

Water security and the urban fringe



Santa Cruz Papalutla and

Santa María del Tule;



water security in relation to the position within the urban fringe of Oaxaca de Juárez

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Executive summary

The main objective of this research is to analyse the household water security within Santa Cruz Papalutla and Santa María del Tule in relation to the position within the urban fringe of Oaxaca de Juárez. Every household develops its own water security strategy in a multidisciplinary field of actors and processes. Especially the urban fringe is a dynamic field, because it is here where rural society meets urban society. Within this research there is the mainly urban orientated municipality of Santa María del Tule and there is the more rural orientated Santa Cruz Papalutla. This research uses the Household Water Security Model to explain the influence of the urban fringe on the water security of the households in the two case municipalities. It is based on the multidisciplinary household water security model of Webb and Iskandarani, which was developed for the analysis of flaws in international water policy. The adapted model still follows the main thoughts of Webb and Iskandarani (household water security depends on the availability of water, as well as the accessibility and entitlement to water), but it sees the household more as actor within a wider context. This makes it possible to include the urban fringe concept in the model. The combination of the two with profound analysis of the households, involved actors and local context, does eventually result in answers to the question how the water security of households within Santa Cruz Papalutla and Santa María del Tule relate to their position within the urban fringe of Oaxaca de Juárez.

Preface

This research forms the final part of my study in human geography at the University of Groningen, the Netherlands. It contains the results from one and a half year of study on the water security of Santa Cruz Papalutla, Santa María del Tule and their households in relation to the position within the urban fringe of Oaxaca de Juárez.

The results of this study were made possible with the help of many people, to which I owe my gratitude. I like to name a few of those people who were in particularly helpful. First of all I would like to thank Dr. P.C.J. Druiven for his advice, corrections, and above all for introducing me into the village of Santa Cruz Papalutla. Secondly, I would like to thank the inhabitants of Santa Cruz Papalutla, and Santa María del Tule, as well as other respondents from outside those two communities, for their hospitality and their response to my research. Special thanks go to my girlfriend Josefina, who has given me the best cultural introduction I possibly could have imagined.

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Glossary

<i>Adobe</i>	Sun-dried brick out of clayey mud with remainders of vegetation and small gravel.
<i>Aguas negras</i>	Sewage waters
<i>Agua purificada</i>	Purified water
<i>Arroyo</i>	Temporal creek
<i>Ayuntamiento</i>	Local community council, town council
<i>Bienes Comunales</i>	Communal land or property
<i>Canícula</i>	Hot dry period in midsummer
<i>Cargo</i>	Post or obligation
<i>Cisterna</i>	Cistern
<i>Comisariado de bienes comunales</i>	Committee of management of communal resources
<i>Drenaje</i>	Tube system through which a household drains its sewage waters
<i>Garrafon</i>	Nineteen litres bottle with purified water
<i>Minifundia</i>	Small property (less then five hectares)
<i>Municipio</i>	Municipality, basic unit of local government
<i>Pozo</i>	Well
<i>Pozo profundo</i>	Well of at least fifty meters deep
<i>Pipa de agua potable</i>	A truck that transports a certain quantity (capacity ranging from 3.000 to 20.000 litres) of drinking-water
<i>Presidente de comité</i>	Chairman of a committee
<i>Río</i>	River
<i>Sierra</i>	Mountain
<i>Tanque elevado</i>	Water tower
<i>Tierra caliente</i>	Tropical lowland (altitude between 0 and 1000 meters)
<i>Tierra de humedad</i>	Land that has the capability to support crops without the use of irrigation techniques

Tierra de riego

Irrigated land

Tierra de temporal

Seasonal rain-fed land

Tierra fría

Cold highland (altitude above 2000 meters)

Tierra templada

Temperate upland (altitude between 1000
and 2000 meters)

Tinaco

Additional storage tank

Zacate

Forage

Chapter 1. The Household Water Security Model

Fresh and clean water is a basic necessity for human life. The importance of water has led to the general opinion that the access to sufficient and save fresh water is a universal human right. However, there are places around the world where this right can not be guaranteed. Already 1.2 billion people live without sufficient access to fresh water, many of whom live in developing countries. It are especially the marginalised that pay a high price for sufficient and save fresh water. Researchers and politicians are aware that water insecurity holds a threat to a stabilized world, as the number of local and regional water conflicts are increasing (read box 1.1). It is therefore not so surprising that increasingly more research is being done to better understand how households negotiate water security in relations to their surrounding.

Box 1.1 : Los conflictos por agua en México

“El crecimiento poblacional y el crecimiento económico han ejercido mayor presión sobre las reservas de agua en México, al punto que el volumen demandado de agua siempre es mayor que el volumen suministrado, lo que obliga al gobierno a decidir a quién dejar sin este recurso, generando problemas distributivos. La competencia por el recurso es ya causa de conflictos a diferentes escalas y a diferente intensidad, presentándose tanto entre una misma comunidad, entre diferentes comunidades, municipios e incluso estados. En un intento por controlar el uso del agua y de evitar los conflictos, el marco institucional ha ido cambiando, sin conseguir del todo una reforma acorde con el nivel del problema.”

Source : Instituto Nacional de Ecología, 2005

The goal of this chapter is to develop a multidisciplinary household water security model, which will be used to analyse how the water security of households within two municipalities relate to their position within the urban fringe.

1.1 Defining water security and the household

In the early days of rural development and environmental management, water security was not a theme that stood on its own. Until the nineteen-seventies most attention was given to food security; water security was only seen as part of the food security problem (Webb and Iskandarani, 1998). At the beginning of the eighties water security became more a subject of its own as expanding cities within the third world caused water shortages. These shortages were not only felt within the city but also in their urban fringes, as more of its water was extracted towards the city. Solutions to these problems were not easily found as the used food security models of the seventies were framed in a uni-disciplinary or uni-sectoral context, thereby not overseeing the whole range of water security problems. In reaction Webb and Iskandarani did develop the multi-sectoral household water security model.

Water security as defined by Webb and Iskandarani (1998) is the access to sufficient and safe water for a healthy and productive live by all individuals at all times. Although the central unit in their model is the household, Webb and Iskandarani use the individual in their definition of water security. Even if the definition would include the household it still would not specify its position. UNICEF (2002) however defines water security as “the availability to a household of enough water of adequate quality year-round to assure its members' survival, health and productivity, without compromising the integrity of the environmental resource base.” Furthermore, water security should be considered “in the context of the twin threats of deteriorating quality and a shrinking fresh water resource base.” This definition is specifically formulated to understand how households negotiate their water security strategies in a constrained environment. Besides, it not only recognizes that households are subject to their surrounding, but they are also an active participant. This specific characteristic also comes forward in the definition of a household as given by Druijven (1990): “a unit that ensures its maintenance and reproduction by generating and disposing of a collective income base, which is used for production or consumption purposes. It has a limited set of resources (land, capital, and labour) and a set of needs and consumption desires.” Besides seeing a household as a participant, this definition also recognizes that a household does not have to act rationally. The preference of the household above the individual is made on

the fact that the household consists out of individuals who are bound to each other in their behaviour as a family.

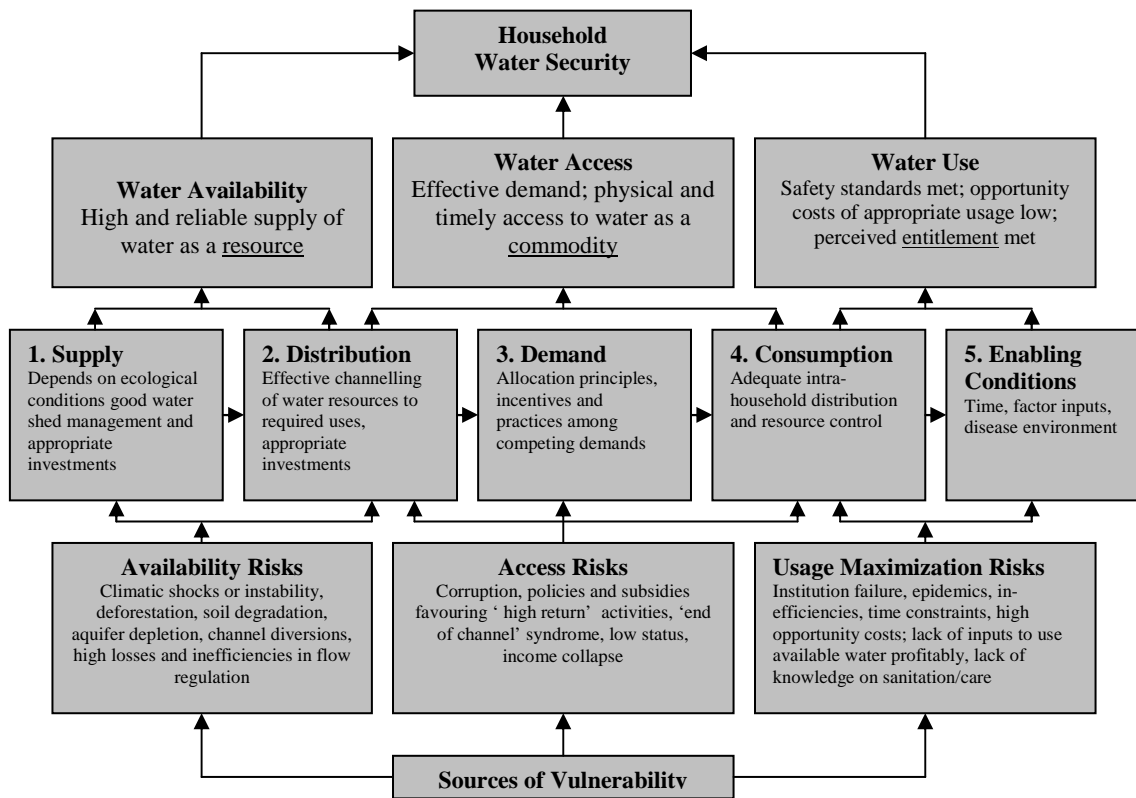
Following from the above, it can be concluded that a household is partially able to negotiate a certain water security level. The space to negotiate depends on the context of the household. This context is made up out of a dynamic set dependent and independent variables. A permanent outcome of the negotiation does therefore not exist. This also leads to the conclusion that each negotiated water security and its resulting water culture or water strategy is unique in itself. Despite its uniqueness a water culture categorization can be made, as certain households do operate in a comparable spatial context. Steps were already made towards the development of a strategy categorization for food security. For example, Scherr (1999) made a categorization based on soil degradation and officials in the United States of America use a categorization as defined by the Core Food Security Module (Anderson, 2001). But, there is still no categorization that is based on the water culture of households. This research will develop such a categorization, which will be based on the in depended variables of the Household Water Security Model.

1.2 The Household Water Security Model

The availability of water and the accessibility and entitlement to water are the key variables within the household water security model of Webb and Iskandarani. Those variables allow water to be considered as a natural resource, meaning that water needs to be physically present in a region. They define the availability of water as the high and reliable supply of fresh water as a natural resource, which is directly influenced by its supply and distribution (see figure 1.1). Since there are several modes that supply households with water, the question of availability then becomes: to what extend are water systems able to supply water to a region, and how can water be obtained with the techniques that a household has available? However, the availability of water does not pay attention to restraints in access such as the lack of income to buy fresh water for example. Therefore, the second column of standards is water access; also known as effective demand. Effective demand is the physical and timely access of households to water as a commodity. Water access is most directly influenced by the distribution and consumption of fresh water. Consumption on its turn is influenced by the distribution of water through water demand. The availability and accessibility at all times to sufficient

water is not an absolute guaranty to a healthy and productive life. The stage of the water cycle from the purchase of water to the use of water and the draining of sewage water are part of the last stage called 'entitlement'. This trajectory has great influence on whether the 'ideal water security' is met. The pattern of water usage is related to human entitlements; a dynamic social field of processes through which a household can gain or lose certain rights. This means that interactions of a household with its social environment have a decisive influence on its water usage pattern. Those interactions in itself are articulated through possibilities and constraints in the consumption of fresh water and through enabling conditions (Webb and Iskandarani, 1998).

Figure 1.1: Conceptual diagram of household water security model as developed by Webb and Iskandarani



Source: Webb and Iskandarani, 1998

The framework does not stop with those three columns and their underlying subcategories. The model allows for two 'cross-cutting notions', with vulnerability being the first one. Webb and Iskandarani (1998) describe vulnerability as: "the reality that individuals may not be able to secure water when and where they need it,..." (p.5). The second 'cross-cutting notion' is 'multi-tasking', better known as inter-linkage.

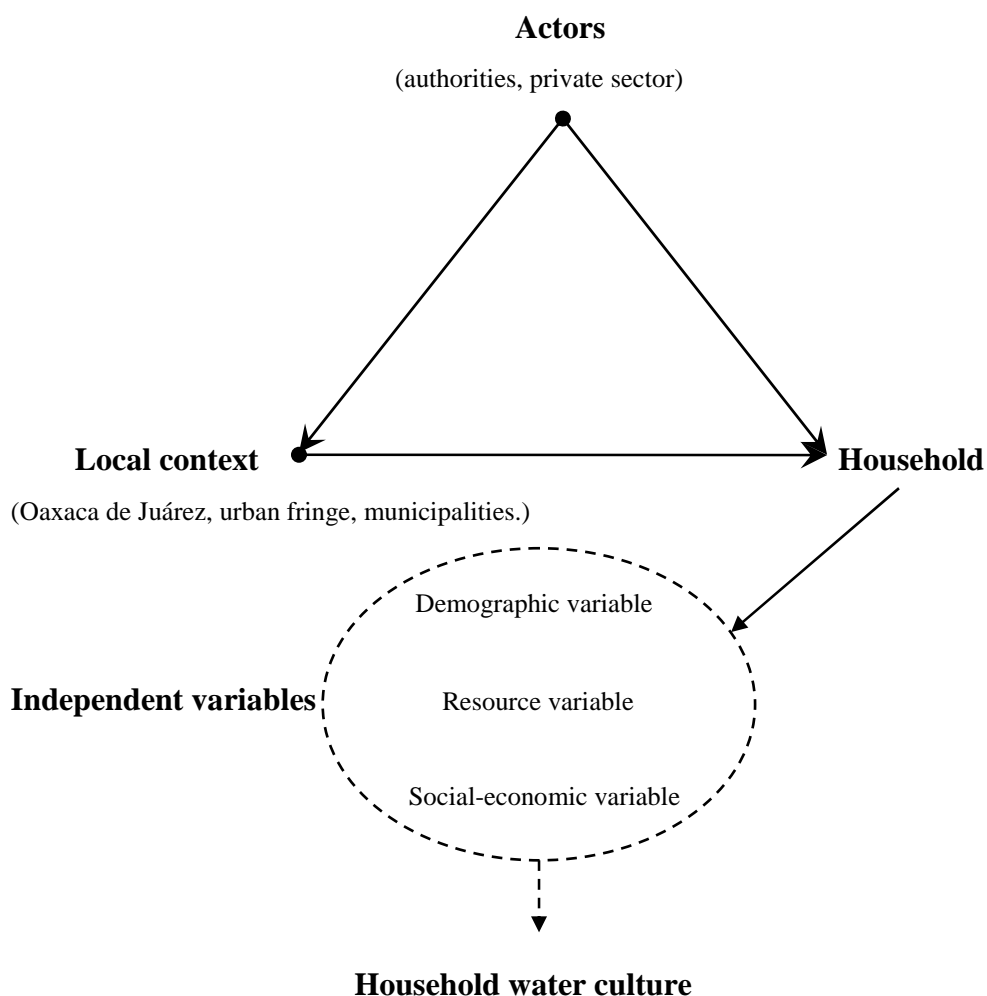
Inter-linkage pays attention to the multidimensional demands of the approach. For example, water availability failure can be driven by access- and/or availability risks; “...consideration of the risks to water security demands multidimensional attention beyond a single sector and beyond single usage (Webb and Iskandarani 1998, p.5).” However, the model as described above holds some major disadvantages within the context of this research.

As had been said before did Webb and Iskandarani develop the household water security model to analyse water policy and its shortcomings. As a result the model pays particular attention to policy influences on the water security of households. However, another perspective is used to understand why and how a household negotiates certain water cultures and how this relates with its surrounding. This asks for the analysis of the context in which a household negotiates its water security. This study acknowledges that the context of a household is made up of dependent and independent variables. The distinguished independent variables within this study are the demographic variable, the resource variable and the social-economic variable. However, those variables are not totally independent. For example, the number of members within a household does influence water consumption characteristics of a household and the income possibilities of a household. By making those adjustment the model still complies with the multidimensional standards as set by Webb and Iskandarani. The multidimensionality of the HWSM model is even further elaborated by the recognition of three different intervention levels. Although their model does not visualise these levels and their mutual relationship, Webb and Iskandarani do describe them as necessary to understand the whole process. Their micro-level comprises individuals, households, social-groups, donors or NGO’s, local government, etc. Income transfer activities or equity-focused projects are examples of processes that operate at the meso-level, and which are aimed at raising effective demand among targeted population categories and on raising welfare standards of lower-income households. Ultimately they include the world opinion, technological developments, global warming etc. to their macro-level. However, the used category as described by Webb and Iskandarani will not be applied within this research.

Figure 1.2 shows the HWSM model as adapted from the household water security model by Webb and Iskandarani. A prominent appearance within this model have the three different levels of interventions. The first level contains interventions from the government, the private sector and Non Governmental Organizations. However, there

are no NGO's active within the area of research. Governmental interventions and interventions from the private sector influence the water security of households as well as their local context. The local context is defined as the research area which is not only the physical context but also in more detail the social-economic context of Oaxaca de Juárez, its urban fringe and the two case municipalities. The evolved HWSM does not include the macro-level as described by Webb and Iskandarani as its involvement would make the model to complicate.

Figure 1.2: The Household Water Security Model (HWSM)



The main objective of this research is to analyse how the water security of households within two given municipalities relate to their position within the urban fringe. The urban fringe is usually referred to as the border between the city and its surrounding

countryside. Some definitions use only the quantitative aspect of an urban fringe. For example: “The urban ‘fringe’ is that part of metropolitan counties that is not settled densely enough to be called ‘urban’. Low-density development (2 or fewer houses per acre) of new houses, roads, and commercial buildings causes urban areas to grow farther out into the countryside, and increase the density of settlement in formerly rural areas.” (Anderson 2001, p.2). However, using this definition does not emphasise the fact that within an urban fringe social-economic processes from the city meet with those from the countryside. The outcome of this mixture differs from place to place and time to time, which also result in a dynamic urban water security.

1.3 Conclusion

The goal of this research is to analyse how the water security of households within two given municipalities relate to their position within the urban fringe. This research uses an adapted version of the household water security model to analyse those relations. The original household water security model, as developed by Webb and Iskandarani, was used for the discovery of flaws in water policy. As a result, their model does not offer the opportunity to analyse how the water security of a household relates with its position in the urban fringe and therefore the model needs to be adapted. Webb and Iskandarani have put the household at the centre of the model. However, their model does not fully pay attention to the different levels which influence this security. The adapted Household Water Security Model (HWSM) changes this. Three levels of interventions are described. First of all there is of course the household itself, but the opportunities and constraints of a household are not only influenced by its social-economy, resource and demographic variables but also by its wider context. Within the HWSM this wider context comprises the local context (including the urban fringe) and actors on national level, such as the government and private sector. Although the model does pay more attention to the context of a household this context does include all involved actors and processes that influence the water security of a household, because this would make this research too difficult and extensive. Another problem of the HWSM is that it does not fully explain the relationship between the variables of the household. This research therefore does refer now and then to the original model of Webb and Iskandarani.

Chapter 2. Research questions and methodology

This chapter builds a bridge between the theory of the first chapter, and the collection and analysis of research data. The goals are therefore to describe the objectives and research questions, to define the research areas, and to analyse the used methodology.

2.1 Objectives and research questions

The main objective of this research is to analyse the household water security within Santa Cruz Papalutla and Santa María del Tule in relation to the position within the urban fringe of Oaxaca de Juárez. On the one hand there is the mostly urban orientated municipality of Santa María del Tule and on the other the more rural orientated Santa Cruz Papalutla. However, this difference does not in itself explain the differences between the household water cultures of the two case municipalities. The HWSM shows that the water security of a household is first of all influenced by its wider context than its own. In this case the context comprehends two levels; the local context and context on national level (water policy and private sector). When looking at the local context the following research question needs to be answered:

- What are the social-economic, demographic and resource characteristics of Santa Cruz Papalutla, Santa María del Tule and the urban fringe of Oaxaca de Juárez?

Santa Cruz Papalutla and Santa María del Tule are part of the local context in which households negotiate their water security. However, these two municipalities are also subject to their own local context, which is in this case the urban fringe of Oaxaca de Juárez. This leads to the formulation of the following question:

- How are those social-economic, demographic and resource characteristics related to the position of Santa Cruz Papalutla and Santa María del Tule within the urban fringe of Oaxaca de Juárez?

The social-economic, demographic and resource characteristics of Santa Cruz Papalutla and Santa María del Tule does lead to certain possibilities and constraints that characterize their water security. As those characteristics are related to the position of Santa Cruz Papalutla and Santa María del Tule within the urban fringe, the following questions can be formulated:

- How can the water security of Santa Cruz Papalutla and Santa María del Tule be characterised in terms of possibilities and constraints?
- How are those possibilities and constraints related to the position of Santa Cruz Papalutla and Santa María del Tule within the urban fringe of Oaxaca de Juárez?

The first sub-questions do attend the local level as explained within the Household Water Security Model (see chapter one). However, most attention within this research goes to the households of Santa Cruz Papalutla and Santa María del Tule. The HWSM does lead to the conclusion that the same type of questions formulated for the local level are to be answered for the household level:

- What are the social-economic, demographic and resource characteristics of households from Santa Cruz Papalutla and Santa María del Tule?
- How are these social-economic, demographic and resource characteristics related to the position of its household within the urban fringe?
- What categorization of household water security cultures can be made considering the social-economic, resource and demographic variables?

However, the local context and the household context are both influenced by interventions that are made by the government and the private sector. The following questions are formulated as follow:

- How did developments in water policy and the private sector of the last forty years influence the water security within the Oaxacan urban fringe and within Santa Cruz Papalutla and Santa María del Tule?

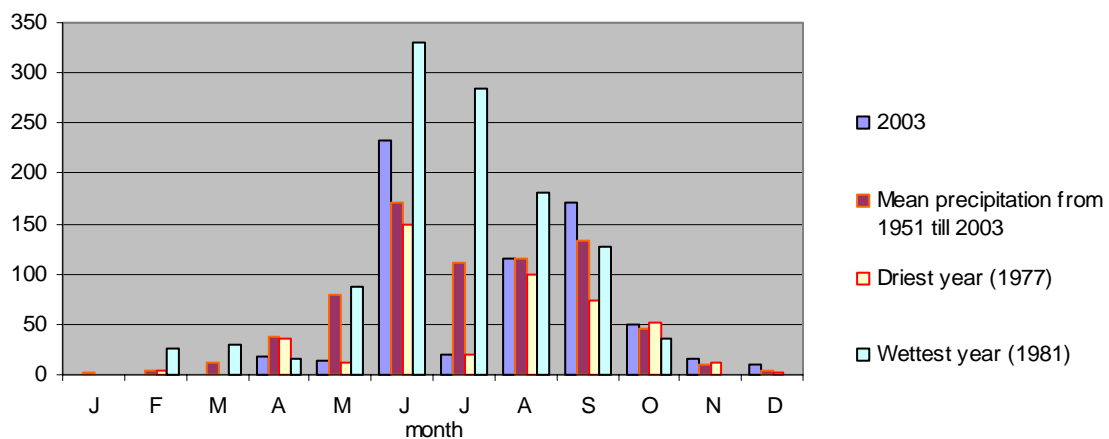
- What were the results of forty years of private and water policy developments on the position of Santa Cruz Papalutla, Santa María del Tule and their households within the urban fringe?

Analyses of the HWSM will be completed when answering those nine questions. With the information from those nine research questions it is possible to formulate an answer on the main question of this research. The final results of the research questions and the main question of this research will be enumerated in chapter eight.

2.2 Selection of research area and research population

The fieldwork of this research took place within the Mexican state of Oaxaca, which is one of the three poorest states within Mexico. With a mean annual precipitation of less than 800 mm., it is also a very dry state (see figure 2.1). One of its driest areas can be found in the Tlacolula Valley. The Tlacolula Valley is not only home to Santa Cruz Papalutla and Santa María del Tule, but is also one of the three valleys that comprises ‘Los Valles Centrales de Oaxaca’. All three the valleys are joined on a place where Oaxaca de Juárez has been build (see map 3.2). Besides low annual averages, the precipitation is also characterised by its irregularity and intense tropical storms. All three characteristics hold a threat to the water security of those who inhabit the valley. It means that negotiation of water security is a continuing process. Those characteristics make the area interesting within the context of this research.

Figure 2.1: Monthly precipitation, Oaxaca (mm.)



Source: CNA., Registro Mensual de Precipitación Pluvial en mm. Inédito

Another argument for choosing Santa Cruz Papalutla and Santa María del Tule as the two case municipalities is their distinct different position within the Oaxacan urban fringe. Santa María del Tule is situated fifteen kilometres outside the Oaxacan city centre while Santa Cruz Papalutla is situated at thirty kilometres from the city (see also map 3.2). As a result of their position, the daily live within Santa María del Tule is more directed towards the city than the daily live within Santa Cruz Papalutla.

A last argument for the preference of these two municipalities has to do with the already available amount of usable data. ‘Los Valles Centrales de Oaxaca’ (The Central Valleys of Oaxaca) have been particular popular since several decades with geographers and sociologists. Together these professionals have been building an extensive database. The available amount and high quality of data makes it very attractive for young scientists to practise research techniques. There are no studies on the household water security of Oaxaca de Juárez, or on one of its other municipalities within the Central Valleys. But, this is certainly compensated by the amount of available data from geographical and social works. Data gaps from preliminary work have mostly been filled with data from the fieldwork, which took place from late February 2004 till the end of July 2004. The work was partly done in the dry season, as well the first couple of months from the wet season. It gave the researcher the possibility to look for changes in household water security strategies under natural fluctuations in water availability.

2.5 Research methods; opportunities and constraints

The project has been a time consuming process from its very first beginnings to the very end. At forehand made intentions and research concepts were adjusted for several times, due to the changeable situations that characterise developing countries. Nevertheless, a good result does above all depend on the research concept and its preliminary study, which in the beginning were mostly influenced by experiences of other researchers. After half a year of preparations, the research concept and its creator were tested in the field.

Before the actual fieldwork began, time was used on gathering water management data within Oaxaca de Juárez. Most of this data was extracted from governmental institutes, such as the ‘Comisión Nacional del Agua’ (CNA), ‘Instituto Estatal del Agua’ (IEA), ‘Secretaria de Desarrollo Urbano, Comunicaciones y Obras Publicas’ (SDUCOP), and ‘Instituto Nacional de Estadística Geografía e Informática’ (INEGI). At the same time the researcher made himself familiar with the Spanish language. The main part of the fieldwork started when the researcher got permission to execute research in Santa Cruz Papalutla and Santa María del Tule. The research in the two case municipalities was accompanied by all the necessary comforts and help that the generous locals could offer me. The execution of fieldwork developed throughout several phases. The first phase comprehended the collection of data through observations and preliminary interviews.

Those interviews and other research techniques were executed in the absence of a translator, which did not lead to severe communication problems. However, this does not mean that some smaller communication problems could have had minor effects on the value of the data.

With the results from the preliminary phase a survey was developed (for its results read chapter five). The development, data gathering and analysis of this survey comprehended the second phase. The use of a survey within the fieldwork served two purposes. Its first purpose was to get a general picture of the water security and water culture within Santa Cruz Papalutla and Santa María del Tule. Secondly, it formed a database from which households were chosen for the in-depth interview phase. Appendix IV shows the survey questionnaire as had been shown to forty (equally divided among Santa Cruz Papalutla and Santa María del Tule) randomly chosen members of a household. The choice for a random selection was made on experiences by other researchers. Examples showed that the willingness to co-operate depends on personal contact between the researcher and his respondent. Especially within a rural community is an unknown researcher often seen as suspicious, as he or she could be a representative from the government. Another danger lays in the design of a questionnaire. Two survey pilots were taken to prevent biases within the questionnaire of the survey.

The third phase comprehended the selection of six households (three in each case municipality), which were thoroughly analysed on a case study approach. Goal of this phase was to get a detailed description of its water security for the better understanding of the differences between each strategy in relation to the position of the household in the urban fringe. The respondents were selected from those who participated in the second phase. Another criteria for being chosen was that the three households within each municipality showed substantial mutual differences in their demographic composition and social-economic position, with the goal to get as much different characteristics as possible. Chapter six and seven describe the most important results from those case studies.

Chapter 3. Santa Cruz Papalutla, Santa María del Tule and the urban fringe of Oaxaca

3.1 Introduction

With an total area of 1.923.040 square kilometres the ‘Estados Unidos Mexicanos’ (United States of Mexico) are together more then fifty six times bigger in land size than the Netherlands. Its thirty one states exists out of high rugged mountains and high plateaus, which are succeeded by fertile coastal low plains and desserts (CIA, 2005). Alike its physical environment, the economic welfare differs considerably within the country. Oaxaca is together with Chiapas and Guerrero one of the least developed Mexican states. Oaxaca lays between the parallels 15 39 and 18 42 northern latitude and between the meridians 93 38 and 98 32 occidental longitude and it has a coastal line with the Pacific Ocean. Besides the Pacific Ocean, Oaxaca is also bordered with the federal states of Guerrero to the west, Puebla to the northwest, Veracruz to the northeast and Chiapas to the east (see figure 3.1).

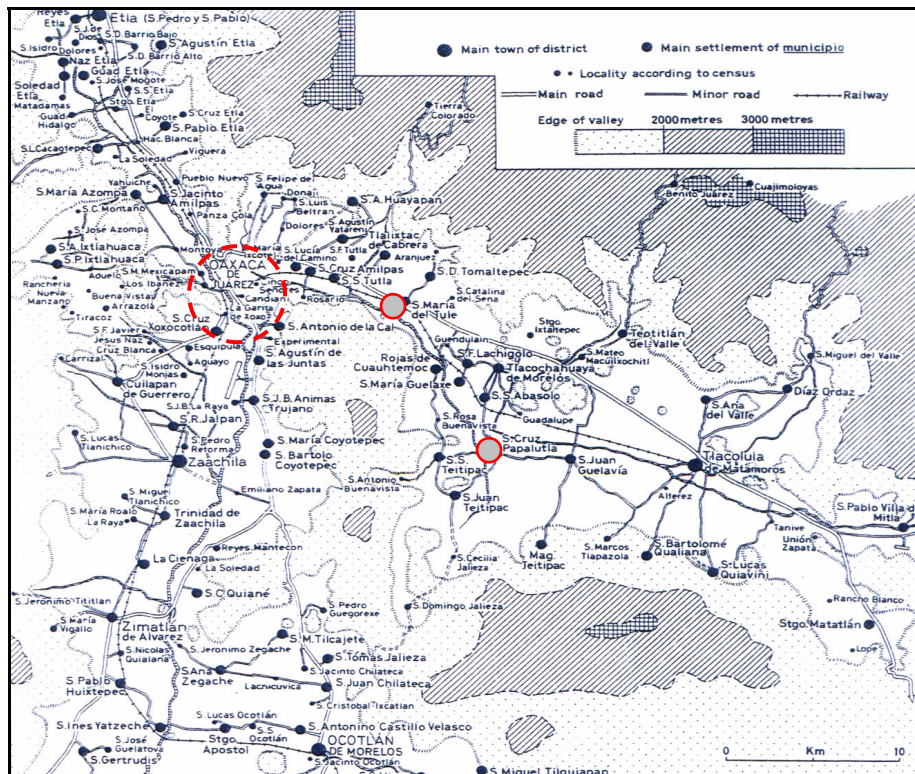
Map 3.1: Mexico



Source: INEGI, 2005

Most of the 95.364 square kilometres of Oaxaca is mountainous area with some peaks in excess of 3000 meters. In the middle of this mountainous area lays ‘Los Valles Centrales de Oaxaca’. Map 3.2 shows most of the Central Valleys with the city of Oaxaca de Juárez at its hart in the open circle and the two case municipalities on the closed circles.

Map 3.2: Central Valleys



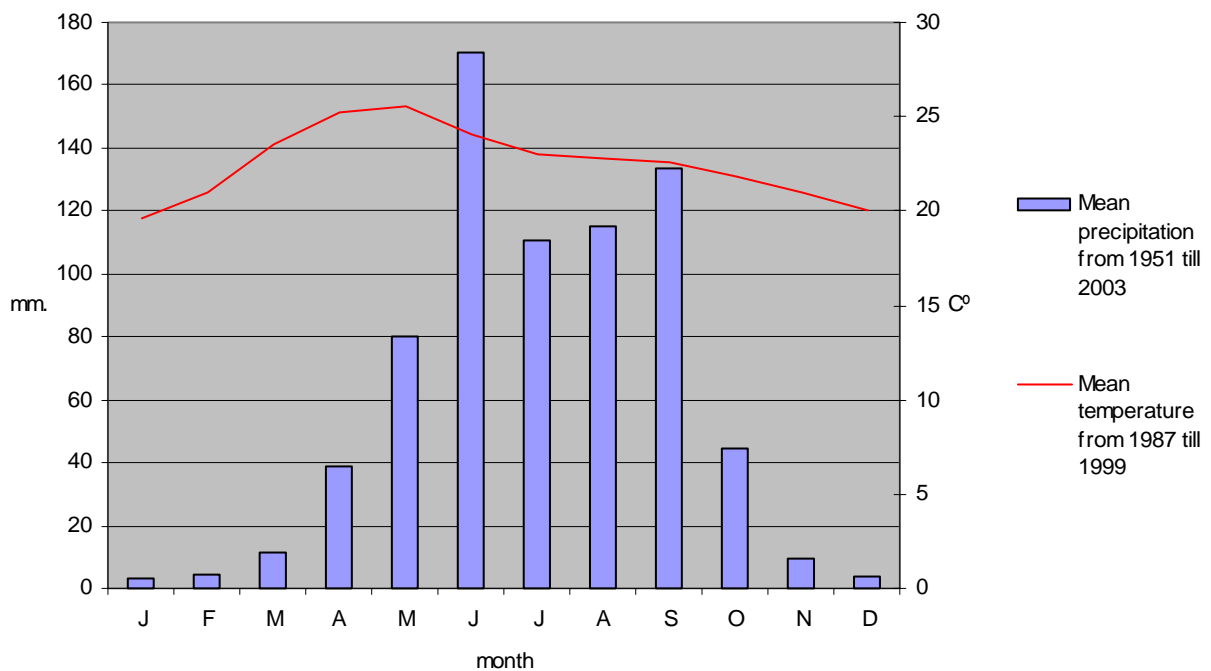
Source: Clarke, 2000

Since the middle of the twentieth century is Oaxaca de Juárez (also known as Oaxaca) expanding rapidly as a result of inter-state migration. The marginal living conditions on the Oaxacan countryside, the public facilities within the city and the available work attracted a lot of peasants and their families to Oaxaca. The city was not only flooded with migrants but also with increasing numbers of commuters from nearby countryside. However, the enormous inflow of migrants and commuters could not be incorporated into the formal labour market of the city. Especially the migrants were forced to work in the informal sector. It is estimated that in 1987, 62.7 per cent of the labour force in Oaxaca city worked in the informal sector (Murphy et. al., 1990). Most of those informal employers were active in the service sector owning or working in one of the many ‘negocios comerciales’ (small business). Typical ‘negocios’ are ‘comedores’

(small restaurant), pharmacies, garages, retail shops, etc. Other important employers within the city is the government and the tourist sector. Only a very small percentage of employers work in the industrial sector. The growth of the informal sector did suppress the incomes for the maintenance and expansion of public services within the city, which already stood under a high pressure. The city its water resources for example could no longer provide its population with sufficient and clean drinking-water. The cheapest solution was to extract water from its urban fringe.

As noted in chapter two is the semi-arid climate of Oaxaca first of all characterised by an irregular and low annual average precipitation (see figure 2.1 and 3.1). However, tropical storms or cyclones from the Gulf of Mexico or the Pacific Ocean sometimes cross the Central Valleys thereby pouring lots of rain into the valleys.

Figure 3.1: Oaxaca; climate

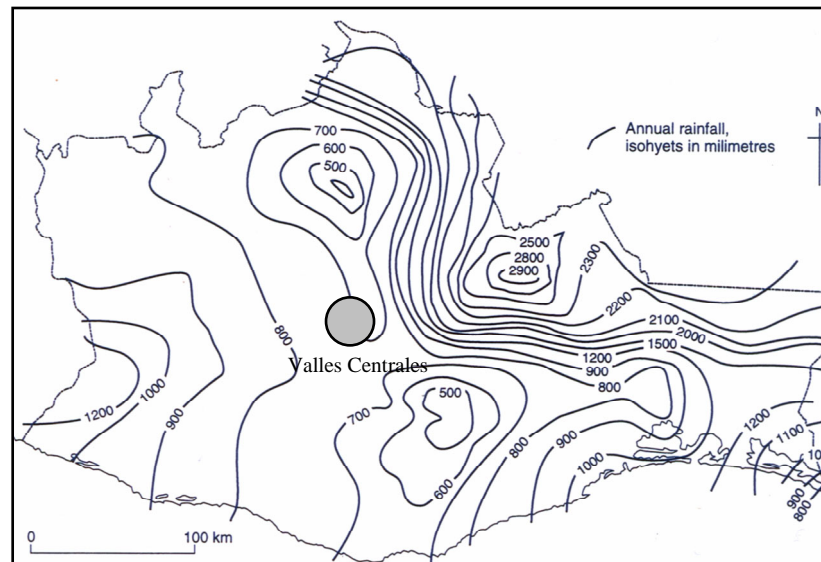


Source: INEGI, 2004

Each year Oaxaca has a dry winter season and a wet summer season, the latter beginning around June and ending in October. The Tlacolula Valley, which is home to the two case municipalities, is the driest valley within the Central Valleys. Annual precipitations drop below 600mm. in the area around Tlacolula de Matamoros, while Oaxaca city has a mean annual precipitation of 650mm. The capital is not the wettest

place in the Central Valleys. With an annual precipitation of 750mm. Ocotlan (35 kilometres to the south of the capital) has a higher annual precipitation than any other place within the Central Valleys. However, this is nothing compared with the average of 2000mm. in the eastern Zapoteca and Mixe mountains (Clarke, 2000).

Map 3.3: Oaxaca; precipitation



Source: Clarke, 2000

The bottom of the Central Valleys lays around 1500 meters above sea-level and is locally indicated as *tierra templada*. The *Tierra templada* is one of the three temperature zones that are calibrated with altitude and vegetation. The other two temperature zones are the *tierra caliente* and the *tierra fría*. The *tierra caliente* is the zone up to 1000 meters, and the *tierra fría* runs from 2000 to 3000 meters. Due to its altitude do day and night temperatures differ considerably in Oaxaca. An average summer day reaches twenty-five degrees while average summer nights are often not colder than fifteen degrees. Average winter temperatures show even greater difference between night and day, as day temperatures lay around twenty degrees and night temperatures around eight degrees. The high average temperature decreases the availability of water, due to a higher evaporation in comparison with precipitation. This negative balance contributes to low ground water levels, which easily can be seen by taking a look at the dry riverbeds around Oaxaca.

The hydrological system of the Central Valleys is based on the Atoyac river and its tributary the Rio Salado. The Atoyac crosses the Central Valleys, beginning in the

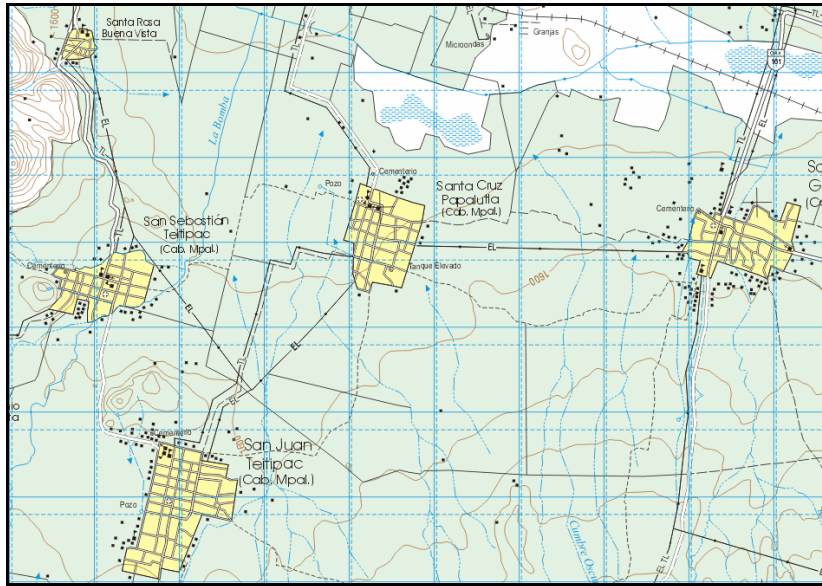
northern valley of the Central Valleys complex. The river runs down south through Oaxaca city and leaves the Central Valleys in the south of the 'Valle Grande'. The Rio Salado runs through the Tlacolula Valley and joins the Atoyac in the capital. Although most riverbeds are dry during most time of the year tropical storms or cyclones do sometimes reach the Central Valleys thereby causing heavy floods. The enormous amount of water in a relative short period does create wild currents, often resulting in deaths, damage to properties and infrastructure, and erosion. But, erosion has been accelerated since the rapid expansion of settlements, due to the clearing of vegetation for economic development. Current natural vegetation within the valleys is characterised by the existence of cactus and thorn scrub. Typical agricultural products of the Central Valleys are maize, beans, and squash, with the occurrence of specialization with altitude and by locality (Clarke, 2000). Agriculture provides income for sixty per cent of the formal labour force in the federal state of Oaxaca (see table 3.2). Most of them are marginalised self-subsistence peasants with only a *minifundia* (small property; less than five hectares). The cultivation and profits from those lands depend largely on the humidity of the ground to support the growth of crops. Most of the agricultural land in Oaxaca is *tierra de temporal* (seasonal rain-fed land), six per cent is known as *tierra de humedad* (land that has the capability to support crops without the use of irrigation techniques), and another six per cent is known as *tierra de riego* (irrigated land) (Ortiz, 1992).

3.2 The case municipalities and their position within the Oaxacan urban fringe

The rapid expansion of Oaxaca de Juárez has increased the interactions with its urban fringe. Within this urban fringe lifestyles from the countryside collide with those from the city making it a dynamic field of social-economic processes. This does also have its consequences for the water security of the area and its inhabitants. Santa Cruz Papalutla and Santa María del Tule are two communities within this dynamic field.

Placed in the middle of the Tlacolula Valley at the parallels 16 57 northern latitude, 96 35 eastern longitude and thirty kilometres from Oaxaca city lays Santa Cruz Papalutla (see map 3.4). Papalutla or Papalotla means 'donde abundan las mariposas' (where butterflies are abundant), and Santa Cruz stands symbol for its Christianity (INAFED, 2000a).

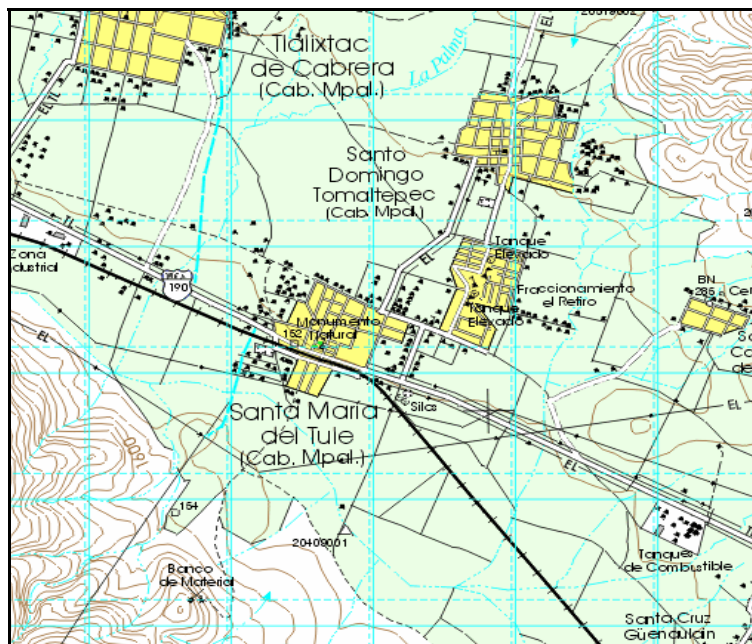
Map 3.4: Santa Cruz Papalutla and its surrounding 'campo'



Source: INEGI

At the most western end of the Tlacolula Valley at the parallels 17 03 northern latitude, 96 38 eastern longitude and fifteen kilometres from Oaxaca lays Santa María del Tule (see map 3.5) or shortly known as El Tule. Santa María is the patron saint of the municipality. Tule comes from the Náhuatlán word Tulle or Tullin, which is the indigenous name for reed-mace (INAFED, 2000b).

Map 3.5: Santa María del Tule and its surrounding 'campo'



Source: INEGI

In the year 2000 Santa Cruz Papalutla counted 1833 inhabitants. According to INEGI (2000) fifty-six per cent of the occupied population within Santa Cruz Papalutla worked in agriculture, which is mostly practised on its 'campo' (field). The average farmland size lays around 2.8 hectares, which is a little bit higher than the state average of 1.5 to 2.5 hectares (Schilthuis, 2004). In spite of this average, only a few landowners do not belong to the *minifundia*. Another aspect of the agricultural property is that most landownership is private, with a small group renting land from the *bienes comunales* (communal land or property). The *bienes comunales* is in this case also known as an 'ejido' (read box 3.1), and is as such registered in the INEGI statistics (INEGI, 1991). An 'ejido' sometimes forms part of the traditional village structure and sometimes constitutes its own community (Kirkby, 1973), like in Santa Cruz Papalutla where a total of 1386 hectares was divided amongst 280 labourers (INEGI, 1991).

Box 3.1: Ejido

In short, an ejido is an agricultural land unit that is expropriated from large private holdings and redistributed to communal farms. Within Mexico communal land ownership had been widely practiced by the Aztecs, but the institution was in decline before the Spanish arrived. The conquistadors instituted several land distribution systems, which were finally superseded by debt peonage after the Mexican independence of 1821. Although legally abolished by the constitution of 1917, which provided for the restoration of the ejido, peonage remained a general practice until the presidency of Lázaro Cárdenas. The intent of the ejido system was to remedy the social injustice of the past and to increase the production of subsistence foods. The land was owned by the government, and financed by a special national bank which supplied the necessary capital for reclamation, improvement, initial seeding, and so forth. As whole communities belonged to an ejido, it also had a substantial impact on the internal structure of municipalities.

However, the ejido system became increasingly costly due to the complete absence of market mechanisms. As a result more and more agricultural products were imported, which led to poverty on ejidos. Free market principles were introduced in 1992 to reform the sector. However, till this day most ejidos struggle to compete in an open market economy as they do not have the access to sufficient financial resources.

Sources: Ronfeldt (1973), Kirby (1973) and World Bank (2001)

Primary agricultural products, as produced in Santa Cruz Papalutla, are maize, beans, and squash. Secondary products are alfalfa (used as food for cattle) and garlic. However, in trying to make maximum yields peasants are experimenting with new products, such as flowers. Although most households do see agriculture as their primary source of income, its marginality has forced most households to apply income diversification. Additional incomes were initially made from activities such as the manufacturing of artesian textiles, through the production of 'cestos' (baskets) and the bottling of 'mezcal' (local alcoholic beverage). However, most of these activities have almost disappeared as profits were minimal. It is therefore not strange that an increasing number of inhabitants give up their marginal living conditions on the countryside for the promising perspectives that lies in the city. Besides, there is also an increasing number of people who are daily commuting to their work in the state capital. The youngest of these commuters just finished secondary school, while the oldest commuters are in their fifties. The majority of those are men and work as a teacher, or a cleaner, technician and salesman. The exact number of commuters are not known, but samples from within Santa Cruz Papalutla indicated that in every ten households there were three households with one or more members who commuted. It must be said that the real number of commuters differs daily, since most commuters work on an irregular basis. Although commuting is becoming more common, the larger part of the households within Santa Cruz Papalutla still generate their incomes within the municipality. However, incomes are not only generated from agricultural activities. Table 3.1 shows the main economic activities within the municipality. Most of those activities are based on selling primary necessities. A remarkable figure are the number of music bands within the village. Not only do these 'bandas' have an important social function, they also generate incomes (for more information about those 'bandas' consult the thesis of M. Uunk; expected in 2006).

Agriculture within El Tule is historically not as important as in Santa Cruz Papalutla. El Tule was known as an artisan village where lime products were produced for the local and regional markets. Those lime art crafts were mainly produced until the end of the nineteen twenties. At the beginning of the third decade most artisans had given producing lime crafts as its yields were no longer sufficient to support the household. Some became 'campesinos' (peasants) on one of the three local 'ejidos', while a reasonable percentage began commuting. It is estimated that seven in every ten households are well known with commuting. Like those from Santa Cruz Papalutla, do

commuters from El Tule range in age and often work in the service or construction sector. Besides the fact that commuting is more common in El Tule, it is also more common for women to earn an income within the city. To explain the higher percentage of commuting women, we must take a look at the differences in lifestyles of the two case municipalities.

Table 3.1: Economic and social activities within Santa Cruz Papalutla, in 2004

<i>Activity</i>	<i>Numbers</i>
Grocery shops	20
Pharmacies	2
Ferreterias	2
Home-made clothing shops	2
Communal kitchen (selling prepared food on Sunday)	1
Videogames hall	1
Cornflower mills	2
Tortillerias	2
Music bands (<i>banda's</i>)	11
Internet corners (including communal computer learning centre)	2

Based on work by Schilthuis (2004)

Of the 1833 inhabitants that included Santa Cruz Papalutla in 2000, more than forty per cent spoke an indigenous language. On the other hand, less than eight per cent of the 7272 inhabitant within El Tule spoke an indigenous language (INEGI, 2000). These figures indicate the presence of a more traditional lifestyle within Santa Cruz Papalutla. This indication is further founded when involving the household size. Traditional families have the characteristic to be more extensive than a household with a modern lifestyle. The average 4,2 household members in El Tule and 4,6 in Santa Cruz Papalutla do support this (INEGI, 2000). The differences between Santa Cruz Papalutla and Santa María del Tule do not stop with statistics on indigenous speaking and family size. The lifestyles within Santa María del Tule are more characterised by consumption, individualism, and woman emancipation, due to its intense social-economic interactions with the capital.

Besides working in the city, the agriculture sector or as an artisan, there are a lot of people from El Tule that works within the growing local tourist sector (read box 3.2).

The role of the local and federal government as investors was particularly important in the development of this sector. Most of the investments made by the government were technical infrastructural projects. Nowadays, El Tule has been equipped with an electricity network, telephone network, communal drinking-water infrastructure, a sewage system, paved roads, etc.

Box 3.2: Tourism in El Tule

Since the end of the nineteenth century, El Tule is well known for its ‘Arból del Tule’; one of the largest and oldest trees in the world. The cypress, known in Spanish as ‘ahuehuete’ (*Taxodium mucronatum*), already existed before date and has a circumference of 54 meters. Those unique characteristics gave it national and international fame. A growing number of tourists are visiting El Tule each year. As a result, El Tule has developed an economy that is largely based on tourism, which also includes the re-introduction of traditional lime-handcraft. The area around the tree is nowadays characterised by the appearance of small commercial shops, who thrive on selling regional handcraft, postcards, ‘mezcal’, food, photo camera’s, etc. In spite of the fact that tourism has helped to increase the living standards within the village, it has also some negative impacts, amongst others on local water management.

A lot of expensive water is nowadays used for the physical look of the area around the ‘Zócalo’ (main square) of El Tule. The high water consumption has seriously lowered the ground water table underneath the ‘Zócalo’. This situation holds a threat to the ‘Arból del Tule’, which increasingly has more difficulties in extracting sufficient groundwater.

On the other hand there are the marginal investments by the federal government in Santa Cruz Papalutla. The last infrastructural investment program dates from the late seventies when an impoverished countryside triggered national subsidies. The better developed water infrastructure of Santa María del Tule stimulated a higher water consumption per household in comparison with households from Santa Cruz Papalutla. However, it is not only the infrastructure that makes the difference. The different economies of both municipalities are linked with different patterns of economic water consumption. Calculations with INEGI statistics show that the average daily water supply from the public water infrastructure to the households within Santa María del Tule is 570 litres. However, the survey within this research tells us that the actual

number must lay around an estimated three hundred litres per household, making it 70 litres for each person. The difference in water supply and consumption can be explained by the water leakage from the infrastructure, which despite the investments of the past, is not well maintained. Water consumption within Santa Cruz Papalutla is estimated at one hundred and eight litres of water for each household and 23 litres for each person. This number is extremely low compared to western standards, which go up to an average of above six hundred litres in the United States of America (NIROV, 2003). But, even compared with other places within Mexico this number is low when considering the daily average water supply of 390 litres per person in cities with more than 50 thousand inhabitants, and 280 litres for cities with between 50 thousand and 2500 inhabitants (Corbett et. al., 2002).

3.3 Conclusion

This research takes place in a region that is characterised by its physical roughness and its climatologically toughness. Despite those constraining conditions have the Central Valleys been home to many civilizations. The first civilizations that inhabited the valleys mainly thrived on trade with agricultural products and handcraft. Central place in those trades has always been Oaxaca de Juárez. Currently these trades are still the main sources of income together with a new tourist sector. Within the last century Oaxaca de Juárez has expanded rapidly including its social-economic importance for the surrounding urban fringe. Two municipalities within this urban fringe are Santa Cruz Papalutla and Santa María del Tule. With less inhabitants, a larger distance from the city, a more traditional lifestyle and the absence of a modern economic sector, does Santa Cruz Papalutla have the more rural position of the two. Santa María del Tule on the other hand does maintain closer social-economic ties with the state capital, which is mainly influenced by the presence of an important tourist attraction. As a result large investments have been made in local infrastructure by the federal and local government. Santa María del Tule has a relatively well developed water infrastructure in comparison with Santa Cruz Papalutla, which uses a water infrastructure network that is based on network of the late seventies. The economic developments within Santa María del Tule have also positively influenced the prosperity of its inhabitants and their water consumption pattern. With an estimated average amount of three hundred litres of water each day do the households within El Tule consume considerably more than the estimated average of one hundred and eight litres within Santa Cruz Papalutla.

Chapter 4. Water policy and water infrastructure within the Oaxacan urban fringe

The previous chapter concentrated on the social-economic characteristics of both case municipalities and their households in relation to their position within the urban fringe. This chapter will do the same for the water-policy and water infrastructure within the urban fringe. However, for a better understanding of the water policy within the urban fringe and its resulting infrastructural developments, it is first of all necessary to understand national Mexican water policy. This chapter will therefore begin with a short description on national water policy developments since the end of the 19th century.

4.1 Developments within Mexican water policy since the beginning of the 20th century

Since the introduction of modern Mexican water policy by Porfirio Diaz at the end of the 20th century, it can be described as mostly centralized, technocratic, and urban biased. Until the late nineteen-sixties, Mexican water management in general was led by the federal ‘Secretaría de Recursos Hidráulicos’ (SRH), and especially its department ‘Dirección General de Agua Potable y Alcantarillado’ (DGAPA). DGAPA was concerned with water supply and sewage systems of mostly urban areas. This urban bias in water policy resulted in a strong incentive to purchase water rights from rural areas in order to secure urban water supplies (Hearne and Trava, 1997). At a time of economic prosperity the Mexican countryside, and in particular the indigenous municipalities of the southern states, were mostly ignored. Growing social and political unrest eventually led in the beginning of the nineteen-seventies to the creation of development programs for the countryside. However, these programs in itself were partly being developed with the intention to prevent further migration to the cities. Nonetheless, they included amongst others the assembly of water and sewage infrastructure.

Under the presidency of Luis Echeverría Álvarez (1970-1976), the number of urban and rural water systems controlled by the SRH had grown significantly, which made DGAPA no longer efficient. The replacement of DGAPA by the ‘Dirección General de Operación de Agua Potable y Alcantarillado’ (DGOSAPA) needed to solve this problem. But, by the mid nineteen-seventies DGOSAPA increasingly complained about the many deficiencies in urban water and tax systems. The low standards and low levels

of local participation also reinforced the idea of the service as being a gift from the federal government. In improving the water security the federal government transferred old responsibilities of the SRH (water supply and sewage) to the newly ‘Secretaría de Asentamientos Humanos y Obras Públicas’ (SAHOP). Unlike SRH, SAHOP was directly oriented on urban service and development. The financial, economic, and social crisis at the late seventies would soon afterwards cause a shift in Mexican water policy.

Until the beginning of the nineteen-eighties, Mexican water policy had not allowed for decentralization and privatization. However, due to the economic and social crisis Mexico had to implement Structural Adjustment Program’s (SAP’s) in turn for foreign aid. These SAP’s also had drastic consequences for the Mexican water sector. It all began in 1980 with a string of decentralization reforms, beginning with the transference of some water supply operations from SAHOP to state governments (infrastructural responsibility remained federal). This reform was amongst others followed by the even more dramatic Municipal Reform of 1983, which stipulated that water supply and sanitation service were the primary responsibility of municipalities. The latter reform stimulated the idea that water within a territory belonged to its inhabitants. Federal services were further decentralised at the end of 1983 by the agreement to transfer the construction and administration of the water supply and sewage systems to state governments.



Meanwhile, the crisis led to the abolishment of rural development programs, causing further impoverishment on the countryside. For example, water infrastructure that was build with the help of ‘petrol dollars’ in the nineteen-seventies soon started to break down. The urban bias in water policy became stronger within this period, as most development support was again directed towards urban areas.

Illustration 4.1: Communal drinking-water tap ruin in Santa Cruz Paplutla

Table 4.1: Evolution of the Mexican water management structure

	<i>Federal Administration</i>	<i>State Administration</i>	<i>Municipalities</i>
1876	Porfirio Diaz becomes president and begins centralized, technocratic, and urban biased developments in Mexican water systems		
1948	Ministry of Hydraulic Resources (SRH) creates the General Office of Potable Water and Sewage (DGAPA).		
1971	The General Office of Operation of Potable Water and Sewage Systems is created under SRH.		
1976	Function is transferred to Ministry of Human Settlements and Public Works (SAHOP). SRH changes into Ministry of Agriculture and Hydraulic Resources (SARH)		
1980		Operation of Water Supply Systems transferred to states.	
1983		Constitutional reform transfers the management of water supply and sewage to Municipalities and States.	
1989	The National Water Commission (CNA) is created under supervision of SAHR		
1992	Establishment of privatization in the water sector with the Law on National Waters		
1995	CNA is included as a semi-autonomous part of the Ministry of the Environment, Natural Resources, and Fish (SEMARNAP)		

Sources: 'El Colegio de Sonora' (2005), Hearne and Trava (1997)

The severe financial, economic and social problems resulted in less attention to the problems that water security faced. This situation changed again with the arrival of Carlos Salinas de Gortari to the presidency in 1988. Today's most important legacy of this president is the administrative 'Comisión Nacional del Agua'. The CNA was created in 1989 under supervision of 'Secretaría de Agricultura y Recursos Hidráulicos'

(SAHR), which was the successor of SRH. One of the main purposes of the CNA is to achieve more consistency and coherence in Mexican water policy. Consistency needs to be achieved through the reformation of politically biased public water agencies into autonomous self-sufficient private enterprises. However, up to this day there is a saying that Mexico is re-invented every six years, (each new president makes major institutional changes), making it very difficult to reach the goals that were set for the CNA.

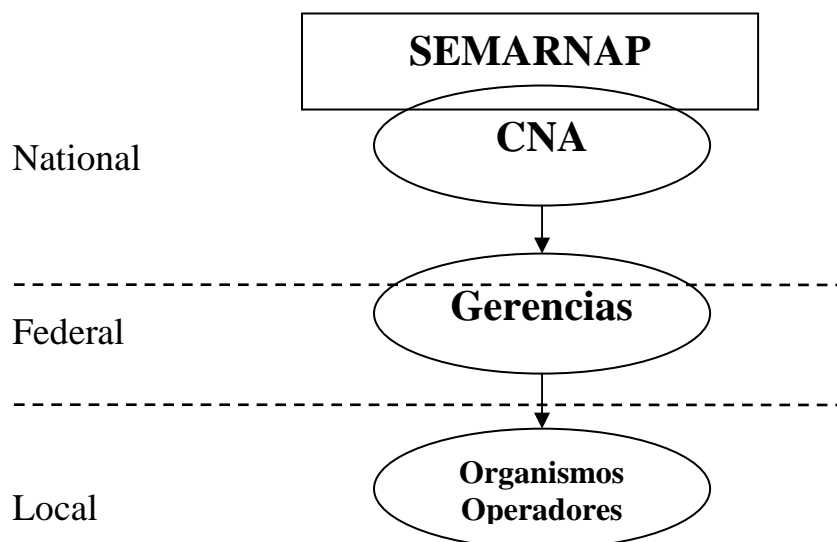
Under supervision of international institutions, such as the World Bank and NAFTA, the Mexican government started in December 1992 with its latest stage in water policy reforms. The 'Law on National Waters' was passed with the purpose to set up a context in which private parties could participate within the Mexican water sector. The purposes of privatization are to reach a fair distribution of public wealth, to care for conservation, to achieve a balanced development of the country, and to improve overall living conditions of the population. Although these privatization reforms have opened up the Mexican water sector considerably, they do not have the intention to reach an established free water market. The 'Law on National Waters' describes amongst others the rules and requirements for concessions and transference of water rights. It allows private companies to make certain contracts for the exploitation and development of water infrastructure within a certain time period. However, the establishment and operation of private companies only takes place in urban areas, emphasizing the urban bias of Mexican water infrastructural developments.

4.2 Water policy and management within Oaxaca

Current water policy within Oaxaca is bound to the 'Ley de Aguas Nacionales' (Law on National Waters) and to the 'Ley de Agua Potable y Alcantarillado del Estado de Oaxaca' (Law on Potable Water and Sewage of the State of Oaxaca). At the basis of those laws lies the point of view that water is a common good and therefore national property. The administration of this common good is entrusted to the CNA. This institution is responsible for the development of a national water policy under supervision of SEMARNAP (Ministry of the Environment, Natural Resources, and Fish). The CNA directs its water policy to a lower level of thirteen districts, or so-called 'Gerencias' (see figure 4.1). Those districts are again subdivided into 20 'Gerencias Estatales'. The 'Instituto Estatal del Agua' (Federal Water Institute, hereafter IEA) is a

normative, public and decentralised institution for the Oaxacan water sector, that operates since 1993. Its purpose is to administrate and preserve state waters, under normative supervision of the ‘Gerencia Pacífico Sur’ (one of the thirteen CNA districts, covering most of the state of Oaxaca and Guerrero) and the state government. Another purpose of the IEA is to assist and coordinate municipal ‘organismos operadores’ (executing organisms). This is particular important for rural areas where those organisms, locally known as ‘comité de agua potable y alcantarillado’, often lack sufficient technical knowledge and financial resources to maintain or expand their drinking-water infrastructure.

Figure 4.1: Model of Mexican water management hierarchy.



The local water committees are responsible for the water supply, its quality and the administration of the contribution. Within the city of Oaxaca the ‘Administración Directa de Obras y Servicios de Agua Potable y Alcantarillado de la Ciudad de Oaxaca’ (Administration Organ for Drinking-Water and Sewage-infrastructure in the City of Oaxaca, or shortly ADOSAPACO) is the main ‘organismo operador’. The delivery, and administration of clean water within Santa Cruz Papalutla and Santa María del Tule is for the most being managed by the local ‘comité de agua potable y alcantarillado’ (committee on drinking and waste waters). This body consists of a *Presidente de comité* (Chairman of a committee), ‘tesorero’ (financial administrator), ‘secretario’ (administrator) and ‘vocales’ (a helping hand within a committee).

Both Santa Cruz Papalutla and Santa María del Tule do have one or more individual water infrastructural networks, including water reservoirs and public water wells or *pozos*. These *pozos* are manually operated by the members of the ‘comité de agua potable y alcantarillado’, including the water quality control. The only purification method that is being applied in both municipalities is the addition of chlorine to water. Those who use the public water system need to pay a monthly contribution to the committee. The height of the contribution is being determined by the local *ayuntamiento* (local community council, town council). Within Santa Cruz Papalutla and Santa María del Tule this contribution has been established at ten pesos (0.71€²) for each connection with the main water pipe. However, within El Tule there are households who must pay twenty pesos instead of ten, as the household includes a ‘negocio comercial’ (commercial business). Households with such an activity are said to consume substantially more water than a household without commercial activities, and therefore must contribute more. The contribution is normally being collected at a monthly assembly at the ‘palacio municipal’ (municipal office or town hall). The *ayuntamiento* does not interfere within this administration except when there is a household who does not fulfill its obligation. In those cases the local *ayuntamiento* will come to a judicial verdict. Situations like this are uncommon as regulations are not well known by both parties, and/or not strictly implemented.

A new task of increasing importance for the ‘comité de agua potable y alcantarillado’ is to inform the local population on how to save water and avoid waterborne diseases. Several international institutions, like the World Bank and UNESCO proved that a lot of water can be won and diseases prevented by changing the water-culture of the average household. Those advices have been integrated within today’s Mexican water policy. One way of informing the public is through information-posters or wall-paintings, which normally can be seen near the ‘palacio municipal’.

² According to the rate of fourteen pesos against one Euro, 2004.

Box 4.1: Water-culture and information services

The provision of information on water in Santa María del Tule is primarily directed to particular measures in reaching a more efficient water culture within the household. However, local posters also include basic information on the importance of fresh water and its scarcity. The purpose of this information is to increase the awareness for a durable water-culture.

The provision of information in Santa Cruz Papalutla seems to have a different purpose, as posters pay attention to measures that can help to prevent the outbreak of epidemics like cholera and *dengue* (tropical fever). So far this does seem to be successful, as the last epidemic was registered in the early nineteen-nineties.

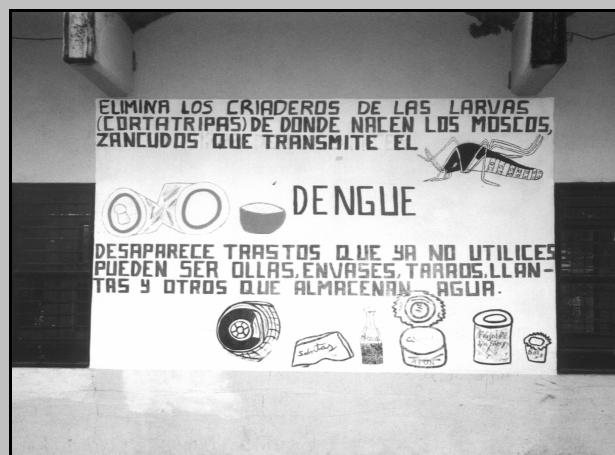


Illustration 4.2: Wall-painting on water and waste culture within Santa Cruz Papalutla

This information service is not only been offered by local water committees. Especially the provision of information on a save water culture has since several decades been arranged by the Mexican Ministry of Health. Local ‘Casas de Saludes’ (health centres) are playing an important role in this assumption, as its doctors continue to organize public information meetings.

Although it operates the public drinking-water system, the ‘comité de agua potable y alcantarillado’ does not have the task to maintain or expand the drinking-water infrastructure. Decisions on maintenance or expansion of the system are made by the local council. However, the ‘comité de agua potable y alcantarillado’ does have a saying in infrastructural developments since its know-how and small financial contribution are valuable for possible maintenance or expansion. The greater part of the finance must

come from the *ayuntamiento*, which on its turn depends on subsidies from other parties. Each municipality gets an annual so called grass-roots, anti-poverty subsidy of approximate 17.000 US\$ dollars from the Mexican government and the World Bank (Clarke, 2000). This annual subsidy has been introduced since the early-1990s to boost funds of peasant communities. Without taking any account of area or population, the sum of subsidy is the same for each municipality. It is therefore not surprising that several Oaxacan municipalities do complain that the sum of remitted money by far is not enough for necessary water infrastructural maintenance, let alone its expansion. It has been estimated that due to the absence of investments in water infrastructure within Oaxaca de Juárez, sixty percent of the water leaks from its water infrastructure (M. Brian Riley, 1998). A last resource in gaining necessary funds is the IEA, which however does not have an adequate budget to fully support all subsidy claims, made by most of the 570 Oaxacan municipalities. Those who are considered for a subsidy still complain that the remitted sum is insufficient.

4.3 Water infrastructure of Santa Cruz Papalutla and Santa María del Tule

Within Santa Cruz Papalutla a lot of water is used for the cultivation of mostly maize, beans, squash, alfalfa and garlic, which are grown on *tierra de riego* and *tierra de temporal*. Irrigation is only possible in those places where there is a high enough water table for water pumps to be efficient (Kirkby, 1973). As a result, most agricultural activities within the municipality of Santa Cruz Papalutla is found to its western edge, where the average winter water table lays at a depth of seven meters. To extract ground water some peasants use electrical pumps. However, the use of electrical pumps is only possible near an electricity network. In the years 2001 and 2002 a special electricity network was build to the west of the Santa Cruz Papalutla (see map 4.1). Instead of using the public electricity network, the countryside does have its own 220 volts network, as pumps only work on 220 volts. The maintenance of the irrigation system (including electricity network) within a municipality does belong to the *comisariado de bienes comunales* (committee of management of communal resources). Besides being responsible for the irrigation system of a municipality, the committee is also responsible for the management of other communal resources. In order to accomplish its tasks, the *comisariado de bienes comunales* collects taxes from residents in return for grazing and irrigation rights and for permission to cultivate the communal grounds. As the

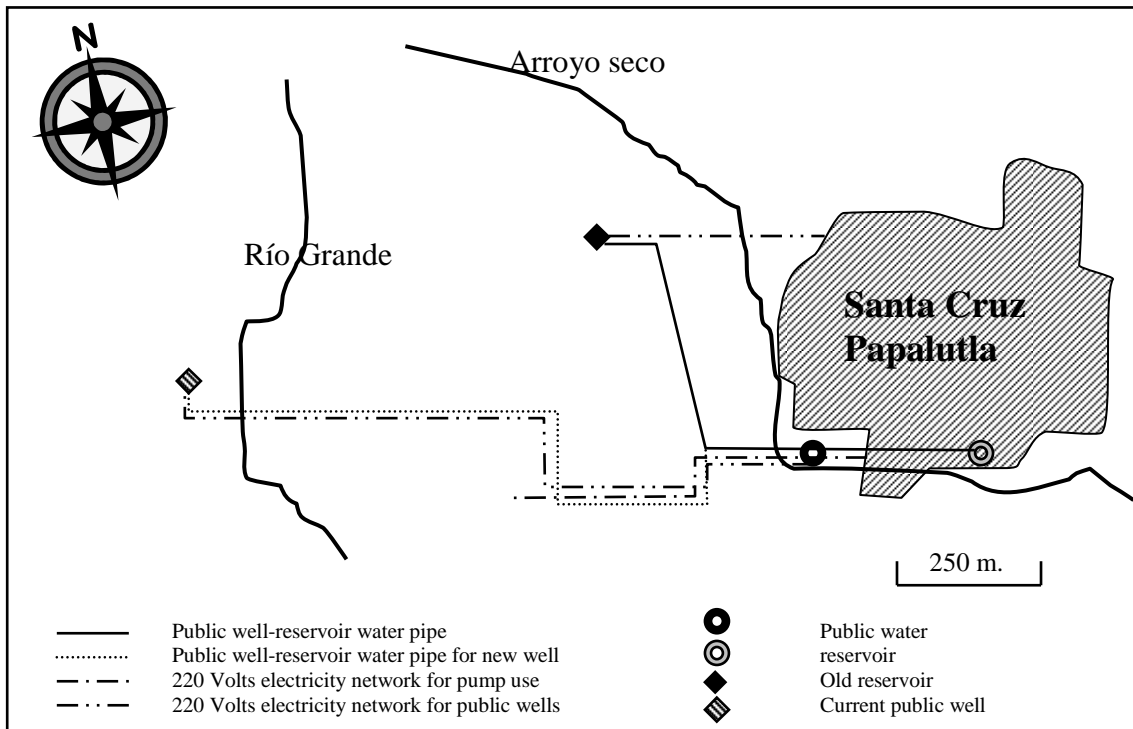


electricity network does only comprise a small percentage of the cultivated area around Santa Cruz Papalutla most agricultural plots must be irrigated with the use of gasoline pumps. However, rising oil-prices do make this way of pumping increasingly expensive.

Illustration 4.3: Gasoline water pump on the 'campo' of Santa Cruz Papalutla

Through the use of an electrical pump it is possible to irrigate up to five hectares a day, if supported by a regular water supply (Clarke, 2002). However, developments within Santa Cruz Papalutla increasingly make it difficult to extract sufficient water, since ground water levels are dropping. An increase in the use of more powerful water pumps has been the result, which means that more water is being extracted these days. It is therefore not strange that ground water levels are still dropping. This has had devastating consequences for the already constrained possibilities of *tierra de humedad*. There are only a few plots left in the north-west corner of the municipality that can apply this type of cultivation, as certain ground layers make it difficult for water to infiltrate. In 1991 most of the agricultural plots around Santa Cruz Papalutla were known as *tierra de temporal*. However, since then this number has decreased quite significantly in favour of *tierra de riego* as it became more affordable for peasants to apply well-and-furrow irrigation (INEGI, 1991; Clarke, 2002). Well-and-furrow irrigation is also less directly subordinated to droughts, giving peasants more production security.

Map 4.1: Schematic visualisation of key water systems on the western 'campo' of Santa Cruz Papalutla (2004)



Based on fieldwork data and maps from INEGI

Of the 397 'viviendas' (households) that were counted in Santa Cruz Papalutla 318 were connected with the local drinking-water network (INEGI, 2000). The public drinking-water network is provided by one public *pozo* at some two hundred meters to the west of the village in the middle of agricultural fields (see map 4.1). The pump of this well has the capacity to deliver a daily average of forty-three cubic meters of water (INEGI, 2004). An additional water pump serves as a back-up system if the main-pump should fail. The well itself is made out of bricks, has a width of three meters and is twelve meters deep. This depth is no longer sufficient for today's municipal public wells, due

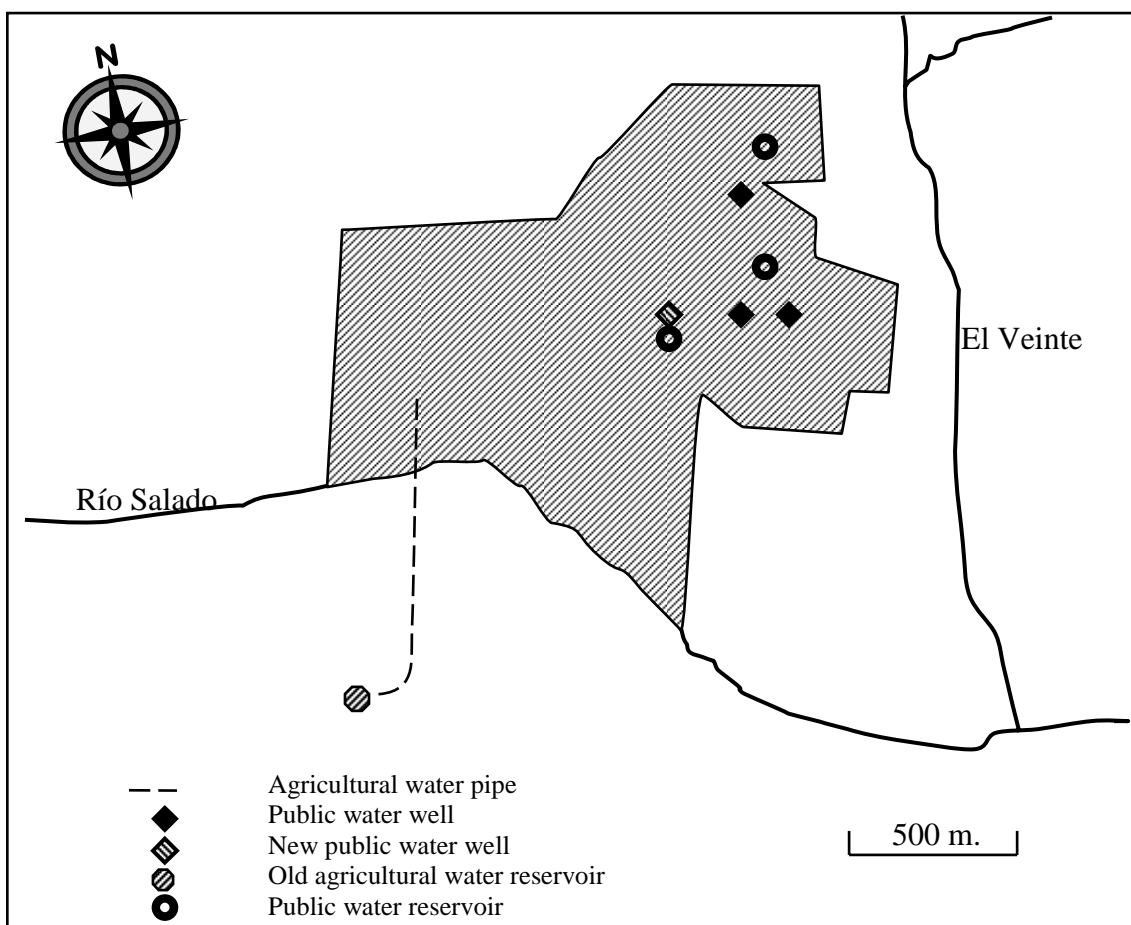


to the lowering of the ground water table. Therefore, work on a replacement *pozo profundo* (well of at least fifty meters deep) had started since the end of 2003. When finished, the new well will be equipped with one pump and the chlorine injection system. The new well is expected to deliver a daily average amount of more than seventy cubic meters of water.

Illustration 4.4: New public drinking-water well of Santa Cruz Papalutla

Public drinking-water is not directly transported from well to households within Santa Cruz Papalutla. First of all the water goes to a concrete *tanque elevado* (water tower). The purpose of this water tower is to have a reserve in times of water scarcity. But, a water tower also keeps sufficient water pressure within the network, making sure that even the most distant households are receiving water. The same type of drinking-water system as described for Santa Cruz Papalutla is also found within Santa María del Tule.

Map 4.2: Schematic visualisation of key water systems within and around Santa María del Tule (2004)



Based on fieldwork data and maps from INEGI

Although the method of water delivery in Santa María del Tule is the same as in Santa Cruz Papalutla, its network and systems are however more extensive and modern. The reason for this not only lays in the size of the village, but above all in the more intensive infrastructural investments. Paragraph 3.2 already described how more tourists were supposed to be drawn to the village in the nineteen-seventies and early eighties by

improving the infrastructure of the municipality. Not only the road network was about to be improved, attention was also given to its electricity network, telephone network, health infrastructure and water networks. Those investments were eventually regained by the indeed growing number of tourists and its resulting increase in local prosperity. Investments like those that were made in El Tule have not been made in Santa Cruz Papalutla due to its relative and absolute distance with the capital and due to its insignificant economy, which does not have the perspective to generate significant investments.

Of the six public water pumps within Santa María del Tule, only three are in operation these days (INEGI, 2004), which together deliver a daily average amount of 993 cubic meters of water to the three separate municipal drinking-water networks. Emanating from this volume, and the number of occupied houses with a drinking-water connection in the year 2000, it means that the average available water volume per occupied household lies around a 0.57 cubic meters. The same calculation for Santa Cruz Papalutla gives an average amount of 108 litres per occupied house. However, these numbers only can give some indication of the actual used water volumes, as they do not take into account the inefficiency of the water networks. But, the distorted picture is also caused by the characteristics of the local economies. Many households in Santa María del Tule do have their economic activities within the village, while a lot of activities in Santa Cruz Papalutla take place on its 'campo'. Statistics on water consumption in El Tule are therefore structurally higher than statistics from Santa Cruz Papalutla, as they include a substantial part of the water consumption for economic activities. In spite of those distortions, it can be concluded with great certainty that the total available amount of drinking-water for each household lays lower in Santa Cruz Papalutla than in Santa María del Tule.

Despite the higher availability of water within the within Santa María del Tule, are its volumes also declining. The increase in water insecurity has led to the construction of a seventh public water well and its adjoining water reservoir in 2004. The construction has been executed by a private building contractor in assignment of the local *ayuntamiento*. The new *pozo profundo* reaches more than fifty meters into the ground, and its pumps are operated on three times 220 volts to give it the power to extract an estimated daily average of five-hundred cubic meters (INEGI, 2004).

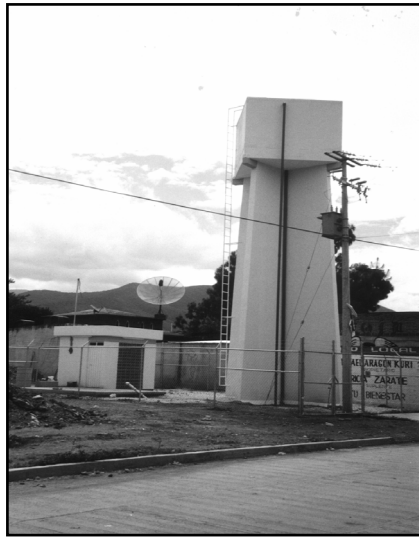


Illustration 4.5: New public drinking-water well of Santa María del Tule

The consumed water within both case municipalities is discharged without any preceding treatment. According to INEGI (2000), only 26 of the 397 ‘viviendas’ within Santa Cruz Papalutla had a *drenaje* (Tube system through which a household drains its sewage waters) to communal ground, a street, or a septic-tank. The remaining 371 households have their wastewater individually drained on their own premise. In contradiction to Santa Cruz Papalutla does Santa María del Tule have a municipal sewage system. Another distinct difference between the water infrastructure of both case municipalities is the appearance of household water reservoirs systems in Santa María del Tule. At the basis of such a system stands a *cisterna* (cistern). From advertisements in local newspapers, it becomes clear that the capacity of a cistern normally differs from 1.000 to 10.000 litres (the largest commercial cisterns do have a capacity of up to 15.000 litres). A small cistern can be bought from around one hundred and fifty Euros, climbing to around 1400 Euros for a ten thousand litre tank. The bigger the cistern the bigger the prestige of its users, since the increase in capacity means higher operational costs. However, the choice for a certain sized cistern is first of all made with the idea to increase water security. As the more wealthier households are found within Oaxaca de Juárez and Santa María del Tule, it is here were most cisterns can be seen. A second reason for its distribution is that the necessary quantity of water can only be provided by the public drinking-water network of urban areas or by private companies, who only settle in areas where sufficient sales are to be made (see box 4.2).

Box 4.2: Pipas de agua potable

Some fifty registered private water companies, within Oaxaca de Juárez and its immediate surrounding, do thrive on selling water (Sección amarilla, 2005). The transportation of this water is being done through *pipas de agua potable* (drinking-water trucks). *Pipas* come and go in different sizes, but the smallest water trucks carry three thousand litres of drinking-water up to ten thousand litres. Only a few trucks within the urban fields of Oaxaca de Juárez do have a capacity of more than ten thousand litres.

Each water company has its own price-table, but each price is far higher than those for water from the public network. Another aspect of the water prices, as charged by commercial water companies, is that they are more or less the same for each company, due to mutual competition. However, when ordering a *pipa*, customers must pay the whole water capacity of the truck, even when they do not want its whole content. One of those *pipa* companies is 'Agua Pure del Sureste'. This company has two price categories for drinking-water, with the first category accounting water from *pipas* with a capacity of four thousand litres or less. Buying water from those trucks means that a buyer must pay according to the ratio of 300 pesos to four thousand litres, which is the same as 0.0054 Euro per litre. Above four thousand litres a buyer pays the ratio of 500 pesos (€ 35,71) to ten thousand litres.



Illustration 4.6: 'pipa de agua potable'

Although *Pipas* do sell most of their water in the centre of Oaxaca de Juárez, they are also regularly seen in its marginal suburbs. Most inhabitants from those suburbs do rely for their water supply on those *pipas*, due to the absence of a public drinking-water network. The marginal households normally buy water by using buckets. Commercial water companies calculate a slightly higher price when filling buckets, as water delivery to the marginal is less profitable.

4.4 Conclusion

This chapter began with an overview of Mexican water management developments, which until the early nineteen-nineties can be characterised as mainly centralised, technocratic and urban biased. This has had significant consequences for water infrastructural developments within Santa Cruz Papalutla and Santa María del Tule. The rural position of Santa Cruz Papalutla within the Oaxacan urban fringe and the absence of an important economic sector has resulted in low infrastructural investments. On the other hand there were the relative high infrastructural investments within Santa María del Tule, due to the presence of a significant tourist sector. Those developments were mainly supported by the federal government in Oaxaca de Juárez, as investments within Santa María del Tule helped to strengthen the tourist sector of the capital. So, water infrastructural developments are closely related with the position of each municipality in the urban fringe. However, the economic crises of the nineteen-eighties abruptly halted all infrastructural investments. In regaining the confidence of investors, Mexico had to reform its economy and political sector. This eventually led amongst other to the introduction of decentralization and privatization within the Mexican water sector. Both processes were institutionalised with the federal ‘Law on National Waters’, in 1992. However, until this day it did not result in substantial improvements of the water security from those inhabiting the Oaxacan urban fringe, as the availability of water is still diminishing.

With the background information from chapter three and four it is now possible to get a better understanding of how and why the households of Santa Cruz Papalutla and Santa María del Tule do create certain water security strategies in relation to their position within the Oaxacan urban fringe. The next chapters will describe the results from the fieldwork data, beginning with those from forty survey respondents.

Chapter 5. Survey data from Santa Cruz Papalutla and Santa María del Tule

The interest of this chapter goes to the results from forty surveys that were taken within Santa Cruz Papalutla and Santa María del Tule. The development of this survey had two particular purposes. It was first of all developed with the intention to analyse the household water cultures within the two case municipalities and to compare those results with the position of those households within the urban fringe. Besides that, the survey has also been used as a database to select six households for a case study approach. This chapter will only pay attention to the first purpose.

5.1 Social-economic, resource and demographic characteristics

From the previous chapters it became clear that agriculture is the main source of income within Santa Cruz Papalutla. This fact corresponds with the statistics from the survey, as eighteen of the twenty responding households did cultivate agricultural land. This cultivation was mainly done on land to the west of the village as lower groundwater levels, lime rich depositions and the absence of since and salt does make it the most prevailing within the municipality. Four of the eighteen agricultural households did cultivate less than one hectare, ten cultivated in between one and three hectares and five did cultivate more than three hectares of which only one ‘campesino’ had more than five hectares to its availability. However, it is not uncommon that incomes from those plots are insufficient in supporting the household. Fifteen of the twenty respondents did apply income diversification within the village, while only six of them were commuters and/or knew at least one member within their household that commuted to Oaxaca de Juárez. The respondents from Santa Cruz Papalutla found it difficult to commute to the city, because they had no social contacts with people from the city. Contacts are very important in gaining work in the absence of employment offices. Households without those relatives or friends, are often further constrained by low schooling levels and limitations in transportation. The majority of people from Santa Cruz Papalutla does not own a car and are therefore confined to the possibilities of the public transportation system. Most older household members have another characteristic that reduces their will to work within the city. Their often traditional way of live is accompanied with

certain beliefs and habits that are absent in the 'outside world'. In their eyes this world is a danger to the local lifestyle of the community. They believe that Oaxaca de Juárez is equal to capitalism with its spoiling consumption, individuality and lack of respect for traditional values and standards. On the other hand the people from the city are negative about 'paisanos' (people from the countryside) and their lifestyles, which makes it even more difficult for them to encounter work within the city.

In contradiction to Santa Cruz Papalutla, did the majority of respondents from El Tule commute or had experience with commuters within their households. The shorter distance and higher public transportation frequency between El Tule and Oaxaca makes it easier to commute. But, there is also a higher percentage of inhabitants that have relatives or friends within the city, that joined higher levels of education, and who show more communality in lifestyles. It is therefore not surprising that agriculture is less prominent in El Tule. Eventually, nine of the twenty respondents said to cultivate land on less than three hectares. More prominent are incomes from the service sector of which the greatest share comes from local activities in the tourist industry.

Besides substantial differences in the economic and social life of both case municipalities, do they also have distinct demographic characteristics. Survey results underscore the fact that the average household from Santa Cruz Papalutla consist out of more members in comparison with households from El Tule. This higher average is explained by the relative traditional lifestyles of its households in comparison with those from El Tule. Large families are not only the standard within traditional communities, but they also secure its social-economic position and future retirement of the parents. The higher number is also related to the not yet fully accepted use of contraception. The demographic differentiation between the two case municipalities is further extended when examining the migration process. Considering the average low income-levels within Santa Cruz Papalutla, it is not strange to expect more emigration. However, the decision to migrate depends amongst others on the availability of sufficient financial resources to support the migration process. But, since most individuals within Santa Cruz Papalutla do not have the ability to gain those resources in a short period, the actual 2,9 per cent of the population that migrate is lower than the 4,8 per cent from El Tule (INEGI, 2000). One consequence of the higher percentage within El Tule is that there are less males inhabiting this municipality, as it are mostly males who migrate. Within El Tule 45,7 per cent of the population is male and 48,6 per cent within Santa Cruz Papalutla is male (INEGI, 2000).

5.2 Household water cultures

The first paragraph has described and analysed social-economic, resource and demographic variables of the respondents in relation to their position within the urban fringe. Those variables form the context in which a household negotiates a certain water security level which is translated through an unique water culture. Most household water cultures within Santa Cruz Papalutla have an important agricultural factor, as quite a lot water is needed for the cultivation of crops such as maize, alfalfa and garlic. Most of these agricultural products are grown on *tierra de riego*. Only two of the eighteen respondents that cultivated land, applied *tierra de humedad* besides *tierra de riego*. Those two plots are to be found at the north-western edge of the municipality, where water infiltration is difficult due to certain ground layers. The other sixteen peasantry-households declared to apply only for well-irrigation as ground water depths on other places within the municipality laid in between seven and twelve meters. All nine peasantry respondents from El Tule said to use only well-irrigation. None of them used the Río Salado as a water source. This is not strange because the river has cut itself deep into the valley thereby obstructing the application of canal-irrigation or *tierra de humedad*. As most plots within both case municipalities are irrigated, they are fed with water from wells. Four peasantries from Santa Cruz Papalutla extracted ground water with the use of electrical pumps, while nine applied only gasoline pumps and finally five respondents used both methods. Gasoline pumps are more common, because electrical water pumps are bound to a special electricity network that is not available to all peasants. However, the call for an extension of the electricity network is becoming stronger as increasing fuel costs make the use of gasoline pumps more expensive. In advance of a decision from the *comisariado de bienes comunales*, some peasants already tap electricity. The nine peasantries from El Tule are only able to utilize gasoline pumps. An electricity network is not present as its construction costs do not outweigh the expected exploitation results. The already high irrigation costs within El Tule are further raised by the use of more advanced gasoline pumps. A quick inquiry in the two case municipalities showed that most water pumps within Santa Cruz Papalutla are said to have the power to extract an average amount of five to fifty litres of ground water per minute, while water pumps within El Tule extract at least ten litres per minute rising to seventy litres. The higher water consumption on the countryside around El Tule is primarily a results of higher prosperity levels. This form of water security is not

very durable as the availability of water and its accessibility is being threatened by over exploitation of the municipal water resources.

There are other household related economic activities besides agriculture within Santa Cruz Papalutla and Santa María del Tule that influence a water culture. Four of the twenty respondents within El Tule came from a household that consumed more than two hundred litres each day within their 'comedor'. Tourists are the main source of income for those small restaurants and hygiene is an important aspect in attracting tourists. Their daily water consumption therefore lies between an estimated two hundred and forty, and three hundred and fifty litres. The only commercial activities within Santa Cruz Papalutla that consume quite a lot of water are the two cornflower mills and two tortillerias. The household related economic activities within both case municipalities are not only supplied with water from private water wells but also with water from the public drinking water network. The number of connections that a household has with the main water pipe is for a lot of people sensitive information, as they do not want to contribute for every extra connection they have with the public water system. Especially rural communities are reluctant to cooperate on this matter as they believe that all resources within their community belongs to them. The irony is that this believe was unconsciously stimulated by the government. Past infrastructural developments were especially directed to urban areas. At the same time the government did not give much attention to rural infrastructure, which led within those communities to the general way of thinking that the government was not interested in their development and resources. This has seriously lessened the preparedness of rural communities to accept enforced governmental contributions that are directed to the use of communal resources. It is therefore not so strange that the non-response in Santa Cruz Papalutla was structurally higher in comparison with El Tule.

Besides water from private and public wells there is also the possibility to buy purified water at local shops. This water is very important to a lot of households as it is the only water resource that they use for human consumption. From posters or meetings at the local health centres people from villages often learned that un-purified water can cause serious diseases. Purified water is sold in different compositions and different sized bottles. But, the price of the same purified water is not everywhere the same, as transportation costs are settled within the price. The costs of purified water therefore increase with the distance from Oaxaca de Juárez (see table 5.1). Despite its higher costs, nineteen respondents from Santa Cruz Papalutla did only drink and use purified

water in their kitchen. But, only eight respondents from El Tule did regularly drink or use purified water within the kitchen. The remaining twelve respondents from El Tule did not only stick to purified water but also consumed water from the public well, because they thought that the addition of chlorine made it safe for human consumption. The infrastructural developments of the nineteen eighties gave a lot of inhabitants the idea that public water had become equal to purified water.

Table 5.1: Prices of purified water bottles for Oaxaca de Juárez, Santa María del Tule and Santa Cruz Papalutla, in 2004 (\$/€)

Type of bottle	Oaxaca de Juárez	Santa María del Tule	Santa Cruz Papalutla
Garrafon	12/0,86	18/1,29	20/1,43
0,5 Litre bottle (Agua Ciel)	3,5/0,25	4,5/0,32	5/0,36

The daily amount of water that a household from one of the two case municipalities consumes does first of all depend on the availability of water. Households from El Tule do encounter less difficulties in their water supply. One way in which they secure water is through the installation of a reservoir system. In times of water shortages eleven respondents from El Tule were able to apply this system. Of the twenty respondents from Santa Cruz Papalutla there was only one with such a system as described above. Arguments that can be thought of why it is not common for these people to increase their security through a cistern are related with the high costs to purchase and operate the system. But, it is also not well accepted within the local community because it would only stimulate to consume much more water. In times of extensive drought the households from Santa Cruz Papalutla still rely on the sources they always used. When these times of extensive droughts occur a household from Santa Cruz Papalutla must sometimes take drastic measures in securing sufficient water. Most measures are directed to save as much water as possible, but there are also measures that are directed to gather as much water as possible. The first household activities on which water will be saved is on cleaning. All respondents within Santa Cruz Papalutla did tell that they first off all could not take any shower in times of water shortages. The next step in water savings inflicted the cleaning activities in the house and ultimately on the human consumption of water. Estimations about water savings were made between five and

twenty litres of water each day. With an estimated twenty to one hundred litres does this number lay higher in El Tule as the average higher water consumption means that there is also more water to be saved with each activity. But, it were also here the cleaning activities on which water was saved first. One cleaning activity within El Tule on which quite a lot of water is being saved is on cleaning the floor. An estimated twenty to three hundred litres of water are weekly being used by the seventeen respondents who did clean their floor. The highest consumptions were made by those who own a 'comedor'. At least one time each day are the floors of these small restaurants being cleaned. On the other hand there are far less households within Santa Cruz Papalutla that clean their floor with water, as it does to quickly become filthy again with the dust from the unpaved streets.

5.3 Conclusion

This chapter has investigated general water culture aspects of forty households within Santa Cruz Papalutla and Santa María del Tule in relation to their position in the urban fringe of Oaxaca de Juárez. The link between water culture and the position of a household in the urban fringe is primarily formed by the social-economic, resource and demographic variables of the household and secondly by its wider local context. Understanding a water culture means that knowledge about those variables, the local context and involved governmental and private actors is needed. Therefore this chapter began to analyse the social-economic, resource and demographic variables of the respondents. Paragraph two paid specific attention to the outcome of these variables on their water cultures. When combining the two paragraphs it is possible to understand the process in which the water cultures of the respondents are formed to a certain extent. However, for a more thorough knowledge of these processes we need to involve the wider context of each respondent. This wider context therefore runs as a red line throughout this chapter.

Both case municipalities show some striking mutual differences in their social-economic situation. Economic activities within El Tule are more diverse as its proximity to Oaxaca de Juárez and the appearance of a natural attraction has stimulated the development of a tourist sector. Examples of tourist related activities are small restaurants, traditional handcraft, retail shops, tourist guides, etc. To even further exploit the possibilities of the tourist sector within El Tule and thereby further strengthening the tourist sector of the capital, the federal government initiated infrastructural developments. Most El Tulians did take advantage of those developments as these developments initiated economic growth. The absence of a stimulating economic sector in Santa Cruz Papalutla is the cause for the lower prosperity of its inhabitants and the less developed water infrastructure. The most important economic activity within this village is a non-competitive agricultural sector. Some respondents did often find temporary work in other sectors within their village. But, raising income through commuting was found difficult as the isolated social position of the respondents within the urban fringe is an obstacle in finding work within the city of Oaxaca. The overall higher prosperity of El Tulians does give them more possibilities to secure the availability of water as well as its accessibility and entitlement to water. This eventually

is translated in the higher water consumption of the respondents within El Tule in comparison with those from Santa Cruz Papalutla. But, the water consumption statistics of Santa Cruz Papalutla does often not include agricultural water consumption. When including this economic activity, it are often these households who consume more water. A threat to the agricultural productivity and overall water consumption within Santa Cruz Papalutla are the falling ground water depths all around the village. Although the same happens in El Tule, ground water levels are still higher there. Another disadvantage for the households within Santa Cruz Papalutla is its average bigger size. The average smaller household within El Tule does mean that basic water needs are smaller than in Santa Cruz Papalutla. The isolated position of Santa Cruz Papalutla within the urban fringe does also translate to the relationship with the federal and national government. The two parties do have a very different vision on water security. The vision of the federal and national government is within Santa Cruz Papalutla seen as a threat to their water security in favour of the city its water security. The current situation does not seem to improve mutual co-operation.

Although the distinct difference between the water culture and water security of the two case municipalities, they both have a declining water availability in common. This also has negative consequences for the access and entitlement to water. Unless a drastic shift in water culture will take place, both case municipalities will sooner or later witness problems in the availability of basic water needs, as well as in its accessibility and entitlement to basic water needs, regardless their position within the urban fringe.

Chapter 6. Three case studies within Santa Cruz Papalutla

This chapter analyses three households from Santa Cruz Papalutla on a case studies approach. The goal of those case studies is to relate unique characteristics in water culture with the position of that household in its village and in the context of the urban fringe. Each case was carefully selected from the results of the foregoing survey round. Criteria for households to be included were based on mutual differences in their independent variables. The reason for these criteria was to create a condition that allowed encountering as many water culture aspects as possible. All of the three spokesmen in Santa Cruz Papalutla were males, since they were the head of the household. Nonetheless, two of the three interviews were taken in the presence of other household members. The presence of female members was especially valuable for the purpose of this phase, as it gave an insight of the gender influence on water culture.

The analysis of each household will begin with a matrix that mentions the independent variables of the household water security model, as well as characteristics of the water culture. Each household will then be further analysed in terms of unique water cultural characteristics.

6.1 The López family; high and reliable income

Demographic structure of the household

	Men (age)	Women (age)
Head of the household	39	35
Children	18*, 14	16
Daughter in law		17*

Economic and resource characteristics of the household

Available land for cultivation	4,5 Ha. (67% irrigated)
Regular income resources	Agriculture (maize and alfalfa), migration (remittances) and pharmacy (drinking-water, drinks and food).
Irregular income resources	Construction work, selling prepared meals within the village

Water culture characteristics of the household

Number of wells in use	4**
Number of taps on premise	1
Cisternas	-
Tinacos	1 (750 litres)
Average daily water consumption on the premise	300 litres***

* Married

** Three wells are shared with other 'campesinos'

(see also table 6.1)

*** Estimation

The spokesman of the López household is the thirty-nine year old señor Pedro López³. He and his wife (thirty-five years old señora Liliana Garza de López) have three children of which the eldest is the eighteen years old Marco, who has recently married María Sánchez de López. The other two children of the family are sixteen years old Lucia and fourteen years old Giovanni.

³ The names in these case studies have been changed for privacy reasons.

The households does derive its incomes mainly from its agricultural activities and its privately owned pharmacy. Agricultural incomes are made in the summer, when some part of the maize and alfalfa is being sold. The incomes from these products are an estimated seventy per cent of the total incomes during the harvest season. Outside the agricultural season the household mainly leans on incomes from the pharmacy and remittances. When incomes from these sources are below average, señor Pedro and his familie are able to derive income from construction work or from selling prepared food within the village. Together, these sources give the López family a relative high and stable income in comparison with other households from within the village. Reliable and high incomes has made it possible to construct a semi-sewage system that leads *aguas negras* outside the premise, as well as an own reservoir system, and a bathroom complete with a shower and a toilet with flush water.

Table 6.1: Wells in use with the López household

Well number	Accessory agricultural plot size (Ha.)*	Well depth 2004 in (meters)**	Construction material of the shaft	Average ground water table during the dry season of 2003/2004 (meters)**	Average ground water table during the wet season of 2003 (meters)**	Method used to extract water out of the well	Pump capacity in wet season (litres per minute)**
1	1,0	8,0	No used material	10,0	7,0	Gasoline pump	25,0
2	1,0	12,0	Concrete shuttering	10,0	7,0	Gasoline pump	20,0
3	2,0	12,0	Concrete shuttering	10,0	7,0	Gasoline pump	20,0
4	0,5	15,0	Concrete shuttering	10,0	7,0	Electrical pump	50,0

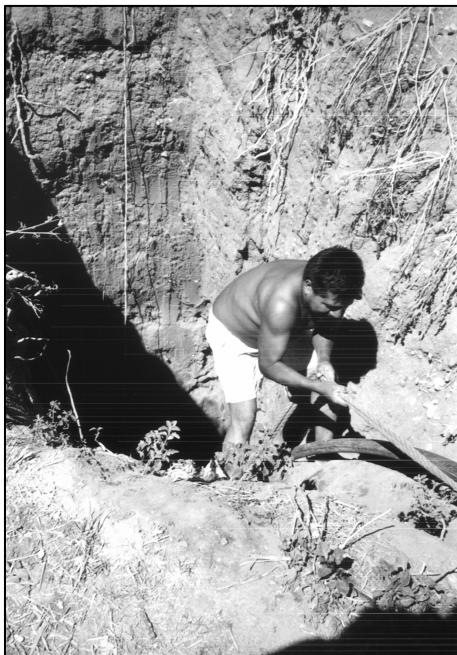
* All land officially belongs to the ayuntamiento, including the wells.

** Estimations

Within the López household, most water in the summer is used for growing crops. For its agricultural activity the family has five land-units with a total surface of 4,5 hectares (2,8 hectares is the average plot size within Santa Cruz Papalutla against 2,6 within El Tule) to the west of the ‘cabecera’ (main settlement). Two units lay fallow while the other three units are divided in two units of each one hectare and one unit of half a

hectare. The latest field is used for the production of commercialised alfalfa. The water to support its production is being delivered by one of the in total four wells that are used to secure the overall agricultural production of the family. This first well, which measures a depth of fifteen meters, is even deep enough for the continuing supply of water during the dry season. The same *pozo* is shared with three other ‘campesinos’, with señor Pedro being the first person who is responsible for its exploitation, as the well is placed on the land which he cultivates⁴.

A drop in the agricultural water supply is the most dramatic events for the the López household. Unfortunately are these events regular during the first few weeks of the wet-season and during mid-summer or locally called *canícula* (hot dry period in midsummer). It is especially in those times that the young agricultural crops need sufficient water to secure maximum yield. In increasing agricultural water security, a peasant is able to apply certain strategies. A first example is the maintenance of water infrastructure to secure its efficiency. But, the maintenance of the irrigation system and its wells is being managed by the *comisariado de bienes comunales*, which often passes this work to a ‘jornaleros’ (day labourer). These people are eventually paid by those who use the well. Continuing shaft maintenance throughout the past decades has increased the average well depth within Santa Cruz Papalutla from around seven meters



to an average ten meters. Other examples of water security maximization are the use of more powerful water-pumps that are able to supply more water and from deeper depths, and the cultivation of products that consume less water. Water security for agricultural purposes can also be gained by increasing the accessibility to water. Examples in this matter are the exploitation of more than one well, as well as establishing supportive mutual relationships with fellow users, the *comisariado de bienes comunales* and the local *ayuntamiento*.

6.1: Well maintenance

⁴ All land within the municipality officially is being rented from the *comisariado de bienes comunales*.

The water consumption on the premise of the López family is served by one connection with the main water pipe. Water from this connection is not used as a source for drinking-water since the members of the household drink purified water from *garrafones* or other sized bottles. The López household replaces each emptied *garrafone* on an average of once in every three days from their own drinking-water stock within the pharmacy. The yield from selling water bottles is very limited as contractors do claim a great percentage of those yields. The negotiation position of the López family in this regard is limited as there are many other ‘negocios comerciales’ that are selling purified water. The stock of purified water within the López pharmacy is supplied by two contractors from Oaxaca de Juárez. One contractor delivers and collects twice a week the *garrafones*, and another contractor delivers smaller water bottles with a content of one and a half, and half a litre of purified water. The household makes an average profit of 150 pesos a week by selling *garrafones*. However, the actual yield amounts five-hundred pesos, which means that three hundred and fifty pesos must be paid to the contractor. Yields from the two other types of bottles are more fluctuating, as their yield is influenced by weather conditions. During dry and hot periods the yield climbs to an estimated amount of eight hundred pesos each week, against an average of 460 pesos per week during cooler conditions. After the contractor has collected its share of the profit an average of four-hundred and two-hundred pesos respectively, remains for the López family.

Comparing the López household with the average household from Santa Cruz Papalutla, it is striking that its economic activities gives the household enough financial resources to secure sufficient water for the agricultural production and for its demand on the premise, all year round. This relative strong position is also translates to its possibility to use a *tinaco*, resulting in a daily average water consumption of 50 litres per person.

6.2 The Nuñez family; a poor household

<i>Demographic characteristics of the household</i>		
	Men (age)	Women (age)
Head of the household	41	40
Children	18	23*, 20*, 16
<i>Economic and resource characteristics of the household</i>		
Available land for cultivation	2,0 Ha. (60% irrigated)	
Regular income resources	Agriculture (maize), cestería, migration (remittances)	
<i>Water culture characteristics of the household</i>		
Number of wells in use	1	
Number of taps on premise	1	
Cisternas	-	
Tinacos	-	
Average daily water consumption on the premise	120 litres**	

* Married

** Estimation

At the head of the Nuñez household stands señor Crispín Nuñez and his wife señora Josefina Arrazola de Nuñez. They are parents of four children who are all older than the age of fifteen. The youngest of the four is daughter Rosanna, who is consecutively being followed by her brother Andy, and her married sisters Mariana and Chalida. The premise of Nuñez household is quite empty. The small old house of the family is made out of *adobe* (sun-dried brick out of clayey mud with remainders of vegetation and small gravel) and wood. Besides the house, the premise accommodates amongst others a fence of cactuses, some small trees, small cattle, and an open air toilet and sink at the back of the premise.

The Nuñez household earns income through the cultivation of maize and production of baskets. Besides those activities it receives remittances from their emigrated sons-in-law. The agricultural monoculture of the household is based on a total of two hectares, of which 0,8 hectare lies currently fallow. The remaining 1,2 hectares are separated in

two plots, of which one measures 0,8 hectares. The costs to irrigate the 1,2 hectares are relatively high as the Nuñez household needs to purchase expensive gasoline for the operation of their pump, which has a capacity of only fifteen litres per minute. The water for the 1,2 hectares must come from the one well that the family has to its availability. The shaft of the well has a depth of ten meters and the absence of an expensive concrete shuttering asks for regular maintenance as erosion reduces its efficiency. In finding a better way to increase the availability of water, señor Crispín Nuñez is negotiating with an alliance of three peasants and the local *comisariado de bienes comunales* to gain well exploitation rights in return for the services of the household. In the contrary to the current well of the Nuñez household, the new well will have a concrete shuttering and a profound depth that will secure the supply of water even in periods of extensive droughts.

Within the house of the Nuñez family there is one tap that is connected to the communal drinking-water network. Although the water of this network is not save enough to secure the health of its consumers, the household members consume it. The family knows that the consumption of this water bears a certain health risk, but they also think that it is not life-threatening. To them does the safety of purified water not outweigh the low costs of water from the public network. The only precaution they take in minimizing health risks is by boiling all water before consuming it. An estimated amount of only twenty litres per day is being consumed from the public network by each individual household member, which includes cleaning activities. Note here that this and other numbers on household water consumption are estimations, due to the absence of water meters in both case municipalities. The low consumption in the case of the Nuñez family is said to be the result of the absence of a shower and a flush on the toilet. But, fact is that they do not possess the sources to consume more water than they already consume. “Our perspectives on water security look grim” is after all the thought of señor Crispín on its agricultural water security. On the one hand he is sure that within a short period of time he will have secured the access to a second well, but on the other hand he worries that even this well will become insufficient within ten years from now. Unlike many other inhabitants in Santa Cruz Papalutla señor Crispín does not see a solution in increasing maintenance of each well: “The rate in which each well is running dry or is becoming insufficient, is to high too speak of a secured future”.

The Nuñez household is one of the poorer household within Santa Cruz Papalutla. This position is first of all characterised by the fact that all family members are active in the income strategy of the household. Secondly, these members do not receive substantial incomes from a diverse range of economic activities. The loss of one financial source can not be substituted by another financial source. Its economic weakness does translate in the few opportunities that the Nuñez household has in negotiating sufficient water security for its agricultural production. To somewhat secure a regular water supply during the agricultural season the family does save money that will give them the opportunity to buy water from other peasants. Another water saving strategy, which is uncommon in Santa Cruz Papalutla, is the conducting of rain water to a water-cask. But, again like most households in Santa Cruz Papalutla does the Nuñez household not use flush water for its toilet. These and other water saving measures are still sufficient to make water shortages bearable within the Nuñez household.

6.3 The Hernández family; an extended family

<i>Demographic characteristics of the household</i>		
	Men (age)	Women (age)
Grandparents	62	63
Head of the household	34	32
Children	13, 11	8
<i>Economic and resource characteristics of the household</i>		
Available land for cultivation	3,2 Ha. (31% irrigated)	
Regular income resources	Agriculture (maize, garlic and alfalfa), construction work	
<i>Water culture characteristics of the household</i>		
Number of wells in use	2*	
Number of taps on premise	2	
Cisternas	-	
Tinacos	-	
Average daily water consumption on the premise	175 litres**	

* One well shared with other 'campesinos'

(see also table 6.2)

** Estimation

The last interviewed household within Santa Cruz Papalutla is the Hernández family. Its seven members live in two separate houses on one premise, which are mainly constructed out of wood and *adobe*. The spokesman of this extended family is the thirty-four year old Señor Luís Hernández. Luís is father of three children and husband to señora María Sánchez de Hernández. The remaining two members of this family are the parents of María, who live in the second house. Although being an extended family, the two units can be seen as one household, as each of its members is closely interlinked with each other in the creation of daily livelihood strategies. This connection becomes apparent when focusing on the economic activities of the household.

The economy of the Hernández household is primarily based on agriculture. But, outside the agricultural season señor Luís works in the construction sector that delivers

him work throughout the Tlacolula Valley. The three children of señor Luís are still too young to be fully active within the income strategy of the household. Only the thirteen years old Manuel Hernández is regular seen with his farther on the agricultural fields. The younger brother of Manuel will join them next year for the first time. Señora María sometimes helps his husband during the harvest, but she is mainly active on the premise in taking care of her children and parents.

By paying a certain contribution to the local *comisariado de bienes comunales* the Hernández household has been given access to 3,2 hectares of communal ground, of which actually 2,2 hectares is currently being cultivated. The contract between señor Luís and the *comisariado* also includes irrigation rights, which must be shared with two other peasants. In return señor Luís has the obligation to cash a certain percentage of its yield to the *comisariado*. Lately, a dispute about the amount of extracted water per peasant has disturbed the mutual relationship between Luís and each of the other two peasants. This did not stay unnoticed by the *comisariado de bienes comunales*. The Hernández household now runs the risk of losing its cultivation rights. An exclusion from this land would also mean the loss of two water wells that are especially valuable to the household in times of extensive droughts, when these wells are the only water source for the household. But, even now does one well not provide enough water to fulfil all the water needs of the family. So far, water scarcity occurred for several times outside the agricultural season. Señor Luís is afraid that this will sooner or later happen, as periods of extensive droughts are no longer a phenomenon of the dry season.

Table 6.2: Wells in use with the Hernández household

Well number	Accessory agricultural plot size (Ha.)*	Well depth in 2004 (meters)**	Construction material of the shaft	Average ground water table during the dry season of 2003/2004 (meters)**	Average ground water table as during the wet season of 2003 (meters)**	Method used to extract water out of the well	Pump capacity in wet season (litres per minute)**
1	2,2	15,0	Concrete shuttering	9,0	6,0	Gasoline pump	40,0
2	1,0	12,0	Concrete shuttering	10,0	7,0	Electrical pump	40,0

* As all the land officially belongs to the ayuntamiento, the wells are also their property

** Estimations

Each member of the Hernández household consumes a daily average of twenty-five litres of water. The provision of water on the premise is arranged by two connections with the communal drinking water network. The first tap was constructed at the end of the nineteen eighties when most of the houses within the village got their own connection with the main water pipe. Today this tap stands at the back of the premise together beside a sink. It is the place where the younger members of the household wash themselves and where señora María washes cloths and cleans the dishes. The second water tap was constructed within the house of the grandparents to make their lives more comfortable. Having two water taps also means that the household must contribute an additional ten pesos to the local 'comité de agua potable y alcantarillado'. But, according to señor Luís: "...this price is very low when compared to water prices within the capital, because the government does have more saying there". The low water price from the public network is also one of the main reasons why the members of the Hernández household are drinking it, after it is boiled. Señor Luís admits that water from the public network is not the cleanest in the world, but he does not see why it should be a risk to his health and that of his family. "The addition of chlorine will prevent us from getting any disease". The same water is also used to feed an extended collection of small cattle, which comprises three turkeys, two donkeys, four pigs, six chickens and a rooster. Together they consume an average of twenty litres from the public water network each day.

Like the Nuñez household does the Hernández family not have much sources of income and are its primary incomes derived from agricultural activities. Those primary incomes are mostly made by señor Luís, while the children of the family are beginning to become involved in the income strategy of the household. The Hernández household has currently access to two wells, but the price to use both wells is relatively high compared with their income strategy. A second disadvantage of one of the well is that it does not deliver enough water during the dry season to support the family. To make things worse, the Hernández family does run the risk of losing its irrigation rights as a result of a dispute with other peasants and the *comisariado de bienes comunales*. The water security of the Hernández household can therefore be indicated as fragile.

6.4 Conclusion

This chapter has analysed three households from Santa Cruz Papalutla and their water cultural aspects. Each household was chosen from the data, as gathered in the preliminary survey phase. The important criteria for being chosen as a case was that the characteristics of the household pointed to mutual diversification in water cultural aspects. The analysis within this and the next chapter are paying special attention to the unique water culture and water security characteristics of the selected households, as well as common aspects since its outcomes are being influenced by the position of a household within the urban fringe of Oaxaca de Juárez.

In accordance with the characteristics of Santa Cruz Papalutla was agriculture an important or not the most important source of income of the three households. However, agriculture alone is not sufficient enough in supporting the livelihood strategies of each household. Income diversification and the inclusion of as much man power in the income strategy as possible are measures that a household can apply in raising its incomes. Closely bound to the income strategy is the water culture and water security of a household. A first characteristic of a typical water culture within Santa Cruz Papalutla is that it shows an agricultural component and a component that is related to household activities. The agricultural production of a household is secured with water from wells that lay on the fields and are often shared with other peasants. Declining ground water levels around Santa Cruz Papalutla are making it increasingly more difficult to gain sufficient water. But, the availability of water is not the only problem that peasants face. Another obstacle is the access and entitlement to wells. The higher the economic prosperity of a household the better change it has to develop this entitlement and access. However, the Nuñez and Hernández household showed that the development of creative solutions can somehow enlighten the lack of financial resources. When concerning the agricultural component there is the possibility to create social capital within the community through which water security can be negotiated. Especially in this case are the mutual relationships with other peasants and the *comisariado de bienes comunales* important. But, then again is social capital often arranged with the help of financial resources. A second option lies in the choice to cultivate certain crops that do not consume much water (*zacate* maize instead of maize for human consumption, etc.).

Concerning the water security on the premise, water saving methods are the most important strategies that can be applied without using financial sources. Most other water security strategies make use of financial sources. For example the use of a 'tinaco', the construction and maintenance of a well, buying water, etc. In the end are those with the least financial resources victims as they relatively pay more for a lower quantity and quality of water. Two examples in this respect are those households who consume water from a well or the public water network instead of purified water. Secondly, the Nuñez and Hernández household make relative high costs to secure their access to a well that is known to be unreliable in its water supply.

These and other examples show that the water culture and water security of a household is the product of its own social-economic, resource and demographic context, its local context (including its position within the urban fringe) and a product from actors on federal and national level. Influences that do come from outside the municipality are thought to stability of local water security. Especially influences from the federal and national government are in this respect seen as not welcome within Santa Cruz Papalutla. It is therefore not strange to note that households from this village have developed quite different water cultures, in comparison with the city of Oaxaca. How does this apply for Santa María del Tule?

Chapter 7. Three case studies within Santa María del Tule

7.1 The García family; an extended family

<i>Demographic characteristics of the household</i>		
	Men (age)	Women (age)
Grandparent		55
Head of the household	27	26
Children	4	2
<i>Economic and resource characteristics of the household</i>		
Available land for cultivation	-	
Regular income resources	Pharmacy, teaching	
<i>Water culture characteristics of the household</i>		
Number of wells in use	-	
Number of taps on premise	2*	
Cisterna	1 (5.000 litres)	
Tinaco	1 (1.000 litres)	
Average daily water consumption on the premise	350 litres**	

* Including the shower

** Estimation

Next to the Zócalo and the mighty old tree of El Tule stands the house and pharmacy of the García family. Señor Miguel García forms the head of the household with his wife señora Rosaria Rosalez de García. They are the parents of two children of four and two years old. The oldest member of the household is the fifty-five year old widow señora Chalida Modesto de García who has been living with her eldest son and family since 1999. Her husband (señor Pedro García) died in 1999 due to the complications from 'dengue'. Miguel works as an English teacher in a secondary school in Oaxaca de Juárez, while Rosaria works in their own pharmacy. The incomes from those economic activities have made it possible to construct their two storey house/pharmacy out of

concrete and bricks. Another striking difference in this aspect is that the floor within the house is made of concrete.

The absence of an agricultural based livelihood-strategy does result in a distinct different water culture in comparison with a typical household from Santa Cruz Papalutla. To secure sufficient water on the premise the García households does not have the access to a well, like the three households of the previous chapter. However, the García household does compensate the absence of this back-up system by another reservoir system. Like many others in El Tule does the García household own a cistern. The household has recently replaced its old 2.500 litres cistern with a five-thousand litres cistern, which has considerably extended its water availability during droughts. Since the cistern itself is supplied with water from the public network, water levels within it need to be constantly sufficient, as the supply is especially unregular in the dry season. If water is becoming scarce a household can adapt its water consumption culture. Again, this normally means postponing of certain activities, such as cleaning the floor. The concrete floor within the house/pharmacy of the García family is daily being cleaned with water. In the contrary to Santa Cruz Papalutla is this ritual not uncommon in Santa María del Tule. Up to an estimated amount of one hundred and fifty litres of water is being spend each week by cleaning the floor in the house/pharmacy of the García household. Even more water can be saved with the shower. Each household member does normally take a shower every day, thereby consuming an estimated fifty litres per person. Also the toilet within the García house works with water from the public network. Average water consumption on the toilet is being estimated on ten litres each day per person.

Alike the López household in Santa Cruz Papalutla does the García household derive its drinking-water from its own pharmacy. However, there are some substantial differences between the purified water component of both 'negocios'. The García household does have a much wider selection of purified water bottles and its turnovers are also much higher. The higher turnovers make it possible to ask lower prices for purified water in comparison with those from Santa Cruz Papalutla (see table 5.1). Exact figures on turnovers made by the García household were not given, but they are estimated at fifteen hundred pesos each week for *garrafones*. Yields from smaller bottles are especially high during the summer when sales are boosted by the climate and the tourist high season. Estimations run from twelve hundred pesos to fourteen hundred pesos each

week during the summer, while sales during the winter months lay between a thousand pesos and twelve hundred pesos each week.

In spite of the fact that the availability of water, as well as the accessibility and entitlement to water seems to be higher el Tule from this first interview, there are some worries about the future water security situation of the García household. A steady decline in water availability has been noticed by señor Miguel, who remarks that the quality of the water has also worsened as a result of increased economic activity around the village and due to the absence of a clean garbage culture and purification station. Miguel and his wife are for sure that the local 'organismos operadores' do not have the financial resources and legislative possibilities to solve the increasing problems in local water shortages and its worsening quality. Chalida adds that solutions only can be found on higher governmental levels, as problems in water quantity and quality do not only occur within Santa María del Tule, but throughout the entire Central Valleys.

7.2 The Flores family; no income diversity

Demographic characteristics of the household

	Men (age)	Women (age)
Head of the household		38*
Children		21, 18

Economic and resource characteristics of the household

Available land for cultivation	-
Regular income resources	Comedor (small restaurant)

Water culture characteristics of the household

Number of wells in use	-
Number of taps on premise	1
Cisterna	1 (5.000 litres)
Tinaco	1 (500 litres)
Average daily water consumption on the premise	240 litres**

* Divorced

** Estimation

A few blocks from the García household, and still in the tourist centre of el Tule, lives señora Flor Flores with her two daughters Anna and Vianney. Flor moved from Tlacolula to El Tule in 1996 after she had divorced from her husband. With the help of some family members she began a ‘comedor’ in the tourist centre of Santa María del Tule. After a difficult start, in which Flor had to take care of here young children, and at the same time earn an income from the restaurant, she eventually made the business profitable when her daughters began to help within the ‘comedor’. Anna started to work in the small restaurant after she had finished the secondary school, in 1999. Vianney followed in 2003, when she got her diploma from the secondary school.

Water expenditures and security within this household are largely based on the ‘comedor’. The activities within the small restaurant and the living part (which are both placed underneath the same roof) are supplied by water from one connection with the local public water network. The greater part of the water consumption by the Flores

household is made within the comedor. To serve the activities within the small restaurant, señora Flor has recently replaced a 2.800 litres cistern by a new one, which has a capacity of five-thousand litres. The purchase of a new cistern was partially financed with money from family members, since the cistern could not be bought alone. Estimated water consumption on cleaning activities in the household are estimated around a daily seventy litres. Most of this water is used within the 'comedor' to clean its floor, vegetables and the dishes. The average water consumption of each member within the Flores household lies around an estimated daily eighty litres, which lays well higher than the estimated average fifty litres within the village. The economic activity of Flor and her two daughters has been appointed by the local *ayuntamiento* as a 'negocio comercial'. The consequence is that Flor needs to pay twenty pesos each month instead of ten pesos for its connection with the public water network.

As said before did the Flor witness a difficult financial start in El Tule, resulting in marginal levels of water availability, accessibility and entitlement. "In the beginning I regularly went with my daughters to the Río Salado to get water for our activities within the house and the comedor. But, of course we did not drink it, because everybody already knew that this water was polluted." In reaction to the question if Flor was the only one who had collected water from the river, she said that it used to be common for other inhabitants to do the same. "I have been told that they used to get their water (including drinking-water) from the Río Salado, streams, and from their own wells. But, with the developments that took place some twenty to twenty-five years ago, most of today's houses got a tap that were connected to the public water infrastructure". Señora Flor did refer here to the infrastructural developments of the nineteen-eighties, which were largely sponsored by the federal government. Through the stimulation of local infrastructural developments more tourists were expected to visit El Tule. Before these infrastructural developments were being made, it was not uncommon for inhabitants to extract water from all kinds of sources, as not all households were connected to the public infrastructure. One respondent told with disgust: "I know for sure that people used to steal water from our well.... I am not the only one who witnessed this, as there are more well owners who will tell you the same". Another respondent came with the remarkable story that even after the infrastructural improvements of the early eighties, some households used to collect water from the monumental fountain on the *Zócalo*, as these persons did not want to pay for public water. This illegal custom only ended when

local 'topiles' (policemen) caught some inhabitants and had put them in the local 'cárcel' (jail). Those stories do not stand on their own as widespread water conflicts used to create tensions amongst the inhabitants of El Tule. Those tensions are related with the infrastructural developments of the eighties when local peasants were afraid that the construction of new public water wells would undermine ground water levels in underneath their plots. But this water related problem was not the only bottleneck that caused tension within the municipality. Some peasants and households were angry, because their land was expropriation for infrastructural developments. Tensions eventually led to the outbreak of some armed violence in the late nineteen seventies and continued to the beginning of the nineteen nineties. Only since the local *ayuntamiento* and state government directly interfered with those conflicts, did most conflicts ceased. Most of those disturbances did the Flores family not witness, but this does not mean that water right conflicts do not exist anymore. Señora Flor for example is afraid that in the near future she will not be able to provide herself and her daughters with sufficient water, as water costs and expenditures are rising. For an overall better future it would be better if her eldest daughter is going to marry, because this would give Flor and her daughters access to more financial resources, as well as other water sources. Until that time does the sufficient availability of water, as well as its accessibility and entitlement depend on the willingness of family-members and friends and on incomes from the 'comedor' to support the Flores household.

7.3 The Morales family; an agricultural orientated household

Demographic characteristics of the household

	Men (age)	Women (age)
Head of the household	44	42
Children	22*, 16	19, 16
Daughter in law		21*

Economic and resource characteristics of the household

Available land for cultivation	2.6 Ha. (63% irrigated)
Regular income resources	Sale of garlic, sale of alfalfa, sale of beans, sale of handcraft (cestos), sale of reed, migration

Water culture characteristics of the household

Number of wells in use	2**
Number of taps on premise	-
Cisterna	-
Tinaco	-
Average daily water consumption on the premise	70 litres***

* Married

** Both wells shared with other 'campesinos'

(see also table 6.1)

*** Estimation

The last of the in-depth interviews was taken on an agricultural/directed household. Father Leonardo Morales and his wife Lucia Alvarador de Morales have built their income strategies around the traditions that they inherited from their parents. The Morales side has always been active in the production of ceramics and product from 'carrizo' (reed). On the other side there is the Alvarador family who are traditionally active in the production of agricultural products. Those specializations are all being applied within the income strategy of the Morales household, as the productivity diversification does give it the opportunity to maximize incomes and minimize the risk of not gaining sufficient income. Although this strategy can not be applied by the poorest households (Druiven, 1990), the prosperity level of Morales household does

not stand far from a poor family. In increasing the purchase power of the household, the eldest son of Leonardo and Lucia has emigrated since several years to the United States of America from where he regularly sends money to support his parents and wife.

The average land size owned or borrowed by a peasant from Santa María del Tule is 2.6 hectares, which is a little less than the 2.8 hectares in Santa Cruz Papalutla, as agriculture within El Tule is more directed towards the cultivation of fruits. Of the 2.6 hectares of agricultural land as owned by the Morales family, 1.6 hectares were cultivated in 2004. Six-thousand cubic meter of land is being used for the production of beans, while two plots of each 0.3 hectare are being used for the cultivation of alfalfa and garlic, while the remaining 0.4 hectare is used for the cultivation of squash. All product do need a regular supply of water. Until the beginning of the nineteen-nineties señor Leonardo had the opportunity to extract water from a communal water tank to ensure this supply. This reservoir (which is still placed on a hilltop just south from the village) is out of service these days, as a falling water supply made its use insufficient. The Morales family was planning for the construction of a private well. But, at first its construction was not allowed by the local *comisariado de bienes comunales*, as both parties could not agree on the owning status of this well. Eventually its construction took place, but only after señor Leonardo had agreed to share exploitation rights with certain peasants. The construction of the well has mainly been financed by the Morales (who still own most exploitation rights), as well as the three other users and the *comisariado*. Its location besides the Río Salado ensures sufficient water all year round. The second well that is used by the Morales, supplies water to 0.6 hectare for the cultivation of beans. The production of beans takes place on the hills in front of the southern edge of the valley. The higher altitude also results in lower groundwater levels.

Table 7.1: Wells of the Morales household

Well number	Accessory agricultural plot size (Ha.)	Well depth in 2004 (meters)**	Construction material of the shaft	Average ground water table during dry season of 2003/2004 (meters)**	Average ground water table during wet season of 2003 (meters)**	Method used for getting water out of the well	Pump capacity in wet season (litres per minute)**
1	0,6	12,0	No material used	11,0	9,0	Gasoline pump	20,0
2	1,0	10,0	Concrete shuttering	7,0	5,0	Gasoline pump	20,0

* As all the land officially belongs to the ayuntamiento, the wells are also their property.

** Estimations

In the absence of a connection with the public water network are the water needs on the premise supplied with water from the new well. The second well does not have the capability to supply water during the dry season. Water accessibility in the summer is sometimes easy as the household uses river water from the Río Salado, for the washing of clothes and dishes, as a source to clean the house, as a drinking-water source for the animals, and as a bath for each of its members. The increasing water pollution has not changed the habit of the household to use the water from the river. According to señor Leonardo: “This water can not be bad for our health, only if we consume it. But, my family does not bath in the river, or wash its cloths with this water if the water is heavily polluted. The local government gave us no other option but to use the water from the river, while they could have easily prevented this from happening”. When the Morales had constructed their house in 1981, it was placed some fifty meters outside the village and from the communal water infrastructure. Lately, the extensions of El Tule have reached the edge of the Morales household, but water infrastructure was not extended to their premise, this in spite of the fact that señor Leonardo did urge the *ayuntamiento* and the ‘comité de agua potable y alcantarillado’ for several times to extend the public water network to their premise. Until today there has not been undertaken any action in this matter, which has led to great frustrations with Leonardo.

7.4 Conclusion

This last regular chapter has analysed the last three case studies of this research. Three households from Santa María del Tule were chosen to gather data on their household water security strategies. Like the ones within Santa Cruz Papalutla, the households in Santa María del Tule were chosen on mutual differences in independent variables.

Unlike in Santa Cruz Papalutla is agriculture not the most important employer in El Tule. Two of the three households within this chapter derived their primary income from another sector than agriculture. But, even those two households did not earn enough from one economic activity alone. Income diversification is therefore also a common used income strategy within El Tule. Somewhat different is the inclusion of all family members within this strategy. In Santa Cruz Papalutla it is common that every member is involved in the income strategy of that household if he or she has the ability to do so. This is a result of the average lower prosperity within Santa Cruz Papalutla. The average higher prosperity within El Tule does permit to apply less resources. More children therefore have the ability to join primary and secondary school, that results in better perspectives for their own future.

As a result of the different economy and higher prosperity levels are the average household water cultures and water security levels within El Tule different from those in Santa Cruz Papalutla. Households without agricultural activities do often not have high economic water consumption patterns. However, one of the interviewed households did show a relative high economic water consumption as it used water for cleaning activities within its 'comedor'. But, for the most part does the average household within El Tule consume lesser water on economic activities. As most households do not own land they do not have instant access to this type of water resource. The only source to which they have instant access is to the public water network. However, to enlarge its water security most households within El Tule substitute a well for their own water reservoir system. The use of this system is however only reachable for those who have a sufficient income to purchase, maintain and use it. The poorer households still rely on the same strategies as used within Santa Cruz Papalutla (social capital, use of a well, etc.). Nonetheless is the accessibility of water within El Tule higher because the average ground water level underneath the municipality is higher in comparison with Santa Cruz

Papalutla. On the other hand, the availability of clean water is also declining in El Tule, due to a higher water retraction than supply of water and because a lot of water is polluted.

The difference in water infrastructure is remarkable when comparing both case municipalities. In contradiction to Santa Cruz Papalutla, relative large investments have been made to develop the infrastructure of El Tule. Those investments were the result of federal interference within the village, which is first of all quite difficult within a traditional community such as Santa Cruz Papalutla. The attention of the government itself was based on the proximity of the municipality to Oaxaca de Juárez and on the appearance of a tourist attraction that could stimulate tourism within the capital when being further developed. The positive influence of these investments is still felt today as the infrastructure results in better availability, access and entitlement of most households to water.

Chapter 8. Conclusion

The main objective of this research was to analyse the households water security within Santa Cruz Papalutla and Santa María del Tule in relation to their position within the urban fringe of Oaxaca de Juárez. The investigation was done in the context of the Household Water Security Model as adapted from a model with the same name developed by Webb and Iskandarani. The HWSM pays particular attention to the wider context of the household. In developing a water culture and water security strategy a household is influenced by developments on local and national level. Within this research the national level is made out of the Mexican government with its water policy and the private sector in Mexico. The local level is the urban fringe including the two case municipalities and the capital of Oaxaca. In understanding water security strategies, information is amongst others needed on the social-economic, resource and demographic characteristics of the two case municipalities and their households in relation to the urban fringe.

The position of el Tule within the urban fringe is more urban orientated in comparison to Santa Cruz Papalutla. This does amongst others result in the lower importance of agriculture within its boundary, higher levels of infrastructural development, higher levels of education and a society with a lifestyle that has more similarities with an urban lifestyle than a rural lifestyle. On the other hand there is the more rural orientated municipality of Santa Cruz Papalutla. Agriculture is within this village more important, infrastructure is far less developed and the community is known as traditional and difficult to penetrate for outsiders. The more dynamic El Tule also shows turbulent developments in its number of inhabitants. The influence of the nearby capital on the lifestyles within El Tule is shown through the demographic characteristics of the village. In comparison with the average household size in Santa Cruz Papalutla is the average household from El Tule more similar in size and composition with the average household from the capital.

The physical context of the two case municipalities is more or less the same. The research area is known as semi-arid, meaning low levels of unregular precipitation and a high evaporation. Overall ground water levels are therefore low throughout the urban fringe. There are only a few places where water infiltration is difficult, due to the groundstructure. The most important difference between both case municipalities within

the physical context, are the higher average ground water levels underneath El Tule. The average ground water level within El Tule lies at a depth of seven meters while it ranges from seven to twelve meters in Santa Cruz Papalutla. Note here that these ground water levels are averages from within the wet period, ground water levels within the winter are even lower. Furthermore, the possibility for agricultural activity within the urban fringe is limited due to a thin layer of fertile land, which is highly sensitive to erosion. The availability of water, accessibility and entitlement to water, largely depend on those characteristics as described above. The resulting household water cultures and security strategies are an answer to the possibilities and constraints of those characteristics.

Due to the importance of agriculture within Santa Cruz Papalutla, the average household water culture has an important agricultural component. Water for agricultural activity is normally secured through the access to one or more irrigation wells. This resource is not only used for economic purposes. In times of water supply failures by the public drinking water network, a household can still rely on water from those wells. But, sometimes even these wells do not provide sufficient water to support a household in its daily activities. Water can then be secured through social capital, or through sufficient purchasing power. However, average prosperity levels within Santa Cruz Papalutla are not high enough that they allow for water to be bought in securing the agricultural activities of a household. The low prosperity is further translated through the absence of a well developed individual and public water infrastructure. The village has one public water system based on a network from the nineteen seventies. Maintenance or further expansion of this network are not feasible as the local *ayuntamiento* does not have the financial resources to support those activities. The water infrastructure on most premises is very primitive in contrast to households from El Tule (it is not uncommon to have an own water reservoir system that is based on a cistern, with an average capacity from 5000 litres). The higher prosperity of El Tule was mainly stimulated by the development of the local tourist sector in the nineteen eighties, that was largely stimulated with investments from the federal government. The spin off from those investments not only increased local live standards, but also local infrastructural standards. Water infrastructure within El Tule is as a result younger and extensive in comparison with Santa Cruz Papalutla. The better part of this infrastructure can be found in the centre of the village where most investments were made around the central 'Árbol del Tule', for which El Tule is famous with tourists. The higher

prosperity, and better developed and maintained water infrastructure in El Tule has led to higher levels of water consumption for household related activities. But, it is estimated that when including economic activities the average household water consumption within Santa Cruz Papalutla lays higher, due to the inclusion of agricultural water consumption. However, more research is needed for specific statistics on this matter.

As had been shown with the water infrastructural developments of the nineteen eighties in El Tule, the government does also have a significant position that influence the water security and water cultures of households. Water policy forms the basis through which the government is trying to reach water security for all its inhabitants. Mexican water policy is characterised as centralized, technocratic, and urban biased. The development of national water policy lays in the hands of the CNA. This policy is subsequently guided to lower levels of water management organisations. Local traditional and/or indigenous communities are characterised by their relative autonomous water management organisations, as a result of past developments in mutual understanding between the government and these communities. The developed isolated position of those communities means that the federal and national government do not have a strong hold on the water policy of those communities. But on the other way around, local water management organisations find it hard to create their desired water security, as governmental support for its water policy is hard to gain. The relation between the national and federal water management organisations with their antithesis in El Tule is based on more mutual understanding, as the position of El Tule within the urban fringe has resulted in a more intense and mainly friendly relationship with the capital and the federal government.

The economic crisis of the late nineteen seventies and early nineteen eighties had consequences for Mexican water policy and its organisation. International organisations pressured for the decentralisation and privatization of the Mexican water sector in return for financial aid. Although institutional reforms were made to allow for controlled privatization, there are only a few players on the Mexican water market, which together only hold a small share of the market. The water market within Oaxaca is mainly limited to so called 'pipas de agua potable' companies and the market for purified water bottles. The area of distribution for purified water bottles can be found throughout the state, but the market for water from 'pipas de agua potable' is only limited to larger nucleus. Both types of water markets have the characteristic that its prices increase with

the distance from the central area of distribution. Especially those more rural positioned areas do have less purchasing power to buy this water.

A last purpose of this research was to develop a household water security categorization based on the social-economic, resource and demographic variables of a household. As has been described throughout the previous chapters and in this conclusion are both case municipalities quite different from each other in these variables. It also became clear that the position within the urban fringe of Oaxaca de Juárez indeed correlates with the differences in water security of the two villages. A categorization within this research can therefore be based on the differences between the two case municipalities as had been describes above. However, this categorization is only based on the two case municipalities and it is quite straight forward. Degradations in this categorization are possible as the households of the two case municipalities had shown. The given categorization therefore only fits within the context of this research, but nonetheless is should give an indication on which future categorizations can be based.

A last note within this research is that the difficulties for Santa Cruz Papalutla and its households to secure the availability, access and entitlement to water to support its livelihood strategy are more apparent in comparison with the average household from El Tule. But, it must be said that the water extraction en culture within both municipalities are not durable enough to secure future water needs. In this respect it is valuable to start research in predicting the future of water security in the case municipalities and their households in relation to their position within the urban fringe. Another interesting and important subject for future household water security research is to investigate what strategies are achievable to confront the increasing problems in the availability, accessibility and entitlement to water in the urban fringe of Oaxaca de Juárez. When finding solutions, special attention must be given to the relationship of a household within its wider context. This research paid particular attention to this wider context in the form of the urban fringe. The researcher hopes that the results from this research will contribute to a better understanding of water security processes within the urban fringe, and that this research eventually will stimulate the development of a durable water culture for future generations.

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