Heat Impacts on Occupational Health

A Comparison Between Agricultural and Industrial Settings in the Time of Climate Change

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ABSTRACT

Past studies have shown that workers laboring in dangerously hot climates have the potential to experience detrimental effects to both their health and productivity. In the time of climate change, increasing global temperatures exacerbate this relationship and threaten the welfare of thousands of lower and middle-income workers in tropical developing countries. In collaboration with Thammasat University in Thailand and in contribution to the “High Occupational Temperature: Health and Productivity Suppression” (HOTHAPS) international study, our goal was to evaluate and compare how natural and artificial heat in Pathumthani and Samutprakan provinces affect agricultural and industrial workers using observations, interviews, and Wet Bulb Globe Temperature data. The analysis of our data showed that agricultural workers feel the effects of heat more than industrial workers due to their direct exposure to the natural environment, lack of amenities, and lack of regulated working time. This analysis served as the focus of our recommendations to the workers, foreman/owners, researchers, and influential health and environmental organizations.

EXECUTIVE SUMMARY

Heat causes thousands of fatalities each year worldwide, but, in countries with tropical climates, high temperatures that persist for extended periods of time are common and often overlooked as potentially dangerous. Thailand is no exception; elevated temperatures frequently go unnoticed and little research has been done to study how heat affects health in this tropical country. The Faculty of Public Health at Thammasat University, representing Thailand, is contributing to the "High Occupational Temperature: Health and Productivity Suppression" (HOTHAPS) international study. Our study contributed to Thammasat University's work as they continued their research for HOTHAPS. The project extended the topic of evaluating and comparing the climate conditions caused by two different sources of heat in Pathumthani and Samutprakan provinces. As a result, the study showed how heat impacts the occupational health of agricultural and industrial workers.

Introduction

Pathumthani contributes to Thailand's economically invaluable rice production. Most agricultural workers in this province have below-average educations that provide them with few career opportunities, relatively low incomes, less than adequate living environments, and a financial obligation to their family. These workers cultivate rice, a staple food and source of profit in Thailand, throughout the year in either rain-fed or irrigated paddies. The entire cultivation process takes a total of four months, during which time workers labor outdoors for extended periods in the heat. Due to this demanding process and the susceptibility of the workers to the climate, agricultural workers may be more vulnerable to contracting heat-related illnesses.

Samutprakan is an industrial and fishing province where most residents typically have above-average educations and adequate living conditions. There are thirty-one certified steel and iron companies in Thailand that produce and export steel, including Siam Steel Syndicate Co. (Limited) throughout the province. In a factory that manufactures steel rods using a variety of machinery and furnaces, heat generated artificially can bring temperatures up to 65 degrees Celsius. Industrial workers labor in high temperatures for eight hour shifts, only feeling relief during short breaks. The two sites differ in their sources of heat - outdoor environmental and indoor artificial - which sets the stage for a comparative study exploring the relationship between heat exposure, health, and productivity.

Prolonged exposure to heat threatens the human body's thermoregulatory system, a multi-organ system with the sole purpose of heating and cooling the body. In order to maintain a homeostatic core temperature of 37 (±0.6) degrees Celsius, the complex system controls heat exchange between the environment and the body (Constance & Shandro, 2011). Heat stress, any kind of discomfort or physiological strain related to heat exposure, occurs once the body becomes overwhelmed by both environmental heat, natural or artificial, and metabolic heat, created internally by the body. Exposure to high temperatures, humidity, and direct sun leads to dehydration and subsequent malfunctioning of the thermoregulatory system. Prolonged exposure to dangerously hot climates can lead to heat-related illnesses such as exhaustion, collapse, rash, cramps, and stroke.

The persistently hot, humid, and sunny climate of Thailand is ideal for a study about the physical workload and heat stress of laborers. Data support an overall increase in temperatures in this tropical country over the last century with projections of higher temperatures that will persist

for longer periods of time. Major organizations and continuous research have recognized climate change and its resulting natural phenomena as a serious threat to human livelihood. As one of the most vulnerable countries to climate change because of its long coastline and susceptibility to flooding, heat, and drought, Thailand's culture, economy, and quality of life will undoubtedly be affected by the increasing global climate.

In 2008, the World Health Organization began the HOTHAPS international study to promote awareness and research of occupational health and heat exposure. Their goal was to determine if workers are affected by heat exposure, which occupational sites are at higher risk for heat-related illnesses, and how global climate change is contributing to the effects of heat on health. In 2009, the Faculty of Public Health at Thammasat University conducted a pilot study to represent Thailand in HOTHAPS research. However, the study did not measure health and was not able to determine a direct relationship between heat and adverse health effects, showing a need for additional research on the relationship between heat and occupational health.

We hope our work will influence further investigation of this topic as well as contribute relevant information to Thammasat University, the HOTHAPS international study, and the WHO. Our data and observations expose the potential threat of climate change and the need for prevention methods for heat related illnesses for low and middle-income workers in Thailand and other countries.

Methodology

The goal of this project was to consider the impacts of heat on the occupational health of agricultural and industrial workers, in Pathumthani and Samutprakan province respectively, to understand if climate change is causing or has the potential to cause increased heat stress on vulnerable workers. To achieve this goal we completed the following objectives:

1. Observed the micro-climate, typical environmental working conditions, and amenities in outdoor rice paddies and an indoor steel factory.
2. Collected health statistics from a voluntary sample of workers through a series of interviews.
3. Submitted data to Thammasat University for the international HOTHAPS study. The study will use this data to draw conclusions regarding the relationship between health and climate change; these results will be published at a later date.
4. Analyzed the data we collected in order to draw conclusions and make conjectures on how changing ambient conditions and heat exposure are affecting the health of agricultural and industrial workers.
5. Conducted a comparative analysis between agricultural and industrial workers to determine who seems more affected by heat and, consequently, climate change.

In order to complete the objectives of our study, we collected data at several rice paddies in Lard Lum Kaew district in Pathumthani province and at Siam Steel Indicate Co. (Limited), an industrial factory in Muang district in Samutprakan province. We assessed both sites on arrival, noting working environment, amenities, accessibility, and heat conditions. To determine the climate conditions in both locations, we used a Wet Bulb Globe Temperature (WBGT) meter provided by Thammasat University to measure indoor and outdoor climate data. The WBGT heat index is calculated from the readings of three thermometers and responds to all four elements of the thermal environment that impact climate: radiant heat, air temperature, wind speed, and humidity. The meter recorded data every thirty minutes for ten days both in the rice paddies and steel factory.

We collected health statistics using a heart rate monitor, supplied by Thammasat, in the form of a chest strap and watch. Three consenting workers in both the rice paddies and steel factory wore the chest strap underneath their clothes and watches on their wrists. While this was recorded hourly, body temperature of the same workers was taken using a glass mercury thermometer and recorded at the beginning and end of workdays. These data were recorded in diary notes, which also included the time each worker began and ended work, the duration of their breaks, as well as the type of work they performed. Next, we observed and recorded the cooling actions taken by each worker and how much water they drank within that hour. However, due to publishing protocol, we do not have access to the diary note data.

Next, we sought willing interview participants including workers, factory foremen, and rice paddy owners. We gave workers an information sheet to explain the project and our purpose and a consent form to grant us permission to interview them and use their disclosed information. There were two sets of interviews; we used the first set with the agricultural and industrial workers while the second set aimed to question the owners of the rice paddies and the shift foreman of the steel factory, varying only with regards to productivity and estimates of future economic loss. The questionnaire included questions pertaining to heat exposure, impacts of heat on health and productivity, and heat reduction approaches. The analyses of our collected data led us to make the following conjectures.

Conjectures

In both the agricultural and industrial settings, workers are exposed to temperatures at which they can experience heat-related illnesses.

According to the WBGT data Thammasat University collected, heat indices in both settings indicated that workers are vulnerable to heat-related illnesses. In the rice paddies, the maximum heat index was 46.8 degrees Celsius; in the steel factory, workers were exposed to heat indices as high as 46.6 degrees Celsius. Not all workers in the rice paddies and even fewer workers in the steel factory admitted to experiencing adverse health effects due to heat. According to the intensity of these heat indices, both steel workers and rice paddy workers, without the proper protection, are likely to experience heat-related illnesses such as sunstroke, muscle cramps, and heat exhaustion because they are laboring in dangerously hot environments.

Agricultural workers experience the detrimental effects of heat more than industrial workers.

The workers in the rice paddies reported that their health and productivity has been altered negatively as a result of the intense heat. Workers have long shifts, averaging 7 hours, without a set manufacturing quota. They have no way to escape from the heat due to lack of amenities. This intense labor and lack of preventative tools adds to the intensity of the heat and makes it difficult to maintain good health and productivity. During the interview process, there were multiple complaints of minor health issues and several accounts of heat-related deaths. Workers also noted a decrease in productivity. If the weather is too intense, workers take more breaks or work less to avoid over-exerting themselves. Steel workers, on the other hand, do not feel that the heat strongly affects their health or productivity. From the interviews, we learned about half of the steel workers reported heat stress problems, but none of the problems were worse than rash. Although the temperatures in the workplace are higher than those in the rice paddies, the consistent climate allows the workers' bodies to acclimatize to their working environments.

There are gaps in the understanding of heat stress and prevention methods.

From the interviews, it is apparent that workers vulnerable to heat-related illnesses either showed no interest in or were unaware of the consequences of prolonged heat exposure. However, only in the agricultural setting did workers' lack of knowledge about heat-related illnesses prove to be detrimental to their health. While many wear hats to protect their skin from the sun and use medicinal herbs as treatment, most workers take minimal breaks and do not hydrate themselves properly. In the steel factory, however, heat-related illnesses were less frequent. Though only 50% of the industrial workers know the symptoms of heat stress, all workers follow the factory policies regarding heat stress precautions. Steel workers are also taught safety practices and have a more regulated schedule to prevent such illnesses. Unlike the agricultural workers, industrial workers have thermometers within the workplace in order to track their heat exposure.

Agricultural and industrial workers have both become acclimatized and therefore do not readily experience heat-related illnesses.

The consistent outdoor climate of the agricultural setting leads workers to adapt to their surroundings quickly compared to a laborer experiencing a hot climate for short periods of time. Outdoor laborers often get heat-related illnesses when they first begin working in the incessant heat, but their bodies become progressively more adjusted and the risk for short-term illness decreases. Industrial workers, who labor for short periods of time and take frequent breaks in cool areas, do not need their bodies to acclimate to the same degree as agricultural workers. Similar to rice paddy farmers, steel workers experience some health effects early in their careers but slowly "adapt to their environment," as described by one industrial worker (Interview 12, January 24, 2012). Prolonged exposure to dangerous climates has proven to be an effective defense against health risks. However, in the presence of an increasing global climate, the potential for adequate acclimatization decreases and development of heat-related illness increases.

Recommendations

The analysis of our data showed that agricultural workers feel the effects of heat more than industrial workers due to their direct exposure to the natural environment, lack of amenities, and lack of regulated working time. Agricultural workers will be more susceptible to the worsening climate conditions due to climate change; thus our recommendations are more directed to the agricultural sector. Our recommendations for workers, foremen, owners, and future researchers propose increased availability of amenities for the workers, education on heat stress prevention, and a change in policy that would lead to prevention of heat stress.

Recommendations for Owners/Foreman

- In order to prevent and dissipate heat stress and the resulting symptoms, we suggest rice paddy owners provide the appropriate amenities to their workers including an outdoor thermometer, a cool or shady place to rest, and a clean source of drinking water.

- We recommend that owners of rice paddies and foremen of the steel factory educate workers on heat stress and the symptoms that occur in order to promote awareness, prevention, and safe work behavior.
- To ensure proper acclimatization and healthy work practices, we advise owners to maintain occupational health standards and policies developed by leading agencies in the field.

Recommendations for Individual Workers

- We believe it would be beneficial if workers learn about heat stress, symptoms, and prevention methods in order to avoid the development and consequences of heat-related illnesses.
- We recommend that both agricultural and industrial workers adhere to all safety policies implemented by their employers.
- Workers are advised to continue wearing protective clothing while working.

Recommendations for Researchers and Influential Health and Environmental Organizations

- Future researchers would benefit from collecting objective health statistics pertaining to occupational heat stress.
- We recommend that qualified health and environmental organizations implement prevention methods for heat stress.

Prevention, Education, and Awareness Tools

- Website to publically display Thammasat University's contribution to HOTHAPS, our final report including findings and recommendations, photos, deliverable material, and contact information for further research and information. The website can be found at www.heatisthesilentkiller.weebly.com.
- A short awareness video including interview testimonials from agricultural and industrial workers and narration describing the effects of heat on these individuals and how climate change makes this a more urgent concern. This can also be found on the website.
- Two awareness posters (see Appendix J) written in Thai, the first illustrating the temperature ranges at which certain heat-related illnesses can be experienced by workers and the second reminding workers to stay hydrated and suggests they drink the recommended three liters of water per day.

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CHAPTER 1: INTRODUCTION

Heat causes thousands of fatalities each year worldwide, earning the nickname the "silent killer." Due to lack of acclimatization, heat and its dangers often receive more attention in countries with temperate climates. Yet, in countries with tropical climates, high temperatures that persist for extended periods of time are common and often overlooked as potentially dangerous. Statistics on heat-related illnesses and mortalities in tropical countries are not readily available, and there is little publicity concerning ways to avoid heat-related illnesses. Thailand is no exception; elevated temperatures frequently go unnoticed and limited research has been done to study how heat affects health in this tropical country. This lack of knowledge concerning heat-related health effects is an alarming concern for workers who labor in environments with high heat exposure.

Thailand's economy is highly dependent on the agricultural and industrial sectors, which creates a wide availability of jobs that require workers to labor in hot and humid environments. Workers who face these types of working conditions are ultimately more susceptible to heat-related illnesses (University of Maryland Medical Center, 2010). In the agricultural sector, laborers work in an outdoor environment where they are directly exposed to the sun. Almost half of the labor force in Thailand is employed in agricultural jobs and face these conditions, but not necessarily out of choice. Faced with the obligation to provide for their families, these workers have few other career options due to their limited education (Central Intelligence Agency, 2012). In the industrial sector, the majority of the work is indoors, where workers are exposed to man-made heat produced by industrial machines. Industrial workers are generally required to be better educated than the average Thai, and as a result have various career options. The dangerous and hot conditions of industrial jobs result in higher pay that entices workers to pursue industrial careers.

Agricultural and industrial workers are exposed to two different types of extreme heat: heat produced by environmental climate conditions and heat that is a byproduct of man-made machinery. Despite the different types of heat generated in each work setting, if and to what degree workers are affected by the high temperatures remains unclear. It is difficult to determine if either type of heat has a greater effect on the health of workers. There is a lack of research regarding the intensity level of heat exposure and the kinds of amenities available to help the workers alleviate heat stress. This information, along with additional research on health statistics, is necessary to determine if the workers have acclimated to their working conditions and the high temperatures they regularly endure.

Research on how workers in Thailand are affected by heat is of increasing concern due to the impacts of climate change. There are substantial data that support an overall increase in temperatures in Thailand over the last century and, according to the Intergovernmental Panel on Climate Change (IPCC), climate change will continue to cause higher temperatures that last for longer periods of time (Thai Meteorological Department, n.d.; Bernstein et al., 2007). This rise in temperatures and change in the seasonal climate has the potential to affect the lives of many Thais, especially workers that labor in hot environments.

In 2008, Dr. Tord Kjellstrom of Australian National University and the World Health Organization (WHO) began the "High Occupational Temperature: Health and Productivity Suppression" (HOTHAPS) international program to explore how workers "are affected by, or adapt to, heat exposure while working and how global heating during climate change may increase such effects" (Kjellstrom, Gabrysch, Lemke, & Dear, 2009). The program also aimed to determine which occupational site is at higher risk for heat-related illnesses: outdoor work sites that are exposed to naturally produced heat or indoor work sites that experience the intensity of heat produced by the industry. Thailand was one of the countries that initially received funding from the WHO and began researching for HOTHAPS. The program was halted in 2009 due to lack of funding; however, Thammasat University requested necessary funding from the Office of Higher Education Commission in Thailand to continue the research.

Between September and October of 2009, the Faculty of Public Health at Thammasat University, representing Thailand, began contributing to the HOTHAPS international program by conducting a pilot study in the Pathumthani and Ayutthaya provinces (Tawatsupa, Lim, Kjellstrom, Seubsman, & Sleigh, 2010). The university collected heat exposure data in one agricultural setting and in several industrial settings, and the results indicated that all workers in the study face prolonged exposure to dangerously high temperatures that make them vulnerable to heat-related illnesses. The team, however, did not collect any data regarding the workers' health, and instead only showed the possibility of a worker developing heat-related illnesses due to the climate conditions. As a result, the team was not able to determine a direct relationship between heat and adverse health effects, showing a need for additional research on the relationship between heat and occupational health.

Our project extended Thammasat University's work as they continued their research for the international WHO study. The goal was to evaluate and compare how the climate conditions in Pathumthani and Samutprakan provinces have impacted the occupational health of agricultural and industrial workers. To accomplish this goal, we observed the climate and working conditions of each site and used interviews to collect statistics on the health of workers in several rice paddies and one steel factory. We analyzed the data we collected to draw conclusions and compare how high temperatures are affecting the health of rice paddy and steel factory workers. With these findings, we hope to influence further investigation of this topic as well as contribute relevant information to Thammasat University, the HOTHAPS international study, and the WHO. Furthermore, our data collection and observations expose the potential threat of climate change and the need for prevention methods for heat related illnesses for low and middle-income workers in Thailand and other countries.

CHAPTER 2: LITERATURE REVIEW

This chapter reviews the background of our study and the literature referring to the health of rice paddy workers in Pathumthani province and steel workers in Samutprakan province, Thailand. First, we provide a brief overview of the country and province demographics. Next, we describe the statistics and procedures involved with rice cultivation and steel milling. Descriptions of the health effects of heat, evidence of climate change, and details of the HOTHAPS program are then presented. Finally, these data are supported by pertinent case studies.

2.1 Pathumthani and Samutprakan Province Description

Thailand is primarily a rural developing nation populated by 67 million people. Of this population 40% are of working age (15-39 years) with 21% of the population comprising the young (0-14 years) and 39% comprising the older (40+ years). Life expectancy in Thailand is approximately 74 years old with an increasing elderly population and decreasing population growth, death rate, and infant mortality (U.S. Census Bureau, 2011). Approximately half of Thailand still remains underdeveloped compared to the western world. Figure 1 (below) uses education, employment, income, housing, community life, and infrastructure to calculate the top twenty achieved human development level per province in Thailand (United Nations Development Project, 2007). The human development of Thailand reflects the quality of life of the inhabitants of the country without taking into account per capita wealth.

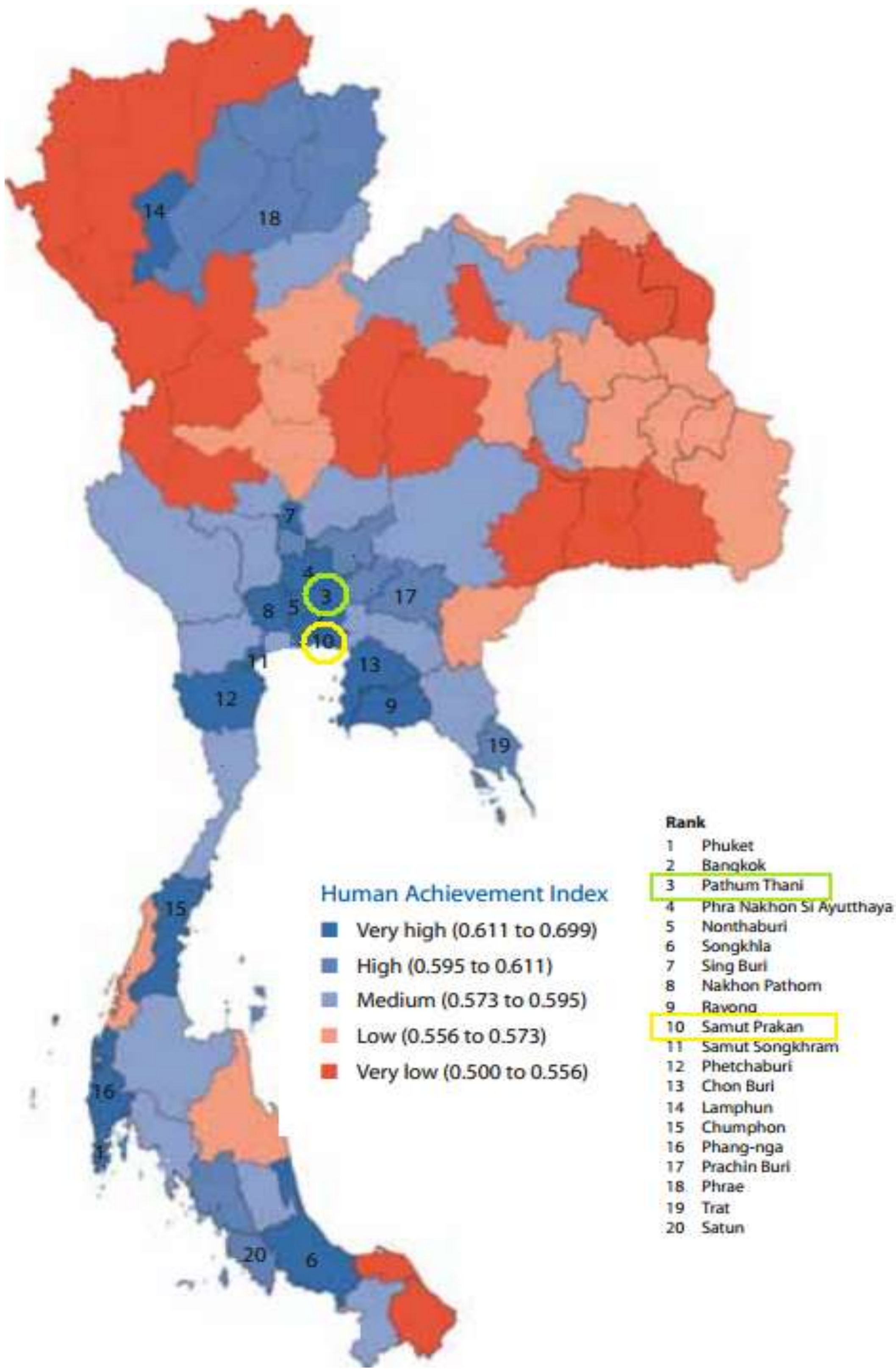

Figure 1: Human Development Achievement by Province in Thailand
(Modified after United Nations Development Project, 2007)

As can be seen in Figure 1, Pathumthani (top green circle) and Samutprakan (bottom yellow circle) are considered "very high" on the human achievement index. In Pathumthani, 14% of the 495,000 employed residents work in the agricultural industry (United Nations Economic and Social Commission for Asia and Pacific, 2000). Most workers have a below-average education, relatively low incomes, and less than adequate living environments because of their dependence on agriculture for their livelihood and lack of career flexibility. Even with high human achievement, according to a 2006 study by the United Nations, a "deterioration of the natural environment" along with unequal development of the province has put a strain on nearly half of the agricultural populations, causing persistent poverty.

Samutprakan is an industrial and fishing province due to its proximity to the Gulf of Thailand. Most residents are industrial workers who, in general, are aware of the dangers of heat stress but continue to work in these occupations nonetheless. They typically have above average educations, which allow them to choose which profession to pursue (United Nations Development Project, 2007). Due to the large number of workers, the presence of heat stress factors, rapport with Thammasat University, as well as close proximity to Bangkok, these locations were chosen as the areas of study.

2.2 Economic Dependence on Rice Cultivation

Agriculture makes up 12% of the gross domestic product or the market value of all products made in Thailand (U.S. Department of State, 2011). Thailand is the largest exporter and fifth largest cultivator of rice in the world, where more than half of all arable land is dedicated to rice cultivation (International Rice Research Institute, n.d.). Rice also supports the people by providing jobs, income, and food, making it an irreplaceable asset to Thai culture, livelihood, and economy (Sintunawa & et al., 2009).

In Pathumthani, rice is the most abundant crop. Figure 2 shows rice production in all of Thailand's provinces. A larger circle indicates more planted area in hectares while the color gradient indicates total rice yield. Pathumthani harvests approximately 91,000 hectares of rice per year and produces approximately 424,000 metric tons per year. In comparison to other provinces, Pathumthani produces an average rice yield on relatively few hectares (International Rice Research Institute, n.d.).

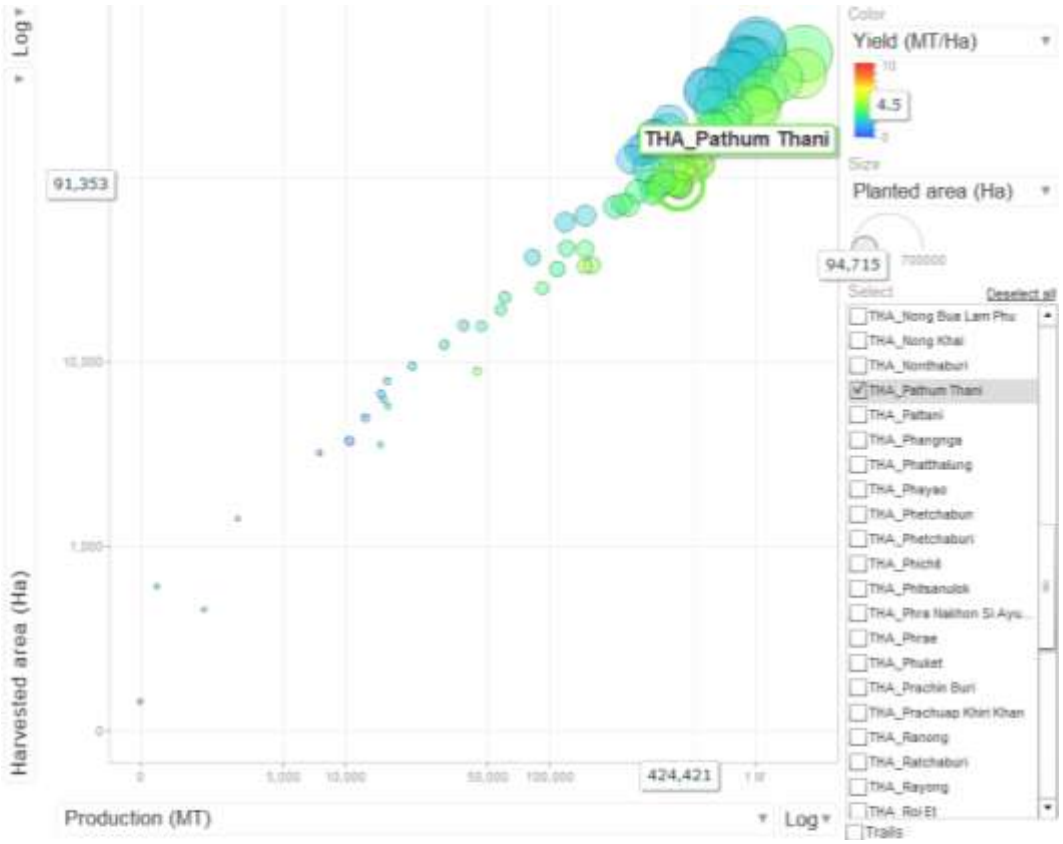

Figure 2: Pathumthani 2008 Rice Production (International Rice Research Institute, n.d.)

Throughout Thailand, native long-grain Jasmine and Pathumthani rice is cultivated in either rain-fed or irrigated paddies (rice fields). The three types of paddies include upland fields or open fields on mountain-sides and sloped hills, lowland fields enclosed with a small layer of standing water, and deep water fields completely flooded with water (Van Nguyen, 2006). Depending on the type of paddy and distance to a water source, rice can be planted *na bi*, a unique Thai term that refers to planting that occurs once a year during the monsoon season or *na prang*, multi-seasonal planting occurring two or three times a year. In Pathumthani, rain-fed, deep water, *na prang* rice paddies are most abundant (Khush, 1997).

Two methods of planting are employed within Thailand. In the northeast, agricultural workers traditionally plant by hand whereas in the central areas, such as Pathumthani, workers broadcast seeds by dispersing them mechanically. The entire rice planting process takes four months total. Figure 3 below illustrates the whole process. First, workers prepare the fields and create elevated travel paths and depressed irrigation tracks. To prepare and increase absorbed moisture of the rice seed, workers immerse them in water in a covered bucket for one night. The broadcasting process begins after pumping water from the field to prevent seeds from rotting. Workers spray diluted chemical herbicides designed to control weeds. Once rice plants begin to sprout, workers flood the field again and spray pesticides to ward off insects, fertilizer to maximize growth, and vermicides to kill worms commonly found in paddies. While waiting for the rice to grow, workers continuously tend to the fields, injecting hormones to increase growing speed and spraying chemical controls until the harvesting process begins.

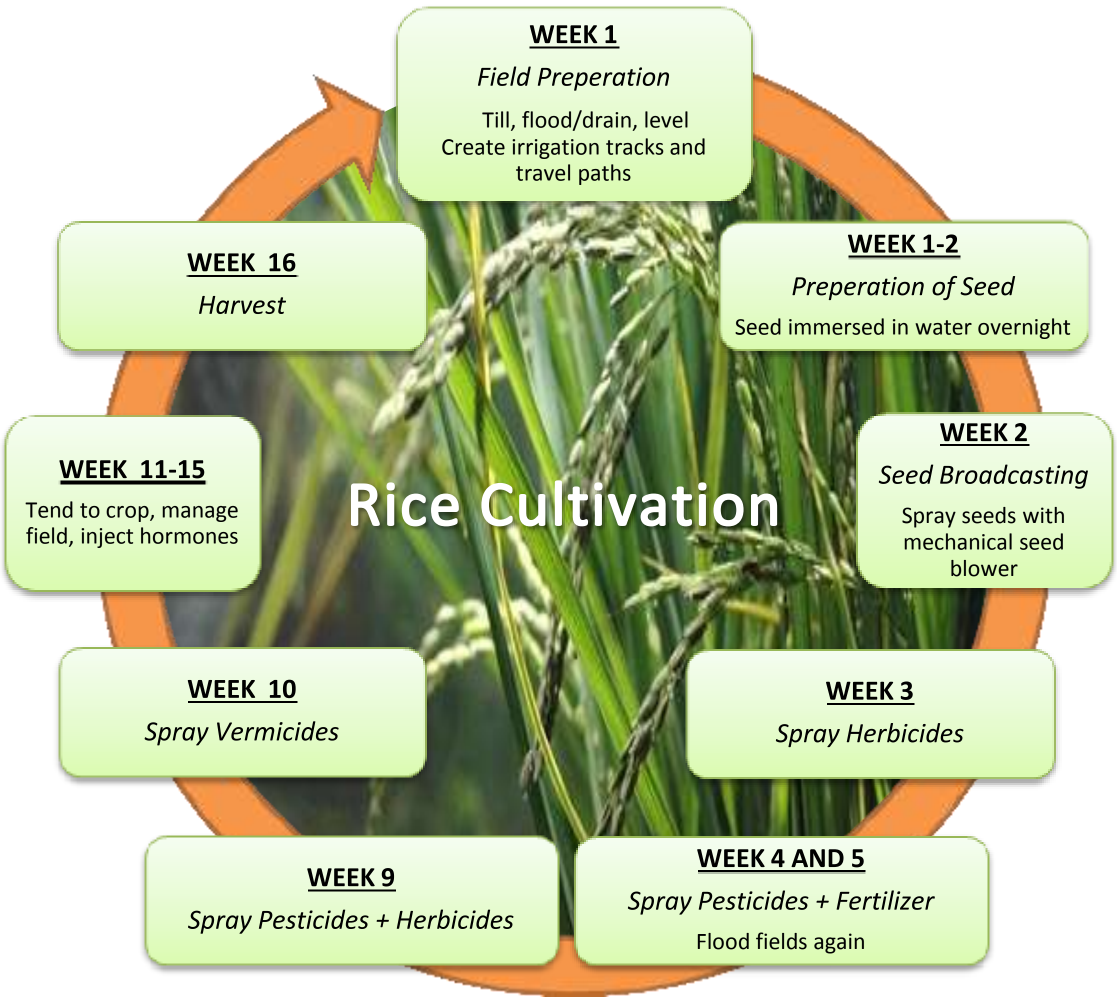

Figure 3: Rice Cultivation Diagram for Four Month *Na Prang* Cycle

Workers in the rice paddies are exposed to the natural environment leaving them vulnerable to changing temperature, humidity, and radiation from the sun. The environmental conditions can also affect the maturation of the rice, changing the frequency and severity to the farmers' work. Due to the nature of agricultural work, susceptibility of the workers to the climate, and the demand to cultivate rice, agricultural workers may have a higher chance of contracting heat-related illnesses.

2.3 Steel Industry and Production

While Thailand is a major steel exporter, steel is also in high domestic demand because of the large industrial sector, including construction, throughout the country. In 2011, steel comprised 1.5% of Thailand's GDP (*Statistics and Reports*, 2010). As a whole, Thailand consumes approximately two million metric tons of steel and iron each year. About 70% of that product is imported while 30% is made locally. About 400,000 metric tons are exported worldwide. There are thirty-one certified steel and iron companies in Thailand, including the study site Siam Steel Syndicate Co. (Limited) in Samutprakan province.

The billet manufacturing process, occurring at our study site, begins with the preparation and transport of scrap metal to the Electric Arc Furnace (EAF) (see Figure 4, below).

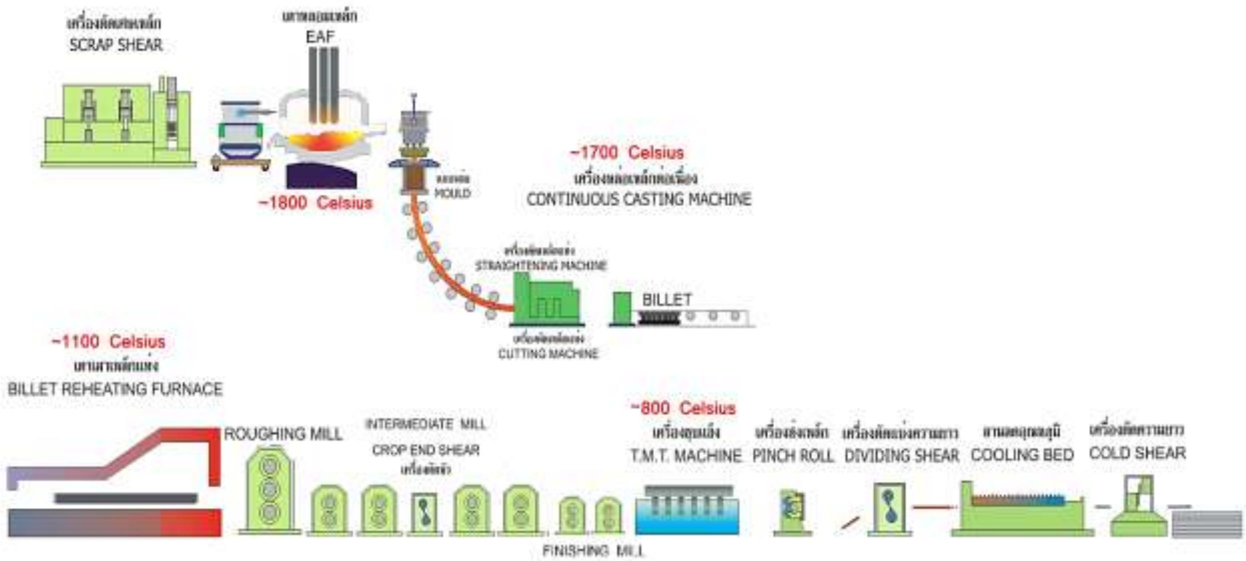

Figure 4: Temperatures of Major Machines in the Steel Making Process
(Modified after Siam Steel Syndicate and Co. [Limited], 2008)

The scrap is melted, catalyzed by oxygen, and mixed with carbon to ensure proper quality. The molten metal is poured by ladle into the Continuous Casting Machine, where it is molded, straightened, and cut into billets. Next, the billets are molded into bars in the rolling mill. First, billets are reheated in the Billet Reheating Furnace to 1100 degrees Celsius. The soft metal is stretched and cut in a series of mills. Once the size and quality of metal bars meet the required standards, it is hardened and strengthened by the Thermo Mechanical Treatment (TMT) Machine. Finally, the steel bars are cooled, cut to standardized lengths, stored, and distributed.

In the steel factory, temperatures can reach up to 65 degrees Celsius and metal can be heated to 1800 degrees Celsius. Although the workers are not exposed to solar radiation, the heat produced in the factory can reach dangerous temperatures in a concentrated area. The steel factory is also exposed to the external climate because of its open layout and limited enclosed spaces. Thus, external heat as well as the heat generated by the machines can impact industrial workers' health.

2.4 Heat-Related Health Effects

The human body contains a thermoregulatory system with the sole purpose of heating and cooling the body. In order to maintain a core temperature of 37 (±0.6) degrees Celsius, the multi-organ system must allow heat exchange between the environment and the body through four methods (Constance & Shandro, 2011). First, increasing blood flow cools the body but pressure from solar radiation in hot climates inhibits this process. Heat can also be transferred between two contacting surfaces by conduction or between a surface and a gas or liquid by convection. These methods work best if the body is submerged in water (Keim et al., 2002). Lastly, the most efficient mode of cooling, especially during environmental heat stress, is evaporation.

Perspiration, occurring when glands secrete sweat in an attempt to cool the body, evaporates from the skin causing approximately 580 kilocalories of heat per liter of sweat to be lost (Weiner, 1945). An average person exercising in a hot climate can lose 2 to 3 liters of sweat per hour, which roughly equates to half a pound. The majority of heat loss occurs at the head and upper body. Perspiration that drips from the body without evaporating does not contribute to cooling; therefore, keeping these areas exposed in hot climates is essential for successful thermoregulation. However, exposure becomes increasingly less effective as humidity rises. The body's capacity for heat dissipation is affected by two sources. Metabolic endogenous heat increases during physical activity whereas exogenous heat increases during exposure to a hot environment (Constance & Shandro, 2011). Heat stress occurs if the heat and temperature produced by these two heat sources exceeds the ability of the thermoregulatory system. Heat stress is therefore defined as any kind of discomfort or physiological strain related to heat exposure. Athletes and laborers in hot climates constitute most of the victims of heat-related illnesses due to their elevated production of endogenous heat and their exposure to exogenous heat (Bouchama & Knochel, 2002).

Heat-related illnesses occur once the core body temperature rises past the point where heat dissipating mechanisms can operate. Failure to maintain the homeostatic temperature of 37 degrees Celsius leads to minor and severe illnesses such as fatigue, exhaustion, cramps, collapse, rashes, and stroke. Some people may experience nausea, irritability, heavy sweating, and decreased urine output (US Dept. of Labor, 2011). The most dangerous consequence, heat exhaustion, occurs once the body's salt and water stores deplete due to excess sweating. General symptoms include thirst, weakness, discomfort, anxiety, dizziness, fainting, and headache (Bouchama & Knochel, 2002). Heat collapse or fainting occurs when the body tries to control the internal temperature by dilating the blood vessels. As a result, blood pools in the lower extremities, primarily in the legs. The relatively stagnant blood will not return back to the heart to be pumped into the brain, causing a lack of oxygen, dizziness, and eventually fainting (Chawsithiwong, 2008). A person is recommended to sit or lie down on breaks because of this risk of collapse.

Electrolyte imbalance from profuse sweating causes painful muscle spasms or heat cramps. If a laborer or athlete fails to drink water regularly through strenuous activity, the salt content in the body becomes too high. Conversely, drinking too much water will dilute the body's fluid without replacing the lost salt content (Chawsithiwong, 2008). Those exerting energy in hot climates must remain aware of their intake of electrolytes and beverages especially at the end of a workday or workout because tired muscles are more susceptible to cramping. Dehydration is easily recognized this way because insufficient water intake increases the concentration of urine which will translate to a darker color. A strict re-hydrating schedule every 15 to 20 minutes and checking the color of your urine regularly is highly recommended by the Occupational Safety and Health Administration (Occupational Safety and Health Administration, 2011).

The most common heat-related illness in hot work environments is *malaria rubra*, also known as heat rash or "prickly heat." When sweat does not evaporate, skin ducts become clogged and inflamed, causing a painful rash characterized by red papules. This rash can form pustules if the skin becomes infected with the common bacteria *staphylococci* (Constance &

Shandro, 2011). Heat rash is likely to occur where clothing is most restrictive. By exposing areas with the most active sweat glands, bathing regularly, and resting in cool places, heat rash may be successfully prevented (Chawsithiwong, 2008).

Heat stroke may occur once the core body temperature reaches 40 degree Celsius. Central nervous system abnormalities such as delirium, convulsions, or coma are possible (Bouchama & Knochel, 2002). Other symptoms may include confusion, irrational behavior, loss of consciousness, hot, dry skin, or profuse sweating (U.S. Department of Labor, 2011). Classic heat stroke is caused by environmental heat. Exertional heat stroke is caused by strenuous physical activity when the rate of heat loss is less than the rate of heat being produced metabolically (Bouchama & Knochel, 2002). Heat stroke can lead to multi-organ dysfunction syndrome and, if ignored, death.

Those predisposed to heat-related illnesses should take extra precautions in order to prevent the thermoregulatory system from being overwhelmed. Laborers exposed to these conditions include those in declining health: people 65 years of age or older, overweight individuals, or heart disease patients. Medications such as blood pressure pills or antihistamines can also increase a person's risk to heat-related illnesses (Center for Disease Control and Prevention, 2011). High temperature, humidity, and direct sun exposure are the normal conditions for heat stroke and heat exhaustion. Other dangerous environments include those with indoor exposure to radiant sources and limited air movement. Low fluid consumption and lack of acclimatization also increases the chance heat-related illnesses (U.S. Department of Labor, 2011).

In addition to the illnesses and conditions mentioned, changes in climate that result in consistently higher temperatures have been linked to mosquito-borne, rodent-borne, waterborne, infectious, and noninfectious diseases such as West Nile Virus, Dengue Fever, encephalitis, malaria, and cholera. Similarly, chronic organ failure and other long-term diseases are suspected to be linked to chronic dehydration and other heat-related illnesses. Unfortunately, the risk of chronic dehydration may be an underestimated consequence because little research has been done to connect these health problems. Though our study looked at dehydration and heat stress, we did not have enough relevant and long-term data to make conclusions about chronic illnesses, even if they are expected to be instigated by heat and climate change.

The persistently hot, humid, and sunny climate of Thailand is ideal for a study about the physical workload and heat stress of laborers. A short study done in Thailand by Rangsit University in 2002 sought to increase awareness in the workplace and suggest prevention methods for laborers. Their results suggested that high physiological strain coupled with hot thermal conditions could result in negative consequences for health, safety, well-being, and productivity. Immediate measures were recommended in excessively hot and humid locations to reduce physiological strain by using improved technology and setting up work/rest regimens (Yoopat et al., 2002).

In the United States, a report entitled *Criteria Document for Occupational Exposure to Hot Environments* (1972) was published by the National Institute of Occupational Safety and Health (NIOSH). More recently, the EPA developed a step-by-step plan for the prevention of heat-related illnesses. Though the reports were developed decades ago, both have been used as conventional standards for occupational safety and health around the world. The two documents agreed upon implementing work/rest regimens, instructing workers and supervisors to recognize symptoms, monitoring and reducing environmental heat at the job site, rescheduling tasks so that the most energy-dependent is done during the coolest part of the day, and researching cooling garments (U.S. Environmental Protection Agency [EPA], 1993). The two agencies suggested that workers be exposed to the environment gradually until their bodies acclimate and are able to function normally within the new climate.

A study completed by L.C. Senay, et al. discovered the different steps of acclimatization and is widely accepted as the standard for understanding one's tolerance to heat. When the body is first exposed to hot surroundings, heat transfer from the body to the environment is deficient because the thermoregulatory system is unable to cool the body as fast as it heats. Evaporation rates increase in order to relieve the core temperature. The increased evaporation and expansion of plasma volume in the blood acclimatize the body and causes the core temperature to stabilize (Senay et al., 1976). This study found that those who are gradually exposed to a new, hotter environment are likely to develop a tolerance to the climate and perform more efficiently with less health risks. Acclimatization can cause the thermoregulatory system to become more sensitive and start employing heat dissipating mechanisms earlier so as to stabilize the core temperature before it escalates too high. This method, though seemingly effective, is incredibly dangerous and might contribute to long-term health effects. In part, our study will evaluate the accuracy of this claim.

2.5 Impacts of Climate Change

An increase in greenhouse gases including carbon dioxide, methane, and nitrous oxide has accumulated in Earth's atmosphere. This gas layer allows the heat from the sun into the atmosphere, but prevents it from leaving as infrared radiation. Over time, the heat builds up and changes the global climate. First officially recognized by the United Nations in 1979, climate change is now defined by the U.S. Environmental Protection Agency (EPA) as any measurably significant change in climate, including temperature and precipitation, over time (U.S. Environmental Protection Agency [EPA], 2011). The link between climate change, natural phenomena, and most significantly, human livelihoods, has been recognized by major organizations, including the World Meteorological Organization (WMO), the United Nations Environment Programme (UNEP), and the International Panel on Climate Change (IPCC). Nearly all the world's scientific agencies that accept climate change are in agreement that climate change is occurring largely because of human activity.

Since the age of industry, human actions have been implicated in the bulk of greenhouses gases. Specifically, the burning of fossil fuels, industrial emissions, deforestation, and unsustainable land use practices has exponentially increased emissions. In 1990, the IPCC began publishing assessment reports that introduced climate change as an important world-wide trend that must be recognized among all countries (Intergovernmental Panel on Climate Change [IPCC], n.d.). According to the IPCC, the Earth will experience more frequent hot days and heat waves, heavy precipitation and drought, increased cyclone activity, and extremely high sea levels (Bernstein et al., 2007).

The twentieth century was the hottest on record and, this century, global average temperature is expected to rise 3 degrees Celsius. In Thailand, the annual mean temperatures have increased approximately 0.75 degrees Celsius over 58 years, as shown in Figure 5 below (Thai Meteorological Department, n.d.).

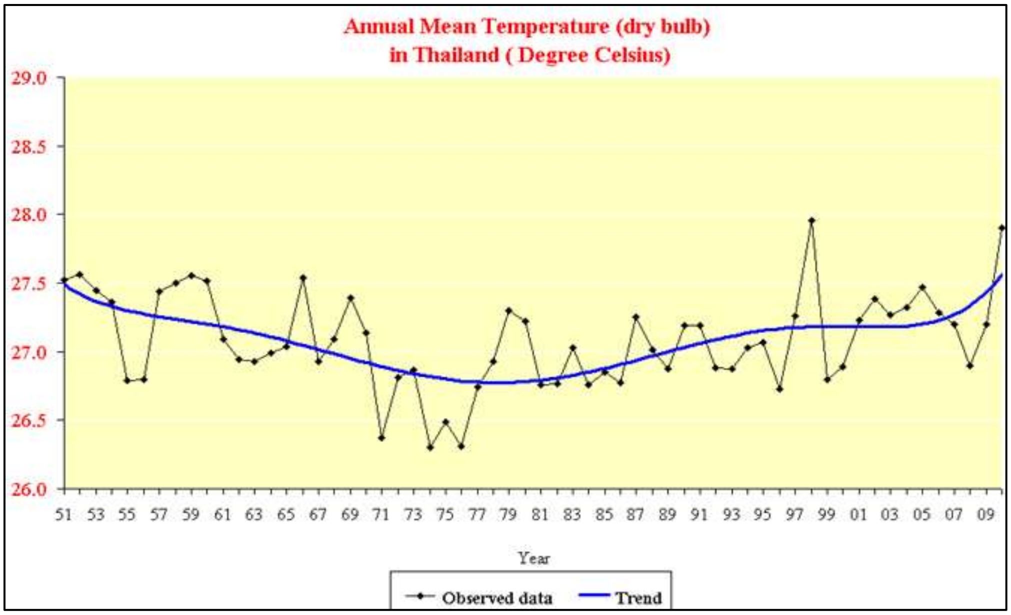

Figure 5: 1951-2009 Annual Mean Temperatures for Thailand
(Thai Meteorological Department, n.d.)

Similarly, the minimum and maximum temperatures for the country have been increasing since 1951. Unfortunately, Thailand is one of the most vulnerable countries to climate change because of its long coastline and susceptibility to flooding, heat, and drought. To date, the country has already experienced these conditions that have damaged many major cities and villages and injured thousands. From these data, climate change is evident in Thailand and accepted as an occurring phenomenon that will continue in the future. Quality of life is being threatened because of air pollution, malnutrition, heat stress, vector-transmitted infectious diseases, and other accompanying effects of climate change. Undoubtedly, Thai culture, livelihood, and economy are being affected as well.

A current hypothesis suggests that people living in hotter climates can survive and adapt to increasing temperatures better than people living in colder temperatures. However, if the temperature increases too quickly, adaptation will not occur and morbidity and mortality will increase (Sintunawa et al., 2009). This hypothesis reiterates the lack of data pertaining to tropically hot countries and climate change. It also indicates the need for further research about the health effects that increasing temperatures have on workers.

2.6 High Occupational Temperature: Health and Productivity Suppression (HOTHAPS)

The "High Occupational Temperature: Health and Productivity Suppression" or HOTHAPS program was begun by the World Health Organization in 2008 to promote worldwide awareness that heat exposure affects occupational health in particular. The Faculty of Public Health at Thammasat University in Thailand, initially received research funding to collect data in low and middle income locations. Two months later, HOTHAPS was halted due to limited funds. In 2010, Thammasat University requested funding from the Office of Higher Education Commission in Thailand to continue the program.

HOTHAPS not only analyzes the effects of heat exposure on worldwide occupational health and productivity but also forecasts the trends regarding climate change and suggests the possible impacts that climate change could have on humans. The report explores preventative measures, some of which were developed into suggested guidelines. In 2011, HOTHAPS began focusing on field studies to gain insight on the working environments in different countries. The field studies have also led to preventative occupational health programs. Recently, gathering data about health and productivity has been the main focus. All of the results will be published in 2013, including reports to the IPCC to provide advice on prevention methods for heat exposure.

The main objective of the HOTHAPS program is to conduct a scientific analysis to determine the effects of climate change on human health. To do this, the program is divided into five sections to illuminate the relationship between increasing temperature and health in hot climate countries, by gathering heat, health, and prevention data. Part one of the HOTHAPS program considers pilot studies in small populations to determine whether the study is worth repeating on a larger population. Part two focuses on heat monitoring by using the WBGT meter. Part three focuses on the occupational heat impacts. Questionnaires were to collect first-hand accounts about working conditions, health, productivity, and current prevention methods. Productivity, specifically for the HOTHAPS program, measures the ability to produce a specific quantity of quality goods or services in a timely manner. Productivity is influenced by worker efficiency and can be improved by either increasing the output or decreasing the input. Overall, productivity depends on working conditions and climate and is an important statistic because it indicates the overall income of a business and is used to determine the health of employees. The growth of productivity in Thailand will improve living standards by increasing personal income, making it a driving force in this study.

The fourth part focuses on the health impacts, work capacity, and prevention by quantifying measurements of productivity and heat exposure levels. These measurements are based on the total time and amount of sunlight each worker is exposed to, as well as heart rate measurements. The final part of this study assesses local climate change by considering the relationship between heat and health as well as demography, work capacity, and the well-being of workers. Thus, statistical data on local climates is combined with climate change forecast models to predict the impacts of heat on and productivity of working populations.

2.7 Related Case Studies

The results of recent case studies show that there is an abundance of workers who labor in hot environments but do not have access to the proper amenities to protect themselves from heat stress. In 2010, a research team conducted a study in India by interviewing industrial workers at ten different work sites (Balakrishnan et al., 2010). The goal of the study was to learn how the workers perceived their exposure to heat. While there was a large variation among the workers' responses, it became apparent that they did not have access to sufficient amenities that could relieve their exposure to heat. Other case studies have shown that agricultural workers in particular usually do not have access to amenities as well. A study that took place in 2009 examined the working conditions and heat exposure of sugarcane workers in Costa Rica (Crowe, de Joode, & Wesseling, 2009). Sugarcane workers can be divided into two categories: field workers and mill workers. Similar to our project, the field workers labor outdoors and are exposed to naturally produced heat, while the mill workers are exposed to man-made heat produced by sugarcane-processing machines in the mill. The researchers found that the mill workers were most often exposed to harsher climate conditions, but the field workers had fewer amenities to alleviate heat stress.

A study conducted in a Nicaraguan sugarcane farm in 2009 studied current heat stress prevention methods in order to improve how workers rehydrate themselves (Cortez, 2009). The study revealed that the workers were exposed to extremely high temperatures, but a new rehydration system that increased water intake improved their productivity. This change in productivity could indicate the possibility that heat does have short-term impacts on health, but more research is needed to make a strong case for this hypothesis.

The results of recent case studies still conclude that the effects of heat exposure in an occupational setting are undefined and require further research. Despite varied reports of health effects, it is certain that amenities available to workers are poor at best and new preventative methods need to be explored and used. Studies have also indicated that in light of increasing global temperatures, the effects of heat will likely increase, which augments the need for further research into health effects and preventative methods for heat stress.

The Thai Cohort Study and the Thammasat University pilot study recently collected valuable data on Thai workers, rice paddies, and industrial sites that were relevant to our study. Both studies focused on the impacts of heat stress on health and productivity levels, but recognized the need for more research relevant to the relationship between climate and health. Here we outline some of the key findings that pertained to our project.

2.7.1 Thai Cohort Study

In 2005, the Sukhothai Thammathirat Open University (STOU) began collecting data in Thailand for a large-scale study aimed to evaluate the effects of heat stress on physical and psychological health in an occupational setting (Langkulsen, Vichit-Vadakan, & Taptagaporn, 2010). The university recognized that few previous studies had examined the relationship between heat stress and health problems in at-risk tropical, developing countries. Survey responses from 40,913 full-time Thai workers were analyzed based on explanatory variables that contribute to the degree at which heat stress affects health, such as age, gender, occupation, job location, education level, income range, pre-existing illnesses, diet and physical activity, and additional workplace dangers. The questions included identification of high temperature experiences, the rate of frequency of these experiences, and evaluation of overall heath and psychological well-being. Psychological health was assessed in terms of anxiety, excessive fidgeting, or lack of motivation.

The study also accounted for factors unrelated to heat that might cause adverse health effects by assessing workers who did not experience other workplace hazards. This restriction of data ensured that heat stress symptoms were linked to temperature only. A statistical ratio analyzed the relationship between the above-mentioned variables and health and was then adjusted to prevent the ratio from being influenced and skewed by other factors. In other words, the ratio represented the correlation between a single variable and health impacts as accurately as possible.

Figure 6, below, shows that the highest percent of respondents with poor health were individuals who were frequently exposed to hot temperatures at work. As age increased, women were more affected by heat stress while men showed a decrease in heat-related health problems. The most significant result of this case study was a strong correlation between reports of heat stress and signs of poor physical and psychological health. This relationship, evident with both those who did and did not have other work hazards, shows that occupational health problems cannot be strictly explained by non-thermal hazards in the workplace.

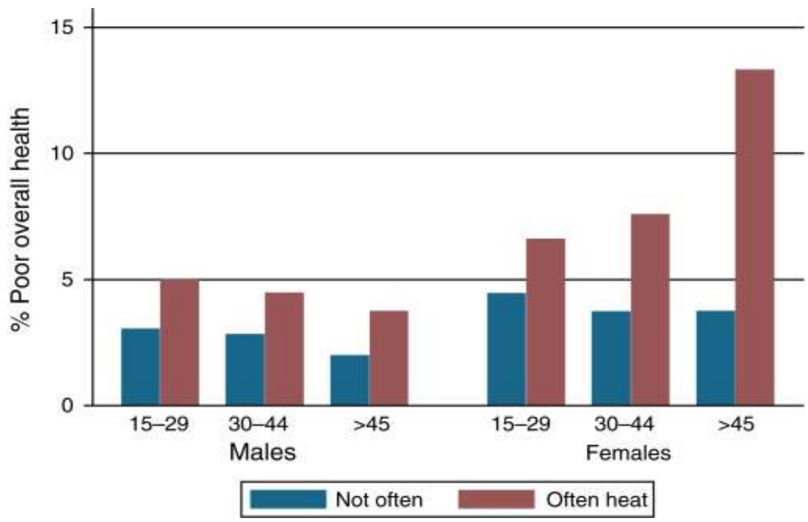

Figure 6: Prevalence of “Poor Overall Health” by Age and Gender
(Tawatsupa, Lim, Kjellstrom, Seubsman & Sleigh, 2010)

The strengths of this case study include the large number of participants, varied demographic distribution, and the amount of data compiled for more accurate analysis. The survey was well detailed and provided many analyses on the effects of demographic factors and other health hazards. However, for the comparative purposes of our project, the weaknesses are that the data does not accurately reflect the education level of the average Thai. The participants of this study are university students and are better educated than the average Thai. Therefore, this data is more likely to represent a steel worker who is required to complete a certain number of years of education than a rice paddy worker who typically receives below-average education. The data could not prove a cause and effect relationship between heat stress and physical and psychological problems. There was no data on the chronological order of the reported heat stress and health problems, and as a result, heat stress could not be identified as the preceding influence that caused the health problems. Furthermore, the health and environment observations are objective because the factors were not directly measured by the project team.

2.7.2 Thammasat University Pilot Study

Between September and October of 2009, the Faculty of Public Health at Thammasat University conducted a HOTHAPS pilot study in the Pathumthani and Ayutthaya provinces to investigate the possible health and productivity impacts of climate change (Tawatsupa, Lim, Kjellstrom, Seubsman, & Sleigh, 2010). The goal of the study was to compare heat exposure in industries where heat is a byproduct of production and occupations where heat occurs naturally. For this reason, data was collected at a pottery factory, power plant, knife factory, construction site, and a vegetable field. The Faculty calculated heat exposure indices and surveyed workers in order to record perceived changes in productivity due to high temperatures. The Wet Bulb Globe Temperature (WBGT), relative humidity (RH), and temperature were collected during the 6:00 AM to 6:00 PM workday for five consecutive days. The WBGT is a heat exposure index that combines air temperature, humidity, wind speed, and solar radiation and expresses it as a single number in degrees Celsius. Similarly, the heat index combines humidity and temperature into one number expressed in degrees Celsius. These measurements account for several environmental factors besides temperature, which makes them useful in analyzing the health risk of heat exposure. The team used the heat index chart in Table 1 (below) to evaluate how dangerously hot each occupational setting was. The chart describes which heat-related illnesses workers are vulnerable to when the index falls within a certain range.

Table 1: Possible Heat Disorders at Specific Ranges of Temperatures
(Modified after Langkulsen et al., 2010)

Category	Heat Index	Possible heat disorders for people in high risk groups
Extreme Danger	130°F + (54°C or higher)	Heat stroke or sunstroke likely.
Danger	105–129°F (41–54°C)	Sunstroke, muscle cramps, and/or heat exhaustion likely. Heatstroke possible with prolonged exposure and/or physical activity.
Extreme Caution	90–105°F (32–41°C)	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Caution	80–90°F (27–32°C)	Fatigue possible with prolonged exposure and/or physical activity.

The results of the study indicate that the workers in each setting face prolonged exposure to dangerously high temperatures. The outdoor WBGT measurement was highest at the agricultural site, and four out of the five work sites had ranges of heat indices that lie in the 'Extreme Caution' category. Furthermore, measurements were taken in the rainy season when temperatures are typically lower, implying that workers face much higher temperatures during the summer season. This pilot study illuminates the possibility that workers are susceptible to heat-related illnesses. However, it is difficult to determine how and if heat directly harms the workers' health because this study did not collect any data on the previous or present health statuses of the workers.

The Thai Cohort Study and the Thammasat University pilot study collected valuable data that adds to relevant research we used to develop our study. Though these two studies provided a good backdrop for our fieldwork, we realized a more systematic methodology would be advantageous to our study. Thus, we collected environmental data as well as health statistics on workers.

2.8 Summary

Previous studies have shown that heat could be a factor in occupational health; however, there is not enough definitive data to come to that conclusion. This gap in the research gave us an opportunity to explore further testing and sampling. We gathered sufficient data about occupational health in two provinces to support this hypothesis as well as compare the effects of indoor and outdoor climate conditions.

CHAPTER 3: METHODOLOGY

The goal of this project was to consider the impacts of heat on the occupational health of agricultural and industrial workers, in Pathumthani and Samutprakan provinces, respectively, in order to understand if climate change is causing (or has the potential to cause) increased heat stress on vulnerable workers. To achieve this goal we completed the following objectives:

1. Observed the micro-climate, typical environmental working conditions, and amenities in outdoor rice paddies and an indoor steel factory
2. Collected health statistics from a voluntary sample of workers through a series of interviews
3. Submitted data to Thammasat University for the international HOTHAPS study. The study will use this data to draw conclusions regarding the relationship between health and climate change; these results will be published at a later date
4. Analyzed the data we collected in order to draw conclusions and make generalizations on how changing ambient conditions and heat exposure are affecting the health of agricultural and industrial workers
5. Conducted a comparative analysis between agricultural and industrial workers to determine who seems more affected by heat and, consequently, climate change

We observed and recorded the health and heat measurements of agricultural and industrial workers. Our observations and data were detailed in the diary notes, a chart created by Thammasat University to record field data. Please refer to Appendix A for an example of the diary note chart. We also recorded interviews with workers and other stakeholders. To illustrate the steps taken to evaluate the effects of climate change on workers, Figure 7 is provided below.

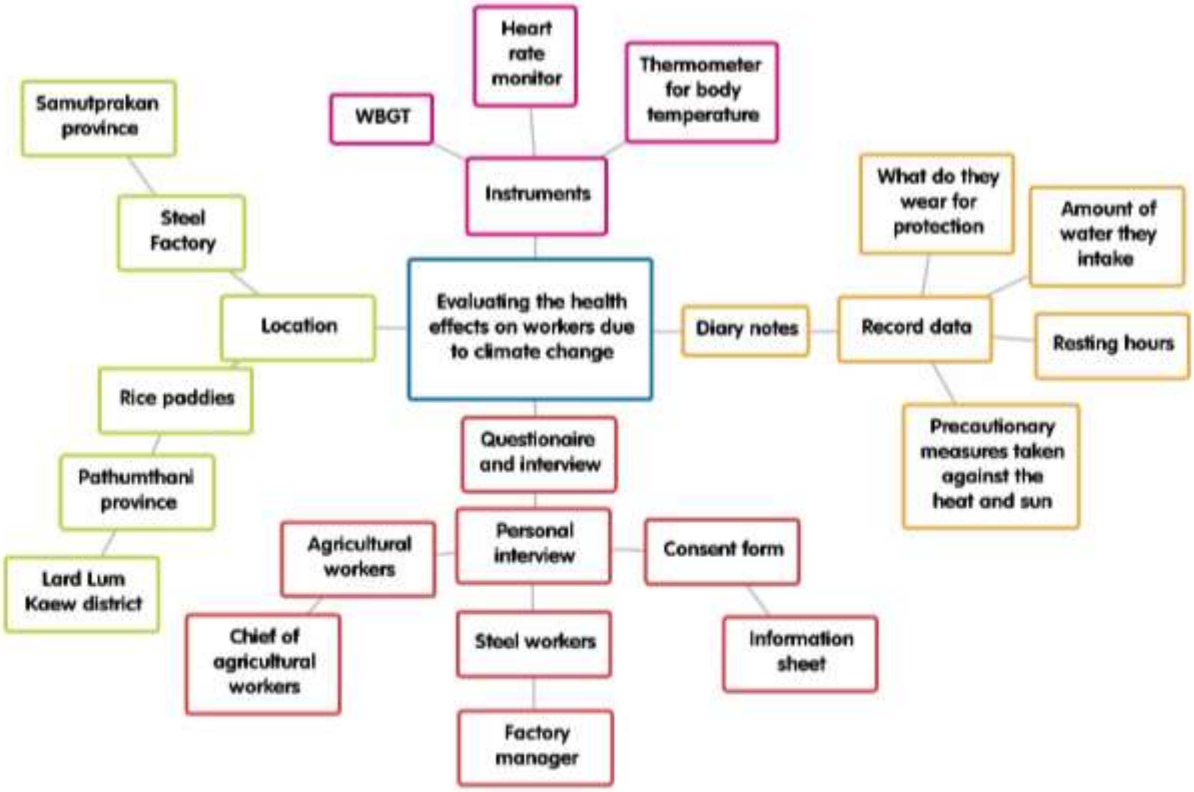

Figure 7: Methodology Flow Chart for Evaluation of Climate Change and Health Affects

3.1 Site Assessment

In order to complete the objectives of our study in the agricultural sector, Dr. Uma Langkulsen of Thammasat University chose the Lard Lum Kaew district in Pathumthani province due to accessibility by local transportation, level of safety, and the large number of paddies and workers that accurately represent the typical Thai rice paddy. To collect data in the industrial sector, the university chose a steel factory in Muang district in Samutprakan province based on size, level of safety, and the large number of workers that represent a typical Thai steel factory.

When we arrived on site, we met the principal field researchers Piriya Tipkongka and Sukrit Tangto. They taught us how to read the instruments and record data. They also helped us develop a good rapport with the workers in order to increase participation. At both sites, we sought willing participants, including workers, factory foremen, and rice paddy owners. By studying their schedule and provisions, we agreed upon the most convenient time and location for interviews.

3.2 Measurements

Gathering quantitative data gave us exact measurements in the field. Empirical evidence is especially useful in supporting a hypothesis because the data not only avoids bias possible in observations but is also easy to analyze and present. Our measurements by scientific instruments formed part of our understanding of the environmental conditions and general health of workers.

3.2.1 Environmental Measurements

To determine the climate conditions in both locations, we used Wet Bulb Globe Temperature (WBGT) to measure indoor and outdoor climate data. The WBGT heat index is calculated from the readings of three thermometers. The globe temperature responds to environmental heat load. The natural wet bulb responds to the rate of evaporation, which is affected by humidity and wind. The dry bulb responds to normal air temperature. The combined thermometer readings proved to be the most useful index because it responds to all four elements of the thermal environment that impact climate: radiant heat, air temperature, wind speed, and humidity. Although the WBGT does not measure heat stress on individuals (only the environmental conditions), it does give a measurement for relative humidity and air temperature, used as measurements in the heat index, which can be used to approximate heat stress on a person (Budd, 2007). More importantly, we were able to compare our calculations to the WBGT threshold limit values established by the American Conference of Governmental Industrial Hygienists (ACGIH, 1992). Thammasat provided the QuestTemp 34 meters, shown below in Figure 8, and set the instruments in a location that represented average ambient temperature. The meter recorded data every thirty minutes for ten days both in the rice paddies and steel factory.

Figure 8: Wet Bulb Globe Temperature Meter

3.2.2 Health Measurements

We collected health statistics by using instruments to record heart rate and body temperature. Heart rate, the number of heart beats per minute, is often used by individuals and medical professionals to determine the degree to which the body is exerting itself. Strenuous activity generates a need for oxygen that is fulfilled by the cardiovascular system. The heart will pump blood faster through the lungs and to the muscles as work intensity increases, making the measurement the prototype for determining effort. Studies have also shown that monitoring heart rate can help track one's health (Zhang & Zhang, 2008). We used a heart rate monitor, supplied by Thammasat, in the form of a chest strap and watch. Three consenting workers in both the rice paddies and steel factory wore the chest strap underneath their clothes and watches on their wrists. Though this monitor can be cumbersome for the workers, the equipment is fairly inexpensive and accessible compared to newer models. In the rice paddies, we followed the same three workers around the province and walked into the field in order to avoid disrupting the worker's activity. For the steel workers, heart rate was taken hourly preceding the workers break. We recorded heart rate in the diary notes hourly so that we could determine the most strenuous part of the day and compare this information to our climate data.

Because heat-related illnesses occur at specific internal temperatures, we recorded body temperature in the diary notes for comparison to potential health risks. We measured body temperature at the beginning and end of workdays by using a glass mercury thermometer provided by our sponsor. Although the newer digital thermometer works fast, is easy to read, and is easily sanitized, the measurements are not as accurate as the traditional mercury thermometer. The mercury thermometer used was difficult to read, but its affordability and accuracy made it the ideal instrument.

3.3 Observations

We observed and recorded the daily activities of three agricultural and three industrial workers in diary notes. These observations made by team members, taken every hour, obtained real information regarding workers' physical response to the heat and actions to dissipate heat stress. Diary notes were not dependent on workers' answers, making the data more accurate without requiring more information and time from the workers. For the diary notes, we gathered general information about each worker and the site. The time each worker began and ended work, the duration of their breaks, as well as the type of work was noted. Next, we observed and recorded the cooling actions taken by each worker, including using a fan or air-conditioning, and how much drinking water they consumed within that hour. We needed to estimate productivity by approximating the area they farmed or the amount of steel they produced per hour. However, measuring productivity is a difficult and unstandardized process; therefore, the Thammasat staff took these measurements.

3.4 Questionnaire/Interview

Before each interview, we gave the workers information sheets and consent forms. The information sheet explained the project and clarified our purpose. By signing the consent form, participants showed willingness to participate and granted us permission to use their disclosed information. Please refer to Appendix B for an example of the consent form. There were two sets of interviews; we gave the first set to agricultural and industrial workers while the second set aimed to question the owners of the rice paddies and the shift foreman of the steel factory. The questionnaire is based on the HOTHAPS survey, and includes questions about the type of work, heat exposure at work, impacts of heat on health, impacts on productivity and work activities, heat reduction approaches, and effect of heat during non-working hours. The two forms of interviews varied only with regard to productivity and estimates of future economic loss. Please refer to Appendices B through E for examples of survey excerpts in Thai and English.

Benefits of conducting the interviews included the ability to record their responses and note the participants' body language and tone of voice. The interviews contained both fixed-response and open-ended questions. Fixed-response questions allowed for easy analysis and reliability but constrained the respondents' answers. Responses to open-ended questions are more detailed but harder to analyze (Knight, 2002). By employing both question formats, we acquired more specific information. It is important to be sensitive to workers' culture in order to minimize their discomfort so they do not feel pressured to answer with a bias (Seidman, 2006). We accomplished this by using our Thai partners to converse with them and help us understand the cultural norms that we should follow when interviewing.

Upon first arrival to the rice paddies in Lard Lum Kaew district, Pathumthani, our team introduced ourselves to agricultural workers to build rapport. At the steel factory in Samutprakan, the workers were informed of the company's participation in the study. We were introduced to the site by touring the steel refining process and the interviewees daily work routine. At both sites, consent forms and information sheets were distributed to each interviewee. The interview was timed to finish approximately in 15 minutes but tended to last longer due to some volunteered anecdotes by participants about their experiences with heat and health. Sessions were also video recorded for translation, reference, and presentation of our results. Not all workers understood the meaning of all the questions; therefore, if they could not give an answer, we needed to note down the reasons. Upon completion, we gave out small gifts to those who participated in the rice paddies as incentives to and appreciation of their participation. However, we did not provide gifts at the steel factory because the company was participating as a whole, not just volunteering individuals. Submitting data to Thammasat University completed the data collection process.

CHAPTER 4: FINDINGS AND ANALYSIS

In this chapter, we provide our observations from both the agricultural and industrial settings. We include data on heat, health, and productivity, the three major components of our study. Due to publication sensitivity and our agreement with Thammasat University, we do not have access to complete diary notes and limited access to WBGT data. Nevertheless, our findings and analyses are still informed by these data in addition to interviews, observations, and anecdotal material. While we are restricted from presenting specific numbers, we can make predictions and general conclusions about occupational health as it is affected by heat. Finally, we include four analytical conjectures regarding the differences between the two sites and the relationship of heat on health and productivity.

4.1 Site Description by Sector

Based on our site visits and simple observations, we will first describe the physical and structural findings of the two kinds of sites we assessed. This includes evaluations of shade, water, and other amenities. We also recorded ambient temperature and behaviors of workers, including preventative measures that were taken to mitigate heat stress.

Agricultural Rice Paddies

For three days, we followed a group of agricultural workers, paddy to paddy, in the Rahang district of Pathumthani province. During the day, workers endured temperatures that ranged from 20 to 43 degrees Celsius as they sowed seeds, sprayed herbicides and vermicides, and tended rice. On the first day, it was relatively cool and windy in the morning, but by afternoon, the sun was intense and temperatures were high. The next two days were equally hot but less windy, providing limited relief. At the first paddy, about six workers broadcasted seeds onto the mud field with a 60 pound mechanical seed blower seen in Figure 9.

Figure 9: Rice Paddy Worker (left) Wearing a Mechanical Seed Blower, Preparing to Broadcast Seed (right)

Along one side of the paddy, there was an irrigation system composed of a series of basins, seen below in Figure 10. One of the basins was a source of water for the workers, which they used to cool off while cleaning themselves and their clothes during the day. At this site, a small covered hut was provided to the workers as a source of shade.

Figure 10: First Rice Paddy Site with Irrigation Basins in the Early Morning

During mid-afternoon, we moved to another rice paddy where five workers were spraying diluted chemical herbicides on the small, dry shoots using the same seed blowing machine and technique. This process is depicted in Figure 11.

Figure 11: Rice Paddy Workers Spraying Herbicides and Pesticides on Second Site

We remained at the third site for two days. This paddy had been planted previously, flooded again (as shown below in Figure 12), and was being sprayed with vermicides. Similar to the previous paddies, this site had irrigation basins and a common area in the shade to rest and cool off. This paddy also provided workers with a hammock and table. Workers used the bathroom in the paddy owner's house located at the edge of the paddy. At all sites, workers were not required to wear specific protective clothing; however, like site two, most opted to walk barefoot and wear long sleeve shirts, hats with face coverings, and shorts. Additionally, agricultural workers drank their own water or used the communal water bucket on the rare occasion they took breaks. Most workers chose not to break frequently for water because they would have to stop working and leave the paddy.

Figure 12: Third Rice Paddy Flooded with Irrigation Tracks

Our presence at the paddies allowed us to interact with the workers during breaks. Surrounding the third rice paddy were houses and compounds where owners and workers lived. Using a sample of convenience, we began interviewing by going door-to-door asking tenants if they would participate in our study. At first, people were often afraid that we were soliciting; however, we explained the purpose for our visit, the study, the nature of the questions and their participation rights, all in Thai. We also presented each agricultural worker with gifts after their interview as an incentive and a token of our gratitude for supporting our research.

Interviews revealed that agriculture is usually a private family business, but some workers are employed and paid by product yield. Young men and women are less interested in becoming agricultural workers, resulting in an aging rice farmer population with workers who are usually between the ages of 35 and 50. For most workers, rice cultivation is a lifetime job that usually lasts for about 40 years. Workers have limited education and few opportunities to change careers. Financial obligation is also a motivating factor. One worker illustrated this when he said, “I never stop working and I never take a day off because I am needed” both to maintain the rice paddy and provide for himself and his family (Interview 1, January 10, 2012). Considering all of these factors, workers endure harsh climate conditions in order to make a profit and support the family business.

Industrial Steel Factory

The Siam Steel Syndicate Co. (Limited) steel factory in Samutprakan province was the chosen location to study man-made heat exposure in an indoor environment. Our field study began with a factory tour of the melting process and production of metal billets in order to understand the type of work and conditions the workers endure on a daily basis. The second day on site began with a concluding tour of the factory, including seeing the molding and production of the final steel bars (Figure 13, below).

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Figure 13: Bundled Steel Bars Waiting for Shipment

The process of melting scrap metal takes between 50 minutes to 2 hours to complete. A continuous rotation of workers keeps the factory running constantly, with three eight-hour shifts beginning at 8 a.m. Every one to two weeks, workers are changed to different shifts. Four men, all under the age of 28, work 50 minute shifts in front of the Electric Arc Furnace (EAF). The age restriction is needed to prevent illness and injury because the work is difficult and strenuous. These men added carbon and oxygen to the EAF using long steel hoses to maintain standard metal quality (seen in Figure 14) while engineers monitored the process in a nearby control room connected to the air-conditioned break room. The room contained a water basin with clean, cool water for workers to drink and wash their hands and face. We noticed that breaks were required after each melting process and when a worker became fatigued or dehydrated.

Figure 14: Steel Worker Wearing Protective Equipment (left),
Stoking Fire of the Electric Arc Furnace (right)

We used a sample of convenience to begin interviewing the melt shop workers and engineers. The melt shop contained the EAF, making it the hottest location in the factory, as temperatures can reach up to 65 degrees Celsius. The sample size was restricted due to the number of employees working per shift. We explained in Thai the purpose for our visit, the study, and the nature of the questions as well as their participation rights. This time we did not present each worker with incentive gifts because it is their obligation to the company to participate; however, workers could refuse to participate nonetheless.

From the interviews of the steel workers, we learned that every EAF worker is required to and does wear protective gear (shown in Figure 15 below), including a heat-proof cotton shirt and pants, gloves, ear plugs, helmet, face mask, and protective eye wear.

Figure 15: Steel Worker's Protective Face and Ear Equipment

Most workers have been employed at the factory for an average of two years. All 400 employees at the factory are educated through high school and engineers have received their Bachelor's Degree. They receive a constant wage but are dependent on the wage to support themselves and their families. They work in dangerously hot environments because they have a guaranteed income and job and know they will receive relief from the heat. Our specific interview data is presented and analyzed in subsequent sections.

4.2 Data Presentation and Analysis

From the site descriptions, interviews, observations, and heat and health data, we consider the socio-economic, physical, and health dimensions of our findings. As we evaluated our data, four important trends emerged that merit discussion.

Indoor Artificial versus Outdoor Natural Heat

We studied heat imposed on the workers from the natural environment in the outdoor agricultural setting and artificially generated from the machinery in the indoor industrial setting. We observed the different locations and Thammasat staff recorded data in the diary notes every hour for three workers each day. For the three days that we were in the rice paddies, the peak temperature seen during data collection via WBGT monitors was 42 degrees Celsius, and the low was 21 degrees Celsius. Furthermore, because Thailand is a tropical country located close to the equator, the intense solar radiation causes outdoor workers to feel the effects of heat strongly. Conversely, indoor workers in the steel factory were involved in the melting process, where they worked in front of a furnace that radiated heat from a core temperature of approximately 2000 degrees Celsius. The peak temperature during the two days on site was 34 degrees Celsius, and the low was 30 degrees Celsius.

Table 2 (below) presents averages for temperature, relative humidity, and the calculated heat index values during our days on site. On average, the steel factory was hotter as expected, which led to a higher heat index. However, the relative humidity was higher in the rice paddies. Though the industrial workers endured much higher spot temperature values than the agricultural workers, there is little to no relief from the sun and heat in the rice paddies. Also, the industrial temperature remains more constant, whereas the agricultural temperature is more varied and extreme. One rice paddy worker expressed the feelings of many agricultural workers when he said, “There is a lot of heat everywhere, but I feel like it is getting hotter every year, especially in the last 3 years” (Interview 2, January 10, 2012). This is similar to most industrial workers who also feel a difference in temperature, but note it has little effect on them (Interview 14, January 24, 2012). Quantitatively, 85% of agricultural workers and only 54% of industrial workers feel as though it is getting hotter year to year. Agricultural workers are exposed to environmental heat, and because they work every day, any difference in temperature is apparent.

Table 2: WBGT Calculated Averages for Agricultural and Industrial Settings

	Rice Paddies	Steel Factory
Temperature	26.60 °C	32.15 °C
Relative Humidity	72 %	68%
Heat Index	29.10 °C	40.32 °C

From our qualitative analysis of the interviews, all 15 agricultural workers who answered felt that heat during work is a problem, but only 7 out of the 11 industrial workers interviewed felt this way. To prevent heat stress, typical methods are employed, seen in Figure 16. The majority of agricultural workers seek shade (about 90%) and drink water (about 65%) to relieve heat stress. In comparison, all industrial workers primarily seek air-conditioning and take breaks to relieve heat stress. These discrepancies can largely be attributed to the availability of amenities that help combat the effects of heat in the two environments.

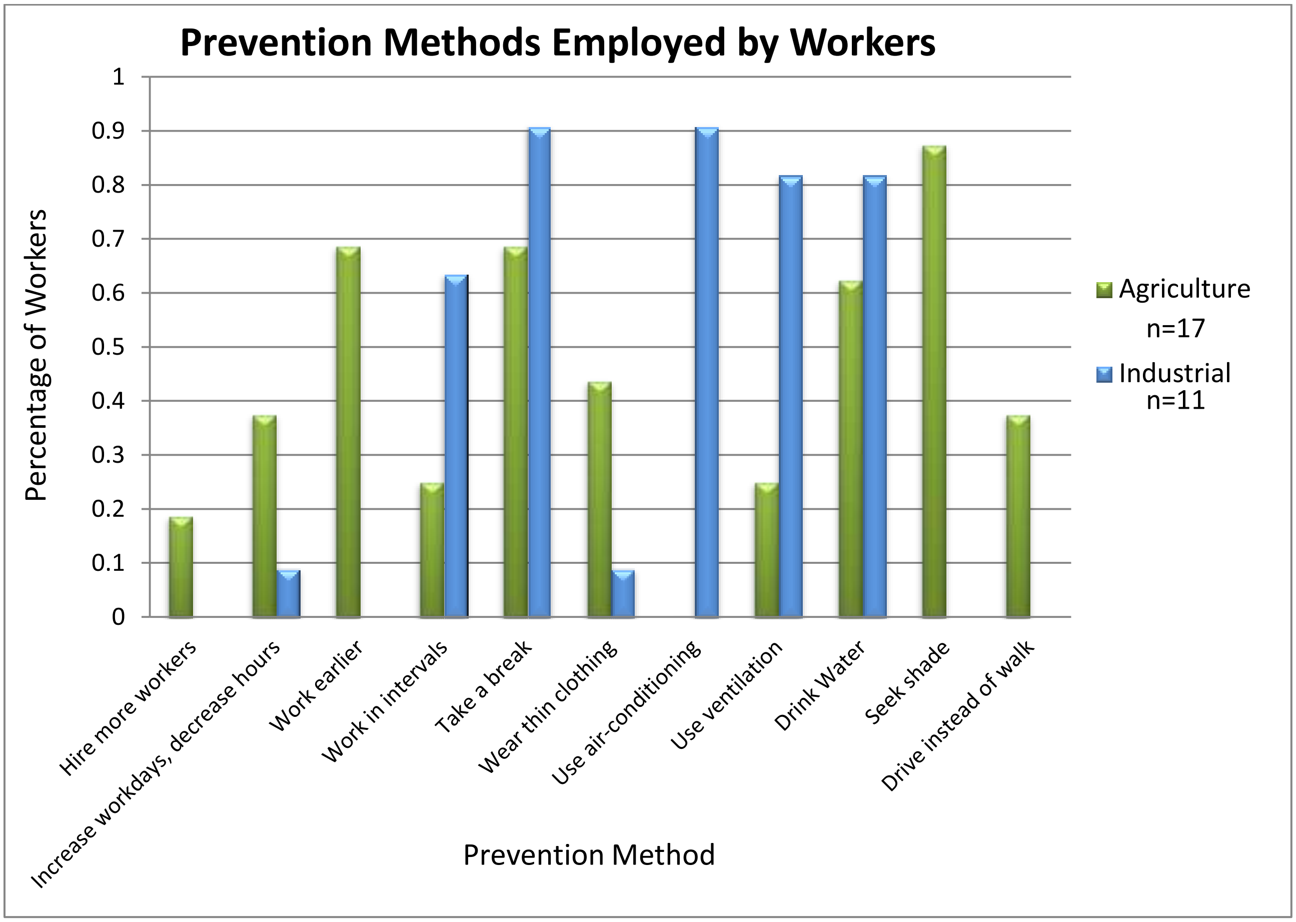

Figure 16: Prevention Methods Used by Agricultural and Industrial Workers

The steel factory workers have access to amenities provided and regulated by the factory, including the air-conditioned break room, whereas the agricultural workers must alleviate heat stress themselves. One steel worker described his experience: “I feel the heat in front of the furnace but I feel better once I get out of that area into the air-conditioning” (Interview 16, January 25, 2012). Conversely, one agricultural worker stated that he “used to sit under the shade to get out of the heat, but because of the flood, the trees are gone” (Interview 3, January 11, 2012). As agricultural workers are responsible for their own welfare and have little education on illness prevention methods, they work in persistently hot conditions that can ultimately lead to health problems.

Comparative Incidents of Heat-Related Illnesses

To evaluate how workers are affected by the heat in their employment setting, we asked if workers knew the symptoms of heat stress and if and how often they experienced these symptoms, including but not limited to exhaustion, rash, dizziness, and cramps. Through the personal experience of the workers, these questions allowed for the collection of health statistics, anecdotes, and opinions about how occupational heat is affecting their health.

Perhaps due to the subjective nature of self-reporting, we discovered a wide variance in our findings. In the agricultural setting, 16 out of 17 workers admitted to heat illnesses but most also insisted that they were "strong" and could withstand their working conditions (Interview 7, January 11, 2012). Whether this declaration of strength and immunity to their working conditions was a testament to acclimatization or merely a façade is indeterminable. However, when negative effects of heat were reported, the workers disclosed that they took medication and alleviated their symptom in other ways. One of the agricultural workers said, "I get nauseated from the heat and it gives me leg cramps which I use Thai herbs to cure" (Interview 4, January 11, 2012).

During one agricultural interview, an elderly woman explained an extreme case of a heat-related illness. She recalled an instance during which a middle-aged man who was farming alone collapsed from heat exhaustion and died in the field. He passed away due to the strength of the sun and length of time he was left alone without medical attention. As we collected data, it became obvious that some workers were unaware of warning signs and would not seek shade or rest until they experienced more dangerous symptoms, such as collapse. When one agricultural worker was asked what he would do if his friend fainted, he responded, "I would help him to shade" (Interview 9, January 16, 2012).

Many steel workers (about 50%) made similar claims that they did experience heat illnesses but were able to manage. Unlike agricultural workers, steel workers replied openly instead of defensively denying experiencing symptoms. The humility of the steel workers made their opinions seem more credible than those of the agricultural workers. Also, with the amenities provided to the workers, it was logical that they reported less illness due to heat. However, one steel worker disclosed that "every day I get a rash" that is "very itchy" (Interview 13, January 24, 2012). Agricultural workers reported many instances of heat rash, which could result from the coupling of frequent sweating and wearing cotton clothing.

For both study sites, the most common ailments reported were profuse sweating and exhaustion. However, a much larger number was reported from workers in the rice paddies than those from the steel factory. Agricultural workers also reported frequent accounts of headaches, dizziness, and moodiness, all of which are symptoms of dehydration. Dehydration, a major concern, is likely to occur in both the rice paddy and steel factory. In the rice paddy, we noted that the workers' intake of water was minimal. According to The Institute of Medicine, the average man should consume 3 liters of liquid a day. Agricultural workers averaged drinking 1.65 liters per day, a significantly low amount when considering their exhaustive work in a hot climate. Though industrial workers drank water frequently on breaks, about 63% admitted having dark-colored urine, a sign of improper hydration. From these presented data and Figure 17 below, we can determine that heat-related illnesses occur more frequently in the agricultural setting than in the industrial setting.

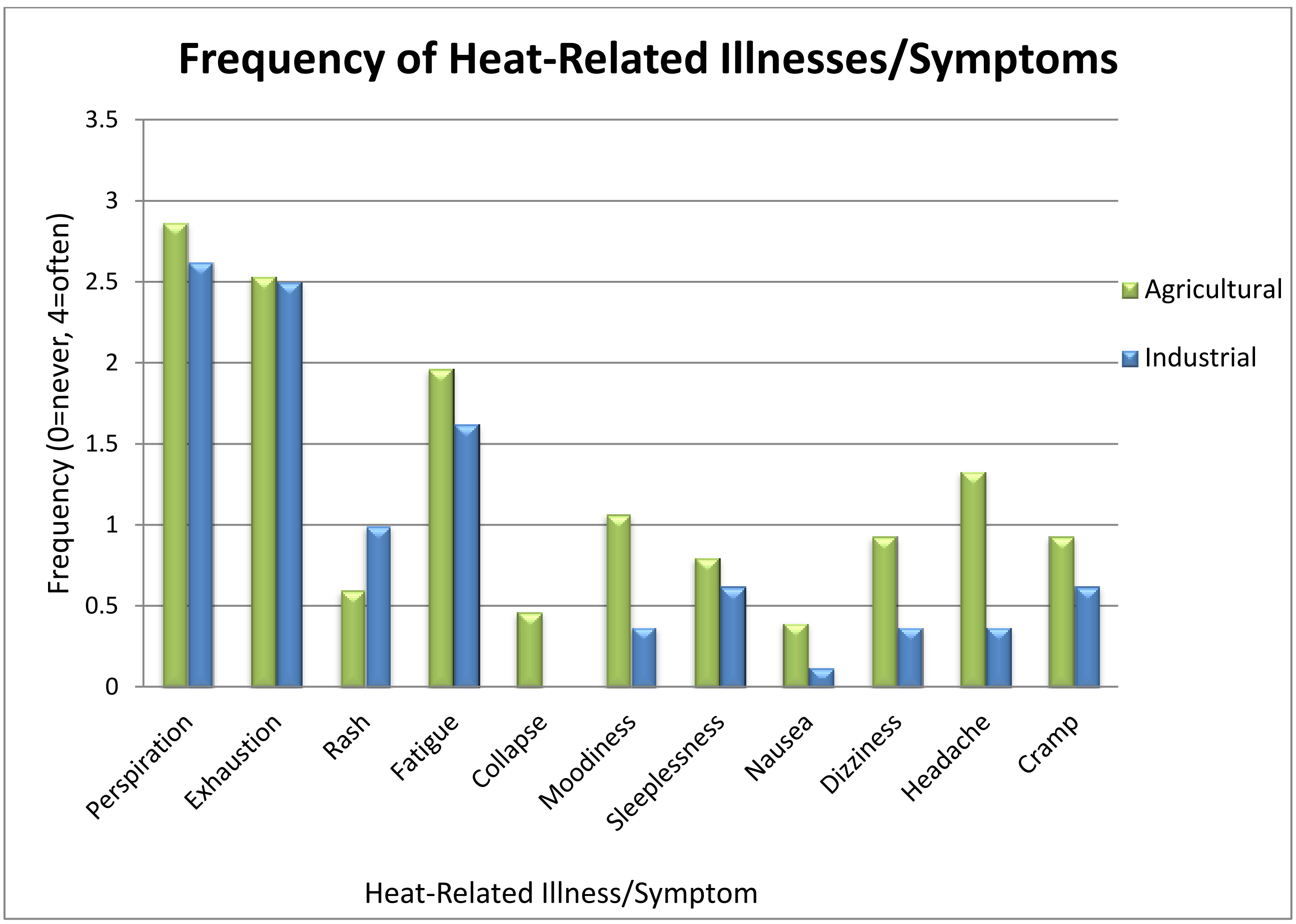

Figure 17: Frequency of Heat-Related Illnesses/Symptoms Experienced by Both Agricultural and Industrial Workers

Effects of Heat Stress on Productivity

Heat and climate change impacts agricultural and industrial workers' productivity differently. The interview results suggest that the productivity of agricultural workers is decreasing compared with the steel factory where heat appears to have no effect on productivity. Agricultural workers were first asked if they think heat is affecting their productivity. One worker immediately answered, "Absolutely, yes. I think that heat greatly has [an] impact on productivity" (Interview 2, January 10, 2012). Moreover, agricultural workers provided two main supporting arguments: heat impairs both worker productivity and crop productivity. First, as outside temperature increased, efficiency decreased. Workers may avoid overexerting themselves in the extreme heat by working longer to get the same crop yield. Additionally, workers tended to avoid working in the heat if temperatures were too extreme. One rice paddy owner stated that he "sometimes [does] not go to work because of the heat and over time [he has] lost a profit of 8,000 Baht" (Interview 8, January 11, 2012). Another agricultural worker remembered that "one time [he] did not go to work because it was too hot" (Interview 3, January 11, 2012). Furthermore, the quality of rice is affected by sunlight because seeds can be damaged by excessive heat. Higher temperatures make the grains smaller and deplete nutrients. From these interviews, productivity of agricultural workers seems to be affected by increasing ambient conditions.

Industrial workers were asked about productivity change indoors due to heat produced from the EAF and other machinery. One worker explained that he tries to "exceed goals and quotas," but noticed his productivity to be the same compared to the rest of the year (Interview 17, January 25, 2012). Out of the 8 workers that responded, 7 denied a change in productivity, and surprisingly, 1 worker said his productivity increased during the summer. All workers also noted that steel quality was unaffected as well. According to these interviews, the heat generated in this industrial setting seemed to have no effect on the productivity of the steel workers.

4.3 Conjectures

In both the agricultural and industrial settings, workers are exposed to temperatures at which they can experience heat-related illnesses.

According to the WBGT data Thammasat University collected, heat indices in both settings indicated that workers are vulnerable to heat-related illnesses. Figure 18 categorizes heat indices based on the intensity of the heat-related illnesses they can cause.

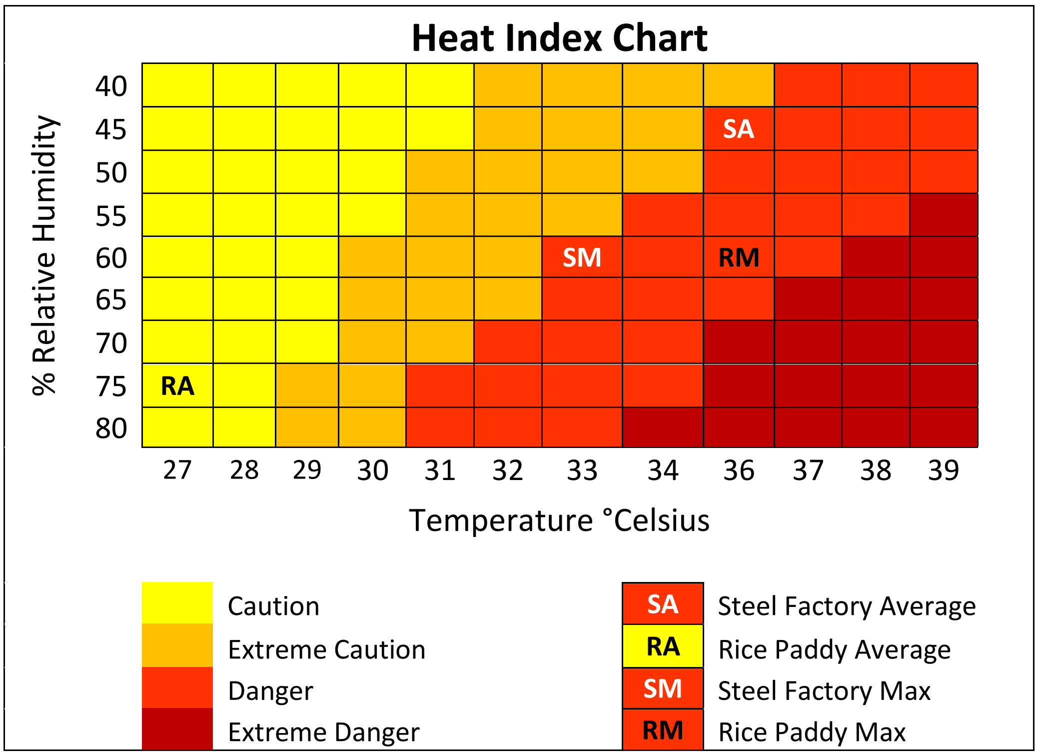

Figure 18: Average and Maximum Heat Indices in the Steel Factory and Rice Paddy

In the rice paddies, the average heat index was 29.1 degrees Celsius, which is in the 'Caution Category'; however, the heat index reached as high as 46.8 degrees Celsius, which is in the 'Danger Category.' In the steel factory, the average heat index was 40.3, but workers were exposed to heat indices as high as 46.6 degrees Celsius; both the average and the mean are classified in the 'Danger Category.' According their respective categories in Figure 18, both steel workers and rice paddy workers are likely to experience heat-related illnesses such as sunstroke, muscle cramps, and heat exhaustion. Prolonged exposure with exhaustive physical activity can lead to the most dangerous heat-related illness, heat stroke. Very few workers in the rice paddies and even fewer workers in the steel factory admitted to experiencing adverse health effects due to heat; however, the heat indices show that the workers are working in environments that are dangerous enough to cause heat-related illnesses without proper protection.

Agricultural workers experience the detrimental effects of heat more than industrial workers.

The workers in the rice paddies reported that their health and productivity has been altered negatively as a result of the intense heat. Over the last few years, workers have noticed climate changes that have resulted in hotter weather. According to our interviews with the agricultural workers, 86% felt the climate has increased compared to past years. Due to the fact that this type of agricultural work takes place outdoors, the increase in temperature adds to the already intense tropical weather that the rice paddy workers must endure. During the interview process, there were multiple complaints of minor health issues and several accounts of heat-related deaths. Workers also noted a decrease in productivity; if the weather is too intense, workers will take more breaks or work less in order to avoid over-exerting themselves. About 57% of workers even reported that they would skip work if the weather was too hot. One worker, when asked if his productivity was ever affected by the heat, responded, “Yes, by about [100 kg] of rice per acre” (Interview 1, January 10, 2012). A decrease in productivity threatens the livelihood of the worker and his/her family. The worker will be forced to work more frequently in the oppressive climate, risking his health to avoid losing necessary pay. Workers have long shifts, averaging 7 hours, without a quota and have no way to escape from the heat due to lack of amenities; this intense labor and lack of preventative tools add to the increasing intensity of the heat and make it difficult to maintain good health and productivity.

Steel workers, on the other hand, do not feel that the heat strongly affects their health or productivity. During our interviews, about half of the steel workers reported heat stress problems, but none were worse than rash. Additionally, steel factory work takes place indoors and is therefore unaffected by any small changes in climatic temperatures. Although the temperatures in the workplace are higher than those in the rice paddies, the consistent climate allows the workers’ bodies to acclimatize to their working environment. The short work shifts in the factory and the availability of amenities also help the workers escape from the heat and sustain their health and productivity.

There are gaps in the understanding of heat stress and prevention methods.

From the interviews, it is apparent that workers vulnerable to heat-related illnesses either showed no interest in or were unaware of the consequences of prolonged heat exposure. The few that understood the consequences usually disregarded the potential threats for several reasons. In the rice paddies, workers are obligated to complete their job as they are paid by yield. Since their livelihood depends on individual labor, they choose to face the dangers of heat stress in order to earn more money rather than take more frequent breaks at the expense of their income. One agricultural worker attested to this behavior during his interview: "I do not have a thermometer or watch the weather. I just do my job" (Interview 2, January10, 2012). Though some of the rice paddy workers saw the potential for illness or physical harm, the importance of their financial obligations outweighed their health. In the steel factory, however, heat-related illnesses were less frequent. Though only 50% of the industrial workers knew the symptoms of heat stress, all workers followed the established policies regarding heat and heat stress.

Only in the agricultural setting did workers' lack of knowledge about heat-related illnesses prove to be detrimental to their health. One agricultural worker responded that he "would not know what to do" in order to protect himself from heat stress (Interview 5, January 11, 2012). While many wore hats to protect their skin from the sun and have used medicinal herbs to treat illnesses, most workers took minimal breaks and did not hydrate themselves properly. This lack of understanding could result from their lower education level or pressure to gain a living wage. Industrial workers were educated through high school and received relevant training, creating a better foundation of knowledge regarding their health. Steel workers were also taught safety practices, such as the use of first aid kits, and had a more regulated schedule to prevent such illnesses. Unlike the agricultural workers, industrial workers checked thermometers within the workplace in order to track their heat exposure. Though rice paddy farmers enjoyed the freedom of regulating their own schedule, they also forced themselves to perform exhaustive work for long periods of time without proper training in the area of heat-related health risks.

Agricultural and industrial workers have both become acclimatized and therefore do not readily experience heat-related illnesses.

The consistent outdoor climate of the agricultural setting leads workers to adapt to their surroundings quickly compared to a laborer experiencing a hot climate for short periods of time.

Outdoor laborers often get heat-related illnesses when they first begin working but their bodies become progressively more adjusted to the continuous heat exposure. This occurs because the beginning stages of acclimatization should happen in short intervals so as not to overwhelm the thermoregulatory system. As the human body slowly recognizes the climate, heat dissipating mechanisms work faster and more efficiently to maintain the core body temperature at a healthy 37 (±0.6) degrees Celsius. The result of working outdoors for long periods of time is that, once the body acclimatizes, the risk for heat-related illnesses decreases. In both settings, the thermoregulatory system functions less effectively as the laborers age. Many of the agricultural workers, who are typically older in age, experienced heat stress more often than the younger steel factory workers.

Unlike the agricultural setting, working in the indoor steel factory does not require the same heat tolerance. Industrial workers, who took frequent breaks in areas with cooler climates, do not need their bodies to acclimatize to the same degree as agricultural workers. Industrial workers labored in higher temperatures but for shorter periods of time. Similar to rice paddy farmers, steel factory workers experienced some health effects early in their careers but slowly "adapt[ed] to their environment," as described by one industrial worker (Interview 12, January 24, 2012). The short working periods allowed for safer acclimatization; however, the bodies of industrial workers will not be able to withstand higher temperatures for the same duration as an agricultural worker, who cannot escape as easily from the heat. Prolonged exposure to dangerous climates and certain temperatures has proven to be an effectual defense against health risks. However, in the presence of an increasing global climate, the potential for adequate acclimatization decreases and development of heat-related illness increases.

From the collected data, we found agricultural workers laboring outdoors and thus experience the effects of heat more frequently than industrial workers laboring indoors. While both experience dangerous temperatures that put workers at risk of heat-related illnesses, the lack of amenities provided prevent agricultural workers from escaping their environment and allowing their body to rest. Not only do their low education level and lack of career opportunities limit the workers to a career in agriculture, but these factors also create a lack of awareness of the potential health threats. The aging population in the agricultural sector also increases the risk of experiencing heat-related illnesses. Though agricultural workers appear to acclimatize thoroughly in response to their extended stay in the paddies, the method of building a tolerance to the heat will prove to be more difficult as the global temperature continues to increase. Climate change creates a sense of urgency for laborers in dangerously hot climate with little protection or awareness of health risks. For this reason, we drafted recommendations in the next chapter to improve working experience before the global climate threatens the occupational health of the lower and middle classes beyond salvation.

CHAPTER 5: RECOMMENDATIONS AND CONCLUSIONS

The analysis of our data showed that agricultural workers feel the effects of heat more than industrial workers due to their direct exposure to the natural environment, lack of amenities, and lack of regulated working time. If the current climate conditions persist and worsen due to climate change, then agricultural workers will be most susceptible to the harsh conditions that it imposes. Thus, our recommendations are more directed toward the agricultural sector rather than the industrial sector because industries usually have prevention methods already in use to protect workers. Our recommendations for workers, foremen, owners, researchers, and health and environmental organizations propose increased availability of amenities to the workers, education on heat stress prevention, and a change in policy that would lead to prevention of heat stress illnesses. These recommendations will be given to Thammasat University Faculty of Public Health and will ideally be conveyed to the agricultural sector in a form that Thammasat deems appropriate.

5.1 Recommendations for Owners/Foremen

In order to prevent and dissipate heat stress and the resulting symptoms, we suggest rice paddy owners provide the following amenities to their workers:

Digital or Mercury Outdoor Thermometer: While the majority of interviewed agricultural workers check the daily forecast for high and low temperatures and humidity of the province, they are generally unaware of the current ambient conditions within the field throughout the day. All workers noted that there is no measurement of heat in the workplace and they typically remain uninformed about hot weather throughout the day. However, workers need to be aware of the health dangers at certain temperatures and the risks they are taking if they continue to work in extremely hot conditions during specific times of day. Therefore, it is evident from our data that a tool for measuring heat while outdoors is needed. To satisfy this, an easy to read and accurate thermometer, which measures temperature and humidity, should be placed in an open area near a resting site. This inexpensive amenity will allow workers to check temperatures regularly and monitor their heat stress vulnerability throughout the day.

Clean Source of Drinking Water: While agricultural workers believe they are well hydrated, they only drink about 1.65 liters of water per day, half of the 3 liter recommended daily requirement (for the average man with light exercise). Paddy workers, however, are working moderately to vigorously in extreme heat for approximately six hours per day; they should be drinking 4 or 5 liters to rehydrate and replenish water lost from sweat. Currently, most workers provide their own drinking water from home and when that source runs out, they have limited access to another source. In order to assist in and ensure proper hydration, owners should install or provide a water source near each paddy. This source of clean drinking water should be safe for consumption and easily accessible. For example, water spigots connected to public water (if available), well pumps, or bottled water should be sufficiently supplied each day. Water stations throughout the field or easier and non-obtrusive ways for workers to carry water on their person will also be beneficial. An improved and clean drinking water source will prevent dehydration and other heat stress symptoms.

Cool or Shaded Place to Rest: When workers break during the day, 88% withdraw to a shaded and cool place to sit and escape from the heat. However, from our observations, there were few shaded areas with minimal access to cooling mechanisms in the working area, which is highly important during the peak of the work-day. We recommend that each paddy have sufficient resting places for every worker, located in the shade and near their water source. For example, large, sturdy huts or pavilions with a table and chairs could be provided, as illustrated in Figure 19 below.

Figure 19: Hut in the Middle of a Rice Field (left), Umbrella at the Edge of a Rice Field (right) (Projects in Asia, 2008)

Also, the resting place must be in a central location close to where workers are cultivating. If a building is not plausible, the owner should ensure trees or umbrellas that provide shade throughout the day (see Figure 19, above). This would be an affordable option to help the workers avoid constant direct sun and heat exposure.

We recommend that owners of rice paddies and foremen of the steel factory educate workers on heat stress and the symptoms that occur in order to promote awareness, prevention, and safe work behavior.

According to our interviews, almost 40% of rice paddy workers and 33% of industrial workers are unaware of heat stress precautions. Workers and owners need to be aware of the symptoms; thus, we recommend an educational or awareness program to be used to promote safe practice against heat during work. The steel factory workers are oriented on heat stress before beginning work and the prevention policies should be taught and subsequently enforced. Due to the fact that the rice paddy workers travel from paddy to paddy it would be most beneficial to educate the owners of the paddies to enforce safe practices within their field. The awareness of these safe practices could be given in the form of a pamphlet, an affordable means to spreading awareness. The distributors could give a short information session that covers the materials within the pamphlet. Pamphlets would include pictures and simple writing that the less educated workers could easily comprehend that covers material on how to avoid heat stress as well as recognize symptoms of heat illnesses. Due to illiteracy that mostly occurs in the most susceptible elderly population, the information session would be most helpful along with encouragement of those who have learned from the pamphlet to educate their community. Furthermore, educational material, in the form of a poster, could be placed in areas where workers often visit or take breaks to continually remind the workers of safe practices against heat (see Appendix J.)

To ensure proper acclimatization and healthy work practices, we advise owners to maintain the following occupational health standards and policies developed by leading agencies in the field.

After reviewing standards created by institutes focused on occupational health and safety, such as OSHA, EPA, and the CDC, all agencies agreed on similar practices to reduce heat stress in the workplace. The practices are summarized in a document created by NIOSH entitled

Criteria for a Recommended Standard: Occupational Exposure to Hot Environments. Though the document's most recent revisions were published in 1986 and suggestions are not designed for just agricultural workers, the guidelines are accepted as the standard for maintaining good occupational health and can be easily adapted for outdoor laborers. Techniques to minimize heat stress were developed by following a heat balance equation that looks to reduce heat stress by eliminating factors that can overwhelm the thermoregulatory system. These include metabolic heat load, environmental heat load, and heat exchange by convection, radiation or evaporation. Metabolic heat load can be controlled through work practices whereas environmental heat load can be controlled more mechanically.

To minimize the environmental heat load, NIOSH encourages the use of engineering controls. Convective heat loss, or heat lost from contact between the skin and air, occurs once the air temperature is lower than one's skin temperature. Maximizing this difference in temperatures is achieved through proper ventilation such as fans in rest areas. Heat gained from a radiant heat sources can only be decreased by reducing the time spent in close proximity to the source. For the agricultural workers, however, this radiant heat is transmitted by the sun. In order to decrease one's exposure to the sun, the owner of a paddy can provide spaces for workers to relocate to during breaks or encourage heat-reflective clothing. Finally, evaporated heat loss through perspiration can be maximized if air speed is increased, air temperature is decreased, and humidity is decreased. Since evaporation is the most efficient method of cooling, the paddy owners could install proper forms of ventilation as mentioned above; however this would be expensive and would not be possible without government assistance. Thus, to maximize evaporation of sweat, workers need to wear thin clothing that is easily penetrable by the wind.

The NIOSH recommended certain work practices to limit heat exposure time and temperature in order to decrease both the metabolic and environmental heat loads. Altering the work-rest regimen to permit more regular resting periods will allow workers to stop working before they feel extreme heat discomfort. Also, working in intervals can prove to be beneficial because shorter, more frequent periods of time spent in the heat puts less strain on the body. Finally, workers are recommended to drink a sufficient amount of water hourly to prevent dehydration.

A medical examination to determine physical fitness, heat tolerance, and compromising medical conditions is recommended for workers who have never labored in a dangerously hot climate before. After the owner of a paddy fully understands the health of individual workers, he/she can begin a heat acclimatization program personally designed for each laborer. The institute recommends that a worker of average health and fitness start with 20% exposure to the working environment on the first day and a 20% increase each successive day. However, an unfit individual takes about 50% more time to acclimatize than the physically fit (Revised, 1986). Taking into account a worker's health and monitoring their performance during the start of their employment is essential to proper acclimatization. With hourly hydration from an adequate water supply and maintenance of one's electrolyte balance, a worker can healthily gain a tolerance to a hot climate that will decrease his/her chances of developing heat-related illnesses. By studying and following these standards created by the NIOSH, an owner of an agricultural work setting can minimize the risk of heat stress on employed workers.

5.2 Recommendations for Workers

We believe it would be beneficial if workers learn about heat stress, symptoms, and prevention methods in order to avoid the development and consequences of heat-related illnesses.

In an attempt to avoid experiencing the impacts of heat exposure, workers should be aware of the causes and symptoms of heat-related illnesses and appropriate working practices. If workers understand which temperatures have the ability to cause heat stress, they can monitor the outdoor thermometer provided at each paddy to avoid working for too long in intense heat. Workers should also pay close attention to how they feel physically and check themselves regularly for symptoms that could be signs of heat stress.

We recommend that both agricultural and industrial workers adhere to all safety policies implemented by their employers.

Even though safety policies might consist of detailed steps and may seem unnecessary, it is important that each policy is explained carefully and every worker is asked to follow the steps. Policies may include the work-rest regimen, a drinking regime, and a suggested protective clothing etiquette. More specifically, workers should not overexert themselves, and if they begin to feel sick they should take a break in a cool, shady place and drink plenty of water. Most of the time the working condition for these workers is very hot climate and therefore forcing themselves to work under this extreme weather will certainly lead to illness and heat stroke.

Workers are advised to continue wearing protective clothing while working.

Proper work clothing and protective equipment is important because it protects from solar radiation while still allowing adequate air ventilation. Workers should continue to wear a face and head covering, thin, long sleeve shirts, and thin pants that protect the body from heat during the day and cold breezes in the morning. Workers should also understand the health benefits to wearing such clothing. The use of protective clothing is a simple and convenient solution to prevent the body temperature from escalating high enough to cause illness.

5.3 Recommendations for Researchers and Influential Health and Environmental Organizations

Future researchers would benefit from collecting objective health statistics pertaining to occupational heat stress.

We, along with past researchers, have not been able to assertively determine a direct relationship between high occupational temperatures and adverse health effects which is in part due to the fact that most of health statistics that have been gathered have been self-reported by study participants over a short period of time. While this method is useful for collecting a baseline of data, this process is subjective in nature; participants may withhold information, not be able to accurately describe ailments, and not be able to correctly estimate when or how many times they have fallen ill. As a result, researchers have not been able to use collected health statistics to make a strong case that high temperatures in the occupational setting cause adverse health effects. For this reason, we hope that future researchers will use health records or monitor study participants over a long period of time in order to collect health data that is not as subjective.

We recommend that qualified health and environmental organizations implement prevention methods for heat stress.

On average, workers who were not aware of proper prevention methods or did not have access to suitable amenities reported more cases of heat-related health problems than workers who knew how to properly protect themselves from heat stress. Additionally, workers who were not educated on proper prevention methods reported much higher losses in productivity than workers who knew how to protect themselves. We contacted numerous health and environmental organizations (see Table 3 below) to explain our study and directly recommended that they implement prevention methods outlined in this chapter and other established methods and programs for workers who do not already have access to them.

Table 3: Contacted Qualified Health and Environmental Organizations

Organization	Contact Information
Bureau of Occupational and Environmental Disease, Ministry of Public Health	*Email*: media.envocc@gmail.com
The Office of Environmental Fund	*Email*: envfund@hotmail.co.th
The Ministry of Natural Resources and Environment	*Email*: webmaster@mnre.mail.go.th
Global Environmental Change and Human Health Project	*Email*: spinil@inweh.unu.edu c/o Dr. Lucilla Spini, executive officer
START-SEA Global Change System for Analysis, Research, and Training - South East Asia Center	*Email:* START@start.org
National Centre for Epidemiology and Population Health Australian National University (ANU), Canberra, Australia	*Email*: Kjellstromt@yahoo.com c/o Professor Tord Kjellstrom

Such programs could educate workers, owners, and foremen on heat stress and symptoms or train workers in mitigation methods (National Agriculture Safety Database, 2003; Occupational Safety and Health Administration - National Institute for Occupational Safety and Health, n.d.). These qualified organizations, either governmentally or privately funded, should not only choose and implement the most efficient prevention methods, but also educate volunteers to teach workers the correct use and benefits of such methods.

5.4 Prevention, Education, and Awareness Tools

Occupational health and the heat effects due to climate change are becoming more prominent research fields. Organizations have begun making it their mission to create and implement prevention methods while educating and aiding individuals and communities in order to cope with the resulting heat stress. We created three tools to assist researchers and qualified health and environmental organizations accomplish their goals.

First, a website was created to publically display Thammasat University's contribution to HOTHAPS and our final report, including findings and recommendations, photos, deliverable material and contact information for further research and information. The website can be found at www.heatisthesilentkiller.weebly.com. Figure 20 (below) shows the homepage of the website.

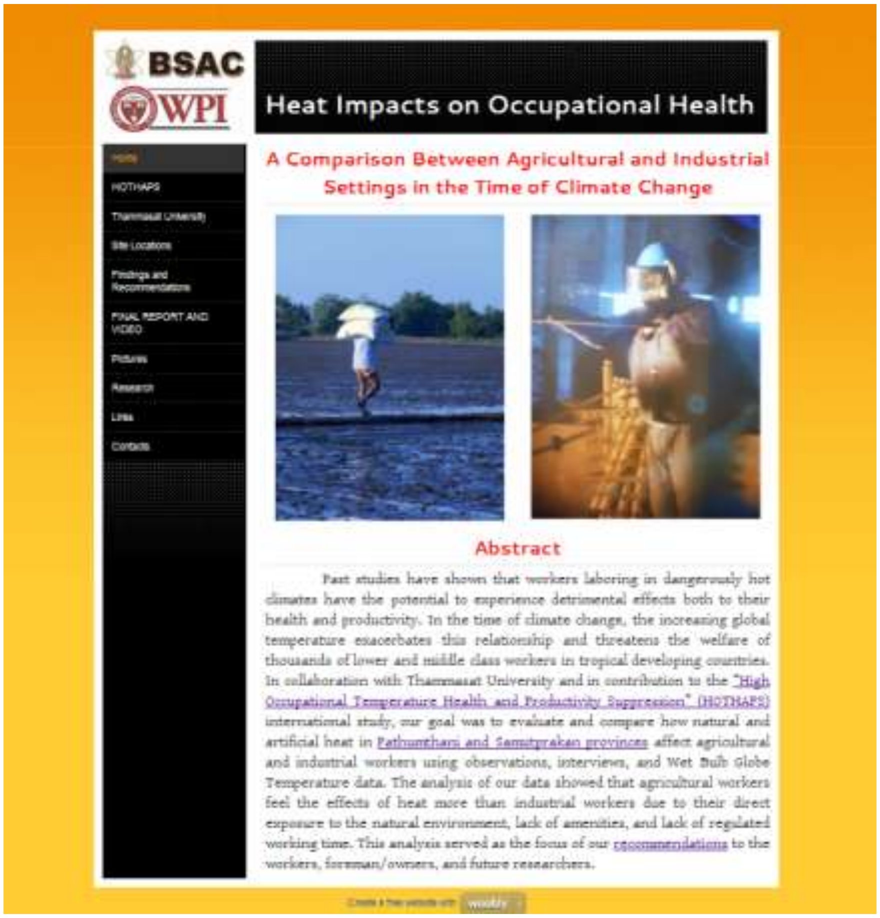

Figure 20: Homepage of Public Website

In order to provide a visual tool that can be distributed and viewed by a wide audience, including organizations, researchers, owners and foremen, and workers, we made a short awareness video. The video includes interview testimonials from agricultural and industrial workers and narration describing the effects heat is having on these individuals and how climate change is making this an urgent concern. This video is subtitled in English and recognizes HOTHAPS, Thammasat, and our study. This video can also be found on the website.

Finally, we designed two posters (see Appendix J) written in Thai to be displayed near work sites and visible to workers. The first poster illustrates the temperature ranges at which certain heat-related illnesses can be experienced by workers. The second reminds workers to stay hydrated and suggests they drink the recommended three liters of water per day. As mentioned above, rice paddy owners and steel factory foremen should display these posters to encourage safe work behavior. Similarly, organizations and trained staff can use these or similar material to educate people on heat stress and the symptoms that occur while promoting awareness and prevention.

5.5 Conclusion

Over the course of this study, we learned how to carry out an investigation on a real world problem while crossing cultural barriers. It was not without difficulty, as we faced differences in language, reluctance of participation by the workers, inaccessibility to data due to publishing rights, and lack of internet and technology. Working as an international collaboration of Thai and American students from Chulalongkorn University and Worcester Polytechnic Institute and experiencing different working styles, there was not a day that we did not face some challenge. With that said, we were able to overcome these obstacles and experience hands-on field research that will prepare us for our post-graduate careers. We learned about the life of agricultural and industrial workers in Thailand and experienced the heat in which they endure their work. It was astonishing that the workers were able to function in heat that was disabling for both the Thai and American students. By being able to collect data first hand, we gained insight to the severity of the problem of heat stress that goes beyond textbooks and numbers. After this experience, we find it hard to imagine that the concern of heat stress on workers has not been made a more immediate area of research as the impending threat of climate change worsens.

We now look at climate change as one of the greatest threats facing the world today. The onset of greater natural disasters, inexplicable weather anomalies, and quantifiable ozone depletion is hard to ignore. Though there is significant new research on climate change, studies are mainly focused on the effects toward the more modernized western world, and oftentimes the impact on less developed countries is overlooked. However, climate change is resulting in more dangerous heat levels in tropical areas. Additionally, people, specifically workers, in tropical climates are exposed more frequently to heat and are thus more susceptible to the effects of climate change.

Participating in the HOTHAPS international study, our findings suggest that industrial and agricultural workers are exposed to climatic conditions at which heat-related illnesses can be experienced. We found through interviews that although industrial workers are exposed to higher ambient working conditions, agricultural workers are more at risk for heat stress because of lack of amenities, education, and protective standards and protocols. At both locations, there are gaps in workers’ understanding of signs, symptoms, and prevention methods for heat stress. Finally, we found these workers to be fairly acclimatized to their work environment and do not frequently experience significant heat-related health effects.

In summary, climate change, heightened by the vulnerability of workers and the tropical climate, is an immediate threat in Thailand. Since we cannot simply stop climate change, changes in practice must occur in order to protect Thailand’s workers. We recommend that education and awareness programs, an increase in amenities for the workers, and safety policies to preserve workers’ health be introduced into the agricultural sector. Climate change is happening at an alarming rate. Further research and urgent action is crucial now before thousands of workers across the globe face conditions that will irrevocably affect their health and livelihood.

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APPENDIX A: DIARY NOTES

Daily Record

Name (worker) .... Date .... Name (interviewer) ....

Begin Work Time .... Stop Work Time .... Type of work...

Weather ☐ clear sky ☐ cloudy ☐ little rain ☐ thunderstorm ☐ storm/lightning

☐ cool ☐ cold ☐ very cold

Ways to reduce heat (cooling actions) ① shade ② fan ③ air-conditioning ④ drink water/mineral water ⑤ other

Time	Breaking time during work (minutes)	Ways to reduce heat (cooling actions)	How much water intake?	Abnormal condition from heat	Productivity	Heart Rate (times/min)	Temperature (°C)

APPENDIX B: ABRIEVIATED INTERVIEW FOR PADDY OWNER (THAI)

ส่วนที่ 1 ข้อมูลทั่วไป	
อายุ ....ปี	age ▢▢

ส่วนที่ 2 ข้อมูลการทำงาน	
1. จำนวนผู้ประกอบอาชีพในภาคการเกษตร (หรือสถานประกอบการ)........คน โดยเป็นลูกจ้างประจำ..............คน และลูกจ้างชั่วคราว................คน อื่นๆ โปรดระบุรายละเอียด...	emp ▢▢▢ per ▢▢▢ tem ▢▢▢
2. การทำงานของผู้ประกอบอาชีพในภาคการเกษตร (หรือสถานประกอบการ) โดยเฉลี่ย..................................ชั่วโมง/วัน.................................วัน/สัปดาห์	hr ▢▢, day ▢

ส่วนที่ 3 การสัมผัสความร้อนขณะทำงาน	
1. การสัมผัสความร้อนขณะทำงานในภาคการเกษตร (หรือสถานประกอบการ) เป็นปัญหาในบางช่วงของปี ❍ ใช่ ❍ ไม่ใช่	issue ▢

ส่วนที่ 4 ผลกระทบทางสุขภาพจากความร้อน	
1. ท่านรู้จักโรคเพลียแดดหรือโรคลมร้อนที่เคยเกิดขึ้นเมื่อปีที่แล้ว ❍ ใช่ ❍ ไม่ใช่	know1 ▢
2. หากมีเหตุการณ์ดังกล่าวเกิดขึ้นในภาคการเกษตร (หรือสถานประกอบการ) จะมีการรายงานหรือจัดการอย่างไร...	
3. ในภาคการเกษตร (หรือสถานประกอบการ) มีผู้ที่มีความรู้เรื่องผลกระทบของความร้อนที่อาจจะเกิดขึ้นหากมีการสัมผัสความร้อน มากเกินไป ❍ ใช่ ❍ ไม่ใช่ ถ้าใช่ โปรดระบุว่าคือใคร..	expert ▢
4. ความถี่ของการเกิดอาการของ<u>ภาวะเครียดจากความร้อน</u>ในภาคการเกษตร (หรือสถานประกอบการ) ในช่วงฤดูร้อน..ครั้ง/ปี	freq ▢▢
5. ท่านรู้สึกว่าระดับความร้อนในอดีตกับปัจจุบันมีความแตกต่างกัน ❍ ใช่ ❍ ไม่ใช่ ถ้าใช่ โปรดระบุรายละเอียด..	feel ▢

ส่วนที่ 5 ผลกระทบที่มีต่อกิจกรรมการทำงานและประสิทธิภาพในการทำงาน	
1. ในสภาพอากาศที่ร้อนมีผลกระทบต่อตารางเวลาทำงานหรือผลผลิ ตที่ได้ในแต่ละวันอย่างไร..	

ส่วนที่ 5 ผลกระทบที่มีต่อกิจกรรมการทำงานและประสิทธิภาพในการทำงาน	
2. หากมีคลื่นความร้อนเกิดขึ้น (*คลื่นความร้อน หมายถึง อากาศร้อนจัดที่สะสมอยู่ในพื้นที่บริเวณหนึ่งเป็นระยะเวลานาน อากาศแห้ง ลมนิ่ง ทำให้ความร้อนจากแสงอาทิตย์ไม่เคลื่อนที่ เช่น พื้นที่มีอุณหภูมิ 38-41 องศาเซลเซียสแล้วไม่มีลมพัดต่อเนื่อง 3-6 วัน ไอร้อนจะสะสมจนกลายเป็นคลื่นความร้อน เป็นต้น*) 2.1 ในอีก 2-3 วันข้างหน้า ภาคการเกษตร (หรือสถานประกอบการ) มีแผนเตรียมการป้องกันผลกระทบที่จะเกิดขึ้น ❍ ใช่ ❍ ไม่ใช่ ถ้าใช่ โ 2.2 เป็นระยะเวลานาน 1 สัปดาห์ ภาคการเกษตร (หรือสถานประกอบการ) มีแผนเตรียมการป้องกันผลกระทบที่จะเกิดขึ้น ❍ ใช่ ❍ ม่ใช่ ถ้าใช่	few ▢ week ▢
3. ภาคการเกษตร (หรือสถานประกอบการ) มีการประเมินความสูญเสียทางเศรษฐกิจที่เกิดจากประสิทธิภาพการทำงานที่ลดลงจากสภาพอากาศที่ร้อน ❍ ใช่ ❍ ไม่ใช่	assess ▢
4. ท่านสามารถประเมินระดับความร้อนที่ทำให้ประสิทธิภาพการทำงานลดลง ❍ ใช่ ❍ ไม่ใช่ ถ้าใช่ โปรดระบุรายละเอียด...	level ▢

ส่วนที่ 6 แนวทางการป้องกันความร้อน	
1. ภาคการเกษตร (หรือสถานประกอบการ) มีนโยบายหรือกฎระเบียบเกี่ยวกับการทำงานในสภาพอากาศร้อน ❍ ใช่ ❍ ไม่ใช่ ❍ ไม่ทราบ ถ้าใช่ ท่านปฏิบัติตามนโยบายหรือกฎระเบียบ ❍ ใช่ ❍ ไม่ใช่	policy ▢ follow1 ▢
2. นโยบายหรือกฎระเบียบเกี่ยวกับการทำงานในสภาพอากาศร้อนมีประโยชน์ ❍ ใช่ ❍ ไม่ใช่ ❍ ไม่ทราบ ถ้าใช่ โปรดระบุรายละเอียด.. ถ้าไม่ใช่ โปรดระบุรายละเอียด..	useful ▢
3. ภาคการเกษตร (หรือสถานประกอบการ) มีความตระหนักในเรื่องมาตรฐานความปลอดภัยในการทำงานเกี่ยวกับความร้อน ❍ ใช่ ❍ ไม่ใช่ ❍ ไม่ทราบ	aware ▢
4. ภาคการเกษตร (หรือสถานประกอบการ) มีนโยบายเรื่องจุดตัดของอุณหภูมิที่สามารถสะท้อนถึงการทำงานที่จะลดลงในสภาพอากาศร้อน	cutoff ▢

ส่วนที่ 6 แนวทางการป้องกันความร้อน	
❍ ใช่ ❍ ไม่ใช่ ❍ ไม่ทราบ	
5. ท่านทราบว่าอุณหภูมิสูงเกินจุดกำหนดจากอะไร ❍ การพยากรณ์สภาพอากาศ ❍ การอ่านค่าอุณหภูมิจากเทอร์โมมิเตอร์	thres ▢
6. ภาคการเกษตร (หรือสถานประกอบการ) มีนโยบายหรือมาตรการลดความร้อนในสถานที่ทำงาน ❍ ใช่ ❍ ไม่ใช่ ถ้าใช่ ท่านปฏิบัติตามนโยบายหรือมาตรการ ❍ ใช่ ❍ ไม่ใช่ โปรดระบุรายละเอียด..	reduce ▢ follow2 ▢
7. ภาคการเกษตร (หรือสถานประกอบการ) มีการตรวจวัดความร้อน ❍ ใช่ ❍ ไม่ใช่	monitor ▢
8. ผู้ประกอบอาชีพในภาคการเกษตร (หรือสถานประกอบการ) ได้รับแจ้งเกี่ยวกับสภาพอากาศที่ร้อน ❍ ใช่ ❍ ไม่ใช่	inform ▢
9. ภาคการเกษตร (หรือสถานประกอบการ) มีนโยบายเกี่ยวกับภาวะเครียดจากความร้อน ❍ ใช่ ❍ ไม่ใช่ ถ้าใช่ ผู้ประกอบอาชีพปฏิบัติตามนโยบาย ❍ ใช่ ❍ ไม่ใช่	stress ▢
10. ท่านมีวิธีลดภาวะเครียดจากความร้อนอย่างไร (ตอบได้มากกว่า 1 ข้อ) ❍ เพิ่มจำนวนผู้ประกอบอาชีพในช่วงฤดูร้อน ❍ เพิ่มวันทำงาน ลดชั่วโมงการทำงาน ❍ เริ่มงานตั้งแต่เช้าตรู่ ❍ แบ่งการทำงานเป็นกะ ❍ หยุดพักระหว่างทำงาน ❍ สวมใส่เสื้อผ้าที่มีลักษณะบาง เพื่อระบายความร้อน ❍ พักในห้องที่มีเครื่องปรับอากาศ ❍ มีระบบระบายอากาศ เช่น พัดลม ❍ มีการชดเชยภาวะขาดน้ำ เช่น ดื่มน้ำเปล่า/น้ำแบบต่างๆ ❍ หลบในที่ร่ม ❍ ขับรถแทนการเดิน ❍ อื่นๆ โปรดระบุรายละเอียด...	manage1 ▢ manage2 ▢ manage3 ▢ manage4 ▢ manage5 ▢ manage6 ▢ manage7 ▢ manage8 ▢ manage9 ▢ manage10 ▢ manage11 ▢ manage12 ▢

จบการสัมภาษณ์เวลา..น.	time2 ▢▢.▢▢

APPENDIX C: ABRIEVIATED INTERVIEW FOR PADDY OWNER(ENGLISH)

Part 1 General Information	
Age …............................Years	age ▢▢

Part 2 Work Information	
1. Number of workers employed ....people Permanent employees..............people Part-time employees................people Other	emp ▢▢▢ per ▢▢▢ tem ▢▢▢
2. Average length of work.................Hours/day..........................Days/week	hr ▢▢, day ▢

Part 3 Heat Exposure During Work	
1. Exposure to heat during work is a problem ❍ Yes ❍ No	issue ▢

Part 4 Effect from Heat	
1. Are you aware of any heat stress problems during the past few years ❍ Yes ❍ No	know1 ▢
2. If such incident occur during work, will it be reported or how will it be handled...	
3. Is there anyone around who knows the effect of heat on health ❍ Yes ❍ No If yes, state who..	expert ▢
4. Heat stress occurrence ....times/year	freq ▢▢
5. Do you feel the difference in the heat between the past and the present? ❍ Yes ❍ No If so, state the details...	feel ▢

Part 5 Effect on Work and Productivity	
1. How does hot weather affect work schedule or productivity in each day?	
2. If a heat wave occurs (*Heat waves are a prolonged period of abnormally hot weather. The weather is dry with no wind. For example: an area of 38-41 degrees Celsius with no wind for 3-6 days, the heat will accumulate into heat waves)* 2.1 In 2-3 days, will you have a plan to handle the situation? ❍ Yes ❍ No If so, state the detail... 2.2 In the next week, will you have a plan to handle the situation? ❍ Yes ❍ No If so, state the detail...	few ▢ week ▢

Part 5 Effect on Work and Productivity	
3. Are there any assessments of the economic loss caused by hot weather ❍ Yes ❍ No	assess ▢
4. Can you evaluate the heat level that reduces the productivity of work ❍ Yes ❍ No If so, state the details...	level ▢

Part 6 Prevention from Heat	
1. Do you have policy about working under heat ❍ Yes ❍ No ❍ Don't know If so, did you follow the policy ❍ Yes ❍ No	policy ▢ follow1 ▢
2. Is the policy useful? ❍ Yes ❍ No ❍ Don't know If <u>yes</u>, state the details... If <u>no</u>, state the details...	useful ▢
3. Are you aware of the safety standards of heat and work? ❍ Yes ❍ No ❍ Don't know	aware ▢
4. Is there a policy that determines the effect of heat on productivity? ❍ Yes ❍ No ❍ Don't know	cutoff ▢
5. How do you know that the temperature is too hot to work ❍ Weather forecast ❍ Thermometer	thres ▢
6. Is there a policy to reduce heat in workplace❍ Yes ❍ No If yes, did you follow it ❍ Yes ❍ No State the detail..	reduce ▢ follow2 ▢
7. Is there a measurement for heat in the workplace ❍ Yes ❍ No	monitor ▢
8. The workers are informed about hot weather ❍ Yes ❍ No	inform ▢
9. Are there any policies about <u>stress from heat</u>? ❍ Yes ❍ No If so, does the worker follow this policy ❍ Yes ❍ No	stress ▢ follow3 ▢
10. How do you <u>relieve stress caused by heat</u> (Can choose more than 1 answer) ❍ Hire more farmers ❍ Increase work days, decrease working hours ❍ Work in the early morning ❍ Work in intervals ❍ Take a break during work ❍ Wear thin clothes ❍ Air-conditioning ❍ Ventilation/ use of fan ❍ Drink water ❍ Stay in the shade ❍ Driving instead of walking ❍ Others	 manage1 ▢ manage2 ▢ manage3 ▢ manage4 ▢ manage5 ▢ manage6 ▢ manage7 ▢ manage8 ▢ manage9 ▢ manage10 ▢ manage11 ▢ manage12 ▢

Time interview ended....................................	time2 ▢▢.▢▢

APPENDIX D: ABRIEVIATED INTERVIEW FOR FARMER (THAI)

ส่วนที่ 1 ข้อมูลทั่วไป	
อายุ ....ปี	age ▢▢

ส่วนที่ 2 ข้อมูลการทำงาน	
1. ลักษณะงาน..	
2. ท่านทำงานนี้มานาน..........................ปี..........................เดือน	yr ▢▢, mo ▢▢
3. การทำงานเฉลี่ย.................................ชั่วโมง/วัน.........................วัน/สัปดาห์	hr ▢▢, day ▢
4. เวลาทำงานของท่าน คือ เวลา..........................น. ถึง เวลา...........................น.	peri ▢▢-▢▢
5. พื้นที่นาต่อฤดูการปลูกข้าว จำนวนทั้งสิ้น...ไร่ จำนวนผลผลิตรวมต่อฤดูการปลูกข้าว................ตัน หรือ..................กิโลกรัม	rai ▢▢▢ kilo ▢▢▢▢ ton ▢▢

ส่วนที่ 3 การสัมผัสความร้อนขณะทำงาน	
1. ท่านรู้สึกว่าสภาพอากาศในบริเวณที่ทำงาน ❍ ไม่ร้อน ❍ ร้อนเล็กน้อย ❍ ร้อนปานกลาง ❍ ร้อนมาก	temp ▢
2. เดือนที่ร้อนที่สุดในช่วงฤดูร้อน..	hotmo ▢▢
3. ท่านคิดว่าการสัมผัสความร้อนขณะทำงานเป็นปัญหาในช่วงฤดูร้อน ❍ ใช่ ❍ ไม่ใช่	prob ▢
4. ท่านได้รับผลกระทบจากการสัมผัสความร้อนขณะทำงานอย่างไร.........................	
5. ชุดเสื้อผ้าที่สวมใส่ขณะทำงานในยามปกติเป็นอย่างไร...................................	
6. ท่านทำงานที่ต้องสัมผัสกับแสงอาทิตย์ตลอดทั้งวัน ❍ ใช่ ❍ ไม่ใช่ ถ้าใช่โปรดระบุ...ชั่วโมง/วัน	sun ▢ sunhr ▢▢
7. เมื่อจำเป็นต้องสัมผัสความร้อนขณะทำงาน ท่านมีวิธีหลีกเลี่ยงการสัมผัสความร้อนอย่างไร..	
8. ท่านดื่มน้ำระหว่างทำงาน ❍ ใช่ ❍ ไม่ใช่ ถ้าใช่ โปรดระบุจำนวน...............................แก้ว หรือ...............................ลิตร	water ▢ glass ▢
9. ทุกครั้งที่ท่านดื่มน้ำ นจะดื่มน้ำในปริมาณที่เพียงพอต่อความต้องการของร่างกาย ❍ ใช่ ❍ ไม่ใช่	avai ▢

ส่วนที่ 4 ผลกระทบทางสุขภาพจากความร้อน	
1. ท่านรู้จักโรคเพลียแดดหรือโรคลมร้อนที่เคยเกิดขึ้นเมื่อปีที่แล้ว ❍ ใช่ ❍ ไม่ใช่	know1 ▢
2. ในที่ทำงานมีผู้ที่มีความรู้เรื่องผลกระทบของความร้อนที่อาจจะเกิดขึ้นหากมีการสัมผัสความร้อนมากเกินไป ❍ ใช่ ❍ ไม่ใช่ ถ้าใช่ โปรดระบุว่าคือใคร..	expert ▢
3. ท่านรู้จักอาการของภาวะเครียดจากความร้อน ❍ ใช่ ❍ ไม่ใช่	know2 ▢
4. ท่านเคยมีอาการของภาวะเครียดจากความร้อนขณะทำงานหรือไม่	
4.1 เสียเหงื่อในระหว่างทำงาน ❍ ไม่เคย ❍ น้อย ❍ ปานกลาง ❍ มาก	sign1 ▢
4.2 หิวน้ำ ❍ ไม่เคย ❍ น้อย ❍ ปานกลาง ❍ มาก	sign2 ▢
4.3 ผื่นคัน ❍ ไม่เคย ❍ น้อย ❍ ปานกลาง ❍ มาก	sign3 ▢
4.4 เหนื่อยล้า อ่อนเพลีย ❍ ไม่เคย ❍ น้อย ❍ ปานกลาง ❍ มาก	sign4 ▢
4.5 หน้ามืด เป็นลม ❍ ไม่เคย ❍ น้อย ❍ ปานกลาง ❍ มาก	sign5 ▢
4.6 หงุดหงิด ❍ ไม่เคย ❍ น้อย ❍ ปานกลาง ❍ มาก	sign6 ▢
4.7 นอนไม่หลับ ❍ ไม่เคย ❍ น้อย ❍ ปานกลาง ❍ มาก	sign7 ▢
4.8 คลื่นไส้ ❍ ไม่เคย ❍ น้อย ❍ ปานกลาง ❍ มาก	sign8 ▢
4.9 วิงเวียน มึนงง ❍ ไม่เคย ❍ น้อย ❍ ปานกลาง ❍ มาก	sign9 ▢
4.10 ปวดศีรษะ ❍ ไม่เคย ❍ น้อย ❍ ปานกลาง ❍ มาก	sign10 ▢
4.11 ตะคริว ❍ ไม่เคย ❍ น้อย ❍ ปานกลาง ❍ มาก	sign11 ▢
5. ความถี่ของการเกิดอาการของภาวะเครียดจากความร้อนของท่านในช่วงฤดูร้อน ....ครั้ง/ปี	freq ▢
6. สีของปัสสาวะของท่านมี ❍ สีเหลืองอ่อน ❍ สีเหลืองเข้ม	urine ▢
7. ท่านรู้สึกว่าระดับความร้อนในอดีตกับปัจจุบันมีความแตกต่างกัน ❍ ใช่ ❍ ไม่ใช่ ถ้าใช่โปรดระบุรายละเอียด...	feel ▢
8. หากท่านรู้สึกว่ามีอาการของภาวะเครียดจากความร้อน ท่านจะมีวิธีจัดการอย่างไร...	
9. ท่านเคยมีการเจ็บป่วยจากความร้อน ❍ ใช่ ❍ ไม่ใช่	sick ▢

ส่วนที่ 5 ผลกระทบที่มีต่อกิจกรรมการทำงานและประสิทธิภาพในการทำงาน	
1. ในช่วงฤดูร้อนการสัมผัสความร้อนขณะทำงานมีผลต่อการทำงานของท่านอย่างไร …………………………………………………………………………………	
2. ในช่วงฤดูร้อนการสัมผัสความร้อนขณะทำงานมีผลทำให้ปริมาณผลผลิตที่ท่านทำได้ ในแต่ละฤดูการปลูกข้าว ❍ เพิ่มขึ้น ❍ ลดลง ❍ เท่าเดิม โปรดระบุรายละเอียด………………………………………………………………… .มีผลกระทบต่อรายได้ของท่าน ❍ ใช่ ทำให้รายได้เพิ่มขึ้น…………………บาท ทำให้รายได้ลดลง…………………บาท❍ ไม่ใช่	quan ▢ inco ▢, nuin ▢▢▢
3.ในช่วงฤดูร้อนการสัมผัสความร้อนขณะทำงานมีผลทำให้คุณภาพของผลผลิตที่ท่านทำได้ในแต่ละฤดูการผลิต ❍ เพิ่มขึ้น ❍ ลดลง ❍ เท่าเดิม โปรดระบุรายละเอียด…. ………………………………………………………………	qual ▢
4. ในช่วงฤดูร้อนการสัมผัสความร้อนขณะทำงานมีผลทำให้ ระยะเวลาในการลงนาของท่าน ❍ นานขึ้น ❍ น้อยลง ❍ เท่าเดิม	long ▢
5. ท่านเคยหยุดงานโดยมีสาเหตุมาจากความร้อน ❍ ใช่ ❍ ไม่ใช่	rest ▢
6. หากมีการพยากรณ์ว่าจะมีคลื่นความร้อนเกิดขึ้น *(คลื่นความร้อน หมายถึง อากาศร้อนจัดที่สะสมอยู่ในพื้นที่บริเวณหนึ่งเป็นระยะเวลานาน อากาศแห้ง ลมนิ่ง ทำให้ความร้อนจากแสงอาทิตย์ไม่เคลื่อนที่ เช่น พื้นที่มีอุณหภูมิ 38-41 องศาเซลเซียสแล้วไม่มีลมพัดต่อเนื่อง 3-6 วัน ไอร้อนจะสะสมจนกลายเป็นคลื่นความร้อน เป็นต้น)* 6.1 ในอีก 2-3 วันข้างหน้า ภาคการเกษตรจะมีแผนเตรียมการป้องกันผลกระทบที่จะเกิดขึ้น ❍ ใช่ ❍ ไม่ใช่ ถ้าใช่โปรดระบุรายละเอียด…………………………………………………………… 6.2 เป็นระยะเวลานาน 1 สัปดาห์ ภาคการเกษตรจะมีแผนเตรียมการป้องกันผลกระทบที่จะเกิดขึ้น ❍ ใช่ ❍ ไม่ใช่ ถ้าใช่โปรดระบุรายละเอียด……………………………………………………………	few ▢ week ▢

ส่วนที่ 6 แนวทางการป้องกันความร้อน	
1. ท่านคิดว่านโยบายหรือกฎระเบียบเกี่ยวกับการทำงานในสภาพอากาศร้อนมีประโยชน์ ❍ ใช่ ❍ ไม่ใช่ ❍ ไม่ทราบ ถ้าใช่บุรายละเอียด……………………………………………………………………… ถ้าไม่ใช่โปรดระบุรายละเอียด……………………………………………………………	useful ▢

ส่วนที่ 6 แนวทางการป้องกันความร้อน	
2. ท่านมีความตระหนักในเรื่องมาตรฐานความปลอดภัยในการทำงานเกี่ยวกับความร้อน ❍ ใช่ ❍ ไม่ใช่	aware ▢
3. ท่านทราบว่าอุณหภูมิสูงเกินจุดกำหนดจากอะไร ❍ การพยากรณ์สภาพอากาศ ❍ การอ่านค่าอุณหภูมิจากเทอร์โมมิเตอร์	thres ▢
4. ท่านมีวิธีลดภาวะเครียดจากความร้อนอย่างไร (ตอบได้มากกว่า 1 ข้อ) ❍ เพิ่มจำนวนผู้ประกอบอาชีพในช่วงฤดูร้อน ❍ เพิ่มวันทำงาน ลดชั่วโมงการทำงาน ❍ เริ่มงานตั้งแต่เช้าตรู่ ❍ แบ่งการทำงานเป็นกะ ❍ หยุดพักระหว่างทำงาน ❍ สวมใส่เสื้อผ้าที่มีลักษณะบาง เพื่อระบายความร้อน ❍ พักในห้องที่มีเครื่องปรับอากาศ ❍ มีระบบระบายอากาศ เช่น พัดลม ❍ มีการชดเชยภาวะขาดน้ำ เช่น ดื่มน้ำเปล่า/น้ำแบบต่างๆ ❍ หลบในที่ร่ม ❍ ขับรถแทนการเดิน ❍ อื่นๆ โปรดระบุรายละเอียด..	manage1 ▢ manage2 ▢ manage3 ▢ manage4 ▢ manage5 ▢ manage6 ▢ manage7 ▢ manage8 ▢ manage9 ▢ manage10 ▢ manage11 ▢ manage12 ▢

จบการสัมภาษณ์เวลา.....................................น.	time2 ▢▢.▢▢

APPENDIX E: ABRIEVIATED INTERVIEW FOR FARMER (ENGLISH)

Part 1 General Information	
Age …........................... year	age ▢▢

Part 2 Work Description	
1. Type of work...	
2. How long have you been working....................years........................months	yr ▢▢, mo ▢▢
3. Average working time ....hours/day ....days/week	hr ▢▢, day ▢
4. Your work starts at ....o'clock to.........................o'clock	peri ▢▢-▢▢
5. Total area of rice paddies................................ Rai Productivity ....Tons ....Kilograms	rai ▢▢▢ ton ▢▢ kilo ▢▢▢▢

Part 3 Heat Exposure During Work	
1. You feel that the weather is ❍ Not hot ❍ A little bit hot ❍ Moderately hot ❍ Very hot	temp ▢
2. The hottest month is	hotmo ▢▢
3. Is heat exposure during work a problem ? ❍ Yes ❍ No	prob ▢
4. How does heat exposure affect you ?	
5. What do you wear ?...	
6. Do you work under heat all day? ❍ Yes ❍ No If yes, length .... hours/ day	sun ▢ sunhr ▢▢
7. When you are exposed to heat, what do you do to avoid heat?	
8. You drink water during work ❍ Yes ❍ No If yes, how much ....glasses or ....litres	water ▢ glass ▢
9. Everytime you drink water it is sufficient for your body ❍ Yes ❍ No	avai ▢

Part 4 Effect from Heat	
1. Are you aware of any heat stress problems during the past few years ❍ Yes ❍ No	know1 ▢
2. Are there anyone who knows the effect of heat on health ❍ Yes ❍ No If yes, state who...	expert ▢
3. Do you know the symptoms of heat stress❍Yes ❍ No	know2 ▢
4. Have you ever experienced the symptoms of heat stress during work 4.1 Sweat ❍ Never ❍ A little ❍ Moderately ❍ Much 4.2 Exhaustion ❍ Never ❍ A little ❍ Moderately ❍ Much 4.3 Rash ❍ Never ❍ A little ❍ Moderately ❍ Much 4.4 Fatigue ❍ Never ❍ A little ❍ Moderately ❍ Much 4.5 Fainting ❍ Never ❍ A little ❍ Moderately ❍ Much	 sign1 ▢ sign2 ▢ sign3 ▢ sign4 ▢ sign5 ▢

Part 4 Effect from Heat	
4.6 Moodyness ❍ Never ❍ A little ❍ Moderately ❍ Much 4.7 Sleeplessness ❍ Never ❍ A little ❍ Moderately ❍ Much 4.8 Nausa ❍ Never ❍ A little ❍ Moderately ❍ Much 4.9 Dizzyness ❍ Never ❍ A little ❍ Moderately ❍ Much 4.10 Headache ❍ Never ❍ A little ❍ Moderately ❍ Much 4.11 Cramps ❍ Never ❍ A little ❍ Moderately ❍ Much	sign6 ▢ sign7 ▢ sign8 ▢ sign9 ▢ sign10 ▢ sign11 ▢
5. How often heat stress occurred during summer? .... times/ year	freq ▢
6. The color of your urine is ❍ Pale yellow ❍ Dark yellow	urine ▢
7. Do you feel the difference in heat between the past and present ? ❍ Yes ❍ No If yes, please state the details	feel ▢
8. If you are experiencing heat stress, what would you do ?	
9. You ever get ill from the heat ❍ Yes ❍ No	sick ▢

Part 5 Effect on Work and Productivity	
1. How does heat exposure effect your work?	
2. During summer, heat exposure during work causes productivity to ❍ Increases ❍ Decreases ❍ No change Details .... Does it effect income❍ Yes, increases/ decreases by .... baht ❍ No	quan ▢ inco ▢, nuin ▢▢▢
3. Heat exposure during work causes productivity in different season to ❍ Increases ❍ Decreases ❍ No change Details..	qual ▢
4. Heat exposure during work affects length of farming ❍ Longer ❍ Shorter ❍ Same Details (days)	long ▢
5. Have you ever been absent from work due to heat ❍ Yes ❍ No	rest ▢
6. If a heat wave occurs (*Heat waves are a prolonged period of abnormally hot weather. The weather is dry with no wind. For example: an area of 38-41 degrees Celsius with no wind for 3-6 days, the heat will accumulate into heat waves)* 6.1 In the next 2-3 days, will you be preapred to handle the situation ❍ Yes ❍ No If so, state the detail... 6.2 Next week, will you be prepared to handle the situation ❍ Yes ❍ No If so, state the detail...	 few ▢ week ▢

Part 6 Prevention	
1. Do you think that the policy of working under hot weather is useful ❍ Yes ❍ No ❍ Don't know If yes, state the details	useful ▢

Part 6 Prevention	
If no, state the details..	
2. Are you aware of the safety standards in working with heat ? ❍ Yes ❍ No	aware ▢
3. How do you know that the temperature is too hot to work ❍ Weather forecast ❍ Thermometer	thres ▢
4. How do you relief stress caused by heat (Can choose more than 1 answer) ❍ Hire more farmers ❍ Increase work days, decrease working hours ❍ Work in the early morning ❍ Work in intervals ❍ Take a break during work ❍ Wear thin clothes ❍ Air-conditioning ❍ Ventilation/ use of fan ❍ Drink water ❍ Stay in the shades ❍ Driving instead of walking ❍ Other	manage1 ▢ manage2 ▢ manage3 ▢ manage4 ▢ manage5 ▢ manage6 ▢ manage7 ▢ manage8 ▢ manage9 ▢ manage10 ▢ manage11 ▢ manage12 ▢

Time interview ended.....................................	time2 ▢▢.▢▢

APPENDIX F: THAI CONSENT FORM

ใบยินยอมของอาสาสมัคร

โครงการวิจัย “สถานการณ์และผลกระทบของการเปลี่ยนแปลงสภาพภูมิอากาศและความร้อนที่มีต่อผู้ประกอบอาชีพในประเทศไทย”

วันที่ให้คำยินยอม วันที่…………..เดือน……………………………. พ.ศ…………………

ก่อนที่จะลงนามในใบยินยอมให้ทำการวิจัยนี้ ข้าพเจ้าได้รับการอธิบายจากผู้วิจัยถึงวัตถุประสงค์ของการวิจัย วิธีการวิจัย อันตรายหรืออาการที่อาจเกิดขึ้นจากการวิจัย หรือจากยาที่ใช้ รวมทั้ง ประโยชน์ที่จะเกิดขึ้นจากการวิจัย อย่างละเอียด และมีความเข้าใจดีแล้ว ซึ่งผู้วิจัยได้ตอบคำถามต่างๆ ที่ข้าพเจ้าสงสัยด้วยความเต็มใจ ไม่ปิดบัง ซ่อนเร้น จนข้าพเจ้าพอใจ และเข้าร่วมโครงการนี้ด้วยความสมัครใจ

ข้าพเจ้ามีสิทธิ์ที่จะบอกเลิกการเข้าร่วมการวิจัยนี้เมื่อใดก็ได้ถ้าข้าพเจ้าปรารภนา โดยไม่เสียสิทธิ์ในการรักษาพยาบาลที่จะเกิดขึ้นตามมาในโอกาสต่อไป

ผู้วิจัยรับรองว่าจะเก็บข้อมูลเฉพาะเกี่ยวกับตัวข้าพเจ้าเป็นความลับและจะเปิดเผยได้ในเฉพาะรูปแบบที่เป็นสรุปผลการวิจัยเท่านั้น

การเปิดเผยข้อมูลเกี่ยวกับตัวข้าพเจ้าต่อหน่วยงานต่างๆที่เกี่ยวข้อง กระทำ ได้เฉพาะในกรณีจำเป็นด้วยเหตุผลทางวิชาการเท่านั้น และจะต้องได้รับคำยินยอมจากข้าพเจ้าเป็นลายลักษณ์อักษร

ผู้วิจัยรับรองว่า หากเกิดภาวะแทรกซ้อนใดๆ ที่มีสาเหตุจากการวิจัยดังกล่าว ข้าพเจ้าจะได้รับการรักษาพยาบาลโดยไม่คิดค่าใช้จ่าย และหรือจะมีการชดเชยค่าตอบแทนตลอดจนเงินทดแทนความพิการที่อาจเกิดขึ้นตามความเหมาะสม

อาสาสมัครสามารถติดต่อผู้วิจัยได้ที่ คณะสาธารณสุข มหาวิทยาลัยธรรมศาสตร์ ศูนย์รังสิต อาคาร ปิยชาติ ชั้น 10 ต.คลองหนึ่ง อ.คลองหลวง จ.ปทุมธานี 12121 ผู้รับผิดชอบ คือ รองศาสตราจารย์ ดร. นันทวรรณ วิจิตรวาทการ คณบดีคณะสาธารณสุข มหาวิทยาลัยธรรมศาสตร์ ศูนย์รังสิต โทรศัพท์ 02-9869213-9 ต่อ 7449 หรือ 081-6557663

ข้าพเจ้ายินยอมให้ผู้กำกับดูแลการวิจัย ผู้ตรวจสอบ คณะกรรมการจริยธรรมการวิจัยในมนุษย์และคณะกรรมการที่เกี่ยวข้องกับการควบคุมยา สามารถเข้าไปตรวจสอบ บันทึกข้อมูลทางการแพทย์ของข้าพเจ้า เพื่อเป็นการยืนยันถึงขั้นตอนโครงการวิจัยทางคลีนิกโดยไม่ล่วงละเมิดเอกสิทธิ์ ในการบิดบังข้อมูลของการสมัครตามกรอบที่กฎหมายและกฎระเบียบได้อนุญาตไว้

☐ ข้าพเจ้าได้อ่านข้อความข้างต้นแล้ว และมีความเข้าใจดีทุกประการ และได้ลงนามในใบยินยิมนี้ด้ยควาามเต็มใจ

☐ ข้าพเจ้าไม่สามารถอ่านหนังสือได้ ผู้วิจัยได้อ่านข้อความในใบยินยิมนี้ให้ข้าพเจ้าฟังจนเข้าใจดีแล้ว ข้าพเจ้าจึงลงนามในใบยินยิมนี้ด้วยความเต็มใจ

ลงนาม……………………………….อาสาสมัคร

(………………………………..)

ลงนาม……………………………….พยาน　　　　ลงนาม…..…………………………พยาน

(………………………………..)　　　　(………………………………..)

APPENDIX G: ENGLISH CONSENT FORM

Title of Project:
"Evaluating Occupational Health Effects of Climate Change on Agricultural Workers"
Date……………………………………

In order to sign the consent form for this research, I received an explanation and objectives of the research from researcher. Moreover, I realized and had a great understanding of the hazards or conditions that may result from this research, including those benefits that may arise from the research. The researcher willingly to answer all question that I may have doubt until I am satisfied and participate in the program voluntarily.

I have the right to terminate participation at any time if I wish. This will be in charged without losing the right to health care that will be coming in the future.

Researchers are committed to organize the information about me is confidential. Only the summary form of research can be disclose to the public.

In order to reveal my personal information to any public organization, this could only happen in the case considered as a very necessary. Also, the personal information will could only reveal after getting a written permission.

Researchers ensure that there will be no problems related to health issues. If so, all the medical treatment expenses will be free of charge, and the compensation will be received in return.

The volunteers are able to contact researchers at Faculty of Public Health, Thammasat University. The address is 10th fl. Piyachat Building, Klong Neung district, Klong Luang, Pathumthani Province 12121. The responsibility is considered under control of Associate Professor Dr. Nuntawan Vijitwatakarn, Dean of Faculty of Public Health, Thammasat University. Tel ; 02-9869213 to 7449 or 081-6557663

I agree to the research supervisor, audit committee on Human Research Ethics, and committee on Drug Control to be able to verify medical information of myself. This is conducted to confirm the clinical data collections. This will be accomplished without infringing the right of each individual.

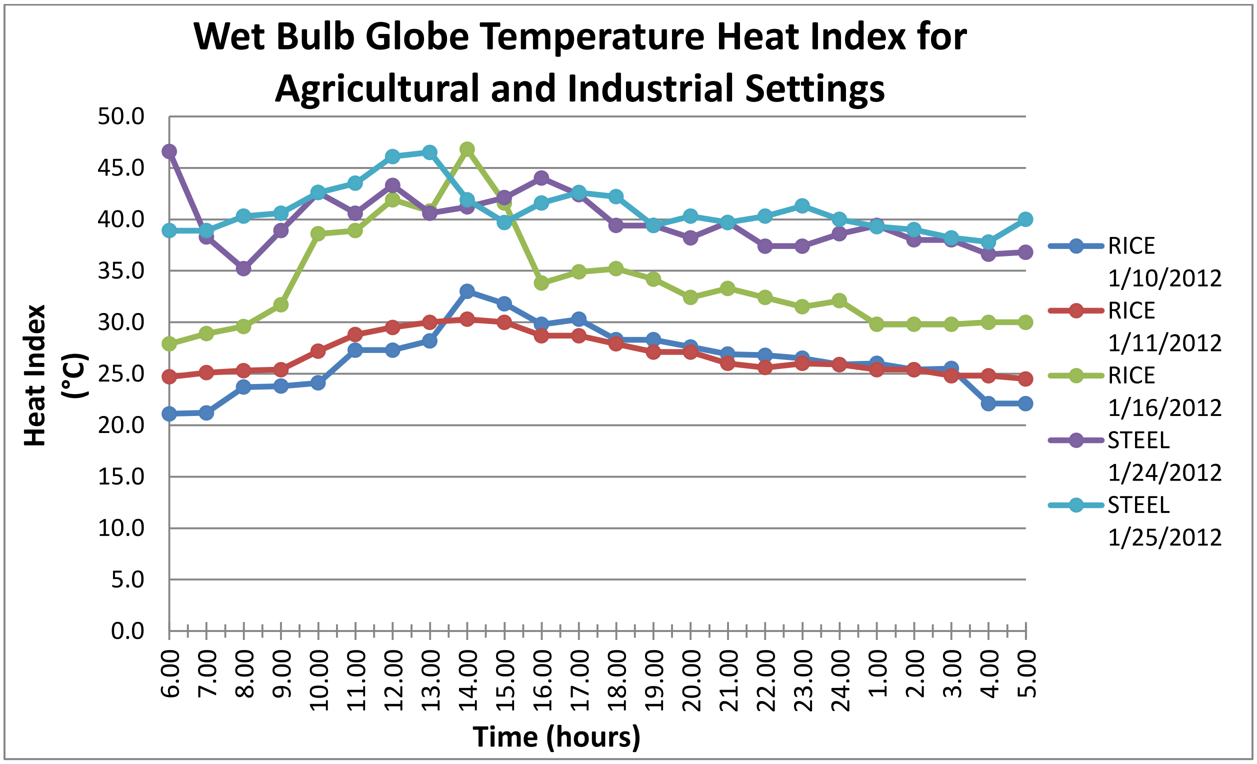
☐ I have revised all above information, and all information is clearly understood. I have signed this consent form according to my willingness.

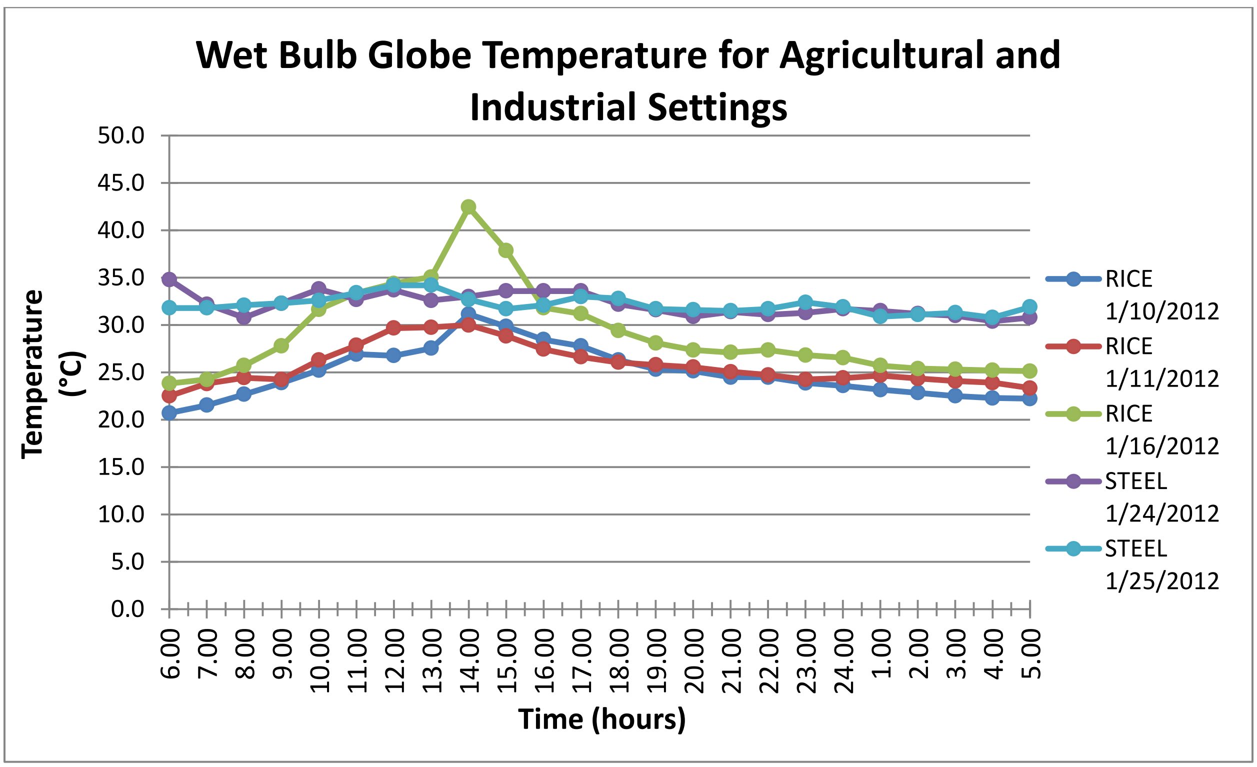
☐ As I am illegible, researchers are willing to read through and clearly explained the information to me. Thus, I have signed this consent form according to my willingness.

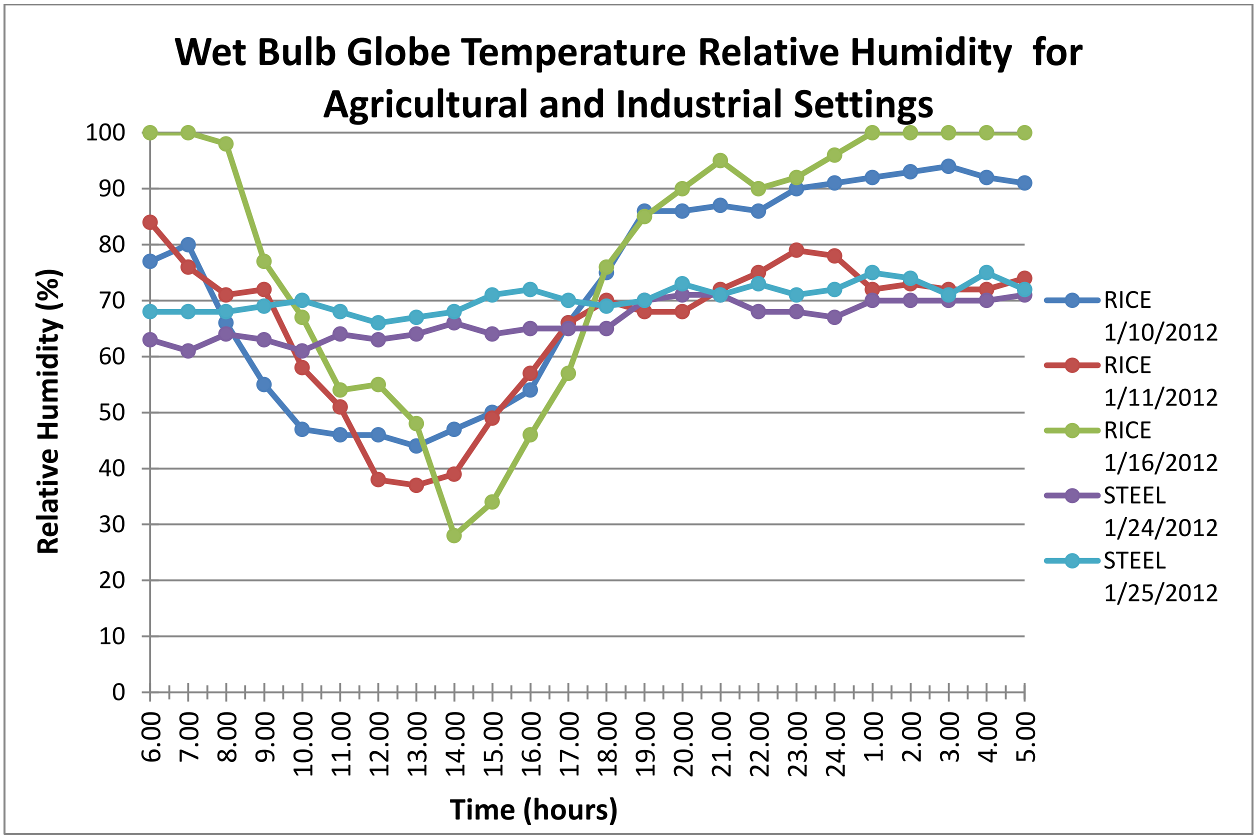
……………………………………. Volunteer
(………………………………………)

………………………………Witness ………………………………Witness
(……………………..) (……….……………)

APPENDIX H: WET BULB GLOBE TEMPERATURE DATA GRAPHS






Wet Bulb Globe Temperature Relative Humidity for Agricultural and Industrial Settings
Relative Humidity (%)
100
90
80
70
60
50
40
30
20
10
0
6.00
7.00
8.00
9.00
10.00
11.00
12.00
13.00
14.00
15.00
16.00
17.00
18.00
19.00
20.00
21.00
22.00
23.00
24.00
1.00
2.00
3.00
4.00
5.00
Time (hours)
RICE 1/10/2012
RICE 1/11/2012
RICE 1/16/2012
STEEL 1/24/2012
STEEL 1/25/2012

APPENDIX I: INTERVIEW DATA

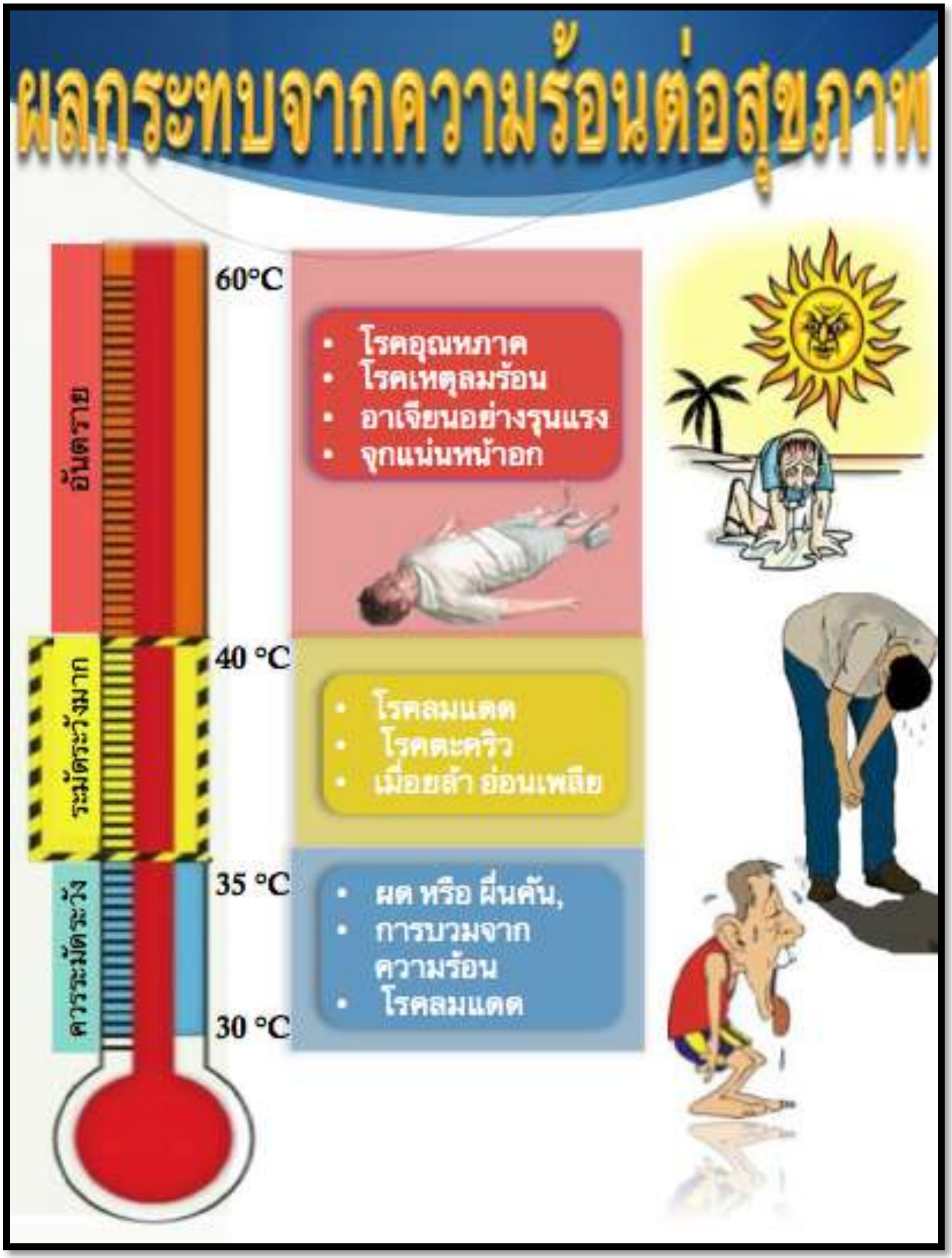
General Work Information

Averages	Agricultural Workers	Industrial Workers
Age	45.3 years	30.5 years
Career	25-30 years	1.7 years
Shift length	5-6 hours	8 hours
Working days per week	4 days	6-7 days

Heat Exposure During Work

	Agricultural Workers	Industrial Workers
See exposure to heat during work as a problem	100%	64%
Know of a heat stress issue occurring	93%	55%
Know an expert to talk to regarding heat stress	60%	64%
Know symptoms of heat stress	62%	50%
Feel a difference in the heat (past and present)	86%	55%
Missed work because of heat	57%	13%

APPENDIX J: INFORMATIONAL POSTERS FOR THE WORKPLACE




ดื่มน้ำ
เพื่อทดแทนเหงื่อที่เสียไป
ควรดื่มน้ำอย่างน้อย
3 ลิตร ต่อวัน
เพื่อสุขภาพที่ดีนะค่ะ