The complexity of adaptation to climate change. Exploring adaptation in Rio Grande, Ecuador.
I hereby declare that this dissertation has been composed by me and is based on my own work

Signed ………………………..
Abstract of Dissertation

Climate change has become one of the most challenging problems in terms of development, having adverse effects in populations that are already vulnerable to other stressors. At present, the importance of adaptation to climate change has been widely recognized with the objective of reducing the impacts on socionatural systems. Through an analysis grounded in critical realism and network political ecology, the experienced socionatural changes in the communities of Rio Grande river basin, including divergent perceptions of drivers of change, vulnerability and risks among different actors were explored. The results of the study demonstrated the argument that adaptation is a complex process that does not occur in isolation and in response to one stressor, it belongs to a network of factors, including multiple stressors of change, subjectivities, power, politics, scales institutions, norms, and values, which create the context in where it occurs. Additionally the way in which people experience impacts on their livelihoods is differentiated among actors. This research suggest that in order to create long-term socially just responses that can deal with the uncertainties of a changing world, adaptation strategies, policies and programs should take into consideration the underlying factors that influence vulnerability and adaptation.

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Acronyms

ACJ Asociación Cristiana de Jovenes (Young Men’s Christian Association)

CHRB Chone River Basin

EE Ecuador Estrategico

MAE Ministerio del Ambiente Ecuador (Ministry of the Environment Ecuador)

MAGAP Ministerio de Agricultura, Ganadadería y Acuacultura Pesca (Ministry of Agriculture, Livestock, Aquaculture and Fisheries)

PMPCH Proyecto Multipropósito Chone. (Chone Multipurpose Project)

PNBV Plan Nacional de Buen Vivir (National Plan for Good Living)

RGMRB Rio Grande Micro River Basin

SENAGUA Secretaria Nacional del Agua (National Secretariat for Water)
Chapter 1: Introduction

Climate change nowadays one of the most challenging and complex problems that the world is experiencing, impacting principally systems that are already vulnerable to other stressors and thus having determinant consequences for development (Paavola & Adger, 2006; Adger, 2007; Leichenko & O'Brien, 2008; O'Brien, 2009). There is now a recognition that climate change is not just a natural atmospheric phenomena, but it is a reality that brings together multiple factors of the social and natural world, in where the boundaries between nature and humans are blurred (Latour, 1993), and thus becoming a process involving different relations and networks between the human and non-human world. The impacts of climate change and the fact that humans are embedded in environment and climatic systems, leads to a call for action from society in order to mitigate and adapt to the changes induced by climatic events.

Climate change agenda began with a dominance of mitigation over adaptation, but at present the latter is recognized as extremely important given that adaptive measures are necessary to reduce the negative impacts climate has on development plans and programmes (Adger et al., 2007; Adger et al., 2003). In literature climate change adaptation has been defined in different ways, but the most common definition is the one by the IPCC in where adaptations are adjustments in response to changes and effects of climate induce events (IPCC, 2007). Nonetheless it is also argued that this way of understanding adaptation lacks of a broader perspective, as adaptation measures which contribute in the reduction of vulnerabilities to climate change are not only a result of climate, but also other stressors that generate change in the system.
Additionally adaptation is not universal, and thus adaptive decisions, its barriers and successes are entrenched in specific contexts which are a result of the interaction of a variety of factors including divergent perceptions of risk, environmental changes, politics, economics, culture, and the relationships of these factors across levels and scales (Adger et al., 2009; O’Brien, 2009). The consideration that adaptation is shaped by responses to multiple stresses, in various scales with the participation of many actors (Pohlmann, 2011) could promote fairer and more just adaptation measures. Moreover the inclusion of local contexts and the diverse perceptions of change and impacts among different actors can contribute to a better achievement of adaptation (Hulme, 2008).

In Ecuador, climate change has been declared a National policy, given rise to new initiatives and programs that address the issue of changing climate and its impacts, such as the National Strategy for Climate Change and PACC. Therefore this study aims to contribute with the efforts in Ecuador, by evaluating the way in which adaptation is being understood, studied and implemented in order to promote better and more socially just decisions and policies concerning adaptation. With an example of a case study carried out in five communities of Rio Grande Micro River Basin (RGMRB), which were chosen for their vulnerability to climate variability (MAE, 2009), and because it has become an area of high intervention of governmental institutions due to the construction of a dam as a response to flooding events, this dissertation will address and demonstrate how adaptation is influenced by multiple causal factors, including subjectivities of different actors as well as recognizing the reality of socio-ecological system in which these communities are embedded. The research question for this study is: *What are the adaptation measures to socio-ecological changes in RGMRB and the underlying factors that motivate and influence such adaptations?*
Adaptation measures will be explored by determining who is adapting, to what specific changes and in which way as suggested by Smit et al. (1999). Besides just focusing on climatic extremes and variability as suggested by the authors, in this dissertation these questions will be approached in a wider analysis which recognizes the hybrid nature of climate change, thus including all natural and social factors that are part of the complexity of adaptation to change, thus aiming to understand how actors in RGMRB experience changes, hence determining to what people need to adapt and in which way the corresponding adaptation measures are influenced by the multiple factors that shape adaptation.

Critical realism and network political ecology provide a useful theory and methodology to perform a wider and holistic research approach to adaptation, as they pay particular attention to the way in which actors have divergent experiences of a reality, depending on how it makes sense to people (Danermark, 2001), and the interconnectedness of the different factors, levels and processes involved in adaptation measures. The study and the data collection to determine the changes that exist in the area and the degree to which actors create divergent accounts of risk and vulnerabilities was done through participant observation, informal conversations, and formal interviews with key informants of the institutions working directly in the area, and farmers from the visited communities - Platanales, El Pueblito, Tablada de Sanchez, Los Corrales and Juan Callo-. Additional information was gathered from relevant literature related to the subject and it was used to compliment the information obtained on the field.

As climate change has become a national policy in Ecuador, and adaptation policies and strategies are being implemented, this work hopes to influence the way in which these are approached at a national and local level, shifting the dominant view
of adaptation in the country which mainly consists of technocratic top-down responses to change to a more holistic multiple-factor approach, arguing that adaptation measures such as the ones promoted by PACC, will be more relevant if more attention is given to what matters to the most vulnerable people, by considering the existence of a multitude of perceptions and factors that underpin vulnerability and should be included in adaptation measures in addition to the planned techno-scientific and knowledge solutions to climatic stimuli. In the case of RGMRB, the results of this study have the intention of informing the involved institutions on how they can better shape their planned development initiatives and programs with the communities to promote more efficient measures that will help and benefit the inhabitants to cope with current and future socio-ecological changes that might affect their livelihoods and hence the development of the area. Nonetheless, it is important to mention that there is still a need for further study in the area as it is necessary to have a better understanding of the power, politics and the strength of the relationships between the different causal factors in the adaptation network (Birkenholtz, 2012).

This dissertation is structured as follows: first adaptation and vulnerability to climate change are reviewed, including their different definitions, approaches and importance for development (Chapter 2). Additionally in this section there is a review of current plans and policies related to climate change adaptation in Ecuador as they are relevant for the case study. Chapter 3 explains critical realism and network political ecology as the chosen methodological approaches for research and analysis and in chapter 4, the methods for the case study data collection and analysis. The following section covers the findings obtained in the field and desk based research. The first part of this section gives an overview of the study area, in order to understand the context of changes and adaptation. To answer the research question the main
stressors of socio-ecological change in the area are introduced, this are increased climate change variability and the construction of the dam as part of the project Multipropósito Chone. Following the argument of divergent perceptions, changes are further analysed depending on how they are perceived between the different actors in the basin particularly governmental institutions and local farmers (Chapter 5). Once the stressors of change are identified and the differences on perceptions of risk and change, this section also introduces the identified adaptation measures – planned and autonomous– that help people cope with change. The different identified factors that drive adaptation are also included in this section. Although these adaptations help reduce the impact of stressors and are useful for future climate change, they are not necessarily a direct response to a single climatic stimuli, thus corroborating the argument of this dissertation. Finally in chapter 6, the conclusion provides an overview of the complexity of adaptation in RGMRB, also providing recommendations for decision-makers and institutions in the area involved in development plans and impact reduction programs to promote more holistic and relevant plans that will help people cope with changes, in a more socially just way.
Chapter 2: Literature Review

2.1 Understanding adaptation to climate change

Climate change and adaptation research is a prominent topic in the international agenda, projects and policies, particularly in middle and low income countries (Adger and Brooks, 2003; Downing et al., 1997; Huq and Reid, 2004; O’Brian et al., 2004 to cite few), as they are considered to be the most vulnerable due to the combination of their limited resources, physical infrastructure and systems of governance (Ayers & Dodman, 2010; Weisser et al., 2014). Furthermore it is argued that impacts of climate change have the potential to negatively affect the prospects of development for these countries (Agrawal, 2008), thus being defined by many development institutions such as the World Bank as the “development challenge of our generation” (Agrawal, 2008 pg. 8).

Climate change discourse and its linkage to development began in the 1990s, with a clear dominance of the mitigation agenda, focusing on global warming and the reduction of greenhouse gases (Huq and Reid, 2004). Initially climate change was approached at a global scale, and had little relevance in work related to poverty alleviation and sustainable development. In this stage, the majority of research was focused on the quantification of climate change, presented by models and statistics that showed how the increasing concentration of GHGs provoked a change in average global temperature. This was paired up with demonstrations of the possible outcomes of a changing climate including the direct biophysical, social, and economic consequences (Hansen et al., 2006). Noting that climate change impacts are potentially adverse for important development sectors such as agriculture and water (Huq and Reid, 2004), and are affecting already vulnerable populations (Paavola & Adger, 2006), researchers and governments became more concern with the link
between development goals and poverty reduction and adaptation (Ayers and Dodman, 2010). Thus adaptation became a development tool to assist people develop their capacities to make decisions that will help them improve and live “the lives they value” (UNDP, 2007 pg. 7). Nowadays adaptation is extensively discussed in the development agenda and planning as means of reducing risks and impacts and vulnerabilities induced by climate change events (Adger et al., 2007).

There are a variety of approaches used by researchers to understand climate change and adaptation; each one has their own underlying definitions, assumptions and perceptions of the reality of climate change. In the specific context of adaptation to climate change, the most common definition is the one used by international frameworks like the UNFCCC, in which adaptation is referred as the “adjustments in natural or human systems in response to observed or expected changes in climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities” (IPCC, 2007 pg. 869). Climatic stimuli is associated with numerically measurable changes and impacts (Orlove, 2009), and it is referred to either climate change scenarios which provide a set of possibilities of future climates, or current measureable changes in temperatures, precipitation, intra-season variation, frequency of extreme events and catastrophic transformation of ecosystems (Tompkins & Adger, 2004). Mainly this definition of adaptation alludes to the responses to anthropogenic induced climate change, rather than naturally occurring climate variability, although in reality as argued by Huq & Reid (2009) it is difficult to differentiate between the actions that enhance adaptation to anthropogenic induced climate change and adaptation actions towards natural climatic variability. Adaptations can also be classified in many ways depending on what people are adapting to, who is performing the adaptation, and how it is being done (Smit et al, 1999). Adaptation can be anticipatory - responding
to prediction on historical events-, or reactive - triggered by current experience (Adger et. al., 2005). Additionally adaptation can be autonomous or planned, depending if the actions are taken spontaneously by affected people at a local level, or are the result of planned interventions (Forsyth, 2013).

For programs that use the UNFCCC definition, adaptation is considered to be a response to only climate change, and adaptive actions tend to be top-down and managerial in nature, usually opting for technological short terms solutions such as sea walls, dams, irrigation systems or early warnings. When adaptations are shaped as a response to simply the atmospheric stimuli factors such as the role of politics, power and networks are often excluded (Adger et al, 2007; Thompson et al., 2006; Brooks, 2003). In addition to this, is worth noting that usually technology and/or infrastructure solutions become obsolete in a changing future, but most importantly they mask the changes, and do not grasp the underlying non climatic factors and causes of vulnerability (Ayners & Dodman, 2010), thus not enhancing a change of behaviours leaving individuals with limited capacity to adjust to changes outside the technological solutions. In this cases, adaptation lacks a broader perspective of the external and internal factors that influence adaptation, such as perceptions, behaviours, values, and culture (Agrawal, 2008). These are very valuable for government policy, development programs and decision making processes as they are a direct influence (Adger et al., 2009, Pohlmann, 2011).

For a wider understanding of climate change and adaptation, including power, networks and fairness, it is important to incorporate the “social” or “human” dimension to the impacts from atmospheric changes as well as the inclusion of the biophysical
reality into the social world, thus acknowledging it as a hybrid complex system of multiple agents in where dialectical boundaries between society and nature are blurred (Latour, 1993). Social sciences adaptation research, has followed this second approach, focusing on the perceptions of climate change within and between societies (Pohlmann, 2011), based on social construction theory. Climate change impacts and adaptation are understood according to this critical perspective through the study on how people perceive and acknowledge the changes in the system, the underlying causes, and how people react in response to their perception (Koch et al., 2007; Pattemger, 2007). The concept of adaptation in this case is better defined as “the process of change in response to a change in the physical environment or a change in internal stimuli, such as demography, economics and organization” (Denevan, 1983 p. 40). The principal difference with the previous definition is that it includes other dimensions besides the climactic one, giving a specific cultural and socio-political context to the process of adaptation (Nelson et al., 2009; O’Brien, 2009; Weisser et al, 2014). The inclusion of context and social construction in adaptation research and practice is essential because adaptations occur at concrete places, norms, connections and subjectivities as well as specific climatic events and other stressors that modify and create the idea of adaptation and its practices, hence influencing governance and decision making process.

2.2 Understanding vulnerability in adaptation to climate change

As previously mentioned the understanding and implementation of adaptation has become a very important area in the field of climate change research and development, mainly because of its impacts to already vulnerable communities adversely affecting developmental processes. In consequence with this argument, it
is vital to first explain the approaches to vulnerability in terms of climate change. Similarly to adaptation, vulnerability was firstly based on its biophysical component, where the main focus of study was the events or hazards brought by climatic events, such as droughts, floods, changes in temperature and storms. Thus in this category vulnerability is defined by the climatic hazards and the damages it may potentially cause in a system (Brooks, 2003). These damages are quantifiable, and show a linear relationship between the likelihood of occurrence, the nature of the hazard and the sensitivity of the impacted system. The main limitation of this understanding is that it does not take into account the internal state of the human systems, including social and political factors that also contribute to vulnerability despite of the nature, occurrence and power of the natural/climatic hazard. Therefore adaptation measures that follow this perception of vulnerability will most likely be the ones that only respond to specific climatic stimuli.

Limitations in this way of framing vulnerability, has given rise to the use of social vulnerability in adaptation to climate change, where the outcome is dependent on both the occurrence of the climatic hazard in addition to the social inherent factors of the system, such as economic, political and geographical resources (Adger and Brooks, 2003) which determine the susceptibility or ability to cope to the change caused by the hazards and thus being a differentiated phenomenon among actors within and between locations. The addition of the social factors creates a context, in which after the identification of vulnerabilities, adaptation measures can be studied and performed. Numerous factors could determine vulnerability, such as location, gender, age, politics, livelihood, belief systems, networks, decision making and other environmental and socio economic elements that are characteristic of the system (Wisner et al, 2004; Adger, 2001). Nonetheless, poverty -income per capita - has been the most widely
used indicator when studying social vulnerability, including many vulnerability and adaptation reports in Ecuador. Researchers have developed indexes for measuring and mapping vulnerability, allowing for the identification of the most vulnerable actors and how it varies within specific geographical units (Downing and Patwardhan, 2003). These conventional quantitative studies produce results at a national level and their accuracy is not yet known (Dow et. al., 2006), creating a limit for the adaptation measures that proceed the identified vulnerabilities.

In view of what has been discussed, is important to acknowledge that adaptation measures vary according to the identified vulnerabilities in a determined area, community or individual. The recognition and understanding vulnerability depends on identified factors and objective indexes produced by outside members, but it also relies on the public response to the issue, their experience and perception and how they feel the ‘climatic hazard’ has impacted their daily lives (Pohlmann, 2011). Measuring perceptual dimensions of vulnerability is a difficult task and is often performed by environmental psychologists (Adger, 2006), and it has the limitation that not all underlying factors of perceived vulnerabilities can be pinpointed. Notwithstanding these limitations, it is important to consider how vulnerability is perceived by the potentially vulnerable population as it contributes to adaptation, because it can be the case that although there is an impact from a climatic hazard, the perceptions actors have towards the risk it represents can limit adaptive actions, even when people have the capacity and the resources to adapt (Grothmann & Patt, 2005).

Understanding vulnerability and adaptation is better explored by using an approach that recognizes the existence of multiple-factors that influence and underpin the measures taken to reduce the impacts to the socionatural systems, hence also
promoting broader development and risk reduction measures that will further benefit the individuals and communities at a local level.

2.3 ‘Multiple- factors’ approach in understanding adaptation to climate change

Up to this point it has been argued that for the understanding of adaptation to climate change first it is important to determine the stimuli to which actors are adapting. Furthermore it is also crucial to consider the risks and vulnerabilities caused by changes in the system from a biophysical perspective and how they are perceived, acknowledged and experienced by the actors in the determined area of study. Most importantly it is vital to acknowledge that vulnerability and adaptation actions to climate change, and how these are perceived, do not occur in isolation, rather they occur in a specific socionatural context which includes demographic, cultural, social and economic factors and changes (Adger et al., 2005); and are dependent of underlying powers and network relations (Adger et al., 2009) that occur at multiple scales, levels of governance, with a diversity of actors and stakeholders. As a consequence of the complexity of climate change adaptation, research in the topic is shifting towards a multi-factors, multi-scale and/or multi-level approach (Adger et al., 2009; Carina and Keskitalo, 2004; Cash et al., 2006; Nilsson et al., 2012; O’ Brien and Leichenko, 2000; O’Brien et. al., 2004, among others), in where adaptation not just a response to a climate hazard, but other connected events and challenges that can trigger change and affect adaptation measures.

As part of the research and understanding of the complexity of climate change adaptation, researchers have highlighted the importance of institutions - formal, informal, public or private- as they embody the rules that condense the values,
norms, thus providing a context and direction for actions (O’Riordan & Jordan, 1999). Institutions are also considered a key factor for the determination of adaption at a variety of levels and scales, from local to national up to global scales (Agrawal, 2008; Koch et al, 2007; Nelson et al, 2009). The importance of institutions is given by their capacity to act as mediating and sometimes governing bodies that connect actors with resources (social and natural), determine flows of external support, and create a bridge between the actors and policies at higher levels (Agrawal, 2008).

The integration of institutions reflects the argument that, knowledge, decisions and perceptions about climate change adaptation are dependent of the institutional and political context in which adaptation takes place, and also on how the institutions inform their decisions and actions.

Although adaptation to climate change is a result from the interaction of factors in multiple scales, studies often choose a local or regional scale for the research of adaption, as it is argued that here is where climate change will be mostly felt and where adaptive actions should start (Paavola & Adger, 2006). Nevertheless, decisions at local level and shaped by interactions and decisions at higher levels in a specific context of climate change impacts and other socionatural factors, therefore for a valuable comprehension of adaption is important to consider multiple scales involved and its social construction based, and how they influence adaptation values based on their power, aims and own interests in solving the problem of climate change (Adger et al., 2005).
2.4 Networks

Adaptation to climate change is not just a response to a climatic event in order to reduce risk and vulnerability, it is also an outcome of the connection of different actors, decision makers, external and internal factors that create a complex network, that is also constructed by underlying factors related to perceptions norms and beliefs. Adaptation is determined by the relations and distribution of power inside this network (Agrawal, 2008). For an understanding of climate change and most importantly the proposal of policies and adaptation programs in a specific location affected by climatic events it is important to research the connections within networks as it could be the case, that groups that have less power and no voice in decision-making, may be further ignored due to certain adaptation mechanisms (Pohlmann, 2011), as it the case that adaptation actions that may benefit certain actors, can potentially damage others (Keskitalo & Kulyasova, 2009 ). A network approach could facilitate and improve adaptation actions, as a holistic consideration of the components of the networks of climate change vulnerability and adaptation can make such actions more equitable and legitimate.

To wrap up what was discussed, it can be concluded that adaptation programs, projects and local actions to climate change are a result of responses to changes in socio-ecological systems caused by climatic events as by other stressors. Notwithstanding, these actions are not autonomous (Adger et al., 2005), they belong to a network of process and actors at multiple scales that exist in a specific context, that has no boundaries between nature and society, and it is shaped by perceptions, beliefs, norms, values and power. This approach will be used in this dissertation as there is a need for a critical and holistic understanding of climate change adaptation
in order to inform and create effective responses towards the impact of a changing climate and environment.

2.5 Adaptation to Climate Change in Ecuador: policies and programs

Climate change and climate variability impacts are already felt in Ecuador, and these are only going to be aggravated with the predicted increase in average temperature, in intensity of precipitation and drought events in Coastal, Andean and Amazonian regions of the country. Research at a national level has demonstrated that the most likely consequences of climate change are: 1) higher intensity of climatic events, such as the ones caused by phenomena like “El Niño”, 2) sea level rise, 3) glacial retreat, 4) decrease of river runoff, 5) higher incidence of tropical diseases, 6) invasive species in sensitive ecosystems and 7) extinction and loss of biodiversity. In addition of these biophysical factors, climate change events are also expected to affect the entire country’s development and economy, by affecting infrastructure, social institutions, impeding the access to natural resources and productivity. (Cáceres & Núñez, 2011). Already from 1960 up to 2007, 68% of the total registered events that resulted in a loss of infrastructure and human lives have been caused by climatic events (Cáceres & Núñez, 2011), and by 2025 it is expected the monetary cost of these impacts will be approximately $5.6 billion dollars (Amat y Leon, 2008).

In recognition of the context of the biophysical impacts of climate change on the environment and society, the government of Ecuador has been actively involved in participating and being a member of international treaties and frameworks that deal with climate change, adopting the UNFCCC in 1994 and ratifying the Kyoto Protocol
Following these global legal frameworks, Ecuador has committed itself to create policies, plan and programs in order to act in accordance to the effects of climate change and its potential impacts in the development of the country. Such policies and programs are being approached in terms of adaptation and mitigation, and they are in concordance and included within the Constitution of the Republic of Ecuador, the 2013-2017 National Plan for Good Living and National Environmental Policy, although not directly mentioned in the context of climate change, but nonetheless relevant as measures to reduce the impact and vulnerability caused by climate induced events (Cáceres & Núñez, 2011). The 2008 Constitution, approaches climate change by stating that the State shall take appropriate measures related to climate change mitigation, through the reduction of GHG emissions from deforestation and air pollution by the promotion of forest protection and conservation as well as protecting people at risk. In terms of adaptation, the Constitution calls for action and responsibility in areas related to biodiversity, desertification, risk management and other relevant environmental topics (Asamblea Constituyente, 2008, Art. 414; Art. 395). It is worth mentioning that the majority of climate change relevant articles (Annex 1) are highly related to mitigation efforts, and reduction of vulnerability focusing on environmental aspects, thus approaching adaptation under the IPCC terms. Nonetheless they still set a milestone for boosting adaptive capacity and measures of systems and populations.

At present, the government of Ecuador, going beyond what is stated in the constitution, it has implemented a National Plan for Good Living, which consists of a series of objectives and goals from 2013 until the end of the current government 2017 in order to measure the progress towards a ‘good living’ and sustainable development,
and thus develop a long term planning strategy. This national plan also directly and indirectly includes objectives related to the approach and management of climate change. From a total of the 12 objectives in the PNBV, policies 3 and 7 are the most relevant to adaptation to climate change. Objective 3 is related to the improvement of people’s quality of life, with the provision and the right of the populations to receive social services such as food, water, environmental sanitation, physical culture, and housing among others. In this objective specifically policies 3.10 and 3.11 are related to climate change as they seek to guarantee preservation of the cultural and natural heritage against natural and anthropogenic threats; thus also insuring the constant and sustainable provision of natural resources, such as access to safe water. Furthermore objective 7 of the Plan, guarantees the rights of Nature and promotes environmental sustainability. This objective supports all environmental management, and more specifically actions regarding climate change as stated in the policy 7.10:” To implement climate change mitigation and adaptation measures to reduce economic and environmental vulnerability with emphasis on priority groups” (Senplades, 2013 pg. 71). Using both the constitution and the goals and policies of previous and current PNBV, in 2009 by executive order, adaptation and mitigation to climate change were declared a National policy (MAE, 2012), conferring MAE the responsibility for the formulation and execution of a climate change strategy and plans for the implementation of measures to raise awareness about climate change in the country, and promote actions to reduce the impact of natural and anthropogenic climate change processes (Correa, 2009). This decree also recognizes the importance of the

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1This is the third PNBV. There has been one for every presidential term of the current president Rafael Correa. Objectives between the plans remain similar, but goals change for each plan.
integration between institutions for a more holistic formulation of adaptation programs and policies, thence in 2010 the Interinstitutional Committee for Climate Change was created promoting the connected participations of public organisms, entities and companies to work together in programs and criteria related to climate change mitigation and adaptation. What is worth noticing, is that these committee only included public institutions at a national level, thus resulting in policies and programs that have a top-down extensive nature.

The Ministry of the Environment along with the other members of ICCC, have produced the first National Strategy to Climate Change 2012-2025. This document translated the policies and created measurable guidelines and goals related to climate change including the need for regional and international articulation, which works in consistency with international climate change frameworks. Also it emphasizes the need for the participation of civil society for the implementation of measures at a local level, trying to maintain environmental integrity and to protect vulnerable groups and ecosystems (MAE, 2012). This strategy has selected several areas or sectors that are most relevant to adaptation according to where climate change impacts will be most likely felt, as well as by following the objectives of PNBV, public policy, and those identified as the most vulnerable according to international frameworks such as the IPCC (MAE, 2012). These sectors are: 1) food sovereignty, agriculture, livestock, aquaculture and fisheries, 2) Productive and strategic sectors, 3) Health, 4) Water resources, 5) Priority groups, 6) Natural Resources, 7) Human settlements and 8) Risk management. These areas for research and implementation are considered the most vulnerable and there is no doubt that they are fundamental for the country’s development, but at the same time is where there is a higher information about the
impacts, meaning that there might be other vulnerable sectors that are not being approached because of the lack of information (Cáceres & Núñez, 2011). Concerning the interinstitutional efforts of climate change policy in Ecuador, this strategy also calls for the integration of the public as well as private actors, civil society, academia, and local governments, thus promoting a management across levels and scales and most importantly this inclusionary participation may reduce the risk of just having policies and programs that are accumulated and do not represent a real action in the management of climate change.

The involvement in climate change at a national level has opened the doors for the implementation of a series of programs and projects at regional and local level. According to a report by the Inter-American Development Bank, there are a total of 17 projects and 185 studies related specifically to climate change adaptation in agriculture, water, and infrastructure and risk sector (Ludeña & Wilk, 2013). All these projects have the peculiarity of having a technological approach, usually with objectives and plans involving the construction of water storages, walls, reforestation, and irrigation systems. As mentioned before these are immediate responses to perceived or predicted changes in the climatic patterns that have an impact on the natural and social systems. Although these projects work in collaboration with the communities, still there is a need for a deeper understanding on the causes of vulnerability and a recognition of adaptation measures that might be already in place. Also the great majority of studies have taken the approach of showing the evidence of climate variability and change and its impacts in national scale and in strategic sectors such as specific river basins, as the case of the Survey of Current Vulnerability to Climate Risk in Water Resources Sector produced by the Ministry of the Environment. The
existence of national policies have pushed for the participation and of state institutions, including financial mechanisms for adaptation measures, but what is worth mentioning is that still many of the programs and projects are performed by NGOs receiving external funding.
Chapter 3: Methodology

3.1 Critical Realism as a methodological approach

The methodology and methods are a pillar component in qualitative research practice as they derive from the way in which knowledge is justified during research. In this chapter I seek to introduce the chosen methodologies for this research, their epistemological and ontological foundations which are the basis for the formulation of the research question and the way in which data is acquired. The first part of the chapter covers the description of critical realism and network political ecology and how they are relevant to the study of adaptation to climate change. This is followed by a description of the used methods for data collection and analysis.

As previously mentioned in this study I am trying to find the adaptation measures in RGMRB, but principally the context in which adaptations and variability occurs. A qualitative research is consistent with the aims and objectives of the research as it is able to capture, understand and give meaning to the actions, experiences and situations that are being researched (Oppenheim, 1992, Hesse-Biber & Leavy, 2006) allowing for a comparison between perceptions and actions from the different actors. The study of adaptation to climate change from a social perspective should include the direct causes of biophysical vulnerability but it also should consider people’s perceptions, worldviews and how people relate to the reality of changing climate. For this reason, in this study I have chosen a critical realist tradition, to explore causality of the studied processes including the underlying powers and connections, and how they operate, thus determining the capacity to adapt to climate change and the success of adaptation measures.
Climate change and variability research in Ecuador as previously explained, has followed a "top-down" assessment that is usually guided by a positivist approach, centered in elements that are quantifiable, statistically relevant, focusing on biophysical processes, models and risks. By guiding the study under critical realism, I attempt to present an innovative method for approaching climate change adaptation in Ecuador, so it is just not defined as a necessary action, but also a result of causal networks that represent local realities and vulnerabilities, actor’s experiences and understandings of their surroundings.

Critical realism is a combination of realist ontology with a constructivist epistemology, in where the world is stratified into different domains (Sayer, 2000). The first one is the empirical domain, which refers to what we experience and it is linked with direct causality; the actual domain follows the empirical domain and it refers to the idea that events occur and are real regardless of our experience and finally the real domain represents what exists, it is the combination of the other two domains and in which social mechanisms construct events (Danermark et al, 2001). Events do not occur in a closed system and reality is not just a series of events; social as well as socio-ecological events are a result of a network of casual mechanisms, some of them might be invisible but still existent (Danermark et al., 2001). These causal mechanisms, structures and processes exist in an open system in where they interact with each other (Sayer 2000). Additionally, there are a variety of factors that affect causal mechanisms, and they can exist on different levels and thus have a diversity of implications. Single independent variables cannot be extracted (Bhaskar, 2010), thus critical realism has a contextual approach in which processes are more important than variables, and the generation of tendencies instead of quantifiable specific conditions (Alvesson, 2009).
The study of causal processes creates a more holistic perspective which is necessary to understand adaptation to climate change. When studying causal mechanisms or processes there is a necessary abstraction of causal powers, but not as independent variables, instead they are approached contextually and conceptually about their operations and for their explanation (Roberts, 2014). Furthermore, critical realism states that events that exist independent of our knowledge, and the construction of our reality, make it a useful methodology to "understand ecological change through epistemological scepticism but ontological realism to underlying biophysical processes" (Forsyth, 2001 pg, 148). It is expected that with this approach there will be an illustration of the networks and mechanisms that interact and influence adaptation to change in socionatural systems.

3.2 Critical Realism and Network Political Ecology

The application of critical realism in socio-environmental research highlights the complexity of mechanisms involved in biophysical and social processes, it recognizes the importance of scientific explanations and knowledge which provides accurate information about reality that exists independently from our experience, but it also argues the recognition of the social construction of reality, which is influenced by the context including discourses and political action (Forsyth, 2001). In conjunction with this critical realist argument, political ecology theory supports the argument of the continuous construction of the environment and social reality, emphasizing that this construction is created in political and power field in an open system (Peet and Watts, 1996), in other words is contextualized. This critical realism and political ecology methodological approach to adaptation to climate change as explained by Forsyth (2001), will be useful in determining the causal effects, construction of boundaries, and
it will provide a more accurate and socially just representation of the biophysical phenomena.

The utilization critical realism and political ecology implies that processes or events are a result of a network of mechanisms that influence the construction and the reality of these events and its results (Danermark et al., 2001), thus it is relevant to also focus this research in a network political ecology approach to climate change adaptation research as proposed by Birkenholtz (2012). Although there are components of this theory that are not entirely applicable to this research, it is still relevant and provides a proper rationale for the chosen methods to answer this study's research question. Additionally ‘network political ecology’ is strictly related to the methodological arguments previously discussed. It connects extensive and intensive methods of research, focusing on local and contextual differentiated construction of events including vulnerability and adaptive strategies as well as objective and universal insights and solutions on adaptation to climate change. This guides the research towards a focus on causality in which certain factors enable events, processes or actors to influence social and environmental reality or change. Likewise it recognizes the actual domain, by proposing that the scale of research and influence should be in a regional resource use system and a projected climatic change induced variability (Birkenholtz 2012). The determination of a scale also helps with the contextualization of the processes, and additionally a network approach determines the region of study as the dimension of cause and consequences of these processes and events (Neumann, 2009), yet still fixed within a broader political, economic and environmental context. Moreover, the network component of this methodology adds a point for consideration when researching causality and connections, this is the examination of the type, strength and structure of connection and how are they
positioned within the network. This creates a map of vertical and horizontal connectivity that might result in causality on the experiencing and construction of the effects of climate change and adaptation measures.
Chapter 4: Methods

The study draws its results from research methods, sources and tools that were decided upon the methodological approaches. Sayer (2000) and Birkenholtz (2012), argue in favour of the use of a combination of intensive and extensive research methods and tools that are consistent with critical realist ontology. A case study research method – selected for this study- is well suited for a critical realism, network political ecology methodology as it provides the tools for the researcher to explore a complex set of actors, events and relationships in a particular context (Hartley, 2004), as it answers to questions of how and why covering the contextual conditions of the research (Yin, 2009). Data collection in this case study involves multiple sources for data, providing the information necessary to map the causality of the research and thus facilitating a holistic understanding of adaptation to climate change. This study had a fieldwork component for data collection using participant observation and semi-structured interviews; and a desk based component for data collection via examination of relevant literature, press releases, reports, official documentation and analysis of quantitative data from published databases.

4.1 Data Collection

4.1.1 Field work and qualitative data collection in communities of Rio Grande Micro River Basin

The fieldwork component of the research was carried out from the 03th – 15th of June 2014, in Rio Grande River Basin. The selection of this basin as an area of study was based on its categorization as a vulnerable basin to climate change (MAE, 2009) and additionally because of the fact that in the last years this basin has received particular attention and intervention of behalf of governmental institutions as a result
of the construction of a dam as part of the *Multipropósito Chone project* (PMPCH). This special characteristics of the basin provides an adequate context for the study of how people react to the perceived vulnerabilities and changes impacting the area. From the total 31 communities in the basin, to avoid risky situations due to weather conditions and the construction of dam only five communities were visited, these were: Platanales, El Pueblito, Tablada de Sanchez, Los Corrales and Juan Callo. These communities were also chosen as they are a representation of the typical characteristics of the communities located in the basin, including peoples’ livelihoods, dwelling, agricultural and livestock activities. Access to these communities was via roads in good condition, and when these were not available, I had the collaboration of local community members that helped me with transportation with a canoe along the river to reach the upper basin communities.

During the time visiting the communities I had the opportunity to engage in direct and participant observation by spending time in the fields with farmers. This method allowed me to get a local understanding of the contexts - physical, social, cultural and economic - in where the participants lived and worked; also it provided an insight on how people relate and behave. Farmers in the area traditionally have their reunions in community centres, one of them being the *Seguro Social Campesino* – meaning rural social security. After a meeting I attended as advised by a key informant, I informally approached some of the attendees which subsequently agreed to participate in the study by giving me access to their properties and activities. A total of seven properties were visited. In addition to this, using a snowball approach and by direct recommendation of key informants, I contacted other members of the communities that have a close connection to the state institutions working in the area. Overall the group of participants represent the main occupation group active in the
area, as the majority of them were involved in the agricultural sector. Though female and male actors participated in the study, there was a majority of male participants. As expected from the chosen qualitative method the number and nature of participants are not a proportionate representation of the population, instead of having a representative sample, the validity of data relies on the information provided by different actors (Keskitalo & Kulyasova, 2009).

During this stage of research I was able to spend the day in some cases, or a couple of hours in other cases interacting with the farmers and helping them in their daily work and household activities. To understand causalities, context and networks, observation practices in the field are not sufficient (Hesselber, 2011), thereupon whilst in the field I also carried informal semi-structured open ended interviews with the participants. The use of this method was appropriate considering the informal setting of research and the necessity of an interview method that provides flexibility, but it also allows the researcher to take the leading role, shaping the direction of the interview depending on the perceived prompts from the interviewees. To increase the efficiency of the informal interviews, while conducting them I followed a pre-established guide of questions – found in Annex 2-, this ensured that the general topics and areas of information necessary were covered in each interview. Although is worth noting that for every interview that was carried out, the wording and order of the question varied with each participant. This inconsistency could have modified the answers as they depend on how the questions were posed by the researcher.

During one conversation with a local community member, I was invited to the local high school and there I was offered the opportunity to talk to a group of parents that were having a meeting. Although a group interview was not a planned method, the information gathered by this method was valued and relevant for analysis, and
additionally it represented an opportunity to observe the relationship between community members. For this group interview I used the same pre-established set of questions mentioned previously, trying to have the opinion of all the participants in the group.

The data for this study was also drawn from six 1 hour long-, semi- structured interviews to informants from key institutions that are working in the basin – MAGAP, MAE, SENAGUA, ACJ. This style of interviewing is characterized by a structured, open-ended and standardized set of questions to all participants, allowing also for an additional contribution from the interviewees, by giving them the opportunity to give as much detail and information as they consider relevant, at the same time opening spaces for the researcher to ask follow up questions, thus obtaining all the information necessary to get a grasp of the participants viewpoints, knowledge and experiences. In these interviews wording remained consistent throughout the multiple interviews. The questions for these interviews can be found in Annex 2.

These interviews were conducted in a more formal manner, in the offices of the participants. It is important to be aware that this might have caused some bias and restrictions to the answers from the interviewees as they were in their working area. Participants for these interviews were contacted using snowballing, and by directly approaching the key institutions. Although snowballing might be proven very useful for increasing the number of interviews, it also has the disadvantage that it might create a sample that is not very diverse as they belong to the same circle and may be prone to biases.

It is worth noting that during fieldwork I tried contacting people that might have different views on the adaptation to climate change in the area, the construction of
PMPCH and that do not share the ideas with the interviewed participants. By the end of fieldwork I had no response from these actors.

All interviews and informal conversations were held in Spanish. There was no need of an interpreter as Spanish is my mother tongue. At all times I had a pen and a field notebook making all the appropriate annotations during observations and interviews. All participants were informed about the research objectives via a PLS found in the appendix section, and once involved in the research it was explained to them that anonymity will be retained throughout the process, including interviews, conversations and the transcription and analysis of the collected data.

The recording of interviews can be proven as a useful technique for gathering all the information gained from the interviews, hence a tape recorder was used during the interviews when possible. All six formal semi-structured interviews with participants from state agencies and institutions were recorded, upon previous verbal or written consent from the interviewees following the ethical standards suggested by the University of Edinburgh. In the case of the interviews with the farmers, because of the nature of participant observation it was harder to record the participants, but nonetheless in cases when activities were passive, and we had the opportunity to simply sit and talk, interviews were recorded with the consent of the participants. Transcriptions of interviews to a digital file were performed preferably at the end of the day as well as with a transcription of the field annotations.

4.1.2 Desk-based data collection

Desk-based data collection involves the examination of secondary data, qualitative and quantitative, previously compiled and reported by different researchers, providing useful information for answering the research question as well as
complementing the data collected during fieldwork. The sources for qualitative data I used in this research were newspapers articles that mainly covered the topic of the PMPCH and people's perceptions; technical reports of studies in the area which had information about climatic trends, impacts and social vulnerability to climate change; and official policy documentation about the rationale behind the construction of PMPCH and its objectives, and national climate change adaptation policy. The secondary quantitative data collected was census data of the population in the area, including economic activities, living arrangements and coverage of basic services such as electricity and water. The collection of this information was important for the situational analysis and socionatural, economic and political context of the area, to gain a deeper understanding of the socio-environmental and climatic variability in RGMRB.

The information and findings of a desk-study method can be very valuable when considering all the technical and ethical limitations. First of all it is worth noticing that the majority of sources used for data collection applied a positivist extensive methodology, especially those related to climate variability, impacts and vulnerability. This is taken into consideration during the analysis, especially when making a comparison with the primary data. Other possible problems with secondary data are the bias and validity of the information, thus affecting accuracy of the information. In this study I reduced this problem by using sources that are official, published and have an explanation of their methods section and use correct citation if necessary.

4.2 Data analysis.

The analysis of the collected data was based on the methodological approach of critical realism and networks previously described. Qualitative data obtained from
participant observation and the semi-structured interviews was analysed concurrently at the same time as it was being transcribed, in which the first patterns were identified. The information was divided in themes following an inductive coding which is related to the research question resulting in an overall knowledge of the whole case study, not just single variables or contributing factors.

The next step in the analytical methods used in this research is theorization, thus making a deduction and a connection between the findings and theory. The final step for analysis is retroduction that as explained by Sayer (1992 pp. 107) is a "...mode of inference in which events are explained by postulating (and identifying) mechanisms which are capable of producing them". In other words, this last step of analysis is vital for the understanding of the causal relationships and the mapping of networks that influencing decision-making, perception and knowledge of climate change adaptation.

Information collected from secondary sources was analysed in conjunction with primary data. A methodological triangulation, allows for a comparison between the primary data, and the information presented in the secondary sources and theory.

In this chapter drawing from insights of critical realism and network political ecology I presented the methodology and methods chosen in this research for the collection of primary and secondary data to proceed with the examination of the complex and connected nature of climate change adaptation in RGMRB. This will be done by examining first the social and ecological change in the area, how are they perceived by different actors and the existent adaptation measures. Furthermore these factors will be analysed using the political ecology network approach to understand the context and connection between stressors of change, scales, actors and other structures and processes that mediate vulnerability and adaptation.
Chapter 5: Findings and analysis

5.1 Rio Grande micro river basin: geography, people and economy.

Rio Grande micro river basin has a total area of 60 km² and it is located in the coastal region of Ecuador in the province of Manabí, in Santa Rita parish, the largest parish in Chone canton. Together with Mosquito and Garrapata rivers, they are the main tributaries of one of the major river basins in the area, Chone river basin. These rivers originate at 500m.a.s.l, and in contrast to the majority of hydrologic systems in Ecuador where the runoff comes directly from the Andes mountains snowmelt, CHRB tributary rivers receive their runoff from Chongon-Colonche mountain range (MAE, 2009). Located in the middle-upper section of CHRB, RGMRB topography is characterized for having river valleys and small hills in the lower sections of the micro basin, and steeper hills of about 100 to 400m.a.s.l in the upper basin (Carvajal & Rodriguez, 2010).

Figure 5.1. Map Rio Grande micro river basin. This maps shows the communities inside the basin. Note that some of this communities are do not longer exists due to the construction of PMPCH. The red dots represent the locations in where the study took place. Map produced by INEC (2010) modified by author.
There are about 31 communities distributed within RGMRB, as shown in the map above, with a total population of 4000 habitants (INEC, 2010). In the study all participants had a primary and secondary education; VII Census of Population and VI of Housing 2010 data also showed that 60% of the population in the area has a primary and basic education whilst 22% of the total population has concluded their secondary studies.

Communities in the basin are characterized as rural settlements that started spontaneously without any previous planning (ACJ Key informant, 2014). Statistics from the study of three communities in RGMRB show that 48.83% of the people working in the basin do not own their land, and live in borrowed or leased terrains (SENAGUA, n.d). This is a common practice in the rural areas on the province of Manabi, where workers besides their salary, receive a piece of land have their house in exchange for labor in the land. However, it is important to note that there are some individuals that have land of their own, but live and work on other people’s properties.

Houses within a community are located at a considerable distance from one another and they are surrounded by agricultural and/or pastureland, and few native forest patches. Data obtained from the VII Census of Population and VI of Housing 2010, reveals that 74% of houses in RGMRB have roofs made out of zinc, and the majority of houses have walls made from wood, coated cane and brick, as shown below:
Table 5.1a. 5.1b. Housing Construction Materials. Percentages of houses in RGMRB being constructed with different materials. Tables produced by the author with data from the VII Census of Population and VI of Housing (2010)

<table>
<thead>
<tr>
<th>Material for roof construction</th>
<th>Percentage of surveyed houses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>0.59%</td>
</tr>
<tr>
<td>Asbestos</td>
<td>0.79%</td>
</tr>
<tr>
<td>Zinc</td>
<td>74%</td>
</tr>
<tr>
<td>Tile</td>
<td>7.50%</td>
</tr>
<tr>
<td>Palm or straw</td>
<td>16.13%</td>
</tr>
<tr>
<td>Other</td>
<td>0.89%</td>
</tr>
<tr>
<td>Total: 100%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material for wall construction</th>
<th>Percentage of surveyed houses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>0.39%</td>
</tr>
<tr>
<td>Brick</td>
<td>11.58%</td>
</tr>
<tr>
<td>Adobe</td>
<td>0.10%</td>
</tr>
<tr>
<td>Wood</td>
<td>23.66%</td>
</tr>
<tr>
<td>Coated cane</td>
<td>64.16%</td>
</tr>
<tr>
<td>Other</td>
<td>0.10%</td>
</tr>
<tr>
<td>Total: 100%</td>
<td></td>
</tr>
</tbody>
</table>

The materials used for construction, are the most economic and easier to obtain, fulfilling the function of maintaining an adequate temperature inside the houses. Besides a dwelling, properties in the area also have other buildings such as barns, wooden dryers, and concrete platforms for drying cacao and coffee seeds, piggeries and poultry pens. These buildings are a vital element for the daily activities and lifestyle of the Rio Grande population.

The provision and access to basic services, energy and water are considered the most important necessities. Data from the 2010 census in the area, information from conversations with the people showed that generally the population obtain water for irrigation, animals and human consumption directly from the closest river, stream waterways and/or wells.

Table 5.2. Water Provision. Percentages of people that obtain their water from different sources. Table is produced by the author with data obtained from the VII Census of Population and VI of Housing 2010 (2010)

<table>
<thead>
<tr>
<th>Water Source</th>
<th>Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water supply network</td>
<td>0.20%</td>
</tr>
<tr>
<td>Wells</td>
<td>41.78%</td>
</tr>
<tr>
<td>Streams, river, waterways</td>
<td>57%</td>
</tr>
<tr>
<td>Other (e.g. rainwater)</td>
<td>1.48%</td>
</tr>
</tbody>
</table>
Water is either pumped by pipes and hoses or it is retrieved directly from the source using tanks and carried in by horses, mules or donkeys. Studies in the area have shown that water quality from these sources is below optimal for human consumption, having values above the national limits for the three out of four analyzed parameters, which are faecal coliforms, BOD5, dissolved oxygen and total dissolved solids (ACJ & MAE, 2012).

Similar to other rural areas of CHRB, the majority of the economically active population –female and male– in Rio Grande work in the agricultural and livestock sector.

Table 5.3. Labour activities in the communities of RGMRB. The information in the table belongs to CIMA (n.d), as part of their consultancy project “Valuation of risk of the construction of the dam for PMPCH. The surveyed area for this project consisted in 20 different communities of the basin which were directly affected by the dam construction.

<table>
<thead>
<tr>
<th>Labour Activities</th>
<th>Total Surveyed</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer (own property)</td>
<td>148</td>
<td>63.52%</td>
</tr>
<tr>
<td>Farmer - Livestock – labourer</td>
<td>32</td>
<td>13.73%</td>
</tr>
<tr>
<td>Farmer (own property) – labourer</td>
<td>10</td>
<td>4.29%</td>
</tr>
<tr>
<td>Farmer (own property) – cowboy - livestock</td>
<td>15</td>
<td>6.44%</td>
</tr>
<tr>
<td>Labourer</td>
<td>28</td>
<td>12.02%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>233</td>
<td>100%</td>
</tr>
</tbody>
</table>

Other economic activities observed and mentioned during the fieldwork are running small businesses that provide basic products to the population. Women with many children usually stay at home and earn their living by cooking for their neighbours and/or doing their laundry. People in the area, particularly those involved in agriculture identify themselves as jornaleros or campesinos montubios, which means farmers
and/or countrymen belonging to the *Montubio* ethnic identity\(^2\). As mentioned above, people in RGMRB work on their own properties or on the landowner’s properties getting paid by day of work. Nonetheless, there are limitations to this system, as jobs are not secured by a contract, and many times landowners do not require labour for several days, thus farmers are prone to finding themselves without a job. Biophysical factors such as the area’s soil fertility, adequate climate and reliable water supply, facilitate and secure farmers jobs and income, as these are essential for plant growth and production. This is directly linked with the capacity of the farmers to benefit from the land to satisfy their needs.

The most common perennial and transitional crops in the area are maize, peanuts, rice, cassava, cacao, banana, coffee, sugar cane, and citrus crops such as oranges and tangerines. The choice of product for cultivation depends on the total area of land, its geography, past experiences, knowledge and prediction of weather, and market prices. Although not general in the entire basin’s area, but still very common among farmers, especially the ones that own their own properties, is the cultivation of a variety of crops, mixing transitional and perennial crops, and even sometimes plantation of trees for shadow and nutrient fixation. This results in a diverse agro ecosystem. When asked about what kind of plants they had in their properties, answers usually involved at least three different types of crops, as expressed in the following quote from a farmer in El Pueblito: “Yes, I have my own land, where I grow oranges, tangerines, cacao, banana, soursop, mango, coffee…” (Participant #6, 2014). Mixed cropping or polyculture farming, is linked to agricultural biodiversity which has

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\(^2\) *Montibuo* ethnic identity is a mestizo group from the rural coastal area of the country that is characterized by its connection with the environment and land, mainly through their ranching and agricultural activities (Roitman, 2008).
been avowed as a critical factor for food security in vulnerable populations (Thrupp, 2002).

This is a traditional practice in the area. For local people having different crops cultivated in their lands means a reduction of risk and a way of securing profit and production from their land, as they cannot afford any major losses in agriculture. They consider themselves to be lucky enough to be able to have more than one product and easy access to resources, thus reducing their vulnerability, as expressed by the following participant.

"God is always looking upon us with eyes of pity, we lack nothing. The land provides us with anything and we can survive in any way. Here we have bananas, plantain, cacao, and many other things" (Participant #1, 2014)

Agricultural and livestock products are consumed locally by farmers and their families, but a great quantity of products are transported to markets in Chone, as well as to other places inside and outside the province. There are enough resources and capacity for people to grow and raise food for their own consumption, but the case is that it is a common practice for people to leave the area and travel to the closest city to purchase their food, especially meat, vegetables and spices. RGMRB dependency on the natural and agricultural resources as it is their main source of profit to satisfy their other needs has also resulted in negative impacts to the environment. As people aim for an increase in agricultural productivity and economic profits, they also have expanded the agricultural frontier resulting in an increment of deforestation rate in the basin. This expansion started increasing in 1973 in hands of the local farmers as a result of the agrarian"3 reform and is still ongoing. In the late 90s a major deforestation

3 In 1973, the government of Ecuador approved for a new land reform. The aim of this reform was to change the land tenure in the country that was inherited from the colonial periods and where the majority
peak was reached, when farmers in the area rushed to increase their agricultural and livestock productivity to overcome the damages caused by El Niño phenomenon of 1997-1998 and the 1999 financial crisis ⁴ (SENAGUA Key Informant, 2014). Deforestation is targeted by government institutions and NGOs in the area as the main factor for the contamination of the river basin and as a main cause of flooding events in the lower basin, institutionalizing it among the people in the basin.

Agricultural production in the area is not only vital for sustaining the livelihoods of the local population in the rural areas; it also plays a role in the development of the neighbouring urban sectors. The parish of Santa Rita, where RGMRB is located has a total of 3,951 hectares of agricultural and pastoral land, which with the other two rural areas of the canton contribute with 26% of the total province production and 8% at a national level (GAD Chone, 2012). The local population acknowledges the importance of agriculture, nonetheless they consider that they themselves and the government institutions in the area that work with them are still lacking knowledge, capacity, resources, and organization to reach full agricultural productivity.

Economic activities, housing, territorial organization, and lifestyle point to clear characteristics of a rural administrative division. Nonetheless the communities within RGMRB are classified as the peripheral zone of the urban parish Chone-Santa Rita,

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⁴ In 1999, under the government’s neoliberal precepts, Ecuador experienced the worst economic crisis on its history with a hyperinflation and a breakdown of the banking sector. This crisis had the greatest impact in the lower and middle income families, creating social problems such as migration, insecurity and increase in poverty and unemployment (ICG, 2007).
meaning that they are under the administrative influence of Chone municipality. This has resulted in low management capacity an intervention from the local governments, poor representation in the municipal and provincial council, and inappropriate legal ground for the communities in Rio Grande. For this reason since 2011, the communities in RGMRB and from Mosquito and Garrapata basins have been organizing themselves to appeal for the creation of new rural parish with the name of Rio Grande. This will allow them to receive the proper interventions from the government necessary in all rural communities under the ‘Territorial organization, Autonomy and Decentralization Code”, providing them a legal ground to receive more benefits from the state including roads, public health, education, among other things that contribute to the development of the area.

5.2 Socionatural impacts and changes in Rio Grande micro river basin.

Research in the area showed that there are two main stressors of social and ecological change in the river basin, these are increased climate variability and the construction of the dam as part of the development project PMPCH. Given the nature of these stressors it can be argued that the study area is confronted by both the impacts of increased climate variability and by the consequences of development. It is important to clarify that given the researcher’s position and the interviewees’ and participants’ perspectives and experiences, it may be the case that there are more factors causing socio-ecological variability. Nonetheless these two factors are the most representative and experienced by all the participants and interviewees of the study. The way in which all the different actors in RGMRB experience and understand the changes caused by these stressors, will determine the impact – positive or
negative –, their vulnerability and the decisions they make to cope and adapt to changes.

5.2.1 Climate induced changes: climatic trends, variability, risks and impacts.

Key informants from governmental institutions, farmers, and scientific research in the area have recognized the increased climatic variability in the area. To understand how this stressor has caused a social and ecological change first it is important to know the past, present and future climatic trends, in order to explore in the ways in which their variability have impacted the ecosystem and the social structures. Additionally, perceptions of change and risk among the actors in the basin have to be considered, recognizing that the subsequent adaptation measures depend on how actors perceive the risks from socio-ecological change.

RGMRB as part of CHRB is considered to be one of the most vulnerable basins in the country. Its atmospheric and physical characteristics such as complex topographic system and the incidence of sea surface temperature variations such as El Niño Southern Oscillation, and social factors particularly the low institutional capacity to react towards disaster events, makes this basin highly vulnerable to present and future climate change events (MAE, 2009; Cáceres & Núñez, 2011).

In normal conditions, RGMRB experiences two clear meteorological seasons every year, classified as winter and summer. The marked differentiation of these two periods is influenced by the air masses arriving from the Pacific Ocean (INHAMI, 2008). Average atmospheric temperature during these seasons varies along the range of 22 and 28 °C. Future climatic models, predict there will be an 0.22 °C
increase in temperature per decade in the CHRB, particularly in the upper basin further away from the coastline, exactly where RGMRB is located (MAE, 2009). Demarcation of seasons in the area, is more appropriately done by looking at precipitation. Usually winter starts in December lasting for six months in where the area experiences heavy rainfall events, whereas in the summer season, which begins in mid-May until the end of November, precipitation values descent considerably, drying up land, rivers and streams. Between these two seasons the maximum annual average rainfall varies between 1500-1750ml and the minimum annual average is between 0-500ml (ACJ & MAE, 2012). In relation to changes in future precipitation models cannot yet predict with precision how rainfall patterns are going to change in the future, although it is expected an increase in occurrence and intensity in episodic events such as droughts and floods (MAE, 2009).

As previously mentioned climatic variability in RGMRB makes the area susceptible to high risk climatic events and hazards impacting livelihoods, wellbeing, and access to resources, agricultural productivity, economy, and infrastructure. Studies have identified three major climatic threats in the area: droughts, flooding and landslides (ACJ & MAE, 2012; MAE, 2009; INHAMi, 2008). All these impacts are related to precipitation levels and the state of the river, thus exerting pressure on the water resource systems. In terms of probability, droughts are more likely to occur specially during the summer, having a more extensive impact over the area (MAE, 2009). However the vulnerability assessment performed by MAE (2009) in CHRB, shows that the impact of droughts is lower compared to the impact from flooding and landslides (Annex 4). The threat of flooding in the basin is related to precipitation levels during winter and river or streams overflowing, affecting principally the population that live and have their land close to the riverbanks.
Deforestation is institutionalized as the most relevant anthropogenic factor related to the increase in intensity and frequency of flooding and landslides events. The reduction of forest cover, increased concentration of sediment in the river, and higher levels of precipitation, have resulted in the obstruction of river channels increasing the likelihood of flooding events (INHAMI, 2008). Likewise with forest cover loss the soil is exposed, becoming quickly saturated during heavy rain episodes thus losing stability resulting in landslides.

5.2.2 Perceptions of climate induced changes.

Before discussing how inhabitants of the communities in RGMRB perceive and experience this climatic variability induced events, first it is important to understand they ways in which people make sense and predict weather and climatic patterns. Research revealed four local methods for predicting daily weather and seasonal change. When the rainy season is about to start, farmers observe an increase in the amount of water that runs down the streams. Precipitation is also related to the appearance of birds and insects such as cicadas (Cicadidae) and to the observation in changes of vegetation such as the growth of flowers and leaves in the local trees identified as Pechiche and Ceibo. The great majority of participants mentioned changes in the moon as the most reliable tool to predict precipitation events, thus informing farmers when to cultivate and harvest. These methods have the characteristic of showing a strong connection between people and their surrounding environment. Traditional knowledge informs changes in the environment which influence decisions related to agricultural activities.

A higher variability in the way the environment behaves as a result of the changes in the climatic conditions could limit the methods for prediction and decision
making, as mentioned by one participant in Juan Callo: “We had our rules, but now changes are so sudden, we are just so confused. I cannot longer have an opinion” (Participant #4, 2014)

The observations of changes and variability in the environment have led to the perception that in the last 10 to 20 years, climate has indeed become more variable, demonstrated by the disorganization of patterns, constant changes from one day to another and how the changes between seasons are not as precise as they used to be. This creates a stress in the socionatural system and it has become a hazard with specific impacts and vulnerabilities. The most common way of noticing a change is by the observed precipitation, in the last years, the area has experienced a decrease on rainfall levels during winter, an increase in temperature, and unexpected heavy precipitation events during summer months.

Changes in the system as a result of climate are perceived differently among participants depending on their socio-economic background, access to resources and geographic location within the basin. However, there are some general perceptions about how climate variability has impacted the area. Climate induce changes are principally related to agriculture and reduction of plant productivity. Lower precipitation levels during the last five winters have caused a decrease of citrus fruit production, which used to be the principal agricultural product in the area. Tangerine trees are suffering from fungal diseases (Phytophthora citrophthora) that along with a decline in water availability affect plant-growth and thus the quality and quantity of the product, as expressed by a farmer in Tablada de Sanchez: “Now, with changes in climate, tangerines are small. They do not grow as much as they used to, with just a little bit of
pulp, and they no longer have a yellow colour. This year harvest was very poor” (Participant #1, 2014)

It is observed that there are less citrus trees cultivated in the area, and many farmers and landowners have shifted their cultivation system to more drought resistant crops such as maize. Nonetheless regardless of the weather variability, farmers continue to practice a mix cultivation system. Other socionatural changes induced by climatic events in RGMRB are health related problems; small children are getting sick more often and higher temperatures are the cause of the appearance of dermatitis in small children, as revealed by mothers during research.

Extreme climatic events, principally those caused by past El Niño Phenomenon which resulted in extremely damaging floods and landslides are considered by the population in RGMRB as the stressors of change. In the past they have had a high impact in their lifestyle, infrastructure –roads and bridges– and losses in productivity. Although there is not a determined increased incidence and variability of these events, people relate climatic stress to their occurrence, as gathered from the conversations with participants when talking about climate change, they made reference to the El Niño of 1997. Floods and landslides related to the phenomenon, forced people that lived closer to the riverbanks to find shelter in higher grounds of the basin and eventually move there temporarily. As an impact of floods and landslides, people lose their material possessions and agricultural land. There is a high social resilience as people are able to survive and quickly recover from the impact, by using accessible natural resources (Tompkins & Adger, 2004). Nonetheless as a consequence of the pressure to overcome damages, there is an increased impact in the ecosystem by the expansion of the agricultural frontier as previously mentioned.
Climatic variability in the area is related to changes in temperature and particularly precipitation, which according to research might result in a higher incidence of floods, landslides and droughts which are considered to be the most relevant hazards in the area. Even though floods are considered to be the most determinant cause of socionatural change in the past, currently participants perceive that droughts signify more risk than floods. It is noticeable that perception of change is determined by the way in which people’s livelihoods are affected rather than the occurrence of the climatic events themselves.

### 5.2.3 Dam construction induced changes risks and impacts.

The second main stressor of change in RGMRB is the construction of the dam as part of the PMPCH, which started in 2011. The principal objective of the dam is to reduce flooding in the city of Chone, which because of its geographical location and lacks of urban planning and infrastructure experiences every year flooding events with devastating consequences. The secondary objective of this project is the provision of residential and irrigation water to the area. The project in addition to being a direct response to the flooding risks in the area, has political foundations and influences; it is politically justified by objectives of the current national development plan\(^5\), which look for an efficiency in the management of strategic sector – one of them water– thus improving people’s quality of life by mitigating flooding events and by the provision drinking water and for irrigation.

\(^5\)Objective 3: “To improve people’s quality of life”; Objective 7: “To guarantee the rights of Nature and promote environmental sustainability globally”; Objective 11: “To ensure the sovereignty and efficiency of strategic sectors for industrial and technological transformation” (PNBV, 2013)
Research shows that the main changes induced by the construction of the dam are social, infrastructural, and institutional. The environmental changes although important, will not be discussed in depth when considering adaptation measures as people in the area have not yet perceived how environmental impacts caused by the dam might affect their lifestyle since the dam is not yet completed. Similarly to other invasive projects, the construction of the dam has an immense impact in the area where it is being built. It results in people’s and communities’ displacement, taking away the land of a number of small producers as well as large landowners, putting at risk the continuity of cultural heritage, economic and agricultural productivity, and the wellbeing of the population. This is the case in RGMRB, where people had to sell their lands, and migrate to different areas, as well as settlements provided by the

Figure 5.2. Map PMPCH. This map shows the area impacted by the construction of the dam. Arrow shows where the dike is being built. Blue lines represent the areas that will be flooded for water storage. Source: SENAGUA (2012)
The abandonment of their land has caused psychological and emotional issues within the displaced communities, as people have a great sense of attachment with the physical location of their property but also the activities connected to it and the meaning it has for them.

The following quotes from participants of Tablada de Sanchez and Platanales explain how people experience the fact that they have to move to a new settlement:

“What we miss the most is the agriculture, as it was our main source of income for many years. In these new houses we cannot grow many things and we cannot have our animals as we used to.” (Participant #2, 2014)

“It took me a while to finally accept the fact that I had to leave. I was born and raised there, and it hurts. We are like animals being removed from their habitat. They [government] told us that they were going to give us everything, but still the change is radical. Yes, it is very pretty [new settlement], and people in the city always say that it is spectacular. But I feel that when we look out the window, there are no trees, we cannot go to our streams and river. We feel as if we were in jail” (Participant #3, 2014)

People displacement and compensation efforts on behalf of the State, have also induce changes in the infrastructure of the area, including irrigation systems, schools, cemeteries, electrical network and roads. New first class roads have been

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6As part of the dam construction project, and to reduce the impact on the local population, SENAGUA along with EE are providing houses to the most vulnerable people of the displaced communities. These houses will be located in two different settlement areas, Tablada de Sanchez and La Arabia. The first settlement in Tablada de Sanchez which partially completed, and there are already 16 families completely reallocated as informed by a key informant from the involved institutions. Images of the settleelement can be found in Annex 6.
constructed and others are in process of construction connecting the communities in the river basin and thus improving the mobility in the area. A better road system results in a direct positive effect in the economy of farmers, as they can easily transport their products to the markets. Nonetheless in terms of mobility, not all actors experience the same benefits. There are still families living in the higher lands of the upper basin. These families have not been displaced, thus not receiving compensation from the government, yet they do experience the changes caused by the dam construction mainly in terms of mobility. The flooding of the river to create the dam’s reservoir has destroyed the usual summer roads that connected the communities with the main highway. At present people have to travel and transport their products by canoes, all year long, until new roads are constructed.

As a consequence of an initial conflict between community members opposing to the construction of the dam and the government\(^7\), the State took a special interest, naming it a flagship project, fostering an intensive state intervention aiming for social and environmental benefits that will reduce the impact of the construction. (SENAGUA key informant#1, 2014). This functioned as a political tool to discredit the initial opposition and bring more supporters in favour of the dam. Additionally conflict resulted in the division in the communities which affected the distribution of resources and benefits, as the strategy used by the government was to provide services and benefits only to those individuals who were in favour of the project (SENAGUA Key

\(^7\)After the agreement that determined the construction of the Dam in 2010, communities of RGMRB participated in an uprising against the project, as they claimed it was directly impacting their human rights, and the access to water. There was an additional complaint arguing that the project was not socialized with the communities before its approval for construction (MANCOMUNIDAD RIO GRANDE, 2XXX), leading to a late start of the dam construction and a social conflict in the communities. For further information about the reasons behind the conflict refer to Annex 3.
Informant #2, 2014). Nowadays, there are various governmental institutions working directly in the area, and in further stages of the project it is planned for a higher number of institutions and agencies to be involved in the development of RGMRB, intervening in the defined strategic sectors such as agricultural productivity, housing development, mental health, education and reforestation projects.

Currently, as observed in the field and informed by the interviews, there are three main institutions working in the area. These are SENAGUA, which is the manager of the PMPCH; MAGAP, working mainly in agricultural productivity projects with the people of displaced communities, and intervening in knowledge and capacity building with farmers that belong to other communities in the basin; and EE the public company in charge of the development and construction of the new settlements. With the collaboration of these governmental institutions, at least two new formal institutions have appeared in the area; these are Junta de Regantes and Mi Campito. The former is exclusively formed by farmers displaced and resettled in Tablada de Sanchez or La Arabia, with the main objective of organizing farmers in an association providing them the opportunity to work legally, thus securing their labour by reducing the dependency on landowners. Additionally this organization gives them the authority to manage their natural resources especially water for irrigation and to participate as a group in the decisions that concern agricultural productivity in the area. Mi Campito is also an agriculture organization, formed by members of the community of El Pueblito, which is the result of the participation in the ‘Agrarian Revolution Schools’, that aims to support and encourage partnerships by small and medium farmers to generate technological innovations for the development of agriculture in the area (MAGAP Key Informant #3, 2014)
Social changes induced by the construction the dam are mostly felt by the people in the communities that were displaced and/or lost a great part of their land. Therefore the perception of the construction of the dam is related to how they have had to abandon their place and change their way of living, rather than an adaptation response to flooding and a project that promotes the area’s development, as perceived by the government. However, there are also some positive impacts; the increased intervention of the government has resulted in the construction of roads that were much needed in the area, facilitating transportation of products and thus collaborating with the development and economic growth of the area. The perception of changes and accounts of risks caused by this stressor were different among the actors in the basin, depending on their experience. This differentiation should be consider as the way in which changes impact people’s and communities needs and livelihoods, is a determination of vulnerability and adaptation measures.

5.3 Adaptation to change in RGMRB

5.3.1 Planned adaptation to change in RGMRB.

The description of the main stressors of social and environmental change in the area provided an answer to the question of ‘adaptation to what’, which is one of the three necessary points to understand adaptation (Smit et al., 1999). In this section by describing and analysing the adaptation measures observed at a local level, the remaining questions of ‘who’ is adapting and ‘how’ will be discussed, focusing particularly on the elements – social, cultural and ecological– that influence adaptation actions. Research revealed the existence of planned and autonomous adaptation in the area. The former corresponds to decisions and actions from government institutions that have been working directly in the area whereas the latter are actions
by the local population, as an unplanned response that aims to reduce the impact of stressors and sustaining their livelihoods.

Planned adaptation is observed as actions from the projects and programs carried out by the government institutions that are intervening in the area, principally to mitigate the impact of the variability caused by the construction of the dam, which in itself should be categorized as the main adaptation to climate in the area. The dam was constructed with the underlying assumptions that it is a 'necessary' technological and institutional measure to reduce the impact of flooding in the city of Chone, which is the most vulnerable area to flooding in CHRB; and as a sign of progress and development in the region. The following quotes by key informants of SENAGUA define the context in which this institution understands climate change in the area.

“If we talk about climate change, in this canton [Chone], we refer to the topic of flooding” (SENAGUA Key Informant #3, 2014) Roque

“[…] Chone absolutely needed something to mitigate flooding and the provision of residential water, that currently is obsolete […]. This project was claimed by the community because there is too much water during the winter, and very little during the summer” (SENAGUA Key Informant #1, 2014)

Under these circumstances the dam construction and its different environmental and social programs work under the assumption that the main driver of change in the area is the increased climatic variability, represented by the occurrence of flooding events. In this manner, the dam construction project is a proactive, planned approach to adaptation to a purely biophysical stressor. The main limitation with this type of adaptation is that it lacks a connection with local reality and the perceptions of
the population regarding socio-ecological change. Whilst for the government the construction of the dam for flooding mitigation will promote development in the area, people living in RGMRB perceive it as a project that changes the social structure and livelihoods of the communities as expressed by various participants during informal conversations. This demonstrates the fact that many times adaptation actions that may benefit certain actors, can also reduce the adaptive capacity of others (Keskitalo and Kulyasova, 2009).

Additional adaptation actions planned by governmental institutions in RGMRB, instead of being a direct response to increased climatic variability, are actions resulting from socio-ecological changes caused by the dam construction, but have the potential to increase farmers’ capacities to adapt to current and future climate change. As people were displaced from their territory, the government built new settlements to reallocate families to reduce the social impact. The location of these settlements is on higher grounds of the basin, thus protecting the communities from the risk of river overflowing and flooding events, which are estimated to be more intense in the future. Furthermore, it is expected that with the dam construction and the storage of water in the dam reserve, inhabitants of the new settlements will be direct beneficiaries of continuous water provision for human consumption and the irrigation of the agricultural land where people work (SENAGUA Key Informant#2, 2014). Constant access to water, as one of the main strategic sectors for development and a basic necessity, will aid the population to cope and better adapt to the more prominent dry periods, which are already perceived in the area. Programs implemented to reduce the social impact instigated by the dam construction and foster development in the area, are short term solutions that can also limit the population’s capacity to adapt as they might be also a causal factor for change with wider consequences on the socionatural system. In this
case study this is particularly observed in the displacement and resettlement of the communities. People's adaptive capacity to cope change can be limited by the fact that people are unfamiliar with their new territory and takes time for them to adapt to their new way of living, which in the future might create the need of further adaptation actions.

Another kind of planned adaptation that similarly to the dam is responding to a single stressor, is the implementation of the Climate Change adaptation project through effective water governance or PACC for its Spanish initials which responds to the vulnerability of this basin towards climate induce events, and the impacts to environment and society. This pilot project was concerned with climate change adaptation through an efficient management of water resources in the agricultural sector, by the application of new technologies and the constructions of infiltrating and erosion control ditches with the goal of increasing soil fertility and productivity in the area. A second component of this project was education of the community, focusing particularly on students, and looking to create awareness about the importance of climate change and to ensure the future participation of the community in other projects such as reforestation. Although the adaptation measures in response to climate change in this project, has been proven to be effective in the short term (ACJ & MAE, 2012), and there has been an involvement with the community, this is still a top-down linear approach to adaptation to climate change which presents solutions without previously understanding the perceptions and needs of the participants involved. The poor inclusion of subjectivities, norms and even live styles into the adaptation decisions made by this institutions has resulted in a rather unsuccessful project, where participants, as expressed during participant observation, have not perceived any change in their assets and livelihoods.
The second most important governmental institution in the basin is MAGAP, which is directly involved in the development and productivity of the agricultural and livestock sector, with a special attention to capacity building and labour security. This institution is implementing an agro-productive project in the area, with the objectives of diversifying livelihoods and providing employment to local farmers to promote labour stability (MAGAP Key Informant #3, 2014). The main beneficiaries of this project up to now are the displaced farmers that are involved in the resettlement program with the government. With the collaboration of MAGAP, farmers have organized themselves into a new formal institution Junta de Regantes, which has facilitated farmers with access to secure paid work by working in state owned farms, and also with the management of water resources in relation to their necessities. Development planning actions such as this one that diversify livelihood opportunities can reduce the impact of declining assets due to changes caused by stressors (Forstyh and Evans, 2013). Nonetheless, this adaption measure has limitations, particularly related to the dependency that is created between Junta de Regantes and the State represented by the governmental institutions working in the area. Farmers now depend on decisions made at different scales, by outside members of the association that might have different perceptions and foundations which inform their actions.

A second stage of this project is to form and create capacities among RGMRB community members to shift from a purely agricultural and resource based economy, to the production of manufactured goods. This measure benefits members from both displaced and not displaced communities which are involved in the ERA programs which have the objective of transferring knowledge and capacities to the farmers to improve the sustainability of agricultural practices. It is noteworthy to mention that these adaptation measures are not spread equally among all the communities of
RGMRB, the main beneficiaries are the people who were displaced, who are considered the most vulnerable towards the impacts caused by the dam construction as they were forced to leave their lands and households. Actions taken by the government can help people to adapt to their new lifestyles and have a better capacity to cope with current and future climate variability. Yet, at the same time there is a tremendous change in the social structure and relations within and between the communities and the state. Inhabitants of these communities have created a tight relationship with the state institutions becoming less autonomous and more dependent on the decisions that institutions make, thus demonstrating that institutions can affect social distribution and vulnerability by determining the management of the resources (Willibanks & Kates, 1999). This has proven to be a key element for dealing with the effects of change as they provide assistance to the population (Hill, 2013), by influencing the adaptive actions at a local level. The decisions that the government will take in order to reduce changes are at the same time influenced by wider national policies related to the country’s development plan; and so the adaptation process depends on the nature of the relationship of the actors at a local level and the government and effectiveness of state institutions (Brooks, 2003)

5.3.2 Autonomous adaptation to change in RGMRB.

Contrary to planned adaptation, autonomous adaptation can be understood as the actions that are not a conscious response to climatic stimuli but are rather triggered by the perceived changes in the socionatural system, that have an impact on the stability of livelihoods, and are driven by individual and local experiences, without an official intervention (Forsyth & Evans, 2013). These decisions and actions are taken by private actors, in this case the local population of RGMRB.
With this background the first and most notorious adaptation measure is multiple cropping which was clearly expressed by one farmer in El Pueblito: “We have to be prepared, not only focusing in one particular activity, in our land we have to have a little bit of everything, we have to cultivate banana, plantain, coffee, cacao and when possible citrus trees as well” (Participant #7, 2014). This is a traditional activity that has persisted over time, becoming institutionalized among farmers and with a great potential to respond to higher climatic variability. Additionally, to reduce the impact of droughts and maintain a constant supply of drinking water and water for irrigation, farmers with sufficient economic resources have constructed wells and small reservoirs in their properties to store water during high precipitation seasons for later use. It is recognized that people in RGRB, have a better capacity to adapt than people in the city, also showing a high resilience to changes as they manage to cope with stress and changes, but also maintaining the same basic structure that informs their livelihood decisions and way of functioning (Pelling, 2011).

These autonomous adaptive responses are driven by how the socio-ecological changes are represented as a hazard for vulnerable people’s livelihoods. Changes because of stressors can lead to resource scarcity, which in this case study is perceived as the reduction of agricultural productivity and accessibility to water resources, thus coping mechanisms are implemented to reduce the risk of losing their livelihoods and resources. The importance of natural resources in the area is an evidence of how people have an attachment to their land and territory, and the access to these resources is one of the reasons inhabitants of Rio Grande have for not leaving the area even in situations of risk and change. Place attachment is a causal factor that enhances communities’ resilience to impacts and informs successful adaptation strategies (Amundsen, 2013). Additionally, it is also important to mention that even
though there is no a direct planning, autonomous responses also reflect pre-existing structures and methods of managing resources that reflect the social vulnerability of the area (Marino & Ribot, 2012). Adaptation measures, in this study respond to pre-existed measures that limited adaptation actions, such as community members and farmers disorganization that impeded collective action to respond to changes in their systems.

5.4 Limits and barriers to adaptation.

Adaptation to change is a continuous process, which responds to challenges and opportunities in order to sustain the system in the case of being affected by stressors that cause change. In the case of RGMRB, it was possible to identify some of the different causal factors guiding the adaptation measures implemented at a local level. As different actors, social and environmental stressors, political agendas and perceptions of risk come together to cope to change, these same elements can create limits and barriers to adaptation, hence differentiating the level adaptation among the different actors in the river basin.

Considering the different planned and autonomous adaptation actions, it was observed that not all participants in the study have the same level of involvement and participation concerning adaptation. The main reasons for this, as expressed by the participants, were lack of information and capacity building on behalf of the government, and organization. Studies have mentioned that the main barriers to adaptation are those associated with poor information regarding climate forecasting paired up with low levels of awareness, information and action amongst decision and policy makers (Adger et.al, 2009). In the case of Ecuador in general, climate forecasting and climate change models are not well developed, because of this lack
of clarity, government institutions consider that planned adaptations are limited by the fact they do not have the complete information to make decisions (MAGAP Key Informant #3, 2014), thus potentially increasing the vulnerability of the local population. The most noticeable limitation to adaptation is the poor capacity building on behalf of the government institutions to all the communities of the basin. Despite the efforts on carrying on workshops, particularly focus on the use of technology and sustainability for agriculture and livestock, in RGMRB the results have been unfortunate, with the possible exception of the people from the displaced communities. The reasons for this limitation can be explained by the fact that farmers do not believe government institutions have proper capacities, as well as how previous workshops have not had any positive impacts. This limits the possibility of adaptation actions, which is mainly influenced by the lack of trust and capacity of institutions.

Furthermore and most importantly, the way in which climate change and variability is perceived and understood among the local population and decision makers, also influences the ways in which adaptation is shaped and constraint. Research revealed that for participants of RGMRB and key informants of strategic institutions, climate change and variability are atmospheric events outside the social world, in which human role is limited as a reactive action after they have suffered the impacts. When asked about how participants are prepared in the occurrence of high risk climatic events, participants answered with expressions such as the following remark by a farmer of Tablada de Sanchez “[…] we just depend on God’s mercy” (Participant #1, 2014)”. The boundaries created between nature and society, and how people remove themselves from the process of changes in climate, can serve as an explanation on why adaptation measures identified in the area are not usually a response to the knowledge of climatic variability or future climate change, and the
limitations to this adaptation does not rely on the nature of the event; rather adaptation measures in RGMRB are limited by perceptions of risk held by society, as well as how farmers perceive their role in the measures related to reducing the impact of changes.

In this situation the adaptation capacity and the implementation of measures that might help the communities better cope with future climate change, is also limited by political factors that affect decision making and actions. The fact that nowadays these communities are still considered urban areas, part of Chone canton, and thus have a poor management capacity and intervention from the local and provincial governments, means a barrier for the implementation of possible adaptation measures. Additionally as these communities are not considered separated from the urban area of the canton, perceptions of risk and necessities are generalized to the entire population, and this has resulted in the implementation of actions that are not connected with the needs and perceptions of the local communities, as it is the case of the dam construction, which has triggered other socio-ecological changes in the area.

5.5 Networks of adaptation.

Adaptation practices and coping strategies to changes in the socio-ecological system are a result of a network of actors and causal processes which have created the context in which these adaptation actions are formed and limited. This map illustrates the network indicating nodes and connections across space and provides a visual summary of the complexity of climate change adaptation in RGMRB. This network shows how the main drivers for adaptation are the socio-ecological changes perceived by the actors in the area including the governmental institutions. Subjectivities and perceptions play a vital role on the identification of changes and adaptation measures, as they influence to what people adapt and how. Socio-
ecological changes are a result of stressors in the system, which are the increased climatic variability and the dam construction as previously discussed; they influence decisions of adaptation among different actors. The identification of these factors as stressors is at the same time a result of the experiences, values and perceptions of actors inside the network.

![Map of network of adaptation](image)

**Figure 5.3.** Map of network of adaptation, constructed based on the frameworks and models proposed by Agrawal (2008, pp. 30) and Birkenholtz (2012 pp. 309).

There is an interconnectedness between the communities and government institutions at different levels, depicting the fact that adaptation measures from one actor are not isolated from another and are also dependent on underlying factors such as politics and perceptions of risk, as demonstrated by the fact that government institutions consider flooding the principal risk and hence promoted the construction of the dam as part of a political project; whilst for people living in the basin, drought represents a higher risk for their livelihoods. Therefore for them the dam construction
is not a solution but rather a stressor of change. This serves as a justification for a better integration between actors for an effective response (Clark et al., 2002). The relations and complexity of the network should be understood including power distribution between individuals, groups and actors, as an important determinant of the process of adaptation (Thompson et al., 2006). The strength of relationships and power were observed in the connection between displaced communities and the programs from institutions to reduce the impact of the dam construction, as decisions made for these programs directly influence displaced people lifestyles. At the same time people who were displaced have certain power over the State as they have the right to demand a proper compensation. Nonetheless, the information obtained in this study was not enough to illustrate adequately the strength of the relationship as it is suggested by Agrawal (2008).

The network of adaptation also represents the fact that stressors of change and adaptation measures are hybrids and socionatural as they are biophysical in nature but also framed by wider social processes, with different actors including nature and other human and non-human interests. The factors that underpin the network shape the way people perceive the surrounding environment, changes and risks, and consequently inform and enable actors to make decisions to adapt.

Although this network map provides the current context and factors for adaptation, it is expected to change over time in relation to changes in different causal factors including perceptions and socionatural realities which also influence vulnerabilities and adaptation measures; adaptation is a process that is continuously changing.
Chapter 6: Conclusion

6.1 The complexity of adaptation.

Grounded in critical realism and network political ecology, this study has addressed the research question: *What are the adaptation measures to socio-ecological changes in RGMRB and the underlying factors that motivate and influence such adaptations?*, and have thus provided a critical understanding of the process of adaptation to climate change to discover the complex and causal relationships and connections that determine adaptation. The case study in RGMRB in Ecuador revealed that in fact, in order to understand how adaptation occurs and for it to be successful, it is necessary to broaden its concept by first recognizing that adaptations are not just a response to changes by existent climatic stimuli, but they are rather constructed by different natural and social factors and stressors which determine to what is adaptation responding, who are the responding actors and how these adaptation measures are implemented in order to reduce impacts and vulnerabilities.

In the case of RGMRB in Ecuador, it was observed that the main drivers for adaptation were dependent and differentiated by the actors’ perceptions and experiences of change and risk to livelihoods. Research revealed two main stressors of change in the area, increased variability of climate and the construction of the dam as part of the PMPCH. How these stressors were perceived by the actors depended on their power, political and geographical position, their livelihoods and past experience. Whilst for governmental institutions working on the dam construction and involved in the area as part of the social alleviation project to reduce the impact of the dam, the main cause of climate related risk was flooding events. On the other hand
people living in the basin, who work in the agricultural sector, perceive that droughts were the main stressor for change. In the case of the dam construction, people in the area as they did not perceive that the risk of flooding requires adaptation, they consider the dam as an invasive project, especially those communities that had to be displaced. A same reality can be seen and perceived in different ways, informing the way in which decisions are made. In relation to these perceptions of risk and change, research also revealed that adaptation measures in the area that can help the population cope with climate change, are not simply a response to the existence of the identified stressors, rather they are a response to the perceived impact, which is usually the loss of assets and livelihoods, thus demonstrating the multiple-factor causality of adaptation.

Differentiation on perception of risks leads to divergent ways of adapting to the socio-ecological changes in the area. The two most prominent types of identified adaptation measures were reactive planned and autonomous adaptation, which had the main objective of reducing the impact caused by the changes in opposing to a response to a climatic stimuli, and was often driven by feelings of place attachment. Reactive planned adaptations in RGMRB were mostly short term technical solutions, that although necessary they have the principal limitation that they lack the inclusion of the context in which adaptation is necessary, without addressing the underlying non-climatic factors that cause vulnerability as is the case of the dam construction and the programs of reforestation, which omitted the variety of perceptions of risks and only focused on the stressors of change. A more adequate adaptation requires a more holistic and long-term consideration of vulnerability caused by the climatic and developmental stressors, which also considers the socionatural context in which adaptation occurs.
Autonomous responses identified as adaptation measures, reflected how stressors impacted people’s livelihoods and were designed so people can cope with the change rather than the events in themselves. These responses although defined as unplanned, they are not isolated from a context as they reflect pre-established mechanisms and structures, which inform the best adaptation mechanisms. Both planned and autonomous adaptations are a result of the network of causal factors that define adaptation measures. As part of this network planned and autonomous adaptation can work together to reduce vulnerability by providing livelihood diversification, or technical solutions as it is being done by the governmental institutions in RGRMB, but also recognizing that experiences and perceptions of risk vary between actors at different scales and levels. Nonetheless is also important to take into account that perceptions of risk can also limit adaptive action, such as in the case of El Nino phenomenon, that event though the communities have the capacity to adapt, this actions are limited by the fact that the impacts are not constant threat to their livelihoods. This demonstrates that adaptation actions are connected with local needs and present priorities.

With this in consideration adaptation and development programs can address various risks, contrary to just assuming that adaptation measures are only responses to climatic or physical stressors disconnected from the social world. Adaptation measures that are better connected with local realities taking into account the subjectivities of perceptions and world views of different actors can deal more adequately with the changes and impacts at different levels of the system and in accordance with the felt priorities of the most vulnerable, thus being more socially just.

Despite the existent adaptations in RGRMB there is still a need to promote a more socially just adaptation to change in the area. Future adaptation measures
should shift from an allocation of solutions to stressors of change in strategic and vulnerable sectors, and be expanded to a wider study on how risks are defined and perceived and the underlying structures of power, politics, vulnerability, norms, and culture. These factors should be considered valuable for the governance processes as these constructions influence decisions of adaptation in all scales and levels. As observed in RGMRB, where adaptations measures were influenced by the different perception of the actors. In this case the government has a stronger decision making power and thus influence the socio-ecological changes and the consequent adaptation measures which at the same time are informed and follow a wider political and developmental project, the PNBV. Decisions from different scales impact adaptation at a local level, hence the importance of the consideration and inclusion of perception at a local level to facilitate a connection between national climate changes policies with the adaptation measures already established at local level.

Development plans for adaptation and policies should integrate the differentiation of risk and vulnerabilities and aim for a vulnerability reduction approach, addressing the fundamental reasons underlying vulnerabilities, not just on the occurrence of events that induce change. Moreover programs and institutions in the area should address the fact that climate change is not separated from society norms and rules, and through decisions strengthens the connection of inhabitants to their environment, so people instead of being just victims of socio-ecological change, they feel as they are part of the system and have a role in the reduction of future induced climate change impacts. A holistic adaptation measures will more realistically related to the model of “Good living” which guides the development of the country, and aims for an increased focus in human development starting at a community level with an
appreciation of values, culture, ethics which allows for a better relation between people and most importantly the environment.

Throughout this dissertation it was argued that approaches to climate change which have a principal focus on technical challenges are insufficient as it lacks a connection with local communities by forgetting about the adaptive elements existent in the context where adaptation occurs. This poor connection can lead to solutions that could create more inequalities, injustices and further increase vulnerabilities, thus the necessity of promoting an approach that includes a wider range of subjectivities, and the nature of relationships and power. Although in this study the different perspectives of risk, changes and factors that drive adaptation were identified, there is still a need for further research to better identify the strength and directionality of relationships within the adaptation network, including political and power distribution. Additionally it is recommended to further explore other causal factors that influence how adaptation occurs such as markets, and other private institutions at different scales. Once there is a better understanding of how power is distributed among all these actors, it will be easier to identify the roots of vulnerabilities and promote adaptation actions that not only help to reduce the impact of changes in the socio-ecological systems, but also act as a social and political tool (Pelling, 2011) for actions that promote more just and equal measures for adaptation and development.
Appendix

Annex I: Articles related with climate change management the National Constitution of Ecuador.

TITLE II, RIGHTS, Second Chapter, Right of well living, First Section

Water and Feeding

Art. 12. - The human right to water is fundamental and inalienable. Water constitutes strategic national heritage for public use, inalienable, imprescriptibly, cannot be taken away, and essential for life.

Art. 13. - People and communities have a right to safe access and permanent to healthy food, enough and nutritive; preferable locally produced and in correspondence with their diverse identities and cultural traditions.

The Ecuadorian Government will promote food sovereignty.

Second Section

Healthy Environment

Art. 14. - It is recognized the right of the population to live in a healthy and ecologically balanced environment that guaranties the sustainability and the well living, sumac kawsay.

It is common interest the environment preservation, conservation of the ecosystems, biodiversity and the integrity of the genetic heritage of the country, the prevention of any environmental harm and the recovery of the degraded natural spaces.

Art. 15. - The State will promote, in the public and private sectors, the use of green technologies and the use of alternative energy with no contamination and low impact. The energy sovereignty will not be reached in detriment of the food sovereignty, and won’t affect the right to water.

It is prohibited any development, production, tenure, commercialization, importation, transport, storage and use of chemical, biological and nuclear weapons, of persistent organic contaminants highly toxic, prohibited international agrochemicals, and the experimental technologies and biological agents and genetically modified organisms that are prejudicial for human health or that they go against the food sovereignty or the ecosystems, such as the introduction of nuclear residuals and toxic waste in national land.

Sixth Chapter

Rights of freedom

Art. 66. - It is recognized and guaranteed to the following:

The right to live in a healthy environment, ecologically balanced, free of contamination and in harmony with nature.
Seventh Chapter

Rights of Nature

Art. 71. - The Nature or *Pacha Mama* (Mother Earth), where there its life, has the right to be integrally respected with their existence and the maintenance and regeneration of their life cycles, structure, functions and evolutionary processes.

All people, community, town or nationality can demand to the public authority the fulfillment of these rights of nature. To apply and interpret these rights the principles established by the Constitutions will be observed.

The State will encourage to the natural and legal people, and to the collectives, to protect nature, and promote the respect to all the elements that form an ecosystem.

Art. 72. - Nature has the right to restoration. This restoration will be independent to the State’s obligation and the natural and legal people to indemnify the individuals and collectives that depend of the affected natural systems.

In the cases of severe environmental impact or permanent, including the ones caused by the exploitation of non-renewable natural resources, the State will the establish the most effective mechanisms to reach the restoration, and it will adopt the adequate measures to mitigate the harmful environmental consequences.

Art. 73. - The State will apply precaution measurements and restrictions to the activities that might lead to the extinction of species, the destruction of ecosystems or the permanent alteration of the natural cycles.

It is prohibited the introduction of organisms and organic/inorganic matter that can change the national genetic heritage definitively.

Art. 74. - The people, communities, towns and nationalities will have the right to benefit from the environment and the natural richness that will allow them a well living.

The environmental services will not be susceptible of appropriation; its production, benefit and use will be regulated by the State.

Ninth Chapter

Responsibilities

Art. 83. - Are rights and responsibilities of the Ecuadorians, without prejudice of other articles in the Constitution and the law:

6. Respect the rights of nature, preserve a healthy environment and to utilize the natural resources in a rational manner, and in a sustainable manner.

Title VII, Well Living Regime, First Section

Nature and Environment

Art. 395. - The Constitution recognize the following environmental principles:

1. The State will guarantee a balanced sustainable model for development and respectful with the cultural diversity, that conserves the biodiversity and the
natural resilience capacity of the ecosystems, and it assures the satisfaction of the necessities of the present and future generations.

2. The environmental management policies will apply in a transversal manner and will be obligatory by State in all levels and by all the natural and legal people in the national territory.

3. The State will guarantee the active and permanent participation of people, communities, towns and nationalities affected in the planning, execution and control of all the activities that generate environmental impacts.

4. If the case of debt about the reach of legal dispositions in environmental matter, these will apply in the most favorable sense to the protection of nature.

Second Section

Biodiversity

Art. 400. - The State will exercise the sovereignty of the biodiversity, which administration and management will be done with intergenerational responsibility.

It is declared of common interest the conservation of biodiversity and all its components, in particular the agricultural biodiversity, wild biodiversity and the genetic heritage of the country.

Art. 401. - It is declared that Ecuador is free from transgenic seed and crops. With the exception, if is only the case of national interest, with a duly explanation by the Presidential office and the approval of the National Assembly, it will be possible introduce genetically modified seeds and crops. The State will regulate under strict norms of bio-security, the use and development of modern biotechnology and its products, like its experimentation, use and commercialization. It is prohibited the application of risky or experimental biotechnologies.

Art. 402.- It is prohibited the grant of rights, including the ones of intellectual property, about derived or synthesized products, obtained from the collective knowledge in connection with national biodiversity.

Third Section

Natural and Ecosystem Heritage

Art. 404.- The natural heritage of Ecuador is unique and invaluable, comprises the physical formations, biological and geological, which value from an environmental, scientific cultural or landscaping point of view demands its protection, conservation, recuperation and promotion. Its management will be subject to the principles and warranties stated in the Constitution and they will be done according to the territorial system and an ecological zoning regarding the law.

Art. 405.- The national system of protected areas will guarantee the conservation of the biodiversity and the maintenance of the ecological functions. The system will integrate the State subsystems, autonomous, decentralized; communitarian and private, and its regulation will be done by the State. The State will assign the necessary economic resources for the financial sustainability of the system, and it will enhance
the participation of the communities, towns and nationalities that have ancestrally inhabited the protected areas in its administration and management.

The natural or legal foreign will not be able to acquire any kind of property right of the land, or have any concession in the national security areas or in the protected areas, according to the law.

**Fourth Section**

**Natural Resources**

Art. 408.- Are of inalienable property and imprescriptibly of the State the non-renewable natural resources and in general the products from the underground, mineral and hydrocarbon deposits, substances in which nature is different from the ground, even the areas covered by territorial water and the maritime zones; as the biodiversity and the genetic heritage as well as the radio electric spectrum. All these goods can only be exploited following strictly the environmental principles established in the Constitution.

The State will participate in the benefits from these resources, in an amount that will not be inferior to the ones of the company exploiting the resources.

The State will guarantee that the means of production, consumption and use of the natural resources and the energy preserve and recuperate the natural cycles and will allow dignifying living conditions.

**Fifth Section**

**Soil**

Art. 410. - The State will provide the farmers and rural communities the support for the conservation and restoration of the soil, similarly for the development agricultural practices that will protect and promote the food sovereignty.

**Sixth Section**

**Water**

Art. 411. - The State guarantees the conservation, recuperation and management of water resources, watersheds, ecological flows, related with the hydrologic cycle. All the activities that may affect the quality and quantity of water and that affect the equilibrium of the ecosystems, especially in the zones with high water density will be regulated.

**Seventh Section**

**Biosphere, urban ecology and alternative energy**

Art. 413. - The State will promote the energetic efficiency, the development and use of green, clean and healthy technologies, as well as promoting the use of renewable energies, of low impact and that won’t put the food sovereignty in risk, as well as the ecological equilibrium of ecosystems or the right to water.
Art. 414. - The State will adopt the adequate measures to achieve climate change mitigation, through the limitation of greenhouse gas emissions, deforestation and atmospheric pollution. The State will take measures for the conservation of the forests and the vegetation and it will protect the vulnerable population.
Annex II. Formal and informal semi-structured interview questions

As mentioned in the methods section of this dissertation, data was gathered through formal semi-structured interviews to key informants of the governmental institutions working in RGMRB and by participant observation and informal interviews to members of the communities in the basin. The template of questions used are described below. The set of questions in here are translated to English from the original questions that were written in Spanish.

Set of Questions 1: Interviews with governmental institutions working in RGMRB.

- What would you think are the most prominent socio-ecological changes in the area of RGMRB? Can you identify who are the most affected by this changes?

- Considering the socio-ecological changes that you previously mentioned, how do you think these are affecting the livelihoods of the people in the area?

- Have you observed any reaction on behalf of the community members when faced with this socio-ecological changes, and in cases of impacts induced by climatic events? How do activities change?

- In your opinion, what are the capacities that the people in the communities have in order to adapt to this socio-ecological changes? Would you say there is a difference in the way people adapt to change?

- How would you say the institution you work for, and other institutions working in the area contribute in the creation of adaptive capacity to cope with change?

- What would you say are the benefits of the projects that are being developed in the area? Who are the main beneficiaries from the services your institutions and other institutions brings to the area?

- With an emphasis of the construction of the dam, how would you say that this project has influenced in the vulnerability and adaptive capacity of the people in the area? How do you think it is related with the capacity to adapt to future climatic changes?
Set of Questions 2: Informal interviews with members of communities in RGMRB.

This is a template of questions used as reference when talking to community members. It is important to note that the wording and order of these questions might have fluctuated between participants.

- What are your daily activities? Can you please describe them to me?

- Have you noticed any difference in your lifestyle and livelihoods compared to the past? What did you used to do that now you cannot? And what other new opportunities do you think you have now?

- What do you consider to be the biggest risks on your livelihoods? What do you do to prevent them?

- Which natural resources are the most valueble to you? Has the accesibility to these natural resources changed?

- Who takes the decisions regarding access and management to natural resources in the área?

- In what way do you predict changes in climate and weather?

- How do you think is the climate in this area? What climatic events have you experienced in the last 10-20 years? Are these events normal?

- Have you noticed a change in the quantity of water available for consumption? If you think there is a change, what do you think is the reason?

- In general, can you mention any strategy of plan that has helped you cope with the socio-ecological changes you are experiencing including climatic variability?
Annex III. List of community participants and institutions key informants.

Table III.4. List of community participants and institutions key informants

<table>
<thead>
<tr>
<th>Participant/key Informant</th>
<th>Research Method</th>
<th>Sex</th>
<th>Profession</th>
<th>Community/Institution</th>
<th>Date</th>
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<td>Juan Callo</td>
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Annex IV. Social conflict due to the construction of the dam in RGMRB. Communication emitted by representatives of the communities in Rio Grande.

This document was obtained from one of the participants in this study, and translated into English by the author.

Central Committee of the rural communities in Rio Grande Parroquia Santa Rita – Canton Chone – Province of Manabi.


SENAGUA SCAM

The following are a few, not all, of the lies that the SENAGUA tells to scam Chone and the people living there. For a long period of time they have been repeating the following:

1. FLOODING CONTROL: LIE. The Rio Grande dam won’t stop floods, it will just only increase their. Because once the dam is filled it has to expel more that it takes, therefore flooding will increase and will be in a greater scale. La Esperanza has provoked flooding even during the summer season. In the EIA and PMA (Environmental Impact Assessment and Environmental Management Plan, by Calidad Ambiental CIA. Ltda, July 2010) p.111, it says that the flooding control over the city of Chone cannot be only attributed to the Rio Grande; there has to be control of the affluence of the rivers Mosquito and Garrapata due to the effects that these rivers can have and its tributaries.

2. IRRIGATION FOR 2.250 HECTARES: LIE. It will not be for the 2200 hectares, it will only cover 1597.5 p110 EIA-PMA. Paredes has recognized that the irrigation is seen as a marginal process and it is not viewed as important in this project.

3. 1500 ANNUAL WORKING PLACES: LIE. It will only be 700 working places that will be created annually and they will only be temporal during the three years that lasts the dam construction. Pp.425 EIA-PMA. This is another scam of SENAGUA to the people of Chone, especially to the young that are looking for a job. Chinese are not interested in hiring local professionals because they are catalogued as mediocre. Workers in the San Antonio Settlement have complained that they did not receive their payments fully.

4. THE DAM FLOODING WILL ONLY CAUSE A LOSS OF 600 HECTARES: LIE. More than five thousand hectares will be lost; about 14000 hectares of
productive land will be isolated. Plantation of Forests for Protection, pp 465-466 EIA-PMA. There is the need of a protection ring in the reservoir that can go from the dimension 70 to the cota 120m.a.s.l, which means that the rural /farmer communities that stay won’t be able to use a part of their land because they will be inside the protection ring, land that the Government is not paying.

5. THE RIO GRANDE DAM WILL PREVENT DROUGHTS: LIE. Droughts and also flooding are a natural phenomenon that humans can’t control. The Rio Grande dam will have a dimension of 70 meters over sea level, and the pipes for irrigation will be at 45 meters. How they are going to take water to zones like Boyaca and Eloy Alfaro that are above the 120 meters.

6. ONLY 155 PEOPLE WILL BE DISPLACED DUE TO THE DAM CONSTRUCTION: LIE. This is another lie that can be found in the p. 462 of the EIA-PMA (see also p. 436), which implies that the technicians never did a real census of the Rio Grande watershed, where more than eight thousand people live there according to the 2010 census, also according to the registers in the Seguro Social Campesino of Rio Grande, Platanales y Salazar.

7. DRINKABLE WATER: LIE. The construction of the new drinkable water plant has not been hired. There is enough pure water under the aquifers in the Rio Chone valley, which can be extracted at low cost using special pumps. There have been studies about the subject that SENAGUA is hiding because this solution is the cheaper than building a dam.

8. AGRICULTURAL DEVELOPMENT: LIE. More than five thousand hectares of productive land will be lost to irrigate someday 1591.RIO GRANDE produces about 20 million dollars annually to the local economy, that is why there are going to be serious problems because there is no way to substitute this money that is vital for the economy. Remember that when the agricultural production decreases the commerce drops and there is less money to spend. No one has debated the subject.

9. THE WETLAND LA SEGUA IS NOT GOING TO BE AFFECTED: LIE. With the construction of the San Antonio Drain, which has already started, the wetland La Segua will be affected due to the following reasons: a. this work will capture all the waste water that comes from the oxidation lagoon; b. during the rainy season the water level increase due to solid sediments product of erosion from higher grounds. This sediment will become part of the wetland, thus hampering the wetland’s storage capacity; and c. with the loss of the water storage capacity in the wetland, this site will stop being the home of different water bird species. In the file 925 (EIA y PMA), paragraph sixth it is stated that, Wetland La Segua is an ecosystem that has to be protected over any action that
develops directly or indirectly in its surroundings, argument strong enough to stop the San Antonio Drain.

10. THE JOBO IS THE APPROPRIATE GEOLOCALLY SITE TO BUILD THE DYKE: LIE. The elevations on the left margin, downstream, are unstable and their geological origin is the product of old seismic movements, which makes it inappropriate to hold water. The work will be located in a HIGHLY SEISMIC zone. *Multipurpose Chone*, represents a high risk, because the project is located in a highly seismic area, this implies that it is intended to build a dam in an area with highly seismic risk without taking into account the future consequences. Only with this argument the idea of building this dam should have been discarded, in case of seismic event “intensity MM VIII-IX” as cited in the file, the consequences will be fatal.

11. THAT THE SOCIALIZATION OF THE PROJECT HAS BEEN DONE: LIE. There were never previous consultations as is stated in the article 398 of the Constitution and article 28 of the law of environmental management. These consultations and socialization events should have been done before signing the contract July the 24th 2010 for the Rio Grande dam and the San Antonio drain construction. Phase I of the PPM Chone, that has other components that were not included in the contract. In this sense SENAGUA has never shown the socialization acts and consultations has have been made in the communities of Rio Grande. In the different studies made over the past years the CENTRAL COMMITTEE OF THE RURAL/FARMER COMMUNITIES OF RIO GRANDE was no identified with any jurisdiction power through the agreement N. 2410, March 13th 1997, issued by the Sub Secretaria del Litoral del Ministerio de Bienestar Social. Which means that the consultants never established contact, not even dialogued with this organism that represents to more than 30 communities in this area of Chone.

12. IN RIO GRANDE THERE ARE ARMED PEOPLE: LIE. What we want is to live in peace with our families. Peace that today we don’t have because every day they threaten us even to militarize us. What felony have we committed? They are criminalizing us for defending the “Pacha Mama” (Mother Nature)? There are not only ten or fifteen families opposing the construction of the Rio Grande Dam. In this fertile place of Chone ther are more than1600 families that the different consultants and government officials NEVER asked.

They can go and take the sixty million dollars somewhere else, as we do not agree that that the best investment is the dam. Instead a new sewerage system for the city of Chone should be built, which flooded few days ago due to a light rain; hire also the new drinkable water plant because the one we have already does not have enough supply and it is obsolete; investment should focus on channels, dredging of rivers, purification of waste water that is contaminating the water from the channels and La
Segua wetland, which is a place that should not be touched neither directly or indirectly, specially not by PMPCH.
Figure V.4. **Risk of flooding in CHRB.** The red area shows a high risk of flooding where the city of Chone is located. RGMRB, indicated by the arrow shows areas with high and medium risk of flooding, principally affecting the communities of El Ceibo, El Aguacate, Canitas, and La Tranca. Map produced by INHAMI (2008).
Figure V. 5. Vulnerability to drought in CHRB. According to this map the Canton Chone with RGMRB is located has a low vulnerability to drought events. Infrastructure is adequate but it as a higher institutional vulnerability. Source: MAE, (2009)
Figure V.6. Vulnerability to flooding CHRB. According to this map the Canton Chone with RGMRB is located has a high vulnerability to drought events, that is paired up with a higher institutional vulnerability. Source: MAE,(2009)
Annex VI. Images

Figure VI.7. Resettlement Tablada de Sanchez. Photo taken by author (06 June 2014)

Figure VI.8. View of RGMRB from property located in Tablada de Sanchez. Photo taken by author (08 June 2014)
Figure VI.9. Maize plantation La Arabia in El Pueblito. Photo taken by author (08 June 2014)

Figure VI. 10. Traditional house in RGMRB. This house is constructed with cane and it is possible to observe how in the property there are different kind of agricultural products cultivated. Photo taken by author (15 June 2014)
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