

Educating Greek Students about Climate Change through Serious Games

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by

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Abstract

In Greece, climate change is projected to have detrimental effects, disrupting agricultural production, wildlife species, public health and economic standing. Studies have shown that increasing education can help combat climate change. The goal of this project was to develop serious games about climate change as resources for the Environmental Education Centre of Eleftherio-Kordelio and educators throughout Greece. Using a knowledge survey, observations, and other forms of assessment, we developed, tested, and refined 6 serious games with 185 students. These games, along with 8 others, are presented in a booklet that can be disseminated to Greek educators.

Authorship

Olivia Gulezian, Angelica Puchovsky, Vital Tavares and Kassidy Utheim all contributed to the research and writing of this report. In addition to writing individual sections of this report, all members edited the paper for grammar, content, and flow as a group. The Environmental Education Centre Staff contributed to the serious game creations and advice videos. The following is a breakdown of how the report was written for this project.

Abstract: Angelica wrote the abstract chapter and Olivia helped revise and edit its content.

Executive Summary: Angelica wrote the executive summary chapter with the help of Olivia and Vital's edits and revisions.

1.0 Introduction: Angelica and Vital wrote the majority of the introduction chapter while Olivia helped make significant revisions.

2.0 Background: The breakdown of each major section in this chapter is represented below.

2.1 Climate Change: Angelica and Vital wrote the climate change section initially. Angelica wrote the majority of the finalized section and Kassidy wrote the subsection on urban resilience. All team members worked to revise this section.

2.2 Educating Citizens About Climate Change: Angelica and Olivia wrote the majority of the Educating Citizens About Climate Change section and the whole team helped make revisions.

2.3 Using Serious Games for Climate Change Education: Angelica and Kassidy wrote the majority of the Using Serious Games for Climate Change Education section and the whole team helped make revisions.

2.4 The Environmental Education Centre of Eleftherio-Kordelio: Olivia and Vital wrote the majority of the Environmental Education and the whole team helped make revisions.

3.0 Methodology: Each team member equally contributed in writing the methodology chapter. Angelica and Olivia made revisions to this chapter.

4.0 Decisions about Climate Change Game Design and Facilitation Strategies for the Greek Context: Angelica and Olivia wrote the majority of the findings chapter. Kassidy helped make revisions.

5.0 Serious Game Designs: Angelica wrote the Serious Game Designs chapter. Olivia helped write game descriptions and both Angelica and Olivia revised this chapter.

6.0 Recommendations: Olivia wrote the recommendations chapter. Vital helped make revisions to this chapter.

Appendix: The breakdown of each major Appendices is represented below.

A: *Climate Change Survey in English and Greek:* All team members helped create and adapt this survey.

D: *Completed Observational Data Tables:* Kassidy recorded the majority of observational data.

F: *Serious Game Booklet:* Olivia designed the booklet and Vital wrote most of the climate change topic backgrounds. Each team member helped edit and discuss content and organization of the booklet. Olivia designed and wrote cards for “Before the Storm” and designed “Cause and Effect Game.” Kassidy and Olivia designed the cards for “Race for Resilience.” Each team member also created and adapted a variety of the games in the booklet.

Final Report Design and Visuals: Olivia formatted and designed the entire paper into a single cohesive document and created the majority of report figures. Angelica helped create report figures as well. All photographs in this document were taken by the authors.

Executive Summary

Around the world, impacts of climate change have disrupted agricultural production, wildlife species, public health and economic standing of regions (Georgakopoulos, 2017). Greece is already suffering from the impacts of climate change and is estimated to have detrimental effects in the coming years; temperatures are expected to increase, extreme weather events are likely to become more frequent and intense and sea levels are estimated to rise (Georgakopoulos, 2017). Figure 1 shows the impacts of climate change estimated to occur in Greece during the 20-year period of 2045 to 2065.

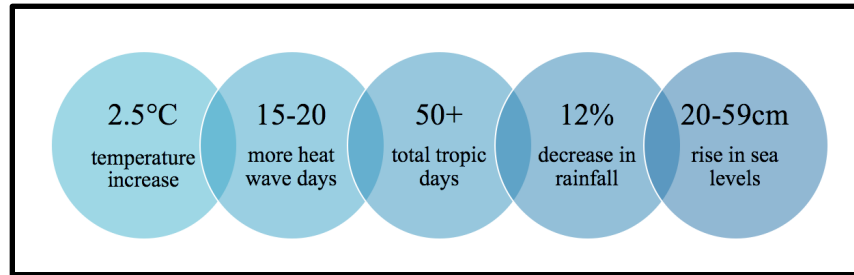


Figure 1: The Impact of Climate Change on Greece in the 20 Year Period 2045-2065 (Georgakopoulos, 2017)

Public education about climate change can raise awareness and potentially change individuals' behaviors in ways that may mitigate its effects (Cordero, Todd, & Abellera, 2008). The current mandatory Greek curriculum does not include environmental education; students learn about climate change on a voluntary basis (Environmental Education Centre Staff, personal communication, March 13, 2019). In the past, climate change education has focused primarily on mitigation strategies rather than helping urban communities adapt and become resilient (Muller, 2007). The Environmental Education Centre of Eleftherio-Kordelio in Thessaloniki, referenced as KPE throughout the report, is one of 54 centres located around Greece that focuses on educating students and the community about the environment, sustainability and resilience planning. KPE uses innovative educational methods with the goal of encouraging students to actively care for their environment.

In a 2008 study of college students, Cordero concluded that "effective climate change education should emphasize the personal connection between the student, energy, and climate change using active learning methods" (Cordero et al., 2008). Serious games, games that are both fun and educational, are an innovative tool that can be used as a climate change education strategy. Studies have shown that serious games transfer knowledge better than textbooks while also being accessible and improving students' social skills (Stege, Van Lankveld, & Spronck, 2011; Göbel et al., 2018).

The goal of this project was to develop serious games about climate change as resources for Greek educators. Through surveys, observations, interviews and embedded assessments, we tested students on their current knowledge, developed and evaluated serious games about climate change and produced a digital distributable serious game booklet for KPE.

Development, Testing and Refinement of Serious Games

We worked on creating games about climate change resilience and mitigation strategies in addition to climate change causes and impacts to support with KPE's goals. We used the following methods to develop the game content and mechanics and to test, evaluate, and refine the games:

Survey: We distributed a pre-knowledge survey to students at the beginning of each climate change program. The students were presented with a variety of true and false statements to identify their current knowledge. The survey included statements such as: "Extreme weather events are likely to become more frequent and intense due to climate change" and "The use of public transportation can contribute to mitigating the greenhouse effect." Survey results helped guide the development of game content.

Interviews: We interviewed KPE staff members to gain insight on effective game facilitation strategies and recommended game design adjustments.

Observations: We observed students' behavior following an observational protocol and recorded observational data during each game.

Embedded Assessment: We used embedded assessments during the facilitation of the games to assess learning outcomes and student engagement. We also held debriefing sessions with KPE's staff after playing games to discuss how to refine the games based on students' behavior and overall game effectiveness.

We adapted and developed 14 serious game designs using the methods above. We tested 6 of these games with a total of 9 groups of students; each game was tested 1 to 5 times and was continuously adjusted to better fit student and teacher curriculum needs. It is important to note that students attended KPE on a voluntary basis and were likely to have pre-existing interest and knowledge on climate change topics. The findings presented in the study do not reflect the full population of Greek students.

Results and Findings

Decisions about Game Content: Game content should be developed based on student's prior knowledge, incorporating both new and existing knowledge that relate to their interests, experiences and surroundings. The following findings helped guide the development of game content:

Students demonstrated a strong understanding of certain climate change topics. In the pre-knowledge survey, over 85% of students surveyed demonstrated a strong understanding of the impacts of climate change on extreme weather events, agricultural and food production, sustainable energy and wildlife species.

Students demonstrated a need to expand their knowledge on particular climate change topics. In the pre-knowledge survey, about 50% of students surveyed did not demonstrate an understanding of certain climate change topics related to carbon dioxide contributions to the

greenhouse gas effect, changes in habitable land, public transportation as a form of climate change mitigation and changes in the cost of living.

Lessons Learned about Game Mechanics and Facilitation Strategies: Game mechanics should include physical action, collaboration and competition while being informative, fun and short; about 10-20 minutes long. Facilitation should be clear, concise and complete, incorporating all game components: duration, age group, preferred space size and game facilitation difficulty. The following findings helped guide the development of our game mechanics and facilitation:

Games were more effective when they related to the Greek context. Students learned more when games pertained to their experiences and surroundings. This was confirmed when playing a game called *Sinking Island*. In this game, students learn about rising sea levels and the importance of teamwork and strategy. The game was much more effective when students were asked to imagine that they were on a Greek island rather than an Arctic island.

Game instructions must be detailed and provide clear examples for students. Facilitation is effective when game instructions are acted out and explained in detail. For example, when facilitating a game called *Survivor*, students turned to their neighbors and teachers for clarity, but were unclear on how to play until we demonstrated examples. We played a practice round in front of students and in response students nodded their heads and told us that they now fully understand the game.

Greek students enjoyed short games that involve competition, physical action and teamwork collaboration. When playing the games *Sinking Island* and *Survivor*, students became active and competitive, engaging with each other and the game as a whole. According to one of the students, “We are in the process of growing up, but we still love to play games.” We also noticed that students became unengaged when game durations took longer than 20 minutes. In the first test of a game called *Answer with your Feet*, students became uninterested; game discussions took too long, too many rounds were played and physical activity was limited. Adjustments were made to play fewer rounds, spend less time discussing answers and more time playing the game; students became more engaged and excited to continue playing.

Serious Game Booklet

To fit the needs of KPE and in hopes of having a lasting impact on Greece as a whole, we created a distributable game booklet for educators throughout the region, which can be referenced in Appendix E. After a series of conversations with the KPE staff and review of other resources for educators, we made the following decisions about booklet features and organization:

Symbols to Indicate Climate Change Topics: The booklet incorporates a set of four climate change topics: climate change causes, climate change impacts, resilience strategies and

mitigation strategies. Each topic is represented by a distinct symbol, represented in Figure 17. Every serious game includes a climate change lesson on at least one of these topics.



Figure 17: Climate Change Topic Booklet Symbols

Information about Climate Change for Greek Educators: The booklet provides brief explanations of climate change topics, categorized by the four main topics described above.

Complete Game Descriptions: Every game design includes descriptions of the game's objectives, facilitation guidelines, and debriefing questions, represented in Figure 18. Game descriptions also include game duration, number of players, preferred space size and facilitation difficulty, represented as symbols shown in Figure 19.

Game Materials: The booklet includes a complete game outline of all material designs and complexities. Some games include pre-made card materials to make them easier for busy teachers to implement successfully.

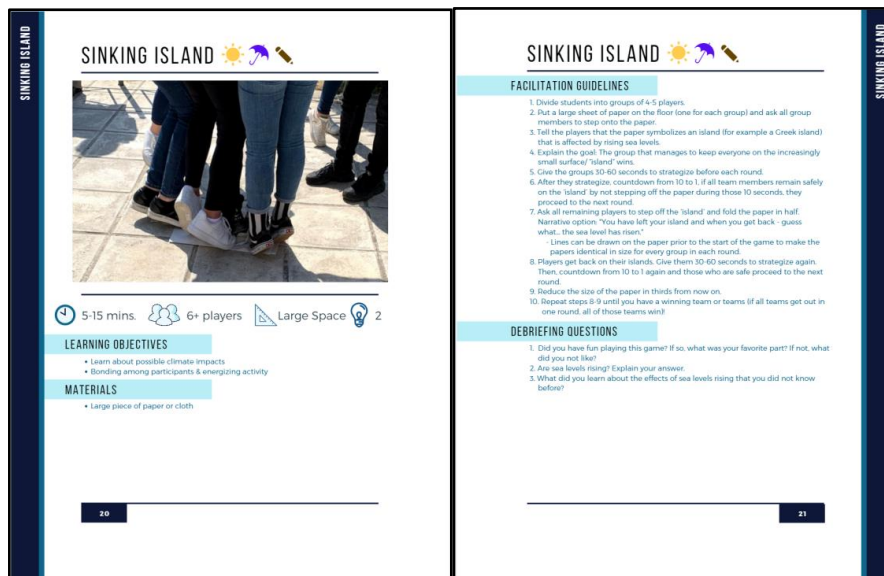


Figure 18: Sinking Island: Example of a Serious Game in the Booklet



Figure 19: Aspects of Game-play Booklet Symbols

Video Clips: The booklet includes a variety of short videos that contain brief interviews with KPE staff members. These video clips aimed to provide Greek educators with an additional resource of environmental education strategies and advice. The interviews were broken down into three topics: the importance of climate change in the educational curriculum, tips for game facilitation and student engagement and how to overcome challenges of climate change education through games.

Additional Elements: The final section of the booklet includes contact information of Greek emergency personnel and a brief page with tips to design a serious game, based on expert interviews and research.

Recommendations

To extend the work described in this report, the next steps for KPE would be:

Further develop the booklet. Translation of the booklet from English to Greek will enable it to be easily accessible and understandable for educators around Greece. The booklet can be continuously improved upon by adding new games, updating background information and including additional resources as needed.

Test and refine additional games. We tested multiple games and made adjustments based on feedback and observations but there are still some games in the booklet that have not been tested. Further testing and adjusting will be beneficial to keep improving the quality of the games.

Disseminate the booklet. The booklet could be distributed digitally or physically to the other 53 Environmental Education Centres that fall under the Ministry of Education. Each centre could reach out to schools that they work with and share the booklet with them. From there, we hope that word will travel and the existence of the booklet will reach many educators, influencing numerous Greek students' lives.

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1.0 Introduction

Around the world, impacts of climate change have disrupted agricultural production, wildlife species, public health and economic standing of regions (Georgakopoulos, 2017). Studies have shown that Greece is already suffering from the impacts of climate change and is estimated to have detrimental effects in the coming years (Georgakopoulos, 2017). Governmental bodies and international organizations such as the United Nations have come up with plans to educate populations and give them the opportunity to mitigate and cope with the effects of climate change (United Nations, n.d.). Previous studies of students have demonstrated that increasing education on the topic helps to raise awareness and promote change (Cordero, Todd, & Abellera, 2008).

Climate change is currently not part of the mandatory Greek curriculum; students learn about climate change on a voluntary basis (Environmental Education Centre Staff, personal communication, March 13, 2019). In Greece, climate change has had its own set of impacts including increase in temperature, extreme weather events and rising sea levels (Georgakopoulos, 2017). In particular, it is expected that sea levels will rise by 20-59 centimeters between 2045 and 2065, which will decrease the amount of habitable land currently in Greece by 3.5% (Georgakopoulos, 2017). A previous study found that a portion of Greek students do not understand certain effects that climate change will have on the world as well as what factors worsen climate change (Athanasiadia, Gavrilakis, & Liarakou, 2010). Therefore, it is important to educate future generations of Greek citizens to expand their knowledge on climate change and mitigation and resilience strategies.

The Environmental Education Centre of Eleftherio-Kordelio in Thessaloniki, also referenced as KPE throughout the report, is one of 54 centres located around Greece and focuses on educating students and the community about the environment and sustainability. KPE was established by the Ministry of Education in cooperation with the Municipality of Eleftherio-Kordelio (The Environmental Education Centre, n.d.). Experiential, activity-based and game-based learning are the main strategies of education used by KPE in order to create a fun and interactive environment. KPE currently has many programs for students including waste management, sustainability and energy. Serious games, games that are both fun and educational, are a primary tool used by KPE throughout their various programs. Studies have shown that serious games transfer knowledge better than textbooks while also being accessible and

improving students' social skills (Stege, Van Lankveld, & Spronck, 2011; Göbel et al., 2018). KPE would like to expand their educational toolkit of serious games and activities for their climate change program. Educating the youth of Thessaloniki, Greece through serious games about climate change could empower them with the necessary knowledge to mitigate its effects.

The goal of this project was to develop serious games about climate change as resources for Greek educators. Through surveys, interviews with the KPE staff, observations and embedded assessments, we tested students on their current knowledge, developed and evaluated serious games about climate change and produced a digital distributable serious game booklet for KPE. The serious game booklet is a tool for educators to teach students about climate change topics and mitigation and resilience strategies. In the future, the booklet can be distributed to educational facilities throughout Greece, having the potential to educate a larger pool of students and positively impact the environment.

2.0 Background

Without the presence of education, our world would have no ability to grow or improve, making education one of the most universally significant aspects to any society (Green Teacher, 2005). Climate change education in particular should be future oriented; students should envision their goals and learn about the steps they can take to achieve such goals (Cordero et al., 2008). Within the next 20 years, many citizens will face the negative impacts from climate change as it is expected to intensify throughout the world (Georgakopoulos, 2017). Citizens would benefit from expanding their climate change knowledge, identifying how they will be affected and learning how their actions can help their environment.

Serious games are effective educational tools used throughout the world and demonstrate a potential solution to educate Greek students (Göbel et al., 2018). In this chapter, we first discuss climate change on a broad scale, identifying how it affects Greece and individual citizens. Next, we examine the relationship between climate change and education. Last, we present serious games as a solution to educate Greek students about climate change. We also discuss The Environmental Education Centre of Eleftherio-Kordelio, also referenced as KPE throughout the report, presenting their role of educating Greek students and their desire to implement serious games in their climate change program.

2.1 Climate Change

Climate change occurs from the intensification of the greenhouse gas effect (Georgakopoulos, 2017). As a result, average temperatures are increasing and numerous environmental, economic and health related issues are evolving (Georgakopoulos, 2017). In this section we discuss climate change in Greece and the resulting environmental and economic impacts. We then explain the effects of climate change on individual citizens, presenting their relationship with climate change and various mitigation strategies that can be implemented.

2.1.1 Climate Change in Greece

Climate change occurs when an excess of greenhouse gases is emitted into the environment, resulting in a temperature increase (Georgakopoulos, 2017). Carbon dioxide, a prominent greenhouse gas present in the environment, nearly doubled in atmospheric concentration in Greece from 1958 to 2017 (Georgakopoulos, 2017). Further intensification of this problem will put the entire Greek community at risk of suffering health issues due to poor air quality (Haines, Kovats, Campbell-Lendrum, Corvalan, 2006). Estimates for climate change impacts in Greece between the 20-year period of 2045 to 2065 are represented in Figures 1, 2 and 3.

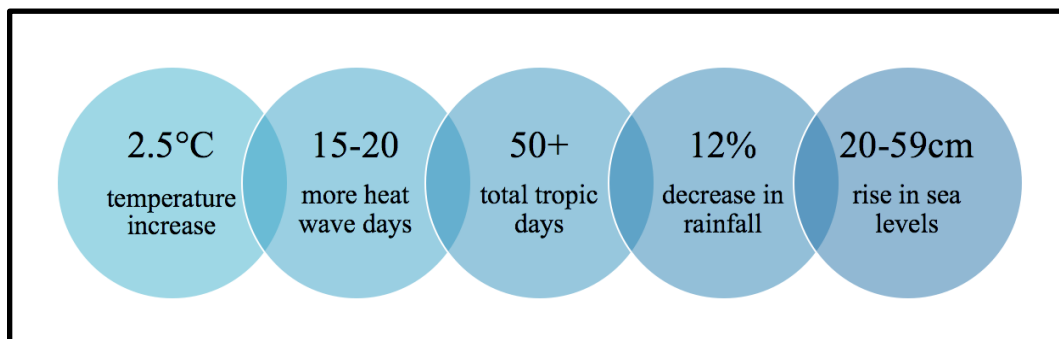


Figure 1: The Impact of Climate Change on Greece in the 20 Year Period 2045-2065 (Georgakopoulos, 2017)

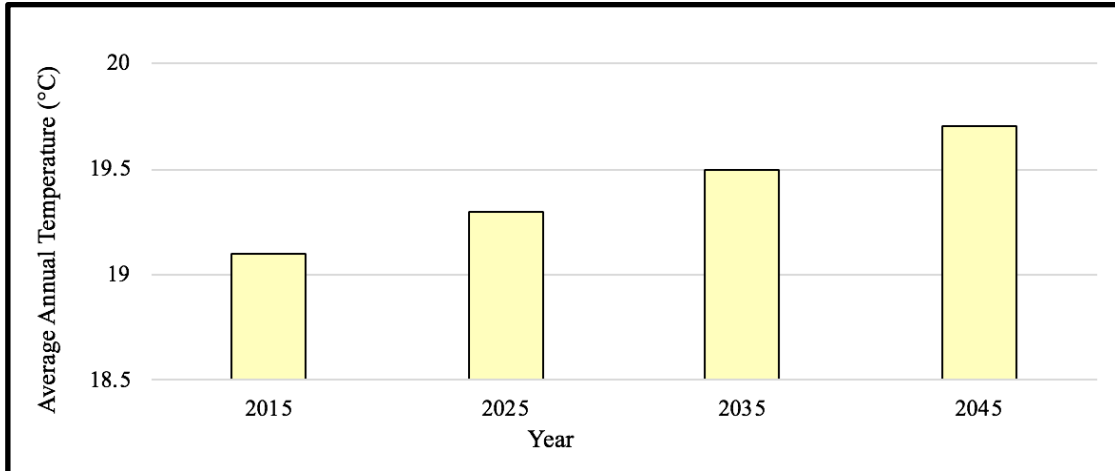


Figure 2: Projected Increase in Average Annual Temperature in Greece, 2015 to 2045 (Georgakopoulos, 2017)

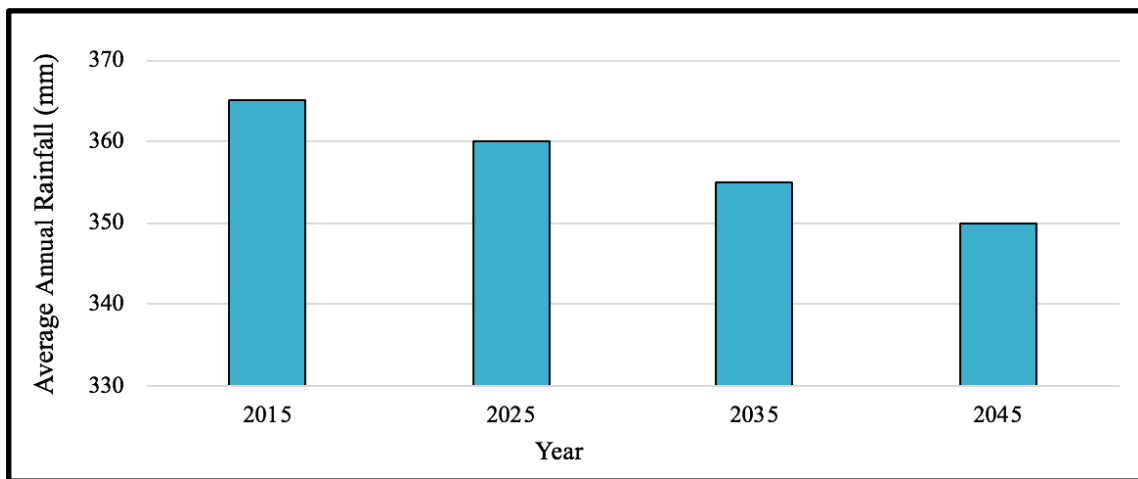


Figure 3: Projected Decrease in Average Annual Rainfall in Greece, 2015 to 2045 (Georgakopoulos, 2017)

Agriculture and tourism represent Greece's largest sources of income and are estimated to be strongly affected by future climate change conditions (Giannakopoulos, Kostopoulou, Varotsos, Tziotziou, & Plitharas, 2011). There is an estimated 1% decrease in overnight stays in the country for the 20-year period of 2045-2065, resulting in an €825 million revenue loss for the tourist industry annually (Georgakopoulos, 2017). 90% of tourism infrastructures are located on the coast and 3.5% of this land is estimated to be lost due to rise in sea levels (Georgakopoulos, 2017). Many Greek citizens also rely on agriculture as a source of food and income and if rainfall indices continue to decrease, soil will become drier and Greece will not be able to

produce as high-quality wine and other products as they previously could (Georgakopoulos, 2017).

2.1.2 Urban Resilience in Greece

One important aspect of climate change is urban resilience. In general, urban resilience is defined as the ability of a city or urban system to withstand a wide array of shocks and stresses, such as climate change (Leichenko, 2011). In order to be resilient and withstand shocks and stresses, cities use persistence, transition or transformation (Meerow, Newell, & Stults, 2016). Persistence refers to resisting disturbances and trying to maintain the current state, transition refers to incrementally adapting to shocks and stresses and transformation refers to radical changes in response to these shocks and stresses (Meerow et al., 2016).

There are many strategies to create climate change resilience in an urban community such as Thessaloniki, the second largest city in Greece (Thessaloniki, 2018). These strategies include integrating energy efficiency in municipal buildings, bioclimatic designs and microclimate improvements in open spaces, and alternative means of transportation (Frantzeskaki, 2016). Thessaloniki recently joined the network of “100 Resilient Cities” with the goal of implementing policies to help the city prevail with the adversities of climate change and develop its economy and culture in a sustainable way (Thessaloniki’s Resilience Challenge, 2019). Recently, the city released the 2030 Resiliency Plan which focuses on implementation plans for projects and policies centered around United Nations Sustainable Development goals.

2.1.3 Individual and Collective Contributions to Climate Change

Individuals can have a direct impact on climate change by becoming aware of their actions, identifying how climate change affects them and recognizing climate change mitigation strategies (Georgakopoulos, 2017). In this section we discuss the impacts of climate change on individual citizens, the effects of individual citizens on climate change and climate change mitigation strategies.

Previous studies have presented evidence on the contributions climate change has on vector borne and other infectious diseases (Haines et al., 2006). Not only is climate change negatively impacting the environment, but it is also affecting the public health of citizens; the burning of fossil fuels promotes the greenhouse gas effect, which results in air pollution

increases (Georgakopoulos, 2017). Air pollution, temperature increase, extreme weather events and lack of agricultural and economic resources are going to continuously impact each citizen individually.

A prevalent issue impacting climate change globally is food waste (Abeliotis, Chroni, Costarelli, & Lasaridi, 2015). To make food, there is an involved operation; first the food is produced, then processed and transported to its designated location then refrigerated if needed and cooked; each individual step burning fossil fuels (Abeliotis et al., 2015). In Greece it is estimated that 100 kg of food is wasted per person annually, 30 kg being avoidable (Abeliotis et al., 2015). Typically, this waste is categorized as “organic waste,” which, when decomposed, releases carbon dioxide and methane gas into the atmosphere, increasing levels of greenhouse gases (Abeliotis et al., 2015). Individuals can make a positive impact by making slight changes in their daily lives such as buying only essentials when grocery shopping or eating leftovers from the night before.

Climate change is directly influenced by the behavior of each individual citizen within a given region (Georgakopoulos, 2017). Individual citizens can make minor adjustments in their daily routines to help mitigate climate change (Georgakopoulos, 2017). Reducing the emission of greenhouse gases is one way to mitigate climate change (Haines et al., 2006). Many transportation vehicles burn fossil fuels, so citizens that utilize these forms of transportation are contributing to worsening the climate (Haines et al., 2006). Recent studies have demonstrated that converting to vehicles powered by hydrogen and other renewable energy sources could save 3700-6400 lives annually by reducing air pollution (Haines et al., 2006). Although not feasible for all citizens, identifying alternate methods of transportation will lessen the amount of dangerous gases being emitted into the atmosphere, decreasing mortality rate and the presence of infectious diseases within a region.

2.2 Educating Citizens about Climate Change

As the climate is changing, it is becoming more important to educate citizens about the effects of climate change and what they can do to help (Rueckert, 2019). “Increasing education can improve the overall health and longevity of a society, grow economies, and even combat climate change” (Rueckert, 2019). In this section, we discuss the benefit of identifying students’ current educational levels and explain effective education strategies.

2.2.1 Identifying Students' Current Knowledge

Education should incorporate both the students' prior knowledge as well as new information. A climate change study conducted in Greece in 2010 presented a list of 22 statements in which 8th and 11th grade students answered "agree," "disagree" or "N/A." Analyzing the results, it became apparent that although a portion of students were knowledgeable on the topic, there was still a significant number of students who were unaware of particular causes, effects and solutions of climate change. For example, about 43% of 8th graders either disagreed or did not answer the statement "the average global sea levels have risen in recent years" (Athanasia et al., 2010). Rising sea levels are a threat to Greek citizens as 30% live within 2 km from the coast (Georgakopoulos, 2017). The study identified the concern that students may be uneducated about certain effects of climate change that directly affect them.

Additionally, the study represented a concern involving climate change prevention. For example, 51% of all students either disagreed or did not answer the statement "solar energy does not exacerbate the greenhouse effect" (Athanasia et al., 2010). Greek students learn about solar energy in school and this percentage was inconsistent with the amount of solar energy education they are presented with in class (Athanasia et al., 2010). The study demonstrated that students might not have sufficient knowledge about how climate change effects can be mitigated.

Identifying the current knowledge of students on particular topics will enhance the ability to effectively educate them (Green Teacher, 2005). As displayed throughout the previously described study, a large portion of students may be unaware of particular climate change topics and mitigation strategies. As a result, identifying the knowledge of students prior to developing an educational curriculum will increase the lesson's effectiveness. Education should touch upon both current knowledge on a particular topic as well as new information, to increase success (A. Crocker, personal communication, January 26, 2019).

2.2.2 Climate Change Education Strategies

Previous research confirms a need for new models of climate change education as these strategies have not been innovated in many years and students have shown significant misconceptions about climate change topics (Cordero et al., 2008). Educational strategies must

spark interest in the students, teach them memorable lessons and encourage them to make a difference in the world (Green Teacher, 2005). An improved understanding of students' ideas and how they are developed can lead to better instructional methods and ultimately enhance the public's understanding of science (Cordero et al., 2008).

Catering strategies towards topics that directly relate to each student and their everyday lives will optimize educational potential (A. Crocker, personal communication, January 26, 2019). For example, demonstrating the estimated agricultural food reduction in an area, such as olive oil production, helps create relationships between personal experiences and education. A study concluded that “effective climate change education should emphasize the personal connection between the student, energy, and climate change using active learning methods” (Cordero et al., 2008). Emphasizing the connection between students and distinct climate change topics will support educational effectiveness.

2.3 Using Serious Games for Climate Change Education

Serious games are digital or hands-on games not intended to be played solely for amusement (Göbel et al., 2018). Serious games are educational tools that teach various topics such as teaching and training, social inclusion, health, digital transformation and many other societal issues (Mouaheb, Fahli, Moussetad, & Eljamali, 2012). In this section we discuss the benefits of serious games and hands-on games as a form of education with a game example.

Having fun while learning helps students remember information better because it is a memorable learning experience (“Teacher's Corner: Making Learning Fun.,” 2016). In a case study conducted by Stege, Van Lankveld and Spronck (2011), students played a digital serious game and results helped researchers conclude that serious games transfer knowledge better than textbooks. The students also enjoyed the game as 79% of them said they would like to play similar games more often.

2.3.1 The Benefits of Hands-On Games

Serious games are divided into two categories: digital and hands-on games. In this section, we discuss the benefits of hands-on games specifically. We discuss the educational benefits associated with hands-on serious games, explain the social benefits and discuss the accessibility of hands-on serious games.

A recent study conducted by Rahman, Sahrir, Zainuddin and Khafidz (2018) found that hands-on serious games can be both engaging and educational. The study was based on a Malaysian hands-on educational board game called Global Zakat Game, a game that teaches people about Zakat, the obligation that an individual has to donate a certain mandatory amount of money each year to charitable causes (Rahman, 2018). The students in the study were asked to answer a set of ranking questions. Students reported a high level of interest in playing the board game and a high desire to play again. After the game, students also demonstrated high levels of knowledge of the game topic.

Hands-on games teach children about important social skills and are easily accessible (Göbel et al., 2018). Education through games provides an experiential learning environment which lets students learn by doing rather than by lecture, triggering influential emotional connections (Green Teacher, 2005). “The best education is one that is sensory-rich, emotionally engaging, and linked to the real world” (Green Teacher, 2005). Serious games provide the best of both worlds by being fun, interactive and engaging while still educational. Hands-on games are also extremely accessible as the only resources required are what the games include, such as game pieces and facilitation tools. Due to their accessibility, hands-on serious games are able to reach a wide audience and impact many students (Göbel et al., 2018).

An example of a hands-on serious game is “Sinking Island” from the Red Cross Red Crescent Climate Centre (Red Cross Red Crescent Climate Centre, n.d.). In this game, participants are divided into groups of 4-5 players. A piece of paper is placed on the floor and the facilitator tells the players that the paper symbolizes an island affected by sea level rise. The players have 10 seconds to all fit on that one sheet of paper, as seen in Figure 4. The teams who are all on the paper at the end of the 10 seconds move on to the next round. The sheet is then folded smaller and the team must again fit on that paper within 10 seconds to move on to the next round. The paper continues to get smaller each round until there is one team left standing. After the game is completed, the facilitator conducts a debriefing session to make sure that the participants understand what they just learned about rising sea levels and land reduction.



Figure 4: Sinking Island Game

2.3.2 Serious Game Design Process

There are three steps in designing a serious game; pre-production, production, and post-production, as displayed in Figure 5 (Ryerson University, n.d.).

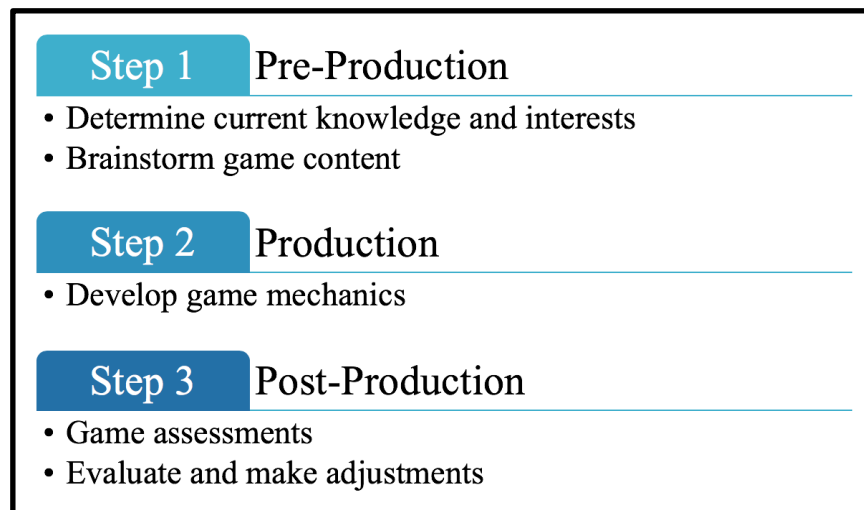


Figure 5: Steps in the Game Design Process

The pre-production step encompasses the brainstorming of game content and educational topics covered (M. Sharma, personal communication, February 4, 2019). The creation of any successful serious game begins with developing a vision (Designing Digitally, Inc., 2017). The vision works to achieve the game's overall goal and illustrates what the game should accomplish. The next phase of pre-production is identifying the audience. As explained by Monty Sharma,

the director of MassDiGI at Becker College, “Kid are not kids,” meaning all kids have different learning abilities, maturity levels and experiences. For younger audiences, serious games have the potential to be seen as “chocolate covered broccoli” (M. Sharma, personal communication, February 4, 2019). Covering anything in chocolate does not instantly make it better, similar to calling something a game when its purpose is to be educational. It is beneficial to limit the extent of educational purpose in each game by assuring that students have fun while learning.

The next step of the design process is production which includes the development of game mechanics, or how the game is set up and how it works (D. O’Donnell, personal communication, February 4, 2019). Serious games should include continuous challenge, flexibility and simplicity, promoting discovery and enjoyment (Green Teacher, 2005). Game mechanics should support game content (M. Sharma, personal communication, February 4, 2019). For example, complex content such as the relationship between climate change and economics should involve complex mechanics such as a card game, which incorporates distinct strategy and decision making. Students will react differently to various game designs; implementing alternative game mechanics will enhance the ability to positively impact each student.

The final step of the process is post-production which includes the evaluation of each game design. Evaluations can be done by filling out questionnaires, holding debriefing sessions, conducting interviews, and many other creative means of gathering feedback (L. Dodson, personal communication, February 7, 2019). Multiple sources of feedback are valuable and may include observing participants’ engagement in addition to assessing their learning. Having a set of feedback and suggestions provides the information needed to make adjustments to game designs.

2.4 The Environmental Education Centre of Eleftherio-Kordelio

The Environmental Education Centre of Eleftherio-Kordelio (KPE) is located in Thessaloniki and was established by the Ministry of Education in cooperation with the Municipality of Eleftherio-Kordelio (The Environmental Education Centre, n.d.). KPE focuses on educating schools and local communities about the environment and sustainable development (The Environmental Education Centre, n.d.). Their vision, displayed on their website, is represented in Figure 6.

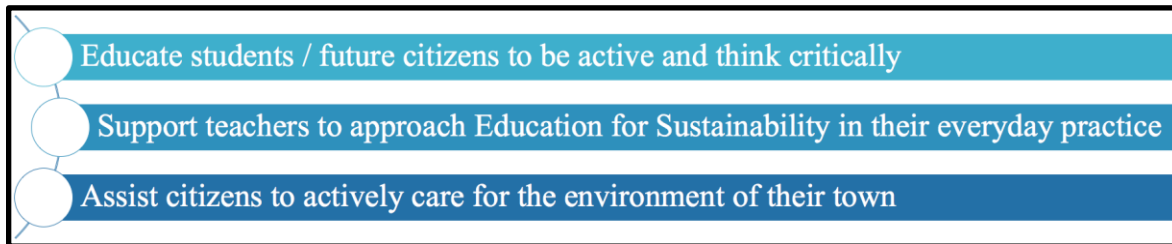


Figure 6: Vision of the Environmental Education Centre (The Environmental Education Centre, n.d.)

Throughout this section we discuss KPE as an organization and the goals they work to achieve when educating students about climate change.

Students of all ages visit KPE on a voluntary basis, outside their regular curriculum. KPE presents an opportunity for students to learn about pressing issues related to climate change, including mitigation and urban resilience strategies. In addition, KPE offers many educational programs about the environment including the following:

- Thessaloniki – Sustainable city
- Open spaces and the urban green
- Energy: from nature to society
- Sustainable water management
- Rubbish in everyday life

More specifically, the climate change program involves a series of presentations and interactive exercises to educate students about various aspects of climate change. Some sub-topics of the program include the greenhouse effect, energy and natural disasters. In addition to hosting programs, KPE also provides teacher training, completes research in the field and organizes workshops, seminars and events (The Environmental Education Centre, n.d.). The KPE staff is composed of five experienced science educators and collaborates with organizations, centres and authorities often (The Environmental Education Centre, n.d.).

3.0 Methodology

The goal of this project was to develop serious games about climate change as resources for Greek educators, specifically for the Environmental Education Centre of Eleftherio-Kordelio (KPE). The target audience for the games was 13-15-year-old Greek students. Since aspects of

this project involved children under the age of 18, we considered issues of consent and privacy. Our procedures were approved by the WPI Institutional Review Board (see Appendix D for details). The study was broken up into a series of objectives listed in Figure 7.

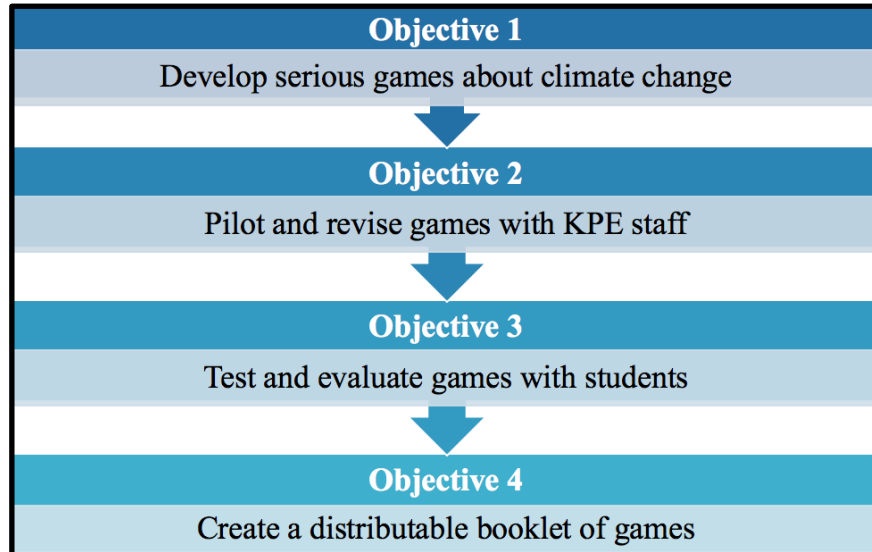


Figure 7: Project Objectives

A variety of methods were implemented to achieve these objectives. This chapter explains the application and execution of each project objective.

3.1 Objective 1: Develop Serious Games about Climate Change

We developed serious game designs by selecting game content and game mechanics. Throughout this section, we discuss the steps taken to develop games. Figure 8 shows the research questions that guided the evolution of our game content and mechanics.

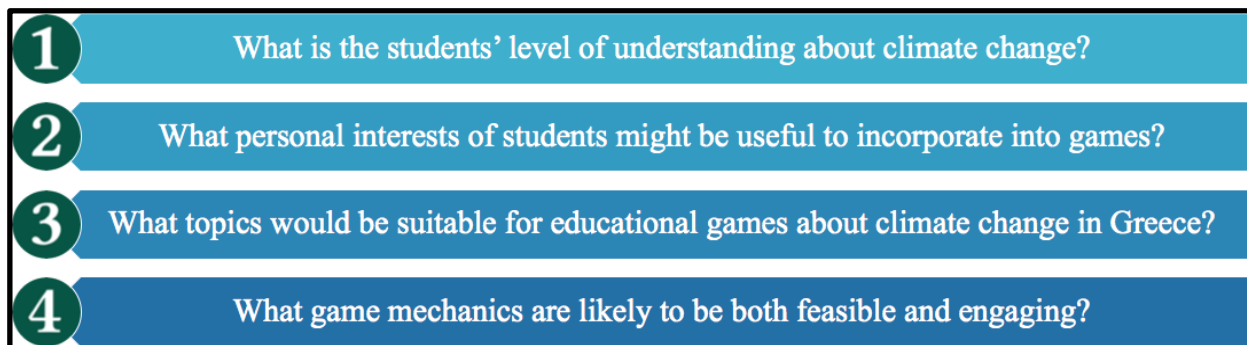


Figure 8: Objective 1 Research Questions

3.1.1 Identify Game Content

A game's content is the educational topic and amount of information presented in the game. Games are more successful when the content builds off of students' prior knowledge and interests (A. Crocker, personal communication, January 26, 2019). We examined the current climate change knowledge of students by implementing a variety of methods: a survey, observations and embedded assessments. The survey, shown in Appendix A, is composed of ten true or false statements and two short answer questions, touching upon numerous climate change topics, personal interests and experiences. The survey is composed of original and adapted questions from a prior study of the climate change knowledge of Greek students (Athanasia et al., 2010). The survey was written in Greek. Eleni Anastasopoulou, a graduate student studying Geology at Aristotle University and our co-researcher, translated all of our work from English to Greek throughout the project and translated students' responses during debriefing sessions. We distributed and facilitated the survey with the help of the KPE staff prior to testing the games. We analyzed survey responses using Google Forms result analysis to understand students' views on climate change and identify knowledge gaps. Gaps in knowledge then served as ideas for game content.

We also observed students play existing KPE games facilitated by experienced staff. We observed what game topics students enjoyed learning about. We used the observation data to inform choice of effective game topics; topics were catered towards what the students did not know, briefly touching upon their pre-existing knowledge and experiences.

3.1.2: Determine Appropriate Mechanics to Pair with the Content to Develop Games

We used two methods to identify effective game mechanics: interviews and observations. We interviewed serious game experts to understand the game mechanic design process, identifying how to appropriately pair game mechanics with content. In addition, we focused on understanding the relationship between game mechanics, student engagement and knowledge propagation. We also referenced the Red Cross Red Crescent Climate Centre website and other sources to obtain game mechanic examples. We adapted previously developed game mechanics by implementing established climate change content topics identified in Section 3.1.1.

Next, we conducted student observations (Fermilab, n.d.). We aimed to identify the game mechanics students enjoy playing at KPE. We gathered observational data throughout our first week at KPE and continued doing so throughout the term in order to obtain a larger data set.

3.2 Objective 2: Pilot and Revise Games with Environmental Education Centre Staff

We piloted the serious games with the KPE staff to get their insight regarding the research questions represented in Figure 9.

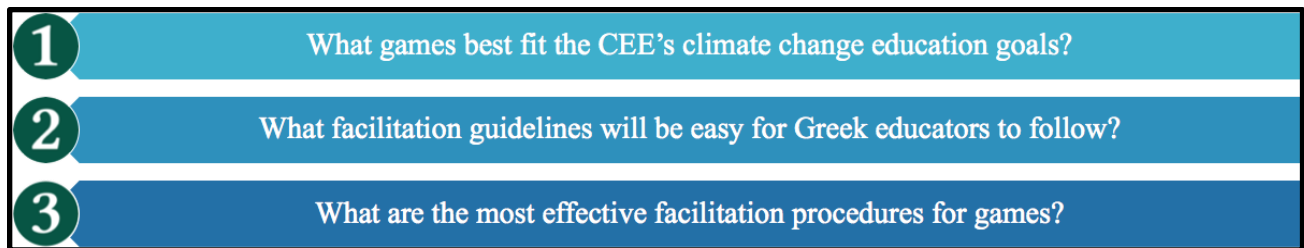


Figure 9: Objective 2 Research Questions

Using the game development process previously described, we developed some original games and adapted games from other sources, with a range of content and mechanics. We then collaborated with the KPE staff to determine how to effectively facilitate the games. We relied on the feedback to make improvements before executing the games with the KPE students.

We reviewed and discussed each serious game with the KPE staff prior to playing them with students. We identified the game's objectives, required materials, facilitation guidelines and post assessment questions to fully portray the game's purpose and procedures. The KPE staff then provided feedback and suggestions for improving the games. Feedback included facilitation tips, adjustments to mechanics, and changes in content and post-assessment improvements. This aimed to increase educational value, student engagement and understanding.

3.3 Objective 3: Test and Evaluate Games with Students

We completed a full evaluation of the tested games and made necessary adjustments. The evaluation process consisted of surveys, post-game assessments and observations to see how effectively the games reached our goals and how they could be improved. Altogether, we tested

6 games with 185 students over a period of 7 weeks. Some games were evaluated only once while others were refined over multiple iterations. In this section we discuss the embedded assessments we created, the debriefing sessions with the KPE staff and the observations collected. Figure 10 includes research questions that collectively addressed this objective.

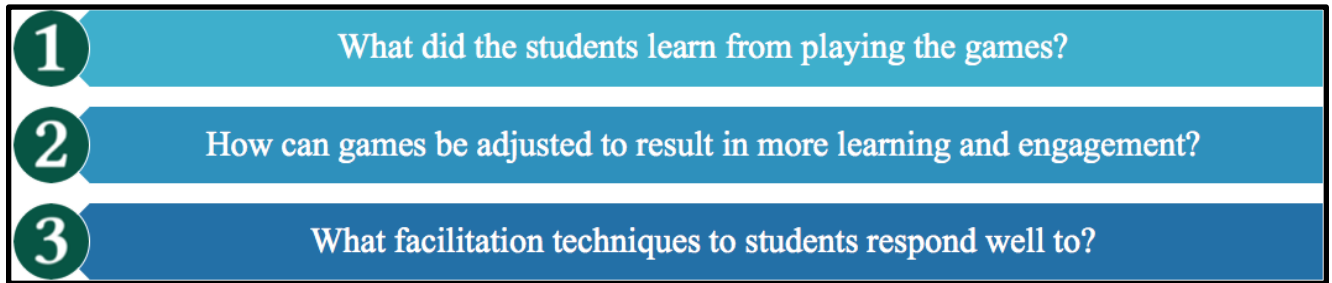


Figure 10: Objective 3 Research Questions

3.3.1 Embedded Assessment

Post-game assessments were created to evaluate game effectiveness and distinguish advantageous strategies to assess current knowledge in a fun and engaging way. After a game was played, we implemented the post-game assessment that consisted of questions to make the students reflect on what they learned while playing and help us determine how much they learned. An example of questions asked for a game focused on sea levels rising is shown in Figure 11.

Did you have fun while playing this game? If so, what was your favorite part? If not, what didn't you like?

Are sea levels rising?

What did you learn about the effects of sea levels rising that you didn't know before?

What actions can you take to slow the rising of sea levels?

Figure 11: Sea Level Post-game Assessment

The post-game assessments gave KPE students the opportunity to demonstrate what they learned from playing the games. We often facilitated these assessments with the help of the KPE staff. We used the assessment results and feedback to improve the games.

3.3.2 Debriefing with the Environmental Education Centre Staff and Group Observations

We participated in debriefing sessions with the KPE staff to discuss the outcomes of the games after they were played. The responses from the post-game assessments were communicated to us to help us determine how successful the games were. The KPE staff also gave us any other feedback they or the students had for us in regard to the games. We then implemented their feedback and made any other necessary adjustments to the games and/or facilitation guidelines.

In addition, we observed the students play games and made adjustments to fit their needs and desires. We recorded observational data into a table, represented in Appendix B. Observational data was recorded throughout the facilitation of each game, included in Appendix C. The game evaluation process consisted of analyzing game mechanics and content. We aimed to educate students and empower them to enact positive change. The main aspect we sought when evaluating the games was recognizing how much the students learned when playing.

3.4 Objective 4: Create a Distributable Booklet of Games

The deliverable of this project was a booklet comprised of serious games about climate change that could be distributed to and used by KPEs throughout Greece and other Greek educators. In order to design the booklet content and features, we considered the following questions represented in Figure 12.

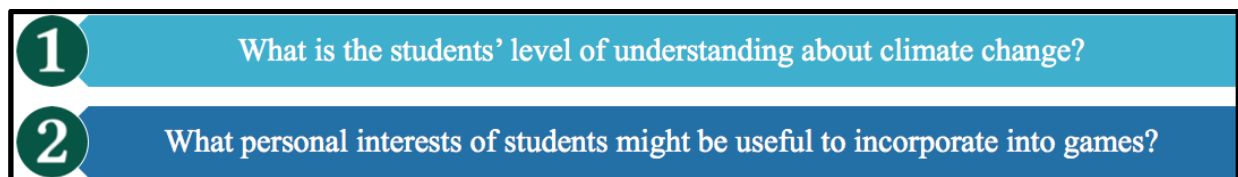


Figure 12: Objective 4 Research Questions

To make these decisions we followed a process that included a series of discussions with staff and a procedure of drafting, feedback, and revision. We also looked at other examples of

booklet resources for educators. The serious game designs in the booklet are a compilation of games we developed, adapted games from various resources and KPE's original games. The booklet also includes brief explanations of particular climate change topics. We included serious game designs approved by the KPE staff as they were the primary audience of the booklet. The booklet contains a series of 14 climate change serious games, 6 of which have been tested successfully with students at KPE; each game includes additional features listed in Figure 13.

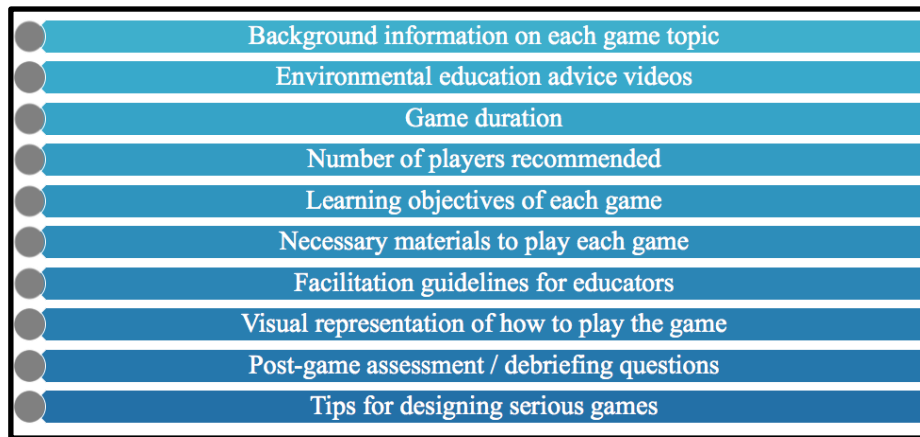


Figure 13: Booklet Features

4.0 Decisions about Climate Change Serious Game Design and Facilitation Strategies for the Greek Context

In this chapter we present decisions made and lessons learned when deciding game content, mechanics and facilitation strategies. We first reveal our findings that led to the game content development by identifying the goals of the Environmental Education Centre of Eleftherio-Kordelio (KPE) and the current knowledge of a sample of Greek students between the ages of 13 and 15. We discuss knowledge gaps and similarities of tested students. Next, we demonstrate the findings that resulted in game mechanic and facilitation strategy development. These findings assisted in the serious game development process, identifying effective facilitation strategies and appropriate game adjustments.

4.1 Decisions about Game Content

The Environmental Education Centre prefers games that focus on climate change causes and impacts, resilience and mitigation strategies. KPE's preferences were communicated to us through interviews and meetings. KPE also wants to incorporate games that relate directly to their students such as specific resilience plans for the city of Thessaloniki.

Students demonstrated a strong understanding of certain climate change topics. Based on the survey results of the 126 tested Greek students at KPE, more than 85% of tested students demonstrated an accurate understanding of the effects of climate change on:

- Farming and food production
- Sustainable energy
- Extreme weather events
- Habitats of other species

The details of students' responses to these questions are shown in Figure 14. It is important to note that students choose to attend programs at KPE voluntarily and thus are likely to have pre-existing interests in and knowledge of environmental issues. These findings do not reflect the full population of Greek students. Nevertheless, we found these results useful when selecting game content.

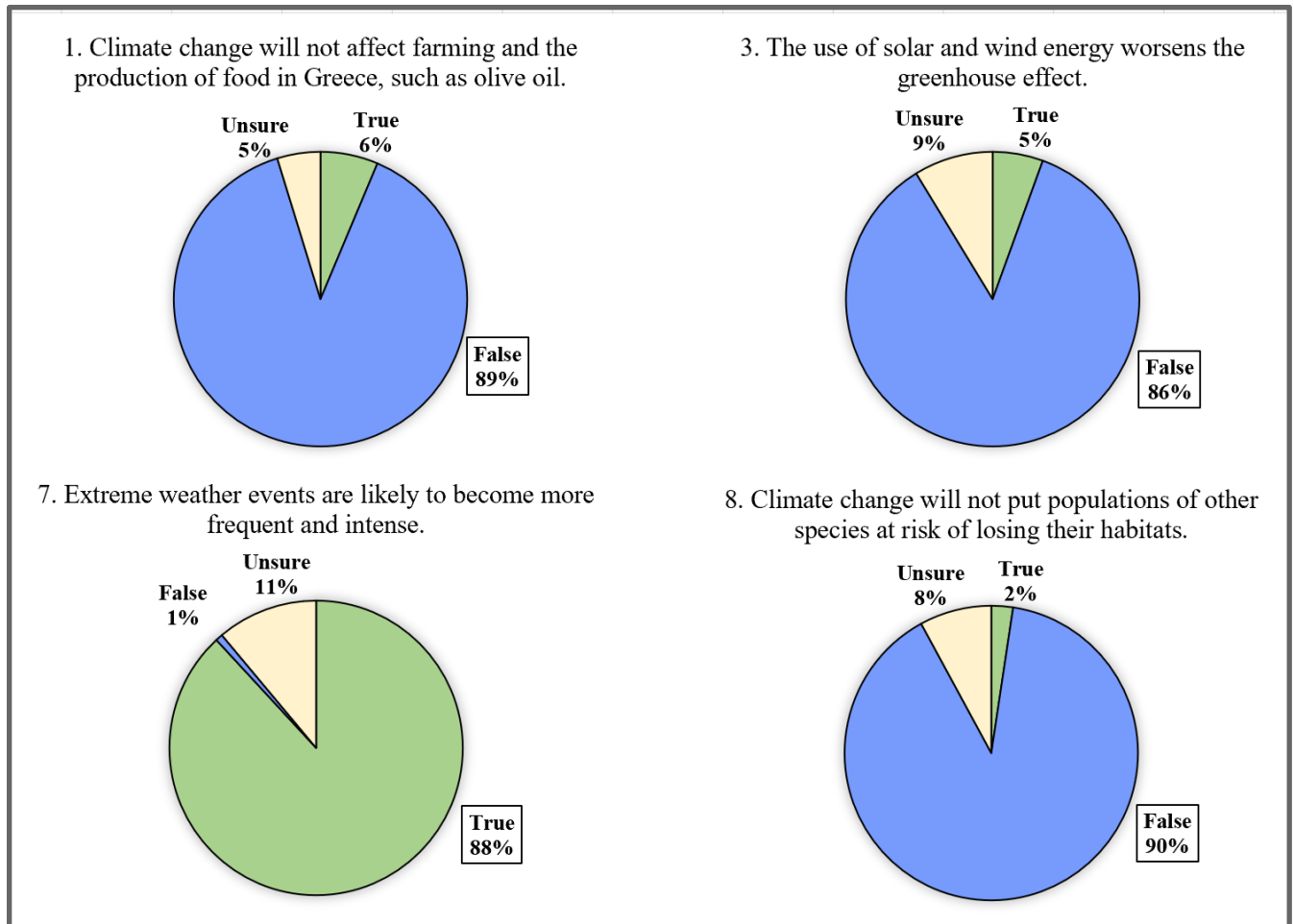


Figure 14: Examples of Accurate Climate Change Knowledge Amongst 126 Tested Students Before Completion of KPE's Program

Students demonstrated a misconception or knowledge gap about other climate change topics. Based on the survey results of the 126 tested students at KPE, about 50% of them did not demonstrate an accurate understanding of the following topics:

- CO₂ contributions to the greenhouse effect
- Changes in habitable land
- Public transportation as a climate change mitigation strategy
- Changes in cost of living

The details of students' responses to these questions are shown in Figure 15.

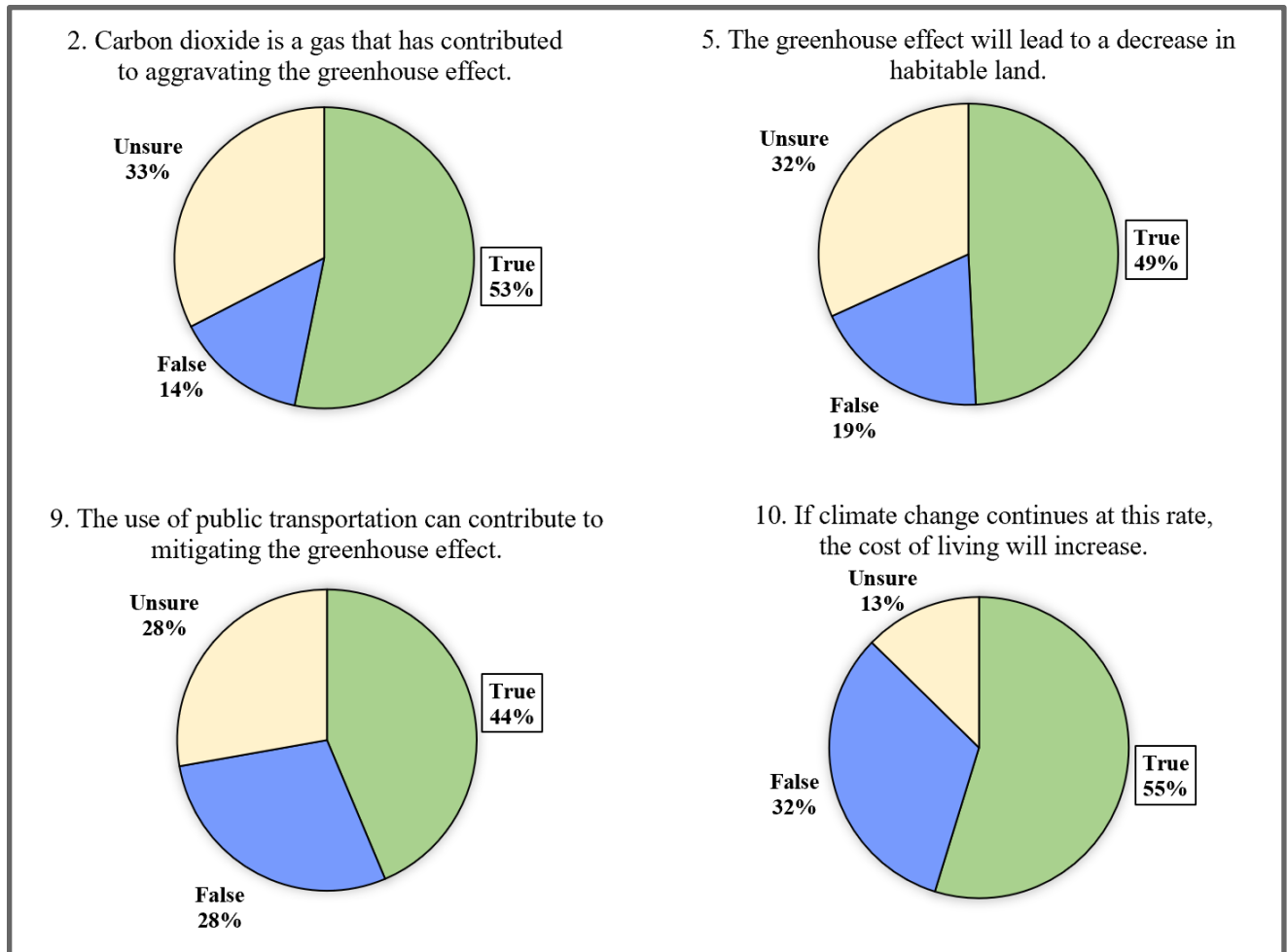


Figure 15: Examples of Climate Change Knowledge Gaps Amongst 126 Tested Students before Completion of KPE's Program

We made decisions about game content using the combination of KPE's goals and findings from the pre-knowledge survey. We incorporated the students' pre-existing knowledge topics in games to teach new topics. For example, in a game called "Before the Storm," a card game that addresses extreme weather events and preparation, students discuss extreme weather events, a topic that they have shown they understand, and learn about resilience strategies that they can use to prepare for those extreme weather events. We also incorporated climate change topics students did not demonstrate an understanding of into games to expand student knowledge. For example, a game called "Traffic Jam" was developed to increase students' knowledge on the benefits of public transportation, as survey results showed a knowledge gap for that subject.

4.2 Lessons Learned about Game Mechanics and Facilitation Strategies

Our experience observing and facilitating games reinforced several principles that are important for educational games. In this section we discuss the importance of relating game content to its intended audience, reveal game facilitation findings and strategies and identify preferred game mechanics.

Games were more effective when presented in a specific Greek context. This was shown in a game called *Sinking Island*, where students learn about rising sea levels and the importance of teamwork and strategy. During the first facilitation of the game, we instructed students to imagine that they were on an Arctic island. During the debriefing session, the majority of students shook their heads “no” when asked if rising sea levels were affecting Greece, one student said, “rising sea levels will not affect Greek islands for another 100 years.” To relate to our audience, the game was adjusted; students were told to imagine that they were on a Greek island. The next time the game was played, the majority of students answered “yes” when asked if Greece is affected by rising sea levels. One student responded “ummm, yes of course!!!” as if that question should not have been asked. We worked to apply this finding to future games designs. It is important to note that we received specific evidence of learning from a small portion of students who answered questions during debriefing sessions.

Game instructions must be detailed and provide clear examples for students. By collaborating with KPE staff and observing students, we gained insight on game facilitation. Facilitation is effective when game instructions are acted out and explained in detail. For example, when facilitating a game called *Survivor*, students turned to their neighbors and teachers for clarity after the instructions were explained but were unclear on how to play until we demonstrated examples. We played a practice round in front of students and in response they expressed that they fully understand the game.

Greek students enjoyed short games that involve competition, physical action and teamwork collaboration. When playing the games *Sinking Island* and *Survivor*, students became active and competitive, engaging with each other and the game as a whole. According to one of the students, “We are in the process of growing up, but we still love to play games.” We also noticed that students became unengaged when game durations took longer than 20 minutes. In the first test of a game called *Answer with your Feet*, students became uninterested; game

discussions took too long and physical activity was limited. Adjustments were made to the game to satisfy the insights gained through student observations. We spent less time discussing answers and more time playing the game; students became more engaged and excited to continue playing. Students were also more engaged when the game was played with fewer rounds; 6 rounds as opposed to 10.

5.0 Serious Game Designs

Our team developed and adapted a variety of serious game designs to be implemented at the Environmental Education Centre of Eleftherio-Kordelio (KPE) and educational facilities throughout Greece. These serious games focus on climate change causes and impacts, resilience and mitigation strategies. In this section we present a summary of the serious games developed and adapted for the Greek context. We also discuss the reasoning for developing a serious game booklet.

5.1 Descriptions of All Created and Adapted Serious Games

This section explains each adapted and developed serious game design that was tested at either KPE or the American Farm School. We also discuss the adapted and developed games we were unable to test and describe the goals of each game. Last, we describe the games previously implemented at KPE that are presented in the serious game booklet.

5.1.1 Serious Games that Were Tested with Greek Students

The games tested at KPE and the American Farm School are briefly described below:

Answer with your Feet: Students reflect on their existing climate change knowledge and daily actions. A variety of climate change questions are presented to students; questions are answered by moving to a specified area of the room, to indicate either “agree,” “disagree,” or “unsure.”
(Adapted from Red Cross Red Crescent)

Before the Storm: Students are presented with a card game about extreme weather resilience plans; they have to make decisions and compete with one another. One student represents the “judge” and the remaining students work to select the best “action card” to pair with a climate change forecast. The student with the best “action card” or resilience plan receives a point. Students typically play numerous rounds. (Adapted from Red Cross Red Crescent)

Connecting Dots: Students are presented with a climate change effect (e.g. heavy rainfall). Students identify stakeholders that are affected by heavy rainfall (e.g. agriculture). The remaining students try to point out a stakeholder affected by a previously existing stakeholder (e.g. food production). Each time a connection was made, students were asked to hold a string that connects the stakeholders. At the end of the game, the string was pulled to represent the connection between all climate change events and stakeholders identified. The game can be played in a variety of ways (e.g. drawing on a poster board) with different stakeholders (e.g. emergency resources and citizens).

Sinking Island: Students learn about rising sea levels and the importance of teamwork and strategy. Students are split into groups of four/five; each group represents a village of people on a sinking Greek island (standing on a piece of paper). Groups compete to stay on their island (paper); each round the island is folded smaller, which represents the passing of ten years. (Adapted from Red Cross Red Crescent)

Survivor: Students learn about the importance of resilience planning and working together. Students are presented with four different climate change weather events where they had to perform a specific physical action. Some actions require teamwork, others are individual. Each time an event “occurs” the students have to undergo its designated action. Each round students get out; the last student standing is named the “survivor.”

Traffic Jam: Students simulate traffic and carbon emissions associated with transportation. Students are split into three groups: bikes, cars, and a bus. Each group represents a different carbon emission and are assigned a point value; bike = 0, car = 1 and bus = 2. Six to eight students can fit in one bus while only one student can fit in a car or on a bike. Points are

calculated to demonstrate what vehicles have the highest carbon emission and the benefits of public transportation.

5.1.2 Serious Games that Were Not Tested with Greek Students

Ort Report: This game aims to educate students about food waste and its effects on climate change. Students are broken up into teams of 6-8 people during their lunch or snack times; teams compete against one another to produce the least amount of waste. The team with the smallest amount of food waste wins and receives an incentive (i.e. being first in line to move to their next class), the team who produced the most waste has to undergo a “punishment” (i.e. cleaning up the lunch room). (Adapted from Nature’s Classroom)

Extreme Weather Tag: The objective of this game is to educate students about extreme weather events and the impacts they can have on people. One student is selected as the “tagger” and represents an extreme weather event. The tagger aims to tag each student; when a student is tagged they must link arms or hold hands with the tagger and join in acting as the extreme weather event together. The goal of the game is for every student to link arms and demonstrate the intensity and detrimental effects of extreme weather.

Race for Resilience: The topic of this game aims to educate students about climate change causes, impacts, resilience and mitigation by going through an obstacle course relay race. Students answer questions, come up with examples and undergo different activities in each obstacle to expand their knowledge.

Cause and Effect Card Game: This game aims to educate students about climate change causes, impacts and mitigation strategies. They play a game similar to “go fish” and match climate change causes with their designated impacts and mitigation strategies. (Adapted from education.com)

Survival of the M&M’s: This game aims to educate students about resilience planning and rationing resources in the case of a disaster. Students are given colored M&M’s to represent

different resources and various disaster events. Students must decide which resources to use and which to save, demonstrating that resources must be rationed in case of an unexpected event.

Hop ‘til you Drop: This game aims to educate students about climate change impacts, resilience and mitigation. Students follow a designated path by answering questions about climate change impacts, resilience plans and mitigation strategies. When students correctly answer questions, they advance to the finish line quicker.

5.1.3 Pre-existing Environmental Education Centre Games in the Serious Game Booklet

Find Someone Who: Find Someone Who encourages collaboration and teamwork while students work to find classmates that follow certain criteria. Every student is given a statement that is relevant to climate change or sustainability and must find 3 students that follow that statement. They ask each other interview questions and fill in a sheet of paper. For example, one statement is “Find someone who uses the stairs instead of the elevator” and the students ask their classmates “why do you do this?” and “how do you feel about this?”

Greenhouse Gas Effect: The Greenhouse Gas Effect game aims to educate students about the greenhouse gas effect in a fun and interactive way. Students are split up into groups: one student is the Earth, 6-8 students are CO₂ and the rest of the students are sunlight. Students demonstrate sunlight being trapped in the ozone layer by CO₂, causing the Earth’s temperature to increase.

5.2 Serious Game Booklet

As the deliverable for our project, we created a distributable serious game booklet (shown in Appendix E) to comply with the needs of KPE in hopes of having a lasting impact on Greece. After a series of conversations with the KPE staff and review of other resources for educators, we made the following decisions about booklet features and organization:

Symbols to Indicate Climate Change Topics: The booklet incorporates a set of four climate change topics: climate change causes, climate change impacts, resilience strategies and mitigation strategies. Each topic is represented by a distinct symbol, represented in Figure 16.

Every serious game includes a climate change lesson on at least one of these topics and is presented with its designated symbol. Urban resilience and adaptation have recently emerged as significant climate change education topics for KPE. For this reason, we included “resilience strategies” as a main topic throughout the booklet.



Figure 16: Climate Change Topic Booklet Symbols

Information about Climate Change for Greek Educators: The booklet provides a brief explanation of each climate change topic described above. This will aim to provide educators with background information they may not be previously aware about.

Complete Game Descriptions: Every game design includes a descriptive representation of all game objectives, facilitation guidelines, and debriefing questions, represented in Figure 17. Game descriptions also include game duration, number of players, preferred space and facilitation difficulty, represented as symbols shown in Figure 18. Facilitation difficulty refers to the level of facilitation experience recommended to facilitate the designated game on a scale of 1 to 5. The game objectives identify the intended lessons within the game. Facilitation guidelines contain a series of instructions for facilitators to conduct the game. Last, debriefing questions aim to help facilitators recognize student knowledge expansion and enjoyment. Complete game descriptions work to increase student and facilitator understanding.

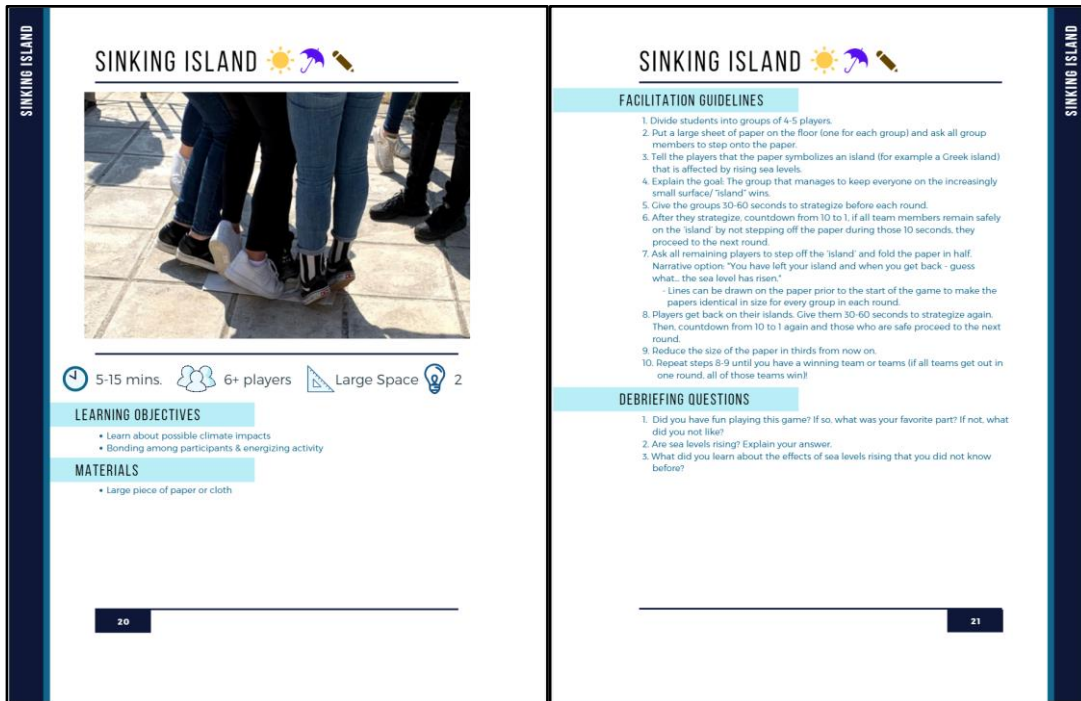


Figure 17: Sinking Island: Example of a Serious Game in the Booklet



Figure 18: Aspects of Game-play Booklet Symbols

Game Materials: The booklet includes a complete outline of all material designs and complexities. When playing the game *Sinking Island* for the first time, students were confused on how to fold the paper or “island” between each round, which represents the decrease in habitable land. Game adjustments included marking the spots to be folded on each paper or “island.” As a result, students had more time to focus on their strategy. A picture of how the paper should be marked is included in the booklet, represented in Figure 19, as well as additional game examples and materials. This will aim to increase facilitator success and game effectiveness.

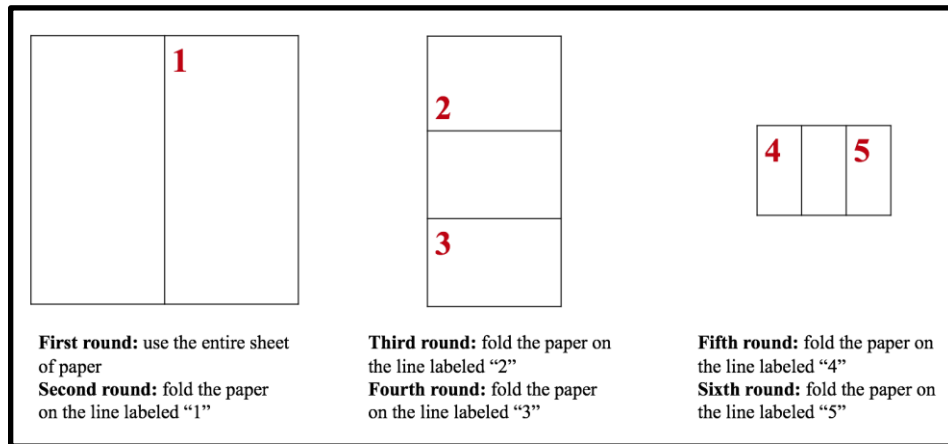


Figure 19: Sinking Island Game Material Guidelines

Video Clips: We created both a digital and physical version of the booklet, which slightly differ. In the digital version, we include short videos at the end of KPE staff members giving advice about climate change education, strategies and methods. These video clips aimed to provide Greek educators with an additional resource to environmental education strategies and advice. The interviews were broken down into three topics: the importance of climate change in the educational curriculum, tips for game facilitation and student engagement and how to overcome challenges of climate change education through games.

Additional Elements: The final section of the booklet includes contact information of Greek emergency personnel and a brief page with tips to design a serious game, based on expert interviews and research undergone throughout the project.

6.0 Recommendations

We hope that the development of the booklet is a step towards broader implementation of climate change education in Greece. To extend the work described in this report, the next steps for the Environmental Education Centre of Eleftherio-Kordelio (KPE) would be:

Further development of the booklet. The booklet should be translated from English to Greek to make it easily accessible and understandable for educators around Greece, as many educators speak English but are more comfortable speaking Greek. We also believe that the

booklet can be continuously improved upon by adding new games, updating background information and including additional resources as needed.

Further development of the games. We tested multiple games and made adjustments based on feedback and observations but there are still some games in the booklet that have not been tested with Greek students. We think that further testing and adjusting will be beneficial to keep improving the quality of the games.

Dissemination of the booklet. KPE could actively distribute the booklet to partner institutions through a digital file that can be uploaded on their websites. The distribution of the booklet could be completed in two stages. First, the booklet could be distributed digitally or physically to the other 53 Environmental Education Centres as they all fall under the Ministry of Education and have each other's contact information. Second, each centre could reach out to schools that they work with and share the booklet with them. From there, we hope that word will travel, and the existence of the booklet will reach many educators and be able to influence many Greek students' lives.

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*Appendix A: Climate Change Survey in English and Greek***Climate Change Survey (English)**

Grade Level/School: _____

True/False

Please answer the following true/false questions by circling “a” “b” or “c”. If you do not know the answer, choose “unsure,” do not guess.

1. Climate change will not affect farming and the production of food in Greece, such as olive oil.
a. True b. **False** c. Unsure
2. Carbon dioxide is a gas that has contributed to aggravating the greenhouse effect.
a. **True** b. False c. Unsure
3. The use of solar and wind energy worsens the greenhouse effect.
a. True b. **False** c. Unsure
4. TV does not consume energy when it is turned off by remote control.
a. True b. **False** c. Unsure
5. The greenhouse effect will lead to a decrease in habitable land.
a. **True** b. False c. Unsure
6. One of the impacts of intensifying the greenhouse effect will be the appearance of new diseases.
a. **True** b. False c. Unsure
7. Extreme weather events are likely to become more frequent and intense.
a. **True** b. False c. Unsure
8. Climate change will not put populations of other species at risk of losing their habitats.
a. True b. **False** c. Unsure
9. The use of public transportation can contribute to mitigating the greenhouse effect.
a. **True** b. False c. Unsure
10. If climate change continues at this rate, the cost of living will increase.
a. **True** b. False c. Unsure

Climate Change Survey (Translated into Greek)

Climate Games Project – Παιχνίδια για την κλιματική αλλαγή
Worcester Polytechnic Institute
ΚΠΕ Ελευθερίου Κορδελιού & Βερτίσκου

Ερωτηματολόγιο για την Κλιματική Αλλαγή

Τάξη/σχολείο: _____

Απαντήστε τις παρακάτω ερωτήσεις κυκλώνοντας (α), (β) ή (γ). Εάν δεν ξέρετε την απάντηση, επιλέξτε το «Δεν είμαι βέβαιος/α» μην επιλέγετε κάτι στην τύχη.

1. Η κλιματική αλλαγή δεν θα επηρεάσει τη γεωργία και την παραγωγή προϊόντων, όπως το ελαιόλαδο, στην Ελλάδα.
α. Σωστό β. Λάθος γ. Δεν είμαι βέβαιος/α
2. Το διοξείδιο του άνθρακα είναι ένα αέριο που έχει συμβάλει στην επιδείνωση του φαινομένου του θερμοκηπίου.
α. Σωστό β. Λάθος γ. Δεν είμαι βέβαιος/α
3. Η χρήση ηλιακής και αιολικής ενέργειας επιδεινώνει το φαινόμενο του θερμοκηπίου.
α. Σωστό β. Λάθος γ. Δεν είμαι βέβαιος/α
4. Η τηλεόραση δεν καταναλώνει ενέργεια όταν την κλείνουμε από το τηλεχειριστήριο.
α. Σωστό β. Λάθος γ. Δεν είμαι βέβαιος/α
5. Το φαινόμενο του θερμοκηπίου θα οδηγήσει στη μείωση της έκτασης της κατοικήσιμης γης.
α. Σωστό β. Λάθος γ. Δεν είμαι βέβαιος/α
6. Μία από τις επιπτώσεις της κλιματικής αλλαγής θα είναι η εμφάνιση νέων ασθενειών.
α. Σωστό β. Λάθος γ. Δεν είμαι βέβαιος/α
7. Τα ακραία καιρικά φαινόμενα είναι πιθανό να γίνουν πιο συχνά και πιο έντονα.
α. Σωστό β. Λάθος γ. Δεν είμαι βέβαιος/α
8. Η κλιματική αλλαγή δεν θα επηρεάσει άλλα είδη ζώων και φυτών.
α. Σωστό β. Λάθος γ. Δεν είμαι βέβαιος/α
9. Η χρήση των μέσων μαζικής μεταφοράς μπορεί να συμβάλλει στη μείωση του φαινομένου του θερμοκηπίου.
α. Σωστό β. Λάθος γ. Δεν είμαι βέβαιος/α
10. Αν η κλιματική αλλαγή συνεχιστεί με τους ίδιους ρυθμούς, το κόστος ζωής θα αυξηθεί.
α. Σωστό β. Λάθος γ. Δεν είμαι βέβαιος/α

Appendix B: Observational Data Table Template

Observational Data Table

Classroom Observation Narrative Log

Instructor:

Date:

Course:

Course meeting time:

Observer:

Number of students present:

<i>Time</i>	<i>What's Happening in Class</i>	<i>Observer Impressions</i>

Appendix C: Completed Observational Data Tables**Observational Data Table 1: *Sinking Island 3/13*****Classroom Observation Narrative Log**

Instructor: Vital (Facilitator)

Date: 3/13/19

Course: Sinking Islands

Course meeting time: 9am - 1pm

Observer: Climate Games Team

Number of students present: 37

Time	What's Happening in Class	Observer Impressions
10:30	Vital began facilitating the game, explaining who we are and what the game was called.	Students were engaged and excited because we were showing them the game (Vital said he was Brazilian and they got excited)
10:32	Olivia counted students off to separate them into 7 groups	They liked that Olivia counted in Greek and were impressed
10:33	Students split up into their respective groups	They split up into their groups quickly and were ready to play the game and listen
10:34	Vital began to narrate the storyline of the game	Students were attentive and focused.
10:36	First round of the game → Entire paper (not folded)	This step was completed very quickly. Not much strategy was needed. Students were smiling and laughing as they began to understand the game more.
10:38	Second round of the game → the paper was folded in half	Students strategized with their team members. Some students began taking their coats off to take up less space when trying to fit on the "sinking island."
10:39	Third round of the game → the paper was folded into a third.	Teams were very engaged and competitive. Lots of laughing and talking with each other and the alternative teams. Students hugged and huddled to take up less space.
10:41	Fourth round → paper was folded again into another third.	This round was the most difficult and fun for students. Teams jumped on each other's backs, hugged, huddled and stepped on each other's feet to stay alive. Students were laughing and smiling and cheering each other on if their team was already out.
10:45	Students and facilitators went inside to debrief about the game.	Students responded positively to the game. The students who raised their hands in the debriefing session said they enjoyed the game and learned more about rising seas levels. A lot of students did not seem concerned and believed this climate change issue was not affecting them.

Observational Data Table 2: *Sinking Island 3/19*

Classroom Observation Narrative Log

Instructor: Vital (Facilitator)

Date: 3/19/19

Course: Sinking Islands

Course meeting time: 9am - 1pm

Observer: Climate Games Team

Number of students present: 18

Time	What's Happening in Class	Observer Impressions
11:00	Vital began facilitating the game, explaining who we are and what the game was called	Student were engaged, paying attention to Vital and not talking to their classmates
11:05	Olivia counted students off to separate them into 4 groups	Students were excited, laughing/ joking/ smiling while listening for their respective number
11:08	Students split up into their respective groups	Students were energetic and enthusiastic, ran to their designated group area, laughed and joked with their new team and prepared to listen to the rest of the instructions
11:11	Vital began to narrate the storyline of the game	Students listened closely and were very receptive to the "problem" of the game
11:14	First round of the game → students strategized and then implemented their ideas	Students were having a lot of fun, giggling and collaborating with each other to achieve the goal of the first round
11:16	Second round of the game → the paper was folded in half and students worked on strategizing with their team and again implementing their ideas	Students were loud and interactive, the majority of students were laughing and smiling and working hard to solve the problem presented in the game
11:18	Third round of the game → the paper was folded into a third and students worked on strategizing, this time it was harder to fit on the paper. One team got out.	Students implemented their strategies, some students took their jackets off, some were hugging and some jumped on each other's backs. The students were very engaged and determined to win the game and stay on their island. Lots of laughing and excitement.
11:20	Fourth round → paper was folded again into another third. Another team got out.	Students again implemented their strategies, continued to jump on one another and huddled around the paper. Again students were engaged and interactive. Students who "lost" continued to engage with the game and cheer on their other classmates.
11:22	Fifth round → the paper was folded again into another third. Both teams got out and therefore both "won"	Students concluded the game and were excited, laughing and smiling. Some students asked to play the game again → we did not have time unfortunately.
11:30	Students and facilitators went inside to debrief about the game.	We asked the questions: Did you have fun? (Answers were very positive, students said to have had a lot of fun while playing the game) What did you learn? (students said to have

	<p>learned about sea levels rising and the impacts it will have on islands around the world), this led to a further discussion about Greece specifically. Students said the issue of sea levels rising are not affecting Greece. One student said it won't begin to affect Greek islands for another 100 years. Students did not realize that sea levels were also affecting the mainland, which was discussed. We explained the threat of sea levels to Greece in particular. After realizing that Greece was being directly affected by rising sea levels, one student vocalized that they should begin mitigation and resilience strategies now.</p>
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Observational Data Table 3: Connecting Dots 3/19

Classroom Observation Narrative Log

Instructor: Eleni (Facilitator)

Date: 3/19/19

Course: Connecting Dots

Course meeting time: 9am - 1pm

Observer: Climate Games Team

Number of students present: 18

Time	What's Happening in Class	Observer Impressions
12:00	Eleni tells the students the name of the game and has them get into a circle around her	Students listened to Eleni and were interested because they wanted to know what the string was for
12:01	Eleni tells them the extreme weather event is extreme rainfall and asks them to think of stakeholders that are affected by this event. She told them that she represented the extreme rainfall	About 1/3 to 1/2 of students raised their hands for Eleni to call on them
12:02	Eleni gave the string to one student who named a stakeholder that was affected by extreme rainfall and was able to explain why.	The student named a stakeholder that was different than we thought of and explained it well. The other students listened to the stakeholder and explanation
12:05	Eleni then asked the students to name a stakeholder that was affected by the previous stakeholder. This continued until all of the students had a stakeholder	The students were able to name stakeholders easily (did not need much assistance from Eleni)
12:13	Eleni then had the students say if their stakeholder affects or is affected by any other stakeholders that were mentioned	Students were able to make many connections and payed attention (Possibly due to the fact that they constantly were holding the string and didn't know when a connection would be made to their stakeholder)

12:22	Eleni pulled on the string and explained how if extreme rainfall occurs, it not only has a direct effect on certain stakeholders, but it also has an indirect effect on other stakeholders.	Students began to understand how the event could indirectly affect them and seemed to enjoy physically feeling the connection
12:24	Eleni asked them questions to debrief the exercise and see what they learned	Since it was a small group, they were able to all participate in the debriefing and give their opinions and ideas about the game
12:30	Game Ended	

Observational Data Table 4: Answer with your Feet 3/21**Classroom Observation Narrative Log**

Instructor: Vital (Facilitator)

Date: 3/21/19

Course: Answer with your Feet

Course meeting time: 9am - 1pm

Observer: Climate Games Team

Number of students present: 34

Time	What's Happening in Class	Observer Impressions
10:36	Vital began facilitation and had the students gather in a circle and started explaining the directions of the game	Students seemed a little bit low energy but were engaged and listened to Vital and Eleni explain the rules of the game. Some students seemed a little nervous and others were smiling and laughing.
10:39	Vital asked the first question: are sea levels rising?	About 88% of students answered yes (4 students answered no), they shared why they chose the answer/side of the room that they did. Students were engaged and all paid attention to one another.
10:41	Second question: does the TV use energy when it is turned off by the remote control?	5 students answered no (15%), 29 answered yes (85%). Students again shared their thoughts about their answers. Three students changed their minds and switched sides. They did not understand the question at first. Students were very active, about 15 people raised their hands to share their thought about the question. They are engaged and most were laughing at Giorgos' joke
10:44	Third question: Do you think food waste contributes to climate change?	2 boys consistently disagree with the rest of the group. They did not seem as engaged as the other students, they seemed a little nervous to participate. A variety of students shared their opinions on the question. They seem nervous (probably because we are here)
10:47	Fourth question: do you think food production will	All went to the no side, including the 2 boys

	be the same in the future despite climate change?	
10:50	Fifth question: How worried are you about the climate changing?	Most students answered “a lot,” about 10 students were split between “a little bit” and “not at all.” They were very engaged and again, a large portion of students were eager to share their opinions with the class.
10:54	Sixth question: Can climate change affect Greece’s economy?	All students answered yes right away. Numerous students raised their hands to discuss the topic further.
10:59	Seventh question: Which do you use most? Car, Bus, or Bicycle?	About 10 students answered “bike” and the rest answered “car.” A few students are starting to get distracted/bored/tired. Others are still raising their hands
11:07	Eighth question: Step in the circle if you prefer local products.	About 12 students stepped into circle. Still raising hands to explain. Some new people are starting to participate
11:15	Ended Game	Students went back to their seats.

Observational Data Table 5: *Sinking Island 3/21*

Classroom Observation Narrative Log

Instructor: Vital (Facilitator)

Date: 3/21/19

Course: Sinking Islands

Course meeting time: 9am - 1pm

Observer: Climate Games Team

Number of students present: 32

Time	What’s Happening in Class	Observer Impressions
12:36	Olivia began facilitating the game, explaining who we are and what the game was called	Students seemed to be excited to be outside instead of sitting at desks inside
12:37	Olivia counted students off to separate them into 8 groups of 4	Students did not pay great attention to the numbers and they were in English so they may have had trouble understanding all of the numbers.
12:38	Students split up into their respective groups	Took a bit to split up and find group
12:39	Olivia began to narrate the storyline of the game	They seemed curious about how the game will work (looking at the paper)
12:41	First round of the game → Entire paper (not folded)	They thought it was easy. Some sarcastically clapped and said congratulations
12:42	Second round of the game → the paper was folded in half	Started to use strategy (one leg)
12:43	Third round of the game → the paper was folded into a third. 1 team got out	They started talking more and discussing strategy of how to all stand on the island

12:45	Fourth round → paper was folded again into another third. 2 teams got out	Started to get into the game because it was getting challenging
12:46	Fifth round → the paper was folded again into another third. 3 teams got out	They are getting very excited and scared to fall over. Smiling and laughing
12:47	Sixth round → the paper was folded again into another third.	They are standing on each other's feet now to stay on. The other who were out were laughing and the students still playing were trying to concentrate and stay on
12:49	Students and facilitators went inside to debrief about the game.	Some students were engaged, but others were not at times. Most of them laughed at Giorgos' joke (shows that they're engaged)

Observational Data Table 6: *Answer with your Feet 4/3*

Classroom Observation Narrative Log

Instructor: Olivia (Facilitator)

Date: 4/3/19

Course: Answer with your Feet

Course meeting time: 9am - 1pm

Observer: Climate Games Team

Number of students present: 24

Time	What's Happening in Class	Observer Impressions
9:28	Giorgos began facilitation and had the students gather in a circle and started explaining the directions of the game	
9:31	Olivia asked the first question: are sea levels rising?	All students said yes right away
9:33	Second question: does the TV use energy when it is turned off by the remote control?	All answered yes right away again. All looked at Giorgos and multiple students answered why
9:35	Third question: Agree or disagree. Food waste does not contribute to climate change?	They all disagreed. A couple students started to get distracted and unfocused on the activity, but most were still paying attention
9:38	Fourth question: The greek economy is not influenced by climate change. Agree or disagree? (teachers stopped answering so they wouldn't influence the students)	A little more than half disagreed and a little less than half were unsure. A couple more people were getting distracted now, but still the majority were paying attention and interested. One or two were getting antsy from standing long and shaking their leg.
9:41	Fifth question: Extreme weather events will become more frequent and intense. Agree or Disagree?	They all agreed quickly. A few more were distracted

9:44	Sixth question: What do you use for transportation? Car, bus, or bicycle?	3 bus, 1 bicycle and the rest car (one was in between car and bus). Most students were paying attention during this question
9:47	Seventh question: Step in the middle if you use the fan instead of the AC usually	A little more than ½ of the students entered the circle
9:51	Eighth question: Step in the circle if you often buy things that you do not need or use.	About ½ of the students entered the circle (all were girls except 1) (outside the circle were all boys except 2). About ⅓ of the students were distracted at times (payed attention for certain questions that Giorgos asked
9:57	Ninth question: Sit down in your seats if you use the stair more than the elevator	Only 2 stayed standing (lived on the 3rd floor)
9:59	Tenth question: How worried are you about climate change and how it will affect you and the world? Very worried, not really worried, or in between.	All are very worried. ⅓ of the students stayed in their seats and did not really pay attention to the discussion. One kid said he doesn't care if he dies from climate change, he doesn't want to live with the consequences of it.
10:06	Ended Game	Students went back to their seats.

Debriefing:

- The students liked that it was in English.
- They also liked that it was energizing and got them moving.

Observational Data Table 7: *Sinking Island 4/3***Classroom Observation Narrative Log**

Instructor: Angelica (Facilitator)

Date: 4/3/19

Course: Sinking Island

Course meeting time: 9am - 1pm

Observer: Climate Games Team

Number of students present: 24

Time	What's Happening in Class	Observer Impressions
11:16	Students gather to play sinking island	Students are engaged and looking at the facilitator to wait for instructions.
11:17	Eleni, Angelica and Giorgos start to separate the groups, 6 total	Students remain engaged and enthusiastic about playing the game.
11:18	Angelica proceeds to give instructions	Students are paying attention
11:20	First Round begins	All students pass
11:21	Students fold paper in half and strategize for second round	Students are focused and laughing while they plan what they're going to implement for the next round.
11:22	Students play second round	All groups pass.

11:23	Students fold paper and play 3rd round	2 groups are out. Students are laughing
11:24	Students fold paper and play 4th round	No group is out. Students start to jump on each other's backs. Students are having fun
11:25	Students fold paper and prepare for 5th round	Everyone is out. They are all laughing or with some smiley face

Debriefing:

- Students say they had fun and learned about sea levels.
- They say it is difficult to survive with this issue.
- They believe rising sea levels are affecting Greece.

Observational Data Table 8: Survivor 4/3**Classroom Observation Narrative Log**

Instructor: Kassidy (Facilitator)

Date: 4/3/19

Course: Survivor

Course meeting time: 9am - 1pm

Observer: Climate Games Team

Number of students present: 24

Time	What's Happening in Class	Observer Impressions
11:30	Kassidy explains the rule of survival	
11:32	Students test the games	
11:33	Heat wave	3 students are out - confused at what to do at first
11:34	Wildfire	2 students are out
11:35	Hurricane	1 student is out. Students were laughing
11:35	Flood 4	2 are out
11:36	Hurricane	1 is out
11:36	Wildfire	2 are out. Students were sprinting
11:37	Flood 5	3 are out
11:37	Hurricane	1 is out
11:38	Heat wave	1 is out
11:38	Wildfire	2 are out
11:39	Wildfire	0 out - they started getting quick & smart!
11:39	Heat wave	1 is out
11:40	Flood 2	1 is out. Students were moving their arms very fast because they were excited and wanted to win
11:41	Wildfire	1 is out
11:41	Heat wave	0 out
11:42	Flood 2	1 is out - students were very competitive!
11:43	Heat wave	0 out
11:44	Wildfire	1 is out - upset that he didn't win

11:44	SURVIVOR	1 winner - he was very proud, but sad because everyone else "died"
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Debriefing:

- The "Survivor" is sad because everyone else lost
- They were having fun and not bored until they started having a discussion inside

Student Question Responses:

- It's not good to take action at the last minute
- In the critical moments, you care about yourself instead of wanting to help others too
- They need time to prepare and realize what's happening - need to plan
- *add snowstorm to game*
- Everyone was for himself and didn't focus on working as a team when we called "flood"
- Resilience plans can help all of these
- When we're in danger, we don't usually try to help others because we just help ourselves

Observational Data Table 9: *Sinking Island 4/8***Classroom Observation Narrative Log**

Instructor: Vital (Facilitator)

Date: 4/8/19

Course: Sinking Island

Course meeting time: 9am - 1pm

Observer: Climate Games Team

Number of students present: 16

Time	What's Happening in Class	Observer Impressions
12:06	Students gather to play sinking island	Students are moving slowly and are forming a circle very slowly
12:07	Vital counts off numbers to separate the groups, 4 total	Students pay attention to Vital giving him a name
12:08	Vital proceeds to give instructions	Students are paying attention. They are looking intently
12:09	First Round begins	All students pass and are paying attention
12:10	Students fold paper in half and strategize for second round	Students were a little confused about how to fold the paper
12:11	Students play second round	Some students are starting to strategize and lift a leg
12:12	Students fold paper and play 3rd round	Students are looking around to see what other groups are doing. Some people have legs up and some are on each other's back. A couple of students are laughing
12:13	Students fold paper and play 4th round	Students are talking to each other within the groups to plan how they are going to all fit. Some are laughing and scared to fall over
12:14	Students fold paper and play 5th round	Students are smiling and laughing
12:15	Game over	

Student Quotes:

- “If your base is weaker, you’re not going to last long”
- “If there were less people, they would fit better”
- “In this game we care only about ourselves and not the others. If we only focus on ourselves and not others, the society is going to be destroyed.”

Observational Data Table 10: Before the Storm 4/9**Classroom Observation Narrative Log**

Instructor: Olivia (Facilitator)

Date: 4/9/19

Course: Before the Storm

Course meeting time: 12:45pm - 1:30pm

Observer: Climate Games Team

Number of students present: 18

Time	What’s Happening in Class	Observer Impressions
12:42	Olivia began facilitation and had the students sit at a table and started explaining the directions of the game	
12:45	Students began playing the game	Students were excited when they found out about the blank card and that you can make up your own action
12:51	Judge picked their favorite	Students wanted to make their case why their card was better. Student made his own card for increased rain in 1 week and said that they should make channels so that the water goes there and it doesn’t flood
12:52	Next round starts	Students are playing intently and waiting for the judge to pick a card.
12:53	Judge picked a card	Players were trying to make their case again. They are in a healthy debate. She chose to get water when preparing for 40 Celsius 3 days in advance and a student wanted his which was to cover the windows from sunlight
12:55	Next round	2 blank cards were put in and they said “Oh no” and laughed. A lot of laughing erupted from a group (2 students put the same card so then each student had to explain why they picked that card and the best answer wins)
12:59	Judge picked a card	Winds in 24 hours, Stay inside and away from the windows won. Students are laughing and getting competitive
1:00	Next round starts	The judge said she loved one and the player who’s card it was got excited, put his hands in the air, and yelled “Ah”
1:03	Judge picked a card	Communication won for cloudy skies with dark cloud in a distance and 1 week. Almost everyone won once in this group
1:04	Next round starts	Students placed their cards with assertion

1:08	Judge picked a card	Student is very passionate about his card. Snowstorm in 3 days. Picked repair roads because you have access to grocery stores and other necessities
1:08	Ended Game	

Debriefing:

- They said they had a lot of fun.
- They said that they “thought about what they would do if something happened like heavy rain and it was fun”
- Sometimes it is important to already know what to do and not making decisions on the spot because those decisions aren’t always good. It is good to have a plan and precautions in place.
- One student said she learned the word prepare.

Other Student Observations (Multiple games were played simultaneously):

- Students were very engaged and had a lot of fun
- when the judge realized she was the judge for the entire game she said “oooo yay I can be mean”
- One boy in the group was trying to be funny and put down a card that clearly did not fit
The forecast
- The same 2 people got most of the cards (the winner got 5 and the second winner got 4)
- Students were laughing the entire time
- They said that they “thought about what they would do if something happens like heavy rain and that was fun”
- They said that it is “important to already know what to do because if you’re thinking of something on the spot they may not work as well. Always have a plan”
- “If the weather is bad, trees could fall and ruin your house”
- All students yelled “yes” when asked if they had fun
- When students put their action cards down it was not anonymous, next time make sure it is
- Might be better to switch judges so everyone gets a turn
- One girl was very good at speaking English and helped translate for the whole class
- Students were loud and excited, not the best listeners, I think because they were having fun

Observational Data Table 11: Survivor 4/9

Classroom Observation Narrative Log

Instructor: Olivia/Vital (Facilitator)

Date: 4/9/19

Course: Survivor

Course meeting time: 12:45am - 1:30pm

Observer: Climate Games Team

Number of students present: 18

Time	What’s Happening in Class	Observer Impressions
1:10	Olivia explains the rule of survival	Students are laughing at the instructions (crouching heat wave one). Students had a lot of clarification questions

1:14	Students start the game	
11:33	Heat wave	Students start falling over and laughing
11:34	flood	Students did hurricane first and then we repeated ad they quickly got into boats
11:35	Wildfire	They sprinted and the last person knew she was out
11:35	Hurricane	They did heat wave by accident but then figured it out
11:36	Flood	They were having fun and dancing while rowing
11:36	Heatwave	The guy who got out,
11:37	Flood 4	They ran to hug people instead of row because they were in a rush.
1:37	Flood 5	Guy screamed “Wait wait wait” because he wanted to get in a boat
1:38	Wildfire	They ran so fast that they ran into the wall/tables
1:38	Wildfire	They were listening for the word and one student tripped trying to get to the wall
1:39	Hurricane	Girl yelled because she got out
1:19	End game	

Most important lesson students said they learned when there are extreme weather events:

- Acting fast
- Being clever
- Work as a team
- Survival of the fittest

Other Students Observations:

- Students were pushing to get through for the wildfire
- Girl said “This is so stressful”
- Lots of laughing
- Students hesitated for the wildfire
- Students are out of breath at the end because of the running
- They prepared a team but they lost because of the chaos and got picked out one by one
- Students were very vocal and had a few questions after exposing survivor
- Game instructions clicked when we showed them an example
- Students were very excited and engaged, ran to the middle of the room to start the game
- Were very attentive and asked a lot of questions to better strategize, all very competitive
- Kids were screaming and really got into the game
- When we said heatwave one time a boy screeched super loudly
- When we said flood and to get in a boat kids were dancing and rowing
- VERY COMPETITIVE kids were pushing each other and were out of breath
- Everyone clapped and cheered for the “survivor”
- Asked to play another round and when we said we could all the students cheered and ran to the middle of the room to play again
- One girl asked if we could facilitate the second round in Greek
- Kids were hugging and laughing when we said flood and hurricane
- One student said “this is so stressful” and laughed

- Learned “have to be clever and act fast”
- “Work as a team and be fast”
- “Survival of the fittest and sacrifice”
- “Have to always prepare”
- Most student use the stairs over the elevator
- Most students prefer a car over a bus or bike, only 3 student prefers the bus
- “Cars are more practical because you can control the fuels it burns and what goes into their car” she would prefer a bike but is too tired after school
- The same girl continuously answered questions and was very confident and knowledgeable about climate change — other students were less interested in the educational aspect more so the games
- “Car is easier and more efficient and this area is not bus or bike friendly” “feel safer driving with their mom or dad”
- “Bike is eco-friendly”
- “Bike is more athletic”
- “Take bus because parents don’t have time to drive”
- “Bus is more environmentally friendly than the car”

Observational Data Table 12: Answer with your Feet 4/9

Classroom Observation Narrative Log

Instructor: Eleni (Facilitator)

Date: 4/9/19

Course: Answer with your Feet

Course meeting time: 12:30pm - 1:30pm

Observer: Climate Games Team

Number of students present: 18

Time	What’s Happening in Class	Observer Impressions
1:25	Eleni began facilitation and had the students gather in a circle and started explaining the directions of the game	Students were watching Eleni
1:26	Elevator or stairs?	3 elevators and the others were stairs (may not have elevator as a choice). Stairs are easier. We have to wait for the elevator to come. Claustrophobia, scared it would get stuck. Working the glutes, exercising your feet. She thought that saving energy was the obvious reason why to use stairs (she thought everyone thinks about energy. At least she does)
1:29	Bike, car, bus?	4 bikes, 3 buses and the rest cars. Cars are practical and can control the energy used and what goes in and out of it. Solar energy car exists. It is easier to go anywhere you want and faster. They do not live in a bike or bus friendly city. They are on a hill so bicycles would be difficult. Bicycles are eco-friendly. It is kind of a sports thing to do biking. Bus said that their parents don’t have time to drive

		them so they have to take the bus. Friendlier for the environment than the car. If they had a place for bikes, they would choose that. Around here there is not traffic, but takes the bus if they want to go into the city because there they have traffic.
1:34	Game Ended	

Observational Data Table 13: Survivor 4/10**Classroom Observation Narrative Log**

Instructor: Giorgos and Xenia (Facilitator)

Date: 4/10/19

Course: Survivor

Course meeting time: 9am - 1pm

Observer: Climate Games Team

Number of students present: 23

Time	What's Happening in Class	Observer Impressions
11:04	Vital explains the rule of survival	When he said we are working with extreme weather events they said "Oh no!" The students mimicked Vital's examples of the movements (they were getting excited and running around to try out the movement. Vital asked which way they would run with wildfire and they either yelled "there!" and pointed or actually started running in that direction
11:09	Students start the game Giorgos and Xenia facilitated because they did not understand English too well	
11:10	Wildfire	They were confused where to run at first but then ran very fast and screamed with excitement
11:10	Flood	They jumped up and down and ran to find people
11:11	Hurricane	A girl hopped up and down because she got a group and was successful
11:11	Wildfire	Half ran the wrong way and then realized a few seconds later
11:12	Heat wave	
11:12	Flood	Jumped up and down while rowing
11:12	Wildfire	They ran to hug people instead of row because they were in a rush.
1:13	Flood 4	All were smiling and laughing
1:13	Wildfire	Student ran into Chrysoula and got out and was laughing
1:13	Flood 2	All were laughing

1:14	Wildfire	Boy ran in the wrong direction at first and then realized and said “Oh!” and then knew he got out
1:15	Wildfire	Last boy won and raised his hands in the air because he won
1:15	End game	

Observational Data Table 14: Traffic Jam 4/10

Classroom Observation Narrative Log

Instructor: Vital (Facilitator)

Date: 4/10/19

Course: Traffic

Course meeting time: 9am - 1pm

Observer: Climate Games Team

Number of students present: 23

Time	What’s Happening in Class	Observer Impressions
11:17	Vital began facilitation and assigned the students to 8 bicycles, 8 cars and 7 bus passengers plus 1 teacher as the bus driver. He told the rules (no running, everyone only goes around twice)	Students were curious about the signs and looked for the 3 different types. The teacher said “Ahhh” when we showed the different colored balls of paper. Students were listening intently. Some were talking quietly about it and missing some of what Vital was saying. Students were asking questions and trying to fully understand the game. When the girls got the cars, they screamed “Yay!” and started running away to start the game.
11:25	The students started	They are all smiling and pretending to have their hands on a wheel.
11:27	Second lap started	Some students were running to get a new ball. On the bus, a girl put her arms down and the girl in front of her told/yelled at her to put her hands back on. The bus was smiling and laughing as they finished their final lap.
11:30	Ended Game	

Debriefing:

- Students ran to get their ball from the box, but then were told to sit and wait for it.
- Students opened their papers and started yelling their number (one student said penta because he thought it was a 5 instead of a 2)
- They all go with their bikes inside the municipality, but they can’t go on central routes. Drivers are careless, so it makes riding a bicycle dangerous. Can make more bike lanes.
- Their family goes around more with a car, not a bus, so that’s what the student does. The bus routes are not that often and sometimes the bus is crowded. It’s always late most of the time. Sometimes it is dangerous because there are thefts. When you have to go someplace, you just take the car because it is easier. Sometimes they don’t fix the buses and go to inspection. They can do it like in England, 2 story bus. Some stops have that the bus will be there in x minutes, but other stops don’t have that.

- The bus route goes near a hospital and maybe we could take the bus if there were not drug addicts inside of it. Drug addicts stop at the hospital to get supplies, so if it didn't stop there, more people might take the bus. We can make a complaint to the mayor/city hall, maybe we can make a change in Thessaloniki and maybe the entire country could make that change
- Some said they use heated natural gas or heated petroleum or wood on the fireplace to warm their house. Electricity uses energy. We have to use fuels to make electricity in factories.
- In the summer they have the air conditioner to produce CO2

Debriefing Questions and Student Responses:

- What did you learn from the game? A: The bicycles don't emit CO2. The bus has many people and has more CO2 emitted than 1 car.
- Why the routes? A: Bikes can do smaller routes, but the cars and buses do longer routes. Bicycles can go through the bike lane.
- Why can't cars and bikes go through the bus lane? A: Because traffic. To prioritize buses. In reality, this doesn't exist like that
- What do you see in the bus lanes in real life? A: Drivers park their cars
- When they are in a place outside out Thessaloniki, there are not a lot of buses. What can the municipality do to have less CO2 in the environment? A: Maybe you can do a bus lane. We can go with bus instead of cars.

Observational Data Table 15: Before the Storm 4/11

Classroom Observation Narrative Log

Instructor: Olivia (Facilitator)

Date: 4/11/19

Course: Before the Storm

Course meeting time: 12pm - 12:45pm

Observer: Climate Games Team

Number of students present: 18

Time	What's Happening in Class	Observer Impressions
12:02	Olivia began facilitation and had the students sit at a table and started explaining the directions of the game. Eleni translated because some didn't understand English	Students asked questions and were curious about the cards
12:12	Students began playing the game	Students needed some guidance (in greek). Judge read the cards intently to make a decision.
12:16	Judge picked a card	For thunder and lightning in 1 week, he chose to evacuate

12:17	Next round starts	Heatwave to last 1 month starting in 3 days. Students were laughing at some of the cards that they put down
12:18	Judge picked a card	He chose the prepare by getting water card. Students were not the most competitive
12:19	Next round	24 hours and 35 mm of rain. The judge didn't turn one card over and one student told him to turn it over (because it was his). Judge was explaining his thought process. Student tried to make his case
12:21	Judge picked a card	
12:22	Next round starts	Likelihood of 30% flooding in 24 hours. Judge was talking and smiling. More students started to make their case for the cards to convince the judge. Judge narrowed down to 2. Judge asked the 2 students to plead their case. Judge explained his thought process
12:25	Judge picked a card	Monitor weather won
12:26	Next round starts	Strong winds in 3 days. One kid drew pictures for his blank cards every time (he had 3 blank cards total).
12:29	Judge picked a card	Picked the written card (not the drawing one)
12:30	Ended Game	

Anything new learned?

- There are many ways to prepare for weather events
- There are some phenomena that she didn't know existed. She thought some were really weird. She didn't think about them previously
- All screamed "Yes!" when asked if they had fun

Observational Data Table 16: Survivor 4/11

Classroom Observation Narrative Log

Instructor: Angelica (Facilitator)

Date: 4/11/19

Course: Survivor

Course meeting time: 12pm - 12:45pm

Observer: Climate Games Team

Number of students present: 18

Time	What's Happening in Class	Observer Impressions
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12:33	Angelica explains the rule of survival	Students were paying attention and looking at Angelica and Eleni when they explained. Students took off jackets to make moving easier. Girls ran up to Eleni when she said to come closer because they were excited
12:	Students start the game	
12:37	Flood 4	Students ran. They rowed very fast
12:38	Wildfire	One boy didn't run so he got out
12:	Heatwave	Boy didn't know he was last
12:	Hurricane	5 people linked arms
12:	Hurricane	They scrambled to find 2 others. They were all yelling and getting excited
12:40	Flood 2	Boy got out so pushed a girl to get in a boat
12:	Wildfire	Ran into the wall
12:41	Heatwave	Girl won and jumped in the air with her hands up
12:41	End game	

*Appendix D: Worcester Polytechnic Institute International Review Board***WORCESTER POLYTECHNIC INSTITUTE**

100 INSTITUTE ROAD, WORCESTER MA 01609 USA

Institutional Review Board

FWA #00015024 - HHS #00007374

Notification of IRB Approval

Date: 01-Mar-2019

PI: Demetry, Chrysanthe

Protocol Number: IRB-19-0467

Protocol Title: Developing Climate Games for Greek Students

Approved Study Personnel: Gulezian, Olivia~Puchovsky, Angelica~Tavares B M Mendonca Filho, Vital~Utheim, Cassidy~Vaz, Richard F~Demetry, Chrysanthe~

Effective Date: 01-Mar-2019

Exemption Category: 2, 4

Sponsor*:

The WPI Institutional Review Board (IRB) has reviewed the materials submitted with regard to the above-mentioned protocol. We have determined that this research is exempt from further IRB review under 45 CFR § 46.104 (d) (2.) For a detailed description of the categories of exempt research, please refer to the [IRB website](#).

The study is approved indefinitely unless terminated sooner (in writing) by yourself or the WPI IRB. Amendments or changes to the research that might alter this specific approval must be submitted to the WPI IRB for review and may require a full IRB application in order for the research to continue. You are also required to report any adverse events with regard to your study subjects or their data.

Changes to the research which might affect its exempt status must be submitted to the WPI IRB for review and approval before such changes are put into practice. A full IRB application may be required in order for the research to continue.

Please contact the IRB at irb@wpi.edu if you have any questions.

*if blank, the IRB has not reviewed any funding proposal for this protocol

Appendix E: Serious Game Booklet

SERIOUS GAMES FOR CLIMATE CHANGE

APRIL 2019



PREPARED AND PRESENTED BY

OLIVIA GULEZIAN, ANGELICA PUCHOVSKY,
VITAL TAVARES & KASSIDY UTHEIM



IN COLLABORATION WITH

THE ENVIRONMENTAL EDUCATION
CENTRE OF ELEFThERIO-KORDELIO

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We are students at Worcester Polytechnic Institute (WPI), located in Worcester, Massachusetts. As part of our degree requirement, we completed a project in Social Sciences in Thessaloniki, Greece. The goal of this project was to educate Greek students on the topic of climate change, specifically using serious games as educational tools. The booklet approaches different topics that explore relationships between society and climate change. We hope to empower the future generation in order to mitigate climate change, adapt to its effects and be resilient for the years to come.

Eleni Anastasopoulou, a graduate student studying Geology at Aristotle University, acted as our co-researcher throughout this project. Eleni contributed valuable insight, dedicated hours of hard work and effort and translated for us throughout the project.

THE ENVIRONMENTAL EDUCATION CENTRE

The Environmental Education Centre of Eleftherio-Kordelio, referred to as "KPE" throughout the booklet, is located in Thessaloniki and was established by the Ministry of Education in cooperation with the Municipality of Eleftherio-Kordelio. The Centre focuses on educating schools and local communities about the environment and sustainable development.



VISION

- Aim to educate students / future citizens to be active and think critically
- Support teachers to approach Education for Sustainability in their everyday practice
- Assist citizens to actively care for the environment of their town



MEET THE TEAM

THESSALONIKI ENVIRONMENTAL EDUCATION CENTRE
EMPLOYEES



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INTRODUCTION

This booklet contains a series of games that seek to educate 12-15 year old Greek students about climate change. The booklet discusses different topics that explore relationships between society and climate change. The hope is to empower future generations to mitigate climate change, adapt to its effects and be resilient for the years to come. The games can be adapted and adjusted to be played by other age groups.

Throughout the booklet, you will notice that the games were designed to be interdisciplinary and will touch upon multiple topics. This is due to connections between various game topics and how climate change affects us in many ways.

In addition, the booklet contains a series of supportive materials that can be found as a hyperlink in our digital version as well as a website URL (Uniform Resource Locator) at the end of the hard copy booklet.

The information and games in this booklet have been inspired by and adapted from various sources which can all be found in the references section. We do not claim ownership of any material in this booklet.

We hope you enjoy!

CLIMATE CHANGE



IT IS EXPECTED THAT SEA LEVELS WILL RISE BY 20-59CM BY 2045, WHICH WILL DECREASE THE AMOUNT OF LAND CURRENTLY IN GREECE BY 3.5%.

Climate change effects are noticeable throughout Greece. These consequences can damage the environmental and socioeconomic relationships in the country. Climate change primarily occurs when an excess of greenhouse gases are emitted into the environment, resulting in a temperature increase. Studies have shown that if climate change continues to develop at its current pace, it will have detrimental effects to the standards of living. In Greece, climate change has had many impacts including an increase in temperature, extreme weather events and rising sea levels. In particular, it is expected that sea levels will rise by 20-59cm by 2045, decreasing the amount of land currently in Greece by 3.5%. Climate change is currently not part of the mandatory Greek curriculum; students learn about climate change on a voluntary basis. A study found that a portion of Greek students do not understand certain effects that climate change will have on the world as well as what factors worsen climate change. Therefore, it is important to educate future generations of Greek citizens to expand their knowledge on climate change, mitigation and resilience strategies.



DEFINITIONS

Carbon Dioxide

A colorless, odorless, poisonous gas resulting from fossil-fuel combustion and the breakdown of organic matter

Climate

The long-term average of conditions in the atmosphere, ocean, and ice sheets and sea ice described by statistics, such as means and extremes

Climate Change

a change in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels

Global Warming

a gradual increase in the overall temperature of the earth's atmosphere generally attributed to the greenhouse effect caused by increased levels of carbon dioxide, CFCs, and other pollutants

Greenhouse Effect

the trapping of the sun's warmth in a planet's lower atmosphere, due to the greater transparency of the atmosphere to visible radiation from the sun than to infrared radiation emitted from the planet's surface

Greenhouse Gas

a gas that contributes to the greenhouse effect by absorbing infrared radiation. Carbon dioxide and methane are examples of greenhouse gases

Mitigation

the action of reducing the severity, seriousness, or painfulness of something

Resilience

the capacity to recover quickly from difficulties; toughness

Temperature


the degree or intensity of heat present in a substance or object, especially as expressed according to a comparative scale and shown by a thermometer or perceived by touch

Weather





the state of the atmosphere at a particular place and time as regards heat, cloudiness, dryness, sunshine, wind, rain, etc

KEY TO SYMBOLS

These symbols represent 4 major climate change topics. They will be used in the title of every game to indicate the major topics that the game covers.

-  Climate Change Causes
-  Climate Change Impacts
-  Resilience Strategies
-  Mitigation Strategies

These symbols represent the estimated duration of each game, recommended number of players, recommended space size and a scale of how challenging the game is to facilitate (from 1 being not difficult at all to 5 being challenging and requires experience facilitating).

-  Game Duration
-  Number of Players
-  Space Size
-  Facilitation Difficulty

CLIMATE CHANGE CAUSES

GREENHOUSE EFFECT

THE TRAPPING OF THE SUN'S WARMTH IN A PLANET'S LOWER ATMOSPHERE, DUE TO THE GREATER TRANSPARENCY OF THE ATMOSPHERE TO VISIBLE RADIATION FROM THE SUN THAN TO INFRARED RADIATION EMITTED FROM THE PLANET'S SURFACE



The greenhouse effect is a **natural process** that occurs when an excess amount of greenhouse gases are emitted into the environment and causes the Earth's surface to warm. When the solar energy enters Earth's atmosphere, some energy is **reflected** back and the rest gets **absorbed** into the Earth. The Earth re-radiates that heat/energy and greenhouse gases, including water vapour, carbon dioxide, methane, nitrous oxide, and ozone, trap the heat within Earth's atmosphere. **Carbon dioxide** has been the main greenhouse gas contributor to climate change, and it nearly doubled in concentration in Greece's atmosphere from 1958 to 2017. The greenhouse gas effect is **intensified** by many different actions including burning fossil fuels, deforestation, and biomass burning. This phenomenon is one cause of **global warming**.

Climate change is directly influenced by the **behavior of each individual citizen** within a given region. To undergo daily actions such as food production, lighting and heating, electricity must be produced. This results in the burning of **fossil fuels** and leads to the intensification of the greenhouse effect.

CLIMATE CHANGE CAUSES

FOOD WASTE



In Greece, it is estimated that **100 kg** of food is wasted per person annually, **30 kg** being avoidable. Typically this waste can be categorized as “organic waste,” which, when decomposed, releases **carbon dioxide and methane gas** into the atmosphere. In Greece, there is an estimate of 5,672.5 Gg of carbon dioxide released annually, which can be reduced with a few lifestyle adjustments.

OVER-CONSUMPTION OF GOODS

Consumerism plays a major role in the worsening of climate change. The amount of **water and energy** needed to produce products in factories is significantly more than the amount of water and energy needed to shower or run a household. Buying products that never get used is an example of over-consumption because it is a **waste** of energy and water. Also, goods with complex packaging can affect the environment if not **recycled** properly. Over-consumption can be reduced if citizens only purchase what they need and refrain from making unnecessary purchases.

CLIMATE CHANGE IMPACTS

ECONOMICS

THE CONDITION OF A REGION OR GROUP AS REGARDS MATERIAL PROSPERITY.



The 21st century is responsible for bringing fast paced **technological advancements**. Societies progress at a quadratic or even exponential pace. In economics for instance, markets evolve and adapt to crisis in more efficient ways and businesses prosper through innovation.

This complex web of society allows new players to be **stakeholders** in the decision making process. Climate change has been taken into consideration when governments and companies invest their time and resources into new causes and analysis of processes. Around the world, impacts of climate change have **disrupted** agricultural production, wildlife species, public health and economic standing of regions, affecting not only the macroeconomics of nations, but also the consumer's households.

Sectors of the Greek economy are concerned on how they can **mitigate** consequences of climate change. In order to surpass the economic crisis that has affected Greece since 2008, Greece needs to develop a strategy for **resilience** and **adaptation** for the effects of climate change.

CLIMATE CHANGE IMPACTS

TREES AND URBAN HEAT ISLANDS (UHI)

"TREES ARE THE LUNGS OF THE EARTH"

This sentence has perpetuated through generations, especially when it comes to lessons in environmental education. **Trees and plants** are responsible for providing the oxygen we breathe through photosynthesis.



In urban spaces, trees are not only responsible for providing oxygen, but also cooling the regions around green spaces. Urban areas have higher Greenhouse Gases Emissions, increasing the amount of carbon dioxide in the area. As a result, cities trap enough carbon dioxide to create a micro-environment with higher temperatures. This phenomenon is denominated **Urban Heat Island (UHI)**.

UHIs are more easily noticed during the day and especially in low wind regions. Some cities could be 3 degrees Celsius hotter than its surrounding areas. It is important for cities to have **green spaces** because they will help to mitigate the effects of UHIs. Individuals can also reduce the effects of UHIs by creating small scale environments of green spaces in and around their homes. One example is to put plants on balconies to cool off the surrounding area.

CLIMATE CHANGE IMPACTS

EXTREME WEATHER EVENTS

DURING THE PAST FEW YEARS, THE NUMBER OF EXTREME WEATHER EVENTS AROUND THE WORLD HAS INCREASED SIGNIFICANTLY. EXTREME WEATHER EVENTS INCLUDE UNEXPECTED, UNUSUAL, UNPREDICTABLE, SEVERE AND UNSEASONAL WEATHER. HERE ARE SOME EXAMPLES OF EXTREME WEATHER EVENTS:



Heat waves → Periods of high temperature or high heat index markings. Heat waves can occur in both humid and dry environments. In regards to climate change, the temperature of Greece is expected to increase 2.5°C by 2045. Heat wave season is also expected to increase by 15-20 days by 2045.

Floods → An overflow of water in areas that are usually dry. Floods concern specialists in agriculture, civil engineering and public health fields. Floods may occur from extreme rainfall or an excessive flow rate of channels or other bodies of water.

Wildfires → Large, uncontrolled infernos that quickly burn and spread through wild lands. Around 90% of wildfires are human induced. For a wildfire to occur, all of the elements of the fire triangle must exist: a heat source, oxygen and fuel.



CLIMATE CHANGE IMPACTS

RISING SEA LEVELS

Since 1900, the global average sea level has been continuously rising. With the **intensification** of climate change, the average global temperature is increasing, causing polar ice caps to melt and inserting tons of water into the oceans aggravating sea level rise.

In Greece, it is estimated that in by 2045, the sea levels will rise by 20-59 cm. 90% of **tourism** infrastructures are located on the coasts of Greece and on islands, so Greece's **GDP** could significantly decrease with the loss of land. In addition, **30%** of Greece's population lives within less than 2 Km of the coast, posing a major **infrastructure** problem if sea levels continue to rise at this pace. Thessaloniki, Patra and other coastal cities populations are threatened and have to come up with plans to cope with the effects of rising sea levels.

FOOD

Food is intrinsically related to climate change. Throughout the years, changes in climate have affected **agricultural production**, reshaped the way **society wastes food** and how food **safety** has improved its technology due to more resistant plagues, viruses and bacteria.

As a consequence of increasing temperatures, the water cycle of regions is affected, reducing precipitation level and making the air drier. Moreover, the soil starts a process of desertification. These effects combined have a heavy toll in agricultural production.

RESILIENCE STRATEGIES

RESILIENCE IS DEFINED AS THE CAPACITY TO RECOVER QUICKLY FROM DIFFICULTIES AND THE ABILITY TO SPRING BACK TO SHAPE.



In other words, resilience is the characteristic associated with being **flexible** and persevere through hardships. In an ever changing climate, people and communities have to be able to **adapt and cope** with the effects of climate change.

When it comes to climate action, urban centers have found obstacles in dealing with the fast transformations and reinventing themselves in order to completely adapt to climate change effects. That is why many cities are now betting on **urban resilience** plans.

Urban resiliency is defined as the ability of a city or urban system to withstand a wide array of **shocks and stresses**, such as climate change. Typically, there are shocks and stresses derived from climate change, triggering negative **spillovers** to environments. In order to be resilient and withstand these shocks, cities use **persistence, transition, or transformation**.

Some resiliency strategies include integrating energy efficiency in municipal buildings and alternative means of transportation. In addition, cities can **collaborate** and share resources through a resiliency network in order to persevere together and cope with the effects of climate change.

MITIGATION STRATEGIES



People have designed strategies to reduce or stop the advancement of climate change. Those strategies refer to climate change **mitigation**. Entire governments, cities, NGOs and private companies work on **plans** to reduce causes of climate change.

In this booklet, you will find approaches to mitigate climate change. These games seek to educate the youth of Greece on how different actions, as small as they can be, could help slow down the advancement of climate change. Some examples of climate change mitigation include: recycling, use of renewable energy, reduction of fossil fuel emissions, efficient transport, etc.

MITIGATION STRATEGIES

SUSTAINABILITY

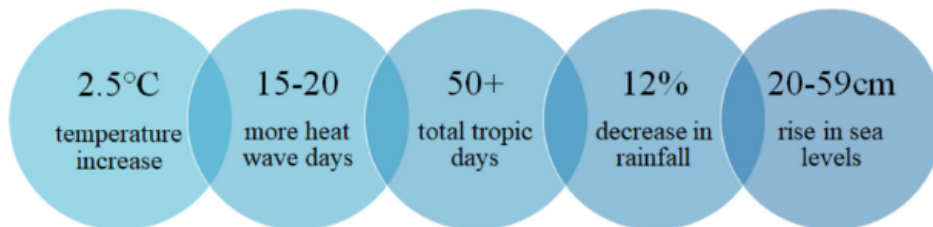
Sustainability is understood as the ability to **maintain change** in a balanced environment. This concept is often related to the exploitation of resources, but can also be used to measure how much is a society thriving **socioeconomically**. The organizing principle of sustainability is sustainable development. It is understood by the capacity of meeting human development through the sustainable use of **natural systems**. In 2015, the United Nations released a series of goals for sustainable development to be reached in 2030. There are **17 goals** total, touching upon the most simple human needs up to the integration of globalized economies.



ADDITIONAL CLIMATE CHANGE INFORMATION SPECIFIC TO GREECE

CLIMATE CHANGE ESTIMATES IN GREECE FOR THE 20 YEAR TIME PERIOD OF 2045-2065:

- Temperature rise by 2.5 degrees celsius
- 15-20 more heat wave days per year
- 50 or more tropical days per year
- 12% decrease in rainfall
- 20-59 cm rise in sea levels
- 3.5% loss of land
- 90% of tourism infrastructures are located on the coast and tourism is one of Greece's main sources of income
- Extreme weather events will be more frequent and intense



KNOWLEDGE SURVEY

 = correct answer

GAME CONTENT WAS ESTABLISHED USING RESULTS FROM A PRE-KNOWLEDGE SURVEY WITH 126 TESTED KPE STUDENTS.

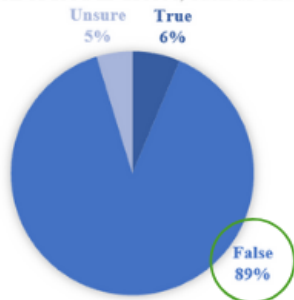
Strongest areas:

- Extreme weather events
- Farming and Food Production
- Sustainable Energy
- Habitats of Other Species

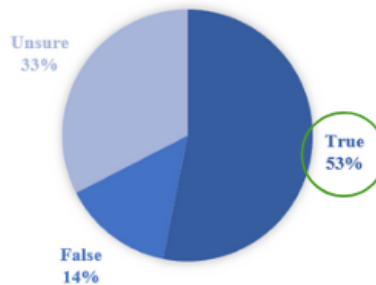
Weakest areas:

- CO2 and the Greenhouse Effect
- Change in Habitable Land
- Benefits of public Transportation
- Changes in the cost of living due to climate change

1. Climate change will not affect farming and the production of food in Greece, such as olive oil.



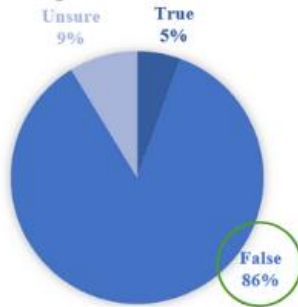
2. Carbon dioxide is a gas that has contributed to aggravating the greenhouse effect.



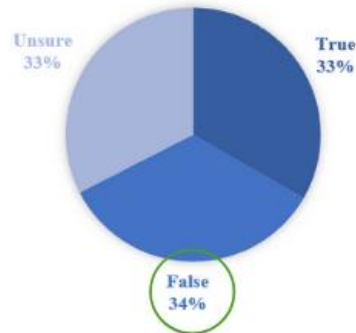
KNOWLEDGE SURVEY

 = correct answer

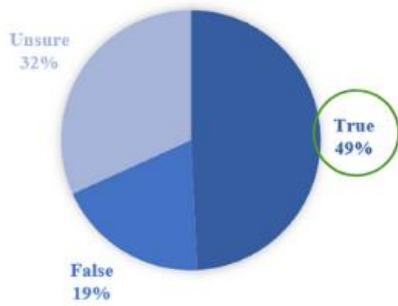
3. The use of solar and wind energy worsens the greenhouse effect.



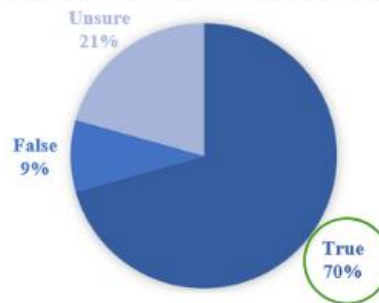
4. TV does not consume energy when it is turned off by remote control.



5. The greenhouse effect will lead to a decrease in habitable land.



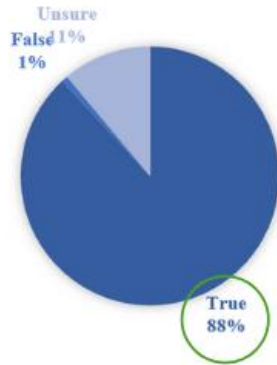
6. One of the impacts of intensifying the greenhouse effect will be the appearance of new diseases.



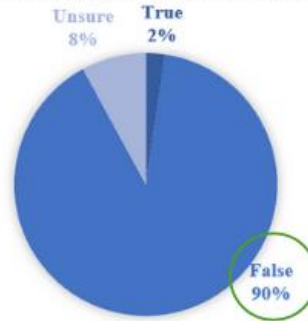
KNOWLEDGE SURVEY

 = correct answer

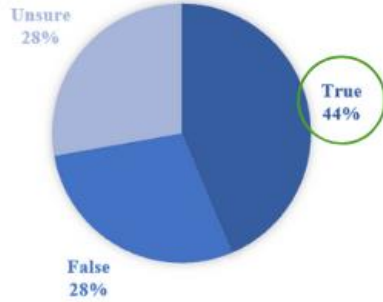
7. Extreme weather events are likely to become more frequent and intense.



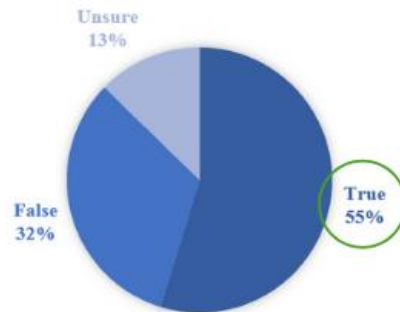
8. Climate change will not put populations of other species at risk of losing their habitats.



9. The use of public transportation can contribute to mitigating the greenhouse effect.



10. If climate change continues at this rate, the cost of living will increase.



SERIOUS GAMES



WHAT ARE SERIOUS GAMES?

Serious games are digital or hands-on games not intended to be played solely for amusement. They are meant to be educational tools to learn about various topics such as teaching and training, social inclusion, health, digital transformation and many other societal issues. Having fun while learning helps students remember information better because it is a memorable learning experience. Hands-on games teach children about important social skills and are easily accessible. Education through games provides an experiential learning environment which lets students learn by doing rather than by lecture, triggering influential emotional connections.

SINKING ISLAND



 5-15 mins.  6+ players  Large Space  2

LEARNING OBJECTIVES

- Learn about possible climate impacts
- Bonding among participants & energizing activity

MATERIALS

- Large piece of paper or cloth

SINKING ISLAND

FACILITATION GUIDELINES

1. Divide students into groups of 4-5 players.
2. Put a large sheet of paper on the floor (one for each group) and ask all group members to step onto the paper.
3. Tell the players that the paper symbolizes an island (for example a Greek island) that is affected by rising sea levels.
4. Explain the goal: The group that manages to keep everyone on the increasingly small surface/ "island" wins.
5. Give the groups 30-60 seconds to strategize before each round.
6. After they strategize, countdown from 10 to 1, if all team members remain safely on the 'island' by not stepping off the paper during those 10 seconds, they proceed to the next round.
7. Ask all remaining players to step off the 'island' and fold the paper in half.
Narrative option: "You have left your island and when you get back - guess what... the sea level has risen."
 - Lines can be drawn on the paper prior to the start of the game to make the papers identical in size for every group in each round.
8. Players get back on their islands. Give them 30-60 seconds to strategize again. Then, countdown from 10 to 1 again and those who are safe proceed to the next round.
9. Reduce the size of the paper in thirds from now on.
10. Repeat steps 8-9 until you have a winning team or teams (if all teams get out in one round, all of those teams win)!

DEBRIEFING QUESTIONS

1. Did you have fun playing this game? If so, what was your favorite part? If not, what did you not like?
2. Are sea levels rising? Explain your answer.
3. What did you learn about the effects of sea levels rising that you did not know before?

ORT REPORT



 10 mins.  2+ players  Small Space with Tables  1

LEARNING OBJECTIVES

- Learn about the relationship between food waste and climate change
- Observe how much food waste is produced by their classmates on a daily basis
- Learn how their actions (reducing their personal food waste) can mitigate the issue
- Have fun with classmates → friendly competition
- Increase enthusiasm about limiting food waste

MATERIALS

- Two buckets per group
- Bucket 1 → for food waste
- Bucket 2 → liquid waste
- Scale to measure the food and liquid waste

ORT REPORT

FACILITATION GUIDELINES

1. First undergo a small food waste activity, such as a fact about food waste, to educate students about the issue and how it relates to climate change.
2. Encourage groups to finish their snacks/ meals.
3. Collect all food and liquid waste and place it into the designated bucket (group and type of waste).
4. Weigh the food and liquid waste.
5. Prior to announcing the results, sing the "ort report song" to encourage enthusiasm and excitement amongst students.
♪ Oo, Ah, Ort Report. I said Oo, Ah, Ort Report ♪
6. Announce the results and present the first and last teams with their incentive and "punishment" accordingly.
7. Game winners/ last place:
 - The team with the least amount of waste left over are the winners and will be given an incentive (i.e. they can be the first to walk to lunch/ snack time next time, they can be first to undergo a different activity throughout the day, they can be the first to walk to the bus at the end of the day, etc.).
 - The team with the most amount of waste left over are the last place team and will get a "punishment" (i.e. they have to clean up the lunch/ snack room).

DEBRIEFING QUESTIONS

1. Did you have fun playing the game? If so, what was your favorite part? If not, what didn't you like?
2. Does food waste affect climate change?
3. What did you learn about the effects of food waste on climate change that you didn't know before?
4. What actions can you take to control the amount of food waste produced?

BEFORE THE STORM

Time Card

1 week

1 week

Forecast Card

Forecast!

Expected snowstorm with 20-30cm of snow.

Action Card



Store Food!

Harvest and/or buy food to store in case food becomes inaccessible!



10+ mins.



4+ players



Small Space with Tables



3

LEARNING OBJECTIVES

- Discussion-based activity
- Learn about extreme weather events
- Practice making decisions to prepare for disasters
- Friendly competition

MATERIALS

- Before the Storm deck of cards (included in the back of the booklet)

BEFORE THE STORM

FACILITATION GUIDELINES

1. Ask for a volunteer from each group to be the judge for the game.
2. Shuffle the time cards and have the judge place one on the table. This represents the lead-time of a forecast: how much time is expected to elapse between the issue of the forecast and the actual occurrence of the forecast event. When groups go through all 3 time cards, reshuffle and then continue playing.
3. Shuffle the forecast cards and have the judge place one in front of/ next to the time card.
4. Shuffle the action cards and distribute four cards to each player (except the judge). Some cards might be blank, tell the players that that is OK!
5. Inform players that they should play just one action card per turn, face down. The action cards correspond to recommending a plan for disaster preparedness in response to the forecasts and time given to prepare. The aim is to have a card that will be chosen by the judge as the most appropriate action for that lead time.
 - Note: When a player writes their own card, they must only write down one action (not multiple actions).
6. Have the judge shuffle and review the action cards. Players can try to convince the judge that their card is the best.
7. The judge awards 1 point to the best choice (that player keeps the action card in their score pile).
 - If two players have the same winning card, they both keep it and get 1 point each.
8. Continue play for 6+ rounds (1 forecast card is 1 round). The player with the most cards in their score pile wins. Ties are friendly (multiple winners result in a tie).

DEBRIEFING QUESTIONS

1. Did you have fun playing this game?
2. What did you learn that you didn't know before?

ANSWER WITH YOUR FEET

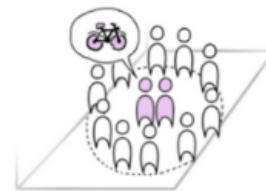
Numerical Arrangement
E.g. Favourite decade



Cluster Arrangement
E.g. Favourite food



Circle Arrangement
Eg. Step in if you ride a bike to work



 5+ mins.  6+ players  Medium Space  2

LEARNING OBJECTIVES

- Energizer / introductory exercise
- Opinion-based learning

MATERIALS

N/A

FACILITATION GUIDELINES

1. Clear the room and make sure there is space for people to move around.
2. Ask all participants to stand up.
3. Ask a series of questions and ask participants to self-organize along a spectrum (Agree, disagree, or I don't know areas/If they do something step inside the circle, if they don't stay on the outside of the circle).
4. With each question, ask 2-3 participants to share the details of their answer and ask follow-up questions if necessary.

ANSWER WITH YOUR FEET

EXAMPLE QUESTIONS

NUMERICAL ARRANGEMENT (Yes/Don't Know/No):

1. Are sea levels rising, specifically in Greece?
2. Do you think TV's use energy when they are turned off by remote control?
3. Do you think food waste contributes to climate change?
4. Do you think food production will be damaged by climate change?
5. Do you think Thessaloniki's infrastructure will be damaged due to climate change?
6. Can climate change affect Greece's economy?
7. Do you think the pollution in the bay will increase due to climate change?

NUMERICAL ARRANGEMENT (Spectrum):

8. How worried are you about the climate changing? (spectrum question)
 - > One side: very worried
 - > Middle: Worried, but not much
 - > Other side: not worried at all
9. How do you think climate change will affect extreme weather events?
 - > One side: they will become more frequent and intense
 - > Middle: They will not be affected
 - > Other side: they will become less frequent and intense

CLUSTER ARRANGEMENT:

10. What do you think is the biggest threat to Greece?
 - > Wildfires
 - > Rising sea levels
 - > Extreme rainfall

CIRCLE ARRANGEMENT:

11. Step in the circle if you use renewable energy in some way.
12. Step in the circle if you use the stairs instead of the elevator.
13. Step in the circle if you buy things that you don't use.
14. Step in the circle if you prefer local products.
15. Step in the circle if you turn on the fan instead of the AC when it gets hot.

DEBRIEFING QUESTIONS

1. What did you learn during this exercise about your classmates or about yourself?
2. Was it hard to go against the majority for some questions?
3. Have any of your opinions changed after this exercise? If so, which ones and how?

CONNECTING DOTS

OPTION 1



 10-15 mins.  4+ players  Small Space  4

LEARNING OBJECTIVES

- Learn about the indirect effects of a climate change phenomenon on aspects of a city or specified location (e.g. Thessaloniki)
- Incentivize reflection from students, stimulating teamwork and collaboration

MATERIALS

- String

CONNECTING DOTS

OPTION 1

FACILITATION GUIDELINES

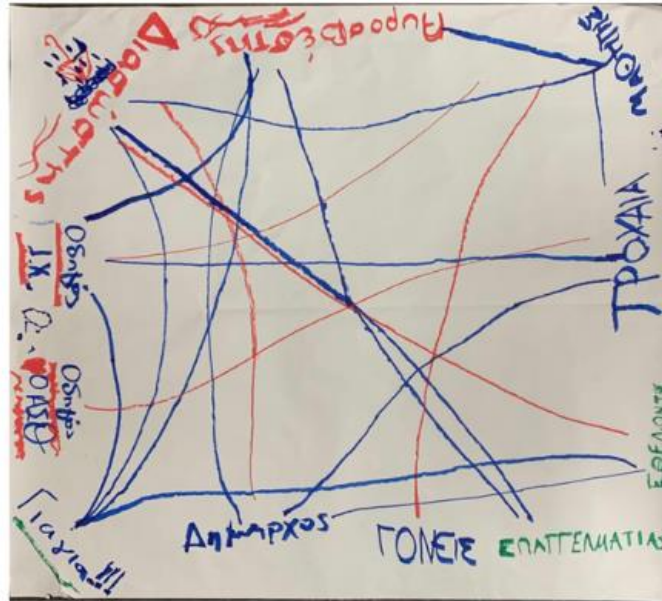
1. Ask players to gather in a circle around the facilitator.
2. Present a climate change event to the students.
3. Ask students to pick a stakeholder that is affected by the climate change event and discuss how the event affects them (only a couple stakeholders for this).
4. Have the remaining players pick a stakeholder that is affected by one or more of the already existing stakeholders.
5. Have the players discuss how the particular event will affect their stakeholder and how other stakeholders affect them.
6. Every time there is a connection from one stakeholder to another or from a stakeholder to the climate change event, the players will give each other a string that they will have to hold throughout the game, representing their connection.
7. At the end of the game, when all connections are made, the climate change event/facilitator will pull on the string and the players will feel the pull/impact that the event has on their stakeholder.
8. Players will play many rounds with other climate change phenomena to see the different impacts.
9. After finishing the game(s), explain to the players that there are many things that are not directly connected to climate change, but they still feel the impacts that climate change has.

DEBRIEFING QUESTIONS

1. For this climate change event, who do you think is impacted the most?
2. How would you prevent this disaster from happening?
3. From the solutions you just told me, how can we apply them to our everyday lives?

CONNECTING DOTS

OPTION 2



 10-15 mins.  4+ players  Small Space  4

LEARNING OBJECTIVES

- Learn about the effects of climate change in people's everyday lives
- Incentivize reflection from students, stimulating teamwork and collaboration

MATERIALS

- Large piece of paper
- Markers/writing utensil

CONNECTING DOTS

OPTION 2

FACILITATION GUIDELINES

1. Gather players in a circle around the large paper.
2. Present the students with a climate change event.
3. Each player will pick a different person in the community that would be affected by the climate change event.
4. Have players discuss how the particular event will affect their stakeholder. After successfully identifying how the event would impact their stakeholder, have them write their stakeholder on the paper by the side closest to them.
5. Have players discuss how other stakeholders affect them.
6. Every time a connection is made, draw a line connecting the people together on the paper. Continue this until no more connections can be made.

DEBRIEFING QUESTIONS

1. What did you learn from this activity? (Try to get them to explain how climate change can directly or indirectly impact everyone)
2. For this climate change event, who do you think is impacted the most?
3. How would you prevent this disaster from happening?
4. From the solutions you just told me, how can we apply them to our everyday lives?



TRAFFIC JAM



 10-15 mins.  15+ players  Large Space  4

LEARNING OBJECTIVES

- Explore the relationships between efficient transportation and carbon dioxide emissions
- Explore approaches to climate change mitigation

TRAFFIC JAM

MATERIALS

1. Chalk or signs to show where the different forms of transportation should go
2. Name Tags for the students representing vehicles (optional)
 - > Car
 - > Bus
 - > Bicycle
3. 4 buckets, 3 labeled:
 - > Car
 - > Bus
 - > Bicycle
4. Colored paper with point values written inside and crumbled into balls
 - > Red (worth 2 points)
 - > Yellow (worth 1 point)
 - > Green (worth 0 points)

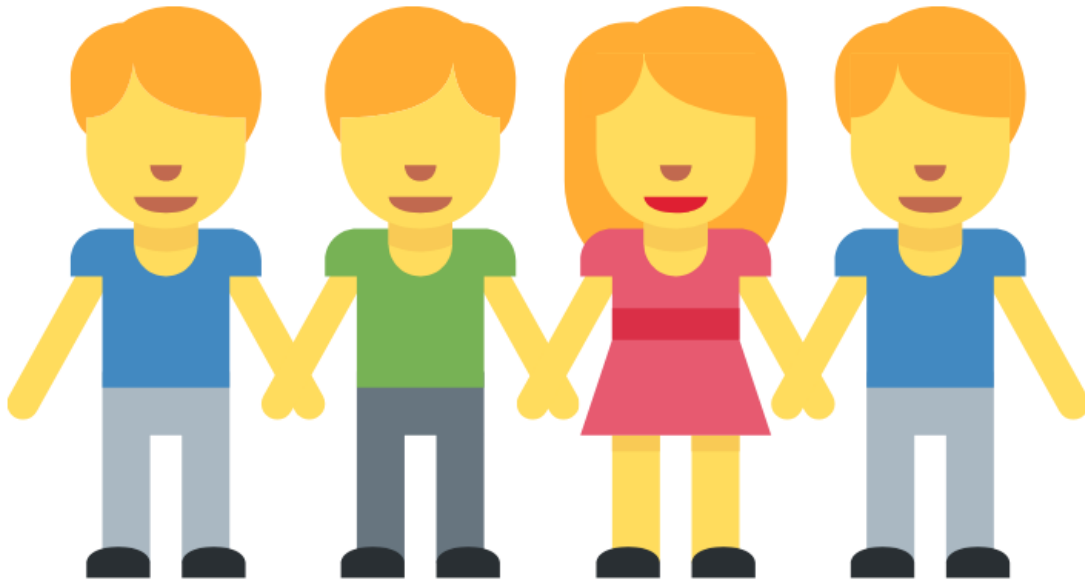
FACILITATION GUIDELINES





1. Draw a pathway representing streets with chalk or put up signs to show the pathways. If possible, make intersections for fun.
2. Separate players into groups and assign each player a vehicle.
 - > 1 car = 1 student
 - > 1 bicycle = 1 student
 - > 1 bus = 6-8 students
3. Each car will receive one yellow ball, each bus will receive one red ball total, each bicycle will receive one green ball.
4. Players will walk around the course and put their ball in the bucket at the end of the lap, then pick up another ball (of the same color) at the start.
5. Repeat for a predetermined number of laps.
6. Have players gather back into their 3 groups (cars, buses and bicycles) and hand back their balls to them.
7. Have them open their papers and count up the number of point their group has.
8. Write down the total point value for each group and the number of people that were in the group for everyone to see. Explain that each point is carbon emission, so the group with the highest number of points emits the most pollutant gases.

DEBRIEFING QUESTIONS

1. Why does the bus have a lower carbon footprint?
2. Why should we use bikes when possible?
3. Thessaloniki is a city with a lot of traffic. Why does public transportation seem to be a good alternative?

EXTREME WEATHER TAG



 5-10 mins.
  10+ players
  Large Space
  2

LEARNING OBJECTIVES

- Learn about how extreme weather events can affect people
- Be active and energetic
- Demonstrate the domino effect of climate change topics (extreme weather events in this case)
- Learn about how when a plan is not in place (not resilient) prior to an extreme weather event, everything becomes chaotic and more people will be negatively impacted

MATERIALS

N/A

EXTREME WEATHER TAG

FACILITATION GUIDELINES

1. Pick one player or have one volunteer to be the "tagger," who will represent an extreme weather event.
2. The player who is the "tagger" runs around trying to tag the other students.
3. Once a player is tagged, they become a "tagger" in addition, and hold hands or link arms with the student who is already it (now both players represent an extreme weather event).
4. The more players tagged, the longer the line of students becomes, showing how weather intensifies and grows.
5. When all players have been tagged, the game is over. The last player remaining wins.

DEBRIEFING QUESTIONS

1. What did you learn about the growth of extreme weather events?
2. How does the scalability of the event affect isolated populations?
3. Did you have fun playing this game?
4. How should you prepare for extreme weather events?

SURVIVOR



 10-20 mins.  10+ players  Medium Space  4

LEARNING OBJECTIVES

- Survive extreme weather events
- Climate change resilience
- Teamwork

MATERIALS

N/A

SURVIVOR

FACILITATION GUIDELINES

1. Tell the group of students to stand in a clump in the center of the room/area.
2. Explain the rules:
 - > If there is a flood, you must get in a "boat" with the specified number of people and pretend to row.
 - > If there is a hurricane, you must cross your arms and link hands with the specified number of people.
 - > If there is a wildfire, you must run to the opposite side of the room than the fire is coming from (opposite of where the facilitator points to).
 - > If there is a heatwave, you must crouch to the ground with your hands covering your head.
3. The last person to complete these tasks or the people that are unable to complete the task (do not fit in a group) get out and stand off to one side of the room, out of the way of the players still in.
4. Each round, pick a new number and/or task. As people get out, the total group gets smaller.
5. Keep playing until there is 1 person left - they are the survivor!

DEBRIEFING QUESTIONS

1. What did you learn from playing this game?
2. Did you have fun?
3. How does this relate to your life?

HOP 'TIL YOU DROP



 5-10 mins.  4+ players  Large Space  5

LEARNING OBJECTIVES

- Learn about urban resilience plans and which are most effective

MATERIALS

- Chalk
- Game cards (index cards)

HOP 'TIL YOU DROP

FACILITATION GUIDELINES

1. Split the students into "X" groups of 3-8 players each.
2. Draw "X" paths using the chalk (try to make them similar distances from start to finish and the same number of left and right turn options. If you can make the paths identical, that would be ideal). Assign a different group to each path.
3. Place the game cards with the questions facing up at each intersection where students must make a choice.
 - Write the resilience plan questions on one side with the 2 options for answers. On the other side, write which answer corresponds to which direction on the path. The better answer should correspond to the shorter path.
 - Example question: If strong winds are predicted to occur, would you first:
 - a. Secure any loose outdoor items
 - b. Buy food to store
 --> The best answer is "a", secure any loose outdoor items. Winds could cause items to damage homes or injure people while storing food is not as important in this particular situation.
4. Explain to the students that there are different climate change disasters that are about to occur, so they will be tasked with the decision of which resilience plan to use in each disaster situation. Tell them that they are in a race to complete the path the quickest. They should be trying to answer correctly so that you can take the fastest route to the finish.
5. Explain to the students that they must complete the course by hopping (decide if you'd prefer them to hop on one foot or both feet).
6. Have the students get to their starting point on the paths and once they are all in positions, let them know that they may begin.
7. If possible, have the students tell the teachers/instructors what their decision is at each intersection before moving on during the game (best scenario is if one instructor is assigned to each group).
8. After the students have informed their instructor, have them flip over the index card to reveal which direction corresponds to which answer and have them follow the corresponding direction for their answer.
9. Have the students continue hopping and answering the index card questions at each intersection until they have completed the entire path.
10. Congratulate the team that completes the game the quickest, but allow the other groups to complete their path so that they are able to answer all of the questions/scenarios.

DEBRIEFING QUESTIONS

1. The group that finished the fastest, what decisions did you make? The group that finished last, what decision did you make?
2. Are there any decisions that you would change now that the game is over?

CAUSE AND EFFECT

<p>Πυρκαγιές</p> <hr/> <p>Πυρκαγιές</p>	<p>Αύξηση διοξειδίου του άνθρακα στην ατμόσφαιρα</p> <hr/> <p>Αύξηση διοξειδίου του άνθρακα στην ατμόσφαιρα</p>	<p>Ξηρασία</p> <hr/> <p>Ξηρασία</p>
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 10 mins.  2-6 players  Small Space with Tables  3

LEARNING OBJECTIVES

- Help students rationalize causes and consequences of climate change and brainstorm solutions by stimulating critical thinking
- Practice thinking and decision making

MATERIALS

- Cards: Could be pre-labeled cards (located in the back of the booklet) or created by the students as a warm up exercise for the game
- Permanent marker

CAUSE AND EFFECT

FACILITATION GUIDELINES

1. Split the students in groups of 5-6 and have them sit in a circle.
2. Shuffle the cards and deal 4 cards to each student.
 - If the cards need to be made, label them with numerous causes and effects of climate change, mitigation strategies and urban resilience
3. Place the remainder of cards in a pile face down in the middle of the circle and flip over the top card so everyone can read what it says.
4. The student who goes first will have the option of picking up the face-up card or choosing a new card from the stack. The object of each turn is to match a "cause" card with an "effect" card.
5. Cards that have matching causes and effects will be pairs.
6. Players must discard one card into the face-up stack after each turn. Players should always have 4 cards in their hands.
7. When a player thinks she's made a match, he/she must show the matching cards to his/her opponent. If the match makes sense, the match will be approved. If not, then she'll have to try for a new match during her next turn.
8. The student with the most correct matches wins.

DEBRIEFING QUESTIONS

1. Did you have fun playing this game?
2. What did you learn that you didn't know before?

RACE FOR RESILIENCE



 10+ mins.  4+ players  Large Space  5

LEARNING OBJECTIVES

- Discussion based activity
- Learn about climate change causes, mitigation strategies and resilience plans
- Practice thinking and decision making under pressure
- Incentivize reflection from students, stimulate teamwork and collaboration

MATERIALS

- Cards (located in the back of the booklet)
- Permanent marker
- Tape

RACE FOR RESILIENCE

FACILITATION GUIDELINES

1. Split players into teams of 4-5 people.
2. Present each team with the same climate change issue/ topic (i.e. rise in temperatures with an increase in CO2 in the environment and decreased food production) and have them start the obstacle course.
3. The first obstacle will involve the pairing of the given climate change cause with its particular impacts. A variety of climate change causes and impacts will be labeled on cards. Teams will be presented with one climate change cause. Each team will have to select 3 impacts to pair with that cause. You must approve their cards before each team can move on. Once approved, tell the team that they can move to the next obstacle.
4. The second obstacle involves the identification of mitigation strategies. Ask each team to come up with 3 mitigation strategies. Teams will write their strategies on a piece of paper. You must approve their strategies before each team can move on. Once approved, tell the team that they can move to the final obstacle.
5. The final obstacle involves the identification of a resilience plan for the given climate change issue/ topic. The resilience plan will be presented in the form of a scavenger hunt. Hide the resilience plan steps throughout the space available. Disperse different resilience plans throughout and assign each team one of them. The plans will be numbered, so have the teams follow the steps on their designated numbered card. The cards when placed together will display a resilience plan to help cope with the given climate change issue/ topic.
6. The team who finishes the obstacle course first wins.

DEBRIEFING QUESTIONS

1. What did you learn?
2. Which resilience plan will be most effective for the given climate change issue/ topic?

SURVIVAL OF THE M&M'S



 10+ mins.  2+ players  Small Space with Tables  4

LEARNING OBJECTIVES

- Learn how to use resources in an efficient way
- Practice thinking and decision making under pressure
- Learn how to plan and prepare for expected climate change events.

MATERIALS

- M&Ms
- Straws
- Plates

SURVIVAL OF THE M&M'S

FACILITATION GUIDELINES

1. Give players 2 of each colored M&M. Each color represents a different resource:
 - > Green M&Ms represent trees
 - > Red M&Ms represent food
 - > Yellow M&Ms represent money
 - > Brown M&Ms represent land
 - > Blue M&Ms represent water
 - > Orange M&Ms represent shelter
2. Present players with a different climate change event each round (i.e. rise in sea level) in which particular resources are necessary to stay alive. If a player does not have the necessary resources to survive the event, they are out of the game.
3. Each round, have players put aside 2 M&M's (the resources they may not need for that particular event). They will have to strategically select which M&M's to keep and which to put aside. M&M's can be moved by sucking through a straw to pick them up from the plate.
4. Each round M&M's will "reproduce" by doubling (for example, if a player keeps 2 green M&M's, the next round they will have 4 green M&M's, if they keep 1 green M&M, the next round they will have 2 green M&M's). Players will not be able to foresee what climate change event will happen next. As a result, they must strategically select which M&M's to put aside and which to keep and "reproduce" to account for whatever may happen in the future.
5. The game will have a specified number of rounds (players will be presented with a set number of climate change events).
6. The player with the highest number of M&M's (resources) at the end wins.

DEBRIEFING QUESTIONS

1. What did you learn?
2. Is it better to use up all your resources when you need them, or to save them in order to plan and prepare for potential climate change events?

GREENHOUSE GAS EFFECT



20+ mins.



16-25 players

Large Open
Space

4

LEARNING OBJECTIVES

- To understand how the greenhouse effect works, what human activities affect it, and how it affects the increase in Earth's temperature
- Learn about how to reduce greenhouse gas emissions, avoid greenhouse gases and mitigate climate change
- Critical thinking and combine information to find solutions

MATERIALS

- Name Tags (Laminated paper with sunlight and CO₂ molecules labels separately)
- Colored chinks

GREENHOUSE GAS EFFECT

FACILITATION GUIDELINES

1. Select a volunteer to represent the Earth.
2. Select 5-8 students to represent the CO₂ molecules (have them wear the CO₂ name tag).
3. Select 10-16 students to represent the Sun's rays (give them the corresponding name tag). Note: The number of students representing the sun's rays should be about twice as high as the number of CO₂ molecules.
4. Have the student, who represents the Earth, sit at the center of the space. From a certain distance from the Earth (about 3-4 steps), draw a circle and then draw another circle with a different chalk color at a greater distance (about 7-8 steps) from Earth.
5. Have the students representing the sun rays stand around in the outer circle and tell them that they can only move in a straight line.
6. Tell the first part of history (before the Industrial Revolution). Have 2 CO₂ students take their place in the inner circle.
7. Tell the students representing the sun's rays to move to Earth. Tell the CO₂ students that they must stand in their spot with their hands down.
8. Tell the sun ray students to return back to their original place in "space". Tell the CO₂ students that they can try to tag the sun rays (without moving their feet). During this, if the sun rays hit a CO₂, have them stop and remain close to Earth.
9. Count how many rays are trapped near Earth. Explain that this heat provides the Earth with a mild average temperature and allows life to still develop. Students place 1-2 jackets on the "Earth" to represent this increase in temperature.
10. Have all students representing sun rays return to the outer circle. Now, tell the second part of the story (industrial revolution). Ask students if CO₂ is increased in the atmosphere. 1-2 more CO₂ students should now take their place in the inner circle.
11. Repeat steps 7 & 8.
12. Measure how many rays are now trapped near the Earth and compare with the previous round. Ask the students what impact this has on Earth's temperature. Students place 1-2 more jackets on the "Earth."
13. Tell all students representing the sun rays to return to the outer circle. Tell the third part of the story (oil discovery). Ask students if CO₂ is increased in the atmosphere. Have 1-2 more CO₂ students take their place in the inner circle.
14. Repeat steps 7 & 8.
15. Count how many rays are now trapped near the Earth and compare with the previous round. Ask what impact this has on Earth's temperature. Students place 2-3 more jackets on the "Earth."

GREENHOUSE GAS EFFECT

FACILITATION GUIDELINES CONTINUED

16. Tell all students representing the sun rays to return to the outer circle. Now tell the fourth part of history (today's era). Ask students if CO₂ is increased in the atmosphere. Have 1-2 more CO₂ students take their place in the inner circle.
17. Repeat steps 7 & 8.
18. Count how many rays are now trapped near the Earth and compare with the previous round. Ask what impact this has on Earth's temperature. Students place 2-3 more jackets on the "Earth."
19. Tell all students, except the "Earth," to return to their positions. Ask them what conclusions they made. Ask the student representing the Earth how he/she feels under all of the jackets.
20. Have students propose solutions to reduce greenhouse gas emissions. When a student proposes a correct solution, ask him/her to remove a jacket from the "Earth."
21. The game ends when all jackets have been removed.

DEBRIEFING QUESTIONS

1. Did you have fun playing the game?
2. Did you learn anything from playing this game? What did you learn?
3. What are your final conclusions after playing this game?
4. What can we do to reduce the production of CO₂ and greenhouse gases?

GREENHOUSE GAS EFFECT

STORY

First Part:

Imagine 2-3 thousand years. In the atmosphere of the Earth, among other gases, there is also a small amount of CO₂. It comes mainly from volcanic eruptions and fires. The plants absorbed it to live, and what was left in the atmosphere kept the sun's rays on Earth. So the Earth maintained a satisfactory temperature and hosted life. Otherwise we will freeze

Second Part:

The years have passed ... we reached the industrial revolution for centuries, around 1750. The man discovered the machine and the use of coal to produce energy and movement. He built trains, boats, factories that all burned coal for their engines to work and produce or produce. And as the charcoal was burning, the CO₂ grew ... and slowly raised to the upper layers of the atmosphere ...

Third Part:

We are in 1900. We discovered something more precious than coal ... oil, black gold! We used oil to work the factories, to move ships and trains, to heat the buildings, build cars and planes. Movements were multiplied, the products produced by the factories as well. People spread and grew up, needed timber to build their homes and more land to cultivate, and they began to cut forests.

Fourth Part:

We arrive to today. The earth's population has surpassed 7 billion and is rising rapidly. We use more energy than ever! In homes for lighting, heating, work for appliances, in the city, in stores, in services, in factories to produce more and more products, to transport products from every corner of the earth to move ... Every family has one or more cars, we travel with airplanes more and more often since they are inexpensive! And of course, we use fossil fuels ... coal, oil, gas. And we consume too much, even if we do not get used to everything we buy. And we produce a lot of food, we throw a lot of food, we eat much more meat and we cut the forests to spread our crops. Scientists warn: CO₂ has grown a lot and will grow more and more if we do not take action! We move to self-destruction ...

FIND SOMEONE WHO



 10+ mins.  10+ players  Small Open Area  2

LEARNING OBJECTIVES

- Introductory exercise
- Opinion-based learning
- Understand what people currently do in relation to climate change and why/how they should make changes

FIND SOMEONE WHO

MATERIALS

- Pen/pencil
- Clipboard (not necessary but helpful)
- Piece of paper with the “find someone who...” statements
- These statements include:
 - Find someone who has heard that ice caps are melting.
 - Find someone who feels like the seasons have changed.
 - Find someone who has a way to reduce energy consumption.
 - Find someone who uses solar panels to warm water (boiler?).
 - Find someone who uses the stairs instead of an elevator.
 - Find someone who turns off the lights when they leave or when they do not need them on.
 - Find someone who buys things that they do not use.
 - Find someone who has a personal story about climate change or the impacts of climate change.
 - Find someone who prefers local products.
 - Find someone who worries about climate change.
 - Find someone who has ideas about what causes climate change.
 - Find someone who has heard that there have been many fires over the last few years.
 - Find someone who uses a fan instead of an air conditioner to cool down.
 - And any other “find someone who” statements that you would like to add.

FACILITATION GUIDELINES

1. Hand out one statement paper (and the clipboards if available) to every student.
2. Instruct them to stand up and find 3 people who match their statements.
3. Have them write down a description/explanation of why the person matches that statement.
4. The students continue until time is up.

DEBRIEFING QUESTIONS

1. What were some interesting or good answers for question 1? question 2? And so on...
2. Did you enjoy this game? What did you like about it?



TIPS FOR DESIGNING SERIOUS GAMES

- Create games that relate to your audience.
- Think about what content you would like to teach your students first, then decide which mechanics would be more effective for that specific content. Pair more complex mechanics with information-heavy content.
- Make sure the game clearly gets your intended objective across.
- Don't make the game overly educational. Have a good balance of education and fun.
- When designing games, take into consideration the space that you will be using and the number of students that will be participating. Many times this will impact the game and adjustments will need to be made.
- Continuously test and adjust your game to improve.

ENVIRONMENTAL EDUCATION ADVICE VIDEOS

**The importance of climate change
education:**

<https://youtu.be/s9WgWEgUzP4>

**Advice on facilitation and student
engagement:**

<https://youtu.be/-vKtQ-lQhjw>

**How to overcome challenges
associated with climate change
education through serious games:**

https://youtu.be/p49hH0PO_Lk





CONTACT INFORMATION FOR EMERGENCY RESOURCES IN GREECE

- Emergency: 112
- Ambulance: 166
- Fire Department: 199
- Police: 100
- Anti-drug Police: 109
- Coast Guard: 108
- Tourist Police: 171
- Pharmacies: 107
- Hospitals: 106
- Forest Fire Authority: 191
- Traffic Police: 10400
- Weather Service: 148
- International Phone Assistance: 139
- General Telephone Information: 11888

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APPENDIX

CARDS AND FACILITATION RESOURCES

- Sinking Island Material Guidelines
- Before the Storm Cards
- Cause and Effect Cards
- Race for Resilience Cards

SINKING ISLAND MATERIAL

First round: use the entire sheet of paper
Second round: fold the paper on the line labeled "1"

Third round: fold the paper on the line labeled "2"
Fourth round: fold the paper on the line labeled "3"

Fifth round: fold the paper on the line labeled "4"
Sixth round: fold the paper on the line labeled "5"

BEFORE THE STORM CARDS



Negotiate!

Seek funding from international sources



Repair Roads!

Repair / check flood structures (roads, routes, etc)



Review!

Assess what was done in the last storm and adjust accordingly



Play Sports!

Things seem calm so have fun!



Store Food!

Harvest and/or buy food to store in case food becomes inaccessible!



Gather Families!

Move families to safe shelter. Pack only essentials.



Evacuate!

Make sure to evacuate areas that have flooded in the past.



Prepare!

Practice evaluation routes and meeting locations.



Communicate!

Broadcast weather warnings on the Television and Radio.

BEFORE THE STORM CARDS



Herd!

Move animals to a safe place.



Communicate!

Check to make sure communication devices are working properly.



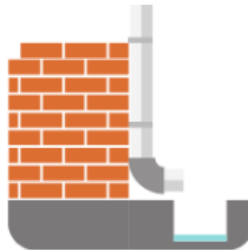
Satellite!

Check the weather for a more detailed forecast.



Prepare!

Store drinkable water.



Clean Up!

Make sure the gutters and down-pipes are clean and free of waste.



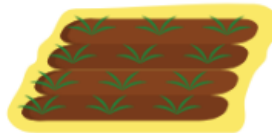
Check Supplies!

Check and restock emergency supplies.



Dig Ditches!

Dig drainage ditches to reroute water.



Tend to Fields!

Prepare the fields for growth.



Relax!

Socialize with friends, play with pets or play games.

BEFORE THE STORM CARDS



Recover!

Acquire seeds and tools to replant any damaged crops.



Prepare!

Move valuables to higher ground or a secure location.



Help Out!

Take care of people in the community that may not be able to help themselves.



Prepare!

Have a flashlight handy and buy extra batteries.



Monitor!

Check weather again in one week.



Unplug!

Unplug electrical appliances and switch them off at the circuit board.



Monitor!

Check the weather every week to see if there's any change.



Prepare!

Fill vehicles with gasoline and fill extra gas cans.



Secure Items!

Secure any loose outdoor items.

BEFORE THE STORM CARDS



Prepare!

Seal windows and doors to prevent leaks!



Trim Trees!

Trim trees so they don't fall on your house.



Prepare!

Have a list of emergency contacts ready.



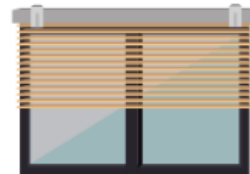
Clear Drains!

Remove debris and objects from outside drains.



Prepare!

Make a first aid kit and get trained on basic first aid procedures.



Cover!

Cover windows that receive a lot of direct sunlight.



Stay Inside!

Stay indoors until it is safe to go outside.



Communicate!

Call your neighbors, friends and family to check in on them.

BEFORE THE STORM CARDS

24 hours	3 days	1 week
.....
24 hours	3 days	1 week
Forecast! Skies are partly-cloudy and you can see dark clouds in the distance.	Forecast! It is a nice day, and will most likely remain a nice day.	Forecast! Strong winds. There is a 70% probability that winds will blow in excess of 120 km per hour.

BEFORE THE STORM CARDS

<p>Forecast!</p> <p>Heavy rains expected for 3 consecutive days.</p>	<p>Forecast!</p> <p>Light showers are very likely to occur.</p>	<p>Forecast!</p> <p>Regions west of here are experiencing unprecedented rains.</p>
<p>Forecast!</p> <p>Accumulated rainfall expected to reach 40% above normal. The likelihood of severe flooding is 30%.</p>	<p>Forecast!</p> <p>Up to 35mm of rain likely to occur in this region, with 90% probability for a duration of 24 hours.</p>	<p>Forecast!</p> <p>Temperatures are expected to rise above 40°C.</p>
<p>Forecast!</p> <p>Strong chance of severe thunder and lightening.</p>	<p>Forecast!</p> <p>Expected snowstorm with 20-30cm of snow.</p>	<p>Forecast!</p> <p>Heatwave predicted with no rainfall for 1 month.</p>

CAUSE AND EFFECT CARDS

<p>Ξηρασία</p> <p>.....</p> <p>Ξηρασία</p>	<p>Λιώσιμο των πάγων στους πόλους</p> <p>.....</p> <p>Αύξηση της θερμοκρασίας</p>	<p>Αύξηση διοξειδίου του άνθρακα στην ατμόσφαιρα</p> <p>.....</p> <p>Αύξηση της θερμοκρασίας</p>
<p>Επιδείνωση του φαινομένου του θερμοκηπίου</p> <p>.....</p> <p>Επιδείνωση του φαινομένου του θερμοκηπίου</p>	<p>Έντονες βροχοπτώσεις</p> <p>.....</p> <p>Έντονες βροχοπτώσεις</p>	<p>Περισσότεροι καύσωνες</p> <p>.....</p> <p>Περισσότεροι καύσωνες</p>
<p>Αύξηση της θερμοκρασίας του πλανήτη</p> <p>.....</p> <p>Αύξηση της θερμοκρασίας του πλανήτη</p>	<p>Αλλαγές στα φυτά και ζώα μιας περιοχής</p> <p>.....</p> <p>Αλλαγές στα φυτά και ζώα μιας περιοχής</p>	<p>Μείωση παραγωγής τροφίμων</p> <p>.....</p> <p>Μείωση παραγωγής τροφίμων</p>

CAUSE AND EFFECT CARDS

<p>Καύση ορυκτών καυσίμων</p> <p>.....</p> <p>καύση ορυκτών καυσίμων</p>	<p>Αύξηση θερμοκρασίας ωκεανών</p> <p>.....</p> <p>Αύξηση θερμοκρασίας ωκεανών</p>	<p>Μετακινήσεις ανθρώπων με κάθε είδους οχήματα</p> <p>.....</p> <p>Μετακινήσεις ανθρώπων με κάθε είδους οχήματα</p>
<p>Αλλαγή του κλίματος της περιοχής</p> <p>.....</p> <p>Αλλαγή του κλίματος της περιοχής</p>	<p>Εξαφανίσεις ειδών (φυτά, ζώα)</p> <p>.....</p> <p>Εξαφανίσεις ειδών (φυτά, ζώα)</p>	<p>Μεταφορές προϊόντων με κάθε είδους οχήματα</p> <p>.....</p> <p>Μεταφορές προϊόντων με κάθε είδους οχήματα</p>
<p>Άνοδος στάθμης της θάλασσας</p> <p>.....</p> <p>Άνοδος στάθμης της θάλασσας</p>	<p>Καταστροφή αγροτικής παραγωγής</p> <p>.....</p> <p>Καταστροφή αγροτικής παραγωγής</p>	<p>Καταστροφές σε υποδομές (δρόμοι, γέφυρες κλπ)</p> <p>.....</p> <p>Καταστροφές σε υποδομές (δρόμοι, γέφυρες κλπ)</p>

CAUSE AND EFFECT CARDS

<p>Μείωση της αγροτικής παραγωγής</p> <hr/> <p>Μείωση της παραγωγής αγροτικής</p>	<p>Καταστροφές περιουσιών (σπίτια, αυτοκίνητα κλπ)</p> <hr/> <p>Καταστροφές περιουσιών (σπίτια, αυτοκίνητα κλπ)</p>	<p>Απώλειες ανθρώπινων ζώων</p> <hr/> <p>Απώλειες ανθρώπινων ζώων</p>
<p>Πιο έντονοι καύσωνες στις πόλεις</p> <hr/> <p>Πιο έντονοι καύσωνες στις πόλεις</p>	<p>Μετανάστευση ανθρώπων</p> <hr/> <p>Μετανάστευση ανθρώπων</p>	<p>Πλημμύρες</p> <hr/> <p>Πλημμύρες</p>
<p>Χαλάζι - Ανεμοστρόβιλοι</p> <hr/> <p>Χαλάζι - Ανεμοστρόβιλοι</p>	<p>Εκπομπή διοξειδίου του άνθρακα από οχήματα</p> <hr/> <p>Εκπομπή διοξειδίου του άνθρακα από οχήματα</p>	<p>Αύξηση τιμών τροφίμων</p> <hr/> <p>Αύξηση τιμών τροφίμων</p>

CAUSE AND EFFECT CARDS

<p>Εκπομπή αερίων θερμοκηπίου από θέρμανση</p> <p>.....</p> <p>Εκπομπή αερίων θερμοκηπίου από θέρμανση</p>	<p>Εκπομπή διοξειδίου του άνθρακα από παραγωγή ηλεκτρικής ενέργειας</p> <p>.....</p> <p>Εκπομπή διοξειδίου του άνθρακα από παραγωγή ηλεκτρικής ενέργειας</p>	<p>Αύξηση των έντονων καιρικών φαινομένων</p> <p>.....</p> <p>Αύξηση των έντονων καιρικών φαινομένων</p>
<p>Πυρκαγιές</p> <p>.....</p> <p>Πυρκαγιές</p>	<p>Συγκρούσεις για το νερό/έδαφος</p> <p>.....</p> <p>Συγκρούσεις για το νερό/έδαφος</p>	<p>Καταστροφή κοραλλιών από αύξηση θερμοκρασίας νερού</p> <p>.....</p> <p>Καταστροφή κοραλλιών από αύξηση θερμοκρασίας νερού</p>
<p>Υπερκατανάλωση</p> <p>.....</p> <p>Υπερκατανάλωση</p>	<p>Καταστροφή δασών</p> <p>.....</p> <p>Καταστροφή δασών</p>	<p>Σπατάλη τροφίμων</p> <p>.....</p> <p>Σπατάλη τροφίμων</p>

CAUSE AND EFFECT CARDS

<p>Μείωση γλυκού νερού</p> <p>.....</p> <p>Μείωση γλυκού νερού</p>	<p>Επιπτώσεις στην υγεία</p> <p>.....</p> <p>Επιπτώσεις στην υγεία</p>	<p>Περιοχές κοντά στην θάλασσα θα πλημμυρίσουν</p> <p>.....</p> <p>Περιοχές κοντά στην θάλασσα θα πλημμυρίσουν</p>
<p>Χιονοδρομικά κέντρα ίσως μειώσουν την λειτουργία τους</p> <p>.....</p> <p>Χιονοδρομικά κέντρα ίσως μειώσουν την λειτουργία τους</p>	<p>Νησιά θα κατακλυστούν από θάλασσα</p> <p>.....</p> <p>Νησιά θα κατακλυστούν από θάλασσα</p>	<p>Δημοφιλείς παραλίες θα κατακλυστούν από τη θάλασσα</p> <p>.....</p> <p>Δημοφιλείς παραλίες θα κατακλυστούν από τη θάλασσα</p>
<p>Επιπτώσεις στην οικονομία</p> <p>.....</p> <p>Επιπτώσεις στην οικονομία</p>	<p>Φτώχεια</p> <p>.....</p> <p>Φτώχεια</p>	<p>Περισσότεροι καύσωνες</p> <p>.....</p> <p>Περισσότεροι καύσωνες</p>

CAUSE AND EFFECT CARDS

<p>Πυρκαγιές</p> <p>.....</p> <p>Ξηρασία</p>	<p>Αύξηση τιμών τροφίμων</p> <p>.....</p> <p>Αύξηση τιμών τροφίμων</p>	<p>Ξηρασία</p> <p>.....</p> <p>Ξηρασία</p>
<p>Εξαφάνιση ειδών</p> <p>.....</p> <p>Εξαφάνιση ειδών</p>	<p>Λιώσιμο πάγων</p> <p>.....</p> <p>Λιώσιμο πάγων</p>	<p>Άνοδος στάθμης της θάλασσας</p> <p>.....</p> <p>Άνοδος στάθμης της θάλασσας</p>
<p>Πλημμύρες</p> <p>.....</p> <p>Πλημμύρες</p>	<p>Μετακίνηση πληθυσμών</p> <p>.....</p> <p>Μετακίνηση πληθυσμών</p>	<p>Αύξηση της θερμοκρασίας του πλανήτη</p> <p>.....</p> <p>Αύξηση της θερμοκρασίας του πλανήτη</p>


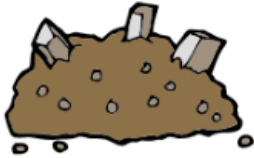
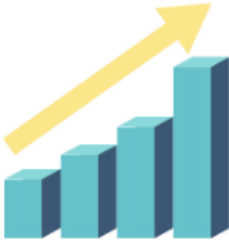



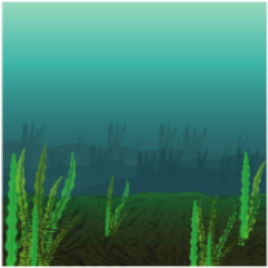


CAUSE AND EFFECT CARDS

<p>Αύξηση διοξειδίου του άνθρακα στην ατμόσφαιρα</p> <p>.....</p> <p>αύξηση διοξειδίου του άνθρακα στην ατμόσφαιρα</p>	<p>Επιδείνωση του φαινομένου του θερμοκηπίου</p> <p>.....</p> <p>Επιδείνωση του φαινομένου του θερμοκηπίου</p>	<p>Καταστροφή δασών</p> <p>.....</p> <p>καταστροφή δασών</p>
<p>Ξηρασία</p> <p>.....</p> <p>Ξηρασία</p>	<p>Άνοδος στάθμης της θάλασσας</p> <p>.....</p> <p>Άνοδος στάθμης της θάλασσας</p>	<p>Πλημμύρες</p> <p>.....</p> <p>Πλημμύρες</p>
<p>Αύξηση διοξειδίου του άνθρακα στην ατμόσφαιρα</p> <p>.....</p> <p>αύξηση διοξειδίου του άνθρακα στην ατμόσφαιρα</p>	<p>Πυρκαγιές</p> <p>.....</p> <p>Πυρκαγιές</p>	




RACE FOR RESILIENCE CARDS

<p>Cause</p>  <p>Air pollution</p>	<p>Cause</p>  <p>Cities not designed to deal with climate change</p>	<p>Cause</p>  <p>Poor waste treatment</p>
<p>Cause</p>  <p>Pollution</p>	<p>Cause</p>  <p>Lack of green spaces</p>	<p>Cause</p>  <p>Greenhouse effect</p>
<p>Cause</p>  <p>Overconsumption</p>	<p>Cause</p>  <p>Overpopulation</p>	<p>Cause</p>  <p>Deforestation</p>

RACE FOR RESILIENCE CARDS

<p>Cause</p>  <p>Burning Fossil Fuels - CO2 Emission</p>	<p>Impact</p>  <p>Drier soil</p>	<p>Impact</p>  <p>Extreme weather events incident increases</p>
<p>Impact</p>  <p>Droughts</p>	<p>Impact</p>  <p>Ozone layer hole</p>	<p>Impact</p>  <p>Increase in ocean temperature</p>
<p>Impact</p>  <p>Change in ecosystems</p>	<p>Impact</p>  <p>Reduction in humidity</p>	<p>Impact</p>  <p>Polar caps melting</p>

RACE FOR RESILIENCE CARDS

<p>Impact</p>  <p>Some species will become endangered/extinct</p>	<p>Impact</p>  <p>Ocean acidification</p>	<p>Impact</p>  <p>Urban heat islands</p>
<p>Impact</p>  <p>Rising temperatures</p>	<p>Impact</p>  <p>Respiratory diseases</p>	<p>Impact</p>  <p>Release of toxic substances in land, air and bodies of water</p>
<p>Impact</p>  <p>Higher energy consumption</p>	<p>Impact</p>  <p>Floods</p>	<p>Impact</p>  <p>Extreme rainfall</p>

RACE FOR RESILIENCE CARDS

Impact



Sea level rise

Impact



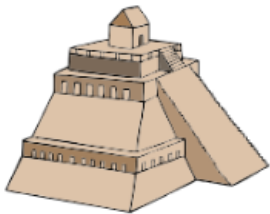
Hurricanes

Impact



Acid rain

Impact



Increased erosion in
archeological sites

Impact



Declining food production

Impact



Traffic jam and emission
of gases

Impact



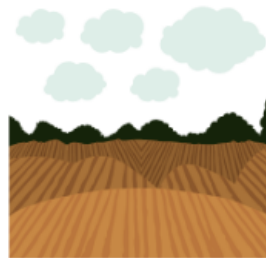
Tourism decreases

Impact



Price of goods increase

Impact



Damaged agricultural
production