

Norwegian University
of Life Sciences

Master's Thesis 2020 30 ECTS
The Faculty of Landscape and Society

Uncertainty and Inaction: a study on forces of concern in the Cerrado of Mato Grosso, Brazil

Benjamin Scott Wolley
International Environmental Studies

Acknowledgements

A big thank you to all who were involved along the way and made this study possible.

First, many thanks to my advisor, Associate Professor Esben Leifsen, whose patience, support and advice made the completion of this project a possibility. Through many periods of my own uncertainty his guidance was instrumental.

I would like to also extend thanks to the people of Mato Grosso who were kind enough to welcome me and participate with my study.

Additionally, I thank the professors, advisors and staff of the two universities I attended during my degree program, Norwegian University of Life Sciences and University of Maribor, who introduced me to new ideas and concepts which helped to shape and enrich my academic studies.

Finally, thanks to my friends and family, many of whom gave their support from abroad.

Any errors are mine alone.

Abstract

This study is an analysis of uncertainty and inaction among actors of the agricultural industry in the *Cerrado* region of Mato Grosso, Brazil. The *Cerrado* is a vast savannah biome neighboring the Amazon and is fraught with both concerns for the environment, the sustainability of industrial farming and those seeking land rights within it. The region, which is the largest exporter of soy in the world, is of great ecological importance but presently lacks strong protection and is experiencing vast deforestation due to industrial agriculture. There are colonization projects to provide land rights to landless farmers, however the process also presents uncertainties in adaptation. As such it requires further study to understand how and why only limited responses to climate change are enacted. Data was collected through qualitative interviews of individuals living in the region and through selected literature. The information was analyzed to see how uncertainty arose among respondents and how this can lead to inaction. Uncertainty was identified surrounding continued soy production, climate change and land tenure. Responses to reduce uncertainty proved difficult for many respondents due to limited resources, knowledge gaps and skepticism. The results suggest uncertainty will remain as a cause for inaction unless methods to reduce it can be proven effective. Further findings indicate that complex land tenure regimes as well as weak enforcement of nature protection both need to be addressed with a firmer stance.

Table of Contents

Acknowledgements	ii
Abstract	iii
Table of Contents	iv
1.1 Background	1
1.1.1 The <i>Cerrado</i> and Agriculture Within It.....	1
1.1.2 Small-Scale Farming, Settlements and Colonization	6
1.2 Problem Statement and Research Questions	10
1.3 Theoretical Framework.....	11
1.3.1 Uncertainty	11
1.3.1.1. Introduction.....	11
1.3.1.2. Uncertainty	12
1.3.1.3 Risk and Ambiguity	14
1.3.1.4. Effects.....	16
1.3.1.5. Summary	17
1.3.2 Inaction	17
1.3.2.1. Introduction.....	17
1.3.2.2 Causes	19
1.3.2.3. Responses.....	22
1.3.2.4 Summary	23
2. Methods	24
2.1. Area of Study.....	24
2.2. Research Design	24
2.2.1. Qualitative Research	24
2.2.2. Data collection, Sampling and Analysis.....	25
2.2.3. Interviews	26
2.3 Privacy and Limitations	28

2.3.1. Information letter and consent	28
2.3.2 Limitations.....	28
2.3.3. Personal Data	29
3. Results and Discussion	29
3.1 Introduction to Study Area.....	29
3.2 Description of participants.....	32
3.3 Uncertainty and Inaction	32
3.3.1 Soy Production	32
3.3.2 Climate Change.....	35
3.3.3 Land Tenure.....	44
4.0 Conclusion	50
4.1 Research Question 1	50
4.2 Research Question 2	50
4.3 Concluding Remarks	51
5. References.....	53



Figure 1: *Cerrado* vegetation showing signs of controlled burning near Sorriso, Brazil. Photo taken August 2019.

1.1 Background

1.1.1 The *Cerrado* and Agriculture Within It

The *Cerrado*, Brazil's savannah vast biome seen above in Figure 1, has been noted as one of the most ecologically diverse regions in the world (Strassburg et al., 2017). Despite its size and importance, until recent years, little attention has been paid to conservation in this region, with the Amazon biome dominating Brazilian and international conservation efforts. These have had considerable success, with mechanisms such as the Soy Moratorium drastically reducing deforestation due to soy cultivation (Gibbs et al., 2015). However, this control was implemented solely in the Amazon, leading to the unintended consequence of soy expansion in the *Cerrado*. This has led Brazil to be the world's largest producer and exporter of soy beans. With food commodity, animal feed and biofuel industries increasing demand for soy, both within and outside of Brazil, there has been year on year growth of this market, with much of the natural vegetation land converted to soy farming coming from the *Cerrado* (Sawyer, 2008). While great wealth has come about due to the ever-expanding soy frontier, this has profound negative impacts for the environment and some of those living in the region.

To create an over view picture of the economic, ecological and social situation in *Cerrado* the following will be discussed. First a look at the study area, the *Cerrado* portion of the state Mato Grosso in Brazil. It will include discussion on agriculture and soy production in the region, along with the continued impacts of cultivation on the environment and on individuals. Lastly the land tenure and colonization of landless farmers in the state will also be discussed, regarding the complexity of the system and how it impacts upon those living there.

Mato Grosso is one of 27 states of Brazil, and one of the largest, shown in Figure 1 below. The state is covered by three ecological biomes as shown in Figure 2 below, the rainforest (Amazonia), wetlands (Pantanal) and savannah hence force referred to by its Portuguese name *Cerrado* (Lathuilliere, Johnson, Galford, & Couto, 2014). Mato Grosso, while one of the largest states, represents only about 1.5% of Brazil’s population, meaning the density is quite low. This is reflected in its mainly agrarian society, a mix of both traditional and continuously expanding industrial farming (de LT Oliveira & Hecht, 2017). This farming, though almost entirely on the latter of the two forms mentioned, has brought great wealth to some in the region, topping salaries in far more developed states (Richards, Pellegrina, VanWey, & Spera, 2015). As well as leading to development of infrastructure and services in the region (Fearnside, 2001b). However, soybean farming remains inaccessible for the majority of farmers due to large inputs and initial resources required.

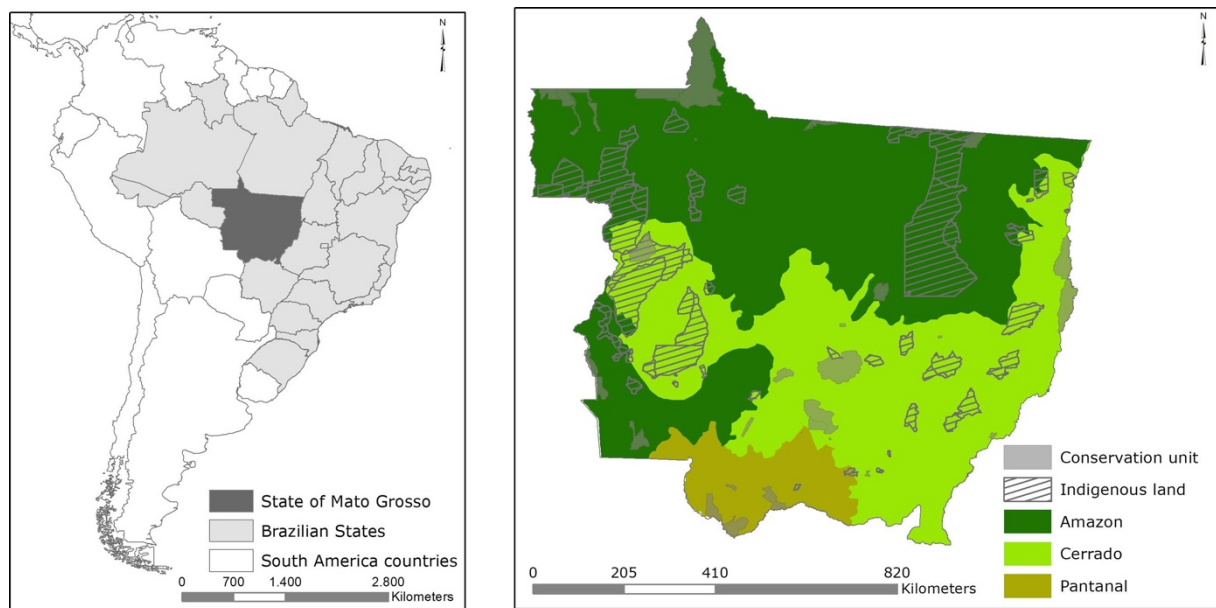


Figure 2. Mato Grosso's location within Brazil as well as a map displaying ecological biomes of the state. Adapted from Lathuilliere, M., Johnson, M., Galford, G., & Couto, E. (2014). Environmental footprints show China and Europe's evolving resource appropriation for soybean production in Mato Grosso, Brazil. *Environmental Research Letters*, 9, 074001. (Lathuilliere et al., 2014) Copyright 2014 by the Name of Copyright Holder. Adapted with permission.

In recent years the rapid expansion of the soy frontier, both from production shifting from the Amazon biome and newly cleared land, has generated great investment (Lathuilliere et al., 2014). This has transformed a savannah landscape made up of small-scale farms, into one dominated by large industrial farms (Adams, 2008). While this has brought much needed infrastructure to the region such as the BR-163 highway, it has also allowed traditional farmers to become marginalized (Fearnside & de Alencastro Graça, 2006). These improvements have made the once difficult to access region more reachable, bringing in groups of both wealthy farmers trying to capitalize on the agriculture boom, especially soy and landless farmers looking for plots of land to cultivate on a subsistence level.

The importance agriculture has for the economy in Brazil cannot be understated. In 2014 it represented around 20% of Brazil's GDP (de LT Oliveira & Hetch, 2017). In Mato Grosso, this number swells to over 70% when including both sectors of agriculture and the supporting agribusiness industry (Guilhoto, 2004). Within some of the major cities in the *Cerrado* there is great pride and appreciation for the industry which has brought the region to international prominence. The region often gets the title of "Soybean Capital of the World", and individual cities in the *Cerrado* use it to promote themselves as such (Peine, 2010). There are several factors which help influence this and give Mato Grosso an economic advantage in drawing individuals to migrate and participate in this industry.

It has been shown across Brazil that land clearing is linked with the price of land (Cattaneo, 2008). Due to the low population density there are many opportunities for conversion to farmland. This conversion, known as extensification of land, along with intensification (increasing output per area) are a direct result of increasing agricultural, mostly soy, opportunities in the region (Lathuilliere et al., 2014). These methods are greatly increasing output to meet demand, however focusing on increasing yield often permits overlooking negative externalities that it brings about (Pretty, 2018). Considering that soy demand is increasing, as well as production in Mato Grosso, it is likely the agriculture sector will continue to dominate the state for years to come. As such it is important to examine the negative impacts caused by this industry.

Despite the importance, and in recent decades boom, of agriculture in the *Cerrado*, the ecological make-up of the region does not create the easiest cultivable conditions without intervention. The soil in the savannah is often weathered and not nutrient rich (Richards, 2015). As such, industrial farmers must resort to nitrogen rich soil fertilizers to ensure high yields, often from international suppliers (Lauthuiliere et al., 2014). Soybean farming also leads to soil compaction and erosion (Fearnside, 2001b). This already fragile soil is further strained by soy production which most often employs the use of chemicals and pesticides, known as agri-toxins in Brazil, which can damage both soil and water sources (G. d. L. T. Oliveira & Schneider, 2016). Nutrient loss in soil is devastating as it is considered non-renewable on a human time scale (Gomes et al., 2019). With the delicate environmental conditions of soil and water, as well as the people who depend upon them, further expansion of harmful agriculture can have profound impacts.

Irrigation is an important factor when considering agriculture in Mato Grosso. The *Cerrado* biome has two distinct seasons, dry and wet. The wet season, from September to April, accounts for over 95% of yearly rainfall (Bäse, Elsenbeer, Neill, & Krusche, 2012). This aligns with the traditional soy growing season as it is water intensive (Lauthuiliere et al., 2014). While generally there is no need for irrigation for soy, double or even triple-cropping per year is common with varied crops during the dry season. As such irrigation is needed during the dry season, causing year-round high demand for water (Lauthuiliere et al., 2014). The dry season can see a number of different crops such as cotton, corn and sunflowers, but the biggest during the wet season is soy.

Soy cultivation requires considerable inputs in addition to water, to include machinery and pesticides which favors large, commercial farms. However, the industry is not labor intensive, so it brings few full-time jobs. Despite some national programs designed to support soy cultivation by small-scale soy farms, large operations dominate the landscape of Mato Grosso (Júnior, Leite, Clemente, & Perez, 2012). The negative environmental impacts this have been reported extensively, and the 2019 Amazon wildfires which garnered worldwide attention are coupled with increased soy production. While international condemnation of the practices and ever-increasing soy frontier persists, there are farmers and officials in Mato Grosso pushing for expansion of farmland. Even with difficulties, such as soil nutrient depletion, high investment, workers inequality and chemical inputs, industrial agriculture is the dominating industry in Mato Grosso with growing environmental concerns.

The *Cerrado* has been referred to as a biodiversity hotspot, with a large number of endemic species (Strassburg et al., 2017). Across more than 2 million square meters the *Cerrado* hosts over 160,000 species, many of which have co-evolved with each other (Ratter, Ribeiro, & Bridgewater, 1997). Recent trends in increasing land use for agriculture have threatened some species due to decreased natural vegetation. The shrinking area remaining for the rich biodiversity is a concern for conservationists, as is the increasing carbon emissions due to agriculture (Richards, 2015). These two factors have garnered some response to protecting the savannahs of Brazil, however when compared to the Amazon this response has been far less.

Despite its intrinsic value, the *Cerrado* has not been afforded large protections like the neighboring Amazonia biome. In fact, soy farming was recognized as a driver of Amazonian deforestation, leading to the voluntary zero deforestation Soy Moratorium. This encouraged soy supply chains to source their soybeans from farms located in the Amazon which did not expand into natural vegetation and had both positive and negative impacts (Gibbs et al., 2015). It must be said firstly that land clearing in the Amazon did decrease following the Soy Moratorium, dropping to about 1% of soy expansion (Gibbs et al., 2015). The vast majority now instead taking place on already cleared land, such as pastures. However, as the main culprit for forest clearing in the Amazon has always been cattle ranching this now gave a loophole for farmers to switch soy production to their already cleared pastures and clear new land for grazing (Junior & Lima, 2018). Furthermore, the Soy Moratorium was only valid for the Amazon biome, meaning the *Cerrado* received no protection. In the years following its implementation land clearing for soy in the *Cerrado* remained high (Gibbs et al., 2015). The unintended consequences of protecting the Amazon leading to increased land clearing in the *Cerrado* shows the undervaluing of the fragile ecosystem. This is further reflected through governmental policy.

In contrast to the Soy Moratorium only protecting the Amazon, Brazil's Forest Code extends protection to the *Cerrado*. The Forest Code (FC) rules that 20% of privately owned land in *cerrado* must be maintained as natural vegetation compared to 80% in the Amazon Biome (Soterroni et al., 2019). While this extends at least some protection, it greatly contrasts the protection given to the Amazon by both the FC and Soy Moratorium. Furthermore, critics say enforcement is difficult given the vast spatial aspects of protection the *Cerrado* (Gibbs et al., 2015). Though there exists considerable land already cleared that could be used for soy farming, there is evidence the FC is not being adhered to and enforced leading to clearing in

more accessible areas of Mato Grosso (Gibbs et al., 2015; Soterroni et al., 2019). The success of the Soy Moratorium is contested, especially due to the spillover effect outside of the Amazon. It has been noted the two biomes are highly interlinked, thus protecting only one can lead to severe impacts on the other ((Sawyer, 2008). The *Cerrado* suffers from a lack of protection of the Soy Moratorium and a weaker, and often unenforced, application of Brazil's Forest Code. As such is it expected land clearing will continue to carve away at the unique ecosystem which exists in the *Cerrado*.

The rapid increase in industrial agriculture is directly linked to land use change and weakening of the savannah biome. However, the economic prosperity it has brought to some and the environmental damage that is occurring are not the sole outcomes of this process. It impacts the people living in the region as well, with varying degrees of affects. The already well positioned have been able to capitalize and expand their operations (de LT Oliveira & Hecht, 2017). Unfortunately, this leaves the majority struggling to find success in a region dominated by large scale farms (Adams, 2008). This becomes exacerbated with Brazil's complicated land tenure and colonization schemes aiming to assist the disenfranchised.

1.1.2 Small-Scale Farming, Settlements and Colonization

The agricultural boom in Mato Grosso has brought great wealth and prosperity to only some of its residents. Since soy is a crop with heavy inputs, it is far more suitable for mechanized farming, leaving small-scale farmers out of most opportunities. While small-scale farmers far outnumber those with large operations, the area under their cultivation is a small fraction compared to that under industrial farming systems (Mier y Teran G.C, 2015). Despite the lesser footprint, these small-scale farms provide Mato Grosso and Brazil with a significant amount of food production, as well as jobs. It is estimated that around 38% of total agricultural value produced in Brazil comes from small-scale farms (Rocha, Burlandy, & Maluf, 2012). These farms help reduce food insecurity, especially in rural regions while also providing income for those in areas with limited employment options. Furthermore, they help protect traditional knowledge in farming, which large-scale agricultural expansion is eroding (Adams, 2008). While they provide benefits to a larger number of individuals when compared to industrial agriculture, these farms exist in a space of modern-day colonization which creates complications to their existence and success.

Given that climate change will likely cause upsets to food security, ensuring access to nutritional sources is key (Wheeler & Von Braun, 2013). This will be critical in areas like the

Cerrado as compared to the global north. Family farms in Brazil produce mostly staple foods such as manioc, beans and rice but also sometimes cash crops like soy and coffee. Staple crop production in family farms has helped reduce hunger in recent years, assisting Brazil in reaching Millennium Goal targets six years early (Rocha et al., 2012). This is in contrast to the industrial farms in Mato Grosso which are export oriented, especially soy which is sent worldwide directly from the region (Jepson, 2006a). While agriculture such as soy has benefited more than just wealthy land owners, in areas such as infrastructure improvement, it does not help greatly in feeding the poor nor providing them with a livable salary.

One striking feature of small-scale versus industrial farming in Brazil is that the former generates, on average, 89% more income per hectare than large scale (Rocha et al., 2012). While showing the efficiency of family farming, it also reveals that far more people depend on this income. It contrasts with industrial farming which requires far fewer workers, as it is highly mechanized (Adams, 2008). Increasing land in the *Cerrado* under soybean farming actually results in a reduction in jobs, as it is common for small-holder land to be consolidated and sold. While the biodiversity is highly important to be protected, so too are the rural landscapes and viability which family farmers have created (Brannstrom, 2005). While historically Brazil has always had a strong large-scale industrial sector, from sugarcane, cocoa and coffee to the modern-day soy industry, small-scale farming provides far more employment and wages and thus support a wider population (Rocha et al., 2012). In addition, small-scale farmers are the ones who carry down traditional, and often key, knowledge of agriculture.

Traditional agricultural knowledge encompasses the knowledge which is passed down to and among farmers about agricultural systems. While it is often disregarded in favor of scientific knowledge, traditional knowledge plays a major role in small-scale farming and represents the ‘surviving’ knowledge which has proven useful over time (Norgaard, 1984). It can include crop selection and information on how this crop interacts with certain environments and responds to different inputs (Brush, 2005). In the *Cerrado* where large industrial farms gain more land each year, encroach on settlements of small-scale farmers, traditional knowledge is not appreciated. Through this process, there is a loss of traditional knowledge of utilizing the land such as identifying fertile soil areas in a biome with poor nutrients (Adams, 2008). This knowledge is best protected when small scale farmers have rights to land and the ability to work it as they know it. However, land tenure in Mato Grosso, and Brazil as a whole, can be quite complicated.

For decades there has been a large-scale migration into Mato Grosso, with a mix of wealthy farmers from the south and poorer farmers from the northwest (Mier y Teran G.C, 2015). The former are often drawn by the cheaper price of land (Cattaneo, 2008). Though the lack of protection and enforcement towards land clearing in the *Cerrado* likely also has an influence. There is also a large population of traditional farmers who were settled here through colonialization schemes, both public and private. While private colonization is not as common, it did originally help shape some urban areas in Mato Grosso. Private colonization occurred mostly between 1970-1990 in the region (Jepson, 2006a). It was brought about both through non- and for-profit initiatives which sold private land to encourage resettlement into rural areas (Rausch, 2014). This includes some present-day cities, such as Sinop, or as it was originally known *Sociedade Imobiliária do Noroeste do Paraná* (Northwest Parana Real Estate Company) began through private settlement (Leão Rego, 2014). While during its time this did bring in a great number of settlers and offer a relatively straightforward path to land tenure it has given way to other forms of local colonization (Rausch, 2014). Today the most common forms are public and spontaneous (also known as invasion) settlement.

With respect to land tenure movements there are various actors at play in Mato Grosso and wider Brazil. *O Movimento dos Trabalhadores Rurais Sem Terra*, MST (Landless Rural Workers Movement) is a peasant movement aligned with *La Via Campesina* and has found success throughout Brazil in giving landless peoples their own plots of disused or underutilized land in which to cultivate (Blesh & Wittman, 2015). Another, *Instituto Nacional de Colonização e Reforma Agrária* (National Institute for Colonization and Agrarian Reform), or INCRA, is a public institution designed to find similarly unproductive land and allot it those who can then settle upon it (Reydon, Fernandes, & Telles, 2015). While both organizations seek to give land to those who have the ability to work it but lack the land rights, they differ in one key aspect. MST, once finding land which has legally been deemed underused, will invade the space and work to gain legal control of it through the government, while INCRA first makes a decision on what land will be reappropriated and then who will receive it (Blesh & Whittman, 2015).

These movements have redistributed land across Brazil and Mato Grosso, and today there exist settlement communities of small-scale farmers (usually between 50-120 hectares each) (Lima, Skutsch, & de Medeiros Costa, 2011). In Mato Grosso *MST* operates but with less frequency than other states. Land invasions are carried out by groups of collective farmers,

who can also work with INCRA to legitimize their titles (Perz et al., 2010). These abandoned spaces are targeted by schemes such as INCRA to take land which is already cleared for agriculture and distribute it to farmers without any land themselves. The goal is to take this unproductive land and turn it into a productive space for farmers who lack means to purchase it. This permits them to contribute to both their wellbeing and the Brazilian economy (Reydon et al., 2015). INCRA continues to resettle farmers in interior states with a far lower population density from coastal ones (Lisansky, 2019).

The first way to receive land requires landless farmers to apply for it and also not currently hold any state appropriated lands (Lima et al., 2011). The land is free to be worked as farmers see fit, and once the deed is obtained, they can sell or lease it. While the land allotted is often small and has an element of luck as to who receives it and its location, there are benefits to living in INCRA settlements including accessibility. INCRA has been instrumental in having roads built to their settlements to allow for transport of goods and materials (Fearnside, 2001b). INCRA also offers credit for farmers, to invest in tools and the development of services (Faber, 2003). Since there are limited credit systems in place this offers a lifeline to farmers to invest in their own enterprises.

With respect to services in settlements, this is weighed down by bureaucracy. INCRA does offer assistance in bringing services such as electricity, water and medical support to settlements. This can be a long drawn out process, with some reporting yearlong struggles to gain electricity (Faber, 2003). Despite that, non-INCRA settlements around Brazil have a harder time gaining access to services and have little assistance in putting pressure on the government without a public body backing them. This is evident through one study which found 91% of settlement households with electricity when compared to 61% of rural farm households without it in Alagoas, another state of Brazil (Cavalcanti & Barros, 2007). Brazil itself is known for difficult bureaucracy, and INCRA is no exception – however it does offer some leverage when compared to those not settled through it.

For those who choose to engage in spontaneous settlement, as is common with MST aligned movements, there are some key advantages and disadvantages. One of the biggest factors is that through invasion of unused land, the settlers have control over where they go. This allows for preparation and selection of the most suitable sites. Furthermore, it is immediate as opposed to lengthy application and settlement through INCRA (Lidansky, 2019). However, this method makes getting proper land title difficult and creates an informal market, which

does not provide guaranteed continued land tenure (Jepson, 2006b). It had also been linked to violent clashes over land without clear ownership (Jepson, 2006b). This has occurred between invaders and the owners of the disused land as well as between settlers (Alston, Libecap, & Mueller, 2000). INCRA can step in to formalize spontaneous settlements or squatters, but there is no guarantee of this occurring. It is most effective when spontaneous settlements exist with a larger number of individuals or families (Faber, 2003). Settlements in general can gain more benefits if operating with coordination between plots.

While soy is mostly grown by mechanized farmers, up to 19% comes from small farms (Rocha et al., 2012). Due to a social contract implemented by the Brazilian National Program for the Production and Use of Biodiesel (PNPB), a small number of small-scale farmers have also turned to this lucrative crop. This contract obliges biofuel producers to secure 15-30% of their raw material stock from small scale farmers, varying by region and type of oilseed (da Silva Júnior, Vianna Leite, Clemente, & Perez, 2012). However, the biofuel producers often choose settlements with the best conditions such as flat fields and accessibility, limiting who can participate (Lima, Skutsch, & Costa, 2011). While subsistence farming has long been a staple of rural Brazil, through programs such as PNPB, there are some incentives for small scale farmers to move from subsistence to a more economically rewarding farming scheme. This is made only in some settlement communities which are favored but could be a way for coordinated communities to take advantage of this cash crop.

Across the state now exists large territory under industrial operation, and small communities of farmers with plots under 100 hectares (Lima et al., 2011). These small operations have a number of benefits, particularly socially and environmental, however they exist in the highly contested space of land tenure in Brazil. While progress has been made in distributing land to landless farmers, this is a complicated process leading some to skip it in favor of invasion. Both methods are recognized by land reform movements in Brazil but only the former guarantees assistance in community building.

1.2 Problem Statement and Research Questions

Large scale industrial farming, especially soybean cultivation, has transformed the *Cerrado*, Brazil's savannah biome (de LT Oliveira & Hecht, 2017). Years of agricultural expansion have turned the region, and Brazil, into a major soybean exporter and brought both wealth and questions of sustainability and equity to the region (Fearnside, 2001b; Gollnow & Lakes, 2014). The *Cerrado* is home to megadiversity in Brazil and contains many endemic species

and once vast forests (Martinez-Alier, 2003; Strassburg et al., 2017). Despite this, its neighboring biome, the Amazon, has received stronger protection including the Soy Moratorium which had the consequence of shifting soy farming from the Amazon into the *Cerrado*, exacerbating problems. This is occurring in a region which could be greatly impacted by changing conditions especially anthropogenic climate change and could further complicate complex land tenure regimes which cause uncertainty among those living there. As uncertainty is one cause for inaction there is need to examine how it manifests among individuals in the *Cerrado* (Gifford, 2011). Without addressing uncertainty, further inaction or delayed responses towards both climate change and land tenure reform are likely. With this in mind the following research questions were formed.

1. How does uncertainty affect inaction towards climate change by actors in and around the agricultural industry of Mato Grosso?
2. How does land tenure complicate uncertainty and inaction among stakeholders in Mato Grosso?

1.3 Theoretical Framework

1.3.1 Uncertainty

1.3.1.1. Introduction

Undoubtedly present in life, uncertainty has proved to be barrier in decision making thereby impeding results and livelihood improvement (Gray, 2011). There are a wide range of interpretations for this phenomenon across varied fields of science and humanities. While these interpretations vary, uncertainty itself rises from a state of having either an incomplete view of a situation or the potential results of a decision be unknown (Aimin, 2010). There are some who suggest uncertainty as an opposite to knowledge (Davidson, 1988). In environmental sciences uncertainty plays an important role as its reduction can lead to both better informed decision making and innovation (Ettlie & Bridges, 1982). These are critical qualities to have during an epoch during which earth systems are affected by human activity and will require action on the part of many to mitigate environmental damages.

Uncertainty is contextualized uniquely by different people. It can be said the future itself is uncertain, but uncertainty is exacerbated with forces individuals have little control over such as climate change (Polasky, Carpenter, Folke, & Keeler, 2011). It is crucial to understand how uncertainty manifests to different actors, and how they both interpret and choose to respond to it. There are a great number of factors which can affect how one encounters and views uncertainty within their societal position. While these factors are not uniform, it has been

shown education level, security, health and household size can play a major role (Akay, Martinsson, Medhin, & Trautmann, 2012). These are most often tied to socio-economic status, therefore, how the impoverished and wealthy view uncertainty, and use it in their decision making can vary greatly (Akay et al., 2012). While neither can be rid of uncertainty in its entirety, it is important to note its effects on each group are often different. Hence the decisions and outcomes surrounding it are also varied.

This section will attempt to present the different ways uncertainty is present with respect to the environment and agricultural development. First by examining uncertainty itself, with focus on livelihood status as a factor. Assessing uncertainty by dichotomizing risk versus ambiguity will follow. Lastly the effects as well as ways to reduce and respond to uncertainty will be discussed.

1.3.1.2. Uncertainty

While there is overwhelming evidence and belief in climate change and its potential devastating effects, there is also a great deal of unknown regarding its extent, impact, who and where will the greatest effects be felt, and who bears the burden. Even if it were possible to convince the entire population of climate change, it is almost inconceivable to have full agreement on the extent of impact, due to vast levels of uncertainty (Martinez-Alier, 2003). Already mentioned were factors that can influence how one views uncertainty, and they can further be divided when uncertainty is viewed from those living in poverty and those living in wealth. In order to consider different viewpoints, with respect to those living in Mato Grosso, uncertainty will first be discussed from these frames of poverty and wealth.

Uncertainty plays a pivotal role in the lives of low-income farmers and workers. Generally, these actors are limited in the diversification of income sources which means they do not have as much flexibility in taking risks, otherwise they can jeopardize their livelihood (Yesuf & Bluffstone, 2009). Furthermore, in addition to the climate crisis these workers face, they too face pressures of everyday life such as providing for families and communities on a limited budget. These are immediate needs which must be addressed before consideration of future responses to climate change can be enacted. Responding to uncertainty could help those in marginalized positions, however in most cases it requires upfront costs that are viewed as high risk by those with limited means (Yesuf & Bluffstone, 2009). Considering this, potentially costly adaptation techniques to climate change which can take time to 'pay off' are often viewed as a risk from an investment perspective.

Uncertainty, especially within groups with limited access to resources and credit, gives rise to reluctance to invest in the absence of a guaranteed positive outcome (Yesuf & Bluffstone, 2009). For those living without vast resources, even in the face of environmental pressures, there will be hesitation to mitigate future damages unless it is proven as a necessity. People feel confident in addressing things they know, and uncertainty has a two-fold impact on impoverished farmers (Akay et al., 2012). Firstly, even in the area in which they are most comfortable, agriculture, adaptations such as switching crops presents a risk. It could come with a benefit of greater income; however, this is not certain. Secondly, responses to climate change too carry risk, and for a farmer to sacrifice a portion of his income to address this there must be a high enough perceived risk (Akay et al., 2012). For those running industrial operations there is also risk in investment, especially if they perceive they are being forced or comparing their position to others (Gifford, 2011). Without an obvious need at the present, the nature of the position for these farmers leads to uncertainty in their decision making, which can lead to little or no improvement of their livelihoods. Without experience to back up their decisions, and by observing others doing the same justifying their own inaction it can be difficult to reduce uncertainty.

While focus on peasant farmers is essential, uncertainty does not just affect the impoverished, but also those at the opposite end of the livelihood scale. The wealthy can escape more easily uncertainty around their land tenure, income and risk. Their ability to adapt is influenced by their capital and in many cases they are willing to take larger risks as the payoff is often greater than the risk (Yesuf & Bluffstone, 2009). This can include investments in new crops or use of fertilizers and chemicals. However, this group is not immune to climatic changes just as peasant farmers. While they might not be pressed into action until future events force them, a reduction in uncertainty and calculated response, even involving risks, might help bring it about sooner.

Uncertainty is often viewed as lacking the knowledge to act on a situation. This can be explained in part by knowledge gaps. Closing these gaps, alternatively deemed ‘narrowing the uncertainties’ is an effort which requires unbiased learning (Hulme, 2018). This works best when access to knowledge is unrestricted, though pursuing knowledge is political and therefore *who* and *what* types of knowledge are accessible may not be the same for everyone (Hulme, 2018). Without equitable distribution of knowledge, uncertainty reduction can favor those who are better able to access it.

1.3.1.3 Risk and Ambiguity

Uncertainty causes decision makers to take a risk. Some define risk as being the situation arising when all outcome probabilities are not known, bringing uncertainty when this condition is not fulfilled (Aimin, 2010). However, others have said that not all uncertainties are risks (Ellsberg, 1961). It is possible to further divide uncertainty into risk and ambiguity. The former represents unknowns where the probability for each outcome is known, such as coin toss and later when the probability is unknown, such as chance of rain next week (Akay et al., 2012; Scoones, 2019). Another interpretation of the two has risk as the condition of known probability and outcomes and ambiguity as where these are contested (Scoones, 2019). In both cases risk is calculable, and ambiguity is less so, which has been shown to cause another dividing line between the rich and poor in the ability to respond to each. Specifically, the poor tend to be averse to both risk and ambiguity, with the rich avoiding the latter (Akay et al., 2012). As uncertainty brings about both, understanding how these impact individual's ability to respond is needed.

Risk is presented as a hurdle to decision making, but one which can be taken into account in a calculated manner. Farmers are facing increased scrutiny in adopting practices that are better for the environment, regardless of their background factors (Greiner, Patterson, & Miller, 2009). In doing so, risk must be assessed, and probable outcomes considered. In most cases it has been shown that those living with limited means are more risk adverse than the wealthy, as even minor disruptions can more severely impact them and they lack access to credit which would assist in the event the risk does not pay off (Yesuf & Bluffstone, 2009). Risk must be considered as one seeks to minimize this calculated uncertainty to have a chance at the desired outcome. However, the position of said decision maker helps to shape how he or she interprets risk. Even when the uncertainty is calculable, the means in which to address it are not equal (Aimin, 2010). Without equal access to credit, resources and knowledge/experience, vulnerable groups such as low-income farmers tend to avoid risk to stick with what they know. On the other hand, the wealthy are willing to make risks, as the impact of an undesirable outcome has less of an impact and they are more willing to gamble for a larger pay, which poorer groups cannot afford (Yesuf & Bluffstone, 2009). While risk proves to be a prominent element to uncertainty in an underprivileged economic class, both the wealthy and poor demonstrate a willingness to avoid ambiguity.

Ambiguity entails more uncertainties than risk. Ambiguity is subjective and appears when outcomes are unknown or not fully understood (Ellsberg, 1961). For farmers responding to climate change, this is done without many years of proven experience unlike their knowledge of crops. Attitudes towards ambiguity aversion among peasant farmers and wealthy farmers have not had as much coverage as risk in formal literature. An example of ambiguity could be sticking with a reliable crop or switching to a new technology one that does not, as of yet, have a proven track record. The second may provide an opportunity to increase yields, but may be sensitive to local conditions and techniques, causing fluctuation in year to year output (Henrich & McElreath, 2002). While it can be said adaptations are calculable, therefore represent risk, further impacts from changing climatic conditions that have not been experienced are ambiguous. These are not 100% predictable and thus make decision making far more uncertain. As ambiguity aversion has been demonstrated across a wide range of individuals, considerations for it can help explain some unwillingness to respond to complex economic and environmental issues – no matter how pressing they may be.

Uncertainty is used as a blanket term for unknown outcomes. Risk and ambiguity both are encompassed by uncertainty, but each are characterized by the known probability of outcomes. Risk involves decision making based on calculated outcomes and is normally something to be overcome only by those with limited resources. This is due to the nature of those who are wealthier, being able to afford to take risks due to the lower impact it presents to them. Ambiguity, however, has been shown as a deterrent to both impoverished and wealthy, as its outcomes are far less calculated (Akay et al., 2012). Throughout this study it is important to remember that the less wealthy have greater uncertainty present in their lives and less resources to respond to it. Humans are more comfortable in taking calculated risks in areas they are familiar with (Scoones, 2019). However, the outcomes adaption to climate change and agricultural expansion have not been well explored and creates a great deal of ambiguous uncertainty which hinders responses. When addressing uncertainty is it helpful to consider whether outcomes are able to be defined by probability, indicating risk, or are unknown, indicating ambiguity.

1.3.1.4. Effects

With uncertainty an inherent part of the lives all decision making cannot stop because of it. However, it can complicate this process and require greater consideration (Henrich & McElreath, 2002). The unknown is a common fear which must be addressed and is subjective based upon who is facing it (Anderson, Carleton, Diefenbach, & Han, 2019). This unknown, however, must be confronted in decision making. It is even suggested that if individuals were to embrace the uncertainty it could be an opportunity for action (Scoones, 2019). This is not as easy for some as for others. Though it may provide the grounds to take uncertainty and reframe it in order to turn a negative into a potential for action (Hulme, 2009). This can be done through reduction of uncertainty.

While almost all individuals display some risk or ambiguity aversion, a reduction in either one or both can be helpful in avoiding harmful effects of uncertainty (Akay et al., 2012). Complex equations have been modelled to attempt to predict decision making under uncertainty, but it is important to remember there is always subjectivity (Dillon & Scandizzo, 1978; Scoones, 2019). While these attempts to explain how decisions are made, as there is always subjectively present there is always a need to understand conditions and circumstance of those involved in decision making. Reductions in risk and ambiguity provide decision makers more confidence in their choices. These can include providing information related to what is uncertain and experiences of others to evaluate how their decisions turned out. However, often times access to mechanisms which reduce uncertainty are not available to all or come at a price.

Dealing with uncertainty favors the wealthy. They have more resources at their disposal which can allow them to take risks when necessary (Akay et al., 2012). Though peasant farmers may be risk adverse, this does not mean they can completely avoid making risky decisions (Henrich & McElreath, 2002). In order to make decisions under uncertainty, assuming they cannot access the same monetary resources or credit, peasant farmers must either take disproportionately larger risks or wait for others to see the results to reduce their own risk. Given that small-scale farmers have the most to lose and are generally risk adverse, the latter is more common (Yesuf & Bluffstone, 2009).

Lastly, and central to this study is how uncertainty if not addressed can lead to inaction. Even with severe threats to the environment and economy, the uncertain nature of them makes it difficult to take action (Butler, Reed, Fisher-Vanden, Keller, & Wagener, 2014). Inaction is

not brought about solely by uncertainty. In fact, there are a great number of factors leading to inaction, with uncertainty being one (Gifford, 2011). Though uncertainty's existence in the decision process can complicate and exacerbate these other conditions.

1.3.1.5. Summary

Uncertainty has a way of profoundly affecting decision making. It allows individuals to use it to justify skepticism or inaction towards adaptation and climate change (Spence, Poortinga, & Pidgeon, 2012). This has different impact depending upon one's background factors, often linked to their socioeconomic status. For those living with limited means uncertainty, in both the form of risk and ambiguity, can greatly affect their ability to adapt. For the wealthy risk can pose barriers but less so, while ambiguity has a deeper impact as outcome probabilities are unknown. The combination of both of these leads to a system of business as usual, as the uncertainty involved proves too high a cost for many to enact transformation change, at least at the present moment. Bridging uncertainty and inaction, Barret and Dannenberg say, 'whereas collective action fails when threshold uncertainty is large, reductions in this uncertainty may bring about the behavioural change needed to avert a climate 'catastrophe.''' (Barrett & Dannenberg, 2014, p.36). Uncertainty is linked to inaction, but as uncertainty is perceived in different ways so too is inaction.

1.3.2 Inaction

1.3.2.1. Introduction

With climate change an ever-present threat, the need to take action, to adapt, control current and mitigate future damages is necessary. While scholars have attempted to lay out planetary boundaries to keep humanity operating within safe earth limits the response to climate change has not been forceful enough to guarantee this safe space will last (Steffen et al., 2015). This is critical for those involved in the agricultural field. It is an absolute necessity in life to produce food, however agriculture is responsible for a great deal of damage to our planet (Stoknes & Rockstrom, 2018). Considering the pressure that farmers are under to realign their operations to be less impactful on the environment, or in some cases restore it, inaction on their part is used as critique by many outside the field (Greiner et al., 2009). Considering the many other driving factors of anthropogenic climate change, the intense scrutiny of farms may not always be just, however, in order to mitigate the effects of climate change then agriculture is one sector where inaction can be addressed.

Agriculture is key industry in most nations, and especially in developing nations which employs a larger percentage in agricultural operations (Esham & Garforth, 2013). Brazil is no exception, and for the study area in Mato Grosso there are a varied assortment of types of farmers who contribute to the economy and societal community. Something to make clear early on is the divide between the number of small- and large-scale farmers, and the area of land they each use. The small-scale farmers far outnumber large operations; however, the latter group occupy a far greater amount of land and are ever expanding. This dynamic is characteristic of farming in Mato Grosso, and nearby state and countries (de LT Oliveira & Hecht, 2017; Hecht, 2005). The expansion of the soy frontier has seen the transition of traditional farming to the lucrative mechanized farming (Adams, 2008). The effects of this are felt in a number of areas, with increased environmental impact, decreased jobs compared to traditional farming and, considering the high costs of entry, a case of the already wealthy getting wealthier (de LT Oliveira & Hecht, 2017). Despite these negative impacts to environmental and society, little action has been taken to rectify them.

Given the vastly disproportionate land size per farm for small scale farmers, responses to climate change have a smaller impact individually than if a large industrial farm acts). However, small-scale farmers could also improve their livelihoods through changes to more resilient crops, diversifying income streams and taking collective (community) action (Wijen & Ansari, 2007). Throughout this paper inaction will be examined as an effect of the agricultural industry in the face of climate change. It is not to portray small-scale farmers as the driver of externalities in agriculture, that almost entirely lies with industrial farming, particularly soy in Mato Grosso. However, inaction is also an effect that hinders implementation of sustainable farming practices and potential future security in a changing environment, so even if small-scale farmers actions alone are not enough to balance agriculture to safe earth system levels, they have the ability to take smaller actions to maintain and better their positions.

However, despite the incentive for improvement, and the potential for irreversible climate change effects, inaction is extremely prevalent (Gifford, 2011; Steffen et al., 2015). Despite that, recent years have shown small steps in the right direction, after decades of inaction (Watts et al., 2018). While not enough to declare any early victories, overcoming inaction to bring about change is a real possibility. In order to show this, and further relate it to interviews from Mato Grosso, causes of inaction will first be examined. These will include some of Robert Gifford's Dragons of Inaction such as distancing, complacency and of course

uncertainty. Effects of inaction will then be discussed including the approach to global tipping points and delayed response. Lastly response to inaction will be discussed, to include transformational adaptation.

1.3.2.2 Causes

Inaction is prevalent across all actors. Like uncertainty, its causes vary greatly from individual to individual and are subjective. While fully rational actors would weigh costs and benefits fully before decision making, there are many causes that give hesitation or cause the actor to take no action at all (Johnson & Levin, 2009). Since perfect rationality can never be assumed, all individuals have some biases or interferences which give rise to inaction (Johnson & Levin, 2009). Robert Gifford, a psychologist, attempts to give logic behind the phenomenon of inaction.

Gifford identifies what he calls the “Dragons on Inaction”. These 29 different dragons are set in seven categories of: limited cognition, ideologies, comparisons with others, sunk costs, discredence, perceived risks and limited behavior (Gifford, 2011). In some fields humans are viewed as perfectly rational actors, especially within Rational Man Organizational Theory (or Economic Man). This theory assumes the individual uses total rationality in his pursuit to maximize utility or achieve goals (Argyris, 1973). However, this uses an actor which in reality does not exist. Humans are affected by a number of influences, and in Gifford’s work dragons, which influence their perspectives. Individual thinking is not always rational, and his use of dragons to illuminate barriers in thinking helps show why inaction, even if irrational, is the chosen course or action (Gifford, 2011). While a ‘Rational Man’ actor would seek the maximum benefit, this fictional character would also need perfect information and see through any possible forms which impact his thinking.

Too often studies assume rationality for rural farmers, especially when expected to fall in line with top down approaches, when this is not the case (Blaikie et al., 1997). While rationality would benefit humans, Gifford says humans are not near as rational as once thought. Instead, as he highlights through dragons listed in the category of limited cognition, individuals are affected by uncertainty, ignorance and optimism bias, among others, which limits them in acting (Gifford, 2011). Ignorance can be justification for some to discount traditional knowledge as they fail to understand where or how said knowledge comes about Others share his views but add that limited cognition cannot be used as a justification for inaction (Baas &

Ramasamy, 2008). Rather studies should consider where these pitfalls of inaction occur and how they can be better understood and overcome.

In addition to limited cognition, the remaining categories of Gifford's dragons will be touched upon as they help build a wider framework for viewing inaction. Ideology includes beliefs and views, stressing the importance of perception towards the system one finds themselves in, and if it is just. Comparisons with others is a powerful category as it is also topic of discussion for many authors besides Gifford. It highlights the danger of inaction when seeing others doing the same, or when inequality is present (Gifford, 2011; Wijen & Ansari, 2007). Sunk costs hinder action when investment in a certain area feels more important to maintain, than changing and losing perceived progress. This can also be retrospective, where early investment in adaptation would have been cheaper than the present (Arkes, Kung, & Hutzel, 2002). Discredence shows that mistrust and denial stemming from knowledge of others allows actors to not take advice or respond if they cannot accept the views of others. Perceived risk is Gifford's next category, and he lists several types of risk as a cause of inaction. As risk is part of uncertainty, this is perhaps a way to diversify types of risk but ultimately these stem from uncertainty. Lastly, limited behavior acknowledges that sometimes inaction is actually incomplete, or non-sufficient, action, and often steps taken are not enough. This is justified by individuals in that while they might not be doing everything, they are doing something. Gifford lays out a large number of causes for inaction which make it easy to see how something like uncertainty can hold back investment into personal development and adaptations to climate change.

Some of these sources of inaction are expanded in further literature. Distancing sheds light on the tendency of humans to recognize the severity of climate change but predict the heaviest effects to be felt elsewhere (Spence et al., 2012). This idea allows actors to not take action, even when they if they accept that the situation will have grave impacts for some. Simply they cannot envision it happening to them, which allows them to create a distance between them and problem, making it seem less pressing to deal with (Spence et al., 2012). Awareness alone makes it difficult to create enough certainty that there is a need to respond, at least not immediately based on individuals' perception (Juana, Kahaka, & Okurut, 2013). This distancing can also be impacted by individual beliefs and concerns, as they vary between actors (Arbuckle et al., 2013). Without close up experience or impacts, inaction due to distancing will not be alleviated without a change to personal views.

Complacency is another driver of inaction which allows one to passively ignore or take small, rather unmeaningful steps, towards action (Doan, 2014). With respect to earth systems approaching tipping points such as the two degree increase limit, widespread complacency has allowed mitigations to not be enacted (Ackerman & Stanton, 2006). It is easy for farmers to fall into complacent routines, as when they are experiencing success there is a natural desire to maintain the status quo and keep yields high. Some even suggest that early benefits brought about by climate change (such as small increase in temperature) will lead to some acceptance for the phenomenon and cause some farmers to not wish to upset this small initial gain (Ackerman & Stanton, 2006). Furthermore, even acceptance that there will be a need to act, is it possible to view this a future rather than current problem. Positive illusion, or ability to control future events, allows for compliancy by giving the image that the problem will not become overwhelming in the future and will still be manageable (Johnson & Levin, 2009). Complacency becomes a dangerous game as prolonging inaction almost certainly will increase response costs in the future.

While the above section lays out the many ways in which inaction is caused, it is important to make one distinction from Gifford. He includes uncertainty as a dragon but places it in the category of limited cognition. His model includes seven categories, with each having a number of dragons. While uncertainty certainly plays its role for limited cognition, it has far more impact than being singled out in this category alone. Many more categories hinge on uncertainty, as without a complete knowledge set very little can be certain. Uncertainty should not be excluded as such, but instead understood to be integrated within most causes of inaction.

1.3.2.3. Effects

Inaction, of course, has the effect of a lack or underuse of action. This allows problems to not be addressed to a level which can reach a state of resolve. Considering the social and environmental problems those living in Mato Grosso will face, inaction's effects are already pushing them, and the globe closer to tipping points (Barrett & Dannenberg, 2014). These tipping points, in connection with Earth systems, if reached, represent a moment when the system will be so far out of balance it cannot return to its original state (Steffan et al., 2015). This monumental shift in how the Earth operates cannot be understated and could mean a shift from the planetary state we have prospered under to one in which adaptation proves extremely difficult. Inaction is a driving force for pushing the world to tipping points. Despite a plethora of evidence showing the effects we are racing toward, far too little has been done

(Watts et al., 2018). In Mato Grosso this includes expanding soy industry through land change use, marginalized peasant farming into settlements with limited opportunity and continued use of fertilizer and chemicals. With each passing day inaction allows these to continue unabated, we too approach the as of yet undefined tipping point.

Not knowing where or when this tipping point threshold will be passed creates inaction through uncertainty, complacency and positive illusion that there is still time for action. However, this means that when inaction is shed for response it may be too late. Delayed response can occur when inaction is overcome, but too late, having no or only a partial impact (Watts et al., 2018). This can be seen in small steps made in recent years trying to rectify the climate situation and as of yet have not produced results to rectify climate change concerns. Unless the response to inaction seeks to reduce uncertainty, delayed response will remain a very real possibility.

1.3.2.3. Responses

Methods for responding to climate change inaction are not simple. Given the complex problems faced, and the evidence for limited response in the present, overcoming inaction will take a dedicated shift towards transformation adaptation. If uncertainty is accepted as a precursor to inaction, its reduction could help force proper responses. Uncertainty and inaction together impede response or cause improper or delayed responses to issues which are growing. A proper response would be one that targets drivers of climate change and societal inequality. This can be done through identification of who or what is most vulnerable and rejecting inaction (Eriksen & O'Brien, 2007). Determining vulnerability is a complex process and must look not only at outcomes but also root causes. Furthermore, vulnerability in climate change is often focused solely on analysis of the climate, leaving out the social and political aspects (Eriksen, Nightingale, & Eakin, 2015). Consideration of a more multifaceted approach to vulnerability assessment could lead to a more capable adaptation.

This fight against inaction could be used in attempts to bring about transformational adaptation. This form of adaptation seeks to not respond to effects, but address root causes – which can be important in the event of delayed response (Eriksen et al., 2015). The jump from incremental adaptation to transformational adaptation must note the difference between the two. The former being described as small adjustments which help manage the balance of natural systems and humans (Few, Morchain, Spear, Mensah, & Bendapudi, 2017). Addressing the latter requires greater planning than a top down approach seeking to apply a

one size fits all outcome. Instead, looking at individual or regional situations, and the reasons for why certain groups are vulnerable can lead to planning for transformation adaptation. While this can lead to more meaningful, and lasting, impacts for stakeholders, it is far more difficult to enact than with incremental fixes (Kates, Travis, & Wilbanks, 2012).

Karen O'Brien offers one framework which could prove useful for bringing about transformational adaptation. She proposes a three-sphere nested model with the practical sphere at the core, contained inside the political sphere, further contained inside the personal sphere (O'Brien, 2018). Starting from the center, practical adaptations are the easiest to implement, but offer the least amount of leverage in effective response. Political responses have more weight as it looks at systems and structures, though is more difficult to implement due to scale and political disagreements (O'Brien, 2018). O'Brien believes the personal sphere, the outermost, is most likely to enact transformational adaptation. It encompasses personal and shared worldviews and beliefs and is considered the most powerful as it can lead to individuals to behave in a way that their actions are beneficial to climate goals (O'Brien, 2018). While changing one's worldviews is not an easy task, the amount of action that could rise from personal acceptance of climate issues and the impact of many individuals acting towards a common goal gives hope for unified action towards transformational adaptation.

1.3.2.4 Summary

Gifford says, "the scientific and ethical reality is that a certain degree of uncertainty is an inescapable element of any climate model..." (Gifford, 2011, p.292). At the same time uncertainty cannot be used to justify inaction (Baas & Ramasamy, 2008). If uncertainty is a cause, inaction is an effect. The former gives rise to the latter, and the consequences could be large for both the *Cerrado* and those who call it home. Those who inhabit it could face the effects of climate change. As such it may require addressing before the full effects can be realized. This concerns those living in settlements, who are already the most vulnerable and may not being able to sustain major changes as well as the wealthy. Those wealthy are the same ones who, in some cases, justify their actions based on assumptions of how others act. These moments of inaction may not have negative impacts for the time being, but as we approach global tipping points there is a growing need to have them addressed.

2. Methods

2.1. Area of Study

The chosen areas of study for this project lie in the northern the state of Mato Grosso in Brazil, specifically the cities and surrounding regions of Sorriso and Sinop. Mato Grosso is one of Brazil's largest states and lies in the center of South American continent. Its geographical position lends some advantages to cultivation of certain crops, in particular cotton, corn and most importantly soy. Mato Grosso is identified in numerous publications for its rise in soy production, as well as the negative effects that come from changing land use and intensified agriculture (Gollnow & Lakes, 2014). Mato Grosso as a whole is not only the center of soy production in Brazil but is also at the center of a debate surrounding protection of the *Cerrado*, the savannah biome which covers most of the state. The *Cerrado* is noted for its great species richness as well as a buffer zone to the nearby Amazon region (Werneck, Nogueira, Colli, Sites Jr, & Costa, 2012). Despite its noted importance and its close proximity, it lacks many of the protections afforded to the Amazon (Strassburg et al., 2017).

Sorriso and Sinop were both selected as research sites based upon several criteria. Firstly their proximity to nearby settlements of both landless farmers and large scale soy production facilities (Lima, Skutsch, & de Medeiros Costa, 2011). Furthermore, these cities and their peri-urban surroundings have already received a number of articles and attention due to their competitive advantage in soy production. Additionally, their respective sizes ensured there were additional actors to be interviewed through the public sector (Rural Workers Union, Rural Syndicate, etc.) as well as the private sector (private farmers, NGOs, etc.). Lastly from a logistical standpoint, these two cities provided the easiest way to get in touch with interviewees while at the same time having somewhere to maintain myself while conducting research.

2.2. Research Design

2.2.1. Qualitative Research

As the aim of this project was to incorporate personal accounts of actors both from marginalized groups (i.e. landless farmers and subsistence farmers) as well as from the public and private sector, it was decided to perform qualitative research to collect data from a smaller number of respondents but with detailed interviews and from observations. The data was collected from these varied sources to both see where contradictions and common themes

interwove themselves between respondents. Furthermore, text-based research from journal articles, books, NGO publications and other relevant texts provided additional knowledge and theory to cross reference. Initial plans involved employing a grounded method however the process became more deductive once the theoretical framework was constructed and data was analyzed with it in mind. The analysis of respondent's personal experiences and views along with observations during the data collection period help to build a comprehensive understanding of land tenure and climate change, as well as environmental responsibility in the region.

In addition, in order to corroborate or challenge personal claims by some respondents it was attempted to seek respondents from different sectors and different backgrounds across the board in Mato Grosso. In doing so I increased the chances at narrowing in a more accurate result through the process of triangulation (Berg & Lune, 2012). While my overall sample size of 23 respondents plus observations during my time in Brazil is not sufficient to draw conclusions on the populations as a whole, it can be helped in gaining insights into the study area and building theory. This theory was constructed into the theoretical framework for the study after data collection and analysis led to identification of common themes.

2.2.2. Data collection, Sampling and Analysis

As proper probability sampling would require greater time and means than were available for this project, a mix of non-probability sampling methods were chosen during the selection of those to be interviewed. Additionally, in order to find relevant and current literature regarding the conditions in Mato Grosso, purposive sampling was used to find journal articles and to find initial respondents for interviewing. During each interview there was also a question designed to illicit further potential sources, a method know as snowball sampling where momentum can be built from a small base of sources to expand by asking if they have further leads (Bryman, 2012). Snowball sampling proved useful as it helped to gain referrals for new interview locations as well as in some cases providing direct contact to further sources.

For the purpose of this thesis theoretical sampling was engaged. The goal for this sampling method is to continue with collection and analysis until a point of saturation where very little novel information is incoming (Bryman, 2012). In order to be satisfied with this theoretical saturation, collected data must be continuously reviewed in order to understand where overlaps and discrepancies are formed, and weather future data collection is needed. In doing so I grouped my data when possible (i.e. similar socioeconomic farmers on different

settlements, government employees, etc.) to see when respondents began to repeat already discussed themes,

In order to build a theoretical framework respondents' interviews were analyzed. As initially the study was aimed at researching the possibility of soy cultivation by small-scale farmers respondents were asked to discuss this scenario. However, it became apparent through interviews that there were barriers to this occurring, which came about from the risk and costs involved. This helped uncover the uncertainty which was present in respondents' discourse and introduced uncertainty as piece of the theoretical framework. While respondents rarely outright explained uncertainty in the exact term, the concept arose through their questioning of risks of change, adaptation and the nature of the future developments of their livelihoods. It also came about in the form of skepticism towards impacts of farming or claims of climate change. The uncertainty that respondents exposed help form the second half of the theoretical framework.

Inaction is, in part, explained by uncertainty (Gifford, 2011). When discussing soy with settlement farmers some noted that they knew soy could offer a different income but were hesitant to try to implement it. Uncertainty influenced this form of inaction. However, inaction was present in other interviews in the form of delaying response to climate change, even when a large number of respondents felt it could have severe impacts on the region. When discussing climate change with respondents there was also discussing about how they felt the impacts could affect them, and what could be done about it. Some lacked ability to respond, while others chose not to respond preferring to maintain what they know as business as usual. This inaction was identified through a number of respondents, however the reasons for it were not uniform.

The primary sources for this study were the personal interviews conducted as well as literature (including some non-scientific sources such as company publications, NGO statements, newspaper articles, etc.) regarding environmental and social topics in both the region and a general sense. These, along with observations, provide the collected data to be analyzed in this project.

2.2.3. Interviews

As there was a varied number of respondents, not all interviews progressed in the same fashion. Initially there was intent to have open discussion and observation. However, as the

scope and direction of the project changed, I made a shift to semi-structured interviews, with some questions planned in advance and some raised directly to information received from the respondents during the interview. By incorporating this flexibility there was a chance to change the direction or order of the interview, in the event something was brought up that needed addressing. This is one advantage of the semi-structure interview process, with an additional being the flexibility opens up responses that were not initially intended for but relevant none the less (Bryman, 2012). While in some cases respondents' additional responses to non-intended topics may have added on time and additional analysis, they brought in new perspectives I had not anticipated and therefore were a welcome addition.

In total 23 respondents were directly interviewed, some multiple times, as well as observation on settlements and an event held through the Rural Syndicate office of Sorriso. Below is a list of those interviewed during the data collection process, names with an asterisk (*) were interviewed in English, or in part English:

Respondent Background	Location	Names (changed for privacy)
Former soy and current beef private farmer	Sorriso	Caio*
Agronomy Professor at local institute	Sorriso	Eric*
Local NGO official	Sorriso	Maria
5x farmers on invaded settlement	Near Sorriso	Antonio, Alexandre, Arthur, Anderson, Andre
Farmer with drying facilities for soy	Sorriso	Paula
Seminar on soy agribusiness and trading	Sorriso	-
Former senior Rural Syndicate official	Sinop	Tiago*
Official at Rural Workers Syndicate (different public office from above)	Sinop	Isabela
Retired agronomy professor/consultant	Sinop	Vinicius

2x seasonal workers on large soy farms	Sinop	Gabriel, Gustavo
9x farmers at INCRA settlement	Near Sinop	Joao, Jose, Joaquim, Jerome, Jadir, Jonas, Jorge, Jacinto, Juselina

Table 1.0 A description and names of respondents, their location and their roles.

The interviews varied in length, while some followed a structure, during other ones additional topics were discussed. An estimated average length of one hour would be appropriate, though some lasted up to three hours. All interviews were conducted in Portuguese, Brazil’s national language, although English was used on several occasions to clarify or explain a concept difficult to translate. Interviews were coded in the language they were conducted in, but responses will be presented in English as translated by the author, either paraphrased or with direct translation in the footnotes.

2.3 Privacy and Limitations

2.3.1. Information letter and consent

Before each interview respondents were informed of the purpose of the study, how their data would be handled and how they could get in touch with the author if they had any questions or wish to withdraw consent. This information was required and approved by the Norwegian Centre for Research Data AS. While respondents had the choice to indicate whether or not to remain anonymous, I took it upon myself to inform them I did not intend to use their names nor exact location in respect to those living in settlements due to the sensitivity of their situations.

2.3.2 Limitations

There were some limitations to note during the course of this study. Firstly, while a wealth of publications exist surrounding environmental, economic and sociocultural changes in Mato Grosso, encountering potential respondents before arrival proved difficult. Once on location it became easier however in Brazil it can often be difficult to arrange meetings due to other commitments on the part of respondents. Therefore, some interviews had to be rescheduled, done at the last minute or unfortunately canceled. I had intended on having more respondents but given the difficult working conditions not all could be completed. Another limitation was the language barrier encountered. High levels of English are not common among Brazilians,

making it necessary to do the vast majority of work in Portuguese. While I have a moderately high-level working knowledge of the language, it needs to be said that some points and words could have been taken out of context when translated. The people of Mato Grosso were receptive and willing to talk about both themselves and their way of life, however as some of their ideas held are opinion based, they should not be treated as factual.

2.3.3. Personal Data

As per standards set forth by the Norwegian Centre for Research Data, all personal data was collected and stored with their protection in mind. This personal data was not made available to those working outside the project, and the names and contact info of respondents remains password protected for only the author to access. Audio files have also been stored behind password protection. Both the personal data and audio files will be deleted upon completion of this thesis.

3. Results and Discussion

3.1 Introduction to Study Area

I arrived at the study region in Mato Grosso in July 2019 and stayed for a total of one and a half months. I spent time in two cities, Sorriso and Sinop, with many large soy operations in their territory as well as the city of Lucas do Rio Verde, which has most of its operations focused on maize. To reach the area required a bus ride of around eight hours from the state capital of Cuiaba to Lucas do Rio Verde, with additional time to reach the soy-based cities. This ride was through the heart of the *Cerrado*. Despite this, very little natural vegetation remained on the sides of the highway, due to industrial farming operations which cover almost all area near the road. This is clear when viewing publicly available satellite imagery, and extends to the north along with Mato Grosso's northern border with the state of Para, where Santarem, a major river port for exporting soy (Adams, 2015).

The city of Santarem is where most soybeans grown in Mato Grosso are exported, and has seen a large increase since soy production shifted from the Amazon to the *Cerrado* (Adams, 2015). Just over ten years before my time in Mato Grosso there was an article which described the trip from the state to the north via BR-163. He described it as shaded, being able to see very little beyond the road due to natural vegetation and upon arrival in Santarem found a dusty, and cleared expanse (Adams, 2008). I cannot say I witnessed the same some ten years

later, though I had arrived in the dry season. In my experience natural vegetation along the highway was sparse and giant industrial farms and facilities now lined this road.

The cities themselves are proud of their agricultural importance, touting their agricultural and agribusiness importance, as seen below in Figure 3. From a state of the town mascot of Lucas do Rio Verde holding both soy and corn harvests to a city park having panels about soy cultivation with photos, agriculture is inescapable. The Rural Union of Sorriso (in cooperation with a local NGO) offered brochures on “Sustainable soy for the conservation of biodiversity”, women in agricultural and material for children about good agricultural practices seen below in Figure 4. The tourism office of Sinop offered me a brochure about business tourism focusing on agribusiness while also promoting the quality of life in the city. I found myself in a region which promoted soy and industrial agriculture as not only for prosperity but in some cases as helpful for the environment.



Figure 3. A sign in Sorriso saying “Welcome to Sorriso, the National Capital of Agribusiness” (*Bem vindo a Sorriso, a Capital Nacional de Agronegocio*) with agro-industrial operations in the back. Photo taken August 2019.



Figure 4. Brochures and information from Sorriso's and Sinop's Rural Unions and a local NGO. They promote sustainable soy, sustainable agricultural practices to educate children, agribusiness tourism and women in farming. Photo taken August 2019.

This is not dissimilar to the experience of researchers Brannstrom and Brandao at an agricultural trade fair in Brazil. At this fair elite farmers promote their way of life and linked their destructive agricultural methods as being in harmony with Brazil's protection laws (Brannstrom & Brandao, 2012). Sustainability was emphasized, very similar to these cities in Mato Grosso, yet there are overwhelming concerns related to farming in the *Cerrado* (Miranda, Bustamante, Miranda, Oliveira, & Marquis, 2002; Werneck et al., 2012). Furthermore, it appeared as though soy and commercial farming was inclusive, offering a higher quality of life to those in the region. There is no question these practices have increased the wealth, but as to who and at what impact must be assessed deeper (VanWey, Spera, Sa, Mahr, & Mustard, 2013).

3.2 Description of participants

Initial plans were to find small-scale farmers of soy, taking advantage of social contract programs such as PNPB. While some locations exist, they are not as common as it would seem as they require cooperation and favorable conditions to be selected (Lima et al., 2011). Instead my interviews led me to speak with various farmers – split between two settlements, one created through INCRA and the other, and much smaller, through invasion (spontaneous) settlement. Additionally, independent farmers, officials from local unions, federal institutes, an NGO and seasonal workers involved with agriculture were interviewed. For privacy their names have been changed as per Table 1.0 in methods section 2.2.

3.3 Uncertainty and Inaction

This section regarding uncertainty and inaction of stakeholders has been split it into subsections after reviewing the respondent's interviews and noting in which areas uncertainty and inaction arose. As not all participants are involved in every aspect of this thesis they will only appear in sections of relevance.

3.3.1 Soy Production

My initial intent was to discuss soy and threats it could pose due to the climate crisis we face. While this was discussed in some form with all respondents, not all were directly in the soy supply chain so their thoughts around climate change were not centered around soy production. However, many included soy in their interviews, as after all it is culturally interwoven into the region's identity.

One of the first events I observed in Mato Grosso was a seminar about soy production and how to predict future pricing trends of the crop. The event was attended by around 20 farmers who came to hear from both a local NGO and an investment/trading group for predicting future prices of soy. They noted that continued soy production faced three main problems in the region: climate change, swine flu (lowering demand for soy), and political problems. Going forward these impacts could reduce demand for soy, as well as make the production more costly or difficult. However, they seminar exposed the ambiguity that lies in betting on future prices to maintain profits. Given that soy demand could drop or face challenges even this profitable industry has uncertainty. The future of soy in the region was then discussed with several actors.

Maria, who works in the office of the same NGO from above told how she and others worked to promote responsible soy. She explained that soy under the current conditions, if continued, would negatively impact the local environment. Considering the mega diversity present in Brazil, the loss of species could have great impacts (Martinez-Alier, 2003). While the goal was to make soy operations sustainable, she told me that some operations failed or converted to other agricultural activities, commonly grazing. This was due to volatiles mentioned in the seminar as well as concerns of climate change. Based on that Maria said soy was a crop for medium and large sized farms and did not see it becoming normal on a small-scale or settlement level. Though responsible soy is the direction her NGO and the Rural Union wish to go in, she said it is not there yet. Due to the heavy production, the already nutrient poor soil of *Cerrado* is at risk of poor harvests (Richards, 2015). To continue to reap benefits of soy, farmers must have the capital for investment.

As a former soy farmer who switched to raising cattle, Caio, explained that the change was due to two primary reasons. Firstly, changes in soy prices meant that the same level of profit could not be assumed yearly. Secondly, while the farm area he operates with his father and some employees is far larger than settlement plots the investment needed for soy is very high, due to inputs and machinery. Normally his family would rent equipment for harvesting, but since most farms in the region harvest in the same period it was expensive and competitive. Without the guarantee that soy would continue to be lucrative, his family went to year-round grazing along with more traditional crops. Though he had some ability to invest, he judged the risk as too high to continue after some years of mediocre profit. Uncertainty regarding continued success was enough to choose what he deemed as a 'safer' option with cattle ranching as primary income (Yesuf & Bluffstone, 2009). This could be a predictor for other farmers to wean off soy in coming years, should conditions worsen.

Another farmer, Paula, did not grow soy, however she had drying facilities for soy beans. She told me she did not work with large operations, rather small or medium sized commercial farmers. She explained that due to her limited space she was always able to find clients to fill it, but she knows a number of farmers who have backed away from soy, due to economic concerns. When I asked about soy on settlements, she said that she was not aware of any which produced the crop and that it would make more sense for them to use crops which do not require additional steps, such as drying, which is an added cost or added labor.

Both Isabela (an official at Sinop's Rural Workers Union) and Eric (agronomy professor at federal institute in Sorriso) believe that soy expansion will continue but at diminishing rates. Isabela, who works primarily with settlement farmers, says that for some years now there has been almost no interest in settlements she works with to convert to soy. The difficulties being that money is scarce and the space available to each farmer is small. She explained that many do not possess the experience in the industrial agriculture field, and to acquire it as well as invest is too much of an unknown. Eric also added that there is little space to expand the area under soy cultivation – at least if laws are adhered to, and the risk in doing so could upset local ecosystems. He did not think it would be worth the risk for most small farms to engage in soy cultivation.

This was echoed by some of those interviewed in the INCRA settlement near Sinop – one which Isabela works with. One resident, Jerome, said that he and others would not justify the risks of soy in a small setting without financial support. Given the need for inputs to soy production, he asserted that the risk was too great. Jonas, another resident, added that each year was different in terms of harvests and sales, but with staple crops they can rely on selling them locally or keeping them. Soy however is mainly exported which means they need to negotiate how to do so. Isabela explained that there are local cooperatives and markets which purchase crops from settlements, but these are crops commonly consumed in the Brazilian diet, not crops like soy or cotton.

Despite uncertainty about continued soy dominance in the region, some actors still support it. The five settlers in the invaded plots near Sorriso had hopes for soy, or maize. The backgrounds of these men varied when compared to the INCRA settlement, they were younger and without families living on their plots. Antonio, who seemed a sort of de facto organizer of the group, explained that their property was chosen due to favorable conditions. However, it was initially meant to be larger and with far more settlers, however the property owner made a claim and was able to block more spontaneous settlers. Due to this, the group had doubts about the ability for soy cultivation as it was too little area. Alexandre said that they had not been there for long but was unsure if it would last because of the dashed hopes. Antonio said there was still a chance for more to join the settlement but unless that happens soy cultivation is unlikely, though maize sold to bioethanol plants could be an option.

For the time being this spontaneous settlement was growing staple crops, which they used for themselves and to sell in Sorriso's markets. Even with their initial hopes to get in on the cash

crop industry, both uncertainty about future development the settlement, and instability led to questions about soy. Adopting new crops is unlikely to occur if the risk perceived about the change is too great, leading most small scale farms in the region to stick with staple crops (Akay et al., 2012). Inaction on crop adopting is linked to individuals perceived risk, which in the case of soy in small holder farmers could lead to economic hardship without concert knowledge of success.

Thiago, a retired senior official at Sinop's Rural Union and soy producer however said soy would continue. He agreed that soy had brought great changes to the *Cerrado's* physical landscape but that it can, and should, continue given its regional importance. He was doubtful of the extent of the negative aspects of soy, saying it often gets criticism by outside sources (later used as justification for inaction) but these are not always proven.

There is very little doubt about the prosperity and value of the soy industry in Mato Grosso (de LT Oliveira & Hecht, 2017). However, some individuals in the region have begun to question its dominance and its continued expansion. Respondents such as Eric, Vinicius (a retired professor) and Maria brought up uncertainties about biodiversity and land use (Ratter et al., 1997; Strassburg et al., 2017). These, along with other respondents concerns over the lack of realistic opportunities in small-farm settlements have kept some from trying to entering the industry. Others such as Caio have shifted away from it, not having a large enough reward to counter the risk (Akay et al., 2012). Respondents concerns and experiences on small-scale farming seems to indicate that new opportunities remain limited, despite programs such as PNPB (Lima et al., 2011). While large industrial operations are likely to continue, the remains some ambiguity surrounding its continued financial success as well as environmental concerns that may come about. As such locals in Mato Grosso demonstrate uncertainty regarding the soy industry.

3.3.2 Climate Change

Climate change was a central topic discussed with all respondents, however it was interpreted by different actors in different ways. The subjectivity around uncertainty is also present in how individuals interpret certain topics as well (Ellsberg, 1961). Across the range of respondent's climate changes was perceived individually, at different intensities of concern and reflexively, as to how it impacted upon themselves in a personal way. This led to different responses, or little to no action at all, depending on how it was perceived.

Eric explained that his students of agronomy were educated with climate change in the *Cerrado* as an inevitability, which is widely accepted in literature (Werneck et al., 2012). In the region he was most concerned with loss of biodiversity, land use change and soil erosion. Changes in temperature and precipitation were a key concern of his curriculum. Due to the dry and wet seasons, farming in the region is highly dependent on using crops that are adapted to both seasons. Additionally, average temperatures in the *Cerrado* are expected to rise greater than the worldwide average, up to four degrees Celsius (Siqueira & Peterson, 2003). He said changes in either of these could upset the crops grown, and they were experimenting at the institute with drought resistant varieties of crops. While he acknowledged that the extent and impact of climate change were not fully known, he was of the opinion that actions needed to be taken immediately for the upcoming years.

He specifically mentioned that land use change from forests to agriculture and pasture had left little space for expansion – a point contested by other actors. He said, however, that the land protected in the Amazon works to counterbalance the loss of vegetation here. Though the Amazon has more protection due to the stronger Forest Code and Soy Moratorium, it is a different biome (Silva & Lima, 2018). This does not agree well with other reports, considering the high value of the number of endemic species and biodiversity in the *Cerrado* (Siqueira & Peterson, 2003). Furthermore, inaction towards preventing further deforestation in the *Cerrado* shows that some believe land in different areas has an equal biological value.

Climate change on the INCRA settlement was widely acknowledged but varied in interpretation. Jorge, among others, was concerned with how conditions could change and affect crop harvests. Explaining that “*problems rise if a harvest diminishes.*”¹ Not knowing how climate change will affect their livelihood and main source of food is one source of uncertainty (Butler et al., 2014). Jorge said that already they barely produced enough to make a living and feed themselves, and if it was reduced this could cause problems. However, adaptations or preparations for this had not been implemented, and continued uncertainty could lead to delayed response, jeopardizing the situation further (Watts et al., 2018). This sentiment was echoed by most others interviewed at the settlement, and raised questions of future food security under climate change (Wheeler & Von Braun, 2013). Vinicius and Isabela both said that settlements suffer from lacking capital and assistance, showing that

¹ Translation “... os problemas aumentam se as safras diminuirem.”

investment into adaptation is taken only when the risk is prevalent enough. Here uncertainty directly links to inaction, as it presents ambiguity towards outcomes of investment.

Juselina, of the INCRA settlement, explained that those living there are aware of climate change and of broad concerns. However, she did not feel as though the specific impacts upon their lives were clear, or how addressing climate change was possible given their situation. She acknowledged that soy farming had the benefit of more inputs and thought increased fertilizer could provide her with larger harvests but lacked money to buy a sufficient amount. When asked about the impacts of fertilizer and chemicals she said she knew it could affect the local area but not too harshly, especially when compared with large operations. The runoff from fertilizers and chemicals is a concern for small-scale communities as it can have impacts off the farm which is using it (Jergentz, Mugni, Bonetto, & Schulz, 2005). However, other farmers such as Joao, Jadir and Jose agreed that using fertilizer and chemical throughout the settlement is justified. Joao said many farms in Mato Grosso are larger than the settlement itself and thus use far more. Given the poor soil quality in the *Cerrado*, the use of fertilizers is widely supported by actors (Lathuilliere et al., 2014).

While this can lead to an increased yield, it may harm the community in the long run if fertilizer runoff is great and soil nutrients are depleted. Organic fertilizers were scarce on the settlement but could represent an example of transformational adaptation. Organic fertilizer, such as manure from livestock, could help promote nutrient cycling and reduce biogeochemical flows from fertilizers (Steffen et al., 2015). While respondents noted the need for chemical fertilizer, there are already studies showing the effectiveness of nutrient cycling in fragile soils of Brazil (da Silva, Poggiani, Libardi, & Gonçalves, 2013). As the settlement did not have systems in place for this, it represents a knowledge gap of an area that would both have a positive impact on their crops and reduce local risks of climate change. Further education, in tandem with the Rural Workers Union could help to narrow or close this gap. However, if residents decide to go the route of chemical fertilizers, as some wish to employ, there is risk of inaction or inappropriate action in responding to climate change justified by others, in this case industrial farms, performing the same activity (Gifford, 2011; Wijen & Ansari, 2007). Gifford describes a 'social risk' in how others view our actions, and from the lens of an individual looking towards industrial farming's heavy use of fertilizers and chemicals it gives weight to the idea that others would want to employ this as well (Gifford, 2013).

There was also uncertainty, both within the INCRA settlement and squatter settlement as to when, if not already, large scale climate effects would be felt. Juselina said that change is coming but questioned simply ‘when?’ adding that it seems everyone has a different idea. Unfortunately this message is common and represents one of the largest knowledge gaps in the field as there is little proof as to when a tipping point could be reached, even if there is great concern that is sooner rather than later (Hulme, 2018; Steffen et al., 2015). This sentiment was also raised by some at the squatter settlement, with Antonio saying during “...*in my life things always change... but, [we] adapt, there is no difference.*”² Yet when asked what he planned to do if conditions changed he said he would have to wait and see, thinking it was better to assess the situation before acting. Even if he accepted some degree to climate change, uncertainty towards it and its outcomes gave rise to a delayed potential response (Watts et al., 2018). While these feelings are common when facing uncertainties, the lack of capacity to address them breeds inaction.

One of his neighbors, Artur, had similar views. He too has spent most of his life working in fields and thought the biggest climate issues would be changes in precipitation and temperature. However, again, at the present he did not see the point in crafting a response due to reasoning similar to Antonio. He further presented the idea that those in the squatter settlement already had issues they needed to address, such as if their small settlement would be legitimized or if they would face claims from the original owner. While he did believe, to an extent, climate change was going to be a challenge, the more immediate risk in his view was securing land rights.

When discussing climate change with Isabela, with respect to those on settlements, she reiterated that there is a lack in capacity to respond as their budgets do not allow for it. She also placed some blame on politics for creating scenarios in Brazil where politics supersede responding to issues, such as climate change. While the topic was originally centering around the potential for settlements to grow soy, she said that changes to the ‘normal’ are costly. Settlements sourcing and testing new crops or crops better suited for new climatic conditions represent high risk and ambiguity. As plots are small, even devoting some space can make a sizeable reduction in yield if the risk does not pay off. Since results of new crops, or new treatments under climate change have unknown outcomes this creates an ambiguous scenario which involves considerable uncertainty (Akay et al., 2012). Isabela said there is

² Translation: “...na minha vida coisas mudam sempre... mas adaptaram, não há diferença.”

always hopes to implement new, improved crops but it is not often this succeeds. This uncertainty, especially within impoverished groups, is likely to lead to risk aversion and sticking with traditional crops unless a better social safety mechanism is in place.

Land use change is also a pressing issue in the *Cerrado*, and is one measure of global tipping points which gives value to tropical lands (Steffen et al., 2015). While land clearing is overwhelming the result of large landowners making room for new industrial agriculture, some settlement residents fear what that could bring. Jadir said he would be worried if large farms came into their area, which at the moment has a border of natural vegetation.

Uncertainty about the continued protection this would offer caused concerns for him as the community does not have the resources or support to act against it. This is a sentiment echoed across multiple themes in this study, as those in vulnerable positions are unable to make adaptations or adjustments of sufficient amounts as they lack resources or power to do so. While this is a form of inaction, it also shows the difficulty those who are most vulnerable suffer when facing uncertainty as adaptation comes with costs not attainable for them (Eriksen & O'Brien, 2007).

The views of the settlement residents broadly show concerns for climate change, but inaction is prevalent. For some this is due to the perceived risk not being at the forefront of their concerns, making adaptation at this moment seem unnecessary (Gifford, 2011). Adaptations such as experimenting with new seeds/crops are also costlier for those on settlements, as they involve both risk and investment. Further methods to slow progress towards tipping points such as habitat banking or land sparing are unrealistic given the small size each settlement farmer is allotted. This paradox of having limited capability to respond or influence in responding to climate change while representing a more vulnerable group highlights the difficulty some face in tackling the problem, helping to explain some inaction on their part (Eriksen & O'Brien, 2007; Gifford, 2011). Noting the desire for risk and ambiguity aversion among vulnerable groups it appears that some respondents have enough uncertainty to warrant a response without the necessary information or capital. This conforms with the views of many who view climate change as a threat, but lack capacity to act (Gifford, 2013).

Thiago, a retired senior official at Sinop's Rural Union informed me that the current climatic circumstances in Mato Grosso are a blessing. A large land owner and producer of soy himself, he explained that nature and climate in the *Cerrado* are harmonized across the twelve-month calendar. He discussed the common three round cycle, beginning with soy planting in

September and harvesting in February. This, as he explained, was during the regions rainy season – needed for the cultivation of soy (Bäse et al., 2012). The following round he plants cotton, but said others opt for corn, millet or sorghum among others. This was collected in June, leaving the in-between months used for grazing.

This set of circumstances has led some, including Thiago and other members of his family, to expand and accumulate great wealth. While he acknowledged the need for fertilizers and chemicals, often sprayed by small aircraft he contended that the area was ideal for agriculture saying simply that the climate provides the opportunity. I asked him what if this ideal balance did not remain in place forever, if climatic conditions were to shift. He reiterated the good conditions but said he did have some issues particularly with erosion and seasonal flooding. As a long-time resident of the region he added that the rainy season was variable, and there are times when there is too much or too little water. This is backed up by research which contents deforestation is increasing runoff and decreasing evapotranspiration (P. T. S. Oliveira et al., 2014). However, Thiago believed that deforestation in the *Cerrado* was minimal citing already privately-owned land that was protected by the Forest Code, including his own. Despite the many studies showing deforestation in the region, he believed it would be possible to expand the area under cultivation – a statement which several other respondents opposed.

Part of this reluctance to accept knowledge about climatic stresses that impact the *Cerrado* and hence impact the livelihoods of those living there is linked to uncertainty (Poortinga, Spence, Whitmarsh, Capstick, & Pidgeon, 2011). Without witnessing first-hand the stresses of changing climatic conditions, some individuals cast doubt upon claims of this phenomenon which can be influenced by their personal beliefs or even hopes that such stresses will not occur to themselves (Gifford, 2011; Gray, 2011). It also allows distance from the problem making action seem unnecessary (Gifford, 2011). Thiago, a successful farmer and businessman, has been able to capitalize through industrial farming would stand to lose a great deal if conditions in the *Cerrado* changed drastically affecting his livelihood. Other large land owners and industrial farmers in Mato Grosso may be well informed on the topic, but skepticism can cause uncertainty in their perspective on the validity of climate change claims (Poortinga et al., 2011). Skepticism aligns well with Gifford's take on perceived risk (Gifford, 2013). This view of climate risk as either a non-issue or an issue too small to engage in action towards it can help explain why so little is done in the *Cerrado* in creating transformational adaptation plans.

Thiago's discourse was problematic as he further invoked several dragons of inaction. In particular, discredence and the doubting of 'foreign' opinion was brought up through his accusations that other countries also use fertilizer and chemicals, in far greater amounts yet still criticize Brazil (Gifford, 2011). He also believed that the 20% protection of the Forest Code was infringing upon land owners' rights and felt that raising it would negatively impact farmers. Though he added that small land owners, such as those in settlements, should be fully exempt as they already had very limited land to work with and using it all would have little environmental impact. Given the vast amounts of deforestation and threats to diversity, there is wide agreement by scholars that stricter actions must be taken to protect undisturbed in the *Cerrado* (Ratter et al., 1997). While there have been some examples of success in Brazil, such as the Soy Moratorium for the Amazon (though causing spillover effects to the *Cerrado*) some actors such as Thiago have not internalized threats of climate change and distanced themselves from the perceived impacts. This impacts how their practices and inaction delay adaptation.

Similarly, those living in the squatting settlement as well as INCRA both addressed inaction towards climate change in the context of comparisons with others – namely big farms. Skepticism plays a role in addressing climate change, as well as blame shifting (Poortinga et al., 2011). While small-holder farmers have far less negative impact than large one, the impacts felt by climate change will be severe. Across all respondents in Mato Grosso there is little internalization of climate problems and action to address them. Following O'Brien's Three Sphere Model, internalization could come about through leverage of the outermost personal sphere to shift worldviews and accept that climate change, even with uncertainty attached, must not be met with inaction.

With respect to climate change, the topic itself was mostly accepted across stakeholders, though a few felt it was not a concern for now. Not all viewed it as an imminent threat requiring action, permitting business as usual to continue. While Eric and Vinicius both believed that it was something that needed immediately action, others such as Thiago and some settlement farmers did not perceive a large present risk. For the former comparisons with others gave reluctance to acknowledge any harmful impacts to the environment. Along with the current benefits of agriculture, especially soy, that benefited Thiago he had incentive to continue with business as usual. For settlement farmers like Jadir and Juselina, the uncertainties of how climate change could impact upon them made it difficult in looking at adaptation, as how specific impacts would be felt, and when, are unknown. At the present

there appears to be fairly widespread acknowledgment of climate change, but adaptation to the stresses it causes are limited, in part due to uncertainty.

On uncertainty Scoones says, “Risks and uncertainties are experienced by and through different people, depending on who they are, where they live, how rich they are and their abilities to respond to uncertain events, shocks and stresses.” (Scoones, 2019, p. 27) Across those interviewed regarding climate change their many views towards the topic, some firm in accepting climate change but not knowing the impacts, others more skeptical. While their reasons to have uncertainties and interpret risk varied, one common theme across the board was inaction towards climate change is prevalent in the *Cerrado* and Mato Grosso. Each individual has knowledge gaps, and without complete knowledge rationality suffers and ambiguity rises (Gifford, 2011; Hulme, 2018; Yesuf & Bluffstone, 2009). These phenomena hinder appropriate response to climate change, but at the present exist in force in the study area.

Interviews for this study support uncertainty being one causes for inaction towards climate change. Gifford included uncertainty in his section on limited cognition, along with ignorance and optimism bias which compete to breed inaction even in the face of potential monumental hardship that climate change could bring (Gifford, 2011). While some in Mato Grosso are advocating for more sustainable practices, others downplay the necessity and others lack capability or resources to act. Acting towards climate change can be done in two ways as discussed in section 1.3.2.3. incrementally and transformationally. The first is less complex and can be enacted by most any actor. It could be seen as adopting new crops adapted to local environmental conditions or using organic fertilizers to reduce runoff of phosphorus and nitrogen. While beneficial, neither address the root causes of climate stresses in agriculture. Transformational adaptation could entail addressing the demand for crops and their exportation and assessing the value of externalities such as loss of soil nutrients and CO₂ emissions from transporting and exporting crops. Transformational adaptation is more difficult and requires action by individuals with motive for climate protection. With a mix of actors and capabilities, a model such as O'Brien's three spheres may prove useful in the *Cerrado*.

Recalling the levels of practical, political and personal, each growing in potential leverage as well as difficulty to enact, offers a framework of responding to climate change in a way which can leave a lasting difference (O'Brien & Sygna, 2013). The central sphere, the practical, is

considered the easiest and in practice in Mato Grosso could take shape in industrial farming reducing use of fertilizers and chemicals or breaking up monoculture farms to favor a more diverse crop blend which would strain the *Cerrado*'s fragile soils less. These responses do not address driving forces, but together could represent a first step in promotion of ecologically friendly farming in the region. Next, the political sphere could continue to impact the region, especially if enforcement, and perhaps increase of protected area, of the Forest Code and consideration of rekindling the forces behind the Amazon's Soy Moratorium for other biomes. Enforcement would remain difficult in the large regions especially ensuring responses do not shift production to neighboring biomes as the moratorium did for the *Cerrado*. Responses from the first two spheres would begin the process of creating a space where agriculture can operate within a safe space of earth's systems outlined in the planetary boundary approach (Steffen et al., 2015). However, the greatest impact would come from the outermost, and most difficult to enact, sphere.

The personal sphere requires individual and collective worldviews and beliefs to be assessed in an effort to prompt adaptation that has outcomes for the greater good (O'Brien & Sygna, 2013). In the case of the *Cerrado*, realization that the region has ecological value as well as impacts outside of the physical area it occupies would represent a shift in collective thinking. The personal sphere aligns with Gifford's dragon of ideology, as it challenges longstanding personal and collective beliefs (Gifford, 2011). It should be seen that the personal sphere must apply not only to smallholders but those involved with large scale farming. As the latter group produce most of the externalities, their actions need to be addressed the most. Transformational adaptation on their part would have more impact as it tackles the drivers of climate change, which in the agricultural industry originate mostly from industrial production and exportation.

Personal transformation could come about through acceptance not only of climate change, but the immediate need to take action. Or, when considering soy, the destructive nature of the industry and questioning whether the growing need and production will have greater costs in the long run negating current profits. These steps require concentrated effort and can challenge one's views that inaction may be comfortable in the present but not in the long run. Personal transformation in the *Cerrado* requires individuals to assess changing climatic conditions and the need to respond as well as how to do so. This can be brought about sooner through uncertainty reduction and narrowing knowledge gaps to give individuals less risk and ambiguity when responding to decision making (Hulme, 2018; Yesuf & Bluffstone, 2009).

While this is but one framework to encourage adaptation in the face of uncertainty and inaction, it offers a path to help those living and working the land in the *Cerrado* to do so sustainably.

3.3.3 Land Tenure

Land tenure in rural Brazil, especially for those living on settlements or without land of their own is extremely complicated. Through speaking with those interviewed I collected data and heard things I have seen little mention of in literature. This is in addition to confirmation of some wider themes regarding land tenure in Brazil. While Brazil's government set out with ambitious plans for colonization of the interior with land distribution, the process has been linked with corruption and accusations of increasing deforestation (Araujo, Bonjean, Combes, Motel, & Reis, 2011; Fearnside, 2001a). Given the fragility of the *Cerrado* and livelihoods that go along with it there are a wide range of responses that at times conflict between them, and also with scholarly opinion.

Since most interviewees (outside of the squatter settlement) already legally owned their land uncertainty relating to tenure was mostly a past issue for them. However, uncertainty is a feature of the land tenure laws of Brazil (Araujo et al., 2011). The process for landless farmers to gain control of the land they work, either given to them or squatted upon, can take years, even a decade according to some respondents. During this time there is no legal protection of land ownership, and those using it do not have rights to sell or lease it, legally. However, many respondents said despite the law, this is commonly not adhered to as there are not bodies which can enforce it effectively.

Caio said his father, during the days when they focused on soy, had been able to expand his territory by purchasing land from settlements – before they received the deed. This act carries considerable risk and ambiguity, considering that firstly it is illegal. Secondly his father still could not get the deed until the settlers did, and then they must transfer it to him which they could decide not to do. As such the cost was extremely high, but settlers could make far more money doing this than by waiting for the deed and working the land. Caio said his father feared being caught but the expansion was made worthwhile by increasing their operations size. He made clear that those who sold land to this father were always paid but considering the legality of the actions both sides risked losing out. He decided the risk (and in this case ambiguity) of punishment was a push to end the practice and focus on a 'safer' style of farming.

Caio also discussed land tenure more generally in the region. As his family had acquired some of their land from settlers, he appeared to be extensively aware of the intricacies of the system. He was of the opinion that squatting was more common than INCRA colonization. He said invaders often, “... *hear about land that is available to be distributed and rush to move in there to gain a claim*”. This allows for faster settlement he explained, and while it has a lengthy legitimization process this is no different from INCRA. However, he explained that living on this land was not the goal for all settlers, some sought to sell it, even illegally, as soon as possible to turn a profit. Saying, “*each time property control changes hands the price goes up*”. This may be the case in some instances, but those interviewed on the INCRA settlement seemed to be more long term oriented in maintaining their land. The squatters seemed to have less attachment, possibly arising from the relatively new status and uncertainty for future developments. While I did not have an opportunity to speak to INCRA settlers without a title to their land yet, it is possible they would share some similar thoughts.

All those on the INCRA settlement were asking about their land, and how they came to settle upon it. I have selected one to serve as an example as they all had somewhat unique stories but fell into the same process. Joao, of the INCRA settlement, described the process of gaining his land as a difficult one. A native of Ceara, he had moved to Mato Grosso years before in the hopes to participate in a colonization project. Despite no guarantees he arrived and spent several years working at various places before being allotted land through INCRA at the settlement. He described these years as difficult, and he questioned whether staying in the region was the best choice saying as time went by waiting became more difficult. However, he reached a point where he had been living for almost six years in the region and felt moving to another and restarting the application process for being allocated land would make his time spent in Mato Grosso a big loss. The feeling of investment of his time and effort in applying for distribution of land, shows an example of sunk costs (Arkes et al., 2002). The feeling of giving up the chance at land distribution in the hopes of finding it another region was too much.

His choice paid off as he was eventually selected for a spot at this settlement. He said that he knew many others who were not however, showing that INCRA is a complicated system and some people ‘luck out’ over others. This process is embedded with uncertainty and waiting for potential years can increase uncertain feelings. He, along with the others interviewed at the settlement, were allocated plots of land north of Sinop, which had a road connection but

limited service. Isabela explained that the city worked with the Rural Workers Union to help connect the settlement. INCRA settlements do face some challenges in gaining access to services, but are generally more successful than independent settlements (Faber, 2003). While Joao said this was not a quick process, today the settlement is fully connected and has a standard of living in line with the region. Having been rewarded with titles to the land offered the settlers control over it, and they chose to use it as they wish. The title to land has proven to most to be more valuable than selling it.

In addition to enquiring about the possibility of soy cultivation, I also asked residents if they had any interest in selling their land given the high costs paid for some land in the region. Overwhelmingly the answer was no, at least not for now. Jose said that selling the land might give them money but would once again leave them without land. Having no land takes away their livelihood as land is more than just physical space for them, it also ensures they can make a living and eat. The ambiguous nature of what will happen if they were to sell their land and move forward is not a jump those with titled land seemed willing to make. There is a risk involved with waiting as well, as tipping points are approached, especially in fragile areas such as the *Cerrado*, and if reached could make cultivation extremely difficult and thus remove value from the land.

This is in contrast to the experiences at the squatter settlement. The quality of homes and infrastructure is basic on this settlement, though it does have connections to electricity due to its proximity to other structures and the highway. However, the settlers here do not have deeds like those settled on the INCRA settlement. They have been living here for a relatively short period but set up basic infrastructure and crops to legitimize their farms. Alexandre said that it was one of the first things the five agreed to was setting up living quarters as it would be harder for them to be removed, but in the early days this was a constant uncertainty and did not give them confidence to invest more than was necessary for basic accommodation.

These illegal sales were also discussed with the squatter settlement. Antonio does not believe their settlement this practice would help them as he feels they are lucky the landowner is not pursuing their eviction. Being located on the territory of a land owner who successfully defending his land could cause them legal issues but according to both Andre and Alexandre the land owner had agreed to give up the land. This could cut down on the customary five year squatting period needed to gain legitimate rights to the land (Araujo et al., 2011). It was

contended by the two, as well as Antonio, transferring the land through sale to other parties could cause issues in obtaining legal title. Until then the settlement is working the land with subsistence crops and looking for opportunities to cooperate for bigger projects, such as the new bioethanol plant being built nearby.

As the lots have a very small area adherence to the Forest Code to keep natural vegetation would be difficult, and their land was already cleared when given to them. Isabela said that settlements are not viewed as sources of deforestation, since they are created from already cleared and unused land. Eric said the most common way for settlement plots to expand is not clearing new land, but purchasing deeds to adjoin plots, which is mentioned in literature (Lima et al., 2011). He said is contingent on owners having the deed in order to legally sell it, which is the case in the INCRA settlement but not with the squatters. Since the latter has taken over land in an already cleared area which has now been reclaimed by the owner there is little chance for expansion, unless INCRA decides to distribute the land. Antonio said it would be unlikely as the landowner had successfully convinced the local authorities he would make use of the land, it was speculated to be used as pasture.

The INCRA settlement, being older and officially established, did not have to content with issues of legal titles. All respondents already had the deed to their land. Due to this guarantee those in the community had invested considerably more into their accommodation and farms as compared to the squatter settlement. They did not have the same uncertainty if they could one day be evicted giving them reason to invest in their land. This can be viewed as uncertainty reduction or closing a gap when compared to the uncertainty of squatted on land without a title (Hulme, 2009). Presumably if settlers who are squatting reduce uncertainty regarding their land tenure, this could prompt action to develop their land and livelihoods further. Giving them confidence that their land they have secured will remain in this possession can prompt investment as it is now long-term tenure. This could include adaptations towards climate change that would secure their ability to maintain the lands they occupy.

The idea of land tenure was also briefly discussed with two workers employed seasonally at industrial farms, including soy – Gabriel and Gustavo, interviewed together. Their stories are similar to many of those in settlements, both coming from the northeast with hopes to settle in Mato Grosso. However, they had not been successful in obtaining land. Gustavo explained that he was waiting already for several years but was not sure if it would happen anytime

soon. He said that immediately after arriving he also sought out work to sustain himself, and has performed a variety of jobs, mostly labor related, which pay fairly but are not long lasting usually. Being able to sustain himself was possible with this lifestyle he explained, although he felt it would be easier with his own land. He added that while pay was usually fair that to save up to purchase land was difficult. While waiting for a chance for settlement, he explored other paths and was also considering purchasing land with financing, though this was difficult to obtain. As Isabela explained, most looking to purchase small plots of land need some form of financing, but credit is difficult to obtain as they are viewed with uncertainty by lending officials.

When asked about his opinion on INCRA and settlements, Eric said that it was a '*beautiful thing in the mind... in reality less*'³. He said corruption was high, and it was full of 'backroom' deals. He accused larger agricultural producers of influencing decisions, with intent to take over additional land which is sitting unused. While I did not encounter this specific line of thinking in other interviews, given the other stories of illegal land leasing and selling this could hold a great deal of truth. He added that some settlements got lucky, in that they had better access to water or transportation. We also discussed social contract theories such as PNPB, which he had not heard much about. However, he was aware of the building of two new bioethanol plants previously mentioned. He said if a settlement could get a contract with one, it could be beneficial but was not sure how they could arrange that.

Outside of settlements Thiago raised new thoughts regarding land tenure not discussed in other interviews. Firstly, he and his family had a considerable amount of land dedicated to industrial farming and he raised the point that 20% of his land must remain as natural vegetation. On a map, he pointed to where he held reserve land to fulfill the 20%, to the east of Alta Floresta, another city of Mato Grosso. This city has not been mentioned as it is located in the north, in the Amazon biome. While this biome has more protection, buying land located in this area is cheaper than devoting 20% of farm space to natural vegetation. This is a circumvention of the Forest Code and is one example of the *Cerrado*'s value being superseded by economic motives. Naturally the Amazon biome is too of great ecological importance, but that does not diminish the value of the *Cerrado* and its biodiversity (Ratter et al., 1997). This inaction on the part of a wealthy land owner illuminates how complicated

³ Translation "... uma coisa na mente, na realidade menos."

laws surround land tenure do not always function as designed and can create situations in which actors find a loophole to fulfill requirements.

Thiago also described that part of Mato Grosso already had protection, about 5% being state reserves and 15-20% being indigenous areas. He explained the latter, which are found scattered across the state as seen in Figure 2, are mostly forested. While this holds true as most indigenous forests are better maintained, deforestation is on the rise in some (Fearnside, 2005). Land tenure and indigenous rights are outside the scope of this study; however, this thought was included as it underscores the ability to shift responsibility of environmental protection. Under the Forest Code private properties must take accountability for controlling damage to forests by adhering to legislation regarding protection on their own lands and not allow it to be shifted to others, such as indigenous peoples (Fearnside, 2005). While land tenure is complicated, it should not be allowed accountability to be shifted to other places or peoples. Inaction on the part of private landowners has the ability to become commonplace if accountability is not adhered to.

Land tenure in Brazil as a whole appears to work towards a righteous goal. Decades long projects on colonization of interior lands has brought populations from the coastal states into the formally unused lands which have turned into agricultural titans (Lisansky, 2019). This process has greatly benefited some who have been able to consolidate land into large industrial farms capable of producing large yields with minimal labor (Adams, 2008). At the same time public bodies such as INCRA as well as peasant organizations such as MST, and independent groups, have succeeded in gaining land rights for some formerly landless farmers, but not all. This drawn out process has been as success for those at the INCRA settlement I interviewed, but for others they are still working on obtaining their legal land or have chosen to enact their own process through squatting. Other respondents reported on corruption in the process and illegal land deals, possibly influenced by large land owners. While this topic lacks substantial formal literature, it does represent how difficult and tenuous the situation can be.

Land tenure will continue to favor some over others, especially if climate change impacts are felt greatly in the *Cerrado* where those choosing to settle may not have a back-up plan. If land distribution is to continue in Mato Grosso it could benefit from assessment from bodies such as INCRA in a more streamlined approach to granting land rights. Both formal and spontaneous settlers face long waits to receive deeds and can be settled in areas without

development or access to services, which can take time to be initiated (Faber, 2003). Furthermore, claims of corruption and violence can negatively impact the process and intent to benefit those who are most vulnerable and in need of this process the most. Based on respondents' thoughts towards INCRA, and settlements in general in Mato Grosso, they believe there is good intent, but it does not live up to the hopes of many. Having land to work is essential for farmers, but the process can breed uncertainty while waiting and whether they will receive suitable or appropriate land. Further climate stresses in the *Cerrado* could also impact the soils, meaning land distribution must be done wisely. With certainty regarding rights to land and its continued ability to be suitable for the livelihoods of those in Mato Grosso the region stands a better chance in both combating inaction towards climate change and safeguarding those inhabiting the fragile *Cerrado* biome.

4.0 Conclusion

4.1 Research Question 1

How does uncertainty affect inaction towards climate change by actors in and around the agricultural industry of Mato Grosso?

How and where uncertainty arose from respondents varied. For some, such as most living on settlements, climate change was at least in part accepted as inevitable. However, uncertainty arose due to questions such as how, when, where and who will feel these effects and to what degree. Furthermore, due to limited resources, the risk of costly adaptation was viewed as too great for some without certain knowledge of the outcomes. This gave reason to not initiate proactive action towards climate change. For others skepticism and feelings of discredence led to questioning the extent of climate change in the *Cerrado*, providing further justification for inaction. Mato Grosso has a wide range of agricultural actors, from small settlement farms to massive industrial operations. While climate change represents great uncertainty in the future for all in the region, inaction is being justified due to this lack of certainty. Without ways to reduce uncertainty, those who rely on farming in the *Cerrado* will be ill-prepared for the effects of climate change due to widespread inaction.

4.2 Research Question 2

How does land tenure complicate uncertainty and inaction among stakeholders in Mato Grosso?

Brazil has a number of unique schemes regarding distribution of land and settlement/colonization of rural areas. In Mato Grosso the National Institute for Colonization and Agrarian Reform (INCRA) operates to appropriate disused and previously cleared land to landless farmers. Spontaneous, or invasive, settling also occurs when groups of individuals enter disused land not yet appropriated and apply for tenure. This study saw interviews from both types of settlers, as well as respondents with knowledge of the topic. While land distribution has a noble goal, reports of corruption and favoritism weaken the structure. With long waits and no control over where they are assigned land, settlers face either waiting for an uncertain future or invasion which is also an uncertain action as there is no guarantee of gaining tenure or being supported by the state. Without firm certainty of land tenure, already difficult responses to climate change are viewed with ambiguity, leading to inaction. The administration of settlements is a large task that appears to not have as much oversight by the government as is needed to ensure it can achieve its goal and run without long waits and inequitable processes.

In addition to settlements, private land owners are also affected by land tenure. This is not in relation to their legal ownership, but in some cases how they must take care of their lands. Current conditions under the Forest Code protect 20% of privately-owned land as natural vegetation there is evidence this is circumvented by conserving land in other regions under the same owner. This inaction towards conservation has allowed a great deal of deforestation in the *Cerrado*, especially after the Soy Moratorium made soy farming the Amazon more difficult there.

In general land tenure in the *Cerrado* is a complicated system and creates difficulties for those living upon it. Since these difficulties lead to uncertainty regarding gaining rights to land as well as environmental responsibility, inaction follows. This inaction, along with no or minimal climate change adaptations have helped to create a challenge for Brazil in both distribution and protection of land.

4.3 Concluding Remarks

Brazil has long been in the world's eye regarding climate change and nature conservation, however this is overwhelmingly centered upon the Amazon biome. There is no doubt the Amazon is essential and must be protected, but the *Cerrado* must also be acknowledged for its importance and be afforded stronger protection. At the same time steps should be taken to ensure that any protection or adaptation does not cause undue harm to other regions, like the

Soy Moratorium has done for the *Cerrado*. Any measures implemented must face the burden of not only protecting and enhancing the environment but also the people who call this region home. The current state of soy production, climate change acknowledgement and response, and land tenure systems promote uncertainty, which in turn give rise to inaction preventing change that could not only improve the *Cerrado* but also the livelihoods of its residents.

5. References

- Ackerman, F., & Stanton, E. (2006). *Climate change: the costs of inaction*: Global Development and Environment Institute, Tufts University.
- Adams, R. T. (2008). Large-Scale Mechanized Soybean Farmers in Amazônia: New Ways of Experiencing Land. *Culture & Agriculture*, 30(1-2), 32-37.
- Adams, R. T. (2015). Neoliberal Environmentalism among Elites: Becoming “Responsible Producers” in Santarém, Brazil. *Culture, Agriculture, Food and Environment*, 37(2), 84-95.
- Aimin, H. (2010). Uncertainty, risk aversion and risk management in agriculture. *Agriculture and agricultural science procedia*, 1, 152-156.
- Akay, A., Martinsson, P., Medhin, H., & Trautmann, S. T. (2012). Attitudes toward uncertainty among the poor: an experiment in rural Ethiopia. *Theory and Decision*, 73(3), 453-464.
- Alston, L. J., Libecap, G. D., & Mueller, B. (2000). Land Reform Policies, the Sources of Violent Conflict, and Implications for Deforestation in the Brazilian Amazon. *Journal of Environmental Economics and Management*, 39(2), 162-188.
doi:<https://doi.org/10.1006/jeem.1999.1103>
- Anderson, E. C., Carleton, R. N., Diefenbach, M., & Han, P. K. J. (2019). The Relationship Between Uncertainty and Affect. *Frontiers in Psychology*, 10(2504).
doi:10.3389/fpsyg.2019.02504
- Araujo, C., Bonjean, C. A., Combes, J.-L., Motel, P. C., & Reis, E. J. (2011). Does land tenure insecurity drive deforestation in the Brazilian Amazon?
- Arbuckle, J. G., Prokopy, L. S., Haigh, T., Hobbs, J., Knoot, T., Knutson, C., . . . Widhalm, M. (2013). Climate change beliefs, concerns, and attitudes toward adaptation and mitigation among farmers in the Midwestern United States. *Climatic Change*, 117(4), 943-950. doi:10.1007/s10584-013-0707-6
- Argyris, C. (1973). Some limits of rational man organizational theory. *Public Administration Review*, 253-267.
- Arkes, H. R., Kung, Y.-H., & Hutzler, L. (2002). Regret, valuation, and inaction inertia. *Organizational Behavior and Human Decision Processes*, 87(2), 371-385.
- Baas, S., & Ramasamy, S. (2008). *Community based adaptation in action*.
- Barrett, S., & Dannenberg, A. (2014). Sensitivity of collective action to uncertainty about climate tipping points. *Nature Climate Change*, 4(1), 36-39.

- Bäse, F., Elsenbeer, H., Neill, C., & Krusche, A. V. (2012). Differences in throughfall and net precipitation between soybean and transitional tropical forest in the southern Amazon, Brazil. *Agriculture, Ecosystems & Environment*, 159, 19-28.
doi:<https://doi.org/10.1016/j.agee.2012.06.013>
- Berg, B., & Lune, H. (2012). *Qualitative Research Methods for the Social Sciences, 8th Edition*. Boston: Pearson.
- Blaikie, P., Brown, K., Stocking, M., Tang, L., Dixon, P., & Sillitoe, P. (1997). Knowledge in action: local knowledge as a development resource and barriers to its incorporation in natural resource research and development. *Agricultural Systems*, 55(2), 217-237.
- Blesh, J., & Wittman, H. (2015). “Brasilience:” assessing resilience in land reform settlements in the Brazilian Cerrado. *Human ecology*, 43(4), 531-546.
- Brannstrom, C. (2005). Environmental policy reform on north-eastern Brazil’s agricultural frontier. *Geoforum*, 36(2), 257-271.
- Brannstrom, C., & Brandao, P. R. (2012). Two hundred hectares of good business: Brazilian agriculture in a themed space. *Geographical Review*, 102(4), 465-485.
- Brush, S. B. (2005). *Farmers' rights and protection of traditional agricultural knowledge*.
- Bryman, A. (2012). *Social Research Methods* (4 ed.). New York: Oxford University Press.
- Butler, M. P., Reed, P. M., Fisher-Vanden, K., Keller, K., & Wagener, T. (2014). Inaction and climate stabilization uncertainties lead to severe economic risks. *Climatic Change*, 127(3-4), 463-474.
- Cattaneo, A. (2008). Regional comparative advantage, location of agriculture, and deforestation in Brazil. *Journal of Sustainable Forestry*, 27(1-2), 25-42.
- Cavalcanti, B. C., & Barros, R. R. d. A. (2007). Desiring the city: the urban imaginary in rural collective settlements in a Brazilian submontane Atlantic forest reserve. *Horizontes Antropológicos*, 3, 0-0.
- da Silva Júnior, A. G., Vianna Leite, M. A., Clemente, F., & Perez, R. (2012). *Contract Farming: Inclusion of Small Scale Farmers in the Brazilian Biodiesel Production Chain*.
- da Silva, P. H. M., Poggiani, F., Libardi, P. L., & Gonçalves, A. N. (2013). Fertilizer management of eucalypt plantations on sandy soil in Brazil: initial growth and nutrient cycling. *Forest Ecology and Management*, 301, 67-78.
- Davidson, P. (1988). A technical definition of uncertainty and the long-run non-neutrality of money. *Cambridge Journal of Economics*, 12(3), 329-337.
- de LT Oliveira, G., & Hecht, S. B. (2017). *Soy, globalization, and environmental politics in South America*: Routledge.

- Dillon, J. L., & Scandizzo, P. L. (1978). Risk Attitudes of Subsistence Farmers in Northeast Brazil: A Sampling Approach. *American Journal of Agricultural Economics*, 60(3), 425-435. doi:10.2307/1239939
- Doan, M. D. (2014). Climate change and complacency. *Hypatia*, 29(3), 634-650.
- Ellsberg, D. (1961). Risk, ambiguity, and the Savage axioms. *The quarterly journal of economics*, 643-669.
- Eriksen, S. H., Nightingale, A. J., & Eakin, H. (2015). Reframing adaptation: The political nature of climate change adaptation. *Global Environmental Change*, 35, 523-533.
- Eriksen, S. H., & O'Brien, K. (2007). Vulnerability, poverty and the need for sustainable adaptation measures. *Climate Policy*, 7(4), 337-352.
- Esham, M., & Garforth, C. (2013). Agricultural adaptation to climate change: insights from a farming community in Sri Lanka. *Mitigation and Adaptation Strategies for Global Change*, 18(5), 535-549. doi:10.1007/s11027-012-9374-6
- Ettlie, J. E., & Bridges, W. P. (1982). Environmental uncertainty and organizational technology policy. *IEEE Transactions on Engineering Management*, EM-29(1), 2-10. doi:10.1109/TEM.1982.6447460
- Faber, E. (2003). Grassroots and Government Conflict.
- Fearnside, P. M. (2001a). Land-tenure issues as factors in environmental destruction in Brazilian Amazonia: the case of southern Pará. *World Development*, 29(8), 1361-1372.
- Fearnside, P. M. (2001b). Soybean cultivation as a threat to the environment in Brazil. *Environmental Conservation*, 28(1), 23-38.
- Fearnside, P. M. (2005). Indigenous peoples as providers of environmental services in Amazonia: Warning signs from Mato Grosso. *Global Impact, Local Action: New Environmental Policy in Latin America*, 187-198.
- Fearnside, P. M., & de Alencastro Graça, P. M. L. (2006). BR-319: Brazil's Manaus-Porto Velho Highway and the potential impact of linking the arc of deforestation to central Amazonia. *Environmental management*, 38(5), 705-716.
- Few, R., Morchain, D., Spear, D., Mensah, A., & Bendapudi, R. (2017). Transformation, adaptation and development: relating concepts to practice. *Palgrave Communications*, 3, 17092. doi:10.1057/palcomms.2017.92
- Gibbs, H. K., Rausch, L., Munger, J., Schelly, I., Morton, D. C., Noojipady, P., . . . Walker, N. F. (2015). Brazil's soy moratorium. *Science*, 347(6220), 377-378.
- Gifford, R. (2011). The dragons of inaction: psychological barriers that limit climate change mitigation and adaptation. *American psychologist*, 66(4), 290.

- Gifford, R. (2013). Dragons, mules, and honeybees: Barriers, carriers, and unwitting enablers of climate change action. *Bulletin of the Atomic Scientists*, 69(4), 41-48.
doi:10.1177/0096340213493258
- Gollnow, F., & Lakes, T. (2014). Policy change, land use, and agriculture: The case of soy production and cattle ranching in Brazil, 2001–2012. *Applied Geography*, 55, 203-211.
- Gomes, L., Simões, S. J., Dalla Nora, E. L., de Sousa-Neto, E. R., Forti, M. C., & Ometto, J. P. H. (2019). Agricultural expansion in the Brazilian Cerrado: increased soil and nutrient losses and decreased agricultural productivity. *Land*, 8(1), 12.
- Gray, S. T. (2011). From Uncertainty to Action: Climate Change Projections and the Management of Large Natural Areas. *Bioscience*, 61(7), 504-505.
doi:10.1525/bio.2011.61.7.3
- Greiner, R., Patterson, L., & Miller, O. (2009). Motivations, risk perceptions and adoption of conservation practices by farmers. *Agricultural Systems*, 99(2), 86-104.
doi:<https://doi.org/10.1016/j.agsy.2008.10.003>
- Guilhoto, J. (2004). The regional (state level) importance of the agribusiness GDP in the Brazilian economy. *Anais do XXXII Encontro Nacional de Economia, João Pessoa-PB (2004)*.
- Hecht, S. B. (2005). Soybeans, development and conservation on the Amazon frontier. *Development and Change*, 36(2), 375-404.
- Henrich, J., & McElreath, R. (2002). Are peasants risk-averse decision makers? *Current Anthropology*, 43(1), 172-181.
- Hulme, M. (2009). *Why we disagree about climate change: Understanding controversy, inaction and opportunity*: Cambridge University Press.
- Hulme, M. (2018). “Gaps” in climate change knowledge: Do they exist? Can they be filled? *Environmental Humanities*, 10(1), 330-337.
- Jepson, W. (2006a). Private agricultural colonization on a Brazilian frontier, 1970–1980. *Journal of Historical Geography*, 32(4), 839-863.
doi:<https://doi.org/10.1016/j.jhg.2004.12.019>
- Jepson, W. (2006b). Producing a modern agricultural frontier: firms and cooperatives in Eastern Mato Grosso, Brazil. *Economic Geography*, 82(3), 289-316.
- Jergentz, S., Mugni, H., Bonetto, C., & Schulz, R. (2005). Assessment of insecticide contamination in runoff and stream water of small agricultural streams in the main soybean area of Argentina. *Chemosphere*, 61(6), 817-826.

- Johnson, D., & Levin, S. (2009). The tragedy of cognition: psychological biases and environmental inaction. *Current science*, 1593-1603.
- Juana, J. S., Kahaka, Z., & Okurut, F. N. (2013). Farmers' perceptions and adaptations to climate change in sub-Saharan Africa: A synthesis of empirical studies and implications for public policy in African agriculture. *Journal of Agricultural Science*, 5(4), 121.
- Júnior, A. G. d. S., Leite, M. A. V., Clemente, F., & Perez, R. (2012). Contract Farming: Inclusion of Small Scale Farmers in the Brazilian Biodiesel Production Chain *Proceedings in System Dynamics and Innovation in Food Networks*, 396-407.
- Junior, C. S., & Lima, M. (2018). Soy Moratorium in Mato Grosso: deforestation undermines the agreement. *Land Use Policy*, 71, 540-542.
- Kates, R. W., Travis, W. R., & Wilbanks, T. J. (2012). Transformational adaptation when incremental adaptations to climate change are insufficient. *Proceedings of the National Academy of Sciences*, 109(19), 7156-7161.
- Lathuilliere, M., Johnson, M., Galford, G., & Couto, E. (2014). Environmental footprints show China and Europe's evolving resource appropriation for soybean production in Mato Grosso, Brazil. *Environmental Research Letters*, 9, 074001. doi:10.1088/1748-9326/9/7/074001
- Leão Rego, R. (2014). Imagining the model, designing the city: Planning diffusion in twentieth-century Brazil. *Planning Perspectives*, 29(4), 557-569. doi:10.1080/02665433.2014.921578
- Lima, M., Skutsch, M., & Costa, G. (2011). Deforestation and the social impacts of soy for biodiesel: perspectives of farmers in the South Brazilian Amazon. *Ecology and Society*, 16(4).
- Lima, M., Skutsch, M., & de Medeiros Costa, G. (2011). Deforestation and the social impacts of soy for biodiesel: perspectives of farmers in the South Brazilian Amazon. *Ecology and Society*, 16(4).
- Lisansky, J. (2019). *Migrants to Amazonia: spontaneous colonization in the Brazilian frontier*: Routledge.
- Martinez-Alier, J. (2003). *The Environmentalism of the poor: a study of ecological conflicts and valuation*: Edward Elgar Publishing.
- Mier y Teran G.C, M. (2015). Soybean agri-food systems dynamics and the diversity of farming styles on the agricultural frontier in Mato Grosso, Brazil. *The Journal of Peasant Studies*, 43, 1-23. doi:10.1080/03066150.2015.1016917

- Miranda, H. S., Bustamante, M. M., Miranda, A. C., Oliveira, P., & Marquis, R. (2002). The fire factor. *The cerrados of Brazil: ecology and natural history of a neotropical savanna*, 51-68.
- Norgaard, R. B. (1984). Traditional agricultural knowledge: past performance, future prospects, and institutional implications. *American Journal of Agricultural Economics*, 66(5), 874-878.
- O'Brien, K., & Sygna, L. (2013). Responding to climate change: The three spheres of transformation. *Proceedings of the Conference Transformation in a Changing Climate*, 16-23.
- O'Brien, K. (2018). Is the 1.5°C target possible? Exploring the three spheres of transformation. *Current Opinion in Environmental Sustainability*, 31, 153-160. doi:<https://doi.org/10.1016/j.cosust.2018.04.010>
- Oliveira, G. d. L. T., & Schneider, M. (2016). The politics of flexing soybeans: China, Brazil and global agroindustrial restructuring. *The Journal of Peasant Studies*, 43(1), 167-194. doi:10.1080/03066150.2014.993625
- Oliveira, P. T. S., Nearing, M. A., Moran, M. S., Goodrich, D. C., Wendland, E., & Gupta, H. V. (2014). Trends in water balance components across the Brazilian Cerrado. *Water Resources Research*, 50(9), 7100-7114. doi:10.1002/2013wr015202
- Peine, E. K. (2010). Corporate mobilization on the soybean frontier of Mato Grosso, Brazil. *Contesting development: Critical struggles for social change*, 132-145.
- Polasky, S., Carpenter, S. R., Folke, C., & Keeler, B. (2011). Decision-making under great uncertainty: environmental management in an era of global change. *Trends in Ecology & Evolution*, 26(8), 398-404. doi:<https://doi.org/10.1016/j.tree.2011.04.007>
- Poortinga, W., Spence, A., Whitmarsh, L., Capstick, S., & Pidgeon, N. F. (2011). Uncertain climate: An investigation into public scepticism about anthropogenic climate change. *Global Environmental Change*, 21(3), 1015-1024. doi:<https://doi.org/10.1016/j.gloenvcha.2011.03.001>
- Pretty, J. (2018). Intensification for redesigned and sustainable agricultural systems. *Science*, 362(6417), eaav0294.
- Ratter, J. A., Ribeiro, J. F., & Bridgewater, S. (1997). The Brazilian Cerrado Vegetation and Threats to its Biodiversity. *Annals of Botany*, 80(3), 223-230. doi:10.1006/anbo.1997.0469
- Rausch, L. (2014). Convergent agrarian frontiers in the settlement of Mato Grosso, Brazil. *Historical Geography*, 42, 276-297.

- Reydon, B. P., Fernandes, V. B., & Telles, T. S. (2015). Land tenure in Brazil: The question of regulation and governance. *Land Use Policy*, 42, 509-516.
doi:<https://doi.org/10.1016/j.landusepol.2014.09.007>
- Richards, P. (2015). What Drives Indirect Land Use Change? How Brazil's Agriculture Sector Influences Frontier Deforestation. *Annals of the Association of American Geographers*, 105(5), 1026-1040. doi:10.1080/00045608.2015.1060924
- Richards, P., Pellegrina, H., VanWey, L., & Spera, S. (2015). Soybean development: The impact of a decade of agricultural change on urban and economic growth in Mato Grosso, Brazil. *PLoS one*, 10(4).
- Rocha, C., Burlandy, L., & Maluf, R. (2012). Small farms and sustainable rural development for food security: The Brazilian experience. *Development Southern Africa*, 29(4), 519-529.
- Sawyer, D. (2008). Climate change, biofuels and eco-social impacts in the Brazilian Amazon and Cerrado. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 363(1498), 1747-1752.
- Scoones, I. (2019). What is Uncertainty and Why Does it Matter?
- Silva, C. A., & Lima, M. (2018). Soy Moratorium in Mato Grosso: Deforestation undermines the agreement. *Land Use Policy*, 71, 540-542.
doi:<https://doi.org/10.1016/j.landusepol.2017.11.011>
- Siqueira, M. F. d., & Peterson, A. T. (2003). Consequences of global climate change for geographic distributions of cerrado tree species. *Biota Neotropica*, 3(2), 1-14.
- Soterroni, A. C., Ramos, F. M., Mosnier, A., Fargione, J., Andrade, P. R., Baumgarten, L., . . . Câmara, G. (2019). Expanding the soy moratorium to Brazil's Cerrado. *Science advances*, 5(7), eaav7336.
- Spence, A., Poortinga, W., & Pidgeon, N. (2012). The psychological distance of climate change. *Risk Analysis: An International Journal*, 32(6), 957-972.
- Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., . . . Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science*, 347(6223). doi:10.1126/science.1259855
- Stoknes, P. E., & Rockstrom, J. (2018). Redefining green growth within planetary boundaries. *Energy Research & Social Science*, 44, 41-49. doi:10.1016/j.erss.2018.04.030
- Strassburg, B. B., Brooks, T., Feltran-Barbieri, R., Iribarrem, A., Crouzeilles, R., Loyola, R., . . . Scarano, F. R. (2017). Moment of truth for the Cerrado hotspot. *Nature Ecology & Evolution*, 1(4), 1-3.

- VanWey, L. K., Spera, S., Sa, R. d., Mahr, D., & Mustard, J. F. (2013). Socioeconomic development and agricultural intensification in Mato Grosso. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 368(1619), 20120168. doi:doi:10.1098/rstb.2012.0168
- Watts, N., Amann, M., Ayeb-Karlsson, S., Belesova, K., Bouley, T., Boykoff, M., . . . Chambers, J. (2018). The Lancet Countdown on health and climate change: from 25 years of inaction to a global transformation for public health. *The Lancet*, 391(10120), 581-630.
- Werneck, F. P., Nogueira, C., Colli, G. R., Sites Jr, J. W., & Costa, G. C. (2012). Climatic stability in the Brazilian Cerrado: implications for biogeographical connections of South American savannas, species richness and conservation in a biodiversity hotspot. *Journal of Biogeography*, 39(9), 1695-1706.
- Wheeler, T., & Von Braun, J. (2013). Climate change impacts on global food security. *Science*, 341(6145), 508-513.
- Wijen, F., & Ansari, S. (2007). Overcoming Inaction through Collective Institutional Entrepreneurship: Insights from Regime Theory. *Organization Studies*, 28(7), 1079-1100. doi:10.1177/0170840607078115
- Yesuf, M., & Bluffstone, R. A. (2009). Poverty, risk aversion, and path dependence in low-income countries: Experimental evidence from Ethiopia. *American Journal of Agricultural Economics*, 91(4), 1022-1037.



Norges miljø- og biovitenskapelige universitet
Noregs miljø- og biovitenskapelige universitet
Norwegian University of Life Sciences

Postboks 5003
NO-1432 Ås
Norway