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Madagascar, Factor 5: Climate Volatility

Strategic Plants Allowing Farmers and fellow Malagasy to Prosper into a Promising Future

"Behave like the chameleon: look forward and observe behind" ("Behave like the Chameleon: Look Forward and Observe Behind.," n.d.). This Malagasy proverb connects almost perfectly with Madagascar's current dire situation. Madagascar's geographical location shelters the perfect storm for a humid climate, regular cyclones ("MADAGASCAR - A Country Study," 1994), and arid dry land in the south. Its common locust infestations cause troubles for most of the Malagasy people, as 71.1% of the land is used for agriculture, ("The World Factbook: Madagascar," 2016) and 80% of the population works as subsidence farmers ("Reproductive Health at a Glance: Madagascar," 2011). Despite this large number, most of Madagascar still lives in poverty with children having fatal cases of malnutrition. Part of this is due to the rising temperatures, produced by volatile climates in Madagascar. Climate change has taken away much of the island's biodiversity, as many species are not able to handle the new environments (Lee et al., 2008). This rise in temperature has also taken its toll on the agriculture and vegetation through the increase of invasive pests such as locusts (Harvey et al., 2014), which create a mountain of problems for the rural farmers in Madagascar. With the rural subsistence farmers being the main source of food for the Malagasy families, when natural disasters combined with political instability struck, the combination set Madagascar into extreme vulnerability and insecurity with both food and water. With droughts also caused by volatile climates, Madagascar's main crops like rice have trouble growing, but once the rice is grown and ready to sell, there is little production and income made off of it, as access to markets is limited for rural farmers ("Madagascar | WFP | United Nations World Food Programme - Fighting Hunger Worldwide," 2016). These culminated problems make for why Madagascar is one of the countries with the most food insecurity, and why it is struggling to improve and limit the effects of climate volatility on their lives and agriculture. Agriculture is a key component not only evidently in their food security, but in the Malagasy people's careers and lives, as most of their time in a day is dedicated towards agriculture. As a result, it is crucial to find solutions to eliminate the effects of climate volatility on Madagascar, ideally in a few decades to ensure the quality of life is better for the Malagasy. Like the proverb hinted at, looking at Madagascar's past is the only way that the country is able to progress successfully.

With a population of 23,812,681 as of July 2015, ("The World Factbook: Madagascar," 2016), about 85% of the Malagasy people live in rural areas ("Rural Poverty Portal," n.d.). This vast majority of the population living in rural areas, mainly as farmers, coincides with problems such as accessing urban areas for medical help and healthcare, availability to urban areas to sell goods, and education. Despire the decrease in the total fertility rate (TFR) for women in Madagascar since 1997 of 6.0 births to 5.2 births (Iarivony, Rabeza, Barrère, & Mariko, 2005),

according to a recent United Nations Press Release, Madagascar still has a high fertility rate compared to the rest of the world (2011). There has also been a correlation between the education of the woman and

her fertility rate; the less education received, the higher the total fertility rate. For instance, 28% of women in rural areas do not have an education, while 11% of women in urban areas do not, which follows the pattern of a higher total fertility rate in rural areas. Furthermore in general, women with a secondary level education or higher have a significantly lower total fertility rate than those who do not have a secondary level education. With an average farm subsidence family size of 4.7 members, 22% of households are matriarchal, or led by women. It is rare to find a household with more than 9 members, while it is even more infrequent to find an orphaned child. Only 23% of rural homes have access to safe drinking water, which is a great difference from the 74% of urban homes that do have access. In terms of diet, babies are breastfed at a median duration of 21.9 months and the majority receive supplementary foods when they are six to nine months old, which is the healthy norm crossboard (Iarivony, Rabeza, Barrère, & Mariko, 2005). The average Malagasy will eat rice, up to three times a day, as it is considered a key grain in their diets. Rice is usually accompanied with a type of protein like chicken or beans ("Madagascar," n.d.). In addition, Malagasy who live around the coast of the island of Madagascar are able to incorporate fish, shellfish, and coconuts into their diets, these foods soon becoming the main part of their diets as they are able to conveniently acquire them ("Food & Daily Life," n.d.). Moving on to the educational aspect of daily life in Madagascar, 50% of the labour force has not received a formal education. Due to the lack of support and supervision in schools in rural areas, the schools are not effective for the students (Reuter & Venart, 2014). However, the schools are not the only things that are not effective; access to health care has not been easy for the rural Malagasy either. 76.5% of Malagasy live in poverty, resulting in them not being able to afford health care, which notably impacts the children negatively. Malagasy children most commonly die of malaria, diarrhea, and neonatal complications; without access to the basic immunizations, these children are more prone to these fatal diseases and conditions ("Health and Nutrition," n.d.). In order to combat this issue and others, in 1980, the Malagasy government brought in 1,500 health aids, which worked, but very minimally. As of 2000, according to Professor Dieudonné Randrianarimanana, the cabinet director of the Madagascar Ministry of Health, Family Planning and Social Protection, only about 60% of Malagasy have access to health care, some having to walk ten kilometers just to reach treatment. As a result, in 2007, The Madagascar Action Plan 2007-2012 (MAP) was instituted, and has become the backbone to the promises of improving health care, eradicating major diseases, promoting more hygienic routines, and more ("Primary Health Care: Back to Basics in Madagascar," n.d.). These are factors that the Malagasy have to overcome, as in order to survive, they have to dedicate their time to farming.

For a subsidence farm family, by definition, agriculture and farming is how they support themselves at the minimal level. In Madagascar, the average subsistence farm size is 1.3 hectares. Madagascar's famous biodiversity and diverse soil types allows for farmers to grow a variety of agriculture ranging from tropical fruits to coffee and vanilla to the staple grain, rice ("New Agriculturist," 2013). Traditionally, rice is grown in paddies in waterlogged fields, about 10 cm apart. To contrast, a method new to agriculture called System of Rice Intensification (SRI), presents planting the rice 25 cm apart in areas that do not have to be water logged. This method proposed just decades ago allows for stalks to grow larger, with the ending result in producing more rice ("Climate & Agriculture," n.d.). Along with rice, maize, cassava, sweet potatoes, and yams are also major crops grown ("New Agriculturist," 2013). Other farming practices include slash and burn, known as *tavy*, which has caused deforestation, as its method is based on cutting down the smaller trees. The trees are dried, then burned before the rain season, to make room for

fields for planting rice, corn, and eventually secondary vegetation. *Tavy* has a shorter crop cycle for rice, and is known for protecting the vegetation against the periodical droughts that occur in Madagascar ("MADAGASCAR - A Country Study," 1994). On the other hand, this clearing of forests for future farmland has sacrificed 85% of Madagascar's rainforest ("Madagascar | WFP | United Nations World Food Programme - Fighting Hunger Worldwide," 2016). In order to prevent more damage to the rainforests, the government announced that they would fine, and in excessive cases, imprison those who would continue practicing *tavy*.

Madagascar is one of the top ten most vulnerable countries to natural disasters, which manifestly presents problems to the agriculture. Its regular droughts, floods, cyclones ("Madagascar | WFP | United Nations World Food Programme - Fighting Hunger Worldwide," 2016), and appearances of locusts have prevented farmers from improving their agricultural productivity ("New Agriculturist," 2013. With five million people living in these threatened areas, it exemplifies that these natural occurrences not only affected the agricultural production, but also the people in terms of employment and safety ("Madagascar | WFP | United Nations World Food Programme - Fighting Hunger Worldwide," 2016). Another barrier for employment and jobs in general in rural Madagascar is, because more than 75% of the population lives in poverty (Market, 2009) and 92% live on less than two dollars a day ("Madagascar: Measuring the Impact of the Political Crisis," 2013) the Malagasy remain in low paying jobs, like farming, and do not have the capital to successfully farm. For example, farmers are not able to afford things like fertilizer, resulting in not receiving an optimal vegetative output, leaving them in a trap that poverty is for the Malagasy. Additionally, not having the appropriate education necessary, or any education at all, not having the skills needed for higher paying jobs, as well as simply not having access to markets to sell their crops has been a main problem for the impoverished Malagasy (Market, 2009).

Madagascar is flawed in access to food markets and adequate nutrition for its citizens. To illustrate, food markets in Sub-Saharan Africa are largely influenced by the liberalization and location of them. However, with the liberalization of the food markets resulted in a significant price increase of food in the markets overall. This especially affected the price of rice, as the price of rice rose by 60% when the markets were liberalized (Townsend, 1999). This increase in price of such an important grain and food overall would harm the urban citizens, and even the rural families who did not produce enough grains to survive. In isolated rural areas, there is limited access to markets, which is caused by limited access to capital for agricultural interests, as mentioned before ("Madagascar | WFP | United Nations World Food Programme - Fighting Hunger Worldwide," 2016). In these rural areas, children are more susceptible to malnourishment. Unfortunately, "Madagascar has the 5th highest rate of stunting in the world…," while 42% of the children are underweight ("Nutrition at a Glance: Madagascar," n.d.). Part of this issue is due to the droughts that Madagascar faces regularly; in 2006 when Southern Madagascar faced a severe drought, the number of malnourished children rose drastically. According to Project Director Antoine Deligne of GRET, an NGO funded by the European Union, malnourishment can also be caused by, "Poor transport and communication, lack of irrigation infrastructure and inadequate access to safe drinking water and sanitation"(Chinyama, 2007). This lack of adequate nutrition made Madagascar decrease their GDP by over 720 million US dollars caused by vitamin and mineral deficiencies ("Nutrition at a Glance: Madagascar," n.d.).

A volatile climate can negatively affect any nation, but especially harms the fragile environment and agriculture of Madagascar. Climate volatility like an increase in temperature, is able to cause droughts which evidently hinder farmers. A personal account of the true impacts of this drought reveal how hard this ever fluctuating climate can be on the villagers, “We can hardly meet our family’s food needs, it hasn’t been raining for months so we can’t grow anything.” The Malagasy woman expresses that she has to walk up to 12 kilometers just to find water in the next village ("UN World Food Programme: USAID Brings Smiles And Hope To Drought-hit Southern Madagascar," 2016). One drought, in 2016, eliminated the maize crop in Southern Madagascar, which put farmers in immediate danger, as they did not have a main source of income anymore. As a result, many of the women have resorted to turning wood into charcoal, then selling it at a market (Nguyen, 2016). This tree depleting activity is a negative feedback loop, where because there are a scarce number of trees, as the women used all of the wood from the trees to turn into charcoal, there is less carbon sequestered by the trees. If there is less carbon sequestered, then the climate will warm more, thus causing more droughts, repeating the cycle again, and hurting the people and agriculture.

One other threat brought to the Malagasy people and their food security is the increasing population of pests and harmful insects caused by rising temperatures. For instance, ever since April 2012, swarms of locusts have invaded the vegetation and rendered them unvaluable ("Madagascar Locust Crisis," n.d.). Swarms of locusts are able to eat up to 100,000 tons of green vegetation per day. With 60% of rice agriculture being under locust affected regions, this pest's’ population dramatically increased by increasing temperatures, is deadly (Coppola, 2007). This invasion of this extremely harmful pest not only directly eats the vegetation, but consequently, it cripples the family’s household food and their primary source of income. It is very hard for farmers to recover from these disasters, as these small, poor subsistence farmers do not have the capital and money to recover, thus in the end affecting their nutrition, food security, and income (Harvey et al., 2014). In response to this worsening situation, in September of 2013, the Food and Agricultural Organization and the Ministry of Agriculture sought out a way to improve the locust situation through the Three-year Emergency Programme (2013-2016). The status of this programme was measured by the population numbers of locusts and to what extent they were affecting the vegetation. In previous efforts like the 2010-2011 and the 2011-2012 campaigns, there was no success, as underfunding came to be a problem. As a result, this uncontrolled population of locusts was able to increase their numbers rapidly and lead to the plague that presented itself in April 2012 ("Madagascar Locust Crisis," n.d.). The Three-year Emergency Programme is divided into three sections, each section dedicated to treating different size areas such as, 1.5 million hectares, 500,000 hectares, and 150,000 hectares. The goals for this program were, “Capacity for monitoring and analysis of the locust situation strengthened, locust control capacity strengthened, human health preserved and environment protected, implementation and coordination of the Programme (including the National Locust Emergency Plan), and assessment of the effectiveness of locust campaigns and the impact of the locust crisis on crops and pastures (Coppola, 2007). This plan so far, has been successful, as they have controlled over 1.8 hectares of land with biopesticides and sprays ("Madagascar Locust Crisis," n.d.).

Limiting the effects of a volatile climate in Madagascar would only pave the way to food security for the Malagasy and benefit the livelihoods of the people. For an average Malagasy subsistence farm family, lowering the effects of a volatile climate would also decrease the adversity of rising temperatures, damaging natural disasters, and invasive pests such as locusts. There has been a clear correlation between volatile climates and how its characteristics like rising temperatures has caused a less desirable environment for growing maize, rice, and wheat; three essential crops for the Malagasy diet and if not available for the people, starvation and disparity would appear. Rising temperatures also cause more severe and a more often occurrence of cyclones, droughts, and floods. Madagascar's high percentage of the population that is in poverty worsens these occurrences and is hard for the small rural farmers to go back to a normal routine (Harvey et al., 2014). As a result, finding a solution for the Malagasy people to combat this problem would yield benefits to the farmers as their crop yield would increase immensely. Furthermore, the impoverished farmers would be able to sell more of their crops without being hindered by a fluctuating climate. More crops is usually the equivalent of more income, which would only help farming families and all farmers whether they are in urban or rural areas. Apart from people, finding a proper way to react to rising temperatures and to limit the climate's frequency of rising, would help the environment thrive. For example, with more crop yields, the slash and burn agricultural practice would be minimized, thus sustaining the rainforests and letting them grow back. In addition, decreasing the population of locusts would preserve the environment and not unbalance the delicate food web of nature.

In the future, if not controlled, a volatile climate's effects could be heavily influenced by variables including population growth, pollution, and water scarcity. A population increase would entail more resource consumption, when there are not enough for all. With a sudden population boom, if no changes are made to Madagascar, then the boom will most likely be accompanied by a bust of the population. In addition, because of the need for more resources during a population increase, trees would be cut, thus increasing the temperature. When trees are cut, erosion of soil occurs and is able to runoff and pollute sources of water. This would make for water insecurity, hurting the people of Madagascar more and more. Without clean water in close proximity, people have to walk to the next village, which can be at least 12 km away. In addition, with the more severe droughts brought by the volatile climate, water scarcity is a magnified problem.

Climate volatility is a complex problem that requires commitment from each part of the people in Madagascar. To address the calamitous droughts that hinder the growth of essential crops, new plant varieties that are more drought resistant can be introduced. This can be exemplified through the genetically modified rice that is the combination of two species. O. sativa and O. glaberrima. The outcome of this combination is that it produced a rice that is fit for the varying conditions of places like Madagascar. This rice matures quickly, yields high amounts, is tolerant of droughts, and Africa's major pests (Below, Artner, Siebert, & Sieber, 2010). A problem common in Africa, including Madagascar, is that the soil does not receive enough water for the crops to grow properly. A solution to this dry soil that has been used in southern Africa is to plant millet and sorghum, cereal crops that can be used for construction, food, feed for livestock, and fuel. These plants are able to handle droughts, and can be sold to others for more income. This recommendation is able to have some plants grow and thrive in times where the Malagasy go months without rain (Shiferaw et al., 2014), There have already been efforts made

on the Nosy Hara archipelago, off the northern tip of the island of Madagascar, focused on protecting the coral reefs surrounding the islands around the archipelago. Coral reefs have the special ability to sequester carbon, which makes them valuable in Madagascar's time of increasing temperatures, as carbon increases atmospheric temperatures. The resilient corals were set aside, off limits to fishing ("Marine Protected Areas – Helping to Face Climate Change in Madagascar," 2014). This climate change management can be applied to the whole island through protecting other coral reefs around the island, as well as other carbon sequestering resources. For example, in addition to the slash and burn policies, certain trees could be sectioned off from wood collectors. This method, as well as the aforementioned methods, would decrease the amount of atmospheric carbon, thus solving the issue of volatile climates in Madagascar.

Although these ideas may seem simplistic, the implementation of these requires effort and attention from all sectors of Madagascar. For example, in order to encourage farmers to use the rice made to fit Madagascar's environment in place of their conventional rice, the national government can give an incentive to the farmers that may not want to spend the extra money on the rice. In order to do this, the government should lower the price of the modified rice to the cost of regular rice for the farmers, or the government can pay the farmers extra if they farm with the modified rice. This method of compensation would also work with promoting the use of millet and sorghum in order to sustainably use their resources. In order to acquire the money to give to the farmers, the government can allocate a portion of their budget to investing in crops that would benefit their country in the long run, or receive financial aid from other countries or organizations specifically for their food security. For example, the national government could ask for a loan from the World Bank, and pay the fees back when the nation is in a stable stage. The community as a whole would evidently have to be willing to plant the new rice, and learn how to grow them properly. As for the urban and rural farmers in order to execute these new crops, would be committed to plant the crops, and sell to local markets if there is excess from their family for the same price as conventional rice in order to reduce food insecurity and to help Madagascar's economy overall. However, the farmers should be able to sell the rice at the same price if the government is compensating them. The same involvement from all is also required for the implementation of protecting the corals and trees. As exemplified through the policies on the slash and burn method, fines and penalties do not stop the people from practicing the prohibited. Therefore, strict oversight should be given to the corals and trees, accompanied by teaching the farmers and citizens the reasoning behind their policies. By educating the people, more respect will be given to the policies and to the national government. The United Nations could assist by gathering countries and alerting them of the delicate ecosystems of the coral reefs around Madagascar, and to have caution when fishing or commuting around Madagascar. This would allow for minimal interference while this project is being expanded. Inevitably, help from the rural farmers and urban farmers is needed, as aforementioned when their crops do not yield well, they resort to obtaining wood and turning it into charcoal, depleting the beneficial rainforests. This intertwines with growing the drought tolerant plants, that will prevent the citizens from resorting to selling charcoal. These involvements for the recommended solutions allow for assurance that the ideas will execute with little financial, social, and political hindrance.

By expanding current efforts and reaching out to global organizations, plants could be the future of Madagascar. Since Madagascar is so focused on agriculture, aiming solutions at the people's main source

of income and livelihood will prove to be effective and efficient. Using the Malagasy proverb of using the past's events to guide the future, seeing how preserving trees and coral, and how planting optimal plants for Madagascar's environment can drastically help, it is clear to see that these solutions are the most beneficial ones that will work almost instantaneously. These are the most logical solutions for the impoverished in Madagascar as they benefit the rural farming families as much as they benefit anyone else. The combatting of climate volatility and its effects will ensure that barriers like pests, cyclones, and prolonged droughts will not be as much as a limiting factor for the farmers as it is right now for them. If not acted upon, the delicate ecosystem and environment of Madagascar is going to deteriorate year after year with the detrimental rising temperatures. However, access to markets will have to be open more for food security to become a reality for the Malagasy. In addition, with more food being produced, families will no longer need their children on the fields, resulting in that the children are able to obtain an education, carrying themselves out of the cycle of low paying jobs.

Despite natural disasters still occurring, with nothing that the Malagasy can do to stop them, the Malagasy are able to react to them intelligently through the proposed solutions. The 80% of the population who are subsidence farmers will find themselves with more resources than needed and will begin to decrease their food insecurity, as well as the community and village around them. These plants are the start of beginning after the end for Madagascar; they provide immediate and long term solutions for the island and strategically use Madagascar's ecosystem and natural resources to their benefit. Madagascar's plants and their preservation will lead to Madagascar's own preservation.

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