Newman (Newman, 1999), explains that a city cannot achieve healthiness and livability before implementing environmental sustainability and simultaneously, only healthy and sustainable cities can maintain environmental sustainability for a long period of time.

Williams & Maginn acknowledge the crucial contribution of the government, which can, arguably, alter the urban development, by interfering and adjusting the urban policy, through city infrastructure funding, tax reduction, migration, national and public healthcare etc. (Thompson, 2012). On the other hand, Psiharis and Petrakos (2016) consider the fact that there is a general belief that urban and regional development is structured in a way that serves political wills and in extent, that governmental decisions have a major role in the transformation of urban development. However, the researchers suggested that this is a false assumption and that, although governmental and political will play an important role in urban policy making, the issues regarding regional and urban development are more complex and depend on several other factors.

Researchers Riffat, Powell and Aydin, while analyzing the topics of environmental sustainability, urbanization and future cities, concluded with the fact that cities are facing the rapidly-growing challenges of climate change, healthcare, food and water security, changes in demographics, social instabilities, congestion and other effects which are threatening the quality of life, the economic success and the environmental sustainability of these cities. The researchers pursued the new model of "future cities", which is

aspiring to tackle those challenges and includes more efficient methods in order to achieve greater welfare, energy savings, the reduction of the overall consumption and the protection of the environment. The study claims that recent developments and innovations have the potential to tackle the challenges that define the urbanized and populated cities and provide the emerging cities with a toolkit aiming to enhance the global quality of life by integrating environmental technologies, fostering comprehensive urban development, ensuring fiscal sustainability and promoting good governance (Riffat, Powell and Aydın, 2016). However, the researchers are aware of the challenge of creating such a model and claim that by simply applying those new technologies, neither a greater quality of life nor sustainability and future healthy cities can be guaranteed. The catalytic role is given to governance and management, who will ultimately be a driving force by utilizing technological advancements and forming efficient organizational and development strategic plans (ibid.). Consequently, the impacts of overpopulation and density in urban areas were summarized, accompanied with possible mitigation strategies (See Figure 4.1)

High traffic density	✓ Efficient public transport ✓ Compact city design
High amount of waste	✓ Recycling
Urban warming	✓ Increasing green space, ✓ Using reflective materials
Increasing Air pollution	✓ CO_2 capture, ✓ Filtering exhaust gases, ✓ Increasing efficiency of industrial processes/vehicles
Increasing energy consumption/sinking resources	✓ Using renewable sources, ✓ Achieving low energy buildings, ✓ Increasing efficiency of devices/processes
Lack of biodiversity/natural habitat	✓ Increasing green space, ✓ Developing animal/plant protection areas
Sinking water resources	✓ Water purification ✓ Desalination ✓ Rainwater harvesting
Rising food demand/poverty	✓ Vertical farming ✓ Artificial food production ✓ Greening the deserts
Land shortage for housing	✓ Constructing multifunctional buildings, ✓ Creative architectural designs
Weak Social cohesion	✓ Improving sociocultural environment ✓ Increasing the number of organisations-events that bring people together

Source: https://futurecitiesenviro.springeropen.com/articles/10.1186/s40984-016-0014-2

Figure 4.1

The Impacts of Density and Mitigation Strategies

Taking everything into consideration, it is clear that significant uncertainty engulfs any quantitative interpretation around the densely populated cities and the categories of urban green, income inequality, health and welfare. Despite the fact that there is high-

quality scientific research that supports both the benefits and the crucial drawbacks, much work is required in order to substantiate the recommended elasticities (Ahlfeldt and Pietrostefani, 2019). For instance, Ahlfeldt . and Pietrostefani . conducted an extensive research where 347 estimates of density elasticities were considered, such as wages, health, well-being, open space preservation and biodiversity, energy efficiency, sustainable mode choice, social equity, pollution reduction, innovation, job accessibility, rents, the value of space, various amenities, public service delivery, the cost of providing public services, safety, accessibility of public and private services, ease of traffic flow, other transport and environmental outcomes and so on. At the same time, the researchers carried out an extensive and comprehensive literature review research and investigated 180 studies in order to distinguish the effects of the densely populated cities. In spite of their analysis revealing sizable benefits and costs related to increases in density, the researchers argue that much work lies ahead of this sector in order to be eligible to say that related research can provide us with any conclusion. The researchers also acknowledge the fact that there are numerous other high-quality and more frequently-cited research, which have the tendency to be less positive towards the density effects over time. In their conclusion, the researchers underline the significance of this complex and rapidly-growing issue and advocate for increased and serious focus from the research community. There is a growing need to gain a deeper, more comprehensive understanding of heterogeneity of the effects of the densely populated cities in order to tackle the world's most pressing issues (ibid.).

To conclude, it is logical to say that the impacts of urbanization and population density on socioeconomic factors are complex issues with differing viewpoints among scientists. However, regardless of its potential benefits, there is a broad consensus supporting that concentrated population on a larger scale, undeniably leads to a significantly larger ecological footprint compared to rural areas.

CHAPTER 5

DEMOGRAPHIC AND ADMINISTRATIVE ENVIRONMENT

" …We are supposed to belong to the same family sharing common traits and impelled by the same basic desires, yet we inhabit a divided world. How can it be otherwise?"

Indira Gandhi, Speech at the 1972 Stockholm Conference

5.1 Greece's Demographics

The research for this study is conducted in Greece and specifically, in the historical city of Athens. Greece was chosen as one of the best options to perfect the main points and ambitions of this paper. This is due to the fact that Athens ranks amongst the most densely populated cities of Europe. To be precise, according to Eurostat, there are three regional units of Attica that rank among the top ten most densely populated regions in the EU (Eurostat, 2020). Further explanation will be provided at the *Study Area* and *Sample and Data Collection* subsections.

Nestled in the southern and southeastern tip of continental Europe, Greece covers an area of roughly 132.049 square kilometers. The population data provided by the Hellenic Statistical Authority (ELSTAT), can reveal population trends, as well as a slight decline over the past few decades. Here's a breakdown (European Commission, 2023):

- 2001 census: The actual population in the country was 10.9434.080 inhabitants where there was a new 50/50 split between males (5.41 million- 49,51%) and females (5.52 million- 50,49%).
- 2011 census (revised results of the Population and Housing trends): The population decreased to 10.816.286 individuals where there was a slight skew towards females (5.51 million- 51,0%) compared to the male population (5.3 million- 49,0%).
- 2021 census (preliminary results of the Population and Housing trends): The latest estimation indicates further decrease in the population, dipping it to 10.432.481 individuals. The gender ratio continues to favor females (5.36 million- 51,4%) with a further increase over males (5.08 million- 48,6%).

Eurostat forecasts signify a rather different population structure in the upcoming decades. This is due to a combination of factors, including a low birth rate and an aging population. The same forecast estimates that the total population of Greece is projected to decline to a number close to 8.92 millions by 2050. At the same time, the population structure will further change. For example, the financially active population group rate (15-64 age group) is estimated to undergo a decrease of 16,1%, which will drop the percentage from 67,5% in 2000 to 51,45% by 2050 (European Commission, 2023).

Greece witnessed a significant shift in population distribution, mainly cause by postwar situations of the 20th century. Internal migration fueled the growth of Greece's central cities (Athens, Thessaloniki etc.), while the rural areas and islands faced a significant decline in residents. This migration trend is continuing in recent years. To be exact, there is an increase of the percentage of people living in urban or suburban areas by 3,8%, which accelerated from 72,8% in 2001 to 76,6% in 2011 (see Figure 5.1). Despite the fact that the percentage keeps on getting higher, it seems that the pace of urbanization towards the big cities is slowing down. The European Commission acknowledges this trend and justifies it due to the reason that Greece may have already reached or surpassed the limits of high level of urban concentration compared to its overall population size (ibid.).

Areas	2001	2011
Population distribution (%)	100,0	100,0
Urban and suburban areas	72,8%	76,6%
Rural areas	27,2%	24,3%

Source:https://eurydice.eacea.ec.europa.eu/national-education-systems/greece/population-demographic-situation-languages-and-religions

Figure 5.1

Urbanization trends in Greece

As far as employment and unemployment trends, the ELSTAT Labor Force Survey conducted research and revealed the percentage of labor force in total population from 2017 to 2021, the percentage of the unemployed in the total labor force from 2017 to 2021 and the evolution of employment rate in the month of December 2009 to 2022 (ibid.).

1. Population aged 15 years and over by employment status, 2017 - 2021

Thousands

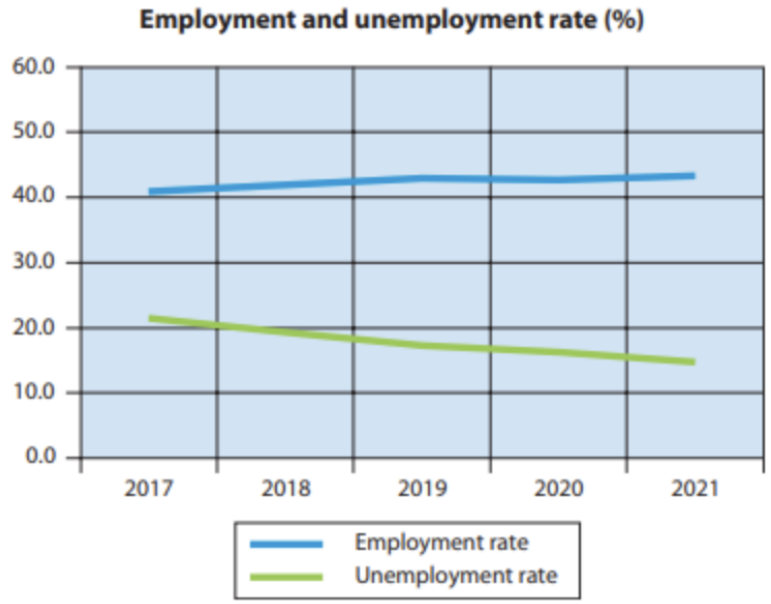
	2017	2018	2019	2020	2021
Employed	3,752.7	3,828.0	3,911.0	3,875.5	3,928.0
Unemployed[1]	1,027.1	915.0	818.9	755.0	677.7
Persons outside the labour force	4,397.2	4,397.1	4,373.6	4,448.5	4,459.7
Employment rate (%)[2]	40.9	41.9	43.0	42.7	43.3
Unemployment rate (%)	21.5	19.3	17.3	16.3	14.7

(1) It refers to persons aged 15 - 74 years.
(2) Employment rate represents persons in employment as a percentage of the total population.

Source:https://eurydice.eacea.ec.europa.eu/national-education-systems/greece/population-demographic-situation-languages-and-religions

Figure 5.2

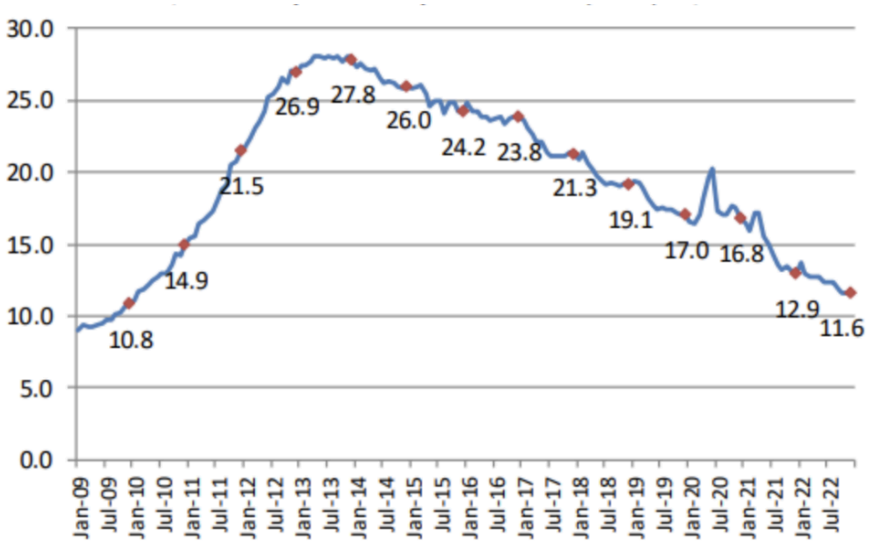
Population aged 15 years and over by employment status, 2017-2021



Source:https://eurydice.eacea.ec.europa.eu/national-education-systems/greece/population-demographic-situation-languages-and-religions

Figure 5.3

Employment and unemployment rate (%)



Source:https://eurydice.eacea.ec.europa.eu/national-education-systems/greece/population-demographic-situation-languages-and-religions

Figure 5.4

Unemployment rate (%) by month, December 2009-2022

Figure 5.2, Figure 5.3 and Figure 5.4 project an overall decrease in the unemployment rate and an increase in the employment rate of the total population.

5.2 Administrative divisions of Greece

Prior to 2011, Greece's administrative system, Kapodistrias 1998-2010, comprised 13 regions, 54 prefectures and 1033 municipalities and communities, a relatively large number in consideration of Greece's size and structure. The country's previous administrative structure relied on *prefectures* (νομοί, *nomoi*) as the primary territorial division. Greece has been widely considered as the most centralized country in the European Union (Loughlin, Hendriks and Lidström, 2011). According to the 2021 census of the Hellenic Statistical Authority, ELSTAT, the region of Attica, which contains the capital city of Athens, has the smallest area (3.808,10 km²) after the Ionian Islands (2.306,94 km²) and the autonomous area Mount Athos (390 km²), while at the same time, has by far, the largest population (3.814.064 individuals) (ELSTAT, 2021). This highly centralized system resulted in numerous consequences, especially for the rural and smaller municipalities and communities, which were considerably understaffed, not allowing for any progress to take place.

On January 1, 2011 the old administrative structure underwent reform, with the prefectures being abolished and reorganized by the implementation of the Kallikratis programme. Kallikratis, which was named after the ancient Greek architect Callicrates, focused on strengthening the local autonomy of the authorities by reducing the numbers of municipalities and communities and implementing decentralized policies which would promote self-governance and autonomy. The decentralization methods aimed at enhancing the public transparency and accessibility to the citizens. At the same time, the impracticality of additional administrative costs was acknowledged and cost-saving drastic methods were taken on several sectors (Loughlin, Hendriks and Lidström, 2011).

To be precise, the Kallikratis programme introduced a new way of administration by reducing the decentralized agencies of national administration from 13 administrative districts to 7 administrative districts (see Table 5.1). Likewise, the 54 secondary, regional-level self-governing entities, named *prefectures*, were replaced with 13 regions or *periferies*, which are further subdivided into 74 regional units (περιφερειακή ενότητα, *periferiaki enotita*) within the existing regions. Similarly, for the primary, local-level self-governing entities, the total number was reduced from 914 municipalities (Δήμος, *Dimos*) and 120 communities to a much smaller number of 325 municipalities. The municipalities were further subdivided in municipal units, municipal communities and local communities (ibid.).

Table 5.1

Kallikratis subnational entities

Decentralized Administrations	**Regions**	**Number of Municipalities**
Attica	Attica	66
Aegean	South Aegean	34
	North Aegean	8
Crete	Crete	24
Epirus-Western Macedonia	Epirus	19
	Western Macedonia	12

Macedonia-Thrace	Central Macedonia	22
	Eastern Macedonia and Thrace	38
Peloponnese-Western Greece-Ionian Islands	Peloponnese	26
	Ionian Islands	7
	Western Greece	19
Thessaly-Central Greece	Thessaly	25
	Central Greece	25

The last major administrative reform in Greece is the Kleisthenis I programme, named after the ancient Greek legislator Cleisthenes and refers to the law 4555/2018, adopted in July 2018 and implemented a year later, in September 2019. Building upon the 2011 Kallikratis reform, the third-reform, Kleisthenis programme, is focusing on further strengthening the local governance in Greece by enhancing democratic participation and improving the functionality of the local and regional authorities. To begin with, the municipal elections were shifted from a five-year cycle to a four-year cycle, in order to promote citizen participation and engagement. Secondly, a new political tool was given to the local authorities where the municipalities and regions have the ability to hold referendums on matters of local importance. On top of that, six categories of municipalities were introduced, while the distinction between municipal and local communities as subdivisions of the municipalities was abolished. Last but not least, the five municipalities of Corfu, Kefalonia, Servia-Velventos, Lesbos and Samos, established during the 2011 Kallikratis reform, are now divided into smaller municipalities in order to improve the efficiency of those units and to address the overall local needs.

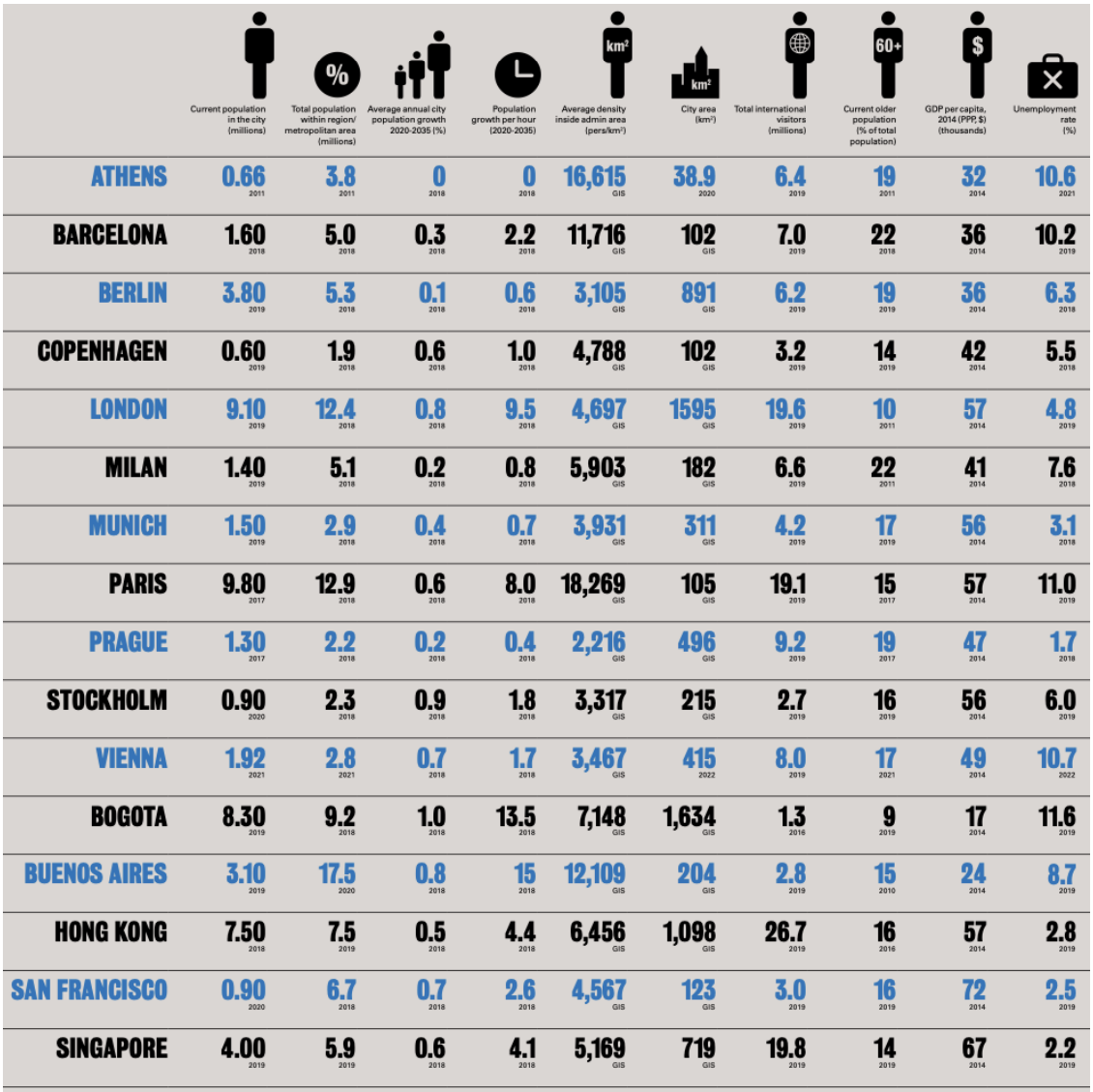
5.3 Region of Attica Demographics

Attica, the triangular peninsula, jutting into the Aegean sea, is the most populous region of Greece. According to Eurostat (2020), Attica is also the region with the highest GDP in Greece, but at the same time, in 2017 the unemployment rate was at 21,6%. Although

the unemployment rate is high compared to other European countries, the numbers peaked in 2013 at 28,7% and are gradually declining (Eurostat, 2020). The region is supervised by the Decentralized Administration of Attica and incorporates eight electoral districts: Athens A, Athens B1, Athens B2, Athens B3, Piraeus A, Piraeus B, East Attica and West Attica. Unfortunately, there is a population shrinkage by approximately 35.965 people between 2011 and 2021 and it is estimated to have a population loss of 0,4% (ELSTAT, 2021).

5.4 City of Athens Demographics

According to the Urban Age, Athens has shown a flat growth curve of 0.1% to 0.2% (see Figure 5.5). In the sample, the Urban Age compared sixteen major cities, such as Barcelona, Berlin, Paris, Vienna, Buenos Aires etc. Athens is the smallest in comparison. standing at 38,9 square kilometers and hosting approximately 660.000 people within a much spacious metropolitan region of 3.8 million individuals. Reportedly, Athens has a considerable compact administrative area of 16.615 people per square kilometer, which is three times higher than the city of London, which reached 4.697 individuals per square kilometer or even five times higher than Berlin, which encompasses 3.105 people per square kilometer. Athens stands as a prominent tourism destination, and Greece strategically leverages its tourism industry to generate significant capital. The influx of international visitors significantly bolsters Athen’s population annually. At 6.4 million, the following figure represents a substantial contribution, though it remains one-third the volume of visitors recorded in London, Paris or Singapore. The average GDP of the Athenians is US$32,484, which indicates a stronger economic growth than several Latino countries but ranks the Athenians as the lowest earners in Europe (LSE, 2022).

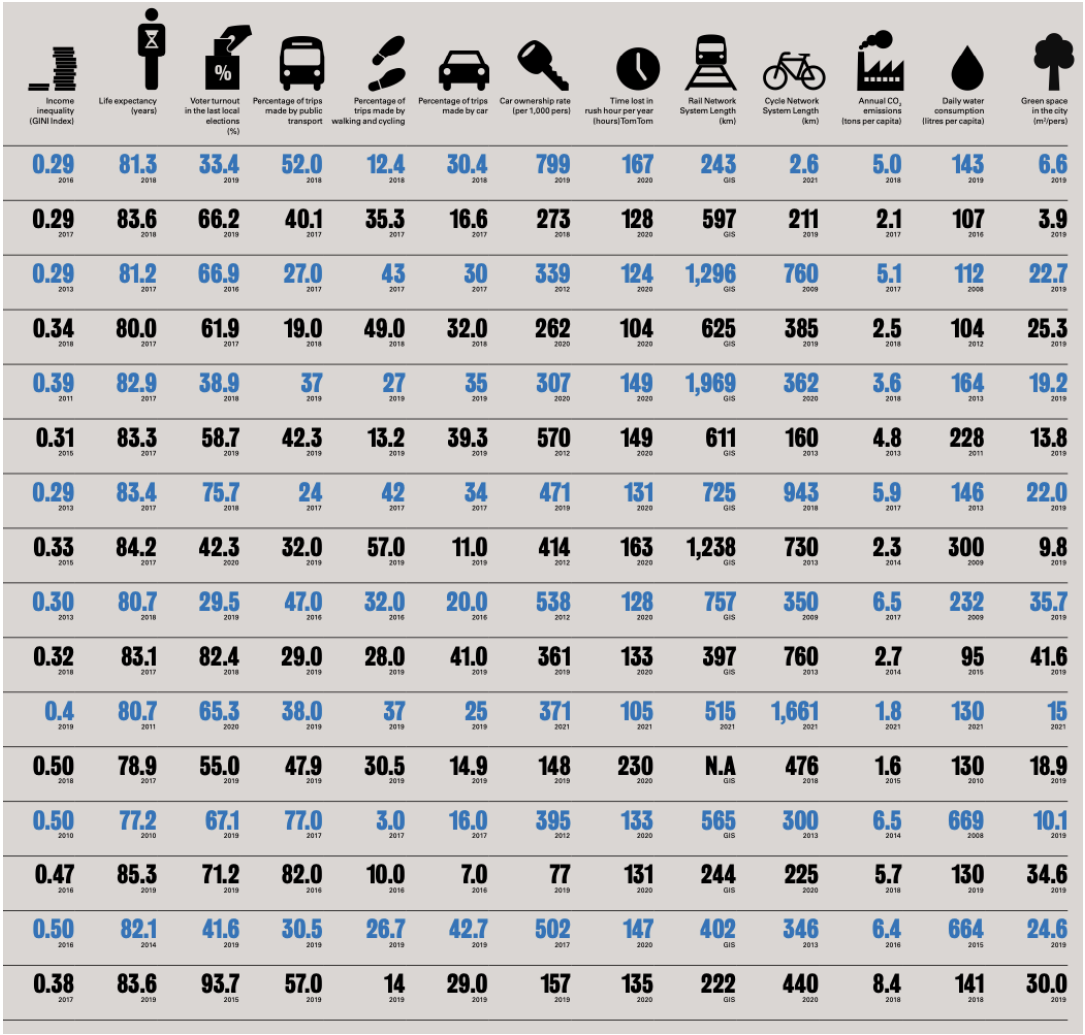


	Current population in the city (millions)	Total population within region/ metropolitan area (millions)	Average annual city population growth 2020-2035 (%)	Population growth per hour (2020-2035)	Average density inside admin area (pers/km²)	City area (km²)	Total international visitors (millions)	Current older population (% of total population)	GDP per capita, 2014 (PPP, $) (thousands)	Unemployment rate (%)
ATHENS	0.66 2011	3.8 2011	0 2018	0 2018	16,615 GIS	38.9 2020	6.4 2019	19 2011	32 2014	10.6 2021
BARCELONA	1.60 2018	5.0 2018	0.3 2018	2.2 2018	11,716 GIS	102 GIS	7.0 2019	22 2018	36 2014	10.2 2019
BERLIN	3.80 2019	5.3 2018	0.1 2018	0.6 2018	3,105 GIS	891 GIS	6.2 2019	19 2019	36 2014	6.3 2018
COPENHAGEN	0.60 2019	1.9 2018	0.6 2018	1.0 2018	4,788 GIS	102 GIS	3.2 2019	14 2019	42 2014	5.5 2018
LONDON	9.10 2019	12.4 2018	0.8 2018	9.5 2018	4,697 GIS	1595 GIS	19.6 2019	10 2011	57 2014	4.8 2019
MILAN	1.40 2019	5.1 2018	0.2 2018	0.8 2018	5,903 GIS	182 GIS	6.6 2019	22 2011	41 2014	7.6 2018
MUNICH	1.50 2019	2.9 2018	0.4 2018	0.7 2018	3,931 GIS	311 GIS	4.2 2019	17 2019	56 2014	3.1 2018
PARIS	9.80 2017	12.9 2018	0.6 2018	8.0 2018	18,269 GIS	105 GIS	19.1 2019	15 2017	57 2014	11.0 2019
PRAGUE	1.30 2017	2.2 2018	0.2 2018	0.4 2018	2,216 GIS	496 GIS	9.2 2019	19 2017	47 2014	1.7 2018
STOCKHOLM	0.90 2020	2.3 2018	0.9 2018	1.8 2018	3,317 GIS	215 GIS	2.7 2019	16 2019	56 2014	6.0 2019
VIENNA	1.92 2021	2.8 2021	0.7 2018	1.7 2018	3,467 GIS	415 2022	8.0 2019	17 2021	49 2014	10.7 2022
BOGOTA	8.30 2019	9.2 2018	1.0 2018	13.5 2018	7,148 GIS	1,634 GIS	1.3 2018	9 2019	17 2014	11.6 2019
BUENOS AIRES	3.10 2019	17.5 2020	0.8 2018	15 2018	12,109 GIS	204 GIS	2.8 2019	15 2010	24 2014	8.7 2019
HONG KONG	7.50 2018	7.5 2019	0.5 2018	4.4 2018	6,456 GIS	1,098 GIS	26.7 2019	16 2016	57 2014	2.8 2019
SAN FRANCISCO	0.90 2020	6.7 2018	0.7 2018	2.6 2018	4,567 GIS	123 GIS	3.0 2019	16 2019	72 2014	2.5 2019
SINGAPORE	4.00 2019	5.9 2019	0.6 2018	4.1 2018	5,169 GIS	719 GIS	19.8 2019	14 2019	67 2014	2.2 2019

Source:https://www.lse.ac.uk/Cities/Assets/Documents/Urban-Age/Athens-Urban-Age-Task-Force-Spatial-Compendium.pdf

Figure 5.5

Athens-in-comparison (1)



Income inequality (GINI Index)	Life expectancy (years)	Voter turnout in the last local elections (%)	Percentage of trips made by public transport	Percentage of trips made by walking and cycling	Percentage of trips made by car	Car ownership rate (per 1,000 pers)	Time lost in rush hour per year (hours) TomTom	Rail Network System Length (km)	Cycle Network System Length (km)	Annual CO_2 emissions (tons per capita)	Daily water consumption (litres per capita)	Green space in the city (m^2/pers)
0.29 2016	81.3 2018	33.4 2019	52.0 2018	12.4 2018	30.4 2018	799 2019	167 2020	243 GIS	2.6 2021	5.0 2018	143 2019	6.6 2019
0.29 2017	83.6 2018	66.2 2019	40.1 2017	35.3 2017	16.6 2017	273 2016	128 2020	597 GIS	211 2019	2.1 2017	107 2016	3.9 2019
0.29 2013	81.2 2017	66.9 2016	27.0 2017	43 2017	30 2017	339 2012	124 2020	1,296 GIS	760 2009	5.1 2017	112 2008	22.7 2019
0.34 2018	80.0 2017	61.9 2017	19.0 2018	49.0 2018	32.0 2018	262 2020	104 2020	625 GIS	385 2019	2.5 2018	104 2012	25.3 2019
0.39 2011	82.9 2017	38.9 2018	37 2019	27 2019	35 2019	307 2020	149 2020	1,969 GIS	362 2020	3.6 2018	164 2013	19.2 2019
0.31 2015	83.3 2017	58.7 2019	42.3 2019	13.2 2019	39.3 2019	570 2012	149 2020	611 GIS	160 2013	4.8 2013	228 2011	13.8 2019
0.29 2013	83.4 2017	75.7 2018	24 2017	42 2017	34 2017	471 2019	131 2020	725 GIS	943 2018	5.9 2017	146 2013	22.0 2019
0.33 2015	84.2 2017	42.3 2020	32.0 2019	57.0 2019	11.0 2019	414 2012	163 2020	1,238 GIS	730 2013	2.3 2014	300 2009	9.8 2019
0.30 2013	80.7 2018	29.5 2019	47.0 2016	32.0 2016	20.0 2016	538 2012	128 2020	757 GIS	350 2009	6.5 2017	232 2009	35.7 2019
0.32 2018	83.1 2017	82.4 2018	29.0 2019	28.0 2019	41.0 2019	361 2019	133 2020	397 GIS	760 2013	2.7 2014	95 2015	41.6 2019
0.4 2019	80.7 2011	65.3 2020	38.0 2019	37 2019	25 2019	371 2021	105 2021	515 2021	1,661 2021	1.8 2021	130 2021	15 2021
0.50 2018	78.9 2017	55.0 2019	47.9 2019	30.5 2019	14.9 2019	148 2019	230 2020	N.A GIS	476 2018	1.6 2015	130 2010	18.9 2019
0.50 2010	77.2 2010	67.1 2019	77.0 2017	3.0 2017	16.0 2017	395 2012	133 2020	565 GIS	300 2013	6.5 2014	669 2008	10.1 2019
0.47 2016	85.3 2019	71.2 2019	82.0 2016	10.0 2016	7.0 2016	77 2019	131 2020	244 GIS	225 2020	5.7 2018	130 2019	34.6 2019
0.50 2016	82.1 2014	41.6 2019	30.5 2019	26.7 2019	42.7 2019	502 2017	147 2020	402 GIS	346 2013	6.4 2016	664 2015	24.6 2019
0.38 2017	83.6 2019	93.7 2015	57.0 2019	14 2019	29.0 2019	157 2019	135 2020	222 GIS	440 2020	8.4 2018	141 2018	30.0 2019

Source:[*https://www.lse.ac.uk/Cities/Assets/Documents/Urban-Age/Athens-Urban-Age-Task-Force-Spatial-Compendium.pdf*](https://www.lse.ac.uk/Cities/Assets/Documents/Urban-Age/Athens-Urban-Age-Task-Force-Spatial-Compendium.pdf)

Figure 5.6

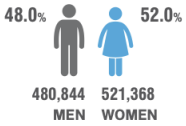
Athens-in-comparison (2)

Although the unemployment rate bursted in the previous years, it seems that it is now stable at 10.6% within the region of Attica (see Figure 5.6) (LSE, 2022). Despite the fact that there are movements in the sustainable transport area, Athens' car ownership is relatively high at 799/1000 individuals. Research evidence suggests that 30% of the trips in Athens are made by car, which is rather high compared to cities like Paris or Barcelona, who score at 11% and 17%. Public transportation constitutes the primary mode of travel for over half (52%) of Athens' trips. In contrast, active mobility, such as walking and cycling remain unutilized. This is due to several reasons. To be precise, the city's topography and the limited extent of its cycling infrastructure, which currently measures only 2.6 kilometers, when Paris cycling network is significantly higher at 730 kilometers.

Paris, whose density is the only one that exceeds Athens, has five times more transport networks. At the same time, Paris has one of the lowest annual amounts of *CO2* at 2.3 tons per capita, while Greece, which is much smaller in size and population, has two times higher levels of *CO2* at 5 tons per capita. The levels of green space in Athens, scoring at 6.63 square meters per person, are relatively low compared to most of the other european countries (ibid.).

5.5 Attica's regional units

Attica is subdivided in eight subordinate regional units (ELSTAT, 2021):



Regional Unit of Kentrikos Tomeas Athinon

Municipality	Population		Men		Women	
	2011	2021	2011	2021	2011	2021
ATHINA	664,046	**643,452**	315,210	310,569	348,836	332,883
VYRON	61,308	**59,134**	28,992	27,910	32,316	31,224
GALATSI	59,345	**57,909**	28,399	27,715	30,946	30,194
DAFNI - YMITTOS	33,628	**33,886**	15,829	16,118	17,799	17,768
ZOGRAFOS	71,026	**69,874**	33,097	32,790	37,929	37,084
ILIOUPOLI	78,153	**76,730**	37,098	36,445	41,055	40,285
KAISARIANI	26,458	**26,269**	12,486	12,488	13,972	13,781
NEA PHILADELFEIA - NEA CHALKIDONA	35,556	**34,958**	17,043	16,809	18,513	18,149

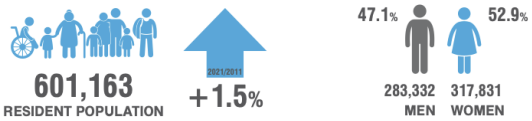
Source: https://elstat-outsourcers.statistics.gr/census_results_2022_en.pdf

Figure 5.7

Central Athens Regional Unit

The first and most populous one is *Kentrikos Tomeas Athinon* (Central Athens Regional Unit) (see Figure 5.7). According to the available data, the total population stands at 1.002.212. This figure represents a 2.7% decrease compared to 2011. It consists of eight municipalities, with Athens being the capital of the country and by far, the most populous one, reaching 1.002.212 residents in 2021. According to Eurostat, the Central

Athens Regional Unit is the second most densely populated region in Europe (Eurostat, 2020), with 11.796,14 inhabitants per square kilometer (ELSTAT, 2021), following Paris. The territory of reference encompasses an area of 87,27 square kilometers.



Regional Unit of Voreios Tomeas Athinon

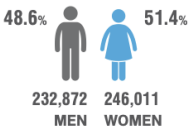
Municipality	Population		Men		Women	
	2011	2021	2011	2021	2011	2021
AMAROUSIO	72,333	**71,830**	33,738	33,516	38,595	38,314
AGIA PARASKEVI	59,704	**62,147**	27,822	29,104	31,882	33,043
VRILISSIA	30,741	**32,417**	14,605	15,410	16,136	17,007
IRAKLEIO	49,642	**50,494**	23,770	24,084	25,872	26,410
KIFISIA	71,259	**72,878**	33,389	34,400	37,870	38,478
LYKOVRYSI - PEFKI	31,153	**30,998**	14,897	14,782	16,256	16,216
METAMORFOSI	29,891	**30,174**	14,599	14,522	15,292	15,652
NEA IONIA	67,134	**64,611**	32,505	31,197	34,629	33,414
PAPAGOS - CHOLARGOS	44,539	**45,266**	20,278	20,651	24,261	24,615
PENTELI	34,934	**35,610**	16,868	17,096	18,066	18,514
FILOTHEI - PSYCHIKO	26,968	**27,636**	11,946	12,530	15,022	15,106
CHALANDRI	74,192	**77,102**	34,743	36,040	39,449	41,062

Source: https://elstat-outsourcers.statistics.gr/census_results_2022_en.pdf

Figure 5.8

Regional Unit of Voreios Tomeas Athinon

The *Regional Unit of Voreios Tomeas Athinon* is the second most populous region in Attica (see Figure 5.8), with a total population of 601.163. This figure signifies a positive change of 1.5% relative to 2011. The regional unit incorporates twelve municipalities, with Kifissia serving as the administrative head of the urban area, while Amarousio functions as the primary urban center.



Regional Unit of Dytikos Tomeas Athinon

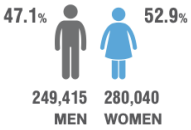
Municipality	Population		Men		Women	
	2011	2021	2011	2021	2011	2021
PERISTERI	139,981	**133,630**	68,563	65,077	71,418	68,553
AGIA VARVARA	26,550	**26,759**	12,650	12,747	13,900	14,012
AGIOI ANARGYROI - KAMATERO	62,529	**61,462**	30,925	30,219	31,604	31,243
AIGALEO	69,946	**65,831**	34,008	32,014	35,938	33,817
ILIO	84,793	**84,004**	41,594	40,833	43,199	43,171
PETROUPOLI	58,979	**60,146**	28,582	28,999	30,397	31,147
CHAIDARI	46,897	**47,051**	23,245	22,983	23,652	24,068

Source: https://elstat-outsourcers.statistics.gr/census_results_2022_en.pdf

Figure 5.9

Regional Unit of Dytikos Tomeas Athinon

The regional unit located west of Athens, is called *Regional Unit of Dytikos Tomeas Athinon*, with the total population reaching 478.833 inhabitants (see Figure 5.9). A 2,2% decrease is evident, compared to the previous population figures. The regional unit consists of seven municipalities, where Peristeri hosts the highest numbers of population. According to data provided by Eurostat, Dytikos Tomeas Athinon ranks seventh on the most densely populated regions in Europe (Eurostat, 2020). Notably, it stands as the third-densest region unit within Greece with population density up to 7.126,08 inhabitants per square kilometer in an overall area of 66,8 square kilometers (ELSTAT, 2012).



Regional Unit of Notios Tomeas Athinon

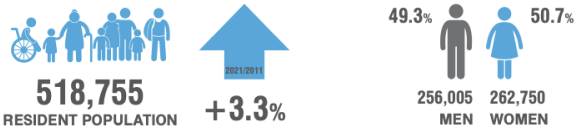
Municipality	Population		Men		Women	
	2011	2021	2011	2021	2011	2021
KALLITHEA	100,641	**97,616**	46,782	45,558	53,859	52,058
AGIOS DIMITRIOS	71,294	**71,664**	34,668	34,624	36,626	37,040
ALIMOS	41,720	**43,174**	19,663	20,499	22,057	22,675
GLYFADA	87,305	**89,597**	41,135	42,257	46,170	47,340
ELLINIKO - ARGYROUPOLI	51,356	**50,027**	24,604	23,758	26,752	26,269
MOSCHATO - TAVROS	40,413	**39,661**	19,440	19,178	20,973	20,483
NEA SMYRNI	73,076	**72,853**	33,607	33,642	39,469	39,211
PALAIO FALIRO	64,021	**64,863**	29,429	29,899	34,592	34,964

Source: https://elstat-outsourcers.statistics.gr/census_results_2022_en.pdf

Figure 5.10

Regional Unit of Notios Tomeas Athinon

The *Regional Unit of Notios Tomeas Athinon* is located south of the center of Attica and covers an area of 70 square kilometers (see Figure 5.10). Data from Eurostat indicates that Notios Tomeas Athinon is the fifth most densely populated region in Europe and second in Greece with population density reaching up to 7.692,46 residents per square kilometer (ELSTAT, 2021). There are eight municipalities present in the region that boast a population of up to 529.455 inhabitants. A slight decline of 0.1% can be observed since 2011.



Regional Unit of Anatoliki Attiki

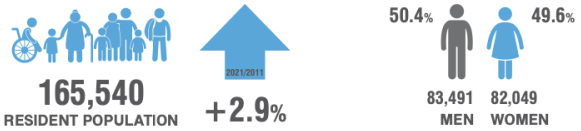
Municipality	Population		Men		Women	
	2011	2021	2011	2021	2011	2021
ACHARNES	106,943	**108,169**	53,905	53,622	53,038	54,547
VARI - VOULA - VOULIAGMENI	48,399	**52,546**	23,654	25,329	24,745	27,217
DIONYSOS	40,193	**42,376**	19,492	20,530	20,701	21,846
KOROPI	30,307	**30,817**	15,277	15,349	15,030	15,468
LAVRIO	25,102	**25,199**	12,474	12,520	12,628	12,679
MARATHONAS	33,423	**31,331**	18,661	16,266	14,762	15,065
MARKOPOULO MESOGAIAS	20,040	**21,722**	9,845	10,631	10,195	11,091
PAIANIA	26,668	**28,036**	13,192	13,727	13,476	14,309
PALLINI	54,415	**59,459**	26,694	28,914	27,721	30,545
RAFINA - PIKERMI	20,266	**22,327**	9,839	10,821	10,427	11,506
SARONIKOS	29,002	**30,047**	14,345	14,774	14,657	15,273
SPATA - ARTEMIS	33,821	**34,915**	16,730	17,254	17,091	17,661
OROPOS	33,769	**31,811**	18,509	16,268	15,260	15,543

Source: https://elstat-outsourcers.statistics.gr/census_results_2022_en.pdf

Figure 5.11

Regional Unit of Anatoliki Attiki

An examination of regional population data reveals that *Regional Unit of Anatoliki Attiki* boasts the most significant increase since 2011, with a growth rate of 3.3% (see Figure 5.11). In 2021 the resident population of this region stood at 518.755 individuals. This region is relatively low density compared to the other regional units of Attica with the numbers reaching up to 332,02 residents per square kilometer. This is due to the fact that the Regional Unit of Anatoliki Attiki holds an area of 1.517 square kilometers, considerably spacious compared to other regions (ELSTAT, 2012).



Regional Unit of Dytiki Attiki

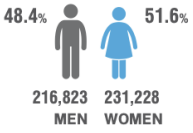
Municipality	Population		Men		Women	
	2011	2021	2011	2021	2011	2021
ELEFSINA	29,902	**30,147**	14,925	14,873	14,977	15,274
ASPROPYRGOS	30,251	**31,381**	15,872	16,108	14,379	15,273
MANDRA - EIDYLLIA	17,885	**17,822**	8,785	8,699	9,100	9,123
MEGARA	36,924	**38,033**	19,488	20,122	17,436	17,911
FYLI	45,965	**48,157**	22,869	23,689	23,096	24,468

Source: https://elstat-outsourcers.statistics.gr/census_results_2022_en.pdf

Figure 5.12

Regional Unit of Dytiki Attiki

The *Regional Unit of Dytiki Attiki*, headquartered in Elefsina, has the second lowest population in Attica, with numbers not exceeding 165.540 in 2021 (see Figure 5.12). There is an increase of 2.9% in population and the overall density of the regional unit is considered low, with numbers up to 160,28 individuals per square kilometer, in a large area of 1002 square kilometers (ELSTAT, 2012).



Regional Unit of Peiraias

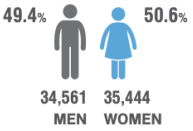
Municipality	Population		Men		Women	
	2011	2021	2011	2021	2011	2021
PEIRAIAS	163,688	**168,151**	78,200	80,642	85,488	87,509
KERATSINI - DRAPETSONA	91,045	**89,536**	43,922	43,247	47,123	46,289
KORYDALLOS	63,445	**61,248**	31,642	30,257	31,803	30,991
NIKAIA - AGIOS IOANNIS RENTIS	105,430	**103,488**	51,200	50,061	54,230	53,427
PERAMA	25,389	**25,628**	12,448	12,616	12,941	13,012

Source: https://elstat-outsourcers.statistics.gr/census_results_2022_en.pdf

Figure 5.13

Regional Unit of Peiraias

Following, located south of Athens, the *Regional Unit of Peiraias* hosts the most important port in Greece. According to data from ELSTAT, the population is 448.051 and has a slight decrease compared to 2011 (see Figure 5.13) of 0.2 since, but an overall increase compared to the previous decades. The municipality of Piraeus is the fifth most populous municipality in Greece and the second largest within Athens urban area (ibid.)



Regional Unit of Nisoi

Municipality	Population		Men		Women	
	2011	2021	2011	2021	2011	2021
SALAMINA	39,283	**37,220**	19,638	18,340	19,645	18,880
YDRA	1,966	**2,070**	977	1,023	989	1,047
AGKISTRI	1,142	**1,131**	580	571	562	560
AIGINA	13,056	**12,911**	6,456	6,328	6,600	6,583
KYTHIRA	4,041	**3,644**	2,055	1,870	1,986	1,774
POROS	3,993	**3,261**	2,180	1,603	1,813	1,658
SPETSES	4,027	**3,748**	1,969	1,833	2,058	1,915
TROIZINA - METHANA	7,143	**6,020**	3,631	2,993	3,512	3,027

Source: https://elstat-outsourcers.statistics.gr/census_results_2022_en.pdf

Figure 5.14

Regional Unit of Nisoi

Lastly, *Regional Unit of Nisoi*'s territorial scope hosts eight municipalities and encompasses the Saronic islands, as well as a section of the Peloponnese peninsula and a collection of islands situated off the eastern Peloponnese coastline. The region unit's total area is 897,6 square kilometers (see Figure 5.14). Data analysis suggests that the Regional Unit of Nisoi has experienced the most substantial population decline among Attica's regional units. This decline stands at 6.2% compared to the figures projected in 2011 and the 2021 population was 70.005 individuals. A similar trend of population decline is, unfortunately, observable in various island communities throughout the country, leading to a gradual and concerning depopulation of these areas (ELSTAT, 2012).

CHAPTER 6

PLAN QUALITY EVALUATION FRAMEWORK

"If I have seen further, it is by standing on the shoulders of giants"

Isaac Newton (1643-1727)

6.1 Background

A plan is one of the planner's most valuable tools in order to strive for future growth and development (Dalton *et al.*, 1989). Research on plan quality evaluation has evolved and expanded considerably in recent years, with a clear focus on hazard mitigation plans and less on municipal climate change plans (Horney *et al.*, 2016; Stevens, Lyles and Berke, 2014). A simple definition of plan quality evaluation is: A measure of presence or absence of key components within a plan (Dalton *et al.*, 1989).

If planning is to be considered a discipline, it is essential to establish evaluation criteria which determine the effectiveness and distinguish high quality plans from the ones that fall short (Alexander and Faludi, 1989). It is a known fact that a successful execution of any adopted plan has the ability to significantly impact the community's well-being across multiple dimensions and ultimately, improve the quality of life. These aspects encompass a wide variety, from environmental justice and resilience to hazards to the efficiency of transportation and cost-effectiveness of infrastructure, as well as other crucial considerations.

It is obvious that the preparation of such instruments is a collective effort from the government, the public and the stakeholders, transforming it to a matter of democracy, values and future growth (Berke and Godschalk, 2009). This reveals the true nature of these plans, which is to report, inform and unite. Initiatives that overlook the synergy of these elements are demonstrably less likely to succeed. It is crucial for the planners and the government to acknowledge the weight of responsibility the public has entrusted them with (Baer, 1997).

6.2 Issues

Despite the fact that municipal plans are of crucial importance to the communication between the government, the public, the stakeholders, as well as other internal and external entities, it is abstruse that there are no mandated evaluations against plan quality standards. Scientific evidence reveals that there is a critical knowledge gap that exists regarding the quality of plans due to the absence of regular evaluation and assessment policies against benchmarks for best practice standards (Berke and Godschalk, 2009). Researchers Berke., Godschalk and Hopkins , which are widely considered among the pioneers of plan quality evaluation discipline, confirm the claims. They attribute this gap on five primary reasons (Berke and Godschalk, 2009; Hopkins, 2001):

- The difficulty in evaluating the quality of plans arises, in part, from the inherent complexity of such plans, as well as the long-term focus that they usually aspire to have. The reality of these plans is that they are designed to address multifaceted issues or even aspirations, over extended timeframes. This situation often counters any intention of assessment against plan quality standards.
- Another point Hopkins makes is that this gap may stem from the variety of academic perspectives regarding the nature and fundamental purpose of those plans. In the reading passage the author provides two examples to illustrate this concept. Firstly, the plan intends to be plain and concrete, focusing on reporting developments and public investments. In contrast, the nature of another plan is to be more transient provisional outlines, in order to be utilized as a tool for professional deliberation.
- Moreover, the researchers suggest that perhaps the gap originates from the inherent uniqueness of the plans, which are designed to satisfy specific local needs.
- At the same time, the complex legal framework of land-use planning, such as constitutional principles and laws, further increases the gap in our knowledge.
- Lastly, another consideration Berke brings to the table is that the evaluation gap can also be attributed to the fact that there is a prevailing perception that these plans can serve as artistic endeavors and thus, this disproportion counters any intent for evaluation against standardized plan quality criteria.

The researchers conclude by stating that systematic assessment of plans is the only true way to identify the plan's weaknesses, appreciate the strengths and recognize any

possible trends. Mirroring the academic framework, the aforementioned researchers point out that the evaluation of plans serves as a learning process, enabling us with the ability to improve and enhance our plan preparation and composition skills.

6.3 Characteristics

Content analysis on plan quality evaluation is usually conducted by creating or adopting key *characteristics*, supported by the relevant *indicators*. The characteristics and indicators designed for this specific paper are further described in the following chapters. This section examines the available academic literature and highlights the proposed characteristics of numerous comprehensive studies across the plan quality evaluation context. Later in the paper, the *Methodology* chapter will synthesize key characteristics for evaluating plan quality, drawing upon insights from the various comprehensive studies examined in this subsection. It is critical to understand that most of the following research literature, as well as the most influential available academic articles, use to form synopsis and summarize the characteristics and indicators that are found among the various plan quality assessments. Concurrently, the researchers adopt the ones that are most commonly used and finally, they design or pick the most appropriate ones that would fit the evaluation of their specific samples.

To begin with, a considerably influential perspective, cited repeatedly in academic papers internationally, regarding the conceptual dimension that should be taken into consideration when assessing a plan is that of Berke and Godschalk. More specifically (Berke and Godschalk, 2009):

- The first proposed framework that the researchers suggest is the internal plan quality. This dimension evaluates the format and content of the essential components of the plan. Those components vary from the issues and vision statement, the fact base, the goal and policy framework, the implementation and monitoring.
- The second dimension is the external plan quality. By assessing the plan's scope and coverage, this framework refers to stakeholder values and the current local context and focuses on the overall maximization of use and influence of the specific plan.

The authors conducted a meta-analysis research of sixteen published plan quality evaluations and revealed the trends of strengths and weaknesses of those plans. To be

precise, the researchers identified the major plan-quality internal and external characteristics, drawn from 712 mandated, non-mandated, regional, local, state, sustainable development and non-sustainable development plans.

More specifically, the internal characteristics consist (ibid.):

1. Issue identification and visioning: A snapshot of community needs, assets, trends and aspirations.
2. Direction-setting elements that include goals: Public values embodied in future land-use plans.
3. Fact base and policy selection: Assessment of present and future patterns and supporting arguments.
4. Policies for guiding future settlement patterns: Guiding principles and achieving land-use goals.
5. Foundation for plan implementation actions: Commitments aligned with policy objectives.
6. Monitoring and evaluation: Community change tracking system
7. Internal consistency: Assessment of the integration of the first six elements

Additionally, the external characteristics encompass:

1. Organization and presentation: Strategies to ensure accessibility for diverse audiences.
2. Interorganizational coordination: Alignment and cooperation with complementary public or private fields and policies.
3. Compliance to ensure consistency with federal and state mandates: Complying with the legislative intent behind plan mandates.

Another pioneer in the plan quality evaluation context, Baer, proposed a set of *standardized criteria* back in 1997. These criteria were designed to improve the plan quality evaluation. By analyzing several plans, he distinguished the trends and formed the following categories (Baer, 1997; Berke and Godschalk, 2009):

- *Adequacy of content*, which translates to the political context, the administrative authorities, the purpose, the funding etc.
- *Rational Model* considerations, which refers to evaluation criteria, goals, objectives, internal coordination and cooperation etc.
- *Procedural validity*, which considers every group that worked in the plan, the data, models and methods used etc.

- *Adequacy of scope*, which claims the consideration of relevant and significant issues (of equity and efficiency), any financial and fiscal implication and cost-efficient strategy, the political feasibility etc.
- *Guidance for implementation*, which prioritizes the scheduling and coordination, the costs, the timeframe, the impact analysis etc.
- *Approach data and methodology*, which relates to everything regarding data, such as the flexibility of adding data, the methodology of the cited sources etc.
- *Quality of communication*, which encompasses any communicative and rational skills, such as the quality of presentations and the comprehensiveness of the proposals etc.
- *Plan format*, which contains any procedural element, such as the size of the document, the date of the publication, the graphic design, the citation etc.

Moreover, a valuable insight for designing the most suitable characteristics for this paper is that of Ellis, Gunton and Rutherford who formed a methodology in order to evaluate environmental public systems. The researchers made a synopsis of the literature of most influential international efforts, publications and reports on sustainable development. The analysis included the publications of World Bank (1995), Laffery and Meadowcroft (2000), OECD (2001), Dalal-Clayton and Bass (2002), UN DESA (2002), European Commission (2004), IISD (2004), OECD (2005), CESD (2005), Gunton and Galbick (2006) and Gunton and Joseph (2007). Then, the researchers created eight criteria which were the most spotted ones in the literature review and accompanied them with associated components in order to further instruct the evaluation (Ellis, Gunton and Rutherford, 2010; Zeiger, 2012).

Zeiger made a summary of the key characteristics that were found in Ellis, Gunton and Rutherfor's comprehensive literature review with the exception of the Canadian studies CESD (2005), Gunton and Galbick (2006) and Gunton and Joseph (2007) and the addition of IDPM (2001) and Steurer and Martinuzzi (2003). Zeiger found that the aspects that were most referenced were the following and concluded that due to that, these should be the best aspects that should instruct his study, about the evaluation of the German federal government's environmental sustainability planning system (see Figure 6.1) (Zeiger, 2012).

1) Comprehensive Goals with Measurable Targets
2) Effective Strategy
3) Integration

4) Monitoring
5) Leadership and Accountability
6) Adaptive Management
7) Stakeholder Collaboration
8) Legal Framework

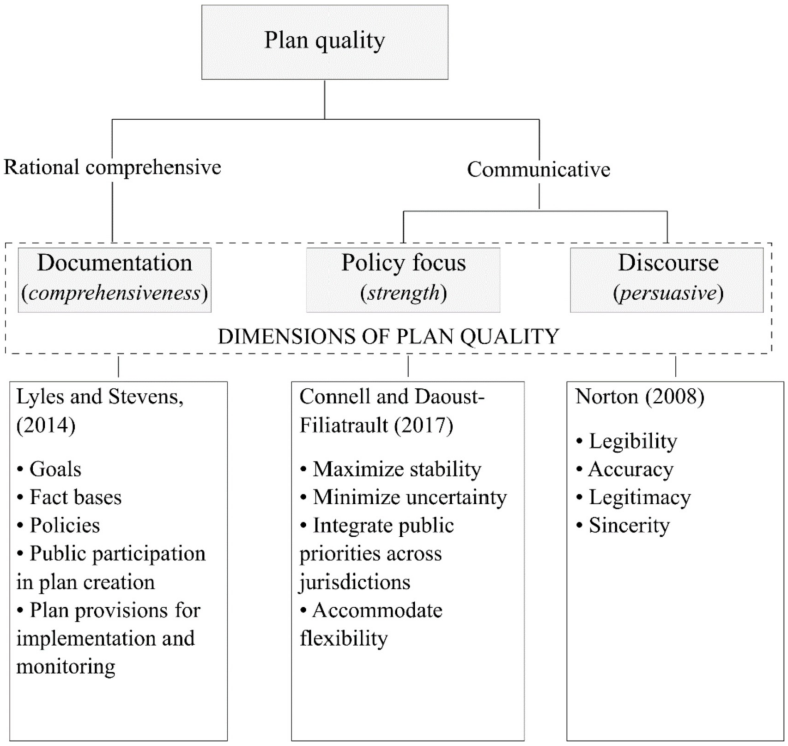
	Comprehensive Goals with Measurable Targets	Effective Strategy	Integration	Monitoring	Leadership and Accountability	Adaptive Management	Stakeholder Collaboration	Legal Framework
World Bank 1995	X	X	X	X		X	X	X
Meadowcroft and Lafferty 2000	X		X	X			X	X
OECD 2001	X	X	X	X	X	X	X	
IDPM 2001	X	X	X	X	X	X	X	
UN DESA 2002	X	X	X	X	X	X	X	
Dalal-Clayton and Bass 2002	X	X	X	X	X	X	X	
Steurer and Martinuzzi 2003	X	X	X	X	X		X	
IISD 2004	X	X	X	X	X	X	X	X
European Commission 2004	X		X	X	X		X	
OECD 2006			X	X	X	X	X	
Ellis, Gunton and Rutherford 2010	X	X	X	X	X	X	X	X

Source: https://summit.sfu.ca/item/12531

Figure 6.1

Most referenced aspects

Additionally, Hossu, Ioja, Mitincu, Artmann and Hersperger, summarized various academic research papers and adopted several key characterics in order to evaluate the quality of Romania's Local Environmental Action Plans. The researchers later decided that the best option for the Romanian context is the framework of Conell and Daoust-Filiatrault (Hossu *et al.*, 2020) (see Figure 6.2).



Source: https://journals.sagepub.com/doi/10.1177/0739456X17709501

Figure 6.2

Conell and Daoust-Filiatrault's Plan Quality Evaluation Framework

Conell and Daoust-Filiatrault divided the plan quality in two main aspects- the rational comprehensive and the communicative. These aspects were separated into three *dimensions*. The first aspect is the *rational comprehensive*, which contains the *documentation dimension* and translates to the comprehensiveness of the document. The second aspect is the *communicative*, which encompasses the *policy focus dimension* and focuses on the strength of the plan and the *discourse dimension* which measures the persuasiveness of the document. Through a comprehensive analysis of academic literature, the researchers identified the key criteria which would most appropriately fit to their specific context.

Evidently, the most commonly cited criteria (Guyadeen and Henstra, 2023), used in order to evaluate the quality of plans are (Berke *et al.*, 2006; Berke and Godschalk, 2009; Horney *et al.*, 2016):

1. Fact base
2. Goals
3. Policies
4. Implementation

5. Monitoring and evaluation
6. Coordination
7. Participation
8. Plan organization and presentation

The aforementioned summarize the criteria that can be found across the plan quality evaluation context. They will later be examined and applied in the *Characteristics* section of the *Methodology* chapter. Indeed, it can be argued that there are other criteria that better fit on certain samples. It is crucial to understand that researchers usually pick, adopt or design the ones that better fit the framework and express the specific aspects of their own studies. The eight aforementioned characteristics serve a great purpose of summarizing the requirements of the average plan quality evaluation. Specific points that need to be mentioned, can be expressed as indicators and will be incorporated in these eight standardized characteristics.

6.4 Qualitative and Quantitative Indicators

To begin with, global literature and academic papers take advantage of the use of indicators in order to measure or assess relevant components. Plan quality evaluations adopt several characteristics which are supported by numerous indicators, according to their specific context, in order to formulate the most effective research methods that aim to achieve a satisfactory evaluation.

There are two types of indicators that need to be considered in order to gain a better understanding of climate change evaluation before choosing the most appropriate set. The first type are the quantitative indicators and they are focused on calculating the performance of climate change components by measuring their respective numbers. The components have been explored during the literature review in the *Climate Change* chapter and can provide the reader with a more comprehensive interpretation of the factors that trigger climate change or the issues that follow as a consequence. Research within the first category is primarily concerned with the quantification of these diverse plan quality components through the application of pertinent indicators. For example- GHG emissions measured in tons per capita.

The second type are the qualitative indicators and they contain the rational and communicative perspectives of the plan quality evaluation framework. The studies which belong to this type, focus on whether the plan addresses the goals and issues, refers to

relevant public policies, encompasses stakeholders and public participation, communicates with the reader and suggests implementation strategies. For instance- "Does the plan include a clearly defined goal for improving the overall environmental quality of the country?" (Hossu *et al.*, 2020b), an indicator which refers to the *fact base characteristic* of the study.

This paper aspires to adopt the most appropriate set of indicators in order to assess Greece's most urbanized regional unit. One of the paper's hypothesis proposes that plan quality evaluation benefits from both qualitative and quantitative indicators, even if the paper itself isn't concerned with quantification-based assessment. By exploring and valuing all relevant measures, a more comprehensive set of indicators can be developed for effective plan assessment. Later in the paper, in the *Indicators* section of the *Methodology* chapter, the chosen set of indicators will be revealed.

Climate change's quantitative indicators will be further investigated in the section below, while the qualitative ones will be examined and applied directly in the *Methodology* chapter.

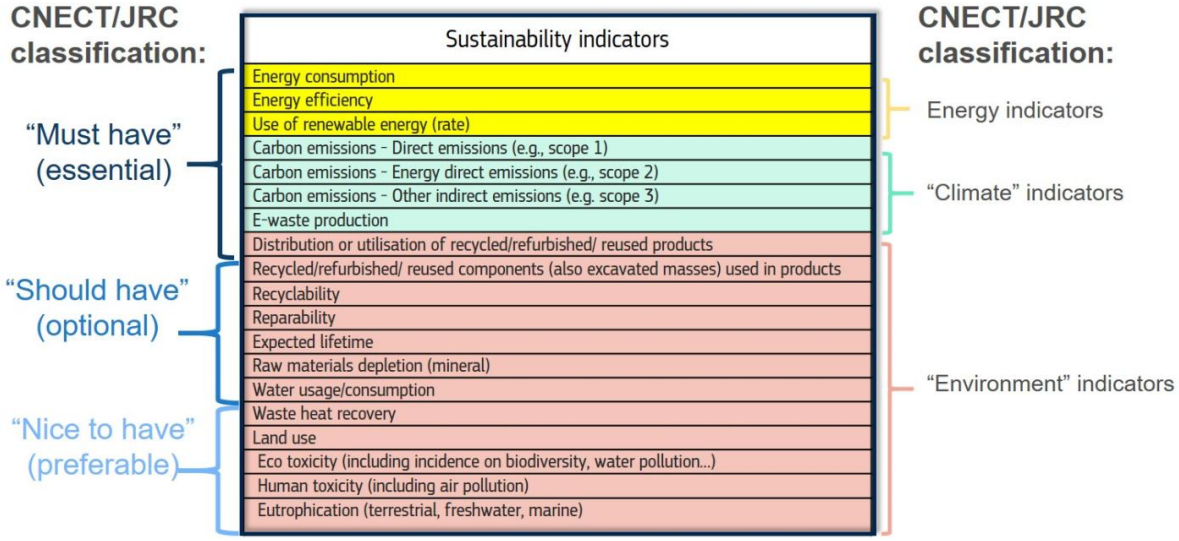
6.5 Climate Change Quantitative Indicators

Climate change's quantitative indicators need to be investigated before examining the research methods of this paper. This type of indicators is not concerned with addressing the rational and communicative perspectives of a plan, but instead, they aim to measure the relevant components of climate change and calculate the performance of the municipality. An examination of this type of in-depth indicators can provide this paper with a holistic view- essential for the comprehensiveness of the paper. Additionally, these components were previously explored in the *Climate Change* chapter and further confirmed in this section. It is noteworthy to mention that the indicators which aim on the components that trigger climate change, as well as the ones that are affected by it, have been carefully chosen after a comprehensive literature review in order to be pertinent to the Central Athens Regional Unit context.

Lowe et al. (Lowe *et al.*, 2015), confirm that it is possible to create healthy and sustainable cities with the use of relevant indicators planned to influence local, metropolitan, state and federal policies. In the case of United States, Holden and Martin & Morehead (Holden, 2006; Lowe *et al.*, 2015), point out that the Seattle Indicators of Sustainable Communicate and Greater Portland Pulse, have been promoting sustainable

development policies through relevant indicators, as well as sustainable infrastructure in combination with partnerships between the private and public sector since 1990.

The European Commission conducted a survey in 2023, in order to collect inputs on sustainability indicators from stakeholders involved in the design, development, deployment and operation of telecommunication networks (see Figure 6.3). To be precise, the survey was aiming to identify common indicators to measure the sustainability of electronic communication networks (ECNs) and the provision of ECSs. The Directorate-General for Communications Networks, Content and Technology (DG CNECT) and the Directorate-General for Joint Research Team (DG JRC) defined the prioritization of the indicators. The indicators were separated into three main sections (European Commission, 2024).



Source:https://joint-research-centre.ec.europa.eu/scientific-activities-z/green-and-sustainable-telecom-networks/sustainability-indicators-telecom-networks_en

Figure 6.3

Sustainability indicators divided into three sectors

The first section, called "Must have", encompasses all indicators essential for sustainability. The essentials include every energy and climate indicator, such as energy consumption and carbon emissions. The second section, named "Should have", translates to the optional indicators and the last section is characterized as "Nice to have", meaning the preferable indicators for sustainability. The last two sections include every "Environment" indicator apart from the "Distribution or utilization of recycled/refurbished/reused products", which belongs to the essential section.

There are numerous studies and publications that indicators can be drawn from. The choice of indicators in scientific research is driven by their relevance to the research question and the ability to provide valid and reliable data.

According to the UN (United Nations, 2017) there are 248 indicators adopted by the General Assembly, 2017, formed and designed to succeed the Sustainable Development Goals for the 2030 Agenda for Sustainable Development.

The International Organization for Standardization (ISO) outlines the methodologies for identifying and establishing a set of 104 key performance indicators in 2018 and another 79 in 2019, for city services and quality of life. The organization claims that the indicators are designed to serve as a comprehensive guide for any city, municipality or local government seeking to measure or evaluate their overall performance in a comparable and variable way, regardless of the size or location (ISO, 2018; ISO, 2019).

The European Telecommunication Institute (ETSI), which is a standardization organization in the field of information and communications released a set of 76 key performance indicators for sustainable digital multiservice cities (ETSI, 2017), aiming on the people, planet, prosperity and governance (Liu and Ebrahimi, 2024).

The International Telecommunications Agency (ITU), which is a specialized agency of the UN, created a set of 52 key performance indicators focused on the economy, environment, society and culture (ITU-T, 1990).

The United for Smart Sustainable Cities (U4SSC) designed a set of key performance indicators as a critical tool for achieving the UN's SDGs. These key performance indicators empower cities and communities on a global scale, with the overall aim to evaluate the impact of Information and Communication Technologies (ICTs) on achieving smart and sustainable development. This is a self-assessment tool designed to be aligned with the SDGs (U4SSC KPI, 2021).

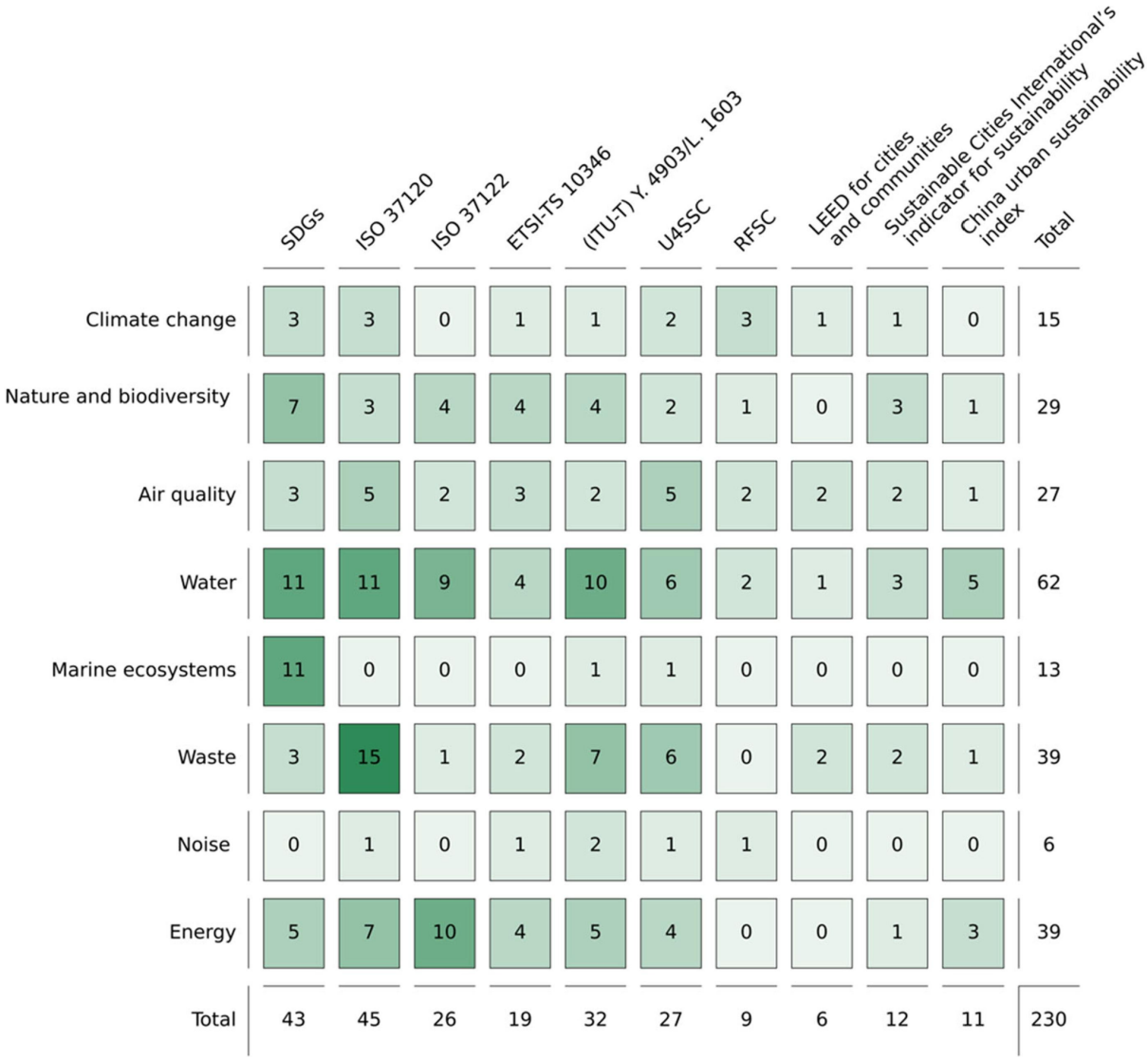
The European Reference Framework for Sustainable Cities and Communities published a set of 28 key performance indicators, guiding planners towards just, green and productive cities (RFSC, 2016).

The Leadership in Energy and Environmental Design (LEED), which is the world's most widely used green building rating system, developed a set of 14 key performance indicators for Sustainable Cities and Communities (LEED, 2021).

Sustainable Cities International released another set of 32 key performance indicators focused on the three pillars- economy, society and environment (Liu and Ebrahimi, 2024).

The Urban China Initiative (UCI), along with the McKinsey Global Institute (MGI) published a set of 21 indicators for China's urban sustainability index in their annual project of 2013 and later in 2014 (Li *et al.*, 2014).

Liu H. and Ebrahimi B. made a synopsis (see Figure 6.4) of the aforementioned sources and revealed the indicators that were most frequently mentioned, in order to address the eight main environmental challenges in the Norwegian context (ibid.).



Source: https://www.sciencedirect.com/science/article/pii/S2590252024000047#b0025

Figure 6.4

The Number of Indicators Addressing the Environmental Challenges

The synopsis revealed the degree of how many times indicators for the eight greatest environmental issues were mentioned. A total of 230 indicators are addressing the eight environmental challenges. The SDGs have the highest number of indicators, while LEED

for Cities and Communities encompass the lowest number. Additionally, the highest number of indicators is by far directed at water pollution with a total of 62 indicators, while the lowest number is referring to the noise pollution with 6 indicators overall. The only environmental challenges that include indicators from all of the 10 aforementioned studies are water pollution and air quality.

In our case, the indicators are being analyzed and translated with a direction to climate change. There is a direct and indirect connection between the indicators and the aftermath of climate change or the factors that trigger it (see Table 6.1). It is crucial to understand that some of the environmental challenges, such as noise pollution, are not directly related to climate change and thus, including it in this paper would be a lack of coherence. At the same time, there are other critical environmental issues, such as *marine areas degradation*, which are not related to the Central Athens Regional Unit context and will be excluded as well.

Table 6.1

First-Type-Indicators for Climate Change

The most critical Climate Change Challenges	**Most frequently cited indicators in the 10 aforementioned sources**
Direct Climate Change	1. GHG emissions per capita (t *CO2* e capita/ yr.). 2. $CO2$ emissions per unit of economic output by sector. 3. Disaster mortality and impact rate per 100.000 population. 4. Indicator to measure the strength of Climate Resilience Strategies.
Biodiversity Loss and Natural Degradation	1. The ratio of annual land consumption rate (hectares/year) to annual population growth rate (percentage). 2. The proportion of local breeds defined by their status according to the IUCN Red List criteria as Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), (Data Deficient (DD), Not Evaluated (NE).

	3. The Red List Index (RLI). 4. The percentage change in the abundance of a native species over a defined period of time. 5. The proportion of countries with national legislation targeting invasive alien species (IAS) prevention and control, as well as an evaluation of resources aimed at the assistance of IAS management programs. 6. The total area (hectares or square kilometers) or the proportion of land and water preserved for the protection of the environment within a defined area. 7. The percentage change in the extent (hectares or square kilometers) of various water ecosystems.
Air Pollution	1. Annual mean concentration of PM2,5(ug/m^3). 2. Annual mean concentration of PM10(ug/m^3). 3. Annual mean concentration of NO2(ug/m^3).
Freshwater Pollution	1. Proportion of amounts of water with good ambient water quality. 2. Percentage of change in major water ecosystems. 3. Indirect indicators such as percentage of wastewater that receives treatment. 4. Index of coastal eutrophication.
Waste Management	1. The amount of annual municipal solid waste generated per capita. 2. Percentage of the city's hazardous waste that has been recycled. 3. Percentage of the total amount of recycled plastic waste within a city.

Energy Consumption	1. Total energy consumption per year. 2. Total energy consumption per capita. 3. Proportion of renewable energy consumed within a city. 4. Electricity consumption per capita.

Source: https://www.sciencedirect.com/science/article/pii/S2590252024000047#b0025

CHAPTER 7

SUMMARY OF THE LITERATURE

"I was telling governments what they should do. I was taking the stance that I am a civil servant. I am a citizen of the world. I'm not a human being; I'm a scientist, able to see the danger. My responsibility is to help protect the environment, so I'm defending it"

Mostafa Tolba, UNEP Executive Director (1976-1992)

To summarize, sustainability becomes a central tenet of modern thought (Thiele, 2016). In an era of collapsing civilizations, global economic decline and accelerating climate change, sustainability stands as an revolutionary ideology (European Commission, 2021). It is complex to adopt new strategies and ways to live within the planet's limits but it's clear that there is a demand for groundbreaking scientific advancements and public policies to achieve such a transformation (Thiele, 2016).

It is critical to recognize that sustainability's key areas are interconnected and they influence each other. Scientists agree that progress in one area benefits the others, while the decline in one hinders them all (Placet, Anderson and Fowler, 2005; Caradonna, 2022). However, this feature presents a challenge. While considering multiple areas simultaneously is essential, research often faces a lack of evidence and data (Ahlfeldt and Pietrostefani, 2019). The literature review showed that there is a growing consensus among scientists supporting that a thriving social and economic sector hinges on a healthy and sustainable environment (Hayden, 2022).

The scientific evidence that was examined in the paper overwhelmingly shows that human consumption has surpassed Earth's ability to replenish resources (Wackernagel *et al.*, 2002). Countries that prioritize sustainable practices are more likely to be peaceful. In contrast, countries that deplete their natural resources, or rely on other countries who do so, face greater pressure and instability and are more prone to wage wars (Goodland, 1995).

In the same section of the paper the "Current Opinion in Environmental Sustainability" was presented. The journal gathers research and focuses specifically on concepts hovering around environmental sustainability and change and outlines six main

areas that need to be studied when analyzing the term. Our paper recognizes the six main areas suggested by the journal and aims on addressing them via the utilization of relevant indicators. In cases where indicators that cite every of the six main areas cannot be found in the literature review, new ones were designed (in the *Methodology* chapter). To be precise, the second area which refers to "Human settlements and habitats" had not been addressed by the scientific synopsis. Thus, our paper crafted new ones which aimed to detect urban sustainability, urban sprawl and population density.

Despite not always being the case (Ones and Dilchert, 2012), overwhelming scientific evidence now confirms climate change as a critical and rapidly-growing global issue. The data provided in the literature review suggest that human activity significantly worsens climate change. Setting aside humanity's relatively short time on earth, its impact has been profound, becoming a disrupting force that jeopardizes the earth's delicate ecological balance (VijayaVenkataRaman, Iniyan and Goić, 2012).

The literature review showed that biodiversity loss and natural degradation, air pollution, freshwater pollution, waste management and energy consumption are the most cited issues in climate change studies. It is worth noting that in order to maintain focus on the core topic, this paper primarily addresses environmental challenges directly to climate change for the Central Athens Regional Unit's context. Therefore, while arguably similarly important, including issues such as noise pollution, would be a lack of coherence. Moreover, major issues such as marine degradation, which are not relevant to the Central Athens Regional Unit's context- will be excluded as well.

While most scientific research across disciplines advocates for investing in climate change reduction methods, a concerning gap exists within the economic sector (Tol, 2009). Despite the government's willingness to invest heavily, economists struggle to confidently estimate the scale of risk and economic viability of such investments. This uncertainty hinders clear-cut economic decision-making.

The scientific evidence presented in the paper underscores the urgency of addressing climate change, highlighting three key responses: mitigation, adaptation or suffering (Chen, Suzuki and Lackner, 1982). However, even with drastic implementation of mitigation strategies, the lingering effects of past GHG emissions will likely cause some degree of unavoidable suffering. Hence, it is critical to invest in adaptation strategies simultaneously. Additionally, the literature review showed that existing scientific evidence might not be enough to pinpoint a definitive "safe" threshold of GHG concentration (Caradonna, 2022).

The literature review also showed that Greece faces heightened vulnerability to climate change and high temperatures. Recent years have experienced the devastating consequences of climate change, where prolonged floods, severe wildfires, exceptionally high temperatures highlight the country's exposure to natural disasters (Koundouri, 2023). Unsustainable urban development, urban sprawl and high population density further exacerbate the situation (OECD, 2020), contributing to several major issues such as the UHI phenomenon (Municipality of Athens, 2021).

However, the "Densely Populated Cities" section revealed that the relationship between urbanization, population density and whether they can be socioeconomically beneficial, is a complex topic with ongoing debate among scientists. On the contrary, one aspect enjoys broad consensus: high degree of population concentration and density in urban environments undeniably lead to much larger ecological footprint compared to the rural areas.

The literature review in the "Plan Quality Evaluation" section presented evidence supporting that developing effective climate action plans requires a collective effort- a democratic process involving central and local governments, the citizens and stakeholders. On the other hand, scientists state that there is a critical knowledge gap in this area too, due to the lack of regular evaluation against established practice benchmarks (Berke and Godschalk, 2009).

The most commonly cited criteria (Guyadeen and Henstra, 2023) and the ones this paper will utilize in order to evaluate the quality of plans are (P. R. Berke *et al.*, 2006; Berke and Godschalk, 2009; Horney *et al.*, 2016):

1. Fact base
2. Goals
3. Policies
4. Implementation
5. Monitoring and evaluation
6. Coordination
7. Participation
8. Plan organization and presentation

Finally, the literature synopsis of the qualitative climate change indicators most widely cited the direct climate change, biodiversity loss and natural degradation, air pollution, freshwater pollution, waste Management and energy consumption as the necessary aspects when approaching and measuring climate change. Apart from areas

unrelated to the context of the Central Athens Regional Unit (e.g. marine areas degradation), this paper will utilize indicators that cover the same areas.

To conclude, having established a strong foundation through this literature review, the paper now progresses to outlining the research methodology employed to investigate the quality of climate change plans of Greece's most densely populated regional unit.

CHAPTER 8

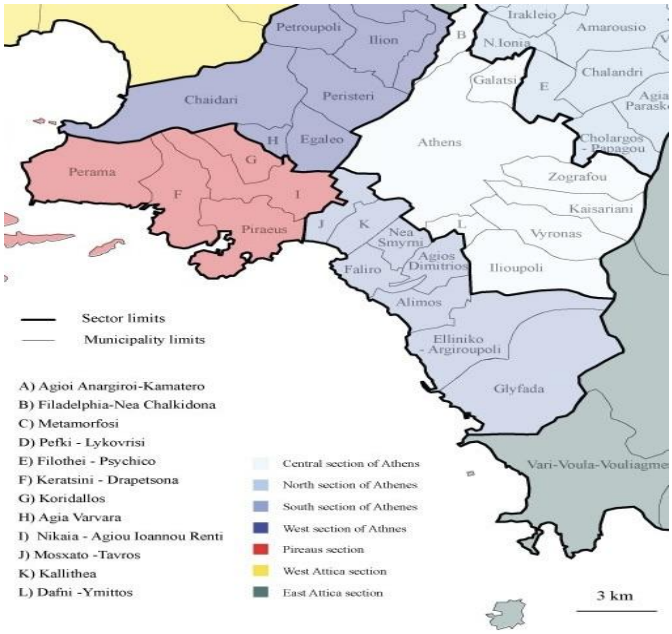
METHODOLOGY

"The scientific method is nothing but the expression of necessity of the elementary rules of formal logic"

Albert Einstein (1879-1955)

8.1 Study area

The research was conducted in the Central Athens Regional Unit of the Attica region (see Figure 8.1). Drawing on a comprehensive literature review, this paper investigates the hypothesis that densely populated cities produce significantly increased greenhouse gas emissions and potentially exacerbating the effects of climate change compared to the more rural areas. Thus, the study area was found most appropriate for the paper due to the fact that it holds the highest place in population and density throughout Greece. Moreover, according to data provided by Eurostat, it ranks second on the most densely populated regions in Europe (Eurostat, 2020b) at 11.796,14 inhabitants per square kilometer (Eurostat, 2020a), following Paris.



Source: https://www.athenssocialatlas.gr/en/article/metropolitan-governance/

Figure 8.1

Metropolitan area

At the same time, most cities worldwide produce crucial documentation, such as strategic and operational plans, statistics and overviews in their native languages. In-depth understanding of this information, as well as access to it, is fundamental for the plan quality evaluation, the literature review and the overall comprehension of this study. Additionally, there is high quality, valuable research provided by Greek researchers in their native language that can be only appreciated in its full nuisance by having native, bilingual or high proficiency of the language, as the author of this paper possesses.

Furthermore, this paper expands on prior research suggesting a positive correlation between population size and plan quality (Berke *et al.*, 1999; Stevens, 2013; Tang and Brody, 2009) and builds on the idea that countries, regions or municipalities with higher population are more likely to produce higher quality plans (Hossu *et al.*, 2020c). Expanding this concept further, a significant number of Greek municipalities did not display a strategic, environmental or climate change plan on their official websites. Moreover, a noteworthy proportion of these municipalities failed to provide such sources upon request via electronic mail. In contrast, the majority of municipalities within the Central Athens Regional Unit possessed a climate change and environmental review, typically incorporated within a comprehensive strategic plan encompassing various municipal features and challenges simultaneously. However, it is worth noting that two of the Central Athens Regional Unit's municipalities did not incorporate a climate change, nor a strategic nor business plan in their official website and they failed to deliver one via electronic mail request. Taking everything into consideration, the Central Athens Regional Unit was found to be the most appropriate sample for this paper.

8.2 Sample and data collection

The data was collected directly by each municipality's official website and if necessary, by e-mail request. Each plan is at the latest approved versions (see Table 8.1).

Table 8.1

Sample municipalities

Municipality	**Population (2021) (ELSTAT, 2021a)**	**Plan's Years Range**
Athens	643.452	2021-2030
Vyron	59.134	2012-2014
Galatsi	57,909	2019-2023
Dafni-Ymittos	33.886	2021-2027
Zografou	69.874	2019-2023
Ilioupoli	76.730	2012-2020
Kaisariani	26.269	-
Nea Philadelfeia- Nea Chalkidona	34.958	-

8.4 Research Approach

The research consists of two main steps. The first one is to identify the key urban environmental and climate change challenges (see Figure 8.2). In order to achieve that- a comprehensive literature review of scientific literature and gray literature was carried out. Consequently, the key urban environmental and climate change challenges were identified and finally, the connection between the densely populated cities and environmental unsustainability was addressed.

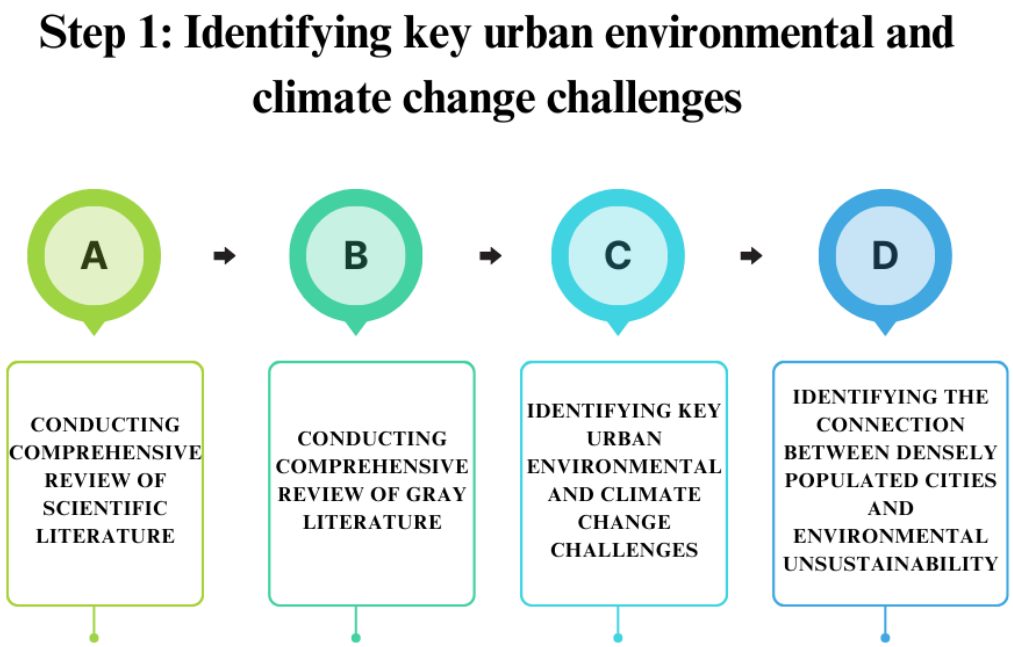


Figure 8.2

Step 1 of the Methodology

The second main step was to conduct the evaluation of the municipal climate change plans (see Figure 8.3). After outlining the eight main plan evaluation characteristics used, relevant climate change indicators were gathered from existing studies. In order to ensure a comprehensive evaluation, these indicators were then carefully analyzed to select the most appropriate ones and further indicators were proposed in order to cover possible gaps and align the research with the Central Athens Regional Unit context and the paper's framework. Finally, the coding and analytical techniques of the research were established, paving the way for a thorough evaluation of the municipal climate change plans.

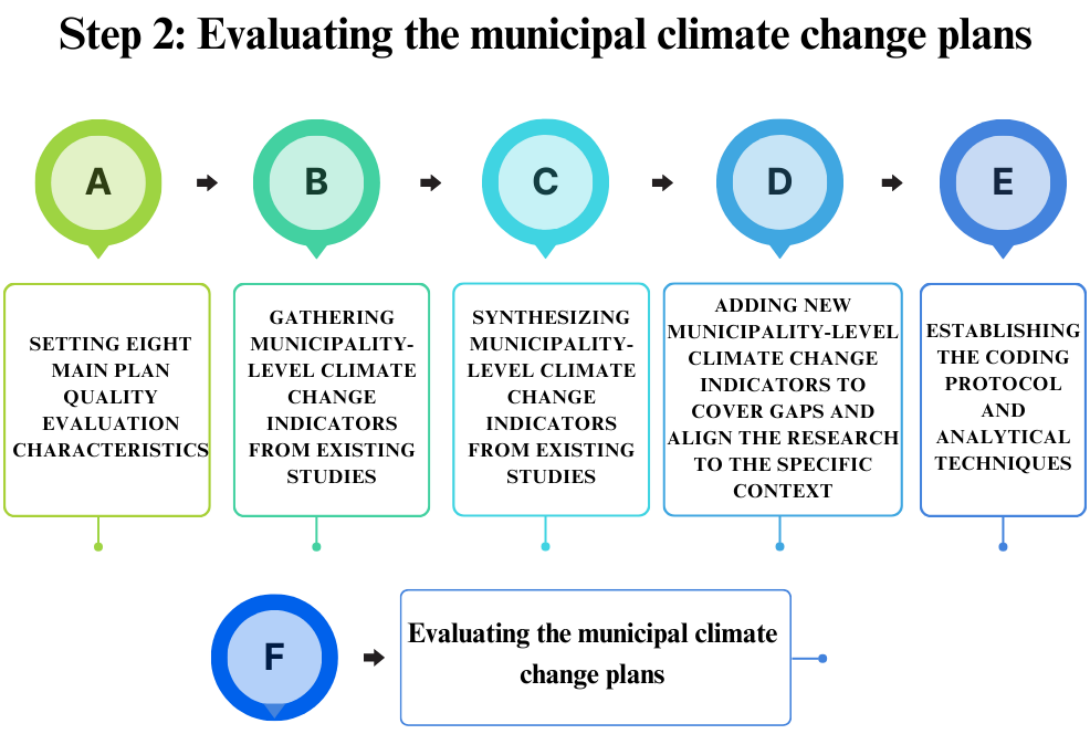


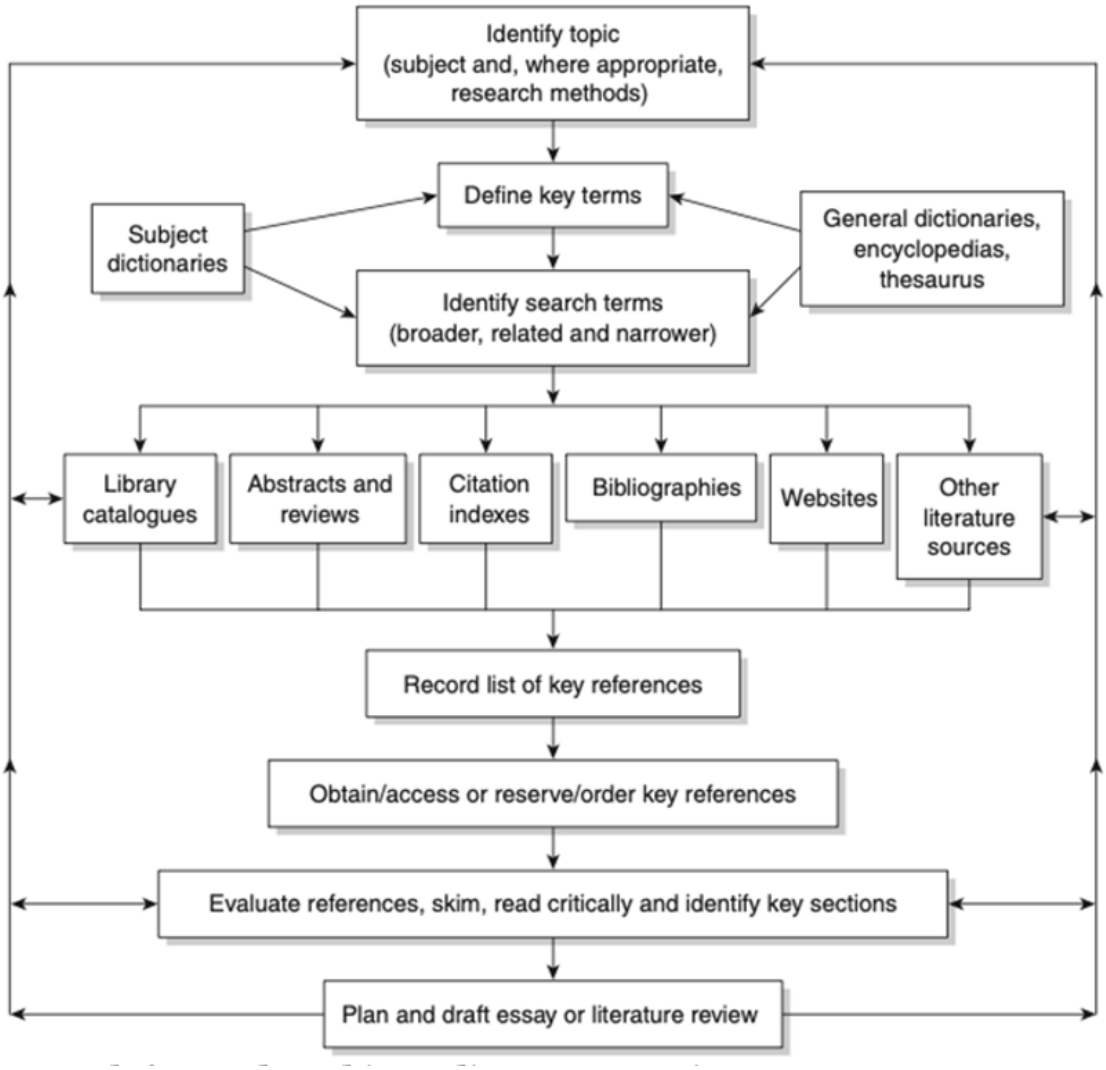
Figure 8.3

Step 2 of the Methodology

Step 1: Identifying Key Urban Environmental and Climate Change Challenges

A. Conducting comprehensive literature review of scientific literature

Literature search was carried out and the findings of the already existing scientific studies were used throughout the paper, in a way that they provide the pillars of the paper and the essential background before the evaluation of the municipal plans. The literature review pushes the topic and research problem, a step forward and establishes new ideas and concerns for further investigation and research that will be later addressed in the *Further Research* subsection. To that extent, some fields of this research were already examined, providing the opportunity to set the basis for this paper after extensive analysis. The literature review method practiced in this paper was influenced with respect to the Healey & Healey scheme (see Figure 8.4) (Healey, 2014).



Source:https://www.academia.edu/3420441/How_to_conduct_a_literature_search

Figure 8.4

Literature Review Method

The comprehensive review of scientific literature was conducted during the months of October 2023 and January 2024 with the use of numerous databases, including Wiley, Science Direct, Research Gate, Web of Science, Taylor & Francis, Springer, Emerald Insight and Sage Journals. The search strings were constructed with the objective of identifying articles that addressed climate change, sustainability, environmental sustainability, densely populated cities, urbanization, environmental urbanization, urban sprawl, climate change indicators, environmental indicators and plan quality evaluation. The database searched yielded a combined total of 148 studies which were published between 1931 and 2024. Finally, a full-text review of these studies was undertaken to

gain a more comprehensive understanding of the research content, findings and methodologies.

B. Conducting comprehensive review of gray literature

In order to evaluate the municipal climate change plans, as well as to gain a better understanding of the environmental and climate change challenges that define the specific local governments, a comprehensive gray literature review was carried out during the months of January 2024 and March 2024. The analysis extended beyond peer-reviewed journals to encompass reports, environmental plans, publications, policy documents, strategic and business plans and other pertinent gray literature sources. The municipal plans are illustrated in Table 8.2. In order to obtain that information, the documents were retrieved directly from official government websites or if necessary, by electronic mail request.

Table 8.2

Plan Titles

Municipality	**Plan Title**	**Plan's Years Range**
Athens	"Action Plan for the Climate"	2021-2030
Vyron	"Municipality of Vyron business plans" Section: "Environment and quality of life in the Vyron's municipality"	2012-2014
Galatsi	"Sustainable Energy and Climate Action Plan"	2018-2030
Juridiction of Ymittos	"Strategy for Sustainable Urban Development - Ymittos 2023"	2021-2027
Zografou	"Municipality of Zografou business plans 2019-2023"	2019-2023

	Section: "Natural environment, pollution issues, network service infrastructures "	
Ilioupoli	"Action Plan for Sustainable Energy"	2012-2020

C. Identifying key urban environmental and climate change challenges

To gain an in-depth understanding of environmental and climate change challenges, a multifaceted research approach was employed. This approach consisted of:

- A thorough review of scientific literature and pertinent gray literature:

Existing studies, publications and reports that aim to address urban environmental issues and the climate change phenomenon were analyzed.

- Investigation of municipal webpage:

Information shared on the official local government websites was leveraged to complement the findings from the literature review.

D. Identifying the connection between densely populated cities and environmental unsustainability

A critical part of this paper and one of the objectives is to address the connection between the densely populated cities and environmental unsustainability. Thus, this paper carries out a thorough literature review and presents its findings. The core issue will be further examined by creating specific indicators, designed to reveal whether the most densely populated local governments of Greece are addressing this issue on their official municipal plans.

Step 2: Evaluation the Municipal Climate Change Plans

A. Setting eight main plan quality evaluation characteristics

Researchers who attempt to evaluate land-use, hazard mitigation and adaptation plans usually cite eight main characteristics (Guyadeen, Thistlethwaite and Henstra, 2018b):

1. Fact base
2. Goals

3. Policies
4. Implementation
5. Monitoring and evaluation
6. Coordination
7. Participation
8. Plan organization and presentation

Indeed, there are some studies that exclude some of the main characteristics, only in an attempt to consider different areas and prioritize specific angles. Hossu. et al. subsumed further dimensions, such as stability maximization, uncertainty minimization, integration of public priorities across jurisdictions, flexibility accommodation, legibility, accuracy, legitimacy and finally, sincerity (Hossu *et al.*, 2020a). One can assume that the majority of these aspects are included as indicators in the eight main characteristics. For Guyadeen D., the aforementioned eight characteristics are the main contributors that drive plan quality evaluation (Guyadeen, 2018).

It is noteworthy to underline the fact that most of the eight main characteristics are interconnected. There are chains of actions that define the success and comprehensiveness of every following characteristic. For example, the *implementation* characteristic can be measured and evaluated only in relation to its former, *policies* characteristic. The commitment of a municipality to execute the plan's policies can provide us with valuable insight in order to have a better understanding and assess the plan.

The *information base*, also known as *fact base*, provides the vital groundwork for a robust climate action plan. The information base is commonly used as a tool and provides the empirical foundation and evidence that is needed in order to direct the plan's development (Stevens, 2013; Qiao *et al.*, 2018; Donoghue and Katz-Rosene, 2023) and rationalize, justify and prioritize the goals and policies (Baer, 1997; Horney *et al.*, 2016; Guyadeen *et al.*, 2023). A descriptive fact base that addresses climate change as a local issue can be a valuable asset by citing the current environmental local impacts and predicting the ones to come (Berke and Godschalk, 2009; Rudolf and Grădinaru, 2017; Hossu *et al.*, 2020). To be precise, a well-developed and solid information base would encompass the impacts of climate change, the vulnerabilities of the specific geographic location, the area's pollution rate, the degree of greenhouse emissions in comparison to previous years and its future estimations, extreme weather conditions, description of the economy, demographics, SWOT analysis, the municipality's assessments etc. (Donoghue and Katz-Rosene, 2023; Guyadeen and Henstra, 2023).

Goals aim to capture aspirations, public concerns and present and future needs (Lyles, Berke and Smith, 2014). They are derived from the *information base* (Guyadeen, Thistlethwaite and Henstra, 2018c) and serve as a roadmap and foundation of the *policies* characteristic, outlining the envisioned future (Stevens, 2013d). At the same time, an essential element of a comprehensive climate change plan is the inclusion of clear short- and long-term goals and their connection to mitigation and adaptation strategies for climate change (Araos *et al.*, 2016; Baker *et al.*, 2012; Li and Song, 2015; Guyadeen, Thistlethwaite and Henstra, 2018).

Policies translate plan goals and objectives into action. They influence the public and private decision making and strive to achieve the climate change goals of the central and local government (Berke and Godschalk, 2009).

Implementation refers to the commitment of executing the plan's policies. Effective implementation requires outlining clear concrete steps that guarantee the succession of every plan goal and at the same time, holds the stakeholders accountable (Berke and Godschalk, 2009; Heidrich *et al.*, 2013; Guyadeen, Thistlethwaite and Henstra, 2018). To be precise, the implementation section should establish timelines and deadlines, prioritize actions, allocating funding sources (Horney *et al.*, 2016; Tang *et al.*, 2010).

Monitoring and evaluation encompass a systematic tracking system that continuously evaluates the implementation activities and actions so that the degree of succession of the plan goals can be identified and calculated. Specifically, this section aims to establish explicit targets and performance indicators and provide robust information and sources for further assessments (Baker *et al.*, 2012; Stevens, 2013; Donoghue and Katz-Rosene, 2023).

Interorganizational coordination projects how external stakeholders influence the implementation and monitoring of the plan. More specifically, this influence can refer to a horizontal integration, meaning the alignment with other local and municipal plans, or a vertical integration, meaning the involvement and connection with external organizations and governmental departments (Berke and Godschalk, 2009; Donoghue and Katz-Rosene, 2023a). This is a critical characteristic for climate change plans due to the fact that these plans usually align with other initiatives. To be precise, the majority of climate change plans are parts of major comprehensive strategic plans that encompass a plethora of affairs, such as land-use, transportation etc. (Guyadeen, Thistlethwaite and Henstra, 2018c).

Public Participation refers to the engagement of public and stakeholder participation, which is crucial in order to identify vulnerabilities and inefficiencies in specific geographic regions, industries and departments. At the same time builds legitimacy and boosts the trust between the municipality, the public and the stakeholders regarding the plan (Aguiar *et al.*, 2018). In order to ensure transparency, a robust plan should provide a clear insight of the development of the plan, as well as how the stakeholders are expected to perform and operate (P. R. Berke *et al.*, 2006; Guyadeen, Thistlethwaite and Henstra, 2018c).

Organization and presentation is a vital characteristic that ensures the comprehensiveness and accessibility of the plan. A plan should strive to be organized and presented in a way that the public, stakeholders, scientists and other internal and external entities are approached and inspired to participate and contribute to the municipality's vision (Stevens, 2013a). There are several tools that can help utilize the organization, such as a table of contents, a summary, a glossary and visuals (Berke and Godschalk, 2009).

B. Gathering municipality-level climate change indicators from existing studies

This paper uses qualitative indicators in order to evaluate the municipal climate change plans of the Central Athens Regional Unit. The coding protocol encompasses 52 indicators based on the aforementioned characteristics (see Table 6). A critical characteristic of effective protocols is that they contribute to the collective understanding of plan quality by building upon the established body of knowledge, gathered by existing protocols (ibid.). Thus, this paper takes into consideration the qualitative indicators and methodologies that have been proposed by numerous existing studies and chooses the ones that most appropriately describe this specific context. More specifically, this study adopts indicators from Guyadeen D. et al. (2018), Hossu C. et al. (2020), Guyadeen d. & Henstra D. (2023), Donoghue S. & Katz-Rosene R. (2023), Stevens M. (2013), Hu et al. (2018), Li S. & Song Y. (2015), Tang Z. et al. (2010) and Berke P. et al. (2006).

C. Synthesizing municipality-level climate change indicators from existing studies

To identify the most common indicators used to address climate change challenges in municipal plans, a three-step synthesis of the nine selected environmental indicator frameworks was conducted.

I. Framework Overview: Each framework's focus, thematic categories and total number of indicators were analyzed.

II. Climate Change Focus: The analysis then narrowed to the climate change-specific indicators within each framework.

III. Common Indicator Identification: Consequently, the number of indicators constantly appearing across all nine frameworks in the climate change category was identified.

Consequently, Figure 8.3 projects the final indicator framework (including the new designed municipal-level indicators that are discussed in the next subsection):

Table 8.3

Indicators

Characteristic	**Indicator Description**	**Indicator**
Fact base	Climate Change Awareness	Does the plan include a description of the causes of climate change?
	Climate Change Impacts Recognition	Does the plan recognize the global and local impact of climate change?
	Population Density Awareness	Does the plan directly link population density to environmental unsustainability?
		Does the plan directly or indirectly address the environmental challenges of population density (e.g. High traffic density, urban warming, high amount of waste, increasing air pollution, increasing energy consumption, sinking water sources, land shortage for housing etc.)?

	Emissions tracking	Does the plan track all different types of emissions it aims to reduce (e.g. Is there a list for GHG and HFCs emissions?)
	Base Year for Emissions	Does the plan include a base year for emissions?
	Target Year for Emissions	Does the plan include a target year for emissions?
	Prediction for Emission Trends	Does the plan predict how much pollution will be reduced in the future?
	General Climate Change Impacts	Does the plan directly or indirectly address the general impacts of climate change (e.g. increasing temperatures, air quality, quality of life etc.)?
	Specific Climate Change Impacts	Does the plan address the specific impacts of climate change to the jurisdiction
	Sample Area Vulnerability	Does the plan mention specific geographic locations that may be more vulnerable to climate change?
		Does the plan mention specific demographic populations that may be more vulnerable to climate change?
		Does the plan mention specific industries that may be

		more vulnerable to climate change?
Goals	Broad Goal for Adaptation	Does the plan establish at least one broad goal focused on adaptation to climate change
	Specific Goal for Adaptation	Does the plan establish at least one specific goal focused on adaptation to climate change (e.g., development reduction in hazard areas found in the jurisdiction)
	Mitigation-Population Density-General	Does the plan include at least one broad goal related to mitigation strategies on the impacts of population density?
	Mitigation-Population Density-Specific	Does the plan include at least one specific goal related to mitigation strategies on the impacts of population density (e.g. Creative architectural designs, increasing green space, developing animal/plant protection areas, achieving low energy buildings etc.) ?
	Mitigation based on Community Emissions	Does the plan establish at least one objective focused on community emissions (i.e. The ways the community can

		reduce the impacts of climate change?
	Mitigation based on Government Emissions	Does the plan establish at least one objective focused on government emissions (i.e.The ways the local government can reduce the impacts of climate change)?
	Mitigation–Long-Term GHG Emissions	Does the plan include at least one long-term (i.e., 10 years or greater) target for reducing GHG emissions?
	Mitigation–Short Term GHG Emissions	Does the plan include at least one short-term (i.e., less than 10 years) target for reducing GHG emissions?
Policies	Communication	Does the plan include at least one policy for public awareness, education, and participation?
	Land Use	Does the plan include at least one policy for efficient land use (e.g., compact development, mixed use, infill, and brownfield)?
	Transportation	Does the plan include at least one policy on transportation (i.e. transportation strategies, transit-oriented development, pedestrian-friendly, and bicycle-friendly transit)?

	Energy	Does the plan include at least one policy on renewable energy (e.g., solar energy and wind energy)?
		Does the plan include at least one policy on energy efficiency (e.g., energy star ratings and green buildings)?
	Waste Management	Does the plan include at least one policy on reducing waste (e.g., landfill methane strategies, recycling strategies, and other strategies for reducing waste)?
	Natural Resource Management	Does the plan include at least one policy on resource management conservation, such as protecting critical environmental areas and conservation zones (e.g., watersheds, lakes, streams, and tree canopy)?
	Water Management	Does the plan include at least one policy on the conservation of water demand and supply (e.g., water metering, greywater reuse, and water restrictions)?
	Food & Agriculture	Does the plan include at least one policy on food security and agriculture (e.g., conservation of agricultural lands, support for local

		farmers, and support for organic food)?
	Hazard Reduction	Does the plan include at least one policy on hazard reduction (e.g., locating away from known flood zones)?
	Sustainable Urbanization	Does the plan include at least one policy for sustainable urbanization?
		Does the plan include at least one policy on reducing urban sprawl?
Implementation	Dedicated Implementation Section	Does the plan incorporate a dedicated section outlining the implementation strategies for achieving the proposed goals?
	Implementation Hierarchy	Does the plan establish a clear hierarchy for implementing the proposed actions?
	Responsible Entities	Does the plan delineate specific entities responsible for the execution of the outlined actions?
	Timelines	Does the plan identify timelines for implementation?
	Financial Tools	Does the plan include at least one policy on financial mechanisms to incentivize action or collect revenue

		related to climate change (e.g., carbon tax, GHG reduction fee, development charges, and funding for GHG reduction projects)?
Monitoring and evaluation	Dedicated Monitoring and Evaluation Section	Does the plan incorporate a dedicated section outlining the monitoring and evaluation strategies of the plan?
	Interorganizational Responsibility	Does the plan identify interorganizational departments responsible for monitoring the plan?
	Schedule for Revisions and Updates	Does the plan establish a schedule of periodic revisions, incorporating the findings from ongoing monitoring?
	Quantifiable Goals and Policies (includes Indicators)	Does the plan include goals and policies that are quantifiable and based on measurable objectives and/or targets (includes indicators)?
Interorganizational coordination	Horizontal Coordination	Does the plan include at least one horizontal connection with other local plans/programs (e.g., official plan documents and other climate change initiatives)?
	Vertical Coordination	Does the plan include at least one vertical connection to federal, provincial plans and

		regional plans (where applicable) (e.g., provincial legislation on climate change)?
Participation	Stakeholder Engagement	Does the plan identify the organizations and stakeholders that participated in the formulation process?
	Public Participation	Does the plan acknowledge the public participation in the formulation and development of the plan?
	Participation Rationale	Does the plan delineate the rationale behind the involvement of organizations and stakeholders?
	Narrative of the Plan Evolution	Does the plan incorporate a narrative that details the trajectory of its evolution?
Plan organization and presentation	Executive Summary	Does the plan contain an executive summary or similar section that provides an overview/summary of the plan?
	Table of Contents	Does the plan include a table of contents detailing plan chapters and subheadings?
	Glossary of Terms	Does the plan include a glossary or definition of terms?

	Illustrations	Does the plan use clear illustrations (e.g., diagrams and graphs)?

D. Adding new municipality-level climate change indicators to cover gaps and align the research to the specific context

The qualitative indicators were selected in order to cover a plethora of components, such as climate change, environmental sustainability, densely populated cities, urbanization and the rational and communicative perspectives of plans. In cases where the aforementioned sources did not fully cover some of the components that this paper aims to address, new indicators were formed by either modifying existing ones or designing new ones (see Table 8.4).

Table 8.4

Additional Indicators

Indicator Description	**Indicator**
Population Density Awareness	Does the plan directly link population density to environmental unsustainability?
	Does the plan directly or indirectly address the environmental challenges of population density (e.g. High traffic density, urban warming, high amount of waste, increasing air pollution, increasing energy consumption, sinking water sources, land shortage for housing etc.)?
Mitigation-Population Density-General	Does the plan include at least one broad goal related to mitigation strategies on the impacts of population density?
Mitigation-Population Density-Specific	Does the plan include at least one specific goal related to mitigation strategies on the impacts of population density (e.g. Creative architectural designs, increasing green space,

	developing animal/plant protection areas, achieving low energy buildings etc.) ?
Sustainable Urbanization	Does the plan include at least one policy for sustainable urbanization?
	Does the plan include at least one policy on reducing urban sprawl?
Target Year Emissions	Does the plan include a target year for emissions?

E. Establishing the coding protocol and analytical techniques

This paper uses a binary scale for the indicators in order to calculate an index score for each individual characteristic and finally, produce the overall quality score for every single municipal plan involved (P. R. Berke *et al.*, 2006; Guyadeen, Thistlethwaite and Henstra, 2018; Stevens, 2013; Donoghue and Katz-Rosene, 2023; Horney *et al.*, 2016). For the first step of the coding, the number "0" was assigned in case an indicator was absent and the number "1" was assigned if the indicator was present.

After every municipal plan was entirely coded, the research entered the second phase where a total score for each characteristic was calculated. The characteristic score was measured by aggregating the scores of all constituent indicators through summation. The resulted sum was then normalized by dividing it by the total number of indicators (n) available within a characteristic. The possible results reflected a value ranging from 0.00 to 1.00, where a number close to 1 would project a comprehensive plan of greater quality than a plan which scored closer to 0.

For the third phase of coding, the plan's overall quality score was measured and projected the strength and comprehensiveness of each municipal plan. This involved calculating the total quality score by summing the weighted scores of individual characteristics and then normalizing the result by the total number of characteristics.

As a result, each municipal plan included single indicator scores, followed by individual characteristic scores and finally, a total plan quality score. The *Discussion* section will delve into the implications of this paper's findings and identify the areas where further qualitative analysis could yield deeper insights.

CHAPTER 9

ANALYSIS AND FINDINGS

"Science is not just a body of facts, but a way of thinking critically and objectively about the world around us."

Marie Curie (1867-1934)

9.1 Results

This section presents the findings of the research investigation. Interpretation of the findings will be provided in the subsequent *Discussion* section.

- Fig 9.1 projects the overall plan quality evaluation scores by characteristic.
- Fig 9.2 summarizes the quantitative results of the plan quality evaluation, such as the standard deviation, the characteristic mean scores, the minimum and the maximum indicator mean scores.
- Fig 9.3 presents each characteristic's mean score.
- Fig 9.4 details the municipalities' plan quality overall scores.

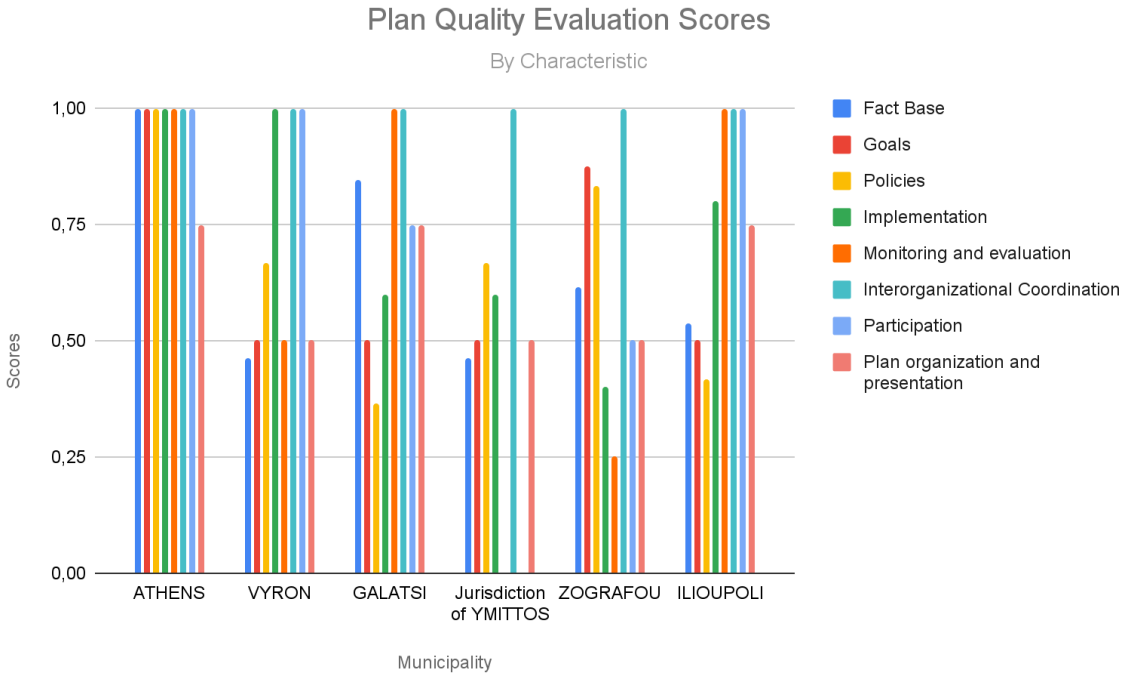


Figure 9.1

Plan Quality Evaluation Scores

	Characteristic Mean	Standard Deviation	Minimum Indicator Mean Score	Maximum Indicator Mean Score
Fact Base	0,6538461538	0,4788222314	0,1666666667	1
Goals	0,6458333333	0,4833211053	0,1666666667	1
Policies	0,6666666667	0,4747126633	0,1666666667	1
Implementation	0,7333333333	0,4497764451	0,5	1
Monitoring and evaluation	0,625	0,494535355	0,5	0,6666666667
Interorganizational Coordination	1	0	1	1
Participation	0,7083333333	0,4643056215	0,6666666667	0,8333333333
Plan organization and presentation	0,625	0,494535355	0	1

Figure 9.2

Coding calculations

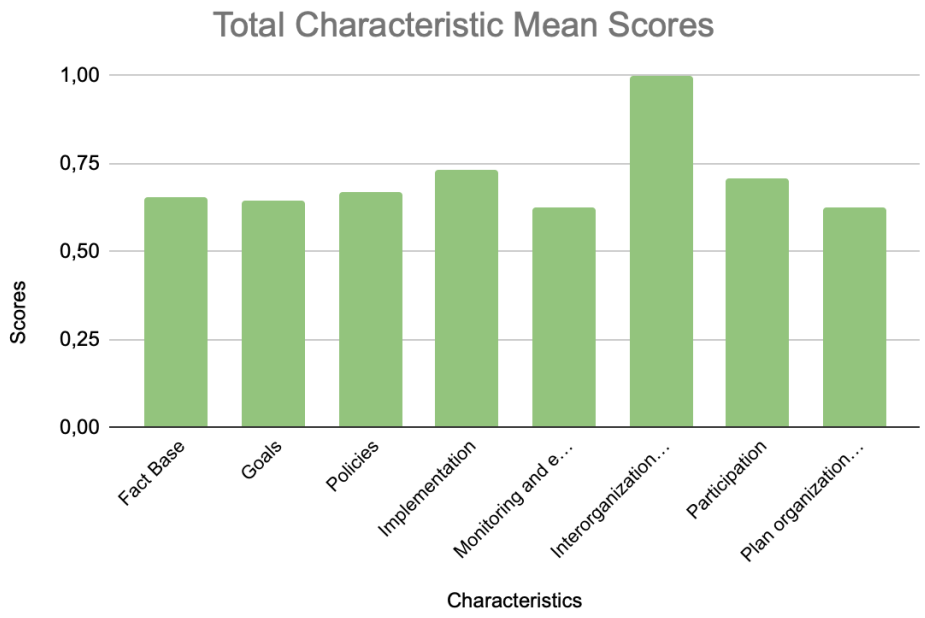


Figure 9.3

Total Characteristic Mean Scores

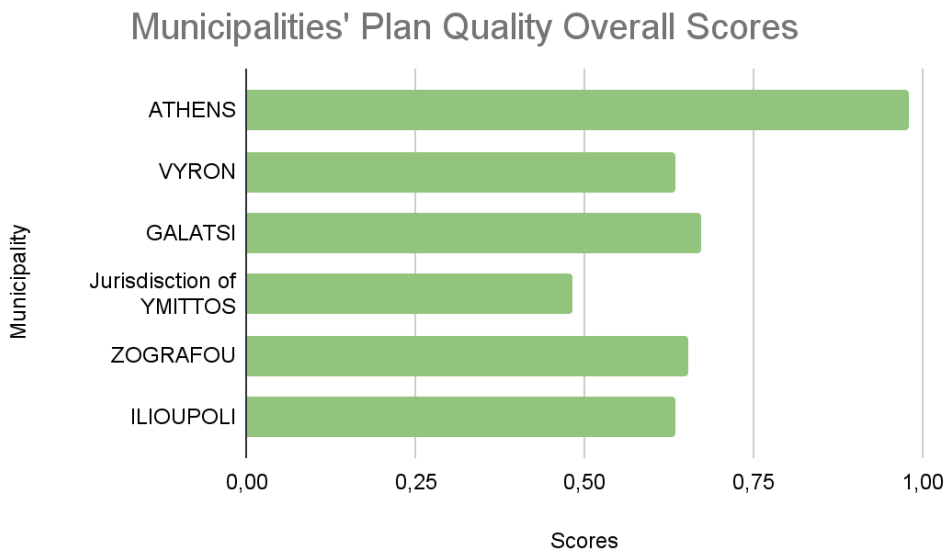


Figure 9.4

Municipalities' Plan Quality Overall Scores

Analysis of the data reveals an above-average mean score for each characteristic but close to 0,5, suggesting a mediocre plan performance (see Figure 9.2). Additionally, the standard deviation highlights the variability within the data (see Figure 9.1), which will be explored further in the *Discussion* section. The highest mean score was achieved by the *Interorganizational Coordination* characteristic with a perfect score, indicating that

every municipality performed satisfactorily in this area, followed by the *Implementation* characteristic with 0,7334. Apart from the *Interorganizational Coordination,* every other characteristic attained a narrow distribution around the mean, close to 0,5. Conversely, the lowest characteristic mean scores were observed in Monitoring and Evaluation and *Plan organization and Presentation* who scored evenly at 0,625.

Regarding each municipality's plan performance, it is clear that the jurisdiction of Athens with the "Action Plan for the Climate", boasts the highest quality climate change plan with distinction at 0,98, followed by the municipality of Galatsi at 0,67 (see Fig 9.4). Beyond Athens, the other municipalities demonstrated modest performance, with scores hovering near the average.

To be precise, there was an absence of only a single indicator in Athens' plan which aimed to detect whether there is a glossary or definition of terms. Considering that strategic and climate change plans often utilize-arguably complex terminology, such as GHG, HFS, *CO2,* SWOT etc., as well as the fact that government plans are supposed to be accessible for the public to read, a dedicated section with explanation of these terms should have been incorporated. It is also noteworthy to underline the fact that none of the municipal plans included a glossary, which influenced the baseline score and set it to 0,75 for the *Plan Organization and Presentation* characteristic.

On the contrary, the findings of the evaluation showed that the lowest plan quality and the only below-average score was demonstrated by the jurisdiction of Ymittos at 0,48. Considering the fact that the municipality of Dafni-Ymittos did not encompass a climate change, strategic or business plan in their official website and failed to provide one by e-mail request, the "Strategy for Sustainable Urban Development - Ymittos 2023" was included in the research. The aforementioned plan was developed by Ymittos Protection and Development Association (ΣΠΑΥ) which consists of twelve municipalities who are centered around Ymittos mountain (Municipali of Dafni-Ymittos, municipality of Ellinikos-Argyroupoli, municipality of Zografou, municipality of Ilioupoli, municipality of Kaisariani, municipality of Kropia, municipality of Paiania, municipality of Papagou-Holargos, municipality of Agia Paraskevi, municipality of Athens, municipality of Vari-Voula-Vouliagmeni, municipality of Vyron). Additionally, Ymittos' plan was the only one who scored "0" on a characteristic. More specifically, the plan scored "0" on both *Monitoring and Evaluation* and *Participation*.

9.1.1 Fact Base

The fact base characteristic exhibited modest performance, above the average at 0,65 (see Figure 9.5). The indicator that was most absent in the plan was *Climate Change Awareness*. To be precise, only Athens's plan included a description of the causes of climate change. All of the plan addressed directly or indirectly the environmental challenges of population density but only half directly linked population density to environmental unsustainability. All of the plans addressed the general impacts of climate change but the majority (66,6%) did not include specific impacts of climate change to the jurisdiction in their analysis. Most of the plans (83,3%) mentioned specific geographic locations that may be more vulnerable to climate change but the majority (66,6%) were considerably lacking to identify specific demographic populations and industries that may be more vulnerable to climate change.

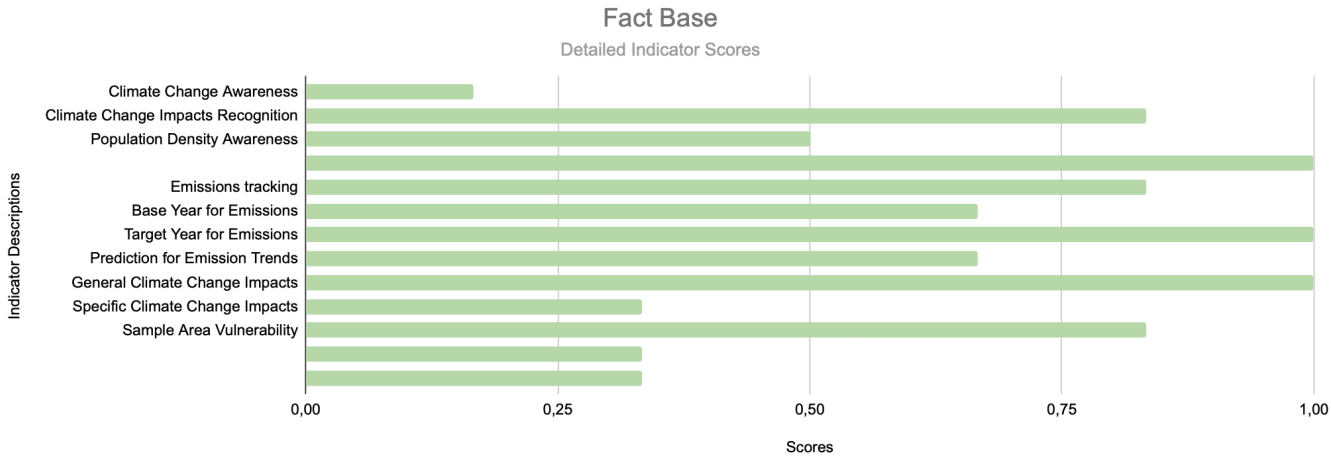


Figure 9.5

Fact Base Scores

9.1.2 Goals

The *Goals* characteristic achieved the second-lowest score on the list, at 0,64 (see Figure 9.6). The *Broad Goal for Adaptation* indicator scored the lowest at 0,16, due to the fact that only Athens established clear adaptation strategies. Regarding Mitigation strategies on the impacts of Population Density, 66,6% of the municipalities incorporated a broad goal and 50% included a specific goal. Additionally, all municipalities encompassed at least one short-term target for reducing GHG emissions and 66,6% of them included at least one long-term target setting the score at 1 and 0,66.

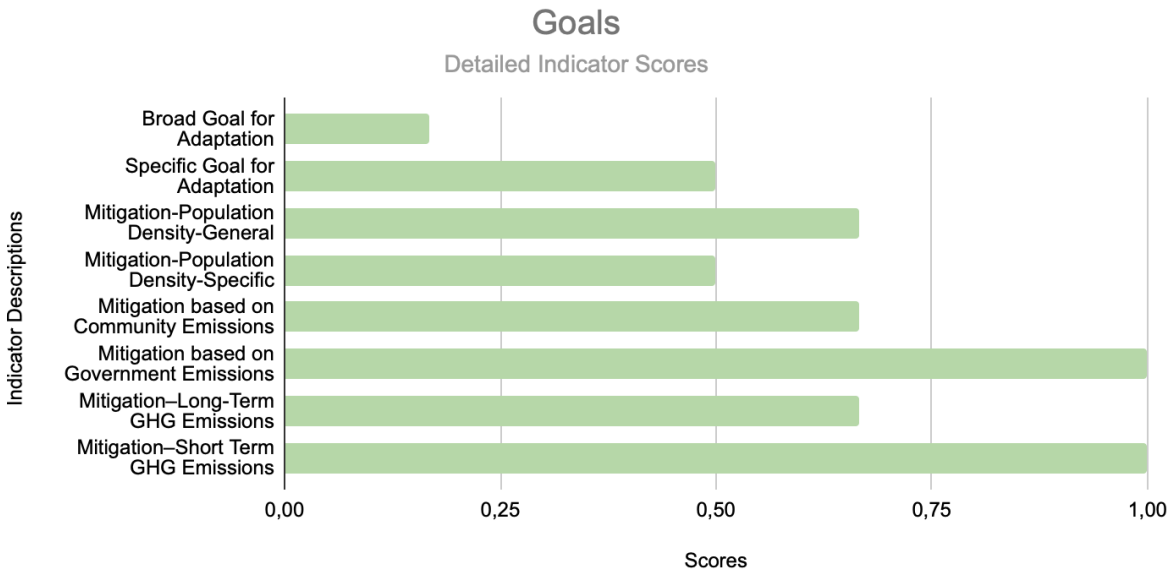


Figure 9.6

Goals Scores

9.1.3 Policies

The *Policies* characteristic scored higher than the two previous ones but still relatively moderately at 0,66 (see Figure 9.7). Excluding Athens's plan, every other one did not incorporate either one policy on food security and agriculture, greatly affecting the mean score of the entire characteristic. Most of the plans are also lacking to establish sustainable urbanization policies, with half of them being able to include one policy on the matter and only the 33,3% incorporating at least one policy on urban sprawl. However, the majority of the plans (83,3%) encompassed policies on public awareness, education, and participation efficiency, land use, transportation, renewable energy, energy efficiency and waste management.

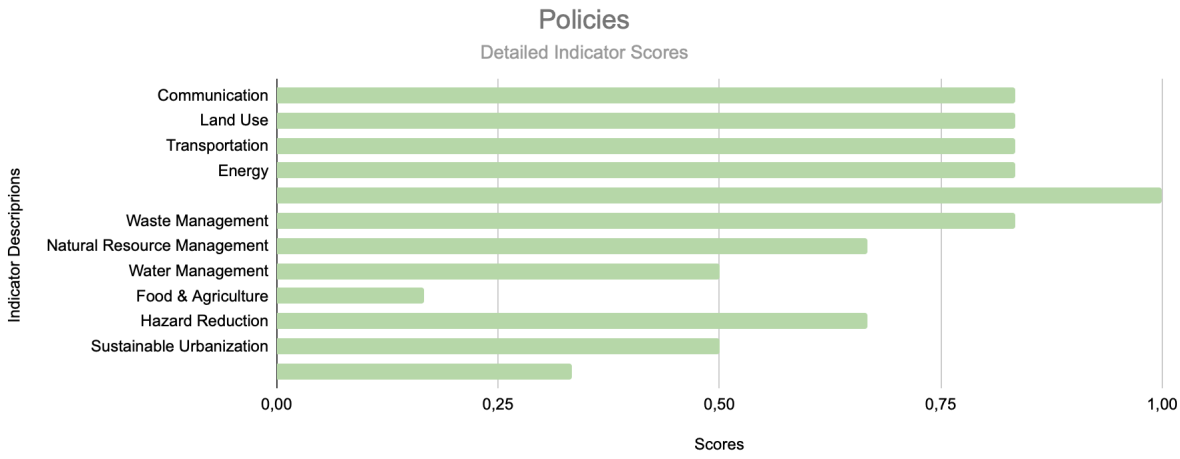


Figure 9.7

Policies Scores

9.1.4 Implementation

The *Implementation* scored the highest characteristic mean score at 0,73 (see Figure 9.8). The majority of the plans included a dedicated section outlining the implementation strategies for achieving the proposed goals and established a clear hierarchy for implementation. However, only half of them delineated specific entities responsible for the execution of the outlined actions and 66,6% of them identified timelines for implementation or mentioned the financial mechanisms to incentivize action or collect revenue related to climate change.

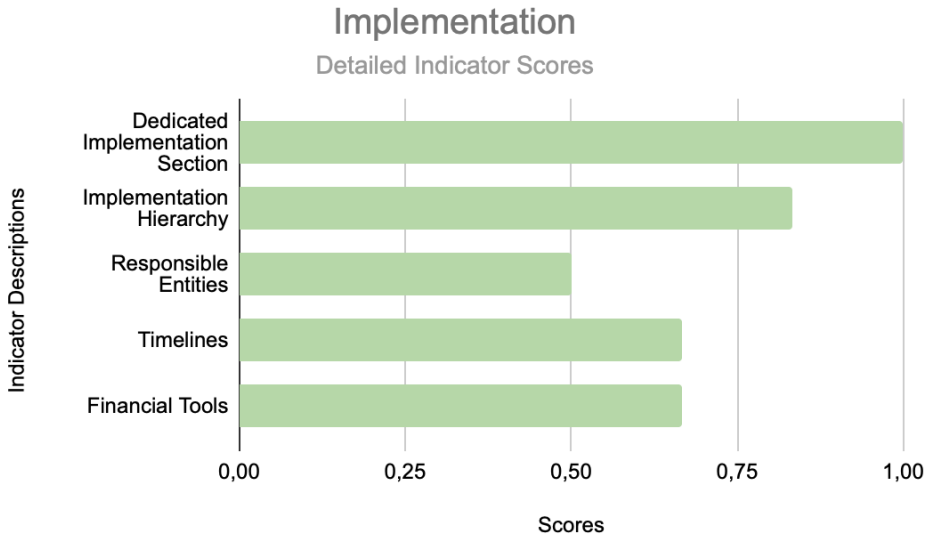


Figure 9.8

Implementation Scores

9.1.5 Monitoring and Evaluation

The *Monitoring and Evaluation* characteristic scored the lowest (along with the *Plan Organization and Presentation* characteristic) at 0,62 (see Figure 9.9). Three out of the four indicators scored 0,66 and were present in only four out of six municipalities. Those indicators encompassed the incorporation of a dedicated section outlining the monitoring and evaluation of the plan, the identification of interorganizational departments responsible for monitoring the plan and the inclusion goals and policies that are quantifiable and based on measurable objectives and/or targets.

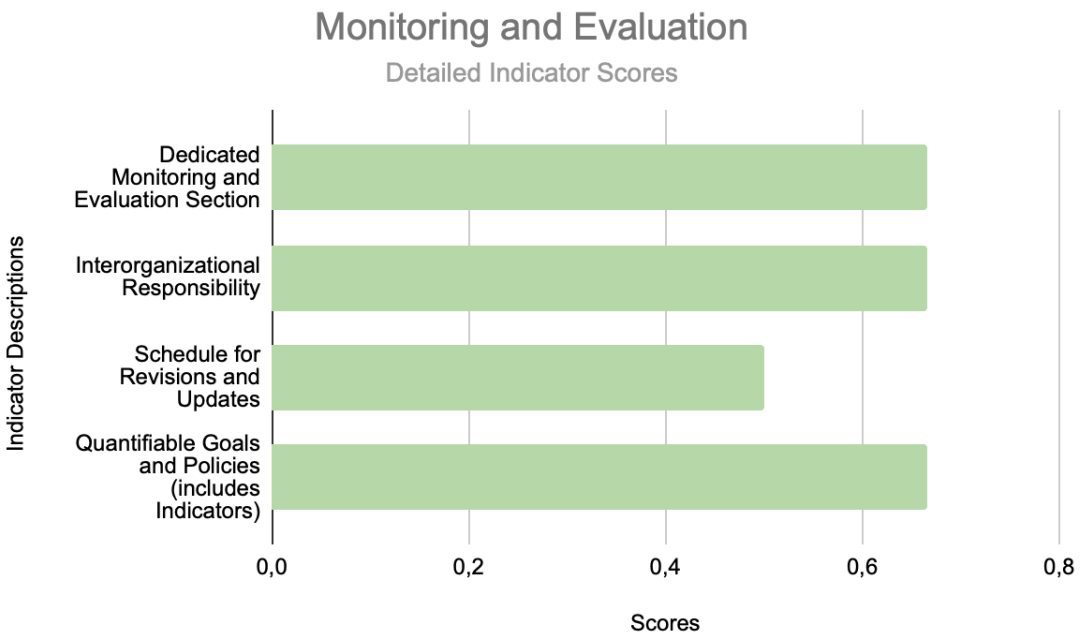


Figure 9.9

Monitoring and Evaluation Scores

9.1.6 Interorganizational Coordination

The *Interorganizational Coordination* scored the highest among the characteristics (see Figure 9.10). It encompassed only two indicators that were present in every municipal plan, whether that involves a horizontal or the vertical connection.

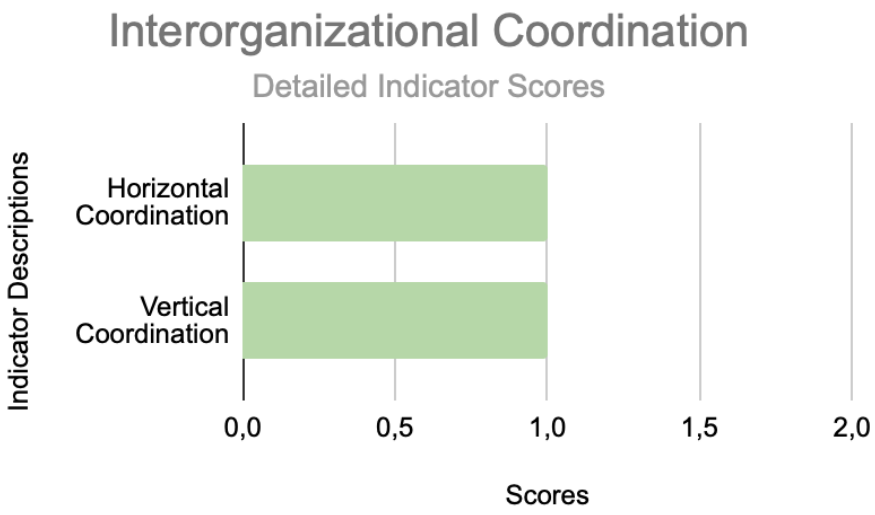


Figure 9.10

Interorganizational Coordination Scores

9.1.7 Participation

The *Participation* scored high in comparison to the other characteristics at 0,7 (see Figure 9.11). It includes four indicators, where three of them are present in 66,6% and one of them in 83,3% of the municipalities. The former ones refer to the identification of the organizations and stakeholders that participated in the formulation process, the acknowledgement of the public participation in the formulation and development of the plan and the incorporation of a narrative that details the trajectory of its evolution. The most satisfactory indicator delineates the rationale behind the involvement of organizations and stakeholders and scores 0,83.

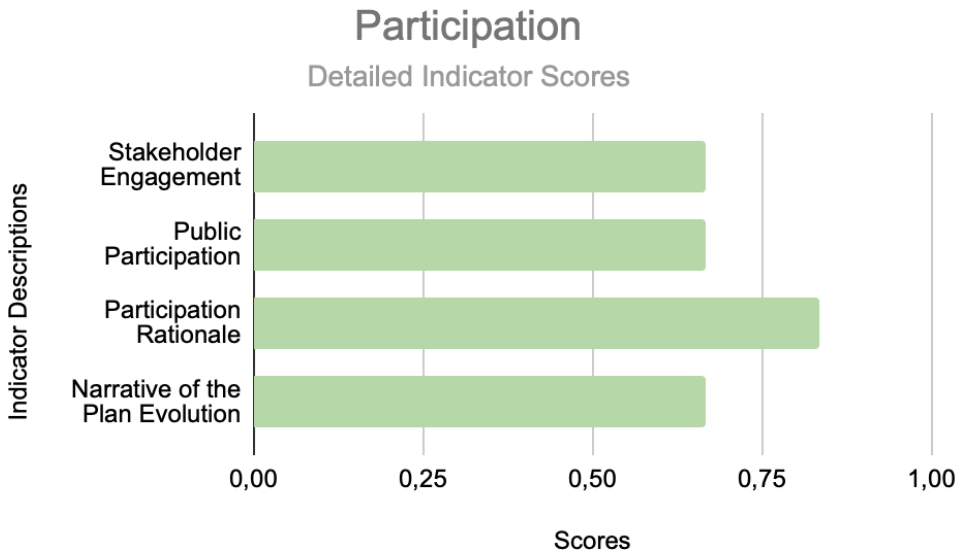


Figure 9.11

Participation Scores

9.1.8 Plan organization and Presentation

The *Plan organization and Presentation* is the last characteristic and includes the lowest mean score along with *Monitoring and Evaluation* at 0,62 (see Figure 9.12).

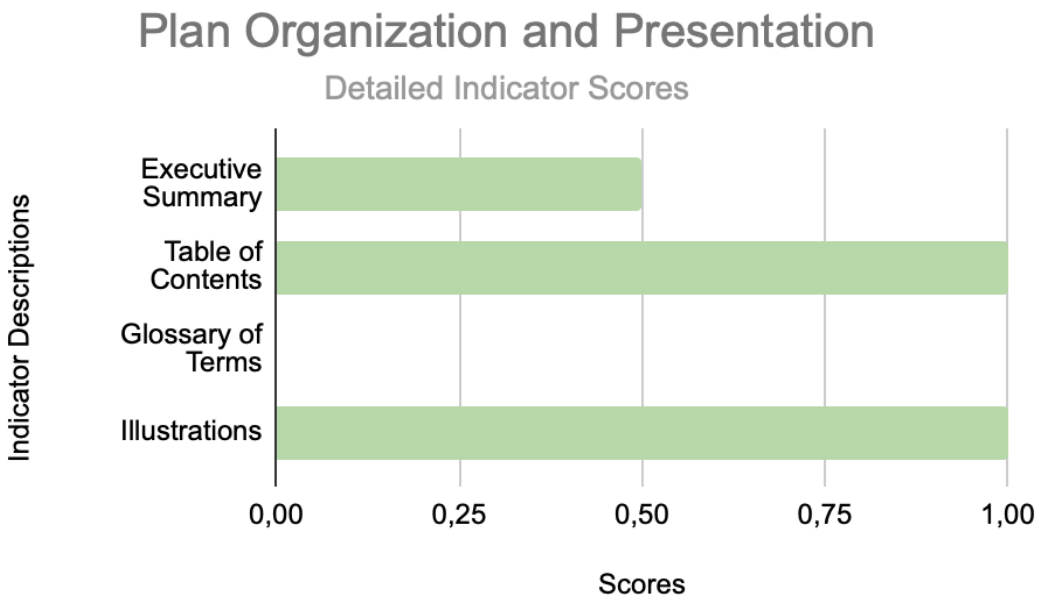


Figure 9.12

Plan Organization and Presentation Scores

The indicators generally have a high score, with every municipality able to include a table of contents and use clear illustrations. The reason why the characteristic scores low is that none of the plans incorporated a glossary or definition of terms.

9.2 Discussion

9.2.1 Mitigation over Adaptation

The findings of this research investigation echo prior studies, suggesting a continued prioritization of mitigation strategies over adaptation approaches in addressing climate change (Baynham and Stevens, 2013; Heidrich *et al.*, 2013; Lysák and Henriksen, 2014; Guyadeen, Thistlethwaite and Henstra, 2018). To be more precise, only Athens's plan established at least one broad goal focused on adaptation and incorporated a robust fact base projecting the importance of it. The findings show that 50% of the municipal plans encompass at least one specific goal focused on adaptation to climate change. However, this can be interpreted differently as none of the plans (apart from Athens's) directed their adaptation strategies towards the reduction of the impacts of climate change but instead, they plainly established flooding and fire prevention tactics. While the outcome may seem similar, as highlighted by Koski and Siulagi (2016), the framing of climate change can significantly influence the approaches adopted within climate change action plans and thus, it can affect the outcome (Koski and Siulagi, 2016).

9.2.2 Weak factual foundation

The results of this investigation are consistent with the findings of Katz (2023), who observed no statistically significant correlation between the date of the plan's creation and its score (Donoghue and Katz-Rosene, 2023). This study stands in contrast with the perspective advanced by Stevens (2013), who suggest that newer plans tend to exhibit superior performance over the older ones due to the incorporation of more recent knowledge and heightened awareness regarding climate change (Stevens, 2013). However, the present study reveals a potential significant factor that may contribute to this observed discrepancy: The majority of Greek municipal plans (83,3%) demonstrate a deficiency in their factual foundation concerning climate change. As Stevens. (2013), such a lack of robust data could potentially impede the development of comprehensive and effective climate action plans.

More specifically, the fact base scored a mean of 0,65 with a standard deviation of 0,47. The indicator of climate change awareness scored an average of 0,16, meaning that only a single plan (Athens) included a description of the causes of climate change. This contradicts with the study of Guyadeen et al. (2019), whose *Climate Change Awareness* indicator score was the strongest feature of the endure fact base characteristic.

Additionally, some indicators were considered present (e.g., “Does the plan establish at least one specific goal focused on adaptation to climate change?”) but specific features were regarded indirectly (e.g. Whether the plan develops adaptation strategies specifically for climate change), due to the fact that they were mostly absent but the outcome was thought to be similar. However, there is a disproportionate relation between the *Climate Change Awareness* and *Communication* indicators, as the majority incorporated a weak factual foundation but generally included numerous policies for public awareness, education, and participation. It appears that Greek municipal plans identify the importance of public participation in addressing environmental challenges but at the same time, they fail to utilize the medium as a methodological approach to provide a solid foundation as a bedrock for public knowledge.

Nevertheless, municipal climate change plans hold immense potential to foster honest accountability with citizens. These plans can serve as a crucial intermediary, delivering a transparent and comprehensive picture of environmental challenges and the rapidly growing danger of climate change. By doing so, they can stimulate meaningful civil participation. Furthermore, municipal plans should act as a valuable point of reference for the cities. They can facilitate communication and knowledge exchange between municipalities. Cities can learn from each other’s experiences and approach on environmental issues. Ultimately, transparent and well-developed municipal climate change action plans become a key variable on building trust and fostering collaboration between central, local governments and their citizens.

9.2.3 Population Density

Notably, all municipalities addressed the environmental challenges posed by population density but half of them directly linked population density to environmental unsustainability. This reveals that Greece's most densely populated regional unit is continuously trying to cope with the aftermath of high population concentration but are vaguely aware that density is a significant factor that leads to environmental unsustanability. Additionally, half of the municipalities encompassed at least one specific goal related to mitigation strategies on the impacts of population density and 66,6% of the municipalities included at least one broad goal on the same issue. However, it is worth noting that mitigation strategies were suggested in order to tackle the climate change issues that were triggered by high population density but the factor was once again not directly mentioned (except from Athens’s plan).

Exceptional was the factual foundation of Athens' plan which identified and expanded on the impacts of high population density. More specifically, Athens's plan discussed the social, economic and environmental issues of high population in cities in a globalized context, identified the importance of local government's participation on reducing the impacts of climate change and explicated that high population density, urban sprawl and unsustainable urbanization has led to major social and environmental issues. Moreover, Athens's plan identified population density as the significant factor of the

Urban Heat Island phenomenon and added that Athens's high population density leads to the deterioration of quality of life, increased feeling of discomfort and air pollution, the overheating of buildings, significant effects on health and high energy cost on buildings and cooling devices that further increase the city's carbon footprint.

Moreover, the jurisdiction of Ymittos identified the consequences of high population density by mentioning that from the eastern side of Ymittos, the corresponding environmental pressures are milder due to a low degree of population concentration and density. Additionally, the municipality of Zografou acknowledged that it is one of the most densely populated areas with poor geometric road characteristics. The plan mentions that high population density in the area has led to the increasing influx of cars, lack of sufficient spaces for recreation and parking, development of marginal conditions along the main road axes and detrimental environmental pollution.

It is clear that local governments are aware of the issues triggered by population density but there needs to be further research on whether their implementation policies are sufficient in order to tackle the challenge. In contrast, regarding urbanization and sustainability, only half of the municipalities incorporated at least one policy for sustainable urbanization and only 33,3% of the municipalities encompassed at least one policy on reducing urban sprawl. The findings revealed that the most densely populated regional unit of Greece and the second in the entire Europe (Eurostat, 2020) does not clearly identify high population concentration as a significant factor that drives climate change. On the contrary, Athens, which is the most populated municipality of the region (and the country) (European Commission, 2023) fully unveils and aims to tackle the effects of high population concentration. Finally, the effective issue resolution by local governments necessitates the initial step of accurate identification.

9.3 Limitations

Despite the fact that plan quality evaluation and content analysis are frequently cited and regarded by researchers on a global scale, there are certainly limitations that should be addressed. First and foremost, the inherent limitation of the current methodological approach, which relies on binary-scale content analysis and index score, lies in the treatment of each indicator and characteristic with equivalent weight. However, there are certainly individual characteristics and indicators that hold greater salience for climate change plan quality, while others serve a predominately ancillary or complementary function (Guyadeen, Thistlethwaite and Henstra, 2018; Donoghue and Katz-Rosene, 2023).

Moreover, the inherent limitation of a binary-scale approach restricts its ability to capture the nuanced quality of the plan's elements, due to the fact that it can only identify the presence or absence of the indicators. Thus, the areas where the local government could potentially improve- can only be assumed, as the binary scale only highlights the components that are missing entirely from a specific plan. There are certainly some studies that have adopted a more extended index score content analysis, by involving a larger scale system as an evaluation method. To be precise, Baker I. et al. (Baker *et al.*, 2012), adopted a five-point scale where number "0" is assigned when an indicator is absent, the number "1" when the criterion is acknowledged but lacks detail and definition, the number "2" when the indicator is present and addressed in a moderate level, the number "3" when the criterion is fairly mentioned but is insufficiently descriptive and finally, the number "4" when the indicator is addressed by a detailed analysis using a plethora of tools, such as risk assessment, local climate scenario modeling, fieldwork etc. However, it is important to underline the fact that such a study requires large-scale research and application and could potentially still lack efficiency if done by a single researcher due to subjectivity implications.

More specifically, content analysis and plan quality evaluation could not eliminate entirely the degree of subjectivity due to the fact that the researcher is called to use value-based judgments regarding each indicator and characteristic (Guyadeen, Thistlethwaite and Henstra, 2018). However, our paper chooses to adopt a binary-scale and index score approach due to the fact that such a method would exclusively reveal whether the indicator is absent or present. In contrast, studies who adopt a wider-scale method of plan quality evaluation underlie a higher degree of subjectivity, unavoidably. Consistent with

Baker et al. (2012), our study avoided further subjectivity due to the fact that only a single researcher had to take on the responsibility of coding every plan. In this way, the paper augmented the uniformity, coherence and accuracy.

Concurrently, the normalization process assigns equal weight to each characteristic, regardless of the available number of indicators within each individual characteristic. Hence, there are characteristics that carry a disproportionately greater influence on the final score due to the fact that they contain smaller numbers of indicators compared to the characteristics that contain a larger number. This is because, ceteris paribus, a characteristic that contains a smaller number of indicators would carry a correspondingly greater weight on the equation, inflating its contribution to the overall score, when in contrast, the characteristic which encompasses a larger number of indicators would result in a smaller output and total score.

9.4 Further research

This paper posits that evaluating municipal climate change plans through a combination of qualitative indicators (in plan quality evaluation) and quantitative indicators (in a quantitative analysis) can offer a more comprehensive understanding of local government performance. Such integration would provide a holistic view of the municipality's strengths and weaknesses in mitigation or adaptation of climate change. In recognition of the ongoing need of research in this domain, this paper examined the most cited quantitative indicators in the *Indicators* section. This exploration serves as a springboard for further investigation into the efficacy of these indicators and the potential development of robust metrics for municipal climate change plan evaluation and performance.

Finally, additional research can further investigate the Greek context by evaluating the municipal plans of other major cities such as Piraeus, Thessaloniki, Ioannina etc. Indeed, the Central Athens Regional Unit encompasses the highest population concentration-by-far-in the Greek context and ranks second in the EU but it is worth noting that South Athens Regional Unit, along with West Athens Regional Unit also hold places in the top 10 EU list (Eurostat, 2020). Further research, building upon the existing knowledge can provide a more comprehensive review of the quality of plans of the most densely populated regions in Europe and offer valuable insights for the improvement of Greek climate change action plans.

CHAPTER 10

CONCLUSION

"Nothing in life is to be feared, it is only to be understood. Now it is time to understand more, so that we may fear less"

Marie Curie (1867-1934)

Humanity stands as a major driver of climate change. Despite its brief tenure, it has already left a significant remark. The relentless rise in greenhouse gas emissions fuels and worsens the rising global temperatures and extreme weather events and creates a chain of reactions that severely impact life on earth.

While some degree of damage may be irreversible and is estimated to amplify the degradation of the quality of life for several decades to come, it is humanity's duty to take drastic action and mitigate the issue. However, despite the strong scientific consensus that supports major investments on climate change mitigation and the willingness of governmental entities for implementation, economists struggle to confidently estimate the scale and economic viability. This uncertainty hinders clear-cut decision-making.

Cultivating a profound awareness for sustainability is undeniably a key for achieving a better and more equitable standard of living. Sustainability has become a central tenet of modern thought, reaching the status of a movement or even an ideology such as democracy. In an era where civilizations fall and economies decline, in the age where global climate change rapidly increases and basic human rights cease to exist, sustainability aims to tackle the world's most crucial issues and learning to live sustainably becomes the biggest challenge of our times, demanding groundbreaking and revolutionary science.

Furthermore, urbanization and population density and their impact on society and economy is a multifaceted issue with ongoing debate among researchers. Nevertheless, a broad consensus exists that high population concentration in urban areas undeniably results in significantly larger ecological footprint compared to the rural areas.

The climate change plans of Europe's second most densely populated region-Greece's Central Athens Regional Unit, showed that there is a need for improvement in several sectors. Greece faces heightened vulnerability to climate change due to high

temperatures and increasingly frequent extreme weather events. Recent years have seen a surge in natural disasters, prolonged floods and devastating wildfires that cost many lives and had severe impact on the environment and the economy. Additionally, Greece has been troubled with unplanned urbanization, urban and suburban sprawl, housing construction in forested areas and coastal zones, further worsening the air quality, energy consumption and the excessive use of water. The most high-level inspections reveal constant violations and illegal construction remains a major environmental issue for Greece.

On the contrary, the majority of Central Athens Regional Unit's plans are lacking the factual foundation and climate change awareness. Moreover, the preponderance of plans prioritize mitigation over adaptation strategies in addressing climate change, leading to a less coherent approach. The findings revealed that local governments are continuously trying to cope with the aftermath of high population concentration but are vaguely aware that density is a significant factor that leads to environmental unsustanability. However, Athens's municipal plan identified population density as the substantial factor of the Urban Heat Island phenomenon and added that density leads to the deterioration of quality of life, increased feeling of discomfort and air pollution, the overheating of buildings, significant effects on health and high energy cost on buildings and cooling devices that further increase the city's carbon footprint.

To conclude, environmental sustainability and the prevention of the effects of climate change unequivocally stand as the most pressing challenges in the 21st century. Urbanization and population density are major factors influencing sustainability efforts. The climate change plans of Greece's most densely populated regional unit showed that there is room for improvement. Humanity should strive to seek innovative solutions to safeguard the environment and elevate the global quality of life on earth. The environmental crisis is upon us, impacting every facet of our existence- from the health of our society to the stability of our economies. The environment is the foundation upon which everything rests, and its protection is no longer a choice but an imperative.

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Appendix

CHARACTERISTIC	INDICATOR DESCRIPTION	ATHENS	VYRON	GALATSI	DAFNI-YMITTOS	ZOGRAFOU	ILIOUPOLI	Indicator Mean
Fact Base	Climate Change Awareness	1	0	0	0	0	0	0,1666666667
	Climate Change Impacts Recognition	1	0	1	1	1	1	0,8333333333
	Population Density Awareness	1	0	0	1	1	0	0,5
		1	1	1	1	1	1	1
	Emissions tracking	1	1	1	0	1	1	0,8333333333
	Base Year for Emissions	1	1	1	0	0	1	0,6666666667
	Target Year for Emissions	1	1	1	1	1	1	1
	Prediction for Emission Trends	1	0	1	0	1	1	0,6666666667
	General Climate Change Impacts	1	1	1	1	1	1	1
	Specific Climate Change Impacts	1	0	1	0	0	0	0,3333333333
	Sample Area Vulnerability	1	1	1	1	1	0	0,8333333333
		1	0	1	0	0	0	0,3333333333
		1	0	1	0	0	0	0,3333333333
Goals	Broad Goal for Adaptation	1	0	0	0	0	0	0,1666666667
	Specific Goal for Adaptation	1	1	0	0	1	0	0,5
	Mitigation-Population Density-General	1	1	0	1	1	0	0,6666666667
	Mitigation-Population Density-Specific	1	0	0	0	1	1	0,5
	Mitigation based on Community Emissions	1	0	1	0	1	1	0,6666666667
	Mitigation based on Government Emissions	1	1	1	1	1	1	1
	Mitigation–Long-Term GHG Emissions	1	0	1	1	1	0	0,6666666667
	Mitigation–Short Term GHG Emissions	1	1	1	1	1	1	1
Policies	Communication	1	1	1	0	1	1	0,8333333333
	Land Use	1	1	1	1	1	0	0,8333333333
	Transportation	1	1	1	0	1	1	0,8333333333
	Energy	1	0	1	1	1	1	0,8333333333
		1	1	1	1	1	1	1
	Waste Management	1	1	0	1	1	1	0,8333333333
	Natural Resource Management	1	1	0	1	1	0	0,6666666667
	Water Management	1	1	0	0	1	0	0,5
	Food & Agriculture	1	0	0	0	0	0	0,1666666667
	Hazard Reduction	1	1	0	1	1	0	0,6666666667
	Sustainable Urbanization	1	0	0	1	1	0	0,5
		1	0	0	1	0	0	0,3333333333
Implementation	Dedicated Implementation Section	1	1	1	1	1	1	1
	Implementation Hierarchy	1	1	0	1	1	1	0,8333333333
	Responsible Entities	1	1	0	1	0	0	0,5
	Timelines	1	1	1	0	0	1	0,6666666667
	Financial Tools	1	1	1	0	0	1	0,6666666667
Monitoring and evaluation	Dedicated Monitoring and Evaluation Section	1	1	1	0	0	1	0,6666666667
	Interorganizational Responsibility	1	1	1	0	0	1	0,6666666667
	Schedule for Revisions and Updates	1	0	1	0	0	1	0,5
	Quantifiable Goals and Policies (includes Indicators)	1	0	1	0	1	1	0,6666666667
Interorganizational Coordination	Horizontal Coordination	1	1	1	1	1	1	1
	Vertical Coordination	1	1	1	1	1	1	1
Participation	Stakeholder Engagement	1	1	1	0	0	1	0,6666666667
	Public Participation	1	1	1	0	0	1	0,6666666667
	Participation Rationale	1	1	1	0	1	1	0,8333333333
	Narrative of the Plan Evolution	1	1	0	0	1	1	0,6666666667
Plan organization and presentation	Executive Summary	1	0	1	0	0	1	0,5
	Table of Contents	1	1	1	1	1	1	1
	Glossary of Terms	0	0	0	0	0	0	0
	Illustrations	1	1	1	1	1	1	1

Appendix 1

Total Municipal Scores