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Thailand: An Innovative Approach for the Coastal Population and Seafood Production

Food insecurity is a critical problem that is faced primarily by developing countries and has had devastating effects on millions of people worldwide. In Thailand, fishing and shrimp farming are essential industries that provide income for thousands of Thai families. The current methods of fishing and farming aquatic species have had devastating effects on the coastline and marine estuarine ecosystems throughout the coastal zone of Thailand. The current rate of destruction that the coastline and mangrove estuaries are facing will increase the amount of insecurity that Thailand's rural and coastal populations will endure. Although alternative and sustainable methods of seafood production and coastal restoration are not yet common in Thailand, there are numerous potential methods to produce a high yield of seafood in a sustainable manner.

Thailand is a Southeast Asian country that consists of 510,890 square kilometers of land. Thailand is also considered a littoral country, meaning that it has a coastal zone. Thailand's coastal zone consists of the Andaman Sea Coast and the Gulf of Thailand Coast. The current population of Thailand is approximately 69,775,900 people, which is considered densely populated considering the amount of land. 50.05%, which is slightly over half of Thailand is considered to be rural compared to the other 49.95% of the land and population that is urbanized (ArcGIS, 2019). The Thai Government, which is referred to as the Kingdom of Thailand is a Constitutional Monarchy style of government. The current head of government in Thailand is Prime Minister Prayut Chan-o-cha, and the current Thai Monarch is Maha Vajiralongkorn. 32.9% of land in Thailand is arable and has the potential to be utilized for agricultural production. Along with this, approximately 40% of land in Thailand is considered to be agricultural. Over 40% of the land utilized for agriculture is used to grow rice and it is considered an essential crop for employment, exports, and consumption by families throughout Thailand. Along with rice, other major Thai crops include sugar cane, tobacco, and palm oil. The farming of shrimp and other seafood is considered an exceptionally important industry in Thailand in towns and areas that are close to the coastal zone. Thailand is considered one of the Worlds primary exporters of shrimp, so this is also considered an essential product and export of Thailand. The average farm size is approximately 5.6 hectares, which equates to around 13.8 acres. Although this is minimal compared to many high-yield farms that are utilized today, the majority of productive farms in Thailand are owned by individual farmers and households. Thailand's coastal zone is highly utilized for the farming of numerous shrimp and seafood species, along with the

commercial fishing of shrimp throughout the coast. Thailand has a tropical climate with a monsoon season that commonly occurs from June until October. Differentiations in climate and humidity in Thailand have proven to drastically affect crop production throughout the country. In Thailand, family life is considered the center of most social circles, and family lines are protected through the generations. Thai families often consist of several generations living under one roof, patriarchy is common with the majority of authority being held by the oldest male. This being said, it is common for familial businesses to be passed down from generation to generation. Elderly family members are valued and cared for by the family, and it is not considered culturally ethical to place an elderly family member in a nursing home or other assisted living facility. The average family size in Thailand, according to ArcGIS was 3.1 in 2019, which is slightly higher in comparison to the United States statistic of 2.6 for the same time period (ArcGIS, 2019). Outside of the major metropolitan and urbanized areas, the typical rural Thai home is constructed of wood and bamboo and often built on stilts to protect the structure from floods during the monsoon season as well as increase the airflow (Hayes, 2008). Because air conditioning is still considered a luxury in many of Thailand's towns, the open-air design is popular to allow the breeze to enter the home. Traditional Thai homes do not have modernized bathrooms with functional showers and toilets, but rather a tub with a water bucket in place of a shower and squat toilets. Another common feature of the traditional home will be the separate kitchen building, this is beneficial to prevent smoke and culinary odors from directly entering the living area. Rice is a staple ingredient in the Thai diet. Shrimp, fish, coconut, and numerous spices are the most popular ingredients in the main dishes. Thai cuisine is most commonly prepared by stir-frying the ingredients all together, along with boiling and grilling which are also common methods of food preparation. There are a plethora of traditional style grocery stores in Thailand, but is it still incredibly common to visit outdoor markets to purchase numerous fresh products. The outdoor markets primarily sell meats, seafood, and vegetables that are harvested by local farmers and fishermen. The majority of the meat, seafood, and vegetable products at these outdoor markets are displayed in the open air throughout the day. The market vendors will set up in the morning with their products, and bargaining is a common practice for determining the pricing of certain products. A wide variety of jobs are available to people throughout all of Thailand. There are skilled positions such as medical and business trades, along with migrant work and unskilled service work that is widely available throughout the country. Outside of developed urban areas, farming, and traditional craftwork are immensely common and utilized. Many jobs and businesses in Thailand are family-owned, and it is estimated that around 80% of all businesses in Thailand are owned by multi-generational families (Cracknell, 2019). The minimum wage in Thailand is approximately 2,293.00 United States Dollars, which equates to 73146.70 Thai Bahts (Minimum-Wage.org, 2020). Education in Thailand consists of 12 years of free schooling. The literacy rate in Thailand is 96.7%; however, Thai students on average rank 35 out of 40 countries on global PISA tests (PISA, 2018). Healthcare in Thailand is controlled by the Ministry of Public Health (MOPH), it is free to citizens, but many times the facilities are densely crowded and waiting times are long. Interestingly, there is a charge for health care services on Saturdays (Sumriddetchkajorn, et al., 2019). Approximately 96% of the population has access to drinking-water deemed safe for human consumption. Electricity is available to the citizens of Thailand as well as telephone service. There is a paved road system; however, rural dirt roads are most common outside of the city centers and urban areas.

The economic growth of Thailand has put a strain on rural environments, which has caused an increase in

new challenges for the traditional way of living. Over the past 20 years, air quality, deforestation, habitat destruction, as well as land erosion and waste issues have increased significantly. Forested land has been consistently utilized for new agriculture, decreasing the forest cover from 53% in 1961 to 25% in 1998 (World Heritage Encyclopedia, n.d). The predominant living environment in Thailand remains to be a rural village environment. Rice farming is the leading source of income for families and individuals in these villages. As population growth increases, village expansion encroaches on land closer to the road systems, which decreases the amount of available land for farming. Rural settlers along the coast primarily rely on commercial and individual fishing, along with shrimp farming as an important source of income. In recent decades, the fish supply has been compromised by the influx of hydroelectric complexes installed to supply the growing population (Hafner, 2020). Currently, there are 26 hydroelectric dams in Thailand, making hydropower the primary source of renewable energy in the country (IRENA, 2017). Although Hydropower complexes do not pollute the water, the destruction of the
shoreline is a concern as well as the destruction of the aquatic wildlife habitats and marine estuaries. The installation of hydropower complexes has also resulted in severe coastal erosion of Thailand's coastline. Coastal destruction along with the influx of developmental growth has created a decrease in the amount of suitable agricultural land, along with the decreased ability for commercial fishing and fishery development along the coast. The severity of coastal destruction in Thailand continues to worsen due to the continuation of development on the coastline, along with tourism and commercial fishing operations. Coastal destruction has decreased the quantity and availability of healthy and established marine species, such as shrimp, that can be caught for human consumption. The rural population is directly impacted by this coastal destruction because the decrease in annual fish catch and fishery production results in a decreased income. Urban populations along with people worldwide are also drastically affected by this because, in 2018 alone, Thailand produced 2.59 million metric tons of shrimp, making it the leading country in worldwide shrimp production (Dublin, 2019). Shrimp that is caught and farmed in Thailand has been in high demand worldwide for years and has provided a steady source of income for fishermen, fishery owners, and farmers throughout Thailand. The topic of coastal destruction when relating it to the seafood and shrimp production industry, along with coastal destruction has a detrimental impact on the entire population of both Thailand and the World. The shrimp and prawn industry alone in Thailand is worth multi-millions of dollars and is considered essential because it composes 20 percent of the total global shrimp and prawn trade (Patmasiriwat, et al., n.d). Without proper coastal conditions and the restoration of aquatic habitats and marine estuaries, the essential seafood and shrimp industry of Thailand will continue to decline which could potentially increase unemployment in rural coastal towns. Along with this, a decrease in these industries could result in a food shortage in these rural towns that depend on the income from these industries.

With land becoming scarce, residents of rural villages would strongly benefit from a sustainable and self-sufficient approach to food supplies that would rejuvenate shorelines and land that have previously been overfarmed or destroyed by modern food collection techniques. One area that should be heavily focused on is the destruction of the mangrove estuaries as a result of modern-day shrimp farming techniques. The reconstruction of mangrove estuaries is essential for the protection of coastal development from factors such as erosion from storms and typhoons (WWF, n.d). In the United States, many species of mangroves have been restored through the propagation of the viviparous seed of a

mangrove, called the propagule. The Marine Resources Council in Palm Bay, Florida has worked to restore numerous species of mangroves through the methods of propagation with the intentions to restore the mangrove population of the Indian River Lagoon (Marine Resources Council, 2020). Although the basic method of propagation has proven to be successful, this method does not combat the need for food supplies such as shrimp and seafood. A potential solution to this would be the utilization of aquaponics systems. Aquaponics is a system that utilizes the symbiotic relationship between marine and aquatic species such as fish and shrimp, and numerous plant species. In this case, specifically, aquaponics can be utilized to raise shrimp and prawns in controlled stock tanks that filter water into raised trays that are utilized to grow plants. The nitrogen cycle that occurs in an aquaponics system allows an increased growth rate of plants due to the increase in ammonia and nitrates in the water. Aquaponic farms have proven to be incredibly sustainable and productive, using approximately 90% less water than other farming methods, along with producing fish and other marine species at a higher rate of growth (Fish2.0, 2015). There is also great potential to utilize these aquaponics systems to grow numerous crops for the consumption of people who are experiencing food shortage. Another benefit of the utilization of aquaponics is that the plant trays on each aquaponic system could be used to propagate mangrove species to aid in the restoration of the estuarine ecosystems that once surrounded the coastline. Depending on the environmental conditions and climate, aquaponics systems can be established in many areas and are personalizable, meaning that they can be constructed to thrive in almost any condition. Because of the utilization of sustainable aquaculture and aquaponics is a relatively new topic for many commercial fishing businesses, there is a high potential for opposition to this concept. An innovative method of convincing fishing businesses to consider utilizing sustainable aquaculture and aquaponics is through the government. If the government officials that regulate the commercial fishing industries can be turned toward the idea of using aquaponics as a means of reforming the seafood industry, the commercial fishing productions will be more willing to add this practice as a supplement to existing businesses. Fishing towns are rural, the coast is more valuable in these towns than the inland, much of which is undeveloped and could potentially support aquaponics outbuildings. It is estimated that 65% of rural towns work on well water, this combined with the potential of solar power wind power, could mean aquaponics factories could eventually be self-supportive (FAO). Along with this, the management and construction of aquaponics systems can be relatively challenging and would require the assistance of experienced workers. Aquaponics systems require routine pH and dissolved oxygen tests to ensure that the water is suitable for the aquatic species and the vegetation being cultivated in the system. Overall, it would be a very innovative and efficient method of increasing the amount of seafood produced while reducing the destruction of the coastal estuaries while restoration efforts are conducted. Another potential solution that would increase the production of shrimp and seafood while preventing further destruction to the coastal estuaries and shoreline includes the utilization of aquaculture and aquaponics systems in urban areas along with rural areas. Although urbanized areas are not considered ideal for agricultural production, there is potential for the construction of aquaculture centers. Raised Polyethylene aquaculture tanks have been utilized in a variety of conditions and areas worldwide for the cultivation of numerous aquatic species. An example of this practice is the proposition of the Urban Aquaculture Center (UAC). This is a large scale aquaculture production facility that was constructed in a 150,000 square foot unused factory site in Milwaukee, Wisconsin as a method of producing sustainable food that does not contribute to environmental problems that are a result of current fishing practices (Snyder, 2008). In Thailand, sustainable aquaculture centers can be constructed in areas that have a surplus of abandoned structures or

available space. Aquaculture tanks and filtration systems can be established in these centers that would provide a controlled environment for the growth and production of many common species that are being fished along the coasts. Aquaculture systems constantly recirculate water through the use of a filtration system. The constant recirculation of water has proven to reduce the amount of waste that gets exposed to the environment (Green Garage, 2016). Aquaculture systems are also incredibly productive because numerous species and organisms in numerous levels of development can all be cultivated in the same vicinity. The utilization of aquaculture systems in both urban and rural areas throughout Thailand can also encourage a wider range of populations to consider supporting aquaculture-grown products that result in less damage to the environment and coastal areas as opposed to traditionally-farmed products. A large aspect of implementing a sustainable agriculture practice such as aquaponics is understanding the governmental pushback. It is well known that the fishing industry in Thailand is in need of reform in regards to issues with forced labor and undesirable conditions for workers on fishing boats. The Thai government has been the focus of ineffective measures being put in place to protect the migrant fishermen, in 2015 an official report from the Thai government noted that inspections of 474,334 fishery workers had failed to identify a single case of forced labor (MFA, 2016). It is apparent that the Thai government values the economic benefit of the fishing industry, and may not be willing to replace the cheap labor and rapid return of the current traditional fishing practices. Being as the country has been the focus internationally of unfavorable working conditions and human rights protection in the industry, introducing an environmentally favorable industry such as aquaculture and aquaponics may be appealing to the government in the area of public relations. Once in place, the technology may slowly develop, until it becomes a necessary aspect of numerous productive fisheries. Conveying that the environment and human rights are being considered in a fisheries business plan, maybe incentive enough to allow the project of installing aquaponics farms to be implemented, and even funded partially by the government. A common weakness in the utilization of aquaculture worldwide is the potential of releasing new diseases and bacteria into the aquatic populations found in nearby coastal water (Green Garage, 2016). Without proper management and testing, aquaculture systems can cultivate certain strains of bacteria and diseases that have not been exposed to the wild populations, which can cause further concerns. Aquaculture wastewater can potentially be filtered and utilized as irrigation for crops and any plot of arable land that is in need of irrigation water. There have been concerns regarding habitat destruction as a result of the development of aquaculture systems. Although this has been an increasingly valid concern, it is not considered a problematic factor when referring to indoor aquaculture that is being constructed in areas that are not being utilized.

All in all, Thailands' coastline and marine estuarine ecosystems have endured severe destruction throughout time as a result of modern fishing techniques and the development of hydroelectric power sources. This has caused increased insecurity for coastal fishermen and families that rely on income from the seafood and shrimp industry. With Thailand being one of the World's leading producers of shrimp, it is essential that a solution is found that will continue to let this industry thrive without continuing with the severe environmental damage that is occurring. Sustainable agriculture has been experimented with and utilized worldwide to combat both food production and environmental concerns, so it is believed that it can be a primary solution in Thailands' production of seafood, along with the health and security of its urban, rural, and coastal populations.

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