An-Najah National University

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ASSESSING CLIMATE CHANGE VULNERABILITIES OF THE SOLID WASTE MANAGEMENT IN PALESTINE -RISK MANAGEMENT APPROCH

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Dedication

I dedicate this work to my dearest family members who directly and indirectly through their love, and support have laid a foundation upon which I have built my academic and personal journey. Your encouragement and your unyielding belief in my abilities have ever been a spring of strength, and I am eternally grateful for the sacrifices you might have made to see me reach this point in my academic pursuit.

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Finally, I would like to appreciate my family who contributed to this research It is your combined support that has made this thesis a reality and I am extremely grateful for support me and make me to continue work on it.

Declaration

I, the undersigned, declare that I submitted the thesis entitled:

ASSESSING CLIMATE CHANGE VULNERABILITIES OF THE WASTE MANAGEMENT INPALESTINE-RISK MANAGEMENT APPROACH

I declare that the work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

Student's Name: **Jafar Talib Ismail**

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Date: 18/2/2024

List of Contents

List of Tables

List of Figures

ASSESSING CILMATE CHANGE VULNERABILITIES OF THE WASTE MANAGEMENT IN PALESTINE- RISK MANAGEMENT APPROACH

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Abstract

Climate change threatens solid waste management in vast ways in Palestine by augmenting environmental risks as well as matters of public health. Thus, this thesis covering the interactions of climate vulnerabilities (temperature, rainfall, extreme weather, sea level and winds) within the regional wastes management practices and aimed at developing strategies towards climate resilience. The goal is to help people cope better with climate change on waste management by providing policymakers with sound advice. The thesis aims to build a holistic approach that guarantees waste disposal practices conform to global norms and contribute to a greener environment by considering climate change vulnerability and waste management. The research included quantitative assessment for historical data (rainfall, evaporation, temperature) and analysis it using R studio software (R programming for integrated development environment to analysis historical data and visualization), then applied to perform ARCGIS 10.8 mapping of the data levels to analyze areas with high climatic changes. This thesis also used qualitative assessments such as interviews with policy makers to determine which vulnerabilities are the most severe and which strategies work best for climate change vulnerabilities. According to experts in ministry of local government said the national strategy play a significant role in the mitigation of climate change and ensuring sustainable demands coordinated efforts in the development of waste management sector in Palestine. The key results showed that some regions like Gaza and south of Palestine has certain challenges and more vulnerable with regard to climate change. According to results the extreme weather such as storms, floods and draughts are high, rainfall and temperature are moderate, winds and rising sea level are low. The main strategies to be included are (Recycling programs, waste to energy, public awareness, sustainable procurement

practices, circular economy, extend producer responsibility, climate resilience infrastructure). In addition to installing methane pipes in Zahrat Al-Finjan, expanding recycling programs for paper, cartons and plastic, reinforcing trash container such as strong frame to prevent movement during high winds and covering it to make transportation more efficient.

Keywords: Climate Change, Mapping, Vulnerability, Waste Management, Palestine, Strategies.

Chapter One
Introduction and Literature Review

1.1 Background

Climate change is a worldwide issue that affects everyone (piao et al, 2019). Developing countries in the Middle East frequently bear a disproportionate share of the consequences, notably human suffering. This is especially true for Palestine, whose uncertain geopolitical climate makes it susceptible to climate-induced disasters. Using a combination of direct and secondary research, climate change vulnerabilities of the waste management in Palestine will be assessed in this work. According to recent studies, Palestine is witnessing several extreme weather events and climate changes, including increased heat and humidity, longer dry days, and a rise in the frequency of rainfall. To evaluate and identify these climate-related vulnerabilities, risk analysis is required. This study aims to examine and analyze the consequences of climate change on Palestine by merging the existing national plan for climate change in Palestine. According to (sarsour, 2022) a multi risk methodology is better to analysis the data.

According to the Palestinian Authority's Climate Change Adaptation Strategy and Program of Action, Palestinians in Palestine are primarily concerned about water and food security. Despite Israel's prolonged occupation, Palestine is developing and implementing climate change adaptation policies and programs to strengthen the resilience of Palestinian communities in the face of the numerous difficulties posed by a changing environment. Particularly, the most severe capacity limits have been discovered in the 61% of the West Bank Strip under Israeli control, known as Area C, and across the remainder of the Occupied of Palestine (Sarsour, 2022). The Palestinian Authority aspires to increase its capability and resilience to tackle the increasingly severe effects of climate change on waste management.

Palestine is susceptible to the effects of climate change, including catastrophic drought and heat waves. Recently, this region has experienced some of the world's most severe humanitarian disasters, including extreme water and food insecurity. In addition, climate change has compounded existing water and food security challenges, increasing Palestinians' susceptibility to its consequences (Khader, El-kilani, R., &Shadeed, S., 2019). In response to these obstacles, the Palestinian National Authority (PNA) and its

partners have undertaken several measures, including developing a National Climate Change Strategy and National Adaptation Plan (NAP). These plans provide recommendations on how to implement various strategies to reduce climate risk and build resilience to the effects of climate change. Even though these programs provide a significant foundation, little is known about their effectiveness in reducing climate-related vulnerabilities and satisfying the needs of the Palestinian community. This study used a qualitative and quantitative assessment of Palestine's climate change-related vulnerabilities. The thesis will focus on risk assessment and include interviews with experts in ministry of local government to identify the most significant vulnerabilities and the most effective means of addressing them. The thesis will also consider existing climate risk mitigation programs and policies. The thesis aims to inform policymakers so that more effective and targeted policies and programs may be established and implemented to mitigate the threats that climate change poses to vulnerable populations and the environment. As part of this research, a policy brief will be created to discuss the findings and give policymakers recommendations.

The inability of the stakeholders in Palestine to deal with climate change vulnerability needs to be addressed in this research. This is crucial since stakeholders who is working in landfills may need more means and expertise to implement the recommended solutions in how to deal if any risks will happen like extreme weather. In addition, the thesis does not explain how stakeholders can be involved or how the research findings can be used to influence policy changes. The strategies do not investigate the possible social and economic reflection of climate change on disadvantaged groups in Palestine. Research is needed to address the broader results and how climate change could affect the socio-economic environment of the population, even though they are focused on identifying and assessing vulnerabilities related to climate change and devising targeted responses. This could result in a skewed understanding of the risks posed by climate change and the efficacy of potential countermeasures. Nevertheless, the approach lacks a crucial element for the effectiveness of any intervention: a strategy for tracking progress when adaptive measures are put into practice. The solutions can be evaluated over time to see if they produce the expected results by keeping an eye on the collected data.

Additionally, solid waste management is a significant focus of the study. To ensure that waste is disposed of in a way that does not exacerbate the consequences of climate

change, waste management strategies should be incorporated into the broader strategy for reducing climate vulnerability. For this reason, input from relevant parties is needed to determine effective waste disposal strategies that adhere to global norms. The results should be tracked to ensure that garbage disposal doesn't exacerbate the issues already there and to aid in making the world a better, greener place to live.

Climate change is a global crisis across nationality with its effect being felt in each and every corner of our planet. Its consequences range across extreme weather events to rising sea levels that affect each and every individual throughout the world. In this regard, developing nation straggling in the Middle East bears disproportionate impacts of climate change with adverse effects rippling through the strata. One such nation grappling under multifaceted challenges occasioned by climate change is Palestine where the complex geopolitical climate that characterizes their existence works in tandem to exaggerate the vulnerability of people to climate induce disasters. Within this complicated landscape, then, this research aims to assess the vulnerability of climate change affecting waste management in Palestine by blending primary research with secondary data analysis. Studies in recent years have identified alarming climate-related changes in Palestine such as increased hotness and humidity, more days of drought as well as alternations in the means of dashing down of precipitation. These changes today call for a careful describing of the impacts that come with them, and this calls for risk analysis approach to reveal the intricate web of vulnerabilities.

Palestine, like any other country, has peculiar concerns over the security of its most basic resources: water and food. Concerning these problems, the Climate Change Adaptation Strategy and Program of Action by Palestine underline that it is rather important to ensure well-being for the population. Despite the ongoing Israeli occupation and its profound consequences, the Palestinian authority remains commitment to develop and implement climate change adaptation policies and programmers that enhances resilience of its communities. This resilience is especially an essential element in dealing with overwhelming challenges that have resulted from changing climatic conditions, more so in Area C in West Bank Strip which has 61% of its total area under Israeli control and across other parts of the Occupied of Palestine. These initiatives are aimed to boost the capacities and resilience of the Palestinian people in those areas most affected by vulnerabilities due to climate. It would be instrumental to realize, as we undertake this

study, that evaluation of climate change vulnerabilities in Palestine calls for a scientific approach that looks into both the immediate and long-term impacts, taking into account the multi-dimensional highly dynamic geopolitical environment under which it operates.

In this research, an investigation on the impacts of climate change vulnerability on waste management in Palestine would be conducted using a risk assessment approach. The existence of a peculiar and singular future that can shape both climate change and waste management make climatic environment in Palestine an interesting case of study. From this perspective, given the importance of waste management in enhancing climate resilience, the study will seek to establish how national programs for adaptation to climate change in Palestine can be consolidated with a risk approach. Thus, this approach aspires to offer an enlightening analysis of the existing and the future climate vulnerabilities which may affect the region underlining at the same time risks and opportunities created in order for dealing with the new terms of climate change.

It is important to appreciate the magnitude of climate-induced disasters Palestine has faced in recent times like disastrous droughts and heatwaves. In a state that already had a vulnerable population, these phenomena have compounded problems especially on water and food security leaving in their wake a huge refugee populace. Meanwhile, the climate change issue in parallel to these existing challenges of water and food security has only made the vulnerability of Palestinians sharper. In light of these pressing challenge, Palestine with its partners has developed initiatives that cuts across development of a National Climate Change Strategy as well as (NAP) National Adaptation Plan. The plans are guided by several strategies targeting the reduction of climate risks and advancement of resilience to climatic change impacts. Though these programs set strong starting points, there are few indications regarding their effectiveness in addressing climate vulnerabilities and serving Palestinian population needs. In this study, we will use as a basis the NAP but add to it a qualitative evaluation through frame works with focus groups. This approach identifies comprehensively the most significant vulnerabilities and most effective means of addressing them, enabling to formulate data-based policy recommendations that will strengthen climate resilience as well as the well-being of Palestinian communities.

With the difficulties presented by climate change vulnerability and efforts to effectively tack waste management, this consequently calls for an interdisciplinary approach. The

major focus of the research will be environmental impacts of climate change on waste management. This will involve developing a policy brief summarizing the findings and articulating practical recommendations to be translated into action to inform decision-making as well as providing the basis for developing earmarked policies and programs. In addition, this research is structured to engage policy actors such that the ultimate findings from the eventual research are translated into actionable items that would in many ways offer an evidence-based effective underpinning for climate resilience in the management of waste in Palestine.

1.2 Research Objectives

1. Identifying and assessing climate change vulnerabilities in Palestineon waste management such as temperature, rising sea level, heat waves, and precipitation patterns.

   The first research objective is to identify and assess diverse climate change vulnerabilities burning upon Palestine with special reference to waste management. This would specifically include examination of impacts from temperature variations, heatwaves, increase in sea-level, and the shift in precipitation patterns.

2. To suggest solutions to mitigate climate risks and its effect on waste management such as fires,accidents, diseases, and ensure climate resilience for the most vulnerable communities in Palestine.

   The second objective of the research will be to understand the direct consequences in regard to climate changes upon waste management in Palestine. This will include analyzing some challenges that are related to the climate which include the rise in fire incidences on Zahrat-Alfinjan and Almenya landfills in Jenin and Bethlehem, accidents related to extreme weather changes, pest spread due to roofs being filled with waste leading rodents to reproduce that can carry and transmit diseases, leakages of toxic stuff and pollution. Therefore, the research aims at creating a wider perspective of climate change-induced risks over waste disposed of within the region by critically examining these effects.

3. To map of the region's vulnerabilities and pinpoint the climate-related threats that are effects on waste management and those that may emerge in the future, mainly for waste management in Palestine.

The third objective of the research incorporates on mapping vulnerabilities to propose effective strategies and approaches that would help in mitigating down the adverse impacts caused due to affects of climate change over the prevailing waste management practice within Palestine. The following strategies have been identified to tackle the challenges in the second objective - reducing the risk of fires, preventing accidents and enhanced controlling of diseases, minimizing the leakage of toxic substances, managing the accumulation of waste as well as pollution. More specifically, the thesis aims to draw up practicable measures for climate-adapted resilience and improved adaptability of waste management systems.

1.3 Significance of the research

In this context, the assessment of the vulnerabilities of wastes management practices to climate change develops a solid platform in planning and implementing adaptive strategies among policy makers and historical data analysis. Clearly, how such changes in the climate will take place, with bounds of temperatures, shifted patterns of precipitation, and many more extreme weather events, the way waste management will be done will obviously be affected. The results of analysis historical data and interviews with experts leading to suggests strategies proposed could enhance the resilience of climate change risk in minimizing the impacts of risks like fire, accident, disease and pollution, in the final instance seeming to promote more sustainably secure practices for the treatment of waste in a climate that is subject to change. The research supports the enhancement of environmental sustainability as well as protection of the Palestinian communities.

Understanding how climate change affects the waste management systems in the region, and how the Palestinian government can create better systems to reduce their vulnerabilities. To better understand Palestine's existing waste management techniques' role in either exacerbating or mitigating climate change, academics have begun to examine these practices in depth. The findings of this study have the potential to inform reforms that would lessen trash production, enhance waste collection and treatment, and lessen the contamination and public health and air pollution based on historical data analysis and interviews.

Further information on how climate change affects the population's health and livelihoods, the frequency and severity of natural catastrophes, The findings of this study

can be used to inform the design of interventions to lessen the adverse effects of climate change on the region's most vulnerable populations, including plans to lessen the severity of droughts, increase the availability of clean water and energy, and enhance the quality of infrastructure and services in areas most at risk.

Research on measuring climate vulnerabilities in Palestine that takes waste management into account is crucial for comprehending the consequences of climate change in the region and developing interventions that can lessen climate change vulnerabilities. This research can aid in creating improved policies and strategies to mitigate the consequences of climate change and its population by offering evidence-based insights into the current status of waste management practices and the implications of climate change.

1.4 Literature Review

1.4.1 Overview

According to (Riyazi, 2020).the threat posed by climate change to global life, livelihoods, and sustainable development is becoming increasingly urgent. Over the past decade, Palestine has been increasingly impacted by extreme weather events such as floods and droughts, resulting in lower agricultural output and other socioeconomic issues. Hence, the Palestinian National Authority (PNA) has designated climate change as a top concern, with a focus on decreasing vulnerabilities and enhancing resilience. This literature review will explore the current literature pertaining to the evaluation of climate change vulnerabilities in Palestine and the development of a policy brief based on the national plan. It will focus on the essential elements of the plan, including the Partner Coordination Meeting, Palestine NDC Implementation Plans, Donor Consolidated Responses, Sectoral NDC Implementation Plans, Quarterly NDC Progress Reports, Country Dropbox Folder, Web Pages, Palestine NDC Implementation Plans, NDC Palestine Country Page, State of Palestine National Communication, and National Adaptation Plans.

Recent studies have centered on the development of national plans and strategies to combat climate change in the region, such as the National Climate Change Action Plan 2016-2025 in Palestine and the report Climate Change in Palestine (2019). These texts urge action to reduce climate vulnerability by enhancing resilience and focusing adaptation actions. It has been suggested that a well-written policy briefing outlining

climate change adaption measures and the necessary commitment from all stakeholders should be prepared (Riyazi, 2020).

A number of important documents, such as the Partner Coordination Meeting and the Palestine NDC Implementation Plans, have been developed to guide the implementation of the NDCs in Palestine (WHO, World Health Organization, 2022). These documents provide a forum for dialogue amongst stakeholders and aid in defining the process's scope and timing. In addition, the Donor Consolidated Answers, Sectoral NDC Implementation Plans, Quarterly NDC Progress Reports, and Country Dropbox Folder have been created to provide stakeholders with comprehensive information regarding the implementation process. In addition, there have been efforts to increase public awareness of the issue, such as the State of Palestine's national communication and the NDCs' web pages. This has the potential to improve public awareness and comprehension of climate change and its effects, as well as the capacity of relevant stakeholders to address climate-related risks (WHO, World Health Organization, 2022).

The Palestine Nationally determined Contribution NDC Implementation Plans and Quarterly NDC Progress Reports provide comprehensive details on the Palestinian National Authority's climate change strategy implementation. These publications detail the actions done to reduce greenhouse gas emissions and increase climate change adaption, as well as the results obtained (Jock Martin, 2024). In addition, they identify any knowledge and resource shortages that must be addressed in order to further enhance resilience and reduce risks. This literature analysis has underlined the significance of identifying climate vulnerabilities in Palestine and examining national climate change strategies and programs. In addition, it has emphasized the numerous papers available to inform this assessment, such as the Palestine National Message, the Country Page – Climate Change in Palestine 2019 and the Palestinian NDC Implementation Plans and Quarterly NDC Progress Reports (WHO, World Health Organization, 2022).

1.5 Vulnerable group

Climate change is an essential issue for many countries worldwide, particularly (Poortinga, 2019). Palestine, which consists of the West Bank Strip, is no exception. As a result, it is essential to identify climate change vulnerabilities to develop adaptation strategies to reduce and manage the risks posed by climate change. This literature review

examines the current state of research regarding climate change vulnerabilities in Palestine, identifies the main exposure areas, and discusses the implications of these findings. Climate change is threatening the physical and economic prosperity of many of the groups in Palestine, but the most vulnerable tend to be those in rural and agrarian communities. Women and children are the most affected due to unequal access to resources and services, even in extreme climate events (Aguilera, 2020). Similarly, society living in poverty and those without adequate infrastructure, food and water security, education, health care, and other social services are disproportionately facing the brunt of climate change impacts. The Sustainable Development Goals (SDGs) are a set of global objectives set by the United Nations to combat poverty, racial inequality, environmental degradation, and other global issues. Together, they form a universally agreed-upon framework for creating an equitable and prosperous world where everyone can live with respect and dignity. The UN's SDGs for Palestine emphasize new approaches, tackling fundamental problems, and fostering broad-based economic development. Goal 13 of the SDGs addresses climate action by encouraging and promoting preventative measures to mitigate climate change's adverse effects. To this end, it is critical to take action and implement initiatives that will make people less susceptible to the negative impacts of climate change.

Improvements in Palestine's environment, economy, and citizens' well-being can be made permanent through linking to SDGs. One possible outcome of such reforms is a better economy that makes better use of its resources. The vulnerable populations in Palestine would benefit from reduced poverty, inequality, and injustice and from lessening the harmful effects of climate change.

Climate change and the Sustainable Development Goals (SDGs) are interwoven worldwide, but Palestine's situation is especially dire. Palestine faces a significant risk from climate change because of its proximity to a scorching and arid region and its inability to invest in adaptation measures. Less rainfall, more extreme weather events, and many other concerns are already significantly impacting the Palestinian economy and society, notably in the agricultural and forestry sectors.

The United Nations' Sustainable Development Goals are becoming increasingly crucial in Palestine because they focus on creating a better and more sustainable future for all. In this context, the Sustainable Development Goals (SDGs) addressing poverty, education,

health, gender equality, and the environment are of particular importance because they directly impact Palestinians' daily lives. So, SDGs, in conjunction with steps to reduce the effects of climate change, may play a significant role in enhancing the standard of living for Palestinians.

1.6 Effects on temperatures

Hammad, & SalamehA (2019) suggested that climate change is already having a significant impact on the region, primarily in terms of increasing temperatures and dryness. Palestine is projected to experience a further increase in temperature of up to 2-4°C over the following decades, as well as reduced precipitation levels. These climate changes significantly impact water resources, agriculture, tourism, and health, among other sectors (Hammad, & SalamehA., 2019). The temperature in Palestine is generally mild, with an average annual temperature of 18°C. Palestine's climate is typically classified as Mediterranean, with dry summers and wet winters. However, due to the country's varied topography and elevation, there is a wide range of climates. In the West Bank, altitudes range from 375 meters below sea level to 1020 meters above sea level (Ministry of local Government, 2020). This is reflected in the annual rainfall, which is highest in the north (up to 700 millimeters) and lowest in the south (80 to 100 millimeters) (agriculture, 2019).

1.7 Environmental effect

Hammad, & SalamehA (2019) states that climate change is a novel and current danger with far-reaching consequences on security, economics, politics, and the environment. Assessing Climate change vulnerability on waste management using historical data about climate change risks. climate change is likely to worsen existing problems and create new risk combinations, particularly in areas with high poverty levels and dependence on the natural environment. According to Thomas (2019), vulnerability to climate change can be described as the susceptibility of a system to the harmful effects of climate change, like climate variability and extremes. This susceptibility is determined by the system's exposure, sensitivity, and adaptability to climate change . Climate change can bring about new stressors and exacerbate existing ones, thus making a system more vulnerable to the impacts of climate change.

1.8 Effect on agriculture

According to Ghanma (2012), 31% of Palestinian land comprises the West Bank Strip, with a total of 1854 km^2 of agricultural land. Of this, 14% is irrigated, while 86% is rain-fed. 2000 km^2 of rangelands, 621 of which are suitable for grazing, and 94 km^2 of forests are also found in this area. Unfortunately, due to Israeli settlement activity and the building of the separation wall, the amount of land for rangelands and forests has decreased significantly (Tomoki N, 2023). Ministry of Agriculture stated that Israeli occupation had decreased Palestinian land, with 62.9 percent of agricultural land in Area C under Israeli control, 18.8 percent jointly managed in Area B, and 18.3 percent under Palestinian control in Area A in 2019. This has created more vulnerability to climate change-related economic impacts for Palestinians than without the long-term effects of the Israeli occupation.

According to the Intergovernmental Panel on Climate Change IPCC (2022), climate change is expected to have a pronounced effect on agricultural conditions such as temperature and precipitation. Models of climate for different regions indicate that winters will become warmer and the amount and pattern of rainfall will change (Tester, P. A., Litaker, R. W., &Berdalet, E. , 2020). These climate shifts will likely impact agricultural production. In this thesis the rainfall is one of the risks that will be assess to show how its effects on waste management.

1.9 Waste management

Several studies have begun to examine how Palestine's climate vulnerabilities are affected by the country's heavy reliance on waste management and repurposing. In this thesis, existing literature were analyzed to determine how waste management implementation influenced by climate change vulnerability in Palestine. The essay "Climate Change Vulnerability in Palestine: A Comprehensive Assessment" (Khalil, 2015). This article examined Palestine's susceptibility because of climate change, paying particular attention to how climate change affects Palestine's agricultural, water, energy, and health sectors. They point out that "the management and repurposing of solid and liquid waste" (Khalil, 2015). are significant issues that can have a major impact on the country's overall vulnerability to climate change.

Assessing climate change in Palestine on current waste management and how they contribute to the vulnerabilities to suggest strategies to enhance waste management

system. The solid waste across Palestine lead to hazardous health conditions, especially among children, and can further jeopardize the country's food security and water resource. The authors also note that sustainable waste management strategies are crucial in mitigating climate change's impact on Palestine (Salah, W. A., Abuhelwa, M., & Bashir, M. J. , 2021).

The UN study "SDGs in Palestine" is the third credible academic resource. This report analyzes the steps Palestine is taking to achieve the United Nations' Sustainable Development Goals and lessen its exposure to climate change. According to the report, "the reduction of solid and hazardous waste generation and the safeguarding of natural resources" are given "special attention" under Goal 12: Responsible Consumption and Production (United Nations, 2020). Given Palestine's dependence on natural resources and its continuous challenges with solid and hazardous waste, this aim is crucial for lowering its climate vulnerability. In sum, this literature analysis's findings highlight the need to consider waste management when evaluating Palestinian exposure to climate change. All three academic sources agree that improper waste management increases the likelihood of health problems and endangers the nation's food and clean water supply. If the United Nations ' Sustainable Development Goals are implemented, Palestinians are less likely to be negatively affected by climate change.

Palestinians' waste management practices pose a substantial threat to their ability to adapt to changing weather patterns (Kuzma, 2021). More specifically, trash collection and disposal services, waste mismanagement, and waste-related health risks have all been connected to climate change. Moreover, climate change can increase waste-related air and water pollution and may exacerbate already-existing water scarcity issues. Since improper waste disposal has a negative effect on human and environmental health as well as economic and ecological progress in the region, it poses a significant obstacle to sustainable growth there. Policymakers can better address the problems posed by trash if they have a better grasp of how climate change influences waste management. Assessing Palestine's climatic risks requires taking waste management into account. Reduced garbage collection and disposal capacity, improper waste management, and the spread of infectious illnesses are all consequences of a warming planet. Climate change also has the potential to exacerbate existing water scarcity issues and increase waste-related air and water pollution. Due to its detrimental effects on human health, economic growth,

and environmental quality, waste management is a significant obstacle to the region's pursuit of sustainable development. Policymakers can better address the problems posed by trash if they comprehend the role that climate change plays in impacting waste management. Palestine must increase its waste management capabilities and advocate for sustainable practices to progress toward the Sustainable Development Goals (SDGs). Identifying the threats that climate change poses to waste management and taking action to reduce these threats is essential to ensuring the protection of the environment and the health of citizens (Salah, W. A., Abuhelwa, M., & Bashir, M. J. , 2021).

1.10 Theoretical Framework

In a study by Nasser Karami discussed by scholars around the world, the issue of very controversial link between drought and climate change in the Middle East (Nasser, 2019). Whereas the common view associates prolonged drought in the region to global warming, Karami dives into a full analysis of climate trend over the different periods that entail 1900–1970, 1970–2000, and 2000–2017 (Nasser, 2019). In this detail, an interesting revelation that counteracts the conventional understanding appears. The study by Karami revealed that although the Middle East experiences natural climate patterns of long-term drought durations, the present drought has gone beyond the historical records by extending over a period of more than a century. This highlights the undeniable influence of global warming on exacerbating drought conditions in the Middle East. Further on, Karami argues for a shift of terms and suggests *drying up* in order to reflect the changing climate of the region as a new norm and persistent pattern different from the classical concept of a "drought" as periodic transient episode. The research indicates a need for further exploration of the modality of climate change in the Middle East showing the complex interplay between natural and anthropogenic factors shaping the climate trends within the region.

Climatic vulnerabilities a major issue as addressed by Weiner in his article. Weinger highlights on the long atrabilious emphasis of the convention on sovereignty of territorial states in the climate planning since 1992 (Yaqoub, 2023). Building on the contemporary political geographical scholarship that challenges unity of the state and its exclusive role in international politics, Weinger extends this discourse to climatic change adaptation. Using discourse analysis and a history of institutional and political investigation that situates climate planning at a series of scales, the paper unpacks how normative

discourses set the stage for prevailing political dynamics that shape tangible future outcomes. Furthermore, Weinger's investigation delves on climate planning within the Palestine-Israel context, both sitting pretty within an asymmetric geopolitical landscape characterized by territorial disputes, sovereignty challenges as well as fragmented statecraft (Yaqoub, 2023). Weigner uncovers two significant institutional constraints on governance of the climate. Firstly, ahistorical adaptive strategies often follow on in the wake of the application of technical-managerial principles as they inadequately account for underlying political constraints. Second, the universalizing portrayal of climate change, which omits political-economic and historical-cultural factors in favor of this purely geo-physical perspective, it overlooks the systemic creation of varying levels of vulnerability.

Tàbara, Jill, Diana, & Marco (2019) explored the pressing need for transformative solutions in the face of high-end climate change scenarios. The study concluded with the awareness that traditional climate strategies and remedies may be inadequate in avoiding the severe disruptions of social-ecological systems since it has the need for a drawing up of a framework that will supersede the limitations inherent in conventional approach in the assessment on the climate. The authors introduce the idea of transformative climate science described as an ongoing process at all times that involves generation, structuring and utilization of knowledge aimed facilitating seamless integration if adaptation and mitigation strategies with sustainable development goals. Drawing from their experience of regional cases in Central Asia, Europe, Iberia, Scotland and Hungary, the authors identify twelve key dimensions representing a practical checklist for scientist and practitioner. This checklist empowers them to design climate assessments that are geared towards transformative outcomes (Tàbara, Jill, Diana, & Marco, 2019). It is important to note, that as the article recognized the potential of transformative adaptation and transformative mitigation, it argues out that societal transformation lies in factors other than mitigation and adaptation policies. This arises from the fact that transformation for societies is inevitably tied to sustainability innovations that bursts out of intentional social learning processes. The article adds immense value to the discourse of climate science through reinforcement of the imperative of transformative approaches in addressing the high end of climate change and recovery of a structured framework for reviewing the climatic situation making it possible to generate action from solutions.

Setyawati et al. discussed the critical issue of emissions of greenhouse gas (GHG) especially CH4 and CO_2 through the waste disposal process in the Piyungan called Integrated Waste Management Facility (Setyawati, Budiastuti, Wijaya, & Setyono, 2021). These emissions may increase global warming problems. Recognizing its significance the as this challenge, in this study examined the role of local institutions in addressing whether- related problems at Piyungan as a climate change mitigation strategy. From the above, the research undertakes an evaluation using a qualitative approach of three key factors associated with climate resilience such as urban systems (infrastructure), social agents (stakeholders), and local institutions. Further, the research adopts quantitative scoring methods as stipulated under the guidelines from the Intergovernmental Panel on Climate Change (IPCC) in assessing waste management strategies. The findings are found to reveal that the Integrated Waste Management Facility in Piyungan does not succeed for a decrease in the CH4 emissions thus highlighting significant concern related to the environment (Setyawati, Budiastuti, Wijaya, & Setyono, 2021). Moderate status divergence is evaluated in the urban systems or infrastructure states at the facility, while relatively positive performance of social agents or stakeholders and local institutions. Notably, the study emphasizes the active role of local institutions that play a pivotal role in climate change mitigations efforts. This research provides some valuable insights into the intricate interplay among waste management, local institutions and, their implications in climate resilience underpin how coordinated actions for effective reorientation of GHG emissions are critical.

The Intergovernmental Panel on Climate Change (IPCC) framework for climate vulnerability assessment is a comprehensive approach aimed at analysis and quantification of the vulnerability of systems/populations to the consequences of climate change. The vulnerability analysis framework of IPCC has four interrelated components that include exposure, sensitivity, adaptive capacity, and the vulnerable. What is subjected to the impact of climate change, such as temperature and extreme weather events, is exposure. Sensitivity gauges how strongly a system or population is affected by these changes based on characteristics/susceptibility. Adaptive capacity measures the ability of the system to adjust, respond and cope with the impacts taking into consideration factors such as resources, knowledge, governance. The term vulnerability denotes the major outcome, depicting the measure whereby a system or population is susceptible to damage from climate change and is due to combinations of exposure, sensitivity, and adaptive

capacity. This framework assists researchers and policymakers in identifying which areas, sectors, and communities are vulnerable to developing tailored strategies that will mitigate this vulnerability and transform it into resilience towards climate change.

Table 1

Components of the IPC framework 1

Component	Description
Exposure	This component checks on the levels of exposure on the climate change and to what extent by addressing all the aspects exposed to the risks of the climate change.
Sensitivity	The degree to which a system or population is affected is addressed under this component.
Adaptive Capacity	The ability of a system or population to adjust and respond to climate change is addressed under the above component.
Vulnerability	The components offer reflection on the extent to which a system or population is at risk from climate change.

1.11 Summary

Much of the environmental challenges that the State of Palestine is experiencing are directly or indirectly related to waste management (Belal, Nidal, Mahmoud, Peter, & Piet, 2020). This problem was exemplified by illustrative data of the United Nations Environment Programmers (UNEP) in 2020 that has informed about an alarming trend that 47% of all waste, including hazardous waste, are still disposed of improperly in unsanitary dumpsites (Marta, 2023). This alarming statistic underscores the dire state of waste management within the region in signifying a significant threat to the environment.

It even gets worse with the data from Heinrich Böll Foundation in the Plastic Atlas report, majorly on municipal solid waste. According to this report, an estimate of 65% of waste finds its way into landfills, a percentage that forms quite a substantial amount of the country's wastes with an additional one amounting to approximately 32% ending up in illegal dumps. What is quite shocking on the other hand is the fact that only 3% of the generated waste is subjected to recycling or reuse processes (Marta, 2023). The major reliance on landfills and unauthorized dumping sites for the disposal of wastages reflect shortage in infrastructures all-inclusive in the management of waste thereby perpetuating environmental risks.

In addition to the environmental challenges that poor waste management poses, account should be made in relation to the peculiar sociopolitical and economic situation in which the State of Palestine exists (Tawfiq & Abdelhaleem, 2022). Further, consistent occupation, economic constraints and social dynamics further make the regional challenge be a global challenge in waste management (Marta, 2023). Such multi-faceted challenges involve holistic strategies that will boost environmental waste management practices, encourage sustainable practices as well as coping with the adverse harmful impacts on the environment that have been exacerbated by the complexities in the context in which Palestine exists.

Chapter Two
Methodology

2.1 Data sources and collection methods

This thesis included main sources of data for the analysis of climate change vulnerabilities in waste management in Palestine were mainly through a combination of primary and secondary sources. For this, qualitative interviews with experts on ministry of local government during writing thesis were carried out that were supported by secondary data and local literature while experts to derive an overview of the prevailing waste management practices as well as climate-related challenges faced by the region besides its resilience strategies (Randal & Abdelhaleem, 2022). Secondary data included information from government reports, environmental agencies, as well as academic research that aided in beefing up the primary data to exquisite a comprehensive view of the subject.

Ethical issues were paramount that ensured the matter of informed consent, confidentiality, and followed ethical guidelines. The quantitative way of analyzing the data was through the method of descriptive statistics in relation to the historical data and the qualitative one for interviews being the application of qualitative content analysis (Husam, Mohamad, Mahmoud, Fuad, & Mutaz, 2014). The aim of the research was to collect robust data whereby duly noting and addressing limitations of the study including potential sample size constraints and availability of data.

The study used quantitative and qualitative methodology to fully evaluate the vulnerabilities of climate change on waste management in Palestine. The study used risk management software (R studio 1.4). Its R programming for integrated development environment to analysis historical data and visualization. to statistically assess the risks associated with climate change and their implications on waste management. The study's design comprises three distinct phases.

Risk Identifications: The initial stage of the study entailed identifying climate change risks that influence waste management in Palestine. The identification of risks conducted using a comprehensive literature analysis, in-depth interviews with relevant experts in the waste management sector in the ministry of local government and asked them about

climate change risks on waste management, vulnerability, sensitivity, adaptive strategy, how risks affects on waste management?, what strategies can be included, how can the national strategy be improved? , what is the efficiency of each strategy? (after results). Potential risks included temperature, precipitation patterns, sea level, heat waves and occurrences of extreme weather events.

Evaluating vulnerability: The second stage assessed the waste management system's susceptibility to climate change's impacts and mapping results on GIS.

Solution formulation: The formulation of these solutions derived from the outcomes of the risk assessment and vulnerability assessment using GIS. The proposed solutions would prioritize mitigating risks, enhancing the waste management system's capacity to respond to these risks, and establishing climate resilience measures within the most susceptible areas.

2.2 Tools

2.2.1 GIS

Geographic Information System (GIS) was the instrumental tool applied in this analysis to map and visualize the geographic distribution of climate vulnerabilities alongside of waste management practices in Palestine. GIS involves a variety of data types, such as climate data, waste management infrastructure, and geographic boundaries. It provides the spatial context hence assessment and visualization of places, trends, and disparities in relation to waste management practices and climate related vulnerabilities in the different regions of Palestine.

GIS utilized in the research to produce and map the themes as well as the spatial analyses, hence increasing the dexterity of the research to indicate areas with specific problems as well as possible hotspots for intervention. Therefore, the research would help in understanding the spatial properties of impacts of climate change on waste management in the region for targeted recommendations of climate resilient strategies.

2.2.2 R studio software

R studio software was used to help in understanding the data. This was done by importing the historical data from excel included 39334 of total amount of data from 1970 -2022, cleaning the data, organizing the different data variables and also doing data visualization.

Descriptive statistics was done using the technique for the ease of summary data from the rainfall, evaporation and temperature data. Also, some data sections that contained null end dates were updated using the approach in R.

Risk Assessment Framework: The researcher formulated a mathematical framework to evaluate climate change risks impacting waste management. This framework considered risks like temperature, sea level, precipitation, and weather extremes, using historical climate data with experts qualitative interviews.

Climate resilience index (CRI): using color rendering index collected from experts to evaluate the vulnerability, sensitivity, and adaptive capacity of the waste management system to climate risks. Each factor was quantified on a scale from 0 (low) to 1 (high), through assessment of the system's resilience.

Interviews and Policy Recommendations

Interviews with experts from the Ministry of Local Government, revealed valuable insights into the current challenges and potential strategies for improving waste management practices to reduce climate change risks. The experts highlighted the need for updating national policies to align with global policies and address specific risks like sea level rise, wind impact, precipitation patterns, temperature and socio-economic factors.

2.3 Results Mapping

Since Palestine is a country with diverse geographic contexts and climate vulnerabilities differing by the region, then it would be pertinent to capture this kind of spatial heterogeneity using Geographic Information Systems (GIS) in mapping climate data, waste management infrastructure among other relevant variables (Cynthia, et al., 2021). This spatial analysis facilitated a visualization of temperature trends, precipitation patterns, and the sites of disposal (Benjamin, 2021). GIS created an opportunity for thematic maps on vulnerability distribution concerning climate as well as the challenge in geographical span of waste management. Overlay of climate data over waste management infrastructure can help in identifying areas at higher risk and need targeted interventions. Excel was used as well to prepare trend figures.

2.4 Analytical Framework

To present mathematically the critical task of identifying climate change risks impacting waste management in Palestine, several factors need to be taken into considerations. Factors include risks such as increased temperatures (T), varying sea-levels (SL), changing patterns of precipitation (P), and growing magnitude of weather extremes (W). Quantitatively, these risks convincingly assessed basing on historical climate data of the past decade (Eq. 1) (Jinlun, Michael, & Axel, 2010). The data encompasses such variables as annual mean temperature, sea-level rise, precipitation amount and the frequency of extreme weather events among other variables which are major foundations for the subsequent steps of the research.

$$Risk = f(T, SL, P, W) \tag{1}$$

$$Risk = \sum_{i=1}^{n} W_i . f_i(p_i) \tag{2}$$

Equation 1has represented the risk equation in identifying the potential risk which is a function of the temperatures, the changes in the sea levels, the precipitation and the weather conditions factor. Building into the phase of identifying the risks, the combined approach applied to aid in identifying and assessing the vulnerability of waste management systems to these climate change related-risks. The qualitative assessment would feature in-depth interviews (I) with experts in ministry of local government. Such interactions helped in getting insight from the experienced people about experiences and perspectives of climate vulnerabilities.

$$CRI = \alpha \cdot (1 - V) + \beta \cdot S + \gamma \cdot A \tag{3}$$

The quantification of these vulnerabilities attained by used historical data for events that have already occurred and development of scenarios based on the use of climate models (CRI) climate resilience index (Eq. 2). This data collected from experts and with the insights of policy makers enhanced the more detailed examination of sensitivity and adaptive capacity on the waste management systems from climate risks.

Based on risk identification phase, an assessment of vulnerability will be made for the waste management systems to these climates relate risks. At the qualitative level, interviews (I), and workshops (W). These coefficients represent a ratio in their relative

importance to others of the constituents and allow one to evaluate climate resilience in a customized manner. Further, the factor indicating the degree of vulnerability, sensitivity as well as adaptive capacity for the concerned factor is provided with mathematical value in the range of 0-1. Out of the computation of CRI, researchers, and policymakers obtain a single value that represents a general essential view on the system's resilience to climate change stresses and the capacity for adaptation to changes and thriving within its dynamic environmental regime.

The first element, vulnerability (V), identifies how the system is vulnerable to climatic-driven risks. These may be of extreme weather conditions and temperature as well as variations in precipitation patterns and sea level. Vulnerability factors are then assigned values starting from 0 (no vulnerability), through 1 (high vulnerability) and then average or weigh the vulnerability scores. Sensitivity (S), on the second component, determines the level at which these vulnerabilities would impact significantly on the system considering the damage potential experienced and disturbance of operations.

Factor sensitivity is also rated in between 0 to 1, where a value of 0 indicates low sensitivity while a value of 1 indicates high sensitivity. This is the third component in regard to adaptive capacity (A), which measures the system's capacity to adapt and respond efficiently. Factors covered under this component entail the resources available, knowledge by institutions, as well as the governance structures in place for effective change. These factors are scored between 0 (representing low adaptive capacity) and 1 (indicating high adaptive capacity).

Table 2

CRI Percentages 1

Risk	α	β	γ	V	S	A	CRI
Temperature	33%	33%	34%	35%	35%	30%	0.44
Rainfall	33%	33%	34%	40%	40%	20%	0.42

Interviews were performed with an expert team from the Ministry of Local Government, Director General of the Joint Services Councils.

Table 2 above shows the percentages of the elements used in eq.2.

According to the team in ministry of local government, sea level rise poses a 10% danger, and there are no measures in place to prevent floods caused by sea level rise, accounting for only 5% of the practical application of strategies. The team recommended the need to have special systems to extract salt water from the Dead Sea and prevent throwing waste on the beaches.

Winds pose a 20% risk, the consequences of winds on society and health are high, as there are no strategies to reduce the risk, and the percentage of these strategies is only 10%.

Economic and social factors have a high impact on waste management. The team said that Palestine has become more vulnerable to climate change as rising temperatures and the precipitation patterns , as well as the fires and floods it causes and the resulting accidents, which impede waste collection and disposal, in addition to chemical leakage, the Ministry has a national strategy to adapt to climate change and its impact on waste management.

The team recommended the need to update national policies to be compatible with global policies.

Chapter Three
Data Analysis and Results

3.1 Data Preparation

The research looked at evaluating how climate change might affect the region in the future, allowing for informed decision-making to occur for those tasked with preserving the health and safety of Palestine's citizens.

This research results were used to assess the degree to which Palestine is vulnerable to climate change, as well as the attitudes and behaviors of communities concerning extreme weather events. This way of qualitative and quantitative of the research design will provide a comprehensive picture of the climate change vulnerabilities of Palestinians.

Additionally, this way led to determine the extent to which the government are aware of and experiencing the consequences of climate change, a methodological practice known as phenomenological design. The primary goal of the phenomenological method in qualitative research, as outlined (Leedy, 2010), is to gain insight into the individual's experience, understanding, and perception of a particular situation caused by climatic change. This involves paying keen attention to participants' intonations, queries, and digressions as they detail their daily encounters with the phenomena in focus.

A causal analysis and risk assessment was conducted using statistical software to analyze and understand the causes and effects of climate change and identify and assess the potential risks posed by climate vulnerabilities. The results of the primary data collection sources and the literature review findings were then be integrated, analyzed, and synthesized to draw conclusions and recommendations regarding climate vulnerabilities in Palestine. Coy (2019) argued that purposefully selecting certain cases containing much information can provide valuable insights and knowledge regarding crucial research objectives. Such suits can be instrumental in understanding the underlying issues being investigated.

Data cleaning is one of the critical parts of the entire process as it ensures that the dataset to use in research is precise and hence reliable. The end dates data particularly as well as the variability in weather stations recorded quite some missing data in this study. So, to address the problem of missing end dates, we took up the task systemically. We started

with identifying the scope of the problem by looking at the data and realized there was a significant chunk of records wherein the respondent had not given correct dates for the end. This sailed on a very challenging ground because one cannot know the duration of weather events in the dataset since there were no end dates. Imputation methods were used to remedy this problem. In particular, the temporal information as well as some pattern in nearby records was used to validate the estimates made for missing end dates in a situation when they existed. Such an approach has allowed us to restore a significant amount of the missing data, ensuring that our analysis is based on as complete a dataset as possible.

Moreover, a range of weather stations resulted in additional complexity in the dataset. Often these stations had varying intervals of data collection, varying formats and maybe some missing observations. I standardized the data that emanated from different stations to ensure that all variables under study have a common format and unit of measurement. I also assessed the effect of missing observations, interpolating and extrapolating appropriately. The aim was that these data cleaning efforts establish a more homogenous and complete data set to be used conduct robust analysis on the climate vulnerabilities of the region.

3.2 Descriptive Statistics

The statistical analysis methodology was employed to understand this problem Hayes (2020) comprehensively. It involves using multiple variables to be considered in the study. The first variable for the analysis is historical climate information. Quantitative Climate data of the last decade were analyzed to determine long-term trends of temperatures, precipitation patterns, and atmospheric concentrations in Palestine. This data can be supplemented with information from historical climate models and qualitative data such as interviews and workshops, which can be further analyzed to determine future climate scenarios.

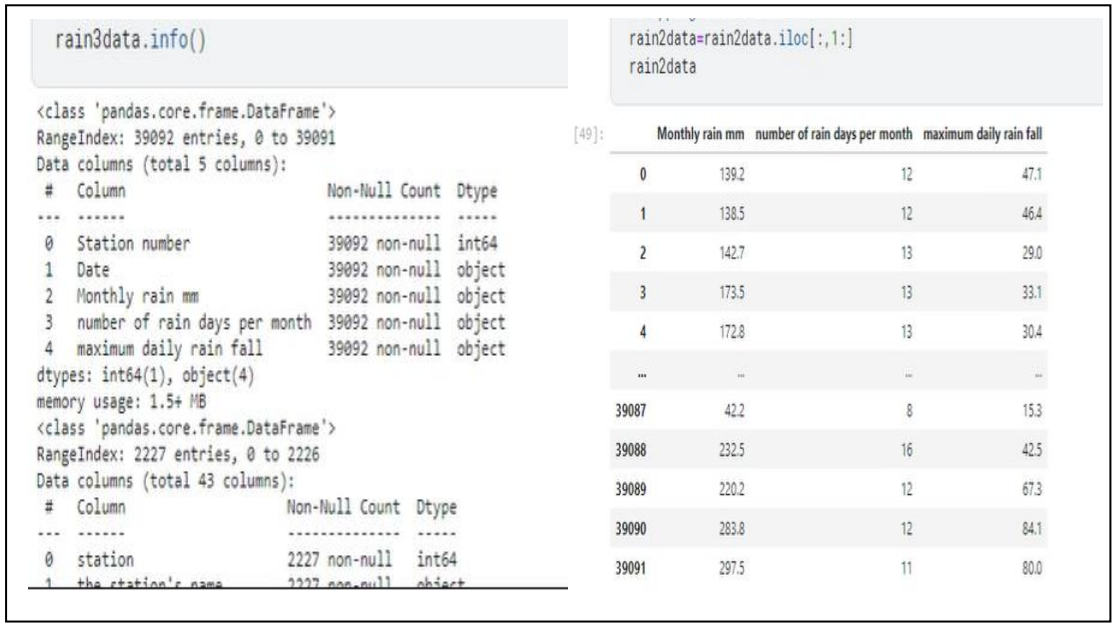
Additionally, the physical-geographical environment and its potential for resilience. This involves gathering and analyzing data on physical factors such as topography, hydrology, soil characteristics, etc. This analysis focuses on the biophysical capacity of the geography to mitigate climate change impacts, such as the potential for drought and flood mitigation or the ability to establish buffers that minimize weather-related risks om waste management. According to Johnson (2019), statistical analysis methodology is geared

towards providing an in-depth understanding of climate vulnerabilities in Palestine. The assessment ultimately results in multiple data sets that will be used to develop effective strategies for mitigating climate change risks on waste management.

The descriptive statistics presented here offer a comprehensive snapshot of the evaporation data for various regions. This data offers useful information regarding three important variables spread – monthly rain (mm), the number of rain days in a month, and maximum rain in a single day. In this context of research on climate change, knowledge about these variables' central tendencies, variability and distribution becomes essential for the definition of patterns, evaluating prospective vulnerabilities and deciding what is possible upon implementation of informed measures towards climate resilience strategies (Issam, Majed, & Stamatia, 2020).

Figure 1

Data Verification and cleaning in R



```
rain3data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 39092 entries, 0 to 39091
Data columns (total 5 columns):
 #   Column                      Non-Null Count  Dtype 
---  ------                      --------------  ----- 
 0   Station number              39092 non-null  int64 
 1   Date                        39092 non-null  object
 2   Monthly rain mm             39092 non-null  object
 3   number of rain days per month  39092 non-null  object
 4   maximum daily rain fall     39092 non-null  object
dtypes: int64(1), object(4)
memory usage: 1.5+ MB
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2227 entries, 0 to 2226
Data columns (total 43 columns):
 #   Column                  Non-Null Count  Dtype 
---  ------                  --------------  ----- 
 0   station                 2227 non-null   int64 
 1   the station's name      2227 non-null   object
```

```
rain2data=rain2data.iloc[:,1:]
rain2data
```

[49]:

	Monthly rain mm	number of rain days per month	maximum daily rain fall
0	139.2	12	47.1
1	138.5	12	46.4
2	142.7	13	29.0
3	173.5	13	33.1
4	172.8	13	30.4
...	...	...	...
39087	42.2	8	15.3
39088	232.5	16	42.5
39089	220.2	12	67.3
39090	283.8	12	84.1
39091	297.5	11	80.0

The figure 1 above shows the data description for the rainfall data in Palestine. These statistics give a basis on which to build when considering the implications of climate change across differing regions and the readiness of each in facing further challenges.

The above statistics observed on the days that experience rain in a month show an average of about 5.53 days, and this is shown to have a range value that was estimated from 0 to 24 days. These statistics show that most days of the month are characterized by showers in some areas while others are characterized by sporadic rainy days. Some variation has

been observed from the skewness and kurtosis from the data but this is proven to be minute from the standard error indicating relatively consistent values (Alessandra, Sara, & Eric, 2019). The maximum daily rainfall within these regions reaches an average of 19.31 mm, with a wide range of 0 mm to 188.5 mm. This variability has implications for local flood risk and resilience of infrastructure, all reinforcing the need for an adaptation strategy accounting for sudden heavy rainfall events.

Knowing descriptive statistics on these key variables is essential to climate change adaptation and resilience planning. The data give a first indication of such patterns and of frequencies of rainfall, which is important for the assessment how regions might be affected by climate change with droughts, floods or extreme weather events (Cecilia, Mark, Brian, Stephen, & Andreas, 2015). Further analysis and modeling will help in the development of climate tailoring strategies to mitigate impacts of these climate-related challenges enhancing climate resilience of these regions.

Table 3

Descriptive Statistics

	Monthly rain mm		number of rain days per month		maximum daily rain fall
Mean	55.11113	Mean	5.52733	Mean	19.31194
Standard Error	0.346787	Standard Error	0.024584	Standard Error	0.106057
Median	29	Median	5	Median	13.4
Mode	0	Mode	0	Mode	0
Standard Deviation	68.7775	Standard Deviation	4.875701	Standard Deviation	21.03406
Sample Variance	4730.344	Sample Variance	23.77246	Sample Variance	442.4317
Kurtosis	4.212015	Kurtosis	-0.13284	Kurtosis	2.132043
Skewness	1.819529	Skewness	0.754541	Skewness	1.357734
Range	612.4	Range	24	Range	188.5
Minimum	0	Minimum	0	Minimum	0
Maximum	612.4	Maximum	24	Maximum	188.5
Sum	2167741	Sum	217412	Sum	759615.9
Count	39334	Count	39334	Count	39334

The average rainfall is shown (Table 3) to have an average ranging above 55.11 mm from the month's rain (mm) statistics and extends from a minimum of 0 mm to maximum of 612.4 mm. The data shows positive skewness and kurtosis having the implication that the distribution of the data is skewed to the right, and it exhibits fat tails-occasionally heavy rainfall events prevail within this region (Rajat, Sharon, & Enda, 2022). The median of

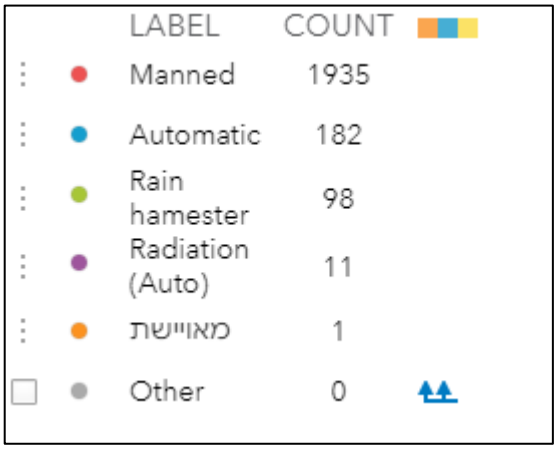
monthly rainfall is 29 mm while the mean is quite significantly higher, which indicates that there are a few outliners with high values of rainfall.

3.3 Data Visualization

The numbers information was composed of manned weather stations, automatic weather stations, radiation instances and a distribution of another unique count referred to as *rain hamster.* From the visualizations presented, a keen look on the different characteristics and distributions patterns of the dataset is presented (Figure 2).

Figure 2

Rainfall Data Variables

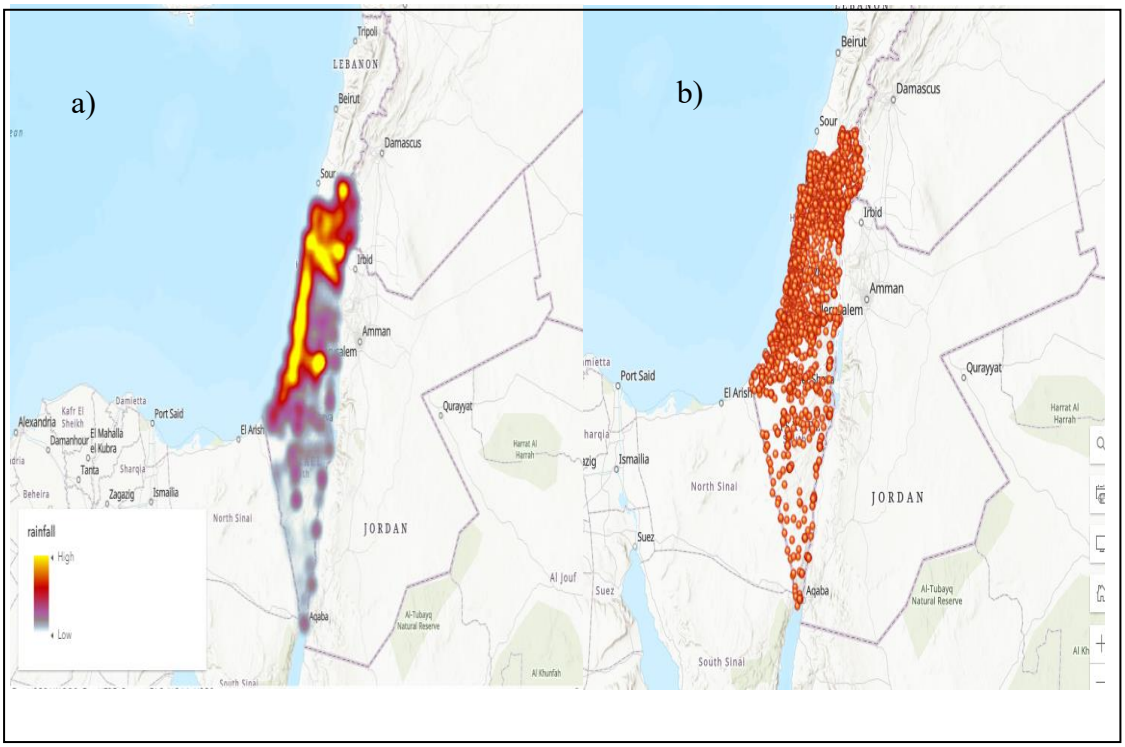


First is to visualize with the manned and the automatic weather stations. The figure depicts the disparity in the two types of weather stations. The data would imply that there were significantly manned weather stations as opposed to the 182 automatic weather-stations which had occurred in 1935 instances (Eyad, 2020). This is paramount as a stark contrast in understanding the sources behind data collection within the dataset since it identifies possible variations in quality of data, how frequently had been the reporting of few data as well as spatial coverage. Rainfall frequency and risk were mapped in Figure 3 based on the utilized data.

Turning to radiation instances, the distribution of how radiation is across the dataset is represented through a histogram. This histogram shows that with recorded 11 instances on radiation measurements these frequencies are distributed (Dalia & Stamatia, 2019). In such a data arrangement, visual inspection of any patterns or variations with respect to the radiation data is readily possible which is a prime need when one has to assess exposures to solar radiation in context of climate and environment studies.

Figure 3

Rainfall Risk and Frequency



The figure above shows the rainfall frequency maps for Palestine. Figure A represents the risk and the B shows the distribution of rainfall data on GIS map, its heavy in some regions and light in others.

3.4 Data Mapping

Mapping is a key visualization of spatial data using a geographic information system (GIS) background, whereby it involves these associated underlying patterns and characteristics. This procedure can connect data with their geographical context, thus helping in more understanding about how the location influences various phenomena. In this research, data mapping was used to describe the geographical distribution of weather stations within which climate data were recorded. The stations are depicted as distinct points on the map and colors of different tints indicate various outcomes or conditions associated with each station. Hence, these show us how climate vulnerabilities come about along space because we based the same concept on visual representations.

Figure 4

GIS Map of stations

Figure 4 shows the GIS Map for the different stations where the data was collected. All these points correspond to a weather station within the study area. By the use of color differentiation, it brings out clearly the diversity of outcome or difference in characteristics being observed at each station. For example, the red dots represent a subset of stations having special patterns or features as indicated by greater selected climate data or trends. The stations may, therefore, be indicative of areas of heightened vulnerability to climate change impacts signifying need for tailored strategies in enhancing resilience against vagaries of climate.

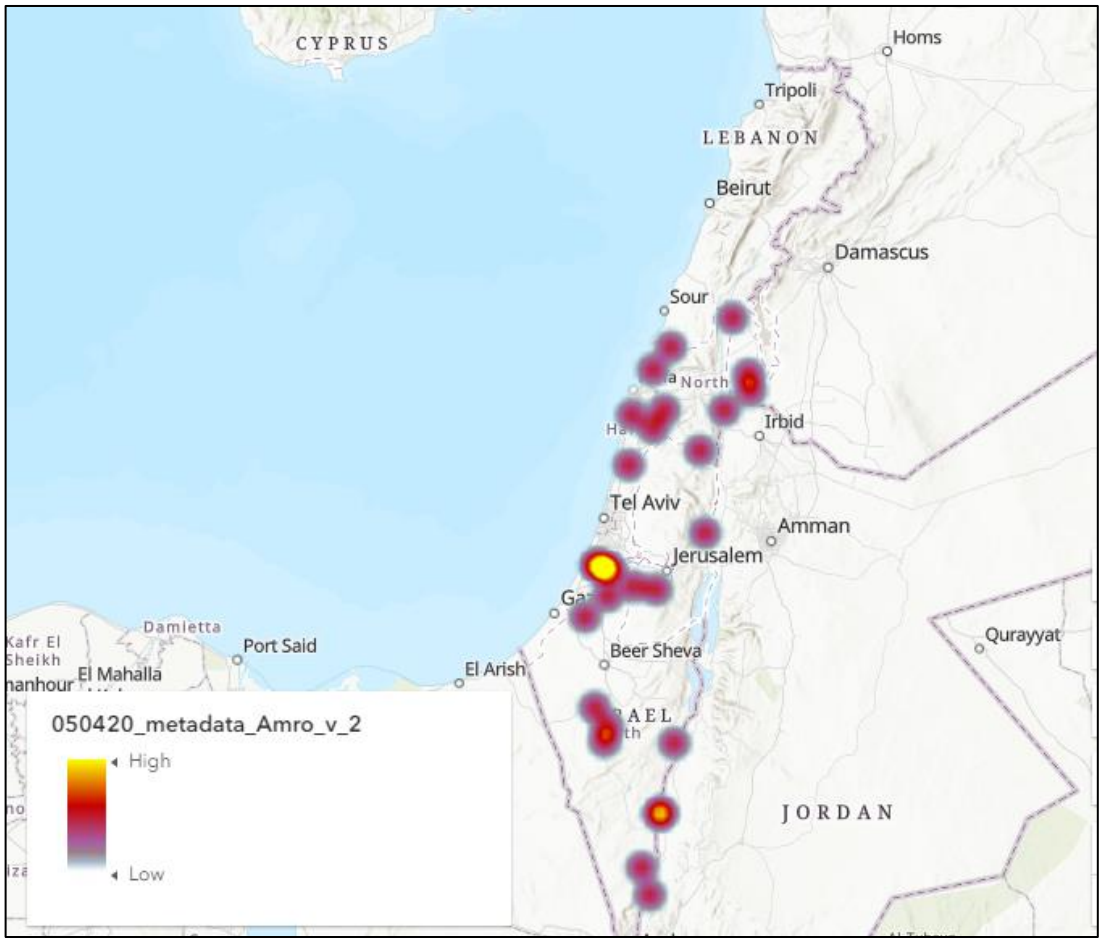
The spatial distribution of weather stations communicates critical information on the spatial component of climate vulnerabilities. The distributions span the entire study area capturing various environmental conditions and climatic parameters associated with it. By this review of the outcomes that any given station's climate model will be associated with, one would discern obvious regional disparities in climate risks such as variations in temperature, precipitation patterns, or other significant climate related parameters. Such information is very helpful to policy makers and professionals trying to deal with climate

vulnerabilities as the same would enable interventions and adaptive measures that target geographical areas (Ahmed, Nurul, & Aisha, 2019). Essentially, data mapping within a GIS setup provides a visual canvas on which we are able to paint a clearer pictorial of the complex interplay between their environment and how the results directly link up with actual economic implications guiding the way for more effective climate resilience strategies.

It is insightful to note the spatial distribution of vulnerabilities across the study area in the pursuit of understanding and mitigation on the impact of climatic changes on waste management. Very high vulnerability is depicted by red marks which indicate the regions requiring urgent focus and specifically designed measures for building resilience enhancement be undertaken urgently. The use of a color-coded map depicting various levels of climate change impacts on selected development sectors in different parts of the country is globally being followed for bringing in area-based development planning where vulnerability to such adverse impacts are known. Regions in yellow highlight on the other hand, depict a lesser degree of vulnerability but are not immune to the threats that accompany climate change. They equally deserve attention as avenues where concerned stakeholders can come into play to help make comprehensive and sustainable waste management a success story.

Figure 5

Evaporation Data for the Different Data Points



Among areas that display a heightened level of vulnerability, Gaza comes out prominently as one of the regions most affected in our study. The red marks around the Gaza Strip in deep red color are urging sign for necessity of targeted interventions and adaptive measures toward climate change impacts organizing waste management. These should include strategies in place towards preventing or reducing the possible threats of rising temperatures, changing patterns of precipitation as well as extreme weather events with respect to guarding the waste management systems and the well-being of the local communities.

In addition, the map records red markings which indicate some areas within Jenin and Bethlehem with raised susceptibility. Though not as raised as Gaza, these are areas that require being focused on since they are still raising susceptibility. This diagrammatic presentation emphasizes the spatial nature of climate vulnerabilities and reiterates to recognize the unique challenges faced by respective localities of the study area. These

provide insights that form basis on which sound decision making can be made by the policymakers among other stakeholders, offering a targeted climate resilience and sustainable waste approach to change of climate.

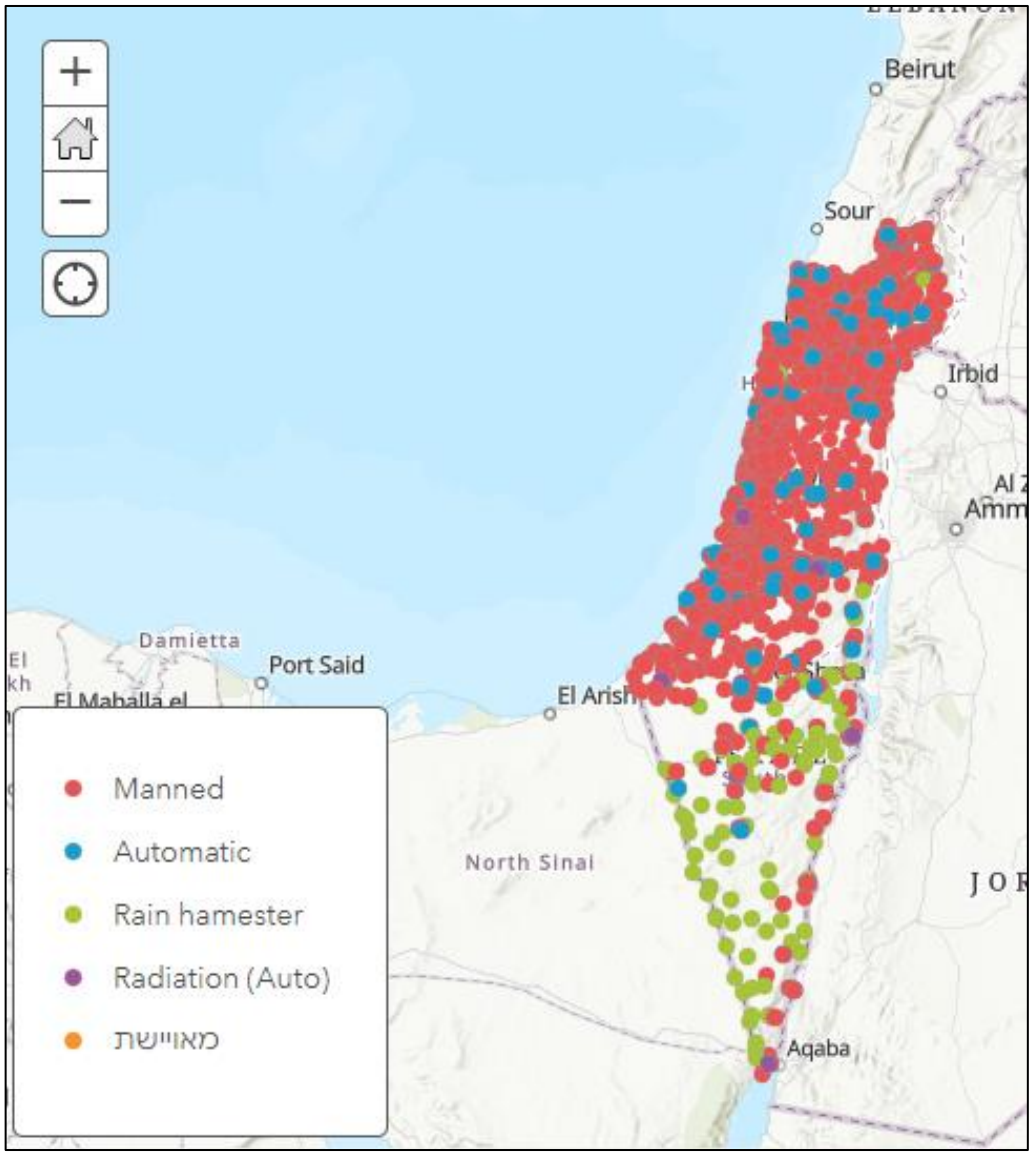
3.4.1 Evaporation Data

Analyzing this evaporation data is an important step of the research to understand the detailed dynamics between vulnerabilities in the climate change and solid waste management. As we go deeper into the data representing patterns of evaporation over the study area the need arises to make use of the power exhibited by Geographic Information Systems (GIS) in unraveling the spatial trends and variation (Rodaa, Z., Uwe, & M., 2019). The adoption of this analytical lens allows the visualization and mapping of the evaporation patterns as well as drawing a new perspective regarding the degree to which climatic factors are affecting different parts.

The GIS will provide valuable information of the spatial distribution of evaporation rates that will help us realize the ultimate goal of climate resilient waste management (Karen, Miguel, & José, 2023). This thesis is going to explain the patterns and trends exhibited in evaporation dataset, hence providing insights on regions most exposed with the effect of climatic change, hence guiding in formation of effective mitigation measures for climatic changes.

Figure 6

Data Visualization



From the analysis of evaporation data, it is quite evident that not all parts in the region have similar vulnerability to climate-induced factors. From the representation under the adventure with Geographic Information Systems (GIS), very eccentric spatial patterns and variations become evident in the distribution of the evaporation pattern across the study region. Of the notable observations includes a host of manned weather stations found in most regions where data was collected (Maher & Ahmed, 2023). These manned stations capture localized climate data and common in large numbers across the study area. Secondly, in line with manned stations, the automatic weather stations are the second most common way. These automatic weather stations are not as distributed as it is for

manned stations, but they are highly technical and intelligent which have real-time second to none.

In this case, through GIS analysis, the existence of hamster weather stations can be observed as well as radiation and rain although less frequent compared to the manned and automatic stations. Radiation stations are put at strategic places across the study area so as to monitor variations in solar radiation, which is key in driving climate change and thus giving out helpful information. On the other hand, rain hamster stations monitor patterns of rainfalls that are directly related to waste management in reference to flooding and erosion.

3.4.2 Irradiation

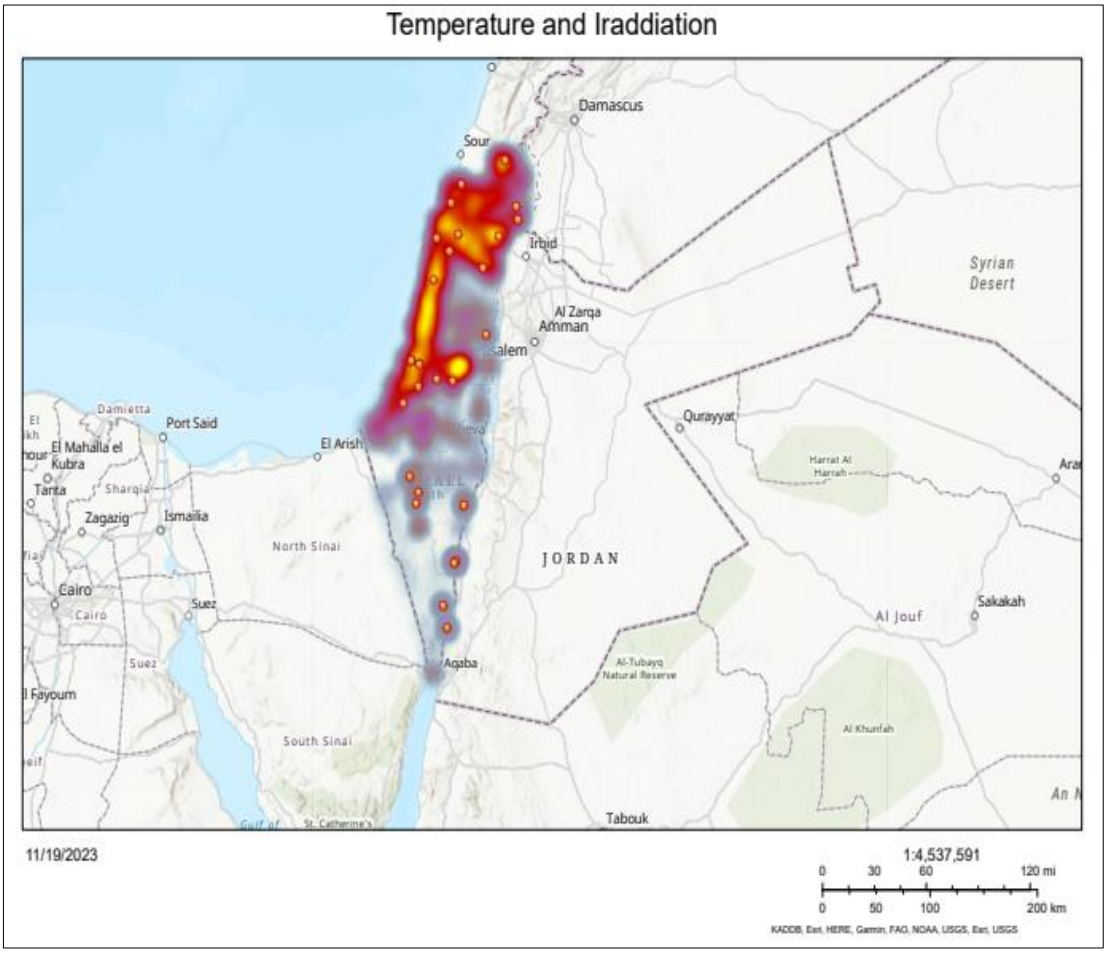
3.4.2.1 Global Horizontal Irradiation

On a deeper analysis of the data representation of GIS, it is apparent that different regions are prone to various climate change vulnerabilities with different measures. Gaza is among the places that have had a high prevalence of evaporation and hence the basis for the choice of our research topic on waste management and climate resilience. On the flipside, there is area in south of Palestine whose vulnerability evaporation levels dwarf all other locations thus accentuating the trend of wide spatial distribution of climate-related effects. Such an observation is a clear indication that there is the need to customize global warming amelioration strategies based on regions.

Direct Normal Temperature Radiation

Figure 7

Temperature Levels Irradiation with Stations



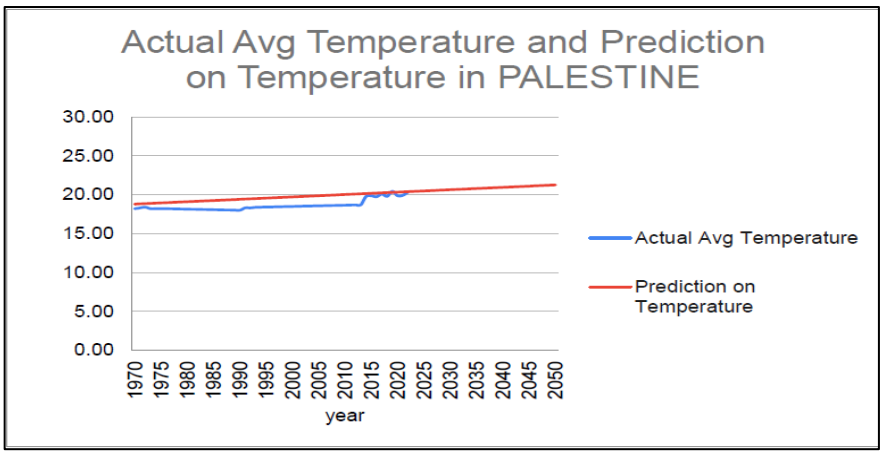
The figure above shows the temperature and irradiation maps for Palestine. Figure shows the labeled stations on the dataset to check on all stations in the dataset.

3.4.3 Forecast

The figure below shows the temperature forecast in Palestine till 2050. As can be seen from the original data, the temperature is a constant value which changes with a small margin from year to year. We cleared a probability distribution over the years to make a prediction till the year 2050. As can be seen, the temperature might increase with time based on the initial statistical data

Figure 8

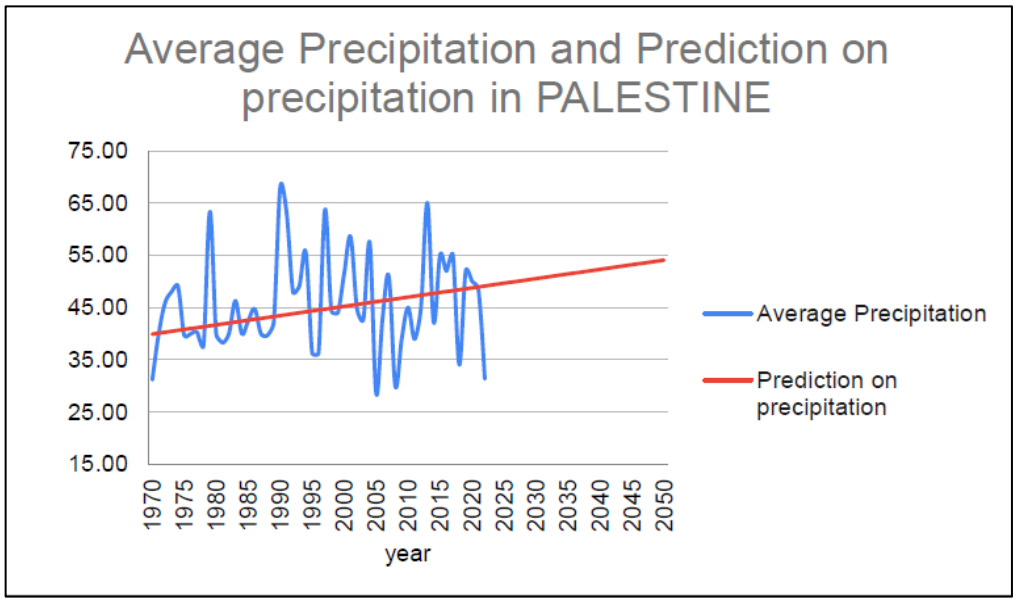
Temperature Prediction



The figure below shows the precipitation prediction in Palestine over the years till 2050. The figure above shows the actual and the predicted average precipitation over the year till year 2050. As can be seen, the rainfall measure over the year changes continuously.

Figure 9

Precipitation Prediction



3.5 Discussion

3.5.1 Climate change impacts on Palestine

3.5.2 Vulnerabilities in waste management

In relation to the West Bank and Gaza Strip, vulnerability in waste management is compounded due to a combination of factors with the first one being down to climate change. It thus presents a separate set of problems to waste management systems within the region, from elevated temperatures as well as altered precipitation patterns to heatwaves together with increasing levels of sea (Shehu, Jibrin, & Toro, 2023). Differences in temperature or mixing the waste may alter the rate of decomposition and generation of Odors and harmful gases that might expose members of the public to health hazards.

Sea level ascend is a major threat to the coastal waste facilities that pose serious contamination and pollution risks, especially in the densely populated Gaza. Besides the physical impact, precipitation patterns elicit excessive rain that accumulates waste, makes transport difficult, and eventually results in water pollution (Mustapha, Mohammed, & Saleh, 2023). Heatwaves pose threats of waste workers' health, hence holding such undertakings hostage.

Climate change also has the impact of more regular fire's occurrences, accidents, diseases and toxic leakages in waste management. Many fire outbreaks are caused mainly at waste sites due to long dry seasons with high temperatures resulting in a lot of emissions to the atmosphere. Instances of extreme weather may bring accidents as well as increased vulnerabilities of the waste workers (Noorashikin & Khairul, 2022). Climate change may also expose conditions its conditions for growth in disease vectors thus endangering the health of the population. Apart from these climate-related threats, waste management in Palestine has problems related to its overall infrastructural and organizational. In summary some of the vulnerabilities include:

Table 4

Vulnerabilities and Their Impact Level

Climate Change Impacts on Waste Management	Impact Level
Temperature Changes	Medium
Precipitation Patterns	Medium
Heatwaves	Low
Rising Sea Levels	Low
Extreme Weather Events	High
Socioeconomic And Political Factors	High
Adaptive Strategies	Medium

Climate change is evident in Palestine, and a great danger is posing towards the waste management systems established for the region. The temperature increases and the trends of precipitation that have directly influenced changes in the discharge of solid and liquid wastes prove beyond any reasonable doubt that the climate is changing. The resultant increase in temperatures will enhance decay of organic garbage with aggravated production and release of greenhouse gasses, extra methane as well as other risks due to fire in disposal places (Zena, 2019). Contrastingly, changed patterns of precipitation would disrupt normal programs of collection and disposal of waste because such changes would overwhelm existing systems. These modifications, together with occasional periods of hot weather, can cause health problems, fires and other dangers, accidents and further increase garbage accumulation and pollution, issues that aside from waste management in Palestine are of great concern.

Positive findings, as well as aspects of the increasing sea level, nevertheless the low impact that currently it is rated may not be negligible in coasts of Palestine. The nearness of the sea to incalculable ash dumps and waste management facilities can make them prone to flooding and an influx of saltwater. This brings in a danger of getting the waste storage sites contaminated or consequent pollution of the surrounding with the disposed items. While sea level rise may not be a current priority now, it is very likely to become increasingly problematic in the future especially taking into perspective ongoing climate change.

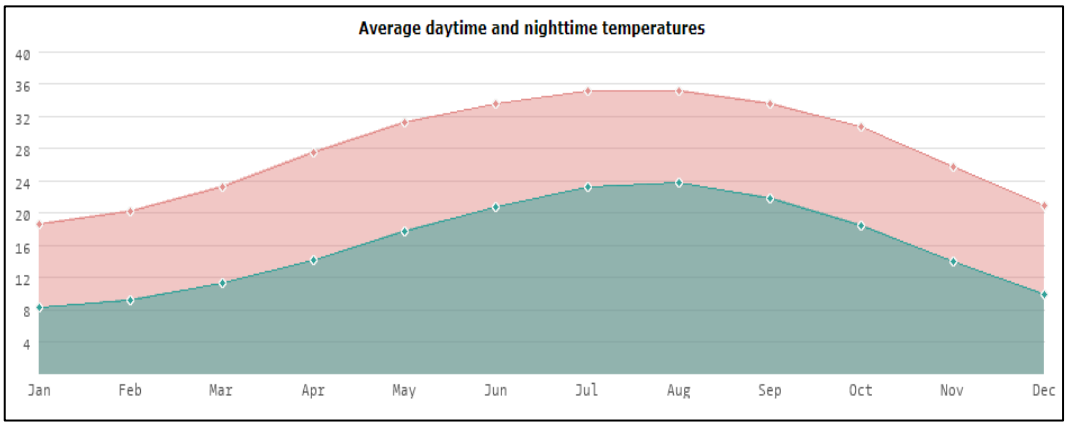
Another crucial factor to consider in the vulnerabilities of waste management in Palestine is the influence from socioeconomic and political conditions. The occupation is a problem can cause great disarray in terms of the development of unified climate adaptation strategies so highly required for resilient waste management. Any strategies devised, therefore, will have to be applicable to the unique climate of Palestine's political situation and adaptable according to the changing circumstances (Zena, 2019). Combining all these factors, it is highly pronounced that there is a dire need for well-engineered climate resilient waste management systems which can help in an effort to alleviate the probable impacts of climate change and safeguard the public health and safety of the Palestinian inhabitants.

3.5.3 Identification of Climate-Related Risks

A special subtropical character of this climate is what characterizes the climatic conditions in Palestine and many countries of the Mediterranean region from the rest of the world, let's say, much of the United States, or Central Europe. It is characterized by its arid and warm nature, giving rise to a notably drier and warmer climate regime. This way, the average daytime temperatures vary from 19 to 35 degrees Celsius that sets such a temperature difference throughout the year (Georgia & Lucy, 2022). During the summer, in a few select places, these temperature changes can be extreme with scorching heat of up to 36 °C. During colder months, and depending on location, temperatures can feel to drop an average of 8 °C over a month.

Figure 10

Palestine Climate Data



Source: world-data

In this relation, the climate of Palestine falls within the general trends that can be labeled as subtropical, but with a great deal of variation, which makes it a very complex climatic unit. The warm and arid characteristics of the environment which are primarily an epitome of hot and dry conditions manifest as a most prevailing climatic archetype. It is to be noticed that the changes of climate throughout the year depend very much on the seasons, featuring temperature and precipitation variations (World-Data, 2023). The hot and dryness that characterize Palestinian weather conditions present a challenge like no other, especially with regard to the aspects of possible water sources and enigmatic effects on many sectors, virtually agriculture (Ammar, Muhammad, & Tanveer, 2022). The interaction of these climatic variables is complex and it reflects the need for synchronized and adaptable climate resilience strategies in adapting to the varying conditions of climatic diversity in Palestine.

It is the variation of temperature and rainfall that determines the state of the environment and the agricultural aspect in the Palestinian climate. Meanwhile, the temperature gradients between the seasons can greatly vary, with vivid months of scorching heat rising as high as 36 °C in some locales during summer months (World-Data, 2023). Such high temperatures coupled with the arid nature of the climate make the environment rather challenging for water resources and sustainable management in agriculture. On the other side, during colder months that are usually experienced in winter, the temperatures tend to be more temperate characterizing this period with an average going down to approximately 8 °C.

3.5.4 Consequences of climate change on waste management

The influences of climate change on waste management in Palestine are complex and lead to noticeable challenges for the country. One of such notable effects involves the worsening existing problems associated with wastes as an outcome of factors propelled by climate. Rise in temperature, coupled with shifting precipitation patterns, can aggravate the production of waste materials especially from cities (Abiodun, Min, Muyang, & Wei, 2022). These environmental changes can mean an increase in the consumption and disposal of single-use items, such as plastics, which aside from straining waste-management systems manifest negatively on the environment. Increasing temperatures cause deformation of potential health-related issues in cases of improper disposition of waste materials, making effective waste management needed even more in this situation.

The qualitative impacts related to climate change, apart from the matter of how much wastes are generated, include risks posed and related waste management site safety, and also the smell which would emanating. For example, in relation to higher temperatures, this increased regime would also mean greater decomposition of organic wastes with more methane (CH4) generation, which is an important greenhouse gas (Gabriela, Marcel, Saulo, & Patricia, 2019). This not only contributes to the changes happening in the climate but may represent a hazard in poorly managed areas of landfill gas. Changing weather also poses increased risk factors of an extreme graduated climatic event like heavy rainfall events leading to flooding. Such incidences may damage the facility for waste storage, interfere with the services for collection of wastes as well as lead to release of hazardous materials into the environment posing risks to both human health and ecosystems.

Another significant consequence of climate change on waste management is the need for adaptation and building resilience. Increased generation, changing patterns of disposal, and extremes of weather due to changed climatic condition are some challenges of climate that waste management systems need to adapt to. This requires investments in infrastructure like building facilities for the disposal of wastes that are climate resilient and proper planning to ensure waste collection and treatment services flow even during extreme weather events. At the same time, such climate change adaptation measures also should include public awareness raising and public education campaigns for

implementing responsible waste disposal habits and cutting back on consumption of disposable items. Besides, the policies and the legislation rules need also to be put in place for accommodating the new emerging challenges from the outside due to climate change emphasizing on the concept of sustainable waste management practices for conservation of environment.

Multi-dimensional strategy is therefore called for in all factors, both its qualitative and quantitative aspects to generation, disposal, and treatment of waste because the impact of climate change on waste management in Palestine. It accentuates the requirement of resilient waste-management systems which would lower environmental and health risks besides highlighting increased involvement of the public and modification of policy to facilitate prolonged waste practices as climate changes.

3.6 Policy Implications

3.6.1 Informed Policy Decisions Impact

The findings present a result of the comprehensive study for the vulnerability related to the climate change in Palestine as related to the waste management. Thus, the empirical evidence on specific climate-related risks faced by Palestinians and detrimental consequences for waste management actualizes devising informed strategies by policymakers and stakeholders.

Identifying these hotspots of vulnerability can aid design appropriate strategies that tackle critical issues like actions and measures targeting climate change-induced waste collection and disposal challenges. Such strategies would include improved infrastructure development, resource distributions, and increasing capacities for sustainable waste management practices (Frances, et al., 2022). Furthermore, research outputs may also be used as a basis for advancing the case for enhanced international support and collaboration in building resilience to climate change in Palestinian waste management sector.

Understanding these developments should allow the international community to better guide its support for the Palestinian people's efforts toward more sustainable waste management and possibly, in a broader sense, sustainable development. Therefore, informed by the research findings, such can be adopted as an implication that informs proactive international policy decisions and initiatives in dealing with the climate-related

vulnerabilities concerning waste management for a more sustainable and climatic resilience future in Palestine and beyond.

3.6.2 Monitoring and assessing effectiveness

This study sector gives a solid foundation for the potential changes in policy and recommendations to enhance the climate resilience and sustainable practice. Therefore, the major policy changes and recommendations that emerge from this finding encompass some of the unique challenges that affect climate change and the interplay within Palestine's complex sociopolitical context.

The policymakers of Palestine should give first priority to climate resilience and sustainability of the waste management practices (Nathalie, et al., 2020). This refers that they should come up with comprehensive policies in almost every aspect of waste disposal that would be more tailored to at least consider or fid the effects of climatic changes. Such policies would have to strengthen the infrastructure for waste collection and disposal, promote recycling as well as waste prevention, and reinforce disaster preparedness after weather-related disasters. Climate change impact assessment and adaptation development will also have to be taken into account when preparing any waste management strategy, intended to make the sector sustainable.

This will call for the international community to work together and support accordingly at the heart of addressing this issue regarding climate vulnerabilities in waste management. Palestine will have to actively engage an international organization and donor for financial aid, technical help, capacity building initiatives among others (Oleg, Gallya, John, Minghua, & Tingyin, 2023). This collaboration can help in embracing the best practices plus new technologies in waste management and helping make the sector more resilient to climate-related challenges.

Palestinian policymakers should target more awareness in terms of public education campaigns to aid enroll the local communities into more sustainable practices in waste management. Citizens' involvement in waste reduction, recycling of the wastes and proper disposal may enhance overall resilience within the sub-sector. Local institutions plus municipalities should also form partnerships with community organizations and non-governmental organizations to deal with prevailing challenges of waste management at the grassroots.

Table 5

Strategies for Climate Resilience

Strategy	Efficiency Improvement	Areas to Consider
Enhanced Recycling	Increased resource recovery through recycling programs	Collection infrastructure, public awareness, sorting facilities
Waste-to-Energy (WtE)	Conversion of waste into energy sources for sustainable power generation	Technology, emissions control, waste stream composition
Smart Waste Management	Utilizing technology for real-time monitoring and optimization	Sensor networks, data analysis, remote sensing
Circular Economy	Promoting the circular flow of resources by reducing waste and reusing materials	Material flows, supply chains, consumer behavior
Public Awareness Campaigns	Raising awareness on waste reduction, recycling, and responsible disposal	Education, outreach, behavior change
Landfill Gas Capture	Capturing and utilizing methane gas emissions from landfills for energy	Gas collection systems, utilization technologies
Sustainable Packaging	Promoting eco-friendly packaging solutions to reduce waste generation	Packaging design, eco-labeling, waste reduction
Extended Producer Responsibility (EPR)	Encouraging producers to take responsibility for their products' end-of-life management	Policy frameworks, producer involvement, collection systems
Decentralized Composting	Implementing local composting systems to reduce organic waste	Composting infrastructure, compost quality standards
Green Procurement	Purchasing products with minimal environmental impact and promoting sustainable practices	Supplier selection, eco-labels, procurement policies

3.7 Monitoring and Evaluation

3.7.1 Potential policy changes and strategic for climate resilience in waste management

Monitoring of adaptation measures is an integral nature of any climate resilience in waste management. It is a consistent collecting of data and continuous following up system linking to the implementation of the strategies until outcomes are determined. So, it's what makes that process different is the measurement of the waste diversion rate. The waste diversion rate is an important issue in measuring the recycling efforts - and how good they are at still reducing waste - and monitoring key performance indicators such as greenhouse gas emissions and practice of waste management. Through which, it's possible to keep a keen eye on these metrics in understanding how well the strategies are performing, as well as if they conform to the goals intended. Regular monitoring remains essential to remain on track and be able to make necessary adjustments as pertains.

Table 6

Assessing Effectiveness

Waste Management Strategy	Effectiveness Criteria	Assessment Result
Recycling programs	Reduction in landfill waste, Cost-effectiveness, Community participation	High effectiveness
Waste-to-energy facilities	Energy generation, Greenhouse gas emissions reduction, Waste diversion	Moderate effectiveness
Composting initiatives	Organic waste diversion, Soil enrichment, Community involvement	High effectiveness
Landfill management	Waste containment, Environmental impact mitigation	Moderate effectiveness
Public awareness campaigns	Knowledge dissemination, Behavior change	High effectiveness
Hazardous waste disposal	Safe handling, Pollution prevention, Regulatory compliance	Moderate effectiveness
Plastic reduction policies	Plastic waste reduction, Marine ecosystem protection	High effectiveness
E-waste recycling programs	E-waste diversion, Resource recovery	Moderate effectiveness
Sustainable procurement practices	Reduced waste generation, environmentally friendly products	High effectiveness
Climate-resilient infrastructure	Enhanced resilience to climate hazards, Sustainable construction	High effectiveness

The pathway course towards climate resilience involves an assessment of how effective the waste management strategies that have been put in place are. Here, one does more than just monitoring but rather they evaluate deeper into how effective the applied strategies are in yielding their intended results. Cost-effectiveness, environmental impact, and the level of community participation are among the factors that evaluators can consider. For instance, they critically evaluate factors such as whether ecological benefits from a certain waste disposal mechanism outweigh economic benefits. Additionally, the assessment reviews how their strategies have helped develop flexibility in handling challenges related to climate changes. A thorough assessment will help understand where the strategies are working and what needs an improvement hence making critical decisions on appropriate adaptations for the future.

3.7.2 Feedback Mechanism

Inclusion of feedback mechanisms is essential in guaranteeing a continuous process of improvement as it relates to waste management. Feedback provides stakeholders, community members, and even experts a channel through which they can give insight with regard to the strategies applied during the process. Information can be obtained from public surveys, from expert assessments or from real-world performance indicators. This information carries great importance for the continual improvement and amelioration of current waste management practices so that they can better cater to the effects associated with climate change. They ensure a creation of powerful feedback loops that keep approaches flexible to respond and adapt to evolving climate challenges and community needs. This enhances the capacity of the system to improve and build resilience in waste management.

3.8 Social and Economic Impacts

Social and economic dimensions are assessed while reviewing the climate change vulnerabilities as part of understanding the holistic impact of the climatic changes over the waste management landscape prevailing in Palestine. The vulnerability pertaining to climate change is not bound to environmental aspects alone but it also hosts linked social and economic dimensions. Assessing these broader consequences mean and summing up the social and economic effects on local communities, economic stability, and public health.

Consequently, assessing these aspects may provide an approach to devising plans not in mitigating against environmental risks but also offering coping mechanisms towards social and economic challenges of bearing presented by the changes in climate borne upon. This comprehensive approach will be guaranteeing the long-term well-being of this region by ensuring sustainability and resilience of response to the climate change vulnerabilities.

Sustainable waste management and considerations of climate resilience are one of the key concepts. It is through this aspect that it can be maintained to have proper waste management at all times, be in a position to handle changing climatic conditions, and support current as well as future generation. Research is at the center of informing long-term sustainability through insight into the best environmental-friendly waste management ways and measures. It informs the development of adaptive measures that would cope with the changing challenges presented by climate change.

Sustainability in waste management is closely related or linked with climate resilience as sustainable practices hence help the communities and regions to sustain the changes, withstand and still be able to prosper despite the adverse impacts associated with the changing environmental conditions brought by climatic related hazards. Research hence provides the basis upon which sustainability could be realized in waste management and climate resilience through insights, guidance, and solutions to a better more resilient future.

Chapter Four
Conclusions and Recommendation

In conclusion, the research has addressed the waste management under climate change vulnerabilities in Palestine. The researcher established that the area is grappling with low performance in waste management as a result of little infrastructure and scarce resources. As a result, an extra pressure is placed on waste management systems through these climate-related hazards, such as changing precipitation patterns and extreme weather events.

The implications of these findings for policy and practice are considerable. Considering climate resilience into the waste management agenda is a matter for the local authority policymaker, who will seek to prompt investment in infrastructure improvements by local authorities while ensuring that those improvements, as well as adaptive measures to manage extant vulnerability and be prepared for whatever future risks emerge from climate change, can be adequately resourced.

This research discussed the vulnerabilities of climate change on waste management., Moreover, since such a thesis entails sustainable waste management and climate resilience, they also demand wide-scale public awareness and engagement, which further necessitates effective community participation and education. Future research should, therefore, explore further the effects of climate change on waste management in other regions of Palestine factoring local variation and socio-economic factors.

The study paved the way for future studies to help us better understand the complex connection between global warming and garbage collection. Extending the study's geographic reach is the first noteworthy direction of travel. By looking at how waste management is affected in different settings, researchers can better understand the universality or otherwise of the found trends due to climate change. Expanding the research's way reach is one promising direction; investigating a more comprehensive range of climate change hazards is another. While the study did produce some valuable insights, its narrow focus on a few dangers calls for more investigation into a broader range of potential obstacles. The complexity of climate change's effects on waste management systems may be better understood if additional climate-related hazards are

considered. These risks include soil erosion, extreme heat events, and shifts in waste composition.

Finally, more research is needed into the potential benefits of using cutting-edge technologies like risk management software. While these tools provide invaluable insights, integrating them can be difficult due to issues with data quality, technical competence, and nuanced interpretation. As a result, researchers need to look at better ways to use this type of software and discover new approaches to making it more precise and valuable.

The proposed strategy forges a route toward resilient waste management techniques in the face of growing climate change issues. Recognizing the important relationship between climate effect and waste, our strategy focuses on creative solutions that address both concerns at the same time. We can reduce greenhouse gas emissions and trash accumulation by improving resource recovery through recycling programs and transforming waste into renewable energy sources. Integrating technology for real-time monitoring and optimization improves resource use while reducing the environmental impact of unnecessary waste. Emphasizing a cyclical flow of resources through waste reduction and material reuse helps to address climate change while also boosting sustainability. Waste reduction, recycling, and responsible disposal awareness programs intensify our efforts to more climate resilience on waste management.

The strategy emphasizes the critical role of environmentally appropriate packaging, producer accountability, local composting systems, and conscious consumption in addressing climate-related waste challenges. By combining these measures, we can create a resilient waste management system that is resistant to climate change, promoting a sustainable and climate-resilient future. Our strategy forges a route toward resilient waste management techniques in the face of growing climate change issues. Recognizing the important relationship between climate effect and waste, our strategy focuses on creative solutions that address both concerns at the same time. By optimizing resource recovery via extensive recycling initiatives and transforming garbage into sustainable energy sources, we address waste generation while simultaneously reducing greenhouse gas emissions. The environmental impact of excessive waste is reduced by optimizing resource usage through the integration of technology for real-time monitoring and optimization. Stressing a cyclical flow of resources by reducing waste and reusing

materials helps to maintain sustainability while fending off climate concerns. Our efforts to address the waste difficulties caused by climate change are strengthened by awareness campaigns about recycling, ethical disposal, and waste reduction. Not only does using landfill methane emissions for energy reduce their environmental impact, but it also helps with our efforts to use renewable energy sources. In order to mitigate waste concerns related to climate change, our strategy emphasizes the critical role that eco-friendly packaging, producer accountability, community composting systems, and conscientious consumption play. By coordinating these tactics, we create a framework for waste management that is adaptable to changing weather conditions, promoting a sustainable and climate-resilient future.

To update national strategy for solid waste management in Palestine, The following points are recommended :

1- Installing methane pipes in Zahrat Al-finjan landfill to mitigate CH4 emissions due to high temperature leading to decomposition of organic matter.
2- Expanding recycling programs for paper and cartons to reduce climate change vulnerabilities leading to fires in landfills.
3- Reinforcing trash container and make strong frame to prevent movement it during extreme weather and high winds.
4- Covering trash container to make transportation effectively and prevent any accidents during extreme weather.
5- Design a strong infrastructure in landfills to mitigate damages it during extreme weather such as floods and winds.
6- Implement audits for solid management processes, documentation related to waste and all monitoring data to control all processing.
7- Developing digital platform for the data to be collected, organizing and analyzing. In addition to expand the policy makers for decisions making through training and development programs according to innovation and technology.
8- Empowerment and public engagement in solid waste management through outreach programs and campaigns.
9- Resource recovery and waste to energy are advanced ways to minimize waste and maximize recycling.

10- Review guidelines and legislation to ensure strategies are update with climate change effects on solid waste management such as extreme weather to mitigate the consequences like damage of infrastructure and pollution.
11- Identify gabs in Palestine by monitoring all processes in the system against climate change vulnerabilities for more sustainable and resilience solid waste management and stronger ecosystem.

4.1 Limitations

The conclusions may not be universally relevant since various regions have unique climatic, environmental, and socioeconomic dynamics.

The study is also constrained in other ways, as it only looks at a subset of the potential consequences of climate change. While the identified concerns were given careful consideration, it is understood that climate change poses a wide range of complex problems that can vary widely from one place to the next. This study is limited by its selected nature and cannot provide a complete picture of all possible dangers. This highlights the need for further research to investigate a broader range of climate-related concerns that could affect waste management systems differently.

The study also has some serious caveats, the most notable of which is its need more data to evaluate the economic and social elements deriving from climate change's effects on waste management. The complex terrain represented by the interplay of environmental dynamics, financial considerations, and societal repercussions was not explored in depth in this investigation. With it, it is easier to grasp the full scope of climate change's effects on waste management. Therefore, future research efforts should adopt a more holistic perspective that considers the nuanced socioeconomic consequences in addition to environmental concerns.

It's also important to note that the study needs more details from local institution’s and stakeholder’s.

In conclusion, the study's limitations are essential reminders of its breadth and emphasis, even as they shed light on vital insights concerning the relationship between climate change and waste management in Palestine. These gaps highlight the necessity of ongoing research efforts that include a more comprehensive range of geographies, dangers, and the socioeconomic aspects of climate change's impacts on waste management.

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جـامعـــة النجاح الوطنية

كليـــة الدراســـات العليـــا

تقييم نقاط الضعف للتغير المناخي على ادارة النفايات الصلبة في فلسطين– طريقة إدارة المخاطر

إعداد

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إشراف

عبد الفتاح حسن

قدمت هذه الرسالة استكمالا لمتطلبات الحصول على درجة الماجستير في الإدارة الهندسية، من كلية الدراسات العليا، في جامعة النجاح الوطنية، نابلس– فلسطين.

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الملخص

يهدد تغير المناخ إدارة النفايات الصلبة بطرق واسعة في فلسطين من خلال زيادة المخاطر البيئية, بالإضافة الي مسائل الصحة العامة. تغطي هذه الاطروحة نقاط الضعف للتغير المناخي (ارتفاع درجة الحرارة, تغير نمط هطول الامطار, ارتفاع منسوب سطح البحر, الرياح) على مناطق إدارة النفايات وتهدف الى تطوير استراتيجيات نحو الاستدامة المناخية, والهدف مساعدة الأشخاص للتعامل بشكل افضل مع التغيرات المناخية على إدارة النفايات وتزويد صناع القرار بالنصائح السليمة. تهدف الاطروحة الى بناء نهج شامل يضمن ان ممارسات التخلص من النفايات تتوافق مع المعايير العالمية وتساهم في بيئة خضراء من خلال الاخذ بالاعتبار قابلية التاثر بالتغير المناخي وإدارة النفايات. شمل البحث التقييم الكمي لبيانات تاريخية لهطول الامطار والتبخر ودرجة الحرارة وتحليلها باستخدام برنامج (R studio 1.4) لتطوير ببيئة متكاملة وتحليل البيانات التاريخية وتصورها, وتطبيقها لرسم خرائط على برنامج ARCGIS 10.8 وتحليل المناطق ذات التغيرات المناخية العالية. استخدم البحث أيضا التقييم النوعي مثل المقابلات مع صناع القرار لتحديد نقاط الضعف الأكثر خطورة واي الإستراتيجيات الأفضل لنقاط الضعف للتغير المناخي. وفقا للخبراء في وزارة الحكم المحلي تلعب الخطة الوطنية دورا هاما في التخفيف من تغير المناخ وضمان استدامة المتطلبات وتنسيق الجهود في تطوير قطاع إدارة النفايات في فلسطين. أظهرت النتائج ان بعض المناطق مثل غزة وجنوب فلسطين لديها تحديات وهي الأكثر ضعفا للتغير المناخي. حيث أظهرت النتائج ان الطقس القاسي

مثل العواصف والفيضانات والجفاف هي الأكثر خطورة, ودرجة الحرارة والامطار معتدلة, الرياح وارتفاع منسوب سطح البحر منخفضة. الإستراتيجيات الرئيسية تتضمن (برامج إعادة التدوير, تحويل النفايات الى طاقة, الوعي العام, ممارسات الشراء المستدام, إعادة استخدام المواد, مسؤولية المنتجين, بنية تحتية مستدامة). بالإضافة الى استخدام انابيب خاصة في مكب زهرة الفنجان لتقليل الانبعاثات, زيادة التدوير لمخلفات الورق والكرتون والمواد البلاستيكية, تقوية الحاويات لمنع حركتها أثناء الرياح القوية وتغطية الحاويات لنقلها بشكل سليم.

الكلمات المفتاحية: التغير المناخي، الرسم، الضعف، إدارة النفايات، فلسطين، الاستراتيجيات