Changing Water Availability

A Regional Study of the Consequences & Farmers' Adaptation Strategies and Responses in

Tukucha Nala & Panchakanya Irrigation System, Nepal

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Cover illustration: Tukucha Nala, Fields & Brick making site (Source: Own work)

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Casper de Vries,
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Executive Summary

Background

The steadily increasing changing environment causing changes in global weather patterns is more over known and defined as climate change. Global climate change put pressure on water availability, combined with population growth and growing degradation of fresh water resources ensuring water availability could be one of the greatest challenges in our near future. Most of the world's fresh water resources are used for agriculture slowly putting pressure on water availability, agriculture and food security. Furthermore most developing countries lack financial capital and the knowledge and technology to *adapt* to the changing climate.
Two main environmental changes are putting pressure on sustaining water availability which are (1) changing rainfall patterns and (2) glacial retreat. The glaciers of the Himalayas provide water for some of the biggest rivers in the world such as the Ganges, Indus and Yangtze. These rivers provide some 1.3 billion people with water supplies. Himalayan glaciers could at current rates, diminish significantly in the coming decades; half a billion people in the region and a quarter billion downstream who rely on glacial melt waters could be heavily affected. Nepal is an agrarian country with a growing population and growing food demand. In this context the call for urgent adaptation to the environmental changes becomes highly important. It is in this background that research has been conducted in two irrigation systems in Nepal. The main assumption derived from the literature is that water availability *is* changing. Water availability is changing due to changing rainfall patterns which will lead to challenges in crop growing within the irrigation systems. The way how these challenges will be met and is responded to have been analyzed through adaptation, coping behavior and responses of farmer's households.
The main research question has been defined as 'What are the effects of changing water availability for farmers' livelihoods in Tukuche Nala and Panchakanya and how do farmers respond and adapt to that?'
This question has been divided into three sub-categories; trends in water availability, the effects and consequences for farmers' livelihoods and responses (divided into adaptation strategies, coping behavior and responses). Sub questions are 'what are the trends in water availability?' What are the effects of changing water availability on the livelihoods of farmers in Tukucha Nala and Panchakanya? And on the category of responses 'which different adaptations, responses and coping strategies of farmers can be distinguished as a reaction to changing water availability?

Between February and May research has been conducted in the Tukucha Nala Irrigation System in Tukucha in the hill area outside the Kathmandu Valley and in the Panchakanya Irrigation System in East Chitwan in the Terai region. Semi-structured interviews and questionnaires have been conducted, additionally use have been made of secondary data mainly in the contextual chapter. Surveys on negative and positive aspects of rainfall have been held and a survey in which respondents had to rank livelihood categories. The research is based on a total of 35 respondents in Tukucha Nala Irrigation System and 34 respondents in Panchakanya Irrigation System. In addition participant observation has been an important research method. In order to select the informants snowball sampling and

convenience sampling have been used. In addition the use of key informants and an existing sample framework in Panchakanya were also helpful in getting in contact with the respondents.

Glacial retreat appeared to be of no direct influence in both irrigation systems, therefore the main focus has been on changing rainfall patterns. Besides rainfall patterns also is looked at changes in other weather patterns such as increase in temperature. This is placed in a broader framework aiming to place these issues in a livelihood context. Therefore other issues are also concerned, among these are off farm activities, pollution, migration and urbanization. The conclusions presented here are not presented as scientific facts, but as qualitative research data derived from farmers' experiences and perceptions of farmers as collected in both field locations. Aim of the research has been to give insight in the perceived experiences of farmers in their daily lives and how these experiences are leading to various types of adaptation. Adaptation is looked at from a broader perspective meaning also taking coping strategies and responses as off farm activities and migration patterns into account.

Rainfall as an indicator of change

The first question addressed is that of a change in water availability. The main conclusion is that there is an overall consensus among the respondents of a decreasing rainfall trend. One of the main problems faced is that of water shortage. Changes in water are defined in several ways causing in their turn different consequences on the farmers' livelihoods. Rainfall has been decreasing since the last 5 to 6 years in addition rainfall falls at different times, there is a late onset of the monsoon while the monsoon either stops at the same time or gradually shows a shift.

Other rainfall characteristics are that rainfall before was continuous and slowly while today it is heavy and short. Current rainfall patterns affects the cropping calendar meaning crops are not grown according the original cropping calendar. Looking at the seasons, rainfall has stopped to fall in winter during the last 5 to 6 years and rainfall in spring today is significantly less. Towards the future the main assumption is that rainfall will continue to decrease putting more pressure on farmers' livelihoods.

Clearly these changes in rainfall have several consequences for the farmers in the irrigation systems. Besides consequences also is looked at the causes of these changes. Besides rainfall another indicator of change was temperature.

Causes of changing rainfall patterns

The causes of changing water availability are various and as such giving an insight in the awareness and other problems derived from this issue.

Water availability is decreasing due to overpopulation and increased water use, and water discharge in the Panchakanya system has decreased due to a resettlement program.

Rainfall decreases due to increase in temperatures. Other causes as perceived by farmers are environmental pollution as a cause of national deforestation, expanding industries from neighbor countries, air pollution from local factories and pollution from increased population. Global warming is also mentioned as a cause of the changing rainfall pattern. The mentioned causes give an insight in the awareness of the farmers but it also gives insight in other existing issues such as local brick making activities and temperature increase.

Temperature as an indicator of change

Temperature is also perceived as an indicator of change causing consequences on farmers' livelihoods. Temperature is rising since the last twenty years and since the last five years even more rapidly. Temperature rise also leads to more periods of drought and

temperature rise leads to more difficulties in living conditions. Furthermore it leads to less labor and an increase in diseases such as diarrhea and skin infection. And towards the future temperatures are continue to rise according to the farmers putting more pressure on their means of living. Both temperature rise and rainfall are interrelated processes of environmental change. Causes found are various but mainly in line with rainfall decrease as a cause of environmental pollution.

Consequences of the change in rainfall and temperature

These changes have various consequences and are far reaching for farmers in both Tukucha Nala (TIS) and Panchakanya Irrigation System (PIS). Consequences are a decrease in crop production and a shift in the cropping calendar as well as more pressure on the performance of both irrigation systems. Another consequence is a rapid decrease in water discharge in the Panchakanya system and land that increasingly has been left fallow. Another consequence is the flooding, which generally becomes less predictable and comes at different times. Generally speaking there is a shift in crop production towards more drought resistant crops, resulting in Tukucha in less paddy and increased potato production. Overall conclusion is that a change in water availability puts more pressure on the farmers' livelihoods. As a result this leads in its turn to reactions and adaptation strategies.

Adaptation and coping strategies

Adaptation means implementing new strategies in order to sustain in the same type of livelihood. Adaptation is placed in a broader perspective, including coping behavior and responses such as off farm activities.

There is a migration trend, a shift towards brick making instead of crop growing in the dry season in TIS and due to rapid population growth there is an increase in construction. Family members especially the husband and sons are currently working abroad putting more pressure on the living conditions of the wife left behind but generating significant income in the family through remittances leading to upgrade housing. Coping reactions are the increase in groundwater pumping causing a decrease in groundwater level influencing the irrigation system. Actual adaptation strategies are the implementation of ponds in order to store water and training and awareness programs at the institutional level and crop diversification by growing less water demanding crops.

Migration as a response to environmental change

One of the trends especially experienced in Panchakanya is that of migration. Main conclusions are that the households with the husband working abroad have farming as their second or even third income. This indicates the importance of working abroad. The average time abroad is two years and the women left behind are facing increased workload in farming while the main reason for going abroad is to generate income. Increase in income results in upgrades in housing, practically all families with husbands abroad improved their house. However there is no clear link between difficulties with crop growing and (an increased trend in) working abroad. However deteriorating agricultural circumstances could be push factors driving household members to off farm activities, besides working abroad working in off farm activities seems as much or even more common than going abroad.

Shifting to off farm activities

Land size is not an indicator for income, as farming proves not to be the only source of income. Beside crop growing people participate in various income generating activities. Thus raising the question how dependent farmers are on crop growing and once crop growing becomes too difficult how flexible farmers or families are to shift to other means of income.

A majority of farmers *with* other activities generate their main income from these off farm activities. Among these activities are small shops such as a medical shop, cybercafé, cycle repair shop, laundry shop or carpenter or broker but also being active in the government service or in goat rearing or poultry. There is no clear link found between parents and children participating in off farm activities. Land size within the Panchakanya system is not an indicator for income as some farmers do have substantial amounts of land outside the system. It is however difficult to extract hard conclusion out of these findings, although it seems clear that farming is not the one and only source of income. Indeed a lot of people have land just for their own consumption while participating in other off farm income generating activities. Income diversification can also be seen as a mean to secure one's income, hence as a type of coping behavior to deal with increased insecurity in farmers' livelihoods.

Conclusion

Farmers indicate a change in water availability resulting in increased difficulties with crop growing and increased competition on water resources. Decreased rainfall leads to a change in the cropping calendar, meaning a shift and less predictable rainfall patterns. Rainfall is significantly decreasing both in winter and in summer in the last years. Onset of the monsoon is delayed and ends at the same time resulting in shorter monsoon. Rain is more heavy, less continuous and short. This results in a shift in crops to more drought resisting crops such as potato and maize. Temperatures according to farmers are rising leading to increase in air pollution and soil degradation which also is a result of poor soil management. Temperature increase leads to more diseases such as diarrhea, skin infection and respiratory problems. Main causes as indicated are environmental pollution such as industrial activities, deforestation, population increase and increased air pollution from neighbor countries India and China. There is an awareness of major environmental pollution problems, sometimes explained as climate change or global warming. Farmers indicate to worry about the future as they will experience increased temperatures and a continuous trend in rainfall decline. Reactions are improved irrigation, ponds to store water but also off farm activities such as brick making and working in the neighbor village in a self owned shop. Some farmer households have family members working abroad. This seems to be an increasing trend in Panchakanya, which makes farming less important besides working abroad and leading to upgrades in housing.

The results derived from the field show many similarities as found and presented in the literature. Although farmers do not have the knowledge of the exact causes of the changes in the weather experienced, they certainly experience them with all consequences impacting their daily lives and living environment. It is clear that the changes experienced are putting more pressure on food production, food security and farming activities in both systems. The Water User Associations therefore fulfill an important role in order to sustain equal water discharge, providing training and awareness programs, maintenance and performance of the system and communication at local government level with community based organizations (CBOs) and the local government. The urge for implementing effective adaptation strategies and raising awareness at community level in order to increase farmers' adaptive capacity, secure farmers' livelihoods and food security has revealed to be stringent.

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List of abbreviations

ABPSD - Agri-business Promotion and Statistics Division
APP – Agriculture Perspective Plan
CBS – Central Bureau of Statistics
CCNP – Climate Change National Policy
CCVI – Climate Change Vulnerability Index
CIDP – Chitwan Irrigation Development Project
CPN – Communist Party of Nepal
CPP – Country Position Paper
DAO – District Agriculture Office
DHM - Department of Hydrology and Meteorology
DIO – District Irrigation Office
DOI – Department of Irrigation
EC – European Commission
FAO – Food and Agricultural Organization
FMIS – Farmer Managed Irrigation System
GA – General Assembly
GDP – Gross Domestic Product
GLOF – Glacial Lake Outburst Flood
ICIMOD – International Centre for Integrated Mountain Development
IMTP – Irrigation Management Transfer Project
IPCC – Intergovernmental Panel on Climate Change
IWRM – Integrated Water & Resources Management
IWUA – Irrigation Water User Association
MOAC – Ministry of Agriculture and Cooperatives
NAP – National Agricultural Policy
NAPA – National Adaptation Program Action
NASA – National Aeronautics and Space Administration
NEC – Nepal Engineering College
NGO – Non Governmental Organization
NWCF – Nepal Water & Conservation Foundation
ODA – Official Development Assistance
PIS – Panchakanya Irrigation System
SACOF - South Asian Climate Outlook Forum
SAFMA – South Asian Free Media Association
SAFTA – South Asian Free Trade Agreement
SAP – Structural Adjustment Program
SAPTA – South Asian Preferential Trade Agreement
TIS – Tukucha Nala Irrigation System
TYIP – Three Years Interim Plan
UN – United Nations
UNDP – United Nations Development Program
UNEP – United Nations Environment Program
UrbWatSan – Urban Water and Sanitation Nepal
VDC – Village Development Committee
WSFS – World Summit on Food Security
WTO – World Trade Organization
WUA – Water User Association
WWF – World Wide Fund Nepal Program

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1. Introduction

"Though many nations are battling the effects of global warming considering it as a burning issue which needs immediate attention, our government has not yet taken any step to tackle the climate change. The government must be aware of the looming crisis invited by the global climate change and act immediately." [1]

Global climate change put pressure on water availability, combined with population growth and growing degradation of fresh water resources ensuring water availability will likely become one of the most challenging tasks of our time.

Most of the world's fresh water resources are used for agriculture rather than for individual household use. As the climate is changing today the ongoing process of climate change has serious consequences for water availability and therefore for agriculture and food security (FAO 2008). People's livelihoods in developing countries are more vulnerable to climate change because of their geographical location and their vulnerability due to poverty and low living standards. Furthermore they lack financial capital and the knowledge and technology to adapt to the changing climate (Xu & Rana 2005; Africa Partnership Forum 2007).

Two main causes of climate change which impose a threat on water availability are (1) changing rainfall patterns and (2) glacial retreat. Due to changing rainfall patterns the number of rainy days will become increasingly irregular leading to more droughts and at the same time to more floods, putting much pressure on rain fed agriculture (Biswas 2004; Barrios et. al. 2003).

On the other hand many rivers are fed by glacial melt water. Glaciers contain enormous amounts of fresh water; they are the water banks of our world, big parts of Asia are depending on these fresh water supplies. Worldwide glaciers are melting at an increasingly rapid speed putting this water supply at risk with huge consequences for the agricultural sector in countries such as India, Nepal and China (Shahgedanova et. al. 2009; Lemke et. al. 2007). The glaciers of the Himalayas provide water for some of the biggest rivers in the world such as the Ganges, Indus and Yangtze (WWF Nepal Program 2005). These rivers provide 1.3 billion people with fresh water supplies. Himalayan glaciers could at current rates of global warming, diminish significantly in the coming decades (IPCC 2007); half a billion people in the region and a quarter billion downstream who rely on glacial melt waters could be heavily affected. Rivers as the Ganges, Indus, Brahmaputra and others could become at current trends, seasonal rivers (UNEP 2008). When glaciers are melting their water stocks are drying up; glacial retreat leads to declining water supplies. On the short term it can lead to an increase in melt-water that flows through rivers, however this will endure only for a short period of years. Most glaciers are already providing less water to rivers. Accelerating melting also increases the risks of flooding in the spring followed by water shortages in the summer. Due to the melting process river flows will increase and flooding will put further pressure on irrigation systems (Orlove 2009).

Glaciers in Nepal are melting between 30-69 meters per decade, while more water is released more water will evaporate due to increasing temperatures (WWF Nepal Program 2005). Nepal is an agrarian country with a growing population and growing food demand. In the 1990s glacial melt occurred at a three times faster rate than in the 1980s, however this rate will only increase into the 21st century. Also with adequate human action glaciers will continue to melt in the next half century. Glacial melt could lead to a serious threat to human development, food security and water availability (Ibid.).

[1] Rajendra Mishra (Kantipur 2009)

At the same time rainfall patterns are changing influencing farming activities in Nepal. The consequences of glacial retreat and changing rainfall patterns are already tangible this makes it more important that effective adaptation strategies are prepared. In this context research has been conducted in Nepal among farmers who are indirectly dependent on water from glaciers and indirect and direct from rainfall. How are farmers experiencing changing water availability in their daily working life and how is this perceived and explained? Are local farmers aware of (global) changing weather conditions and more importantly what are the responses? How are rural communities dependent on their water resources and how does changing water availability leads to adaptation strategies that can sustain their water resources and thus their rural livelihoods?

Farmers could adapt to these changing conditions by implementing strategies such as the storage of water, building of dams and proper irrigation systems and there could be a shift towards other forms of livelihoods which are less dependent on water such as the migration to urban areas. The actual threats of climate change are important to take into account, however the actual experienced consequences are to be dealt with today which obviously demands for strategies of adaptation on the short term and even more towards the future.

In this research questionnaires and semi structured interviews are used and secondary data such as reports and meteorological data from the research area. In addition to overcome the language barrier a translator has been of assistance during the research.

Research was conducted between February and May 2010 in Nepal in the Tukucha Nala irrigation system (TIS) outside the Kathmandu Valley in the hills and in the Panchakanya Irrigation System (PIS) in East Chitwan in the Teraj region. The research has been in cooperation with Nepal Engineering College (NEC) in Patan, Kathmandu and with Wageningen University with the department specialized on Integrated Water Resource Management (IWRM).

The central question in this research has been formulated as follows:
'What are the effects of changing water availability for farmers' livelihoods in Tukuche Nala and Panchakanya and how do farmers respond and adapt to that?'

In the next chapters first the contextual framework will be outlined (chapter 2) followed by the theoretical framework (chapter 3). In this chapter, current issues on changing rainfall patterns and glacial retreat are discussed as well as a section on adaptation in which the concept and relevance and shortcomings of adaptation are being outlined. The methodology chapter (4) will outline in detail both the research objective and the research question and sub-questions followed by a logical explanation of how and why these questions are used. An outline of the main concepts and the strengths and relevance of the types of methods used for this research are presented.

In the next chapters both field locations will be introduced and the main findings and results will be presented. Chapter 5 will present the trends in water availability, chapter 6 presents the consequences and effects of changing water availability. Chapter 7 elaborates on responses and various types of adaptation which could be explained as a reaction to the consequences. These chapters will be followed by the discussion in which the findings and results are analyzed and linked to the literature. The conclusion will give a concise overview and discussion of the main findings and recommendations will be presented here.

2. Contextual Framework

2.1 National Context

The National Democratic Republic of Nepal as the country is officially named is a landlocked Himalayan country located in between two huge neighbor countries; the Republic of India and the Republic of China. Geographically Nepal can be divided into three regions; the Terai region which consist of the plain regions of the country, the Hill region with altitudes between 1,000 and 4,000 meter above sea level and the Mountain region. The Mountain region in Nepal is among the highest regions in the world, with the Mount Everest the world's highest mountain reaching 8,848 meters (CBS 2008).

Nepal has a long history going back for nine thousand years. Gautama Buddha was born in Nepal he was the founder of Buddhism. The earliest inhabitants in Nepal's history were probably of Tibeto-Burman descent. Nepal's modern history started in the 18th century with the reign of Prithvi Narayan Shah, who united the Himalayan country. His successors fought the British East India Company and tried to conquer Tibet and Sikkim. However the Shahs were defeated by the Company and was forced to give Sikkim and parts of areas of the Terai region to the Europeans. During the 19th century the Rana family took over the reins of the Nepal administration. Nepal's Royal Family dates back to the 16th century and the present King is Gyanendra Shah (Maps of World 2009)

Figure 2.1: Map of Nepal (Source: World Factbook 2007)

2.2 The Nepalese political situation and the Maoist movement

The Communist Party of Nepal (CPN) dates back to 1994. From 1996 up until 2006 the Nepalese Civil War took place between the Nepalese Government and the member Maoists of the Communist Party of Nepal. The conflict was initiated by the CPN with the aim to establish a new system of governance by making Nepal a republic named the 'People Republic of Nepal'. Maoist's guerrillas attacked Nepalese police stations, later on the Royal Nepal Army got involved. The Civil War has affected the country very bad politically, socially and economically. The Maoists has made strong influence in the whole country. Many people got killed by them and by the government as well and many people were displaced. Eventually also by the intervention of other countries the civil war came to an end in 2006. King Gyanendra Shah lost power to become a ceremonial monarch.

Box 2.1
Strike ruins vegetables of farmers

In Makwanpur district farmers cannot bring their crops to the market and as a consequence they have started to rotten. Harvested and ripened vegetables will be lost due to the strike which makes transportation impossible. If the strike will continue for a few days more all crops will be lost which are produced. Normally eight to ten trucks with vegetables enter Kathmandu from Bajrabarabi. Due to the strike many farmers bring their produce on foot to the market to minimize the loss.

- Kathmandu Post, May 3

Nepal still suffers from the aftermath of this war. Currently Nepal is still in a political transition period and the country is political unstable influencing farmer's livelihoods. Infrastructure has been indicated as one of the problems for agriculture and farmers are also dependent on the market to sell their crops. However since the end of the civil war in 2006 the country is left in a continuing unstable political situation in which the Maoist movement tries to overrule the current government by calling off strikes. It can happen that the Maoist movement forces a strike paralyzing the country's infrastructure with direct consequences for farmers. During a strike motorized transportation is not possible, therefore people can't move easily, but also food can't be transported and shops are closed down or only opened during restricted time periods of for example two hours a day from six until eight in the evening. These conditions make it difficult for farmers to reach the market and due to a closed market at daytime it is difficult to sell the crops. And thus farmers are sometimes left with their unsold harvested crops, making the crops useless and leave the farmers with their unsold harvest without income.

Without transportation it is not possible to buy gas or fuel and a consequence is to start cooking on wood instead, which is much more time consuming and the smoke is not good for one's health. In times of a strike it is also more difficult to get labor in order to work on the farmer's land. It is also not possible to buy fertilizer or to get help from an engineer if needed. And these consequences will become in effect after one week or less and thus the unstable political situation restraints farmers directly in their daily lives (see also Box 2.1 and 2.2).

Box 2.2

Diary fragment during strike

May 3rd, Farmers in the area of Panchakanya are pissed off and are throwing there unsold harvest as a protest on the streets. Rickshaw's and even horse and carriage did come to a standstill as of today. Only jeep ambulances occasionally are passing by on the main road. A vendor stops by on his bicycle to sell his potatoes, another man comes to the house to buy some tomatoes, which are now sold to a minimum prize. One of the sons in my host family is now more than a week away from home; he is stuck at his uncle's place and is unable to come home. Children are deprived from going to school. The 12th grade interim exam has been burned by Maoists, including the already finished exams. The government is putting his foot down and will not move an inch. This is the kind of situation where a status quo is the only outcome; the situation could worsen and could go on for days I am afraid. The school has been attacked and the airport has been blocked. Clearly at this moment it would be difficult for me to leave; "when will I be able to leave?" is a thought that more and more comes to my mind. I am experiencing a restricted freedom of movement in a country where tensions are rising with an unclear outcome. It is an unusual state of affairs. Army soldiers are patrolling in the highway in order to keep things quiet. Currently the market is closed; buying new seeds or pesticides is not an option. In case of an emergency it is difficult to get transportation to the hospital as an ambulance is very expensive and the only realistic option.

May 4th, a live blockade of people on the Ring Road in Kathmandu is present. The situation has been worsened. The only transportation on the road are water transporting vehicles, NGO- and UN vehicles, the Fire brigade and ambulance and the army itself. Shops are closed during day and night and are only opening their doors between 6pm and 8 pm. Lots of tourists are making their way out of the country. The government is discussing to realize food transportation guarded in escorts by the army. Tanks are on their way to Kathmandu. Helicopters are keeping an eye in the sky. As I am trying to make contact with the outer world, my friends in Kathmandu advise me to stay where I am and to be patient and wait along. My host family advises me calmly not to open any door or window during my night sleep if someone would approach me from the outside. All transportation has been paralyzed since May 1st the day that the strike was proclaimed. Economic damage is rising to 225 million US dollars a day. In total 2 million Maoists have probably come down to the capital of Kathmandu. A strike with a magnitude like this can be compared with the strike from the revolution of 2062-63 (2006) when the late King was deposed. As of today even the elephant and jeep safaris have come to a standstill in Sauraha National Park and tomorrow the Prime Minister will be hindered from entering his office in Singa Durbar. The strike is getting fierce. Today some 400 tourists have been transported in army escort to the Indian border. My family informs me about my travel schedule. I realize I am in a difficult position, but at least I am not too restricted in my freedom; I can conduct interviews and we can eat from the fields and I am relatively close to the border with India, while most of the spectacle is concentrated in Kathmandu. Tourists have left Pokhara; the famous trekking site. Chitwan National Park is closed down. One UML leader has been kidnapped and as of tomorrow people will suffer the consequences is the warning from the government. "Experiencing a strike is another aspect of experiencing the Nepal" I am told.

May 5th, the office municipality has been destroyed. In Narayangot it is possible to book train tickets and sent home luggage. All domestic flights have been canceled due to the absence of tourists. A police office has been overpowered and all weaponry has been confiscated. In Biranj members of a counter party have proclaimed their own strike. Local riots could be the result. In Bhaktapur people are warning; "don't come here Maoists or we will hit you"

Evening time: It would be possible that a two day suspension will be called off, which makes it possible for the remaining tourists to leave. In the Annapurna Himalaya's 82 tourists did not reach base camp as their food has become out of stock. As of today our gas has finished. Buying new gas is not an option, so the mother has to start cooking on wood again in the outside kitchen.

May 6th, since yesterday afternoon Maoists and anti Maoists have been fighting in Kathmandu. About 1200 people have been throwing rocks and used wooden sticks. The army uses tear-gas, there are deads among the victims. Some thirty kilometers away from here in Bharatpur banks have been robbed and laptop computers have been confiscated. The city of Kathmandu is dependent for food on food transportation, within two days potato stacks are finished, so are the onions and vegetables who have already finished. There is no meat in the capital, only rice and lentils. I suffer again from diarrhea however my medicine has finished as well, I am even writing this with a pencil as my second pen has finished yesterday. The government is in consultation with the embassies, who are considering to call back their fellow citizens to their home countries. Some NGO workers are restrained from leaving the country and are taken care of in UML houses (with food supplies). Slowly mobile phone credits are getting out of stock which is a serious restriction in communication among Maoists. The European Union chairman sends a message to the Maoists; "If this strike would lead to another civil war than it would be dangerous"

May 7th, finally due to foreign pressure the strike has come to an end however only for the time being – if the outcomes are not satisfying according to the Maoists, the strike will continue after May the 28th the end of the ultimatum. We are happy and smiling and relieved and free again. It is a strange but joyful feeling knowing that I will be gone before this day of May 28th and yet it is strange that my family as all the other Nepali's are already home for as their 'save haven' called home is their country; the country of Nepal.

2.3 Socio economic context of the Nepalese agriculture sector

Nepal is a country with around hundred indigenous languages and 103 indigenous ethnic caste communities with a total population of 28 million, this makes the country a very multicultural society with different backgrounds and religious beliefs. The main religions in the country are Hinduism, Buddhism, Islam, Kirat and Christianity. The country belongs to the Hindu Kush-Himalaya region to which also seven other countries belong; Bangladesh, Pakistan, Bhutan, China, Myanmar, Afghanistan and India. The main problems the country faces are deforestation, water pollution, wildlife conservation and vehicular emissions (CBS 2008; Population Reference Bureau 2009).

Nepal is a mainly agricultural country. Agriculture provides livelihoods for over eighty percent of the population. The country has also one of the highest population densities compared to the total amount of cultivable land. Total land used for agriculture is one fifth of the total area of Nepal. In 2009 the share of agriculture was 32 percent of total GDP (ES 2009). Main agricultural products are paddy, wheat and barley together accounting for 77 percent of the cultivated land. Of the cereals paddy comprises some 46 percent of total cultivated land with a 56 percent share of total cereal production followed by maize (24 percent) and wheat (17 percent).

The country has a major potential for hydro energy and irrigated agriculture because the most useful resource is water derived from the Himalayas. Irrigation and water supply systems therefore have to be improved (WWF Nepal Program 2005: 5-7).

Access to food depends on income, food prices, income distribution and employment opportunities. Access to food furthermore also depends on infrastructure, transportation and food policies of the government. Food acces is not so much a matter of production but of distribution. Consequently food insecurity leads to poverty and poor health, a low productivity, low income and food shortage. Especially the poor and vulnerable households are struggling with access to adequate food which is the case in both rural and urban areas (ES 2007/08). Nepal has a low crop productivity which is due to poor access to loans and irrigation and research services. Peasants are often dependent on brokers who charge high interest rates. Infrastructure and policy support are lacking. Agricultural land has been declining due to urbanization, industrialization and rapid population growth. Population growth leads to ecological degradation, land fragmentation and degradation. Additionally funding in agriculture is decreasing; in 1980 official development assistance (ODA) in agriculture was seventeen percent which decreased to only 3,8 percent in 2006 (WSFS 2009).

Since the 1990s the Nepalese government started to adopt a liberal economic system, in accordance with the structural adjustment program (SAP) in 1995/96 subisidies on fertilizers and irrigation have been cut. As a consequence the budget of the Ministry of Agriculture and Cooperatives went down to 2,47 percent in 2007-08 one of the lowest levels in the past decades. The results are poor service delivery of agricultural extension and huge constraints in research and technology generation.

2.4 Nepalese policy on food security and agricultural trade

The Nepal Food Corporation (NFC) is responsible for the distribution of food to districts with a food deficit. The NFC functions to stabilize food prices, manage food aid and to provide food at fair prices. Negative consequences of subsidized food distribution is that grain prices for local farmers are lowered which therefore functions as a discouragement to increase crop production. In the recent years mainly subsidized milled rice has been distributed. A consequence of highly subsidized rice distribution is that it undermines the concept of crop diversification and growing more types of crops which, as will become clear, is an essential climate change adaptation strategy. Additionally farmers are discouraged to

grow local types of rice, which influences the agricultural biodiversity and in the longer term Nepalese food security.

Agricultural trade after trade liberalization under the World Trade Organization and other regional agreements in South Asia was not considered a tool to achieve food security (CPP 2007). Food production in Nepal is lacking behind in comparison to population growth which is at a high rate of 2.25 percent. Therefore agricultural trade could play a crucial role in food security, low productivity and the increased threat of the impacts of climate change on agriculture.

Nepal has adopted a very open trade regime with the lowest tariff rate in the region, and without export subsidies or quantitative restrictions. Agricultural tariffs in Nepal are far below WTO's regulations (Mittal & Sethi 2009). Nepal's biggest trading partner is India, with a one third of total export going to India. Nepal is member of the South Asian Preferential Trade Agreement (SAPTA) and currently the South Asian Free Trade Agreement (SAFTA).

The Nepalese government adopted a 20 years Agriculture Perspective Plan (APP) in 1995 which was implemented in the Ninth Plan Period (1997-2002). This Ninth Plan had the aim to stimulate agricultural growth and to increase rural prosperity and decrease poverty (APP 1995). During the Tenth Plan (2002-2007) and the National Agricultural Policy (NAP) of 2004 one of the aims was to empower vulnerable groups in order to improve food security and develop food storage and food safety nets for poor and marginalized farmers. During the Three Years Interim Plan (TYIP) (2007-2010) food independence has lastly been recognized as a fundamental human right. The Interim Plan aims to strengthen food security through management of natural resources and sustainable agricultural production, equal distribution and reduced vulnerability of the population.

2.5 Regional Context

2.5.1 Introduction to the Tukucha Nala Irrigation System

Tukucha Nala Irrigation System (TIS) is located in Tukucha Nala village development committee (VDC) in the northwest of Kavre Palanchok District in the Bagmati Zone, Central Nepal. The VDC is located some ten kilometers from the district head quarter Dhulikel and five kilometers from the nearest town Banepa. Nala is divided into two VDC's; Tukucha Nala and Ugrachandi Nala. In ancient times the city of Nala was a settlement around the lake of what is now Kathmandu Valley. This community is originally home to mainly the Newari people. It is a small community with according to the 1991 Nepal census a population of 4094 individuals in 658 households[2].

TIS is a rather small hill irrigation system comprising only 34 hectare of command area. However as there are thousands of these small systems, 57 percent of all systems is smaller than 50 ha in the Central Development Region (SISP 2001 in Bushan 2001; Nikku & Bushan 2001). Tukucha Nala VDC can be divided into nine wards and irrigated land reaches to ward number three and parts of ward number four and two. The headwork is located in ward number four and from there water reaches ward number two and three. The system is dependent on water from a perennial non snow fed Punyamata river which is part of the Sunkoshi river basin. This river joins the Saptakoshi in the south, which is among the three largest rivers in Nepal. The main canal has a water discharge capacity of 85 l/ps. 650 meters of the in total 2.05 km of the canal is cemented (DIO 1997 in Bushan 2001: 49; Nikku & Bushan 2001: 251-254). The concrete canal was built by the government during the Second Irrigation System Project (SISP) in 1997-98. Maintenance of the canal is often required as the canal can get clogged with sediments as a consequence of monsoon rain. Maintenance of the

[2] In 2001 the total number of households should be 902 (Bushan 2001)

system is possible due to collective action and an efficient water user organization. Figure 2.2 shows a non-scaled map of the catchment area of TIS in the Tukucha Nala VDC and is derived from the Master's Thesis of Bushan (2001).

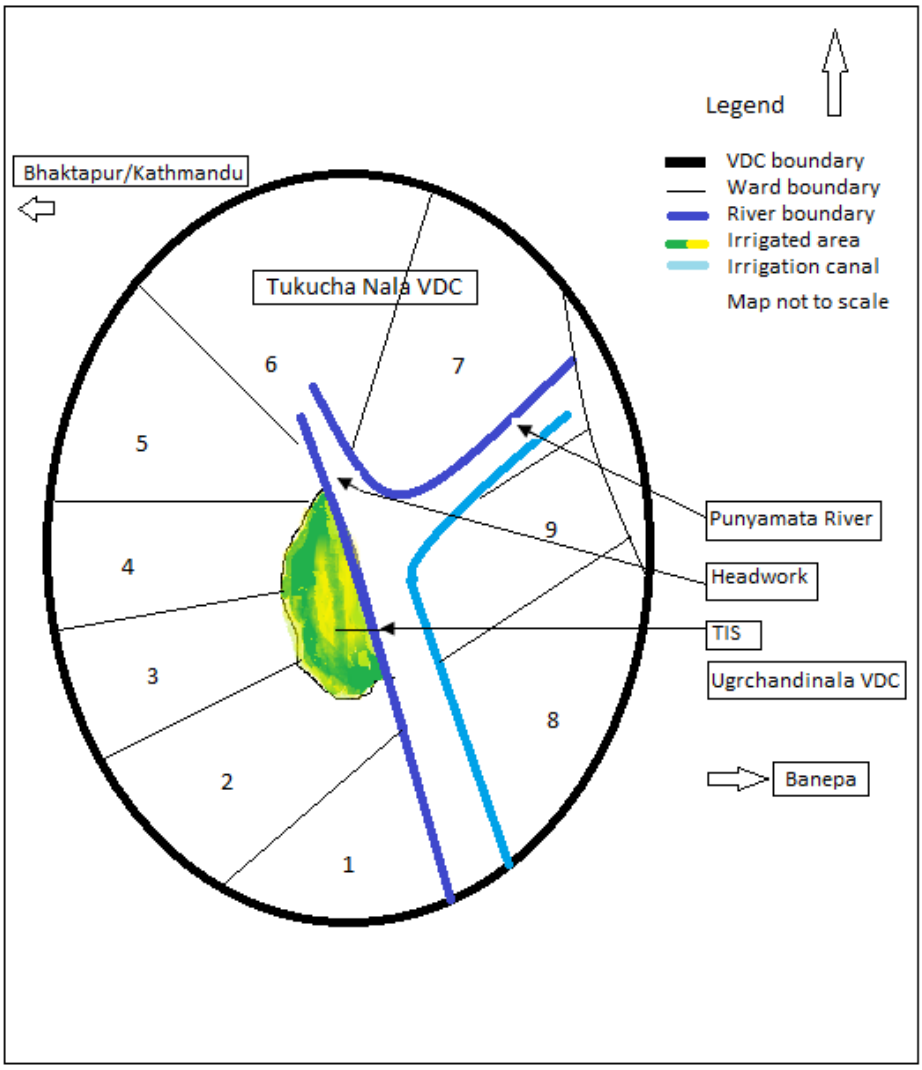


Figure 2.2: Schematic map of Tukucha Nala VDC and irrigation system (Source: Bushan, 2001)

2.5.2 Socio-economic and historical context of Tukucha Nala Irrigation System

All households in TIS have land between half a ropani and ten ropanis.[3] Household economy is based on family farming, family members work in cooperation. All households rear a small number of goats- they deliver milk and meat. Some households keep buffalo, which is much more expensive; one buffalo cost about 150,000 NRs whilst a goat cost around 3,000 or 30,000 NRs.[4] Buffaloes bring in a significant amount of revenue as they deliver milk on a daily base. Milk is sold for about 45 rupees a liter. A buffalo produces about ten liters of milk a day.[5] Just like in Panchakanya ploughing is done by men by using a power tiller, after preparing the field female members of the household are responsible for seeding. Weeding is also done by women and spraying of pesticides again is done by men. Harvesting is done together, just like applying of fertilizers to the field (see box 2.3 & 2.4). Within the household the father is considered head of the household. The households are organized through a strong hierarchy, where the father takes public responsibility and the mother (and daughter) is mainly responsible for taking care of the family household.

Box 2.3
The central gathering point of TN; where the men gather

As observed the field looks greener compared to last month. Not a lot of people are seen, it could be that they mostly work during the morning. However the people who are working are women. As it appears all the women do the work in the field. Once arrived at a central point in Tukucha Nala, which is a point where the school bus drops of the children and where there is a little shop. Here is also a bamboo wooden bench. I am told to please sit down and only men gather here. I count nine young men all listening to one radio conversation on a mobile telephone. It is not clear where it is about, but as I stand up and look down I observe a big group of men sitting down in front of a house playing cards. When walking closer it can be noticed that the men are sitting in three groups, there are a few bystanders who are or observing the game or one is listening to his cell phone, who seems to be the only one with a cell phone and it looks like it gives him some ascribed status. An old men, with a bad set of teeth offers me a cigarette; but no thanks. Another one is chewing tobacco, as the ground is witness of this habit because evenly spread across the village are tons of used packages found of chewing tobacco. The game played is impossible to understand, but the more is to be observed. They are sitting in groups of three to five people in circles on a reed mat all the flip flops equally spread out next to the mat. A few empty cups of coffee and tea are standing under the bench upon which the bystanders are sitting and a few children are standing behind the benches or hanging on a wooden pole seemingly looking interested to the game. A hundred is passed from one guy to another, probably a payment for the game, but that stays unclear.
Drinking tea and playing cards is a daily returning ritual among men. It is one of the most favorite ways of spending leisure time together, if not the most favorite (An extended observation of the breakfast ritual can be found in the appendixes section).

In Tukucha Nala the houses have all the same structure; they are small and consist out of three floors. The ground floor is considered least pure, during the day when the sun is most intense, the animals such as the buffalo and a few goats have their shelter inside the houses. On the first floor people are used to sleep and on this floor the houses have a balcony from where the different rooms are connected. The top floor is considered most pure, here food is prepared in the kitchen and this is the place to have breakfast and dinner together. Most of the time extended families from the father's side live together in houses which are connected to each other. In my family the grandmother and grandfather are living next to us together with their son and his wife and two children.

[3] One ropani equals 0,05 hectare
[4] Jayaram, April 18, TIS and Ujjwal May 7, PIS
[5] Jayaram, March 25, TIS and Bishnu-Hari, April 27, PIS (1 Nepali Rupee (NR) equals €0,01)

Box 2.4

It are women who are observed working in the field

As I walk on a few women pass me with baskets filled with grass on their backs, this is food for the buffalo. In Holland cattle eats grass in the pasture, here the food is brought to the animal. A buffalo is hold not for meat, but for milk and is washed everyday with a jar of water. Probably a buffalo is the biggest most valuable property of the household; therefore it needs to be taken care of properly. The washing is done by throwing water out of the jar on the back of the buffalo. At my guesthouse this is done by the grandmother or the son.

At the river women wash their clothes, and their children and themselves. The clothes are dried in the sun on the grass. However the river at this time of year doesn't provide a lot of water. According to the villagers the river is polluted from an upstream village, of which the inhabitants are used to throw in their garbage and stools. Pollution of the river is a problem a young boy which I encountered on the footpath explains; 'I and my little brother need to collect wood, we don't even have gas to prepare food with, we fished all morning at the river but didn't catch any, this is because of the pollution, I am hungry but I haven't eaten yet, we are poor' (Village boy, March 18, TIS). His brother is chewing on a plastic part, is dressed poorly and shakes the plastic jar with water showing that no fish is in it.

Potato growing

At this time of the year, when there is not a lot of rain, potato is grown and mustard and some leek, but for the far majority potato, because potato is less water consuming. After one irrigation round the compartments are filled with water and they need to be cleared again from the soil that has gone loose. This work is done one by one, by hand, with an ingenious peace of tool, but obviously a very time consuming procedure. Again only women are occupied with this work.

Out of 902 households in the nine VDC wards only 71 households use the system. Among these households the Newari are in majority, 49 households are Newari mainly located in ward three; the middle end of the system. The other group (13 households) is of Sarki, Magarati and Tamang descent, who were considered 'untouchable' in the past. Most of their land lies at the tail end of the system. Despite the state law declaring the abolition of untouchability, discrimination does still take place. The third group are Brahmin and Chetri, with only nine households they are in minority but they have a high status and are located in the head of the system, which is considered the best location in the system in order to receive irrigation (Bushan 2001: 50-51).

Farmers in TIS are involved in off farm activities. Besides farming farmers generate income from construction, brick making and their own business in the near urban area. Renting out land or an apartment or being engaged in seasonal work abroad is also among the possibilities. Brick making, as a recent seasonal activity brings in more income downstream in the system during the dry season, than using the dry land for crop growing. Urbanization is rapidly expanding in the area which causes arable land to be transformed into concrete.

Within TIS it was only since 1986 that drinking water pipes were installed and electricity not before 1991. Local telephones are not generally present, however the use of mobile phones is commonly used for about six to seven years since 2003.[6] In 2000 only five households out of 71 had permanent cemented toilet facilities (Bushan 2001).

In 1982 the community started irrigating from the Punyamata River; however in 1992 a river flood washed away all cultivable land. The District Irrigation Office (DIO) assisted farmers with a financial rehabilitation budget. A collective saving initiative of the farmers raised 10,000 rupeehs for rehabilitation. In 1993 a severe drought hit the same area seriously affecting agriculture. As a result farmers came to be aware about the necessity of irrigation in order to become less vulnerable to these natural circumstances. With locally saved money

[6] Jayaram, March 25, TIS

from the River Control Program the start was made of building cement pipes for irrigation from the Punyamata River. In 1996 the system was rehabilitated with financial support from the District Irrigation Office (DIO) (Nikku & Bushan 2001: 251-254).[7]

2.5.3 Organization of TIS Water User Association

In the same year of 1996 when the system was rehabilitated, also the Water User Association (WUA) of Tukucha Nala was registered at the District Water Resource Committee. Registration is a pre-requisite for receiving rehabilitation funding by the government. Figure 2.3 shows the organogram of the WUA. The General Assembly (GA) should take place two times a year. The WUA Committee is represented by eleven members and should meet four times annually. There are five other committees responsible for training, communication with the District Agriculture Office (DAO), maintenance and operation and agriculture input mobilization. All users in GA select the working committee, installed for two years. Committee members are selected based on their location of the land divided into head, tail and middle land (Bushan 2001: 55-58).

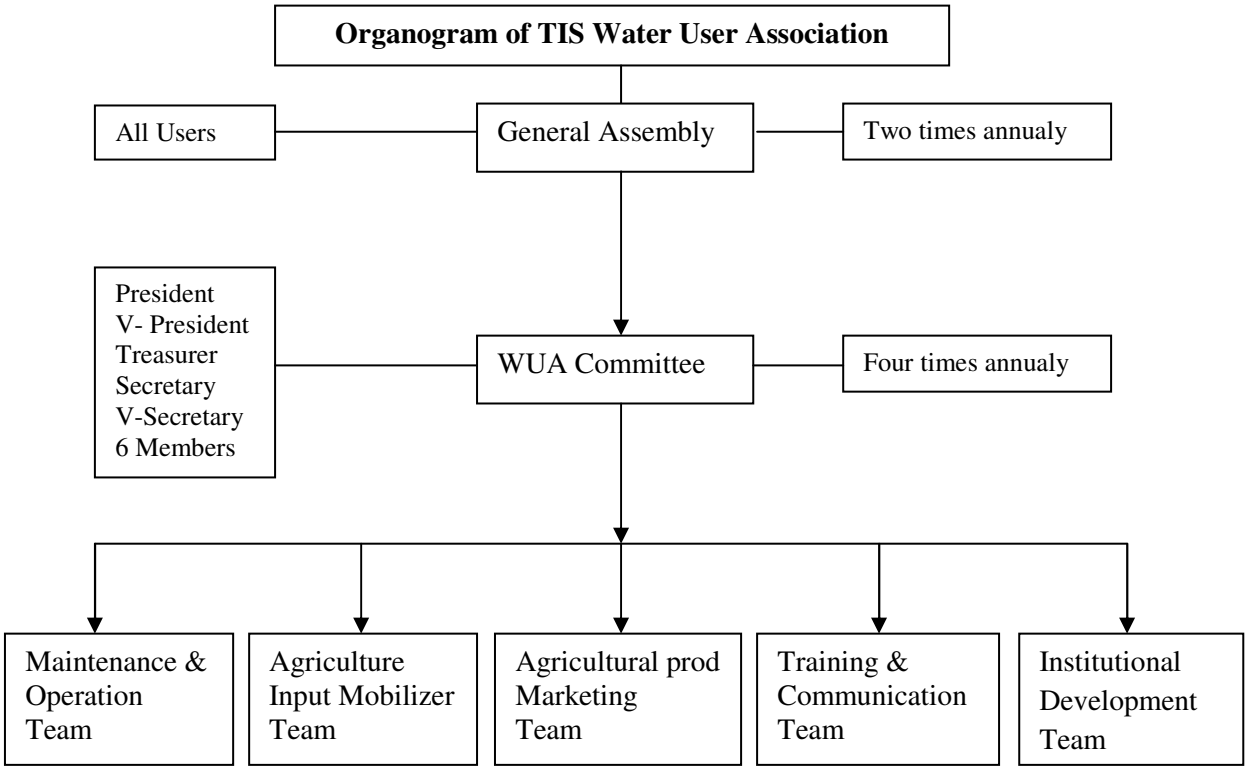


Figure 2.3: Institutional Framework of the Tukucha Nala Water User's Association (Source: Bushan 2001)

2.5.4 Introduction to the Panchakanya Irrigation System

The Panchakanya Irrigation System (PIS) is located in the Ratnanagar District of East Chitwan. The irrigation system has been in use since 1796 and until 1979 PIS has operated

[7] Current detailed information about Tukuche turned out to be not accessible due to the recent Mao destruction of the local VDC office; the office was burned down and all material needed to be reorganized and has been stashed away temporarily in a private house. At the time of conducting the research it was only after three months that the office would reopen again (District Irrigation Officer, April 7, TIS).

under the name ‘Raj Kulo’. Onwards to 1996 it was operated by the government and in 1997 the system has been handed over to the community as it is until today operating as an autonomous farmer managed irrigation system (FMIS).

Chitwan has only been recently settled in the country. Until 1953 the area was forested and only Tharus and Darai people where among the inhabitants of the region. At the time malaria was omnipresent. The government initiated eradication of malaria in 1953 with the aim to realize a huge resettlement program. Within the so-called Rapti-Doon Development Project land was cleared and roads, basic infrastructure, irrigation and communication and health services were realized. As a result of big floods at that same time, hundreds of villages were washed away in the bordering hills. These people ultimately moved to this area to resettle and were given land titles by the government. In the following period of 1953-1970 people from all around Nepal came to the region to settle; between 1960 and 1980 migration was the highest. Currently still people are settling in the area as it is an attractive central location with a high agricultural potential. Compared to Tukucha Nala Irrigation system it is a much more advanced and bigger system.

Panchakanya came under the Chitwan Irrigation Development Project (CIDP) in 1974 for rehabilitation. Construction works started in 1977 to realize a gated concrete headwork at the source, construction of a five kilometer long concrete main canal. Also 5.5 km long drainage works, seven gated outlets for the branch canals and eight gated outlets from the main canal were constructed (Figures 2.4, 2.5 and 2.6). Aim was to bring 600 ha of land under irrigation, however with completion of construction in 1979 only 200 ha could be realized to bring under irrigation. In the second construction phase 400 ha was realized to bring under irrigation at the end of 1983. In 1995 under the Irrigation Management Transfer Project (IMTP) investments were made in the improvement of institutional development of the WUA and the physical infrastructure of the system resulting in more dependable irrigation services in the system and in the end with the realization of the WUA as it is in place since 1997 (Shukla & Sada 2010).

In 1997 during a government-led resettlement program people from Padampur were relocated to Sagun Tole which is located at the catchment area from which water flows to the Panchakanya Irrigation System. The new settlers started abstracting surface and groundwater for both domestic and agricultural uses and deforested land and built check-dams interfering the water flow into PIS and the bordering irrigation system of Khageri. Water discharge is already low in the system during monsoon only 1200 l/ps. and in the dry season as low as 300 l/ps. The resettlement program challenges the efficient and equal water distribution of the system therefore water rotation schemes are put in place.

Figure 2.4: Intake structure (headwork) of Panchakanya Irrigation System

(Source: Own)

Currently total area of Panchakanya comprises 748 hectare. Total cultivable land within the area is 600 hectare of which 571 hectare is irrigated land and 31 hectare is non-irrigated. Currently PIS holds a total of 1612 households of which 1261 are registered farmers of PIS. The system depends on water from a spring source indirectly fed by the Kagheri River (IWUA 2005; Neupane 2005).

The next section presents the institutional framework of the WUA in PIS and elaborates on the main focus which is increasing efficiency of the system by developing an equal water distribution system.

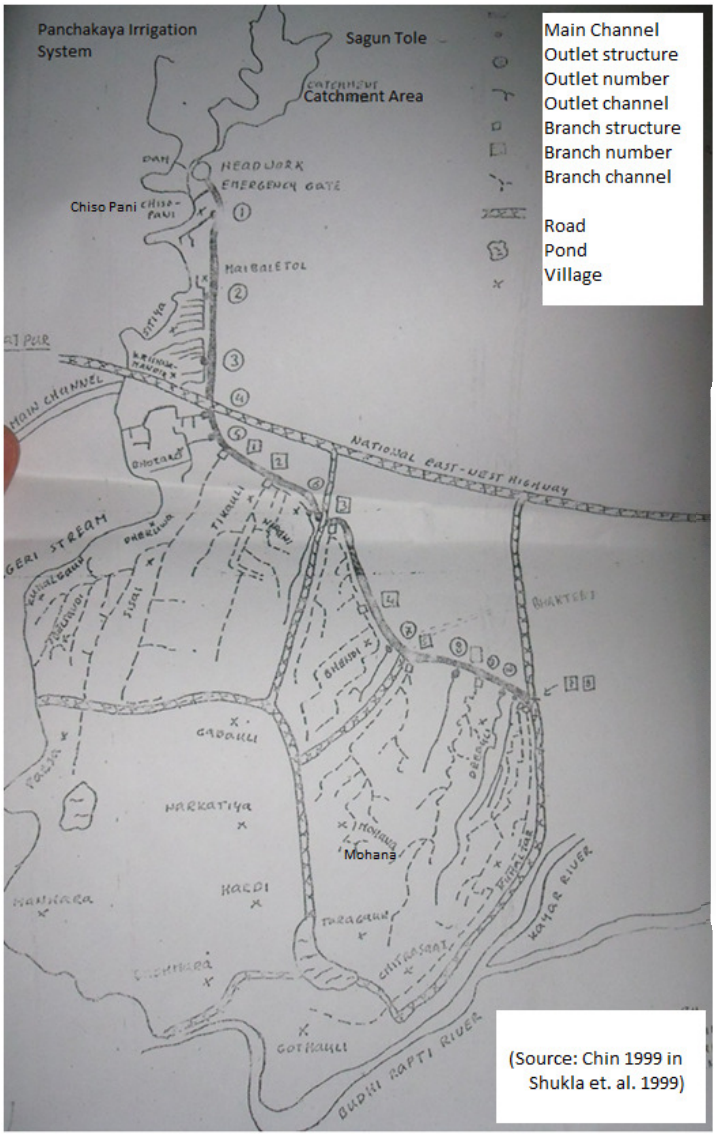


Figure 2.5: Map of Panchakanya Irrigation System

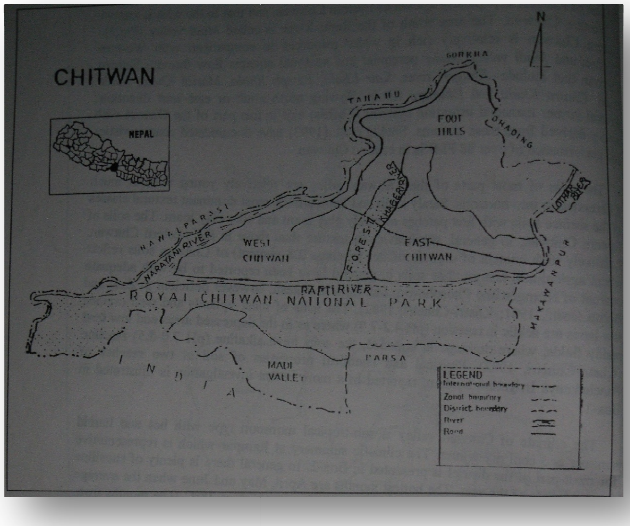


Figure 2.6: Map of Chitwan district in which PIS is located (Source: Neupane 2005)

2.5.5 Organization of PIS Water User Association

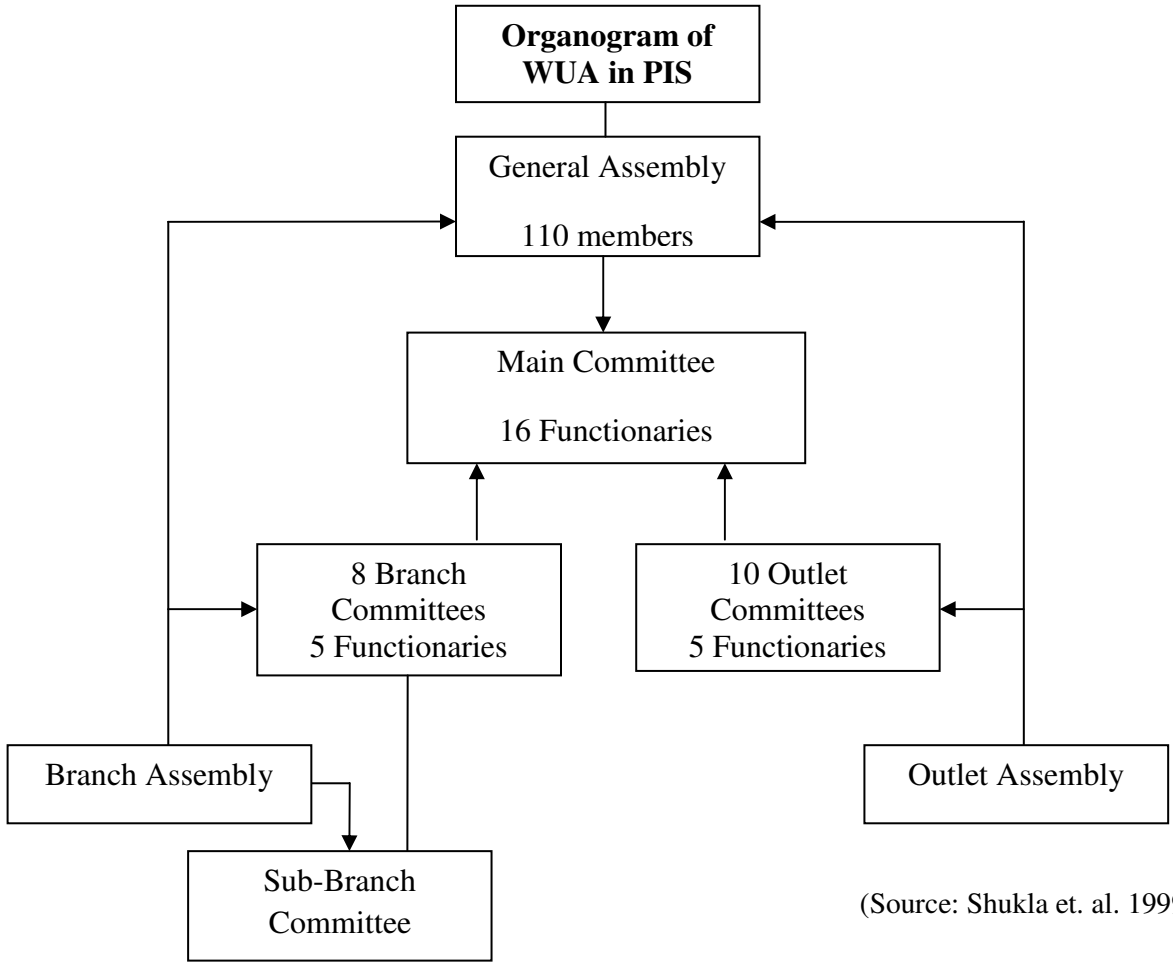
The organizational structure of the Panchakanya WUA consists out of the Main Committee, eight Branch Committees, 31 Sub branch Committees and ten Outlet Committees and a Branch Assembly and Outlet Assembly. Table 2.1 shows the number of members of each committee.

Table 2.1 Member composition of WUA in PIS

SN	Name of Committee	Number of members	Male	Female
1.	Main Committee	17	10	7
2.	Branch Committee	40	25	15
3.	Sub branch Committee	83	53	30
4.	Outlet Committee	26	8	18
5.	GA Member	110	81	29

(Source: Neupane 2005; WUA Election report 2061)

Figure 2.7 shows the current institutional framework of the WUA, which has been in place since 1997. Within the Branch committees, eight chairpersons are selected in the main committee and two members are selected in the main committee from the ten outlet committees. Also one woman is selected in the main committee and the chairperson, vice-chairperson and secretary are elected for the main committee. WUA members are farmers who hold land under cultivation, tenancy or are landholders or farmers without tenancy but getting the right from a landowner for farming within the irrigation system.



(Source: Shukla et. al. 1999)

Figure 2.7: Institutional Framework of the Water User Association in the Panchakanya Irrigation System

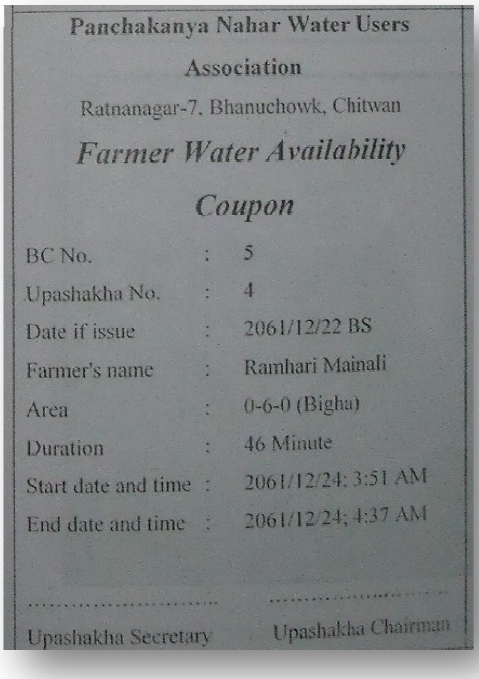
2.5.6 Equal water distribution

One of the responsibilities of the WUA is the equal distribution of water in the irrigation system. Some of the constraints and difficulties faced by the WUA are that there are no proper

rules and regulation for water distribution at the user level. Some of the big farmers used to irrigate their fields with full capacity whereas some small farmers hardly used to get irrigation water especially in the tail of the command area, which can be seen in table 2.2 on water discharge efficiency. In this table it can be seen that water efficiency reduces from main canal to field channel from 94 to eighty percent in the rainy season and from eighty to only 59 percent during the dry season. Farmers at the tail end are not aware of the water distribution schedule and received irregular water distribution.

Water distribution requires proper management. Within the WUA trainings and meetings are held in order to improve knowledge and skills and monitoring and evaluation of implemented activities. The WUA organizes different trainings for the members in the system, focused on good governance training, water share & equity training, field scheduling, awareness training on irrigation management transfer process, construction management training and women users sensitization training. The Department of Irrigation (DOI) part of the Ministry of Irrigation cooperates with the WUA with these training programs. During training programs the attitude of members changed to support equitable water distribution practice (Shukla et. al. 1999). Figure 2.8 shows an example of a farmer water availability coupon which is part of the improvement of equal water distribution within the irrigation system.

Figure 2.9 shows an overview of a water rotation schedule when water discharge is low at 300 l/ps.


Panchakanya Nahar Water Users Association

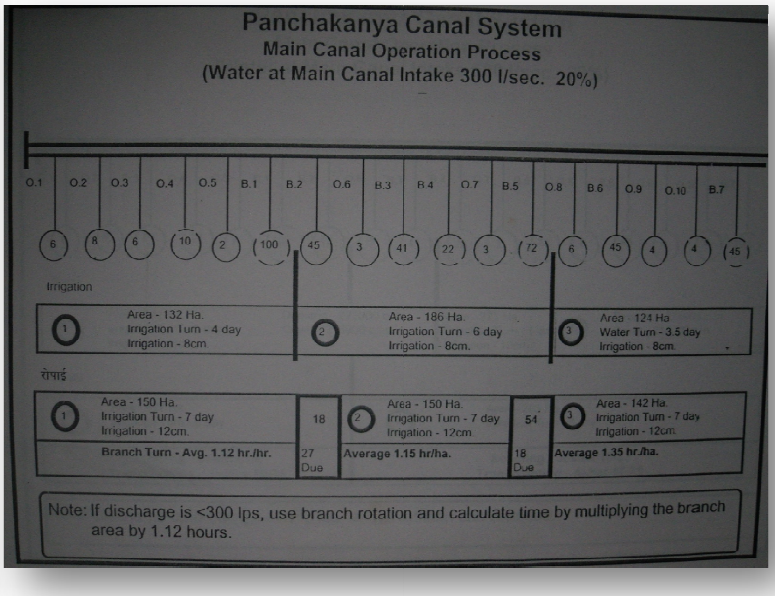
Ratnanagar-7, Bhanuchowk, Chitwan

Farmer Water Availability Coupon

BC No.	:	5
Upashakha No.	:	4
Date if issue	:	2061/12/22 BS
Farmer's name	:	Ramhari Mainali
Area	:	0-6-0 (Bigha)
Duration	:	46 Minute
Start date and time	:	2061/12/24; 3:51 AM
End date and time	:	2061/12/24; 4:37 AM

....

Upashakha Secretary Upashakha Chairman



ıupon ırce: Neupane 2005)

These are examples of how the irrigation system with a decreasing water discharge can increase its performance by implementing tight water distribution schedules and systems. Monitoring is also an important aspect to check periodically whether water distribution has been distributed correctly or not. A supervision team of the WUA including the WUA chairman and secretary are responsible for the monitoring process in Panchakanya. The team monitors whether all farmers were provided adequate water, if not what were the reasons, what improvements should be done. The schedule is being discussed in the meetings and they are responsible to examine whether farmers are aware of the water distribution schedule. The main committee has to decide on any issues related to rotation, conflicts and other water related problems.

Table 2.2: Water discharge efficiency in PIS

Season	Main canal	Branch canal	Tertiary canal	Field channel	Total
Rainy	94%	80%	85%	80%	51%
Winter	80%	70%	69%	59%	23%

(Source: Shukla et. al. 1999)

Water distribution in each branch is managed by having one volunteer workforce in each branch and outlet. The workforce assists the WUA on water distribution work, supervision, repair and maintenance work, labor mobilization and collection of irrigation fees. The WUA faces some organizational problems with water distribution; water availability at the source and the amount of water to be delivered to each branch is not clear. A technical problem is that the system suffers from excessive seepage which causes a water shortage in the tail. The water schedule is not fixed; there is a lack of water and capability to decide how to distribute the excess water.

In order to use water more efficiently the WUA holds an approach of ´more crop per drop´, to reach an increased crop production with more members and a low water availability. Currently the WUA is discussing a reservoir capacity, which would improve water availability and the water distribution schedule. They are defined as storage zones, however first the WUA needs to enhance the storage and supply capacity of the reservoir in order to realize such reservoir zones.
Figure 2.10 has summarized the characteristics of both systems.

Figure 2.10: TIS and PIS compared

	TIS	PIS
Households	658 (71 User households)	1612 (1261 Individual users)
Command area	34 Hectare	600 Hectare (571 non-irrigated)
Water source	Perennial non snow fed Punyamata River	Spring source indirectly fed by Kagheri River
Location	Bagmati Zone, Hills	East Chitwan, Terai
Type of Canal	Both concrete and non concrete	Concrete
Construction of canal	River Control Program	Government

(Source: Bushan 2001; Neupane 2005)

2.6 The host organization: Nepal Engineering College

Figure 2.11: NEC logo (NEC 2009)

Nepal Engineering College (NEC) was founded in 1994. It was established as a nonprofit institution. It has standardized the academic curricula and offers now Bachelor and Masters courses in engineering and technology disciplines such as a Masters course in Interdisciplinary Water Resources Management. The main campus of NEC is located in Changunarayan Village Development Committee (VDC) in Bhaktapur. The vision of NEC is to 'evolve as the center of higher learning, excelling in academics, engaging in education, research and technology transfer as three faceted functions, in the best interest of the society, nation and humanity' (Nepal Engineering College 2009).

3. Theoretical Framework

3.1 Introduction

This chapter will present the main trends in weather conditions which influence water availability and main consequences and adaptations. A detailed schematic overview of the expected main outcomes on these three concepts of this research will be given in section 3.1.1 Section 3.2 will present the main consequences of changing water availability for agriculture and food security. It will become clear that poverty and vulnerability are closely linked to each other. In section 3.3 this concept of vulnerability will be further outlined in relation to adaptive capacity. This section will elaborate on the concept of adaptation, coping behavior and responses; in a schematic overview the main expected outcomes on these concepts are presented. The importance of implementing effective adaptation methods will be argued as this is necessary in order to reduce climate induced impacts on people's livelihoods, food security and poverty. Additionally socio-economic and geographic processes such as the consequences of population growth and urbanization, infrastructure and industrialization will be taken into account. These processes are directly affecting farmers' livelihoods as well and it would be too shortsighted to ignore these processes in the analysis of this context.

3.1.1 Trends in water availability

Nepal is a mainly agricultural country and climate change is likely to have far reaching consequences on water, on agriculture, irrigation, hydro energy, biodiversity and in general on water availability upon which so many people are depending in the Himalaya region among which are the people of Nepal. The notion has to be made here that agriculture itself is a huge contributor to climate change. Both are interrelated processes as through agriculture greenhouse gasses of which mainly methane (7 percent of total combined greenhouse gas contribution) but also carbon dioxide (5,5 percent) and nitrous oxide (6 percent of total, through the use of pesticides) are released. Of these three greenhouse gasses carbon dioxide takes 72 percent of total contribution to global warming (both naturally as human induced). Methane is responsible for 18 percent and nitrous oxide some remaining 9 percent. Agriculture does also contribute to deforestation and desertification as land is being cultivated. Agriculture is mainly responsible for methane which is also about four times a stronger greenhouse gas than carbon dioxide. Methane is released through livestock and rice cultivation. In total the agricultural sector globally is responsible for an estimated 18 to 20 percent of total greenhouse gasses contributing to global warming (Schimel et.al 1995 in IPCC 2000; FAO 2008).

Climate change affects especially the Himalaya region because of its physical and social nature. This region contains the largest amount of fresh water, glaciers and snow besides the North and South Pole. Seventy percent of the world's fresh water is frozen in glaciers. Glacial melt supports biodiversity and humans during dry seasons. As fresh water is already scarce, population growth in the next three decades will only exceed the potential increase in available water (WWF Nepal Program 2005). Trends of climate change in the Himalaya region are; changing rainfall patterns, temperature increase and glacial retreat which in the long run will have a severe impact on the total water supply.

Snow and glacial melt contribute to almost half of the average flow of the major rivers in the region. Ten major rivers originate in the Himalayas and serve directly some 1.3 billion people. However total food and energy production of the Himalaya river basins reaches some three billion people. Among these rivers are the Ganga, Indus, Brahmaputra, Salween, Mekong, Huang Ho and Yangtze.

There is a wide knowledge gap on the actual impact of climate change processes on the Himalayas; data is missing and the region is known to be very complex to study. However

impacts of climate change are huge as 67 percent of glaciers are retreating at an increasingly rapid rate (UNEP 2008; Oerlemans 2005). The changes that are taking place in this region have not only impact on the local communities and environment it affects the whole world as well.
A study by the Department of Hydrology and Meteorology showed that the average temperature in Nepal is increasing since 1971 with a rate of about 0,06 degree centigrade annually (Shrestha et al 1999; CCNP 2009). Some studies show an increased variability and intensity in rainfall. Purdue University has shown that global warming could lead to a shift in the onset of the monsoon by five to fifteen days and a substantial reduction in rainfall in Nepal in the coming century. Indirect consequences of temperature increase are the decrease in water availability, decrease in soil moisture, increase in pests and diseases. Positive consequences of increase in temperature are that crops can be grown at higher altitutes while . increase in temperatures has negative consequences on rice and wheat yields in the Terai in which temperatures are already high and crops are grown already close to their temperature tolerance barrier. Furthermore climate induced temperature increase may lead to a shift and extension of the boundary of the farming and pastoral transition regions. Droughts could lead to desertification as a consequence (Li & Zhou 2001). Climate change has impact on grassland productivity. Upward movement of the tree line is occurring in the Himalayas at a rate of five to ten meters per decade (Baker & Mosely 2007). Adaptation to the consequences of climate change are increasingly important as the majority of the population's source of livelihood is agriculture. Thus both food security and people's livelihoods are at risk.

In this research the aim is not to prove the impacts of climate change on this region, the aim is however on experienced and predicted environmental changes which have a direct effect on communities and people's daily lives. Clearly this calls for effective adaptation strategies; trends, consequences, and adaptation are the aligned foci of this research. Figure 3.1 gives a schematic overview of the main expected outcomes on trends, consequences and adaptation on changing water availability.

Figure 3.1: Schematic overview of main assumptions

Trends in water availability	Glacial retreat	Temperature increase	Changing rainfall pattern			
Consequences of changing water availability	GLOF, Landslides Low river level	Drought Soil degradation	Decrease in water availability	Increased dependency on irrigation system	Increased vulnerability	
Adaptation on changing water availability	Early warning system	Development of drought resistant crops	Crop diversification	Increase efficiency of irrigation system	Drip irrigation	Water storage

(Source: own)

3.1.2 Glacial retreat

Glaciers in the Himalayas are retreating at higher rates which are also accelerating compared to other mountain regions. According to the International Panel on Climate Change (IPCC 2007) annual temperature increase in the region could lead to extensive diminishing of glacial coverage, which could in turn have serious effects on the ten rivers and their basins which originate in the Himalayas.

During the 20thcentury there has been a temperature increase of about 1 degree centigrade with the 1990s as the warmest decade of the millennium and 1998 the warmest year of the millennium. Geological Survey showed that mountain glaciers around the world are decreasing over the past decade; this is the case for the Andes, the Himalayas, the Alps and the Pyrenees (Wessels et. al. 2001). At the short term increased glacial melt will increase

river levels but this will lead to an increase of flooding and land-slides (IPCC 2001). In the long term however melting ice will decrease leading to decreased melt water runoff which could leave the Ganga with less melt water causing water shortages for 500 million people and irrigated agriculture (Singh et. al. 1994 in WWF Nepal Program 2005: 3).

3.2 Consequences of changes in water availability

3.2.1. Consequences of glacial retreat

One of the consequences of melting of glaciers is that while glaciers decrease, glacial lakes increase. Glacial lakes are naturally formed and they are a potential risk of glacial lake outburst floods (GLOF's), with serious impact on downstream areas on the environment and lower living communities. Himalayan glaciers have been retreating at an increasing rate while glacial lakes have been increasing (Fujita et. al. 2001). Changes that occur in mountain glaciers are useful indicators of climate change (Oerlemans 2005). The Dudh Koshi basin in eastern Nepal is one of the biggest basins in the country with large glaciers and glacial lakes and this region has been affected significantly. The majority of the lakes have been formed due to increased temperatures during the second half of the 20th century (Mool et. al. 2001).

As glaciers are retreating faster this is causing increased melt water in glacial lakes which ultimately can lead to an outburst causing a glacial lake outburst flood (GLOF). One well documented so called GLOF was the Dig Tsho which occurred in 1985 and it destructed a complete new hydropower station, thirty houses and fourteen bridges were lost. Also forest and cultivable land was destructed impacting people in communities downstream. Erosion and landslides still form a threat to these forests and cultivable land. GLOF's form a real risk socially, economically and environmentally. Data shows that every three to ten years one GLOF occurs in the Himalaya region (Bajracharya et. al. 2008). Since 1935 more than 16 GLOF's have been reported which all took place in or close to Nepal, this shows that GLOF's are of huge risk for the country. Increasing temperatures due to climate change will only increase the risk of GLOF's with all potential damage for the environment and people living in this area.

3.2.2 Changing rainfall patterns: Impacts for Nepal on agriculture

> *"The rains are increasingly unpredictable. We always used to have a little rain each month, but now when there is rain it's very different. It's more concentrated and intense. It means that crop yields are going down."*[8]

In 2009 total precipitation in Nepal was less than 800 millimeters (mm), far below the normal 1,540 mm resulting for this monsoon to be the driest in a decade. Agriculture in Nepal represents the biggest sector with 36 percent of the country's GDP. Officially sixty percent of arable land in Nepal is equipped with irrigation facilities, but most farmers do not get the needed amount of water from the irrigation projects in place. The remaining forty percent is even more reliant on monsoon rain. Rainfall in Nepal is erratic with over 75 percent of annual rainfall occurring during the monsoon. Farmers are heavily dependent on the monsoon rainfall for crop growing; as a consequence production in 2009 went down by 30-35 percent resulting in increased crop prices (South Asian Climate Outlook Forum 2010: Kathmandu Post 2010).

Due to changing rainfall patterns dry areas will most likely get drier and wet areas will get wetter leading to extreme droughts and at the same time more floods. More extreme weather patterns also leads to unpredictable water flows. Also due to temperature rise evaporation from land will increase, so that less rainfall will reach rivers (IPCC 2007).

[8] The Guardian (2 December 2006): Tekmadur Majsi

Vulnerability and water insecurity will increase. Agriculture and rural development will be most affected by these risks.

Productivity in rain fed agricultural production is influenced by both the timing of water flows as the volume. This means that these water flows will become more variable and uncertain, leading to extreme weather events, with at the one hand severe droughts and at the other hand increased flooding. This will have implications for Nepal who has a limited infrastructure to adapt to the changing conditions.

Temperature increase and water stress are expected to lead to a thirty percent decrease in crop yields in Central and South Asia by 2050 (UNDP 2006: 9). Irrigated lowland agriculture in the Himalayan region will be affected negatively as a result of dry season water. Thirty percent of the water in major rivers in Nepal is glacial melt water. This means that dry season water stress impacts will be huge. With a changing rainfall pattern leading to less predictable rainfall it becomes increasingly essential that farmers move from the dependence on natural precipitation towards irrigation in order to ensure their livelihoods, subsequently ensuring their crop productivity.

3.2.3 Climate induced consequences for crop productivity and vulnerability

Food availability is decreasing in Nepal as a consequence of population growth and changing weather conditions such as drought, flood and landslides. Non stability in crop yields is due to erratic weather conditions due to increased climatic variability. Climate induced instability affects agriculture and is a major sources of food insecurity. The most vulnerable crops are paddy and maize. In 2009 six percent of total paddy area was affected by natural disasters like landslides, flood and drought (ABPSD 2009). Consequences are reducing crop yields and reduced income and increased vulnerability of food supply (Dahal 2005). The impacts of climate change, deforestation, degradation and decline in soil fertility are also causes of increased instability in agricultural production (CPP 2007).

3.3 Adaptation to environmental changes

"Unless the country learns to adapt the people will suffer greatly"[9]

Adaptation is a reaction to the threats of climate change that encompass changes in social and institutional structure and technology. Improving one's capacity to adapt is crucial to adjust to climatic extremes like drought and floods. Furthermore adaptation according to the FAO means 'the adjustments in human and natural systems to respond to actual or expected climate change impacts' (FAO 2009). This does also mean implementing policies, practices and strategies to reduce the consequences or realize opportunities to climate change variabilities (EC 2008).

Livelihood according to Carney (1998) comprises 'the capabilities, assets (material and social resources), and activities needed for a means of living'. Climate change imposes significant pressure on the rural livelihoods of indigenous people living in the Himalaya region. Being vulnerable to changing environmental conditions especially requires being able to adapt in order to reduce the vulnerability. Adaptation to climate change is thus related to vulnerability. Vulnerability can be defined as the "degree to which individuals and systems are liable to or unable to cope with the adverse effects of climate change" (Smit & Pilifosova 2001 in: IPCC 2001). But vulnerability is also determined by future impacts which are either avoidable or unavoidable.

Effective adaptation can be divided into adaptive capacity; this is awareness, governance and knowledge and actual adaptation; which leads to the change of behavior,

[9] The Guardian (2 December 2006): Gehendra Gurung (Practical Action, Nepal)

practices and livelihoods adapted to the new conditions (Mirza 2007). Adaptation could be implemented on different scales; nationally, locally, regional and individually and on different levels; technological, managerial and through policies and politics. It could mean new farming practices or water demand management. Adaptation on individual scale could be a farmer who grows drought resistant crop varieties in circumstances of increasing temperatures and decreasing precipitation therefore reducing the risk of a crop failure. Adaptation however, should be implemented beforehand in order to be effective.

An important distinction needs to be made between planned and autonomous adaptation (Dahal & Khanal 2010; Archarya 2010). Autonomous adaptation means a gradual inbuilt capacity to adjust to climate change. Planned adaptation is intended and based on policies and strategic responses in order to increase the adaptive capacity and implementation of specific adaptations (Dahal & Khanal 2010**).** Planned adaptation could be the building of dams to reduce flood damage or change in land use, breeding new varieties of crops, and developing irrigation systems, warning systems for floods and droughts (Mirza 2007). Currently Practical Action, a Nepali NGO is working on the implementation of early warning systems against natural disasters like earthquakes, droughts, GLOF's and windstorms, arguing that not being prepared on a natural disaster results in serious consequences. Nepal is among the global 'hot-spots' for natural disasters as stated by the World Bank in 2005 (World Bank 2005).

Autonomous adaptation could be understood as tools or coping strategies on individual level of farmers- being the changing of sowing date and harvesting time of crops adjusted to the changing weather conditions in order to insure crop and livestock or changing of cropping patterns. Yet another strategy could be diversification of crops which in turn reduces the risk of crop losses (Archarya 2010). Nationally a state should be responsible to implement effective adaptation strategies and should provide physical, financial and human capital (Ibid.). Adaptation is a process and it is aimed to have long term adjustments. For planned adaptation next to the existing global knowledge it is necessary to conduct local research and to identify cost effective mitigation and adaptation options. Figure 3.2 gives an overview of the main expected outcomes on the range of adaptations, coping strategies and responses. Adaptation covers a broad range of concepts, therefore the distinction between coping behaviour, responses and adaptation strategies is made. This will be explained more thoroughly in chapter 4 **(**section 4.1.4) .

Figure 3.2 : Schematic overview of main expected outcomes on Adaptation, Coping and Responses

Adaptation	Coping	Responses
Implement early warning systems and incorporate disaster risk management and preparedness	Increased fertilizer use	Selling of livestock
Develop drought resistant and pest tolerant crops	Adjust the sowing dates to the changing rainfall patterns	Selling of land
Develop knowledge and infrastructure		Income diversification
Implementation of ponds and water reservoirs to store water		Out migration
Development of drip irrigation	**Adaptation continued** ↓	Commuting
Development of hybrid fertilizers	Crop diversification	Off farm activities
Increase use of organic fertilizer		
Organize training and awareness programs		
Strengthen cooperation between government, regional and local level		

(Source: Own)

3.3.2 Poverty and climate induced vulnerability

Poverty and food security are closely linked to each other. In Nepal poverty reduction has been on the development agenda since the Eight Plan (1991-1997) through the Tenth Plan (2002-2007). Poverty rate in percent of the population in 1995 was 41,8 percent which decreased to 30,9 percent in 2004 (CBS 2005; World Bank 2009). Reasons for this poverty reduction are the increase in remmittances, the proces of urbanization, increase in agricultural wages and increase in off farm activities.

Still poverty is widespread in the Himalaya region; there are a lot of vulnerable livelihoods which urgently calls for the empowerment of poor people to adapt to the current environmental changes. People most vulnerable are the poor, marginalized and lower caste groups; they are the least able to cope with natural disasters, lack the right knowledge, information and skills to reduce their risks (Oxfam 2009). The Climate Change Vulnerability Index (CCVI) ranks the vulnerability of 170 countries to climate change effects for the next thirty years. The South Asian region has been depicted as the most vulnerable region, with Nepal ranking fourth in the index (SAFMA 2010). Nepal is hardly prepared to the consequences of climate change while the country depends most on agriculture. So far there has been little engagement with local populations to learn from their knowledge and experience in adapting to the changing environmental conditions and to address their needs and concerns (Xu & Rana 2005). With the changing rainfall patterns and temperature rise, livelihoods of Nepalese people who rely on farming activities will be affected the most.

3.3.3 Water storage and food production

The Himalayas are now recognized as a region of serious concern for climate change (Dyurgerov & Meier 2005 in ICIMOD 2009: 3). In Nepal temperatures are rising faster compared to global rising temperatures[10]**.** These changes are affecting the monsoon pattern and likely also the frequency of extreme precipitation events. Water in the Hindu Kush-Himalayan Mountains is stored as ice and snow and in natural lakes, wetlands and groundwater aquifers and constructed dams (Nellemann & Kaltenborn 2009 In ICIMOD 2009: 6-9). Of this water about 75 to 90 percent is used for the production of food. Water availability is going to decrease not only due to glacial retreat and changing monsoon patterns but also because of population growth which increases the demand for water and the increasing demand for cereals for the production of animal feed and for human consumption will increase water demand by thirty to fifty percent in the coming decades. Water consumption will increase due to increased income and growing consumption of meat. Irrigated croplands such as rice in the river basins are also depending on glacial water from the mountains.

During the last food crisis prices increased by fifty to 200 percent which led 110 million people into poverty and 44 million more undernourished. Increased food prices have a major impact on lives and livelihoods among which are increased child mortality and people already living in poverty who are spending up to 70-80 percent of their income on food. The last food crisis is caused by speculation on food stocks, extreme weather events, low cereal stocks, the growth in bio-fuels competing for cropland, increased demand for meat and the high oil prices. However current problems faced could cause an environmental food crisis which according to the FAO and UNEP could lead to a thirty to fifty percent increase of food prices.

Small scale farmers in Nepal don't have access to markets and are constrained by high prices for fertilizers and seed. Furthermore there's a lack of infrastructure, investments, of microfinance availability and reliable institutions such as for water provision (ICIMOD 2009: 7-9). These conditions call for new systems for the capturing and storage of water. Therefore land management and storage methods need to be improved, think of installation of new water capture and storage methods and irrigation systems and pipelines from major rivers together this calls for training and implementation towards adaptation (Ibid: 9).

Nepal has a high rainfall variability which means too much water in the wet season and too little in the dry season. In addition current water storage capacity is below what is needed for food production, this means that water storage is of great importance in order to be adaptive to climate change (Brown & Lall 2006 In Vaidya 2009: ICIMOD 2009: 10).

3.3.4 Adaptation lags behind

So far policies have not been shifted towards adaptation in order to minimize the risks involved with climate change. Adaptation has not been prioritized in poverty reduction strategy programs, or implemented in water resource management policies. While agriculture is highly dependent on water availability, aid flows to agriculture have been shrinking since the 1990s (IPCC 2007). This downward trend only increases the vulnerability of agriculture and food security towards the future.

Adaptation to the consequences of glacial retreat has been very marginal so far. It is often very difficult to adapt to the consequences of glacial retreat. Most of the time the minimal efforts on adaptation are focused on hydropower and urban water supply and not so much on commercial irrigated agriculture (Orlove 2009). Also the small scale mountain farmers and herders are not taken into account in adaptation policies. Nepal is facing a

[10] From 1977 until 2000 every year the mean maximum temperature increased by 0,06 degrees Celcius this is 0,6 degrees per ten years while global temperature has risen 0,74 degrees over the past hundred years (IPCC 2007).

reduction in water supply as a consequence irrigating of the fields becomes more difficult (Merz 2003). In total tens of millions of these small scale mountain farmers and herders around the world are affected by glacial retreat. Responses are various; digging new irrigation channels, shift to more drought resistant crops and crop varieties, but also seeking off-farm income. However as these responses and adaptation strategies don't add up it could only lead to more migration to other areas as glacial retreat and changing rainfall patterns will further reduce water supplies (Orlove 2009).

3.4 Conclusion

The main trends influencing water availability are changing rainfall patterns, increasing temperatures and glacial retreat. This will have far reaching consequences on the type of agriculture; the length of growing seasons and crop yields will likely be decreasing, leading to decreased food security, increased food prices, worsening water security and increased water stress.

Glacial has great impacts on water availability and the Himalaya's fresh water resources. Glaciers are melting at an ever increasing speed. The Himalayan glaciers contain huge amounts of fresh water, providing water for commercial agriculture and billions of people in the form of melt-water through rivers. Rivers as the Ganga, Indus, Brahmaputra and others could become seasonal rivers, as the Himalayan glaciers are retreating faster within the coming decades. Flooding of rivers due to increased melt-water is putting pressure on irrigation systems. As the Himalayan glaciers are melting, agriculture will face a decline in water supply, causing serious consequences for human development food security and livelihoods of farmers. Climate change is happening and glaciers will continue to melt for the next fifty years, also with adequate human action, therefore both for rain fed agriculture and agriculture dependent on melt-water of glaciers effective adaptation is needed.

It is clear that Nepal who contributes very little to human-caused climatic changes face great challenges in order to cope with the consequences of changing water availability. Knowledge, technology and financial capital are needed.

As has become clear in this section, Nepal among other countries in the Himalayan region is already vulnerable to climate change. The effects already have impacts for agriculture. A distinction has been made between coping, adapting and responding (figure 3.2) and between planned and autonomous adaptation. Due to implications and marginal progress on adaptation strategies as Nepal ranks fourth on the Climate Change Vulnerability Index (CCVI), it has also become clear that the consequences will only become more severe in the near future. This will put more pressure on agriculture and livelihoods, food security and poverty rates, constraining human development and leaving the region with an ever increasing challenge in order to cope and adapt to these structural changes in its water availability.

4. Methodology

4.1 Research Objective and Research Questions

4.1.1 Introduction

In this chapter the conceptual model will be presented and the research objective, research question and sub-questions are outlined. The relevance of each sub-question will be discussed and a definition of the concepts will be given.
As has been outlined in the previous paragraphs, changing water availability is relevant and an issue in daily life in rural Nepal; consequences directly and indirectly influence farmers' livelihoods. Responses are various, depending on awareness, the role of organizations and the type of consequences.

4.1.2 Conceptual Model

The conceptual model (figure 4.1) starts on top with climate change as the main underlying cause of changing water availability. It is not the aim of this research to prove this link, therefore the arrow is not aligned, meaning the link is an assumption, however the causes as indicated by farmers will be taken into account. The model starts with trends in water availability, which can be divided into two changing water sources. The assumption is that water availability is changing due to changing rainfall patterns and glacial retreat and together they form the changing water availability which will be focused on in the research. The next two underlying boxes are linked to glacial retreat left, and changing rainfall patterns right. They indicate the effects. These consequences have direct and indirect influence on farmers. Agriculture has been divided into two types; glacial water fed agriculture on the left and rain fed agriculture on the right. Glacial retreat has consequences for the left box and changing rainfall patterns has direct consequences for the right box. The assumption is that these consequences lead to adaptation. Adaptation is divided into adaptation strategies, coping behavior and responses. Glacial retreat was not an issue in both selected regions; therefore the left wing of the model has turned out to be not applicable. The last box presents the role of NGO's and Water User Association (WUA) on adaptation.

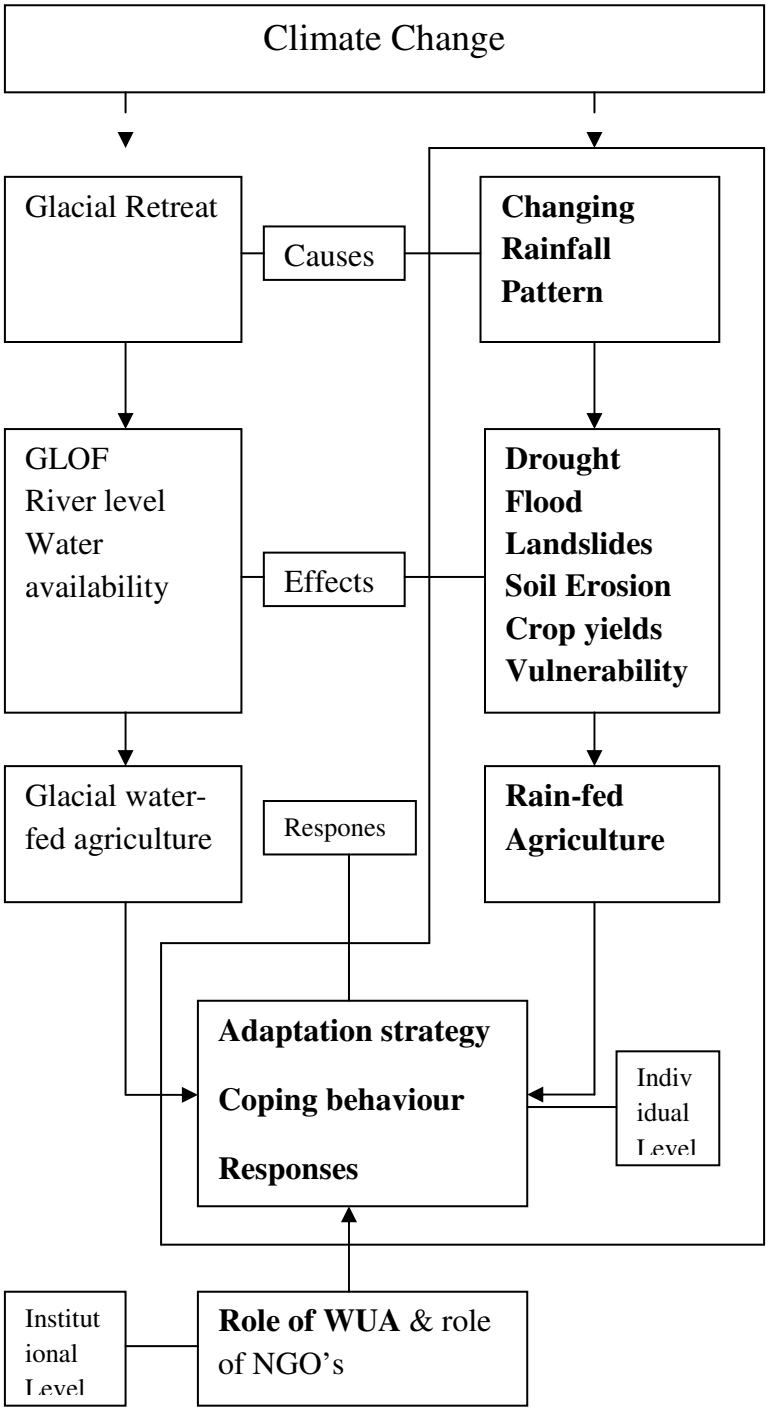


Figure 4.1: Concept model

4.1.3 Research Objective & Research Questions

The data presented will be structured following the research question and sub questions. An overview of the research objectives and research questions is given below.

Research Question:

'What are the effects of changing water availability for farmers' livelihoods in Tukuche Nala and Panchakanya and how do farmers respond and adapt to that?'

Research objective
The research has a main objective which can be identified through 4 separate objectives, the main objective of this research is:

"To identify trends in water availability and the effects and to identify the responses and adaptation strategies of farmers"

The 4 separate objectives can be identified as follows:

1. Identify trends in water availability
2. Identify different consequences of changing water availability for farmers' livelihoods
3. Identify the role of organizations on adaptation to changing water availability for farmers
4. Identify different types of farmers' adaptation to changing water availability

The research question can be divided into three sub-categories among which 4 sub-questions have been formulated. First category is 'trends', the second 'consequences' and the third 'adaptation'.

Sub- Questions
Trends:

1. What are the trends in water availability?

Consequences:

2. What are the effects of changing water availability on the livelihoods of farmers in Tukucha Nala and Panchakanya?

Adaptation:

3. Which different adaptations, responses and coping strategies of farmers can be distinguished as a reaction to changing water availability?

4. What is the role of local organizations and Water User Associations on adaptation with respect to farmers in Tukucha Nala and Panchakanya?

Looking at the main research question; the focus of the research is on trends in water availability, with a main focus on rain fed agriculture. The selected irrigation systems are not depending directly on glacial fed rivers making the issue of changing rainfall pattern the major focus. Besides rainfall patterns other aspects of changing weather patterns such as

increase in temperature and related aspects as competing use of water resources such as groundwater, water from the river and access to water are also incorporated. This is however placed in a broader picture aiming to place these issues in a livelihood context. Therefore other issues are also concerned, among these are; off farm activities, pollution, migration, construction and urbanization and the political situation.

Rainfall is the leading component, however assuming that making a living becomes more difficult other linked aspects are also involved. Looking more specifically at consequences among the issues involved are: drought, flooding and soil fertility. Adaptation which originally was an important aspect of the research appears to be rather limited, however adaptation is looked from in a broader perspective meaning taking also coping strategies, other activities and migration patterns (responses) into account. Concerning organizations operating in the field, no real interventions have been distinguished due to an absence of organizations operating in both the field locations. However the issue of interventions and awareness has still been addressed.

The first question is 'What are the trends in water availability?' The assumption is that water availability is changing, therefore the second sub question addresses the effects of changing water availability. The trends and consequences have been discussed in the theoretical framework. The sub-question is focused on the specific effects in the field at the individual level of the farmer. The third and fourth sub question addresses the responses of farmers (the individual level) en the role of Water User Associations and local organizations (the governance level) on adaptation. Responses can be divided into adaptation strategies, coping behavior and responses. These concepts among others will be defined in the next section.

4.1.4 Defining the different concepts

Different concepts should be defined in order to get a clear notion of what is meant by these concepts. The first is 'changing water availability'. Farmers depend on two sources of water; these are rainfall and melt water from glaciers through rivers. Water availability therefore is defined in these two distinctions. The change in this water availability is glacial melt and changing rainfall patterns. Once glaciers start melting more rapidly this obviously causes change in the availability of water in rivers. Once rainfall patterns become more variable and less predictable obviously the water availability from rainfall is changing. Rainfall feeds agriculture directly and indirectly through rivers. Glacial melt feeds agriculture indirectly through rivers. The only other change in water availability has been taken to a minor extent into account, which is the change in groundwater levels.

The next concept is 'farming households'. This is a broad concept, the focus however has been on two types of farmer households mainly: rain fed agriculture and a combination of rain fed and irrigation. In principle other types of agriculture will not be taken into account. Farmers could also be extended to the household, to other members involved in the farming activities. Thus when speaking about farmers they could also be members of the household such as children, sons and daughters and the men and women being part of the household or working on the farm.

Consequences: this concept refers to the effects indirect and direct influencing the farmers' livelihoods. Consequences refer to the effects of changing rainfall patterns as defined in the former definition.

Livelihood: this concept is defined as the way farmer's households make their living by making use of capabilities, different types of assets which are material and social resources and activities needed for a means of living (Carney 1998). Livelihood refers to daily activities in crop growing but also they make up off farm activities.

Adaptation in this research applies to the long term process of adjusting to changes in water availability and weather patterns. Adaptation is something different than mitigation, it is important to make this difference. Mitigation means reducing the impacts while adaptation aims not to declining the impacts or reduce a process (such as climate change). Instead of trying to reduce these consequences it aims to develop the right strategy in order to deal and adjust to these consequences. Adaptation is very important as the consequences already are far greater than the implemented adaptations. However implementing adaptations costs time, knowledge and has to be financed. This last sub-question is related to the former two because the assumption is that different adaptations depend on the level of awareness of farmers, on the type of consequences and the role of local organizations. Adaptation means sustaining in the type of livelihood by adjusting to the changes through addressing the underlying causes. Adaptation therefore is a long term solution. Adaptation depends on a lot of different factors. Adaptations are linked to types of adaptation strategies. They depend on finances, mobility, infrastructure, policies and knowledge.

Responses: in contrary to adaptation do not have to be sustainable or adaptive, also they do not have to be incorporated in a certain strategy. Responses are closely related to adaptation however when speaking about responses they do not imply that vulnerability of farmers is reduced. A response could mean commuting between rural and urban areas or out-migration but it is not an adaptation.

Coping behavior are reactions which lead to short term solutions they don't reduce vulnerability and they are not aimed to adjust to continuous threats or changes; they could mean the selling of livestock (using up assets and reserves), but in the long run it could be unsustainable and increase vulnerability. Coping strategies are often the same set of measures which have been in use before, indicating that coping strategies are not a long term solution. Next to the other concepts these three concepts; adaptation strategies, coping behavior and responses will be outlined in the course of this Thesis.

4.2 Research Methods and Techniques

4.2.1 Introduction

In this section the different sub-questions will be addressed on how and with which research methods they can be answered. Table 4.1 gives an overview of the different research methods to be used and the number 1 to 5 indicates one of the five sub-questions. Various research methods are being used for different sub-questions, this means that more than one research method will be used, by combining different methods the outcome will be stronger, thus making use of triangulation increases the reliability of the research.

4.2.2 Types of Data Collection

Various methods are used, mainly the use of questionnaires, semi-structured interviews and a priority ranking matrix and a rainfall matrix, in the latter respondents have to indicate negative and positive aspects of rainfall. Also has been made use of secondary data such as reports and local newspapers and meteorological data. In addition observation and participation have played a significant role in order to understand the processes in the selected areas and to get in contact with the respondents. Table 4.1 gives an overview of methods used sorted by sub question.

Table 4.1: Schematic overview of research methods

Research tool	Numbers refer to the specific research question			
Observation	1			4
Participation	1			
Participant Observation	1		3	4
Questionnaires	1	2	3	4
Semi- Structured Interviews		2	3	4
Secondary data research			3	
Participatory research tools		2		
Triangulation	1	2	3	4

4.2.3 Research methods defined by sub-question

Observation: Observation can be used to get a clear picture of the consequences and of the adaptations (sub- question 1 and 4).

Participation: participation is important, in that way as a researcher one can experience the daily activities, one can build on a closer relationship with farmers. By being a participant you will get data which will not easily be accessed through interview data. It is a form of reciprocity and it builds up trust and confidence.

Participant Observation: This is a combination of the former, and while participating it is important also to observe, but participation without observation is hardly possible. Participant observation can be used for collecting data among organizations (sub-question 4) and on different adaptations (sub-question 3) as well as on the first sub-question (1).

Questionnaires: Language has been proved a barrier however the use of a translator was a solution. The problem is that it is not possible to interpret the exact words or to be creative, one is limited in the way of asking questions. By making use of questionnaires not only farmers but also household members are involved in order to get various data on the consequences.

Semi-structured interviews are additionally important next to questionnaires as it is an effective research method to get more detailed data and to be flexible in the topics discussed. Data gathered is less structured however more in-depth.

Secondary data: Use has been made of local databases such as the Rampur meteorological institute and local newspapers and reports on both the irrigation systems. In the field this has proved to be an effective research tool. Information in PIS was already available through reports and available data. Making use of secondary data has been to a certain extend very important.

Participatory research: Use has been made of a priority ranking matrix and river- and rain web. By making use of these participatory tools it was possible to gather new insights on issues which would not that easily have been indicated by making use of questionnaires.

4.2.4 Research population

The research population consists out of 35 farmers on a total of 902 households in Tukucha Nala and 34 farmers on a total of 1612 households in the Panchakanya Irrigation System. Local organization involved in the research is the Nepal Engineering College.

To get access to the research population snowball sampling and convenience sampling have been used. And there has been made use of an existing sample framework in the Panchakanya Irrigation System through which it was possible to get a stratified sample of the population in the area. Therefore the informants are a representative sample of the total population of 1612 households. Through key informants it was also be possible to get access to more informants.

In cooperation with Utrecht University, Wageningen University the Netherlands and Nepal Engineering College the locations of Tukucha Nala and Panchakanya have been selected. These two areas have been selected because they are different from each other. Tukuche Nala is located in the Hills whereas Panchakanya is located in the Teraj. However both systems are mainly rain fed irrigation systems. And both systems are farmer managed irrigation systems. In order to select two locations research data can be compared and is more comprehensive. To select two areas from different regions it will be more interesting to analyze the different and similar outcomes as will become clear in the course of this thesis. Yet another reason is to have a frame of reference and to identify similar responses to possibly similar difficulties of changes in water availability.

5 Trends in rainfall and water availability

5.1 Introduction

Both rainfall and temperature are indicators of change with consequences for farmers' livelihoods, therefore in this chapter changes in rainfall and temperature derived and experienced by farmers in Tukuche and Panchakanya will be presented; changes which have direct effects on farmer's crop yields and way of growing crops. Changes are presented as 'mentioned' rather than as facts.

In this chapter changes in water availability through changes in rainfall (section 5.1) and temperature (section 5.3) are presented. As will become clear rainfall patterns are changing in winter, monsoon and also in quantity. Causes of these changes in rainfall and temperature as perceived by farmers are also incorporated and compared to meteorological data from the Department of Hydrology and Meteorology in section 5.2 and 5.4. Section 5.5 presents a priority ranking graph in which seven livelihood categories have been ranked by 64 farmers. Rainfall has been ranked second, which indicates the importance of rainfall in the daily lives of farmers. Section 5.6 presents the multiple uses of water in the farmer household; water in general is inevitable in the daily life.

The farmers (in total 69) are at the core of this research and therefore all changes, causes and consequences presented here are derived from the farmer's perspective and experiences.

5.2.1 Changes in rainfall

> *"Rainfall is less than ten years before, the rain used to fall also in February, March and April, but now the rain which used to fall in March falls in May. The rain used to be continuously and slow, now the rain is more heavy and comes at different times; the rain runs late."*[11]

There is an overall consensus among farmers from both Tukucha Nala Irrigation System (TIS) and Panchakanya Irrigation System (PIS) of a *decreasing rainfall trend* which can be seen in table 5.1. There are no differences between statements of farmers in TIS or statements made by farmers from PIS about rainfall characteristics, therefore there is no distinction made between the two regions. Practically every farmer would mention mostly even before rainfall was brought up that one of the main problems faced is water. Frequently heard changes in rainfall are that, rainfall is less than before, it has been decreasing, it comes at different times, the monsoon runs late and there´s a shorter monsoon period and rainfall used to be continues and slowly before while today it is heavy and short. Rainfall in winter has stopped to fall in the last five to six years and rainfall in spring is less and towards the future rainfall will continue to decrease affecting farmers' livelihoods.

The normal pattern in rainfall, when taking these changes into account is changing on every aspect; both in time, quantity and length the rainfall pattern is changing.
The next tables will illustrates these mentioned changes more specified. Main conclusion from table 5.1 is that out of the 69 respondents a majority of 84 percent states that rainfall is decreasing. This result is derived from interviews and questionnaires in which not directly is asked whether rainfall is decreasing or not, rather *how* current rainfall can be compared to rainfall over the past years. This is an important difference because the first question holds an assumption and is a closed question while the latter is an open question and holds in contrary not an assumption, therefore the remainder of sixteen percent did not particularly denied that rainfall is decreasing rather they didn't mention a decrease particularly.

[11] Mr. Sapkota, Panchakanya, May 5

Table 5.2 shows mentioned changes in rainfall during the monsoon, the majority of almost ninety percent indicates a shift in rainfall during monsoon, stating that the monsoon rain starts later and more particularly two third states that the monsoon starts later and ends earlier and shows less rainfall while the remaining 23 percent indicates that the total length of the monsoon is shorter which results in the ending of the monsoon to be earlier than normal.

Table 5.1 Mentioned changes in rainfall quantity

Changes in rainfall quantity		
Quantity	Number of farmers (69)	Percentage
Rainfall is decreasing	58	84%
Not mentioned	11	16%

(Source: Own)

Table 5.2 Mentioned monsoon changes in both regions

Changes in monsoon		
Monsoon type	Number of farmers (69)	Percentage
Starts later ends earlier and less rain	38	67%
Starts later ends later and less rain	13	23%
Monsoon unchanged	6	10%

(Source: Own)

Table 5.3: Mentioned winter rain changes in both regions

Changes in winter rain		
Winterrain type	Number of farmers (69)	Percentage
Absence of winterrain	50	72%
Not mentioned	19	28%

(Source: Own)

Another striking statement was that of winter rainfall which table 5.3 above shows; about three quarters of the people stated that winter rain has stopped to fall during the last years. Figure 5.1 shows the range of changes in rainfall and it becomes clear that rainfall according to the statements of the farmers is clearly changing. Of the 69 respondents statements are that rainfall is more heavy than before, rainfall runs late, rainfall is decreasing, rainfall is not continuous and comes in a different quantity and statements are that rainfall shows a changing pattern. Often multiple characteristics are included in one statement as becomes clear in the following quotes presented in box 5.1.

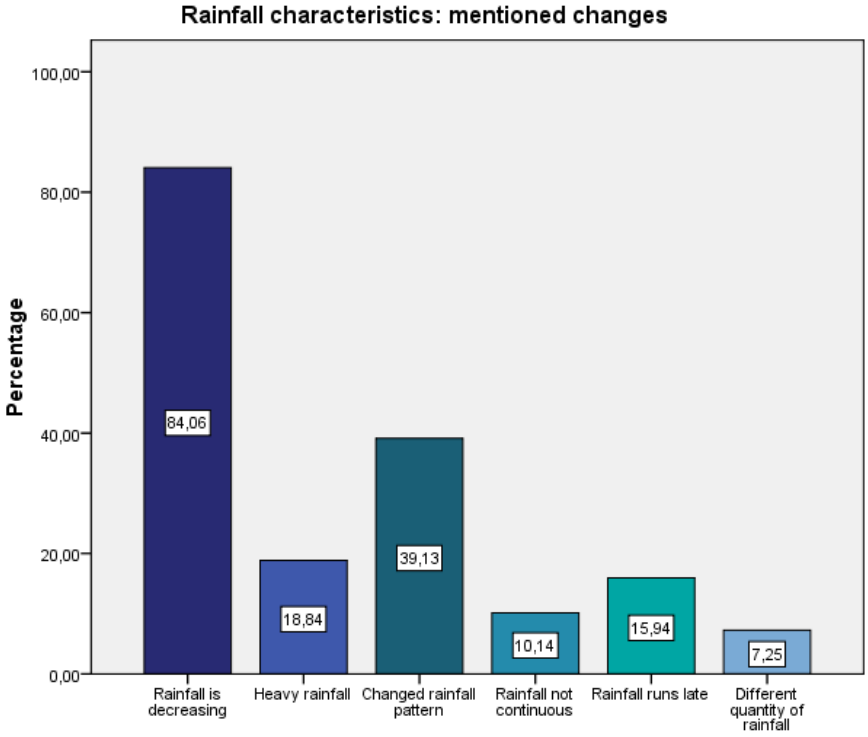


Figure 5.1: Total rainfall characteristics derived from 69 farmers in PIS and TIS

Box 5.1

Rainfall descriptions of farmers in Tukuche Nala

Difficulties with rainfall…

"The rain dimension has changed. There is an unnecessary power of rainfall. The problem is that the rainfall patterns are getting mixed up, in the rainy season it is dry and in the dry season there is rain, like now. It should not be raining. It's getting mixed up because of what I think is the climate change. In the rain season we grow rice, but when it is dry we have a problem. According to my opinion this has been a problem since three years, since 2007. But this is just my opinion."

- *Sunil, Tukuche Nala, March 31*

Unreliability of rainfall…

"The rainfall fluctuates when there should be rain in June it comes in August for example. Or the flood comes in August instead of July. The rainfall also changes in duration. The rainfall in the hill area is not continues but short and the intensity of the rain is high."

- *Gautam, Tukuche Nala, April 7*

Change in rainfall cause of climate change…

"Before it was good, the climate was mediate, now year by year it is decreasing. We get not only at different times rain, but also less days of rain. Before it used to rain now already for 15 days but nowadays like this year it has still not rained, it is dry. The quantity is different. The climate is changing. This is what I am experiencing from a child on; I am looking and see the difference. I was born here, now I am 28. The time period is different. We now sometimes even get ice drops instead of rain."

- *Kumar, Tukuche Nala, April 12*

Absence of rainfall…

"Now the river is just like this dusty road, the river is dry. The water in the river is very low. It is April, and there is almost no water in the river, but at this time of the year there should more water in the river."

- *Sanjeev, Tukuche Nala, April 12*

Statements of farmers sum up a lot of the difficulties or changes that farmers are facing today. Statements often indicate the high unreliability of rainfall, which in turn also has consequences for crop growing. Farmers are experiencing these changes as they live in the

area often for long periods of time. Due to absence of rain the river in Tukuche is also affected, the river downstream is completely dried out; it looks more like a dusty road indeed. As will be presented in the following section are the mentioned causes of these changes in rainfall.

5.2.2 Causes of change in rainfall

> *"The cause of change in rainfall is increased pollution and population increase which by itself increases pollution. It may be global warming that is only my opinion. This is caused by industrialization, vehicles and pollution."*[12]

The next chart (figure 5.2) shows the causes of the change in rainfall as perceived by the respondents. Besides climate change, which 36 percent of the 69 respondents mentioned, causes as perceived by farmers are the problem of population growth, pollution, combined with deforestation and temperature increase. A consequence of population growth is that water availability is decreasing due to increased water use. Pollution more specifically environmental pollution is an often heard cause. Pollution is both a consequence of deforestation and population growth as a cause of the changes in rainfall. Farmers mentioned temperature increase as a cause of changes in rainfall on the other hand changes in rainfall have also been mentioned as the cause of increase in temperature.

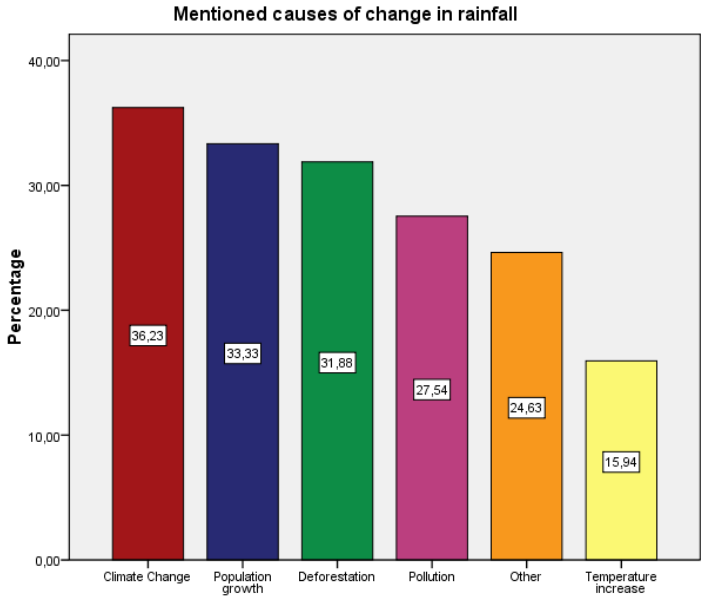


Figure 5.2: Causes of change in rainfall (TIS & PIS)

[12] April 11, Nabin, TIS

5.3 Increase in temperature

Besides rainfall as an indicator of change also change in temperature has often been mentioned. Therefore it is important to take this indicator into account. Increase in temperature affects in several ways the livelihood of farmers as will become clear later on.

In table 5.4 it becomes clear that the majority of the 69 respondents 93 percent indicated that temperatures are increasing, in addition more specifically about half of the respondents mentioned temperature to be increasing in the winter while an additional fifteen percent defined it as a changing pattern in the weather. It should be noted here once more that these results are derived from open questions, therefore it should not be concluded that the other half did not agree on increasing winter temperatures rather that they simply not mentioned it. Thus it should be understood that 93 percent indicated a temperature increase when responding to the question formulated as: "how is the weather compared to twenty years before".

Box 5.2
Farmers experience temperatures to be increasing

Before it was not hot, we had a mediate climate like 25 degrees now I am already feeling like 28 degrees. It is getting hotter and at the same time during the winter it is getting colder. I can remember as a child we only had two times of snow, now just somewhere last year we had two feet of snow, that is something we are not used to. That kind of snow made the trees fell down. People tell me that the climate is changing when I tell them about these changes. We see the changes as we live here. There is now a limitation of rain; I can feel the climate is changing. Nowadays it gets more hot in the summertime and more cold in the winter. At the same time we have too much water during the rainy season and for longer periods too less now in the dry season. Like here for instance they try to grow maize, they are waiting for the rain to come. But if it will be late, the potato will also run late and that will be a problem. Maize is only for the animal, potato is the main crop we grow and can make the most benefit from.

- *Kumar, Tukuche, April 12*

"Now temperatures should be around 27-29 degrees whilst temperatures topping the 37-39 degrees. And in summer it reaches 42-43 degrees."

- *Mr Bishnu Hari, Panchakanya, April17*

Table 5.4: Mentioned changes in temperature pattern in both regions

Changes in temperature		
Temperature change	Number of farmers (69)	Percentage
Temperature increase	64	93
Winter temperature increase	32	46
Changed weather pattern	12	18
Winter colder	4	6

(Source: Own)

Box 5.2 gives insight in how changes in the weather are experienced in the daily life and how these changes came about over the past decades.
These examples shows how these farmers can actually observe the changes and how they are causing consequences for crop growing, the first respondent defines that he feels the climate is changing.

Temperatures are increasing above normal records, both in summer and in winter according to the statements. Other claims are that it is 'less cold and the winter is shorter'[13], and 'it is more hot, there is less rainfall, less winter and consequently more summer'[14]. One

[13] April 28 Ms. Chandrika, Panchakanya
[14] May 3, Ms. Mandjika, Panchakanya

respondent explains how she worries about the future and that the temperature has increased in every season[15]. This is what a senior farmer from Panchakanya Mr. Adhikari explains when asked about the weather compared to fifty years before;

Figure 5.3: Blank maize fields waiting for rain to grow (Tukuche) (source: own)

"At the time we had different methods of crop growing. We used animal dung. Today the temperature has increased and there is less rainfall. Since two to three year does the temperature increase rapidly. Since four to five years the rainfall has decreased."[16]

Besides temperature increase also Mr. Adhikari mentions the temperature to be increasing more rapidly, which in itself is an interesting statement and common explanations have been made about increasingly rapid changes in rainfall. In chapter 8, arguments supporting the use of animal dung instead of chemical fertilizers will be discussed.

5.4 Farmers' experiences compared to meteorological data

'So far, year 2010 is warmest ever recorded in history'[17]

According to the farmers temperatures are increasing, these statements seem accurate. According to the America Climate Agency Report of the National Oceanic and Atmospheric Administration globally the year 2010 is turning out to be the warmest ever recorded in history. The first four months reports 13.3 degrees centigrade which is 0.69 degrees above the 20th century average, with April 2010 making the warmest month ever. For January until September 2010 the global temperature (combined with land and ocean surface) was 0.65 degrees above the 20th century average of 14.1 degrees. Pakistan has recorded the highest temperature ever recorded in Asia on May 26th with 53.5 degrees centigrade (Pakistani Meteorological Department 2010)[18]. According to the NASA the 12-month mean global temperature has reached a new record in 2010 which is despite recent minimum solar irradiance. According to James Hansen from NASA; "Temperatures have continued to rise in the past decade and there has been no reduction in the global warming trend of 0.15-0.20 degrees that began in the late 1970s" (Hansen et. al. 2010). According to Kumar Saraju Baidya, meteorologist at the Department of Hydrology and Meteorology (DHM) temperatures are two to three degrees above average for this time of the year in Nepal; "extreme weather conditions such as drought and rainfall are becoming rampant, and the impact of climate change is being felt across the country." Kathmandu Valley recorded this year the hottest day in the month of March since 1968 with 33 degrees centigrade, in addition two other meteorological stations also recorded the hottest day of the month in March 2010. As has been presented in section 5.2.1, almost 75 percent of farmers indicated that winter rainfall has

[15] May 3, Mss. Mona, Panchakanya
[16] May 5, Mr. Binod-Adhikari, Panchakanya
[17] National Oceanic and Atmospheric Administration (2010)
[18] According to projections of James Hansen (NASA) the year 2012 would even face higher global temperature records in combination with increased magnitude of extreme events such as extreme rainfall and droughts.

become absent in the last years (table 5.3), according to DHM meteorological data of the last thirty years show that winter rainfall has been decreasing since 1990 and that extreme drought conditions during winter have become more rampant after 1990. Also the following DHM data shows close similarity with the farmer's statements; apart from the driest winter ever recorded in 1992, Nepal experienced extremely dry winters in 2006, 2008, 2009 and 2010 (DHM 2010). Normal winter rain has not been received in the recent last years.

5.5 Priority ranking of livelihood categories

In total 64 respondents have been asked to rank seven livelihood categories in order of importance according to their perspective, with a scale from 1 to 7 being 1 the highest priority. These categories when they are ranked tell something about the value of farmers given to the respective categories (see annex 2 for priority ranking table). The categories indicate how respondents value for instance having a 'nice house' or 'family and friends', or how they value their own health in comparison to other categories such as 'rainfall' or 'making money', 'livestock' or 'land size'. By making these choices, one has to think about the categories and one has to argue why a certain category is more important than the other. For instance making money can be argued as being important but this category is a goal in itself while the means by reaching that goal could be realized by having livestock, having big amount of land (land size) or one can argue more importantly the necessity of having rainfall. Thus by weighing these categories one has to think of the individual meaning of each.

The ranked categories give an interesting insight in how farmers value these aspects which make up important parts of their livelihood. A farmer explained the importance of rain; to have land you have to have rainfall in order to grow crops. It is only after that, that you can start earning income and have a nice house.[19] Additionally there was a last category 'other' which could be labeled by one's own preference; therefore unforeseen issues could also be taken into account. Electricity has often been mentioned because during the dry season when there are long periods with absence of rain there are huge electricity cuts.

It becomes clear how rainfall is prioritized highly when ranking these seven categories and that tells something about the importance of rain and it also tells something about how farmers value the other categories in relation to each other. Other often filled in labels in the category 'other' are infrastructure, drinking water and education.

Figure 5.4 shows how each category has been valued after all ranks have been combined. What can be concluded here is that 'health' comes in first and that 'family and friends' shows a more dense variety in the ranking scale and 'rainfall' has been valued as the third most important aspect, while earning money comes in second last before livestock.

[19] April 10, Manos, TIS

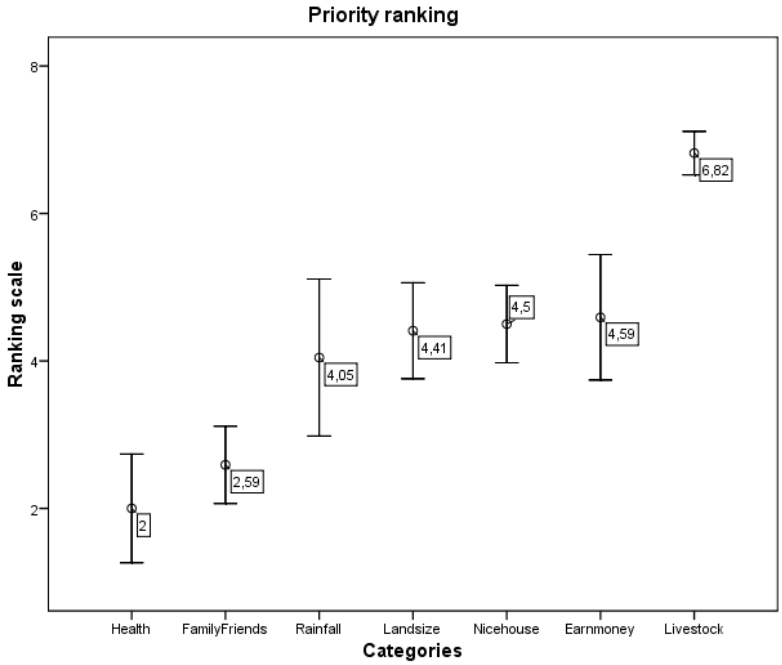


Figure 5.4: Priority ranking of livelihood categories (Source: Own)

5.6 Multiple water use

What is the importance of rainfall; the importance of having a sufficient availability of water? Water is vital, as it is used in so many ways in order to sustain in one's livelihood. Farmers indicated various ways in using water as it is shown in table 5.5.

Table 5.5: Types of water use

Various types of water use					
Household use		**Agricultural use**	**Individual use**	**Other use**	
Cloth washing	Cleaning of the house	Crop growing	Drinking water	To produce electricity	Religious use
Cooking		Livestock	To wash yourself	House construction	Clean environment

(Source: Own)

In this overview it becomes clear in how many ways water is used and why it is that water is highly valued. Water is used to wash cloth, water is used to clean food and to prepare food, and water is used for cleaning the house, for cleaning your own body and also as drinking water and a necessity in agriculture. But water is also important from a religious perspective and water is used in hydropower stations to produce electricity, water is used to make bricks and to make houses and when there is rainfall farmers explain; 'the water cleans the air and there are less diseases and respiratory problems and there is less air pollution'. Water ultimately is vital and plays a central role in the livelihood of farmers. However there are also backsides of rainfall as will be shown in the next section in which the consequences of the changes in the weather; in rainfall and temperature are presented.

5.7 Conclusion

The two main climate related indicators of change influencing farmer's livelihoods are changing rainfall patterns and increase in temperature. According to the farmers rainfall is changing in intensity, variability, and in time. Rainfall is decreasing and is becoming less reliable. Especially during the past winters rain has decreased significantly. There also seems to be a shift in the monsoon period; rainfall start later and ends earlier. Farmers have indicated difficulties in crop growing related to the changes in rainfall.

Causes of change in rainfall are various and not solely derived from experiences. Causes according to farmers are climate change, population growth, deforestation and pollution and last temperature increase. These issues will be discussed upon later on in this thesis.

Temperatures are increasing both in winter and in summer, and they are increasing more rapidly than before. Temperature increase has also been perceived as a cause of decreasing and changing rainfall patterns. The presented changes are in line with DHM data presented in section 5.4 and the statements made by Mr. Baidya from the Department of Hydrology and Meteorology (DHM) are strikingly similar to those made by the farmers.

In line with the presented changes in weather conditions, farmers value rainfall high in the priority ranking index. Out of seven categories rainfall is ranked second by farmers in terms of importance for their livelihood. This finding confirms the extended meaning rainfall has for farmers. Water is highly valued and is vital for farmer's livelihoods. The change in water availability has far reaching consequences as a result which will be the main subject of the next chapter.

Intermezzo I: Photographic impression of fieldwork

Picture 1: Discussing water problems (TIS)

Picture 2: Road leading from Tukuche to the village of Nala

Picture 3: Fields & Livestock in the Hills of Tukucha Nala

Picture 4: Traditional farming tools (daily in use)

Picture 5: Playing cricket on the public road during strike (PIS)

Picture 6: Doing research (at the bench) TIS

Picture 7: Brick oven (TIS)

Picture 8: Construction work an off farm actitivity (TIS)

Picture 9: Traditional Newar house: Maize and reed to dry

Picture 10: My guesthouse in Tukucha Nala (most right)

Picture 11: Panorama view of TIS fields and river

6. Effects of changing water availability for farmer's livelihoods

6.1 Introduction

> *"Now I grow different crops than before and I grow crops at different times. If we have less rainfall I have less crop production as a consequence."*[20]

In this chapter the effects of the changes in rainfall for the farmer's livelihoods are presented. Also major problems with crop growing are presented. Section 6.2 presents problems related with crop growing; it will become clear that among these problems one of the core problems is water shortage. Other related problems are; the use of fertilizer, technology and irrigation. Indirectly these problems can be linked to the shortage of water which is a cause of the changing precipitation pattern. Section 6.3 presents more specific water related problems; here it becomes clear that the irrigation system fulfills an important role. A consequence of an increasing population and an increasing number of water users in Panchakanya Irrigation System (PIS) is that water discharge is at a minimum level. Therefore it challenges the efficiency of the system as becomes clear in the section 6.4 on water discharge. Section 6.5 deals with the causes of the presented problems with crop growing. Section 6.6 presents a perspective of farmers on their future.

6.2 Problems with crop growing

In this section the major problems with crop growing are presented. The three major problems mentioned are first of all the problem with water, secondly the problem with the use of fertilizer, thirdly the problem is the absence of technology according to farmers. The problem with fertilizer use is one of which the Ministry of Agriculture and Cooperatives is developing policies on ever since the 1970s; current problems are the usage of disproportionate nitrogenous fertilizers, due to the low price and ignorance about balanced use this results in increased soil acidity and deterioration of the soil and excessive use causes deterioration of underground water quality additionally excessive use leads to increased emission of nitrous oxide one of the major gasses contributing to global warming leading to climate change (Shrestha 2010: 126-127). Thus fertilizer use can be understood as a huge issue in agriculture. According to farmers fertilizer is often not appropriately
used; it is not used according the WHO recommendations in terms of using the right fertilizer and the right amount. Most often too much fertilizer is used causing problems with soil fertility and causing

Box 6.1
Soil fertility

Poor land management is one of the causes that has led to increased water problems. Deforestation has increased surface runoff and decreased groundwater replacement. Improving water management practices is vital in sustaining the food production. Soil erosion, degradation and declining soil fertility are according to ICIMOD widely recognized major problems.

- ICIMOD (2004) Demonstration & Training Centre Godavari

[20] Mr. Bishnu Maya (PIS), May 5

health problems, chemicals are not used appropriate and different chemicals (fertilizers) are used on the same land, too much and too soon causing a degradation of the soil (see also Box 6.1).[21]

The other major problem is that of a scarce water resource, which is due to a decreasing water discharge in PIS and which is due to a decreasing groundwater level in Tukuche Irrigation System (TIS) and third as a direct consequence of a decreasing and changing rainfall pattern. In PIS due to a resettlement program of a community to Sagun Tole upstream of the river next to the spring source of the system the same amount of water has to be shared with an increased amount of water users. A consequence is that the efficiency of water discharge is increasingly challenged and water users at the tail end receive less water compared to water users closely located at the source in the head of the system (see also table 2.2 in Chapter 2). As they are resettled in Sagun Tole next to the spring source of PIS they are pumping groundwater causing the groundwater level to decrease. As a consequence in PIS water discharge has decreased to only around 300 liters per second (l/ps.) in the dry season and as low as around 1200 l/ps. during monsoon season. In addition as a consequence of decreasing precipitation both PIS and the upstream community of Sagun Tole become more dependent on the spring source causing an increase in this type of water use resulting in more water stress. This dynamic is especially negatively effecting farmers at the tail end of the system. Next to decreasing rainfall and seepage, water discharge is increasingly put under pressure due to water what is being abstracted at the source of the system.

TIS is even more dependent on rainfall and a decreasing and changing rainfall pattern has consequences for crop growing in both systems. Another generally heard cause of a decreasing water resource is population increase (see also figure 5.2). As seen in table 6.1; the population of Chitwan in which PIS is located has increased much more rapidly compared to the country as a whole; between 1961 and 1971 the population increased with 167 percent in Chitwan compared to a national population growth rate of 22,3 percent. These numbers validate the statements that population growth puts increased pressure on water availability.

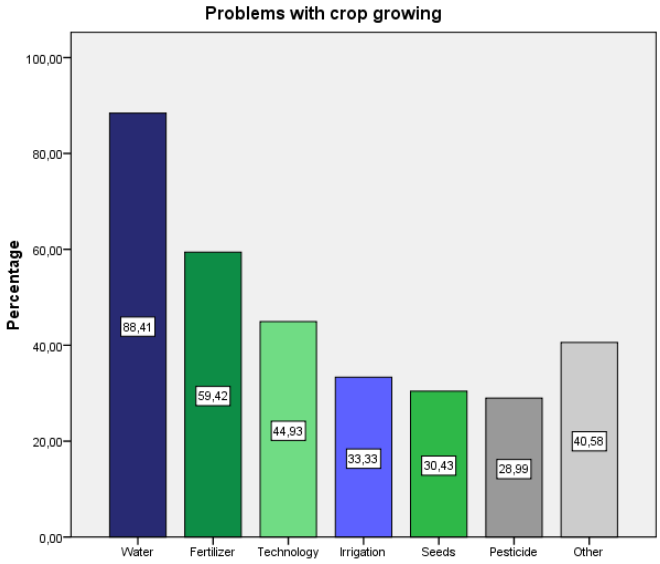


Figure 6.1: Problems with crop growing in PIS & TIS

[21] Chairman of WUA, Tukuche Nala, March 30

Table 6.1: Population growth - Nepal vs. Chitwan District, 1961-2001

Year	Nepal (million)	% increase	Chitwan (thousand)	% increase
1961	9,4	-	69	-
1971	11,5	22,3	184	167
1981	15,5	34,7	259	41
1991	18,5	19,3	355	37
2001	23,1	24,8	470	32

(Source: Adhikari 2002)

The difficulty with irrigation is that there is no good infrastructure and water discharge is too little, which is a consequence of decreasing rainfall. The problem of the soil is that of the traditional cropping patterns; new technology is not used.[22] An often heard statement is that there is not the right knowledge and as one of the consequences that fertilizer is not used appropriate.[23] Another consequence is the changing cropping pattern due to changing weather conditions which will be presented in the next section. As can be seen in figure 6.1 on page 60, major problems with crop growing are water, irrigation, technology, fertilizer and the use of seeds. Among 69 respondents almost ninety percent indicated water to be a major problem, followed by fertilizer and technology.

6.3 Water related problems

Table 6.2 presents specific water related problems. As has been presented in figure 6.1 practically every farmer would mention the problem of water as one of the biggest issues in farming. The biggest issue with water is the low water resource due to less rainfall, or due to the irrigation system or due to decreasing groundwater levels. Often mentioned is the lacking quality of the irrigation system (33 percent) and the changing rainfall pattern (40 percent). These issues are related; once precipitation is low, groundwater use will increase in the form of water pumping and the irrigation system will become more important; as a consequence, farmers will become more dependent on irrigation whilst the system in times of a decreasing water resource itself will be increasingly stressed to perform according to the risen need for irrigation. This issue will be elaborated on further in the next section on water discharge in PIS.

Table 6.2: Water related problems in PIS & TIS

Problem	Number of farmers	Percentage
Low water resource	38	55
Change in rainfall pattern	28	41
Quality of irrigation	23	33

(Source: Own)

[22] Berendra, Tukuche Nala, April 10
[23] Gautam, Tukuche Nala, April 7

6.4 Water discharge in an increasing water competing context in PIS

Figure 6.2 shows actual water discharge in PIS and as can be seen here is that during the rainy season water discharge is 'high' around 1200 l/ps. whilst during the dry season water discharge reaches a minimum varying around 300 to 600 l/ps. Figure 6.3 shows the increasing number of PIS members who are water users. Between 1998 and 2010 the number of members has increased from 766 to 1612 members. This is an increase in twelve years of more than hundred percent. Total land area (figure 6.4) has increased from three hundred hectares in 1998 to 390 hectare in 2008 which is an increase of a quarter of total area. Comparing these figures it shows an increasing number of water users and land area in contrary to a stabilized level of water discharge. As a consequence there is less water available for each individual water user. Water stress is increasing and the performance of the system becomes under pressure. This could explain very well the high claim of respondents (especially at the tail and of the system) that the quality of irrigation is lacking. Furthermore the irrigation system suffers from seepage with water shortage as a consequence.

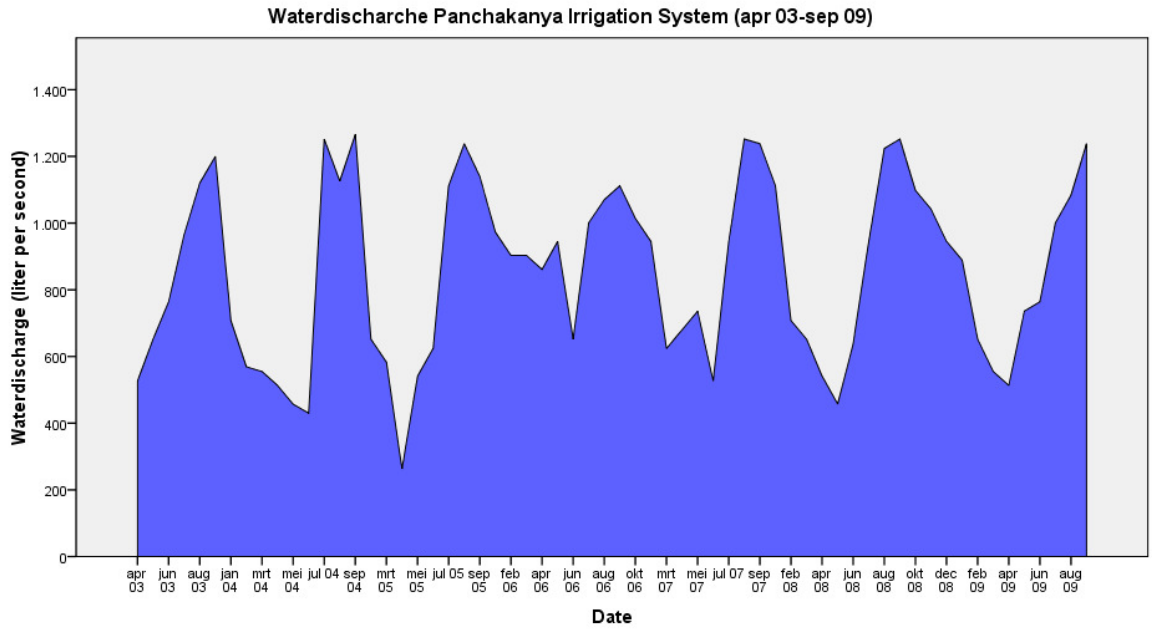


Figure 6.2: Water discharge in PIS (April 2003-September 2009) (Source: Neupane 2005)

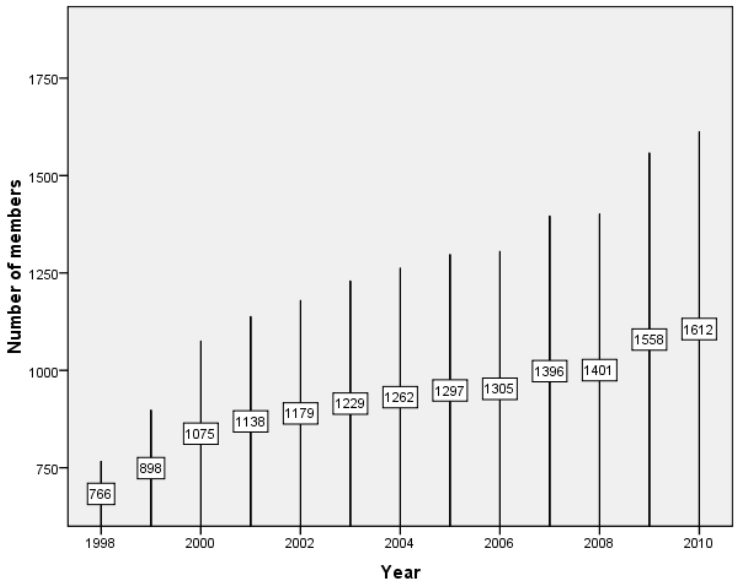


Figure 6.3: PIS amounts of members (1998-2008) (Source: WUA 2010)

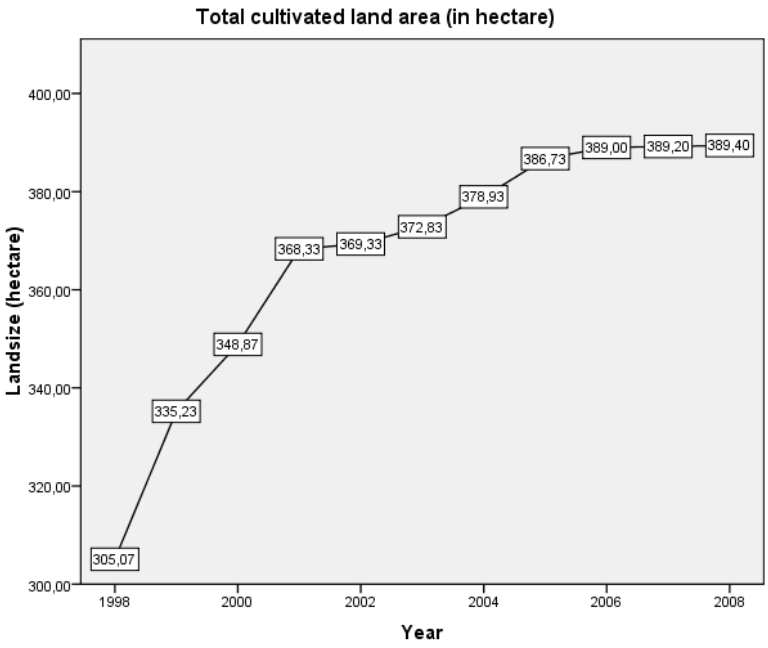


Figure 6.4: Total cultivated land area in PIS (1998-2008) (Source: WUA 2010)

6.5 Causes of problems with crop growing

In this section the causes of problems with crop growing are presented. The biggest problem with crop growing has been indicated as the decreasing precipitation level with fifty percent, followed by a low river level, the use of chemical fertilizer, the lack of knowledge or adaptation and overpopulation (figure 6.6). Comparing figure 6.1 in section 6.1, which presents problems with crop growing, with figure 6.6, which presents the causes of these problems, it becomes clear that the figures show some similarities. Both rainfall, less water, fertilizer and chemical fertilizer are presented in figure 6.1 as a problem and in figure 6.6 as a cause. This is due to the fact that the mentioned causes can also be perceived as a problem itself; less rainfall is defined as a problem and also as a cause of problems with crop growing. Likewise this is the case for fertilizer; it is perceived as a problem as a product and as a cause of the problem of decreasing soil fertility and related health problems.

Figure 6.5: Early but heavy rainfall changes pathways into rivers (TIS) (Source: Own)

Rainfall as presented in chapter 5 is becoming less reliable; the irregularity of rainfall is increasing causing problems with the cropping calendar, causing longer periods of drought and periods with higher intensity of rainfall. Early May 2010 East Chitwan in which PIS is located received a few days of heavy rainfall leaving the fields with an overload of water resulting in a loss of both maize and tomato crops.[24] Figure 6.5 shows how in a matter of hours, intense and early rainfall transforms the unpaved sand roads in Tukuche into river flows of water; the roads become hardly accessible, which is also due to the poorly constructed roads.[25] The dam in Tukuche has been destroyed by a flood several times in the past as it is not concrete.[26] In Tukuche the river level has been decreasing every year; during the dry season the river looks similar to the dusty roads, farmers indicated to have less water to pump out of the river to grow their crops.[27] The spring source in Panchakanya is being used by the community of Sagun Tole and serves the irrigation system in Panchakanya, both groundwater pumping out of the spring source and decreasing rainfall leads to a lower river level in PIS affecting the system. The use of chemical fertilizer causes problems with soil fertility and respiratory and skin problems for the users. Mentioned problems due to the absence of rainfall and increasing temperature and use of chemical fertilizer are increased diarrhea, fever and

[24] Mr Devkota, Chandrika, Observation, May 3, Panchakanya
[25] Observation, Tukuche, April 2010, Respondent, TIS, April 12
[26] Sanjeev, April 15, TIS
[27] Kathri, April 14, TIS

skin infections and increased difficulties with mosquitoes causing malaria.[28] Farmers indicate to suffer from increased heat and presence of mosquitoes.[29] The lack of adaptation is an issue which will be elaborated on more thoroughly in the next two chapters; farmers indicated that they do not have the right knowledge and technologies to adapt. Rapid population growth leads in Tukuche to the transformation of arable land to land for housing construction. Moreover it has been defined as a cause of air pollution, industrialization, deforestation, global warming and ultimately less rainfall which has been argued in chapter 5. In both Tukuche and Panchakanya deforestation has been defined as a big issue leading to water scarcity and landslides, deforestation has been defined as a cause of increased urbanization and industrialization.[30]

A consequence of less rainfall is longer periods of drought and a consequence of more heavy rainfall is too much rain in a short period of time. Both too less and too much rain can cause problems; with both direct and indirect consequences for crop growing (see also box 6.2). When there is too much rain, floods can occur, destroying the arable land (which is a direct consequence for crop growing) and destroying the roads or leave them in bad condition, which hinders transportation (which is an indirect consequence for crop growing), see figure 6.5. Due to landslides damage can be done also to houses as they are poorly constructed which has been the case in Tukuche; in 2009 the main road was damaged by heavy landslides and both fields and houses in Tukuche have been damaged by landslides.[31]

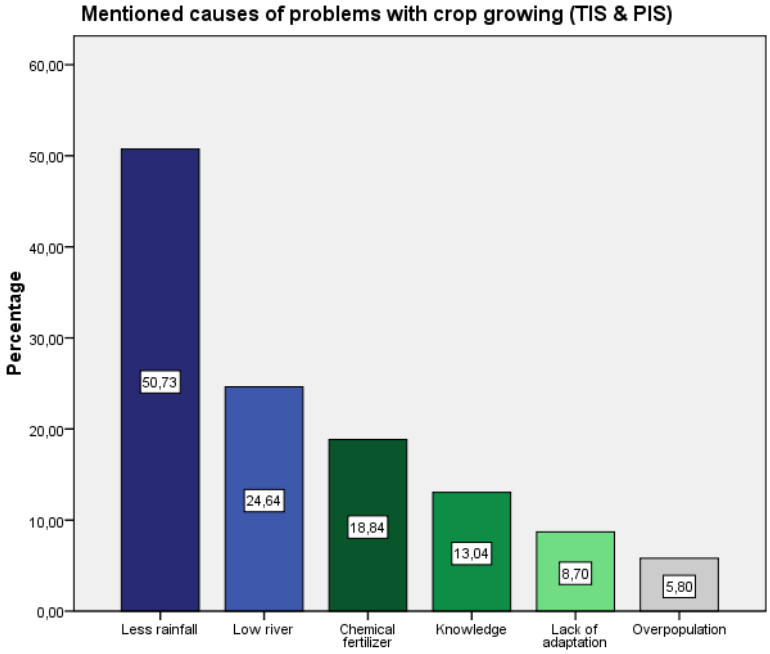


Figure 6.6: Mentioned causes of problems with crop growing (Source: Own)

[28] Bhisnu, May 5, PIS, Mohato, May 6, PIS, Chandrika, May 3, PIS, Mandjika April 28, PIS, Mohato, April 29, PIS
[29] Sukaram, May 6, PIS, Govinda, April 28, PIS
[30] Sri Krishna, May 5, PIS, Mr Devkota, May 9, PIS, Chandrika May 3, PIS, Focusgroup, April 11, TIS, Kumar, April 12, TIS
[31] Khatri, April 15, TIS, Rajan, March 30, PIS

Box 6.2

Drought hits cardamom farmers

Due to long drought farmers in the eastern hills have been hit. Due to lack of rain growing of cardamom is badly affected. A farmer of Basantapur has started destroying his cardamom in order to plant other crops as the saplings had dried-up. Another farmer used to earn Rs 40.000 annually however this season all has turned arid. Increasing problems of pests and droughts have pushed farmers to start growing other crops.

- *Katmandu Post, April 19*

Irregular monsoon proves the cause to price increase

Various prices of crops have continued to increase following up last year. Mansuli rice has reached to Rs 32 per kg an increase of 6,25 percent within a month, mustard oil has increased by 24 percent in the last month while ghee has increased by 62 percent according to the department of commerce. In 2009 (mansuli) rice and mustard oil have reached record high prices of 49,42 Rs per kg and Rs 150 per liter. Long drought and irregular monsoon are cause to an increase of sixty percent in the price of vegetables such as potato.

- *Himalayan Times, April 23*

6.6 Future prospects in farming

In this section the future prospects of farmers are presented. The majority of farmers are pessimistic for several reasons. Some are optimistic about technology development and development of fertilizer and seeds. However the majority of farmers are worrying about the future when it comes to water availability. The chart of future prospects (figure 6.7) shows that two thirds of the 69 farmers estimated that rainfall will continue to decrease, when looking at the second biggest concern it shows that 55 percent estimates a decrease in crop yields, which farmers link to decreasing rainfall (see box 6.3). Generally farmers stated that mentioned difficulties will increase whilst some are optimistic about the use of new fertilizer in the future.

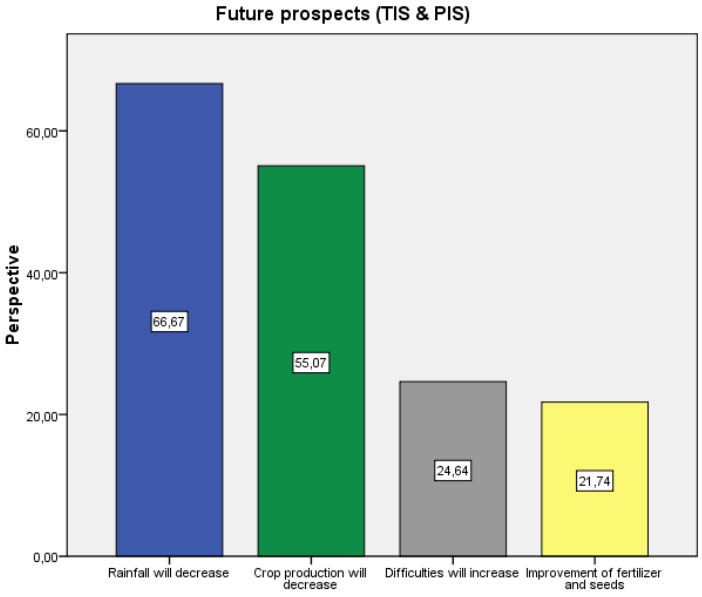


Figure 6.7: Future prospects of farmers in TIS & PIS (Source: Own)

Box 6.3
Future prospects of farmers

"There will be less crops and increased deforestation also the rainfall will be less in the future"
- *Binod, April 11, TIS*

"I am concerned that I will have less production because in the future rainfall will be less; I worry how to feed my children."
- *Mohato, May 6, PIS*

"I don't see a nice future for farmers because the production will be less thus the opportunities will be less."
- *Mona, May 3, PIS*

"I don't think the rain is coming back, this causes a problem for crops that depend on rainfall, who in turn become dependent on irrigation, because of lack of water the irrigation system will degrade in the future and due to the use of chemical fertilizer crop production and soil will degrade by probably 40 percent."
- *Budhan, April 29, PIS*

"I see a bright future because there will be nice fertilizer and hybrid seeds, but the water supply needs to be managed."
- *Adhikari, May 5, PIS*

6.7 Conclusion

In this chapter the major problems with crop growing and their causes have been presented. Problems in both systems are related to water and the use of fertilizer, technology and irrigation. Fertilizer causes the fertility of the soil the degrade as it is often not used appropriate and in PIS water users are facing challenges with decreasing water discharge as a consequence of increased number of water users both in and outside the system and due to a decreasing rainfall pattern. Chitwan in which Panchakanya is located has experienced a major population increase with consequences for water availability as well. More specific water related issues are the increasing irregularity of rainfall which results in less reliable rainfall and the performance and efficiency of the irrigation system both in Tukucha and Panchakanya. Equal distribution of water becomes more important when water discharge is low, while water discharge efficiency actually decreases from main canal to field channel (table 6.3). Tukucha faced landslides that destructed houses, crops and pathways in 2009. Moreover causes of difficulties with crop growing is the decreasing water resource in the form of rainfall and river level, also the use of fertilizer, the lack of knowledge and adaptation have consequences. Farmers in both systems indicated not to be optimistic about the future perspectives on farming; rainfall will continue to decrease and cropping yields will continue to decrease. Farmers are dealing with increasingly difficult circumstances, the next chapter elaborates on how farmers in Tukucha and Panchakanya react to these processes in terms of adapting, coping or responding to the changing environmental circumstances.

7. Adaptation strategies, coping responses and off farm activities

7.1 Introduction

This chapter has the focus on adaptation. The main question leading this chapter is to define adaptation strategies as a reaction to the changing weather conditions, which have consequences for farmers their livelihoods. Which adaptations can be distinguished, what is coping behavior and what are reactions, such as turning to off farm activities.

Adaptation will be approached in the broadest definition of the concept. Besides adaptation- or planned adaptation strategies, as mentioned in the introduction, also responses in order to cope with changing conditions are included. Adaptation as an NGO- or government-led intervention is currently just a minimal part of what can be included on this issue, because planned adaptation was not specifically found at both research locations it was necessary to broaden the concept. In the following sections it will become clear in which ways farmers are responding, coping and adapting to the changing circumstances.

As can be read in section 7.2 an adaptation to less rainfall is that farmers have to start growing different crops; not only the rain has become less reliable also the cropping calendar and the cropping pattern itself has been changing as a result. Section 7.3 elaborates on coping responses to decreasing water availability. Using of water pumps is a coping strategy and is in fact not a solution but a shift of the problem and therefore a coping response on the short term rather than an adaptation strategy on the long term. Section 7.4 will present the case on the recently started brick making activities during the dry season in Tukuche. The changing weather conditions and the degrading soil fertility downstream are the consequence of less available water and these off-farm activities could be understand as a response to these changes.

A seemingly increasing number of members of the family household are working abroad. It could be argued that difficulties in farming whether or not directly related to changing precipitation are one of the push factors moving farmers to off-farm activities locally or by working an extended period abroad. It appears that in a significant amount of cases the main income of farmers can actually be found in farming but in off farm activities. In most cases farmers have multiple types of revenue and farmers are involved in multiple types of income generating activities next to their farming activities. As is presented in section 7.5; this could mean having a shop or being a driver or running a cyber café, but it does also include being abroad for several months to fulfill a job in construction or seasonally work at a hotel in Dubai, India or Saudi Arabia. Section 7.6 elaborates on the meaning and influence of these activities for the household and whether there is any link to be found between housing type and working abroad and main income. However one has to bear in mind that the linkages found are embedded in a bigger process in which the dynamic context is changing the activities of these farmers. Certainly there are more factors driving farmers towards off farm activities locally and abroad, it is apparent that this rural-urban linkage does exist, is strengthening indeed and in constant motion (UN 2005).

7.2 Adaptation to changing rainfall patterns

A lower water resource due to less precipitation has several consequences for crop growing. When rain falls at different times and in different amounts the reliability of rainfall lowers which in turn affects the cropping calendar as it depends on a reliable rainfall pattern. Farmers in both systems have stated to grow a bigger variety in crops as a consequence and that crops are grown at different times (two to three weeks later) as before due to a gradually shifting cropping calendar. The cropping calendar refers to the specific planting and sewing dates of the different crops (Shrestha et. al. 2007).[32] Farmers in Tukuche stated that they grew

[32] The FAO gives the next comprehensive description about the cropping calendar: “The crop calendar provides information about sowing and planting seasons and agronomic practices of the crops grown by farmers in a

only wheat and rice until fifteen years ago while today they grow potato which has become the main crop and more often they grow maize instead of rice because maize and potato are less water demanding crops. In Tukuche they grow two times potato and one time rice (during monsoon), which is different from Panchakanya where the main crop is paddy which is grown two times; during spring and monsoon. Tukuche is more dependent on rainfall and has a less advanced irrigation system compared to Panchakanya which can explain this difference.

Due to less precipitation it becomes more difficult to grow water dependent crops such as paddy. In order to adapt to these changing conditions farmers in both systems have stated to grow less water dependent crops and additionally to grow a higher variety of crops in order to reduce the risk of a crop failure. These responses are adaptation strategies; farmers sustain their crop yields by adjusting to the changing context.

Table 7.1 shows the change in crops for both systems as a consequence of less precipitation; 60 percent stated that they grow more diverse crops of which is 54 and 67 percent of farmers in TIS and PIS respectively. In total 40 percent stated that the cropping calendar has changed, which is 48 and 29 percent of farmers in TIS and PIS respectively. This difference can be explained by the fact that farmers in Tukucha are more dependent on rainfall where farmers in Panchakanya can more rely on the irrigation system. In total 30 percent stated to grow less water dependent crops, which is 28 and 32 percent of farmers in TIS and PIS respectively. And 23 percent claims not to have changed their type of crops (however the use of fertilizer of the latter 23 percent did have changed). Table 7.2a shows the cropping pattern in PIS as determined by the Water User Association (WUA) (see also Box 7.1). In this table it becomes clear that summer paddy is the biggest grown crop, smaller crops grown are maize and wheat. Table 7.2b shows the cropping pattern for TIS before and after irrigation was installed.

Table 7.1: Change in cropping pattern in PIS & TIS

Change in crop growing						
Adaptation strategy	TIS (n.u.f.)	Perc. %	PIS (n.u.f.)	Perc. %	Total number of farmers	Percentage %
More diverse crops	19	54	23	67	42	61
Change in cropping calendar	17	48	10	29	27	39
Less water dependent crops	10	28	11	32	21	31
No change	7	20	9	26	16	23

(Percentages are not exclusive) (Source: Own)

Table 7.2a: Cropping pattern in PIS

Crop type	Summer paddy	Wheat	Maize	Spring paddy	Oilseed	Total crop area
Area (hectare)	400	180	50	250	250	1130

(Source: Neupane 2005)

particular agro-ecological zone. It is a tool developed to assist farmers, extension workers, civil society and the private sector to be able to access and make available quality seeds of specific crop varieties for a particular agro-ecological zone at the appropriate sowing/planting season. It can be used by development-aid workers in the planning and implementation of seed relief and rehabilitation activities following natural or human-led disasters. Furthermore, the crop calendar can serve as a quick reference tool in selecting crop varieties to adapt to changing weather patterns accelerated by climate change." (FAO 2010)

Before farmers in TIS would grow paddy in July during monsoon and harvest paddy in November and December. Until February the land would be kept fallow and until May they would grow wheat. With irrigation practices the cropping production has increased. Potato which is grown two times next to paddy is a cash crop, which has significantly contributed to farmers their income as a result.

Table 7.2b : Cropping calendar, TIS (Before and after irrigation)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cropping pattern before irrigation											
	… Wheat			☼ ….		Paddy				☼	
Cropping pattern of irrigated field (current situation)											
… Potato		☼ ….		Paddy					☼ ….	Potato	☼
Cropping pattern non-irrigated field											
	…		Maize			☼ …		Potato			☼
☼	....Wheat							….		Oilseed	

…… Sowing period ☼ Harvesting period Fallow period

(Source: Bushan, 2001)

Box 7.1

Changing cropping pattern

As a consequence of urbanization arable land is fast disappearing. Paddy production needs to be prioritized for food security. According to the secretary of MoAC there is a need to come up with technologies so that paddy production can cope with problems of drought and problems of irrigation. In addition the impacts of climate change and global warming have totally changed the cropping calendar in the whole of Nepal. Paddy production is also facing difficulties due to the lack of rainfall and absence of proper irrigation facilities (joint secretary MoAC). In the past twelve years paddy production has shown a decrease of twenty percent due to urbanization.

- *Source: Ministry of Agriculture and Cooperatives, June 2009*

Decreasing crop production and their causes

Total grain production which consists out of paddy, wheat, maize, barley and millet declined by 4.33 percent this year compared to 2009. This means a decrease in production from 8,11 million tons to 7,76 million tons. Paddy and maize the two major crops showed a decrease compared to last year: Paddy as the number one crop: minus eleven percent, maize the second major crop minus four percent.

Paddy comprises a 45 percent share of total grain output and maize a 26 percent share making them the two biggest crops.

Food availability will decline due to increasing population, causing a deficit of 1.6 million people who face food unavailability this current year.

According to the MoAC, causes of decline in the total grain production are: the lack of modern irrigation facilities, increasing plotting of productive land for housing construction (see Chapter 7 on Adaptation, section Brick making) and using traditional agricultural methods.

- *Source: Ministry of Agriculture and Cooperatives, June 2010*

7.3 Adaptation and coping responses

The main purpose of irrigation is to become less dependent on natural precipitation patterns, therefore the need of a proper irrigation system increases when other water sources are decreasing or when natural precipitation becomes increasingly irregular. The efficiency of the irrigation system becomes increasingly challenged when more users are being part of the system as a consequence thereof. There are various types of irrigation systems and they are all developed to increase the efficiency in crop growing. Irrigation systems are implemented long term adaptation strategies in order to become less dependent on natural precipitation and to increase crop yields. Another strategy as can be seen in table 7.3 is using a water pump to use groundwater instead of irrigation. This strategy is not an adaptation strategy but a coping strategy. Because it does not adjust to decreasing water availability by using the same amount of water and growing less water dependent crops or different types of crops or make use of an irrigation system, but it shifts the shortage from rainfall to groundwater. It is a short term solution which in the long term can increase farmers' vulnerability due to decreasing groundwater levels and high expenses of water pump use. Yet a majority of farmers are making use incidentally of ground water pumps (92 and 44 percent in TIS and PIS respectively).

Household water users in Nepal are extracting water from the ground, especially in urban areas the shortage of water for households is a huge concern. Groundwater levels are decreasing and the struggle is won by the one who can afford the strongest and biggest water pump. Both in Tukuche and Panchakanya the most heard statement was the use of water pumps, additionally the often heard comment was also that it is very expensive in use to irrigate the land. This is a form of coping on the short term. On the long term and currently in urban areas such as the Kathmandu Valley ground water levels are decreasing by 2.5 meters annually which leads to direct serious shortages of water. Water supply in Kathmandu Valley is already only a quarter, ninety million liters a day, of the actual demand of 320 million liters every day (UrbWatSan 2010).

Other strategies are growing less water dependent crops (29 and 32 percent for TIS and PIS respectively) and growing of different types of rice accounting for 9 and 12 percent respectively. The latter is a form of crop diversification which is an important tool in becoming adaptive to climate anomalies. These are autonomous adaptation strategies on the individual level and growing different crops does affect the cropping pattern obviously.

Other options such as the capture or storage of water is not generally present, however in Tukuche there are ponds developed which can capture water in times of rainfall and are therefore used to store water. These types of ponds are also examples of how to adapt to irregular rainfall. Nine farmers have stated to use certain ponds for the storage of water. In Panchakanya these ponds are not commonly found, however the Water User Association (WUA) is investigating on the implementation of capacity reservoirs. Trees capture water and deforestation of trees is therefore also cause to less ground water.

Yet another purpose of using groundwater is to use this water in the process of making bricks for construction. This type of activity is increasingly occurring all around the Kathmandu Valley up until Tukuche Nala as will be explained in section 7.4.

The absence of long term adaptation strategies is due to the absence of nongovernmental organizations; this issue will be discussed in the next chapter in which some strong arguments for implementation of adaptation are made. Often heard statements among farmers are that coping with a shortage of water or a harvest failure is difficult because the right technology and knowledge is lacking. This is what a farmer from Tukuche Nala has said about this particular topic;

> *"The problem is that there is no main power, there is no centralized knowledge. As farmers we know about farming and farming techniques, but we don't have knowledge about rainfall availability. If there are changes we have no idea in how to deal with that, we just lack knowledge. The river level is low so our way of coping with that is the use of a generator or a pipe."*[33]

This is indeed necessary; centralized knowledge and cooperation on different levels in order to anticipate on these matters (see also box 7.2). In PIS there are training and awareness programs on these matters in order to cope with droughts and equitable water distribution and members of the Water User Association (WUA) do hold meetings about these issues (Neupane 2005: 7-9).

Box 7.2
What would farmers do with 100.000 Rs (1000€) ?

Farmers have been asked this hypothetical question in order to think about possible methods of adaptation:

"I would stop farming and start a business; I am interested in growing herbal plants."
– Amar (PIS)

"I would inform the farmers in how to grow seasonal crops so we have enough water resources. I would dig the big pond so that every season we would have water. I would grow a lot of crops, cauliflower, potato and chili."
– Sanjeev (TIS)

"I would solve the water problem and use water pumps. Now we cannot use any because it is expensive."
– Manos (TIS)

"I would get the farmers organized. Now there is a lack in cooperation. Everybody runs his own little piece of land without working together and that makes it difficult to tackle problems. I should make one group to make a proper planning and to organize the farmers."
– Berendra (TIS)

Table 7.3 Adaptation (A) and coping (C) strategies on difficulties of change in rainfall

Strategy	TIS (n.u.f.)	Perc. %	PIS (n.u.f.)	Perc. %	Total number of farmers	Percentage %
Use of water pump (C)	32	92	15	44	47	68
Less water dependent crops (A)	10	29	11	32	21	31
Irrigation (A)	3	9	8	12	11	16
Different types of rice (Crop diversification) (A)	3	9	4	6	7	10
Ponds (Water storage) (A)	9	26	0	0	9	13

(Source: Own)

[33] Mr. Shrestha (TIS), March 30

7.4 Brick making: an off farm activity in the dry season

Due to a rapid population increase and extension of the capital city and urbanization of Kathmandu Valley, construction of houses are appearing everywhere in the Valley. The process of urbanization is rapidly expanding in Nepal; between 1971 and 2001 an increase from 4.1 to 15.9 percent of the population was living in urban areas (UN 2005: 3). Former arable land is being transformed in construction zones in order to fulfill the unstoppable demand for housing. Since 2009 these activities have reached the border of the Valley just where Tukuche is located. Since 2009 during the dry season for six months in the year when there is no rain and the bricks can dry in the hot Nepali sun, the area downstream in the Tukuche Nala irrigation system is transformed into a brick making site (see box 7.3). The same land which is used to grow rice during the monsoon is used for these activities during the dry season. The bricks are made out of clay and water which is pumped out of the ground. Making these bricks with local ground water will cause the water level to decrease which leave the farmers with even less water and by using clay from the ground the soil is being degraded which in the longer term will have its effects on cultivating the same land to prepare it for crop yields instead of bricks. Bricks on the short term generate more income; landowners farm out there land during the dry season because they argue that water is already low in the dry season downstream in the system, because water is used upstream and sufficient amounts do not reach the total command area of the system, which has been the situation for about five years now. So by contracting out the land when land is not satisfactory usable for farming due to a shortage of water farmers are adapting to the changing situation by sustaining their income but with different means. Although it has to be made clear that not every farmer possess land; most farmers have laborers to work on their land, and then it are actually the landowners who are renting out their land and leave the laborers working on this land without the profit.

Box 7.3
'That's why the brick making'

"Here we had enough water before, but in the lower lying area we don't have enough water anymore. The river source is starting upstream at that village, they take a part of the water and here upstream is still enough water, but not downstream, so they choose to start with brick making activities instead and behind that area it is dry."

- *Kumar (TIS)*

-

Figure 7.4: Bricks left to dry (TIS) (Source: own)

"What has happened downstream where there is no water anymore they have shifted to brick making during the dry season. This brick making industry is expanding and coming near. There are two types of mud; one near the river bank to irrigate and mud used for bricks. This type of field downstream has no water resource so that's why the brick making."

- *Khatri TIS*

Farmers in Tukuche did not indicate that there was any competition with the use of ground water as a consequence of the recently started brick making activities as water for farming is first used from the river, and farmers did not specifically indicate that the use of ground water reduces the water level significantly nor that it decreases the soil fertility. Rather they mentioned the fact that it brings in more income and that the soil is already polluted and therefore the upper layer needs to be cleared which is done by using it in the preparation

process of brick making and that in fact after that period of a few years (three years) these activities will come to an end. Farmers also mentioned that brick making does cause air pollution and that the quality of water and soil is decreasing, however not as a cause of brick making, which is the reason to make these bricks now. So the polluted top layer is used for bricks resulting after three years in a fertile bottom soil which is left. Whether this is true or not urbanization is rapidly expanding and everywhere around the valley similar brick making sites can be found; obviously arable land is being transformed into concrete and not over a period of just three years.

7.5 Off farm activities

Besides being involved in brick making, farmers are also involved in construction of houses or are running their own business; working as a driver in the city or running a carpenter shop, cycle shop or cyber café. Farmers are often involved in much more besides farming and income is generated from multiple activities. The off farm activities; other occupations, in which farmers are involved in Tukuche are being shown in table 7.4; table 7.5 shows the occupation range in Panchkanya.

Table 7.4: Occupation range in TIS (heads of households)

	Activity	Number of farmers (35)	Main occupation farmer	Second occupation farmer[34]	Man	Woman	Percentage
On Farm	Farmer	35	21	14	21	14	100
	Livestock	19	14	5[35]	14	5	54[36]
Off Farm	Work in urban area	5	3	2	3	2	14
	Work abroad	4	1	3	4	0	12
	Brick making	8	8	0	4	4	23
	Own business	7	4	3	5	2	20
	Construction	6	4	2	6	0	17
	Other	10	8	2	8	2	29

(Source: Own)

[34] Total number of farmers with farming as second occupation is >14 due to an overlap in the categories: e.g. A farmer can be involved in work in the urban area in which he has his own business and being involved in construction or other work as well, implicating that farmers are involved in multiple activities.

[35] This means that five farmers have indicated to have livestock as their main occupation and thus farming (growing of crops) as their second, likewise the other numbers in this column should be read according to this reasoning.

[36] Percentages in this column should be read in this case as: 19 out of 35 farmers who are involved in livestock rearing which equals 54 percent.

Table 7.5: Occupation range PIS (heads of households)

	Activity	Number of farmers (34)		Main occupation farmer	Second occupation farmer		Man	Woman		Percentage
On Farm	Farmer	34		14	20		22	12		100
	Livestock	14		11	3		8	6		40
Off Farm	Work in urban area	6		1	5		3	3		17
	Work abroad	12		3	9		12	0		35
	Brick making	0		0	0		0	0		0
	Own business	7		1	6		4	3		20
	Other	7		2	5		4	3		20

(Source: Own)

It can be seen that an extended number of farmers in TIS are involved in brick making and construction as well as a number of farmers who are running a business and a majority is active in other activities, besides farming among them who are working in the city or urban areas. While in table 7.5 farmers in PIS are not involved in brick making but are working abroad or having their own business besides farming as well. Both regions about half of the farmers have livestock next to their main occupation farming. Looking at the other categories in PIS; the majority of off farm activities represent the main occupation and source of income, while in TIS brick making and construction are second income occupations. This could be explained by the fact that these are seasonal off farm activities. In TIS only a minority works abroad while in PIS one third of the farmers have a family member working abroad. It can also be noted that in TIS fourteen out of 35 farmers have main income from off farm activities and in PIS twenty farmers generate their main income from off farm activities, which is forty and almost sixty percent respectively.

Box 7.4
Seeking off farm activities

Finding other sources of income in off farm activities and seeking work abroad seems to be an increasing trend in Nepal.
A research from Blakikie et.al. (2002) showed that in the mid 1970s 35 percent of the poorest households had income from non-agricultural activities with this number being increased to 53 percent in the mid 1990s. For middle income households these numbers are 32 and 38 percent respectively and for the highest income households these numbers have increased from 51 percent to 73 percent. When comparing these numbers to the total active population, World Bank data from the 1980s shows that only fourteen percent of the population worked solely in off farm activities compared to 2001 census data in which this number has increased to 33 percent being employed only in off farm activities. These numbers point to an increasing trend of people being employed in non-agricultural activities.

(Source; Berg 2003: World Bank 1991; ICIMOD 2003)

Seeking off farm activities, which these all are, could logically be a strategy to cope with changing and deteriorating circumstances in agriculture. Farmers mentioned difficulties with traditional ways of farming; the benefit is less, it is difficult without the right equipment

and infrastructure, while urban areas can offer the right infrastructure to start opening a new shop or work in the market or family members, most often the husband are being sent abroad to work. This is a logical response and way to adapt to the changing circumstances; it is an adaptation strategy on the individual level but probably not deliberately planned as such. Growing different types of crops is one way to reduce the risk of losses, having off farm activities reduces the dependency on farming which increases security in income. Working abroad and increasingly in urban areas is a global process, therefore it depends on a variety of factors that is changing the rural context. Urbanization and increased mobility contribute to these changes. Decreasing water availability does also contribute to these changes (see also box 7.4).
Seeking off farm activities is also done geographically by having a family member working abroad as will be further explained in the next section.

7.6 Working abroad

> *"My husband is in Qatar for two years. This creates income for a bigger house and land.Women normally stay behind and the husband stays for 3-4 years. Most husbands are abroad, India, Arab or in another village."*[37]

Working abroad generates income for the family at home and seeking work abroad seems to be an increasing pattern. A consequence of having a family member abroad, most often the husband or son, is that the woman is left behind to work on the land and look after the children; however the additional income creates more possibilities for the households; which are being translated in upgrading of the houses. Houses are expanded or new bigger houses are build, this is a scenery which is exposed in the Panchakanya area, while this was only to a minor extent the case in the hills of TIS. Table 7.6 shows the relation between 34 households from PIS, of which twelve households have family members abroad and 22 households do not have family members abroad, and their type of housing and main income. Two out of twelve households with family members abroad, compared to fourteen out of 22 households without family members abroad have a normal average sized house. Half of the households with family members abroad have an upgraded house; recently renovated house compared to five households (less than 25 percent) without family members abroad. A similar difference can be found for households with family members abroad of which one third (33 percent) has a big house, compared to three out of 22 households without family members abroad having a big house which is about fourteen percent. Main income for households with family members abroad is in most cases not from farming, but from remittances generated by family members working abroad. For households without family members abroad main income equally is derived from both farming and off farm activities.

Box 7.5
Working abroad; the value of remittances

Working abroad looks like an increasing trend; the total number of people working abroad in 1980 was estimated to be 400,000 which has been increased to an estimated 1,4 million of the population. Comparing these numbers to the value of remittances in the mid 1990s which is about 35 billion NRs, total value of remittances equals close to the foreign exchange earnings in 1997 of NRs 38,3 billion. Remittances in early 2000s have even reached one 100 billion NRs which is around 1 billion euro.

(Source: Seddon et. al, 1998)

Table 7.7 shows the same numbers for TIS; only a minority is working abroad, while a majority of farmers without family members abroad generate their main income from farming.

[37] Govinda (PIS), April 28

Three out of four generate their main income from working abroad. There seems to be a likely relation in PIS between housing type and working abroad. Nationally working abroad has been increasing since the 1980s and the numbers of people being abroad are accountable for an ever increasing capital in the form of remittances as shown in box 7.5 which could explain these differences in both type of income and housing.

Table 7.6: Housing type and main income of Households in PIS with Family members working Abroad (HFA) and Not abroad (HFNA)

Type of household	Number of members (34)	Average sized house	Big house	Upgraded house	Main income farming	Farming second income
HFA	12 (6[38] and 7[39])	2	4	6	3	9
HFNA	22	14	3	5	11	11

(Source: Own)

Table 7.7: Housingtype and main income of Households in TIS with Family members working Abroad (HFA) and Not abroad (HFNA)

Type of household	Number of members (35)	Average sized house	Big house	Upgraded house	Main income farming	Farming second income
HFA	4 (1[40] and 3[41])	1	2	1	1	3
HFNA	31	20	2	9	20	11

(Source: own)

7.7 Conclusion

In this chapter it has become clear how farmers respond in various ways in order to cope with difficulties to decreasing water availability and difficulties with decreasing soil fertility. An adaptation strategy in Tukuche which is occurring recently due to rapid urbanization is the process of brick making during the dry season. In Panchakanya an increasing number of farmers are seeking work abroad of which the household can profit. Working abroad is increasingly present in Nepal and most farmers who have family members working abroad have farming as their second income as their main income is derived from working abroad.

Adaptation strategies for both systems are growing less water dependent crops such as maize and potato and growing more varieties of crops in order to reduce the risk of a total crop failure. Coping responses are the use of water pumps which is only a solution on the short term and irrigation itself is also a mean by which one can become less dependent on irregular rainfall and thus is an efficient adaptation strategy to sustain in one's livelihood.

Another reaction is seeking work in off farm activities which is the case in both systems; by becoming less dependent on solely farming household revenues become less insecure as a result. Most farmers with off farm activities generate their main income out of the off farm activities as a result. The next chapter will present a general discussion on the main results and findings of this research.

[38] Number of sons abroad (of which two out of one household)
[39] Number of husbands abroad
[40] Number of sons abroad
[41] Number of husbands abroad

8. Discussion

8.1 Introduction

In the former chapters the results have been presented; in this chapter the three former empirical chapters will be analyzed more thoroughly and linkages with the literature will be made. Similarities and differences with the literature and shortcomings of the research will be discussed.
This research and the problem statement has been structured in three parts; first trends in water availability and weather conditions, second consequences of the changes in water availability and weather conditions and third adaptation and coping responses to these consequences.
The first section, section 8.2 will reflect on the trends, the second section, 8.3 on the consequences and third section 8.4 will reflect on the presented results on adaptation.

8.2 Trends in water availability and weather conditions reflected

Originally two main indicators of changing water availability have been defined, namely changing rainfall patterns and glacial retreat. However for both locations consequences of glacial retreat were not found, because both systems do not depend on water of glacial fed rivers. The issue of glacial retreat therefore has not been taken into account, this does not mean however that the threats and possible consequences for glacial retreat in other regions does not exist or is less relevant; it is a huge issue and indicator of change threatening agriculture and food security both in Nepal and in the whole region of Himalayan countries (FAO 2008; Shahgedanova et. al. 2009; Lemke et. al. 2007). Besides changing rainfall patterns another issue however has been included which is the changing temperature pattern. This has appeared to be an indicator affecting the livelihoods of farmers in both locations as well.

When reflecting on trends in precipitation, in the literature both Biswas (2004) and Barrios (2003) showed that rainfall patterns are changing leading to a decline in the number of rainy days which will lead to more droughts with consequences for agriculture depending on rainfall. Farmers in both systems have similarly indicated that rainfall patterns are changing; leading to a reduction of rainfall, to less rainy days and a shorter monsoon. Data from the Department of Hydrology and Meteorology (DHM) showed that Nepal had extremely dry winters in the period of past five years, winters of 2006, 2008, 2009 and 2010 have had exceptionally dry winters; farmers have mentioned to have experienced recent winters without rainfall, this is also in accordance with DHM data (DHM 2010). Majority of farmers also indicated temperatures to be rising, both in summer and in winter which is also in accordance with actual DHM data.

Causes of these changes are according to farmers increasing industrialization, population growth, pollution, deforestation and global warming. In fact these causes are interrelated. Increase in population which according to the report from 2005 (WWF Nepal Program) will only further exceed the potential increase in water increases a shortage in water availability and at the same time it is a cause of increased pollution (see chapter 2). Population growth also leads to further pressure on food production. Population growth is also a cause of increased industrialization, deforestation and global warming indeed. Deforestation is also a cause of less available water; mentioned causes of farmers are interrelated.

8.3 Consequences of changing water availability further explored

As a result of the changes in rainfall and temperature several consequences have been defined leading to adaptation strategies of changing the type of crop growing, changing the cropping calendar and changing the variety of crop growing. Major issues have been defined as the shortage of the water resource, fertilizer and seeds. More specifically problems have been mentioned as water pollution, river depletion, air pollution, soil pollution, soil fertility degradation, pesticides, the efficiency and performance of the irrigation system and education and knowledge.

It is an extended list of concerns, however analyzing these problems they are in fact all linked to each other. The following reasoning could explain these linkages more clearly; due to less rainfall soil becomes dry which leads to difficulties in irrigation. Less rainfall leads to more periods of drought, which lead to decreasing crop yields. Decreasing rainfall requires an increased use of fertilizer and increased use of pesticide. Often fertilizer is not properly used due to the lack of education and the right knowledge. Soil in turn depletes more and health related diseases such as skin infection or respiratory problems occur due to overuse of pesticide and fertilizer. All these related difficulties lead to a decrease in production. Which cause land to be left fallow or increased vulnerability and risk of harvest failure. Together this puts more pressure on the performance and management of the irrigation system, thus one core problem; the shortage of water results in an increase of all these interrelated problems.

It has to be acknowledged that this research has a bias on water related issues, and it is probably not solely true that these problems are all derived from one issue namely water shortage or changed rainfall patterns. The cause of the use of fertilizer and their problems are also due to the changing agricultural methods and introduction and standardization of crop growing. In that sense it is not a consequence of decreasing rainfall but the intensified use could have been a cause of increased population growth and the importance of increasing crop yields for instance (see box 8.1). According to ICIMOD (2004) poor land management has also increased water problems and soil degradation and declining soil fertility are widely recognized major problems indeed. The decreasing rainfall pattern and consequences for crop yields seem to be in accordance with what has been stated in literature; last year in 2009 total precipitation was less than 800 mm far below the normal 1,540 mm resulting the monsoon to be the driest in a decade, rainfall is erratic in Nepal and as a consequence farmers are heavily dependent on the monsoon rainfall for crop growing. Production in 2009 went down by thirty to 35 percent (South Asian Climate Outlook Forum 2010). According to IPCC (2007) the Asian monsoon will be affected by the changing climate leading to more extreme weather patterns and unpredictable water flows, which is what farmers also mentioned; a changed rainfall pattern and low water resource, more and heavy rainfall for short periods, an irregular rainfall and different quantity (Section 6.2, Figure 11 Water related problems in PIS and TIS; Section 5.2, Figure 4 Rainfall characteristics: mentioned changes)

8.4 Adaptation strategies and coping responses and the lack of planned adaptation

Different adaptation strategies have been presented, mainly on the individual level, planned long term adaptation strategies have not been found in both locations. These strategies are reflected in different aspects; the change in crop growing, the change in types of crops that are grown, the time of which crops are grown but also the type of water use from irrigation or natural rainfall to groundwater pumping or the storage of water through ponds. These are strategies on the production level, yet farmers also react in a dynamic more structural changing way which could be explained as the shift from farming activities to off farm activities in order to sustain in one's livelihood. The outcomes are a changing but strengthening rural urban linkage, increased out migration and urbanization (UN 2005: 3-38). It would be too short sighted to appoint this social geographic change solely to the subject of

changing water availability and the consequences dealt within in this research. The process of urbanization, out-migration and diversification of the (rural) household income by shifting to off farm activities and working abroad is a global process in motion. This geographic process has to be understood from a much broader context indeed. Furthermore it is difficult to prove to what extent the presented changes are the result of these reactions, however this process is changing the context of both research regions and therefore cannot be neglected. This dynamic process is embedded in a broader context, but the presented consequences of changing water availability can certainly be included as a push factor shifting farmers to off farm activities therefore strengthening this process of change.

The first section in chapter 7 on adaptation, section 7.2 deals with coping responses. The term coping responses holds a meaning about responses merely that they can be understood as responses to cope with changes, so it is a type of response in order to cope or to adapt; to deal with the changes without changing the type of livelihood. There are several concepts that are distinguished in the literature (Archarya 2010; Khanal & Dahal 2010), which are; responses, coping behavior and adaptation. A response itself could have nothing to do with adaptation, it could mean shifting to off farm activities which is not an adaptation, while coping behavior are reactions which lead to short term solutions they don't reduce vulnerability; for instance the selling of livestock but in the long run it could be unsustainable and increase one's vulnerability. Adaptation means sustaining in the type of livelihood by adapting to the changes through addressing the underlying causes, this implicates a long term solution, but adaptation depends on several factors; individually it is possible to effectively adapt to these changing conditions. But structural adjustments need a successful implementation of an adaptation strategy depending on finances, mobility, infrastructure, government policies and knowledge (Ibid).

In section 7.2 the importance of a good performing irrigation system has been presented as increasingly important when the number of users increases while water availability does not increases or even decreases. The irrigation system itself is a form of planned adaptation. Other adaptation strategies are the change of type in crops that are grown. Growing less water dependent crops as has been presented, is a short term solution to decreasing water availability just like the response of farmers of growing more different types of rice which reduces the risk of a harvest failure. These are examples of crop diversification; an adaptation strategy realized on the individual level.

According to the Ministry of Agriculture and Cooperatives (MoAC) the impacts of climate change and global warming have totally changed the cropping calendar in the whole of Nepal and paddy production is facing difficulties due the lack of rainfall and proper irrigation facilities (see also Box 3 in section 6.5). Additionally due to the lack of modern irrigation facilities, traditional agricultural methods and increasing plotting of productive land for housing, which have all been mentioned by farmers in both systems and the latter by farmers in Tukuche especially, crop yields are decreasing. These causes have thus been presented in a substantial manner as mentioned by farmers in both systems and are all acknowledged by the MoAC as well.

Box 8.1 is an example of a solution to the presented problems with soil fertility and the use of fertilizers. Farming without using chemical fertilizer could serve as an effective alternative as argued by some farmers in PIS.

When considering the statements made in box 7.2, farmers tried to answer the hypothetical question of what they would do if they had 100,000 rupees, farmers have not been asked to think about an adaptation strategy, however when answering this question farmers came up with certain solutions on their own. Such as starting a different business (seeking off farm activities), inform farmers in how to grow seasonal crops in order to have enough water resources (adaptation strategy), the use of water pumps (coping response) and

Box 8.1

Benefits of crop growing without using fertilizer and pesticides

In 2004 a Community Managed Sustainable Agriculture began in India to start farming without using pesticides and chemical fertilizers and to adopt ecological management of the soil and production process. As a result the yields did not decline and farmers were for the first time not dependent on moneylenders to pay for their cultivation expenses. The number of ecological farmers is increasing and total land used for ecological agriculture has increased with 2 million acres, almost 8 percent of the net cropped area in Andhra Pradesh, India.

Today farmers face difficulties with decreasing water tables, degrading soil fertility, permanent water logging, polluting of water sources, and becoming poisoned by the use of pesticides.

Ecological farming in Andhra Pradesh has also been expanded from fruits and vegetables to paddy and other grains. Productivity has been equal to conventional agriculture with significantly reduced amounts of cultivation expenditures. At the same time soil fertility is increasing which will logically result in a higher production level compared to chemical-based agriculture. A large proportion of farmers have been able to produce sufficient for own consumption as well. At the same time there has been a substantial drop in pesticide related health problems among farmers in the region. In the villages where chemicals have been completely banned out also the groundwater and soil have become pesticide-free.

(Source: Bhattarai 2010)

get the farmers organized (which is necessary for planned adaptation), thus when asking this basically simple question a variety of new insights is been given which have all in some way to do with sustaining in their livelihood by coping, adapting or responding (in turning to off farm activities).

However there is an absence of long term adaptation strategies, which is mainly due to the absence of active NGOs in both regions. NGOs such as ICIMOD and Practical Action Nepal have the right knowledge, finances and infrastructure to implement proper adaptation strategies.

Other responses as argued are the shift to off farm activities and the increase of migration workers, the process of urbanization translates in Tukuche to seasonal brick making activities; arable land is being used for brick making during the dry season. Yet again it is difficult to prove the real factors that have led to these changes, but according to the farmers it is the changing water availability as has been presented in section 7.3; downstream water availability is low and soil has become polluted therefore during the dry season the area is used for brick making, at the same time everywhere in the Valley the same process is occurring and it could not be assumed that this is happening by the same reasons as has been brought up in Tukuche. Brick making could be explained as a reaction to decreasing water availability, but one has to bear in mind that this is just one of the push factors driving to these changes. It totally depends from which perspective one explains this process, from an urban perspective it is the process of urbanization, from a rural perspective it has been argued as decreasing water availability, while in fact it is more likely that urbanization is at the core of this process.

The reason that brick making occurs in Tukuche and not in Panchakanya could be the location; Tukuche is located bordering the Kathmandu Valley which is rapidly experiencing a process of urbanization, while Panchakanya is located in the Teraj in a more rural area and the irrigation system in Panchakanya is more advanced and bigger, therefore the system is likely less affected by the process of urbanization.

Besides brick making farmers are involved in a variety of off farm activities, in a substantial part of the cases farmers generate more income from off farm activities that is generated from farming. Especially in Panchakanya farmer households have members working abroad, generating a significant amount of income through remittances. According to a research from Blakikie (2002, Box 7.4) there has been an increase from the mid 1970s in off farm activities especially among the poorest households, but likewise among middle income and higher

income households. According to Seddon (1998) remittances have increased between 1980 onwards and the number of people working abroad from 400,000 in 1980 to 1,4 million in early 2000s. Especially in Panchakanya this trend has been occurring.
Long term adaptation strategies have not been found however, as has been argued for the implementation of long term adaptation strategies, government policies have to shift towards adaptation, however adaptation has not been prioritized in poverty reduction strategy programs or implemented in water resource management policies. According to Orlove minimal efforts on adaptation are focused on hydropower and urban water supply while not on commercial irrigated agriculture (2009). Thus one can conclude that adaptation lags behind, while effective adaptation is indeed necessary. In the main conclusion some recommendations will be made on the implementation of adaptation strategies.

Intermezzo II: Photographic impression of fieldwork

Picture 12: Partly constructed canal in TIS

Picture 13: Concrete canal in PIS

Picture 11: Pond view and brick making site

Picture 15: At the teahouse: resting and socialising (TIS)

Picture 16: Tukucha Nala panorama view

Picture 17: Working on the irrigated field (TIS)

Picture 18: Sowing of cauliflower seeds (TIS)

Picture 19: Gathering of villagers at my arrival in TIS

Picture 20: Example of an upgraded colored house (PIS)

Picture 21: Collecting drops of water in the city of Patan

Picture 22: Carrying collected water at Patan Durbar Square

Picture 23: Rice field with houses at the background (PIS)

Picture 24: 6 a.m. Sunrise over Panchakanya rice fields

9. Conclusion

In this final chapter the main conclusions derived from this research will be presented in addition a number of general recommendations mainly for policy makers will be given.

The leading research question has been defined as:
'What are the effects of changing water availability for farmers' livelihoods in Tukuche Nala and Panchakanya and how do farmers respond and adapt to that?' This question has been subdivided into 4 sub questions; (1) What are trends in water availability? (2) What are the effects of changing water availability on the livelihoods of farmers in Tukucha Nala and Panchakanya? (3) Which different adaptations, responses and coping strategies of farmers can be distinguished as a reaction to changing water availability? (4) What is the role of local organization and Water User Associations on adaptation with respect to farmers in Tukucha Nala and Panchakanya?
The following sections will present the main conclusions derived from each sub question.

9.1 Trends in water availability: rainfall and temperature indicators

Agriculture and climate change are two interrelated processes; agriculture contributes to global warming through deforestation and methane emission (through livestock and rice cultivation). In total globally agriculture contributes for 18-20 percent of total emissions. As this is important to realize climate change impacts do also influence agriculture. As has become clear two main indicators of change influencing farmers' livelihoods have been defined as changing water availability and temperature increase.

Agriculture is highly dependent on natural precipitation; rainfall. Water availability in Nepal is changing through changing rainfall patterns. Rainfall is changing in several ways; in intensity, duration, time, quantity and variability. 84 percent of respondents stated that rainfall is decreasing and even more rapidly in the recent years. 72 percent stated that winter precipitation has been almost completely absent for the last 6-7 years. These changes are affecting the onset of the monsoon as well; as perceived by farmers in both regions 90 percent claims to have experienced a delayed onset of the monsoon combined with less precipitation, while 67 percent claimed that the monsoon *length* was also shortened compared to the remaining 23 percent claimed that the total monsoon period was shifted. A minority of ten percent stated that the monsoon did not change at all. These perceived changes are similar with rainfall characteristics as described in the literature. Other specifications farmers made about rainfall are that rainfall is more heavy, not continuous and is becoming less reliable.

Causes have been mentioned as temperature increase, climate change, industrial pollution, population growth and deforestation. Thus farmers are aware of the processes that are taking place and are influencing their local environment. Claims are various but the majority of farmers are aware about the processes of deforestation, pollution and population growth and farmers are indicating that these processes do influence the environment. A majority of 93 percent of all respondents claims the temperature to be increasing. This finding is also similar with studies presented in the literature. Farmers are accurate about increasing temperature both in summer as in winter, leading to a shorter winter period as well. The past decade, the first of the 21st century has turned out to be one of the warmest decades in recorded history, with 2010 breaking several all time records.

When farmers were asked to rank seven livelihood categories, farmers valued rainfall as second important next to their own health and family and friends. This simple survey indicates the importance of water in the lives of farmers and the perception farmers have on other categories such as earning money, having a nice house and having livestock.

Main conclusions derived on trends in water availability are that rainfall is changing on several aspects, temperatures are increasing, that farmers perceive these changes as a cause

of climate change, industrialization, pollution and deforestation and that these statements made are very similar to meteorological data and studies presented in the literature (IPCC 2007; FAO 2008; Hansen et. al 2010; Blaikie et. al 2002; Brown & Lall 2006; Dahal 2005; Dyurgerov & Meier 2005; Kantipur 2009; Merz et. al 2007).

9.2 The effects of changing water availability for farmers' livelihoods

The presented changes have direct consequences for farmers' livelihoods. Changes in rainfall affect the cropping pattern and cropping calendar. Therefore it affects food security and agricultural production and the use of fertilizer as well.

The major difficulty is water shortage, therefore water discharge in both systems is low. In addition due to lack of technology and the right knowledge fertilizer and pesticides are often not properly used affecting the soil, groundwater, crops and farmers own health. In PIS water discharge is low while the number of users has been steadily increasing during the past ten years. A cause for difficulties with crop growing is the increasing irregularity of rainfall. When rainfall is not reliable cropping patterns are changing and crops can not be grown according to the cropping calendar. Other consequences as perceived by farmers are longer periods of drought and intense rainfall causing landslides damaging both fields and houses. These findings are in accordance with the presented literature as explained by Dahal (2005), EC (2008), FAO (2010) and ICIMOD (2009) and Shrestha et. al (2007) among others.

Farmers are thus not optimistic about farming in the future; rainfall will continue to decrease, crop production will decrease and in general difficulties in agriculture will become bigger. The only optimistic view is on the improvement of fertilizers and seeds. These findings assume a logical outcome which can be found in the way farmers are dealing with these effects. Therefore a major question in this research has been focusing on adaptation strategies, coping behavior and responding types by farmers. Figure 9.1 presents the main outcomes on trends in water availability and the effects for farmers' livelihoods.

Figure 9.1: Schematic overview of Main Outcomes on Water Availability and the Effects

Trends in water availability	Overall temperature increase	Winter temperature increase	Changing rainfall pattern	Decreased winter rain	Delayed monsoon onset	Decreased reliability of rainfall	Increased intensity of rainfall
Consequences of changing water availability	Decreasing water discharge	Changing cropping calendar	Drought Soil degradation	Decrease in water availability	Increased dependency on irrigation system	Increased vulnerability	Increased pressure on irrigation system

(Source: Own)

Main conclusion derived from the question about the effects of changing water availability for farmers' livelihoods is that the changing rainfall pattern has direct effects for farmers' their crop growing; it affects the cropping calendar and cropping pattern and indirectly the performance of the irrigation system. A changing rainfall pattern and increased temperatures does also cause floods and landslides, and longer periods of droughts. Towards the future current effects are influencing farmers perceptions on their future in agriculture, generally stating that farming perspectives will deteriorate in the future.

9.3 Adaptation strategies, coping behavior and responses

In line with the effects of the environmental changes influencing farmers' direct livelihoods, several reactions can be distinguished. These can be divided into adaptation strategies, coping behavior and responses. Figure 9.2 shows these reactions categorized by the type of reaction.

Figure 9.2: Schematic overview of main outcomes on Adaptation, Coping and Responses

Adaptation	TIS	PIS	Coping	TIS	PIS	Responses	TIS	PIS
Implement early warning systems and incorporate disaster risk management and preparedness (assumption)	No	No	Increased fertilizer use (assumption and outcome)	Yes	Yes	Income diversification (assumption and outcome)	Yes	Yes
Develop drought resistant and pest tolerant crops (assumption and outcome)	Yes	Yes	Selling of livestock (using up assets and reserves) (assumption)	No	Yes	Out migration (assumption and outcome)	Yes	Yes
Develop knowledge and infrastructure (assumption and outcome)	Yes	Yes	Selling of land (using up assets and reserves) (assumption)	No	No	Commuting (assumption and outcome)	Yes	Yes
Implementation of ponds and water reservoirs to store water (assumption and outcome)	Yes	No	Abstracting groundwater by using of water pump (outcome)	Yes	Yes	Off farm activities (assumption and outcome)	Yes	Yes
Development of drip irrigation (assumption and outcome)	Yes	No				Season work abroad (outcome)	Yes	Yes
Development of hybrid fertilizers (assumption and outcome)	Yes	Yes	**Adaptation continued** ↓	**TIS**	**PIS**	Brick making (outcome)	Yes	No
Increase use of organic fertilizer (assumption and outcome)	No	Yes	Crop diversification (outcome)	Yes	Yes			
Organize training and awareness programs (assumption and outcome)	Yes	Yes	Equal water distribution by WUA (outcome)	No	Yes			
Strengthen cooperation between government, regional and local level (assumption)	No	No	Adjust the sowing dates to the changing rainfall patterns (adaptation of cropping calendar) (outcome)	Yes	Yes			

(Source: Own)

The distinction between adapting and coping is sometimes marginal. In this study the distinction between adaptation and coping is that adaptation is long term and means adjusting to the changing environment while sustaining in the type of livelihood. While coping is a short term response and often increases one's vulnerability in the long term. It is not an adjustment but a short term solution not addressing the underlying causes. Therefore coping has often to do with using up assets such as the selling of land or livestock. Responses have been defined as a reaction to the changes however resulting in a change of livelihood,

therefore responses can be understood as shifting from on farm to off farm activities as a mean to diversify one's income, which in turn increases one's income security. Off farm activities can be divided into local off farm and cross boundary off farm activities including working abroad which brings in significant amounts of remittances. Analyzing this scheme there are several differences between the two regions. PIS has a more advanced irrigation system and a proper functioning WUA responsible for equal water distribution and training and awareness programs for their member users. TIS has developed some ponds to store water (13 percent), and a recent transformation of land in TIS has led to brick making activities in the dry season (23 percent of TIS). This is an off farm activity and a reaction to water shortage in the system. Furthermore farmers from both systems have indicated to apply crop diversification, to grow less water demanding crops (drought resistant crops, in total 41 percent) and to have changed the cropping calendar, which are adaptation strategies on individual level to adjust to a changing rainfall pattern and increasing temperatures. Use of organic fertilizer could be a solution to difficulties with fertilizer use, while farmers from both systems have stated to use more hybrid chemical fertilizers. The use of fertilizer is considered a necessity for improving crop yields, therefore it can be argued as an adaptation strategy adapting to increasingly dry soil due to decreasing precipitation and increasing temperature. The use of water pumps to abstract groundwater is a coping strategy which occurred in both systems and is considered expensive and problematic as well by farmers; on the long term it is not sustainable and instead of adjusting to decreasing water availability it is a shift to another source of water supply. Working in off farm activities has not to be underestimated; often landsize is not an indicator for farmers their income as farmers are often engaged in off farm income generating activities. This dynamic should be understood in the context of strengthening rural urban linkages as explained in the document about rural-urban linkages from the UN (2005). Working abroad is increasingly common in PIS and leads possibly to upgrading of private houses due to increased income through remittances. Another conclusion is that farmers who have indicated to have their main income in off farm activities often have more assets and an upgraded house.

The last question addressed the role of the WUAs and the role of NGOs in relation to implementation of adaptation strategies for farmers. NGOs are currently not active present in both systems. The WUAs fulfill an important role in the functioning of the irrigation systems and in PIS training and awareness programs on environmental change and other challenges influencing water availability are held occasionally. The WUA is also the source through which can be communicated on government level with the local government such as the Department of Irrigation of local organizations such as Practical Action Nepal, ICIMOD or other (agricultural based) NGOs.

Main conclusions derived on adaptation, coping behavior and responses are that farmers are adapting on an individual level to changing water availability by growing drought resistant crops, adjusting the cropping pattern and calendar, using hybrid fertilizer and implementing of ponds to store water. At the coping level farmers use groundwater pumps and use up their assets as a coping method to deal with the issues on the short term. Other responses are turning to off farm activities which increases income security by generating multiple types of income in order to become less dependent on agricultural income. Off farm activities can be divided into local and cross boundary activities. Working abroad brings in remittances and significantly increases the household revenue. Farmers are often involved in off farm activities, which makes this aspect not to be underestimated. At institutional level WUAs are mandatory for a proper functioning irrigation system, for training and awareness programs and as a medium of communication with the local government and community based organizations such as local NGOs.

9.4 Recommendations

In this final section it is the right place to present some recommendations in addition to the main findings of this study:

- **Development of less water demanding/drought resistant crops**
  While this is already occurring, it could contribute to sustaining agricultural productivity and is equally important when rainfall becomes increasingly rampant and irregular.
- **Stimulate crop diversification and organic farming methods**
  Instead of subsidizing one type rice crop which stimulates single crop growing, it is important to stimulate crop diversification. This reduces the risk of crop failure and increases the natural crop resistance and is necessary for protecting the soil against exhaustion. Single crop growing is unnatural and increases environmental vulnerability in the long term and reduces local biodiversity. Applying organic farming methods decreases soil degradation, decreases the emission from chemical fertilizer and increases the natural crop resistance. If organic farming would be financially stimulated by the government, production and efficiency would increase ultimately offering a sustainable and attractive alternative to conventional farming methods.
- **Awareness raising at community level on climate change impacts for agriculture**
  If the right knowledge is lacking, or if farmers are not aware about the causes it is impossible to expect proper responses. Much more knowledge and research is needed to inform farmers at community level about concrete impacts of changing weather conditions influencing agricultural activities.
- **Implementation of water storage and rainwater harvesting**
  Water storage is an adaptation strategy which becomes increasingly important as rainfall becomes increasingly irregular. When 75 percent of the rain falls during a short period of days it is important to manage this water and to store this water. Rainwater harvesting therefore is a necessity and an effective adaptation tool in adjusting to extreme erratic rainfall patterns.
- **Implementation of adaptation strategies at individual and institutional level**
  The number one adaptation priority is to secure farmers' livelihoods and food security towards the future. Therefore adaptation strategies need to be developed on local level and need to be implemented in order to reduce the impacts involved with climate change.
- **Awareness raising programs on soil management and fertilizer use**
  Farmers have indicated to lack knowledge and technology; therefore fertilizers are often not properly used. Leading to decreased soil fertility and effecting the farmers' health. Misuse of both fertilizer and soil (by exhausting the soil) is a major problem and could probably given much more attention.
- **Improvement of market linkage**
  Farmers are dependent on the market to sell their harvest. A strengthened linkage is necessary to secure farmers' livelihoods.

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Appendixes

APPENDIX 1. PRACTICAL ACTION TOOLS – PROBLEM STATEMENT

Name of participant/ NAAM	Problem/ Samasha	What could be the solution?/ Samadhan ke ho?	Since when is it a problem?/ Kati samay deki samasha chha?	How do you deal/adjust with the problem?/Kasto yoja samasha?

APPENDIX 2. PRACTICAL ACTION TOOLS – PRIORITY RANKING

Date/Baar:

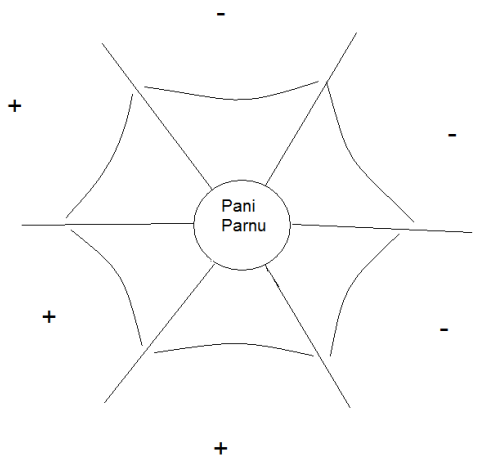
Wealth/Prosperity rank - Unati

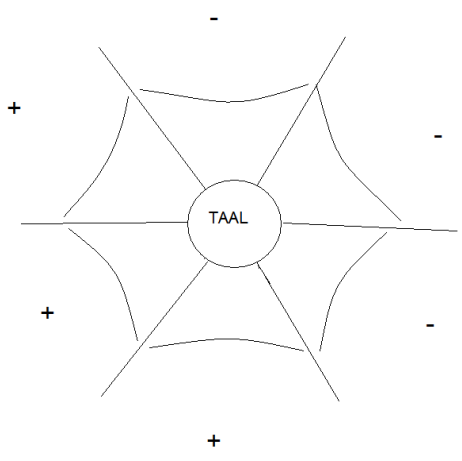
Please indicate with 1 to 7 - Lekhnus 1-7

Name/Naam	Nice house/ Raamro Ghar	Family & Friends/ Pariwaar Saathi Haru	Land Size/ Kid Ackar	Health / Sostha	Rainfall / Paani Pariko	Live stock/	To make money/ Kamaaunu

APPENDIX 3. PRACTICAL ACTION TOOLS – WATER WEB RAINFALL/RIVER

Date/Ajaa: Indicate negative and positive aspects of rainfall (right) and river (left)





APPENDIX 4. QUESTIONNAIRE

Panchakanya & Tukucha Nala Irrigation System; a livelihood study on water supply,
Master: International Development Studies, University Utrecht

The data assessed from this questionnaire will be completely anonymous.

1. General characteristics

Date:
Day part:
Location:

Name respondent:
Gender:
VDC/Ward:
Branch number:

2. Household characteristics

Name	Gender	Occupation
Father:		
Mother:		
Children and age:		
Other members:		

3. Land characteristics

Market crop production	Irrigated field	Rain fed field	Machinery owned/rented	Pump/Well Own/rented	Fallow Land

3.1 Since when do you make use of the irrigation system?
3.2 If land kept bear; why do you leave the land bear?
3.3 Since when?
3.4 What could be the reason for farmers to leave there land bear?

4. Crop production

4.1 Which crops do you grow currently?
4.2 Which crops did you grow before?
4.3 If not the same: Why do you grow other crops compared to before?
4.4 How is the crop production compared to before?
4.5 When do you grow which crops?

5. Other income

Other income	
Shop	
Livestock	
Other	
Abroad	

5.1 Did you sell livestock in the past?
5.2 Do you have more or less livestock than 5 years before?
5.3 How do you value livestock as compared to crop production?
5.4 What are other options besides farming to generate income from?
5.5 Do you have a loan?
5.6 If so: for which purpose?
5.7 Since when?
5.8 What are your main expenditures?

6. Difficulties/Problems

6.1 What are the main problems you experience with crop growing?
6.2 If problems related to water: Why is water supply or rainfall a difficulty?
6.3 How does this affect the crop production?
6.4 If related to fertilizer: Why is this a problem?
6.5 What happens if the harvest is not good?
6.6 Which season of the year is most difficult to grow crops?

7. Rainfall

Rainfall indicator	Rainfall defined	Indication of time	Previous condition
Rainfall amount compared to 20 years before			
Rainfall in winter		Since..	
Rainfall in monsoon			
Rainfall in spring			
Period of rainfall			
Rainfall intensity			

7.1 Does rainfall have any religious aspect?
7.2 How is rainfall or water perceived or treated from a religious perspective?
7.3 How does rainfall affect the cropping season?
7.4 How is the rainfall reliability?
7.5 What could be the reason or cause of all the things you have mentioned?
7.6 How do you deal with this?
7.7 What could be a solution?
7.8 Do you store water (e.g. by a pond)?
7.9 How would you consider rainfall to be in the future?
7.10 If you would have 'ek lakh rupee' what would you do? (Start other business or related to crop growing/irrigation)
7.11 How would you define your future prospects?
7.12 Is there any reason to have worries about the future?
7.13 Do you foresee a career in farming for your children?

8. Weather condition

8.1 How is the weather compared to twenty years before?
8.2 How does this affect the living conditions?
8.3 How does this affect crop growing?
8.4 How do you deal with this?
8.5 How would you consider the weather to be in the future?
8.6 What could be the reason or cause for the things you mentioned about the weather?
8.7 Are there any other reasons you can think of?
8.8 If mentioned environmental pollution; what is the cause of this cause?
8.9 (Optional) What comes into your mind when hearing about glacial melt?

Weather type	Current	Previous		
Temperature				
Winds				
Winter temperature				
Other				

9. Political situation

9.1 How does the political situation influence your daily life?
9.2 How does it specifically affects your farming activities?
9.3 Could you give an (other) example?
9.4 Which would you consider a bigger problem the current political situation or any other mentioned difficulties with crop growing?
9.5 Does this also hold for the future?

10. Migration of family member

Occupation of member	
Time abroad	
Country	
Main reason	

10.1 How has your daily life been influenced or changed while your husband is abroad?

11. Equity in the irrigation system

11.1 Do you know about the irrigation schedule?

11.2 Do all members receive the same amount of water?
11.3 What are problems you face with the irrigation system?
11.4 Do you attend meetings where these problems are discussed?
11.5 Do all members have the same access to water?
11.6 How is the water discharge compared to before?

Concluding remarks
Do you have any comments or questions?

APPENDIX 5. FOCUSGROUP

Date:
Day part:
Number of people present:
Subject:

- Which are the main points discussed?
- What are the main conclusions
- Has the group come to a consensus
- Which are the points of discussion between group members?
- Which are points of unclearness?
- How is the active participation of all people attended?
- What can be said from body language and face expression?
- Who takes charge, who leads the group?
- Which materials are used during the meeting?
- How is the meeting structured?
- Where does the meeting take place and how often?
- How is the meeting valued?

Before and after study:

- Inform participants in advance about the meeting
- Introduction of what will be discussed
- Translator/Use of interpreter

APPENDIX 6. OBSERVATION OF DAILY BREAKFAST RITUAL

Preparation and start of breakfast
Around nine and ten o clock breakfast in Tukucha is served. At the top floor, while sitting on the ground each family member has its own place to sit. We sit on the ground on a mat with the legs crossed and I am served first. Before we eat, the father is informed last, not by the wife but by the daughter or son, by calling 'Ba..' (meaning father) and he will come immediately. I sit in front of the stove upon which the food is cooked. This is done only by the daughter or the daughter and mother together and probably also another women. Preparing of the food starts everyday around five or six o clock.
Structure of where every family member sits, and eating order
The son sits left to me with his back leaned against the wall. The father sits right from me in front of the son. Both mother and daughter are not eating before the father has finished in order to serve the male members with food as food is never served by yourself. The mother takes the place of the father after the father has eaten and the daughter takes the place of the son or if the mother is already finished the place of the mother. I am served first, therefore I don't want to come late because then I would let them wait. This can happen once I need to go to the restroom (for an emergency visit) or want to wash my hands first. Or when I am in the field as happened the first day; everyone asked me "aren't you hungry?" One's at home I still got served the breakfast meal at six o clock, while having dinner at 8. I am served when I have taken my seat on the mat not when still standing. I am served never by the father. I am served mostly by the mother or daughter, they serve the food and sometimes the son passes on the plate to me. First the son and father wash their right hand with a bit of water out of a jug and shake it with their hand on the ground in front of the plate. I start with washing my mouth with water. I eat with one spoon, in my right hand; I only use my left hand to drink water out of an iron cup. They drink water out of the same jug as with which they wash their hand, but without getting in contact with the jug. The father sits with his right knee pulled up and the back of his left foot placed against the back of his right foot. Both son and father eat rather fast. All eat with the right hand, without using any cutlery. They eat two times fast as me, and got served twice by the mother or

daughter; they are sitting squatted on the ground in front of me, just from where the food is served. Rice is served from a plate. Not straight from the pan. The rice is picked up from the plate (which is placed in front of each other on the ground) with the right hand before mixing it nicely with the lentil soup and vegetables it is then soaked up which can be heard with a slurping sound. After finishing the food you have to rinse the mouth and wash your hand again. The father leaves the room without saying something. Once the mother has eaten her first portion, the daughter will eat in the place of the son. She is sitting not towards me and with the knees pulled up. She talks a lot to her mother and the son hangs on the table waiting for me to get finished. The son is most often not involved in the informal chatting but is now in function of serving the daughter.
Every day the same food is served; cooked rice, with vegetables and lentil and ajar.

The use of cell phones

While sitting in a loft which gives me the feeling of being a century back in time, at the first occasion I was surprised of the electronic noise suddenly filling the room. This was the ringtone of the mother's cell phone. The only modern tool is the cell phone, it is probably also a status attribute, the phone generally is very modern and up to date, with music on it and a radio. She calls quite often or listens to music, once while during dinner, with two or one headphones in the ears while eating. Before eating "enjoy the meal" is not common to say. And to indicate that you want some more rice you just add in between the conversation the short word 'rice' or 'some rice', it is certainly more an announcement rather than a question.

After breakfast: working in front of the house

After breakfast the father is not be seen anymore and after dinner he immediately leaves for his room. The father is not often seen in the house, in most cases he will only be seen during breakfast, dinner and after dinner.
The daughter goes to school at 5 o clock in the morning and comes back at ten. She has breakfast when returning from school.
The grandmother is a very aged looking women, singing humming a lot. She always walks with her back ninety degrees bent over. She cuts the mustard in the little field just next to the house, she washes the buffalo, she feeds the chicken or moves the chicken, which is tied with a rope on a stone. The chicken gets a bowl of water or some rice with water. She also feeds the buffalo, which is a bowl full of grass. She will not be found outside the house or the area around it. Also she likes smoking some sort of a water pipe. Inside the house on the ground floor she is often found busy with a small fire on top which is cooked some soup or anything like that, probably not for eating, because cooking is done on the top floor. The son is the brother of my guesthouse father. He is a teacher in Banepa in math for the 5^{th} and 6^{th} grade. Three years ago he graduated. He has a little daughter and a son from about 4 to 5 years old. He can be found carrying water or washing the buffalo as well.