Investigation Into Fire Prevention Techniques For Use In Northern Thailand's Mae Ping National Park

An Interactive Qualifying Project and Interactive Science and Social Project

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Sponsored By:

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Mae Ping National Park

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Abstract

This report is focused on Mae Ping National Park, a protected area in northern Thailand suffering from bushfires. Our sponsor tasked us with finding sustainable solutions to aid the local community against wildfires. The highlights of our findings include a website combined with an application that can automatically send updates to members of the community regarding fires, wind, and air quality, as well as the promotion of the cultivation of termite mushrooms. With these deliverables we hope to promote a safer, less polluted environment.

Acknowledgements

Our project would not have been possible without the contributions made by various individuals over the past 2 months. With their help, our project was able to attain innovative ideas that led to our success, so we would like to thank those who helped us along the way.

First, we want to thank our sponsor, The Club of Recipients of Ananda Mahidol Foundation, and more specifically Dr. Jain Charnnarong. Dr. Charnnorong was able to give us crucial insights of the current status in Mae Ping National Park and how we could help improve the locals' living situation. He was able to put us in contact with the necessary individuals who could help move our project forward, as well as offer important and constructive criticism so we could deliver the best results possible. Without his knowledge on the situation at hand, we would have struggled to come up with solutions that would actually be useful to the community. Dr. Charnnarong took time out of his day, when he could have been addressing important issues within the community of Mae Ping National Park, so that we could grasp the scope and importance of our project.

Next, we would like to thank all the members in the community of Mae Ping National Park who participated in interviews, surveys, and gave feedback to our deliverables. Many individuals gave their perspectives on the situation and with their help we were able to give them solutions that were best fit to their specific problem. The success of our project depended on individuals willingness to implement new strategies to reduce wildfires in their communities.

We would also like to give a special thanks to Dr. Jittra and Dr. Rath, a local botanist and professor in Biochemistry respectively, who educated us on various vegetation, fungi, and other important natural elements that could be identified as flammable material and cause forest fires to spread. Without the knowledge that was given to us regarding the locals burning the forest to harvest and find mushrooms easier, we might not have found our unique solution to teach locals other sustainable methods of mushroom cultivation.

Finally, we would like to extend our appreciation to our project advisors from both Worcester Polytechnic Institute and Chulalongkorn University: Professor Svetlana, Professor Servatius, Professor Supawan, Professor Numpon, and Professor Pat. With their help we were able to polish our writing and presentations, as well as gain new perspectives as to how we could address the situation in Mae Ping National Park. For our project it was extremely important to ask questions in a manner that would not create bias or build tension, and our advisors helped us to accomplish this task.

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Executive Summary

Mae Ping National Park is one of several protected landscapes in Northern Thailand currently threatened by the increasing frequency of massive wildfires. According to the park's records, in the past four years alone the park and surrounding forests have experienced 396 incidents of uncontrolled fires of which the overwhelming majority were man made. Not only are these fires a threat to the park's protected ecosystems, the communities living in and around the park also suffer from the serious health risks posed by the smoke saturating the air. The community most directly affected, Baan Kor, is a small settlement consisting of four villages that exists within the borders of the park. The community's history predates the park's establishment in 1981. Currently residents continue to live and access natural resources in the park under government provisions however; it is undeniable that the establishment of these new laws has changed the way the community is able to interact with the land. Burning practices are a part of the region's cultural history and fire is not an uncommon tool for a variety of agricultural and household tasks. The quotidian use of fire by locals is part of what makes effectively regulating and managing fires in the park so difficult. It is necessary to balance the interests of the government, the community, and the park itself in order to arrive at a sustainable and sensitive solution that satisfies all stakeholders. Through our research and investigations we determined that miscommunication, lack of awareness, and lack of enforcement were some of the main obstacles impeding bushfire management. In collaboration with Mae Ping National Park and the Ananda Mahidol Foundation, we, a team of students from Worcester polytechnic Institute and Chulalongkorn University, addressed this concern by developing tools for monitoring and raising awareness of bushfires in and around Mae Ping National Park to be used by the community and park officials alike.

Methodology & Objectives

The goal of this project is to determine the causes and factors affecting wildfires in Northern Thailand to develop preventative strategies that align with the values of all stakeholders in the region. Constructing such a deliverable requires careful research, interviewing, and analysis. Our approach was thus divided into the following primary objectives:

1. Communicate the way wildfires are started and how they move through Mae Ping National Park to help address the lack of understanding and miscommunications about burning policies to the locals in order to raise awareness about the dangers of burning
2. Develop a tool to monitor bushfire ignition and spread through Mae Ping National Park and surrounding forests, to be used by the Park Rangers, Fire Control Center, and Baan Kor Local

3. Educate the locals on the profitability of sustainable cultivation of termite mushrooms in replacement of fire dependant cultivation techniques

In order to effectively communicate knowledge about wildfire spread, we first had to fortify our own understanding. Through a thorough literature review, we researched the causes and effects of wildfire spread, policies and strategies regarding fire management in Thailand, and local fire practices. In addition, we conducted a community survey distributed through a LINE group chat in Baan Kor. This survey had several questions aimed at evaluating the locals' relationship with fire, understanding of current wildfires, and interest in our proposed solutions. This survey provided us key insights into the opinions of local communities as our limited time frame and remote status throughout this project did not allow us to directly interact with them. We were however, able to conduct interviews with our sponsors, Dr. Jain and several park officials, via online video calls. Based on the responses from this survey as well as insights from interviews with the other stakeholders, we developed our plans for a tool to monitor bushfire ignitions that would be effective for the needs of the park and community. Another key aspect of our methodology was our interviews with subject matter experts, specifically with local botanists. These interviews were very helpful in informing our research into sustainable cultivation methods. Coupled with community responses, these interviews guided the development of our other deliverable— an online marketplace to increase profitability of termite mushrooms.

Findings

Through thorough evaluation of our interview and survey responses we have developed the following findings regarding the major issues involved in fire prevention and management on which we hoped to address.

1. **The major source of wildfires in the park are smaller man made fires lit for the purposes of foraging and cultivation, and fire prevention.** Through research and interviews we were able to identify small man made fires lit for foraging and cultivation as the major source of wildfires in and around the park. Foraging is a major source of income within the community of Baan Kor and traditionally locals will use fire as a tool to burn away underbrush in search of barometer earthstar “puffball” mushrooms. We also discovered through interviews and observations of the community's group chat, that there is a long held belief in the villages that fire also helps to promote mushrooms growth. We learned however from research and interviews with local botanists that the increased fire destruction throughout the park is actually making it more and more difficult for these mushrooms to grow. The increasing scarcity of this product is prompting locals to burn more in search of the mushrooms. This practice is no longer sustainable at this rate and

without intervention, will eventually lead to the eradication of the puffball mushroom in the forest as well as cause serious damages to the park and forests.

2. **The response to wildfires is delayed by a complicated communication system.** Another major issue we identified in fire management is the delayed response time to wildfires owing to a complicated communication system. Through interviews with park officials as well as insights from the local community, we discovered that the communication between the park and the community in response to a wildfire is complicated and inefficient. When we visited the park we learned that most fires are detected in the park via NASA FIRMS satellite monitoring, and once detected there is a long chain of communications in order to disseminate the information to all entities in the park. These delays add hours to a fire response time allowing a small fire to spread into one that is far more destructive. We also identified through surveys with the community, gaps in understanding of the extent of the wildfires and their effects which we believe is in part due to the lack of easy access to fire data. Based on this finding we have identified a need for centralized information regarding wildfires in the area. In order to address this need we developed a LINE Official account and website to be used as a tool for monitoring bushfire ignition and spread through Mae Ping National Park. Based on responses to our survey, we determined that the community had little familiarity with the three main databases used by the Fire Control Center and park officials to monitor wildfires: NASA FIRMS, CuSense, and Windy. They did however have familiarity with a popular messaging application: LINE. Based on this information we decided to use LINE as a tool to provide local community members, volunteers, and park rangers easy access to simplified fire and weather data compiled from the main databases. We believe that this application will be able to help improve response time by efficiently disseminating information regarding wildfires and their effects to all entities simultaneously.

3. **The cultivation of Termite Mushrooms is a sustainable alternative to foraging for other mushroom species.** Having established that the current methods for foraging puffball mushrooms was unsustainable, we sought out alternatives. Through our research and interviews with local botanists we discovered that there is a Termitomyces or “termite mushroom” species growing within the park. These mushrooms are unique as they are cultivated by termites who grow them on substrates in their nests made from dead plant matter. The park has already begun working on a way to harness this symbiotic relationship by creating wooden enclosures around the nests and piling fuel sources (primarily dead leaves) collected from around the park into the enclosures in order to promote the growth of these mushrooms. Through interviews with our sponsor however, we discovered that there is a lack of interest from the community in this species of mushrooms as they are less valuable within the region than the puffball species. The termite mushrooms are however more profitable outside the region. We thus decided to develop a market place where locals could sell termite mushrooms in other areas of Thailand in order to incentivise them to adopt the

cultivation of termite mushrooms over the less sustainable foraging of puffball mushrooms. Through research, interviews, and survey responses we determined that if provided the tools local communities would be willing to focus on Termite mushrooms cultivation. We hope that this marketplace will be a first step towards developing a sustainable solution to reduce forest fuel sources and the instances of fires in the park altogether.

Conclusions & Recommendations

Based on our findings we have determined that many of the issues regarding fire prevention and management in and around Mae Ping National Park stem from a lack of communication coupled with a lack of understanding about the threat posed by wildfires. We developed the following recommendations in order to address these areas and expand upon the tools and deliverables we have developed over the course of our project. We believe our recommendations can be implemented in the future to improve the quality of life for individuals living within Mae Ping National Park.

1. **We Recommend Locals Avoid Starting Fires Outdoors for Any Reason.** Over the course of our investigation we determined that the majority of fires in the park are ignited by local residents. We also recognize that fire is a common tool within the region and has been traditionally used by these communities long before the park itself was established. While these fire dependant practices are not inherently negative, the rate at which fire is being used within the park is unsustainable and efforts must be taken to reduce the instances of burnings. We do not believe it will be possible to eliminate the use of fire completely, however, we believe that it is important to stress that it should be used sparingly and with proper consultation of fire control professionals.
2. **We Recommend Park Rangers Improve Communications With Locals About Prescribed Burning.** Through evaluations of responses to interviews with our sponsors and park rangers as well as our community survey, we have determined that there are deeper communication issues between these groups in regards to prescribed burnings. A portion of the fires started in the park this year were done as prescribed burnings in order to reduce forest fuel sources. When communicating this information to local communities, there were misunderstandings about the bounds of this burning and believed that they were also permitted to burn freely resulting in massive fires in February and March of 2021. We recommend that all burnings, even those being performed by fire authorities, be properly communicated to all parties as clearly as possible.

3. **We Recommend Locals Subscribe to Our Line Account.** In order to increase locals' understanding of the dangers of fire and accelerate responses to wildfires in the area we developed a LINE Official Account to compile and simplify data from the three main online tools used to track fires: NASA FIRMS, CUSense, and Windy. Through our interviews with park rangers and community surveys, we have determined that both groups are unfamiliar with navigating the websites for these tools and must wait to receive information on wildfire

hotspots through a complex system of communication. We therefore recommend that members of the local community, volunteers, and park rangers download and use our LINE Official Account in order to improve response times and quickly disseminate information regarding fires to all parties. We believe the LINE account can even be utilized by park rangers and volunteers in order to predict the spread of a fire and act proactively. If the locals and park rangers familiarize themselves with our new LINE application, we believe it will help decrease the damage from fires.

4. **We Recommend Establishing a Watchdog Program for Wildfires.** In addition to our LINE application, we believe that the formation of a voluntary student watchdog program will help increase the community's general awareness of wildfires and wildfire spread in the region. This program would ideally help to decrease the time between a fire being started and volunteers moving to stop the fire as there would be individuals designated to tracking and predicting wildfire spread.

5. **We Recommend Locals Focus on Termite Mushrooms over Puffball Mushrooms.** Through our investigation we have determined that cultivating termite mushrooms can be a sustainable alternative to the harvesting of other fire provoking species. For this reason we recommend the continued use and creation of the termite nest enclosures established in 2020. These first enclosures were experimental, however, we have determined through research and interviews with subject matter experts that there is strong evidence to suggest that they will produce an increased yield of termite mushrooms. In conjunction with our online marketplace we believe that this mushroom species can be just as if not more profitable to local communities as the puffball species. The enclosures also require little maintenance. Once built, the only upkeep being the addition of dead leaves which has the added benefit of clearing fuel sources throughout the park. We hope that the continued cultivation of these mushrooms will be a first step towards a long term solution for reducing wildfires throughout the park.

6. **We Recommend Locals Use Our Facebook Group to Market Their Products.** Over the course of this project we developed a Facebook group locals can use to market termite mushrooms and other products to outside markets. One of the major obstacles to convincing local communities to cultivate termite mushrooms over puffball mushrooms was the lower value of the termitomyces in the areas surrounding the park. Typically locals have only been selling their products to buyers who come to the community to buy and resell their products. These middle men set the price of the mushrooms which can often be undervalued. Inorder to increase profits within the community, we recommend that locals utilize our Facebook Group to sell products to outside markets where there is evidence of a higher demand. Selling this way not only connects locals to more buyers but it gives them more agency to set the price of their goods. We believe that by using this group local growers can make a greater profit from termite mushrooms in particular which will encourage the more sustainable cultivation of this species

Chapter 1: Introduction

In recent years, climate change has had an increasing effect on our world at large. From chronic shifts in weather patterns to heart-wrenching natural disasters, climate change has severe implications for the present day and, ultimately, our future. A part of this large climate shift is the increase in wildfires across the globe. According to the World Wildlife Foundation, wildfires increased as early as 2015 (WWF, 2015). It is important to understand the impact of wildfires as they are projected to grow due to global warming and longer fire seasons. Lives are impacted due to the destruction caused by fires, whether that be someone's livelihood or their health. A large portion of unaddressed fire problems lies in rural areas that have minimal access to resources such as timely fire fighting responses and fire prevention education. Our research project seeks to create a generalized solution to aid in educating those in rural areas about fire prevention. Through our Line Official Account and education of the locals on the profitability of sustainable cultivation, our project would provide these under-resourced areas with new resources to use for defending against wildfires.

Presently, Thailand is in jeopardy due to frequent wildfires ravaging through the northern portion of the country. Much of Thailand's most attractive aspects like its sweeping landscapes, bustling nightlife, and breathtaking beaches, are being affected by the fires. As of March 28th, 2020, Thailand has seen 3,809 fire hotspots, 10% of these hotspots taking place in the northern province of Chiang Mai alone (Karen, 2020). Also, Thailand has faced one of its worst fire seasons this year with fires burning through over 345,000 rais, about 213 square miles, of land in Northern Thailand (Dr. Jain, 2021). This is a huge area to be damaged by fires, almost the entire size of Chicago (Top 100 Cities Ranked by Area, 2010). But, these wildfires are not exclusive to this year only. Over the past decade national parks in Northern Thailand, like Mae Ping National Park, have been facing annual bushfires that destroy 40-80% of the national park. These fires affect the ecosystem and sadly the animals living in the area, as this year elephants have had their forests and food sources destroyed.

Mae Ping National Park holds four villages that are affected by fires regularly. These villages existed before the area was determined a National Park, meaning their way of living has been changed by the establishment of new laws that did not previously impact them. By understanding how the community views and uses the national park, we can begin to learn the causes of wildfires in the region. Local communities and houses are destroyed by the fires, and almost all of Thailand is experiencing decreases in air quality as a result. The root of the fires come from either natural environmental causes or human causes. Local farmers have been practicing slash-and-burn techniques, burning the forest to harvest mushrooms, and starting fires to scare animals out of the forest, impacting the spread and control of fires within Thailand and the national park. Gig Field, a 40,000 acre field located within Mae Ping National Park, has been severely impacted from these unsafe burning practices, due to the misconception that burning the forest makes mushrooms easier to harvest. Thus, we were tasked by the Park Rangers of Mae Ping National Park with determining the causes and factors affecting the aforementioned wildfires to find solutions that align with the values of all stakeholders. Our group's solution investigates a multitude of issues surrounding this problem. Understanding why these practices

occur, how they work, and how to mitigate them was essential for us. We worked with these local communities to determine a fire prevention solution that also serves their goals. This was vital, as many past strategies have failed because of the communities' lack of support. In terms of past strategies, the most common and effective strategy used was firebreaks. Having a full grasp of these solutions helped create a good template for our project as a whole.

In summary, the goal of our project was to determine the causes and factors affecting wildfires in Northern Thailand to develop preventative measures that aligns with the values of all stakeholders. In pursuing this goal we hoped to produce two concrete deliverables: an app that communicates real time fire data to users and a proposal for a more fire-safe alternative income model. To effectively accomplish this we set out the three following objectives:

1. Communicate the way wildfires are started and how they move through Mae Ping National Park to help address the lack of understanding and miscommunications about burning policies to the villagers in order to raise awareness about the dangers of burning
2. Develop a tool to monitor bushfire ignition and spread through Mae Ping National Park and surrounding forests, to be used by the Park Rangers, Fire Control Center, and Baan Kor Locals
3. Educate the locals on the profitability of sustainable cultivation of Termite mushrooms in replacement of fire dependant cultivation techniques

Effective fire prevention is predicated on knowledge of the causes of wildfire. Similarly, effective implementation is predicated on an informed understanding of the culture and people whom our work will affect. The success of our prevention plan depends on whether the community and our sponsor accepts it. For this reason, we made the community a major focus of our research. Using interviews and surveys, we gained an understanding of their relationship with fire and answer key questions, such as why local farmers use agricultural burning practices, how the community feels about current measures in the region, and how we can design a plan that addresses their concerns as well. By using this method we were able to build off past solutions to propose a plan that integrates a community focus with effective fire prevention. By doing so we developed a proposal that is sustainable and equitable, to minimize the risk of wildfires in the region and ensure that it can be maintained for years to come.

Chapter 2: Background

Fires are a global issue stretching from the coastal forests of California to the rainforests of Northern Thailand and Australia. With the rising impact of climate change across the globe, fires are one of the many ways this impact is becoming more dangerous to the human race. Thus, the urgency to respond to the growing problem is paramount. For residents of Thailand, climate change is affecting them first-hand. Fire seasons have grown in intensity in the past year, leaving Northern Thailand with air quality that is "40 times above [the] international standard" for safety (Karen, 2020). This chapter seeks to detail the situation for fires within Thailand. To begin, wildfires are introduced with their ignition sources from natural causes to human error like carelessness and industrial causes. This segues into the factors affecting the spread of wildfires and how the geography and seasons have a large impact on how dangerous a fire can be. Subsequently, the current measures for fire protection are mentioned next which covers the global measures in the United States, Australia, and Ecuador. In addition, it covers the local laws, regulations, and measures within Thailand for fire protection in the present day. Next, the chapter touches on the impact of the wildfires on the local communities. This section covers the natural resources that locals lose to the fires, how the fires affect them economically, and the health concerns that the locals face every day from the fires. Overall, we outline the importance of fire prevention within Thailand and how their current situation reflects a dire need to respond to fires effectively

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2.1 Stakeholders

To reach an accurate understanding of the current situation within Mae Ping National Park, we determined it was necessary to understand how all the active stakeholders are being affected by the wildfire issues. We concluded that we needed to perform research on and build relations with the park itself, our sponsor Dr. Jain, the government overseeing management of the park, and most importantly the locals within Ban Koor.

2.1.1 Mae Ping National Park

Currently, Thailand is in jeopardy due to frequent wildfires ravaging through the northern portion of the country. Much of Thailand's most attractive aspects like its sweeping landscapes, bustling nightlife, and breathtaking beaches, are hurt by the fires. As of March 28th, 2020, Thailand has seen 3,809 fire hotspots, 10% of these hotspots taking place in the northern province of Chaing Mai alone (Karen, 2020). Also, Thailand has faced one of its worst fire seasons in 2020 with fires burning through over 120,020.9 rais, about 74 square miles, of land in Northern Thailand (WWF, 2015). But these wildfires are not exclusive to this year only. Over the past decade national parks in Northern Thailand, like Mae Ping National Park, have been facing annual bushfires that destroy 40-80% of the national park.

Mae Ping National Park has a 40,000-acre field known as Gig Field that holds four villages that are affected by fires regularly. These villages existed before the area was determined a National Park, meaning their way of living has been changed by the establishment of new laws that did not previously impact them. By understanding how the community operates within the national park, we can begin to learn the causes of wildfires in the region. Local communities are destroyed by the fires and almost all of Thailand is experiencing decreases in air quality as a result. The root of the fires comes from either natural environmental causes or human causes. Local farmers have been practicing slash-and-burn techniques in regions without many restrictions, impacting the spread and control of fires within Thailand and the national park.

Figure 1: Chiang Mai and Northern Thailand's smoky season during February, March, and April (lower picture) vs Chiang Mai the rest of the year (upper picture) (Zander, 2019).

2.1.2 Our Sponsor

Dr. Jain Charnnarong, our Liaison from Mae Ping National Park, has made it abundantly clear what the situation is within the National Park and Gig Field. Much of the wildfire issue stems from the untrained and unmonitored use of slash and burn practices by locals. Rules and regulations for fires set up by the park were ignored by the local population until last year as the ideals of the villagers were addressed within the rules. Despite these efforts, there are still many who do not follow the rules set up by the National Park's fire safety institutions and there remains a call for action. Thus, this is where we step in. Dr. Jain explained that there are three steps to our success for our project. The first step is to give the locals knowledge. This implies

that it is our job to provide the locals with the necessary knowledge for fire safety and upkeep as well as the tools needed to do so. The second step is for us to attempt to change the attitude of the locals towards fire safety. According to Dr. Jain, some locals are not fond of changes to their traditions and practices for farming. Therefore, we must also find a way to ease the local population into the idea of being fire-safe within their farming practices. The last step that Dr. Jain proposed was to put our fire safety plans into action. This step encompasses how effective the plans we come up with the work we have applied so far will be in the national park.

Our group's solution will investigate a multitude of issues surrounding this problem. Understanding why these practices occur, how they work, and how to mitigate them will be essential for us. Also, we will work with these local communities to determine a solution that works to prevent fires that also serves the goals of the community. This will be vital, as many past strategies have failed because of the communities' lack of support. In terms of past strategies, the most common and effective strategy used was firebreaks. Having a full grasp of these solutions will create a good template for our project as a whole.

2.1.3 Government

The Thai government has identified slash-and-burn practices as one of the main causes of fires, as well as recent droughts, undesirable wind patterns, and arson. As a result, the Thai government deployed 500 local officials and soldiers from the Royal Thai Army 3rd Army Region also with several helicopters to help combat the blazes (Karen, 2020). The national government is delegating officials to build firebreaks in national parks to aid firefighters in putting out the fires immediately. Firebreaks work by creating a strip of open space in the forest to stop the spread of fires. They have also put several restrictions on villagers in certain districts from using their slash-and-burn farming practices until the dry seasons come to a close.

The government also instated 3 new acts, introducing new regulations regarding the protection and conservation of the environment. These laws are all being overseen by special committees within the Ministry of Natural Resources and Environment. One of these is labeled the National Park Acts B.E. 2562 (2019), and it amended the older National Parks Act (1961). It extends protections to the forest parks, botanical gardens, and nature learning parks (Pantumkomon & Annez, 2019). It comes with increases on existing penalties as well as integrating a few new penalties and bounties for catching violators. There are also large prohibitions on "Holding, building on, clearing, burning, degrading, or changing land in a protected area (punishable by imprisonment for 5 to 20 years, a fine of 400,000 to 2 million Thai Baht, or both)". The government has also looked to the communities, enacting a Community Forest Act (2019), which creates a separate level of protection for a few natural resources (Pantumkomon & Annez, 2019). This is intended to benefit communities that have been restricted from using forest resources due to government conservation efforts. These areas of the forest must be conserved, restored, managed, and maintained by the local communities who use and benefit from the natural resources (Pantumkomon & Annez, 2019). Communities may apply for this community forest status and would give the local communities access to their cultural ways of farming in a documented and safe way.

2.1.4 Local Communities: Baan Kor

Baan Kor is a small community located in the Li District of Lamphun Province, Thailand. The village is in the farthest sub-district from the city of Lamphun province, where it finds itself situated within the lush natural landscapes of Mae Ping National park. Baan Kor has a long history predating the park itself, which was only established in 1981. It is divided into three major groups: Baan Kor Thung, Baan Kor Jad Saan, and Baan Kor Ruen Pae. Baan Kor Thung is the oldest part of the village, located at the northern end of the creek running through Baan Kor. Baan Kor Jad Saan is the largest part consisting of three smaller sub-communities: Ko Ta, Ko Jork, and Ko Nhong that became populated after Baan Kor Thung was flooded by the building of Bhumibol Dam. Baan Ruen Pae is also quite populated as it is home to nearly a hundred families. All of these people have called this land and the mountains, rivers, and forests their home for many years. To this day the land is the source of their livelihood, and the local communities rely heavily on the natural resources in and around Mae Ping National Park. Baan Kor is mainly a farming community and rice is the main crop, planted year-round along the creek both for food and to be sold/ traded with merchants. Also grown are corn, longan, cotton, tobacco, and lac from the naturally grown lacquer tree. A significant portion of their food and income also comes from their hunting and foraging practices. Especially during the cold season when there is no crop to harvest, foraging for mushrooms can provide a rich and much-needed supplemented income and food store. Currently, however, this community shares its borders with the park and makes use of government provisions as stated in the Community Parks Act (2019) that allow locals to venture into certain areas of the forest to access the natural resources they have been using for many years. However, this means fires are being lit within the park and the penalties being taken for these actions are steep, including fines of up to 2 Million Baht and possibly jail time. In recent years the burning practices of the villages have accelerated at a rate that is no longer sustainable, slowly killing off the species within the area and making the land increasingly infertile. Fires are lit too often and without proper supervision causing the lands within the border areas between park and village to become increasingly infertile. This has been making it more and more difficult to find mushrooms within the boundary areas, and forces locals to venture into protected parklands to gather enough food.

2.2 Nature of Wildfires

This next section of our background will cover any relevant information related to wildfires in an overview context. We dive into the causes of wildfire, what different types of wildfires there are, and how wildfires can spread after ignition. This section can be considered an overview of how fires start and what causes them in a general sense so that we can apply our knowledge of wildfires to the specific problem within Mae Ping National Park.

2.2.1 Natural Ignition Sources

Some natural events that are ignition sources for wildfires. For example, earthquakes, volcanic eruptions, and most notably lightning (Julio-Alvaer, 665). Since humans cause most fires annually, natural events are less of a problem in terms of igniting fires (Balch, 2017). Regardless, natural factors of the landscape can dictate how fires will spread. In various regions of the world, the most important factors in fire spreading are temperature, topography, wind patterns, precipitation, and fuel sources. These factors will be discussed further in **Factors Affecting Wildfire Spread** below.

2.2.2 Human Causes

As our research has progressed we have found that most cases of wildfires have started from negligent human actions with the environment. People may have a campfire that is not properly put out and causes a larger wildfire. Improper cigarette disposal can cause fires. These are just a few examples, but the list is much larger and regardless of what action is done to cause the fire, it could have been avoided if people concerned themselves more with their environment. Globally, humans account for roughly 86% of fire ignitions and 44% of damage resulting from fires overall. (Balch, 2017). There are many ways humans unintentionally start fires, but a common theme involves carelessness and a lack of respect for the environment.

For most of history, until the past few centuries, the general population focused on agriculture as means of survival. When humans needed to consistently produce agriculture to survive, they sought ways to increase their crop yield. An easy way to do this is to clear more land to use for planting crops. Indigenous cultures of the past and present arguably have a better relationship with nature and often have built-in methods of sustainability to their practice (Brady, 1996). Depending on the region, these cultures could chop down parts of a forest to have more area to grow crops. With seemingly endless forests for these cultures, it was possible for indigenous people to safely use parts of the forest for agriculture and rotate these plots over time, to not destroy the forest and ecosystems within. This process of using various plots of land so that the soil can rejuvenate is known as shifting cultivation (Brady, 1996).

While some indigenous cultures may have practiced less sustainable methods of farming like slash and burn, most seemed to have a concern with the land and resources they used. With the population density of humans increasing and technology developing over time, indigenous cultures could no longer remain isolated. Pressure from outsiders to give up land or forced enslavement meant indigenous people had to change their ways. A method of agriculture known as “slash and burn” became prevalent. Shifting cultivation only partially converts forests to fields whereas, when slash and burn are done, the land is permanently transformed. Forests are burned down and the land is then used for farming. While the initial burn can add nutrients to the soil, the problem with the slash and burn method is that no vegetation besides the crops grown to add nutrients back into the ground (Brady, 1996). Over time, the soil becomes less and less fertile until farmers must use a new plot while the soil replenishes its nutrients. As a result, farmers move to a new plot of forest and practice slash and burn again. This method of agriculture is extremely dangerous for the environment as it disrupts ecosystems, removes trees that absorb CO_2 and release oxygen, and leads to soil degradation (Brady, 1996).

Forest fires in our region of focus, Mae Ping National Park, are mostly being caused by the locals through forest harvesting, burning fields, hunting, imprudence, and recklessness. Forest harvesting is the most common cause of forest fire. This practice is where locals light fires

to clear the forest floor and their walking path. It is a belief that the burning will stimulate the growth of mushrooms and other harvested crops, however, there is little to no backing for this practice. Burning fields is the second most important cause. This is a practice used to remove weeds or plant debris that is left after the harvest. This is done to help with the preparation and cleanup for the next round of planting crops. The local community also uses fires in their hunting practices to flush animals out from hiding places. The hunters then use this opportunity to trap and shoot the animals. Imprudence and recklessness among locals is another common cause of the fire, as stated earlier. People tend to throw away cigarette butts or recklessly burn grass without considering the consequences, and this is no different in Thailand.

Today, slash and burn styles of farming still exist and remain a problem because oftentimes these fires are started with the intent to destroy forests, with no concern of putting the fire out or where it will spread. Varying cultures often have a specific burning season for agricultural purposes. In Thailand, this season occurs annually between February-April, within a naturally occurring dry season (Guo, 2014). However, with the local community using fire in all aspects of their daily living, human-caused bushfires have become a year-round problem for Thailand and Mae Ping National Park.

2.2.3 Types of Fire

When trying to fight these fires, it is vital to know the ways in which fires burn and how they move. These can be fueled by a variety of factors such as weather patterns, dry underbrush, the time of year, and wind. Depending on the current conditions, this can cause fires to burn and spread in different ways. As a result, it helps to identify the type of fire to help with prevention efforts. These can be grouped into three categories: ground fires, surface fires, or crown fires.

Ground Fire: Fires in this classification burn organic matter beneath the surface of the forest floor. These usually occur in forests located in temperate regions with extremely high altitudes. These flames penetrate several feet below the surface. The flames spread below the forest surface in a slow, non-flammable manner with moderate levels of smoke. As a result, these flames are extremely difficult to detect and control. While these fires have the slowest fire rate, it has been seen to be the most damaging one. Being below the surface floor, these flames destroy the roots of the plants, causing both small and large trees in the forest to die off.

Surface Fire: Fires classified as surface fires spread onto the soil's surface. The sources that are known to fuel these flames are leaves, dry branches on the floor, grass, small grass, groundwood, and bamboo clumps. These flames are the most common type of fires being experienced in the region of Thailand we are focusing on. These fires do not do enough damage to large trees to destroy them completely, however, they have a massive negative impact on the tress rate of growth as well as the quality of the wood. These fires, if detected early, can be easeily controlled, managed, and dispersed.

Crown Fire: The last classification of fires are crown fires. These fires travel throughout the forest by burning from the top of one tree to the top of another tree. These flames spread extremely fast and could be considered the most dangerous. These fires have a high flame height, meaning the spread of the fire can range quite far up the tree line, whereas others may

only stay closer to the forest floor. This leads to these fires being divided into two types, dependent crown fire and running crown fire. These flames need strong wings, steep slopes, and a heavy fuel load to continue burning. These types of fires are rarely seen in Thailand due to the region's climate having relatively high humidity

2.2.4 Climate and Geography

Natural elements in the landscape dictate how fires will spread. In varying regions of the world, the most important factors in fires spreading are temperature, topography, wind patterns, precipitation, and fuel sources. Different parts of the world have distinct seasons that influence the above factors. The complexity of ecosystems results in these factors affecting each other and altering the risk of a fire. This makes certain regions especially prone to wildfires. In regions that experience droughts, the plants usually do not contain much water, making them an excellent fuel source for the fire to consume as it grows. Regions with warm temperatures are typically more at risk than cold temperatures, but an area like the desert will not have wildfires that cause nearly as much damage compared to other areas because of the lack of vegetation for the fire to consume and continue to spread. Another key factor in the spread of fires is strong winds. Wind can enrage a fire, increasing its intensity and heat output. Another crucial factor in how fast a fire spreads and how intense the flames are is the topography. Fires move the quickest and produce the most heat when moving slightly uphill. According to the Country Fire Authority, the optimal elevation for fire spread is 10 degrees uphill, resulting in up to double the speed and in turn, increased heat output. (Country Fire Authority, 2020) The seasons have a massive impact on how these factors can stack up and create regions at high risk for a wildfire to start, or worse, optimal conditions for the fire to quickly spread and destroy everything in its path.

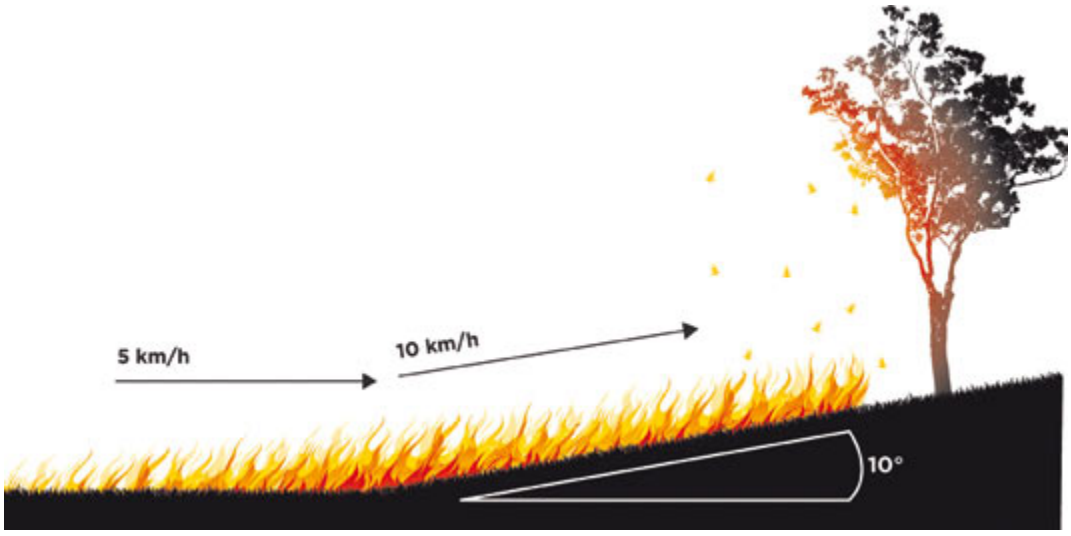

Figure 2: A graphic depicting the nature of fire traveling uphill. Fire speed doubles at angles of 10 degrees above the horizontal (Country Fire Authority, 2020).

2.2.5 Fuel Sources

As mentioned above, fuel sources that can be consumed by fire are a driving factor in wildfire spread. Typically fuel sources for wildfires are dry leaves or other vegetation that are near the ground level. If there is a fire ignition and there are optimal conditions for a fire, for the flame to stay lit and not run out of energy to burn, there must be additional fuel to feed the fire. An example of a dangerous fuel source would be tall dry grass because the fire can rapidly spread through the grass and gain intensity and speed. In Thailand, the main fuel source for wildfires is dry leaves on the ground of the forest, according to our sponsor, Dr. Jain.

2.3 Wildfire Spread and Mitigation Strategies

This section explores current methods used to attempt to slow the spread of wildfires used in Mae Ping National Park. Through our research and discussion with our sponsor, we determined that in Mae Ping National Park, the ways locals are trying to prevent fires or to stop fires from spreading dangerously are: Firebreaks, fuel source reduction, prescribed burns, a new incentive to not burn the forest being the establishment of wooden termite enclosures that can produce valuable Termitomyces mushrooms, and finally the current fire response plan lead by locals in the region.

2.3.3 Constructing Firebreaks and Fuelbreaks

Firebreaks and fuel breaks are closely related terms that are both wildfire prevention strategies. Both firebreaks and fuel breaks involve changing the natural landscape by removing vegetation and other fuel sources from a specific area, in order to create a barrier that wildfires are unable to cross. A firebreak goes a step further, where “organic matter is removed down to the mineral soil,” which prevents any combustible material from being consumed by fire (Bennett). Firebreaks are most effective when they are between 8-15 meters in width, and the direction of the firebreak should run parallel to the direction of the fire. This way, the fire is less likely to be able to get across the firebreak and spread into a new area (Smith). The location of a firebreak is extremely important, as they should be constructed in areas where fires are known to spread through to attempt to slow or stop a fire from moving past. Firebreaks should be constructed with consideration of the following four strategies: to prevent a fire from entering an area, to prevent a fire from escaping an area, to help with prescribed burns, and to provide access to critical areas of the land (Smith).

Currently, in Mae Ping National Park, villagers and park rangers have been working to make firebreaks in select areas. According to our sponsor, the firebreaks are still ineffective because they are not long enough and do not span enough area to stop a fire. The Park Rangers have been able to pay villagers 300 baht a day to help with the construction of firebreaks, but the operation is largely understaffed. As more firebreaks are constructed, managing the park should become easier, as fires will more likely be contained, and the Park Ranger will be more mobile through the forest as there will be large clearings to drive through. While firebreaks are a great tool to prevent wildfire spread, there are a few drawbacks. First, constructing a firebreak takes a considerable amount of effort and time to be done properly. Also, firebreaks must be maintained to prevent vegetation or other debris from building up, or they are vulnerable to fires consuming fuel and passing through. Finally, another long-term impact to consider is the increase of soil erosion associated with firebreaks (Bennett).

Figure 3: Images of current firebreak established in Mae Ping National Park intended to stop the spread of wildfires between areas of the park. (Dr. Jain Charnnarong, 2020).

2.3.4 Fuel Source Reduction

A fuel source refers to anything that can burn in a forest fire. This means all manner of living or dead plant matter that makes up the forest, from grass to trees, can be fuel to a forest fire (U.S Department of the Interior, 2021). While these are all naturally occurring aspects of the forest itself, the accumulation of these burnable materials can cause catastrophic blazes. When coupled with certain climates and weather conditions, excess fuel sources can increase the intensity, speed, and duration of fire making it much more dangerous and difficult to control (U.S Department of the Interior, 2021). With an adequate reduction of these fuel sources however the damage caused by forest fires can be mitigated. There are several methods for reducing forest fuels, however, the ones most relevant to Mae ping park and the surrounding communities are prescribed burns and manual treatments. In order to protect the land and the people who inhabit it, it is of great importance that we carefully consider efficient and sustainable methods for reducing the accumulation of fuel sources in the area.

2.3.5 Prescribed Burns

When a wildfire gets out of hand it can be devastating; however, fire is not inherently bad. In fact, it is a naturally occurring phenomenon that can improve the health of the forest. Periodic burns at low intensities can aid forest decomposition, clear areas for new growth, and even reduce the chances of future burns growing out of control (U.S Department of the Interior, 2021). This benefit of fire is utilized in the method of prescribed burns. Prescribed burning is the use of fire under predetermined conditions to achieve specific objectives, and is well-recognized

as one of the most versatile and cost-effective tools in several land management objectives (University of California, 2021). In terms of forest fuel reduction, prescribed burning is very efficient as it not only clears the fuel sources but consumes them. Unlike manual reduction treatments, prescribed burning resolves the need to transport and dispose of the gathered matter, making it very cost-efficient.

There are however steep risks involved with this method. If not managed properly a prescribed burn can easily grow into a forest fire, fueled by the matter it was meant to remove. The careful maintenance of a prescribed burns condition then is of utmost importance. A prescribed burn must be designed to mimic naturally occurring fires in the area taking into consideration the climate, weather conditions, and safety of the communities in the region (The Nature Conservancy, 2019). The safety of those managing the burn must also be taken into consideration. The proper protective gear and equipment should be readily available before attempting this method. It is also important to note that this method should not be used too liberally and only be performed when there is a great need. Because of fire volatility, manual methods of fuel source reduction are often employed to thin the landscape before attempting a burn (The Nature Conservancy, 2019).

2.3.6 Termitomyces

Termitomyces are a species of mushrooms that grow symbiotically alongside the macrotermitinae species of termites. Through our interviews with local botanists: Dr. Rath and Dr. Jittra, we learned that these termites are native to the region of Northern Thailand that houses Mae Ping National Park and their relationship provides a unique solution to the issue of excess fuel source accumulation. Manual fuel source removal involves hand felling and piling of fuels. The biomass collected is often then disposed of by burning or chipping (University of California, 2021). This method of disposal however is not very sustainable as the frequent burning of collected leaves would release more smoke and PM2.5 particulates into the air. For this reason, we are considering disposing of the collected dry leaves around the nests of the termites in the park to feed on and in turn promote the growth of termite mushrooms, a valuable crop.

The termitomyces are particularly valuable as they are almost exclusively cultivated by their host termite species. The termites grow their fungus on a special substrate called the fungus comb, which they build from primary feces consisting of plant material inoculated with asexual spores. They harvest the mushroom bodies which serve as a protein-rich food source, as well as inoculum for new fungus combs to continue cultivation (Peppel & Aanen, 2020). The fungi in turn thrive in the moist CO2-rich environment cultivated within the termites' nest, and rely on their host species for their continued inoculation (Peppel & Aanen, 2020). This is a naturally occurring process within the termite nests within Mae ping park that not only provides a means of disposal for the forest fuel sources gathered manually, but also promotes the growth of a valuable mushroom species that can be sold to supplement the income of locals during the off-season. Through our interviews with Dr. Jain, we came to learn that many locals were under the misconception that burning the ground would stimulate mushroom growth, however, this has done the opposite and severely decreased the growth of this cash crop in the boundary areas of the forest. This alternative method of collecting fuel sources around termite nests is a much more sustainable way of producing these mushrooms and it can be easily maintained by simply blending some of the mushrooms with water and spraying them by the nests to re-inoculate the nest. We hope that the introduction of this process will not only help decrease the severity of

future fires but decrease the instances of ignition altogether by promoting a new and stronger avenue of income to the local communities via mushroom cultivation.

Figure 4: Volunteers transporting leaves into a wooden enclosure for Termites to use as a food source to create Termitomyces mushrooms.

2.3.7 Bushfire Management in Mae Ping National Park

Currently, the communities within Baan Kor, do not have a designated fire protection force. In the event of fires, individual villages must organize and respond if possible, however, the villages alone do not have the resources to manage intense wildfires. The locals have constructed some firebreak paths that they maintain with air blowers to clear leaves, however, due to the frequency and intensity of fires, they are considering constructing more in the future. The village is surrounded by some naturally occurring firebreaks in the landscape such as hills and rivers. The natural firebreaks are not effective enough to fully prevent the spread of a bushfire, however, although they do help to slow the rate of the fires spread somewhat. Locals have some equipment like air blowers which they can then use to extinguish the remaining fire. Most Bushfire management, in that case, is under the jurisdiction of the Mae Ping park rangers, whose recently established task force is committed to specifically responding to fires in the area and managing their spread.

Chapter 3: Methodology

The goal of this project was to determine the causes and factors affecting wildfires in Northern Thailand to develop preventative measures that align with the values of our sponsor and those of the local communities. As discussed in the background, there are many reasons why fires ignite and spread uncontrollably, however, the main focus of our efforts was on the human factors. The community's impact and response to the wildfires determined how we could improve their situation. With this in mind, our team developed the following objectives to increase awareness about the dangers of burning to the communities in Mae Ping National Park with the goal of reducing damage to the forest from improper burning methods that result in wildfires. To accomplish this goal we outlined the following objectives:

1. Communicate the way wildfires are started and how they move through Mae Ping National Park to help address the lack of understanding and miscommunications about burning policies to the villagers in order to raise awareness about the dangers of burning
2. Develop a tool to monitor bushfire ignition and spread through Mae Ping National Park and surrounding forests, to be used by the Park Rangers, Fire Control Center, and Baan Kor Locals
3. Educate the locals on the profitability of sustainable cultivation of Termite mushrooms in replacement of fire dependant cultivation techniques

3.1 Focus, Scope, & Limitations

We focused our interviews, surveys, and data research on fire causes and prevention in Northern Thailand. This includes the local communities surrounding Mae Ping National Park and more specifically Gig Field. We aimed our questions towards fire experts, local community members, and farmers in these regions. Due to Covid-19 our group had to work remotely and was not physically present to conduct any of the following steps. This limited the control we had in making connections with the Thai community to achieve our goal. Interviews and surveys were conducted mostly by members of our team located in Thailand, as some interviews could only be conducted in Thai. Limitations also included the community's willingness to answer our questions, left uncertainty about the number of responses we should have expected to receive. As a result of these limitations, we framed our methodology to be as useful and functional as possible in hopes of gathering balanced information.

3.2 Objective 1

This objective focuses on one of the biggest challenges being tackled by our group: determining the source and main causes of wildfires within the region and attempting to apply these findings to help communicate the way wildfires are started and how they move to the local communities. To achieve this goal, we conducted a multitude of interviews with a variety of different groups. These included, but are not limited to: sponsor interviews/meetings, park ranger

interviews, and local community interviews. Collectively, these allowed us to have the best possible grasp on the issues and stay on track with our sponsors desired end goal: *decreasing the damage from wildfires along with teaching the villagers sustainable ways to live without burning*. In addition, we observed the local communities daily workings, agriculture techniques, and burning habits in order to confirm past information given to us, and we obtained new and valuable information for the project that we would not have discovered otherwise.

3.2.1 Expert Interviews

Our first method applied to this objective is conducting expert interviews. Experts within the field of fires/wildfires provided us more knowledge on how to approach wildfires as a whole, and then apply them to the fires started in Baan Kor and other communities within Mae Ping National Park. We asked them questions about their work, how they would approach our situation, and other advice or lessons they may have gained when interacting with people about fire prevention, no matter their status. We performed this method alongside our Thai counterparts from Chulalongkorn University who made visits to Mae Ping National Park and later conducted interviews over Zoom to gain information.

3.2.2 Sponsor Interviews/Meetings

To be able to fully understand the causes of the fires we conducted meetings and interviews with our sponsor, Dr. Jain, as well as through our own background research. Past meetings have included discussion of the focus of our project, as well as proper ways to conduct ourselves when it comes to discussing and avoiding sensitive topics when in the local communities. These meetings allowed us to have a clear understanding of where to focus our efforts. The information obtained from our sponsor has helped identify problems we would not have known otherwise. Through these avenues, and continued interviews with our sponsor, we were able to analyze and conclude all possibilities for the causes of the wildfires.

3.2.3 Park Ranger Interviews

Interviews with park rangers were used by the BSAC members of our team during their trip to Mae Ping National Park. In addition, phone interviews were later conducted to hear the Park Rangers' perspective on the most recent fire outbreak in February, 2021. These interviews were conducted with a list of key questions that were used to gain insightful information from the insiders perspective. Their responses helped us in narrowing the possible causes of wildfires in the park and surrounding areas.

3.2.4 Local Community Interviews

Interviews were also conducted with locals to gauge locals' opinions toward the cause of wildfires. The questions asked, found in **Appendix 2**, are the same questions used to interview the park rangers, as well as the sponsor. This was done to compare the answers, minimize bias, and conclude if there are any discrepancies between the different parties. We interviewed multiple community members via online communication through Line and phone calls. Keeping an open mind in the interviews allowed us to exchange our understanding and knowledge with the locals about wildfires in the area.

3.2.5 Observation of Local Communities Routine

To fully gauge the scope of the problem at hand, we sought to understand the agricultural techniques and overall daily routine of the community. By seeing how the community functions, we were able to easily identify points of issues with ways the community uses fires to conduct their farming. In addition, we were able to identify points of improvement and potential solutions that could work with the current daily functions of the communities. By doing this, we hoped to create sustainable solutions that will last.

3.3 Objective 2

Our next objective consisted of developing a strategy for wildfire management for the Park Rangers in cooperation with the local Fire Control Centers and Baan Kor Locals. We planned to design a tool that could last for the foreseeable future. This plan would ideally incorporate the data we have collected from our other objectives, the perspectives of the locals, our sponsors, and all other stakeholders.

3.3.1 Designing and Deploying a Prototype

To begin, we designed a prototype of a self-sustaining wildfire management model for Mae Ping National Park. We met with our sponsor to discuss our initial plan and gained suggestions from them to improve our ideas. Considering these suggestions, we reworked our prototype. Once completed, we proposed our prototype once more to our sponsors before finalizing our model. We then began to perform initial tests on our proposed prototype. The initial tests consisted of us applying our prototype to the local communities for a short period of time. The results from these tests were collected through our own observations, interviews, and surveys with stakeholders. The final portion of this objective consisted of an analysis of our results from the initial tests, sponsors, and stakeholders. We presented this information to our sponsor to show the conclusions that we came to and what needed to be addressed. After we implement our model, we conducted post-tests in a similar fashion to our initial tests. The purpose of these post tests was to see how our prototype model turned out and if what we made would be successful in future fire situations.

After speaking with our sponsors, we came to the conclusion that building a LINE Application that detects fire hotspots was the best prototype to develop. Our plan for our LINE Application consisted of a frontend and backend that interacts with each other to deliver alerts about dangerous fire hotspots to locals. The backend interacts with api's of NASA Firms, Windy, and CuSense to collect data on fire hotspots and translates it to be used within LINE. On the other hand, our frontend consists of two main parts: a website and a LINE Official Account. Our website includes the same alerts we send through LINE, a fire timeline of the fire hotspots being tracked, and instructional videos of the previously mentioned sources. Our aim with this prototype was to give the locals the same tools that our Sponsor uses to warn them of fires, but in a more user-friendly way.

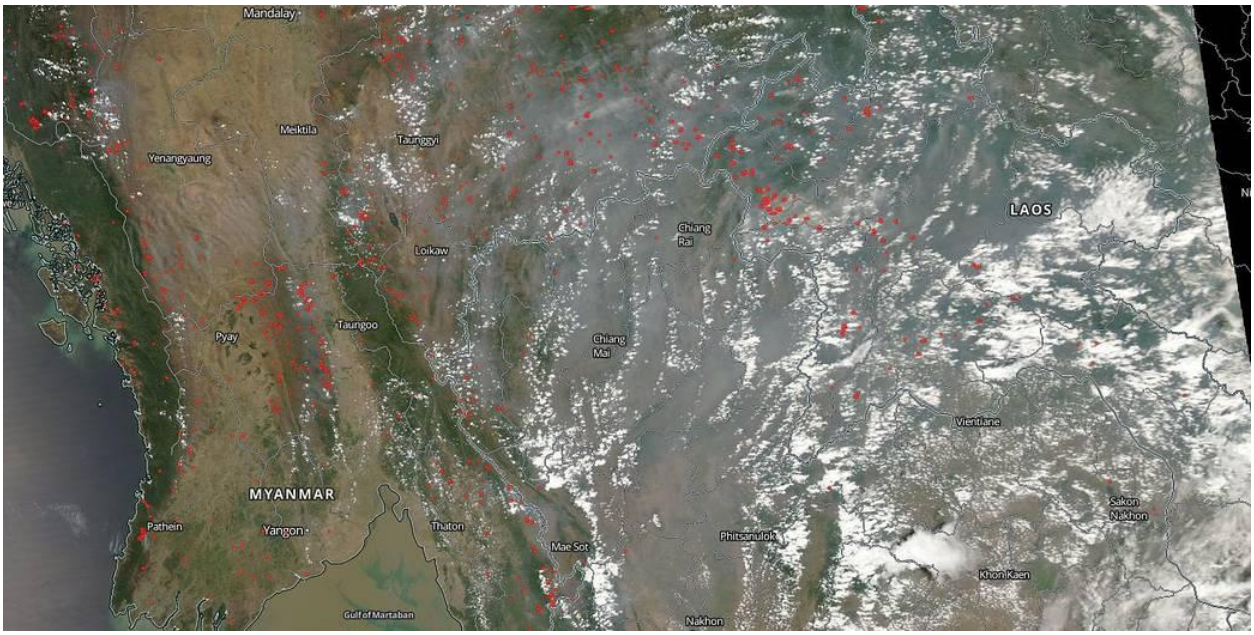

Figure 5: Smoke cover over Northern Thailand and Chiang Mai captured from a NASA satellite (NASA, 2019).

3.3.2 Data Collection

To correctly form our prototype, we researched and studied satellite tools like Sentinel-2 to be able to understand how to detect fires. In addition, we used websites like Nasa FIRMS, CUsense, and Windy to incorporate fire data into our prototype model. In addition, data collected from interviews and surveys with our stakeholders helped shape our prototype. We planed for LINE to be a large component in how we communicate fire risk to locals within Mae Ping National park.

Our data collection comes from our previously mentioned sources, Nasa FIRMS, Windy, and CUsense. Nasa Firms, also known as Nasa's Fire Information for Resource Management System, exports Near Real Time active fire data within 3 hours of their satellites' observation. Their fire information was crucial to the success of our fire prototype and is also what the current Park Rangers are using to notify the locals of potential fires. CUsense is a website for viewing air quality information of mapped locations. We planned to use it to view the current air quality status, temperature, humidity, and concentrations of PM 2.5 . Windy is a resource for current weather conditions. We used it to gain information on Wind direction, speed, gust, rarin accumulation, humidity, and visuals of wind directions.

3.3.3 Community Surveys

In order to assess if the community would be willing to use our Line Application, we conducted an electronic survey. We asked if the locals would like to continue to use Line as a primary mode of communication. Then we asked questions to gauge their current understanding of NASA FIRMS, CUsense, and Windy. Likewise, we asked questions about the communities willingness to use our Line Official account in order to track fires on their own.

3.4 Objective 3

As discussed in our background, one of the major contributors to the severity of wildfires throughout the park are the abundant dry leaves and other organic debris in the area. These act as fuel for any fires nearby and can cause a fire to spread faster and wider than it might have originally. Thus with this final objective, *educating the locals on the profitability of sustainable cultivation of termite mushrooms*, we hoped to introduce new cultivation techniques to the communities and encourage safer foraging practices to mitigate the destructiveness of the forest fires. To address this objective, we first collected data on the wildfire fuel sources in the area by conducting archival research as well as interviews with local community members, park officials, and subject matter experts. We then designed a sustainable method for reducing these sources by analyzing and interpreting the data we collected.

3.4.1 Collecting Data on Wildfire Fuel Sources

Through our Archival research and literature review, we determined that "Anything that can burn is fuel for a fire" (U.S. National Park Service, 2020). This means any vegetation from grasses to leaves, or small trees throughout the park could be potential fuel sources. These sources, while innocuous on their own, and in fact features of the park itself, become a problem once they begin to accumulate en masse. As this finding implicates such a broad range of possible sources our team conducted interviews to gain more region-specific knowledge in order to best address this issue in terms of Mae Ping National Park. Our Thai team had the opportunity to visit the park and conducted interviews with the park's rangers as well as some local community members to determine where we may be able to focus our fuel reduction efforts. Through this interview process we determined that the most common sources of fuel in the park are dry branches and foliage that cover the floor of the forests.

3.4.2 Designing a Model for Fire-Safe Cultivation

While it is not possible to eliminate all wildfire fuel sources, we aimed to reduce the most prevalent one: fallen leaves. The Park's current fire prevention methods include a fire break, which is a corridor of land cleared of all vegetation i.e possible fuel sources in order to prevent further spread of the fires. While this method can help prevent spread from one area to another, the thinning of fuel sources across the park can help reduce the intensity of any burns. A reduction in the intensity of fires makes them easier to put out and increases the effectiveness of the firebreaks already in place. A good way to ensure this is to use rakes and/or blowers to collect fallen foliage across areas of the park and reduce the accumulation of this primary fuel source.

This solution raises many questions however, such as who is going to conduct this labor intensive maintenance? Through our interviews with the local communities and park officials, we determined that many local farmers simply burn away this debris when the season for harvesting mushrooms and planting crops comes. This method of a controlled burn can be useful in some cases to reduce some of the density of fuel sources, however with the accumulation of fallen dry leaves over the year and the added pressure of the dry season, this practice can be the source of much more devastating and harmful wildfires. Our proposed method of leaf collection

however is time and labor intensive and through our interviews, we determined it would not be sustainable for the community as is. Therefore, in order to incentivise local agriculturalists to adopt this method we propose using the collected leaves as a base to grow termite mushrooms. Through our archival research we determined that we can more sustainably dispose of the leaves by having local farmers collect the wet leaves during winter before the fire season when they are unemployed and gathering them around termite nests in the park. As discussed in the background, the termite species that inhabit this area share a symbiotic relationship with a profitable termitomyces mushroom species. We attempted to educate local growers on ways they can utilize manually collected fuel sources as food for growing these mushrooms which they would be allowed to harvest and sell for a considerable profit. This incentive on its own was not strong enough to motivate farmers to take part in this forest maintenance as there is not an easily accessible market for these mushrooms near the village currently. They are however very valuable in cities outside the area; therefore we sought to open up and connect these farmers to these markets as well. During our interviews of locals we heard from one who confirmed that a monetary incentive would make for a stronger commitment as many people are out of work in the off seasons. Ideally this would create a self sustaining and eco friendly system that would address the needs of all parties involved.

3.4.3 Creating a Marketplace

Ideally, our plan to convince the villagers not to burn the forest to forage mushrooms and instead grow termitomyces will result in the villagers having an increased supply of valuable mushrooms. Initially we hoped to use Ricult and other logistics companies to give villagers advice on how to grow mushrooms and then find a marketplace for them to sell their harvest, but we found Ricult would not be useful as its agriculture model does not suit mushroom cultivation. Ricult focuses on farmers who want to start their own farms, providing information on weather forecasts, soil quality, and other methods to improve their farm. In the future, Ricult may be useful if a new area of the forest is used to harvest other crops. There are also no local logistics companies to transport the goods available to the communities in Mae Ping National Park. To overcome this setback, our team created a Facebook page for the locals to post on when they have mushrooms or other goods to sell. Not only will the Facebook page be used to sell the Termite Mushrooms, but also other species of edible fungi, such as the Barometer Earthstar Mushroom and the Puffball Mushroom, which are more valuable than the villagers in Mae Ping National Park are aware of. We promoted the Facebook page through a Line group chat with the local communities, as well as through a presentation on fire prevention given to the school. Our Facebook group also gives the community members advice for how to market themselves on this platform. We hope that this will open the market for these smaller farmers in the local communities to find avenues to sell their mushrooms.

3.4.4 Community Surveys

As mentioned previously, we conducted electronic surveys to gain a sense of the locals perspectives on various information related to our deliverables. The survey also included questions to compare the locals motives in selling harvested mushrooms. We asked questions like if they would be willing to sell termite mushroom instead of puffball mushroom if that would help reduce wildfires, if they would rather sell mushrooms at a lower market price than making an effort to sell at higher price, and if selling mushrooms on facebook was to be more

profitable, would they be willing to sell mushrooms on this platform instead of selling it to middlemen. The responses were mostly neutral, which showed us that the locals would be willing to try new things in regards to the Termite mushroom if we gave them the tools and means to do so.

Chapter 4: Findings

Through an evaluation of our collected data, we have determined that a lack of communication and general awareness of the dangers of wildfires were major issues impeding fire management of wildfires in Mae Ping National Park. In this chapter we will discuss the key findings of our investigation as well as the solutions we have developed in response. First, we will discuss the main source of wildfires that we determined through research and interviews with our sponsors and park officials. We will then go on to discuss the ways in which we addressed the identified problems, with the development of our LINE Official Account and Facebook Marketplace. Our LINE application addresses the issue of delayed communication as it is a tool to monitor bushfire ignition and spread throughout the park that can be easily accessed by Park Rangers, Fire Control Center, and Baan Kor Locals alike. Our Facebook Marketplace was developed to address the fire provoking practices at the root of the majority of wildfires, by promoting locals to transition to a more sustainable method of mushroom cultivation. While we haven't had the opportunity to see how the communities will take to these solutions, we hope that these deliverables can be a first step towards a long term solution.

Finding 1: The major source of wildfires in the park are man-made fires lit for the purposes of foraging and cultivation.

Over the course of our investigation, we discovered that the vast majority of wildfires were incited by smaller man-made fires that grew out of control. Fire is a common tool of the region used by many locals to hunt, cultivate, and forage. Foraging in particular is practiced extensively as forest products, primarily mushrooms, account for approximately 40% of the community's annual income and is the primary source of income during the dry seasons when farming is less profitable. The use of fires for foraging however has become alarmingly frequent. As a direct consequence of this increased reliance, the instances of wildfires have increased as well. When visiting the park and interviewing with park rangers as well as our sponsor, we learned that fire-dependent foraging for mushrooms is believed to be the main source of many of the wildfires. The responses to our community survey support this assertion too, as shown by the graphs in **Figure 6** and **Figure 7**. In 2020 alone, it has resulted in 132 fires burning approximately 1622 acres of land. **Table 1** shows the record of all fire incidents in the park between 2016-2020 categorized by inciting incidents, which affirms this claim. Based on responses to the community survey and chats in the community Line group, we determined that there is a widely held belief in the community that burning the ground promotes mushroom growth. This is in fact untrue, as affirmed by interviews with a local botanist, Dr. Jittra. The increased burnings and subsequent wildfires actually damage the microryza network of fungi beneath the ground and impedes the growth of puffball mushrooms. This in turn prompts locals to burn more as the yield decreases and the puffball mushrooms become harder to find. This cycle of burning is unsustainable. If the rate at which fire is used in foraging is not significantly lessened the puffball mushroom will eventually be eradicated from the park.

Figure 6: This graph shows the survey responses to the question: The use of fire to cultivate mushrooms has caused some of these fires. Over two thirds of the locals surveyed believe using fire to cultivate mushrooms has caused fire outbreaks.

Figure 7: This graph shows the survey responses to the question: Reckless prescribed burning could cause bushfires. A strong majority of locals surveyed believe prescribed burns have caused fire outbreaks

	2017	2018	2019	2020
Collecting forest products	95 fires	66 fires	95 fires	132 fires
Animal farming	-	1 fire	-	-
Slash and burn	-	-	2 fires	2 fires
Tourism	-	-	1 fire	-
Unknown	-	-	-	1 fire
Others	-	-	1 fire	-
All affected areas (acres)	673 acres	750 acres	859 acres	1622 acres

Source: Fire Control Center in Mae Ping National Park

Table 1: This table was translated from one seen in the Fire Control Center in Mae Ping National Park. It describes the instances of fires started in the park over the last four years.

Finding 2: The response to wildfires is delayed by a complicated communication system.

Through interviews with park officials as well as insights from the local community, we discovered that the communication between the park and the community in response to a wildfire is complicated and inefficient. In the event of a wildfire, it is important that all parties be made aware of the danger and respond as quickly as possible. When we visited the park, we learned that most fires are detected in the park via NASA FIRMS satellite monitoring, and once detected there is a long chain of communications in order to disseminate the information to all entities in the park. First the Fire Control Center receives hotspot coordinates from their headquarters in Chiangmai. Then, the data is sent to park rangers and volunteers responsible for the designated area. Only then does each group mobilize to put out the fire. These delays can add hours to a fire response time, allowing for a small fire to spread into one that can no longer be contained. The issues with communication extend further as many members of the local community not involved in fire management are not made aware of the fires until much later if at all. This is alarming as it indicates that the community is not fully aware of the extent of these burnings even though they are those most affected as indicated by our survey results. Based on this finding we have identified a need for centralized information regarding wildfires in the area.

In order to address this finding we developed a tool to monitor bushfire ignition and spread through Mae Ping National Park and surrounding forests. We used Line as a tool to provide local community members, volunteers, and park rangers easy access to simplified fire and weather data from the websites NASA FIRMS, CuSense, and Windy. These three sites are the main databases used by the Fire Control Center and park officials to monitor wildfires in the park. While they all provide public information, we found that most community members had little to no familiarity with them, as shown in the pie charts depicted in **Figure 13** and **Figure 14**. Through interviews with our sponsor we also learned that the sites were quite complicated and difficult to navigate for the locals. For this reason we believed that if we were to organize all the data from these sources into one easy to navigate location, that more people in the community would be able to access the fire data. We also hope it will allow for a better understanding of the effect fires have and encourage locals to be more active in protecting themselves from fires. We chose LINE to be the most effective form of communicating this information due to a survey found by Team 2 of the Thailand IQP. In this survey given to Thai school students, it was found that most locals have smartphones and use LINE as their primary form of communication. We believe that this application and website will be an effective and user-friendly way for the local community members to be proactive in fire safety. Screen grabs of the LINE home page and website can be seen in **Figures 8-12**.

It is important to address however the limitations of this application's development. Given the primarily remote status, and limited timeline of our project work we had limited opportunity to gather opinions from locals regarding the development of our LINE application. While we were able to get some insights from survey responses, they were mostly pertaining to community interest regarding the tool in general. Over the course of development we were given

feedback on design from our sponsors and advisors but we did not have the opportunity to have locals test the application. We designed the tool with the local community in mind as part of the target audience and would like to have done more to user testing with them.

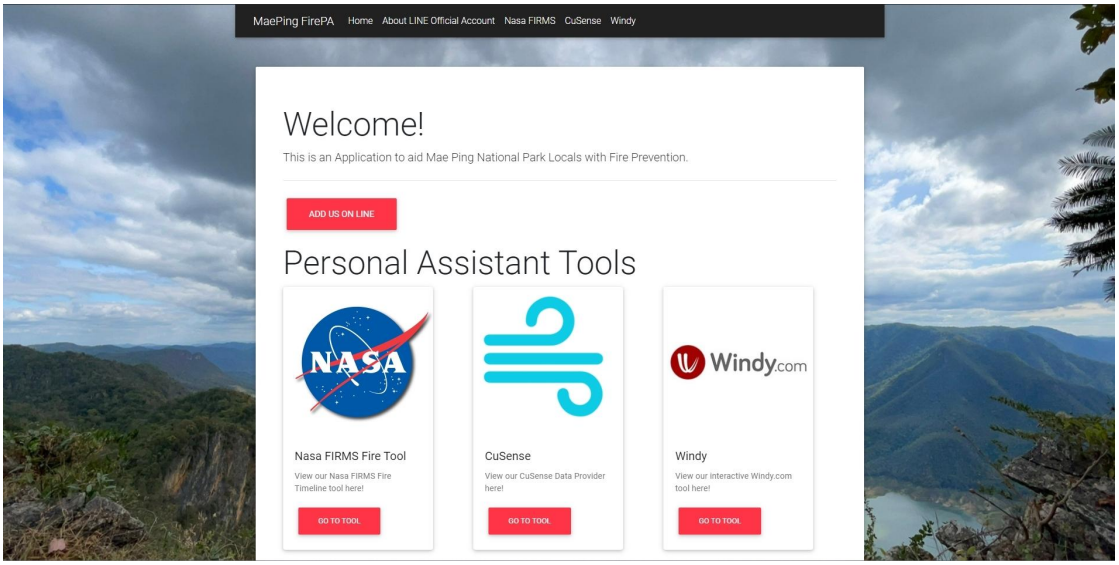

Figure 8: This image depicts the Home page of our LINE Web Application.

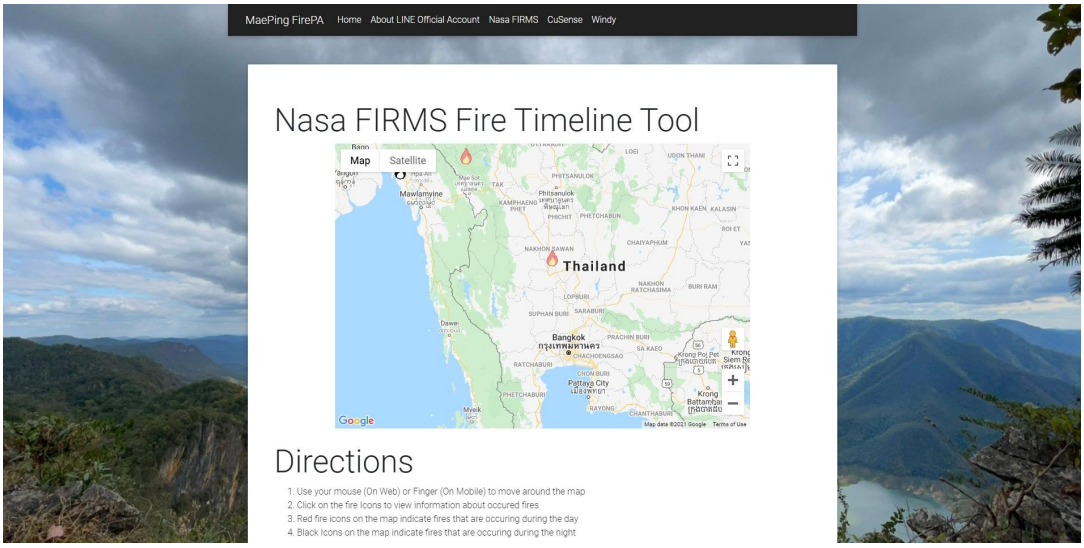

Figure 9: This image depicts the Nasa FIRMS Fire Timeline Tool page of our LINE Web Application

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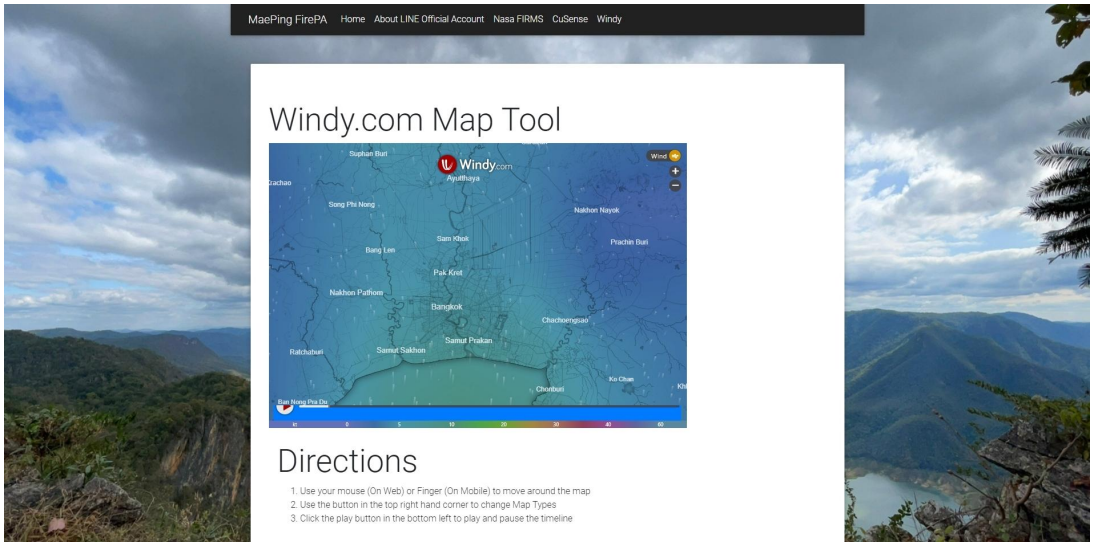

Figure 10: This image depicts the Windy.com Map Tool page of our LINE Web Application.

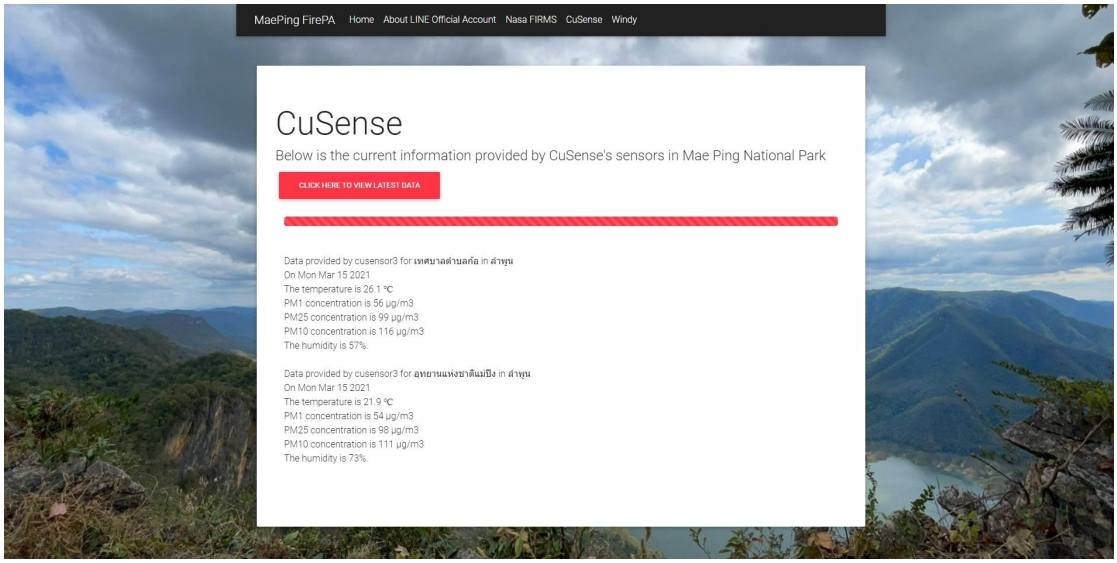

Figure 11: This image depicts the CuSense Page of our LINE Web Application.

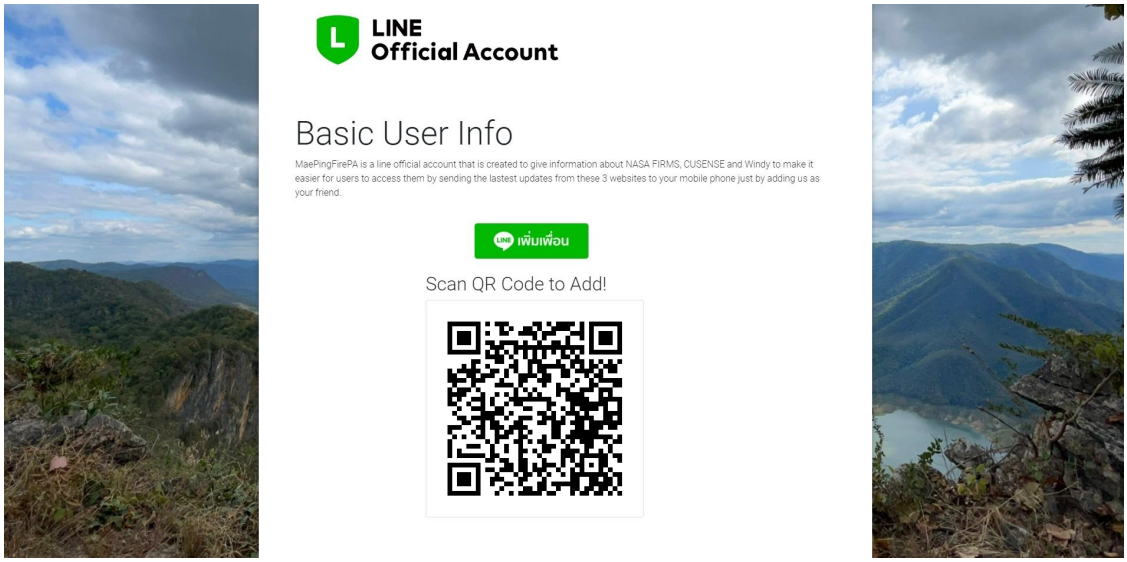

Figure 12: This image depicts the LINE Official Account Page of our LINE Web Application.

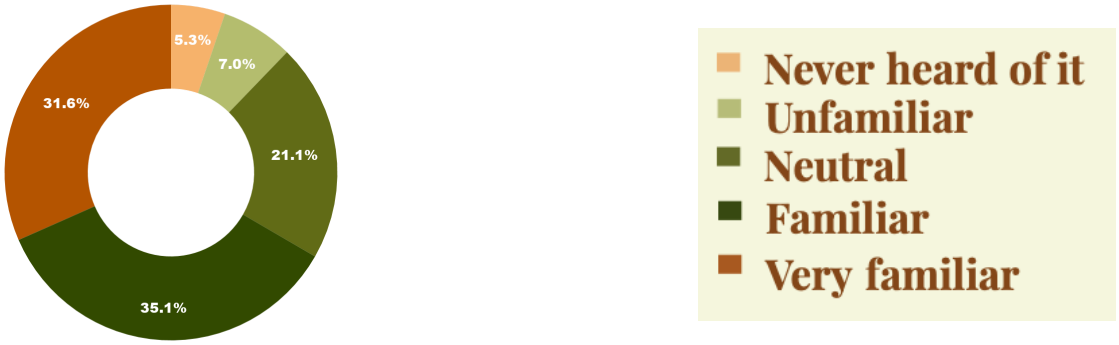

Figure 13: This chart depicts survey results to the question: On the scale of 1-5, I am familiar with Line. The data from this question shows that many local community members are familiar with the application.

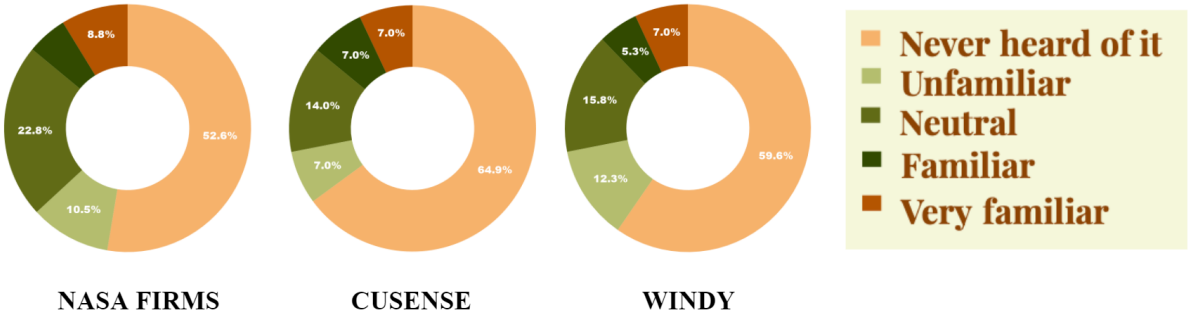

Figure 14: These charts depict the survey results to the questions : On the scale of 1-5, I am familiar with NASA FIRMS, CuSense, and Windy, respectively. The data from these questions show that many local community members are unfamiliar with these databases.

Finding 3: The cultivation of Termite Mushrooms is a sustainable alternative to foraging for other mushroom species.

Through interviews conducted with local Thai botanists in the area, Dr. Rath and Dr. Jittra, we learned of a certain mushroom called termitomyces or termite mushrooms. These mushrooms grow symbiotically alongside the macrotermitinae species of termites and are created through a process of feeding leaves, one of the main fuel sources in the forest, to these termites that are native to the Mae Ping National Park. Through further discussion with the botanists, as well as our groups own research, we learned about the unique solution provided by their relationship. These mushrooms have the ability to improve two aspects of the wildfires in the region: the removal of fuel sources and the reduction of intentional burnings for the collection of forest products. With dried leaves being one of the main fuel sources for the wildfires, the mushrooms provide an almost perfect natural solution as they allow for the removal of potential dangers and the creation of valuable crops. The park has begun taking the steps necessary to make this a long term solution for reducing these fuel sources, by creating fenced off areas for leaves to be collected and produced into mushrooms by termites. These fenced portions of the forest have already begun to yield a large amount of mushrooms, and with plans to create new forest areas for these techniques to be used, it seems to be a profitable solution for years to come and we hope the communities continue to adopt it. The preparation of these termite nests for mushroom cultivation can be seen in **Figure 15 and 16**.

Figure 15 (Left) and Figure 16 (Right): Local volunteers gathering leaves to put into the termite enclosures that will getting eaten by termites and converted into Termitomyces mushrooms

Currently, the local farmers collect their harvest of crops and sell the product to a middle-man of sorts, who buys the mushrooms at an undervalued price then resells them at local markets. However, when conducting our research, we found that one of the biggest issues with this project gaining popularity with the local community was the lack of information provided. One of the only issues with the Termite mushrooms in the local communities eyes was the lack of profitability in local markets when compared to the puffball mushrooms. We found, however, that what the locals were not educated on was the massive increase in profits of these termitomyces in markets in other regions. The termitomyces mushrooms were valued at almost double the puffball mushrooms when other markets were explored outside of the region, as these mushrooms are extremely sought after. We began searching for ways to connect the local

community of Baan Kor to these markets, and what we discovered was that many of these marketplaces also had associated facebook pages that sellers could use, some with over 300,000+ members. We also found that the use of a courier company, such as Kerry Express, could be used to ship products from the park to potential buyers. In light of the COVID-19 pandemic, this provided us with an easy avenue to connect the local community to buyers, while keeping everyone safe through the process.

To address the need for education on the advantage of termitomyces mushroom cultivation, as well counter the current use of fire-provoking cultivation techniques, our team developed a marketspace and marketing materials for the sale of these mushrooms through the use of the online social networking platform, Facebook.

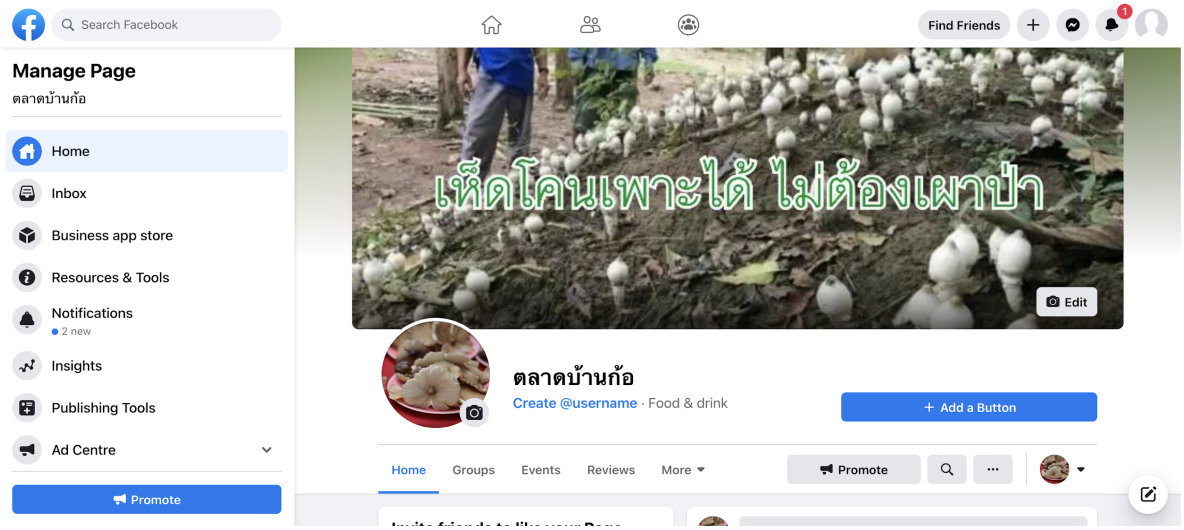

Figure 17: A screen grab of the home page of the Mae Ping Marketplace Facebook group

We hoped that this online group would provide locals with a more frictionless means of selling locally grown products and thus incentivise them to shift towards the more sustainable cultivation of termite mushrooms rather than the current fire provoking methods being used to harvest puffball mushrooms. The group is called Talard Baan Kor, and is a public page anyone from the community can join. To help educate the community members, our group created and posted several infographics. We detailed information on how to make a posting in the marketplace, how to add media such as images and files, and what kind of information you should be adding to a listing. We also posted examples of formats for how to advertise the mushrooms the farmer would be trying to sell. Last, we posted pricing breakdowns on the profitability of the different types of mushrooms when being sold through the middle man versus selling through our marketplace. These infographics shown in **figures 18, 19, and 20** below have since been translated into Thai. We are hoping these will begin to educate the farmers on the usefulness of these mushrooms and will incentivise them to engage with the marketplace.

Figure 18: An infographic we created for the Facebook group that shows how to make a posting on the Facebook page, which has also been translated into Thai

Figure 19 (Left): An infographic we created to show locals what type of information they could post on the Facebook page, which has been translated into Thai.

Figure 20 (Right): Another infographic we created to encourage locals to sell to larger markets for increased profit instead of the traditional middleman, which has been translated into Thai as well.

Once the Facebook page was created with the educational information available for reading, we shifted our focus to promoting the Facebook page to increase engagement from the local community. Surveys were sent out to the local communities through Line to ask about willingness to transition to termite mushroom cultivation, sell the mushrooms through new marketplaces if it would increase their profits, their familiarity with Facebook, and many more. We received 57 responses and the results showed us that the locals would be willing to switch to termite mushroom cultivation if they had the proper means and tools to do so. Some results from the surveys can be seen below in **figures 21-24**.

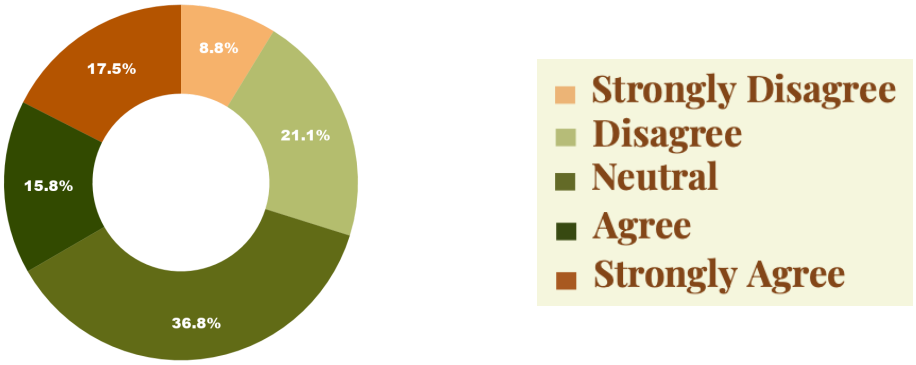

Figure 21: I would rather sell mushrooms at a lower market price than making an effort to sell at higher price.

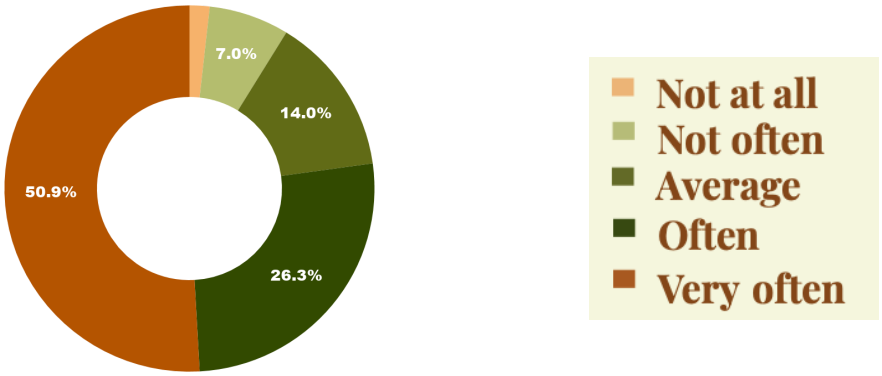

Figure 22: How often do you use Facebook?

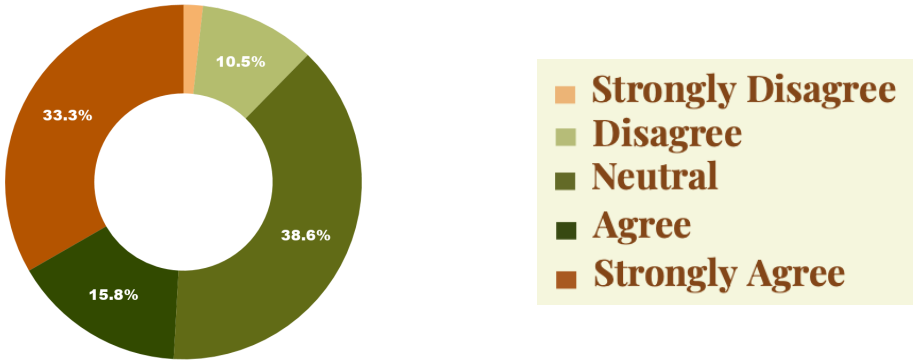

Figure 23: If selling mushrooms on facebook is more profitable, I would be willing to sell mushrooms on this platform instead of selling it to middlemen.

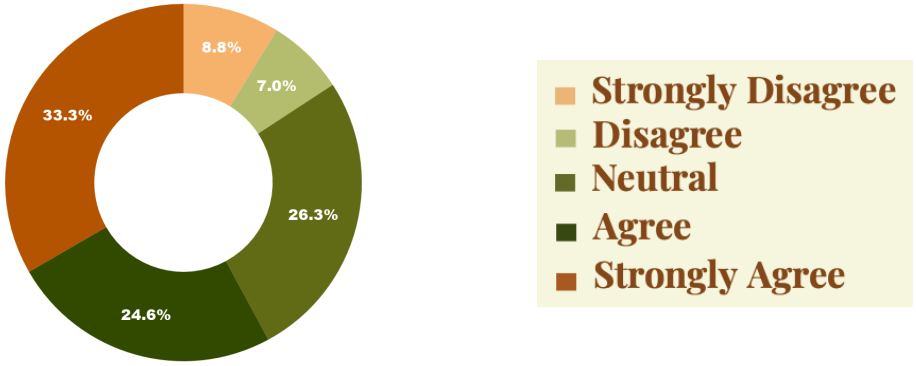

Figure 24: I would be willing to sell termite mushroom instead of puffball mushroom if that would help reduce wildfires

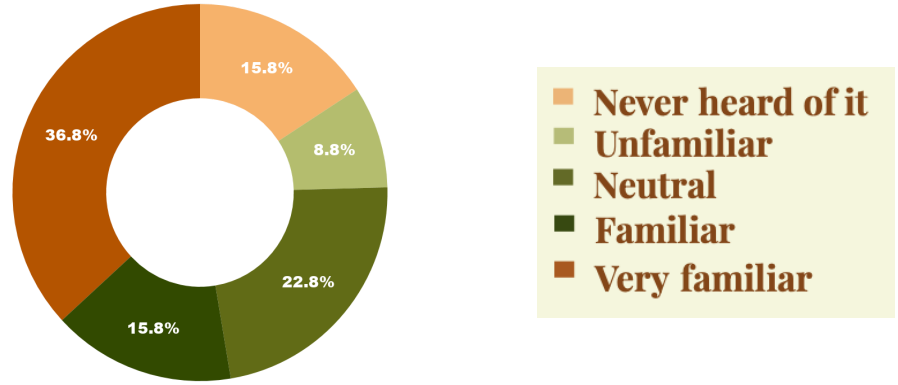

Figure 25: I am familiar with Kerry Express

Mostly positive results came back from our survey, so as a result the group began to look for ways to promote the page. The link to the Facebook group was sent through to the same Line group chat as the surveys. In addition, the Facebook group was advertised to the local students after a presentation regarding fire prevention where they were told to relay the information to their parents. Lastly, after completion of the project all of the information and deliverables will be handed to our sponsor, Dr. Jain, who has strong connections to the community and will use his resources to continue to promote the Facebook group.

Through our groups background research and findings, we have been able to create a resource for the local communities to use which will not only increase their income but also help in the prevention of wildfires. It can be a resource that can aid in the ongoing efforts to promote sustainable cultivation and provide an accessible means of connecting local sellers with outside buyers who are willing to pay market price for them. Past attempts to harvest the Puffball mushroom have shown the lack of ability to control these fires, and the destruction they have caused has shown there is little future for this cultivation technique in the region. The local communities willingness to interact with our Facebook group and the expansion of the termitomyces mushroom project by the park would complement each other long term.

Conclusion of Findings

While we did experience a lot of fluidity with our project, and the need to adapt to constant changes we do believe our deliverables can help the communities within Mae Ping National Park towards a long term solution. Through our Line application we were able to successfully develop a tool to monitor bushfire ignition and spread throughout the park that will be used by the Park Rangers, Fire Control Center, and Baan Kor Locals. Cultivation of mushrooms using these fire-provoking techniques is not sustainable, and with the restrictions that the government is continuing to place on the local communities there is a massive need to look towards other avenues for profits. Through our Facebook marketplace we have been able to provide education on the profitability of sustainable cultivation of the termite mushrooms and have provided avenues for the locals to sell these products to larger markets, showing how it can be a replacement for fire dependent techniques. While we haven't had the opportunity to see how the communities will take to these solutions, we hope that these deliverables can be a first step towards a long term solution.

Chapter 5: Conclusions and Recommendations

In this chapter we will provide a summary of our key findings and then provide recommendations for the stakeholders in Mae Ping National Park regarding how to decrease the amount of forest fires and the damages caused from the fires. Through our research and communications with locals of the region, we realized most of the issues about fires stem from a lack of communication as well as a lack of understanding about the threat posed by wildfires. We believe our recommendations can be implemented in the future to improve the quality of life for individuals living within Mae Ping National Park, both in terms of fire safety and increasing profitability from agricultural products from the park.

5.1 Summary of Key Findings

Our team discovered that the main problems in Mae Ping National Park are miscommunication and lack of information. Individuals within the park are often too dependent on fire as a means of harvesting from the forest as well as to burn excess waste. This caused a large health and environmental crisis in the region, with members of the community lacking the necessary tools and information to help their problem. Park Rangers, who are supposed to be the frontline in terms of stopping fires and monitoring the park, are not properly educated on the ways fire spreads. Some of the Park Rangers are unfamiliar with how to use the main websites used to track fires in the region: NASA FIRMS, CUSense, and Windy. There is also a lack of preparation when fires occur that results in delays before volunteers attempt to stop the fire. These delays allow fires to spread out of control. However, through our deliverables, a Line Official Account that delivers fire hotspot information from the aforementioned websites and a Facebook Group, more information about how fires are managed is available to members of the community. In promoting a plan to grow termite mushrooms, we hope locals will shift away from burning the forest. We found that there is a need to promote information about the damaging effects of wildfires in a simple way that all members of the community can understand.

5.2 Recommendations

With the issues presented above, we have come up with the following recommendations to the stakeholders within Mae Ping National Park in order to help reduce wildfires in the future. While there is certainly a large problem with wildfires that has been occurring for the past decade, we think these small steps could help the locals improve their situation in a short amount of time.

5.2.1 We Recommend Locals Avoid Starting Fires Outdoors for Any Reason

While fires can occur due to natural causes, the overwhelming issue in Mae Ping National Park is fires are started by locals. For various agricultural purposes, farmers will start a fire that they believe will help them with their crops for the future. Whether the farmers are burning excess crop residue or trying to add nutrients back into the soil, these fires they start are not safe. A small burning can quickly spread out of control and damage a large portion of the forest. With this in mind, we recommend that locals do not start their own fires without proper consultation and the necessary means of putting out the fire once they are done. Ideally, no unnecessary fires should be started as the smoke adds to the dangerous amount of P.M 2.5 levels in the area. However, locals have used fires for their own purposes, even before the area came to be recognized as a National Park. This means that new laws that did not previously impact the locals are now something they have to listen to, changing their old traditions. With this in mind, we know changing old habits can be difficult and people may not want to listen to the facts of the situation, but any steps taken that decrease the number of fires in the area will improve the lives of the locals. We found that sometimes locals will start fires for revenge burning against laws they do not believe in, which only makes the problem worse. The people in Mae Ping National Park should not be starting their own fires as they are an ongoing dangerous problem, thus, promoting the removal of burning practices is the safest course of action.

5.2.2 We Recommend Park Rangers Improve Communications With Locals About Burning

We also found that miscommunications between Park Rangers and other locals has caused more fires. With this in mind, we recommend Park Rangers use safer and smarter ways to practice controlled burns, and spread information in a clearer manner to individuals within the community. For example, the reason the fires from February and March, 2021, became so large stems from a miscommunication issue. When Park Rangers announced they were going to attempt a controlled burn to remove fuel sources for the fire, locals understood that it was allowed for them to burn the forest as well. With many fires being started and weather conditions involving high winds, a simple prescribed burn from the Park Rangers turned into one of the worst fire outbreaks in years. This drives the point that until locals and people in charge of the forest can understand how to safely burn, started fires should be avoided for any reason.

5.2.3 We Recommend Locals Subscribe to Our Line Account

We hope to increase the locals' understanding of how fires start and spread in order to create awareness of the dangers of burning. In Thailand, the main online tools used to track fires are NASA FIRMS, CUSense, and Windy. However, people in positions of power like the Park Rangers, often do not know how these applications work. With this in mind, we developed the Line Official Account to make accessing these applications easier. We recommend locals use the Line official account to

improve fire response time. Once a fire is detected from NASA FIRMS, users of the line account will be notified of that fire. Combined with Windy and CUSense, users should be able to quickly access the situation and predict where the fire will spread. From here, a response team can go to where the fire is and attempt to smolder it before it becomes too large to put out easily. If the locals and Park Rangers familiarize themselves with our new Line Application, we believe it will help decrease the damage from fires. A major issue in Mae Ping National Park is the current method of fire response. Currently, the Fire Control Center first receives hotspot coordinates from Headquarters in Chiangmai. Then, data is sent to Park Rangers and volunteers responsible for each area. Only then does each group mobilize to put out the fire which allows for a small fire to spread into one that can no longer be contained. With the Line Application, once there is a fire hotspot, users will immediately be notified of the location of the fire. We are promoting the Line Application so that many of the locals join the page, and we recommend the locals continue to sign up and familiarize themselves with the information within the application so that they can be more aware and knowledgeable about how fires start and spread.

5.2.4 We Recommend Establishing a Watchdog Program for Wildfires

We believe in establishing a watchdog program to monitor bushfires to improve fire response time. Children or anyone with free time can watch NASA FIRMS to look for fires. While the Line Application will already notify users of a fire, the watchdog program will help for individuals without access to the internet. The individuals monitoring NASA FIRMS can send an alert to the Park Rangers, as well as announce it to the volunteers who put out the fires. This program would ideally help to decrease the time between a fire being started and volunteers moving to stop the fire. If the locals can quickly respond to a fire, they have a better chance of putting it out before it spreads into other areas. We also think the watchdog program will help with future generations in Mae Ping National Park, as they will become familiar with the tools used to monitor fires. They can then spread their knowledge to other individuals, which will help promote awareness about how dangerous fires really are to the region. We think a younger target audience for the watchdog program is ideal, as most likely the older generation will not change their ways of living, but the younger generation can become educated on fires and pass this information down as they grow older. In this manner, people who are unaware of the problems from fires will slowly phase out, and the new generation will understand the problem at hand and be more motivated to protect their National Park.

5.2.5 We Recommend Locals Focus on Termite Mushrooms over Puffball Mushrooms

With an outsider perspective, it is clear that locals should continue to build the termite enclosures. As this year was the first time wooden enclosures were set up to house massive amounts of termites and leaves that could be converted into mushrooms, these enclosures were very experimental. However, we know that the termites will produce mushrooms if given the proper food source. We think building more enclosures in different regions of Mae Ping National Park will result in an increased yield of the termitomyces mushroom. If locals continue to support the termite

mushroom plan, they will have access to more mushrooms with far less work. The enclosures require minimal upkeep; the only work is to add leaves for the termites food source. This will also help with removing fuel sources for fires, as dry leaves the main means for fires to spread. Likewise, locals would ideally avoid burning the forest because of the risk of destroying their easy to harvest mushroom. The termite mushroom is more valuable compared to the puffball mushroom. In the past, locals would burn the forest because they thought it would make it easier to find puffball mushrooms. Instead they actually burned away most of the mushrooms and decreased the chances more mushrooms will grow in the future, as fires are damaging to the ecosystem of the forest. With the termite enclosures, the locals should see no need to burn the forest for harvesting purposes, as their product will be within the enclosure.

5.2.6 We Recommend Locals Use Our Facebook to Market Their Products

In order to help connect locals to outside markets, we created a Facebook group where the locals can post their products to sell. This group was made so that locals could sell their crops to larger markets instead of the traditional middle man. The middlemen buy products like mushrooms for a low price to the villagers, typically two hundred baht per kilogram, and then take the mushrooms to different areas of Thailand and sell them for at least double the profit. We recommend locals use and grow their Facebook page to show them that their products can be sold for more value in different markets. Ideally, with the termite enclosures the locals will have many more mushrooms to sell, and by selling to a larger market for more money, they will feel less of a need to burn the forest for other products.

5.3 Suggestions for Future Researchers

With the root causes of the fires stemming from individuals within Mae Ping National Park, future researchers should focus their efforts on building relations with the community. While we were unable to physically go to Mae Ping National Park and promote our strategies to prevent forest fires, we were able to connect with a number of people through online tools. The individuals within the Park are becoming more aware of how harmful the fires are to their health, but need outsiders help in coming up with strategies to stop these fires. It is extremely important to listen to the locals' opinions about what they would like to do in the future, as they are the ones who can implement and maintain any new methods for fire prevention. If the ideas presented to them do not align with their values, then what could be an effective fire prevention strategy will go to waste. In order to become aware of what the individuals in Mae Ping National Park want for their future, you must build connections with them in order to hear their side of the story.

5.4 Project Conclusion

The goal of this project was to gather information and data on various aspects of the causes and effects of wildfires within Mae Ping National Park and its surrounding communities in order to spread information about fire safety to decrease the damage from wildfires. We found that individuals within the park are largely responsible for the ignition of fires, and their lack of understanding about the damage the fires are causing to their environment is a main reason for this. The lack of information and tools to educate members within the community has resulted in repeated fire problems for many years. Even if the locals are starting to become aware of the issues, they struggle to find a way to do things in the right manner simply because of miscommunications within the community. To improve communication, we developed an easy to use application that can monitor fires and show the damage of fires spreading over time. This, in combination with a Facebook group that will be used to connect locals with members from outside of their community, should be helpful in decreasing forest fires and instead increasing the locals' understanding about the ways fires move. We are confident that the work we have done will have a positive impact in the community in the near and far future; thus, aiding in the effort to create a manageable system for decreasing wildfires.

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Appendices

Appendix 1: Geography & Climate in Northern Thailand Impacting Fires

In a broader view of Thailand, we can see that forest fires are dangerous because of their unpredictability. People are impacted by lifelong burns, breathing complications, and can even lose their life. A less apparent physical impact from forest fires is their emission of smoke into the atmosphere. When forests are burned down large amounts of $PM_{2.5}$ and PM_{10} are released into the air. These harmful emissions and other toxins create a layer of smog in the atmosphere (Brady, 1996). This phenomenon has been captured by satellite imaging that shows a black cloud above regions where massive forest fires burned (Jenner, 2019). The fires have caused severe damage to the regional air quality indicated by the increased dust and PM2.5 particle levels, 41-251 micrograms per cubic meter in the air (Moran, 2019).

In recent years the rampant wildfires throughout northern Thailand and surrounding Mae Ping National Park, pose an increasingly greater threat to the lush natural resources provided by the landscape and the reliant communities surrounding it. Damage to these forests can have repercussions upon multiple facets of life in the communities in the region. To mitigate these damages, our project goal is to determine the causes and factors affecting wildfires in Northern Thailand to create a preventative plan that aligns with the values of the local communities. Through a deeper investigation into the topics covered in this background, we hope to provide a tangible analysis of the risks and prevention methods of these fires and continue the effort of protecting this natural resource.

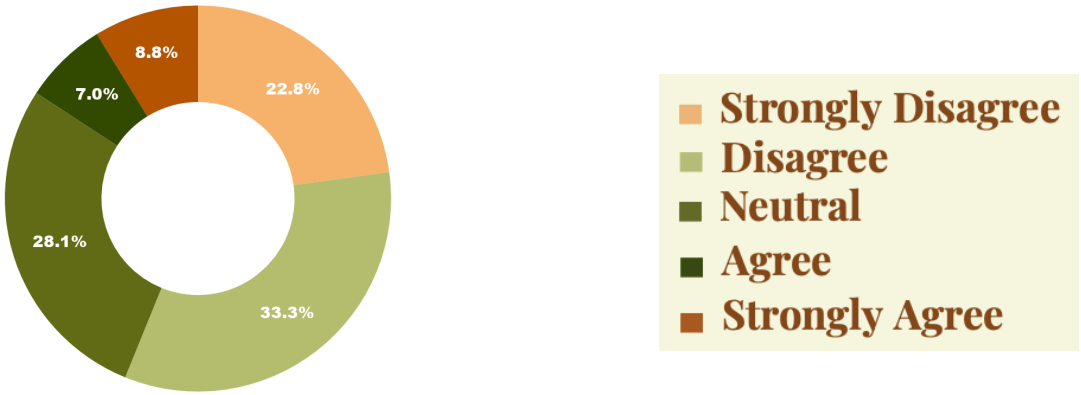
From our review of existing research and studies, we have compiled and presented several topics relevant to understanding the nature of wildfires, the ways wildfires affect this region of northern Thailand, and how that factors into the social issue. We first examined common sources of wildfire ignition, both natural and human, to gain a general understanding of the issue. We then determined factors affecting wildfire spread by compiling research from several academic sources. We also conducted a thorough review of prevention measures in place globally, Thailand's legislative action in the region, and local projects with similar goals, to assist in the development of our fire management proposal. Finally, we reviewed the impact of the wildfires on the local community to establish and incorporate a sense of the social issues into our fire prevention plan.

Appendix 2: Survey Questions & Responses

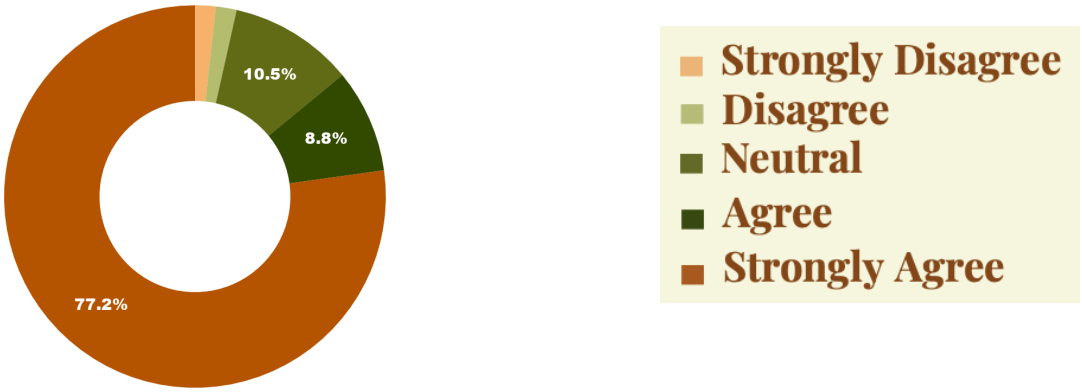
These pie charts represent the responses of 57 individuals who participated in an anonymous electronic survey distributed through a Line chat between our sponsor, Dr. Jain, and the locals in Mae Ping National Park. The survey was conducted by providing a sentence involving the individual's belief on some subject related to our project. Their response could be a scale of 1 through 5, where 1 is strongly disagree, 2 is disagree, 3 is neutral, 4 is agree, and 5 is strongly agree for questions relating to their beliefs. Questions regarding familiarity of applications like Line, NASA FIRMS, CuSense, and Windy were asked with a scale of 1 through 5, 1 being never heard of it, 2 being unfamiliar, 3 being neutral, 4 being familiar, and 5 being very familiar. Questions regarding use of the aforementioned applications were scaled 1 through 5, with 1 being not at all, 2 being not often, 3 being neutral, 4 being often, and 5 being very often. We asked individuals to provide their working status, but not their names. Of the 57 responses, 1 was a Park Ranger, 11 were in the teaching industry, 34 were students, 8 were farmers or merchants, 1 was a weaver, 1 was a volunteer, and 1 was an employee for fire prevention. The responses indicate locals are aware of most of the issues at hand, but struggle to use avenues to address their issues. The pie charts show visuals of the data, while the tables below show each of the individuals responses.

Question 1: I play a role in fire prevention.

Question 2: I use fire in my daily life for various tasks like cooking or waste disposal.

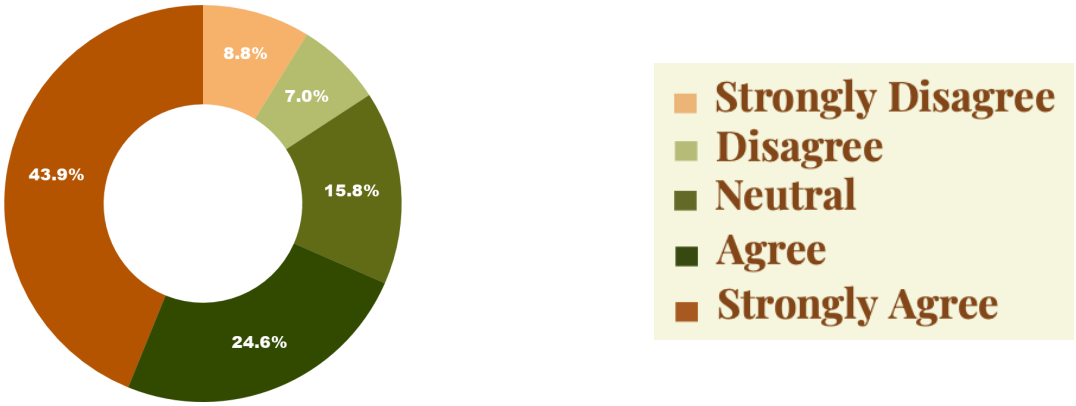


Question 3: Wildfires in the region affect my daily life.

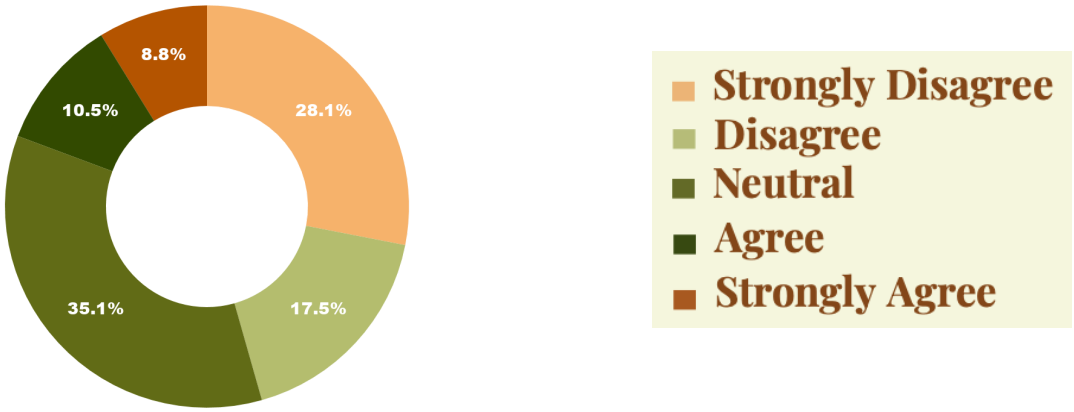


Question 4: The use of slash-and-burn has caused some of these fires

Question 5: The use of fire to cultivate mushrooms has caused some of these fires



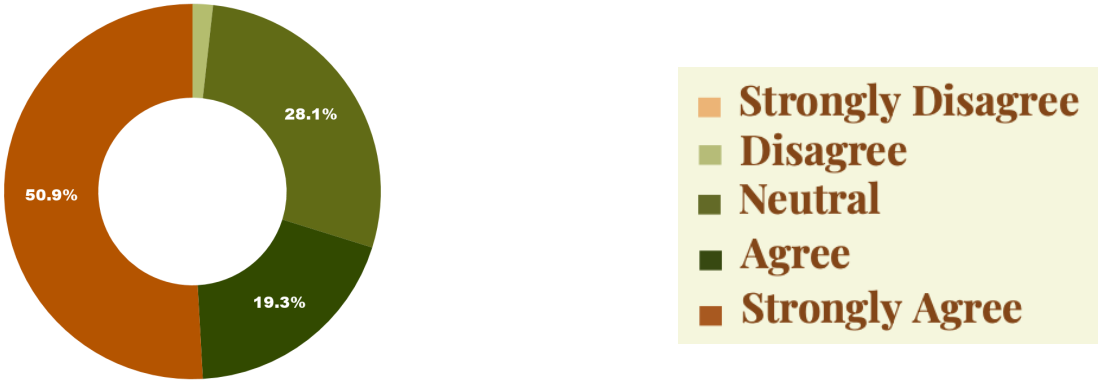
Question 6: The fires are caused by natural events.



Question 7: Reckless prescribed burning could cause bushfires

Question 8: The government has handled the wildfire problem appropriately.

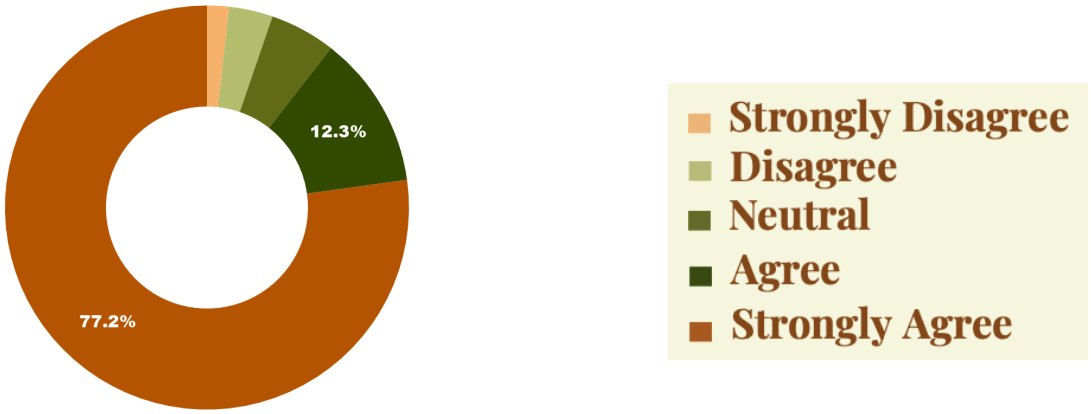
Question 9: Wildfires have become more of a problem in the last 5 years.



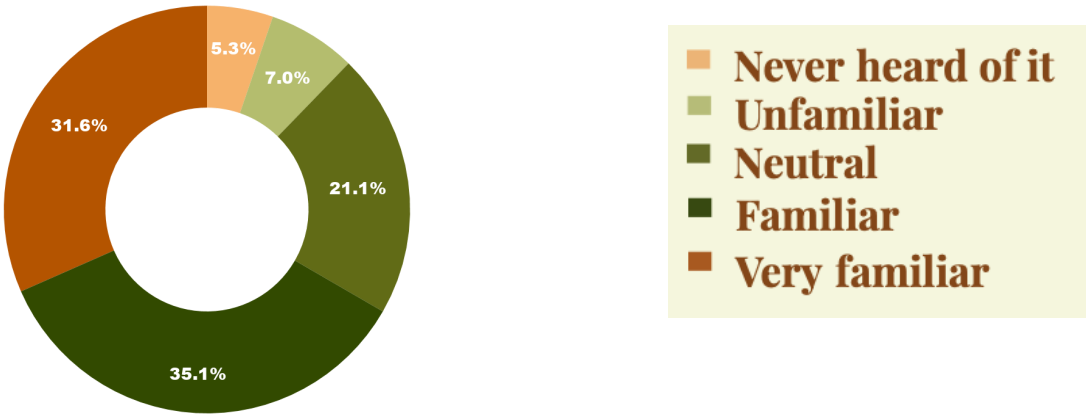
Question 10: The local community is involved in fire prevention.

Question 11: The local community relies on the surrounding forest for resources.

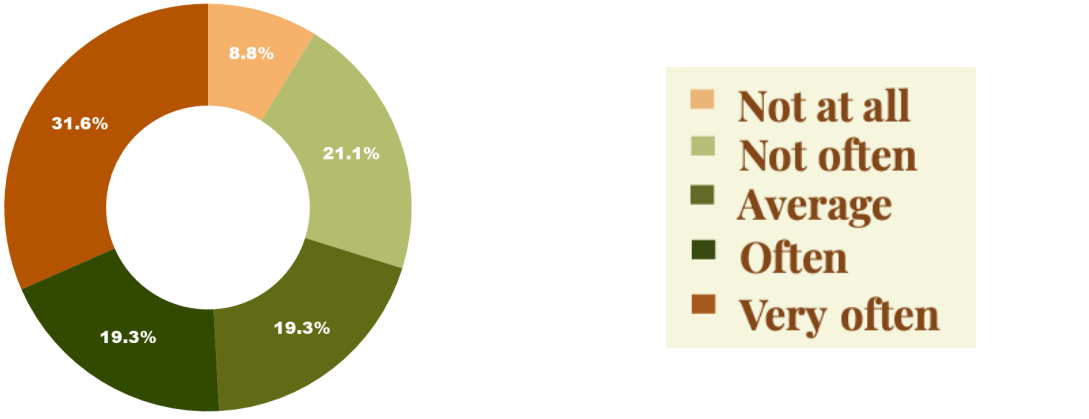
Question 12: The smoke from these fires poses a health risk.



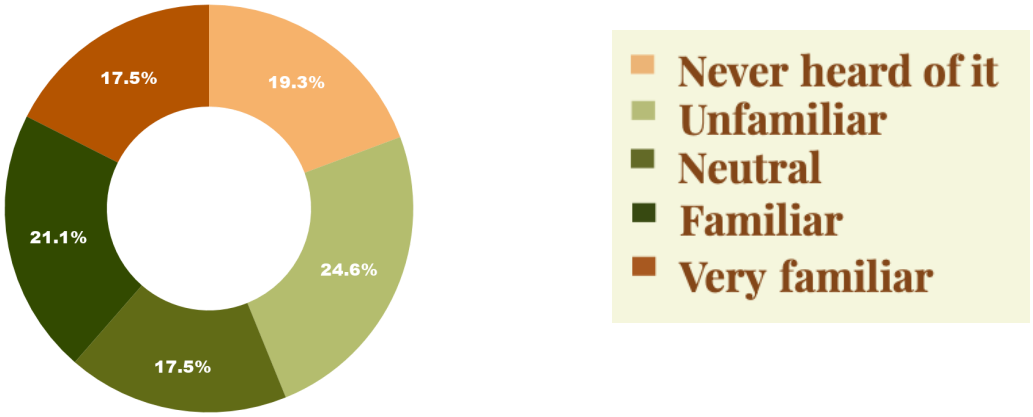
Question 13: On the scale of 1-5, I am familiar with Line.



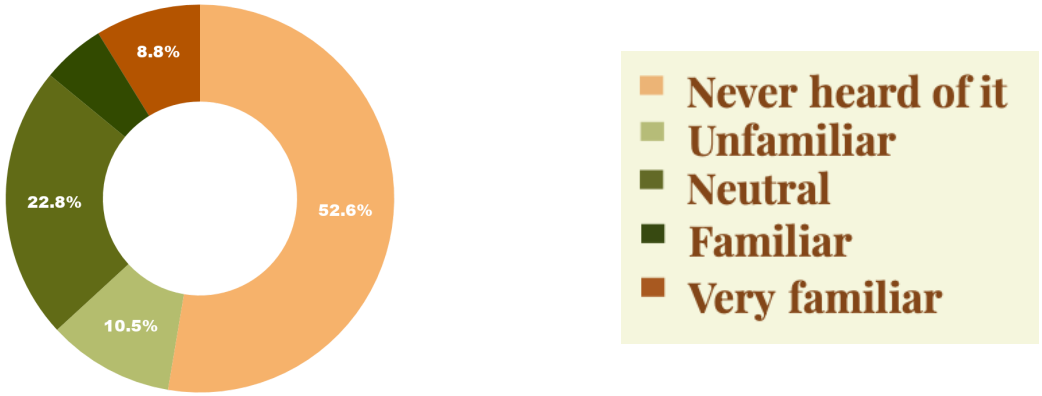
Question 14: On the scale of 1-5, how often do you use Line.



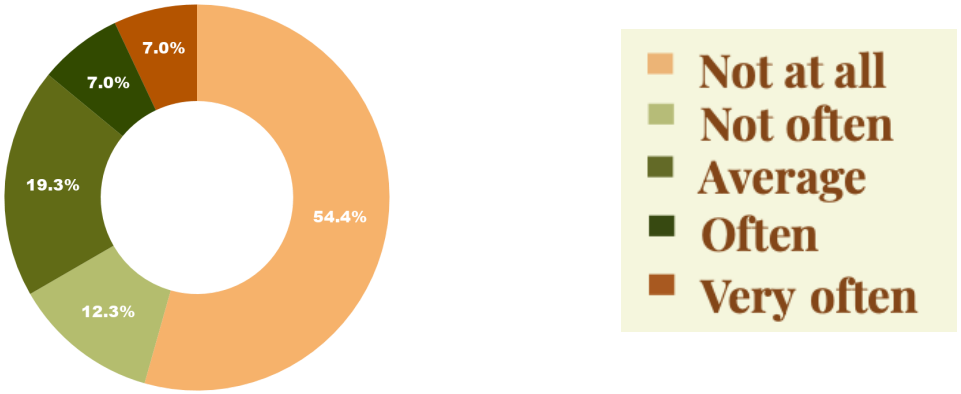
Question 15: On the scale of 1-5, I am familiar with Line Official Account.



Question 16: On the scale of 1-5, I am familiar with NASA FIRMS.

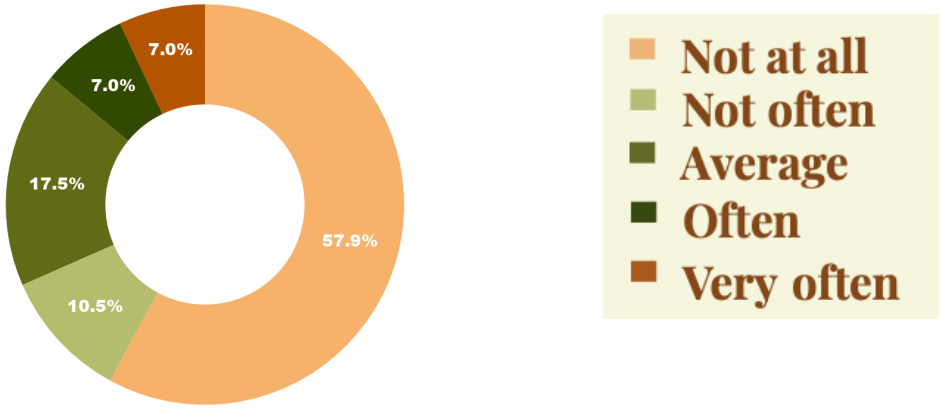


Question 17: On the scale of 1-5, how often do you use NASA FIRMS.

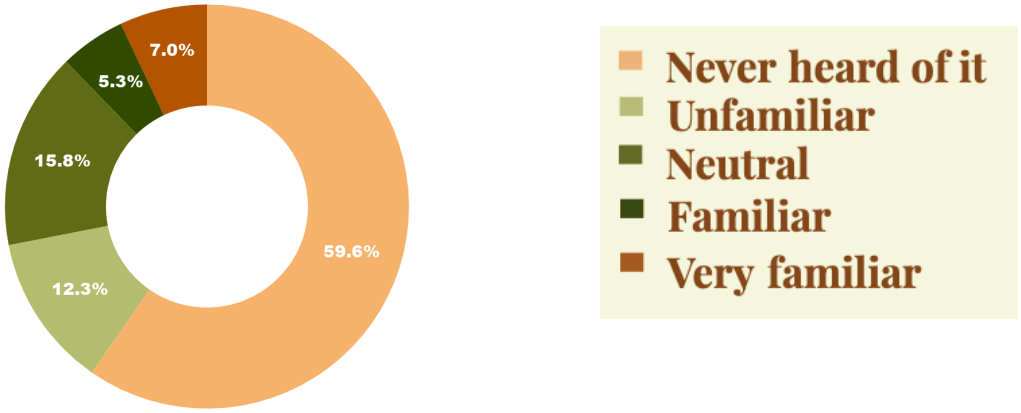


Question 18: On the scale of 1-5, I am familiar with CUSENSE.

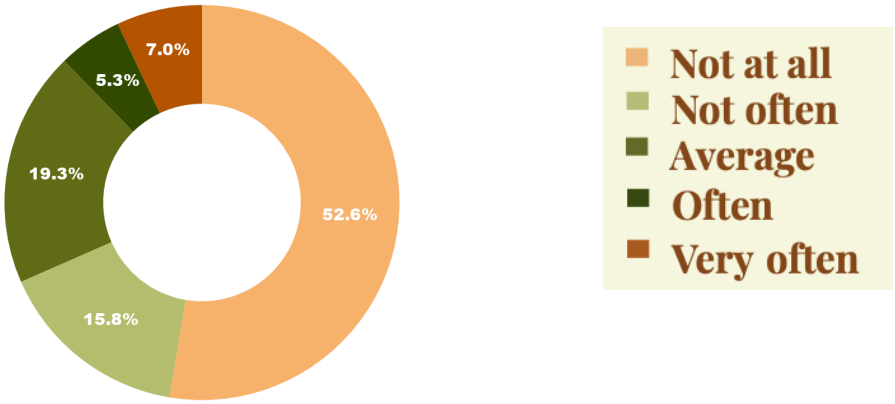
Question 19: On the scale of 1-5, how often do you use CUSENSE.



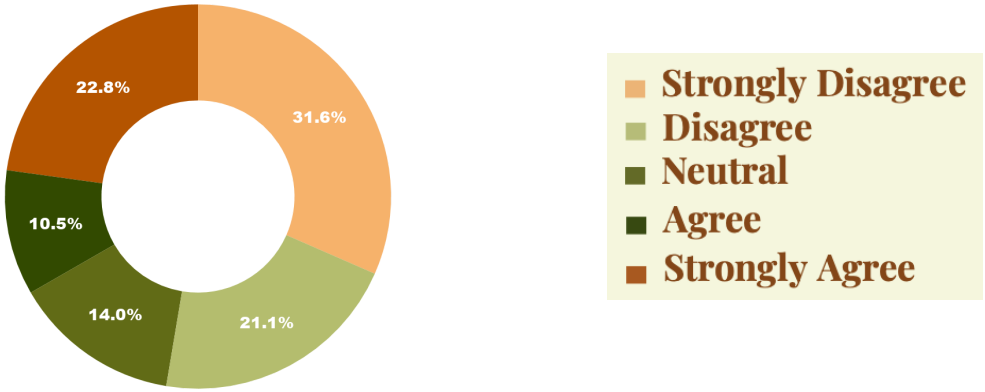
Question 20: On the scale of 1-5, I am familiar with WINDY.



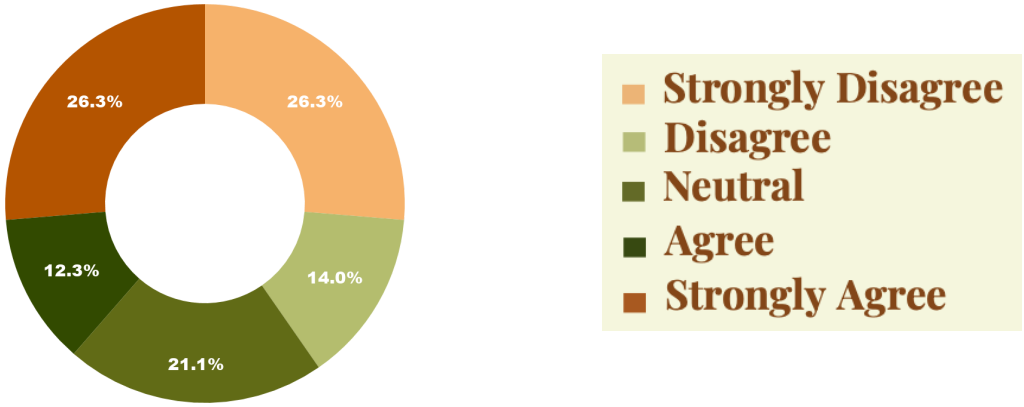
Question 21: On the scale of 1-5, how often do you use WINDY.



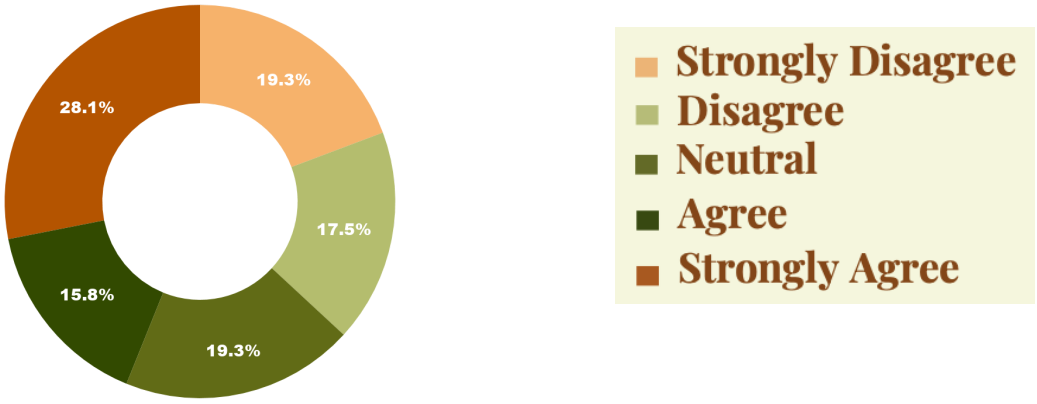
Question 22: I would be willing to use a Line Official Account if it could simplify data from 3 websites (NASA FIRMS, CUSENSE, and WINDY) and make it more accessible.



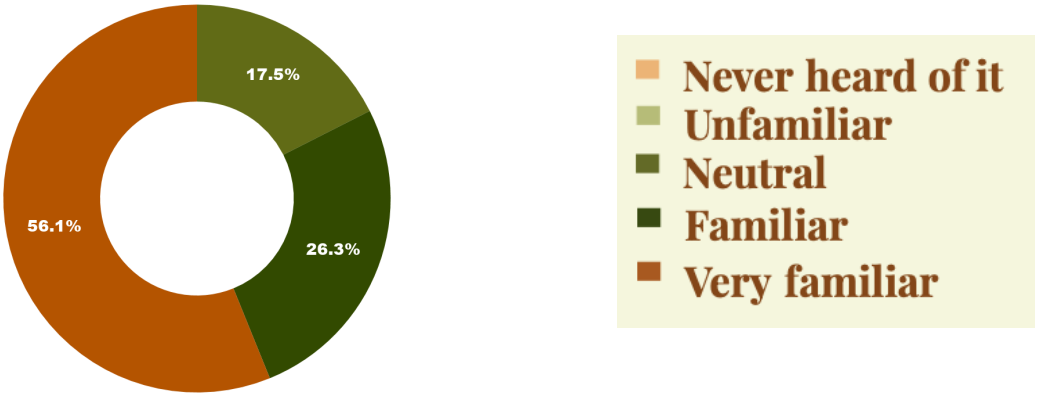
Question 23: If we create a Line Official Account that could simplify the data from all 3 websites (NASA FIRMS, CUSENSE, and WINDY), I would be able to use information from these sources more effectively.



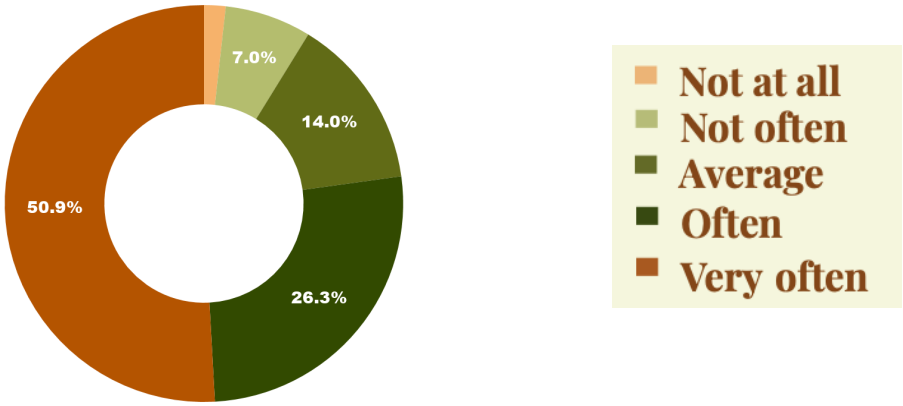
Question 24: By accessing these 3 websites (NASA FIRMS, CUSENSE, and WINDY) using Line Official Account, I would be willing to help watch the wildfire hotspots and spread awareness throughout communities.



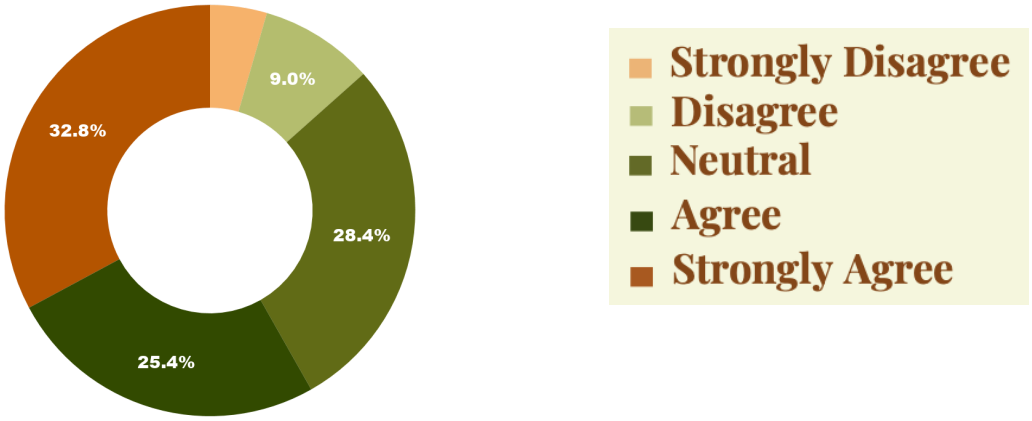
Question 25: On the scale of 1-5, I am familiar with Facebook.



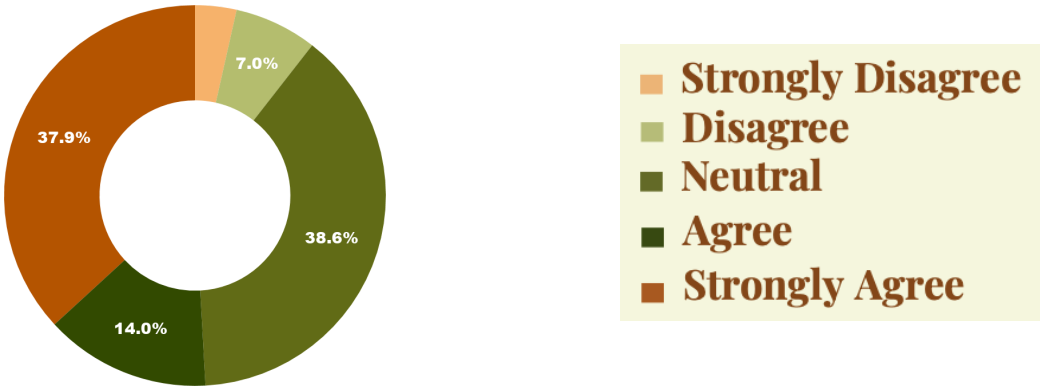
Question 26: On the scale of 1-5, how often do you use Facebook.



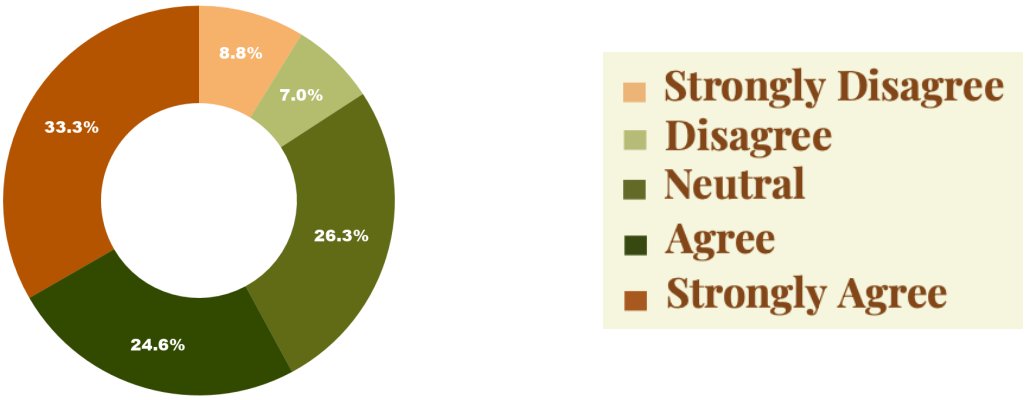
Question 27: I am aware that burning the surrounding area to harvest mushrooms would eventually reduce the mushroom's existence.



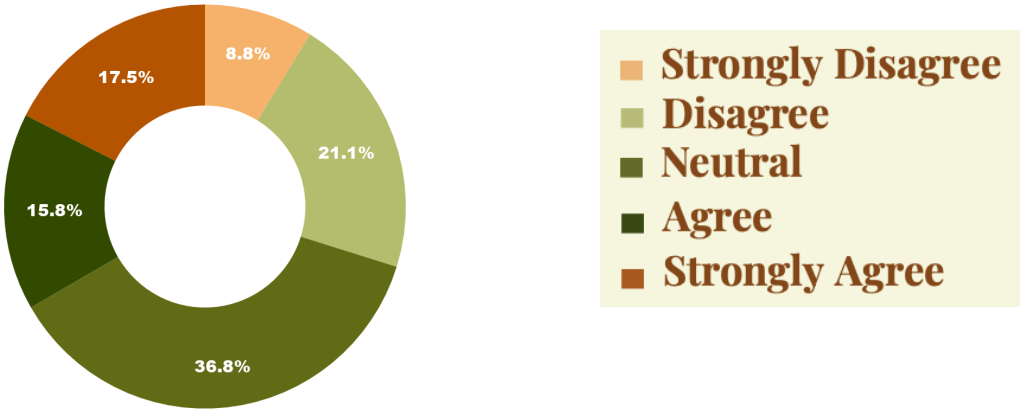
Question 28: I am aware that cultivation of termite mushroom can help reduce wildfire fuel sources.



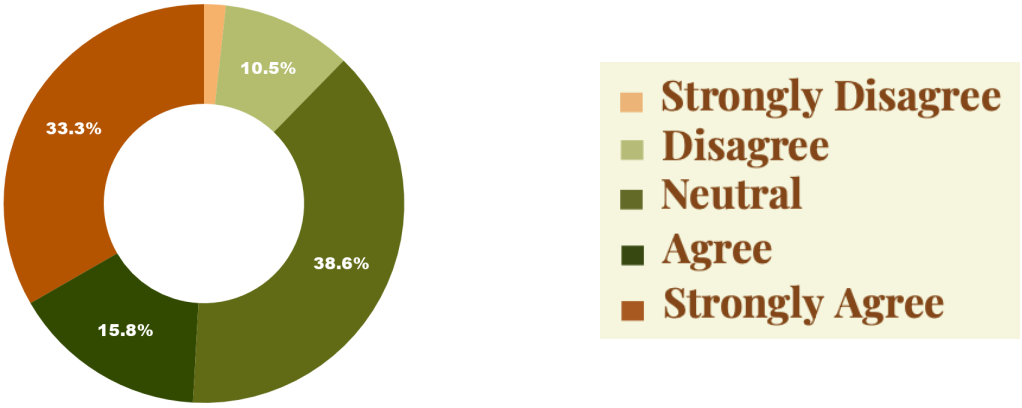
Question 29: I would be willing to sell termite mushroom instead of puffball mushroom if that would help reduce wildfires.



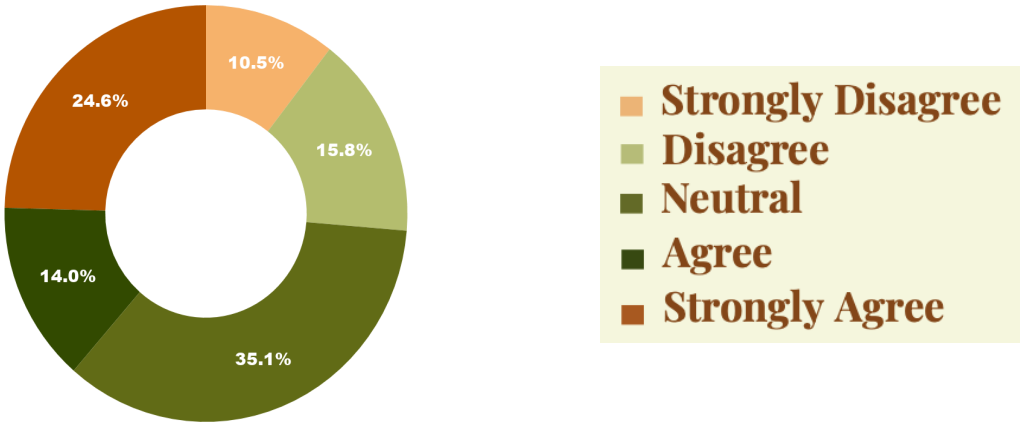
Question 30: I would rather sell mushrooms at a lower market price than making an effort to sell at higher price.



Question 31: If selling mushrooms on facebook is more profitable, I would be willing to sell mushrooms on this platform instead of selling it to middlemen.



Question 32: I am aware of a method to transport goods (mushrooms) to customers.



Question 33: I am familiar with Kerry Express.

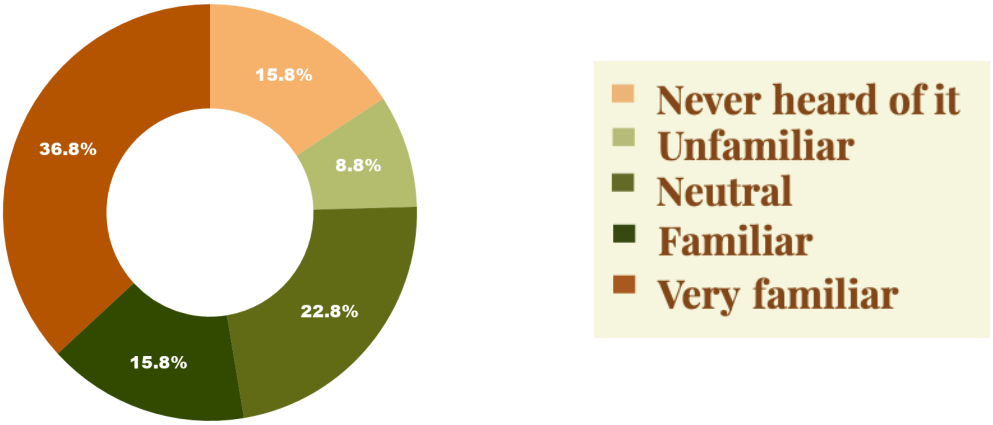


Table 2: Responses from individuals shown with their profession regarding the use of fire.

What do you do for a living?	I play a role in fire prevention.	I use fire in my daily life for various tasks like cooking or waste disposal.	Wildfires in the region affect my daily life.	The use of slash-and-burn has caused some of these fires	The use of fire to cultivate mushrooms has caused some of these fires	The fires are caused by natural events.	Reckless prescribed burning could cause bushfires	The government has handled the wildfire problem appropriately.	Wildfires have become more of a problem in the last years.	The local community is involved in fire prevention.
Park Ranger	Strongly Agree	Disagree	Strongly Agree	Neutral	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Neutral
Services	Strongly Agree	Neutral	Strongly Agree	Disagree	Strongly Disagree	Agree	Strongly Agree	Disagree	Strongly Agree	Strongly Agree
Services	Neutral	Strongly Disagree	Strongly Agree	Disagree	Agree	Strongly Disagree	Strongly Agree	Neutral	Strongly Agree	Strongly Agree
Volunteer	Neutral	Strongly Disagree	Strongly Agree	Disagree	Agree	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Agree
Merchant	Strongly Agree	Disagree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Agree
Services,Teacher	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Agree	Neutral	Strongly Agree	Agree	Strongly Agree	Strongly Agree
Teacher	Agree	Neutral	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Strongly Agree	Agree	Strongly Agree	Strongly Agree
Services	Agree	Disagree	Strongly Agree	Neutral	Agree	Strongly Disagree	Strongly Agree	Disagree	Strongly Agree	Agree
Services, School principle	Strongly Agree	Disagree	Strongly Agree	Agree	Strongly Agree	Strongly Agree	Strongly Agree	Neutral	Strongly Agree	Disagree
Student	Neutral	Disagree	Strongly Agree	Neutral	Agree	Neutral	Neutral	Agree	Strongly Agree	Neutral
Services	Neutral	Strongly Disagree	Strongly Agree	Neutral	Strongly Agree	Strongly Disagree	Strongly Agree	Neutral	Strongly Agree	Neutral
Student	Strongly Agree	Neutral	Strongly Agree	Neutral	Strongly Disagree	Disagree	Strongly Agree	Neutral	Strongly Agree	Neutral
Student	Strongly Disagree	Strongly Disagree	Strongly Agree	Neutral	Disagree	Agree	Agree	Disagree	Neutral	Neutral
Student	Agree	Neutral	Strongly Agree	Neutral	Neutral	Disagree	Disagree	Neutral	Neutral	Agree
Student	Agree	Strongly Disagree	Agree	Neutral	Neutral	Strongly Disagree	Neutral	Strongly Agree	Neutral	Strongly Agree
Student	Neutral	Disagree	Strongly Agree	Agree	Agree	Neutral	Agree	Agree	Agree	Neutral
Student	Agree	Neutral	Strongly Agree	Neutral	Neutral	Disagree	Agree	Neutral	Strongly Agree	Agree
Student	Strongly Agree	Strongly Disagree	Strongly Agree	Agree	Strongly Agree	Neutral	Disagree	Neutral	Agree	Strongly Agree
Student	Agree	Disagree	Strongly Agree	Disagree	Disagree	Strongly Disagree	Disagree	Strongly Disagree	Strongly Agree	Agree
Student	Agree	Disagree	Strongly Agree	Agree	Agree	Strongly Disagree	Strongly Disagree	Neutral	Neutral	Strongly Agree
Student	Strongly Agree	Disagree	Strongly Agree	Agree	Agree	Strongly Disagree	Agree	Neutral	Agree	Strongly Agree
Student	Agree	Neutral	Strongly Agree	Strongly Agree	Agree	Neutral	Strongly Agree	Neutral	Agree	Strongly Agree
Student	Strongly Agree	Disagree	Strongly Agree	Strongly Disagree	Strongly Agree	Neutral	Strongly Agree	Neutral	Neutral	Strongly Agree
Student	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Student	Strongly Agree	Agree	Strongly Agree	Strongly Agree	Strongly Agree	Neutral	Strongly Agree	Agree	Neutral	Strongly Agree
Student	Strongly Agree	Strongly Agree	Neutral	Neutral	Agree	Disagree	Strongly Disagree	Neutral	Strongly Agree	Neutral
Student	Agree	Disagree	Strongly Agree	Disagree	Strongly Disagree	Disagree	Agree	Agree	Agree	Strongly Agree
Farmer, Merchant	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Strongly Agree	Neutral	Strongly Agree	Agree
Farmer, Merchant	Strongly Agree	Agree	Neutral	Agree	Strongly Disagree	Agree	Disagree	Strongly Agree	Disagree	Neutral
Farmer, Merchant	Neutral	Disagree	Strongly Agree	Strongly Agree	Strongly Disagree	Neutral	Strongly Agree	Neutral	Strongly Agree	Agree
Farmer, Merchant	Strongly Agree	Disagree	Strongly Agree	Strongly Agree	Strongly Agree	Disagree	Strongly Agree	Disagree	Strongly Agree	Neutral
Teacher	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree	Neutral	Strongly Agree	Neutral	Strongly Agree	Neutral
Services,Teacher	Neutral	Strongly Disagree	Strongly Agree	Agree	Agree	Agree	Strongly Agree	Strongly Disagree	Strongly Agree	Disagree
Student	Neutral	Disagree	Agree	Agree	Agree	Strongly Disagree	Agree	Neutral	Neutral	Agree
Student	Neutral	Strongly Disagree	Agree	Neutral	Strongly Agree	Strongly Disagree	Strongly Agree	Neutral	Neutral	Neutral
Student	Strongly Agree	Neutral	Strongly Agree	Strongly Agree	Strongly Agree	Neutral	Strongly Agree	Strongly Agree	Agree	Neutral
Student	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Disagree	Neutral	Neutral
Student	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
Student	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
Student	Neutral	Disagree	Strongly Agree	Agree	Strongly Agree	Neutral	Neutral	Neutral	Agree	Agree
Student	Neutral	Disagree	Strongly Agree	Agree	Strongly Agree	Neutral	Neutral	Neutral	Agree	Agree
Student	Neutral	Neutral	Disagree	Neutral	Agree	Disagree	Agree	Neutral	Neutral	Neutral
Student	Disagree	Neutral	Neutral	Strongly Agree	Strongly Agree	Neutral	Strongly Agree	Neutral	Neutral	Neutral
Services,Public Servant	Neutral	Neutral	Strongly Disagree	Disagree	Disagree	Strongly Agree	Agree	Strongly Agree	Neutral	Neutral
Student	Neutral	Neutral	Agree	Neutral	Disagree	Neutral	Neutral	Neutral	Neutral	Agree
Student	Strongly Agree	Neutral	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Strongly Agree	Agree	Agree	Agree
Student	Neutral	Strongly Disagree	Agree	Strongly Agree	Strongly Agree	Agree	Strongly Agree	Neutral	Agree	Strongly Agree
Employee	Agree	Disagree	Strongly Agree	Strongly Agree	Neutral	Neutral	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Student	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree	Neutral	Strongly Agree	Neutral	Strongly Agree	Strongly Agree
Teacher	Strongly Agree	Agree	Strongly Agree	Neutral	Neutral	Neutral	Strongly Agree	Neutral	Agree	Agree
Farmer	Neutral	Agree	Strongly Agree	Strongly Agree	Strongly Agree	Disagree	Strongly Agree	Disagree	Strongly Agree	Strongly Agree
Farmer	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Farmer	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Farmer, Mercahnt	Strongly Agree	Neutral	Strongly Agree	Neutral	Agree	Disagree	Strongly Agree	Agree	Strongly Agree	Strongly Agree
Farmer	Strongly Agree	Disagree	Strongly Agree	Strongly Agree	Strongly Agree	Disagree	Strongly Agree	Agree	Strongly Agree	Agree
Weaver	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Strongly Agree	Disagree	Strongly Agree	Strongly Agree

Table 3: Responses from locals also regarding fire questions with an open response question.

What do you do for a living?	The local community relies on the surrounding forest for resources.	The smoke from these fires poses a health risk.	In your opinion, what is the main cause of bushfire? (short answer)
Park Ranger	Neutral	Strongly Agree	conflict between the community and the agency.
Services	Strongly Agree	Strongly Agree	The lack of human consciousness
Services	Strongly Agree	Strongly Agree	The main cause is from people smuggling the forest and the other forest fires crossing the area. The cause is because the villagers do not have any knowledge and understanding that the mushroom forest will leave a lot. Burning the forests for the cattle to eat the young shoots is also another part of the cattle farmers burn the forests.
Volunteer	Strongly Agree	Strongly Agree	State Forest Fire Management Policy This is due to the long-standing lifestyle of the local people. And although the local community did not burn With kind people burned for If handling fuels, such as leaves, dead branches or trees, are the fuels that cause people to burn. Despite the fact that giving knowledge The belief in proper and proper dependence between people and the forest may help the cause of the burning to be caused by the hands of local communities.
Merchant	Strongly Agree	Strongly Agree	human selfishness
Services,Teacher	Agree	Strongly Agree	human burn the forest
Teacher	Strongly Agree	Strongly Agree	human
Services	Strongly Agree	Strongly Agree	Old beliefs in living lack of knowledge and consciousness.
Services, School principle	Agree	Strongly Agree	Selfishness of people
Student	Agree	Strongly Agree	harvest wild goods
Services	Strongly Agree	Strongly Agree	Burn forest to harvest wild goods
Student	Strongly Agree	Strongly Agree	People in community
Student	Agree	Agree	human
Student	Agree	Strongly Agree	human
Student	Agree	Agree	Incineration
Student	Neutral	Strongly Agree	human
Student	Neutral	Strongly Agree	prescribed burn
Student	Neutral	Strongly Agree	Burn to get more mushroom
Student	Strongly Agree	Agree	Locals
Student	Neutral	Strongly Agree	human burn the forest
Student	Neutral	Strongly Agree	Human
Student	Agree	Strongly Agree	prescribed burn
Student	Agree	Strongly Agree	human
Student	Strongly Agree	Strongly Agree	human
Student	Strongly Agree	Strongly Agree	human
Student	Agree	Strongly Disagree	human
Student	Agree	Agree	human
Farmer, Merchant	Strongly Agree	Strongly Agree	t is caused by some groups of people both in the area and in the vicinity that are not conscious, solving the problem of people entering the forest between February and the rainy months can solve many problems. During December to January only,
Farmer, Merchant	Neutral	Agree	-
Farmer, Merchant	Strongly Agree	Strongly Agree	human
Farmer, Merchant	Strongly Agree	Strongly Agree	-
Teacher	Strongly Agree	Strongly Agree	human and nature
Services,Teacher	Strongly Agree	Strongly Agree	prescribed burn
Student	Agree	Strongly Agree	human
Student	Neutral	Strongly Agree	human
Student	Strongly Agree	Strongly Agree	wind
Student	Agree	Disagree	human
Student	Neutral	Neutral	human
Student	Neutral	Neutral	human
Student	Neutral	Strongly Agree	human
Student	Neutral	Strongly Agree	human
Student	Neutral	Neutral	human
Student	Neutral	Strongly Agree	prescribed burn
Services,Public Servant	Agree	Disagree	human
Student	Agree	Agree	human and nature
Student	Agree	Strongly Agree	human
Student	Agree	Strongly Agree	human
Employee	Neutral	Strongly Agree	human burn the forest
Student	Strongly Agree	Strongly Agree	hunting
Teacher	Strongly Agree	Strongly Agree	prescribed burn
Farmer	Strongly Agree	Strongly Agree	-
Farmer	Strongly Agree	Strongly Agree	human
Farmer	Strongly Agree	Strongly Agree	human
Farmer, Mercahnt	Strongly Agree	Strongly Agree	harvest wild goods
Farmer	Strongly Agree	Strongly Agree	human
Weaver	Strongly Agree	Strongly Agree	Selfishness of people

Table 4: Responses from individuals in the survey relating to the Line Application

What do you do for a living?	I am familiar with Line.	How often do you use Line?	I am familiar with Line Official Account	On the scale of 1-5, I am familiar with NASA FIRMS	On the scale of 1-5, how often do you use NASA FIRMS	On the scale of 1-5, I am familiar with CUSENSE	On the scale of 1-5, how often do you use CUSENSE	On the scale of 1-5, I am familiar with WINDY	On the scale of 1-5, how often do you use WINDY	I would be willing to use a Line Official Account if it could simplify data from 3 websites (NASA FIRMS, CUSENSE, and WINDY) and make it more accessible.	If we create a Line Official Account that could simplify the data from all 3 websites (NASA FIRMS, CUSENSE, and WINDY), I would be able to use	By accessing these 3 websites (NASA FIRMS, CUSENSE, and WINDY) using Line Official Account, I would be willing to help watch the wildfire
Park Ranger	Very Familiar	Very Often	Very Familiar	Neutral	Average	Neutral	Average	Neutral	Average	Agree	Strongly Agree	Agree
Services	Familiar	Often	Never heard of it	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Strongly Agree	Strongly Agree	Strongly Agree
Services	Very Familiar	Very Often	Familiar	Neutral	Average	Familiar	Very Often	Familiar	Average	Strongly Agree	Strongly Agree	Strongly Agree
Volunteer	Familiar	Often	Neutral	Very Familiar	Very Often	Very Familiar	Often	Neutral	Average	Agree	Agree	Strongly Agree
Merchant	Very Familiar	Very Often	Very Familiar	Familiar	Often	Neutral	Often	Familiar	Often	Strongly Agree	Agree	Agree
Services,Teacher	Familiar	Often	Neutral	Unfamiliar	Not often	Unfamiliar	Not Often	Unfamiliar	Not Often	Agree	Agree	Agree
Teacher	Familiar	Often	Familiar	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Strongly Agree	Strongly Agree	Strongly Agree
Services	Very Familiar	Very Often	Familiar	Neutral	Not often	Never heard of it	Not at all	Unfamiliar	Not Often	Strongly Agree	Strongly Agree	Strongly Agree
Services, School principle	Very Familiar	Very Often	Familiar	Neutral	Not often	Never heard of it	Not at all	Unfamiliar	Not Often	Disagree	Strongly Agree	Strongly Agree
Student	Unfamiliar	Not at all	Unfamiliar	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Strongly Disagree	Strongly Disagree	Disagree
Services	Familiar	Very Often	Neutral	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Agree	Agree	Agree
Student	Neutral	Not at all	Neutral	Neutral	Average	Unfamiliar	Average	Neutral	Average	Disagree	Neutral	Neutral
Student	Familiar	Average	Neutral	Neutral	Often	Never heard of it	Often	Very Familiar	Not at all	Neutral	Disagree	Neutral
Student	Familiar	Not Often	Never heard of it	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Disagree	Neutral	Disagree
Student	Neutral	Not Often	Never heard of it	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Strongly Disagree	Strongly Disagree	Strongly Disagree
Student	Neutral	Not at all	Unfamiliar	Unfamiliar	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Strongly Disagree	Strongly Disagree	Strongly Disagree
Student	Familiar	Not Often	Never heard of it	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Strongly Disagree	Strongly Disagree	Strongly Disagree
Student	Unfamiliar	Not at all	Never heard of it	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Strongly Disagree	Strongly Disagree	Strongly Disagree
Student	Very Familiar	Very Often	Familiar	Unfamiliar	Average	Never heard of it	Not at all	Unfamiliar	Not Often	Disagree	Disagree	Disagree
Student	Very Familiar	Very Often	Familiar	Unfamiliar	Average	Never heard of it	Not at all	Unfamiliar	Not Often	Disagree	Disagree	Disagree
Student	Familiar	Often	Familiar	Never heard of it	Average	Never heard of it	Average	Never heard of it	Average	Neutral	Neutral	Neutral
Student	Neutral	Average	Neutral	Unfamiliar	Average	Neutral	Average	Neutral	Not Often	Neutral	Neutral	Neutral
Student	Neutral	Average	Unfamiliar	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Strongly Disagree	Strongly Disagree	Strongly Disagree
Student	Never heard of it	Not at all	Never heard of it	Unfamiliar	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Disagree	Neutral	Agree
Student	Very Familiar	Not Often	Unfamiliar	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Strongly Disagree	Strongly Disagree	Strongly Disagree
Student	Neutral	Not Often	Unfamiliar	Never heard of it	Not often	Never heard of it	Not Often	Never heard of it	Not Often	Strongly Agree	Strongly Agree	Strongly Agree
Student	Familiar	Average	Familiar	Neutral	Average	Neutral	Not Often	Never heard of it	Very Often	Neutral	Agree	Neutral
Student	Neutral	Average	Never heard of it	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not Often	Strongly Disagree	Strongly Disagree	Neutral
Farmer, Merchant	Familiar	Very Often	Familiar	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Strongly Disagree	Strongly Disagree	Strongly Disagree
Farmer, Merchant	Neutral	Often	Neutral	Neutral	Average	Neutral	Average	Familiar	Average	Neutral	Neutral	Neutral
Farmer, Merchant	Familiar	Often	Familiar	Never heard of it	Not at all	Unfamiliar	Not at all	Never heard of it	Not at all	Strongly Disagree	Strongly Disagree	Disagree
Farmer, Merchant	Familiar	Very Often	Familiar	Unfamiliar	Not often	Never heard of it	Not at all	Never heard of it	Not at all	Disagree	Neutral	Neutral
Teacher	Very Familiar	Very Often	Very Familiar	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Strongly Agree	Neutral	Strongly Agree
Services,Teacher	Familiar	Very Often	Unfamiliar	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Agree	Strongly Agree	Agree
Student	Never heard of it	Not Often	Unfamiliar	Familiar	Not often	Familiar	Not Often	Unfamiliar	Average	Disagree	Disagree	Agree
Student	Unfamiliar	Not Often	Never heard of it	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Disagree	Disagree	Disagree
Student	Very Familiar	Very Often	Very Familiar	Very Familiar	Very Often	Very Familiar	Very Often	Very Familiar	Very Often	Strongly Agree	Strongly Agree	Strongly Agree
Student	Neutral	Average	Never heard of it	Never heard of it	Not at all	Never heard of it	Not Often	Never heard of it	Not at all	Strongly Disagree	Strongly Disagree	Disagree
Student	Never heard of it	Not Often	Never heard of it	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not Often	Strongly Disagree	Strongly Disagree	Strongly Disagree
Student	Neutral	Average	Neutral	Neutral	Average	Neutral	Average	Neutral	Average	Neutral	Neutral	Neutral
Student	Familiar	Not Often	Unfamiliar	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Strongly Disagree	Disagree	Disagree
Student	Familiar	Not Often	Unfamiliar	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Strongly Disagree	Disagree	Disagree
Student	Familiar	Average	Unfamiliar	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Strongly Disagree	Strongly Disagree	Strongly Disagree
Student	Unfamiliar	Average	Neutral	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Strongly Disagree	Strongly Disagree	Strongly Disagree
Services,Public Servant	Very Familiar	Often	Unfamiliar	Very Familiar	Often	Familiar	Average	Neutral	Average	Neutral	Neutral	Agree
Student	Neutral	Not Often	Unfamiliar	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Disagree	Disagree	Disagree
Student	Familiar	Not Often	Unfamiliar	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Disagree	Neutral	Strongly Agree
Student	Very Familiar	Often	Familiar	Familiar	Often	Familiar	Often	Neutral	Often	Agree	Agree	Agree
Employee	Very Familiar	Very Often	Very Familiar	Neutral	Not often	Unfamiliar	Not Often	Unfamiliar	Not Often	Disagree	Disagree	Disagree
Student	Very Familiar	Very Often	Very Familiar	Neutral	Average	Neutral	Average	Neutral	Average	Strongly Agree	Strongly Agree	Strongly Agree
Teacher	Neutral	Average	Neutral	Neutral	Average	Neutral	Average	Neutral	Average	Neutral	Agree	Neutral
Farmer	Very Familiar	Very Often	Very Familiar	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Strongly Disagree	Strongly Agree	Strongly Agree
Farmer	Very Familiar	Very Often	Very Familiar	Very Familiar	Very Often	Very Familiar	Very Often	Very Familiar	Very Often	Strongly Agree	Strongly Agree	Strongly Agree
Farmer	Very Familiar	Very Often	Very Familiar	Very Familiar	Very Often	Very Familiar	Very Often	Very Familiar	Very Often	Strongly Agree	Strongly Agree	Strongly Agree
Farmer, Mercahnt	Very Familiar	Very Often	Very Familiar	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Strongly Agree	Strongly Agree	Strongly Agree
Farmer	Familiar	Often	Familiar	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Strongly Disagree	Strongly Disagree	Strongly Disagree
Weaver	Very Familiar	Often	Never heard of it	Never heard of it	Not at all	Never heard of it	Not at all	Never heard of it	Not at all	Strongly Agree	Strongly Agree	Strongly Agree

Table 5: Survey responses from individuals regarding their use of Facebook and thoughts on termite mushrooms

What do you do for a living?	I am familiar with Facebook	How often do you use Facebook	I am aware that burning the surrounding area to harvest mushrooms would eventually reduce the mushroom's existence	I am aware that cultivation of termite mushroom can help reduce wildfire fuel sources	I would be willing to sell termite mushroom instead of puffball mushroom if that would help reduce wildfires	I would rather sell mushrooms at a lower market price than making an effort to sell at higher price.	If selling mushrooms on facebook is more profitable, I would be willing to sell mushrooms on this platform instead of selling it to middlemen.	I am aware of a method to transport goods (mushrooms) to customers.	I am familiar with Kerry Express
Park Ranger	Very Familiar	Very Often	Strongly Disagree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Very Familiar
Services	Familiar	Often	Neutral	Strongly Agree	Agree	Neutral	Strongly Agree	Neutral	Familiar
Services	Very Familiar	Very Often	Strongly Agree	Strongly Agree	Strongly Agree	Agree	Strongly Agree	Neutral	Familiar
Volunteer	Very Familiar	Very Often	Disagree	Neutral	Strongly Disagree	Neutral	Agree	Neutral	Neutral
Merchant	Very Familiar	Very Often	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Very Familiar
Services,Teacher	Familiar	Often	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Very Familiar
Teacher	Familiar	Often	Neutral	Neutral	Agree	Agree	Agree	Neutral	Familiar
Services	Very Familiar	Very Often	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Disagree	Strongly Agree	Strongly Agree	Very Familiar
Services, School principle	Very Familiar	Very Often	Strongly Agree	Strongly Agree	Neutral	Neutral	Neutral	Neutral	Neutral
Student	Familiar	Very Often	Neutral	Agree	Strongly Agree	Neutral	Agree	Neutral	Unfamiliar
Services	Neutral	Average	Neutral	Neutral	Neutral	Disagree	Neutral	Disagree	Unfamiliar
Student	Neutral	Often	Disagree	Neutral	Neutral	Disagree	Neutral	Agree	Neutral
Student	Familiar	Often	Neutral	Neutral	Agree	Disagree	Neutral	Agree	Familiar
Student	Familiar	Often	Neutral	Neutral	Disagree	Disagree	Neutral	Strongly Disagree	Never heard of it
Student	Very Familiar	Very Often	Neutral	Neutral	Disagree	Disagree	Disagree	Disagree	Unfamiliar
Student	Neutral	Average	Disagree	Neutral	Agree	Neutral	Neutral	Strongly Disagree	Never heard of it
Student	Very Familiar	Very Often	Neutral	Neutral	Disagree	Disagree	Disagree	Neutral	Neutral
Student	Very Familiar	Average	Neutral	Neutral	Agree	Agree	Disagree	Neutral	Familiar
Student	Very Familiar	Not Often	Neutral	Disagree	Agree	Disagree	Neutral	Neutral	Neutral
Student	Very Familiar	Not Often	Neutral	Disagree	Agree	Disagree	Neutral	Neutral	Neutral
Student	Very Familiar	Very Often	Strongly Agree	Disagree	Neutral	Neutral	Disagree	Disagree	Never heard of it
Student	Familiar	Often	Agree	Strongly Agree	Neutral	Neutral	Neutral	Neutral	Never heard of it
Student	Very Familiar	Very Often	Agree	Agree	Agree	Agree	Agree	Agree	Familiar
Student	Familiar	Not Often	Strongly Agree	Strongly Agree	Neutral	Neutral	Agree	Agree	Familiar
Student	Very Familiar	Very Often	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Very Familiar
Student	Familiar	Average	Strongly Disagree	Neutral	Strongly Disagree	Disagree	Strongly Disagree	Disagree	Very Familiar
Student	Neutral	Not Often	Strongly Agree	Strongly Disagree	Strongly Agree	Disagree	Neutral	Strongly Disagree	Very Familiar
Student	Very Familiar	Often	Neutral	Agree	Agree	Neutral	Neutral	Disagree	Neutral
Farmer, Merchant	Familiar	Often	Strongly Agree	Strongly Agree	Agree	Strongly Disagree	Strongly Agree	Agree	Very Familiar
Farmer, Merchant	Familiar	Often	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
Farmer, Merchant	Very Familiar	Very Often	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Very Familiar
Farmer, Merchant	Neutral	Often	Strongly Agree	Disagree	Strongly Disagree	Strongly Disagree	Strongly Agree	Agree	Very Familiar
Teacher	Very Familiar	Very Often	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
Services,Teacher	Very Familiar	Very Often	Agree	Agree	Neutral	Neutral	Strongly Agree	Neutral	Very Familiar
Student	Very Familiar	Very Often	Strongly Agree	Strongly Agree	Agree	Agree	Agree	Strongly Disagree	Never heard of it
Student	Familiar	Average	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Neutral	Strongly Disagree	Never heard of it
Student	Very Familiar	Very Often	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Very Familiar
Student	Neutral	Often	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
Student	Neutral	Not at all	Disagree	Strongly Disagree	Disagree	Disagree	Disagree	Disagree	Never heard of it
Student	Neutral	Average	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
Student	Very Familiar	Very Often	Agree	Neutral	Strongly Disagree	Neutral	Neutral	Disagree	Familiar
Student	Very Familiar	Very Often	Agree	Neutral	Strongly Disagree	Neutral	Neutral	Disagree	Familiar
Student	Very Familiar	Very Often	Agree	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
Student	Very Familiar	Very Often	Strongly Agree	Strongly Agree	Neutral	Neutral	Neutral	Neutral	Never heard of it
Services,Public Servant	Familiar	Often	Neutral	Neutral	Neutral	Agree	Agree	Neutral	Unfamiliar
Student	Familiar	Often	Neutral	Agree	Agree	Agree	Neutral	Agree	Unfamiliar
Student	Very Familiar	Very Often	Strongly Agree	Agree	Strongly Agree	Agree	Strongly Agree	Strongly Disagree	Never heard of it
Student	Very Familiar	Very Often	Disagree	Neutral	Agree	Neutral	Neutral	Disagree	Neutral
Employee	Very Familiar	Very Often	Disagree	Neutral	Strongly Agree	Strongly Agree	Strongly Agree	Neutral	Very Familiar
Student	Very Familiar	Very Often	Strongly Disagree	Neutral	Neutral	Strongly Disagree	Neutral	Strongly Agree	Very Familiar
Teacher	Familiar	Average	Strongly Agree	Agree	Strongly Agree	Neutral	Strongly Agree	Strongly Agree	Very Familiar
Farmer	Very Familiar	Very Often	Strongly Agree	Strongly Agree	Strongly Agree	Disagree	Agree	Strongly Agree	Very Familiar
Farmer	Very Familiar	Very Often	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Very Familiar
Farmer	Very Familiar	Very Often	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Very Familiar
Farmer, Mercahnt	Very Familiar	Often	Agree	Strongly Agree	Strongly Agree	Agree	Strongly Agree	Neutral	Very Familiar
Farmer	Neutral	Not Often	Neutral	Agree	Agree	Neutral	Agree	Strongly Agree	Very Familiar
Weaver	Very Familiar	Very Often	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree	Very Familiar