ADAPTATION TO NATURAL HAZARDS IN CENTRAL SULAWESI, INDONESIA – STRATEGIES OF RURAL HOUSEHOLDS

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To my mother

Christiane Marion Binternagel,

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SUMMARY

On the global scale, an increase in frequency and severity of potentially hazardous natural events has to be expected as a widespread phenomenon for at least throughout the 21st century. On the evidence presently available, it is not possible to state with confidence what are the root causes and mechanisms of this phenomenon. Regardless of how such changes are attributed, as human systems become more vulnerable to natural hazards, there is a greater need to understand responses that are able to counter potential future disasters. Such a response is known as adaptation.

Using empirical evidence from Central Sulawesi, Indonesia, this study aims to complement the current research by understanding the key adaptation processes and dynamics of rural households in areas exposed to changes in risk patterns. Households which theoretically possess the fundamental assets to implement an adaptation strategy might not necessarily decide to do so. The objective is, therefore, to investigate the adaptive behaviour of different household types towards natural hazards and to explain why certain households adapt to changing environmental circumstances and others may not. Consequently, this study will examine to what extent the adoption of adaptation strategies is not just determined by factors like resources and assets, but also by the decision-making processes of individual households in a hazard-prone, rural environment. To do so, three research questions have been developed:

(1) How is the perception of natural hazards at the household level configured?

(2) Are households adapting to natural hazards and are the measures leading to a reduction of vulnerability?

(3) Are there differences in the adaptive behaviour of different household types and what are the reasons for that?

For the analysis, a qualitative research design was selected. To judge the influence of a single method and to balance its results, a triangulation of 82 problem-centred interviews, six group discussions in form of Participatory Rural Appraisals (PRAs), and participatory observations in six villages around the Lore Lindu National Park (LLNP) were conducted. Hereby, interviews and PRAs were foremost utilised to capture opinions and attitudes while participatory observations identified open, visible patterns of activity. The 'Sustainable Livelihood Framework' (CHAMBERS & CONWAY 1991) functions as supporting structure for understanding and analysing the vulnerability and adaptation measures of the agricultural smallholders. For a more elaborate analysis of the decision-making process of rural

households and to answer the question why certain households do adapt and others not yet, the theory of 'Diffusion of Innovations' originally developed by ROGERS (2003) was applied.

Results indicate that almost all households in the research area have been affected by natural hazards. Drought represents the most common natural hazard. Further, floods and landslides are regularly recurring natural hazards. In the research area, both are mostly triggered as secondary hazards caused by torrential rain. Respondents hereby perceived an increased magnitude of torrential rain and interrelated impacts in the last ten years, resulting in severe impacts on their livelihoods.

Regarding the second research question, households in the research area are actually adapting to natural hazards. Various types of adaptation strategies have been identified dealing with different natural hazards on the household level. Most common strategies of adaptation are reactive and do not reduce the vulnerability of households in the future. However, the study also identifies anticipatory adaptation (ex-ante) strategies. If purposefully implemented, these strategies might alter the exposure of households to future natural hazards, reduce the sensitivity of plots and crops and in consequence reduce the overall social vulnerability of the agricultural smallholders. Nonetheless, anticipatory adaptation strategies are very rarely applied. Which means that only a small minority of households is actually reducing their vulnerability against natural hazards through adaptation measures.

Concerning the third research question, the investigation revealed the existence of major differences in the adaptive behaviour of the households. Main reasons for the inadequate implementation of anticipatory adaptations strategies are the lack of access to assets and resources as well as interethnic barriers and status homophily in knowledge transfer within the interpersonal networks. In addition, the perceived characteristics of ex-ante adaptation strategies by local households cause substantial obstacles, biasing the decision-making process towards an implementation of anticipatory adaptation strategies.

To diffuse anticipatory adaptation strategies further, the households can use already existing local institutions and customary decision-making structures at the village level. The main goal should be the strengthening of social capital to achieve a decrease in interethnic barriers and status homophily within the crucial interpersonal knowledge transfer. Also essential is the equitable participation of villagers, from different ethnic groups and with access to different assets, within the decision-making process of local village institutions.

RINGKASAN

Pada skala global, peningkatan frekuensi dan keparahan potensi bencana alam telah diperkirakan sebagai fenomena yang meluas setidaknya sepanjang abad ke-21 ini. Berdasarkan bukti-bukti penelitianyang tersedia pada saat ini belum dimungkinkan untuk menyatakan dengan pasti apa akar penyebab dan bagaimana mekanisme dari fenomena ini. Apapun penyebab perubahan tersebut, sistem kehidupan manusia menjadi lebih rawan terhadap bencana alam. Oleh karena itu ada kebutuhan yang lebih besar untuk memahami berbagai tanggap yang mampu menghadapi potensi bencana dimasa yang akan datang. Respon tersebut dikenal sebagai adaptasi.

Menggunakan bukti empirik dari Sulawesi Tengah, Indonesia, studi ini bertujuan untuk melengkapi penelitian yang sedang berjalan dengan cara memahami proses-proses adaptasi kunci dan dinamika rumahtangga pedesaan di area yang mengalamiperubahan pola resiko. Rumahtangga yang mempunyai aset dasar untuk menerapkan strategi adaptasi mungkin saja tidak memutuskan untuk melakukan strategi adaptasi tersebut. Oleh karena itu tujuan studi ini adalah untuk menginvestigasi perilaku adaptif dari tipe rumahtangga yang berbeda terhadap bencana alam dan menjelaskan mengapa rumahtangga tertentu beradaptasi terhadap perubahan keadaan lingkungan sementara yang lain tidak. Penelitian ini akan menguji sejauh mana adopsi strategi adaptasi tidak hanya ditentukan oleh faktor-faktor seperti sumberdaya dan aset, tetapi juga oleh proses pengambilan keputusan rumahtangga secara individu di lingkungan pedesaan yang rawan bencana. Untuk melakukan studi tersebut tiga pertanyaan penelitian dibangun:

(1) Bagaimanakah persepsi bencana alam pada level rumahtangga dikonfigurasikan?
(2) Apakah rumahtangga beradaptasi terhadap bencana alam dan apakah tindakan membimbing kepada penurunan kerawanan?
(3) Apakah ada perbedaan dalam perilaku adaptif pada tipe rumah tangga yang berbeda dan apa alasannya?

Desain penelitian kualitatif dipilih sebagai metode analisis. Guna menilai penggunaan metode penelitian dan untuk menyeimbangkan hasilnya, dilakukan triangulasi triangulasi 83 wawancara yang berpusat pada masalah (*problem-centred)*, enam diskusi kelompok dalam bentuk penilaian pendesaan partisipatif (PRA) dan observasi partisipasif di enam desa sekitar taman nasional Lore Lindu (LLNP). Wawancara dan PRA digunakan untuk memotret opini-

opini dan sikap-sikap, sedangkan observasi partisipatif untuk mengidentifikasikan kegiatan-kegiatan yang terbuka dan nampak. "Kerangka penghidupan berkelanjutan" dari (CHAMBERS & CONWAY 1991) berfungsi sebagai struktur pendukung untuk memahami dan menganalisa kerentanan dan langkah-langkah adaptasi para petani kecil. Guna memperdalam analisis dari proses pengambilan keputusan rumahtangga pedesaan dan untuk menjawab pertanyaan mengapa rumahtangga tertentu melakukan adaptasi sementara yang lain tidak, digunakan teori "difusi inovasi" dari ROGERS (2003).

Hasil studi ini mengindikasikan bahwa hampir semua rumahtangga di daerah penelitian terimbas oleh bencana alam. Kekeringan mewakili bencana alam paling umum. Bencana alam lain yang terjadi secara reguler adalah banjir dan tanah longsor. Keduanya kebanyakan dipicu oleh bencana alam sekunder yang disebabkan oleh hujan lebat. Responden merasakan peningkatan intensitas hujan lebat dan berbagai imbasnya sejak sepuluh tahun terakhir, menyebabkan dampak yang parah pada penghidupan mereka.

Sehubungan dengan pertanyaan penelitian kedua, rumahtangga di daerah penelitian secara nyataberadaptasi pada bencana alam. Teridentifikasi berbagai tipe strategi adaptasi terhadap bencana alam pada tingkat rumahtangga. Strategi adaptasi yang paling sering ditemui adalah strategi reaktif yang tidak mengurangi kerentanan rumahtangga dimasa yang akan datang. Akan tetapi, penelitian ini juga mengidentifikasi adanya strategi adaptasi yang antisipatif (ex-ante). Jika dilaksanakan dengan baik, strategi tersebut mungkin mampu mengubah paparan rumahtangga terhadap bencana yang akan datang, mengurangi sensitifitas petak tanaman dan tanaman dan karena itu mengurangi keseluruhan kerentanan sosial petani kecil. Namun, strategi adaptasi yang antisipatif muncul sangat jarang, yang berarti bahwa hanya minoritas kecil dari rumahtangga yang memang menurun kerentanannya nya melawan bencana alam melalui langkah-langkah adaptasi.

Mengenai pertanyaan penelitian ketiga, penelitian menemukanperbedaan perilaku adaptasi antar rumahtangga. Alasan utama dari ketidakmampuan untuk mengimplementasikan strategi adaptasi yang antisipatif adalah kurangnya akses terhadap aset dan sumberdaya serta hambatan antar etnis dan status (homophily) dalam transfer pengetahuan didalam jaringan interpersonal. Selain itu, karakteristik yang dirasakan dari ex-ante strategi adaptasi oleh rumahtangga lokal menyebabkan hambatan subtansial untuk membiaskan proses pengambilan keputusan terhadap implementasi dari antisipatif strategi adaptasi.

Untuk menyebarluaskan strategi adaptasi yang antisipatif, rumahtangga dapat menggunakan institusi lokal dan struktur adat untuk pengambilan keputusan pada tingkat desa. Ujuan

utamanya adalah penguatan sosial kapital untuk mengusahakan menurunnya hambatan antar etnis dan homophily dalam transfer pengetahuan interpersonal. Yang lebih penting selanjutnya adalah kesetaraan partisipasi penduduk desa, dari etnis yang berbeda dengan akses yang berbeda pada aset, di dalam proses pengambilan keputusan dari institusi lokal desa.

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1 INTRODUCTION

1.1 ADAPTATION TO NATURAL HAZARDS

According to the Intergovernmental Panel on Climate Change (IPCC), an increase in the frequency and severity of potentially hazardous natural events has to be expected as a widespread, global phenomenon for at least throughout the 21st century (IPCC 2001a, 2001b, 2007). While root causes and mechanisms of climate change are currently in the scope of a whole range of investigations, this study aims to complement ongoing research by understanding the key adaptation processes and dynamics of rural households in areas exposed to a change in risk patterns. On the evidence presently available it is not possible to state with confidence whether the described climatic trends in the study are evidence of a shift in conditions attributable to anthropogenic climate change, or are due to regional changes in land cover in recent decades, or are simply characteristic of local variability in the climate over the longer term. Regardless of how such changes are attributed, it will be shown that these climatic trends are affecting the households' livelihoods through natural hazards, and therefore the local population has to adapt to them, and continue to do so.

In South-East Asia droughts, torrential rain, floods and successive landslides constitute major hazards related to climatic dynamics. Specifically, an intensification of the El Niño-Southern Oscillation (ENSO) may aggravate inter-annual variations in precipitation and temperature, and thus harden the adaptive challenges for rural households. Tropical Indonesia constitutes an area exemplarily affected by climatic variability and fluctuations of ENSO. Many of these developments pose significant risks to human livelihoods (MCLEMAN & SMIT 2006). Hence, as human systems become more vulnerable to natural hazards, there is a greater need to understand responses that are able to counter potential future disasters. Such a response is known as adaptation (SMIT et al. 1999, IPCC 2001b). Adaptation takes place through adjustments to reduce vulnerability or to enhance resilience in response to observed or expected changes in climate and associated extreme weather events (IPCC 2007). An understanding of this process is not only important to widen the view on risk management in human systems in general, but it will also allow analysts and decision makers to assess vulnerabilities and potential future damages. In this context this study also aims to empirically respond to research demanded by BERKHOUT et al. in 2006 on the more subtle indirect effects of climate change and on knowledge of better choices about how to achieve efficient, effective and equitable adaptation. The currently emerging research on the subject suggests that vulnerability, through adaptive capacity and capacity development, is closely linked to

social, economic, and cultural processes (MCLEMAN 2010, LOPEZ-MARRERO 2010). However, adaptive capacity in one region or community is likely to differ from another, and even within any given population or community significant variations in adaptive capacity may be encountered (BURTON 1997, KELLY & ADGER 2000, SMITH & WANDEL 2006). Accordingly, not all members of a given population will necessarily live in similar socio-economic or cultural circumstances nor will they share similar access to resources that determine the range of possible adaptation strategies in a given environment.

It has been further recognised that population and demographic changes also influence adaptive capacity (MACKELLAR et al. 1998, O'NEILL et al. 2001, DYSON 2005). Changes in demographic characteristics impact on social capital, institutional arrangements, economic means and other community attributes which factor significantly into adaptive capacity (SMIT & PILIFOSOVA 2003, ADGER 2006, ZIERVOGEL et al. 2006). Yet, adaptive capacity does not always equal adaptation. Households which possess theoretically the fundamental assets to implement an adaptation strategy might not necessarily decide to do so. This study will examine to what extent the adoption of adaptation strategies is not just determined by factors like resources and assets, but also by decision-making processes of the individual households in a hazard prone, rural environment. Social drivers of adaptive behaviour are not yet fully understood in general (SMIT & WANDEL 2006) and, with respect to the local population in Indonesia, still emerging or lacking. The present study enhances this level of knowledge by investigating the reasons for different adaptive behaviour of rural households in Central Sulawesi, Indonesia.

1.2 OBJECTIVE AND RESEARCH QUESTIONS OF THE INVESTIGATION

The objective of the study is to investigate the adaptive behaviour of different household types towards natural hazards and to explain why certain households adapt to changing environmental circumstances and others may not.

Beginning in March 2007 the author undertook a one year-long investigation about the impact of natural hazards and the capacity of rural households around the Lore Lindu National Park (LLNP) in Central Sulawesi to adapt to those threats, and to identify potential barriers and opportunities for enhancing this capacity in the future. Based on this objective, the following research questions have been developed:

(1) How is the perception of natural hazards at the household level configured?

(2) Are households adapting to natural hazards and are the measures leading to a reduction of vulnerability?
(3) Are there differences in the adaptive behaviour of different household types and what are the reasons for that?

The theory of the 'Diffusion of Innovations' (ROGERS 2003) is used among other approaches to address these research questions. The investigation provides empirical evidence on dependencies for diffusion patterns from social and ethnical networks.

The research focuses on the household level through problem-centred interviews, various Participatory Rural Appraisals (PRAs), and participatory observations in six villages around the LLNP in Sulawesi, Indonesia. The 'Sustainable Livelihood Framework' of CHAMBERS & CORNWAY (1991) provided important tools to assess the households' adaptation strategies in the vulnerability context, the available assets and the resulting impact on livelihoods. The study distinguishes nine different household types based on land use and land size. The timeframe in question covers the last 15 years, while the investigative focus rests on processes, determinants and drivers which constrain or lead to adaptation of livelihoods of the households and of the natural resource systems on which societies in the research area depend. Thereby the study contributes to the practical understanding of adaptation as "research that focuses on the implementation processes for adaptation is still not common […] and certainly not in the climate change field" SMIT & WANDEL (2006, p. 285). Consequently, the author examines micro level adaptation strategies, highlights the underlying causes for the processes of adaptation, and explains what influences certain household types to implement anticipatory or ex-ante adaptation strategies which could reduce their vulnerability against future natural hazards.

1.3 STRUCTURE OF THE STUDY

The study has eight chapters. The regional characteristics of rural Sulawesi create a unique setting in which this study was conducted. The second chapter describes the research area and characteristics, such as topography, climate conditions and land use changes, and explains how these conditions influence the occurrence of natural hazards in the area. Further, the research villages will be described in detail. The focus hereby lies on demographic changes in the communities which, following MCLEMAN (2010), influence the process of adaptation to natural hazards.

Chapter three and four portray the main natural hazards of the research area, droughts, floods and landslides, and how a natural hazard becomes a natural disaster. In this context, the concept of 'Risk' has a guiding function. It leads to the conceptualisation and contextualisation of 'Vulnerability' as well as 'Adaptive Capacity'. With this in mind, the 'Sustainable Livelihood Framework' (CHAMBERS & CORNWAY 1991) will provide the supporting structure for understanding and analysing vulnerability and adaptation measures of the agricultural smallholders. Guided by the theory of 'Diffusion of Innovations' (ROGERS 2003) the investigation of the decision-making processes of rural households allows to arrive at insights regarding the reasons for differing adaptive behaviour.

Chapter five explains the methods chosen for the generation, processing and analysis of the field data. A triangulation of three qualitative methods will be applied, based on problem centred interviews, participatory observations and Participatory Rural Appraisals (PRAs). The tools for data processing and analysis consist in particular of commented transcriptions, postscripts and coding techniques.

The results will be presented in chapter six. The answers to the three research questions will be related to the 'Sustainable Livelihood Framework' as well as to the theory of 'Diffusion of Innovations'. To do so, the study will elaborate on the configuration of risk perception of natural hazards and of impacts on the household level. Then it will present adaptation strategies pursued by the households and will answer the second research question if households are factually adapting to natural hazards and if these measures are leading to a reduction of vulnerability. The correlation of land use and land size of households and strategies of adaptation from agricultural smallholders will subsequently be analysed to highlight the pattern of adaptation of different household types. This, together with the results on the examination of reasons for differing adaptive behaviour, will constitute the answer to the third research question. Eventually, highlighting the regional differences of impacts of natural hazards and strategies of adaptation through four selected examples will emphasise the major influence of regional diversity and social structures which either foster or hinder the resilience of communities in the face of natural hazards.

Finally, in chapter seven and eight the author interprets the results of the field study in the context of the leading research objective, elaborates on how individual findings correlate, and what conclusion may be drawn from this. A critical assessment of study design, methodological limitations, and potential shortcomings of the analysis is added to the

discussion as well as a comparison of the findings with other recent studies and how the results may be integrated into the current state of research.

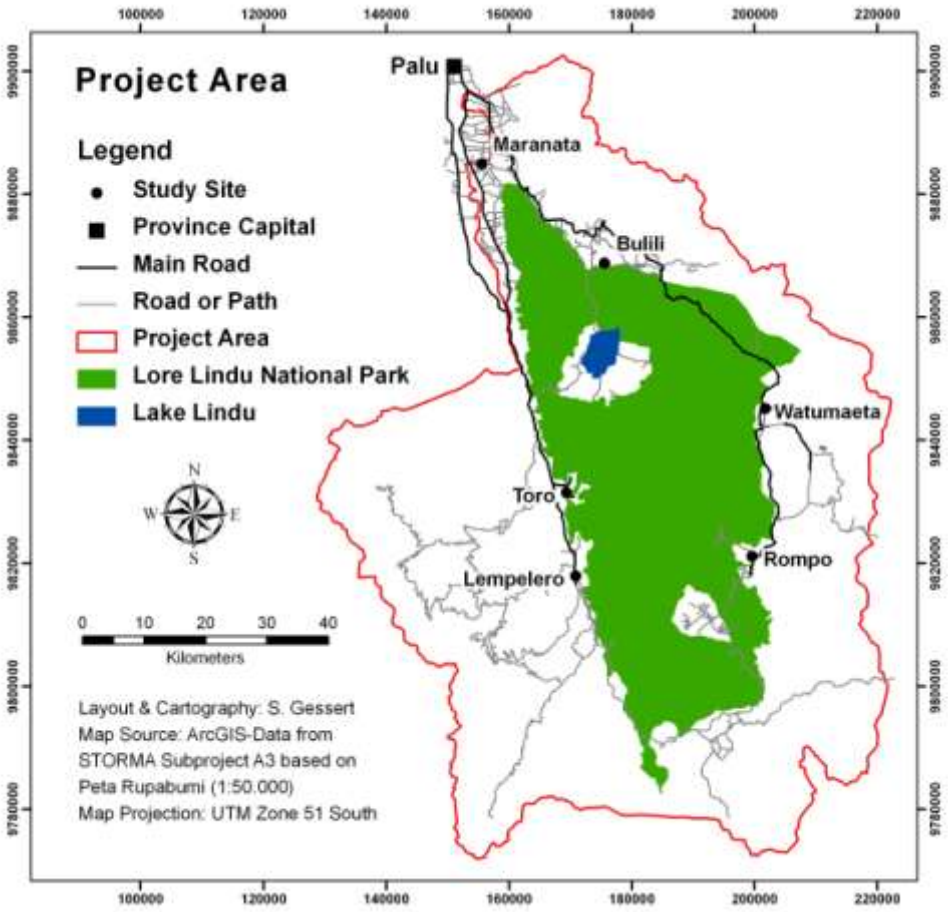
2 RESEARCH AREA

In this section the research area in Central Sulawesi will be introduced. By describing regional characteristics such as topography, climate conditions and land use change, it will be explained how these conditions influence the occurrence of natural hazards in the area. The six research villages will be described in detail. Hereby the focus will be laid on demographic changes and socio-economic characteristics, since – according to MCLEMAN (2010) – those alterations may influence the process of adaptation to natural hazards.

2.1 TOPOGRAPHY AND CLIMATIC CONDITIONS

The research region is located in Indonesia's Central Sulawesi province and covers approximately 7.200 km^2. As shown in Figure 2.1, the Lore Lindu National Park (LLNP) is situated in the centre of the research region towards the south of the provincial capital of Palu.

Figure 2.1: Project Area.

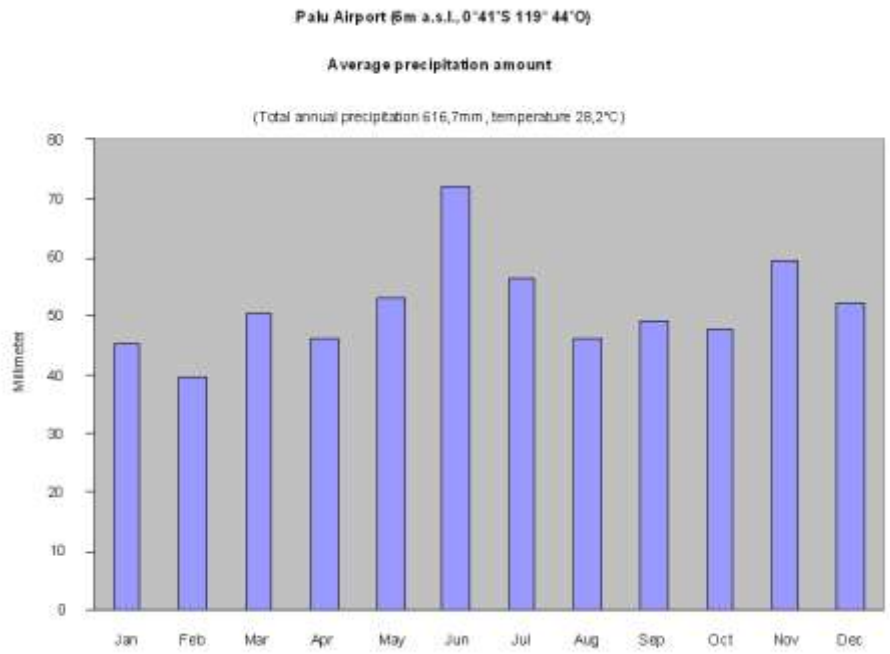


In 1978 the Lore Lindu region was declared as UNESCO Man and Biosphere Reserve and in 1982 LLNP was founded. The main physio-geographical characteristic of the research area is the 12 km wide and 45 km stretched Palu Valley which runs in north-south direction. The

valley is bordered east and westwards by mountains ranges up to 2000 m.a.s.l. and is attached to the narrow Palu Bay. Further important characteristics are the Napu, Besoa, Kulawi, Palolo, and Gimpu Valleys. All of them are represented in the study through a respective research village. The natural vegetation of the research area ranges from a semi-arid meso-climate in the northern Palu Valley (Maranata) to a humid rainforest climate in the more mountainous regions and southern parts of the research area (WEBER 2005).

The climate in the research area is described by GUNAWAN (2006) as a mixture between a monsoonal and anti-monsoonal type due to the heterogeneity of the topography within a short distance. The geographical position of the Palu Bay and the existence of the inland Palu Valley generate a land-sea breeze circulation along the valley. In addition, the rainfall regime in flat regions differs from the one within mountainous regions. A region on the windward side of the mountains affected by land-sea breeze circulation like in Bogor, West Java, receives high amounts of rainfall throughout the year. On the contrary, in the Palu Valley, which is a leeward region for the main wind directions, the air flow is dominated by subsiding air (ibid. 2006). Consequently, with four to six dry months and a sum of average annual rainfall of just 617 mm (see Figure 2.2), the coastal zone around the provincial capital city of Palu is among the driest regions in Indonesia. Within about 35 km, this semi-arid meso-climate at sea level turns into a humid rainforest climate with annual precipitation rates of 3,000 to 4,000 mm within LLNP (KEIL 2004).

Figure 2.2: Average monthly precipitation at Palu between 1996 and 2008.



Source: Hein (2009)

Factors such as the geographical position, the existing of a local land-sea breeze circulation, the windward and leeward sides are affecting local climate conditions and lead to complex local climate patterns in the research area. On the one hand these factors generate an average annual precipitation of less than 620 mm and the occurrence of agricultural droughts in the Palu Valley, and on the other hand, intense precipitation and convectional rainfall which may support the occurrence of floods and landslides within a short distance.

2.2 DEMOGRAPHY AND SOCIO-ECONOMIC CHARACTERISTICS OF THE RESEARCH VILLAGES

After the outline of topographic and climatic conditions in the research area, which may already facilitate the occurrence of natural hazards, the next sub-chapters will present a more detailed description of the six research villages and their distinctive characteristics. Here, demography and socio-economic characteristics in form of population dynamics, migration issues, and ethnicity will be elucidated along with aspects of land availability, natural resource management, and land titles since all of these factors influence the adaptation to natural hazards.

This study searched for patterns to explain reasons for the different adaptive behaviours of households in Central Sulawesi according to their land use characteristics. The selection of households was based on a cluster analysis from SCHIPPERS et al. (2007) in the same research area, who classified all households in three villages by land use aspects. As a result, the three villages Toro, Lempelero and Bulili covered in the respective cluster analysis were selected for the present study. Additionally, in 2008 three further villages (Watumaeta, Maranata and Rompo) were included in the present study because they differ in their development dynamics (migration), composition of population (ethnicity), transformation process (land use and land availability) as well as climatic conditions (altitude) from the census-villages (FAUST et al. 2003, WEBER 2006, WEBER & FAUST 2006). In these three additional villages respondents were chosen by applying Participatory Rural Appraisals (PRAs) and informal interviews with village representatives and key informants to identify households which fit into the household classification characteristics developed by SCHIPPERS et al. (2007).

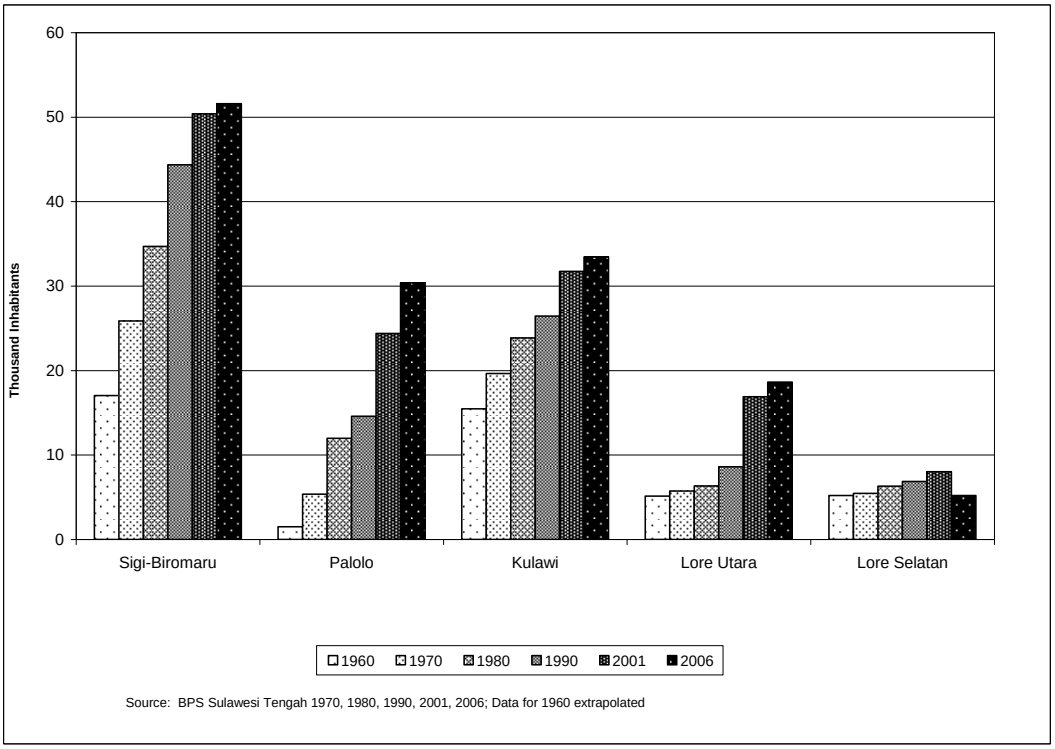
While all households are exposed to risks associated with climate change and could potentially be rendered vulnerable, the poorer households are the most at risk. Following HELTBERG et al. (2009), the reasons therefor are the lack of access to formal and informal risk

management arrangements and the fact that assets and livelihoods of poorer households tend to be highly exposed and sensitive to the direct and indirect risks associated with climate change. Within the research area about 20% of the households live on less than US$ 1 per capita per day (purchasing power parity) and almost half of the population falls below the international poverty line of US$ 2 (purchasing power parity) (VAN EDIG 2005). These figures may already highlight the need for adaptation of agricultural smallholders in the research area. The population size in the region is estimated to be 136,000 people, with a population density of 27.4 people per km^2 (excluding the LLNP area). The two northern sub-districts, Sigi Biromaru and Palolo, are much more densely populated, with 86 and 43 people per km^2 respectively, in comparison to the remaining sub-districts with 10 people per km^2 (SEEBERG-ELVERFELDT 2008).

Of particular interest is the population change as it can affect vulnerability to climate change through the modification of adaptive capacity (MCLEMAN 2010). The influence of demography on adaptation may be experienced indirectly, for instance through changes in the nature and composition of social networks and social capital in a given population. MCLEMAN et al. (2008) for example, have shown how the out-migration of young families from rural Eastern Oklahoma during droughts in the 1930s altered the demographic and social composition of the communities they left behind, resulting in an overall decline in adaptive capacity in rural communities. However, while changes in the demographic composition of a given population may lead to consequent changes in the overall capacity of that population (and of households within it) to adapt to climate change, the outcome might be negative or positive. Thus, in coastal villages in Vietnam, ADGER et al. (2002) found in turn that the out-migration of young workers form villages to cities and frontier areas has resulted in a stream of remittances that are in turn being used to enhance livelihoods in the place left behind.

As Figure 2.3 shows, there is continuing strong population growth in the research area since the last decades. According to MAERTENS (2006), the population in the research area has risen by 60% over the last 20 years. In Palolo for example population growth between 1960 an 1980 has increased by more than 100% within each decade.

Figure 2.3: Population Dynamics within the Lore Lindu Region.



The rates of population growth over such a long time are exceeding by far the natural population growth and are caused by migration patterns (WEBER 2006). The causes for such a strong population growth are local migration within the research area from remote areas (Lore Selatan or the hillsides of the Pipicoro region) to Sigi-Biromaru and, in addition, regional migration (WEBER 2006). The latter, in particular, is of major importance as it brings about sizeable changes of the cultural landscape and the social structures/networks in the villages of in-migration, which in turn influence the exposure of plots and the adaptive behaviour of the inhabitants (ibid.). The main change in the cultural landscape has been caused by Buginese migrants from South Sulawesi in the 1990s, who had already arrived in the 1980s, predominantly in Palolo and Lore Utara. Major pull factors were the availability and suitability of land for cacao production, the increasingly improved infrastructure extended from the main cacao market in Palu to the two sub-districts as well as the boom of the cacao prices (WEBER 2005). In both sub-districts migrants constitute about 21% of all households (MAERTENS 2003). The process of in-migration into the research area has increased the diversity of ethnic groups in the research villages. Furthermore, if one compares the villages, it frequently leads to a variable intense spatial segregation of those ethnic groups into different living areas (WEBER 2006). That segregation might in turn create impacts on the social networks, memberships, and communication behaviour of households at the village

level. Following the description of the research area and the respective sub-districts, as a next step the situation in the particular research villages will be introduced..

Watumaeta is situated in the Napu Valley in the sub-district of Lore Utara at an altitude of 1,300 m.a.s.l. and therefore along with Rompo the highest located research village. The distance to the provincial capital Palu is 102 km. Founded in 1926 by local Napu people, today Watumaeta has 1,562 inhabitants (BPS 2006). At first, only local and Kulawi households settled in the area. The indigenous families are mainly from the nearby villages Wuasa and Alitupu, which used the area as hunting ground (WEBER 2005). Starting in the the 1930s, migration from outside was mainly restricted to some Toraja families. The first Buginese had entered Watumaeta in the early 1960s and their numbers rose slightly again during the 1980s. In the mid 1990s in-migration became a 'political' factor in village life, when a great number of Buginese and Makasarese migrants came to Watumaeta. This migration stream can partly be attributed to the completion of the asphalt road from Palu in the early 1990s, but the most significant pull-factor was the availability of large, flat land areas (see Figure 2.4) that were administered by a responsible village head who posed almost no restrictions on in-migration and offered a secondary forest to newcomers almost at will[1].

Figure 2.4: Wet rice fields in the plains of the Napu Valley.

Source: own picture, Watumaeta (2008)

Watumaeta opened another frontier area for in-migration in 1998 when a new wave of migrants came in search of land, partly influenced by the economic crisis and the high cacao prices at that time (BURKARD 2002a). Impacts of this migration are the extension of the

[1] The position of the former village head was threatened by plans of the provincial government to form one village out of

village in eastern direction, where mostly houses of migrants from South Sulawesi and Java are located. Most of the different ethnic groups in Watumaeta (local: Napu and Besoa, migrants: Buginese, Javanese, Poso, Sundanese) live in clearly demarcated compounds or *dusuns* and intermarriage rarely happens. Locals are represented by the *lembaga adat* (customary village council) and migrants by the Buginese *kepala dusun* (compound head). Regarding resource management, the *lembaga adat* is actively involved in the 'struggle' over natural resources in claiming ancestral land inside LLNP and is entitled to enforce sanctions in case of rule infraction (BURKARD 2002b). After an increased aggregation of the settlement area in Watumaeta, another was added, which was mainly populated by Buginese. However, in the meantime this settlement and farming area expands far beyond the official border of the LLNP (WEBER 2005). Agricultural cultivation is already far inside the LLNP (see Figure 2.5) and vegetables, shadow trees and young cacao trees can be found until the edges of the valley slopes.

Figure 2.5: Agricultural cultivation within the national park (the motorbikes stands at the official LLNP border).

Source: own picture, Watumaeta (2008)

The village **Maranata** is situated in the driest region within the project area, the Palu Valley with a mean annual precipitation of less than 620 mm. The five *dusuns* of Maranata are spread on just 8.65 km^2 at an altitude of 200 to 300 m.a.s.l. in the sub-district of Sigi-Biromaru. Out of the six research villages it represents with a total population of 2,453 people and 284 inhabitants per square kilometre the densest populated village and the village with the highest population in total (BPS 2006). Maranata was founded in 1969 as a governmentally planned migration-village. Participants of the migration programme are mainly from the western and eastern mountains of the Palu Valley and belong to the ethnic groups of Kaili

Da'a (WEBER 2005). According to HEIN (2009), the migration programme was conducted to avoid further erosion damages on the hillsides due to the practised shifting cultivation. From importance for the resilience of the village is the connection to the Gumbasa irrigation system (see Figure 2.6) established in 1980, which allows intense wet rice cultivation independently from the high exposure Maranata's to lack of precipitation.

Figure 2.6: Gumbasa Irrigation System.

Source: Hein, Maranata (2009)

The water from the irrigation system is delivered by the Gumbasa River, which has a catchment area of 2,694 km^2, 41% thereof covered by tropical rainforest (LEEMHUIS 2005). However, the *dusun* 'Lompio' – where several investigations were conducted – is located above the irrigation system and is thus not connected to irrigation. In addition, Maranata owns a weekly market place of regional importance. Thereby, the inhabitants may buffer economic hardship from harvest failures through natural hazards by the realisation of earnings from off-farm income.

Rompo is located at an altitude of 1,300 m.a.s.l. in the Besoa Valley within the sub-district Lore Tengah. The distance to the provincial capital is 135 km. Thus, of all research sides Rompo is the village most remote from the provincial capital Palu. 443 people live in Rompo with a population of seven inhabitants per square kilometre (BPS 2006). Therefore, Rompo represents one of the least densely populated research villages. Following BURKARD (2002a),

the village was founded in 1923 by local families from the nearby Parigi village. In spite of the fact that some Buginese families had temporarily settled in Rompo during the 1970s and 1980s, until ten years ago approximately 95% of the Rompo inhabitants were local Besoa people. This changed in 1999, when 105 households from the Toraja ethnic group moved to Rompo within a planned migration scheme in search of agricultural land (HEIN 2009). However, their expectations of agricultural perspectives being unfulfilled, about 60 of them already left Rompo around 2002. Rompo is surrounded by the national park and community forest. Only community forests are open for conversion of forest into agricultural land (see Figure 2.7), while the National Park has been formally declared as 'prohibited area' in regard to agricultural conversion (BURKARD 2002a). Within the village organisation, the *lembaga adat* plays an important role in Rompo by participating in the creation and enforcement of village rules regarding the use of natural resources (BURKARD 2002b).

Figure 2.7: Conversion of community forest into agricultural land.

Source: own picture, Rompo (2007)

Toro is located within the sub-district of Kulawi at an altitude of 700 m.a.s.l. within the Kulawi Valley. The village represents almost an enclave inside LLNP. Free and accessible land is relatively limited; consequently, the traditional village council strictly regulates migration and land transactions (KOCH 2008). In 2001, Toro was granted a wide autonomy over about 22.95 km^2 of forest land – community forest – to regulate and monitor its utilisation by the villagers as a result of negotiations since access to forest resources had been

officially suspended in 1982 (FREMEREY 2002). Toro is characterised by low immigration and a high share of autochthonous ethnicities. The population structure can be characterised as traditional and static. There are only minor migration processes which have even been decreasing steadily over the last 15 years (WEBER et al. 2007). The village has 2,057 inhabitants with a population of 41 inhabitants per square kilometre (BPS 2005). As shown in Figure 2.8, the land use is characterised by a large amount of wet-rice fields in the valley.

Figure 2.8: Toro and community forest inside LLNP.

Source: KOCH (2008)

In addition, seasonal mixed cropping and agroforestry systems (mainly coffee and cacao) are found, in particular on the slopes of the village (KOCH 2008). The cacao produce is clearly used as cash crop and sold locally to middlemen. Seldom have the agricultural smallholders sold their cacao in Palu at the main market. However, the wet-rice yield will be sold only after getting a sufficient harvest. Primarily, the yield is used for home consumption and as instrument of payment (DIETRICH 2006). Toro is one of the oldest settlements in the Lore Lindu region and has a variety of different ethnic groups as well as a strong emphasis on traditions. The majority of the population are Christians (86%), whereas Muslims with 14% represent the second largest religion The major ethnic group in Toro are the local Moma followed by Rampi (migrated from South Sulawesi) and the local Uma (DIETRICH 2006). In Toro's seven different *dusuns* ethnic segregation is existent. The majority of the indigenous ethnic Moma settled in *dusun* one and two which are also the oldest parts of the village. *Dusun* five, six and seven are relatively recent establishments. Thus, the majority of migrant

household lives in these *dusuns*. Hereby, *dusun* five and seven are dominated by the Rampi ethnic group, whereas the majority of households in *dusun* six belong to the Uma (WOELLERT 2006).

Bulili represents a young and dynamic migrant village at an altitude between 500 and 700 m.a.s.l. in the Palolo Valley in the north-eastern edge of the LLNP. The village was only founded in the 1970s under the name Nopu, obtained legal independence in 2004 from the village Rahmat, and was at the same time named Bulili (KEMPER 2005). Bulili has 1,555 inhabitants with a population of 212 inhabitants per square kilometre and is located in the sub-district of Palolo (BPS 2005). The amount of inhabitants per square kilometre represents the second largest out of all villages and shows along with the land use form the high influx of regional migrants – mostly Buginese from South Sulawesi – who have determined land use during the last 30 years as well as local migrants who were among the first settlers in the 1970s. Less than 5% of the household heads were born in the village and a large share of the village's inhabitants belongs to non-local ethnic groups (46.7%). Most of the people originate from the province of South Sulawesi (79.4%). The rest of the village's population is formed by local and regional migrants (SCHIPPERS 2007). The majority of the population belongs to the Kaili ethnic group; the second largest group are Buginese originally from South Sulawesi. In contrast to Toro, more than 80% of the population are Muslims, whereas Protestants represent with 18% the second largest religion. While all Buginese people are Muslims, the religious affiliation of the Kaili ethnicity is different (KEMPER 2005). In Bulili's different *dusuns* ethnic segregation is existent as well. In contrast to Toro, the ethnic affiliation is stronger accented. Further, there are almost no interethnic marriages conducted between Kaili and Buginese (WOELLERT 2006). Moreover, WOELLERT (2006) found that in Bulili there exists an economic differentiation according to ethnicity and religious affiliation, which differs from the situation in Toro. The Kaili ethnic group represents with 70% the poorest class (Buginese = 23%), while the least poor class is dominated by Buginese with 62% (Kaili 36 %). With respect to religious affiliation, the differences are even clearer. Here, 79% of all Protestants belong to the poorest class, whereas the majority Muslim households are concentrated in the less and least poor class (39% and 38%). Bulili is characterised as a 'quite dynamic or post transitional' village type (WEBER et al. 2007). In the 1980s the Palolo Valley was sparsely populated in contrast to the lower Palu plain. Hence, many Buginese migrants – mostly well educated in cacao cultivation – settled in the Palolo Valley such as Bulili. In the

past, Bulili's agricultural land mainly consisted of wet rice fields, which today, as shown in Figure 2.9, have been converted to intensive cacao plantations (KOCH et al. 2008).

Figure 2.9: Cacao plantation in Bulili.

Source: STEINER (2008)

The share of wet rice cultivation in the whole land use in Bulili has decreased to marginal 0.3%, whereas the cultivation of cacao has increased to 85% (KEMPER 2005). Furthermore, no irrigation system exists in Bulili (DIETRICH 2006). Due to land scarcity and high population density cacao plantations and houses today are located even on the river plain closed to meanders which leads to severe impacts in times of flooding.

In addition, the whole area south of the road is bordering the LLNP. Here the relief steps up from 600 to 1,400 m.a.s.l. However, until 950 m.a.s.l., cleared forest can be found on precipitous slopes. Above that altitude, primary forest still exists but is already being used for rattan and timber extraction (DIETRICH 2006).

Lempelero was founded 1972 at an altitude of 500 m.a.s.l. at the southern end of the main asphalt road to the west of LLNP in the Gimpu Valley in the sub-district of Kulawi. The majority of its 1,157 inhabitants (BPS 2005) are Christian. With a population of six inhabitants per square kilometre (BPS 2005) Lempelero represents the least densely populated research village. However, its population doubled within the last ten years, and the village shows enormous demographic dynamics with a significant proportion of migrants nowadays

due to the abundance of easily accessible forest/agricultural land (KOCH et al. 2008). Rather a cause for the low amount of inhabitants per square kilometre is the large village size of 190 km^2 (compare Figures 2.10 and 2.11), as the three *dusuns* of the village are separated by up to ten kilometres from each other.

Figure 2.10: Lempelero and Lore Lindu National Park.

Source: KOCH (2008)

Figure 2.11: Gimpu-Valley, Lempelero.

Source: Steiner (2008)

Owing to its remarkable in-migration process Lempelero has been characterised as a 'village in transition' by WEBER et al. (2007). Wet rice cultivation is a subordinate type of land use, while agroforestry systems dominate the village's agriculture.

2.3 LAND USE CHANGE

Of particular interest for the present study is the process of deforestation. Consequences of deforestation are droughts, increased risk of flooding, erosion, soil degradation, and reduced water availability (BILSBORROW & DELARGY 1990, SUHRKE 1994, BILSBORROW 2002, BRADSHAW et al. 2007). At first glance, the above mentioned consequences seem to be contradictory processes but within the context of deforestation all of them are closely connected. Many tropical soils for instance are nutrient-poor therefore causing the decline of high yields just after a few years. Therefore, the traditional way of agriculture has been shifting cultivation. However, increased population density leads mostly to a shorter period of land ploughing, which in turn constrains the regeneration of forest and soil and supports soil degradation (EL-HINNAWI 1985, RÖSLER 2004). Moreover, according to BILSBORROW (2002), deforestation leads to increased water surface flow and decreased replenishment of underground water aquifers (because of the lack of vegetation to slow down water runoff and the lack of tree roots to channel the water downwards). Even in regions with high precipitation rates, negative impacts on crop production can take place due the fast water runoff which reduces the water availability and enhances the probability of flooding (METZNER 1981, EL-HINNAWI 1985, BILLSBORROW & DELARGY 1990). Furthermore, on a regional scale, deforestation reduces rainfall in two ways. First, as SALATI & VOSE (1984) pointed out, water vapour produced by forest through evapotranspiration contributes substantially to rainfall. Second, following ROSENFELD (1999) and ACKERMAN et al. (2000), smoke from forest fires can reduce rainfall and possibly cause cloud cover by trapping moisture and inhibiting the formation of raindrops. Thus, large-scale deforestation could cause a decline in rainfall, leading to lower humidity, higher surface temperature, and more severe dry seasons with greater drought stress and still more fires and forest conversion (SHUKLA at al. 1990, LAURANCE & WILLIAMSON 2001).

In the research region deforestation is still an ongoing process (see Figure 2.12). Between 1983 and 2002 the mean annual deforestation rate in the research region was 0.3% (ERASMI & PRIES 2007). The figure is less than the mean annual deforestation rate for the whole of Indonesia which was 2% between 2002 and 2005 (FAO 2006). However, as ERASMI et al.

(2004) pointed out, encroachment processes at the forest margins cannot be fully reflected because e.g. cacao plantations under shade cannot be detected by optical satellite instruments.

Figure 2.12: Forest conversion inside LLNP near Bulili.

Source: KOCH (2008)

Furthermore, there is a great spatial heterogeneity of agricultural production in the research region. For example in Palolo, one of the main valleys encompassing the research village of Bulili, the closed forest decreased by 35% between 2001 and 2004 due to logging, whereas the area covered by cacao plantations increased by 11%. (ROHWER 2006). Further examples are the loss of approximately 2,200 ha of forest belonging to the LLNP in Dongi-Dongi in the north east of the research region due to extensive illegal logging activities in 2001 (ERASMI et al. 2004) and the expansion of agricultural areas by 20% during the last two decades along with clear-cut logging activities (SEEBERG-ELVERFELD 2008).

As a matter of fact the occurrence of droughts, floods and landslides in the research area is directly and indirectly originated and intensified by topographic and climatic conditions as well as the ongoing process of deforestation.

2.4 NATURAL HAZARDS

Main focus of this sub-chapter are the phenomena of droughts, floods, and landslides, as these natural hazards frequently occur in the research area.

2.4.1 Drought

According to the IPCC, 'Drought' in general means "The phenomenon that exists when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect land resource production systems." (IPCC 2007).

Figure 2.13: Dried up fields with irrigation channel.

Source: own picture, Watumaeta (2008)

For a more detailed description WILHITE & GLANTZ (1985) reviewed more than 150 published definitions of drought and clustered them into four types – meteorological, agricultural, hydrologic, and socio-economic droughts. In the context of the present study, agricultural drought is the relevant concept under investigation. Following KEIL (2004), agricultural drought occurs when soil moisture is insufficient to meet the requirements of a particular crop at a particular stage of the growth cycle, resulting in a decline in yield. Hence, meteorological drought is the prerequisite for agricultural drought, but, for a given amount of rainfall, the incidence and severity of the latter depends on the type of agricultural land use and soil properties.

2.4.2 Flood

'Flood' is a rise, usually brief, in the water level of a stream to a peak from which the water level recedes at a slower rate and is characterised by a relatively high flow as measured by stage height or discharge (IHP/OHP 1998). Main causes of floods are intense precipitation (over a short time), continuous rain (over longer time), and snow melt (KELLER 1962). Primary effects of floods are widespread damages to all types of structures (e.g. buildings, canals, roadways, and bridges), loss of human lives, livestock, and crops (see Figure 3.2). Secondary effects might be food shortage caused by the loss of the harvest and water-borne diseases. Long-term effect could be economic hardships, due to e.g. increases of food prices.

Figure 2.14: Flooding of a cacao plantation in the Palolo Valley.

Source: own picture, Kapiroe (2008)

Flooding types in Indonesia are diverse. Due to the regional focus in Central Sulawesi's mainland, the study does not take into account special cases such as coastal floods (e.g. tsunamis), or floods caused by snow melt or volcanism. The most common floods in the research area are caused by very intensive precipitation in a short period of time by e.g. convectional rainfall. Floods are characterised by fast responding catchments, high velocity flow, and a short period of time between intense rainfall and peek flow.

2.4.3 Landslide

A 'Landslide' is, according to the IPCC (2007) (see Figure 3.3), a mass of material that has slipped downhill by gravity, often assisted by water when the material is saturated; rapid movement of a mass of soil, rock, or debris down a slope. Landslide affected areas possess a certain disposition such as slope geometry, material property of the substrate, or vegetation covering. These dispositions and their changes, for example affected through forest conversion into arable land, set preconditions for the occurrence of landslides. They influence the stability of the slope but do not launch the movement. The landslides themselves get mostly triggered by precipitation of high intensity or long lasting periods of humidity (GLADE & STÖTTER 2008).

Figure 2.15: Landslide in the Kulawi Valley on the main road to Toro and Lempelero.

Source: own picture (2007)

3 THEORY, CONCEPTS AND FRAMEWORK

This section focuses on how a natural hazard becomes a disaster. At first, the concept of 'Risk' will be introduced, as it is the overall concept encompassing all further terms and definitions. Next, out of the 'Risk' concept the section will explain the concept of 'Vulnerability' with 'Adaptive Capacity' as a part of it. Thus, closing the gap between natural hazards on the one hand and 'Adaptive Capacity' on the other hand will be the main task of this chapter. After the terms are clarified, the 'Sustainable Livelihood Framework' is going to be introduced. It functions as supporting structure for understanding and analysing the vulnerability and adaptation measures of the agricultural smallholders. Finally, to explore the reasons for differences in adaptive behaviour, the decision-making process of the agricultural smallholders is of interest. Therefore, the theory of 'Diffusion of Innovations' developed by ROGERS (2003) will be explained.

3.1 DEFINITION OF TERMS AND CONCEPTS

The concepts of risk, vulnerability, adaptation, adaptive capacity, and resilience find wide application in the field of global change science and the analyses of these concepts range tremendously in scale (SMIT & WANDEL 2006). Due to continuing debates of scientists in various academic disciplines, there is the need to apply these terms coherently to the object of interest using the most recent and accepted definitions. In this study all terms are applied in the context of adaptation processes of human communities to natural hazards.

3.1.1 Hazard, disaster and the concept of risk

How becomes a hazard a disaster? Following the International Strategy for Disaster Reduction of the United Nations (UNISDR 2004), a 'Hazard' means a potentially damaging physical event or occurrence that may cause the loss of life or injury, property damage, social and economic disruption, and environmental degradation. Thus, the 'Hazard' has the potential to cause damages but not necessarily causing them. THYWISSEN (2002) describes 'Disaster' as a serious disruption of the functioning of the society causing widespread human, material or environmental losses which exceed the ability of the affected society to cope using only its own resources. This implies that a 'Hazard' might lead to a 'Disaster'; however, whether this happens or not depends on various factors which are described in the risk concept. UNISDR (2004: 16) defined 'Risk' as "The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable

conditions." Conventionally, risk is expressed by the notation Risk = Hazard x Vulnerability. Floods, landslides and ENSO related droughts will present the natural hazards in the risk concept for this study. Based on this equation, risk is just existent if (1) there is an existing objective and identifiable hazard; and (2) the society is vulnerable. Consequently, risk has to be defined for individuals and societies referring to a specific place (KRÜGER & MACOMA 2003).

3.1.2 Vulnerability and resilience

The degree to which such risks may cause loss or harm is typically described by climate change researchers in terms of 'Vulnerability' (ADGER et al. 2007). The concept of 'Vulnerability' is under permanent discussion and not explicitly defined. It is still in a developing process and challenged by various schools of thought. One mayor development in this discussion is the shift from impact analysis to vulnerability analysis introduced by BURTON et al. (2002). The former view focuses on predictions of climate events and shifts in climate parameters such as precipitation or temperature, whereas the latter seeks to understand the root causes for losses incurred due to these factors, also recognising that communities are subject to multiple and cumulative stresses (HAMILL et al. 2005).

A general conceptual model of 'Vulnerability' has emerged in the climate change literature (KELLY & ADGER 2000, SMIT & PILIFOSOVA 2003, TURNER et al. 2003, YOHE et al. 2003, ADGER 2006). Consistent throughout the literature is the notion that the vulnerability of any system is a function of the sensitivity of a given population and its social, political, economic, and institutional systems to particular impacts or perturbations associated or caused by climate change; the particular degree and nature of the exposure of members of the population or items to those impacts; and, the capacity of an exposed population to adapt to or to cope with those impacts (ADGER 2006).

V = f (Exposure, Sensitivity, Adaptive Capacity)

Hereby, 'Sensitivity' is seen as "[…] the degree to which a system is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g. a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g. damages caused by an increase in the frequency of coastal flooding due to sea-level rise)" (IPPC 2007: 881). Following UNDP-BCPR (2004), exposure are the elements at risk, an inventory of those people or artefacts that are exposed to a hazard. Of particular

interest for this study is the adaptive capacity of the agricultural smallholders. 'Adaptive capacity' means "The potential or ability of a system to adapt to the effects or impacts of climate change. Enhancement of adaptive capacity represents a practical means of coping with changes and uncertainties in climate, including variability and extremes. In this way, enhancement of adaptive capacity reduces vulnerabilities and promotes sustainable development" (IPCC 2001: 881).

However, vulnerability is not merely registered by exposure or sensitivity to hazards alone; it also resides in the resilience of the system experiencing the hazard (TURNER et al. 2003). 'Resilience' is defined as the capacity of a system to absorb disturbance and reorganise while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks (WALKER et al. 2004). As shown by BERKES (2007), resilience is important for the discussion of vulnerability for three reasons. First, it provides an all-hazard approach, consistent with trends in hazard research to evaluate hazards holistically (HEWITT 2004). Second, resilience puts the emphasis on the ability of a system to deal with a hazard. It allows for the multiple ways in which a response may occur, including the ability of a system to absorb the disturbance, or to learn from it and to adapt to it, or to reorganise following the impact. Third, because it deals with the dynamics of responses to hazards, resilience is forward-looking and helps explore policy options to deal with uncertainty and change. As TOMPKINS & ADGER (2004) put it, building resilience into human-environment systems is an effective way to cope with change characterised by future surprise or unknowable risk. Following BERKES (2007), of particular importance for building resilience are the nurturing of various types of ecological, social and political diversity for increasing options and reducing risks and, in addition, the creation of opportunities for self-organisation including strengthening of local institutions and building cross-scale linkages and problem-solving networks.

3.1.3 Adaptation and adaptive capacity

Adaptation to climate change is believed to take on any number of forms or actions, may be enacted at any scale from the local to the global, and may be undertaken proactively or as a reaction to particular climate-related risks and opportunities (YOHE 2000, SMIT & PILIFOSOVA 2003, ADGER et al. 2007). Thus, societies can respond to natural hazards by adapting to their impacts and thereby reducing the sensitivity to the hazard. Following SMIT & WANDEL (2006: 286) "Adaptations are manifestations of adaptive capacity, and they represent ways of reducing vulnerability". Hence, system modifications in order to better cope with problematic

exposures and sensitivities finally reflect adaptive capacity. In addition, adaptive capacity has been found to be highly responsive to social relationships, economic conditions, cultural norms as well as political and institutional arrangements (ADGER & KELLY 1999, HANDMER et al. 1999, O'CONNOR et al. 1999, YOHE & TOL 2002).

Adaptation can be separated in 'reactive adaptation' and 'anticipatory adaptation' according to their timing relative to the stimulus (ADGER 2005). Reactive adaptation implies ex-post, short term coping strategies, triggered by past or current events. Anticipatory adaptation contains ex-ante or long-term strategies that take place before impacts of climate change are observed. They are based on an assessment of conditions in the future. Adaptation can be further categorised on the level of preparation and outside intervention, it can be either planned or autonomous (TOL et al. 2008). Examples for planned interventions to promote adaptation include the establishment of Flood Early Warning Systems in areas seen as vulnerable to future floods, and the adoption and dissemination of more drought-resistant crop varieties in areas increasingly exposed to drought (JONES 2010). However, the present study focuses on autonomous adaptation strategies, which are considered to take place without the intervention of a public agency (AGUILAR 2001). However, adaptation is not similar to adaptive capacity. Households who possess the essential assets to carry out an adaptation strategy are not necessarily implementing such activities. The action itself is determined through the decision-making process of the individual household.

Development in adaptive capacity research emphasises the need to contribute to practical initiatives that address and improve the capacity of communities and individuals exposed to natural hazards to deal with them (FORD & SMITH 2004, FÜSSEL & KLEIN 2006, LOPEZ-MARRERO 2010). Such practical application contrasts with past analyses that focussed on assessments that did not necessarily investigate local situations influencing the process by which adaptations occur. Consequently, these earlier assessments failed to identify the needs or opportunities for proposing and implementing local initiatives (SMITH & WANDEL 2006). The present study emphasises the local level, particularly rural agricultural smallholders that might be exposed to natural hazards and that potentially face increased future exposure resulting from environmental change.

ADGER (2005) stressed out that the absolute assessment of successful adaptation is quite problematic. Additionally, SMIT & WANDEL (2006) highlighted that vulnerability is a dynamic process with all elements and determinants varying over time, by type and place. Furthermore, the elements and determinants of vulnerability are household specific, including

the adaptive capacity. These assertions combined with the research focussing on the implementation processes of adaptation mean that the study can not estimate the degree of adaptation of households relative to each other because all variables show substantial discrepancy in values and are not comparable (e.g. agricultural smallholders exposure due to climatic conditions and land use patterns, livelihood assets in time, and adaptive capacity vary from village to village - over time and among social groups). Accordingly, as outlined above, the goal is not to produce a score or rating of households' current or future vulnerability. Rather, the aim is to attain information on the nature of social vulnerability, its components, and the decision-making processes which lead – or even hinder – the adoption of innovations. Hence, this study identifies ways in which the adaptive capacity of agricultural smallholders can be increased and exposure-sensitivities of such smallholders can be decreased. Over the past decade literature on adaptive capacity and vulnerability reduction has concentrated on studying the different forms as well as the availability and access to resources as a way of understanding what facilitates or inhibits adaptive capacity (YOHE & TOL 2002, SMITH & PILIFOSOVA 2003, WISNER et al. 2004, BROOKS & ADGER 2005, EAKIN & LEMOS 2006). The determinants of adaptive capacity include the various natural, material, economic, institutional, human, social, and political resources that people can draw upon to deal effectively with hazards. To accommodate that previous research and combine it with the aim of the present study, the Sustainable Livelihood Framework by CHAMBERS & CONWAY (1991), which incorporates in its 'Livelihood Assets' the above mentioned determinants of adaptive capacity, and the theory of Diffusion of Innovation by ROGERS (2003), which investigates the decision-making process, were applied.

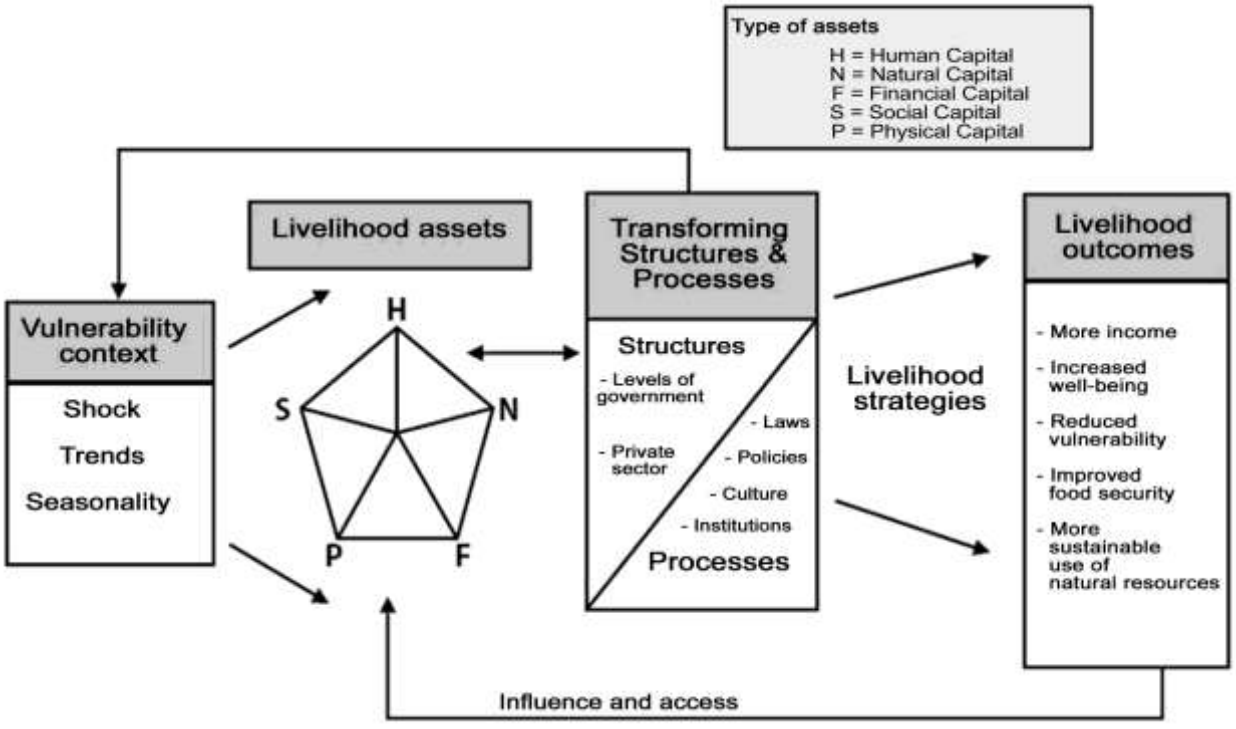
3.2 CONCEPTUAL FRAMEWORK: THE SUSTAINABLE LIVELIHOOD APPROACH

The Sustainable Livelihood Framework is a tool to improve the understanding of livelihoods, particularly those of the poor. Around LLNP the average income is IDR 6 million (US-$ 600) per year (SCHWARZE et al. 2006: 13). Based on a representative household survey, 19.4% of the population in the research area is living on less than US-$ 1 a day and nearly half of the population below the US-$ 2 a day poverty line in purchasing power parity (VAN EDIG et al. 2007: 147). Given that the poor are most vulnerable to disruptive shocks, climate-related disasters or long-term climate change effects, enhancement of their adaptive capacity requires an understanding of how their livelihoods are structured. Using the sustainable livelihood approach can assure a people-centred and bottom-up approach to adaptation which addresses future natural hazards by reducing existing vulnerabilities. However, it needs to be

emphasised that the sustainable livelihood framework is not a linear and stringent approach but various organisations and agencies are applying the key concepts in different ways, while some are placing more emphasis on certain aspects rather than on others (HAMILL et al. 2005).

Based on early studies of CHAMBERS (1989) concerning livelihood strategies and coping mechanisms, the 'Livelihood Research' was developed (SCOONES 1998). Shortly after, the Department for International Development (DFID) of the United Kingdom adopted the framework with great success for its practical implementation of development projects (BOHLE & GLADE 2008). According to CHAMBERS & CONWAY (1991), a livelihood comprises the capabilities, assets and activities requested for a means of living, and is sustainable if it can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets. Figure 4.1 shows the Sustainable Livelihood Framework adopted by DFID. The framework contains the main factors that affect people's livelihoods and typical relationships in-between.

Figure 3.1: Sustainable Livelihood Framework.



Source: modification after DFID (1999) and Hamill et al. (2005)

Within the Sustainable Livelihood Framework the threatening natural hazards would be classified as 'Shock' in the 'Vulnerability Context'. The 'Vulnerability Context' refers to the external environment and is the part of the framework that lies furthest outside people's control. 'Shocks' represent the most extreme and unexpected changes in people's livelihoods,

e.g. through floods, droughts or landslides. 'Shocks' might destroy assets directly. 'Trends', such as economic and population trends influence people's livelihoods, but are usually more predictable and long term. 'Seasonality' refers to seasonal fluctuations in prices and employment opportunities, as well as to the availability of food and resources, e.g. water availability which changes over time and space.

Central to the Sustainable Livelihood Framework are the five different types of 'Livelihood Assets':

'Human Capital' consists of knowledge, skills, ability to work, and health conditions of the household members. It is required in order to make use of any of the four other types of assets.

'Social Capital' refers to memberships in groups or networks, relationships of trust, reciprocity, common rules, norms and sanctions as well as connectedness in institutions.

'Natural Capital' includes land, forest, wild resources, water, quality of the environment, biodiversity, erosion protection, waste assimilation and air quality.

'Financial Capital' comprises savings in form of cash, bank deposits or liquid assets such as livestock and jewellery as well as the access to credit.

'Physical capital' contains infrastructure such as transport, houses and buildings, water and sanitation systems, energy and access to information (communication), as well as means of production such as tools and equipment (HAMILL et al. 2005).

According to DFID (1999) households with more assets tend to have a greater range of options and an ability to switch between multiple strategies to secure their livelihoods. Furthermore, poverty analyses have shown that people's ability to escape from poverty is critically dependent upon their access to assets (ibid. 1999).

The 'Transforming Structures and Processes' determine and influence the access to various types of assets. Structures are organisations, in both the public and private sectors, and at all levels, from international to local level organisations. These organisations trade, deliver services, and set and implement policies; thus having direct or indirect impacts on people's livelihoods. The transforming processes refer to the way structures operate and interact, and include policies, culture, legislation, institutions (such as markets) and power relations (e.g. policy on drought relief and the density of relief providing agencies, fiscal and health policy) (DFID 1999). The investigation of 'Livelihood Strategies' is the main focus of this study. They represent the combination of activities that people make in order to achieve their

'Livelihood Outcomes' and have been distinguished by DFID (1999) and ELLIS (2000) in coping strategies, adopted in response to sudden, unplanned shocks and in adaptive strategies which people develop in response to long-term adverse events. As both strategies represent means of adaptation, this study uses the terms more recently developed by ADGER (2005) of reactive and anticipatory adaptation to stay coherent in the argumentation. Both terms are introduced above and encompass coping as well as adaptive strategies.

People's livelihoods are dynamic and change over time, similarly to the conditions in which they exist. The arrows and feedback loops of the framework display these interactions and influences. The objectives of the people are the results of the livelihood strategies and are displayed in the framework as 'Livelihood Outcomes' (DFID 1999). DFID has identified five livelihood outcomes, as shown in Figure 3.1. However, the actual outcome may differ from the original objective, depending on how successful the respective livelihood strategy turned out to be.

Certainly, the components of the Sustainable Livelihood Framework and the list of outcomes reflect the generally accepted multi-dimensional concept of poverty which is defined by the WORLDBANK (2001) as deprivation of well-being, inadequate levels of income and consumption, lack of access to health and education, powerlessness, voicelessness, and, from uttermost importance for this study, the vulnerability and exposure to risk. The ultimate goal of the sustainable livelihood approach – as pointed out by DFID (1999) – is poverty elimination and the framework presents a tool to archive this goal adequately. However, an in-depth poverty analysis is not the objective of this study. Instead, the focus is laid (1) to investigate the livelihood strategies developed by agricultural smallholders being exposed to natural hazards; (2) to examine if these strategies lead to the intended livelihood outcomes, e.g. reduced vulnerability; and (3) to identify the interrelationship between livelihood assets and the implementation of livelihood strategies. Therefore, this study applies just several components of the Sustainable Livelihood Framework as a structure to understand vulnerability providing guidance on the assessment of adaptation measures but certainly keeping in mind a holistic approach to vulnerability reduction and the interaction and influences of the components.

3.3 THEORETICAL BACKGROUND: DIFFUSION OF INNOVATIONS

For a more elaborate analysis of the decision-making process of rural households and to answer the question why do certain households adapt and others not yet, the Diffusion of

Innovations theory was employed. The theory seeks to conceptualise the diffusion process and explain how, why and at what rate new ideas and technology spread throughout cultures.

The roots of diffusion theory trace to Europe about 100 years ago when sociology and anthropology were emerging as new social sciences. One of the first in diffusion research was the French sociologist GABRIEL TARDE. TARDE observed certain generalisations about the diffusion of innovations that he called "the laws of imitation" and published 1903 in his influential book of the same name. However, his creative insights were not immediately followed up by empirical studies of diffusion. That was not to happen until 40 years later, in the RYAN & GROSS hybrid corn study (1943). Social scientists at the time of GABRIEL TARDE lacked the methodological tools to conduct quantitative diffusion studies. Another root of diffusion research was a group of early anthropologists from England, Germany and Austria soon after the time of Tarde (although not influenced by his writings). These anthropologists were called the "British diffusionists" and the "German-Austrian diffusionists". The central viewpoint of each school was rather similar. Diffusionism was the point of view in anthropology that explained social change in a given society as a result of the introduction of innovations spread from one original source. The diffusionism viewpoint does not have a following today, owing to the extreme claims of the diffusionists that all social change could be explained by diffusion alone. The dominant viewpoint now is that social change is caused by both invention (the process by which a new idea is discovered or created) and diffusion, which usually occurs sequentially. However, these European diffusionists were some of the first scholars to use the term "diffusion". Diffusion research is a particular type of communications research but it began outside the academic field of communication. The RYAN & GROSS (1943) hybrid corn study preceded the establishment of the first university institutes or departments of communication around 1960 (ROGERS 2003).

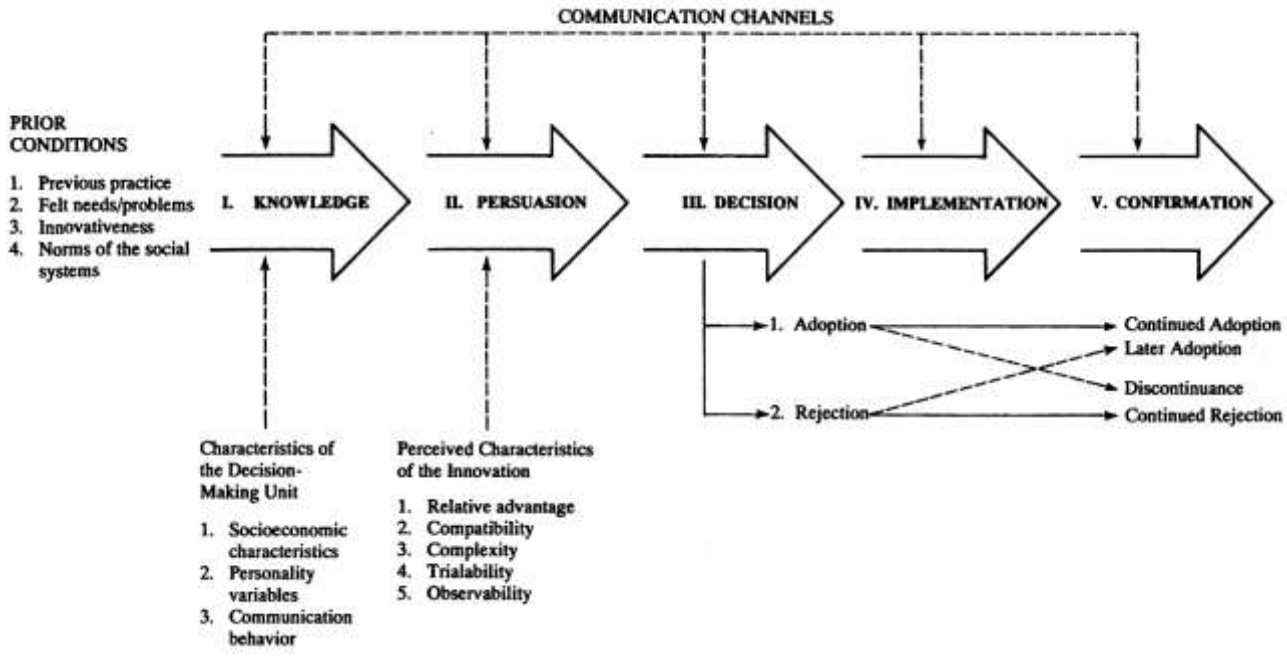
In 1962 EVERETT ROGERS published his book entitled 'Diffusion of Innovations'. The book summarised diffusion research to date, (from over 400 studies) organised around a general diffusion model, and produced a theory for the adoption of innovations among individuals and organisations.

The five editions of ROGERS' Diffusion of Innovations, each about a decade apart, mark turning points in the growth of the diffusion field. At the time the first edition was published in 1962, there were 405 publications about this topic. The second edition (and revision) was published in 1971. By then the number of diffusion publications had risen, to about 1,500. In 1983, when the third edition of Diffusion of Innovations appeared, the total number of

diffusion publications had more than doubled again, to 3,085. The number of diffusion publications approached 4,000 when the fourth edition was published in 1995. In 2003, along with the fifth edition, ROGERS estimated the number of publications to more than 5,200, and the field of diffusion continues to grow (ROGERS 2003). Therefore, the fifth edition, used for the present study, is based upon a yet broader foundation of diffusion research than the four earlier editions.

According to ROGERS (2003: 35-36), 'Diffusion' is defined as "[…] the process by which an innovation is communicated through certain channels over time among the members of a social system.", and 'Innovations' as "[…] an idea, practice or object perceived as new by an individual or other unit of adoption." The broader term innovation will be more specified in the study as adaptation strategies used by agricultural smallholders to adapt to natural hazards. Thus, the present study attempts to explain the diffusion of adaptation strategies between different household types by applying ROGER'S (2003) theory. The main focus is placed on the explanation of the 'innovation-decision process' as the cross-cutting issue between the theory and this study. The innovation-decision process consists of five stages as shown in Figure 3.2 (ROGERS 2003). Within the process, the households pass from first knowledge of an innovation, through forming an attitude towards the innovation, deciding to adapt or reject it, to the implementation of the new idea, and finally to the confirmation of their decision.

Figure 3.2: The Innovation-Decision Process Model.



Source: ROGERS (2003)

In the 'knowledge-stage' the household is exposed to the innovation's existence and gains some understanding about how it functions. Afterwards, in the 'persuasion-stage', the household forms a favourable or unfavourable attitude towards the innovation whereas in the 'decision-stage' the household engages in activities that either lead to a choice to adapt or reject the innovation. Later, in the 'implementation-stage', the household puts an innovation into use and finally, in the 'confirmation-stage', the household seeks reinforcement for an innovation-decision already made. However, the household may reverse this decision if exposed to conflicting messages about the innovation.

In addition, this study focuses on the attributes of innovations as they are crucial for the prediction of the innovation's rate of adoption. "The rate of adoption is the relative speed with which an innovation is adopted by members of a social system." (ROGERS 2003: 221).

The main important attributes of an innovation are the relative advantage, compatibility, complexity, trialability, and observability. For instance, in the present study mainly 'preventive innovations' or anticipatory adaptations might reduce the households' vulnerability to future natural hazards. However, according to ROGERS (2003), 'preventive innovations' are characterized by a particularly slow rate of adoption as the households have difficulties in perceiving its relative advantage in the present.

By employing ROGERS explanatory model of the innovation-decision process the present study aims to explain the causes why households do adapt to certain innovations which could reduce their vulnerability and others do not. This investigation is supported by the analysis of the importance of different communication channels, the perceived attributes of innovations, and the innovation-decision period. Communications channels are categorised by ROGERS (2003) as either interpersonal or mass media in nature, and as originated from either local or cosmopolite sources. Further, "the innovation-decision period is the length of time required for an individual or organisation to pass through the innovation-decision process." (ROGERS 2003: 213).

However, there are four major criticisms of the diffusion research as outlined by ROGERS (2003). The pro-innovation bias, the implication of most diffusion research that an innovation should be diffused to and adopted by all members of a social system, that it should be diffused rapidly, and that the innovation should be neither re-invented nor rejected. Further, the individual-blame bias, the tendency to hold an individual responsible for his or her problems, rather that the system of which the individual is a part. Next, the recall problem in diffusion research, which may lead to inaccuracies when respondents are asked to remember the time at

which they adopted a new idea. Finally, the issue of equality in the diffusion of innovations, as socio-economic gaps among the members of a social system are often widened as a result of the spread of new ideas.

For more details see Chapter 5.4 ("Reasons for different adaptive behaviour") as here the investigation explicitly relates ROGERS's theory of Diffusion of Innovations to the respective research question and regional characteristics. Supported by four sub-chapters, the theory is connected with the empirical data from 82 problem-centred interviews and Participatory Rural Appraisals (PRAs) within the six research villages. The findings on page 118 to 130 explain impacts of prior conditions, attributes of the certain adaptive strategies, chosen communication channels and prevailing structures in knowledge transfer in the study area regarding the decision-making process.

4 METHODOLOGY

This chapter will explain the research methods applied in this study. In a first sub-chapter methods for data generation will be described. Hereby cluster analysis, participatory observations, problem centred interviews and Participatory Rural Appraisals (PRAs) will be highlighted and reasons for selecting these stated. In the second sub-chapter the focus is on methods for data processing and analysis. In particular applied transcription, postscript and coding techniques are going to be elucidated. In the third sub-chapter methodological limitations will be discussed.

4.1 DATA GENERATION

For data generation a triangulation of three qualitative methods was conducted. After FLICK (2002), triangulation means a combination of different methods, temporal and regional settings as well as groups of interests by analysing a problem. Triangulation of methods may provide support to judge the influence of single methods and to balance their results. However, as KRUKER & RAU (2005) mentioned, a too strong mix of methods could as well distract the focus of analysing strengths and weaknesses of a single method. Therefore, a well adjusted mix of suitable and combinable methods was applied consisting out of semi-structured, problem centred interviews, participatory observation, and group discussions in form of Participatory Rural Appraisals (PRAs). Hereby, interviews are foremost suited to capture opinions and attitudes while participatory observations are recommended for identifying open, visible patterns of activity (REUBER & PFAFFENBACH 2005). Another supporting argument to apply a mix of observations and interviews is the longer and more intense contact to persons created through participatory observations, which in interview situations is often just short and only once. Following LÜDERS (2000), neither well detailed interviews nor group discussions may replace a long lasting participation. Supportively, SPITTLER (2001) argues that participatory observation enables to capture complex issues 'at a glance', which might be much more difficult to express in spoken words. But on the other hand, he also noticed that interviews have advantages too as they allow obtaining plenty of information in relatively short time, while the observation of the same circumstances might be quite time-consuming. In consideration of these advantages of all three methods, only a combination seemed to achieve the best possible research outcome.

The field research was conducted in total for more than one year in Central Sulawesi and split into five visits of several months each. This procedure honoured the open, unstructured and non-standardised mix of methods chosen for this research, which enables a wide frame of

observations, adjusted perspectives and new interpretations of the observations during the field research. Additionally, in the time of reflection and research back in Germany, the data could be analysed jointly with a working group, and preliminary results were published and presented at conferences, where the criticism and response of other scientists again influenced the adjustment of objectives of the next sequence of field research. Furthermore, during the time in Germany, new data generation was halted thus resulting in resources and time available to transcribe, translate and code the already taped interviews. Supported by this method of operation, the analysis of first interviews was possible, and thereby changes to the interview guide were conducted and could be applied before entering another cycle of field research.

Further noteworthy is the problem of language skills in conducting the above described methods. Previous experiences from other projects have shown the disadvantages of translated questions from field assistants to the respondents. The related problems ranged from the unwillingness of villagers to answer questions from the assistants to misunderstandings between researcher and assistants in the interviews themselves. Equipped with a basic knowledge of Bahasa Indonesia gained through previous field research in Indonesia and a language course at the Georg-August University Göttingen, it had been mutually decided to improve the author's knowledge of Bahasa Indonesia before arriving in Central Sulawesi by conducting an intensive three week one-to-one language course in Yogyakarta, Java, especially designed for the field research demands and supported by accommodation with an Indonesian family. The strategy proved to be successful, as afterwards direct communication with respondents in interviews, management of group discussion and participatory observation became achievable.

4.1.1 Cluster analysis

Partly, the present study searched for patterns to explain reasons for the different adaptive behaviours of households according to their land use characteristics. Therefore, the selection of households was based on a cluster analysis from SCHIPPERS et al. (2007). In 2004, a household census (n=898) in three villages in the research area was conducted. The census covered socio-cultural interrelations, environmental perception, and socio-economic data. Using a multivariate cluster analysis, the households were classified by land use aspects (ibid. 2007). Aim of the classification was to extract a manageable number of household groups differing in their land use. The households of each group should be as similar as possible (high internal homogeneity), whereas the groups should differ among each other as far as

possible (external heterogeneity). The classification criteria of the cluster (as shown in Table 5.1) were used to randomly select two households within each cluster for qualitative interviews in 2007 in the three census-villages.

Additionally, in 2008 three further villages were included in the present study because they differ in their development dynamics (migration), composition of population (ethnicity), transformation process (land use and land availability) as well as climatic conditions (altitude) from the census-villages (FAUST et al. 2003, WEBER 2006, WEBER & FAUST 2006). In these three additional villages respondents were chosen by applying Participatory Rural Appraisals (PRAs) and informal interviews with village representatives and key informants to identify households which fit into the household classification characteristics developed by SCHIPPERS et al. (2007).

Table 4.1: Land use cluster and their criteria.

Cluster	Label	Scale	Classification criteria		N	N/Cluster Groups
			No agricultural area		30	
1	Cacao specialists	Small	>66% cacao area	<140ares	373	588
2		Medium		≥140ares <300ares	150	
3		Large		≤ 300ares	65	
4	Cacao-rice combiners	Small	Cacao- & rice area: each 33%, OR sum of cacao- & rice area >75%;	<140ares	95	134
5		Medium		≥140ares <300ares	30	
6		Large		≤ 300ares	9	
7	Wet rice specialists		>66% rice area; all scales		69	
8	Other specialists (coffee, maize, other crops)		>66% coffee area OR >66% area of other cropping types; all scales		21	
9	Other combiners or multi-diverse households		All remaining households with agriculture		56	

Source: modification according to SCHIPPERS et al. (2007)

Consequently, 18 interviews were conducted in each village for nine different household clusters. However, as some of the land use clusters do not exist in certain villages, the number of interviews differs from village to village as the number of land use clusters does. The

observed villages range from being characterised by high influx of regional migrants, scarcity of land, intensive cacao cultivation and surrounding pre-mountain tropical rainforest to villages dominated by multi-cropping systems, relatively good land availability as well as a semi-arid meso-climate. By investigating the three additional villages, the study seeks to extend the knowledge about livelihood strategies of rural households living in the research area.

4.1.2 Participatory observation

As parts of the interviews as well as the group discussions were focussed on sensitive topics such as poverty, ethnicity, land size as well as the illegal exploitation of commodities from the LLNP to cope with their impacts, the team needed to build up closeness and trust with the local households. Therefore we chose to begin the field study with participatory observation, which is the most open of all methods (REUBER & PFAFFENBACH 2005).

The participatory observation was conducted in an unstructured, non-standardised, and open manner within the existing familiar structures of the villagers. This means the author participated in the community life e.g. during several days of land conversions, where socialisation during work, breaks and long walks to the remote sides were exceptionally high and frequent. Another opportunity to achieve more familiarity with villagers was to participate in voluntary community work, which is usually done on weekends to maintain the village property (see Figure 4.1)

Figure 4.1: Participatory observation during conversion of community forest into agricultural land and during public work activity.

Source: own pictures, Rompo (2007)

Further opportunities utilised to better embed the research team in the daily village life were for instance participation in religious activities (as mutual church visits with the author or

mosque visits with the research assistants), farming group meetings and daily work activities, which ranged from participation in the daily life of the guest families as the research team was accommodated in a local farming household's residence to participation in school classes or the cleaning of village property. Of course, also leisure activities after the fieldwork, interviews and group discussions were used to build up trust and closeness (see Figure 4.2). It was shown that these informal ways of obtaining data provided an important corrective against information received from formal interviews.

Figure 4.2: Participatory observation during socialising with the head of the customary village council.

Source: own picture, Rompo (2007)

4.1.3 Participatory Rural Appraisals (PRAs)

In addition to interviews and participatory observations several group discussions were conducted. As REUBER & PFAFFENBACH (1995) argue, the objective of group discussions is foremost to gain (semi) public opinions connected to social relations and situations. The central idea behind is that within the dynamics of conversations fundamental facts will be discussed, supported by more spontaneous and therefore authentic comments in certain situations than those expressed in interviews (DREHER & DREHER 1991). Of main interest for the present study is the diffusion of adaptation strategies and their causes. According to LAMNEK (1995), collective communication patterns are hardly able to capture genuine opinions in single interviews but rather in public, social group situations. However, as BOHNSACK (2000) mentioned, individual opinions are not just produced through the group process. They might have existed already before, but their verbal expression will be facilitated through the group discussion. The confidence in the group shall facilitate more openness than in interview situations, which are usually conducted by the research team facing one household alone. For that reason, a mix of four different PRAs was conducted. During the

process of group building for the PRAs it was always intended to create a heterogenic group of individuals of different ethnic backgrounds, gender, and social status. In addition, to support the local community and planning institutions, the original large scale illustration of results was always handed over to the village administration and, upon request,copies also to individual participants. Finally, important to note is that the results of group discussions are a context dependent construction and thus not reproducible (DREHER & DREHER 1991).

4.1.3.1 Timeline

The timeline method supports the exploration of the temporal dimension of people's realities. What is distinctive about the method is that it does allow people to apply their own concept of time. Timeline captures the chronology of events as recalled by local people. It is drawn as a sequential aggregate of past events and thus provides the historical landmark of a community. However, it is not history as such but events of the past as perceived and recalled by the people themselves. Timelines giving a general historic profile of villages are the most common ones (KUMAR 2002). However, regarding the present study, the conducted timelines were modified and focussed on the chronology of 'Droughts and natural hazards' in the respective villages. Certain other major development interventions having a direct or indirect bearing on natural hazards were also recalled. These included the construction of irrigation and drainage systems, dams, the occurrence of famine, forest fires and pests, failure in harvesting, major migration events, and building of schools. Regarding the present study, local people may talk about a particular drought but may not recall the exact time period because they possess a different concept of time and therefore do not remember droughts in terms of the Gregorian calendar but in the chronology of important local events experienced in their lives. But with ENSO related droughts as one specific research topic, it was needed to connect the perceived agricultural drought by the villagers with the specific ENSO years calculated by the climate research centres. With the outcome of the timeline method the author was enabled to present the respondents later in the interviews a local timeframe and the households were able to converge perceived agricultural droughts with year dates.

The method was conducted in the following way: After identifying some elderly persons in the villages willing to talk about the history of the village, they were invited to a group discussion. To initiate the discussion key questions about the history of the village related to natural hazards were asked. During the discussion the research team noted down major events on cards in bold letters. To support the participation of elderly people who are illiterate, the events of the timeline had been depicted in images as well. Once the facilitators felt that the

list was more or less complete and the discussion had considerably weakened, the participants were asked to keep the cards in chronological order – the earlier events on the top and the later events lower down. Then the events were read out and the participants were asked whether they agreed with the order or if they would like to modify it. Later, on the left hand side, year dates were added within a discussion using the already chronologically sorted events as support. Failure of memory and the use of different calendar systems often presented obstacles for the participants arriving at the exact years but in the majority of cases the discussion of the village elders led to success. Afterwards a discussion on the finished timeline was initiated aiming to help the participants to analyse and reflect it again (see Figure 4.3). In a further step the research team enquired about the timeline by asking questions to clarify doubts or to get an in-depth understanding. Finally, the details got drawn to paper and the original handed over to the village administration. A copy was kept for the research. During the stay in the village the timeline was triangulated various times with other elderly persons in the village to verify the correctness of the information. In addition, secondary information such as documents from the village administration proved to be helpful in triangulation.

Figure 4.3: Participatory development, reconfirmation and discussion of PRA-Timeline.

Source: own pictures, Maranata (2008)

However, the output of the timeline itself has only captured limited information. But the main advantages are (1) to provide a good understanding of the historical perspective, which is used in further interviews, (2) the capability to initiate a dialogue and support building a rapport with the local people, and (3) to give a clear message to the elderly people that their views were also taken into consideration and given due importance. Therefore, within the first days of arriving in the villages, the timeline was conducted as the first PRA method, setting the right kind of historical perspective for further analysis by other methods, with the

intention of getting familiarised with community elders, possible interview partners, and the administrative village structure, as well as functioning as 'icebreakers' in the local communities.

4.1.3.2 Impact diagram

Other methods such as the impact diagram are much more sensitive and complex and were therefore conducted later after actively participating in the community life. An impact diagram falls under the broader category of flow diagram. What distinguishes it from other methods is that in the impact diagram the focus is exclusively on impacts of an event. In the present study it is used to identify and depict the impact of agricultural droughts in the research area. The impact can be positive or negative and helps in understanding the linkages, flow of effects and bottlenecks. Following KUMAR (2002), the visual nature of the impact diagram makes it easy for the local people to depict their complex realities and the cross linkages between the various effects of events.

After selecting the topic for the impact diagram and identifying a group of participants who had an interest in the topic and were willing to participate, the process was started with a discussion of drought and then became focussed on impact and consequences. In the centre a card with the topic 'Effects of drought' was kept in bold letters. As the participants came up with points of impacts, the research team noted them down. Afterwards the same list of identified effects was read out to them and the participants were asked if some more points needed to be added or deleted. The participants wrote the effects on small cards in bold letters. Cards in different colours were used depending on whether the impacts were identified as negative or positive. Afterwards, the impact cards were spread down on the ground around the topic card. After asking the participants to look at the cards and see if there were any linkages they arranged them in meaningful patterns and sequences. The inter-linkages were then shown by lines and arrows with coloured pens. The participants were encouraged to make modifications wherever they felt they were necessary (see Figure 4.4).

Figure 4.4: Participatory development of an impact diagram.

Source: own pictures, Watumaeta (2008)

The diagram was noted down on large sheets of paper with all details and depicted on the wall. Then the participants explained the diagram and reflected on the process and findings. Within the subsequent days the diagram was triangulated in interviews and participatory observations by talking to others who knew about the issue.

4.1.3.3 Venn diagram

To understand the people's perceptions about complex relationships of local institutions and individuals a Venn diagram was conducted. Following KUMAR (2002), the method has been found very useful to examine local people's perceptions about institutional relationships. In addition, it provides valuable insights into and analyses of the power structure and the decision-making process, which is of major importance for the present study. Hereby, in particular, the importance and accessibility of local institutions and individuals in case of a

natural disaster were investigated. To represent those institutions and individuals the method applied circles of various sizes. The bigger the circle, the more important the institution or individual was perceived by the community in case of disaster. The distance of the circles from the centre represents the access the village has to them at the time a disaster occurs. In the present study, less distance means easier access. Overlapping circles indicate interactions and the extent of overlap indicates the level of interaction.

The steps in the process of the conducted Venn diagram followed KUMAR (2002). At the beginning the participants were asked to list the various institutions and individuals involved in case of a natural disaster by depicting them on small cards. Subsequently, the group was requested to place the cards according to the perceived importance of the institution/individuals in a descending order. Once the cards were arranged in an order, they were asked whether they agreed or would like to make further modifications. If they were interested, the facilitators encouraged them to make alterations. In a next step the villagers were asked to assign paper circles to the institutions or individuals in such a way that the bigger the circle, the higher the institution or individual ranks on that variable. Then the names of the institutions or individuals were pasted on the circle. Afterwards, a stone was laid down on the ground representing the community. Now the participants were requested to place the circles in such a way that those high on the second variable, accessibility in time of a natural disaster, were kept close together, while those low on the variable were kept away from the circle representing the community. Once all the cards were placed, the group was asked if they agreed with the placement and in case of rejection were encouraged again to make alterations. In some cases, when there were certain institutions/individuals that interacted or worked closely, the participants got encouraged to place these circles with an overlap. The degree of overlap indicated the degree of interaction. Finally the group was asked to discuss and explain why they placed the cards in such a manner. The points of discussion and explanations were recorded on tape and later analysed. The output was copied on sheets of large paper and handed over to the village administration. Another copy was kept for research. Within the next days of staying in the village the Venn diagram and the major findings were triangulated with others knowledgeable about the situation to ensure that the outcome was correct.

There are, however, certain limitations to the method. The Venn diagram became difficult as the number of items increased above 15. Nevertheless, the participants listed more than 30 institutions and individuals of importance for a disaster case. Furthermore, it was complicated to explain the complex theoretical process to the participants. In particular the depiction of the

variable accessibility with spatial distance to the virtual village centre was quite difficult to clarify to agricultural smallholders partly lacking any formal education. Also, the Venn diagram proved to be one of the most difficult methods to facilitate due to the need of many different materials (cards, circular pieces in various sizes, pens, adhesive, and stones). On the one hand, the use of the materials, visuals, and symbols generated a lot of interest among the local people and participation was quite high. On the other hand, facilitation was extraordinarily difficult as the following example illustrates: For Venn diagramming quite a lot of space is needed. Therefore a large covered terrace had been chosen by mutual consent to conduct the method (see Figure 4.5). When the first placement of all cards on the ground was finished at midday, the tropical sun was shining through the sides of the terrace and the heat immediately impeded the participation of the group members. Within the next hour the weather changed and a strong breeze sprang up. This would even have facilitated the discussion, but as it was decided not to draw the symbols with chalk directly on the ground as it would not allow to resize or relocate the circles easily. Instead, we used flexible paper sheets that got disarranged by the wind. Finally, heavy rain mixed with strong wind set in which led to a complete relocation of the group exercise to inside the house. Due to all these inconveniences, the time allotted to the exercise was enormously exceeded and as the sun set and no electrical power source was available the group discussion had to be stopped and continued on the next day. Another practical problem with Venn diagramming is that it can become topically sensitive. In the presence of an individual whose wife holds the position of the village nurse and is thus in charge of *polindes* (village health facility), this institution was rated as having the highest importance and easiest access. However, by triangulation with participatory observation, the *polindes* turned out to be an empty facility; neither medical equipment nor furniture was available apart from any human resources.

Figure 4.5: Preparation of a Venn diagram of institutions and individuals in a disaster case.

Source: own picture, Rompo (2007)

4.1.3.4 Matrix scoring

The matrix scoring method was conducted to attain a comparative understanding of crop preferences from the perspective of a local agricultural smallholder. The participants may know their preferences, but this method helps both the participants and the facilitator to understand the reasons for the preferences and the decision-making process behind (KUMAR 2002). As one focus of the present study is to analyse the interrelation between land use and adaptation strategies, the reasons behind the choice for specific crops are of utmost interest, in particular as land use changes themselves may represent an adaptation strategy.

The method was conducted after KUMAR (2002) in the following way: Once the matrix scoring for crop preferences as purpose of the exercise had been explained in detail, a discussion was initiated and participants were asked to list the various crops they normally cultivated in their village. The names of crops were noted down by the facilitators[2]. In a next step the criteria of the matrix scoring were generated. Here, it was important to elicit criteria from the participants and not just allow the scientists' own criteria to be determinant. As PIMBERT (1991) shows in Table 5.2, it is important and necessary to use the criteria of the people rather than the one scientists would normally apply.

[2] The facilitators consisted of the author and another research assistant, sometimes of two assistants.

Table 4.2: Comparison of the criteria of scientists and farmers.

Criteria Scientists Normally used	*Criteria used by the Farmers*
• Seed size	• Height of plant
• Grain quality	• Ability to intercrop
• Days to maturity	• Flower production
• Seed colour	• Pod production
• Plant height	• Pod filling
• Pest resistance	• Pest damage by the pod borer
• Grain yield	• Grain yield
• Protein content	• Wood bio-mass
• Cooking time	• Quality of wood for construction
	• Taste of grain
	• Storability
	• Grain price in local market

Source: Pimbert (1991)

PIMPERT (1991) has reported an interesting instance which emphasises the need and importance of people-generated criteria. During a crop evaluation in India a comparison between the criteria normally used by the scientists and those applied by the farmers revealed certain striking features. These include a significant difference in the number of criteria used as well as in the perspective. The farmers' criteria were guided largely by practical concerns such as for instance the taste of grain. Further, some of the criteria were not even taken into consideration by the scientists like wood bio-mass and the quality of wood for construction, even though they are still of major importance for the farmers as they use the bio-mass for construction wood and as fuel. If the study had gone ahead with only the criteria of the scientists, some of the criteria would not have been mentioned in the study at all. Therefore, the reasons, e.g. taste of grain, storability, and grain price in the local market that form the very basis of the preferences of the local people for the different varieties would have stayed unexplored. Following KUMAR (2002), this might also explain why some of the highly acclaimed new varieties of crops are not acceptable to the farmers. So if the local people are not given time and space to explore and come up with their own criteria, the chances of missing the people's realities are high. Some of the criteria selected may look strange for scientists but if the local people think they are important, their reasons need to be acknowledged and understood. However, as the present study demands information on certain criteria as drought and torrential rain resistance which were not suggested by the local people, they nevertheless have been included in the method. But these pre-fixed criteria were clearly marked out from those of the respondents and covered at the end of the table. In addition, one aim of the scoring was to arrive at an overall picture for crop preferences. The score was

intentionally not calculated out of the added up score for each crop as this would assume that all criteria have equal weightage in the minds of the participants. Rather, an own 'most preferred crop' criterion was included in the scores of the participants among all the crops. Similarly to the other pre-fixed criteria, it was marked and covered at the end. The criteria from the participants were generated by a pair-wise ranking. Hereby, the crops were compared with each other one by one. The participants were asked to specify their preferences and the reasons thereof. The reasons were nothing but the criteria. After a while, various criteria e.g. 'contributes to cash income', 'home consumption', 'price', 'low work intensity', etc. were attained, which were written down by the facilitators. In a following step it had to be ensured that the criteria were all positive and precise because the use of positive and negative criteria in the same exercise could be confusing. That means criteria such as 'work intensity' and 'quality of soil' were converted into 'low work intensity' and 'low quality of soil is needed'. Afterwards, a matrix was drawn on large paper sheets and fixed on the wall with the crops top to bottom and the criteria left to right (see Figure 4.6). The comparisons were made criteria-wise and not crop-wise. The scoring was made for each crop and noted on the paper sheet. The criteria were covered successively one after the other. To avoid a loss of valuable information while drawing the matrix as mentioned by MAXWELL & BART (1995), the participants' discussions about crops and criteria were recorded on tape.

Besides complementing and supplementing semi-structured interviews quite well (KUMAR 2002), another advantage of the matrix method is that it not only provides valuable data but also initiates a process of analysis amongst the participants. The process of decision-making for scores makes even those not used to systematic ways of analysis come up with major insights. An additional interesting feature is that the method leads to role reversals. It requires facilitators to learn and record the knowledge, judgements, and preferences according to the local people's own criteria.

Figure 4.6: Conducting the matrix-scoring of crop preferences.

Source: own pictures, Watumaeta (2008)

4.1.4 Problem-centred interviews

In total during the years 2007 and 2008, 82 open, semi-structured interviews focussing on natural hazards, including questions on the diffusion of innovations and adaptation strategies, land use change, and decision-making processes were conducted in all six villages (see Questionnaire). All interviews followed the problem-centred interview approach by WITZEL (1989). As stated by MAYRING (1996), this approach is exceptionally suitable for more comprehensive samples of up to 100 interviews, as is the case with the present study. However, after the first sequence of interviews, the length of the conducted interviews turned out to be a problem. The length of 50 pages per interview meant that after 82 interviews the

author would have had to analyse more than 6500 interview pages by first reading and in a second step to code all of them. After abbreviating the Questionnaire adopting a more determined focus on the research objective we could reduce the interview time to less that one hour and to less than 35 pages as average. The interviews were structured by a flexible questionnaire allowing, e.g. for non-standardised comments and explanations, as well as the incidental coverage of additional aspects when deemed necessary by the interviewer. In line with LAMNEK (1995), the design of the questionnaire itself was comprised by headwords of the most important questions, without any rigid order. Questions were randomly asked according to the progression of the interview. There was not any fixed pattern; rather similar topics in the guide were summarised to blocks. To reach the best possible research outcome and to build trust, the interviews were conducted in places as familiar as possible to the respondents, usually at their homes or directly on the plots during lunch break. The team always tried to avoid that the first meeting of researcher and respondents were used for the interview. Therefore we established contacts mostly in advance during participatory observations or earlier group discussions in the village. If no preliminary contact was possible for whatever reasons, we went to the villagers' homes and introduced ourselves, usually after they had returned from their plots in the late evening. Hereby we explained briefly the topic of the study and that all obtained data would be anonymous and not handled over to any government institutions. Of main concern to the respondents was the possibility of disclosure of information to the financial authorities about the real size of their owned land, as the area is subject to taxation and people usually own more land (due to custom law or illegal plots in the LLNP) than declared to the government agents. Later we asked for permission to interview them on the next day. In general we offered to meet the respondents on their plots during lunch break to avoid further interruption of their normal course of life (see Figure 4.7). Of course confidence building within this relative short period of time was hardly possible, the relationship to the respondent would be mostly shallow, and the respondents would somehow be always influenced at least by our presence if not by other factors. But according to BUDE (1990), there are as well advantages as people might provide information to the 'passing by' interviewer that would not be entrusted to a very close acquaintance.

The interviews were conducted in Bahasa Indonesia supported by an Indonesian research assistant and recorded on tape. In a second step, the complete material was transcribed and later translated into English. To avoid a loss of side information and to immediately clarify misunderstandings, the author discussed and documented the relevant outcome and circumstances with the research assistant after each interview.

Figure 4.7: Problem-centred interview on the plot.

Source: own picture, Toro (2007)

4.2 DATA PROCESSING AND ANALYSIS

The processing of interviews and group discussions was carried out by the transformation of the spoken words into text. That meant in a first step interviews and group discussions were recorded on tape in the research area and later transcribed into Bahasa Indonesia by an Indonesian research assistant from Tadulako University with several years of experience in interview transcription. In a second step, all transcriptions were translated by another assistant into English. Afterwards, as advised by LAMNEK (1995), another translator counterchecked the translations again with the transcriptions and in addition also with the original tape recordings if he noticed any obscure or doubtful statements, typing- or listening errors, and other shortcomings. Transcription and translation work was immediately conducted after returning from the research area in the provincial capital of Palu within the facilities of Tadulaku University.

The analysis of the transcription was conducted at Göttingen University by a small research group. The members of the research group coded individually the transcriptions. Afterwards, in a joint meeting results of the coding were presented and - in case of deviations – further discussed. Out of this process, a coding scheme was developed. Text analysis and data management were done using MAXQDA 2007, one of the leading programmes for qualitative data analysis. By conducting a three month field research and data generation in Indonesia combined with the following data analysis at Göttingen University also for three months (within three sequences), the widespread problem of finalising all interviews without having analysed a single one beforehand was avoided. After analysing the transcribed and translated

interviews back in Germany the interview guide became again revised and modified, non relevant aspects were cleared and new interesting aspects, added by the respondents, became integrated before returning to Indonesia for the second sequence of data generation. Therewith, a consistent processing method was applied as a key characteristic of the qualitative research approach (REUBER & PFAFFENBACH 2005).

4.2.1 Transcription

Following KOWALL & O'CONNEL (2000), the purpose of a transcription is to transform an interview into a document which is permanently available for scientific analysis. Hereby, transcriptions are always selective constructions. As REUBER & PFAFFENBACH (2005) stated, already the processing into written language implicates an interpretation. The written language will be interpreted again and finally the author provides interpretations (analysis) from other interpretations (translations), from interpretations (transcriptions) from interpretations (views and opinions of the respondent). All the more, a detailed and accurate transcription is more than necessary. As within the present study the content of the interviews itself was of uttermost interest and not the exact verbal expressions, the author decided to choose the form of 'commented transcription' (see Figure 4.8). Hereby, the transcription is as precise as possible and displays each single sentence of the respondents' statements without summarising.

Following MAYRING (1996), specific language characteristics such as breaks, accentuation, or laughing are noted in the commented transcription to understand or perceive the way of communication as precisely as possible. However, local dialects were translated into Bahasa Indonesian and later into English, syntax errors were revised and phrasing was smoothed. Thus, there is always a dilemma between an as accurate as possible copy of the spoken interview and the need to control and reduce the amount of text which has to be comprehensively analysed. By selecting commented transcription the author tried to keep as much detailed information content from the spoken words as possible through the use of Bahasa Indonesia, finally shifting to English in the transcriptions, and at the same time, compensate for the possible loss of side information by adding comments on the atmosphere at the interview. Therefore, and in particular in combination with the postscript method described below, the author achieved the best possible retrospection of the former interview atmospheres and respondent behaviour patterns.

Figure 4.8: Example of an original commented transcription in Bahasa Indonesia.

P2	:	ah banjir bawa rotan
R3	:	iya
R	:	*sampai saya gagal dulu beli rotan di sini gara-gara itu, habis modal*
P2	:	ada . . . kalau di kebun?
R	:	*itu macam kita punya kebun di (. . .) dulu sudah banyak pohon cokelat yang dibawa*
R3	:	dikikis air
R	:	*kebun cokelat, dibawa air itu pohon cokelat*
P1	:	oh . . .
P2	:	berapa luas pak waktu itu?
R3	:	terbawa arus
R	:	*ada 5 bari cokelat sudah ..e.. 5 pohon cokelat yang dibawa air*
P2	:	yang dibawa ya
R	:	*makanya saya jual itu pak, gara-gara itu*

Legend: P1 = Research assistant; P2 = Interviewer; R = *Respondent* I49R; R3 = wife of the respondent

Source: own interview, Rompo (2007)

4.2.2 Postscript

After conducting the interviews, the content was summarised in form of a postscript. The method aims to reduce risk of data loss caused by any damage of the tape recordings in the remote research area and, as stated by REUBER & PAFFFENBACH (2005), as an assisting method to support the later interpretation of the interviews by providing helpful context information. The postscript was conducted immediately after the interviews when returning to the housing. In a first step formal background information of the respondent and the whole interview itself were recalled including the family name, location of the interview, date, land use cluster and the time of the interview. Afterwards, the research assistant and the author summarised their impressions about the main content of the interview by means of their notes made during the interview, including data on the personal and land use history of the household, the experienced natural hazards (encompassing effects and adaptation strategies), the utilisation and distribution of innovations as well as the social capital. In a last category, the atmosphere during the interview itself was described based on the perceptions of the Indonesian research assistant and the author (see Figure 4.9). This includes the behaviour, all kinds of distinctive attitudes of the respondent, the way of communication, as well as the location itself and outside influences or disruptions such as hard rain, cold, noises or insects.

Figure 4.9: Postscript of an interview.

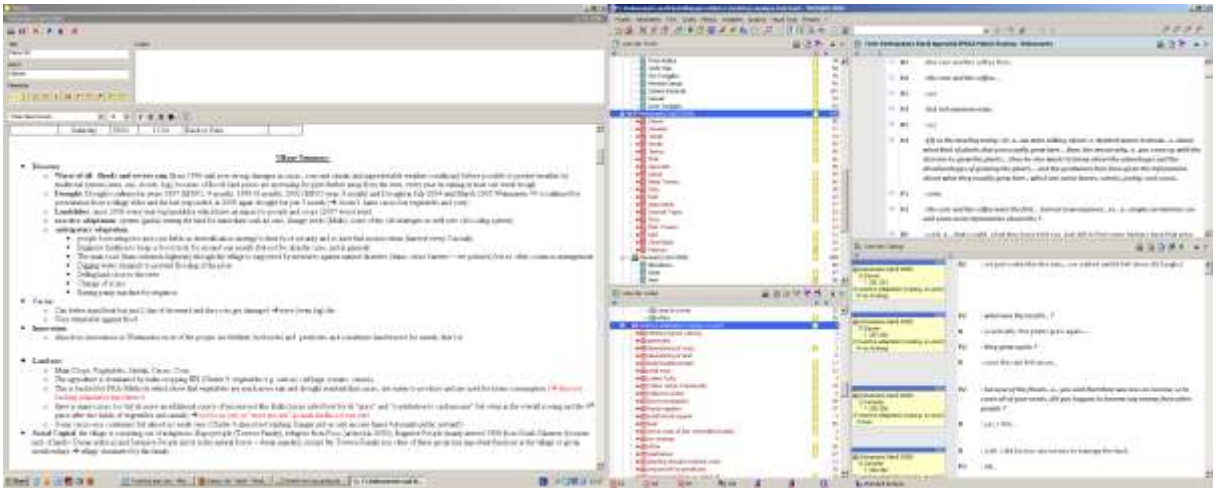
Running number	**17**
Respondent	**I51R**
Location of Interview	**In the Pondok of Bpk. Yourman, on the newly opened plot of Bpk. Yourman**
Date	**04/12/2007**
Cluster	**8**
Time	**15.12 – 16.15**

- **History**:
  - Personal:
    - 24 years old, living and born in Rompo, SD-Education, Farmer, wife born in Katu and has SMP education, 25 years old born, one son (almost 2 years)
  - Land use:
    - 2005 opened 50ares corn
    - no other crops, plot 50m away from the river
- **Disaster**
  - Drought:
    - 2006 – 5 month dry
    - Effect: 25ares of his corn didn't produce fruits,
    - Effects on wellbeing: less income
    - Coping: worked as paid labour and collected rattan, he didn't do anything to his plots, reduced food consumption (twice a day), sold chicken, got cash and rice loans from the kiosk
    - Plan: no plan
- **Innovation**:
  - Herbicides, distance planting (in line – "bekti")
    - Most important innovation are "herbicides" because faster to get rid of the grass, we skipped all other questions to the innovation part as he couldn't answer and many people were just sitting next to him in the pondok and listen; further strong rain starts and the working group session where he was participating already finished
- **Social Capital**:
  - ten families in Rompo are member of his family
  - Member of GKST praying group (meeting once a week), no function, his father is leader of GKST working group
  - No land constraints and no certificate because not enough money
  - Future plan: to plant beans and abandoning of corn
- **Atmosphere**: We already waited two days for Iwan. He was always away working somewhere. Today he was conducting paid labour on the newly opened plot from Bpk. Yourman. After they had their lunch break we ask permission for the interview. It turned out that Iwan has just elementary education and was quite intimidated by our presence and questions. Even worse after a while hard rain started and the workers returned to the Pondok, listening his statements – and therefore he was even more intimidated and hesitating with his answers. So we had to skip whole parts and temporary stop the interview as well because of the circumstances.

Source: own records, Rompo, (2007)

After finalising all interviews within one village the single postscripts were used to create a village depiction encompassing the experienced natural hazards, the adaptation strategies as well as the land use specifications and regulations for the certain village. Those village descriptions work as a framework and as another supportive element in the interpretation of the interviews (see Figure 4.10).

Figure 4.10: Village summary (left) along with translation and coding scheme within MAXQDA (right).



Source: own records, Rompo (2007)

Similar to transcription, the postscript constitutes an interpretation as well. But due to the summarising of perception, the interpretative aspect is even more distinctive. That means, as REUBER & PFAFFENBACH (2005) stated, the postscript does not represent a copy of observed actions or comments, 'as it was'. Rather, it constitutes the own interpretation of the viewed behaviour and heard statements. Therefore, following LAMNEK (1995), the own lack of awareness and selective perception and memorisation should be always taken into account. As it is almost impracticable for a single person to record headwords as well as to lead the interview by signalising active listening, react to the statements, thinking and phrasing the following question and topic all alone, the activity was supported by an Indonesian research assistant. The author was leading the interview and the assistant was taking down headwords. All respondents were previously asked for permission to have headwords taken down during the interviews. There was never any denial regarding taking notes. In addition, the research assistant had been previously briefed about the topics of utmost interest for the postscript. Due to speed and to keep familiarity and intimacy, the headwords were handwritten during the interview whereas the postscript itself was done with a portable computer at the place of accommodation of the research team. It has to be acknowledged that due to torrential rain and power blackouts handwritten notes got damaged and the elaboration of postscripts

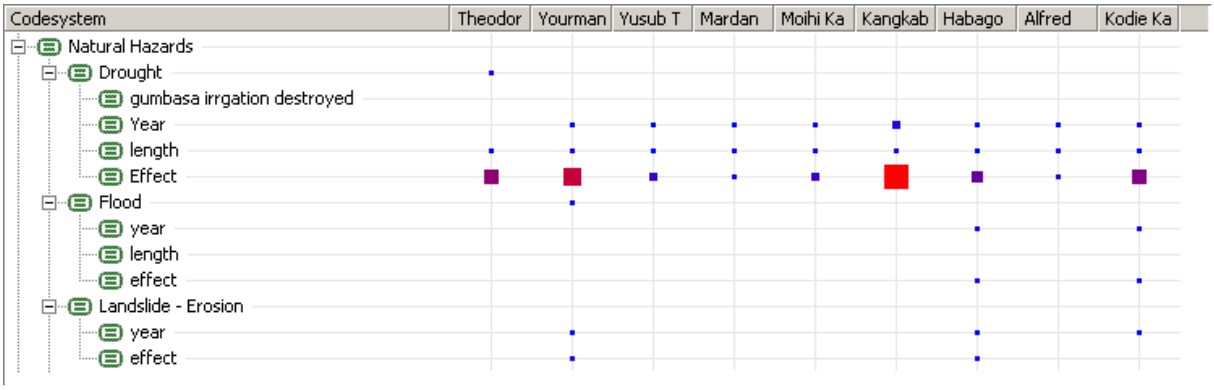
consequently delayed, which means a loss of information as the capacity of remembering, according to LAMNEK (1995), decreases with increasing time, in particular due to the schedule and the high amount of information contained in the interviews.

4.2.3 Coding

Coding assisted the interpretation of the qualitative information obtained from the interviews as described by DUNN (2000) and COPE (2006). There are various different types of coding. Open coding mostly suits for analysing a small amount of interviews due to its openness, in particular for little standardised, narrative interviews. While, thematically, coding presents a more structured approach, topics are predetermined and therefore better to compare than non-standardised (e.g. narrative) interviews. Thematically, coding suits mostly for interviews supported by a flexible interview guide (REUBER & PFAFFENBACH 2005) as applied in the present study. But still, there are different approaches within this type of coding. One approach described by FLICK (1995) presents a three-stage modus which mostly fits a medium amount of semi-standardised interviews. Due to the relatively high amount of primary data in the present study (approximately 3000 pages), a strongly standardised procedure developed by SCHMIDT (2000) was preferred instead which, following (REUBER & PFAFFENBACH 2005), optimally suits a large amount of semi-standardised interview data. Hereby, a five-stage modus was applied. In a first step, categories for analysis (codes) are classified based on the translated interview texts. For the categorization the material was repeatedly read, led by the research questions developed, the Sustainable Livelihood Framework, and the theory of Diffusion of Innovations. Of major interest was to record the respondents' information about experienced natural hazards along with their impacts as well as adaptation strategies and the reasons behind. Further, the adopted innovations, future plans and awareness, land use decision making, social capital, and information about the local institutions were of key concern. The perceived importance of terms and concepts to the respondents and attention to new topics added by the households constitutes a main additional background focus. In a second step, the created categories of analysis were transformed into a code system. Besides description of the single categories the code system contains as well diverse characteristics of each category. The coding system was applied to the text by assigning corresponding sections of text to codes and their associated characteristics (sub-codes). Afterwards, the coding system was pretested by a research group on several interviews and later revised by discussing each modification within the group. In the third step, the revised coding system was applied to all interviews of the study including the already tested ones. As a result, all 82

interviews and six PRAs were encoded. The step aimed at reducing the amount of information even if it meant knowingly accepting thereby a loss of less important information. In a fourth step, as suggested by SCHMIDT (2000), a quantifying overview about the whole data was carried out. Therefore a frequency table in MAXQDA was prepared (see Table 4.3)

Table 4.3: Frequency table of selected natural hazards in Rompo.



Source: own data

The fist column of the table indicates the selected natural hazards and the following columns the respondents. The bigger the square, the more often ideas associated with this topic were mentioned. For reasons of better presentation, in Table 4.3 the amount of natural hazards as well as of respondents was shortened. The original overview tables were made out of all household clusters, natural hazards, innovations as well as anticipatory and reactive adaptation strategies. Supported by the tables, there is coherence in land use clusters and adaptation strategies which were further qualitatively analysed. Finally, in a last step, single interpretations for each cluster were conducted and afterwards summarised to statements about the different cluster groups (see chapter results).

4.3 METHODOLOGICAL LIMITATIONS

Some methodological limitations of the current study must be acknowledged. At first, the cluster analysis has to be mentioned. The analysis from SCHIPPERS et al. (2007) was utilised to typify households in the research villages according to their land use and land size. As the cluster analysis was based on a household census (n=898) from 2004 and conducted by Indonesian research assistants, the information about land use and land size of the individual households did not just, as expected, change over time but proved to be wrong in various instances. Uncovering the different land use patterns and land sizes in the interviews and confronting the respondents with figures from the 2004 survey, the majority stated to be unable to remember or being surprised about ‘errors’ and could not explain them. After

staying a certain time in the research area and getting more familiar, the respondents indicated in individual talks two main reasons for the wrong data. First, in particular coffee and corn plots located in the national park have been kept secret from enumerators as these plantations are illegal. Second, information about plot size had been intentionally underestimated due to fear of the Indonesian tax authority. As the Indonesian assistants were employed by UNTAD, which is a public University based in the provincial capital of Palu, the agricultural smallholders were afraid that information about land size could reach the tax department in the same city and therefore fees and higher real estate tax would be claimed.

Further, the PRAs were not conducted consistently from the beginning and thus not all research villages were covered. As the research design was selected to generate the data from problem-centred interviews in various sequences of three months with in between data analysis in Germany, we found after the first sequence that to base the research solely on the information generated from those interviews would not be sufficient. For example, it would have been difficult to track down exactly the years of the experienced natural hazards as the respondents' memories differed according to varying benchmarks. In addition, based on interviews alone, the complex interrelationship and importance of local institutions and individuals in case of a disaster were hardly understandable. Consequently, the author decided to add another research method and implemented four types of PRAs in the next research circles to complete the data, fill the gaps of understanding, and outbalance the insufficient information provided bythe problem-centred interviews.

The translation of the interviews and group discussions revealed another problem, as they were directly recoded and later processed in an office at UNTAD summing up to around 4,000 pages of text. Problems hereby were regional dialects and side noises as described above, but in particular the information loss due to the processing of interpretations (translation) from other interpretations (transcription). If the transcriber was unable to acoustically understand the meaning of a sentence, she summarised and marked them accordingly. In a second step, the translator tried to transform the previously summarised sentence into English.

To sum it up, the research team experienced various difficulties when applying the chosen methods in the remote research areas of Central Sulawesi. But as the overall research structure was designed to investigate and generate information for a period of three months in the field, then return to Germany and countercheck and evaluate the process for another three months repeating this procedure three times, the adaptation to the difficult circumstances was

successfully supported. Before starting another sequence of data collection in the field, the questionnaire was further improved, methods added or modified, and the data processing customised to the local circumstances. This research approach had been adopted during the preliminary preparation phase to best satisfy expectations to adapt to the conditions in the field.

5 Fifth Chapter

Results

In this section the research questions will be answered and interrelated to the Sustainable Livelihood Framework as well as the Theory of Diffusion of Innovations. Based on the objective of this study, the following research questions have been developed:

(1) How is the perception of natural hazards at the household level configured?
(2) Are households adapting to natural hazards and are the measures leading to a reduction of vulnerability?
(3) Are there differences in the adaptive behaviour of the different household types and what are the reasons for that?

5.1 PERCEPTION OF NATURAL HAZARDS

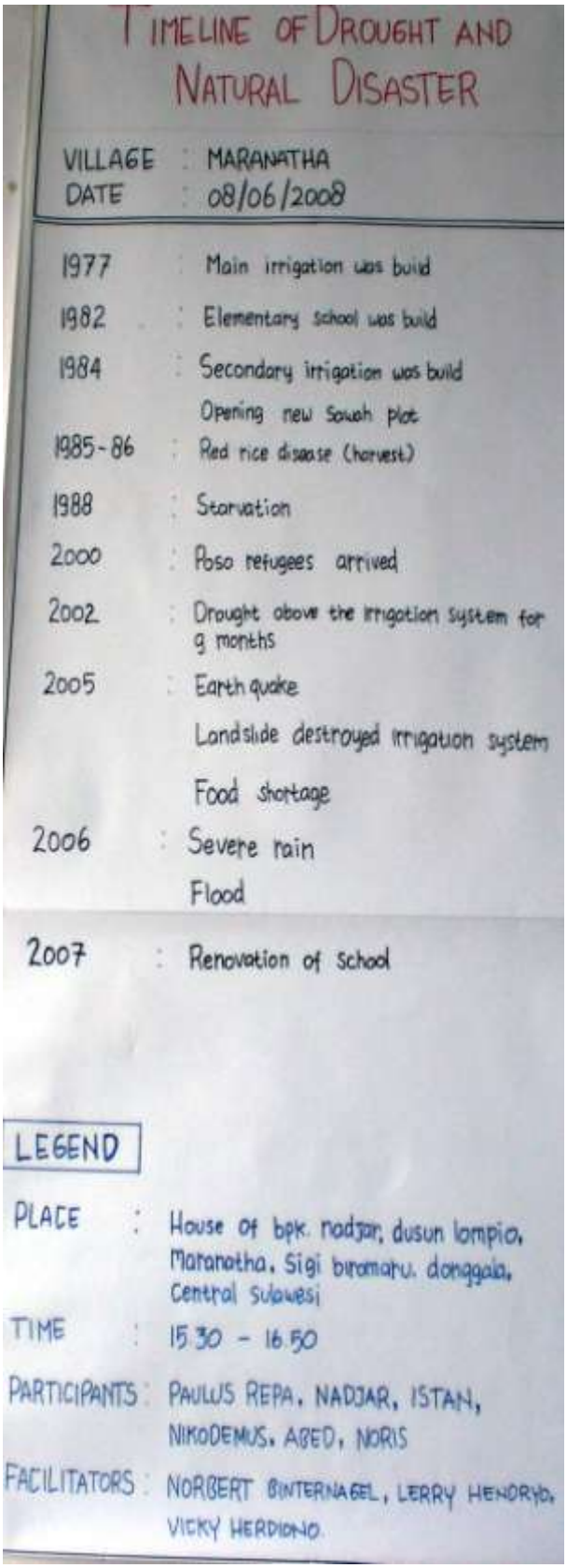
The first sub-chapter contains answers to the first research question. The results are generated out of problem-centred interviews and Participatory Rural Appraisals (PRAs).

5.1.1 Perceived natural hazards

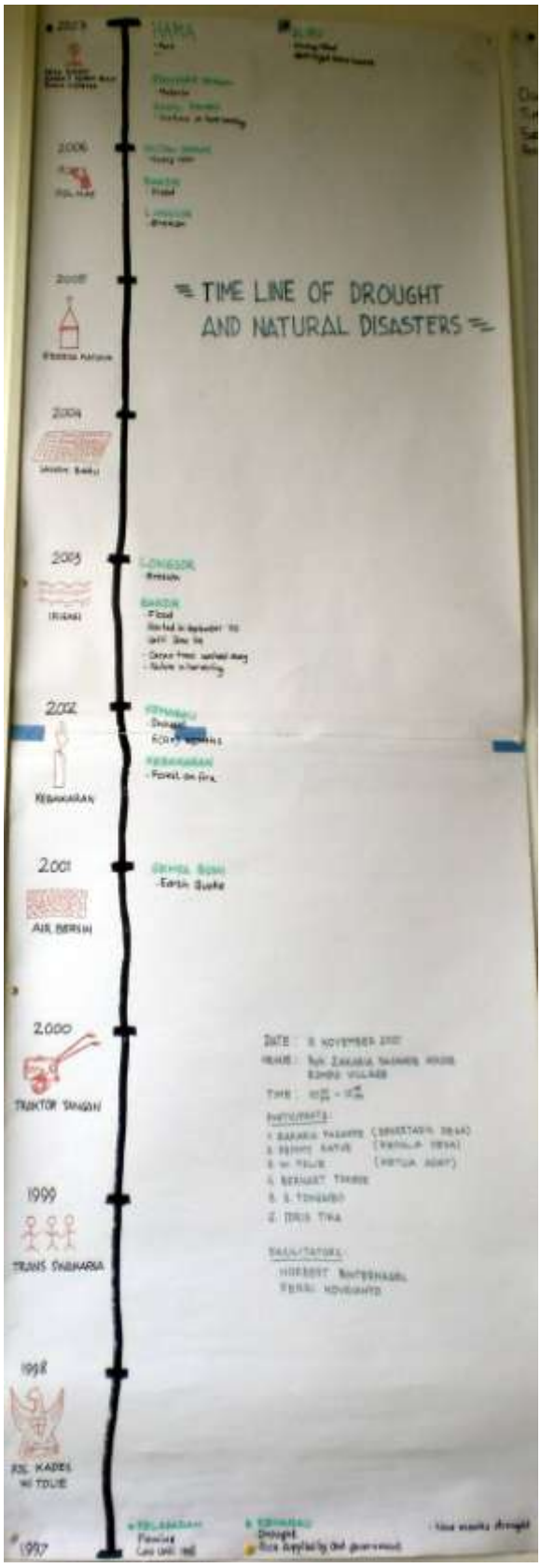
Almost all households interviewed in the research area had been affected by natural hazards. Droughts presented the most common natural hazard experienced by agricultural smallholders followed by floods, landslides, and torrential rain. In general, the prediction of the start of the rain or drought season using the traditional forecasting methods was stated by households as exceedingly difficult in the last ten years. In the interviews villagers perceived the rapid ongoing process of deforestation as the main cause of this uncertainty. As drought represents the most severe natural hazard to agricultural smallholders in the research area, the study investigated in addition the interrelation between ENSO and the occurrence of agricultural droughts. Even without intensification these droughts have a considerable impact on Indonesia with substantial crop failures, water shortage and forest fires (CRUZ et al. 2007, FAO 2008). To investigate the interrelationship several PRA-Timelines were conducted. As a result of the timelines a chronology of major events in the villages was obtained. Therewith the respondents in the in-depth interviews could later make converge their perceived agricultural droughts with the exact years of the Gregorian calendar. For example, Figure 5.1 displays two PRA-Timelines of natural disasters from the Maranata and Rompo villages. The timelines focus on the chronology of natural disasters, which have been a frequent cause of distress in the villages.

Figure 5.1: PRA-Timeline.

Timeline from Maranata village



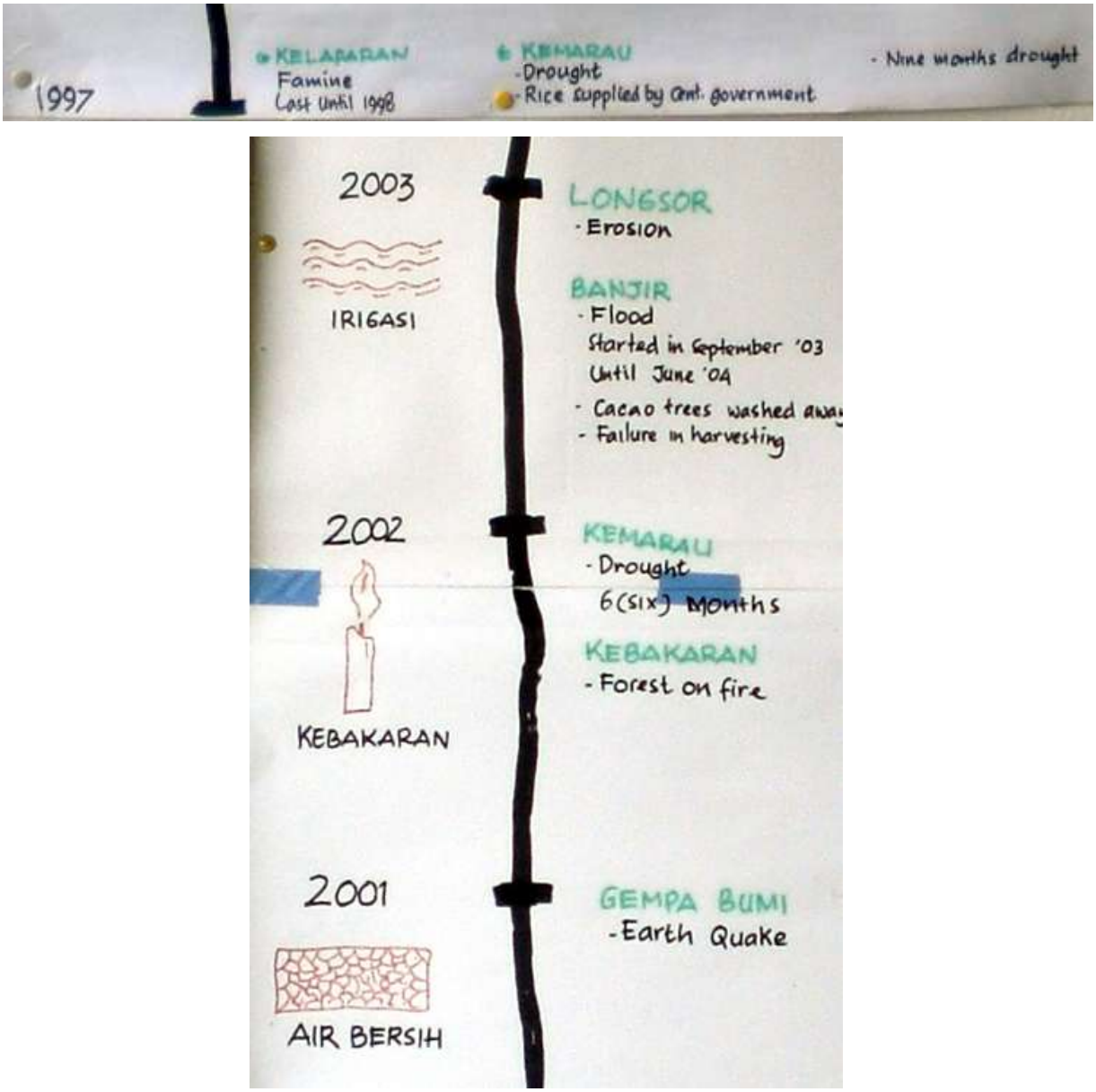
Timeline from Rompo village



Source: own data, Maranata (2008) and Rompo (2007)

Certain other major development interventions having a direct or indirect bearing on natural disasters were also recalled. This includes the construction of irrigation systems, renovation of schools, migration programmes, installation of fresh water systems or the occurrence of crop diseases. For better visibility, Figure 5.2 presents a distinctive section in more detail taken out of the Rompo village timeline.

Figure 5.2: Section out of the timeline from Rompo village.



Source: own data, Rompo (2007)

In the context of the group discussions, Figure 5.2 clearly shows that in 1997 villagers experienced a long lasting drought along with famine and that the government had supported them with rice supplies. Additionally, in 2002 both villages perceived independently of each other another severe drought lasting from six to nine months along with forest fires. In the

semi-structured interviews the highest mention of droughts referred to the year 2002. In addition, most severe droughts were perceived in 1997-98 and 2002, which, according to the National Oceanic and Atmospheric Administration (NOAA 2008), were as well the strongest ENSO events in the last 15 years. Thus, the outcomes of the timeline group discussions are confirmed by the semi-structured interviews and both perceptions are in line with the findings from KEIL (2004) in Central Sulawesi.

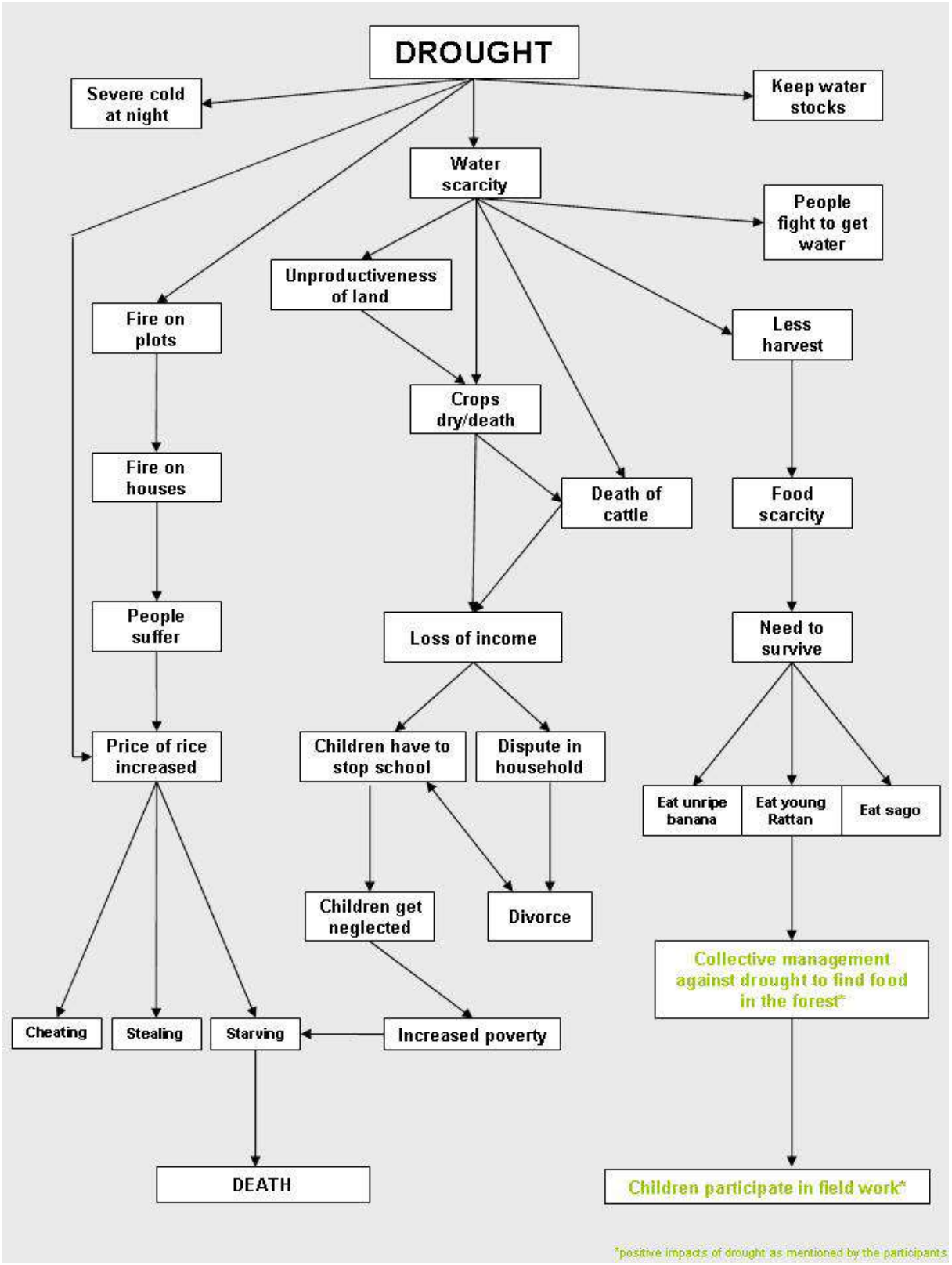
5.1.2 Impacts of natural hazards at the household level

In the problem-centred interviews, agricultural smallholders stated manifold impacts of drought, revealing a slight deterioration in agriculture everywhere, e.g. the drop of leaves and blooms. Furthermore, the reported drought impacts range from production losses (yield decline) due to lack of water and fire, to income degradation and the increased incidence of diseases, as well as the die-off of young cacao trees and the abandoning of plots. However, other major events were also recalled having a direct or indirect relation to ENSO related droughts. These include famine[3], forest fires, rice supply by the government or the construction of new irrigation systems.

To further investigate the impact of agricultural droughts from the perspective of agricultural smallholders, Participatory Rural Appraisals (PRAs) in form of impact diagrams were conducted. Figure 5.3 shows an impact diagram of drought made by the villagers of Watumaeta.

[3] Famines, as pointed out by SEN (1981) are man-made disasters that result from climatic risks and human failure to respond to the resulting declines in food production.

Figure 5.3: PRA-Impact diagram: effects of drought.



Source: own data, Watumaeta (2008)

The major and immediate impact of drought was perceived as scarcity of water, fire on plots, and the increasing price of rice, the most important food commodity. In turn, scarcity of water leads to less harvest, death of cattle, and disputes among the households about the distribution

of water. Additionally, secondary economic effects include the loss of income and increased commodity prices leading to serious social complications within the village community resulting in stealing, cheating, disputes in households and divorces as well as the neglecting of children. Of importance as well were the villagers' perceptions with regard to scarcity of food, which strengthens the need to survive by eating forest gatherings such as young rattan, sago or unripe bananas. This in turn also creates a positive impact of droughts as viewed by the villagers: a closer social cohesion brought about by mutual food management in times of crisis. Within the scope of these efforts, village elders led different groups of villagers for a whole day to the surrounding forest in search of food. Of particular interest is the perception of villagers that the striking of natural hazard leads to economic hardship which at the end results in predominantly negative impacts such as social disputes at the household as well as the village level. It appears that not just financial capital (through less harvest, increased food prices, loss of income), human capital (through scarcity of food, severe cold at night, fire in houses and plots, fights and neglected children), natural and physical capital (through the destruction by the natural hazard itself) are strongly affected by the impacts but that in fact even social capital assets are hit tremendously. This is of major importance as the majority of households rely mainly on their social and human capital to cope with the risks due to lack of financial security and insurance, the predicament that off-farm incomes may have to absorb the hazard impact as well as the slow and unpredictable relief provided by the district or provincial administration in form of natural capital (e.g. erosion protection, irrigation systems) and physical capital (reconstruction of infrastructure, water systems, supply of energy). Thus, the villagers' perceptions showed that owing to the secondary impacts of droughts even social capital assets got weakened at the household as well as the village level. This might further reduce the overall coping capacity of the households.

Apart from drought hazards, forecasting precipitation by traditional methods has become more and more unpredictable in the research area. According to the interviewed households, torrential rain has been increasing its magnitude during the last ten years to the present and may last from 24 hours to one week of constant intense precipitation.

P2	:	if you remember…e…since the early times you cultivated cocoa…e…in what year was the worst rain ever happened?
R	:	just this year…recently…
P1	:	and…e…How long does it usually last?
R	:	usually up to 1 week…

P1 : 1 week?

R : yes

P1 : it rains like 7 days in a row?

R : yes

(I63W about the intensity of torrential rain, 2008.)

Primary effects of torrential rain are harvest failure due to diseases and inundated plants.

P2 : how about the palawija and the cocoa…was there any difference? During the rain, was it just the palawija that died, the cocoa survived or both of them?

R : the cocoa also died during the floods…

P1 : the younger or the older trees?

R : both, sir

R : the roots couldn't survive the floods…

P2 : how many trees died during the hard rain that happened recently this year?

R : oh….a lot, sir…almost 20 trees…

P2 : did it also affect the cocoa pods?

R : of course…the pods were falling apart…it just stopped producing…

P1 : it were difficult times…

R : we had no money….there were less numbers of cocoa….and we were very troubled…

(I63W to the question, what are the impacts of torrential rain, 2008.)

Even worse are the secondary effects, as torrential rain is triggering secondary hazards like floods and landslides which will be described in more detail below. The main adaptation strategy to reduce vulnerability to torrential rain is the construction of ditches on plots as they channel the precipitation through the fields and prevent crops and soil from being washed away.

The occurrence of floods and landslides is closely interrelated with the precipitation of torrential rain. Agricultural smallholders stated an increased and more regular floods occurrence since 2001 compared to the past. Both types (large and flash floods) resulted mainly in widespread damages to crops and properties. Households stated that hundreds of productive cacao trees were drifted away along with several hectares of agricultural land,

resulting in harvest decline, abandoning of land, and changes of income patterns away from farming income to becoming hired labourers. Furthermore, the most important cash crop of the region, cacao, seems to be highly sensitive to floods. Mature cacao trees may die-off within two days if the water does not circulate because of the suffocation caused by inundation. Whereas productive cacao trees can withstand a longer period of drought resulting in reduced yields but still continue to survive.

Flood related disasters are closely connected with the topography and location of the plot. Accordingly, most affected agricultural smallholders cultivated crops in highly exposed locations close to or within flood plains and meanders. The following smallholder statement shows that the impacts of floods and land scarcity [Author's note: along with population growth and bad land use practice] leads to deforestation as affected households open new land within the national park to offset their land losses and create income as a livelihood strategy.

R : so many run in the national park, the only option they would have to survive…better than die in hunger…

R : we know about the law, if we set a foot on the state's restricted land, than we will get jailed….but we will get to eat in the prison… and we don't have to work…

(I56W to the question, why villagers open new plots in the national park, 2008.)

Flood impacts are primarily related to the exposure and the sensitivity of cacao plants. That means supportive measurements for adaptation strategies must be different in comparison to drought where the focus is on enhancing adaptive capacity.

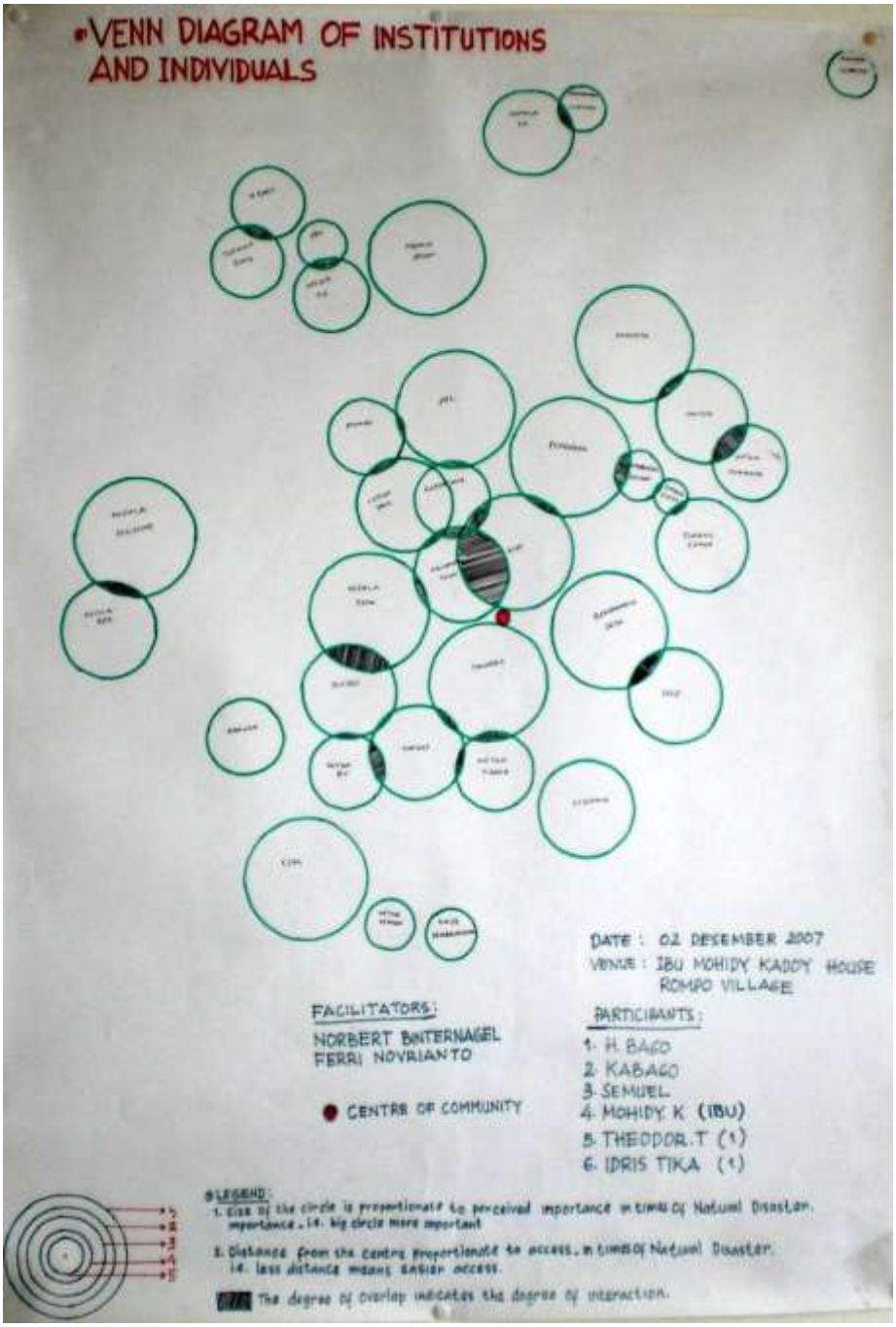
For landslides the picture looks somehow different again. There are less people affected and the primary impacts on people and their assets are not that severe in the research area. Most affected households have lost a few acres of land and several trees. But the secondary impacts as the destruction of irrigation and transportation systems for several months are much more difficult to cope with. With landslides the exposure of plots is again the main reason for the disaster as they are located mostly on steep land and slopes. In contrast to flood awareness, the affected households are sensitive to these exposures and blame themselves for the impact attributable to the choice of plot location and the delayed implementation of adaptation strategies known beforehand such as the planting of stabilising trees (gamal and bamboo) and constructing terraces to increase the resilience of their plots.

The combined observations and perceptions of agricultural smallholders in the research villages indicate that there are three interrelated phenomena that characterise environmental change at the local level: the weather is more variable, the weather is less predictable, and there is an increased frequency of extreme weather events.

5.1.3 Accessibility and importance of local institutions in times of a natural hazard

To understand the people's perception about the complex relationships, a PRA-Venn diagram was conducted. Hereby, in particular the importance and accessibility of local institutions and individuals when a natural hazard strikes were investigated. Figure 5.4 shows a Venn diagram output from Rompo village in Lore Utara sub-district. The participants identified 36 institutions and individuals, which were then assigned circles of different sizes based on their perceived importance.

Figure 5.4: PRA-Venn diagram of institutions and individuals in times of a natural hazard.



Source: own data, Rompo (2007)

The bigger the size, the more important the institution. The circles representing the various institutions were placed in such a way that the distance from the centre of the chart represented accessibility. The longer the distance, the lesser is the accessibility.

Table 5.1 shows all institutions and individuals listed by the participants in the Venn diagram. Column one presents ten different functions to which institutions and individuals are assigned. Column two to six shows five different levels of importance of these institutions as perceived by the participants.

Table 5.1: Importance of village institutions and individuals in times of a natural hazard.

Function	1st Importance	2nd Importance	3rd Importance	4th Importance	5th Importance
Medical treatment	Polindes (Poliklinik Desa = Village Health Facility)	Dukun (traditional healer)	Ketua Kader (Head of the Medical Candidates)		
Psychological care	Pendeta (Priest)	Pastor	Ketua Oikumene	Ketua Permuda (the Youth Leader)	
Reconstruction	Pengusaha (Businessmen, Trader)	Tukang Tempa (Iron Men)	Tukan Batu (Construction Worker)	Operator Sensor (Chain Saw Operator)	Tukang Kayu (Carpenter)
Advice to people who are affected by the hazard	PPL (Agricultural Extension Agent from the Government)	Ketua Tani (Head of Farming Group)	Gapoktan (Body above the Farming Group, everybody is a member)		
Support of people who are affected by the hazard	Kiosk	Kelompok Tani (Farming Group)	H. Bago		
Education	Kepala Sekolah (School Principal)	Kepala TK (Head of Kindergarden)			
Financial support and aid storage	Bendahara Desa (Village Financial Officer)	UEP (Money lending village institution)	Ketua FD (Forum Desa = Head of the Village Forum)	PPK (Sub-district Development Programme)	
Leading the people	Kepala Desa (Village Head)	Ketua BPD (Head of the Village Council)	POLMAS (Village Police)	Keamanam Linmas (Community Guards)	
Village development planner	LPM (Institution for Community Empowerment)	STORMA (Stability of Rainforest Margins)	Baruga (traditional meeting place in the village)		
Opinion leaders to people who are affected by the hazard	Kepala Dusun (Head of a village part)	SekDes (Sekretaris Desa = Village Secretary)	Ketua RT (Head of a Block, below a Dusun)	Kaur Pembagunan (Head of the village department)	

Source: own Data, Rompo Village (2007)

The outcome of the Venn diagram of the Rompo village, in particular the accessibility, is not transferable to other villages due to the specific characteristics of Rompo as a small and remote village neither having medical staff, a government extension agent or even a repair shop for motorbikes. However, the perceived importance of village institutions and individuals is quite helpful to understand structures of immediate relief at the village level. So even the LPM and the government extension agent was considered of utmost importance, it was placed far away, meaning thereby that the villagers did not enjoy easy access. The Gapoktan, though less important than LPM and the government extension agent, were more accessible. The overlap between various institutions and individuals, e.g. the local kiosk and the farming group, offers a clear indication of the degree of interaction amongst them. The local kiosk was mentioned as one of the most important institutions to gain immediate relief regarding food shortages. Of interest is hereby that the villagers in need are able to receive basic food supplies and salt without payment as a kind of loan to return later when they have recovered from the hazard. As the *dukun* (traditional local healer) is paid with rice instead of money, the villagers are even able to receive basic medical treatment through the support of the kiosk loan. In contrast, health care through *polindes* which is of highest importance in the villager's perception would be impossible without payment in money. In addition, the local kiosk and the farming group work close together when a hazard strikes as the extent of overlapping circles already indicates. The farming group, mentioned as one of the most important and accessible institutions, ensures the supply of basic food to the kiosk. This is doable, as every farming group has his own food stock located in a *lumbung* (food storage place, barn). The food stock is managed by a separate treasurer who also cooperates with other institutions and individuals whenever food supply is needed for whatever purpose. Perceived as of particular importance and unproblematic access after the hazard is the *bandahara desa*, the village's financial officer. This person is in charge of collecting and distributing aid and disaster relief funds provided by e.g. the district or provincial administration.

5.2 GENERAL ADAPTATION STRATEGIES

Regarding the second research question the study identifies various types of adaptation strategies at the household level. Following ADGER (2005) the strategies are classified into reactive and anticipatory adaptation.

5.2.1 Reactive Adaptation

The most frequently identified strategies are reactive adaptations which support the household in coping with the effects of natural hazards but do not reduce the vulnerability to future hazards. One of the most common strategies applied is the change in nutrition patterns and the reduction of food expenditures. The reason for this strategy is the direct impact on the households' agricultural productivity resulting in yield decline or the failure not just of the cash crops but also of the crops utilised for home consumption.

5.2.1.1 Changes in nutrition patterns and reduction of food expenditures

P2	:	Do you have to reduce the food consumption during time of the drought?
R	:	yes
R	:	before the drought, I used to have 2 meals a day
P2	:	and during the drought?
R	:	only once a day
P2	:	did you have to eat other food than rice?
R	:	yes, if there was no rice, then we ate cassava or umbut…
P2	:	umbut?
R	:	yes, I took it from the forest
P2	:	what is umbut?
R	:	umbut is a kind of rattan, the edge of rattan plants that can be eaten.
P2	:	the roots of the younger rattan plants
R	:	only once a day
P1	:	was it only breakfast, lunch or dinner?
R	:	breakfast…
P1	:	it must be very hard
R	:	yes. If we would have two meals, then there would be no more food for the next day…

(I40R, 2007).

R	:	The drought impact really influences us. Sometimes we added cassava to the meals as there was no more rice available. We wanted to buy rice, but we could not buy it anymore, because we had no money...e... it means we ate cassava, there was no rice.
P	:	Because of the drought?

R : that is right, because of the drought

(I32T to the question about the drought impact on food patterns, 2007.)

R : the corn was gone…
P1 : the corn?
R : yes, we had to eat bananas and cassava all the time…
R : bananas, cassava…those that could only be planted during the drought
P1 : during the drought..?
R : yes, the "singkong" (kind of cassava)…the one variety that could resist the hot weather…

(I39R regarding the question about drought impacts on food patterns, 2007.)

P2 : and how about the food, sir, did you have to reduce the food?
R : I had to eat once a day...
P2 : and before the drought…?
R : 3 times...
P2 : during the drought, what did you have for meal, sir?
R : almost nothing in particular…some vegetables, even less...
P1 : once a day?
R : yes
P2 : because of the drought, did you have to eat any food that you never used to have before?
R : yes
P2 : what was it, sir?
R : umbul, is a part of rattan which taken to be boiled, cooked and then eaten...
R : so whenever there was no cassava, no vegetables, no rice, then umbul was the alternative...

(I41R, 2007).

5.2.1.2 Paid labour

Another reactive adaptation strategy commonly applied is to sell one's own manpower to generate income. Similarly to the change in food patterns, this strategy further deteriorates the households' human capital. Usually employment is negotiated through social networks

(family structures or organisational memberships) and carried out working on less affected plots of more privileged neighbours. Common activities for paid labour are grass cutting, ploughing, hoeing, or building sidewalks for the rice fields. Also children engage in work as paid labourers contributing to generate income and fulfil the household needs.

R2 : We searched for another work
P1 : What sort of work did you searched for?
R2 : it was for making money
P1 : making money by becoming what?
P1 : I mean, what did you do to get money? What kind of work did you do?
R2 : Such as being a temporary worker for other person.
P1 : For whom did you work?
R2 : I worked for my brother in law
P1 : Where did you work and what did you do?
R1 : ..e.. I helped him to cut grass in his cocoa plantation

(I9L to the question what did he do in times of the drought, 2007.)

R : For fulfilling daily needs of my family I used to work to get money.
P : What did you do?
R : I used to work sometimes for my neighbor or for other family members ... such as helping people to harvest their cacao.

(I12B regarding the question how he supplied the needs of his family in times of the drought, 2007.)

R : Because of economic impacts it was uncertain to found other ways to suppy family needs...therefore sometimes I went to work temporarily. I worked in one's plantation to make money, so from that money we could eat

(I19T to the question how he supplied the needs of his family in times of the drought, 2007.)

P : What did you do to cover the financial shortage in the family?
R : I did a side job….like, plowing someone else's rice fields
P : You worked in someone else's rice fields?
R : Yes
P : But it was during the drought...How was it possible to plow ones ricefields?

R : It was possible; they had an irrigation system for the ricefields...

P : So the water was always available at that time ?

R : well, yes….

(I30T, 2007)

P2 : What did you do during the drought?

R : well….e…the irrigation project was already here at that time…

P2 : and then?

R : I worked there as a paid laborer, I worked at the dam…

P2 : what kind of job was it, sir? What did you do?

R : well, I worked, I dug the irrigation channel

R : even my wife had to work …she helped by working as a cook for other people…

(I40R, 2007)

P2 : okay…e...what was the effect of it to your life?

R : it was difficult times…I could only rely on becoming a hired labor, just to get some food…

R : I helped cut the grass on the ricefields and I also helped process the land by using a hoe...

(I51R, 2007)

R : I looked for another job; life was really difficult at that time….and I had to look for another job to survive…

P3 : what did you do, sir?

R : I helped lifting the corn…

(I54W responding to the question what he did in time of the drought, 2008.)

P2 : Because of the floods…e…you were not able to do anything on your fields, sir?

R : yes, yes

R : I ran the tractor and worked on other farmer's land, the children often went to work as hired labors, and they got paid daily…

(I56W, 2008)

R : as long as there are still some farmers working on their ricefields down there, we would still be able to work as a paid labor…

P1 : as a paid labor….for someone else….

R1 : yes

P1 : and your kids also, went working as a paid labor, sir?

R1 : yes, they did, too…

(I79M to the question about what he did in times of the drought, 2008.)

P1 : Because of drought was there any of your children under 18 years old helping you?

R : Oh yes, one of my child's helped me

P1 : What did the child do?

R : If we went as temporary laborers in one's plantation the child received Rp.5.000 for a day (0.50 US$) and I got Rp.10.000 (1US$) per day

P1 : How old was your child who helped you in the times of the drought?

R : He was 15 years old.

P1 : What did he go for work?

R : He hoes and cuts the grass.

(I19T, 2007)

P : At time of the drought was there any child under 18 years old joining you as paid labourer to fulfil house hold needs at that time?

R : yes, there was.

P : He supported you to make money. Then what did the child do?

R : he worked as a temporary worker

P : Where did he work as a temporary worker?

R : cutting grass in plantation, hoeing in someone's rice field

P : Was it to fulfil the households' needs at that time?

R : yes

(I33T, 2007)

5.2.1.3 Exploitation of natural resources

A further reactive adaptation strategy commonly applied by the households in the research area is the exploitation of products from the surrounding national forest or conservation area. Main activities are the collection of rattan and the cut down of trees. Rattan is usually bought by a middleman directly in the villages and later floated in large rafts to Palu to be sold further. Products from the forest trees as the wood itself or processed charcoal are sold directly by the villagers in Palu. Those activities are negatively affecting the diversity of the natural forest, which is essential to cope with natural hazards. In addition, they foster the process of deforestation.

P1 : was there anything else, sir? Like a kind of job that you did not used to do but then you did during the drought, because of the situation?

R : well, at that time I was near the rattan forest, so I collected rattan, and processed it

P1 : and how many hours a day did you usually do it, sir?

R : like 4 hours...

P1 : and you collected rattans every day?

R : yes

P1 : was it a real job...like you did before?

R : it was just temporary

(I36R, 2007)

R : I looked for rattan, when I got to sell the rattan I used the money to buy some rice

(I47R responding to the question how he anticipated the drought, 2007.)

R : it was really severe…..so we had to cut off woods, and sell it on the market…

(I75M to the question how he anticipated the drought situation, 2008.)

R : we had this order from the Social Department to do this….cut off some woods….as a side job…

P2 : selling woods?

R : yes…selling woods….

P1 : (E)

P2 : (E)

R : also to make some charcoal

P2 : (E)

P1 : (E)

P2 : what kind of woods, sir?

R : the tall woods….

R1 : firewood's…

P2 : from the mountain? Did you take it from the mountain or around here…?

R : still around here….there was no other village nearby at that time…also still very far from the mountain….

R : yes…and we sold the charcoal in Palu...

R : that was our job during that drought…

P1 : so this strategy…did it work? I mean, was it enough to support your life?

R : yes…just that….it was the only way to earn money to buy some foods…

(I76M to the question how he anticipated the drought, 2008.)

R : often we cut off woods to sell it on the market…

(I79M to the question how he anticipated the drought, 2008.)

P1 : did you raise your income from other sources?

R : yes

P1 : by what?

R : rattan

P1 : rattan, for sale?

R : I bought the rattan

P2 : so you were the buyer….?

R : yes, but at that time there were big floods and my rattan were all taken by the water

P2 : that must be devastating for you…

R : well, not really, sir…thanks God, it was not built from my capital…it was someone else's

P2 : oh…

R : I was only trusted to run this place...

(I49R to the question how he anticipated flood, 2007.)

5.2.1.4 Loans

Also to raise a loan constitutes an important strategy for agricultural smallholders in the research area to anticipate the impact of natural hazards. The majority of households does not possess a bank account. All loans stated in the interviews are informally raised through local social structures of trust mainly via the kiosk, relatives or long-term business contacts with the rice mill owners. The loans might be raised in money or in rice. However, in times of crisis a non-monetary commodity cycle is created. Here, the collected rattan is accepted as payment at the local kiosk. In doing so, the rattan gets weighed and the corresponding value retained by the kiosk so it can be used up by the villager to acquire all kind of goods sold in the kiosk.

P1	:	Did you take any loans, Sir?
R	:	yes, I borrowed from the kiosk
P2	:	did you get cash or rice?
R	:	rice, sugar, cigarettes…
R	:	yes, and kerosene, too
R	:	I measured the rattans that I collected and then I paid for the stuff…the income from the rattan was subtracted from the commodities that I acquired.
P1	:	so you paid with rattan?
R	:	yes, using rattans
P1	:	so…with…the rattan that you gathered, you could pay the kiosk?
R	:	yes
P1	:	you gave it to the kiosk, where they measured it?
R	:	yes
P1	:	then they directly subtracted the money from the rattan to pay for your commodities?
R	:	yes
P1	:	the owner of the kiosk did that
R	:	yes
R	:	then they settle the income from my rattans with commodities
P1	:	and if there was any leftover money then you would receive the rest of it?
R	:	no. there was nothing left, sir…

P1 : so you only did that to cover the debt...

R : yes…but often I still owe them, because it was not enough…I mean the amount of the rattans...

P1 : did they take any interest rate at that time?

R : no

P1 : so the price was all the same?

R : yes...

(I47R, 2007)

P : And because of the drought, landslides, and this flood, there was less income for you family....did you borrow any money from your friends or from any organization to cover your household's needs?

R : well, yes...I ever did that...

P : From whom did you borrow?

R : friends...but often only from some relatives...

P : and when they lent you rice, did you have to pay them back with rice again or with money?

R : if I borrow rice then it should be returned with rice.

P : except money?

R : if it is money then it should be returned with money.

(I25T, 2007)

P : Borrowing money I did not but for consumption..e.. the mill rice owner is still the family of my wife so we borrow rice or gabah, later after the harvest I brought it back . . .perhaps it was about four times to anticipate the lack of rice for two months

(I27T responding to the question if he borrowed anything to anticipate the flood, 2007.)

P : Did you take any loan at that time perhaps you borrowed money?

R : I did in 1999

P : from whom? From neighbours or a bank?

R : only from family

(I31T, 2007)

P : Because of the drought, did you take any loans or borrow some money?

R : yes, often...

P1 : during the drought?

R : yes

P1 : where did you usually borrow the money, at the Bank?

R : no, at the kiosks

P : in cash?

R : no, I put it in my bills…

P2 : so you took things like sugar, rice…

R : yes, sugar, rice…

(I35R, 2007)

P1 : And…e...during the floods in 2007 …e…did you take any loan?

R : yes, I borrowed some rice….

P1 : rice?

R : yes

P1 : rice …. from where?

R : the kiosk…

P1 : from the kiosk…and…e…how was the system, did you pay it in cash or could you wait to pay later?

R : it could wait until the next harvest ….

(I54W, 2008)

P1 : Did you raise any loans?

R : yes

P1 : Do the loan was raised from the kiosk, the bank or from your relatives?

R : from the merchant…

P1 : the merchant?

R : the rice buyer…..at the mills….I often took loans there…well, from the lord of he mills, I borrowed money….and often, rice….

(I72M, 2008)

5.2.1.5 Hand irrigation techniques

One of the most frequently mentioned reactive adaptation strategies are diverse kinds of hand irrigation techniques. Those techniques constitute no permanent irrigation system and are not planned for future drought occurrences. Instead, they are able to cope with the immediate impact of a lack of precipitation. Further they are characterised by low technology input and a constant high input of manpower. Examples therefor are techniques with bamboo, buckets, tanks, bottles, shading constructions, and digging holes. The longest lasting watering technique requires renewal after three to four days.

R : I used mineral water bottle, hung it and let the water just fell upon the plants drop by drop
P2 : can you explain to me, how this mineral water bottle was treated with your system?
R : I filled the empty mineral water bottle with some water then I hung it on the rees
P2 : the water fell drop by drop...?
P1 : and how long did one bottle last…e…?
R : 3-4 days

(I49R responding to the question how he anticipated the drought on his cacao plots, 2007.)

P : What did you do for your plantation while the drought happened?
R : I watered my plants
P : How did you do it?
R : I used a tank then I sprayed it to all plants
P : How was the result after you watered it?
R : the plants were not too dry, I did it in the morning and afternoon

(I12B, 2007)

P : What did you do to overcome the drought while your cacao experienced problems?
R : I had my own way..e.. around every single cacao plant I made a hole and I dug it for about 7 centimetres deep..e.. I took some water in the tank and put it in the hole and I watered the cacao
P : in that diameter?

R : Yes, in its diameter, so I watered its steam until it got wet. After watering I covered it with grass ..e...thus, the soil which I made wet would be still humid. Its humidity could stand for 3 days. So for another 3 days I could work for different works ..e. such as cutting grass, or trimming. every single cacao I watered in order to recover. And my cacao was succeeded. There died no cacao plants and returned back to produce well.

(I14B, 2007)

P : When the drought happened, what did you do to face it? Becaus 7 months are quite long.

R : Yes, I took water then I went to water the plants

P : What did you use for watering?

R : I used bamboo

P : Using bamboo?

R : We cut the bamboo then we made a hole in its centre then we filled it with water

P : How did you carry the water?

R : I carried on my shoulder from the river

P : "(E)" For one bamboo how many trees could it covered?

R : one bamboo could water 50 tress.

(I21T, 2007)

P1 : So what did you do to your cocoa fields during the drought?

R : we did any efforts to keep watering the younger, little cocoa trees...

P1 : you kept watering them?

R : yes, every morning and afternoon

P1 : so...e...how did you do the watering? Did you take the water from the river?

R : yes, we used buckets...

P1 : did it work with the watering?

R : it worked. But if it would not done continuously then the cacao would die real soon...

P1 : can you tell me the results?

R : there were about 1000 trees that survived... just 20 trees died...

(I36R, 2007).

P1	:	You kept planting cacao during times of a drought?
R	:	yes
P1	:	nothing happened to your cocoa?
R	:	nothing
R	:	but I had it with sombar
P1	:	how did you perform the sombar?
R	:	I cut the grass then…
R	:	I constructed three stakes then I installed some woods as a cover on top of it
P1	:	as a protection…and so, there was nothing serious happened to your fields in 2001?
R	:	yes
P1	:	you did that to all of the trees?
R	:	yes, to all of them
P2	:	and did it work? The idea, did it work?
R	:	yes, it worked
P1	:	all trees were able to survive at that time?
R	:	all
P1	:	until now?
R	:	yes

(I47R, 2007)

Figure 5.5 shows the above described sombar construction and might illustrate the work intensity needed to build such a temporary construction for around 1000 young cacao plants which are located on one hectare.

Figure 5.5: Reactive adaptation strategy – sombar.

Source: own picture, Watumaeta (2008)

5.2.1.6 Temporary land use change

The following cited interviews constitute examples for temporary land use change as a reactive adaptation strategy. This strategy contains several approaches e.g. the temporary abandoning of crops and land, temporary changes of the cultivation system (usually from wet rice to corn), and the planting of drought resistant crops. For the latter, usually cassava (*manihot esculenta*) is planted to anticipate food shortages in times of drought. Cassava will be mixed as food substitute together with rice. Most of the households stated they do not usually plant and consume cassava, but just in the wake of a drought. However, time for harvesting will take three months, which creates a shortage in food supply in the meantime when households own no other food stock. This example again will illustrate the shortcomings of reactive adaptation strategies.

P1	:	Did you plant other plants which are not usual for you to plant?
P1	:	To anticipate drought?
R	:	Yes, I planted cassava
P1	:	Why? Is cassava strong enough in time of drought?
R	:	Yes
P1	:	Even during the drought it keeps growing?

R : It keeps growing

P1 : For what purpose do you planted cassava at that time?

R : For . . . because in the time of famine cassava could be mixed up with rice

P1 : So it was not usual for you to plant it?

R : No, not usual

(I18T, 2007)

P : Where did you get the idea to plant cassava?

R : It has been done by our ancestors in the past, parents said that too: to prevent drought we should grow cassava, tuber and sweet potato

P : How long does it take to harvest the cassava?

R : for cassava, during the crisis, it takes at least three months to grow and be ready to consume

(I23T, 2007)

P : During the drought did you plant any crops, which you are not usually planting?

R : Yes

P : What plant was it?

R : cassava

P : You planted cassava, was it because of the disasters or you planted cassava already before the disasters?

R : not yet, it just planted cassava after the disaster

(I29T, 2007)

P1 : What happened to your ricefields during the drought?

R : all got dry

P1 : dry…

R : yes, I was not able to grow anything there…

P1 : you were unable to grow anything there?

R : yes

P1 : so what did you do then?

R : I just did some small horticulture farming…in the swamp area….I grew corn….

P1 : and did the strategy work with the corn in the swamp area?

R : yes

(I74M responding to the question what he did when he was affected by drought, 2008.)

P1 : What happened to your…e…ricefields?
R : I was forced by the situation to grow corn there…
P2 : so since you depend on the rain, then if the rain doesn't come, the ricefields will get dry?
R : yes, they get dry….and nothing can be planted on it...
P1 : you changed them with corn (E) and…e…did the strategy work or did the corn die afterwards?
R : the corn worked
P1 : so the corn was able to produce...
R : yes
R : I didn't water the corn….it was able to grow well; it grew on the ex-ricefields land. (R laughs)
P1 : so the corn here in Watumaeta can just grow without water?
P2 : on the ricefields….e….the land saved an amount of water it had absorbed then it is still able to support the corn…
P1 : okay….so you didn't have to carry water to the fields…?
R : no
P1 : do you still grow the corn now?
R : not anymore…
P1 : so it was only during the drought?
R : yes….now I focus on growing paddy again…
P2 : during the drought…you changed the ricefields into cornfields...?
R : yes

(I58W, 2008)

P1 : during the drought in 2002, you changed the ricefields to cornfields…?
R : yes, I had it replaced with corn…

(I75M, 2008)

P1 : Was there any land that you left temporarily abandoned during or after the drought?

R : yes, there was...it doesn't produced well so I just abandoned it.
P1 : how big was the land that you left abandoned, sir?
R : it was more than one hectare.
P1 : how long did you leave the land abandoned and then work again on it?
R : it was about two years

(I35R, 2007)

P1 : So you turned to grow other plants...then...e...what did you do to the other fields?
R : I totally left the rice field as I couldn't be worked there, all dried up...
P1 : all dried up?
R : yes, because of the rain depended rice field system, it was drought and there was no rain at all...
P1 : then you left it, but for how long, sir? You didn't take care of the plot anymore?
R : well, I waited until the rain season...
P1 : and how long was the interval from the drought, until the rain season at that time, when you left it? Do you still remember?
R : eight months
P1 : then you worked on the land again after eight months?
R : I worked on the land again...

(I136R, 2007)

5.2.1.7 Other applied strategies

Further applied reactive adaptation strategies are the reduction of households' expenditures, replanting of crops, or sale of household assets. One frequently mentioned strategy is the reduction of the households spending on chemicals, in particular pesticides during times of crisis. Besides financial reasons, households mentioned being afraid of spraying during droughts as they fear negative impacts on stem and roots. This strategy might have negative secondary impacts as the temporary suspension of pesticides could be related to a widespread reported increase in the occurrence of pests in the households as well as the surrounding plots. Thus, short term droughts might support the cacao-bust cycle. The most cited reactive adaptation strategies in the interviews are changes in nutrition patterns, taking up paid labour, exploitation of natural forests, and hand irrigation. Thereby, natural capital as well as human

capital, especially the number of household members and health, constitute important determinants of adaptive capacity.

5.2.2 Anticipatory adaptation

Besides reactive adaptation strategies the study identifies as well anticipatory adaptation strategies. When purposefully implemented they may alter the exposure of the households to future natural hazards, increase resilience to cope with changes, and reduce sensitivity of plots and crops. In contrast, reactive strategies 'just' cope with the immediate effect of a natural hazard but do not change the impact of future hazards.

5.2.2.1 Food stocks

To keep a food stock is one of the most commonly applied strategies. The food stock itself usually consists of unpeeled rice (paddy) grown in the own rice field. Regarding the present study, the own small rice fields of agricultural smallholders fulfil three important functions (1) income diversifications (in times of an income shock triggered by natural hazards, instable cacao prices or pest on the cacao plots); (2) provision of the households' main food component; and (3) creation of a food stock. The food stock is intended to last for a maximum of six months, as thereafter the next rice harvest will provide another new stock of unpeeled rice.

P2 : Do you keep any food stock, Sir?
R : yes, paddy, sir...
P2 : for how long will it last, sir?
R : the preparation, sir, is for January, February, March, April, because I would be plucking the paddy again on May...

(I43R, 2007)

P2 : Do you keep any food stock at home?
R : yes, paddy and also rice
P2 : how long will it usually last?
R : about six months

(I45R, 2007)

P2 : do you keep any food stock?

R : for?

P2 : drought anticipation…

R : yes

P2 : and how long does it usually last, sir?

R : well, the calculation is…until the next harvest season…

P2 : but how long…

R : usually three months...

(I65W, 2008)

P1 : Do you keep any food stock?

R : yes

P1 : do you usually do it or….because of the natural disaster?

R : Yes…..I learned from the previous experiences…(R laughs)

P3 : (E)

P1 : okay, so you are keeping a food stock because of the drought….and what are you keeping?

R : paddy

(I71M, 2008)

P1 : Do you keep any food stock like rice or dry paddy as a preparation for the drought or any natural disaster?

R : yes

P1 : and for how long does it last?

R : …e…like this, sir….every time we take harvest, then we would just keep some until the next harvest….

P2 : for how many months, sir?

R : four months…..until the next harvest…

(I72M, 2008)

P1 : Before the drought did you prepare any food stock like rice or paddy?

R : yes….

P1 : and how long does it usually last?

R : every time of harvest, we usually keep it until the next harvest…

P1 : how many months is it?

R : the harvest is every three months…

(I78M, 2008)

5.2.2.2 Irrigation management

Further strategies of major importance are different forms of irrigation management. These approaches to anticipate natural hazards are to construct ditches and retention basins, purchase water pumps, and to dig wells. Water pumps, wells and retention basins are usually planned to reduce the sensitivity of plots to lack of future precipitation. The construction of ditches constitutes a special approach as this strategy is aimed at both, to anticipate drought impacts as well as the effects of severe rain on the villagers' plots. The construction of ditches and retention basins is often implemented mutually by farming groups or unions of plot neighbours, whereas the purchase of water pumps and digging wells is conducted by the individual households.

The first two interviews cited are examples for the construction of ditches, in which the first one functions to anticipate drought and erosion, the latter just to cope with severe rain. At the beginning of the drought season, the channel system gets locked to keep the soil moisture. As a consequence, no hand irrigation is needed. In times of severe rain the construction serves as protection against soil erosion.

R : Many people laugh over my fields, because they see too many ditches there…too many water channels, but it makes my job easier…I don't have to trouble myself to carry the water around...

R : it was my own idea

R : if I let the ditch that way, during the rain season then the plants might die of the water that would cover them…that was why I thought of making a good drainage system out of the ditches…e…so the ditches have two functions:…during the beginning drought I shut the channel system if enough water is stored to irrigate the plots and during the rainy season, the channels would be drain-off the water and the plots not be flooded

P2 : so the ditch works as water storage during the drought...?

R : yes, water storage

P2 : even though the water got absorbed by the soil?

R : yes…..we already consider that the drought season usually comes from the

early July until November…e…although the weather change recently…e…the climate in this year, the last time, last June we already started to shut the ditch, so that the water stayed there, and supply the plants nearby…

P : mean, you stored the water inside the ditches during the last days…e…of the rain season…when nearly the drought season approaches?

R : yes, I shut the system

P2 : o that there would be enough water supply for the plants...?

R : yes

P1 : hen was the first time…e…you used the method?

R : since the first time I opened the location...

R : well, I observed the fields along the river, sir….e...and I thought its hard to carry the water to the fields, and there I got the idea of digging ditches as a water storage to be distributed to the fields...

P2 : and how long…e…did it take when you started with the ditches until you had all implemented on the fields...?

R : for one hectare, I required 40 people to dig the ditches...

P2 : and how long did it take?

R : it took only a day…done by 40 people…

P2 : and how long did it take to dig the ditches on all of your fields?

R : because there were only me and my children, supported by 3-4 people, it took me about a week…I did 80 meters a day…..I dug the ditch my own….

P1 : and is there any risk of using this system?

R : well, to avoid the risk, one should not dig too deep for the ditch, it has to be grouped in to different depth, adjusted with the situation…measured carefully

R : if it is dug too deep then during the rain season, the erosion would go over the fields and all efforts would be useless. The ideal depth should be 30 centimetres.

P2 : and you said….e…that you will still be needing this ditch…still be profitable in the future… why, sir?

R : it reduces the number of laborers I have to pay to carry the water to the fields...

(I49R regarding the question why he constructed a system of ditches on his plots, 2007.)

R : well, if the drought happens again, we would be prepared with the presence

of an irrigation system….that way, we can allocate water to go through the cocoa field…

P1 : the irrigation can access through your cocoa field?

R : yes, but only in a condition of during the dry season…

P2 : how does it work, sir…?

R : well…we have pipes that direct the water through almost every fields in here…mine and also everyone's….and all I have to do is to open the channel that leads to my fields, have it filled with water, and close the channel again once it has been full.

(I40R, 2007)

Another example for irrigation ditches focussed on the anticipation of severe rain. Figure 5.6 shows an example for this strategy.

P1 : what is this ditch for?

R : it is to keep the plants safe from the effect brought from the hard rain…

P3 : so the rain ever brought severe impact to the fields before?

R : yes, when the ditch was not built yet….every time it rained, the water would usually enter the fields and damage the plants….even worse for the vegetables they got inundated by water, then the plants would just die….

R : the water usually comes from up there…from the mountain….so to prevent this happens again; I decided to dig a channel for the water…the ditch….

P3 : and so you made the ditch?

R : yes….to keep the field's safe, also the road from being muddy…

R : other farmers up there also dig their own ditches….we connected the channels

R : so in the case where the water comes from up there, other farmers on the upland are prepared as well. Otherwise the water would just flow into the neighbours fields in the lowland …so thanks to everyone's cooperation…

P1 : so do you think it will still be profitable to use this ditch in the future?

R : yes, it will still be profitable…

P1 : why?

R : before there was the ditch the plants never succeeded…e…it worked but

not really as what I expected….e…, often the water flew through the plants and damaged the vegetables…they would get infected with this…e….fungi….e….sticky gum….however, after I dug the ditch, the water would just run-off controlled…

(I67W, 2008.)

Figure 5.6: Anticipatory adaptation strategy - irrigation channels in cacao plots.

Source: own picture, Watumaeta (2008)

To purchase water pumps constitutes yet another example for a strategy of irrigation management to reduce the sensitivity of plots in anticipation of a future lack of precipitation.

P2 : Where did you get your water from?

R : we installed a pipe of 2 ½ cm

P2 : just inside your fields?

R : it was quite deep…about 2 meters, and so the water came out from the land…

R : the machine is on top of it….the water gets sucked by the Alkon-machine…

R : well, the water spring is just like, everywhere, sir….you dig just three

meters, the water just comes out….but the water would just run out in short time if it is being sucked by machine….using eight meters of pipes instead would be considered better….

P2 : did you use a bucket for watering your plants?

R : no, no…I used pipes…

R : I used hose to economize the water usage…I could just let the water sprayed by itself by creating pipes with holes through the fields….

R2 : but then we should buy enough gasoline as a supply….

R : a day, from four at dawn until evening, at all, six litres…

P1 : so, having Alkon machine and thankfully, enough water supply during the drought, was it okay for your needs at home…e…your financial life ?

R : it was okay…

P1 : how much did it cost? The Alkon machine, sir?

R : at that time, it was still Rp 2.350.000,- [around 230 US$]

P1 : and during the drought that lasted for eight months, you continuously used the machine?

R : yes

P1 : it didn't get broken?

R : no

P2 : it depends from the diesel…

R : five times of use, then we would have to change its oil….

(I80M, 2008)

The construction of retention basins and the digging of wells are additional strategies applied for ex-ante irrigation management.

P2 : If the drought happens again….e….what would you do as a preparation to cope with the drought?

R : oh I see….well; to cope with the…e…drought…I already constructed a well in the middle of this….e…cocoa plot….

P2 : oh, in the centre of your cocoa fields…

R : yes

P1 : so you have plenty of water now on your fields?

R : yes, the first time the drought happened I took water from the river…and next time I will not have to go to the river anymore…

(I57W, 2008)

R	:	We have so many irrigation channels and we have so many ricefields around, we planned for everything,
P2	:	you built the water storage reservoir...
R	:	yes, together with the villagers
P2	:	as a preparation for the drought?
R	:	e...not only for that, but also to influence the water flow and …when we encounter any shortage of water like during the drought, then we would set free the water from the water storage reservoir

(I49R, 2007)

5.2.2.3 Terracing

Another strategy mentioned in the interviews is the construction of terracing structures on the plots (see Figure 5.7). Thereby, steep plots are transformed into a terrace structure. Caused by the reduction of water surface run-off velocity, the fast erosion of the fertile layer of soil can be prevented. In addition, terracing is a method to protect the plots against landslides.

Figure 5.7: Anticipatory adaptation strategy – terracing structures on cacao plots.

Source: own picture, Lempelero (2009)

P2 : Did you make terraces?

R : yes

P2 : Why?

R : I do it on my fields to anticipate the erosion, landslides and floods….so that the water will not flow directly to the fields…I mean the water from the hard rain or floods. It is to protect the fertile layer of the soil, not just carried away by the water…

P2 : and where do you make this?

R : on all of my fields sir, at the corn plots and also at the location…e...of some plants like clove, I made terraces there and the result was that everything turned okay…

(I49R, 2007)

5.2.2.4 Shading trees

To protect plots and the agroforestry systems from the impact of landslides and drought effects, the planting of shading trees (e.g. *Gliricidia* or *Jathropa curchas*) was mentioned as a regular measure of anticipatory adaptation. Alongside the protection of the soil from erosion, the most important function of the fast growing trees is to protect the cacao plants from the heat of the sun. Maintaining shading trees in cacao plantations improves the ecological resilience of cacao agroforestry systems to drought effects (BINTERNAGEL et al. 2010). Besides, in order to anticipate landslide and drought effects, households mentioned the utilisation of the leaves of *Gliricidia* for the production of organic fertiliser.

R : I just planted gamal, and protecting trees

P1 : in a landslide location?

R : yes, in a landslide location

P1 : then after you planted the trees, were there any more landslides?

R : there were no more

P1 : are there further functions of gamal or was it only aimed for protecting against erosion?

R : for protecting the soil we have to plant gamal tree. However, the recent research just found that the gamal leaves become fertilizer

P1 : whose research was it?

R : from an NGO. We practiced it here the last years in rice field.

P1 : fertilizer for rice fields or fertilizer for cacao?

R : it could be for cacao as well. We collected its leaves then we made it rotten and we mixed it with cow's and buffalo's waste

P1 : manure?

R : yes, manure then we mixed it with saguer water, we pounded then we closed it. When it was rotten perhaps for two weeks then we mixed it, then we put it in pail then we spread it to the rice field. In this village everything was successful. So if we plant rice we spread it firstly, ten days after we raised the seedlings. So its branches of one rice it could produce 62 stems.

(I17T, 2007).

P3 : When did you grow the gamal trees, sir? At the same time when you grew the cocoa or…?

R : at the same time

P3 : the cocoa and the gamal were at the same age when you planted them?

R : yes

P3 : so, was there any effect brought from the gamal trees to the cocoa?

R : yes, there was, sir….it protected the cocoa from the overheat climate…

P3 : but they were just being planted….?

R : well, gamal grew very fast, sir…

R1 : it grew very quick….it was only 3 months old and it could already protect the cocoa….so it was planted a day before planting the cocoa…

(I159W, 2008).

P1 : Do you have any new ideas or techniques that you now apply on your fields ?

R : I usually grow…shading trees instead of corn. I used to grow corn as shading trees for the cocoa...but now I don't do it anymore. I grow shading trees…I have to clean and take good care of them, I even spray the trees so that it is clean, grow faster, and after a while, then I start to plant the cocoa..

P1 : and the idea works?

R : yes, and fast…the cocoa usually starts to bloom at the age of one year and eight months….well thanks to the shading trees...

P2 : and before, when you were still using corn for shading?

R : well…when I was still planting corn as the shading trees instead of gamal, well, after I took the harvest from the corn, the sun would went through the cocoa and their leaves started to fall…it took them up to three years to grow and produce..

P2 : what about the shading trees?

R : the shading trees, well I don't have to remove them…I only have to clean them from the grass… and take good care of them, the shading trees must be kept alive, once the cocoa reach the age of five years then I can just terminate the shading trees, like every two or three trees between, to keep a good distance with the cocoa trees..

P2 : you reduce the number?

R : yes, so that 75 % of the sunshine can still get through the cocoa field, while the other 25 % can be covered by gamal as a protection to the plants...

P2 : from the sunshine...

R : yes, so 75 % of the sunshine can go in, 25 % to gamal, as a protection to the plants. That is the most important of all according to me, to stimulate fruition

(I44R, 2007)

5.2.2.5 Protective water barriers

To anticipate the impacts of floods the respondents mentioned the collective construction of protective water barriers. The structures are usually constructed of bamboo, rattan, woods, and piled up stones held together by concertina wire (see Figure 5.8).

Figure 5.8: Protective water barrier.

Source: own pictures, Toro (2007)

P : What did you do to deal with the floods?

R : With the friends in the same area, we built a dam up there, we turned the water flow by piling up stones and then we dug. That the water would not go rapidly to the rice field.

P : until now, is the water still blocked?

R : The rice fields are safe now.

P : You mean you have altered the water through the new path successfully?

R : Yes, up to now.

R : to build the dam Sir...e... Did you use bamboo or wood?

R : I used bamboo, wood, and rattan

P : Why you don't use big large woods for the flood barrier?

R : We decided to unroll concertina wire but if we put large woods on top of it, it will give too much pressure and may damage the wire.

P : Does the water barrier still exist?

R : Yes, it is still there, it has been covered and it is much better now.

P : Covered with what?

R : with stones, and sands.

P : is there a flood right now?

R : There is

P : So...e.... is your rice field OK?

R : Nothing happens to them...

(I23T, 2007)

5.2.2.6 Permanent land use change

The following quotations will constitute examples for permanent land use change as an anticipatory adaptation strategy. This strategy encompasses several different approaches e.g. the permanent abandoning of crops and plots, crop diversification including the planting of drought resistant food plants, the permanent change in crop production (e.g. red beans to corn) and collective land use regulations. The interviews revealed that the permanent abandoning of crops (usually corn) was caused either by drought hazards or when plots got inundated by water, while the permanent abandoning of plots was usually due to floods or land fires.

P1 : What did you do with the cocoa?

R : the washed away cocoa...well, I had to move them to another location, and so I left the plot, it was all occupied by water, even until now...

(I36R, 2007).

P2 : Did you have any land that you ever left during the drought, sir?

R : yes

P1 : what was it, sir?

R : the 50 acres of coffee that got burned….all left abandoned...

(I41R, 2007)

R : There were five lines of cocoa trees that were… taken by the water

R : that was why I sold the land at that time…the plots…

P2 : how big was the land size that you sold, sir?

R : 1 ½ hectares

(I149R, 2007)

Crop diversification was mostly conducted by cacao specialists, who sometimes experienced food shortages when cash crops became unproductive due to natural hazards, thus resulting in lack of income needed to purchase food. Therefore, the alternative strategies practised by more privileged households are either to purchase wet rice plots, be they irrigated or close to a river, to ensure income security, or to add corn and vegetable plots due to their shorter harvesting cycles. For less privileged households, crop diversification usually means the anticipatory planting of drought resistant crops such as cassava (*Manihot esculenta*) and taro (*Colocasia esculenta*). Both crops are used to replace rice in times of drought as main food component.

R : after the drought happened, I was trying as hard as I can to buy more plots for ricefields

P2 : ricefields?

R : yes, I did it to anticipate the lack of food …

R : it was to anticipate problems like what happened at the last mehuhe. I wanted to not let such things to happen anymore. Like when I had to work as a hired laborer….that was why I bought a number of plots, ricefields, and after I have my own ricefields, I don't need to go and do…

P2 : mehuhe anymore…?

R : yes…and I don't have to ask for food from… other people….not even from my relatives…

P2 : this mehuhe, sir…did they pay you with money or food?

R : I was paid with food...

(I37R, 2007)

R : Because of the floods, the cocoa trees were mostly unproductive, there weren't many pods and so I focused on growing corn

R : So by growing cocoa trees is a long term deal….but it only takes a while for the corn, like we can take harvest every two months…well….the cocoa is the long term plan….

(I153W, 2008)

P : These 3-4 hectares, are they filled with the same crops or diverse?

R : some are diverse…as for the variety

R : I have planted durian, and mangos…so, I am looking forward to make it bigger…and hopefully, one of the top commodities, later in the future…

P : so, if the price of cocoa in the market fluctuates drastically, what are you going to do with that situation?

R : well, I have programmed all my plants…they're all in scheduled…I have prepared for everything.

(I1L, 2007)

P2 : How are you going to prepare for future hazards?

R : I am going to plant cassava…well, I have it now…

P2 : you have planted cassava now?

R : yes, and it works…also taro...

P2 : taro are like cassava, right?

R : yes, they are similar…but different in process of to make it as food...

P2 : why would you prepare this cassava?

R : if there is a shortage of food supply, like shortage of rice supply, I could just have the cassava…pick them from the fields…

(I41R, 2007)

To anticipate natural hazards, collective land use regulation and group action was regularly mentioned by the respondents. One example are the village conservation institutions (LKD – *lembaga konservasi desa*), that overlook the development process at the village level and support, for example, the planting of trees on river stream areas and, in parallel, restrict people from cutting trees along the riverside by enforcing traditional law penalisation..

R : Well today we have the LKD to anticipate the landslides that occur because of the rain season….we restrict people from opening land from the forest; we don't give permission to deforestation…here in Rompo…

R : We distributed the message to other people around to avoid making fire during the drought. Some people listened, but some people didn't…well, I suppose they just didn't understand well when the officers socialized the issue…although during the training there were some tools…well...

P2 : what kind of tools, sir?

R : there were water sacks, tanks, and hoes, there were…e…some tools to dig the land and also we made borders where the fire wouldn't allow spreading…

(I49R, 2007)

5.2.2.7 Other applied strategies

Furthermore, other less frequently applied anticipatory adaptation strategies are the keeping of livestock and savings. In times of a natural hazard, livestock can quickly be transformed into financial capital.

R : Since 1977, I have been keeping some cows…so even during the most extreme dry season I would still have support….
P1 : and during the drought, did you sell any of your livestock?
R : yes, yes…
P1 : what did you sell?
R : I often sold the goats, cows….

(I75M, 2008)

Financial stocks to anticipate the impacts of natural hazards are rarely held in the research area. In the cases where these reserves are kept, then usually in cash, gold or as bank deposits. Financial assets themselves have the advantage of being a generally accepted tool of exchange when existent in small units.

R : There is a system in that area that people will buy gold when the cacao price is high
P1 : oh yes?
R : They buy the gold and when the drought comes they sell it again.

(I15B, 2007)

P1 : do you keep any money to anticipate for the drought or other natural hazards?
R : yes, although not much...
P1 : not much…and where do you keep it, sir?
R : at the Bank

(I44R, 2007)

The most cited anticipatory adaptation strategies in the interviews were food stocks, different kinds of irrigation management, and the planting of shading/anti-erosion trees. Thereby, financial, human and social capital, especially group memberships and networks as well as connectedness in institutions constitutes an important determinant of adaptive capacity. To hold livestock, savings or food stock requires an income surplus from the agricultural smallholders. To implement strategies as constructing terraces, protective water barriers and different kinds of irrigation management techniques, collective group action is required, which implies that the household itself is either a member of or well connected to this group.

5.2.3 Summary

This sub-chapter contains a short summary of the adaptation strategies most frequently mentioned in the interviews. The strategies will be presented in two tables and differentiated as reactive and anticipatory adaptation strategies. Table 5.2 lists the most commonly identified strategies of reactive adaptation.

Table 5.2: Reactive adaptation strategies**.**

Reactive Strategies	Short Description
Changed nutrition patterns & reduced food expenditures	(1) reduce the number of meals to once a day; (2) replace rice as the main food component through substitutes; (3) reduce the overall amount of food within the meals
Paid labour	Simple activities, also including child labour
Loans	Mainly about social networks of trust (local kiosk, relatives, neighbours, rice mill owners) in cash or rice
Exploitation of the natural forest	Main activities are the logging of rattan and trees. The timber is further processed to construction bars, firewood as well as charcoal to be sold later.
Hand irrigation techniques	Simple practices supported by bamboo sticks, buckets, tanks, bottles and shading constructions (see figure 6.5). Characterised by low technology and high input of manpower. Applied sometimes with great success.
Temporary land use change	Temporary abandoning of crops and land Temporary changes in the cultivation system Planting of drought resistant crops (*Manihot esculenta*)

Source: own data compilation

Anticipatory strategies are more rarely applied and if they are,, then just by a small number of households as compared to those implementing reactive strategies (except food stocks). Table 5.3 lists the most commonly identified strategies of reactive adaptation.

Table 5.3: Anticipatory adaptation strategies**.**

Anticipatory Strategies	Short Description
Food stocks	The majority of households possess a stock of unpeeled rice (paddy) lasting up to six months to anticipate food shortages
Irrigation management	(1) construct ditches and retention basins (see figure 6.6) (2) purchase water pumps (3) dig wells
Terracing	Conversion of steep plots into a terrace structure to prevent the erosion of soil and to protect against landslides (see figure 6.7)
Shading trees	Are seen as more and more necessary to protect the agroforestry system from drought and landslide impacts.
Protective Water Barriers	Simple structures out of bamboo, rattan, wood, stones and concertina wire (see figure 6.8)
Permanent land use change	(1) abandoning of crops and plots (2) crop diversification (3) change in crop production (4) collective land use regulations

Source: own data compilation

Given the cited anticipatory adaptation strategies, the determinants of adaptive capacity are different from those mentioned in the previous chapter. Instead of human and natural capital for reactive strategies, it is now predominantly access to financial capital (to create different kind of stocks), natural (land availability for diversification strategies), and social capital (group memberships, connectedness to institutions, and access to information) that constitute important determinants of adaptive capacity and enable households to implement anticipatory adaptation strategies. In addition, important for ex-ante strategies is human capital in form of education, as it is needed to enable the household members to gain awareness of the possible impacts of future natural hazards on their livelihoods and draw adequate conclusions with regard to possible strategies of successful anticipation.

5.3 INTERRELATIONSHIP BETWEEN HOUSEHOLD TYPES AND ADAPTATION STRATEGIES

In this section the study investigates if there is correspondence between the equipment with livelihood assets defined by the cluster and the adaptive decisions of the different households.

5.3.1 Cacao-rice combiners

Most anticipatory adaptation strategies and a number of innovations are carried out by the group of cacao-rice combiners. These sets of clusters possess manifold strategies to reduce their vulnerability to future natural hazards. In addition, these households own some of the least exposed plots to natural hazards and are therefore in no need to apply as many reactive adaptation strategies as other clusters to cope with the immediate effects of natural hazards. Consequently, they apply the smallest amount of reactive adaptation strategies in comparison to all the other cluster groups. The rice field itself has further functions regarding risk reduction. It enables income diversification and buffers as a result against risks resulting from price decline and uncertainties on the global cacao market as well as income shocks through e.g. pest in the local cacao plots. Furthermore, the rice field serves as producer of an own food stock of unpeeled rice which may last for half a year. Later, a new harvest will replace the previous food stock and so on. Within the group of cacao-rice combiners in particular cluster 6 is very well adapted. The different cases in this household type are quite homogeneous and characterised by a large land size (>300 are), a high level of education in respect to the research area (grammar school (SMP) or high school (SMA), and an indigenous status. As a result, within the village community cluster 6 is perceived as a household with very high social status: possessing memberships and functions in the administrative village structure, owning land titles and additional off-farm income. The driving force hereby could be social affiliation to the indigenous group implying access to well located plots and community land. However, cluster 6 was the rarest household type to be identified all over the research area.

5.3.2 Cacao specialists

The group of cacao specialists represents a set of households which also carries out manifold adaptations strategies and innovations to overcome natural hazards. Clusters 1, 2 and 3 are almost entirely focussed on the production of cacao in their plots. Their high specialisation could lead in the future to disadvantages in risk management due to the strong dependence on the global cacao market price and the ‘boom and bust cycle’ of intensive cacao cultivation. Within the group of cacao specialists, cluster 3 is particularly well adapted, and again

characterised by a large land size (>300 are). But contrary to cluster 6, these households are more heterogeneous. For example, the education level ranges from no formal education to university, the additional incomes from none to several activities including public service or trade and the ethnic affiliation from autochthones to Buginese migrants. The only similarity all cluster 3 households show is their economic success through the revenues of cacao production (increase of the income and continuous land extension within the last ten years). As the cacao boom represents the major economic driving force in the research area (CLOUGH et al. 2010) and consequently influences the land use change, particular focus is laid on the differences within this group. Here we notice that the impact from natural hazards varies considerably between small and large specialised cacao farmers (clusters 1 and 3). Small cacao farmers apply mainly simple reactive adaptation strategies to cope with natural hazards (reduced food consumption, engaging in paid labour and rattan collection to generate additional income). Therefore, their coping strategies are almost entirely based on the households' limited human capital itself. Extended droughts for instance will further decrease human capital (ongoing reduced food consumption combined with more paid labour leads to deteriorated physical health). In contrast, large specialised cacao farmers mentioned the utilisation of a range of anticipatory strategies (e.g. shading trees, food stocks, terrace building, irrigation management and crop diversification) along with technological innovations plus their social networks to overcome natural hazards. Moreover, cluster 3 households regularly mentioned in interviews to possess additional sources of income from kiosks, as public servants, or revenue from rental enterprises. Large specialised cacao farmers are the only household type within this group with more than one anticipatory adaptation strategy. Considering this, their strategies are based not only on human capital, but in comparison to the smaller cacao specialists, also to a large extent on social and financial capital.

5.3.3 Multi-cropping households, wet rice and other specialists

These household clusters apply very few anticipatory adaptation strategies and implement a small number of innovations but carry out the most reactive adaptation strategies of all household groups. In comparison, clusters 7, 8, and 9 are especially heterogeneous. There are almost no similarities of household attributes among their respective clusters except three: land size, education, and land titles. Specialised households possess a low formal educational level with primary school education as maximum qualification, and own very few land titles whereas multi-cropping households have all obtained land titles and higher education. In the

cluster analysis none of the three groups does have any limitations in their size of land. But the average multi-cropping households own double as much land (3,5 ha) than specialist households (1,86 ha). Multi-cropping households implement by far the most anticipatory adaptation strategies as well as technological innovations within this group. Again the pattern proves that land size, education, and in this case land titles, support sustainable adaptive behaviour as the multi-cropping households possess many more strategies for anticipatory adaptation as well as innovations than wet rice and other specialists.

5.3.4 Comparison of exceptionally well adapted household types

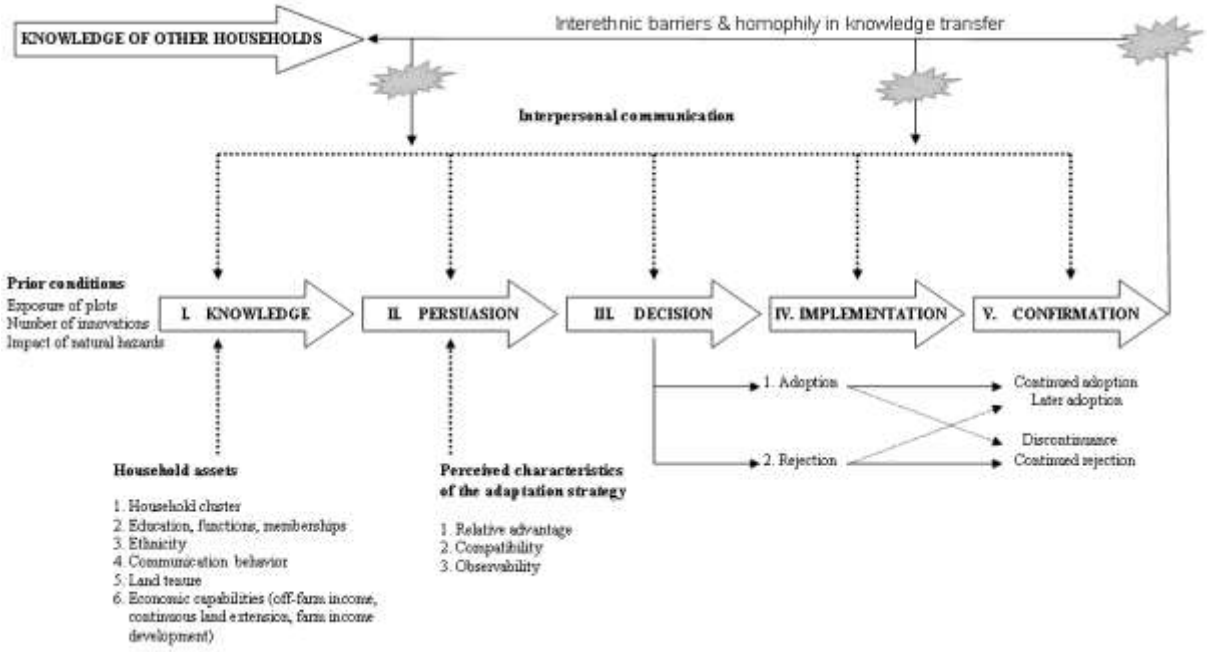
Large cacao-rice combiners (cluster 6) and large cacao specialists (cluster 3) are very well adapted household types. Both are characterised by an agricultural area of more than three hectares, which is quite large for the research area. Another criterion is the land use. Here, cacao specialists must cultivate more than 66% of their whole agricultural area with the cash crop cacao. Regarding cacao-rice combiners, either 75% of the whole agricultural area must be cultivated with cacao and rice, or each of the cacao and rice area under cultivation must be at least 33% of the total agricultural area. In comparison, both show similarities as well as noteworthy differences. Source for their successful adaptation in both cases is their 'Livelihood Asset' base, as access to or possession of sufficient assets supports successful adaptation practices to archive certain 'Livelihood Outcomes'. In particular financial, natural, human and social capital are key components at the household level in the project region. Both household types hold financial stocks available contrarily to other household clusters. Their favourable land use patterns were made possible due to additional incomes (public and private), access to land (local privileged households, open community forest), and social networks (Buginese, autochthones). But the foundations to develop their asset bases are different. Large cacao-rice combiners use their social capital (usually about indigenous networks) to gain additional incomes as public servants in the village structure, open access to the best areas of community land, or obtain important functions in the village, which empowers these households even more within the village community and thus extend the access to further assets. This leads to economic success, which in addition strengthens the asset base, while the foundation of the economic success of large cacao specialists is the cash crop cacao. Having started growing cacao at least ten years ago and having now endeavoured to build-up a wide portfolio of innovations and maintenance skills as well as cultivate highly productive trees (combined with the still high international cacao prices), leads here to the

highest benefits per hectare. This in turn leads to additional private incomes from e.g. trading/kiosks and further continuous land expansion.

5.4 REASONS FOR DIFFERENT ADAPTIVE BEHAVIOUR

By connecting the research results with Rogers's (2003) explanatory model of the innovation-decision process this section aims to explain the third research question about reasons for different adaptive behaviour at the household level and to describe causes for the relatively few numbers of anticipatory adaptation strategies in comparison to other forms of adaptation. The argumentation will follow Figure 5.9 which is a modification of ROGERS (2003) model of the five stages in the innovation-decision process adapted for the present study and the circumstances in the research area.

Figure 5.9: Knowledge transfer and development of adaptive decisions in the research area.



Source: modified after Rogers (2003)

Within the argumentation, explanatory patterns of prior conditions, household characteristics, and the perceived characteristics of the adaptation strategy all target the local circumstances of the agricultural smallholders in the research area and the diffusion of anticipatory adaptation strategies. The analysis starts at the knowledge stage where prior conditions and household assets already influence the agricultural smallholders before they decide to adopt or reject a certain adaptation strategy. In a second step the perceived characteristics of the ex-ante strategy itself will be highlighted as those three major characteristics influence the

persuasion stage of the households in the research area and enforce slow adaptive behaviour. In addition, within the persuasion and later in the decision stage households seek evaluation information, messages that reduce uncertainty about an innovation's expected consequences. Here, the study investigates the particular form of communication channels and shows in combination with findings about the knowledge transfer why those structures also slow down the diffusion of anticipatory adaptation strategies.

5.4.1 Prior conditions and household assets

At the knowledge stage the households are primarily influenced by their prior conditions and own household assets. Regarding the study, main influencing prior conditions are the sensitivity of plots and crops and the successive impact of natural hazards at the household level. If plots are less sensitive and crops are resilient to most common natural hazards, there will be almost no impact on their livelihood assets. Thus, why should households invest labour, time and finances in the implementation of adaptation strategies? Further important prior conditions for the successful implementation of adaptation strategies are the number of innovations already implemented by the households, as already existing innovativeness may support faster adaptive behaviour (ROGERS 2003).

On the one hand, household characteristics affect the knowledge base of the household within the innovation-decision process. On the other hand, they themselves will be influenced by external shocks from e.g. natural hazards (as described in the Livelihood Framework). Formal education and specialist knowledge (from own land use experience) are essential for understanding and mentally apply impacts of future adaptation strategies. Ethnicity, functions and memberships in the village structure either in- or exclude a household from the crucial knowledge transfer in the research area. Communication behaviour including interpersonal communication and change agents are fundamental for the awareness of any adaptive strategy.

Land titles, as part of the household assets, constitute a particularly important factor influencing the implementation of adaptation strategies (see Chapter 6.3). However, the vast majority of respondents in the research area do not possess any land titles. The interviews revealed three main reasons for the lack of legal land ownership. First, the plots are located illegally in the protected natural forest.

P : How did you receive your land?

R : We just took it by ourselves

P : So it was not from government...?

R : Yah?

P : Perhaps any procedure from the village government?

R : No, we just take firstly by ourselves

P : Have you made your land title?

R : Not yet

P : Why you don't do it yet?

R : Because all land is in the upside of the road [in the national park]

R : Because all people who have land in the upside don't make their certificate yet

P : Why they don't make it yet?

R : I have no idea

(I11B, 2007)

P1 : Did you certify all of your land, sir?

R : well, this one here hasn't yet…

P2 : and so these fields around, have any certificate?

R : not yet…

P1 : why?

R : well, I just can't take care of its certificate, sir…it's located in a conservation area…

(I60W, 2008)

P1 : Did you certify all your fields, sir?

R : not yet

R : it's the areal…it just can't

P1 : why?

R : it's part of the National Park

(I69W, 2008).

Second main cause for missing land titles is the lack of financial means necessary to pay for the certification fees which are prerequisite to obtain these titles. The formal certification of one plot independent from its size is estimated to cost around US$ 40, which constitutes a

disproportionate fee when almost half of the households in the research area live on less that US$ 2 per capita per day (purchasing power parity).

P : Do you have land certificates already?
R : Not yet
P : Why you don't make it yet?
R : I need a little bit to explain about that, because that certificate ..e.. we could not provide its budget to make the certificate, because for one place of plantation we need to provide a cash money of about Rp 400.000
P : For one place?
R : Yes, for one location.

(I14B, 2007)

P1 : As for now, have you certified all of your land properties?
R2&R1: Not yet
P1 : Not yet. Do you have any reason why you haven't do it?
R1 : We haven't got any money for the certificate…yet

(I9L, 2007)

P : Do you have any reason why you haven't taken care of the certificate?
R : I haven't got a chance to do it…
P : you haven't got the opportunity or you…
R : it's a budget problem…
P : you haven't got enough money…
R : yes

(I28T, 2007)

The third main argument for lacking land titles are the bureaucratic hindrances, independently from the legal cost, as a combination of 'special fees', unreliability, and the absence of regular opportunities for certification.

P1 : Did you certify all your fields?
R : not yet, sir
P1 : not yet…why?

R : because at that time…e…there were these people from the department of agriculture arriving to measure the land in here, I didn't get the chance because …

P3 : when the officers came, do you have to pay them?

R : yes

P1 : and in additional when taking care of the certificate, do you still have to pay for it?

R : yes

P3 : most people in Watumaeta haven't had any certificate of their land because when the officers come here to measure the land, they still have to pay…e…these officers' transportation fee, food and others expenses. Thus, they can't afford paying any more for the certificate…

(I59W, 2008)

P3 : You haven't certified the rest of the land, why ?

R : well, at that time, there is still very limited service from the department of agriculture…we want it so much, but not everyone is lucky enough to receive the service….well, the management is very messed….

R : we already filed a request to the village government but they haven't given any response….

P3 : (E) so…e…if things like this happen, sir…where do you usually report this? For the certificate, you will report this to…?

R : the village secretary

(I56W, 2008)

P : How about all these farm land, have all being certified or how are they?

R : not yet

P : Why is that?

R : I used to join the program…in the farming group, given the chance to have the land certified

P : but have you taken care the certificate of the land ?

R : not yet because the officials said that it is still drawing

P : Why do you have to wait for drawing?

R : well, that was the problem…once I brought an officer from, from… from

the local government that takes care of land affairs

P : yes

R : we are overwhelmed in what is called, the fee.

P : is it because it costs a lot?

R : yes (R laughs)

(I23T, 2007).

P2 : Does all the land has certificates?

R : not yet…but I got the STPT

P2 : it is the proof of tax payment, right?

R : yes

P1 : why don't you have the certificate?

R1 : it is very difficult to file a request of land certificate

P2 : so all these times there is only this STPT?

R : yes

P2 : still have to pay for it?

R : every year, I have to pay for the STPT

P2 : you have to pay every year, but without certificate…

P1 : when did you start to have this problem to make this certificate?

R1 : from 80's sir.

(I50R, 2007)

R : Well, I have no certificate, yet…

P : you haven't had them certified, yet?

R : not yet, sir

P : why, sir? Do you have your own reason?

R : it depends from the government…

P : what do you mean by that?

R : just before…e…some people came here to measure the land, with iron sticks…and border marks…but they haven't seen lately...

R : it's still on the progress…

(I2L, 2007)

P2 : Have you taken care of the land certificate, sir ?

R2 : not yet...

P1 : why?

R : we already registered our names but…

R2 : they haven't made it…

P2 : they haven't come for the measuring...

R2 : yes

(I52W, 2008):

P1 : Do you have certified all of your land, Mr. Dani?

R : not all...

P1 : why you haven't done it?

R : the officers that take care of the registration do not come here very often….

P2 : (E) how many times in a year do they usually come here?

R : usually once in every 2 years…

(I62W, 2008)

As already highlighted by BURKARD & FREMEREY (2008), land titles – formal and semi formal - are key drivers for agricultural productivity improvements and economic development which support economic success. Economic success through crops and off-farm income facilitates the access to education, functions and memberships, thus indirectly supporting the knowledge stage.

Consequently, the reasons for different adaptive behaviours at the household level are partly rooted in prior conditions and available assets. These preconditions determine the knowledge state of any household, which represents the base of information and awareness from where further behaviour is dependent.

5.4.2 Compatibility, relative advantage and observability as attributes of adaptive strategies

In a second step the focus is on the persuasion level of the decision-making process and hereby on the perceived characteristics of adaptation strategies. Crucial hereby for the project region are in particular three attributes of adaptation strategies: the relative advantage; compatibility; and observability (see Figure 5.9). Following ROGERS (2003) households' perceptions of these attributes predict the relative speed with which an innovation is adopted

by members of a social system as their own perceptions affect its rate of adoption and not the attributes as classified objectively by experts or change agents.

One of the strongest predictors is the relative advantage, which is a ratio of the expected benefits and the cost of adaptation of an innovation. Sub-dimensions of relative advantage include economic profitability, low initial cost, a decrease in discomfort, social prestige, a saving of time and effort, and immediacy of reward (ROGERS 2003). The latter factor explains in part why anticipatory adaptation strategies generally have an especially slow rate of adoption. Therefore, the strategies of interest are new ideas that households adopt in order to lower the vulnerability against natural hazards in future times. The advantages of anticipatory adaptation strategies occur at some future and unknown time, and may not happen at all. Thus in contrast to reactive adaptation strategies, which provide a desired outcome in the near-term future, the relative advantage of an anticipatory adaptation strategy is highly uncertain.

R : Well, I would suggest digging the river so that it becomes deeper, but seeing the condition now, it would impossible. The floods just happened and we can't control the water.

R : I could go with the idea of putting woods around there but I guess it would also be a waste, when the next flood happens, it would still carry the plants with it….

R : yes, no matter what we do….it's a dead spot…

R : there is no solution….

(I55W to the question about anticipatory adaptation strategies to prevent future flooding of his plots from the Larian River, 2008.)

R : If it happens again, sir? I don't want to put myself in trouble by worrying too much. Well, this world is already unpredictable…you never know what happened.

(I8L to the question what would he do to anticipate another drought in future times, 2007.)

P3 : What will be your strategies in overcoming a future disaster occurrence? I mean, to protect the plants….to protect your fields…

R : I don't really know about that...if it happens again, then I will probably migrate to another village…

(I53W to the question about future disaster anticipation, 2008.)

P2 : So if another flood happens, do you have any preparation for it, sir?

R : well, I can't say for sure, everything always happens unexpectedly in here. Like in one moment we say that it is okay, but then later suddenly floods happens…we are always surprised with how nature works … all is uncertain.

R : so we are never prepared….

(I54W to the question about precautions for future floods, 2008.)

As to the second important attribute of an adaptation strategy, compatibility, it is positively related to its rate of adoption (ROGERS 2003) as it also supports the occurrence of slow adaptive behaviour of households since the process of anticipatory adaptation is not consistent with existing values, past experiences, and the needs of potential adopters. Past natural hazards present threats for the households but are usually not devastating. As described formerly, food stocks for three months and simple reactive adaptation techniques are sufficient to survive. In addition, at the household level there is almost no knowledge yet about the fact of climate variability which might lead to an increase in magnitude and frequency of natural hazards such as floods, severe rain, and droughts.

R : As for me, sir, I didn't make any preventive actions; I was only a witness to what happened.

P : so there were no preventive actions from you?

R : no, sir, I just let them happened, it was a fate, anyway…

P : you didn't even consider working on any preventive strategies on your plots?

R : no, sir. Why should I? We overcame the last droughts and will continuo to do so.

(I5L regarding the question about anticipatory adaptation strategies to drought, 2007.)

P : Supposed that there is no rain for nine months, then your cacao is going to die, what will you do there?

R : Perhaps I just go for temporary worker, that is all.

P : But what will you do with your cacao plantation? As anticipation, so your plants don't die?

R : They won't die.

R : They will be kept alive.

(I11B regarding future drought anticipation on his cacao plots, 2007.)

The attribute of observability displays yet another explanation for the slow adaptive behaviour of the households. Observability here means the degree to which the results of an innovation are visible to others. ROGERS (2003) postulates that the observability of an innovation, as perceived by members of a social system, is positively related to its rate of adoption. However, most of the results created by anticipatory adaptation strategies are not yet visible for other households. Advantages might only appear as absences of negative effects on plots if natural hazards aggravate and plot vulnerability is simultaneously reduced. The result here is no increase in e.g. yields by not turning to fertilizers which may stimulate adaptive behaviour, but rather secure livelihood assets during times of natural hazards, which mean in fact no extra benefit for the households, just maintaining the present condition. Consequently, the observability of the adaptation strategy in the research area also enforces slow adaptive behaviour.

5.4.3 Interpersonal networks as prevalent communication channel

At the persuasion- and decision stage, the households seek evaluation information, messages that reduce uncertainty about an innovation's expected consequences. Households usually want to know the answer to the question "What are the advantages and disadvantages of the adaptation strategies in my situation?" According to ROGERS (2003), this type of information, while often available from scientific evaluation of an innovation is instead sought by most individuals from their near peers, whose subjective opinions of the strategies are more accessible and convincing to them. Mass media messages are too general to provide the specific kind of reinforcement that the household needs to confirm his initial beliefs about the adaptation strategy. That can be confirmed for the research region as well. As the examples from different villages show, a prevalent form of information exchange regarding the diffusion of adaptation strategies or agricultural innovations are interpersonal networks rather than mass media.

P1 : Where did you get this idea…e.g. .of carrying the water with a tank to the crops or the hand-irrigation technique with the bottle?

R : We found out about that from the farming group in 2004 until now…

P2 : and before?

R : It was my own idea

P1 : You seemed to have a lot of ideas, where did you get the inspiration from?

R : From many related person that…e…invited us for socialization.

(I49R, 2007)

R2 : It is very simple, often we ask the neighbours what they are using at the moment on their fields, and then we would just following them..

P1 : Okay, from the neighbours…and…e…these neighbours that you mentioned, were they your relatives or from the same ethnic ?

R2 : Yes, we were from the same ethnic…

P1 : What ethnic, sir?

R2 : Buginese

(I52W to the question from where he gained his information to adopt technological innovations on his plots, 2008.)

P2 : The idea of growing bamboo to anticipate landslides, from where did you get the idea, the initiative?

R : My parents told me that I had to grow the bamboo to support the fields against the landslides hazard.

P2 : … and who taught you to use it?

R : my friends next door

(I50R, 2007)

P1 : Is there any other technique besides the constructing of terraces?

R : Yes, one more was taught from the old parents. They advised not to throw away the grass because it could be instead used as fertilizer.

(I21T, 2007)

P1 : From whom did you received the information about the hand-irrigation technique with the 'bamboo drops'?

R : It was from the chief of the farming group

(I30T, 2007)

P2 : Did anyone teach you how to use it?

R : Yes, a friend

P2 : Who taught you at that time?

R : My brother in law.

(I40R regarding the question from where he obtained his information for agricultural innovation, 2007.)

5.4.4 Interethnic barriers in knowledge transfer and status homophily

Within the interpersonal information exchanges, from one household's decision chain to the knowledge base of other households, the study found interethnic barriers in knowledge transfer along with 'homophily'[4], anticipating or aggravating adaptive behaviour between different ethnicities and groups of different social status. As new ideas enter the local system through higher status and more innovative members, homophily acts as an invisible barrier to the flow of innovations within the social system. Homophily is hereby expressed through the fact that the local privileged households interact mainly with one another, and thus the adaptation strategies will hardly trickle down to the less privileged. Homophilous diffusion patterns cause new adaptation strategies to spread horizontally, rather than vertically, within the social system (ROGERS 2003). Homophily therefore can additionally act to slow down the rate of diffusion within the social system. In addition it has to be stated that the Buginese migrants from South Sulawesi, which constitute the major share of in-migration are Muslims with an own language in comparison to the autochthonous Christians. Within the interviews the respondents were asked to name the sources from which they received their information about agricultural innovations or adaptation strategies and in addition to describe the relationship they had to the source.

P : Who taught you about the bamboo-drop-technique?

R : A old guy who had passed away already. He taught us the way so that plants didn't die during the drought. We needed to make one bar of bamboo then embed it in the tree, after make a hole on the bottom side.

P : Do you have blood relationship with that old guy?

R : Yes, he was from my family.

(I26T, to the question about the source of information on adaptation strategy, 2007.)

[4] Homophily means the degree to which a pair of individuals who communicate are similar (beliefs, education, socioeconomic status, and the like). Heterophily presents the opposite of homophily (ROGERS 2003).

P1 : Did you start to adapt by yourself or together with other people?

R : I learnt about it from friends…

P2 : from the same ethnic…..or…?

R : yes, we were from the same ethnic background….

(I72M to the question about the source of information adaptation strategies, 2008.)

P : When you decide to adopt the strategy, did you started together with others or alone?

R : ..e.. I started alone by my own wish

P : Did you discuss it first before starting?

R : yes, we discussed it in the working group how and what to do, but to take initiative we did personally

(I72M to the question about the source of information on adaptation strategies, 2008.)

P : Is there any other technique taught to you besides terracing ?

R : yes, from my old parents who taught not to throw the grass away because it could be used as fertilizer

P : What do you mean?

R : the grass that we killed ..e.. it was my dads message in the past not to throw it away because it will get mouldy in the soil and it would support the fertility of the land

(I21T, 2007)

P : So how did you get that idea?

R : This idea came from our parents, our old grand parents in the past showed my parents how to behave. that was taught to the next generation suppose the drought happened again. that was its way of learning. we watered, if the plot is close to the water. if the plot is far from the water we make shade constructions as protection

(I34T to the question about the source of information for his tent- and hand-irrigation techniques to anticipate droughts, 2007.)

As the examples highlight, the respondents named either relatives, individuals belonging to the same ethnic group or members of similar organisations, in this case the farming group, as the source of their information with regard to the adoption of a certain strategy of adaptation. In addition, households belonging to a similar household cluster were often labelled as well as their main source of information. Since the household clusters are composed of the magnitude of land size and land use, the cluster itself is a socio-economic variable. The transmission behaviour could be thus interpreted as a diffusion of information along a level of similar socio-economic levels, for instance when receiving information from a 3 hectare cacao specialist or a 0.25 hectare maize specialist.

5.5 REGIONAL DIFFERENCES OF ADAPTATION ON FOUR SELECTED RESEARCH SITES

After having presented the perception of natural hazards at the household level, their impacts, the adaptation strategies applied, and the reasons for different adaptive behaviours, the following subchapter will emphasise the regional differences in impacts and strategies as well as highlight the underlying causes. To do so four research villages in different valleys have been selected. They will be illustrated as follows, focussing on their distinct regional characteristics such as power structures, topography, land use, and ethnic composition which may influence their vulnerability to natural hazards as well as their strategies of adaptation. Main source of information for this sub-chapter, besides group discussion and interviews, are various participatory observations and informal talks with elders and local decision makers.

5.5.1 Maranata in the Palu valley

As Maranata in the Palu valley is located almost at sea level and is topographically in one of the driest regions of Indonesia with scarce precipitation for agricultural production (see Chapter 2.2), it is also the village with the highest number of inhabitants, the densest population, and the shortest distance to the provincial capital Palu. One might conclude therefore that strategies to reduce the negative impacts of drought, for example, would be particularly sophisticated and its perception most distinctive. However, the strategies are rather simple and hazard perceptions are characterised by man-made interventions and the consideration of just one single hazard. Yet, founded as a governmentally planned migration village as recently as 1969, Maranata's equipment with physical capital is of vital importance to reduce the negative impacts of natural hazards. For example, almost all village parts of Maranata are connected to the large Gumbasa irrigation system which has a catchment area of

more than 2,500 $km^{2,}$ 41% thereof covered by tropical rainforest. Thus, the irrigation system is able to provide sufficient water supply at almost all times. There is just one man-made disruption due to maintenance work when once a year, regularly and upon previous notice, , the irrigation system is closed for three months. Until now, villagers have been even able to adapt to these disruptions mentioning that they convert the wet rice fields temporarily into corn fields at the beginning of the irrigation maintenance as the soil is still saturated with water, which is sufficient for one harvest.

R : We couldn't work on the rice fields…we had to move to other plots or grew corn….we even grew corn on the plot of the rice fields….

P2 : so you left the rice fields?

R : yes….there was hardly anything we could do on the rice fields….and so I had to change the paddy with corn or beans….

P1 : and the idea just worked?

R : yes

P1 : the corn didn't die?

R : no. the beans (*Vigna sinensis*) could survive, the corn too, and so we were still able to take its harvest and sell it in the market….to buy some rice…

(I72M to the question about what happened when the irrigation did not supply anymore water for his rice fields, 2008.)

Furthermore, there was an earthquake in 2005 causing a landslide which in turn blocked parts of the irrigation system for nine months. Those two events have shaped the perceptions of agricultural droughts of the villagers in Maranata. Moreover, Maranata owns a very well developed transport infrastructure which enables labour migration to the near provincial capital of Palu. In addition, the village possesses a weekly market of regional importance, which provides the possibility of the realisation of earnings from off-farm income and further enables the inhabitants to gain fast access to information. The land use in Maranata is also clearly regulated. At the bottom of the valley all land is irrigated by the Gumbasa system. The irrigation system was built by the government for the purpose of wet rice production. Following the interviews, it seems that the government promulgated directives that no conversion from wet rice fields into cacao cultivation were allowed.

P2 : Seeing through the last days of doing interviews here, we find that most

		people in Maranata just specialize in cultivating rice fields instead of cocoa….is there any specific reason for this?
P2	:	is there any rule of demanding you to just cultivating rice fields instead or is it just that most people here like to cultivate rice fields?
R	:	it was because of the irrigation of Gumbasa….it was meant to cultivate rice fields since the first time introduced in here…..so the area of Pandere to Biromaru is actually designed to cultivating rice fields ….
P3	:	a government program?
R	:	yes, a government program…now it has been limited…that we can't grow annual crops there anymore…
P2	:	so there is a rule from the government?
R	:	yes
P2	:	that you should only cultivate rice fields?
R	:	yes
P2	:	and not to cultivate cocoa?
R	:	it is not allowed, actually…
P2	:	it is restricted?
R	:	yes, restricted…

(I81M responding to the question why there is no conversion from wet rice plots into cacao in the Gumbasa irrigated plots, at the bottom of the valley, 2008.)

Hence, according to the information provided by the villagers, cacao production on the mountainous sides of the valley is hardly possible as the soil is unsuitable since it gets parched already after just three days of aridity. Therefore, there are almost no cacao specialists and cacao-rice combiners in Maranata.

Thanks to the precautions taken by the government equipping Maranata with physical capital (good transport infrastructure, existence of a regional market place, construction of a large irrigation system) as well as natural capital in form of regulated land use, it is well adapted to cope with the local circumstances and seems to be quite resilient to drought hazards. Temporary plot conversions along with temporary paid labour for income generation are the most employed reactive adaptation strategies in Maranata. In combination with the widespread anticipatory adaptation strategy to hold a food stock of rice, which is feasible as almost everybody owns a wet rice field, these simple adaptation strategies seem to be quite successful.

5.5.2 Rompo in the Besoa valley

The village of Rompo in the Besoa valley shows a quite different picture. With a distance of 135 km to the provincial capital Palu, Rompo is the most remote of the research villages. In addition, with one fifth of Maranata's inhabitants, Rompo is the smallest and least densely populated village of all. Main land use forms are corn and multi-cropping fields, whereas cacao and wet rice production are, for various reasons, still beginning but constantly growing.

R : Here..e..we have weaknesses like short of tools, seeds, the good quality cocoa seeds, just like what I experience now..

R : you will find more multi-cropping in here...

R : actually the difference between Kulawi and here…is…they were the first to know about cocoa…e…the variety and others…later there were some agricultural extension agents who came here and introduced us about the cocoa in 2003…actually, since 2000, but at that time, all we knew about is that we could grow the cocoa…

R : yes..so you won't find any farmer who owns like three hectares of cocoa plots or combines with rice fields…we are just starting...you know…to grow …to expand..

R : there is about 30% of the population here that already grow the cocoa trees…

R : after five years...

P1 : and the rice fields here were just starting since 2004?

R : yes, later in 2004

P1 : so, just starting then...

R : and the people started to work seriously on the rice fields in 2004

P1 : after there was an irrigation built...

R : yes

(PRA-matrix scoring in Rompo, responding to the question, why there is so few cacao and wet rice production, 2008.)

Besides, located at an altitude of 1,300 m.a.s.l. and with many sloppy fields, Rompo is quite exposed to severe rain as well as floods and landslides. However, along with the *transwakarsa* migration from South Sulawesi ten years ago (compare Chapter 2.2), the participants and current inhabitants of Rompo have established quite an effective village

administration which regulates the land use as well as the common disasters risk management for the approximately 120 households living in the village. The *lembaga adat* plays hereby an important role participating in the creation and enforcement of village rules regarding the utilisation of natural resources. Regarding interviews with the head of the *lembaga adat*, the institution regulates and prohibits e.g. rattan collection, opening of protected forest sides and the chopping down of trees along the riverside. In addition, the LKD initiated the planting of eucalyptus and hazel trees (*Corylus avellana*) along the river to prevent flood and drought risks as well as the building of a traditional dam done jointly by all the people living in the village.

P1 : Maybe you know if there is collective group action carried out together by the people in Rompo to prevent the natural disaster?

R : yes, yes, there is…

R : if floods happen there is a group like in Parawali….when the irrigation system leaks then almost everyone would go there and help to patch, to do the work together…also during the drought, when there is only few water…e…we would all work together to create the good flow of the water…

(I44R to the question about common disaster risk management activities, 2007.)

R : I remember in 1999, there was a kind of activity that dealt with the natural disaster…an overcome action by planting trees

R : yes, they set trees along the river stream

R : to prevent the floods and landslides…

R : once it was set, and alive, the trees strengthen the cliff's foundation...

P2 : and what do you do for the floods? I mean what kind of anticipation…e…do
you work together with the people to prevent floods?

R : we usually add more trees and….remove the woods that drifted by the water.

P2 : what kind of trees do you usually grow, sir?

R : usually eucalyptus trees

P2 : does this advice come from the village government, or…?

R : the government

P2 : which government, sir?

R : the village government

(I46R to the question about common disaster risk management activities, 2007.)

R : Well today we have the LKD to anticipate the landslides that occur because of the rain season….we restrict people from opening land from the forest; we don't give permission to deforestation…here in Rompo…

R : to avoid making fire during the drought we distributed the message to other people around. Some people listen, but other people didn't…well; I suppose they just didn't understand well when the officers socialized the issue…although during the training there were some tools distributed…as well...

P2 : what kind of tools, sir?

R : there were water sacks, tanks, and hoes, there were…e…some tools to dig the land and also we made walls where the fire would be stopped…

R : further, there are a lot of dams in here because we also have so many irrigation channels …at that time, we had a meeting, we planned for everything, like the Pelengoa area where we built a dam…e…for the village...

P2 : you built a dam?

R : yes, together with the villagers

P2 : as a preparation for the drought?

R : ...e…not only for that, but also to regulate the water flow and because we already had a main pond here…when we encounter any shortage of water issue like during the drought, then we would set free the water from the container here…the dam..

(I49R to the question about common disaster risk management, 2007.)

In addition, the village administration initiated the process of a governmentally funded clean water construction in 2001 and an irrigation system in 2003 which led to the new opening of 50 ha wet rice started in 2004. It still ensures further food security (see Figure 5.10).

Figure 5.10: Irrigation system in Rompo.

Source: own picture, Rompo (2007)

Rompo is one of the few villages were agricultural land is still available. Of further interest is that just one respondent mentioned not to possess land certificates. The high amount of land titles was brought about by the *transwakarsa* programme which, contrarily to the transmigrasi programme, did not reimburse the transportation costs incurred by the migrants but provided a certain amount of land size with the corresponding land titles to each participating household. This might as well explain the wide range of individually applied anticipatory adaptation strategies, from installing water ponds on the hillsides to collecting rainwater during the rainy season to storing it as water reservoir, to digging water channels in the plots, thus avoiding the flushing away of soil in the rainy season and keeping the water in the plots in the dry season by blocking the outflow, up to finally the construction of terraces for plots on steep land to avoid landslides.

P1 : Do you have all the land titles for your fields?

R : yes

P1 : all of them?

R : all of them

(I49R to the question about land titles, 2007.)

R : We also make terraces for the palawija and the cocoa fields...

P2 : what is it for?

R : to anticipate the erosion, the landslides so that is why we make these

R : yes, so that during the hard rain, the water wouldn't just drop by the fields but mostly to distribute the water to not cause any damage to the fields...

P2 : and where do you make this?

R : on all of my fields sir, the multi-cropping also at the location…e...of some tough plants like the clove, I made the terraces there and the result was that everything turned okay

P2 : I remember you also mentioned something about ...e….terraces...

R : yes, terraces…I do it on my fields to anticipate for the erosion with the floods….so that the water will not flow directly to the fields…I mean the water from the hard rain or floods...

P2 : and you do this on your plots up the hill

R : yes, on the hills. And it is to anticipate the fertile layer of the soil not to just go down carried by the water…

(I49R to the question about anticipatory adaptation strategies in his plots; see in addition his statements in the chapter entitled Anticipatory Adaptation Strategies, 2007.)

That means, as opposed to the centrally planned governmental precautionary measures conducted in Maranata, that adaptation strategies in Rompo have been successfully initiated and implemented by a small circle of well educated individuals, migrants from South Sulawesi, which all belong to the same Toraja ethnic group. The same group of people controls the village administration with the respective functions of the village chief, the village secretary, the head of the customary village council and the head of the village conservation council. That shows that human and social capital in form of individual knowledge and skills, networks, memberships, relationships and common rules and sanctions play an important role in disaster risk management activities in Rompo, successfully reducing vulnerability to natural hazards. In addition, the received land titles might initiate a process of investment into anticipatory adaptation strategies.

5.5.3 Watumaeta in the Napu valley

Watumaeta has similar spatial characteristics as Rompo. It is located at comparable altitude and climate conditions in just 30 km distance to Rompo at the entrance to the Napu valley. Therefore, the village is also strongly exposed to floods, severe rain, and landslides.

R : The flood caught my house….once I had to move all the chairs; it was around 30 centimetres high…

R : yes…in this house….well, I had to move all of my properties….and the car had to be pushed to the nearest asphalt constructed road….it was so worse…..the watershed from the river Lariang…

R : it took all my corn away…..the water….

R : including the land…the land was also carried away…

(I57W in response to experienced flood risk, 2008.)

This was proven in the interviews, which stated that floods and severe rain were the worst of all natural hazards in Watumaeta (see Figure 5.11).

Figure 5.11: Damaged cacao plots caused by flood erosion.

Source: own pictures, Watumaeta (2008)

Starting just in 1996 but still increasing, both hazards already had impacts resulting in the increase of land prices as the amount of money for plots more distant from the river is

continuously rising. Landslides also have a serious impact on Watumaeta. Again, this phenomenon is relatively new. Interviews stated that since 2006, every year large landslides continue to occur with strong impacts on people and crops. Hence, in comparison to Rompo, Watumaeta is dominated by land scarcity and the focus on wet rice and vegetable production. Caused by this land scarcity, new plots are opened on the steep edges of the valley slopes as well as in the meanders of the local river which flows through the valley bottom (see Figure 5.12).

R : Every time there is hard rain….the water would just rise and catch the fields… (Author: his plots are located within the meander of the river)

R : it got caught by the floods…the watershed from the river…

R : many people that live down there….went to the national park because here are no fields left, all carried away by the water…

(I56W on the question to flood risk and land availability, 2008.)

Figure 5.12: Inundated vegetable fields within a river plain (meander).

Source: own pictures, Watumaeta, 2008

The opening of plots on the steep edges of the valley slopes (see figure 5.13) as well as in meanders of the local river strongly increases the vulnerability of the villagers to natural hazards, as proved by participatory observations during the research.

Figure 5.13: Newly opened plot on the valley slopes.

Source: own pictures, Watumaeta (2008)

However, the problematic land scarcity alongside with the deforestation of the LLNP is sustained by the village administration. Founded in 1926 by local Napu people, the position of the village head is continuously occupied by a member of the local Towesu family from the Napu ethnicity. In the mid 90ies in-migration became a political factor in village life, when a great number of Buginese and Makasarese migrants came to Watumaeta. In addition, in the year 2000 a great number of Poso refuges arrived. To secure the independent administrative structure of Watumaeta and supplemented by the dominant position of the Towesu family and the local Napu ethnic group, the former responsible village head posed almost no restrictions on in-migration and offered secondary forests to newcomers almost at will (see Chapter 2.2).

The different ethnic groups in Watumaeta (Javanese, Buginese, Poso refugees) are living in clearly demarcated *dusuns* and intermarriages seldom happen. The local ethnic group is represented by the village head and the head of the customary village council and the migrants are represented by the head of the *dusun*, who himself complained in an interview about the discrimination of migrants and their *dusuns* in the granting of public village funds for infrastructure, irrigation or risk management measures such as landsides protections or dams.

That means that even though Watumaeta is within short distance to Rompo and has similar climatic and topographic conditions, the situations are quite different. In Watumaeta land scarcity and insufficient administrative structures are the main cause for more susceptibility and exposure of villagers and their plots to natural hazards, which in turn increases the vulnerability of Watumaeta in comparison to Rompo.

5.5.4 Bulili in the Palolo valley

In Bulili in the Palolo valley, the ethnic composition and the village power structure is strikingly different to Watumaeta. As described in Chapter 2.2, the minorities of the household heads were born in the village and around 80% of the inhabitants originate from South Sulawesi and their ethnicity is mostly Buginese. The land use is highly specialised in intensive cacao cultivation and characterised by land scarcity, so that no multi-cropping households or other specialists apart from cacao or wet rice exist anymore (cluster 8 and 9). However, similar to Watumaeta is the ethnical segregation into different village parts, the almost inexistent interethnic marriages, and the lack of common disaster risk management activities. Here as well the serious impact of land scarcity manifests itself in the establishment of cacao plots and even houses on river plains closed to meanders which lead to severe impacts in times of flooding (see Figure 5.14).

Figure 5.14: Damaged cacao plantation along the flood prone river areas.

Source: own pictures, Bulili, 2007

R : More than 200 trees were taken by the flood

(I12B in response to flood impacts, 2007)

R : Flood impacts in the village we can not count anymore because it is happened almost every year

P1 : Perhaps you could tell me the worst one, what year was it?

R : I think the worst one was in 2004 to 2007

R : It means the effect to my farm was, that many of plants got affected by landslides or erosion and were flooded by water so it decreased the productivity

P1 : What was the impact in 2004?

R : It was around 50 trees

P1 : and in 2005?

R : It were about 100 tress

P1 : and in 2006?

R : in 2006 was same as well

P1 : and in 2007?

R : It is more than 200 trees flew through the water because more than a

hectare was affected

(I12B in response to flood occurrence and impact on his plots, 2007.)

5.5.5 Summary: social structures vs. spatial settings

The sub-chapter describes the importance of social structures in four selected research sites, either fostering or hindering the resilience of communities in the face of natural hazards. Every community has to be analysed on its own as the social settings are different everywhere. The examples highlight that even if the exposure to natural hazards is similar, some villages are less sensitive than others to natural hazards and thus the impacts differ. This is attributable to the existing collaborative disaster risk management structures initiated by individuals or groups. On the one hand, the villages of Maranata and Rompo are relatively well adapted to natural hazards either through provincial government precautions or common disaster risk management at the village level even though both villages possess opposite spatial characteristics and climatic conditions and are both strongly exposed to natural hazards. The resilience of both villages is increased by their reduced social vulnerability, which is expressed through the existence of social structures and processes dealing jointly with disaster risk management. The opposite is true for Watumaeta and Bulili. Bulili is an example for a village with interethnic barriers in knowledge transfer which hinder the diffusion of anticipatory adaptation strategies caused by a high amount of in-migration of Buginese migrants. Watumaeta in contrast symbolises a village with homophilous behaviour inside the interpersonal communication networks. A small autochthonous, privileged group of households keeps the knowledge of adaptation strategies and benefits from structural precautions such as access to the irrigation channels or the possession of flat land areas in secure distance to the Lariang River. In addition, in both villages there are no joint disaster risk management activities existing at the village level. Consequently, interethnic barriers and homophilous behaviour in the communication channels delay the processes of individual adaptation and even augment the vulnerability of households in both villages.

However, all information has to be analysed in the regional context. It is therefore important to consider the fact that even if the equipment with spatial settings is similar (Rompo and Watumaeta), of greater importance for adaptation seems to be how social structures deal with natural hazards and the diffusion of adaptation strategies within interpersonal networks. Of further importance is the ethnic composition in the villages which influences the change in land use and, in turn, the adaptation capacities of those new cultural landscapes to the existing

natural hazards. Moreover, the examples show the strong influence of local power structures for the adaptation to natural hazards. In particular the village administrative body is not to be underestimated in its ability to enhance the resilience of the community, especially since the decentralisation policies of the central Indonesian government ten years ago. These policies lead to a relatively autonomous acting of village officials in administering issues such as land distribution, conversion of community forest into agricultural plots, population pressure due to in-migration, or the distribution of land titles – all most influential with regard to the process of adaptation.

6 DISCUSSION

The following sub-chapters are aimed at discussing the main findings. In a first step, the answers to each of the three research questions will be given (Chapter 6.1). Hereby it will be summarised what each of the three results mean and how the findings are interrelated. Next, a critical assessment is conducted concerning shortcomings in study design and potential deficits of the analysis (Chapter 6.2). The methodological limitations are already discussed in Chapter 4.3. After that, the findings are going to be compared with other related recent international studies (Chapter 6.3).

6.1 WHAT DO THE FINDINGS MEAN?

6.1.1 Hazard occurrence and impacts in the research area

The first research question has focussed on investigating the perceptions and impacts of natural hazards on rural households to understand if there is the need for any adaptive behaviour of the local smallholders in the project region. By conducting in-depth interviews, group discussions, and participatory observations for around one year in the vicinity of the LLNP, the study finds that almost all households in the research area have been affected by natural hazards. Drought represents the most common natural hazard, in which the respondents perceived the most severe droughts in 1997-98 and 2002. Both drought periods were related to the occurrence of ENSO events and had severe impacts such as e.g. famine, forest fires, yield decline, increased appearance of plant diseases, die-off of young cacao trees, and the abandoning of plots (see Chapter 5.1). Further, regularly reoccurring natural hazards are floods and landslides. Both are mostly triggered in the research area as secondary hazards caused by torrential rain. Respondents hereby perceived an increased magnitude of torrential rain and interrelated impacts since the last ten years, resulting in harvest failure due to diseases and inundated plants, the die-off of cacao trees and the abandoning of plots. It appears that the livelihoods of rural households are under the pressure brought about by the impacts of natural hazards. Coping with the problem of multi-hazards, in particular, poses a challenge in the study area.

6.1.2 Adaptation strategies

Following the results of the first research question, in a second step the study focussed on the following questions: whether local households adapt to natural hazards; what are their adaptation strategies and their obstacles; and are these measures leading to a reduction of

vulnerability? Since even households who possess the adaptive capacity to carry out an adaptation strategy are not necessarily implementing these activities, the intention was to assess what kind of strategies are applied, their problems and advantages, and their impact on vulnerability. Within the research villages various types of adaptation strategies were identified dealing with the different natural hazards at the household level. Most common strategies of adaptation are reactive ones that do not reduce the vulnerability of households in the future (see Chapter 5.2.1). By applying reactive adaptation strategies, as e.g. changed food patterns or reduced spending on chemicals, the negative impacts of natural hazards on the 'livelihood assets' might be even intensified. Additionally, one of the most frequent mentioned activities, the collection of rattan from the surrounding LLNP, is often prohibited and implies a loss of biodiversity in order to cope with the consequences of natural hazards. Both examples even deteriorate the human and natural asset base. However, anticipatory adaptation strategies are very rarely adopted (see Chapter 5.2.2). If purposefully implemented, these strategies might reduce the exposure of households to future natural hazards, could reduce the sensitivity of plots and crops and therefore reduce the overall vulnerability of the smallholders. Keeping precautionary food stocks is one of the most common measures applied within this category, followed by irrigation management strategies (e.g. the construction of ditches on plots to anticipate torrential rain), the planting of *gliricidia* (gamal trees for drought anticipation and to prevent landslides), and the construction of terraces (to prevent the erosion of the soil and to anticipate landslides).

Nonetheless, from the analysis of different types of adaptation strategies, their perceived pros and cons, and their degree of utilisation, one can conclude that even if the majority of all local households possess adaptive capacity, only a small minority is implementing adaptation strategies that reduce their vulnerability against future natural hazards. It appears that, caused by different adaptive behaviours, the impact of natural hazards varies considerably between household types and ranges from slight deterioration of the agricultural production to substantial losses of assets.

Given the results from the first and second research question, the next question that arises is why there are differences in the adaptive behaviour of the household types. This leads to the third research question.

6.1.3 Factors of differences in adaptive behaviour

As indicated above, it was found that both types of adaptation strategies are unequally distributed throughout the different household types. Here the study has identified that large cacao-rice combiners and large cacao specialists are exceptionally well adapted household types. Although the characteristics of both types show differences in their ethnic affiliation (the cacao-rice combiners are characterised by an indigenous ethnic status, whereas the cacao specialists are mainly from the South-Sulawesi Buginese ethnic group (see Chapter 5.3.3), they are both privileged households possessing large-scale land property, higher education, and land titles, generating off-farm incomes.

Other factors that increase or decrease adaptive behaviour relate to different patterns of interpersonal communication, the common and most important channel for information exchange, and the diffusion of adaptation strategies and technological innovations in the research area. Thereby, two factors were found to be most relevant for the differences in innovation diffusion: prevalent status homophily within the local interpersonal communication networks, and interethnic barriers in knowledge transfer. Both factors were found to be the main drivers explaining why it was hardly possible to discover trickle down effects in the diffusion of anticipatory adaptation strategies. In villages like Bulili, which is dominated by Buginese cacao specialists (early adopters of anticipatory adaptation strategies), almost no interethnic information exchange was found. In other villages where both household types (and ethnic affiliations) are both early adopters, the information exchange is aggravated through status homophily as the local privileged households interact mainly amongst themselves. Here new adaptation strategies spread horizontally within the social system rather than vertically (see Chapter 5.3.4). Hence, the particular importance of social capital becomes apparent in influencing the adaptive capacity and thereby constrains or facilitates the adaptive behaviour of the communities.

Summarised, the access to assets and resources, the existing status homophily, and interethnic barriers in knowledge transfer are the main causes for substantial differences in the adaptive behaviour of rural households in the research region.

6.2 CRITICAL ASSESSMENT

Improvements in the study design could be to reduce the time working and living in the provincial capital of Palu and to increase the period of stay in the research villages. A

rearrangement in favour of spending more time in the field would have positive effects to set up more confidence. During the study, the time living in Palu was claimed most of the time by the coordination of research activities, the supervision of the assistants at UNTAD, the organisation of transport, research materials, etc. In addition, both the research office and the place of private accommodation were located in Palu. An improvement would be to switch the main place of living directly to the research villages. However, from 2007 to 2009, coordinating necessary issues from the field faced substantial difficulties as in the rainy season substantial landslides destroyed the only main road connecting the western research region to the provincial capital and disconnected the villages from electric power for months. Besides, disrupted transport and electricity infrastructure and the absence of communication channels presented another obstacle, as the access cover for cell phones is still under construction and inexistent in several research villages. Thus, a critical shortage of transport, electricity and communication, which are essential for coordinating research activities, aggravated the recent research and led to the present study design. However, those conditions are under permanent improvement and could be enhanced in the future. Nevertheless, it can not be excluded that limited time in the villages led to incorrect or hesitating statements from the respondents in interviews and group discussions regarding sensitive topics. As well, transcription and communication mistakes cannot be ruled out. Occasionally, elderly respondents were unable to communicate in Bahasa Indonesia and used local languages instead, which were just fractionally understood by the field assistant and the person in charge of transcriptions. In addition, side noise caused by unwanted comments of visitors and/or severe rain pounding on the corrugated metal roofs during interviews led to information loss on the taped interviews. These adverse occurrences were discovered just after the first sequence of transcriptions and it was then attempted to remedy the situation by either introducing temporary breaks or by the provision of immediate spoken additional side information on the recorded tape by the author explaining the situation to the person in charge of the transcriptions.

Concerning shortcomings of the analysis, unfortunately the present study was not successful to comprehensively describe the exact generation of ‘risk perception’ at the household level. Regarding the first research question, the applied methods led instead to a ‘record of risks’ and their impacts as experienced by households. To better judge the households’ perception of risk to natural hazards, a participatory ranking and scoring should have been done, conducted either in groups or even better individually with all the men and women living in the households about the perceived risk of the natural hazards, as successfully shown by LOPEZ-

MARRERO & YARNAL (2010) for flood-prone communities in Puerto Rico. However, more than 160 additional interviews would have exceeded the time frame and financial resources of this study. That in particular is a pity as information about risk perception would be of high explanatory importance for the study, as it is expected that a higher level of perceived risk concerning a hazard would positively influence the adaptation to that hazard (GROTHMANN & PATT 2005, GROTHMANN & REUSSWIG 2006, LOPEZ-MARRERO & YARNAL 2010). However, if risk perception related to a hazard is low – that is, if the risk is not perceived as a threat – then it is unlikely that an adaptation action would be taken in response to that hazard alone (SMITH & WANDEL 2006). Therefore, further research in the LLNP could aim at investigating risk awareness in particular.

6.3 COMPARISON WITH OTHER STUDIES

Regarding the first research question about the occurrence and impacts of natural hazards in the research area, the present study shows that natural hazards had severe impacts on the household level and that the most severe drought periods and their impacts are related to the occurrence of ENSO events in 1997/98 and 2002. These results are in line with findings from KEIL (2004) in Central Sulawesi, who shows that farmers in Central Sulawesi face a substantial risk of recurring ENSO-related drought periods which depressed crop yields by more than one-third.

Concerning the second research question about adaptation strategies at the household level, the study observed that the majority of agricultural smallholders are implementing just reactive adaptation strategies which do not reduce the vulnerability of the households in the future. In addition, by applying these strategies, negative impacts of natural hazards might be even intensified by further deteriorating the human asset base and degrading biodiversity in order to cope with the consequences of natural hazards. Similar findings hold true for SIEGEL & ALWANG (1999), KEIL (2004), and LOPEZ-MARRERO (2010), whose results from poor rural households in Sub-Saharan Africa, drought affected farm households in Central Sulawesi, and flood-prone communities in Puerto Rico point to less effective or even negative impacts of reactive strategies in comparison to anticipatory or ex-ante adaptation strategies. Furthermore, their research showed that reactive adaptation to risks may lower the observed vulnerability but increases the households' vulnerability over the long term. In addition, inefficient risk management strategies can lead to lower than expected incomes and to the frequent depletion of assets.

Those findings lead directly to the third research question, which aims to investigate and explain the causes for differences in the adaptive behaviour at the household level. Here the study found that interpersonal communication is the common form of information exchange in the research area. Along with the detected prevalent status homophily within the interpersonal communication networks and interethnic barriers in knowledge transfer, these structures slow down the rate of adoption of anticipatory adaptation strategies. The same holds true for a most recent study from JONES (2010) on Nepal and India, which points to the inherent impact of social barriers in preventing successful adaptation to climate variability. Though the insights are concerned predominantly with the effects of caste and gender, commonalities can be drawn with restrictions associated with other groupings, such as ethnicity, age and class.

Moreover, the present study observed that agricultural smallholders in the research area are in need to adapt to those hazards. Hereby the most important types of assets currently utilised and needed are social capital (in particular peer networks and local institutions), as the information about adaptive strategies is already existent in the villages even though their diffusion still remains restricted; and further human capital (in particular skills, education, and health) as most adaptation strategies in the research villages are based on those capabilities to cope with hazards (see Chapter 5.2). The limited endowment with and access to both types of assets represent an important accompanying factor causing substantial differences in the adaptive behaviour of households thus resulting in considerable losses of further assets which in turn negatively affect their livelihoods. Consistent with the present case study, the emerging literature on climate change adaptation (SMIT & PILIFOSOVA 2003, ADGER 2006, ZIERVOGEL et al. 2006, MCLEMAN 2010, LOPEZ-MARRERO 2010) identifies social networks and social capital as among the key determinants of adaptive capacity. Further studies (SAYER & CAMPBELL 2004, TOMPKINS 2005, ADGER et al. 2005) pointing to the importance of promoting strong local social cohesion and mechanisms for collective action to enhance resilience. HELTBERG et al. (2009) support these opinions by arguing that the most successful adaptation efforts are likely to be local as communities and other subnational actors respond to the localised manifestations of emerging climate risks. However, as shown in the research area, interethnic barriers in knowledge transfer, which are largely caused by high rates of in-migration of non-local ethnic affiliations with different religion, slow down the rate of adoption of anticipatory adaptation strategies in the villages. But, while changes in the demographic composition of a given population may lead to changes in the overall capacity of that population (and of households within) to adapt to climate variability, the outcome might

be negative or even positive. In rural southern Africa, ZIERVOGEL et al. (2006) found instead that extended social networks that result from migration improved the communication of adaptation practices and helped to transmit information about new technologies and agricultural production strategies and techniques.

Another important reason for hesitant adaptive behaviour of local households might be the issue of land titles. As already described in Chapter 5.2, the majority of households does not invest in ex-ante adaptation strategies for their plots. In addition, the interviews proved that the vast majority of respondents do not possess any formal land titles due to high certification fees and transaction costs, bureaucratic hindrances, lacking financial assets or caused by the fact that plots are illegally located in the protected natural forest (see Chapter 5.4.1). Here, it creates uncertainty not to know whether cultivation of plots can continue or might be restricted at any time in future. Thus, in reverse, the acquisition of formal land titles could create certainty and might motivate households to undertake adaptive investments in their plots to reduce the negative impacts of natural hazards. Unfortunately, going through the bureaucratic process needed to acquire formal land titles would require financial and institutional resources hardly available to most households. There are theoretically three arguments that particularly emphasised why land titling may foster investment decisions, as well as vice versa (see e.g. FEDER & FEENY (1991), FEDER & NISHIO (1999) and BRASSELLE et al. (2002). First, the assurance effect, as tenure security increases the return on long-term land improvements and conservation measures and therefore farmers have a higher incentive to undertake investments. Second, the realisability effect, as with land titles it is easier to sell or rent the land and thus to realise improvements made through investments enhancing such investments. Third, the collateralisation effect, as land titles enable their holders to use land as collateral, which in turn facilitates access to credit and enables the farmer to finance short-term and long-term investments. These points in turn support the argument that hesitant adaptive investment of smallholders may be partly influenced by missing land titles. Based on these theoretical arguments and using longitudinal village and household survey data from Central Sulawesi, GRIMM & KLASEN (2009) found that land titles increase investments in irrigation systems, terrace construction as well as enhance the probability of adopting improved seeds or other new and better technologies. Similar findings hold true for LOPEZ-MARRERO & YARNAL (2010) in Puerto Rico, who state that land tenure security is one of the most important concerns perceived by the flood-prone participants of their study and needs special attention. Most residents in their study sample lack formal land titles, which creates uncertainty for community members; they are uncertain as to whether they will stay or be

displaced. Given this uncertainty, many community members do not want to invest in improving their community situation in general, even if they have the economic and human resources to do so. It seems to be that these arguments about hesitating adaptive investments due to missing land tenure security in Indonesia and Puerto Rico might even hold for Germany as a study by GROTHMANN AND REUSSWIG (2006) indicates. Their findings show that within their research to identify those factors in German private households most important in prompting ex-ante strategies to avoid flood damage, 'ownership' was the most influential socio-economic variable. In addition, GROTHMANN & REUSSWIG (2006) increased the explanatory power of an economic-geographic model by including psychological variables. Hereby, 'non-protective response' to flood risks (denial of the threat, wishful thinking and fatalism) turned out to be the best additional psychological explanatory variable in the mainly economic model. Non-protective responses do not prevent monetary or physical damage, but only the negative emotional consequences of perceived risks, such as fear. Similar statements were made by respondents in the present study concerning future droughts, their impacts and possible strategies to adapt (see Chapter 5.4.2). In addition, these findings are in line with those of LOPEZ-MARRERO (2010), which showed a similar response of denial of the threat, wishful thinking and fatalism of households, when questioned, what are the main factors for not pursuing additional strategies to minimise negative effects of floods? Also, the belief that floods are part of the nature, and that nothing much can be done but to 'learn to live with them', is another factor influencing Puerto Rican households' perceptions that no further strategies are needed. These findings constitute examples of how cognitive factors could reduce adaptive capacity in the communities due to low motivation for engaging in adaptive strategies.

7 CONCLUSION

7.1 SYNTHESIS OF RESULTS

With the increasing recognition that anthropogenic climate change poses potential risks for the well-being of human populations, there has been growing attention devoted to understanding the ways in which human communities are vulnerable to those risks, and the ways in which such vulnerability may be reduced through enhancing the capacity of human communities to adapt (ADGER et al. 2007). The present study investigates adaptation strategies of agricultural smallholders from six natural hazard-prone villages in Central Sulawesi, Indonesia, aimed at minimising the harmful impacts of droughts, floods, and landslides. It has attempted to understand what the barriers for the implementation of adaptation strategies are and provides thereby insights into the role of human behaviour in the process of adaptation.

The objective of the study was to investigate the adaptive behaviour of different household types towards natural hazards and to explain why certain households adapt to changing environmental circumstances and others may not. Based on that objective, the following research questions have been developed.

(1) How is the perception of natural hazards at the household level configured?
(2) Are households adapting to natural hazards and are the measures leading to a reduction of vulnerability?
(3) Are there differences in the adaptive behaviour of different household types and what are the reasons for that?

For the case study the Lore Lindu region in Central Sulawesi, Indonesia, was chosen. It was aimed to understand the underlying decision-making process that leads to different strategies of adaptation. For that reason, the theory about the 'Diffusion of Innovations' (ROGERS 2003) was applied. In order to meet the objective, a qualitative research design was selected containing problem-centred interviews, different types of participatory rural appraisal, as well as participatory observation in six villages around the LLNP. As framework, the people centred, asset based 'Sustainable Livelihood Framework' from CHAMBERS & CONWAY (1991) was used to relate the households' adaptation strategies to the vulnerability context, the available assets, and the approached livelihood outcomes. The applied research methods have allowed providing answers to the research questions. The qualitative analysis revealed the following findings:

First, regarding the perceptions and impacts of natural hazards on the household level the study identifies that almost all households in the research area have been affected by natural hazards. Droughts represent the most common natural hazards, whereas the respondents perceived the most severe droughts in 1997-98 and 2002. Both drought periods were related to the occurrence of ENSO events and had severe impacts such as e.g. famine, forest fires, yield decline, increased appearance of diseases, die-off of numerous young cacao trees, and the abandoning of plots (Chapter 5.1). Further regular occurring natural hazards are floods and landslides. Both are mostly triggered in the research area as secondary hazards through torrential rain. Respondents perceived an increased magnitude of torrential rain and interrelated impacts since the last ten years. The combined observations and perceptions of agricultural smallholders in the research villages indicate that there are three interrelated phenomena that characterise environmental change at the local level: weather is more variable, weather is less predictable, and there is an increased frequency of extreme weather events.

Second, households in the research area are actually adapting to natural hazards. Various types of adaptation strategies are identified dealing with different natural hazards at the household level. Most common strategies of adaptation are reactive ones that do not reduce the vulnerability of households in the future (Chapter 5.2.1). By applying reactive adaptation (ex-post) strategies, negative impacts of natural hazards on the 'livelihood assets' might be even intensified in the long term due to e.g. a loss of biodiversity in the surrounding national park or the deteriorating health of the households. The study also identifies anticipatory adaptation (ex-ante) strategies (Chapter 5.2.2). If purposefully implemented, these strategies might alter the exposure of households to future natural hazards, reduce the sensitivity of plots and crops, and in consequence reduce the overall vulnerability of the agricultural smallholders. Nevertheless, anticipatory adaptation strategies appear very rarely. Which means that only a small minority of households is actually reducing their vulnerability against natural hazards through adaptation measures.

Third, the investigation of adaptation strategies of the nine household types revealed the existence of major differences in adaptive behaviour (Chapter 5.3). Exceptionally well adapted household types are large cacao-rice combiners and large cacao specialists. Both types show similarities as they represent privileged households with large land property, higher education, land titles, and off-farm incomes in contrast to other household types. In the wider frame analysis supported by the 'Sustainable Livelihood Framework' (CHAMBERS and CONWAY 1991), the study shows that successful adaptation of agricultural smallholders is

depending on access to or possession of sufficient assets. Financial, natural, and social capital are key components at the household level in the research area. Both household types hold available financial stocks as opposed to other household clusters. Further, their land use patterns, which foster economic success, were possible due to off-farm incomes, access to land, and social networks. In addition, human capital in terms of education seems to be of major importance for ex-ante strategies, as it is needed to enable the household members to gain awareness about possible impacts of future natural hazards on their livelihoods and work out possible strategies of successful anticipation. However, both household types are among the rarest to be identified all over the research area. In a next step, an analysis of the decision-making process (Chapter 5.4) supported by the theory of 'Diffusion of Innovations' (ROGERS 2003) was conducted. Important factors enforcing slow adaptive behaviour of agricultural smallholders in the research area are the perceived relative advantage, compatibility, and observability of anticipatory adaptation strategies (Chapter 5.4.2). It is embedded in the nature of ex-ante strategies that the advantages occur at some future and unknown time, and may not happen at all. Thus, in contrast to ex-post (reactive) adaptation strategies, which provide a desired outcome in the near future, the relative advantage of anticipatory adaptation strategies is highly uncertain. Regarding the compatibility, most of the results created by anticipatory adaptation strategies are not yet visible for other households. The outcomes are not an increase in productivity or income which is easier to perceive, rather the rewards might only appear as absences of negative effects on plots if natural hazards aggravate and plot vulnerability is simultaneously reduced. In addition, the interviews proved (Chapter 5.4.3) that the prevalent form of information exchange regarding the diffusion of adaptation strategies are interpersonal networks rather than mass media channels as radio, newspapers or television. However, within this interpersonal communication networks the study found interethnic barriers in knowledge transfer and status homophily (Chapter 5.4.4). Status homophily is expressed through the fact that the local privileged households (large cacao specialists or large cacao-rice combiners) interact mainly with each other, and thus the adaptation strategies will hardly trickle down to the less privileged. Homophilous diffusion patterns cause new adaptation strategies to spread horizontally, rather than vertically, within the social system (ROGERS 2003). Status homophily therefore can additionally act to slow down the rate of diffusion within the social system. Interethnic barriers in knowledge transfer and status homophily together explain in part why it was hardly possible to discover trickle down effects in the diffusion of anticipatory adaptation strategies. In villages which are dominated by one ethnic group who are early adopters of anticipatory adaptation strategies,

almost no interethnic information exchange was found. In other villages where all the different ethnic groups represent early adopters the knowledge exchange is complicated through status homophily as the privileged households interact mainly with one another and new adaptation strategies spread horizontally, rather than vertically, within the social system.

To summarise, only a small minority of agricultural smallholders under investigation is implementing adaptation strategies which might reduce their vulnerability against future natural hazards. Caused by their different adaptive behaviour, the impacts of natural hazards vary considerably between the different household types and range from slight deterioration in agricultural productivity to substantial losses of assets. Responsible, at least in part, for the inadequate implementation of anticipatory adaptations strategies are the lack of access to assets and resources (Chapter 5.4.1) as well as interethnic barriers and status homophily in knowledge transfer within the interpersonal networks. In addition, the perceived characteristics of ex-ante adaptation strategies (Chapter 5.4.2) by local households cause substantial obstacles to bias the decision-making process towards an implementation of anticipatory adaptation strategies. Regarding the assets used to adapt to natural hazards in the research area, the most common types are social and human capital in form of memberships in groups or networks (farming groups), relationships of trust (kiosk), reciprocity (mutual constructions), the households' own knowledge, skills, ability to work (paid labour), and health conditions (reduced food consumption). However, the composition of assets used to deal with natural hazards will be subject to constant change, the same as the surrounding conditions of the households (e.g. demographic changes and poverty).

7.2 IMPLICATIONS

This study has benefited greatly from CHAMBERS and CONWAYS' 'Sustainable Livelihood Framework' (1991) and ROGERS's theory of 'Diffusion of Innovations' (2003), and identified important causes of insufficient adaptive behaviour in the research area. However, while ROGERS's theory is capable of supporting the investigation of the diffusion of adaptive behaviour of agricultural smallholders, the study shows that circumstances in terms of climate variability and natural hazards are quite specific. This does not lessen the explanatory value of the theory but allows for extension beyond the theory's limitations when it comes to implications on how to speed up the innovation-decision process. For instance, proposals from ROGERS (2003) to increase the rate of adoption of innovations through the use of incentives are less suitable for the diffusion of anticipatory adaptations strategies. Incentives

(e.g. subsidisations of insurances), ad hoc relief payments or microfinance products may lower the risk perception of households to natural hazards while actually increasing the exposure as those incentives might negatively influence the motivation of agricultural smallholders to enhance adaptive actions. When promoting faster diffusion and implementation of anticipatory adaptation strategies, care must be taken to avoid that the current adaptation measures increases future vulnerability through e.g. maladaptive behaviour.

The implementation of various strategies of adaptation has allowed agricultural smallholders in the research area to 'live with natural hazards'. These successful strategies need to be more widely diffused, possibly at an accelerated rate, and strengthened. One possibility is to make better use of change agents. The study shows that status homophily, inter-ethnic barriers in knowledge transfer, and the availability of assets do not completely anticipate the factual spread of anticipatory adaptation strategies; they just slow down their rate of diffusion. Better use of agricultural extension agents - which are already located in many villages - could accelerate the innovation-decision process for households by demonstrating anticipatory adaptation strategies to the villagers. Furthermore, it should be noted that simply recognising social barriers will not pull them down. Consequently, to enhance strategic impact, it is important to take proactive steps to overcome the barriers of adaptation. The findings of this study demonstrate how interrelationships among the determinants of adaptive capacity enable to adapt to natural hazards. Not everyone however, has been able to implement these strategies. Efforts to actively spread adaptive behaviour must be matched with actions to reduce barriers to diffusion. The study shows that the diffusion of technology (e.g. drought resistant seeds) and external aid (e.g. connection to the governmental 'gumbasa' irrigation system) have increased adaptive capacity, but there is no guarantee that these factors will always be available to everyone. Certainly, the lack of access to financial assets was one obvious obstacle in the research area to conduct more anticipatory adaptation strategies. Social resources or assets, however, if developed efficiently and sustainably over time, provide alternative, 'low -cost' economic means to deal with natural hazards and lower risks (see also WISNER et al. 2004). Continued and intensified community organisation and collective action have proved essential for enhancing adaptive capacity in the research villages. In the present study, community organisation has been observed in the majority of all villages in form of 'public work activities' in order to clean and maintain irrigation and drainage systems as well as to develop collective support systems in form of farming groups, which provide its members with food and labour force in times of a disaster. Similarly argues

PELLING (1997), who showed how community organisation successfully decreased flood exposure and impacts in poor communities in Guyana. Such initiatives do not require substantial economic resources but a degree of community organisation and social cohesion. This study suggests that building community assets that necessarily require large amounts of financial capital does not enhance overall disaster resilience as not all households have access to these assets. In certain contexts, developing social capital might have a stronger outreach and impact. Social capital proved to be an important element for building the capacity to overcome negative impacts of natural hazards and it is in particularly valuable for taking collective action towards vulnerability reduction (see also ADGER 2003, PELLING & HIGH 2005). There are strong indications that integrating cognitive factors into practical adaptation strategies by building awareness of possible extreme hazard occurrence, supporting community driven preventions/collective help-systems, and enhancing public risk perception about the limits and functioning of structural hazard control projects improves quality, impact and sustainability of the interventions significantly. Public risk communication, for instance, showed some success in simultaneously triggering concrete action, reducing barriers of self-protecting behaviour, and strengthening social cohesion. Similarly, JONES (2010) advocates for a concerted effort to increase education and awareness in order to overcome social barriers, to address institutional restrictions in behaviour and entitlement, and to alter restrictive and maladaptive perceptions, norms and cultural constraints, which prevent successful adaptation. Given the current risk of natural hazards in the research area and the possibility of future increases in this risk, raising hazard risk perception seems to be essential.

Community-based adaptation, tailored towards local cultures and conditions, could be one possibility to overcome barriers of adaptation. This community-based adaptation needs to support and develop informed autonomous adaptation to climate variability, involving both local stakeholders and development and disaster risk reduction practitioners. As such, it builds upon existing appropriate cultural norms, while addressing local development issues that help alleviate climate vulnerability and contextualise initiatives within the broader cultural environment (see also AYERS & HUQ 2009). Weak social networks put households or communities at disadvantage when preparing or recovering from a natural hazard in particular if the support from government or external actors is low. Strengthening local coping capacities can also constitute a positive step towards empowering communities rather than reinforcing dependencies, which often result from disaster relief efforts (WISNER et al. 2004). The importance of successful adaptation is even likely to increase. Possible implications of climate change for risk patterns further stress the importance of enhancing people's capacity

to deal with present climatic conditions that will strengthen their capacity to deal with future hazards.

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APPENDIX

INDEX OF FIGURES

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ABBREVIATIONS, ACRONYMS, GLOSSARY AND SYMBOLS

a.s.l.	Above sea level
Bandahara Desa	Village financial officer
Buginese	Ethnic group indigenous to South Sulawesi, Indonesia
DFID	Department for International Development of the United Kingdom
Dukun	Traditional local healer
Dusun	Village part
e.g.	exempli gratia, for example
ENSO	El Niño-Southern Oscillation
Gamal	Gliricidia
ibid.	ibidem, in the same place
IPCC	Intergovernmental Panel on Climate Change
Kepala dusun	Head of a village part
Lembaga adat	Customary village council
LKD	Lembaga Konservasi Desa, Village conservation institution
LLNP	Lore Lindu National Park
LPM	Lembaga Pemberdayaan Masyarakat, Institution for community empowerment
Lumbung	Food storage places, barn
NOAA	National Oceanic and Atmospheric Administration
Palawija	Secondary crops
Polindes	Village health facility
PRAs	Participatory Rural Appraisals
Sombar	Construction to provide shade
Toraja	ethnic group indigenous to South Sulawesi, Indonesia
Transmigrasi	governmental planned migration programme, transportation and land for agriculture is provided
Transwakarsa	private initiated migration programme, land for agriculture is provided
UNTAD	Universitas Tadulako

QUESTIONNAIRE

A.) Introduction:

Recall: date, place, name of respondent & interviewer, household cluster

- **Cluster detection:**
  - Mention the land size, what plants are grown, home consumption or selling.
- **Family:**
  - Please tell us about your family / who lives in this house/extended family
    - Age of family members
    - Education
    - Occupation
    - Have you ever had a different job?
    - Do you or your wife have a side income?
- **Migration history**
  - Where were you and your wife born?
  - Between born in … and living now in …have you ever lived somewhere else?
  - What did you do there?
  - Why did you leave?

B.) Recent land use change

- When did you start with X ?(for all crops)
- Did you grow anything else?
- Abandoning of crops and reasons for that?
- Development of area - extension or reduction?
- Location of the plots? Close to a river, steep or flat land?

C.) Environmental change

- Have you ever experienced problems with natural hazard, for example droughts, floods, landslides etc.?
- When, how long and how many times?
- What happened to your plot? (the following question always for every hazard)
- What were the effects on wellbeing?

- What did you do to cope with the effects?
    - What were the results?
    - Was this a successful strategy?
    - Where did you get the idea to cope the way you did?

<u>Reactive adaptation strategies</u>:

- Because of the hazard did you grow any crop(s) that you usually do not grow?
    - Do you reduce or extended the area of …?
    - Was there any ploughed land afterwards? (Size of the area and how long was the land ploughed?)
- Because of the hazard did you change the amount of inputs you normally apply to … of your plots? (mineral fertilizer, pesticides, herbicides, labour)
- Because of the hazard did your household reduce cash expenditures or economize on food consumption during/after that period of time? (food, clothing, housing, social events, health)
- Because of the hazard did your household utilize any sources of food which are usually not utilized at all?
- Because of the hazard did your household raise income through sources which are usually not utilized, or which are usually utilized to a much lesser extent[5]
- Because of the hazard did any child (age < 18 years) living in your household who is usually not involved in income generation, get involved in income generating activities?
- Because of the hazard did your household take a loan?
    - If yes, from where (relative, kiosk, etc.) and in what form (cash, food, etc.)?
- Because of the hazard did your household sell any assets in order to gain cash?

Anticipatory adaptation strategies:

- Which measures you plan to take when the hazard occurs again?
- Do you keep food stocks?
- Do you keep cash savings now, because of the hazard?
- Do you have a bank account?
- Is there any common management against natural disasters?

[5] Excluding the sale of assets

D.) Innovation/decision making process:

- Please tell us about the adoption of any technology/strategies not used before on your plots and the reasons for that.
- Please tell us about the abandoning of any old technology/strategies and the reasons
- In comparison, which is the most important innovation for you?
- If you compare the plots today and ten years ago what is the difference (e.g. working intensity / income / size)?
- At the time you started growing/using X:
    - How many people already used X?
    - Did you start alone or together with others?
- When did you receive information about that innovation for the first time/when did you see it for the first time?
- Who told you about it? What relations you have to this person?
- Who do you think is the best expert of X in this village? Why? When did he first utilized it?
- Could you please name three other very good farmers?
- What is you relation to these people (relatives, members of any of your groups, same ethnic group?)
- Did these people influence your decision to adapt directly?
- How long did it take from the first time you heard about the innovation X until you first used it? (e.g. Experiments on different plots)
- How long did it take until X was fully established on your farm (as it is today)? Why that long/short?
- During that period from 'first using' until establishing on your whole plots, did you make any changes to the innovation? – Why?
    a. Did you get additional information from other sources (relatives, mass-media, group discussions)?
    b. Which kind of information you received?
- Do you think it is still beneficial to use this strategy further? Why you think so?
- What are the risks using innovation X?
    - Have you ever thought about abandoning X? Why?
- How did you used X in your farm (for all area at once, only for one field or for several)?

E.) Social capital

1. How many members of your family live in the village?
2. Are you member in any kind of group? Which? How often do you meet?
3. Do you or any member of your family have a particular function (in the group or the village)? Have any of your very close friends?
4. Are you regularly sending money/gifts home to your family members in the village you are coming from?[6]
5. Are there any constraints on land use on any of your plots? Laws/agreements with neighbours? Other farmers/village authorities? What and how is it enforced?
6. Is in the village a traditional pawning system existing? If yes, is it very common? Have you ever participated?
7. Are all your land rights secure/equally secured? Which of your plots is not secure and why?
8. What are your future plans?

[6] 'bonding social capital': insurance / possibility to return

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DECLARATION OF ORIGINALITY AND CERTIFICATE OF OWNERSHIP

I, Norbert B. Binternagel, hereby declare that I am the sole author of this dissertation entitled 'ADAPTATION TO NATURAL HAZARDS IN CENTRAL SULAWESI, INDONESIA – STRATEGIES OF RURAL HOUSEHOLDS'. All references and data sources that were used in the dissertation have been appropriately acknowledged. I furthermore declare that this work has not been submitted elsewhere in any form as part of another dissertation procedure.

Göttingen, May 25, 2011 _____

(Norbert B. Binternagel)

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WORK EXPERIENCE

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