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Institutional Aspects of Integrated Flood Management in Guatemala

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Abstract
Guinea Barrientos, H. E. 2014. Institutional Aspects of Integrated Flood Management in Guatemala. *Digital Comprehensive Summaries of Uppsala Dissertations from the Faculty of Science and Technology* 1192. 43 pp. Uppsala: Acta Universitatis Upsaliensis. ISBN 978-91-554-9076-8.

Floods are a recurrent natural disaster in Guatemala. Heavy and prolonged rainfall often results in floods that affect people's life and property. Several institutions and policy instruments at local, national or transnational level address flood management.

The purpose of this study is to provide useful insights of the institutional aspects of integrated flood management at local, national and transboundary level in Guatemala. Papers I and II, explore institutions at local level, paper III at national level, while paper IV addresses flood management institutions at transboundary level.

This research found that for the local and national level, there are several institutions concerned with flood management. In contrast, at transboundary level, and especially for international rivers, flood management institutions are largely absent.

At local level, the Local Councils for Development (COCODEs, the acronym in Spanish) are responsible for flood prevention and preparation. While some municipalities are active in flood prevention, response and recovery activities, their limited economic and technical resources restrict their scope of action. Local stakeholders such as COCODEs, farmers groups and other actors are largely neglected in the decision making process. The National Coordinator for Risk Reduction to Disasters (CONRED, Coordinadora Nacional para Reducción de Desastres), the Secretariat for Planning and Programming of the Presidency *(SEGEPLAN,* Secretaría de Planificación y Programación de la Presidencia*)*, the Guatemalan Ministry of Infrastructure and other national institutions are in charge of planning and implementing flood management strategies, leaving public involvement of local actors mainly to public consultation. At the Central American level, the Coordination Centre for Natural Disasters Prevention in Central America (CEPREDENAC, Centro de Coordinación para la Prevención de Desastres Naturales en América Central), an institution part of the Central American Integration System (SICA by Spanish acronym), shall promote transboundary cooperation regarding disaster management, including flood management. However, transboundary flood management faces several challenges: territorial disputes and sovereignty issues over international rivers are significant obstacles to the implementation of integrated flood management programs.

Keywords: Guatemala, Floods, Integrated Flood Management, Institutional Aspects

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Akademisk avhandling som för avläggande av filosofie doktorsexamen vid Uppsala universitet kommer att offentligen försvaras i Axel Hambergsalen, Geocentrum, Villavägen 16, Uppsala, måndag den 1 december, 2014 klockan 13:00. Disputationen sker på engelska.

Referat

Guinea Barrientos, H.E. 2014. Institutional Aspects of Integrated Flood Management in Guatemala. Acta Universitatis Upsaliensis. Digital Comprehensive Summaries of Uppsala Dissertations from the Faculty of Science and Technology.

Översvämningar är en återkommande typ av naturkatastrof i Guatemala. Den kraftiga och långvariga nederbörden som drabbar landet producerar översvämningar som påverkar människors liv och egendom. I landet finns det flera institutioner och styrmedel på lokal, nationell och internationell nivå som behandlar hanteringen av översvämningar.

Syftet med denna studie är att ge användbar insikt om de institutionella förvaltningar som behandlar översvämningar på lokal, nationell och gränsöverskridande nivå i Guatemala. Artikel I och II utforskar översvämningsinstitutioner på lokal nivå; artikel III utforskar översvämningsinstitutioner på nationell nivå och slutligen artikel IV behandlar institutioner som har hand om översvämningar på gränsöverskridande nivå.

Denna forskning visar att det finns flera institutioner som hanterar översvämningar på lokal och nationell nivå. På gränsöverskridande nivå och särskilt i hanteringen av översvämningar i internationella floder är däremot dessa institutioner i stort sett obefintliga.

På den lokala nivån är det The Local councils for Development (COCODEs, som är akronymen på spanska) som är den huvudsakliga institutionen som ansvarar för förebyggande och förberedelse av översvämningar. Vissa kommuner har en aktiv roll i att förebygga översvämningar, hjälp med katastrofinsatser och återuppbyggande. Men deras begränsade ekonomi och tekniska resurser minskar deras handlingsutrymme. Lokala intressenter så som COCODE, bondeorganisationer och anda aktörer försummas oftast i beslutsfattande processer. Den nationella samordnaren för riskreducering av naturkatastrofer (CONRED, Coordinadora Nacional para Reducción de Desastres), och the secreriat for planning and programming of the presidency (SEGEPLAN, Secretaría de Planificación y Programacion de la Presidencia), samt det guatemalanska infrastrukturdepartementet och andra centraliserade institutioner ansvarar för planering och genomförande av strategier för hantering av översvämningar. De lokala aktörerna får endast föra samråd med allmänheten på lokalt plan. På den Centralamerikanska nivån är det institutionen Coordination Centrum for Natural Disasters Prevention (CEPREDENAC, Centro de coordinación para la Prevención de Desastres Natur en América Central), en del av det centralamerikanska integrationssystemet (SICA som spansk akronym), som är den enhet som ansvarar för att främja gränsöverskridande samarbete avseende katastrofhantering, inklusive hanteringen av översvämningar. Men gränsöverskridande hantering av översvämningar möter flera utmaningar som hindrar ett korrekt och smidigt genomförande av samarbeten. Tvister om gränser och regerande frågor över internationella floder är de största hindren för att genomföra gemensamma och integrerade program för hantering av översvämningskatastrofer.

Nyckelord: Centralamerika, översvämningar, integrerad hantering av översvämningar, institutionella aspekter

List of Papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.

I Guinea Barrientos, H. E., & Swain, A. (2014). Stakeholders' views towards flood risk management in the Paz River catchment area of Guatemala and El Salvador. Local Environment, 1-16. doi: 10.1080/13549839.2013.874986

II Sanchez, A., Guinea, E., Cameron, J., and van Dijk, M. 2014. Exploring decentralization to prepare flood early warning systems in post-dictatorship Guatemala. *Manuscript.*

III Guinea Barrientos, H.E. Swain, A. 2014. Linking Flood Management to Integrated Water Resource Management in Guatemala: A Critical Review. *Manuscript.*

IV Guinea Barrientos, H.E., Swain A., Wallin M. and Nyberg L. 2014. Rainfall-induced natural disasters in Central America: A challenge for regional risk management. *Manuscript.*

Contents

Introduction

Floodplains, with their fertile soils and river access provide excellent opportunities for socio-economic development. However, these plains are also prone to heavy floods that threaten the livelihood of the floodplain dwellers. According to Guha-Sapir et al. (2004), floods are the natural disaster that affect more people in the world than any other. In 2013 alone, floods caused 9545 casualties and affected more than 31 million people worldwide (EM-DAT: The OFDA/CRED International Disaster Database, 2014).

Floods are part of the natural process; they supply floodplains with sediments and nutrients which make for rich ecosystems and fertile lands for agriculture (Valk, 2009). Except for dam failure or landslides, floods are climatological phenomena (Economic Commision for Europe, 2000). Although floods are a natural phenomenon, such activities as deforestation, inappropriate agricultural practices and alteration of drainage patterns in urban areas will make their effect more severe. Human intervention in the river basin will influence characteristics such as frequency, duration and impact. Climate variability and climate change with the resultant changes in precipitation volume and timing (Valk, 2009) have the potential to aggravate these difficulties.

Floods represent one of the most recurrent natural disasters worldwide. The attractive nature of areas along the river channels for agriculture and other economic activities has encouraged people to settle in these flood-prone areas. Still, for many parts of the world, there are relatively poor records; it is only recently that flood databases have been established and maintained. Among existing records, Mitchell (2003), compiled flood disaster deaths in Europe for 1099 to 1829, identifying floods with deaths tolls of up to 400,000 (river/storm surge Netherlands 1530).

Strategies to cope with floods vary from the traditional structural measures such as dikes, river channelization, and retention dams, to nonstructural measures such as flood education and flood warning. Recent trends aim for a more integrated approach with a proactive rather than reactive approach. Integrated Flood Management considers an extension of Integrated Water Management, considers water resources development as *"a proves which promotes coordinated management and development of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems*" (World Meteorological Organization, 2009).

Guatemala is one of the most exposed counties in the world to the risk of severe flooding; the frequent occurrence of floods is documented in disaster databases and media reports. Extreme precipitation events that often strike the Central American isthmus trigger floods – and other related disasters. These are not only a threat to people lives, they also hinder development of the country as they damage private property, civil infrastructure, agriculture and other important economic sectors. According to the Study of Natural Disaster Hotspots of the World Bank, a third of Guatemalan territory is at high risk of flooding (Dilley et al., 2005).

In Guatemala serious floods occur when extreme climatological conditions result in excessively heavy and/or excessively prolonged rainfall with drastically increased runoff. The process is normal, but the dynamics of humans and the environment may affect the frequency and intensity of flooding events. Precipitation in Guatemala may be as high as 4,000 $mm.yr^{-1}$ (US Army Corps of Engineers, 2000), with extreme events such as hurricanes and tropical storms that discharge large amounts of water in a short time. Deforestation of the highlands for example, has reduced the absorption and retention of these quantities which means that the huge runoff volumes reaching rivers inevitably cause inundation of the plains.

Aim of the Thesis

The work that is presented in this thesis was motivated by the need to address the institutional aspects of integrated flood management in Guatemala as a means to improve the present integrated flood management schemes in the country. There are few scientific studies of natural disaster management in Guatemala but even fewer dealing with integrated flood management institutions. Therefore, by studying and understanding the challenges that institutional capacity faces in Guatemala, it should contribute to flood risk management in the country.

While this study is focused on Guatemala, the approach should be relevant for other similar areas in Central America.

The major questions addressed were:
1. How local institutions are involved with integrated flood management issues in Guatemala. (Papers I and II)

2. How integrated flood management is addressed by institutions at national level. (Paper III)

3) What are the challenges to achieve cooperation in transboundary floods in the country. (Paper IV)

The Impacts of Flooding

The concept of "flood" can be defined differently. Some authors define floods strictly in terms of a natural phenomenon, such as Ward (1978) "a flow that is larger than average volume of water along a river channel". Others define a flood in terms of its implications for humans or the environment such as Bakker (2009b) "floods" should be associated with "… harm and damage and considered an undesirable occurrence". The International Disaster Database of the Université Catholique de Louvain in Belgium defines floods as: The *Significant rise of water level in a stream, lake, reservoir or coastal region (EM-DAT: The OFDA/CRED International Disaster Database, 2014)*. In the scope of disaster prevention and management, floods are only relevant if they pose a threat to society or the environment; modern flood prone areas were often functional wetlands in the past.

The natural causes of floods are mostly climatic, mainly due to excessive rainfall or snow and ice melt. However, there can be other causes such as coastal storm surges, landslides and dam failures. Although floods are mostly natural phenomena, human activity such as deforestation, inappropriate agricultural practices and the alteration of drainage patterns through urbanization (ECE, 2000) means damage may be greater. Areas along river channels have always attracted settlement. Both natural characteristics and human intervention on the watershed influence such characteristics as frequency, duration and impact. Climate variability and climate change have the potential to increase flood problems in vulnerable countries due to changes in the precipitation volume and timing (Valk, 2009).

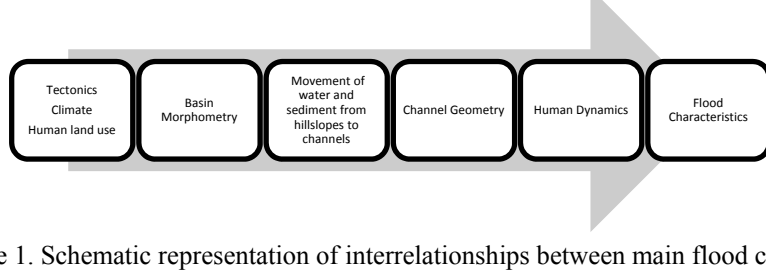

Figure 1. Schematic representation of interrelationships between main flood characteristics

Source: Adapted from Wohl (2000).

Casualty figures are perhaps the best documented flood impact. For instance, Mitchell (2003) compiled flood disaster deaths in Europe for the period 1099 – 1829, identifying floods with death tolls of up to 400,000 (river/storm surge Netherlands 1530). However, there are relatively poor flood records in many parts of the world and it is only recently that flood databases have been created and maintained. One of the more comprehensive and standardized data centres for floods, and other disasters, is the International Disaster Database of the Catholic University of Louvain in Belgium (EM-DAT). According to EM-DAT, the worst flood events in terms of casualties and displaced people have occurred in China, as shown in Table 1. The Chinese floods of 1931 may be the deadliest natural disaster recorded in the 20th century. Flood impact figures show a decreasing trend in the number of casualties; it may be that methods for flood forecasting and warning systems have improved over time, thus the same magnitude of flood results in fewer casualties.

Table 1. Top 10 most important Flood disasters for the period 1900 to 2011 sorted by numbers of casualties at the country level

COUNTRY	DATE	CASUALTIES
People's Republic of China	Jul-1931	3700000
People's Republic of China	Jul-1959	2000000
People's Republic of China	Jul-1939	500000
People's Republic of China	1935	142000
People's Republic of China	1911	100000
People's Republic of China	Jul-1949	57000
Guatemala	Oct-1949	40000
People's Republic of China	Aug-1954	30000
Venezuela	15/12/1999	30000
Bangladesh	Jul-1974	28700

Source: EM-DAT: The OFDA/CRED International Disaster Database (2014)

The impacts of floods are mostly classified in three ways: number of casualties, number of displaced people, and economic and socio-political impact of the event. Whereas the two former parameters are relatively accurate, estimation of the economic impact may be too fuzzy; variables and methods used to estimate economic impact are not standardized. In this respect, the impact of floods on infrastructure, agriculture and the environment are often included in flood assessment studies, while such sectors as tourism, health and transport are not always considered. Thus figures from flood databases such as EM-DAT shall be interpreted with caution.

Assessment studies of the economic impact of floods have been done at local level (Jonkman et al., 2008, Xiao, 2011), at national level (Changnon, 2008, ECLAC, 2005) and at regional level (Mitchell, 2003, Meyer et al., 2009). Yet, the real impact of economic losses on society and countries is not clear; most studies give figures in absolute economic terms, such as a million US dollars. But a 100 million US dollars loss in a European country or in the

United States does not have the same impact as the same 100 million US dollars in a country like Guatemala or Bangladesh. For instance, ECLAC (2005) estimated that Hurricane Stan, in May 2005, had an economic impact of 983.3 and 355.5 million US dollars on Guatemala and El Salvador respectively. These figures give some idea of the impact of that event, but if they are presented in relative terms such as losses as a percentage of GDP or as a percentage of gross capital formation, the information gives more. The economic impact of Hurricane Stan on Guatemala was equivalent to 3.4% of the country's 2004 GDP with the damage alone equivalent to 39% of the country's gross capital formation in the construction sector. For El Salvador, Hurricane Stan represented an economic loss equivalent to 2.2% of the country's 2004 GDP and damage equivalent to 8% of the gross capital formation (ECLAC, 2005).

The magnitude of the impact of floods is closely related to the vulnerability of affected communities understanding vulnerability as *"a set of physical, social, economic and environmental factors and processes that increase the susceptibility of a community to the impact of hazards"* (Kumpulainen, 2006). For instance, the health risk associated with floods is a critical aspect for vulnerable communities where sanitation facilities are inadequate and are prone to spread pathologic agents during flood events (Taylor et al., 2011, Veldhuis et al., 2010). Countries with weak infrastructure and housing are not just vulnerable to the event itself but often have less recovery capacity, because their economy is not strong enough to *finance the costs of reconstruction.*

In Guatemala, floods are mainly a result of extreme precipitation events with excessive rainfall that drastically increases runoff, as precipitation in Guatemala may be as high as 4,000 $mm.yr^{-1}$ (US Army Corps of Engineers, 2000). Hurricanes and tropical storms discharge large amounts of water in few hours. These occur from May to November which is the typical wet season. Normally large floods occur in October when soils are so highly saturated that precipitation is almost immediately transformed into runoff. However, there have been big floods at any time within the rainy season.

Floods have several negative impacts on the country; the most important being threat to human life. Table 2 displays the impact of Hurricane Mitch in 1998 and Tropical Storm Stan in 2005, killing 384 and 172 people respectively and impacting the infrastructure and productive sectors such agriculture, industry and tourism (See Table 2). The data do not show a disambiguation between different hazards. However, according to the newspapers of the time, most of the casualties were due to landslides and most of the economic impact was due to the floods. According to the Economic Commission for Latin America and the Caribbean of the United Nations, ECLAC (2005), the Hurricane Mitch and the Tropical Storm Stan had a combined economic impact of US$ 1,730 million. For a small economy like Guatemala this is devastating and compromises the capacity of the country to meet its development goals.

Table 2. Summary of the impact of Hurricane Mitch and Storm Stan on Guatemala.

	Hurricane Mitch (1998)	*Storm Stan (2005)*
Sector and subsector	*Total Damage (Million US$)*	*Total Damage (Million US$)*
Social Sectors	*48.1*	*148.9*
Housing	*35.3*	*126.5*
Education	*7.9*	*8.1*
Health	*4.9*	*14.2*
Productive Sectors	*578.8*	*215.4*
Agriculture	*499.2*	*77.8*
Industry	*61.6*	*56.7*
Trade and commerce	*18.0*	*80.9*
Tourism		*53.4*
Infrastructure	*115.8*	*446.9*
Water and drainage	*16.1*	*11.9*
Electricity	*10*	*5.1*
Transport and communi-	*89.1*	*430.0*
Environment	*5.1*	*40.5*
Emergency expenses		*78.3*
TOTAL	*747.8*	*983.3*

Source: Compilation of news form Guatemalan newspapers and data from ECLAC (2005)

In sectors like agriculture the impacts are not just economic but also social. According to Banco de Guatemala (2014), the country employs nearly half of its labor force in the agricultural sector. In rural areas there is virtually no other source of income. Thus floods increase internal migration and malnutrition, and bring more poverty to the rural communities that are already the poorest.

Flood Risk Management

According to The United Nations Office for Disaster Risk Reduction (UNISDR, 2009) Disaster Risk Management is: ***"The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster"***.

Floods, as any other natural disaster are the result of a complex interaction between human and natural systems. A flood disaster occurs when a flood affects human communities or their assets (Shaw et al., 2010), therefore the flood risk will be determined by the combination of the probability of the occurrence of the flood (hazard) and the vulnerability and response capacity of the communities in flood prone areas. This was expressed by Uitto and Shaw (2006) in a simple equation, where R= Risk, H = Hazard , V = vulnerability, M= Mitigation, and C= Capacity.

$$R = \frac{(H * V) - M}{C}$$

To cope with floods, traditional management has focused on reducing susceptibility to flood damage using a mix of structural and non-structural measures depending on the social and economic conditions, organizations, institutions, political context, technology, information and knowledge (Tunstall et al., 2004).

Flood Risk Management is understood as a cycle of actions to avoid a hazard transforming itself into a disaster. These actions are normally grouped into preparedness, response and recovery actions. Within this context the Swiss Federal Office for Civil Protection (2014), defines:

Preparedness: as the "*preventive and precautionary measures. Its aim is to minimize vulnerability of people and material assets to natural hazards*". This includes prevention and preparation activities. Prevention consists of activities such as land-use planning that aim to avoid the flood risks that have been previously assessed normally by combining flood hazard and flood vulnerability assessment. While preparation consists of planning the resources and actions needed in case of an emergency, such as training people, preparing packages of food and first aid kits.

Response: as "*all responsive measures to limit the effects and duration of a catastrophe"*. Activities such as alert and rescue are vital, especially to prevent casualties.

Recovery: as all the activities that aim to restore the livelihood of affected people. When climatic conditions have returned to normal, affected people should not be abandoned. Although their lives may no longer be in danger, their lives have been affected and they need support to successfully reconstruct their communities. After a disaster analysis, reconstruction and sometimes relocation can mitigate the negative effect of floods.

Figure 2. The cycle of integrated risk management

Source: Swiss Federal Office for Civil Protection (2014)

Integrated Flood Management

Recent trends towards flood management, aim for a more integrated approach moving from action against hazards to risk management. This new approach, Integrated Flood Management, combines land and water resources development in the context of Integrated Water Management i.e. *"a process which promotes the coordinated management and development of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (WMO, 2009)*. Therefore, rivers should be considered as integrated ecosystems, linking relevant sectors within a holistic approach based on multilateral cooperation, including interdisciplinary planning (ECE, 2000, Valk, 2009). In this sense, integrated flood management has to begin with an appropriate flood policy that leads to implementation of structural and non-structural measures for flood protection and adaptation.

The World Meteorological Organization and the Global Water Partnership (WMO, 2009) proposed six key elements for integrated flood management:

- Manage the water cycle as a whole
- Integrate land and water management
- Manage risk and uncertainty
- Ensure a participatory approach
- Adopt integrated hazard management approaches
- Adopt a best mix of strategies

Manage the water cycle as a whole

Floods are natural processes in any water body, they are also vital for the well-functioning of the floodplain's ecosystems. Since floods are a natural process, integrated flood management calls for avoiding where possible the flood-fighting strategies but instead, to avoid the occurrence of flood damage in critical urban areas, allowing space for the occurrence of some floods, while facilitating areas for storage.

Integrate land and water management

Flood prone areas normally are located in downstream areas of the river basins. Therefore, normally it is there where flood strategies are implemented. Since floods are the product of interaction of the hydroclimatic regime, drainage basin characteristics and human alteration of the drainage basin (Wohl, 2000), Integrated Flood Management considers that floods have to be addressed within the whole system of the river basins, paying attention to land-use dynamics, mainly in upstream areas.

Manage risk and uncertainty

The natural characteristics of floodplains such as fertile soils, proximity to rivers, and easy access to markets attract human settlement and the development of economic activities. However, the negative effect of floods is always a persistent peril for floodplain dwellers and related activities. The flood risk should be considered in the context of other risks, especially the risks associated with poverty, therefore floodplain regulation should take into account both the opportunities and threats of living in floodplain areas.

The severity of floods is related to the hydro meteorological variables, basin characteristics and human dynamics. The hydrological uncertainties, as well as the uncertainties related to the social, economic and political impact have to be addressed as an element of flood risk management.

Ensure a participatory approach

Integrated Flood Management calls for public consultation and the involvement of people on the ground in planning and implementation of any integrated flood management strategies. The identification and participation of stakeholders require an open, transparent and inclusive participation of stakeholders at different levels of the society as well as stakeholders of downstream and upstream areas.

Adopt integrated hazard management approaches

Extreme meteorological events normally cause not just floods but also other hazards, such as landslides, which in turn have the potential to modify floods downstream. A multi-hazard and holistic approach is preferable to a hazard-specific approach. Putting all these elements into practice requires adequate policies, legislation and information as a function of climatic, hydrological

and physical conditions of the area, along with the socio-economic, political and cultural conditions (WMO, 2009). Xia et al. (2001) proposed a systematic management framework for the long-term management of flood impacts and restoration of flooded areas. This would be based on four aspects; sustainable development, ecological quality, macroscopic impacts and changing natural and social systems including tools to cover hydrology, ecology, sociology, economics and interdisciplinary subjects.

Adopt a best mix of strategies

There is a wide range of options that may be used in integrated flood management. According to the Associated Programme on Flood Management (WMO, 2009), the climate, the basin characteristics and the socioeconomic conditions in the region are three factors that define the action or set of actions to be implemented. Furthermore, the Associated Programme on integrated flood management proposes that the flood management plans should adopt flexible strategies that can adapt to the changing conditions of the natural and human dynamics in the area. Table 3, displays several flood management options that may be implemented in integrated flood management plans; these options can be categorized as structural and non-structural measures.

Structural measures include artificial reservoirs, dikes, levees, channelization and river dredging. These measures are usually costly in both economic and environmental terms. Reservoirs deserve special attention. Besides flood control, reservoirs can also have multiple purposes, including recreation and water supply. However, every dam has some probability of failure; since the 12th century, there have been approximately 2000 artificial dam failures (Cenderelli, 2000). The failure of natural and artificial dams has the potential to cause considerable damage and loss of life because the sudden release of stored water generates floods of extraordinary magnitude. Over the last two centuries, floods due to dam failures have caused the deaths of at least 30,000 people. Most dam failures are the result of overtopping, foundation defects and piping and seepage (Cenderelli, 2000).

Nonstructural measures are approaches that recognize that floods happen, and instead of fighting them, try to adapt human activity to the presence of floods. Non-structural measures are not the final solution to flood problems; instead, they should be seen as complementary actions in effective, integrated and adaptive flood risk management plans along with other strategies, according to the specific conditions of the river basin and its components.

Table 3. Common Strategies and Options for Flood Management

Strategy	Options
Reducing Flooding	Dams and reservoirs
	Dikes, levees and flood embankments
	High flow diversions
	Catchment management
	Channel improvements
Reducing Susceptibility to Damage	Floodplain regulation
	Development and redevelopment policies
	Design and location of facilities
	Housing and building codes
	Flood proofing
	Flood forecasting and warning
Mitigating the Impacts of Flooding	Information and education
	Disaster preparedness
	Post-flood recovery
	Flood insurance
Preserving Natural Resources of Flood Plains	Floodplain zoning and regulation

Source: Associated Programme on Flood Management (WMO, 2009)

The willingness to implement flood management options or a combination of options is also strongly linked to the flood awareness of the local communities. Flood awareness is determined by social class, flood experience, how long people have lived in the area and region. (Burningham et al., 2008).

Institutional Aspects of Integrated Flood Management

The integration of land and water resources required for integrated flood management schemes calls for synergy between the different stakeholders at local, national and international levels (WMO, 2006). Institutional and political instruments are key tools for the implementation of flood management initiatives at these different levels. Flood Management uses the river basin as management unit. However, since river basins often trespass national boundaries, Integrated Flood Management requires appropriate mechanisms for cooperation between riparian countries.

Flood impact is highly influenced by social, economic and political aspects as well as institutional capacity; for instance, floods occurring where flood institutions are present normally have fewer casualties and less economic damage that those ones occurring where no flood institutions are present (Bakker, 2009a).

An effective flood risk management program begins with good flood legislation and policies where the government must be the main responsible body for managing disasters (Andjelkovic, 2001). Therefore, flood risk management plans have to be supported by flood control laws and regulation. Flood legislation should cover rural and urban development, environmental management and economic development, among other factors. In this context, governmental institutions should be key actors in developing flood risk management policies and actions through the development and implementation of legislature, plans and programs for flood risk management. The different flood management actors such as local communities and their institutions, social and environmental NGOs, the private sector and so on, should be included in all the flood risk management in the flood policy process.

The government plays a central role in: 1) collecting meteorological data; 2) collecting hydrological data; 3) designing flood maps and scenarios; 4) identifying evacuations areas and actions; 5) identifying recovery actions and 6) identifying available resources for each of these actions.

Social and environmental NGOs, the economic sectors and other formal and informal institutions of the civil society also play a crucial role when planning and implementing flood management plans. However, it is recognized that the effective implementation of Integrated Flood Management plans is highly dependent on good cooperation among the different stakeholders. The

Associated Programme on Flood Management (Tyagi, 2006) presents a typical interaction of stakeholders where the horizontal axis is represented by the various government departments and ministries, while the vertical axis represents the policy and planning and implementation process at different levels of the government.

Figure 3. Integration of the various stakeholders and interest groups in flood management

Source: Associated Programme on Flood Management (Tyagi, 2006)

The good governance of natural resources involves many factors and approaches that determine the success of management initiatives. According to FAO (2014), at local level there is an interaction between the top-down approaches of governmental initiatives and the bottom-up approaches of local institutions and policies.

The top-down approach starts with policy decisions by governmental officials which are then implemented at local level. Bottom-up approaches start from identifying the network of relevant local actors and then listening to their interests, goals, visions and so on as a preliminary step for policy planning and implementation (Sabatier, 1986). Figure 3, displays an example of community activity according to the expected roles.

The Associated Programme on Flood Management (WMO, 2008), suggests that flood management plans should ensure participatory approaches at the "lowest appropriate level" through community participation regarding development policy and land-use planning. While bottom-up approaches may empower the otherwise marginalized actors, its implementation poses several challenges, mainly those related to building consensus among the different actors (FAO, 2014).

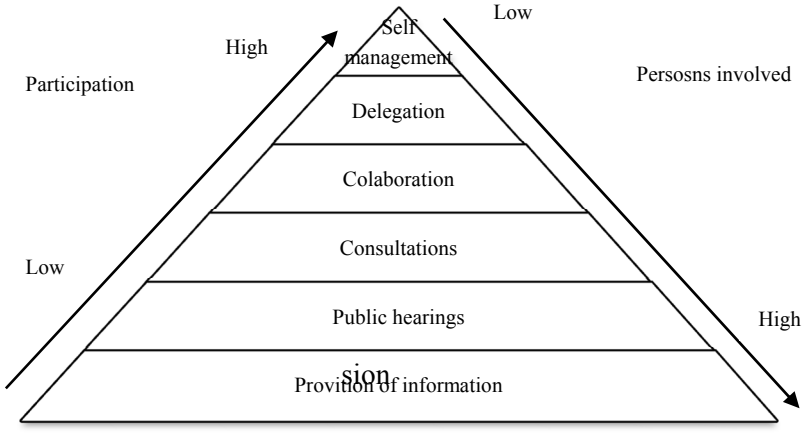

Figure 4. Levels of stakeholder participation

Source: WMO (2008)

Methods

This work summarized the findings of the research works that are annexed to this kappa. Those manuscripts employed the following methods:

1. Literature survey
2. Stakeholder workshops
3. Process tracing approaches
4. Semi structured interviews

Table 4. Research methods used in the appended papers

Research Methods	Appended Papers			
	Paper 1	Paper 2	Paper 3	Paper 4
Literature survey	x	x	x	x
Stakeholder workshops	x			
Process tracing approaches				x
Semi structured interviews		x		

Literature review

An extensive literature survey has been conducted in all appended papers. Literature survey consisted in collecting, analyzing and contextualizing scholarly information about the topics addressed in the different papers. In all the papers, the literature addressed the different topics related to floods and flood management in Guatemala, but especially paying attention to the information about institutions and policies regarding flood management and related topics.

Stakeholder Workshops

Stakeholder workshops aim to identify the common interests, goals and conflicts within a group of stakeholders organized or unorganized who share a common interest in a specific issue or system (Grimble and Wellard, 1997).

Process tracing approaches

Process tracing approaches consist in the analysis of trajectories of change and causation of a specific phenomenon (Collier, 2011). Commonly, case studies are made.

Semi-structured interviews

Semi-structured interviews consist of a set of questions that allow the interviewer to extend beyond specific answers, having freedom in what to talk about and how much to say (Drever, 1995).

Study Area

Guatemala has an area of 108,890 square kilometers. It is situated southwest of Mexico and northwest of Honduras, El Salvador and Belize. The southern part of the country is mostly coastal plains. Mountains and the volcanic chain are dominant in the central part of the country, whereas the north of the country is mostly limestone plateaus (US Army Corps of Engineers, 2000).

Guatemala has a population of 14.76 million inhabitants of which 51% are living below the poverty line (World Bank, 2012). Nearly half of the labor force of the country is employed in the agricultural sector (BANGUAT, 2011).

The country's geography can be divided into four geographical areas of two lowlands and two mountain systems. The lowland areas consist of: (1) Petén and the upper part of Alta Verapaz lowlands, which have typical karst topography in the north where altitude varies from a few to 600 meters; and (2) the pacific coastal belt, from 25 to 50 kilometers wide in the south with altitudes reaching 500 meters above sea level. The two mountain systems consist of: (1) a ridge of volcanic mountains, including 33 volcanoes with maximum heights of 3,000 to 4,200 meters above sea level, parallel with the Pacific coast; and (2) The Cuchumatanes, Chama, and Las Minas massifs, which include summits up to 3,800 meters, lying north of the volcanic mountains. In the northeast, the terrain is dominated by the flood plain of Motagua River and the low-lying coastal plains of the Caribbean coast (US Army Corps of Engineers, 2000).

The weather in Guatemala is influenced by the predominantly mountainous terrain. The climate is generally tropical with rainy and dry season. The rainy season, known locally as "invierno", extends from early May through October; the dry season, known locally as "verano", extends through the rest of the year. Precipitation in the rainy season varies due to the orographic effect of the terrain (US Army Corps of Engineers, 2000).

Data

The analysis of the flood impacts and flood management policies in Guatemala was done using information from academic institutions, flood databases such as EM-DAT data centre, governmental institutions and media reports. Table 5, displays the variables and the sources that were used in this thesis.

Table 5. Information sources for this thesis

Variable	Main sources
Flood casualties	EM-DAT: The OFDA/CRED International Disaster Database – www.emdat.be, Université Catholique de Louvain, Brussels (Belgium) Media reports
Economic impacts of floods	ECLAC (Economic commission for Latin America and the Caribbean)
Hydro meteorological information	National Institute for Seismology, Volcanology, Meteorology and Hydrology (INSIVUMEH, Instituto Nacional de Sismología, Vulcanología, Meteorología e Hidrología)
Flood policies	National Coordinator for Risk Reduction to Disasters (CONRED, Coordinadora Nacional para Reducción de Desastres) Coordinator Centre for Natural Disaster Prevention in Central America (CEPREDENAC, Centro para la Coordinación de Desastres Naturales en América Central)
Socioeconomic variables	Guatemalan Institute of Statistics (INE, Instituto Nacional de Estadisticas)

Results and Discussion

Floods are a natural process; however, human activities have intensified the effects of floods over flood prone communities. With more than half of the population living under the poverty line (World Bank, 2012) and highly concentrated in rural areas (Cox et al., 2009), pressure over natural resources has become a driver of deforestation and other misuses of upstream areas. It has also boosted the settlement of flood prone areas that otherwise should be preserved for conservation. For example, it has been proved that deforestation of the highlands has diminished the ability of the soils to absorb and retain rainwater, in fact some areas severely affected by flooding events such as the provinces of Suchitepéquez and Escuintla have less than 10% of forest cover. (IARNA, 2006).

It is possible to summarize the main causes that increase flood vulnerability as follows: 1) Inappropriate land use management, especially in flood prone areas; 2. Insufficient coverage of hydro meteorological networks; 3. Weak enforceability of building codes, especially for civil infrastructure; 4. Centralization and ambiguity in decision making processes.

Despite the fact that there are no specific institutions or policy instruments concerned with flood management in the country, there are several institutions, policies and legal instruments that deal with water management, infrastructure maintenance, social development, disaster management and other areas that may be linked to flood management. For this research I have categorized this institutional setting and its forward analysis into local, national and transboundary levels.

The local level is where local communities have influence, this could be over an entire watershed or just a part of it. The national level as its name suggests includes all the institutions and instruments that have jurisdiction or application nationwide, while the transboundary level refers to the institutions and instrument with application to transboundary and international rivers. Transboundary rivers are the rivers that cross national boundaries while international rivers are the rivers that serve as legal international border: Suchiate and Usumacinta rivers between Guatemala and Mexico; Paz River between Guatemala and El Salvador; Motagua River between Guatemala and Honduras. Table 6, displays the typology of flood management institutions in Guatemala.

Table 6. Typology of flood management institutions in Guatemala

Institutional level	Institutions	Main role regarding flood management
Transboundary	CEPREDENAC[1] MINEX[2]	Preparedness and response
National	SEGEPLAN[3]	Risk assessment and coordination of measures
	CONRED[4]	Prevention/Mitigation, preparedness, response
	INSIVUMEH[5]	Hydro meteorological data generation
	INDE[6]	Hydro meteorological data generation
	Guatemalan Army	Response
	CIV[7]	Prevention/Mitigation, reconstruction
	Ministry of Agriculture	Watershed management/Soil and water management
	Ministry of Environment	Watershed management /Prevention through environmental policies
	INAB[8]	Watershed management/Forestation and reforestation of upstream areas
Local	Municipalities	Prevention/Mitigation, response, recovery
	Fire departments	Response
	Environmental NGOs	Education, rise of awareness
	COCODEs[9] and other local governments	Prevention/Mitigation, response, recovery

[1] CEPREDENAC: Centro para la Coordinación de Desastres Naturales en América Central (Coordinator Center for Natural Disaster Prevention in Central America)
[2] MINEX: Ministerio de Relaciones Exterionres (Ministry of Foreing Affairs)
[3] SEGEPLAN: Secretaría General de Planificación y Programación de la Presidencia (Secretariat of Planning and Programming of the Presidency)
[4] CONRED: Coordinadora Nacional para Reducción de Desastres (National Coordinator for Risk Reduction to Disasters)
[5] INSIVUMEH: Instituto Nacional de Sismología, Vulcanología, Meteorología e Hidrología (Meteorological service)
[6] INDE: Instituto Nacional de Electrificación (National Institue for Electrification)
[7] CIV: Ministerio de Comunicaciones Infraestructura y Vivienda (Ministry of Communications, Infrastructure, and Housing)
[8] INAB: Instituto Nacional de Bosques (Forestry Service)
[9] COCODEs: Consejos de Desarrollo Comunitario (Community Development Councils)

Institutional aspects of flood management at national level (Paper III):

The following analysis is based on:

Paper III: **Linking Flood Management to Integrated Water Resource Management in Guatemala: A Critical Review.** The motivation for this paper was to address the natural and anthropogenic conditions that influence flood behavior in Guatemala, and analyze the implication for an effective linkage between flood management and water management in accordance with the six principles proposed by the Associated Programme on Flood Management (WMO, 2009): 1) manage the water cycle as a whole; 2) integrate land and water management; 3) manage risk and uncertainty; 4) adopt a best mix of strategies; 5) ensure a participatory approach and 6) adopt integrated hazard management approaches. In order to follow these principles, several institutions and policy instruments are involved.

National institutions dealing with flood management

Although Guatemala has always been prone to natural disasters, it was not until 1969 that the Committee for Emergencies (CONE, Comite de Emergencias) was formed after Hurricane Francelia stroke the country. Seven years later, in 1976, the country suffered one of the most destructive earthquakes in its history. It is estimated that this earthquake killed about 23,000 people and caused economic damage for about US$ 1,000 million (CONRED, 2011).

In 1994 the government started a project to change CONE from an institution focused just to deal with emergencies to an institution with a more dynamic role in preventing natural disasters and reducing vulnerability. In 1996, through the Decree 109-96 of the National Congress, CONE becomes the National Coordination for Risk Reduction (CONRED, Coordinadora Nacional para la Reducción de Desastres), which from then until now has been the institution responsible for the coordination of all the efforts of the country to prevent, mitigate, respond and participate in the rehabilitation and reconstruction of damage caused by disasters. CONRED has commitments and responsibilities at the national, regional and global levels, under which it has taken the decision to adopt concrete actions to promote the reduction of the impact of disasters which have clearly defined effects on sustainable development, and on increasing poverty (CONRED, 2011).

Flood management is addressed at some point in the following institutions:

- National Coordinator for the Reduction of Disasters (CONRED, Coordinadora Nacional para la Reducción de Desastres);

- Secretariat for Planning and Programming of the Presidency *(SEGEPLAN,* Secretaría de Planificación y Programación de la Presidencia*);*
- National Institute for Seismology, Volcanology, Meteorology and Hydrology *(*INSIVUMEH*,* Instituto Nacional de Sismología, Vulcanología e Hidrología*);*
- Special Unit for Integrated Watershed Development of the Ministry of Agriculture*;*
- Special Unit for Water Resources and Watersheds Management of the Ministry of Environment and Natural Resources*;*
- Guatemalan Army;
- Guatemalan Forestry Service (INAB, Instituto Nacional de Bosques*);*

National Coordinator for the Reduction of Disasters (CONRED): CONRED has the mission to coordinate all the efforts in order to reduce the risk of disasters in the country; it functions at national and regional level.

CONRED, as its name suggests, is a coordinator, this means that its work is to bring together all the participants, providing reliable and efficient communication mechanisms as well as suitable methodology for disaster reduction.

Secretariat for Planning and Programming of the Presidency *(SEGEPLAN):* SEGEPLAN is the governmental agency responsible for the formulation of overall development policies in Guatemala; it assesses the implementation of those policies and their impact.

SEGEPLAN works together with CONRED in the policy making process for flood management and risk reduction.

National Institute for Seismology, Volcanology, Meteorology and Hydrology *(INSIVUMEH)*: It is part of the Ministry of Communications, Infrastructure and Housing (MICIVI, Ministerio de Comunicaciones Infraestructura y Vivienda), and it is the national agency that studies, generates and monitors atmospheric, geophysical and hydrological information. It works hand in hand with CONRED to alert the Guatemalan society in the occurrence of natural disasters.

Concerning floods, INSIVUMEH monitors the rivers and lakes of the country through several hydrological stations; this information is crucial for flood management, as it is used for early warning systems.

Special Unit for Integrated Watershed Development of the Ministry of Agriculture: This institution is a unit of the Ministry of Agriculture focused

on territorial planning taking the watersheds as basic units. It promotes agricultural projects with principles of soil and water conservation.

Special Unit for Water Resources and Watersheds Management of the Ministry of Environment and Natural Resources*:* It is committed to develop environmental activities related to the enforceability of the environmental law. One of its objectives is to analyze the alternatives in order to avoid flooding and landslides through economic alternatives that change the intensive use of the land in the upper part of the watersheds.

Guatemalan Army*:* The Guatemalan Army is an active actor when disasters occur; during flooding events that threat human live, the Army has played an active role mobilizing soldiers and equipment like helicopters to affected areas.

Coordination Center for Natural Disasters Prevention in Central America (CEPREDENAC, Centro de Coordinación para la Prevención de Desastres Naturales en América Central: It was created in 1987 as the intergovernmental body in Central America part of the Central American Integration System (SICA, Sistema de Integración Centroamericana), with the mandate of promoting activities, projects and programs towards reduction of the risks of disasters in order to avoid loss of life and economic assets in the Central American countries. CEPREDENAC promotes and coordinates exchange of information, technical and scientific assistance for prevention, mitigation, and response to natural disasters at regional level.

National Institute for Electrification (INDE, Instituto Nacional de Electrificación): INDE is the energy agency responsible for hydropower development in the country. Up to June 2011, INDE operated 31 hydrometric stations. However, INDE focuses just on rivers with hydroelectric potential and mainly in the upper part of the watersheds due to the feasibility of dam building in those areas.

Floods are addressed in the general scope of natural disasters management as a whole; even institutions that are in charge of water resources management do not have flood management as one of their main activities. Water management institutions such as the special units for integrated watershed management that belong to the Ministry of Environment and to the Ministry of Agriculture do not even mention flood management in their action lines.

Institutional aspects of flood management in Guatemala: local level (Papers I and II)

The following analysis is based on paper I and paper II:

Paper I (Scenario building through stakeholder analysis for flood risk management on Paz River catchment, Guatemala-El Salvador). The motivation for this paper was to extract interest and vision of actors regarding floods and flood management in Guatemala from a bottom-up approach. To do this, flood and flood management scenarios with a time horizon of 30 years were projected for Paz River Catchment. Its frequent floods do not just endanger the lives and livelihoods of downstream communities but also affect commerce and tourism between Guatemala and El Salvador. Recognizing that there is a wide range of conceivable strategies for addressing flood hazards - not all workable - it is essential for policy makers to be aware of the general acceptance of any given flood defence/adaptive measure. How different actors or stakeholders perceive flood risk will determine their attitudes towards flood management strategies.

Stakeholder workshops are a structured methodology that aims to involve people, here referred to as stakeholders, in imagining and then planning their future. For the purpose of the exercise, stakeholders were defined as "all individuals and collective entities affected by floods within the transnational catchment area of Paz River, including flood plain dwellers, upstream dwellers, public institutions, private sector entities, and NGOs". In the workshops, stakeholders were asked to imagine scenarios describing future floods and flood management systems in the Paz River basin. These scenarios were projected over a 30 year time horizon. In keeping with the study's purposes, the scenarios were designed to accommodate assumptions regarding developments in the hydro climatic regime due to climate change as well as changing socioeconomic and institutional conditions.

Paper II (Critical analysis of the imposed decentralization structures in post conflict Guatemala: The case of connecting locals to early warning systems). The main motivation of this paper was to analyze the role of the local political organizations with regard to the operation of flood early warning systems. The paper presents an analysis of how the Local Councils for Development (COCODEs, as in the acronym in Spanish) of 17 communities have implemented flood early warning systems.

Local institutions in flood management

The adverse impact of floods mostly affects those who live on the flood plain. The communities have different forms of organization and government. Some are related to the political administration hierarchy of the state, but most forms

of organization are social structures that respond to common interests such as religious, economic and other social activities.

Local institutions play a marginal role in the development of their territories since the decision making process in the country is top-down (with the president at the top of the hierarchy). Local institutions have little power to develop flood management plans. Sometimes flood strategies such as river embankment are planned and implemented by the municipalities with jurisdiction over the flood prone communities However, since municipal budgets represent just ten per cent of the national budget, the economic constrains are often a serious obstacle to the local implementation of flood management strategies. Municipalities often have to apply to projects at national level where the involvement of local communities is restricted to public consultation at most.

Among the local institutions that deal directly or indirectly with flood management are**:**

Local Councils for Development (COCODESs, as in the acronym in Spanish): COCODES are the officially recognized form of organization in charge of urban and rural development at the most local level. These structures are at the bottom of the hierarchical national structure. Since the negative impact of natural disasters are one of the main disruptors of livelihood and development in the country, COCODEs carry out some flood management actions; the branch of the COCODEs that takes part in disaster reduction is known as COLRED (local council for disaster reduction) which in theory plays the role CONRED does at national level. **In paper II** the role and implication of these structures regarding flood early warning systems is analyzed.

Municipalities and COMUDES: COMUDES are the municipal council for development and are led by the mayor of each municipality. It is the immediately higher hierarchy to the COCODEs. COMUDEs are in charge of planning and implementation of development strategies in their municipal jurisdiction including planning and implementing flood management strategies in the flood prone communities within the municipalities. They may work in free association with neighboring municipalities that share the same interests or goals; these associations are called "*Mancomunidades"*.

Informal institutions

In local communities there are several kinds of local organizations that may deal directly or indirectly with flood management. Among these are religious groups, farmers associations, local women's organizations, indigenous associations, and so on. Some of these forms of organization can be traced to the pre-colonial period.

Institutional aspects of flood management at transboundary level in Guatemala (Papers I and IV):

The following analysis is based on paper I and paper IV:

PAPER IV: Rainfall-induced natural disasters in Central America: a challenge for regional risk management. The main motivation of this paper was to analyze the political, legal and economic challenges that the Central American countries have to overcome to achieve transboundary cooperation and then transboundary disaster preparation and response.

Institutions related to transboundary flood management

The following, are institutions related to flood management at transboundary or international level:

Ministry of foreign Affairs: According to the Guatemala's national constitution all the legal issues related to the rivers that serve as the legal international boundary between Guatemala and neighboring countries are the concern of the ministry of foreign affairs, therefore, any flood management strategy that involves the alteration of these rivers would require the approval of this institution. The management of these rivers is subject to the binational commissions.

CEPREDENAC[10]: It was created in 1987 as the intergovernmental body in Central America of the Central American Integration System (SICA, Sistema de Integración Centroamericana), with the mandate of promoting activities, projects and programs towards reduction of the risks to disasters in order to avoid loss of life and economic assets in the Central American countries. CEPREDENAC promotes and coordinates exchanging of information, technical and scientific assistance for prevention, mitigation, and response to natural disasters at regional level.

The special status of transboundary rivers and especially international rivers (those that serve as a national boundary), makes water management and flood management an issue of high hierarchy institutions such as the ministry of foreign affairs. Normally, management alternatives are more rigid and less inclusive than with other formal and informal institutions in the decision making process. However, as a fundamental element of integrated flood management, inclusiveness of local actors is a key element for the successful implementation of any flood management initiatives. There are many examples

[10] CEPREDENAC: Coordination Centre for Natural Disasters Prevention in Central America (CEPREDENAC, Centro de Coordinación para la Prevención de Desastres Naturales en América Central)

where local communities and grassroots institutions that dwell along international borders have started cooperation in water issues such as water supply, even without involvement of their respective governmental authorities (Welling et al., 2012). Such initiatives should be maintained and encouraged. Complemented with formal institutions, these structures may become fundamental when implementing prevention, intervention and recovery activities. Their involvement however, should be harmonized with the international agreements that define the rights and obligations of riparian countries.

There are two factors that call for transboundary cooperation: a) The large proportion of the country that belongs to transboundary watersheds; b) the transboundary nature of rainfall-induced natural disasters in the region.

Guatemala shares many of its watersheds with neighboring countries. According to IARNA (2005), 47.5% of the national territory belongs to transboundary watersheds shared with Mexico, 7% with El Salvador, 6% with Belize and 0.5% with Honduras.

The Mesoamerican region (Central America and the South of Mexico) are often struck by rainfall events that affect more than one country at the same time; extreme precipitation events often produce severe floods in transboundary rivers.

Despite the flood prone nature of transboundary rivers such as Motagua River (shared with Honduras), Paz River (shared with El Salvador), Mopan River (shared with Belize), Suchiate and Usumacinta Rivers (shared with Mexico), there are no specific programs for transboundary flood management. Instead, flood management is embraced in the broader scope of water management.

Although 53% of the international border between Mexico and Guatemala is defined by international rivers, there are few examples of projects that have included the component of "transboundary management". The International Union for Conservation of Nature (UICN) launched the Tacana project between 2003 and 2005 with a clear transboundary component. Tacana is the volcano that serves as the natural boundary for the watersheds Coatan and Suchiate. However, this project did not fulfill its objectives (UICN 2006) especially due to the opposition of the federal Mexican authorities (Aqua-LAC).

The data sharing of hydro meteorological data in the Paz River watershed between Guatemala and El Salvador is the only case where there is real transnational cooperation. Here, cooperation was between the Guatemalan INSIVUMEH which runs the gauge station of El Jobo and its Salvadorian counterpart SNET which runs the gauge station La Hachadura. There are several meteorological stations on respective sides of the boundary which share data.

Joint management is considered the ideal scheme for transboundary flood management (Becker et al., 2007), the country should start technical cooperation with neighboring countries as the basis for further cooperation in other areas until full joint management is achieved.

This technical cooperation could include collection and transmission of data used for flood management, flood modeling, forecasting and analysis. There several examples of data sharing in transboundary rivers in the world but perhaps European transboundary rivers the best: the Rhine (Renner et al., 2009), the upper Tisza (Konecsny, 2006), Danube (Szekeres, 2006), the Köros (Kiss and Lukács, 2006) are good examples of technical cooperation.

In developing countries such as Guatemala that lack of adequate monitoring facilities, the free data available from sources such as the NASA supported SERVIR-Mesoamerica web-based platform or the NASA's two MODIS (Moderate Resolution Imaging Spectroradiometer) sensors are good alternative tools to monitor the hydro meteorological variables in transboundary watersheds. These tools are particularly useful to rapidly assess flood inundation areas immediately after the flooding events.

Due to the lack of adequate hydrological and meteorological data in Central America, flood modelling, forecasting and analysis is a challenging task, especially in transboundary watersheds. However, the recent transboundary floods such as Hurricane Mitch, Hurricane Stan and Storm Agatha provide an excellent window of opportunity for the improvement of data bases, and with this, the future implementation of flood modeling, flood risk mapping and flood forecasting initiatives for transboundary rivers.

Concluding Remarks

Flood management institutions at local, national and transnational level in Guatemala show positive trends regarding the effective implementation of integrated flood management. Activities such as the implantation of early warning systems or the implementation of soil and water conservation programs are important steps towards integrated flood management. However, there are several aspects that need to be addressed:

At local level, there is a need to improve the inclusion of local actors in the decision making process of flood management schemes. Paper II explores the involvement of locals in the implementation and operation of early warning systems. It was found that COCODES which are the most local political structure with the mandate of flood management – among other tasks - do not always include the most vulnerable people in their activities. Public consultation through participatory approaches is one of the key elements proposed for an integrated flood management. However, the involvement of local actors should go further; it is crucial that municipalities and other local institutions take local knowledge into account. Consensus increases the likelihood of success in political action. For instance, the Scenario Building exercise described in paper I, explores public consultation and participation in flood risk management. The scenarios presented in that paper reflect the concerns and opinions of local actors that may be useful for the development of better programs for managing future flooding risks.

At national level, Guatemala is characterized by a high degree of centralism in floods and other disasters management. Decentralization and prioritization of technical and economic resources are a good alternative to improve flood management in the country. However, decentralization should also avoid the overlapping of functions in governmental institutions, mainly regarding watershed management.

At transboundary level, the country has a long way to go regarding flood management cooperation since flood management is restricted mostly to water management. Joint institutions in the transboundary rivers would provide a vehicle to implement projects in the basins, including projects for integrated flood management. However, the affiliation of the country to transboundary institutions such as CEPREDENAC, the economic interdependence with neighboring countries and the transboundary nature of rainfall events, open the door for future cooperation with neighboring countries.

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