Problem Chosen	2024 ICM Summary Sheet	Team Control Number
E		2413855

Green Guardians of Two Historic Cities: Sustainability of Property Insurance

The objective of this model was to design an easy-to-use index that is capable of grading a city's property insurance development based on basic principles of sustainability. Because the four principles of sustainable insurance were established to include the ESG of sustainability (environmental sustainability, governance regulations, and social equity) this model incorporated all four principles into seven unique metrics based on the intersectionality of core ideas (top right figure).

Five metrics and two indicators analyze a city's: financial and pricing, policy support, customer risk engagement metric, geographic climate risk, renters preference, investor intention and natural disaster.The metrics themselves are determined using simple measures of widely available data. The sum of these metrics is reported as the Sustainable Property Insurance Index (SPII) for any developed city.

New York (United States) and Athens (Greece) were analyzed with the model to serve as regional benchmarks. Both cities were selected because each currently has sustainable insurance principles incorporated into their city property insurance plans. The proposed initiatives were aimed specifically towards each city to improve their overall SPII score (bottom right figure). The two cities both scored well initially with SPII scores of 352.18 and 312.17, respectively.

We also proposes a Historical Preservation Index (HPI) model for the conservation of urban historic buildings, aiming to assess and improve the effectiveness of communities in protecting their cultural heritage. This model considers multiple dimensions such as value assessment, risk assessment, prioritization, cost-benefit analysis, and multi-objective optimization, providing community leaders with a systematic decision-making support framework.

Through analysis of the Acropolis and the Ancient Agora in Athens (Greece), the model shows how conservation planning can be based on the cultural and economic value of historic buildings. A practical and flexible tool is developedn for the protection of urban historic buildings and promote the sustainable protection and development of cultural heritage.

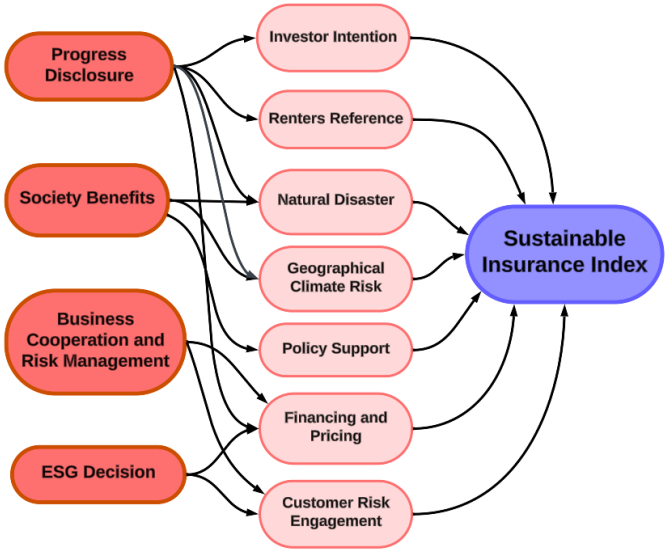

Figure 1 – Sustainable Insurance Index Model

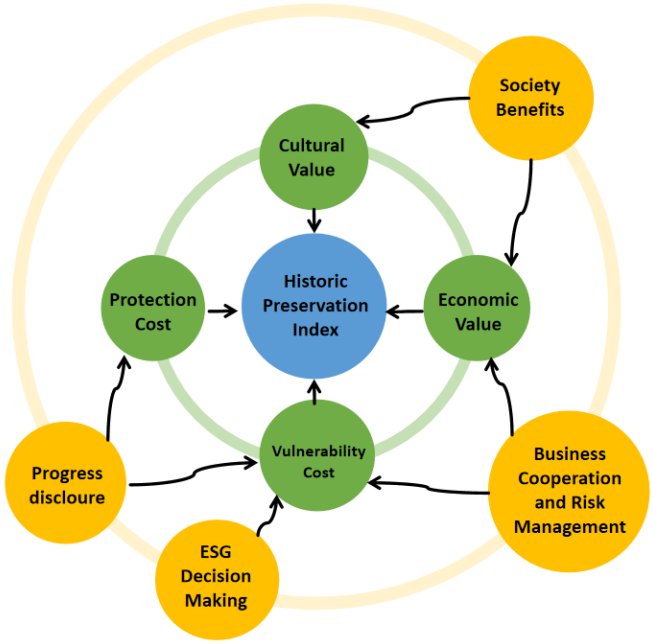

Figure 2 – Historical Preservation Index Model

Contents

1 Introduction

The escalating frequency and intensity of extreme weather events are placing unprecedented pressure on the property insurance sector. In recent times, the world has witnessed a surge in the economic toll from such events, exceeding the trillion-dollar mark and challenging the industry's capacity to sustain profitability and service availability. This evolving landscape of risk is prompting a crucial reassessment of how insurance companies evaluate, price, and offer coverage, with implications that stretch from the boardroom to the individual homeowner. Against this backdrop, the sustainability of the property insurance industry hangs in the balance, navigating the tightrope between managing risks and meeting the needs of a changing world. Ideally, two models will be created to assist insurance catastrophes modelers, community and property developers and historical community leaders based on simple principles and easily available data.

1.1 Principles for Sustainable Insurance

The United Nations Environment Programme Finance Initiative's Principles for Sustainable Insurance offer a worldwide blueprint for the insurance sector to effectively manage and leverage risks and opportunities associated with environmental, social, and governance issues.

The four basic principles founded by this UNEP FI (Principles for Sustainable Insurance, 2012) are as follow:

1. Embedding Environmental, Social and Governance (ESG) issues into Decision-making.
2. Working with clients and business partners to raise awareness of ESG issues, manage risks, and develop solutions.
3. Working with governments, regulators, and other key stakeholders to promote widespread action across society on ESG issues in insurance.
4. Demonstrating accountability and transparency in regularly disclosing the progress in implementing the Principles.

2 Methodology

The distinguishing characteristic of this report's model comes from its derivation. As sustainable insurance is characterized by its four principles, this model intensely utilize these four principles and adding an additional metric for climate risk control to measure the success of sustainable catastrophe insurance and property developers indicated metrics. These five metrics and two indicators of our sustainable insurance index were used to determine how insurance companies can achieve long-term benefits and support real estate developers in adapting their building sites for sustainability.

The distinctive mark of this report's model lies in its derivation. As sustainable insurance is defined by four core principles, and this model rigorously applies these principles while in-

corporating an additional metric for climate risk management to gauge the success of sustainable catastrophe insurance. Utilizing these five metrics and two indicators , our sustainable insurance model aims to outline how insurance companies can attain long-term benefits. This approach ensures that the model not only adheres to the foundational aspects of sustainability in insurance but also emphasizes the critical role of climate risk control in achieving sustainable outcomes in the face of natural disasters.

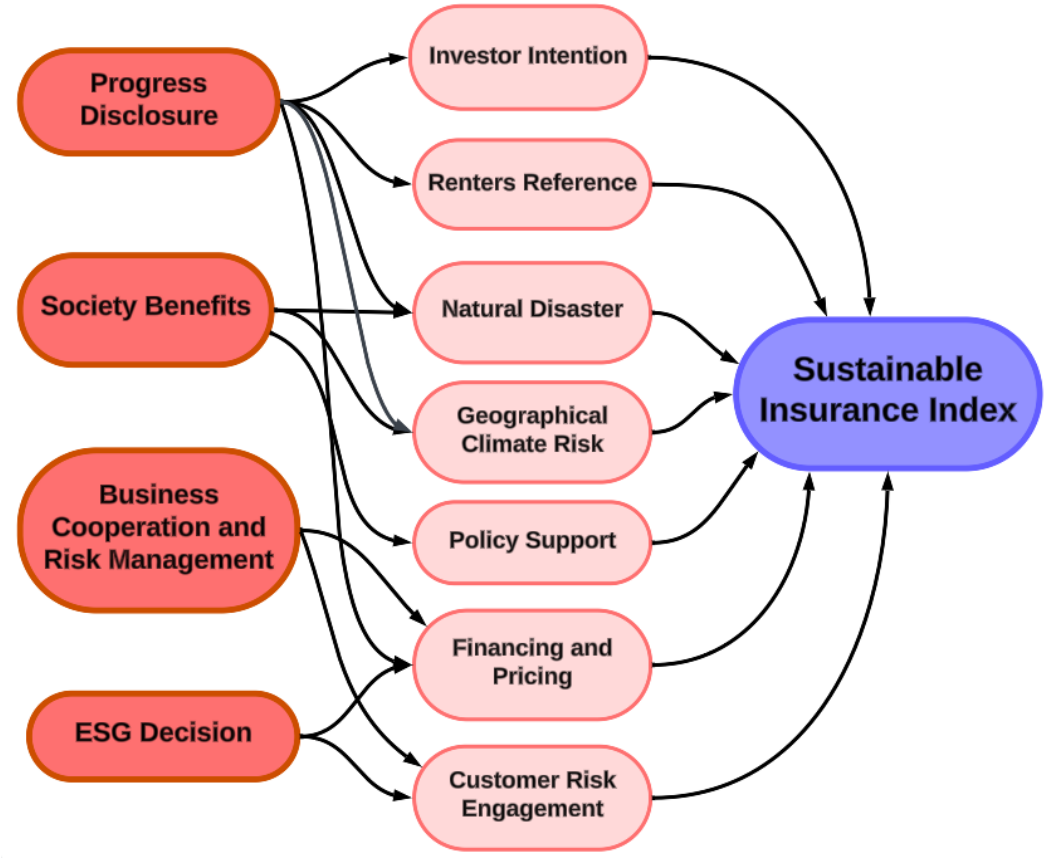

*Figure 2.1 – Process flow for the creation of the Sustainable Insurance Index model. The model incorporated all four principles of **1.1** and grouped them together into five metrics and three indexes. The sum of these metrics is the overall Sustainable Insurance Index.*

This model generates a total score for the **Sustainable Property Insurance Index (SPII)**, which is evaluated on a scale from 0 to 700, with less than 700 representing the optimal standard of sustainable insurance practices. This comprehensive **SPII** score compiles the individual scores from the previously outlined seven metrics.

$$\begin{aligned} SPII = {} & Financial\ and\ Pricing + Policy\ Support + Customer\ Engagement\ Risk - \\ & Geographic\ Climate\ Resilience + Renters\ Preference + Investor\ Intention \\ & + Natural\ Disasters \end{aligned}$$

Every individual metric within **SPII** equation is assigned equal importance and is thus weighted uniformly.Every individual metric and indicator has a potential output ranging from 0 to 100, with 100 signifying the maximum achievable score for any single metric. Consequently, the aggregate maximum score that can be attained across all metrics and indicators is 700.Each of the five metrics and two indicators , along with their respective components, will be thoroughly and individually examined to provide a comprehensive understanding of the entire model.

2.1 Sustainable Property Insurance Index

2.1.1 Financial and Pricing Metric

This Financial and Pricing metric accounts insurance company's financial resilience and the effectiveness of its pricing strategies for sustainable insurance offerings. Catastrophes which produce obvious damage (e.g., hurricanes, tornadoes) result in faster insurer payouts than those with less obvious damage (e.g.,earthquakes). Catastrophes with visible damage, such as hurricanes and tornadoes, typically lead to quicker insurer payouts compared to those with less obvious damage, like earthquakes. Additionally, the timing of cash requirements is related to the scale of the event. The central challenge of this metric is to ensure that premiums are priced to sufficiently cover risks while remaining affordable for customers, striking a delicate balance. The metric incorporates six specific measures: ***the insurer's financial statements, investment performance, liquidity ratio, historical claims rate for particular areas, expense ratio, combined ratio***, and ***premium adequacy***.

Financial indicators collectively evaluate an insurer's financial stability, including its ability to fulfill policyholder obligations and the risks and returns associated with its investment portfolio.Additionally, Pricing strategy indicators are focusing on accessing whether premiums are sufficient to cover expected losses and entire underwriting expenses.For insurers, the concept of sustainable insurance involves finding the right equilibrium between profitability and sustainability.

$$Financial\ and\ Pricing = \frac{CA + IP + LR}{3} + \frac{ER + CR + PA}{3}$$

Where:

- CA = capital adequacy
- IV = investment performance
- LP = liquidity ratio of claims paid to premiums earned
- LR = loss ratio of operation expenses to earned premiums
- PA = premium adequacy
- CR = combined ratio

2.1.2 Policy Support Metric

This metric gauges the extent of government support received during natural disaster scenarios.It is meticulously designed to evaluate government policies and assistance programs that directly impact insurers' ability to respond and recover from natural disasters effectively. The metric encompasses three pivotal measures which are ***regulatory support and relief from the government, government funding and subsidies*** and ***policy advocacy for sustainable rebuilding***.

Regulatory support was found to determine the support extended by regulatory bodies to insurers in the aftermath of natural disasters. The measure of government funding and subsidises allocated by the government to assist insurers in managing disaster claims and promoting sustainable rebuilding practices.Policy advocacy for sustainable rebuilding considers the importance of policy changes achieved through advocacy and the insurer's active participation in the advocacy process.These three measures utilize the records of regulatory interactions and government funding from post-disaster and need to be quantifiable on a consistent scale(0 to 100).

$$Policy\ Support = \frac{RS + GF + PA}{3}$$

Where:

- RS = regulatory support
- GF = government funding
- PA = policy advocacy

2.1.3 Customer Risk Engagement Metric

This metric evaluates customer attitudes towards purchasing insurance for natural disasters, aiming to forecast the market potential for sustainable insurance products.This metric consists three components of measure: ***purchasing power, insurance demand*** and ***risk mitigation activities.***

Fist two measures are specially designed to access the willingness and the level of interest among consumers regarding the purchase of insurance for natural disasters and will be calculated based on the affordability index of insurance products post-engagement initiatives, and feedback on the economic accessibility of risk mitigation measures. Furthermore, measures of risk mitigation highlights how insurance companies that engage in public awareness campaigns aimed at protecting against hazardous events can significantly influence consumer behavior. Through educational efforts, insurers can encourage policyholders to adopt preventive measures—such as using sandbags, installing water-resistant flooring, and elevating appliances—which not only leads to increased purchasing power but also contributes to a reduction in losses during disasters.

Overall, the results of this metric are instrumental for insurance companies in understanding the current landscape and future potential of the sustainable insurance market.

$$Customer\ Risk\ Engagement = \frac{PP + ID + RMA}{3}$$

Where:

- PP = purchasing power
- ID = insurance demand
- RMA = risk mitigation activities

2.1.4 Geographic Climate Risk Metric

Geographic Climate Risk Metric accounts for several key factors that determine an area's vulnerability to climate-related and geographic risks.As a result, three measures were used for this metric: ***geographic vulnerability, climate exposure*** and ***natural disaster risk***.

Geographic vulnerability is used because the intrinsic geographic factors can make an area more susceptible to natural disasters and high scores in this category indicate a greater inherent risk due to geography.Climate exposure captures both the historical context and forward-looking projections related to climate. It assesses how exposed the area is to climatic shifts and extreme weather events, with higher values suggesting greater exposure.The measure of natural disaster risk focuses the historical occurrence (emdat Americans, emdat Greece) and potential for natural disasters, this factor evaluates the likelihood of events like floods, hurricanes, or earthquakes affecting the area. A higher score reflects a history of frequent or severe natural disasters.

$$Geographic\ Climate\ Resilience = \frac{GV + CE + NDR}{3}$$

Where:

- GV = Geographic Vulnerability score

$$GV = \frac{Elevation\ levels + Proximity\ to\ waterbodies + Urban\ density}{3}$$

- CE = Climate Exposure score

$$CE = \frac{Avg\ Temp\ Change + PrecipDev + Freq\ of\ Extreme\ Weather\ Events}{3}$$

- NDR = Natural Disaster Score

2.1.5 Renters Preference Metric

The Renters Preference Metric takes into account several key factors that determine whether renters are willing to stay in a city. So, the indicator uses two metrics: ***rent-to-salary ratio score*** *and* ***apartment price score***.

The rent-to-salary ratio determines what percentage of a potential tenant's household income will go toward monthly rent, which is the ratio of rent to income. The gold standard in the

industry is 30 percent, which means a tenant's rental expense should not exceed 30 percent of gross income. The Apartment Price Score compares the median renter income to apartment prices outside the city center and apartment prices in the city center and scores specific ranges. Apartment price scores(custom indicators) are used to determine whether most people can afford to rent an apartment.

$$Rent\ to\ Salary\ Ratio = \frac{RSRS + APS}{2}$$

Where:

- RSRS = Rent to Salary Ratio Score
- MS = median salary of state
- MR = median rent

$$RSR = \frac{MR}{MS}$$

$$RSRS = \begin{cases} 1 & \text{if } RSR <= 0.3 \\ \dfrac{1 - RSR}{0.7} & \text{if } 0.3 < RSR <= 1 \\ 0 & \text{if } RSR > 1 \end{cases}$$

- APS = Apartment Price Score
- APOC = apartment prices outside the city center
- APCC = apartment prices in the city center

$$APS = \begin{cases} 0 & \text{if } MS < APOS \\ 0.5 & \text{if } APOC <= MS <= APCC \\ 1 & \text{if } APCC < MS \end{cases}$$

This indicator is very important for real estate developers. Since all cities are currently targeting smart cities, there is a need to ensure there is public demand.

2.1.6 Investor Intention Indicator

The Investor Intent Indicator is the number of key factors investors consider when deciding whether to purchase a home. This indicator uses three factors: ***rental yield score, house price-to-rent ratio score***, and ***affordability score.*** These three-factor indicators use their respective global corresponding data to divide and score according to upper and lower quartiles and medians. Market trends and investor intentions will also determine whether real estate developers develop the area.

$$Investor\ Intention\ Indicator = \frac{RYS + HPRS + AS}{3}$$

Where:

$$RYS = \begin{cases} 0 & \text{if } RY <= R_1 \\ \frac{1}{3} & \text{if } R_1 < RY <= R_2 \\ \frac{2}{3} & \text{if } R_2 < RY <= R_3 \\ 1 & \text{if } R_3 < RY \end{cases}$$

- RY = Rental Yield
- RYS = Rental Yield Score
- R_1, R_2, R_3 = lower quartile, median, upper quartile (Global Rental Yield)

$$HPRS = \begin{cases} 0 & \text{if } HPR <= H_1 \\ \frac{1}{3} & \text{if } H_1 < HPR <= H_2 \\ \frac{2}{3} & \text{if } H_2 < HPR <= H_3 \\ 1 & \text{if } H_3 < HPR \end{cases}$$

- HPR = House Price-to-Rent Ratio
- HPRS = House Price-to-Rent Ratio Score
- H_1, H_2, H_3 = lower quartile, median, upper quartile (Global House Price-to-Rent Ratio)

$$AS = \begin{cases} 0 & \text{if } AI <= A_1 \\ \frac{1}{3} & \text{if } A_1 < AI <= A_2 \\ \frac{2}{3} & \text{if } A_2 < AI <= A_3 \\ 1 & \text{if } A_3 < AI \end{cases}$$

- AI = Affordability Index
- AS = Affordability score
- A_1, A_2, A_3 = lower quartile, median, upper quartile (Affordability Index)

2.1.7 Natural Disaster Indicator

Natural disasters may change preferences for location and property type, leading to changes in market demand. The natural disaster indicator is calculated based on ***the number of natural disasters*** such as ***storms, floods, extreme temperatures, earthquakes and wildfires*** that have occurred in the area over the years. The occurrence of natural disasters will reduce people's trust

in safe living in the area, which will cause real estate developers to be unable to profit from it, and the reconstruction process after natural disasters will increase developers' costs and other negative impacts.

$$Natural\ Disaster\ Indicator = 1 - \frac{S + F + ET + EQ + WF}{TNDC}$$

Where:

- S = number of storm
- F = number of flood
- ET = number of extreme temperature
- EQ = number of earthquake
- WF = number of wildfire
- TNDC = total natural disaster of country

2.2 Historic Preservation Index

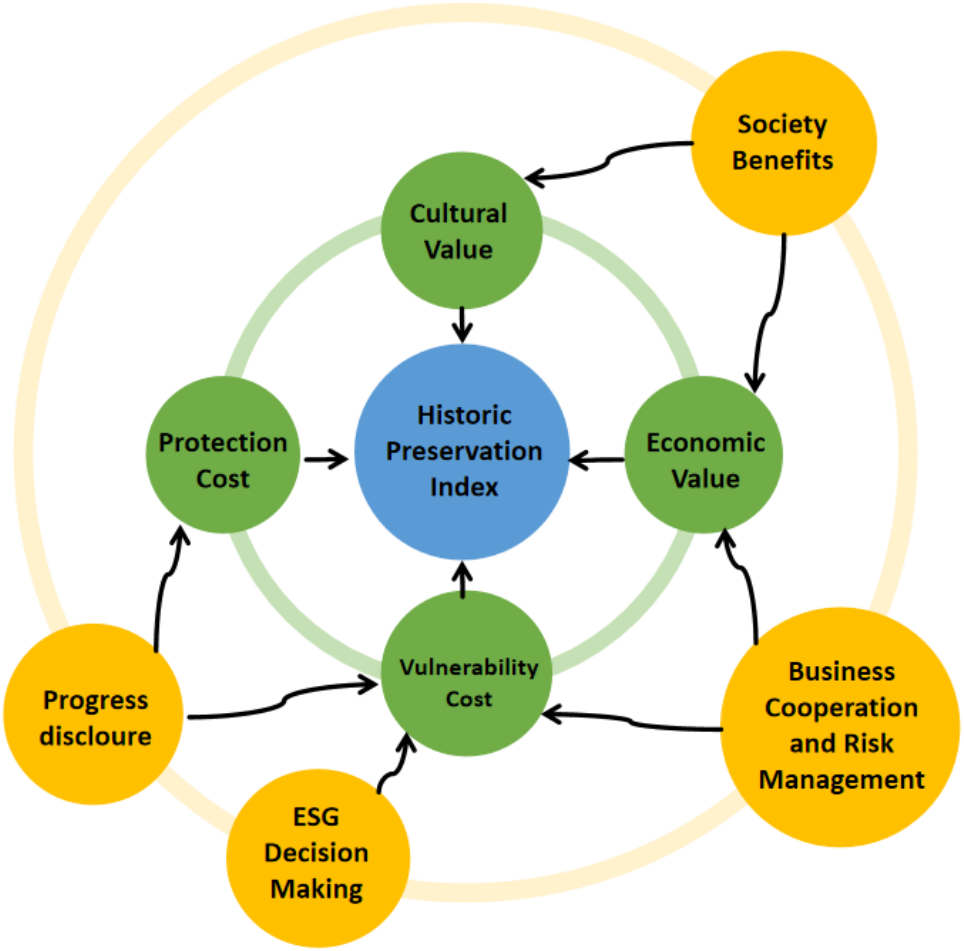

*Figure 2.2 – Process flow for the creation of the Historic Preservation Index model. The model incorporated all four principles of **1.1** and grouped them together into four metrics. The sum of these metrics is the overall Historic Preservation Index.*

By grouping **1.1** principles together, **four metrics can be created**: cultural value, economic contribution, vulnerability assessment, and protection cost. For the remainder of this report these metrics will be referred to as: ***Cultural Value, Economic Value, Vulnerability Cost, Protection Cost***. The four principles of **1.1** were categorized into four metrics which were used to determine how urgent a city is needed for historic preservation (Figure 2.2).

This model outputs a cumulative Historic Preservation Index (HPI) value that ranges across a traditional grading system of 0-100 (where 100 is the highest possible level of urgency in historic preservation). This HPI value is the sum of scores from the four metrics mentioned previously:

$$HPI = Cultural\ Value + Economic\ Value - Vulnerability\ Cost - Protection\ Cost$$

2.2.1 Cultural Value Metric

The Cultural Value metric accounts for a city's multifaceted nature of urban cultural value. To quantify this metric, this report focused on: ***historical significance*** and ***cultural symbolism***.

The main measure that accounts for cultural value is historical significance. historical significance focuses on the historical foundations of cities and their structures, considering the role of the city and its architecture throughout historical development. Through analysis of historical documents, archaeological findings, and expert evaluations, we unveil the historical context and significant events associated with each building. By quantifying the number of historical events, we can assign a historical value rating to each building and the city as a whole.

To account for the cultural symbolism, the HPI model uses the frequency count of references to city buildings in cultural works. We focus on the role and influence of architecture as a cultural symbol in art, literature and social life. By counting how often a building is mentioned in cultural works, we are able to quantify its cultural impact. This assessment demonstrates the position of buildings in cultural heritage and also reflects the public's perception and emotional connection to them.

$$Cultural\ Metric = \frac{Hs + Rf}{2}$$

Where:

- Hs = number of historical events to city buildings
- Rf = frequency count of references to city buildings

2.2.2 Economic Value Metric

When assessing the economic contribution of a city's historic buildings, we consider four key factors including ***tourism numbers, tourism revenue, employment opportunities*** and ***business support***. Together, these factors form a complete picture of the impact of historic buildings on a city's economy.

Tourist attraction is one of the important indicators to measure the economic contribution of historical buildings. We evaluate this indicator through the two dimensions of tourist numbers and tourism revenue. Visitor numbers reflect the building's popularity and attractiveness, while tourism revenue is directly related to tourist spending. These revenues are of great significance for maintaining and repairing historical buildings, and also bring considerable economic benefits to the city.

Employment opportunities and business support are two other important dimensions in assessing the economic contribution of historic buildings. By attracting tourists, historic buildings provide a wide range of local employment opportunities. The building's support for local businesses results in increased foot traffic to surrounding shops and restaurants, driving revenue growth for these merchants.

$$Economic\ Metric = \frac{Tr + In + Jb + Br}{4}$$

Where:

- Tr = number of tourists
- In = tourism income
- Jb = number of jobs
- Br = business revenue

2.2.3 Vulnerability Cost Metric

When assessing the vulnerability of historic buildings in a city, we combine two key factors: ***geographic climate risk*** and ***crime rate***. Together, these two factors demonstrate the vulnerability of historic buildings to different threats, helping us to develop more effective conservation and restoration strategies.

Geographic Climate Risk Metric accounts for several key factors that determine an area's vulnerability to climate-related and geographic risks.As a result, three measures were used for this metric: ***geographic vulnerability, climate exposure*** and ***natural disaster risk*** (Refer to **2.1.4**).

Human factors considerations, such as crime rate, demonstrates the risks that historic buildings may face from damage caused by human activity and neglected maintenance. Not only can criminal behavior directly damage the physical structure of a building, it can also reduce public access to and use of these buildings, thereby affecting funding and resources for their maintenance and conservation.

$$Vulnerability\ Cost = \frac{Gcr + Ci}{2}$$

Where:

- Gcr = geographic climate risk (Refer to **2.1.4**)
- Ci = city's crime rate

2.2.4 Protection Cost Metric

The Protection Cost metric accounts for the conservation and preservation costs of historic buildings in a city. To quantify this metric, this report focused on: ***annual maintenance cost*** and ***repair cost***.

Maintenance cost is an important aspect of conservation, representing the annual financial budget required to maintain and safeguard the buildings. This includes routine inspections, cleaning, minor repairs, and other preventative measures to avoid significant deterioration. Quantifying the

yearly maintenance expenses helps in budgeting for preservation efforts and also underscores the importance of regular maintenance in preventing costly major restorations down the line.

Repair cost shows the expenses associated with necessary repairs and reinforcements to restore the buildings to their former state. This includes addressing structural issues, restoring original features, and updating facilities to meet current safety standards while preserving historical authenticity.

$$Protection\ Cost = \frac{Mn + Rp}{2}$$

Where:

- Mn = Annual Maintenance
- Rp = Repair Cost

3 Current Property Insurance Plans

In this section, we will scrutinize the current property insurance plans of New York and Athens. The examination of each city's plan will be conducted from four distinct perspectives: insurance companies, property developers, government, and the public. Utilizing the results from our model, we will measure and compare the current success of each city's property insurance plans.

3.1 New York, US

The United States is the world's largest insurance market by premium volume, with figures exceeding one trillion U.S. dollars annually. In terms of insured losses, New York has suffered significantly due to tropical cyclones, with costs amounting to almost 40 billion U.S. dollars, while losses from severe weather events have reached approximately 26.7 billion U.S. dollars.

After inspection, the United States is the world's largest insurance market by premium volume, with figures exceeding one trillion U.S. dollars annually. From the However, rapid urbanization ,global climate change and sea-level rising foster New York city to encounter with high frequency of natural hazards like floods, earthquakes, high winds, wildfire, winter storms, tornadoes, lightening. New York interferes insured losses due to tropical cyclones amounted to almost 40 billion U.S. dollars, while losses due to severe weather amounted to approximately 26.7 billion U.S. dollars.In response to the increasing frequency and severity of natural disasters, US insurance premium has risen annually and annual premium was varies from 766 USD dollars to thousands dollars in 2022 according to low and high flood risk areas. Over 50 percent of New Yorkers purchase individual disaster insurance. From government perspectives, funding and grants are offered to alleviate the financial burden caused by disasters. The DFS's role in disaster education and the enforcement of deductibles is also a critical aspect of governmental support, contributing to a more informed and prepared public.Additionally, New York city is allowed to implement in hurricane deductible.

3.2 Athens, Greece

Greece, being one of Europe's most mountainous countries, has 80% of its terrain composed of mountains and hills. Athens, its capital, lies in an expansive coastal plain, flanked by mountains on three sides and opening to the sea to the south. The Mediterranean climate bestows mild, moderately rainy winters and hot, sunny summers upon the city. However, the summer's intense heatwaves, along with the coastal setting, frequently precipitate natural disasters such as wildfires and floods in Athens.

From 1997 to 2020, Greece incurred financial losses of 10.394 billion euros due to extreme weather and climate change, as recorded by the CatDAT database. Greek insurers paid out € 359 million for damages caused by natural disasters from 1993 to 2018.Despite this, only 16% to 20% of Athens homeowners have invested in hazard insurance, reflecting the overall low insurance uptake in the region. The cost of insurance in these circumstances can be a significant factor in this low rate.In contrast, a substantial majority of Greek homeowners which (88%)report having homeowners' insurance. This high rate is likely influenced by the policies of mortgage lenders who seek to safeguard their collateral.

With the aid of the Technical Support Instrument in 2022 and the collaboration with Expertise France, the Greek government is poised to estimate the accuracy of floods. Therefore, the Greek insurance industry requires further regulations and development, necessitating a collaborative effort between the government and the public sector.

3.3 Success of Current Strategies

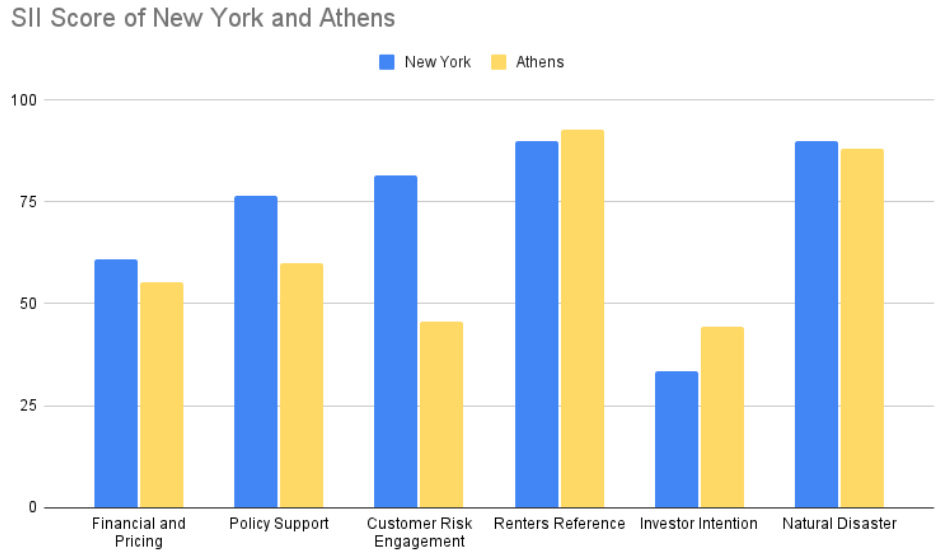

Figure 3.1 – Model results showing current sustainable insurance metrics for both cities. Each of the seven subsections are scored out of 100 points, leading to a possible score of 600 as one metric needs to be subtracted.

In this section, we will leverage the results from our model to assess the efficacy of the sustainable catastrophes insurance in both cities.Specific metrics from our index have been utilized to gauge the decision of underwriting policy to undertake the risks.New York has garnered a score of 352.18, whereas Athens has achieved with a score of 312.17 , both evaluated on a scale of 700.Despite the similarity in score across various matrices, inventor intention emerged as a significant differentiator. Nevertheless, New York's forthcoming initiatives are geared towards enhancing investor intention towards sustainable insurance development among its metrics. The outcomes of the Sustainable Insurance Index are visually represented in Figure 3.1 .

3.3.1 New York Model Evaluation

The following section will evaluate New York's score with the Sustainable Insurance Index. New York achieved a 78.8 for geographic climate resilience when factoring in geographic vulnerability and natural disaster.Compared to the highest risk region(Tornadoes Alley,US), New York Scored fairly high and was assumed to extreme weather due to intense population. For financial and pricing metric, New York achieved a score of 70.8 which represents the market of catastrophe insurance in New York is relatively mature to underwrite the policy. New York's standout performance was in Customer Risk Engagement,where it secured the highest score of 81.6. Score of Financial and Pricing from insurance industry is 60.8.This achievement was bolstered by the government support in public awareness and finance. Additionally, renters reference achieve a score of 89.87 and investor intention about 33.33 and current natural disasters rate in New York city is 89.88 which will help real estate developers to make future decision in US.

3.3.2 Athens Model Evaluation

This section offers an analysis of Athens's performance against Sustainable Growth Index, highlighting its strengths and weaknesses in various metrics. Athens gained 55.4 in financial and pricing as insurance claims is relatively high.For policy support scored for 60.1 as Greece government as well as European Commission start to initiate public awareness to natural disaster in recent years. Customer demand on hazardous insurance is low due to the low compensation rate from insurance company. Renters reference in Athens score 92.72, whereas investor intention rate 44.44 and natural disaster about 88.21 in Athens.

4 Proposed Sustainable Property Insurance Strategy

Sustainable Property of all initiatives for both New York and Athens will be demonstrated below.

4.1 City of New York Initiatives

New York's performance in the Sustainable Insurance Index (SII) positions it favorably among US cities,yet there are clear areas that require attention to elevate its score further. The primary area

for improvement is in future climate, which faces significant challenges due to the over population.

4.1.1 Financial and Pricing Use Initiatives

To increase the score of financial and pricing, insurance companies can refine their pricing models to more accurately reflect the risk associated with climate change. By engaging in reinsurance agreements with other companies, they can distribute the risk, ensuring they have sufficient coverage for substantial claims.

4.1.2 Policy Support Use Initiatives

New York can increase policy support score by facilitating more public-private partnerships for disaster resilience to allow insurance companies to collaborate on large-scale infrastructure. Secondly, establishing policy for offering lower premiums for buildings that meet certain green building standards for both real estate developers and homeowners.Finally, promoting data sharing between government agencies and insurance companies to enhance accuracy risk assessments.

4.1.3 Customer Risk Engagement Use Initiatives

Customer's willingness towards disaster insurance can be increased by stimulating insurance demands by explaining the claims process and the tangible benefits of holding an insurance policy. Corporate with communities an property developers to encourage customers to buy insurance products with bonus offering.

4.1.4 Geographic Climate Risk Use Initiatives

With regards to disasters resilience,New York can reduce climate change by taking some potential actions from the following perspectives.Firstly, real estate developer should develop a sustainable urban development by focusing on green building practices.Secondly, promote public awareness and educational campaign on emergency preparedness to mitigate damages when natural disasters occur.Moreover, New York State has also adopted several statutes, regulations, and policies to reduce GHG emissions of mitigating future climate change.

4.1.5 Renters Preference Metric Use Initiatives

A popular guideline for budgeting for rent is to follow the 30 percent rule, which means you can spend up to 30 percent of your pre-tax monthly income (your gross income) on rent. This has been a rule of thumb since 1981 when the government found that people who spent more than 30 percent of their income on housing were "cost-burdened".Real estate developers can develop in areas away from the city center, allowing more people to live in a comfortable environment without exceeding the 30 percent rule, and tenant preference indicators can rise accordingly. At the same time, the government needs to strengthen the construction of transportation facilities so that office

workers living in the suburbs can more conveniently go to work in the city center. Such a strategy can benefit both the public and real estate developers. People can move to find a house where they can more afford the rent. For example, the median monthly rent in Manhattan is 4130, Brooklyn is 3295, Queens is 2900, the Bronx is 2513 and Staten Island is 2325.

4.1.6 Investor Intention Indicator Use Initiatives

Investors can choose some high-demand, strategically located areas such as Manhattan to buy some houses and rent them out to others. Encouraging developers to increase housing supply, especially in the low- to mid-price range, can help lower housing costs by relaxing land use and building regulations. Encouraging developers to increase housing supply, especially in the low- to mid-price range, can help lower housing costs by relaxing land use and building regulations. In this way, the overall affordability of the people will be improved, and developers, investors, and the people will all benefit at the same time.

4.1.7 Natural Disaster Indicator Use Initiatives

Over the years, storm-related disasters have been the most common natural disaster in New York. So it's crucial to make buildings more wind-resistant and ensure they adhere to stricter building standards and codes, especially concerning their ability to withstand strong winds and flying debris. Also ensure that building foundations, including foundations and basements, can withstand rising water levels and mudslides caused by storms. Strengthen the overall structural connections of the building by adding beams, columns, and supports.

4.2 City of Athens Initiatives

4.2.1 Financial and Pricing Use Initiatives

To enhance its score, Athens should adopt a regulatory approach to the premium pricing of hazardous insurance, tailoring the costs of different types of disaster insurance to various homeowners.To enhance its score, Athens should adopt a regulatory approach to the premium pricing and coverage of hazardous insurance, tailoring the costs of different types of disaster insurance to various homeowners.

4.2.2 Policy Support Use Initiatives

In Athens, Greece, the Policy Support metric has outperformed other areas in the sustainability index. There's room for further enhancement through strategic collaboration between the government and insurance companies to distribute risks more effectively. Moreover, Greece should persist in its investments in infrastructure aimed at predicting disasters, which will bolster protective measures and overall resilience.

4.2.3 Customer Risk Engagement Use Initiatives

In Athens, customer willingness to purchase disaster insurance is notably low, primarily because compensation amounts often fall short of covering the full extent of damage costs. To address this challenge, the government can play a pivotal role by launching public campaigns aimed at educating the population about the benefits of having insurance in mitigating financial losses associated with extreme weather conditions. Such initiatives could highlight how insurance acts as a critical safety net, offering some level of financial recovery that can significantly lessen the impact of disasters. Furthermore, the insurance market in Athens presents substantial growth potential. By increasing awareness and adjusting policies to offer more comprehensive compensation, there's an opportunity to expand the industry's footprint, ensuring greater coverage and protection for the community against the backdrop of increasing disaster risks.

4.2.4 Geographic Climate Risk Use Initiatives

Athens' geographic location and Mediterranean climate make it particularly susceptible to natural disasters such as wildfires and floods. To combat these risks and address chronic pollution issues, one innovative strategy involves the creation of pocket parks. These small green spaces, developed on plots previously neglected and littered with garbage and weeds, serve not only as urban oases but also as a measure to enhance the city's resilience against environmental challenges. Furthermore, the Greek government is focusing on attracting significant investments in renewable energy. This initiative aims to mitigate the impacts of climate change over the long term, reinforcing Athens' commitment to sustainable development and disaster risk reduction.

4.2.5 Renters Preference Metric Use Initiatives

As mentioned above, there is a 30 percent rule to follow when renting. Data shows that the median income of people in Athens is low, with the local average monthly rent accounting for nearly 50 percent of the salary. Local governments need to adopt effective fiscal policies and taxation systems as soon as possible to rationally allocate resources, reduce the gap between rich and poor, promote steady economic growth, and thereby increase the country's average income. The income of local people increases, the preference index of renters increases, and real estate developers have more opportunities to develop or rebuild so that people can enjoy a more comfortable living environment.

4.2.6 Investor Intention Indicator Use Initiatives

Real estate developers can improve the attractiveness of the property by renovating and upgrading the property (such as improving interior decoration, adding modern facilities, etc.), thereby increasing the rent that can be charged. To achieve the social goal of housing affordability, we must incentivize developers to increase the supply of affordable housing, which requires the government to adopt loose policies on land use and building regulations to promote an overall reduction in housing costs and increase public affordability.

4.2.7 Natural Disaster Indicator Use Initiatives

We know from historical natural disasters that Athens experienced many floods and earthquakes. The government needs to design efficient surface and peripheral drainage systems to ensure that rainwater and floods can be drained quickly and reduce water accumulation. To prevent earthquakes, ensure that buildings meet modern seismic design standards, existing buildings are assessed and necessary reinforcements and modifications are made. Reinforce the building foundation, including deepening the foundation, expanding the foundation area, or using underground diaphragm walls to improve its earthquake resistance. So far, there have been no natural disasters in the east and south of Athens. Real estate developers can consider these two areas.

5 Preliminary Research for Preservation Model

A preservation model is proposed for the community of Athens to identify measures to protect buildings within their community. The process begins with an assessment of the value of the community's buildings, followed by risk assessment, prioritization, cost-benefit analysis, and concludes with multi-objective optimization and decision support systems. Encouragement for community leaders to use the proposed preservation model for assessing and implementing protective measures for historical buildings in the community is detailed in an appended letter. (refer to **A (Letter)**)

5.1 Value Assessment

For value assessment, we first identify and document buildings and sites within the community that hold significant cultural and historical value. This involves understanding their historical background, architectural features, and role within the community. We examined two renowned historical and cultural buildings in Athens: the Acropolis and the Parthenon, along with the Ancient Agora.

The Acropolis, one of the most famous sites from ancient Greece, built in the 5th century BC, symbolizes ancient Greek civilization. The Parthenon, the most significant building on the Acropolis, is renowned for its exquisite Doric columns and sculptural decorations. This temple served not only as a place of worship but also as the city's treasury. Over the years, the Parthenon has endured multiple damages and restorations, including bombardment by the Venetians in 1687 and several earthquakes. The Acropolis, as a globally renowned historical site, draws numerous visitors, significantly boosting local tourism. This influx of visitors translates into increased employment opportunities, including for guides, tourism service personnel, and related commercial activities like dining and souvenir sales.

The Ancient Agora, the public hub of ancient Athens, was the center for civic gatherings, commercial transactions, and judicial rulings. Its restoration projects, such as the reconstruction of the Stoa of Attalos, have preserved historical remains while providing community spaces for public use and cultural education. The Agora's ruins and museums, like the reconstructed Stoa of

Attalos, offer visitors a rich cultural and historical experience, similarly driving employment and local commerce.

5.2 Risk Assessment

We gather data on historical natural disaster events, climate change predictions, building conditions and values, and assess the potential risks posed by various natural disasters to community buildings, analyzing potential threats such as natural disasters, human factors, and environmental changes. In Greece, earthquakes and floods are major natural hazards threatening these structures. Earthquakes, in particular, pose a severe threat to the structural stability of these buildings due to Greece's location in an earthquake-prone area. Human factors refer to potential damages caused by human vandalism, neglect in maintenance, and inappropriate restorations. Additionally, excessive tourist flow can stress the preservation of monuments. Climate change, resulting in extreme weather and temperature variations, could accelerate the aging and deterioration of building materials, threatening the long-term preservation of monuments.

Each building or site's vulnerability to damage or destruction must also be assessed. The Acropolis and Parthenon are threatened by natural erosion, earthquakes, and human factors. The region's susceptibility to weathering and acid rain erosion on marble structures could lead to structural damage, and its location in an earthquake zone may result in structural cracks or collapse. On the other hand, the Ancient Agora is affected by natural factors like earthquakes and extreme weather conditions, urban development, and wear from visitors. As a tourist attraction, frequent visitor activity could damage the ground and ruins.

5.3 Prioritization for Preservation

Based on the assessments, we need to determine protection priorities, giving precedence to sites with the highest cultural and historical value and significant impact on the community's economy and social structure.

The Acropolis, as a symbol of ancient Greek culture and history and its significant economic impact on the Athenian community, should be given the highest protection priority along with the Parthenon. The Ancient Agora, which played an essential political and social role in ancient Athenian society and holds significant value for community history and culture, should be given a secondary priority in protection, despite its possibly lower economic impact.

5.4 Cost-Benefit Analysis

As mentioned above in **6.3**, the Acropolis was selected as the highest conservation priority building in Athens, and we advised community leaders on conservation measures for this historic building. Cost-benefit analysis is primarily intended to assess the value of investments in protective measures versus prevention of potential losses. Protection costs mainly involve investments in measures such as strengthening structures, implementing flood protection measures and using refractory materials.

When evaluating the cost of protection, we need to examine in detail the specific costs required for each measure, including materials, labor and possible maintenance costs. In terms of loss prevention, we need to estimate the potential losses that these protective measures can prevent in the future. This includes direct structural damage, loss of cultural heritage value, and economic impacts such as reduced visitor numbers due to damage.

5.5 Multi-Objective Optimization

In devising comprehensive protection measures, the economic feasibility, cost-benefit analysis, necessity of cultural historical preservation, and community support must be considered simultaneously. More resources and funding should be allocated to higher-tier sites to ensure their adequate protection and regular maintenance. Given the Acropolis's tourist appeal, a portion of tourism revenue should be directed towards the structure's protection and maintenance. Additionally, community leaders could actively seek government funding, international donations, and cultural grants to support the preservation and maintenance of the structure.

In implementing protective measures, community leaders should hire professional architectural conservationists, archaeologists, and cultural heritage professionals to ensure the work adheres to international standards. Moreover, establishing regular maintenance schedules, including cleaning, repairs, and structural reinforcement, is crucial to prevent further damage. Community engagement plays a role in the preservation of historical buildings within the community, and leaders should encourage community member participation in preservation efforts, host public tours, and educational events to enhance community understanding and support for preservation efforts. Furthermore, cultural education programs should be developed to impart knowledge about the history and cultural value of the buildings to community members and visitors, enhancing their awareness.

5.6 Our Preservation Model

Considering the above viewpoints and analysis, we have developed a decision support model to help community leaders strategize the protection of buildings based on model results. We propose the HPI index to measure the importance and urgency of implementing protective measures for historical buildings within the community. The system allows the input and storage of data related to buildings, including history, cultural value, economic contribution, vulnerability assessment, and more. The model will consider factors such as cultural value, economic contribution, vulnerability assessment, and protection costs, analyzing the impact of different strategies.

Data and model-based decisions can help community leaders allocate resources and formulate strategies more wisely, balancing cultural, economic, and community needs while protecting cultural heritage. When implementing protective measures using our proposed model, physical protection, legal and policy considerations, emergency planning, and regular monitoring and evaluation are thoroughly considered. Our model aligns with the four principles of 1.1, showing a high convergence with sustainable building insurance. (refer to **Table B-1** in Appendix)

6 Strengths and Weaknesses of Model

SPII Model. The Sustainable Property Insurance Index presented in this report was designed to be a tool for assessing how cities handle extreme weather events. Two cities that are attempting to implement sustainable property insurance planning were analyzed to provide a benchmark to other cities. Any city adopting this model should aim to score an equal or greater SPII value than the presented cities.

The main strength of this model lies in its simplicity and adaptability. Any city with natural disaster, geographic, weather data and property insurance plans can calculate its SPII. Parameters are normalized regionally, making the model more robust. The required data involves basic measurements, which both developed and developing cities can access.

HPI Model. The preservation model's simplicity limits its ability to provide a detailed analysis of a city's historic preservation plan. Currently only four metrics are used to calculate the HPI, allowing cities to focus on one aspect to boost their overall HPI, potentially leading to misplaced sense of urgency and importance for historic preservation.

Future developments should aim to enhance result granularity while preserving overall robustness. Additional parameters could be incorporated for a more precise description of each metric. Further research and model iterations will determine the appropriateness of equal weighting for the metrics and measures.

7 References

United Nations Environment Programme. (2012). ”Principles for Sustainable Insurance” <https://www.unepfi.org/insurance/> (June, 2012).

Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J. R., Mellouli, S., Nahon, K., Pardo, T. A., and Scholl, H. J.(2022). ”Emergency Management against Natural Hazards in the Acropolis of Athens” Special Issue Coping with Social-Natural Disasters: Multi-Disciplinary Scientific Contributions.

Greek City Times. (2023). ”Athens Acropolis to Receive Enhanced Lightning Protection: Approval Granted by Top Advisory Body” <https://greekcitytimes.com/2023/06/26/athens-acropolis-to-receive-enhanced-lightning-protection-approval-granted-by-top-advisory-body/> (Jun. 26, 2023).

NPR News Now. (2012). ”A decade after Sandy, hurricane flood maps reveal New York’s climate future” <https://www.npr.org/2022/10/29/1131608305/> (June, 2012).

UNESCO World Heritage Convention. (1987). ”Acropolis, Athens” <https://whc.unesco.org/en/list/404/>.

Euronews. (2023). ”Athens’ Acropolis is crumbling under tourism pressure. Should you visit quieter places instead?” <https://www.euronews.com/travel/2023/07/23/athens-acropolis-is-crumbling-under-tourism-pressure-should-you-visit-quieter-places-inste> (Jul. 23, 2023).

The Middlebury Sites Network. (2017). ”The Athenian Acropolis, Globalization, and Mass Tourism” <https://sites.middlebury.edu/untouchedbytime/the-athenian-acropolis-globalization-and-mass-tourism/> (Feb 20, 2017).

History Hit. (2021). ”Ancient Agora of Athens” <https://www.historyhit.com/locations/ancient-agora-of-athens/> (Jul. 20, 2021).

World History Encyclopedia. (2020). ”The Art and Culture of Ancient Greece” <https://www.worldhistory.org/collection/70/the-art–culture-of-ancient-greece/> (Apr. 20, 2020).

Statista. (2024). ”Travel and tourism in Greece - statistics and facts” <https://www.statista.com/topics/8595/travel-and-tourism-in-greece/> (Jan. 10, 2024).

Our World in Data. (2020). ”Natural Disasters” <https://ourworldindata.org/natural-disasters> (Apr. 20, 2020).

A A Letter to Athens Community

To the Athens Community Leaders,

Subject: Sustainable Property Insurance Index for Historic Preservation

I am writing to present a comprehensive plan for the future preservation and enhancement of the Acropolis and Parthenon, a cornerstone of our community's heritage and cultural identity. This initiative is centered around the implementation of the **Sustainable Property Insurance Index (SPII)** and the **Historic Preservation Index (HPI)**, two pivotal tools that have shown promising results in other cities facing similar challenges.

Preservation Plan:

Our proposal involves a comprehensive assessment of our community's current infrastructure and historic assets using the SPII and HPI models. The SPII will guide us in understanding our preparedness for extreme weather conditions and in identifying areas where sustainable property insurance can be enhanced. Concurrently, the HPI will help us evaluate the current state of our historic preservation efforts and pinpoint opportunities for improvement.

Timeline:

The initial phase of data collection and analysis is projected to span one week. Necessary processes needed to be carried out furthermore, such as collecting demographic data, assessing regional benchmarks, and conducting preliminary evaluations of the Acropolis and Parthenon.

Following this, a detailed plan outlining specific measures for improvement will be developed over the next six months. Implementation of recommended actions is anticipated to commence in the subsequent year, with ongoing monitoring and adjustments as needed.

Cost Proposal:

We estimate the preliminary assessment and planning phase to require an investment of approximately $50,000, covering expert consultations, data analysis, and initial planning. The subsequent implementation phase's costs will be determined based on the specific actions identified in the plan. To support this initiative, we recommend exploration of various funding avenues, including local government allocations, grants, and partnerships with private entities.

We believe that adopting the SPII and HPI frameworks will not only enhance Athen community's resilience to environmental challenges but also preserve the historical heritage. We invite your insights, support, and collaboration as we start this important journey to a greener and more culturally vibrant future.

In summary, we look forward to discussing this proposal in further detail to lay the groundwork for a resilient and preserved community.

B Appendix

Table B.1 – Intersectionality matrix of the four principles of Sustainable Insurance.

	Our Metrics										
Principle (PSI)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1		✓		✓			✓			✓	
2	✓		✓		✓				✓	✓	
3	✓		✓					✓	✓		
4		✓		✓	✓	✓				✓	✓