Drinking Water Practices in Amazonian Peru: Exploring the Link between Perceived and Actual Drinking Water Quality

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Declaration

I hereby certify that this work is my own, except where otherwise acknowledged, and it has not been submitted for a degree at this or any other university.

Abstract

Perceived drinking water quality is a factor known to cause the failure of drinking water schemes in developing countries. This leads to the loss of health benefits which are the main aims of such schemes. This thesis examines the relationship between perceived and actual drinking water quality and the factors which feed into perceived drinking water quality in a developing countries context.

A mixed methodology approach was used which included the use of the following methods: a questionnaire (*n=96*), participant observations, interviews, a media study, analysis of other texts, sanitary surveys, and analysis of source (2006 *n=32*, 2007 *n=70*) and household (2006 *n=58*, 2007 *n=91*) water samples for thermotolerant coliforms, chlorine, pH, turbidity and colour.

The drinking water situation was found to be more complex than originally thought and drinking water practices were found to be supply driven. The quality of water at the source had little influence on the quality of water drunk in the household, as water was becoming contaminated during collection and in the home.

Household water managers prioritised the importance of the different water sanitation and hygiene interventions as the water situation changed, but the rating of drinking water quality remained consistent and was rated as the most important intervention in both periods. The factors that were associated with perceived drinking water quality significantly changed from 2006 to 2007, but the importance of perceived drinking water quality remained consistent. Therefore the factors that influenced the perception of drinking water quality were not fixed and were responsive to changes in the water situation in the community. A surprising relationship was found between perceived and actual drinking water quality, which can be attributed to chlorine being associated with ‘good’ drinking water.

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List of abbreviations

AI	Asset Index
BOT	Build operate and transfer
CFU	Colony Forming Units
CV	Cramer's V
DNA	Deoxyribonucleic Acid
EPA	Environmental Protection Agency from USA
EPS	Empresas Prestadoras de Servicios
JBIC	Japan Bank for International Cooperation
GAD	Gender and Development
GDP	Gross Domestic Product
HQI	Housing Quality Index
KAP	Knowledge Attitudes and Practices
KTC	Kendall's Tau c
MDG(s)	Millennium Development Goal(s)
mgl^{-1}	Milligram per Litre
MWU	Mann Whitney U
n	sample size
NTU	Nepthelometric Turbidity Units
ODT	Odour Detection Threshold
PCA	Principal Component Analysis
PSP	Private Sector Participation
RQ	Research Question
S/.	Nuevo Sole
SD	Standard Deviation
SODIS	Solar Disinfection
ST	Sign Test
SUNASS	Superintendecia Nacional de Servicios de Saneamiento
TCU	True Colour Units
UK£	UK pound
UN	United Nations
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
US$	US Dollar
USA	United States of America
WASH	Water, Sanitation and Hygiene
WHO	World Health Organisation
WID	Women in Development
WSR	Wilcoxon Signed-Rank Test
WTP	WillingTo Pay
ϕ	Phi
χ	Chi
p	Probability

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Chapter One: Introduction

Although it is rarely acknowledged, perceived drinking water quality is more important than actual drinking water quality (Foltz, 1999; McGuire, 1995; Sheat, 1992). This is because the only way a person can determine drinking water quality is through how the water looks, tastes and smells, and these judgements feed into our assessment of perceived drinking water quality (Dietrich, 2006; Singh, 2006; Tomboullan et al., 2004; Euzen, 2003; Owen et al., 1999; McGuire, 1995). A number of other factors have been found which contribute to our perception of drinking water quality. They include; knowledge of the source (Jones *et al.,* 2007; Doria, 2006; Levallois *et al.,* 1999; Owen *et al.,* 1999a), information on drinking water quality(Celik and Muhammetoglu, 2008; Aini *et al.,* 2007; Jones *et al.,*2007; Contu *et al.,* 2005; Johnson, 2003; Owen *et al.,* 1999a), trust in information (Johnston and Scicchitano, 2000; Jardine *et al.,* 1999; Owen *et al.,* 1999a), trust in supplier (Doria, 2006; Jones *et al.,* 2006; Contu *et al.,* 2005; Strang, 2005; Euzen, 2003; Johnson, 2003; Owen *et al.,* 1999a), past experiences (Dietrich, 2006; Euzen, 2003; Um *et al.,* 2002), economic status (Andreson *et al.,* 2007; Doria, 2006; Turgeon *et al.,* 2004) and health concerns or risk (Aini *et al.,* 2007; Lou *et al.,* 2007; Doria, 2006; Jones *et al.,* 2006; Jardine *et al.,* 1999; Jardine and Hrudey, 1999; Levallois *et al.,* 1999).

When water is perceived to be unsafe adverting behaviour is observed, a person either further treats the water before consumption or chooses to use a completely different water source for drinking. (Celik and Muhammetoglu, 2008; Aini *et al.,* 2007; Jones *et al.,* 2007; Lou *et al.,* 2007; Doria, 2006; Jones *et al.,* 2006; Um *et al.,* 2002; Foltz, 1999) Adverting behaviour in developed countries has been linked to the increased consumption of bottled water (Foltz, 1999). More importantly in the developing world, which contains 80% of the world's population (UNDP, 2007) and where 16% of these people lack access to safe water (WHO/UNICEF, 2008), perceived drinking water quality has been linked to the failure of drinking water improvement projects (Katsi *et al.,* 2007; Singh, 2006; Biswas *et al.,* 2005; Moser *et al.,* 2005; Rainey and Harding, 2005; Allgood, 2004). Failure in this context occurs when the safe water produced is not used for the purpose of drinking or cooking. Therefore the aim of producing clean drinking water is not fulfilled and the health effects of the project are lost. The studies quoted are thought to be the tip of the iceberg as such schemes are rarely evaluated in the public domain (Singh, 2006; Prokopy, 2005). Another important factor is that perception of drinking water quality plays a vital role in the choice of drinking water sources in developing countries, even when sources are perceived to be limited (Herbst *et al.,* 2009; Singh, 2006; Biswas *et al.,* 2005; Nyong and Kanaroglou, 2001).

Surprisingly the perception of drinking water quality has not been studied in any depth in a developing countries context and in developed countries research has mainly focused on perception of drinking water quality in relation to customer relations and choice of products (Foltz, 1999; Owen *et al.,* 1999b; Owen *et al.,* 1999a; Sheat, 1992).

Water cannot be explored outside of its context, it is a flow resource which interacts with many things such as people, technology, economy, governments, and other aspects of the environment, at many different levels (Bakker, 2007; Strang, 2005; Mose, 2003). Because of these complicated interactions, any focus on water must be explored in the contexts of the wider debates generated by these interactions. This also infers that drinking water quality cannot be explored in isolation, but must be studied in the context of where it occurs. This research is situated in the nexus between environmental engineering, human geography and development studies and addresses the call for engineers to become inter-disciplinarians so that they can adopt more appropriate engineering approaches.

1.0 Case study area

The community of Bellavista Nanay was chosen for this study as it was reported that people were choosing their drinking water source due to perceived drinking water quality (Plumb, 2004) and strong links were established with the Gatekeeper prior to the study. The Gatekeeper described a situation where the people had three water sources: river water, rain water and municipally supplied water. People were choosing to drink river water as they did not like the taste of the municipally supplied water (Plumb, 2004).

1.0.1 Peru

Bellavista Nanay is situated 5 km from the city of Iquitos in the Department of Loreto in the north east of Peru.

Peru has a population of 28 million (Instituto Nacional de Estadistica e Informatica, 2008). Two official languages are spoken, Spanish and Quechua (which is generally spoken in the highland areas), although a large number of other indigenous languages are spoken throughout the country, especially in the Amazon. There are three distinct geographical regions in Peru: the coastal desert, the Andean highlands and the Amazon rainforest. It is divided into 25 Departments, Loreto where the case study area is situated being the biggest. Loreto occupies nearly one-fourth of the land mass of Peru and it is estimated that between 57% and 79% of the population of Loreto live in the urban areas of Iquitos and Nauta (Ministero de Economia y Finazas, 2006; Hubbard *et al.,* 2005).

Peru is classified as a lower-middle-income country using the World Bank's classification[1]. Among Latin America and Caribbean countries (11 in total), Peru is ranked 6th using the Human Development Index, Purchasing Power Parity and the Gini coefficient (Soares *et al.,* 2002). Poverty indicators and social statistics for Peru can be found in Table 1.1.

Table 1.1: Poverty indicators and social statistics for Peru and Loreto

Socioeconomic indicator	**Peru** (WHO/UNICEF, 2006)	**Loreto** (Ministero de Economia y Finazas, 2006)
Urban population (% of total population)	70	57
Life expectancy at birth (years)	70	65
Infant mortality (per 1,000 live births)	24	56
Child malnutrition (% of children under 5)	7	-
Access to an improved water source (% of total population)	81	-
Population below the national poverty line (% of total population)	52	63
Literacy (% of population age 15+)	88	92

[1] World Bank data accessed 2008, low-middle-income country is one which has a GNI of US $906 - $3,595

According to the World Bank (2007), 81% of Peru's population has access to an improved water source[2] while 62% of the population has access to improved sanitation (World Bank, 2007; Furukawa, 2005). This data disguises the disparities in the water and sanitation situation in Peru: 92% of the urban population has access to improved drinking water sources compared to only 63% of the rural population (WHO/UNICEF, 2008; Soares *et al.,* 2002). Access to piped water in Peru has been found to be dependent on income, while 100% of the richest people in Peru receive piped water, only 22% of the poorest have this provision (UNDP, 2006).

The cost of drinking water in terms of total household expenditure varies from rural to urban populations and with economic status. As seen in many other countries, low income households generally pay more for their water and in Peru it is the low income urban households (such as those in Bellavista Nanay) that pay disproportionally more, as demonstrated in Table 1.2.

Table 1.2: Peruvian household expenditure on drinking water (Soares *et al.,* 2002)

	Urban (% household expenditure)	Rural (% household expenditure)
Low income	4.2	1.7
High income	1.6	0.8

In Peru water treatment plants and their administration are in the hands of 55 companies known as Empresas Prestadoras de Servicios (EPSs) (*Service Providing Companies*). The EPSs are incorporated into the 44 municipalities and are run on a standalone basis (Coordinadora and Humanos, 2005; Furukawa, 2005). The water and sanitation sector in Peru is publicly owned. There are presently no examples of private sector participation (PSP) in the water and sanitation sector. Until recently the government and population were not eager for the introduction of PSP, due to the civil uprising that was sparked by the privatisation of the

[2] An improved water source is a household connection, public standpipe, borehole, protected dug well, protected spring or rain water collection. WHO/UNICEF. (2008) 'Progress on drinking water and sanitation: Special focus on sanitation '.

electricity company in Arequipa in 2002 (Furukawa, 2005). The World Bank is introducing PSP as a strategy for the development of the water and sanitation sectors in Peru (Furukawa, 2005).

1.0.2 The city of Iquitos

Iquitos has a low altitude at only 120 metres above sea level and is situated 3° south of the Equator (73°W, 3°S) (Roshanravan *et al.,* 2003). It is surrounded by the rivers Nanay and Itaya which are tributaries of the river Amazon (Fujita et al., 2005). Iquitos has a tropical climate: rainfall averages 288cm/year; temperature ranges from 21.8 to 31.6°C and the humidity is persistency above 87% (Johnson *et al.,* 2004; Guarda *et al.,* 1999). There are two seasons; rainy season (November to May) and dry season (June to October) (Guarda *et al.,* 1999), although these months vary the driest months are June through to September (Anon., 2003). During the rainy season the level of the river Amazon and its tributaries rise 10 meters due to the rain falling on the Andes, this causes localised flooding in this area (Guarda *et al.,* 1999).

Iquitos has a population of approximately 400,000 people (Johnson *et al.,* 2004; Roshanravan *et al.,* 2003) and is physically isolated from the rest of Peru, it is the largest city in the world that cannot be accessed by road. The transport links to the other parts of Peru are maintained by air or water, and it is the most populous city in the Amazon rainforest. It was established by Jesuit missionaries in 1750 and developed into a city during the rubber boom in the early 20th century. The economy of Iquitos crashed after the Second World War, due to the farming of rubber in other countries. A second boom period occurred in the 1960s when oil was discovered, which led to the development of the modern city seen today.

Today Iquitos is a centre for tourists wishing to explore the Amazon basin and for shipping. The city's economy relies on small commercial enterprises, fishing, oil, lumber and to some extent agriculture (Roshanravan *et al.,* 2003; Guarda *et al.,* 1999). As seen in Figure 1.1 the city is divided into four administrative districts; Iquitos, Punchana, Belen and San Juan.

Areas of Iquitos such as Belen have been identified as being areas of extreme poverty (Casapia *et al.,* 2007). In Table 1.1 it can be seen that Iquitos has a lower socioeconomic status than Peru in general, with the exception of higher literacy rates. A five level poverty strata was developed by the Ministerio de Salad in Peru (Ministry of Health) and using this classification this area was classified as being in the fourth level, level five being the poorest (Huynen *et al.,* 2005).

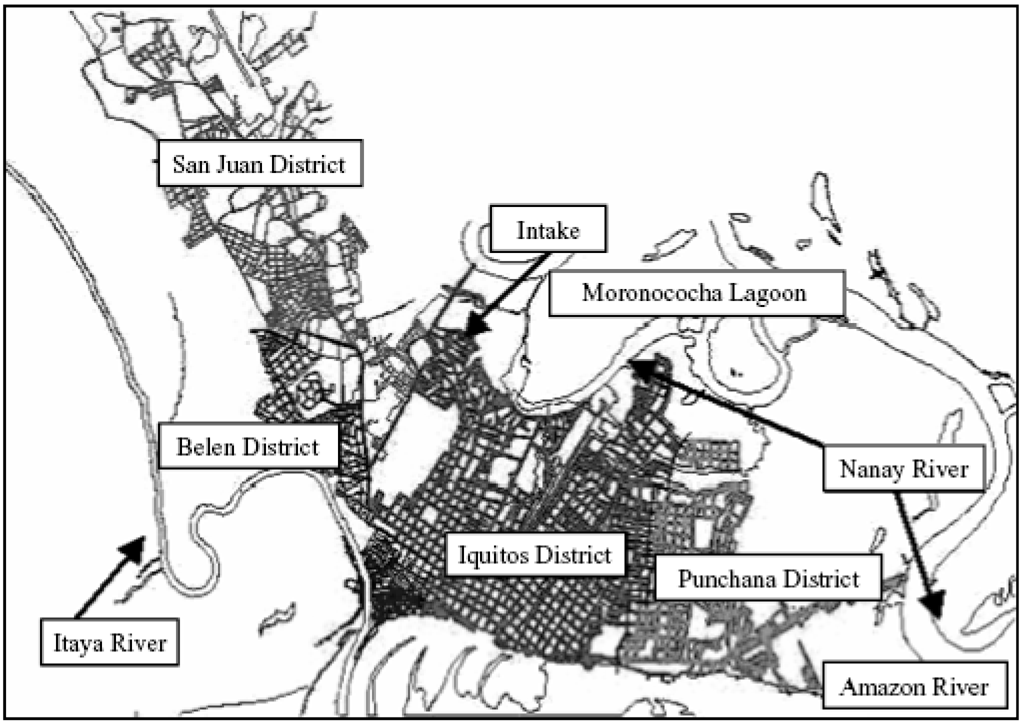

Figure 1.1: Conceptual diagram of Iquitos
(Fujita *et al.,* 2005)

EPS Sedaloreto S.A. is in charge of the water and sanitation sector in Iquitos. They have one water treatment plant, which consist of coagulation, settling, filtration and chlorination (Tickner and Gouveia-Vigeant, 2005), situated in the district of San Juan (Figure 1.1). No wastewater treatment plant exists in Iquitos. Wastewater is discharged untreated to surrounding waters and due to the topography most of the city's sewage flows into the Nanay river (Fujita *et al.,* 2005).

The water and sanitation coverage and service is lower than the national average, as seen in Table 1.3. The water service across the city is not equitable, due to the design of the distribution system (Tickner and Gouveia-Vigeant, 2005). Only a limited pressure can be maintained in the water distribution system, this means that areas close to the drinking water treatment plant receiving 24 hours a day water service, but the service decreases as you move away from the treatment plant (Fujita *et al.,* 2005; Tickner and Gouveia-Vigeant, 2005). A lack of water in the distribution system allows for infiltration of contaminated ground water and raw sewage due to the lack of sewers (Tickner and Gouveia-Vigeant, 2005). The residents of Iquitos have access to drinking water from household taps (50%), public standpipes or wells (33%) and directly from the river (18%) (Tickner and Gouveia-Vigeant, 2005). The average cost of municipally treated water in Iquitos was S/. 20.81[3] and the average sanitation tariff was S/. 6.48[4] per month (Furukawa, 2005).

Table 1.3: Evaluation of Peruvian and Loretan water utilities (Furukawa, 2005)

	National Average	Loretan Average
Water coverage (%)	83	61
Service quality of supply (average hours per day)	17	15
Sanitation coverage (%)	75	55
Unaccounted for water (%)	45	63
Collection ratio (%)	77	55

After the studies of Furukawa and Fujita in 2005 and the change in the perception of PSP in this sector, the Japan Bank for International Cooperation (JBIC) entered into a build operate and transfer (BOT)[5] contract with EPS SedaLoreto S.A. in 2007. This included the modernisation of the drinking water treatment plant and infrastructure causing disruption in the water service and disturbance of the infrastructure throughout the city in 2007.

[3] Approximately £3.12 using the exchange rate of S/. 1 = £0.15

[4] Approximately £0.97 using the exchange rate of S/. 1 = £0.15

[5] A build, operate and transfer contract is a private company constructs water and sanitation facilities with its own finances, operates them for a certain period of time and subsequently transfers the ownership to the public entity.

Water related diseases are prevalent in Iquitos due the climate, landscape and water practices. Malaria and dengue fever are endemic in the city due to its geographical location and the need for water storage in households (Morrison *et al.,* 2006; Morrison *et al.,* 2004a; Morrison *et al.,* 2004b; Schneider *et al.,* 2004; Getis *et al.,* 2003; Roshanravan *et al.,* 2003; Schoeler *et al.,* 2003; Guarda *et al.,* 1999; Hayes *et al.,* 1996). Malaria transmission was found to be seasonal in this region, with peaks in transmission in the rainy season (Guarda *et al.,* 1999). Other water related diseases which are rife include; bacteriological and protozoan diarrhoea (Jones *et al.,* 2004), hepatitis, leptospirosis (Johnson *et al.,* 2004) and yellow fever (WHO, 2007).

Iquitos also has a recent history of water related epidemics. The cholera pandemic of 1991 lasted a year longer in Iquitos compared to other parts of Peru, due to the water inlet for the drinking water treatment plant (Figure 1.1) being downstream of the hospital waste outlet and the lack of wastewater treatment (Tickner and Gouveia-Vigeant, 2005). During the Malaria epidemic of 1997 cases increase 50-fold within Loreto and most of those cases occurred in Iquitos (Guarda *et al.,* 1999).

1.0.3 Bellavista Nanay

Bellavista Nanay is a peri-urban settlement situated 5 km north of the city centre of Iquitos, in the district of Punchana (Figure 1.1). The settlement is situated on a peninsula and along Avenida la Marina on the banks of the River Nanay. This is the river that the wastewater from the city of Iquitos drains into (Fujita et al., 2005). During the rainy season the river rises approximately 10 meters and much of the surrounding land is flooded. As a coping strategy the houses in the small streets either side of Avenida la Marina are built on stilts. A small port is situated at the north end of Bellavista Nanay, where boat taxis can be taken to smaller river communities.

The settlement was founded in the 1960s[6] and the population was thought to be approximately 4,000 (Plumb, 2004) (this is discussed further in Section 4.1). Little data was available on this community, although it is well established and people have land tenure. It

[6] Data supplied by two of the respondents and verified by the Gatekeeper

was not officially found on any maps (including the service map at EPS Sedaloreto S.A.) and official data only existed at district level i.e. Punchana. Therefore, there was the need to collect baseline data on subjects such as housing, socio-demographics and water, sanitation and hygiene (WASH) before the specific issues can be explored.

As in the rest of Iquitos water related diseases impact on daily life in Bellavista Nanay, due to lack of adequate sanitation and wastewater treatment, drinking water practices, climate and landscape. Malaria is endemic to this area as Bellavista Nanay lies in one of the two high transmission zones for this disease (Guarda *et al.,* 1999).

As stated earlier three water sources were identified by the Gatekeeper in this community; river water, rain water and municipally supplied water. Households that are connected to the municipal supply will only receive two to three hours of service a day, as Bellavista Nanay is situated in the area which receives the lowest level of service in Iquitos (Fujita *et al.,* 2005). The water supply situation changed dramatically in 2007 when the municipal water supply in Iquitos was being upgraded. The municipal piped water supply to Bellavista Nanay was terminated in April 2007, it was not reinstated during this the field work period which ended in December 2007.

1.0.4 Political perspective

Alan García's campaign "Agua Para Todos" (*Water For All*) brought water into the political limelight in 2006 (Republica, 2006), but as with many Latin American countries, Peru has had a turbulent political history. After a period of military dictatorship spanning 1948 to 1979, democracy was re-installed with the election of President Fernando Belaúnde Terry in 1980. In the 1980s to 1990s Belaúnde's and then García's policies during his first period in office (1986-1990) destabilised the economy causing hyper inflation (BBC, 2008). The increased social tension which ensued caused terrorist activities of the Shining Path and Túpac Amaru Revolutionary Movement to increase. These organisations had strongholds in the Amazon, where this study is focused.

When Fujimori come to power in 1990, there was widespread opposition to his economic reforms, which led to congress being dissolved in 1992. After this, he revised the constitution and implemented substantial economic reform which included the privatisation of numerous state owned companies, but the reforms lacked support. During his stay in office, terrorist campaigns raged in the countryside, including the Amazon region. He cracked down on terrorist groups and eventually captured the leader of the Shining Path. During this time, atrocities and human rights violations were committed on both sides. Fujimori won a controversial third term in office, but stepped down after a bribery scandal in 2000. He then fled to Japan to avoid being prosecuted for human rights violations, but was eventually extradited in 2007. He was convicted of human rights abuses in 2009 (BBC, 2009).

Alejandro Toledo took office after Fujimori in 2001, but he and his cabinet faced a number of personal scandals, on top of civil unrest due to dissatisfaction over wages and pay, which led to his downfall in 2006. 2006 saw the re-election of Alan García as the president of Peru.

The political situation in Peru encroached on this study in many ways. The researcher entered Peru in 2006 on the eve of the general election and due to predicted political unrest left Lima the following day for Iquitos. She was in the country while the extradition of Fujimori was being sought and was there to witness his return in 2007. The media in this period was dominated by Fujimori's trail. Also while she was staying in Bellavista Nanay, the trial of Ollanta Humala (another presidential candidate in the 2007 election) was being partly heard in Iquitos. This had special relevance for the region where this study was undertaken, as during his military career he was stationed in Iquitos and alleged atrocities where undertaken close to the study area. This led to the researcher's field work being terminated slightly earlier than planned in 2007.

1.1 Aim, Objectives and Research Questions

The aim of this thesis is to investigate the link between perceived and actual drinking water quality in Bellavista Nanay. To do this an understanding of drinking water practices is required. From this the following overarching research questions were devised:

- *What factors are related to the perception of drinking water quality in Bellavista Nanay?*

- *Do people know how safe/dirty or clean/unclean their drinking water is?*
- *Is perceived drinking water quality linked to actual drinking water quality?*

Before the above research questions can be answered the following additional questions need to be addressed:

- *What is the current water and sanitation situation in Bellavista Nanay?*
- *What is the current drinking water quality in Bellavista Nanay*

By addressing these questions the researcher can also reflect on the approaches and methods used, their appropriateness and transferability.

An understanding of the perception of drinking water quality is vital for the success of drinking water schemes, yet very little research has been undertaken in this area. Reflections will be made on the possible use of the chosen methods and approaches in different environmental contexts.

The specific objectives devised to explore the above research questions are:

1. To gather baseline information on the community and drinking water practices
2. To quantify the physicochemical and biological drinking water quality of the drinking water sources available to the community
3. To quantify the physicochemical and biological quality of participants' household drinking water
4. To survey the community on its perception of drinking water quality
5. To investigate the relationship between the actual drinking water quality and the participants perceived drinking water quality

A hypothesised model of the factors that feed into perceived drinking water quality and how they are related to each other can be seen in Figure 1.2. This was derived from the work of Doria *et al., (*2005) and other authors who have explored the perception of drinking water quality in different contexts. This is explored in Section 2.3.1.

The thesis explores the factors and interactions shown in Figure 1.2. It is hypothesised that people can ascertain actual (microbiological) drinking water quality through physicochemical water quality as aesthetic quality changes. This together with perceived risk (formed from knowledge and experience) and perceived contextual indicators feed into perceived drinking water quality. Perceived drinking water quality, not actual drinking water quality, affects behaviour and drinking water practices. All of these factors must be considered in the context where they exist, including the socioeconomic setting.

Seasonality has been shown to effect drinking water practices (Herbst *et al.,* 2009; Katsi *et al.,* 2007; Hoque *et al.,* 2006; Machingambi and Manzungu, 2003; Nyong and Kanaroglou, 2001) and drinking water quality (Hoque *et al.,* 2006; Giannoulis *et al.,* 2003; Howard and Bartram, 2003; Gelinas *et al.,* 1996). As both of these aspects interact with perceived drinking water quality data was collected in both the dry (June and July 2006) and rainy season (September to December 2007). Changes due to seasonality could then be determined and a more holistic insight into the drinking water practices and the perception of drinking water quality in Bellavista Nanay could be gained. Hence throughout this thesis a comparison of the two data sets are made.

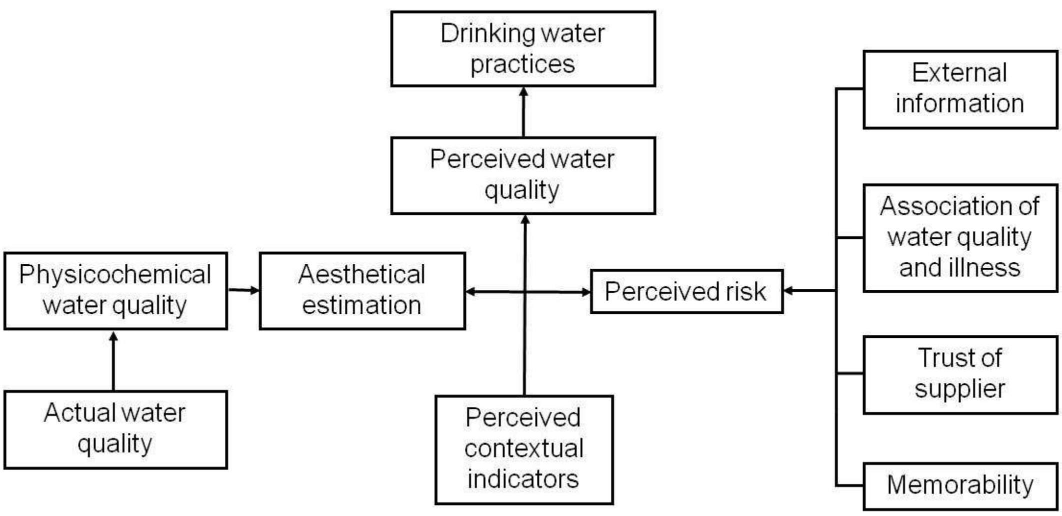

Figure 1.2: Hypothesised relationship between actual and perceived drinking water quality

Adapted from Doria *et al.,* 2005

1.2 Structure of Thesis

Following from this chapter, Chapter 2 reviews the literature which sets the context of this research and its direction. The inter-disciplinary aspects of the thesis can be seen in this chapter as it draws on literature from many different disciplines. Although perception of drinking water quality is the main theme of this thesis, this chapter also engages with the wider debates surrounding actual drinking water quality and water in general.

In Chapter 3 a general discussion on approaches can be found, as this thesis is interdisciplinary it will have a multidisciplinary audience. This leads on to a justification of the mixed methodology approach used. Methods are discussed and those used are presented together with how they address specific research questions. The use of questionnaires and the development of the questionnaire used are discussed. In this chapter the researcher's positionality is also explored

The empirical analysis starts in Chapter 4 which gives an overview of the community and the water, sanitation and hygiene situation, as drinking water quality cannot be investigated out of context. Drinking water practices are then explored in Chapter 5 as they critically affect drinking water quality. Chapter 6 focuses on the actual drinking water quality at source and household level. The microbiological and physicochemical results are presented in this chapter. The external influences on perceived drinking water quality are explored in Chapter 7 as they were identified as possible influences on perceived drinking water quality in Chapter 2. In this chapter many of these factors were ruled out of the subsequent discussion in Chapter 8. This leads into Chapter 8 where the relationship between perceived and actual drinking water is discussed together with the factors which influence perceived drinking water quality. The factors which affect drinking water practices are also explored. This chapter builds on the findings of the previous empirical chapters. The main conclusion drawn from each chapter can be found in a summary section at the end of each chapter.

The concluding Chapter 9 draws together the conclusions from the previous chapters and discusses how this research contributes to the wider debate. Reflections on the approaches used can be found in this chapter as can exploration of the possible applications of this research. The future direction of research in Bellavista Nanay is highlighted together with the importance of conducting more research on the perception of drinking water quality in other developing countries.

Chapter Two: Literature review

The first objective of this chapter is to introduce the issues surrounding drinking water and drinking water quality in developing countries. It then focuses on perceived drinking water quality, aesthetics and risk which are at the heart of this thesis and presents the policy forming debates in the drinking water arena that influence this study.

2.0 Drinking water in developing countries

Water is essential to life, we need to drink 2 to 4.5 litres per day to survive (Howard and Bartram, 2003), but the amount of water required to cover our basic human needs which include hygiene and cooking is approximately between 20 and 50 litres of water per person per day (UN, 2003). Over 20% of the world's population are without access to sufficient supplies of potable water for their basic daily needs (Bakker, 2007). This is why a debate surrounding drinking water as a human right has emerged (discussed in Section 2.4.3).

Drinking water is especially important in developing countries where availability and quality impact significantly on health. The term 'developing country' in this thesis is used to describe a county with lower material wealth, industrialisation, social programs and human rights guarantees, than those countries classified as developed and is used to distinguish between these countries from developed regions of the world (UN, 2008).

2.1 Health, water, sanitation and hygiene

Water, sanitation and hygiene (WASH) have a considerable impact on the health of populations. Dr Snow discovered the first link between WASH when he traced the source of a cholera outbreak to water supply in Soho, England in 1854. More recently the importance of WASH in fighting disease was highlighted by the medical profession when the readers of the British Medical Journal voted sanitation (clean water and sewage treatment) as the most important medical advance since 1840 (Ferriman, 2007).

Since the time of Dr Snow it has been established that poor WASH conditions cause increased incidence of water-related diseases. Water-related diseases are diseases that are transmitted via faecal-oral, water-washed, water-based or water-related insect routes

(Cairncross and Feachem, 2002). They include diseases transmitted by microorganisms such as bacteria, viruses and protozoa, diseases caused by helminths and those transmitted by mosquitoes. A detailed description of water-related diseases can be found in Table 2.1.

Table 2.1: Classification of water-related diseases (Cairncross and Feachem, 2002)

Primary classification	Secondary classification	Infection	Pathogenic[1] agent
Faecal-oral: water borne or water washed	Diarrhoeas & dysenteries	Amoebic dysentery	Protozoa
		Balantidiasis	Protozoa
		Campylobacter enteritis	Bacteria
		Cholera	Bacteria
		Cryptosporidiosis	Protozoa
		E.coli diarrhoea	Bacteria
		Giardiasis	Protozoa
		Rotavirus diarrhoea	Virus
		Salmonellosis	Bacteria
		Shagellosis	Bacteria
		Yersiniosis	Bacteria
	Enteric fever	Typhoid	Bacteria
		Paratyphoid	Bacteria
	N/A	Polismyelitis	Virus
	N/A	Hepatitis A	Virus
	N/A	Leptospirosis	Bacteria
Water-washed	Skin infection	Infectious skin diseases	Miscellaneous
	Eye infection	Infectious eye disease	Miscellaneous
	Others	Louse borne typhus	Bacteria
		Louse borne relapsing fever	Bacteria
Water-based	Skin penetrating	Schistosomiasis	Helminth
	Ingested	Guinea worm	Helminth
		Clonorchiasis	Helminth
		Diphyllobothriasis	Helminth
		Fasciolopsiasis	Helminth
		Paragonimiasis	Helminth
		Other	Helminth
Water-related insect vectors	Biting near water	Sleeping sickness	Protozoa
	Breeding in water	Filariasis	Helminth
		Malaria	Protozoa
		River blindness	Helminth
		Yellow Fever (Mosquito-borne)	Virus
		Dengue (Mosquito-borne)	Virus
		Other (Mosquito-borne)	Virus

[1]A pathogen is an organism capable of causing disease

Poor WASH conditions also increase the incidence of excreta related disease, due to inadequate excreta disposal and poor hygiene. These are not detailed in this thesis as the focus is on drinking water quality.

In Table 1.1 it can be seen that a third of these infections are classified as diarrhoea and dysenteries. Diarrhoea is a term used to describe frequent loose and liquid bowel movements, with dysentery the bowel movements are accompanied by mucus and/or blood in the faeces. The main danger associated with diarrhoea and dysentery is dehydration. When over 15% of body fluid is lost, dehydration is normally fatal. 2.2 million people die globally per year from diarrhoeal disease (WHO, 2009), most of these deaths occur in children under five in developing countries (Kosek *et al.,* 2003). Four billion cases of diarrhoea per year are recorded worldwide (WHO, 2009). More children die annually from diarrhoea than from diseases related to HIV or AIDS (WHO/UNICEF, 2000). The reason why these statistics are so shocking is that diarrheal disease is easily preventable by introducing WASH interventions and treatable by the replacement of lost fluid with oral rehydration therapy, which of course requires clean water. Compared to other diseases such as HIV/AIDS and malaria, this disease attracts little media attention.

The impacts of WASH interventions are normally measured in the reduction of diarrhoeal disease. The studies listed in Table 2.2 are all summaries of other studies undertaken in this area and the average diarrhoeal reduction in relation to a specific WASH intervention have been calculated. In the study by Esrey and colleagues in 1999, increased water quality gave the smallest reduction in the occurrences of diarrhoea cases compared to the other interventions. Esrey's (1991) conclusions are still widely cited as a reason to focus on the other WASH interventions rather than drinking water quality. However, even from Esrey's figures, the worldwide occurrences of diarrhoea would drop by 330,000 cases with improved water quality, so the importance of drinking water quality should not be undervalued. The increased reduction in diarrhoea cases in later studies can be attributed to the inclusion of household drinking water treatment, which was not considered in Esrey's study. When water is treated in the household rather than centrally[7] the reduction of diarrhoea cases is considerably higher.

Table 2.2: Reduction in diarrhoea attributed to various WASH interventions

Authors / **Intervention**	***Esrey et al., (1991)*** Reduction (%)	***Fewtrel et al., (2005)*** Reduction (%)	***Clasen et al., (2007)*** Reduction (%)	***Arnold & Colford (2007)*** Reduction (%)
Water and sanitation	30 *(n=2)*	-	25-40 *(n=4)*	-
Sanitation	36 *(n=5)*	32 *(n=2)*	-	-
Water quality and quantity	17 *(n=2)*	25 *(n=6)*	23-30 *(n=8)*	-
Water quality	**15** *(n=4)*	**39** *(n=9)*	**24-39** *(n=12)*	**29** *(n=10)*
Water quantity	20 *(n=5)*	-	-	-
Water quality and improved storage	-	-	23-39 *(n=7)*	-
Hygiene	33 *(n=6)*	45 *(n=8)*		-
Water quality and hygiene	-	-	15-48 *(n=4)*	-
Water, sanitation, hygiene or health education	-	33 *(n=4)*	-	-

n = number of studies considered
Source: Authors own review of the literature 1991-2007

It was clear that centralised drinking water systems delivering water for all was an unrealistic aim after global coverage for water and sanitation was not achieved during the International Decade of Clean Water (1981-1990). Therefore alternative strategies for delivering safe drinking water at the point of consumption were explored. Household drinking water treatment approaches emerged from these strategies and interest in this approached gained momentum during the 2000s.

Regardless of whether a source of water is clean or safe it may become contaminated in transport, handling and storage (Hoque *et al.,* 2006; Trevett *et al.,* 2005; Trevett *et al.,* 2004; Wright *et al.,* 2004). Gundry and colleagues (2006) demonstrated that around 40% of 'safe' water was significantly contaminated before it was consumed. Even when a household has a piped chlorinated water source it can still become contaminated if the supply is not

[7] Centralised approaches defined as using a drinking water treatment plant and distribution system

continuous, as the water needs to be stored and handled (Oswald *et al.,* 2007). This is highlighted in the statement by Fewtrell and colleagues (2005): "…a water quality intervention at point of use should be considered for any water supply programme that does not have 24 hour access to a safe source of water". The term 'safe storage' is used to mean the vessel used is designed to minimise the contact with hands and other potentially contaminated objects (Hoque *et al.,* 2006; Trevett *et al.,* 2005; Brick *et al.,* 2004; Jenson *et al.,* 2002; Sobel *et al.,* 1998). Often safe storage is combined with household drinking water treatment when solar disinfection (SODIS) (Moser *et al.,* 2005), household chlorination (Sobsey *et al.,* 2003; Quick *et al.,* 1999) or household filtration devices (Clasen *et al.,* 2004) are used as seen in Table 2.3.

The advantage of household drinking water treatment is if water is treated directly before use, any contamination will be treated and the incidence of water-related diseases will be significantly reduced (Table 2.2). The methods of household drinking water treatment are discussed in the subsequent section and can be seen in Table 2. 3.

The studies outlined in Table 2.2 have split the academic community concerning the best approach to take when trying to tackle water-related diseases. Presently academia seems to be pushing hygiene which gives the best reduction in diarrhoeal disease (Table 2.2). To ensure good hygiene a certain volume of water is required, which demonstrates how the interventions are intrinsically linked. In academia certain groups champion certain interventions, while ignoring the larger holistic picture. This is obvious in the wider literature which normally focuses only on one intervention. The fragmentation of research into its separate interventions is fuelled by a lack of WASH research funding. This contradicts the approach taken in the field which is more holistic. On the ground it can be seen that a holistic approach is required as improvement in one area often impacts on all other areas. A more holistic approach to WASH interventions is essential in academic research and teaching, if the health and other benefits which they bring are to be fully understood. Hence it was critical that this study looked at drinking water quality in the wider context all WASH interventions.

2.2 Drinking water treatment

In many parts of the world clean water supplies are not available; therefore drinking water treatment is required before distribution or use. Developing countries have the same water sources as developed countries; ground water[8] which is usually less polluted than surface water[9] (WHO, 2004b), and other sources of water including rain water and fog. When a water source is relatively clean it requires less treatment than a polluted source of water.

Traditional drinking water treatment plants consist of several processes (Figure 2.1), with each process removing differing levels of bacterial contamination. Screening is the removal of large pieces of debris from the water. This process is usually used when the water source is surface water such as rivers which contain large pieces of debris. Next flocculation and coagulation remove colloidal particles which cause turbidity[10] in the water. Once the colloids agglomerate together they can settle out under gravity. This process is called sedimentation. The next process is filtration, which simulates the process in which rock naturally filters waters before it accumulates in aquifers. The final stage is disinfection, which is done once all the turbidity has been removed (as it is known to reduce the removal of bacteria by disinfection) which kills the remaining pathogenic bacteria using chemical agents such as chlorine.

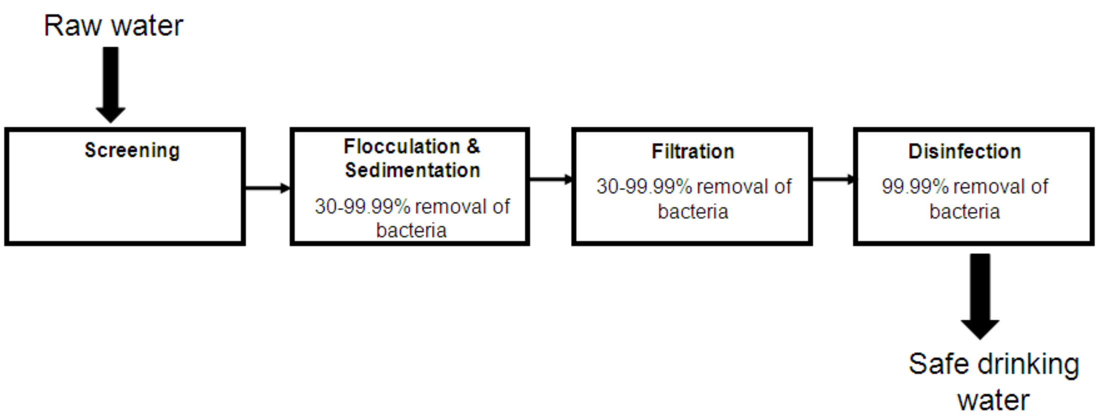

Figure2.1: Traditional drinking water treatment processes

(Percentages taken from WHO, 2004)

[8] Ground waters are water resources located below ground such as aquifers
[9] Surface waters are water resources collected above the ground such as streams
[10] Turbidity is a term used to express cloudiness of the water

Centralised approaches[11] have been used in development projects and the aim of the MDGs would suggest that centralised treatment systems are required (as discussed in Section 2.4.1). If systems are directly transposed from a developed to developing countries setting problems occur due to the need for a consistent electricity supply, specialist chemicals and spare parts. The infrastructure required to deliver water needs to be maintained and the system needs to be kept under constant pressure if infiltration of pollutants is to be avoided (Tickner and Gouveia-Vigeant, 2005).

In Section 2.1 the contamination of water when collected, stored and handled and their merits of household drinking water treatment were discussed. Processes used in household drinking water treatment are the same as those used in traditional drinking water treatment plants (Figure 2.1). They can be used separately or in a series of processes. How water is treated at household level is dependent on the type of water contamination, which can be seen in Table 2.3.

Table 2.3: Household drinking water treatment, effectiveness of each method and examples of use found in literature, adapted from (http://www.cawst.org, 2006)

Household treatment	*Bacteria*	*Helminths*	*Turbidity*	*Examples of use in literature*
Settlement	1-2	0	2	Allgood, 2004, Crump *et al.,* 2005
Coagulation	0-1	?	3	Allgood, 2004, Crump *et al.,* 2005
Cloth filter	0	4	1	Huo *et al.,* 1996
Fine sand filter	4	4	3	
Ceramic filter	3-4	4	4	Ngai *et al.,* 2007, Stauber *et al.,* 2009, Ahamad and Jawed, 2007
Solar disinfection	4	2-4	0	Clasen *et al.,* 2004, du Preez *et al.,* 2008, Brown *et al.,* 2008, Clasen and Menon, 2007, Simpson, 2005
Chemical disinfection	4	?	0	Caslake *et al.,* 2004, Moser *et al.,* 2005, Moser and Mosler, 2008, Rainey and Harding, 2005

Scoring system used: 1 = minimal effect, 4 = most effective,? = unknown effect

In 2008 household drinking water treatment was being used widely in 35 developing countries from Mongolia to Jamaica (WHO/UNICEF, 2008). As this technique is being

[11] Centralised approaches meaning using a large scale drinking water treatment plant and distribution system

extensively used in the world and as it is known to play a successful role in delivering a safe drinking water, the WHO and UNICEF are now evaluating its role in providing safe water as a part of the MDGs (WHO/UNICEF, 2008).

There are many arguments against household drinking water treatment. One points to the increased work load placed on the household water managers, who are predominately women (as discussed in Section 2.4.4). As they now not only have to collect, but also have to treat their water. However with the health benefits that household water treatment brings the time required for treatment will be outweighed by the reduced time taking care of the sick. Cairncross and Valdmanis (2004) argue that there is a lack of information on the longevity of health impacts and behaviour changes after the initial implementation period of household drinking water treatment. This can also be said of centralised water projects, as academics have been trying to clarify the health impacts of these interventions since 1991 (Table 2. 2).

Where water supplies exist, but are of poor quality, it is far more cost effective to ensure correct operation of the central treatment works than to distribute the means for household treatment to every household in the community (Cairncross and Valdmanis, 2004). However, even when water treatment plants are adequately maintained, water can become contaminated after distribution, as discussed in Section 2.1. Household drinking water treatment can provide health benefits more quickly to populations that do not have 24 hour access to water or a safe water supply, than installing centralised systems (Thompson *et al.,* 2003).

Universal access to safe water is still a long way off and the MDGs are only targeting half of those who did not have access to safe water in 1990. Even if a community does not have an improved supply'[12] through household drinking water treatment they can obtain safe drinking water. Household drinking water treatment also gives flexibility of approach due to the numerous treatment methods available (Table 2.3), so the methods can be chosen by

[12] An improved water source is a household connection, public standpipe, borehole, protected dug well, protected spring or rain water collection WHO/UNICEF. (2008) 'Progress on drinking water and sanitation: Special focus on sanitation '.

the household, which means they will be more '*acceptable*' and '*sustainable*' (Thompson *et al.,* 2003).

The economic return of household drinking water treatment is US$5 to US$60 per US$1 invested. This is higher than the calculated return on traditional WASH interventions, of US$3 to US$34 (Hutton and Haller, 2004; WHO, 2004a). The economic return of WASH parameters are important as previously governments lacked an understanding of how these interventions affected general development and poverty (Gutierrez, 2007).

The initial justifications for drinking water improvement projects focus on the health benefits, but assessments have identified a wide range of additional positive effects including time saved collecting water, new income opportunities, new skills and more effective local institutions (Soussan, 2006).

2.3 Drinking water quality

The aim of a drinking water provider and improvement schemes is to deliver safe drinking water. To do this they need to provide water which fits certain quality parameters. The main institutional concern with drinking water quality is the pathogenic organisms in water which cause water-related diseases (as seen in Table 2.1) therefore most countries adopt legislative standards for 'indicator' organisms. A discussion of why indicator organisms are used rather than directly measuring pathogenic organisms can be found in Section 3.2.3. The next concern is chemical parameters which include physicochemical parameters and then aesthetic qualities e.g. turbidity, colour, odour and smell, which are discussed in Section 2.3.2.

Developing countries generally adopt legislation from developed countries, which can be seen in Table 3.4 (page 63), even when the standards may be inappropriate. Developing countries may not have the means to monitor water quality (as many of these standards are based on expensive technology) or the regulatory frame work to enforce them. In developed countries there is a discrepancy in how institutions and individuals rate the importance of drinking water quality parameters, which is illustrated in Figure 2.2. This discrepancy is due to the difference in actual and perceived health risk associated with these parameters, which are discussed in more detail in Section 2.3.3. Due to the adoption of developed countries' regulatory standards it is assumed that the institutional ordering of importance remains the same for developing countries.

Evidence is now emerging that the ordering of these parameters for 'people' in developing countries is also the same as those in developed countries. Microbiologically clean water sources are being abandoned due to chemical contamination such as arsenic (Sultana, 2009; Simpson, 2005) or fluoride (Agarkar, 2003). These chemical contaminants are largely naturally occurring, so the drivers for the risk associated with these contaminants are different from those discussed in Section 2.3.3. The risk may be associated with the unfamiliar types of illnesses caused by these kinds of contaminants (Putnam and Wiener, 1997). Although no studies on this have been undertaken in developing countries it can be assumed that this averting behaviour would result in the loss of the main aim of drinking water improvement schemes which is to reduce water-related diseases.

Contradictions in the importance institutions and people place on different drinking water quality parameters means that when a water supply is installed or additionally treated using institutional water quality standards, it may not be '*acceptable*' to the consumer as it does not comply to 'their' standards. Therefore the consumer will not drink the water or will treat the water further (averting behaviour). When this occurs in developing countries the health benefits of the improved water supply or treatment are lost.

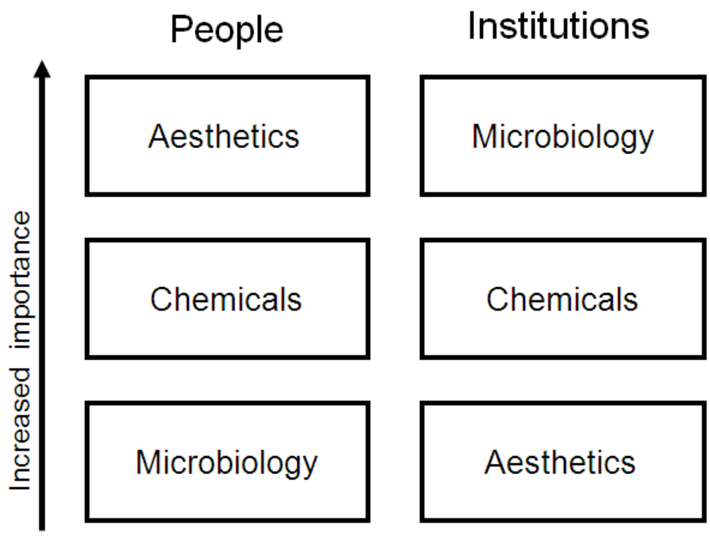

Figure 2.2: Importance attributed to drinking water quality parameters

2.3.1 Perception of drinking water quality

It has been argued by a number of authors that perceived drinking water quality it more important than actual drinking water quality (Foltz, 1999; McGuire, 1995; Sheat, 1992). This is due to the fact that no matter what standards a drinking water meets, if the consumer does not perceive the drinking water to be clean or safe they will not drink it.

Perceived poor drinking water quality has led to averting behaviour in developing country contexts such as Malaysia (Aini *et al.,* 2007) and Turkey (Celik and Muhammetoglu, 2008) as well as in developed contexts (Jones *et al.,* 2007; Lou *et al.,* 2007; Doria, 2006; Jones *et al.,* 2006; Foltz, 1999). Interestingly, averting behaviour has not been reported in a Latin American. This behaviour has been linked to availability of alternative water sources, perceived risk and water quality (Doria *et al.,* 2005). Averting behaviour in developing countries has caused drinking water improvement schemes to fail in their aim of bringing safe drinking water to communities, this results in the loss of projects' intended health benefits (Singh, 2006; Biswas *et al.,* 2005).

Despite the above findings, perception of drinking water quality has not been studied in any depth in a developing countries context. However, in developed countries, research has focused on perception of drinking water quality in relation to customer relations and choice of products (Foltz, 1999; Owen *et al.,* 1999b; Owen *et al.,* 1999a; Sheat, 1992).

Many authors have linked the perception of drinking water quality to a number of different factors, which are categorised in Table 2.4. These factors are heavily influenced by the media and information the public receives, and how they interpret and understand this information (Fressenden-Raden *et al.,* 1987 in (Owen *et al.,* 1999b)).The emotive nature of this subject means that if an incorrect judgement is made, no amount of subsequent effort will be effective in correcting people's perceptions (Um *et al.,* 2002; Jardine *et al.,* 1999; Owen *et al.,* 1999b; Owen *et al.,* 1999a; Sheat, 1992).

Table 2.4: Factors which have been associated with the perception of drinking water quality

Factor	**Literature**
Knowledge of source	Levallois *et al.,* 1999, Owen *et al.,* 1999a, Jones *et al.,* 2007, Doria *et al.,* 2006
Information on drinking water quality	Aini *et al.,* 2007, Jones *et al.,* 2007, Owen *et al.,* 1999b, Johnson, 2003, Celik and Muhammetoglu, 2008, Contu *et al.,* 2005
Trust in sources of information	Owen *et al.,* 1999b, Johnston and Scicchitano, 2000, Jardine *et al.,* 1999
Trust of the supplier	Owen *et al.,* 1999b, Strang, 2005, Johnson, 2003, Jones *et al.,* 2006, Doria, 2006, Contu *et al.,* 2005, Euzen, 2003
Perception of aesthetic qualities of the water	Owen *et al.,* 1999a, Doria, 2006, Contu *et al.,* 2005, Jardine *et al.,* 1999, Jones *et al.,* 2006, Dietrich, 2006, Doria *et al.,* 2005, Lou *et al.,* 2007, Aini *et al.,* 2007, Turgeon *et al.,* 2004, Euzen, 2003, Jones *et al.,* 2007
Past experience (memorability)	Euzen, 2003, Dietrich, 2006, Um *et al.,* 2002
Socioeconomic status	Andreson *et al.,* 2007, Turgeon *et al.,* 2004, Doria *et al.,* 2006
Health concerns (risk)	(Aini *et al.,* 2007; Lou *et al.,* 2007; Doria, 2006; Jones *et al.,* 2006; Jardine *et al.,* 1999; Levallois *et al.,* 1999)

According to Dietrich (2006) personal preference for drinking water is based on both psychological factors (which include personal experience, memory and external stimuli such as perceived contextual indicators) and physiological factors (such as biochemistry, physical body factors, health and external factors such as humidity, temperature etc.).

Doria *et al.* (2005) bought these factors together to produce a hypothesised model on the main factors which affect quality perception of tap water, which can be seen in Figure 2.3. Esthetical (aesthetical) refers to the odour, flavour and visual characteristics of the water. Perceived contextual indicators pertain to the area around the water, whether it is cleanliness of a river bank or labelling of bottled water. External information includes information from the media, the water provider, friends and other resources. Memorability is the remembrance of past health problems attributed to water, which is highly relevant in the case study area due to the prevalence of water-related diseases including the chorea epidemic.

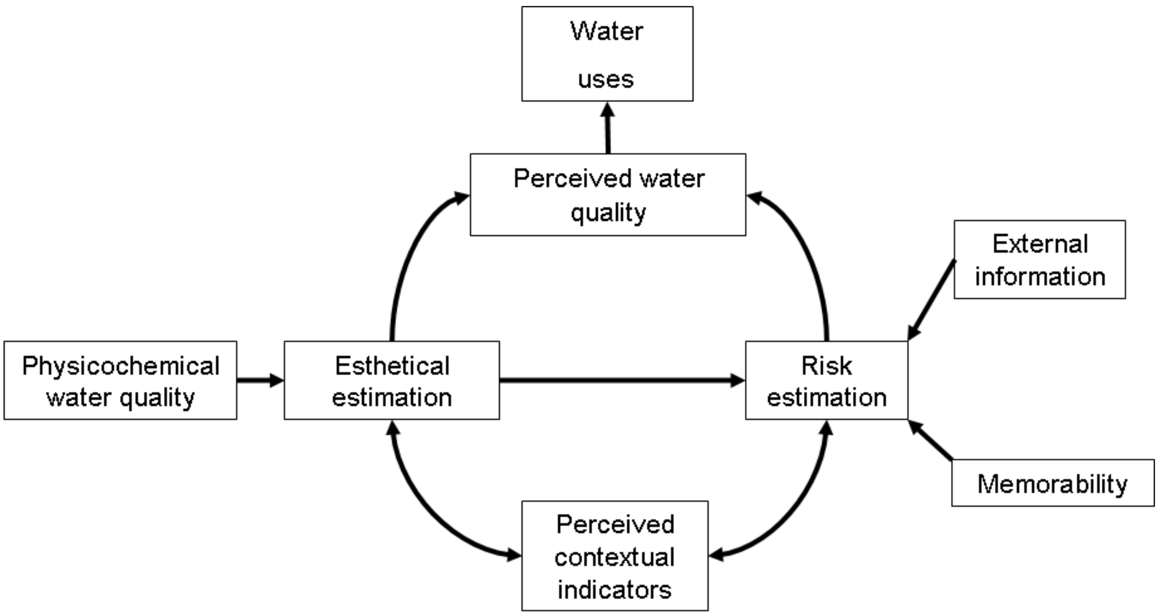

Figure 2.3: Hypothesised model by Doria *et al.,* (2005)

As little was known about how the factors in Table 2.4 interact, Doria and colleagues proposed the model in Figure 2.3. In this model they proposed that physicochemical water quality and contextual information will influence aesthetic variables. The aesthetic variables will go on to influence perceived drinking water quality and risk. Risk perception was hypothesised to be affected by external information and memorability of illness. Perceived drinking water quality will influence behaviour of the consumer. What is missing from this model is the socioeconomic status of the consumer, as wealth affects willingness and ability to pay for a water source and trust of supplier which has been acknowledged by many authors to affect perceived water quality (Table 2.4).

Using a structured equation model approach, Doria and colleagues conducted research with science students from Portugal. Their main findings were that aesthetic estimations were closely interrelated. Perceived drinking water quality was largely influenced by flavour and perceived risk. Contextual indicators play only a weak role in perceived water quality. Perceived risk was largely influenced by colour and flavour rather than external factors. Their work established the link between aesthetic drinking water quality and perceived drinking water quality. However Doria's study did not consider the link between actual and perceived drinking water quality and how this relationship is link to drinking water practices. This work goes beyond Doira's work as it strives to explore these links and how this can influence drinking water practices and use in a developing countries context.

It should be noted that the factors which influence perceived risk are also the factors which influence perceived quality, hinting that these two variables may be the same. In the literature little distinction is made between perceived risk and perceived drinking water quality and this relationship is discussed further in Section 2.3.3.

Perception of drinking water quality has not been studied in any great detail in a developing countries context, but it has been mentioned in a few studies that were focused on other aspects of water supply. A South African study linked perception of water drinking quality to household drinking water treatment which in turn was linked with education levels (Andreson *et al.,* 2007). A trade off between perceived water quality and the effort to obtain it has been observed in Nigeria (Nyong and Kanaroglou, 2001) and India (Asthana, 1997). These studies link perceived drinking water quality to drinking water practices in developing countries.

2.3.2 Drinking water aesthetics

Drinking water aesthetics are defined by the way the water looks, smells and tastes. In the literature reviewed on perception of drinking water quality, aesthetics have been stated to be one of the most common factors said to influence perception of drinking water quality, as seen in Table 2.4. Its importance is due to our senses developing over millions of years to keep us safe from consuming harmful substances. This fact provides the link between aesthetics, perception and risk which are discussed in the previous and subsequent sections.

The way a person assesses a substance to be consumed, is that they first look at its physical appearance, then smell, before it is tasted. This protects us from taking harmful substances into our bodies (Zoeteman, 1980). Our senses are so acute that we can detect some pollutants through smell and taste at levels which cannot be detected by modern instrumentation (MacRae and Falahee, 1995).

The aesthetic qualities of water cannot be considered to be independent variables because our senses are interlinked. Our sense of smell is strongly correlated with taste, as 75% of what we perceive to be taste originates from our sense of smell (Zoeteman, 1980). The visual characteristics of water have also been reported to affect its taste (Maga, 1974). This explains why Doria *et al.,* (2005) found the aesthetic estimations of water to be interrelated. People are highly sensitive to changes in turbidity, pH, mineral and organic content of their drinking water (Dietrich, 2006; Smith and Perrone, 1996). The aesthetic judgements of water are a combination of its chemical content and responses of a person's senses. A personal preference for drinking water is based on both physiological factors (the response to the chemicals in the water) and psychological factors, as our senses are related to memory (Zoeteman, 1980).

In the 19th century throughout the world the taste of drinking water was used to judge its quality, this changed with the scientific advances in the 20th century (Dietrich, 2006; Zoeteman, 1980). In the mid to late 20th century came advances in microbiology, followed by advances in analytical chemistry in the mid to late 20th century. This is when regulations became focused on the microbiological and chemical aspects of drinking water quality

(Dietrich, 2006). Aesthetic assessment of water was rediscovered by the water industry in the late 21st century, so that a biologically safe, chemically safe and palatable product could be produced for the consumer (Dietrich, 2006; McGuire, 1995). The WHO guidelines enforce this as they state that the "…appearance, taste and odour of drinking water should be acceptable to the consumer" (WHO, 2004b).

It is slowly becoming acknowledged that even if water is chemically and biologically safe, but tastes smells or looks strange or different, people will not drink this water and may possibly use a less 'safe' source for drinking (Biswas *et al.,* 2005). This is because the aesthetic quality of drinking water is virtually the only basis consumers can use to judge the overall quality of drinking water. This has been used to partially explain why people are switching from chlorinated tap water to unchlorinated bottled water in many developed countries (Doria, 2006; Raj, 2005; Mackey *et al.,* 2004; Foltz, 1999). Water companies are becoming interested in the aesthetic quality of water as it is uneconomic to treat water to a drinking water standard if it is not being used as a drinking water source.

If water is untreated and 'clean' it will taste and smell of the minerals and organic compounds it contains. A sample of river water may contain between 200 and 300 volatile organic compounds, at concentrations which may cause the water to smell or taste (Meng *et al.,* 1992). If treated, passed through a distribution system or stored, water will pick up taste and odour from the material it comes into contact with (Tomboullan *et al.,* 2004; Turgeon *et al.,* 2004; Powell *et al.,* 2000).

In the literature there are two major concerns about the taste of water: mineral and chlorine content (Lou *et al.,* 2007; Piriou *et al.,* 2004; Turgeon *et al.,* 2004; Bruvold, 1970; Dillehay *et al.,* 1967). Taste quality has been found to be inversely related to mineral content (Bruvold, 1970). Other authors have found that some minerals such as sulphate and magnesium are more objectionable than others such as calcium and silica (Hashimoto *et al.,* 1987) and anions have been found to mask the objectionable taste of cations (Zoeteman and Grunt, 1978). Hardness of water has been perceived by some residents as a threat to their health in places as diverse as Antalya city, Turkey (Celik and Muhammetoglu, 2008) and Oxfordshire, UK (Owen *et al.,* 1999a). Despite the fact that evidence suggests hardness in water is advantageous to human health, due to it reducing the risk of cardiovascular disease and strengthening bones (Sawyer *et al.,* 1994). The taste associated with mineral content can however be reduced by chilling (Pangborn and Bertolero, 1972).

Factors which may influence our sensitivity to chlorine are the chemical composition of the original water and the level of residual chlorine that we are exposed too (Piriou *et al.,* 2004). This is due to the different types of chlorine compounds formed when chlorine interacts with the other chemicals present. The chlorine compounds formed will have different odour detection thresholds (ODT). Piriou and colleagues (2004) found: chlorine had an ODT of 1.1 mgl^{-1} compared to monochloroamine which had an ODT of 1.8 mgl^{-1} (using panellists from the USA). People from different locations have differing sensitivity to chlorine, such as those from France and the USA (Piriou *et al.,* 2004). In general it has been found that people prefer water which contains less chlorine or water without chlorine (Moser *et al.,* 2005; Allgood, 2004; Turgeon *et al.,* 2004). For example it was noted that in the city of Quebec people perceived their drinking water quality to be of better quality as residual chlorine decreased (Turgeon *et al.,* 2004).

The temperature of water is also important as people find cool water (16°C) more pleasing than water at room temperature (Sandick *et al.,* 1984). The temperature of water also plays an important role in the taste and smell of water. When the temperature of water increases the volatility of molecules contained in the water increases, this means that they can be more easily detected by our sense of smell and taste. Many authors have found that temperature has effects on the odour and flavour of water (Omur-Ozbek and Dietrich, 2005; Whelton and Dietrich, 2004; Bruvold, 1972; Pangborn and Bertolero, 1972; Bruvold and Pangborn, 1970).

According to research in the developed world the taste of municipally treated water has led to the huge increase in bottled water sales, quoted to be worth US$ 35 billion annually (Doria, 2006; Raj, 2005; Mackey *et al.,* 2004; Foltz, 1999). There is no evidence that bottled water is safer to drink on the contrary, there is now growing concern about the microbiological (Raj, 2005) and chemical quality of bottled water and the sustainability of this product (Wilk, 2006; Foltz, 1999). The uptake of this water source has also been linked to the consistency of bottled water produced by multinational companies (Foltz, 1999, Wilk, 2006). The aesthetics qualities of bottled water are consistent whenever or wherever the water is purchased. This is important as consumers normally associate any change in the aesthetic water quality with a decrease in overall quality (Dietrich, 2006; Tomboullan *et al.,* 2004; Euzen, 2003; Owen *et al.,* 1999b; McGuire, 1995).

In developing countries, when drinking water improvement schemes have not taken into consideration changes in drinking water aesthetics, rejection of the new or treated drinking water source has occurred. In a study of a water project in Colombo (Sri Lanka), it was found that 30% of the houses that were receiving chlorinated piped water were not using it for drinking. They continued to drink contaminated well water as they did not like the taste of the new source of water. Over half of the households surveyed considered residual chlorine to be a problem (Biswas *et al.,* 2005). In Madhya Pradesh, Bihar and Jharkhand (India), just under half of the hand pumps installed were rejected for drinking and cooking purposes because of aesthetic reasons (Singh, 2006). Drinking water aesthetics have also been linked to the acceptability of household drinking water treatment. Households have rejected chlorination as a treatment type due to its taste and smell (Moser *et al.,* 2005; Allgood, 2004). It has been hypothesised that the uptake of solar disinfection may be hindered by the tepid nature of the water produced.

The safety of drinking water is the main concern of drinking water suppliers and drinking water improvement schemes. Institutions rate drinking water aesthetics as the third most important parameter due to the risks associated with microbiological and chemical contamination. However, people rate this as the most important parameter as it is one of the only ways they can judge the water quality. To summarise, it has been illustrated that even if water is chemically and microbiologically safe but looks, smells or tastes different or strange, people will not consume it and the health benefits of an improved drinking water source are therefore lost.

2.3.3 Drinking water and risk

Human survival and evolution is based on the way we assess and manage risk. Those that learnt from danger and recognised risk survived and went on to reproduce. Those who did not perished from avoidable environmental danger. The perception of risk and how it affects our behaviour has been detrimental to our survival and evolution (Beck, 2003).

Risk is the probability that a potential negative impact will occur. In the context of this thesis it is the likelihood of illness or death resulting from a decision to drink from a certain water source (Johnston *et al.,* 2000). The risk in this context is associated with chemicals or pathogens that may be found in drinking water and can cause illnesses or death. In the literature risk is encapsulated in the term health concerns (Table 2.4) and as such has been linked to perceived drinking water quality, but as previously stated little distinction has been made in the literature between perceived drinking water quality and perceived risk.

Risk can be divided into actual risk and perceived risk. In developed countries a difference has been found between actual and perceived risk from drinking water. Actual risk has been found to be considerably lower than the perceived risk, due to the high quality of the water (Um *et al.,* 2002; Jardine *et al.,* 1999). The difference between actual and perceived risk of drinking water has not been investigated in a developing countries context, where the actual risk is considerably higher due to the high prevalence of water related diseases, so this difference may not exist.

The difference between perceived and actual risk has led to the contradictions in the importance attributed to the different drinking water quality parameters between institutions and consumers in developing countries, as seen in Figure 2.2. The ordering of strange chemicals over microbiological hazards has been linked to the acceptability of naturally occurring hazards (pathogens) compared to technologically imposed ones (Putnam and Wiener, 1997). This conflict in how people and institutions rate the risk of these parameters has led to averting behaviour in consumers (Hagihara *et al.,* 2004), such as people not using municipally treated tap water in Korea (Um *et al.,* 2002), Toronto (Jardine *et al.,* 1999) and Quebec (Levallois *et al.,* 1999).

Risk perception is considered one of the most cited factors said to influence the perception of drinking water quality, as seen in Table 2.4. Perception of risk related to drinking water quality has been defined as an individual's subjective judgement based on aesthetic and non-aesthetic qualities (Turgeon *et al.,* 2004). This definition would suggest that consumers' perception of risk is associated with aesthetic drinking water quality (as discussed in Section 2.3.2) and complicated social, cultural and psychological factors. This mirrors the factors associated with perception of drinking water quality (as discussed in Section 2.3.1). The link between perception of risk and aesthetics has been investigated by numerous authors. This includes the investigation of off-odours and perception of risk (Jardine *et al.,* 1999) and the taste and smell of chlorine and risk (Contu *et al.,* 2005; Turgeon *et al.,* 2004).

The link between perceived risk, aesthetic qualities, and perceived drinking water quality would lead to the conclusion that these factors are intrinsically linked and cannot be separated, as all three concepts are used to assess the safety of drinking water. Hence in the hypothesised model (Figure 1.2, page 12), these factors are all linked.

2.4 Policy forming debates

This section aims to highlight the most relevant present debates which set the political and social background to this thesis. The debates discussed in this section are the Millennium Development Goals (MDGs), economy of water, water as a human right and water and gender, all of which are driving current water policy and therefore influencing this thesis.

2.4.1 Millennium Development Goals

The MDGs emerged from the United Nations (UN) Summit in September 2000 when the Millennium Declaration was adopted. The MDGs form a set of political commitments aimed at tackling development issues and have specific targets which need to be met by 2015. They were adopted by 194 UN Member states in 2000, after the lack of success of the UN Decade of Clean Drinking Water (1981-1990) which aimed to provide "safe water and sanitation for everyone" by 1990 (Sharp, 2008).

In the MDGs there are a total of eight goals and 18 targets nearly all of which can be linked to improved water and sanitation, as water and sanitation are intrinsically linked to development. Target 10, Goal 7 is the specific water and sanitation goal which aims to "...reduce by half the proportion of people without sustainable access to safe drinking water by 2015 compared to 1990". The MDGs are now the focus of the WASH sector and governments as they set clear obtainable targets. With the MDGs focus on national governments and international agencies it implies a top down strategy is being advocated (Satterwaite, 2003).

The success or failure of this MDG is measured by the percentage of the population which has access to an ‘improved water source’. An improved water source is a household connection, public standpipe, borehole, protected dug well, protected spring or rain water collection. The terminology ‘safe’ draws the attention to drinking water quality. The ‘improved’ technologies were chosen due the quality of water they deliver, although no quality standards are specified and there is little evidence to support this choice (Sutton, 2008). These definitions do not consider the well documented phenomena of contamination during collection, storage and handling and the use of household drinking water treatment (Sutton, 2008; Wright *et al.,* 2004). In many situations drinking water quality is more influenced by collection, storage and handling practices than source of the water (Sutton, 2008; Oswald *et al.,* 2007; Gundry *et al.,* 2006; Wright *et al.,* 2004). As Gundry and colleagues (2006) state, “… UNICEF–WHO are assuming an equivalence between improved sources and safe water” which may be unsound. This may be addressed in the future as UNICEF-WHO are evaluating the role of household drinking water treatment in providing safe and sustainable water in relation to this MDG (WHO/UNICEF, 2008).

These categories of unimproved and improved have been criticised as they are specified by ‘experts’ and may not be appropriate in certain situations (O'Hara *et al.,* 2008; Sutton, 2008; Gutierrez, 2007). This approach does not reflect the work being carried out in the field. For example many improvements in water sources are not captured under the definition of an improved water source. This has caused money to be diverted from the implementation of drinking water improvement schemes which are not classified as ‘improved’, but which would be more ‘*appropriate*’, ‘*sustainable*’, cheaper to implement, and target populations in the most need (Sutton, 2008; Gutierrez, 2007). In some cases a MDG focus has caused cherry picking of communities which are easily upgraded to improved water sources (Gutierrez, 2007).

This MDG is purely technology driven and focuses on engineering solutions to the problem of lack of water. It ignores the link between social and political conditions (Sutton, 2008; Gutierrez, 2007). These criticisms led to WHO and UNICEF to adopt a 'drinking water ladder approach' in 2008 (WHO/UNICEF, 2008). In this approach the improvement up the ladder can be monitored, but the apex is still a piped water supply and the definition of improved source has not changed.

This MDG emphasises the quantity of water and the distance to source, but not the quality, continuity, cost or number of people using that source (O'Hara *et al.,* 2008; Sutton, 2008). As Satterwaite (2003) points out, "Proximity does not mean access." The importance of continuity has been linked to contamination of water due to storage and handling practices (Oswald *et al.,* 2007; Wright *et al.,* 2004). Is an unimproved source with 24 hour availability preferable to an improved source which is only available for 1 hour a day? The focus is on household connection, but there is no protection against disconnection (Bakker, 2007; Langford, 2005). Evidence suggests that even when an improved source is installed there is no guarantee that people will use it for drinking and cooking (Singh, 2006; Biswas *et al.,* 2005).

There has been a lack of general information on who has safe drinking water in developing countries, which means there is no reliable baseline for these measurements to be drawn from (O'Hara *et al.,* 2008; Gutierrez, 2007). This lack of baseline measurement has also led to the questioning of the monitoring of the MDGs, due to figures either being based on estimates or surveys which do not fully reflect the conditions on the ground (Sutton, 2008; Gutierrez, 2007; Satterwaite, 2003). For example informal settlements are not included, which greatly skews any sample.

According to the most recent WHO & UNICEF report, 87% of the world receives their water from an improved source and 884 million people are reliant on unimproved water sources. Presently it seems that the world is on track to meet the drinking water target (WHO/UNICEF, 2008). However, it should be remembered that even if the MDG is met, global coverage will not have been obtained.

To reach the MDG for water, Hutton and Bartram (2008) estimate that an investment of US$ 4 billion is required annually, which equates to a per capita spend of US$ 8 (Hutton and Bartram, 2008). These estimates are for improved water supplies that transpose technology from developed countries (Wilderer, 2005). When reading these figures we should not lose sight of the figures quoted earlier that the economic return for this intervention can be as high as US$34 for every US$1 invested (WHO/UNDP, 2007; UNDP, 2006b; WHO, 2004a).

2.4.2 Economy of water

The principal of attaching economic worth to water stems from the theory of the 'tragedy of the commons', where it is claimed that if there is common ownership of a resource, over-exploitation will occur (Hardin, 1968). The aim of attaching the full economic cost to water is to reduce wasteful usage through increased pricing (Bakker, 2007).

The Mar de Plata Water Conference in 1977 promoted the pricing of water at its real economic cost, and the concept of water as an economic good has been debated ever since (Najlis and Kuylenstierna, 1997). This theme carried on into the Dublin Principles (1992) that states "… water has an economic value in all its competing uses and should be recognised as an economic good" (Najlis and Kuylenstierna, 1997). Today the commodification of water is still seen as the answer to the problems of potable water scarcity as acknowledged at the Kyoto Summit in 2003.

One of the main problems with the commodification of water is how does one calculate the real or full economic cost of water? Water is a flow resource over which it is difficult to establish private property rights and calculate the health and environmental benefit. The symbolic, spiritual and ecological functions of water implies some form of collective ownership (Bakker, 2007).

The commodification of water through privatisation has been strongly advocated by the World Bank, the International Monetary Fund, donor agencies and European multinationals (Langford, 2005). The main argument against privatisation is that water companies operate not only to cover initial investment costs, but also to make a profit. There are several different forms of privatisation which have been discussed in detail by many authors

(Haughton, 2002; Bakker, 2007). In the 1990s it was thought that privatisation would revolutionise the water sector in developing countries, through better investment, accountability and profit creation, but the aims of privatisation failed to materialise. During this period (1990-1996) foreign investment in the water and waste industry in Latin American and the Caribbean increased from US$ 0 to a total of US$ 1129 million (Haughton, 2002). A review of the effect of water privatisation in Latin America concluded that there was no compelling argument for water privatisation on public health grounds (Mulreany *et al.,* 2006). What we should not lose sight of in this debate is that even after this drive for privatisation, 90% of the world's water companies are publically owned (Langford, 2005).

The privatisation or commodification of water is often seen as being diametrically opposed to the human rights debate (discussed in Section 2.4.3), but these approaches are not mutually exclusive. Both the Dublin Principle 4 and UN General Comment 15 cite that water is a human right, but use the term 'affordable' therefore they do not consider water to be a free resource. Karen Bakker (2007) argues that 'full' privatisation is inconsistent with human rights unless coupled with a universality agreement and a strong regulatory framework.

What is central to this thesis and often overlooked, is that the private public debate has "…distracted from the inadequate performance of both public and private water providers in overcoming the global water deficit" (UNDP, 2006a; UNDP, 2006b). Now alternative strategies of water management are being explored including public-public partnerships (Bakker, 2007), commons approach (Bakker, 2007), community approach (Bakker, 2007; Langford, 2005) and small scale private providers (Solo, 1999).

WASH suffers from chronic underfunding. Public spending on water is typically less than 0.5% of a country's GDP[13] which is completely overshadowed by other budgets. Ethiopia spends 10 times its WASH budget on its military budget. This is dwarfed by Pakistan as it spends 46 times its WASH budget on its military budget (UNDP, 2006b). For every US$1 invested on WASH interventions and economic return of US$ 3 to 34 can be expected, due to increased productivity and reduced health costs (WHO/UNDP, 2007; UNDP, 2006b; WHO, 2004a).

[13] Gross domestic product

Authors in many locations have identified that it is the poorest people in the community that pay the most for their water (Aguilar and de Fuentes, 2007; Israel, 2007; UNDP, 2006b; Langford, 2005). This is especially true for those without a piped water connection (Israel, 2007). UN General Comment 15 and other literature on the human right to water state that water should be 'affordable', but what does affordable mean?

The UN has recommended that each household should spend approximately 5% of their income on water (Whittington *et al.,* 1991), whereas the World Bank has stated that 4% and 1% of a household disposable income should be spent in water and sanitation respectively (Fujita *et al.,* 2005). In the city of Pusan (Korea), 0.5% of income was spent on water (Um *et al.,* 2002), which can be compared to between 0.88 % and 3.75% in Bolivia (Israel, 2007). In the city of Iquitos in the Peruvian Amazon it was estimated that households paid 2.44% of their income for their water supply, but it was estimated that the people had the ability to pay 3 to 4% of their income for water supply and sanitation (Fujita *et al.,* 2005).

Many households are willing to pay (WTP) high percentages of their income for improved or potable water supplies. The WTP for potable water in communities has been estimated to be as high as 23% of real income in communities in the Ecuadorian rainforest (Hardner, 1996), 5% in five studies on small cities in Morocco and in two informal settlements in Johannesburg (Goldblatt, 1999; McPhail, 1993), and approximately 3 to 5% of income in Mexico city (de Oca *et al.,* 2003). WTP figures only consider the water tariff, not the cost of connection to the water distribution system (Israel, 2007). This cost can be beyond the financial capacity of even those who can afford to pay for the water itself (Laurie and Crespo, 2007).

All of these calculations consider income. Estimation of income in many of these circumstances is incredibly difficult (as discussed in Section 3.3.1) especially when dealing with non monetary economies and casual work, where income varies considerably from one week to the next. WTP may not truly reflect ability to pay when non monetary payment and casual work are the norm. Billing for water can also be inappropriate as monthly and quarterly bills cannot be paid when households are living from hand to mouth.

The poor are always willing and able to pay for water services, as long as the services are relevant and secure. Special arrangements such as weekly or monthly payments and different rates for different types of usage can give the poor access to the service (Soussan, 2004). Households that are not serviced by tap water often pay for the delivery of water rather than use a more distant source. This attaches a monetary value to the water manager's time (Cairncross and Valdmanis, 2004). Hutton and Haller (2004) found the main economic benefit from installing improved water sources to be the time saved, although this is hard to quantify and account for in WTP estimates. WTP for a drinking water source is linked to perception of drinking water quality as people will not pay for a source that they believe to be unclean.

2.4.3 Water as a human right

Water gained its status as a human right in 2002, when Koffi Annan announced, "… water is a fundamental human need, and therefore a human right". The UN adopted water as a human right in 2002 under General Comment 15. The human right to water declares that everyone is entitled "… to sufficient, safe, acceptable, physically accessible and affordable water… to prevent death from dehydration, ...reduce the risk of water-related diseases" (Debreuil, 2006). Without access to water, the human right to good health, education, nutrition and an adequate standard of living are denied (Debreuil, 2006). The human right to water under General Comment 15 is not legally binding, but has been ratified by 151 countries and been adopted into a number of national constitutions such as South Africa, Bolivia and Argentina.

In contrast to the MDGs (discussed in Section 2.4.1) the UN right to water is calling for everyone to have access to safe drinking water. As with the MDG the term 'safe' is used, but not defined. It also contains the term '*acceptable*' which is absent in the MDG. This links the human right to drinking water to the perception of drinking water quality.

General Comment 15 declares that water should be affordable therefore is not indicating that it should be free (Langford, 2005). But what is affordable water? This was discussed in the previous section. As water does not need to be accessed for free to comply with the human rights approach, it has been adopted by the World Bank and many private water companies (Bakker, 2007). In this context, the human right to water becomes compatible with the privatisation of water, which is a cause for concern for many activists' (Bakker, 2007).

A human rights approach emphasises that human dignity comes first and that universal access to sufficient water for basic needs is absolute. The UN Water Conference in Mar del Plata, Argentina, in 1977 established the concept of basic water requirements to meet fundamental human needs and has been reiterated in Agenda 21 and the declaration of the 1994 Cairo Population conference (Langford, 2005). Even Dublin Principle 4 (1992), after it states that water should be recognised as an economic good, goes on to state that it is "… the basic right of all human beings to have access to clean water … at an affordable price" (Bluemel, 2004).

The human rights approach has been criticised by a number of authors (Bakker, 2007; Jayyousi, 2007; Bluemel, 2004). Their main point is that it is anthropogenic and puts human needs above all others including those of the environment. Another concern is that it is compatible with private sector provision of water supply and as with the MDGs it is a top down approach.

On the other hand the adoption of the human rights approach has politicised the cause of water for all and once adopted into national constitutions gives people a tool to demand affordable water. As Langford (2005) states, "…once people feel and experience something as a human right, it becomes a difficult force to restrain".

2.4.4 Water and gender

Evidence of defined gender roles in relation to water have been well documented in the Sudan region of west Africa, East Africa, Nepal, South Asia, Central America and the Andes region (Gender and Water Alliance, 2003). A survey of 35 developing countries found that 64% of the water collection duties were carried out by women, compared to 25% undertaken by men and 11% by children (WHO/UNICEF, 2008). It should also be noted that the majority of the children collecting water were girl children (WHO/UNICEF, 2008).

As seen in the above data, water is a highly gendered issue since in many parts of the developing world it is women who are the water managers in their household. It is their job to collect, treat, use and manage water (Soussan, 2006; Langford, 2005). They are the ones who are exposed to the dangers of unsafe water collection and water-related diseases. It is they who have the added burden of looking after those who become ill due to water-related diseases (Soussan, 2006). The girl child suffers disproportionally because if the household water manager becomes ill or needs help; she is the one who is withdrawn from school (Langford, 2005).

After more than three decades of gender and development activism women are often targeted as the users and therefore beneficiaries of water supply or improvement schemes. The aim of providing access to safe water to women unburdens women from the task of water collection, which in turn will bring positive impacts on health and increases time spent in the economic arena (Singh, 2006; Reed and Coates, 2003; Regmi and Fawcett, 1999; Jordan and Wagner, 1993).

The feminization of poverty was recognised in the 1990s as the United Nations Development Programme (UNDP) Human Development Report (1995) stated that "...70% of the World's poor are female". This led to the women in development (WID) approach (Jordan and Wagner, 1993) which reinforced the role of the woman as a water manager. However, such approaches have been criticised due to the ways in which they reinforce gender stereotypes and create additional burdens for women (Elmhirst and Resurreccion, 2007; O'Reilly, 2006). The gender and development (GAD) approach aims to integrate gender into all development systems, structures and practices. It focuses on promoting changes in institutional practice, women's empowerment and gender equality (Elmhirst and Resurreccion, 2007). As a result, gender and the empowerment of women are promoted in the MDGs, which state that women's contribution to water management must be acknowledged and that gender issues must be integrated into policy (Faisal and Kabir, 2005; Gender and Water Alliance, 2003).

While beneficiaries of water improvement schemes are often cited to be women, decision making bodies in this field are usually dominated by men (Faisal and Kabir, 2005). Therefore plans at all levels tend to ignore women's needs and contributions. The dominance of male decision making and implementation, which focuses on 'expert' led technical based approaches as seen in the MDGs, do not address the greater issues of inequalities in society and may undermine women's role in evaluating the quality of different drinking water sources.

Rydhagen (2002) argues that a feminist engineering approach needs to be adopted which addresses both the practical and strategic needs of women, including gaining a feminist view of the technologies used. Once feminist studies are taken from the social science arena to the arenas of science, technology and engineering, feminist involvement in design and development should occur. Under this approach participants are not only expected to participate, but also influence the outcomes of the negotiations, leaving the idea of an 'expert' engineer and 'expert' rule behind. When women were not consulted and did not participate in the design of standpipe and tube wells, the designs are found to be inappropriate and the projects failed (Faisal and Kabir, 2005; Regmi and Fawcett, 1999). If women are not involved in the planning, design and control of the water systems, they are not likely to be interested in participating in them and again failures occurs (Regmi and Fawcett, 1999). This evidence suggests that a feminist engineering approach can provide '*appropriate*' and '*sustainable*' drinking water improvement projects.

2.5 Chapter summary

This chapter has achieved its objectives which were to introduce the topic of drinking water and drinking water quality in developing countries, discuss perceived drinking water quality, aesthetics and risk, and highlight the current policy forming debates.

Clean and safe drinking water is vital for good health, but a surprisingly high percentage of the world's population lack this luxury. Diseases related to lack of or poor quality water are still killing many people, although these diseases are easily preventable and treatable. Improved drinking water quality has been proved to be an effective and economic tool against diarrhoeal disease. Drinking water quality can be improved through treatment, safe storage and good handling practices. Mounting evidence suggests that a clean source of water does not guarantee that water is safe when it is consumed.

There is a contradiction in the importance that institutions and people place on different drinking water quality parameters, due to the difference in perceived drinking water quality and actual drinking water quality. Perceived drinking water quality has been linked to a number of parameters, the most cited being drinking water aesthetics and risk. The aesthetic quality of drinking water is virtually the only basis consumers can use to judge their drinking water quality. The senses used to judge the aesthetic qualities of drinking water have developed over millions of years to prevent us from consuming harmful substances. If unclean water is consumed there is the risk that a person will become ill or die. Our survival and evolution is based on the way we assess and manage risk. In a developed world context there is a difference between perceived risk and actual risk in relation to drinking water quality. Perceived risk in the context of drinking water quality has been linked to the aesthetics of drinking water and perceived drinking water quality. Little distinction was made in the literature between perceived drinking water quality and perceived risk. From reviewing the literature it was concluded that perceived drinking water quality, aesthetic drinking water quality and perceived risk were intrinsically linked. This relationship formed the basis for the hypothesised model in Figure 1.2.

The difference between perceived and actual drinking water quality, and perceived and actual risk has led to averting behaviour in developed and developing countries. These factors have led to the loss of the health benefits from drinking water improvement schemes, since even if a drinking water is microbiologically and chemically safe, but looks, smells or tastes different or strange, people will not consume it. From the literature it was found that these factors were very important in relation to drinking water sources being sustainable and appropriate, but no studies exploring these factors have been undertaken in a developing counties context.

Delivery of good quality drinking water is the focus of MDG 7. This MDG is focused on a set of ‘improved’ technologies and is based on the delivery of safe water. It has been noted that how water is stored and handled generally has a greater influence on water quality than the source and delivery. This target ignores the quality of water once in the household, the continuity of the source, the cost and the number of people using the source. It is technology biased and ignores the link between social and political conditions. The statistics generated for this MDG have been questioned due to a number of reasons, the main one being that they do not reflect the situation in the field. Even considering all of these criticisms, the MDG targets are presently the main focus of the WASH community and governments, but the provision of an improved water source is no guarantee that the water source will be used for drinking and cooking.

The UN human right to water is not legally binding, but has been adopted into national constitutions. The human right to water is often interpreted as being opposed to privatisation, while it is in fact compatible with private sector provision of water supply. It puts the human right to water above all other including the environment. As with the MDG, it is a top down approach focused on national governments and large institutions. The UN human right to water has politicised the right to safe drinking water for all, compared to only halving those without access to improved water sources in the MDG. It also stresses the '*acceptability*' of water, which is linked to perceived drinking water quality and will make a water supply more '*sustainable*' and '*appropriate*'.

Water and money are intrinsically linked in a number of ways including the commodification of water, costing of water supply, willingness to pay for water and the low priority of water. The commodification of water is a controversial topic and different management strategies other than privatisation are now coming into the limelight. This is because privatisation has failed to deliver water to the World's poor. In many situations poor people are paying the most for their drinking water, but defining the term 'affordable' in this context is problematic. WASH suffers from chronic underfunding due to the lack of understanding in governments between the link between poverty and water. This could be overcome if the significant economic returns of WASH interventions were more widely recognised.

Water is an extremely gendered issue due to the household water managers being predominately women. A technology approach based on 'experts' and dominated by male decision making has often proved to be unsustainable and inappropriate. Drinking water improvement schemes need an interdisciplinary approach, as engineers need an understanding of social sciences to interpret gender in their projects' contexts. A feminist engineering approach is required which extends beyond participation and influences the design and development of technologies used for drinking water improvement schemes to become ‘appropriate’ and ‘sustainable’.

Chapter Three: Approaches and methods

The objectives of this chapter are to introduce and critically analyse different approaches and to justify the approach and methods used in this thesis.

3.0 Mixed methodology approach

The different approaches and their underlying methods can be split into two subcategories: qualitative and quantitative. The two approaches are similar in that they are concerned with answering a research question, by reducing data and relating it to relevant literature. Both approaches strive to uncover and explain variation, try to avoid distortion of data, aim for transparency in their work and address the question of error (Bryman, 2008, Philip, 1998). The differences in the two approaches have been discussed in detailed by Bryman (2008) and are summarised in Table 3.1.

Table 3.1: Some common contrasts between qualitative and quantitative approches (adapted from Bryman 2008)

Qualitative approach	Quantitative approach
Words	Numbers
Small sample set	Large sample set
Points of view of the participant	Points of view of the researcher
Researcher close	Researcher distant
Theory emergent	Theory testing
Process	Static
Less structured	More structured
Contextual understanding	Generalised
Rich, deep data	Hard, reliable data
Micro	Macro
Meaning	Behaviour
Natural setting	Artificial setting

The division of the approaches and their associated methods are not as dichotomous as Table 3.1 suggests. There are several grey areas in the classification of methods, an example of which is structured interviews, which authors have classified under both approaches (Bryman, 2008, Oppenheim, 2003, Patton, 1986, Tashakkori and Teddlie, 2003).

As a result, the two approaches have been used successfully together in a mixed methodology approach. This approach is especially applicable in projects where social and physical issues interact and due to this it has been used successfully in a number of water related fields such as; drought, (Hill and Polsky, 2007), water politics (Laurie and Crespo, 2007), water management (Bakker, 2007, Katsi *et al.,* 2007) and water and gender (Faisal and Kabir, 2005).

Bryman (2008) identified 16 justifications for using a mixed methodology approach can be found in Table 3.2, as can examples of their use in this thesis. Using a mixed methodology in this thesis allowed for the collection of a large amount of data in a limited time. It increased the validity of the results gained (as the researcher was very aware that people often tell you what they think you want to hear). This approach allowed for flexibility in the choice of methods, so specific methods could be chosen to suit specific research questions. The multidisciplinary natures of the research questions addressed in this thesis are ideally investigated by using a mixed methodology approach.

Initially it was thought that the two approaches could be used separately, so that the validity of each approach could be investigated. After the initial field visit however it was noted that using a mixed methodology added greater validity to the results gained and also generated key elements outlined in Table 3.2 (Offset, Completeness, Explanation, Method Development, Context, Illustration and Utility).

There are two main arguments against using a mixed methodology approach. The first argues that qualitative and quantitative approaches have specific epistemological groundings that are diametrically opposed. The second is that each approach represents different paradigms which are incommensurable. Nevertheless the researcher supports Bryman's (2008) argument that questions these assumptions because the approaches overlap and are not therefore separate paradigms (Bryman, 2008).

A diagram of the use of the two approaches together with the methods chosen can be seen in Figure 3.1. The research questions to be addressed in this thesis were introduced in

Section 1.1. and Figure 3.2 shows which methods are used to address each of the research questions (listed below).

RQ1: What is the current water and sanitation situation in Bellavista Nanay?

RQ2: What is the current drinking water situation in Bellavista Nanay?

RQ3: What are the factors related to the perception of drinking water quality?

RQ4: Do people know how safe/clean their drinking water is?

RQ5: Is perceived drinking water quality linked to actual drinking water quality?

Table 3.2: Justification for using a mixed methodology

Classification	Justification	Examples of use in this thesis
Triangulation	Methods combined in order to be mutually corroborated, increasing validity and credibility of results	The use of interview and observation to corroborate questionnaire findings on drinking water practices in the community. Spring water was identified as being a community water source which was then investigated further using observations and interviews with members of the community. It was found that there were no sources of spring water in the community; hence the questionnaire results were disregarded.
Offset	Offset their weakness and draw on strengths	The questionnaire was initially used to find out if people harvested rain water The details of the practices were discovered by participant observation and interviews.
Completeness	A more comprehensive account	The use of observational data, photographic data, questionnaire data, interview data and documentation to gain a more comprehensive view of drinking water practices than could have been gained by using one method or approach.
Process	Quantitative approach provides account of structure and qualitative approach provides a sense of process	The questionnaire data provided the source of information available to the community and the topics. This data was then used to undertake a media study using newspapers.
Different research questions	Each approach is used to answer a different research question in the same context	The use of a questionnaire to investigate perceived drinking water quality and the use of microbiological techniques to investigate actual drinking quality.
Explanation	Opposite approach is used to help explain the findings generated by the other approach	The questionnaire was used initially to question respondents about their household drinking water practices. Informal interviews and open questions were used to find out why certain practices occurred.
Method development	One approach is used to develop a hypothesis or methodology and the second approach is used in the study	The use of the questionnaire to gain data on the types of information available in the first field trip, which was then developed into a media study in the second field trip.
Context	Qualitative and quantitative approaches used to develop a deep understanding of a specific context	The use of observational, photographic, questionnaire data and documentations was used to baseline the community
Illustration	Qualitative data used to illustrate quantitative findings	The data collected via informal interviews was used to explain household drinking water treatment data gained from the questionnaire.
Utility	Using two method will be more useful to practitioners and others	The numbers generated by the questionnaire data are more acceptable by Engineers and Scientists. While the observational, interviews and photographic data are more acceptable to Social Scientists. By using a mixed methodology approach the findings should be acceptable for both disciplines and also increases the multidisciplinary nature of this thesis.

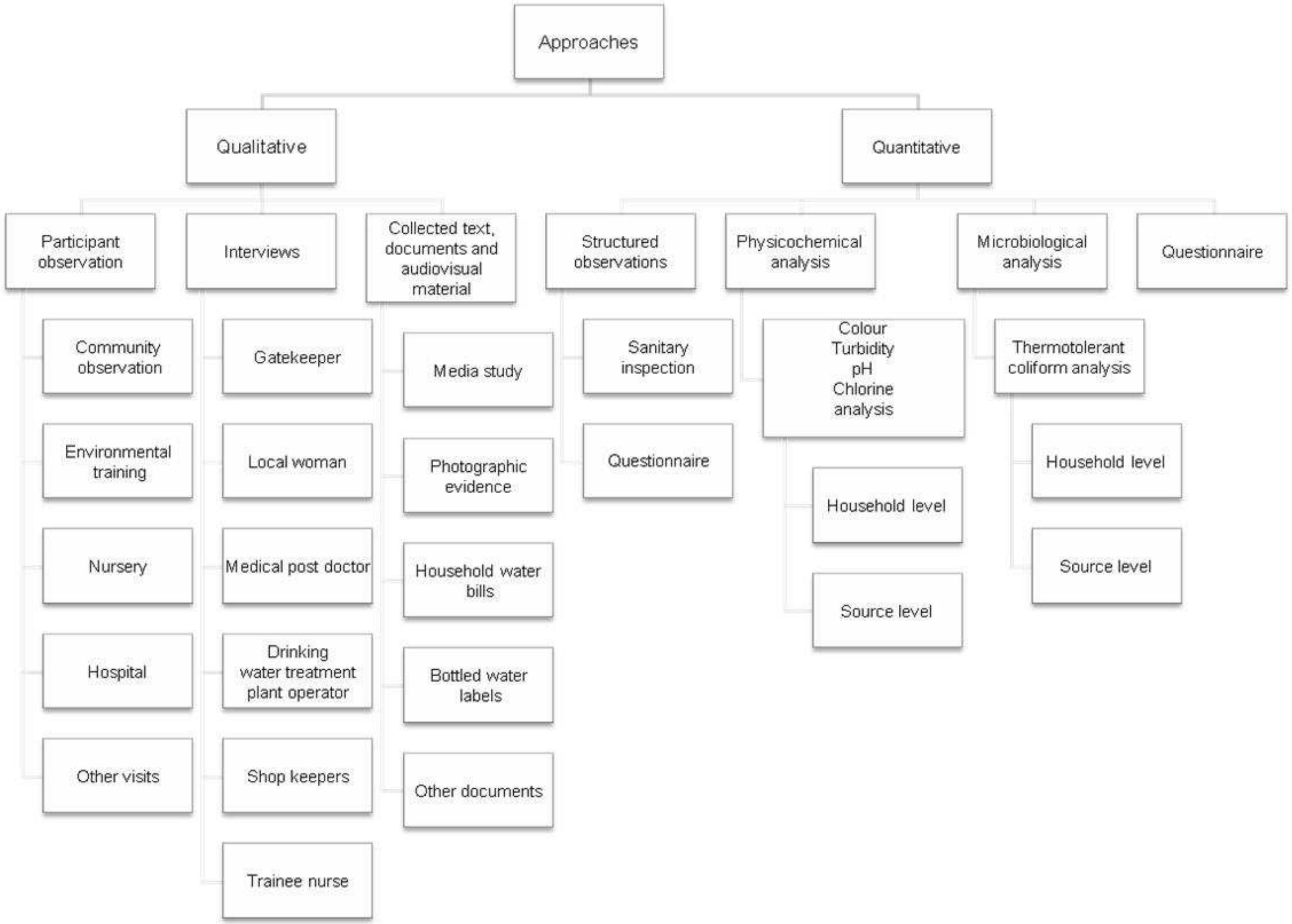

Figure 3.1: Approaches and methods used

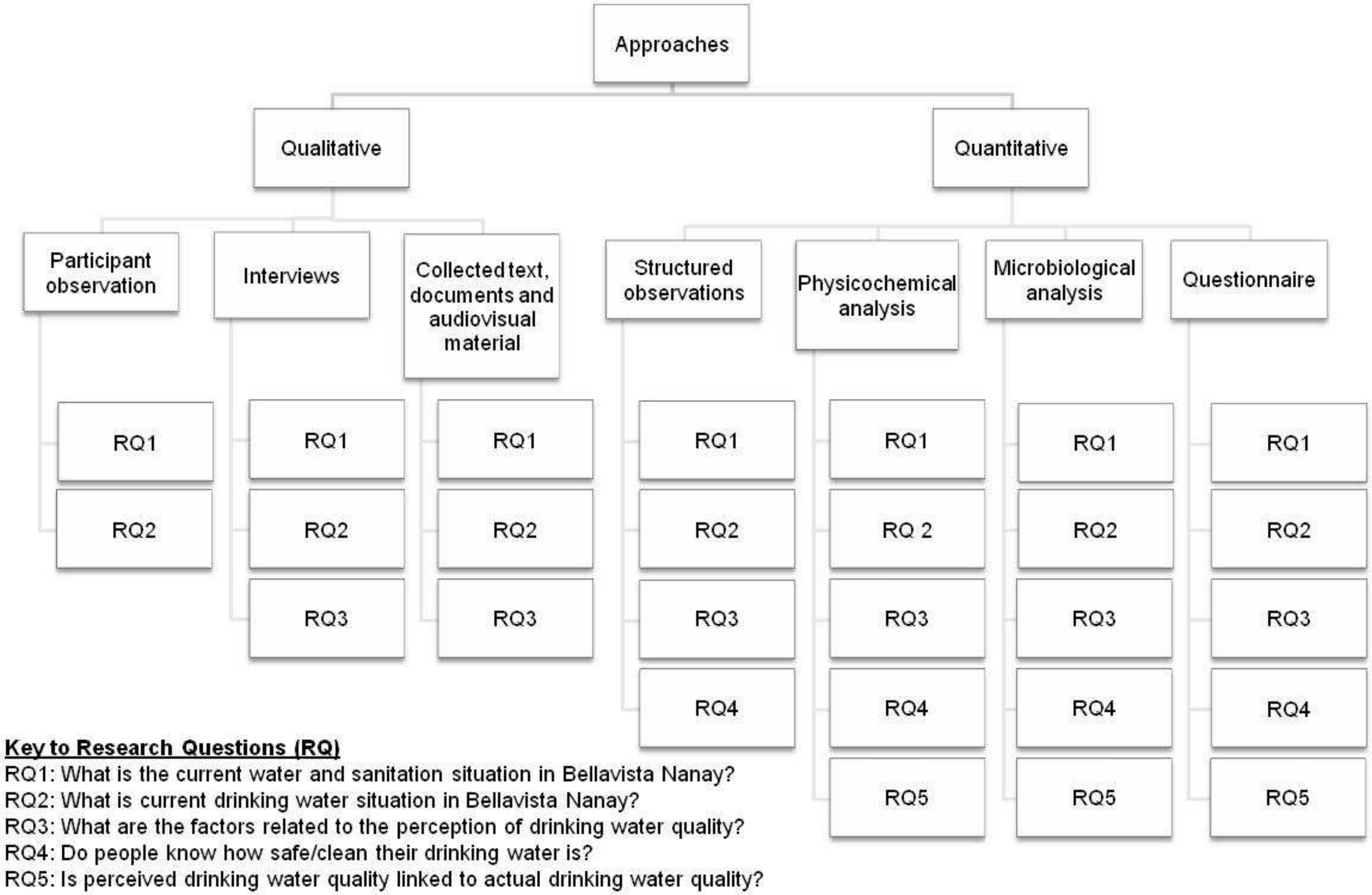

Figure 3. 2: Approaches, methods and research questions addressed

3.1 Qualitative methods

Qualitative methods have been discussed in depth by many authors (Bryman, 2001, Bryman, 2008, Creswell, 2003, Tashakkori and Teddlie, 2003). The emphasis of this section is to give an introduction to the specific methods used and how they relate to the research topic of perceived drinking water quality. The methods used in this study are:

- Participant observation
- Qualitative interviews
- Collection of texts, documents and audiovisual material

How each method was used to address specific research questions can be seen in Figure 3.2.

It has been argued that qualitative approaches are more appropriate when studying the social world as they can encompass and record the complexity and richness which exist in this sphere (Taylor, 2002). Qualitative research is grounded in a local context and time frame, so the results cannot be scaled up or transposed. These methods are specifically suited to the case study approach taken in this thesis. The data generated by this approach is generally thick and descriptive, which can make it difficult to interpret.

The objectivity of these methods has been questioned. Objectivity itself suggests that the researcher is able to obtain knowledge from the surrounding world which exists independently from the research process. However the researcher would argue, like many others, that in reality this separation does not exist. People's perceptions and interpretations are selected and shaped by the understanding they bring to any situation. It is not possible to perceive the world as a separate step prior to attaching a meaning to it (Taylor, 2002). This is particularly relevant in the case of research on perception of water quality due to its subjective and personal nature. It is not possible to collect this kind of data, which is thick, rich and in-depth data, using quantitative methods. In a quantitative study the details or explanations as to why certain practices occur would not be uncovered.

3.1.1 Participant observation

In participant observation the researcher observes the interactions of participants in their own context. This method can be subdivided by the amount of interaction the researcher has with the participants and if the researcher's role is disclosed (Spradley, 1980, Creswell, 2003, Taylor, 2002). This method is most prevalent in anthropology, human geography and sociology, although many other disciplines have used this method, for example: tourism (Taylor, 2002), medicine (Hunter, 2005, Johnson and Barach, 2008) & engineering (Taylor, 2002). It has been used in many areas of water research, especially the sensory aspects of water (Strang, 2005), drinking water practices (O'Reilly, 2005) and the culture of drinking water (Ennis-McMillan, 2006). In drinking water practices and WASH, participant observations are generally incorporated into knowledge, attitudes and practices (KAP) surveys such as the studies on hygiene, sanitation and safe water use in Bangladesh (Ahmed *et al.,* 2001) and water handling, sanitation and defecation practices in rural southern India (Banda *et al.,* 2007).

The time required to research using this method varies, but typically a field researcher may spend several months, years or a lifetime researching their chosen community (Ennis-McMillan, 2006, O'Reilly, 2006), which is significantly longer than other methods. The researcher's responses are bound by their culture and reflexivity is required when analysing the results from this method.

As long as the constraints of this method are thoroughly taken into account, this method produces rich and complex data which cannot be obtained in other ways. The data produced is more explicit than that generated by other methods. Ahmed and colleagues (2001), for example, noted that through observation the most reliable information on hygiene behaviour could be gathered. Participant observation can also be used to compare what people say they are doing to what they actually do. This is clearly illustrated in this thesis in Chapters 5 and 6.

Cresswell (2003) states that the advantages of this method are that the researcher gains firsthand experience of the participants, the information gained can be recorded as revealed, and unusual aspects can be noted. This makes it useful when exploring topics that may be deemed as sensitive by the researcher or participants. This method was highly appropriate for this study due to the exploratory nature of the work and the sensitive subjects encompassed in water and sanitation. There are of course limitations and these include the fact that the researcher may be seen as intrusive and private information may be observed which cannot be revealed. Critical to the success of this method are good observation skills (Creswell, 2003).

Participant observation was undertaken whilst the researcher lived in Bellavista Nanay. The presence of the researcher and the project aims were fully disclosed, due to actively embedding the project in the community (discussed in Section 3.6). The researcher’s level of participation varied in different situations, from non-participation at events such as witnessing rain water harvesting and the lay preachers meeting, to moderate participation in events such as the presentations by Superintendecia Nacional de Servicios de Saneamiento[14] (SUNASS), and finally, active participation at the nursery and cultural events.

In the context of this thesis participant observation was used firstly to aid the development of the questionnaire, e.g. identification of the assets and services which households had, which were used in the development of the income proxy and in defining the terminology used (Method Development). Secondly to validate the data collected from the questionnaire, e.g. when spring water was identified by one respondent as being available in the community, but through observation this source could not be found (Triangulation). Thirdly to gain a deeper understanding of drinking water practice in the community, e.g. observing participants handling their drinking water while providing a sample (Context, Illustration and Completeness). Finally participant observation was important for explaining some of the specific

[14] SUNASS is the regulatory body which address standards, consumer rights, tariffs and privatisation issues

findings generated by the questionnaire, which did not make sense without the additional in depth observational data, e.g. the collection of river water at dusk, which was used for washing rather than drinking (Explanation).

It was acknowledged that the introduction of the researcher into the community may have caused the respondents to change their behaviour, but due to the time span of the study and living in the community certain behaviours were witnessed several times, such as people going to bathe at dusk. The community itself was used to the presence of 'outsiders', as the Gatekeeper (discussed in Section 3.6) had many visitors in the past and visiting foreign missionaries are common in this area. It was felt that by embedding the project, the time spent in the community, the community's exposure to 'outsiders' and by using a mixed methodology approach, this bias was minimised as much as possible.

A questionnaire survey was used to gain access to households, so that general observations could be made. This strategy was also used by Trevett and colleagues (2005) in their study of household drinking water quality in Honduras. It was an important tool in this research because it allowed the researcher to gain access to people's homes, the place where drinking water practices occur.

General observations were made of drinking water practices in the household where the researcher lived and the community (June to July 2006 and September to December 2007). These were recorded in a field diary. Passive observations were also made at a bi-yearly (week long) workshop for lay preachers[15] from the Parroquia San Pedro Pescador as a self administered questionnaire was undertaken to collect socio-demographic and other information (9/6/2006). This data gathered was used in the development of the questionnaire (discussed in Section 3.3). In addition, four mornings (26/09/2007, 05/10/2007, 11/10/2007, 18/10/2007) were spent in the parish nursery where the researcher worked as a volunteer. There she was able to

[15] The lay preachers were local men and women from outlying communities in the parish

observe sanitation and hygiene practices among children ranging from the ages of two to four.

Other visits were made ‘outside’ the boundaries of the community. During these visits general observations were made, which were recorded in field diaries, documents were also collected and interviews were undertaken (as described in Section 3.1.2). During the second field trip a visit was made to the EPS Sedaloreto S.A., the local drinking water treatment plant (19/09/2007). A member of staff was interviewed about the general processes used, which along with observations about the drinking water treatment plant, were recorded in the field diary. This information was used to corroborate the data collected from the physicochemical analysis of water samples (as described in Section 3.2.2) and the questionnaire on the treatment of drinking water (Triangulation). The data was also used to establish the context of drinking water treatment and supply in the community.

The medical post in the community was visited (20/09/2007) and so were all of the hospitals: Ana Stahl (private hospital run by the Adventist church 22/10/2007) Salude (a hospital for teachers and government workers 22/10/2007) and La Hospital Regional (state run hospital 16/09/2007). The aim of these visits was to gain an insight into the availability of information on water-related diseases (Context). At the local medical post a member of staff was interviewed (as described in Section 3.1.2), and at the other institutions observations were made which were recorded in the field diary.

A public presentation titled ‘¡¡Ahorremos aqua potable, se vida!!’ (*Lets save drinking water, its life!*) by SUNASS was made on the 04/10/2007, which was publicised in the La Región on 30/9/2007. This event was attended children from privately run schools[16]. The themes covered, the attendees and the approach taken were noted in the field diary.

[16] A school where which is not run by the state and where the parents pay attendance fees for their children.

3.1.2 Interviews

When a researcher questions the research participants on a certain subject it can be classified as an interview. This method can be further subdivided depending on the structure of the interview (e.g. informal conversations, general interview, and open ended interview) and how the interviewer interacts with the interviewee, such as face to face interviews or telephone interviews.

This method proves useful when participants cannot be observed directly, to gain historical information, and when the researcher would like to control the line of questioning (Creswell, 2003). In the sphere of this thesis interviews were used specifically to control the line of questioning as seen in Table 3.3. The limitations to this kind of data collection are that it provides indirect information compared to participant observation and the participants may be taken out of their natural sphere. Again the researchers presence may bias the response (Creswell, 2003). The limitations were minimised in this research by undertaking all interviews in people's work or home settings and using the interviews in conjunctions with data collected from the questionnaire (described in Section 3.3) and participant observations (as described in Section 3.1.1).

Interviewing has been successfully used in a number of water related areas including; water usage studies (Katsi *et al.,* 2007), management of water (Machingambi and Manzungu, 2003), gender and water (O'Reilly, 2006, Laurie, 2005), water availability (Hersch-Martinez *et al.,* 2004, O'Hara *et al.,* 2008), water and sanitation needs (Bapat and Agarwal, 2003), and water improvement projects (Laurie and Marvin, 1999).

In this thesis interviews were used to add depth and detail to the questionnaire data (Completeness) and to answer questions that arose from this data (Explanation). Specific interviews were undertaken with shopkeepers and the head of the medical post to add context to specific areas such as household chlorination and the prevalence of water-related diseases in the community. The interviews undertaken were semi-structured and took place in the interviewee's place of work.

Unstructured interviews and informal conversations were undertaken with the gatekeeper, a local woman, a trainee nurse, the medical post doctor, local shop keepers and a drinking water treatment plant worker. The data from these interviews were used to develop the questionnaire (Method Development), build on the context of the study gained from other methods (Completeness) and to explain the findings generated through other means such as passive observations and the questionnaire (Triangulation). Details of all interviews can be seen in Table 3.3.

Table 3.3: Details of interviews and themes

Interviewee	Description of Interviewee	Date	Recording of data	Key theme(s)
Gatekeeper	A male community leader who was non native to the country. Aged approximately 37 and educated to a university level.	Throughout the period of the study	Notes kept in field diary	General drinking water practices Household treatment How the community developed Disease in the community His household practices Confirmation of information from other sources
Local woman	A female mother of two, who was born, works and lives in the community. Aged approximately 31 and educated to secondary school level	Throughout the period of the study	Notes kept in field diary	General drinking water practices Household treatment How the community developed Disease in the community Her household practices Confirmation of information from other sources
Medial Post Doctor	A male, aged approximately 39 educated to a university level, who lives outside of the community	17/09/2007 (pm) Interview lasted approximately 20 minutes.	Notes kept in field diary	Educational material on WASH Educational material on water-related diseases Do they have chlorine tablets Who funds the chlorination programme?
Water treatment plant operator	A male operator working and living outside the community. Aged approximately 25 and educated to a university level	19/09/2007 (am) Trip lasted approximately 2 hours	Notes kept in field diary	The treatment process for drinking water at the municipal plant
Local shop keepers (16 in total)	Various, but detailed notes were not kept	18/09/2007 (am) 01/10/2007 (am)	Notes kept in field diary	Do they sell "anything" to treat water for drinking?
Trainee nurse	A male living in the community who is aged approximately 22.	Throughout the period of the study	Notes kept in field diary	Information that was readily available to patients on water-related diseases

3.1.3 Collection of text, documents and audiovisual material

In this method the researcher collects text, documentation and audiovisual material on their research topic, such as photographs (Bunster and Chaney, 1995), video tapes, art objects (Singhal and Rattine-Flaherty, 2006), software and films. These may include private and public materials.

The limitation of this method is that the data may be protected, incomplete, selective or inaccurate. It requires time to find the data and some data such as the interpretation of images may be difficult to analyse (Creswell, 2003). However the advantages are that this method is unobtrusive, the data can be analysed at a time convenient to the researcher, can be collected retrospectively and the data is grounded in the social setting (Tashakkori and Teddlie, 2003). This method has been used in the context of drinking water in areas such as the water sector and gender (Laurie, 2005), water and sensory experiences (Strang, 2005), and drinking water risk events and the media (Driedger, 2007).

Text documents such as government produced maps, Peruvian publications (such as the Altas Departamental del Peru Loreto San Martín (Anon., 2003), Coordinadora Nacional de Derechos Humanos (Cordova Cayo, 2005), and Informe Annual: Derechos Económicos Sociales y Culturales (Derechos Economicos Sociales y Culturales, 2004), household water bills and photographic evidence of drinking water practices were collected to achieve a better understanding of the context of the study. These data was used to validate data collected by quantitative methods such as the questionnaire and to illustrate some of the questionnaires findings. An example of this is the use of content analysis of newspaper articles which was compared to the themes cited by the respondents in the questionnaire.

A content analysis was undertaken to gain an overview of the media coverage on the local and national scale, on topics related water. This analysis was used to uncover the themes and topics that the community was exposed to, as external information is known to affect people's perception of drinking water quality (Owen *et al.,* 1999b, Sheat, 1992, Owen *et al.,* 1999a, Um *et al.,* 2002, Jardine *et al.,* 1999). These data was used to set the context of the study by giving an overview of the information that was readily available to the community on water (Context).

The specific advantages of media analysis are that it is inexpensive, easy to obtain material (with exceptions discussed below) and unobtrusive (Berger, 1998). The main disadvantages are that it is difficult to gain a representative sample and to define the themes and units used (Berger, 1998).

Theme analysis rather than newspaper column inches was used, as a comparison could then be drawn between the television news and newspaper content as in Driedger (2007). After a trial period the television study was abandoned due to technical problems (the field assistant was unable to set the video recorder to tape the appropriate programme). It had been noted by Driedger that if only one media source is to be used, newspaper coverage gave a more comprehensive coverage during water risk events than television. When studying media at community or local level, Driedger (2007) also found print media to be more useful than other media sources due to increased coverage. It was therefore felt that a newspaper study covering both national and local newspaper would be appropriate for this thesis.

The methodology adopted was similar to Driedger (2007), although a predetermined list of themes was not used. The list of themes evolved from the topics given by the questionnaire respondents in the previous year. The units of analysis were dictated by the purpose of analysis (Krippendorff, 2004). Theme analysis continued to be used even after the television study was abandoned.

The period of time when the research was in the field in 2007 (from 12/9/2007 to 27/11/2007) La República (a national newspaper) and La Región (a local newspaper) were analysed. These newspapers were published seven days a week and the dates of this study spanned the time the questionnaires were administered excluding the final questionnaire day (28/11/2007). Any stories relating to WASH were classified into one or more of the following themes; drinking water, sanitation, hygiene, water-related disease, water conservation or other (as seen in Appendices 1 and 2). These themes were then compared to the themes highlighted by the questionnaire respondents (as seen in Appendices 3 and 4) to ascertain where the questionnaire respondents where gaining their information.

Analysis of the labels on bottled water was undertaken in 2007, to gain a deeper understanding of the questionnaire respondents' brand and company awareness (Completeness and Triangulation). The information of special interest on these labels was company ownership, as perception of drinking water quality has been related to trust of source.

In 2006, monthly household water bills (September 2005, October 2005, November 2005, and January 2006) from the researcher's residence were examined. Household water bills were not obtained from other households in this community as only a few houses had a piped water supply that was directly billed, plus the bills were seen to contain confidential and sensitive material. This was done to gain further information to aid the analysis of the cost of municipally treated piped water (Completeness and Triangulation). Gaining this information was pivotal in the discovery of gifting and informal trading of water as discussed in Chapter 4.

As no map of the community could be found, an annotated map of the community was commissioned from a local artist (14/6/2006). This was later redrawn with information gained from www.maps.google.com. A map of the community enabled the spatial distribution of the data to be assessed which would aid practitioners and respondents to visualise the data collected. The map was also used in the reports sent back to the community (Utility). This map can be found in Figure 3.3.

Photographic evidence was collected throughout the community. Photographs were taken of the community, housing, drinking water sources and practices. The data collected from these photos was used to set the context and to illustrate the answers of the questionnaire as in Figure 4.1 which shows typical housing in this community. They were also used to validate the data collected through the questionnaire, such as in Figure 5.6 which shows people collection water from the tanker (Triangulation). Photographs were also taken of the questionnaire respondents (when permission was gained) which were then developed and sent back to them as a memento of the study (as described in Section 3.6).

3.1.4 Field diaries

Field diaries were kept during both field visits (June to July 2006 and September to December 2007). The information recorded not only included the data from the methods above, but also weather conditions, queries, comments, additional information gained from the questionnaire respondents and the researcher's ideas and feelings.

3.2 Quantitative methods

The main characteristics of the quantitative approach were given in Table 3.1. These methods are concerned with measurements which enable data to be compared and correlated using statistical methods (as described in Section 3.5). The emphasis of this section is to give an introduction to the specific methods used and how they relate to the topic of perception of drinking water quality. The methods used in this study are:

- Structured observations
- Physiochemical and microbiological analysis
- Questionnaires

How these methods were used to address specific research questions can be seen in Figure 3.2.

The main drawbacks of quantitative methods are that one needs to know what one is measuring. If an indicator is being used, e.g. income proxy (Section 3.3.1) or indicator bacteria (Section 3.2.3), a relationship between the indicator and what one is trying to measure needs to be established.

3.2.1 Structured observations

One form of structured observation conducted in this research was sanitary inspection. Sanitary inspections are generally used to assess the potential risk of faecal contamination of a drinking water source. They have proved to be a useful tool that can be easily used in the field (Giannoulis *et al.,* 2003, Howard *et al.,* 2003) . Sanitary inspections were first developed by the WHO, which has been emphasising their importance for some time (Lloyd and Bartram, 1991, Lloyd and Helmer, 1991, WHO, 1976, WHO, 1997b).

The sanitary inspections of water sources provided a knowledge base for the perceived contextual indicators (defined in Section 1.1) and corroborated the data collected in the questionnaire on the respondents' perceptions of these indicators (Triangulation and Completeness). This data was also drawn upon to set the context of the study especially where sampling at source, and to illustrate some of the findings from physicochemical and microbiological analysis.

The sanitary inspections took place on 1/7/2006, 11/7/2006 and 28/9/2007. All sites were visited once a week so that any changes that occurred could be recorded. Sanitary inspections were carried out at all source sampling points using the guidelines, methodology and forms from Annex 2 of the WHO Guidelines for Drinking Water (WHO, 1997b).

Some structured observations were also incorporated into the questionnaire and are discussed in Section 3.3.

3.2.2 Physicochemical parameters

The physicochemical parameters chosen are those that affect the perception of drinking water quality and can be easily measured in the field. Doria and colleagues (2005) hypothesised that physicochemical water quality was related directly to aesthetical estimations, although they did not explore this hypothesis in their research. This relationship and link was explored in the thesis and can be seen in the hypothesised model in Figure 1.2 (page 12).

The parameters chosen were visual (turbidity and colour), flavour (pH and residual chlorine) and odour (residual chlorine), all of which are aesthetic indicators of drinking water quality. These parameters are commonly used in international and national legislation, due to the unacceptability of drinking water to the consumer when it falls outside of the ranges stated in Table 3.4.

Table 3.4: Drinking water parameters acceptability and standards

	WHO health guidelines (WHO, 2004)	**Acceptance levels (WHO, 2004)**	**US standards (EPA, 2008)**	**Peruvian Standards (Peru, 1946, SUNASS, 1997)**
Chlorine (mgl^{-1})	5	0.6 - 1	4[1]	>0.5[3]
pH	none	none	6.5-8.5[2]	6.5-8.5
Turbidity (NTU)	none	<5	none	10 ppm
True colour (Hazen)	none	<15	15[2]	20
Microorganisms (cfu/100ml)	*E.coli* 0 or Thermotolerant coliforms 0	none	Total coliforms 0[1]	Total coliforms 5

[1]EPA national primary drinking water standards
[2]EPA national secondary drinking water standards not obligatory
[3]80% of samples from the distribution system need to have this level of residual free chlorine

Physicochemical analysis of respondents' household drinking water and samples taken directly from drinking water sources available to the community were undertaken as described in Section 3.2.4. The results from the household samples were then compared to those taken directly from the source waters, so household contamination could be identified and to confirm the stated source of household water samples (Triangulation). The household results were then compared to how respondents rated each drinking water parameter and the overall rating they gave to their drinking water quality, which is explored in Chapter 8.

Residual Chlorine

Chlorine is the most common disinfectant used to treat drinking water. It can be used on a large or small scale from municipal drinking water treatment plants to household drinking water treatment. The disinfection process using chlorine involves the addition of more chlorine than is required to disinfect the water (residual chlorine), so that a certain level of residual chlorine is present to protect water when it is stored or transported. The residual chorine can be present in two states, free chlorine (hypochlorous acid and hypochlorite) and combined chlorine (chloroamines). Chloroamines are formed when free chlorine reacts with ammonia ions present or added to the water (Sawyer *et al.,* 1994). In general free chlorine is a more effective disinfectant, but dissipates quickly, whereas chloramines have a greater longevity due to being less reactive. It is generally common to find both species of chlorine present when chlorine is used as a disinfectant.

The presence and type of chlorine in samples will depend on the treatment used and the storage time of the drinking water. If chlorine is present then no microorganisms will be found, due to its disinfection qualities. The WHO guidelines for chlorine can be seen in Table 3.4, but it should be noted that they are conservative as no adverse health effects have been identified at higher levels (WHO, 2004). In general if a drinking water has been treated with chlorine the residual will be between 0.2 and 1.0 mgl^{-1}. Some individuals are able to taste chlorine at these levels (Mackey *et al.,* 2004, Piriou *et al.,* 2004). At higher residual levels there is an increased likelihood that consumers will reject a drinking water source (WHO, 2004). Several studies have linked the rejection of drinking water sources or household drinking water chlorination to the taste associated with the chlorine (Allgood, 2004, Biswas *et al.,* 2005, Moser *et al.,* 2005, Um *et al.,* 2002).

Samples were analysed for total, free and combined chlorine by the method described in the Oxfam DelAgua manual (Robens Centre for Public and Environmental Health, 2004). The samples were analysed within three hours of being taken as recommended in the standard method, as chlorine in aqueous solution is unstable (Standard Method 4500-Cl (Clesceri *et al.,* 1998)). The method used was an adaption of Standard Method 4500-Cl G (DPD Colorimetric Method (Clesceri *et al.,* 1998)) using colour scale rather than photometer, so it was appropriate for use in the field. For statistical purposes when levels of chlorine were below 0.1mgl^{-1}, a level of 0.0 mgl^{-1} of chlorine was recorded.

pH

pH is a measure of the hydrogen ion activity in a solution and is used to express the acid or alkaline condition of a solution. pH can affect the drinking water treatment process (Sawyer *et al.,* 1994). No health based guidelines are set for pH by the WHO, but different national standards can be seen in Table 3.4. The national standards are set because when the pH of a drinking water is above or below this level people will not drink it due to taste (as discussed in Section 2.3.2). pH becomes a particularly relevant issue when looking at using rain water as a potential drinking water source. Rain water generally has a lower pH compared to other water sources, which affects its taste (Simmons *et al.,* 2001, Nevondo and Cloete, 1999, Adeniyi and Olabanji, 2005).

During the first field trip in 2006, pH was measured as described in the Oxfam DelAgua manual (Robens Centre for Public and Environmental Health, 2004), but in the second field trip a Palintest ® Microcomputer pH meter was used. The original method used was limited by its sensitivity, as it could only measure pH in the range of pH 6.8 and 7.2. In 2006, 60% of household samples fell at the lowest part of this range (pH of 6.8 or below). Due to this the data collected for 2006 was not analysed further.

The pH meter used in 2007 was able to analyse samples at levels below pH 6.8. It was calibrated daily using BDH buffer tablets at pH 4.00 and pH 7.00 (both $\pm$ pH 0.02) and used in accordance with the instrument manual.

Turbidity

Turbidity is a measure of the cloudiness of water and is caused by particulate matter. The particulate matter can be made of microorganisms, organic detritus, silica, clay, silt, fibres or other material (Zoeteman, 1980). Turbidity measurement was recommended by Wright *et al.* (2004) as it is a major influence in the regrowth and die-off of microorganisms. Drinking water is normally acceptable to a consumer when it has levels less than 5 Nepthelometric Turbidity Units (NTU) (WHO, 2004).

Turbidity was measured using the turbidity tube supplied with the Oxfam DelAgua portable testing kit, using the method in the manual (Robens Centre for Public and Environmental Health, 2004). This method was specifically developed for use in the field, as the standard method for measuring turbidity in water (Nepholometric method 2130 B (Clesceri *et al.,* 1998)) is reliant on the use of a turbidimeter which is not appropriate for field use. The samples were analysed within three hours of being taken and were agitated before being analysed as recommended in the standard method. When turbidity was below 5 NTU, 0 NTU was recorded for statistical purposes.

Colour

Colour in drinking water can be caused by organic matter, metallic compounds or the presence of algae (Zoeteman, 1980, WHO, 2004). In general people can identify colour at the level of 15 Hazen, but the acceptability of coloured water will vary between consumers. Colour and perception of drinking water quality has been discussed previously in Section 2.3.2. No health based limits are proposed by the WHO for colour, although the acceptability of colour to the consumer is often stated in legislation and appears in Peruvian legalisation, which can be seen in Table 3.4.

Apparent colour was measured using a Lovibond® Nessleriser 2250 in combination with colour discs (28411-4) 5 to 70 Hazen units and (28412-2) 70 to 250 Hazen units. This is the standard method for measuring colour in the field (Standard Method 2120 B Visual Comparison Method (Clesceri *et al.,* 1998)). The apparent colour not true colour was used. Apparent colour is the unfiltered colour of the water and more realistically represents the colour that is seen by the consumer. When the colour was below 5 Hazen units, 0 Hazen units were recorded for statistical purposes.

3.2.3 Microbiological analysis

Pathogenic microorganisms are small organisms, such as bacteria, protozoa and viruses, which make people ill. Due to health and safety concerns pathogenic organisms are not measured directly, but are estimated using 'indicator organisms'.

An ideal indicator organism for faecal contamination should have the following qualities (Toranzos and McFeters, 1997):

- Consistently present in faeces and at higher levels than the pathogen
- Absent in uncontaminated waters
- Should not multiply in the environment
- Resistant to environmental conditions and disinfection equal or exceeding that of the pathogen
- Assayed by simple and reliable tests
- Concentrations in water should correlate with the concentration of faecal pathogens or with a measurable health hazard

Comprehensive reviews of this subject have been undertaken for traditional bacterial indicators and non traditional indicators such as phages and DNA probes (Tallon *et al.,* 2005, Lemarchand *et al.,* 2004). Traditional indicators such as total and thermotolerant coliforms and *Escherichia coli* (*E. coli*) were developed for use in temperate regions. Their use in tropical regions is questionable because of reliability (Gawthorne *et al.,* 1996), growth and natural presence in tropical waters (Byamukama *et al.,* 2005), which contradicts the properties of an ideal indicator organism.

The expense and time associated with traditional microbiological analysis led to the development of the hydrogen sulphide test (Manja *et al.,* 1982) which has been used to look at the burden of illness in Nepalese households (Aterya *et al.,* 2006). This test has been evaluated by a number of researchers (Gawthorne *et al.,* 1996, Castillo *et al.,* 1994, Pathak and Gopal, 2005, Pillai *et al.,* 1999, Castillo, 2006). Their findings suggest that the main disadvantage of this method is that it is a presence or absence test, so no indication of the level of contamination can be gained. This test could be used to quantify bacterial contamination using the most probable number method, but this would not be appropriate for the field as a large number of samples bottles and sterile pipettes would be required. Also after evaluation by the WHO it was not recommended as a replacement for other testing procedures for faecal contamination of water. As no systematic efforts have been made to determine if the hydrogen sulphide test fulfils the essential criteria as an indicator of faecal contamination in water (Sobsey and Pfaender, 2002).

The WHO guidelines for drinking water recommend that no *E. coli* or thermotolerant coliforms should be present in a 100 ml sample (WHO, 1997a, WHO, 2004). In these guidelines they note that *E. coli* is a more precise indicator of faecal pollution, but state that thermotolerant coliforms are an acceptable alternative. However Brick and colleagues (2004) found that 93% of thermotolerant coliforms were *E.Coli.* Analysis for *E. coli* is considered too complicated for routine use, especially in the field, while analysis for thermotolerant coliforms has been recommended by a number of authors for field analysis in tropical environments (Lloyd and Bartram, 1991, Howard *et al.,* 2003).

Thermotolerant coliforms were chosen as the microbiological indicator for this thesis because of the well developed and relatively simplistic methodology which makes it appropriate for *in-situ* field analysis. (Robens Centre for Public and Environmental Health, 2004, Lloyd and Bartram, 1991). They have been used extensively in previous studies in tropical environments (Trevett *et al.,* 2004, Hoque *et al.,* 2006, Giannoulis *et al.,* 2003, Gilman *et al.,* 1993, Clasen *et al.,* 2004, Obi *et al.,* 2003, Howard *et al.,* 2003) and therefore the data from this thesis can be compared with other studies.

A biological indicator of drinking water quality was required to obtain a measurement of actual drinking water quality from households and directly from sources available to the community. The results gained from samples taken directly from the sources of drinking water were compared to those taken from the households, so that any contamination of drinking water at the household level could be identified. The households' samples were then correlated with the respondents' rating of their overall drinking water quality obtained through the questionnaire, which is explored in Chapter 8.

Samples were analysed for thermotolerant coliforms, according to the method described in the Oxfam DelAgua manual (Robens Centre for Public and Environmental Health, 2004). Household samples were taken in 500 ml polyethylene terephthalate (PTE) bottles, while source samples were taken in two litre PTE bottles. The bottles were sterilised by rinsing with ten drops of methanol, then rinsing five times with clean water[17], they were then sealed and until the samples were taken. Further details of the sampling strategy can be found in the subsequent section.

The Membrane Lauryl Sulphate Broth was prepared as in Section 3.3 of the Oxfam DelAgua manual (Robens Centre for Public and Environmental Health, 2004) and refrigerated until it was used. The petri-dishes were sterilised using methanol as in Section 3.5 of the Oxfam DelAgua manual (Robens Centre for Public and Environmental Health, 2004). The samples were analysed as in Section 5.4.4 of the Oxfam DelAgua manual (Robens Centre for Public and Environmental Health, 2004).

Depending on the assumed quality of the samples volumes of between <1ml to 100 ml were filtered. When volumes 10, 50 or 100 ml were filtered the appropriate marks on the filter funnel was used measure the volume. A 10 ml measuring cylinder was used to measure volumes of 1 to 10 ml. They were sterilised using ten drops of methanol, rinsed five times with clean water[17]and then rinsed five times with the sample. For samples of below 1 ml a disposable graduated 1 ml pipette was used, this was sterilised using the above procedure. If very small volumes were needed for highly contaminated samples such as the river water each 1 ml pipette was calibrated to determine the volume of each drop. This was done five times and the average volume per drop was used for analysis. When samples of below 5 ml were filtered, the filter was pre-wetted using clean water[17].

All samples were analysed in duplicate and duplicate blank samples were also analysed with each run. The samples were incubated at 44°C +/- 0.5°C for 18 hours.

[17] San Luis™ water was used a prior analysis and analysis throughout the field work showed that this water contained 0 CFU thermotolerant coliforms per 100 ml, no chlorine and was of neutral pH. This was the cleanest source of water available in the field.

The incubator temperature was checked monthly and recalibrated when necessary using method in Section 7.3 of the Oxfam DelAgua manual (Robens Centre for Public and Environmental Health, 2004). All yellow colonies were counted within 15 minutes of removing the petri-dishes from the incubator. If more than 100 colonies were present on the membrane, the number was estimated by dividing the membrane into sections and counting the colonies in a section. The results were then multiplied by the number of sections to obtain the estimate of the total member of colonies on the membrane. The numbers of colonies were converted into the number of colonies per 100 ml of sample.

3.2.4 Water sampling strategies

Each household water manager that answered a questionnaire was asked to supply one drinking water sample. Only one sample was taken from each household due to the limited time spent in the field and the need to explore household drinking water quality in relation to the answers given in the questionnaire. This was a valid sampling strategy at the samples taken were representative of the quality of water drunk at the time when the questionnaire was being answered. The respondents were given a sealed sterile bottle and took the sample from their main drinking water source. This strategy was used to provide a sample representative of the quality of drinking water at the point of consumption in that household. Fifty two samples were obtained from the questionnaire respondents in 2006, while 91 samples were obtained in 2007.

Water samples were taken directly from the sources identified in the questionnaire. These were river water, rain water, well water, tap water, tankered water and the three types of purchased bottled water all defined in Table 5.2. The sample sites for the river, well and tap water samples were identified in conjunction with Field Assistant 2 and observations. The river water sampling sites were chosen as community members were witnessed collecting water from these areas. Tap water was collected from a household which did not have a storage tank therefore the water came directly from the municipal water system. These samples were collected directly into sterile bottles. The river samples were taken in accordance with Section 4.2 of the Oxfam DelAgua manual (Robens Centre for Public and Environmental Health, 2004) using a sterile bottle, where the river was approximately 40 cm deep as people had been observed collecting water at this depth. The well water was collected as in Section 4.3 of the Oxfam DelAgua, (Robens Centre for Public and Environmental Health, 2004). All samples were analysed within three hours of sampling. All sources were sampled weekly or when samples were available. A map of the source sampling points can be seen in Figure 3.3.

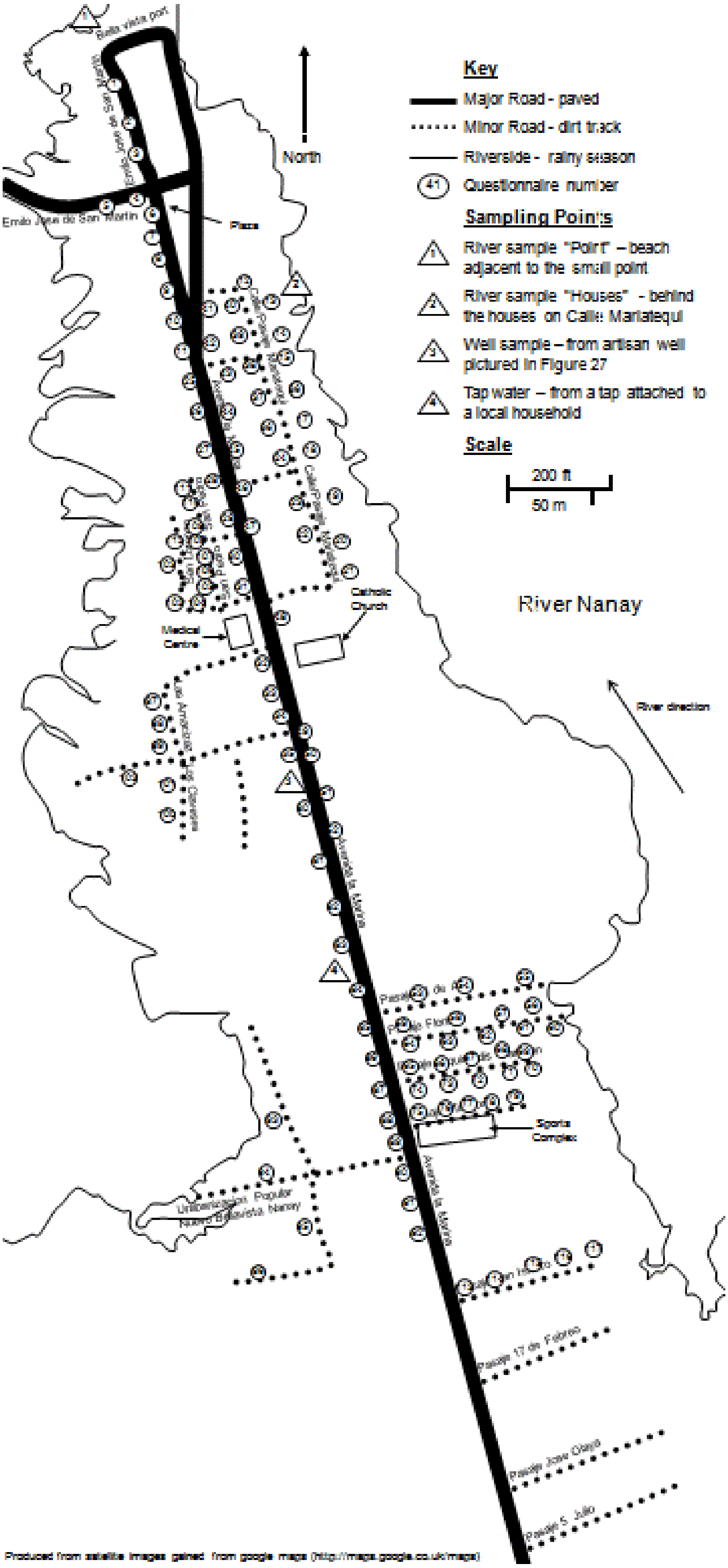

Figure 3.3: Map of Bellavista Nanay showing the sampling sites

3.3 Questionnaire

'Questionnaire' is a term that is used in many contexts, but in this thesis it is defined as a structured way of recording respondents' answers to a "… carefully constructed and ordered set of questions designed to obtain the needed information without either ambiguity or bias" (Johnston *et al.,* 2000). The function of a questionnaire is to measure and obtain dispositional information such as attitudes, opinions and beliefs and situational information such as demographics and resources (Oppenheim, 2003). Questionnaires are normally classified as a quantitative approach, but this classification is dependent on the style of questionnaire used. There is an overlap with interviewing methods which are normally classified as a qualitative approach, although the classification of interviewing methods is also subjective (as discussed in Section 3.0).

Questionnaires can be classified in the way in which they are administered (e.g. self completed questionnaires, postal questionnaires, telephone questionnaires, web based questionnaires, administered questionnaires) and the types of questions they contain (open or closed ended questionnaires) (Oppenheim, 2003). The administering of a questionnaire has to be appropriate to the respondent, sample size and sampling strategy, so consideration should be given to literacy and access to technology. The advantages and disadvantages of open and closed ended questionnaires are summarised in Table 3.5.

Table 3.5: Comparison of open and closed questionnaire methods (Oppenheim, 2003)

Method	Advantage	Disadvantages
Open ended questionnaire	Opportunity to follow up question and probe Useful for ideas and awareness Hypothesis testing Freedom of respondents' answers	Time-consuming and costly Hard to obtain large sample Foreign language fluency required High level of field assistant training required Coding is time consuming and possibly unreliable Demands more effort from the respondents
Closed ended questionnaire	Low time requirement Easier to obtain large sample No extended writing Relatively low cost Ease of processing data Ease of comparing group data Less field assistant training required Lower fluency in foreign language required Useful for hypothesis testing	Spontaneous results lost Bias in answer categories Considered a crude measure May irritate respondents

Open ended questionnaires provide a deeper insight into the effect or feelings of the respondent compared to closed ended questionnaires. The advantages of closed ended questionnaires mean that they can be used in large surveys and censuses, the respondents find the questions easier to answer and the results can be statistically analysed.

The type of questionnaire used is dependent on the questions being explored, the respondents and the researcher. Questionnaires have been used extensively in the field of drinking water. In developed countries postal and telephone surveys have been used because large sample numbers of literate respondents were questioned (Jones *et al.,* 2006, Levallois *et al.,* 1999). The disadvantages of this type of questionnaire are low response rates and that the sample gained may not be representative of the whole population. Jones and colleagues (2006) had a 55% response rate to their postal questionnaire on public perception of drinking water in Canada. Administered questionnaires have been widely used in developing countries, mainly to gain an insight into the current domestic water situation (Nyong and Kanaroglou, 2001, O'Hara *et al.,* 2008, Ozkan *et al.,* 2007, Machingambi and Manzungu, 2003, Moser *et al.,* 2005). This method was adopted because of low literacy levels which limit the use of self administered questionnaires. Very high response rates have been recorded for this type of questionnaire in these contexts. For examples, Ozkan and his colleagues (2007) recorded a 92% response rate to a questionnaire on water usage habits in Turkey, and Nyong and Kanaroglou (2001) recorded a 100% response rate to a questionnaire on domestic water use patterns in Nigeria.

3.3.1 Questionnaire development

The style of questionnaire used was a field assistant administered questionnaire, administered in both 2006 and 2007. The questionnaire was specifically aimed at the household water manger, not the head of the household. This enabled the research team to talk to the person who knew most about the household's water. Another advantage of the method chosen was that it was not dependent on the respondents' literacy. The choice of this method was supported by the Gatekeeper[18] and a previous study in this area[19]. Other reasons why this method was chosen was its high likely response rate and the ease of use for a non-native speaker, as terminology was kept simple due to the use of mainly closed questions.

The question style used was mixed. The majority of questions were closed and involved tick boxes. Those questions which required ratings for importance, quality or gravity used a seven point scale (used in 21 questions in the questionnaire 2006). The seven point scale was adopted due to its successful use by other authors in similar Latin American contexts (Moser *et al.,* 2005) and the proven validity of this methodology for attitude measurements (Oppenheim, 2003). A five point scale was used for recording frequency of activities e.g. hand washing and use of soap (used in two questions). This scale has been found to be more appropriate for recording

[18] The Gatekeeper said…"in 1984 the WHO came to Loreto and they found that Bellavista Nanay had the lowest literacy rate in Peru, below 50%" (4/6/2006)

[19] A self administered questionnaire was used at a bi-yearly lay preacher workshop (9/6/2006). This method proved problematic, as many of the lay preachers had problems reading and writing due to literacy and bad eyesight. Many people in this area have bad eyesight, due to the treatment for Malaria. This information was gained from the Gatekeeper

behaviour (Oppenheim, 2003, Moser *et al.,* 2005). Open questions were used to probe further on a number of issues (six questions), such as reasons behind choices and the kind of information received. The depth of the information gained from these questions could not have been gained by other questioning methods. Forced ranking questions were used (one in 2006 and two in 2007) to force the respondents to prioritise either drinking water characteristics or WASH interventions. This data could not be gained by using any other form of question (Oppenheim, 2003).

The final questionnaire was developed to cover eight topics: household demographics, socio-economic information, community water supplies, household drinking water practices, importance of drinking water quality, water and health, water and hygiene, and sanitation. Its aim was to gain an insight into: opinions; attitudes; awareness; behaviours associated with drinking water; and perceived drinking water quality. An extensive questionnaire was required due to the lack of information available about the community. Also, drinking water practices, quality and perception cannot be treated in isolation, but must be studied within the wider context of socioeconomic factors, education, water, sanitation and health. The questionnaire also included a number of questions that were used to generate an income proxy for each household.

Income proxy

An income proxy was seen as the most appropriate measurement of household wealth, due to some employment in the community being casual and some payments made in non monetary ways e.g. goods. Another advantage of this method is that participants find questions about income or expenditure sensitive and difficult to answer[20] and gathering income or expenditure data is time consuming and complicated (Ferguson, 2002).

Income proxy methods consider housing quality, ownership of goods and assets, the subscription to services, and socioeconomic status of the household , which are

[20] The self administered questionnaire was trialed with the lay preachers, as a part of a study by the parish. The questions on self reported household income had the lowest response rate of any question on the census (34%). From observations it was obvious that the lay preachers found it difficult to estimate their household income. (Observations made 9/6/2006).

correlated with permanent household wealth or income (Ferguson *et al.,* 2003, Bollen *et al.,* 2002). Reviews of different methods and current practices have been undertaken by two research groups (Montgomery *et al.,* 2000, Ferguson *et al.,* 2003). In the review by Montgomery *et al.* (2000), four factors were used extensively in past studies, access to clean water, nature of toilet, indicators of household quality, and ownership of selected consumer durables. Six distinct methods have been used to create income proxies: a sum of the number of assets (Havanon *et al.,* 1992, Clasen *et al.,* 2004, Andreson *et al.,* 2007); weighted scales of household assets (Tiwari *et al.,* 2005); a sum of the respondent's estimate of the current value of assets; the median value for each asset over all households which have the asset; principal component analysis (PCA) which includes weighting of assets (Larrea and Freire, 2002); and mathematical based models such as dichotomous variant of the hierarchical order probit (Ferguson *et al.,* 2003) or the hierarchical order probit (Ferguson, 2002) based on assets. The advantages and disadvantages of each method are discussed in Table 3.6.

Bollen's team (2002) used four of the six methods in Table 3.6 (excluding weighted profile of house and mathematical based models) to investigate economic status in Ghana and Peru. They found that collecting additional data on the monetary value of assets provided very little advantage, due to the reasons listed in Table 3.6. They recommended the use of the sum number of goods owned by the household or the more complicated PCA as income proxies for household wealth in these countries.

Several authors have used a housing quality index (HQI) successfully combined with a sum of assets (Havanon *et al.,* 1992, Tiwari *et al.,* 2005, Bollen *et al.,* 2007). This is a valuable method which is especially useful when the dwelling is owned by the respondents, as improved dwellings would imply household investment.

Table 3.6: Advantages and disadvantages of the methodologies used to calculate income proxies

Methodology	Advantage	Disadvantage
Simple sum	Simple to calculate Easy data collection	Goods are unweighted
Weighted profile of house	Easy data collection	Difficult to develop Variable ratings may be gained
Current value sum	Simple to calculate Weights goods on self reported monetary value	Complicated data collection Estimate of current value of assets is difficult to estimate Estimate of current value of a good or service will vary between respondents
Median value sum	Reduces the variation of estimated value of goods between respondents Goods become weighted	Complicated data collection Estimate of current value of assets is difficult to estimate Difficult to calculate Median value of goods will vary between different regions
Principal component analysis	Easy data collection Goods are weighted	Difficult to calculate Difficult to interpret
Mathematical based models	Easy data collection	Difficult to develop Difficult to calculate

The methodology chosen for this study was a simple sum of assets combined with an index of housing quality (HQI). This method was chosen due it is proven track record (Tiwari *et al.,* 2005, Bollen *et al.,* 2002, Havanon *et al.,* 1992, Larrea and Freire, 2002) and the simplicity of data collection and calculation. The HQI was specifically relevant to this area due to the high level of household ownership[21] in the community and the low ownership of assets[22]. The list of assets was adapted from Montgomery *et al.* (2000), Bollen *et al.* (2002), and Larrea and Freier (2002), who had all used income proxies in Peru. Adaptations to the list were made in consultation with the Gatekeeper and field assistants, so that it was appropriate for use in Bellavista Nanay. The method used can be seen in Table 3.7.

[21] Information gained from the gatekeeper

[22] Asset ownership is low not only due to economic conditions but also due to environmental conditions: high humidity and temperature reduce the lifespan of electronic goods and items such as soft furnishings, fabrics and paper. This information was gained by observation and from the Gatekeeper

Table 3.7: Income proxy methodology

Asset index (AI)	Electricity =1 Tap water =1 Decorative ornaments =1 Radio = 1 Telephone (landline or mobile) =1 TV = 1 Animal ownership = 1 House ownership = 1 Inside toilet = 1 Vehicle ownership; manpowered =1, motorised =2 car, van or truck =3 **Maximum score = 12**
Housing quality index (HQI)	Walls: straw = 1; wood = 2; metal = 3; cement = 4 Roof: straw = 1; leaves = 2; metal = 3; tile = 4 Floor: wood = 1; cement = 2; tile = 2 **Maximum score = 10**

In the asset Index (AI) vehicle ownership was weighted by how the vehicle was powered and its size. This was justified as larger motorised vehicles had to be imported by air or sea from Lima[23], at a high cost to the individual. The weighting given to the housing materials in the HQI were derived from the local cost of the material[24]. The number of rooms in the dwelling (Larrea and Freire, 2002, Bollen *et al.,* 2007) was not used because many of the dwellings in Bellavista Nanay contained non-permanent dividers which could and were moved regularly.

The income proxy score for households was used. It was not divided by the number of adults within the household. This was because the overall household wealth was more important to this study. In this community household wealth was commonly influenced by remittances[25] as much as the earning capacity of the adults in the dwelling.

[23] Information gained from the Gatekeeper
[24] Information gained from the Gatekeeper who had overseen several construction projects.
[25] Remittance is money sent to the household by family members living and working outside the community. This was considered to be a common source of wealth in this community, as family members worked in other parts of Peru, neighbouring countries or in the rainforest. This information was gained from the Gatekeeper

General information

This section was placed first in the questionnaire because the questions were easy to answer and of an impersonal nature, as advised by Oppenheim (2003). In this section the interviewer recorded the items required to calculate the income proxy in a tick box procedure, this was done by interviewer observation and questioning the respondent. The research team recorded the number of residents in the dwelling. Standard age categories were used: infants (aged 5 and below), children (aged 6 to 15) and adults (aged 16 and above) (Larrea and Freire, 2002). As recommended by Oppenheim (2003), more personal information was left until the final section of the questionnaire.

As the questionnaire was administered twice in 2006 and 2007 it was thought that this section would be excluded from the repeated questionnaire in 2007. However, as observational data indicated that wealth had increased in the community since the administration of the questionnaire in 2006, this information was recorded a second time in 2007.

Media and communication

This section was placed second to build the respondents' confidence in answering simple non-sensitive questions. This section covered where people got their information from and their trust in those information sources. It also contained an open ended probing question on what kind of information they had received from the media on drinking water, if any. The information gained in this section was used to test whether external information on drinking water is linked to the perception of drinking water quality in this community (explored in Chapter 7). The information gained from this section is also linked to the themes uncovered in the media study (described in Section 3.1.3).

Water in your community

This is a knowledge based section. The respondents were questioned about the sources of water available and how drinking water is treated in their community. This section was included due to the lack of information available about the drinking water sources and practices in this community. This information was then compared and combined with knowledge gained from other sources e.g. observations and documentation (Triangulation).

Your drinking water

Insight was gained into the drinking water practices of the respondent's household through this section. The 'normal' source of water for drinking and cooking was identified by the respondent. The normal water source used for drinking and cooking could then be compared to the community water sources, to see if there was a difference between these sources. This would indicate whether there is a separation of water for drinking and water used for other activities.

The 'present' source of drinking and cooking water was also identified as this may differ from the normal water source due to availability or seasonality. The respondents were also asked in an open ended question: 'What was the main reason for using this drinking and cooking water source?' This was to gain an insight into the reasoning behind their choice of water source.

Whether the respondents collected their drinking and cooking water from outside their dwelling was of particular interest, because high economic status is associated with having household access to tap water (Aiga and Umenai, 2002, Asthana, 1997). If respondents collected water, the time taken and distance to the water source was recorded. This information was relevant because of the MDGs (as discussed in Section 2.4.1), and time and distance have been clearly shown to influence peoples' choice of drinking water in rural India (Asthana, 1997). How often respondents collected their water was recorded, since storage time could be estimated from this. As discussed in Section 2.1, storage time and how water is stored has been linked to the contamination of drinking water (Hoque *et al.,* 2006, Jenson *et al.,* 2002, Wright *et al.,* 2004). There was also a question on how drinking water is stored, e.g. type of container, and in 2007 an additional question was added on the actual length of time of storage.

A question on whether respondents use this source of water throughout the year was also in this section, as this was linked to source availability and the seasonality of water sources in the community. The security, cleanliness, and the presence of animals at the water collection site were inquired about. These questions are exploring perceived contextual indicators, as potential factors affecting perceived drinking water quality, as hypothesised in Figure 1.2 (page 12). The structure of these questions was developed to be used in conjunction with the sanitary inspection study (described in Section 3.2.1). Collection with other family members was a relevant question, as it was used to gain an insight into whether the respondents use of a water source was related to the other people who used it and whether it was a communal and social process (Asthana, 1997, Biswas *et al.,* 2005).

Payment for drinking water was included due to the lack of information about the cost of water in this community. Additional data on payment was also gathered by other means such as documentation (as discussed in Section 3.1.3). The price of drinking water has been known to affect consumer choice. The higher the price of drinking water the lower the probability of households using that source (Asthana, 1997).

Respondents were asked if they treated their water in their homes. Household drinking water treatment is being widely advocated as a good preventive measure for diarrhoeal disease (Fewtrell *et al.,* 2005, Sobsey *et al.,* 2003, Arnold and Colford, 2007, Semenza *et al.,* 1998, Clasen *et al.,* 2004, Clasen *et al.,* 2007). In other studies, household drinking water treatment has been linked to sanitation, water supply and respondent's education (Andreson *et al.,* 2007). Residual chlorine was measured in the household samples taken (as described in Section 3.2.2), which could be used to confirm the correct use of chlorine as a household treatment. The respondents who treated their water in their household were probed as to why they used a certain method, to ascertain if this behaviour was linked to drinking water quality and health issues. In the questionnaire administered in 2007, the respondents who used chlorine from the medical post were asked what they did when no chlorine from this source was available. This question was added as it was established in the first field visit that chlorine was only sporadically supplied by the medical post.

Household drinking water consumption was also reported by the respondents. This again was general information that was used to set the context of the study. The importance of gaining sufficient drinking water was rated by the respondents. This was done so that the importance of drinking water quality to the respondents could be compared to other WASH interventions.

The respondents were asked if they had access to tap water. This question was used to confirm the questions on the respondents' source of drinking and cooking water. If they did have tap water they were then asked about their knowledge of the ownership of the company, since it has been hypothesised that trust in supplier plays an important role in the perception of drinking water quality. Also, trust of private water companies has become a highly publicised issue in Latin America (Laurie and Crespo, 2007) including Peru (Furukawa, 2005). Respondents were then asked if they drank this water without further treatment. The answers to this question could be used to check the response to the questions on household drinking water treatment, and if the respondents did not treat their water it implied that they trusted the supplier.

Whether the respondents purchased water in bottles from shops was also of interest because it could be linked to the respondents' awareness of water ownership issues. The respondents were asked to name the company and state what type of company it was. This was linked to a study of drinking water labelling, as described in Section 3.1.3.

Quality of drinking water

The perception of drinking water quality was assessed by the respondents on a seven point scale, as were the separate characteristics of drinking water quality: taste, odour, colour, turbidity and temperature. The importance of the separate characteristics of drinking water quality were assessed by the respondents and these were also ranked in a forced ranking question. This data could then be compared to the data gained from the drinking water samples taken from the respondents' households. The importance of drinking water quality was also assessed by the respondents. This information was used to ascertain how important drinking water quality was to them compared with other WASH interventions.

Association of disease with water

The respondents were asked about their understanding of the causes of diarrhoea, as this has been shown to influence people's choices of drinking water source through associated risk. This awareness was again tested in a question which asked about the link between diarrhoea and raw water. The gravity of the effect of diarrhoea on the family was also inquired about, as it was not known how this illness was viewed by the respondents. The respondents were then asked if any members of their household had been ill within the last seven days. Seven days was used as it was standard length of time used in similar questionnaires (Moser *et al.,* 2005). 'Illness' was defined as fever, diarrhoea, and stomach ache or vomiting again this is a standard definition used in other questionnaire . The name and age of the ill person was recorded. This information links in with the association of memorabiltiy of disease and the perception of drinking water quality as in Figure 1.2 (page 12).

Water and hygiene

The respondents rated how important it was for them to obtain enough water for cleaning and good hygiene, again to ascertain its importance compared to the other WASH interventions. The respondents were then asked whether they washed hands after going to the toilet and before eating or preparing food and if they used soap. This was combined with structured observations on the cleanliness of the respondents' hands. The information was used to gain an insight into hygiene practices in the community.

Sanitation

Due to the sensitivity around the subject of sanitation (Black and Fawcett, 2008), this section was placed close to the end of the questionnaire (Oppenheim, 2003). Initially two questions were put in this section: Where is your toilet? What is the possibility that faecal matter can contaminate a source of drinking water? Two further questions were added to the questionnaire in 2007, which were on the importance of good sanitation facilities and a forced ranking question on the importance of good quality drinking water, sufficient water for drinking, sufficient water for cleaning and good hygiene, and good sanitation facilities.

Categories of sanitation facilities and terminology used were discussed with the Gatekeeper and field assistants during the questionnaire development stage. Inadequate sanitary facilities are a source of diarrhoeal disease and the type of sanitary facility has been linked to economic status and prestige (Jenkins and Curtis, 2005, Singh, 2006). The second question in this section was to determine whether the respondents perceived their excrement disposal method as contaminating drinking water sources. This questions links faeces and contamination of drinking water sources and was used to determine how strongly this link was perceived by the respondents. The importance of sanitation facilities were used to ascertain their importance compared to the other WASH interventions. The forced ranking question was used to determine which WASH intervention the respondent thought was the most important.

Personal information

Personal or socio-demographic information was only collected in the questionnaire administered in 2006 as the same respondents were targeted in 2007. In line with the advice given by Oppenheim (2003) this was the last section in the questionnaire. The information collected in this section was age, gender, education and occupation of the water manager of the household (the respondent).

Education and occupation are classified as socioeconomic indicators which change with development and wealth accumulation and have been used as proxies for wealth (Bollen *et al.,* 2007, Laszlo, 2005). Female education levels have been linked to wealth and economic status (Bollen *et al.,* 2007) and Asthana (1997) found that female education influenced the choice of safe water. Educational status has also been linked to the household treatment of drinking water (Andreson *et al.,* 2007).

Gender of the water manager is dependent on custom and culture of the local community (Nyong and Kanaroglou, 2001). The 'traditional' idea of the woman as the water manager (Aureli and Brelet, 2004) was not reinforced by this study, as the household water manager was targeted not the household head or female head. However 82% (*n=96*) of the household water managers were women (as discussed in Section 5.0).

3.3.2 Questionnaire piloting

The questionnaire was devised and written in Spanish. The first draft of the questionnaire was sent to five native Spanish speakers at Newcastle University who made comments on language, completed the questionnaire and recorded the amount of time this took. This version of the questionnaire was then sent to the Gatekeeper to be checked for language and content. The questionnaire was then amended accordingly.

The second draft of the questionnaire was checked by the field assistants for the correct use of terms and colloquialisms (8/6/2006). The third draft of the questionnaire was piloted in the community from 15th to 21st June 2006 with 25 respondents. This draft contained 14 pages and took approximately 40 minutes to complete. The respondents were noticeably restless during the piloting period, so the length and therefore administering time of the questionnaire were reduced. This amended version is known as Questionnaire 1 and can be found in Appendix 5. The other changes made during the piloting period included reordering of questions and sections. This made the questionnaire flow more easily. Easier and less sensitive sections were put at the start of the questionnaire to build the respondents' confidence in answering the questions. Detailed notes of the changes made after piloting can be found in Appendix 6. The main changes were due to adapting questions to local conditions. Questionnaire 1 was ten pages and took approximately 20 minutes to administer. This questionnaire was administered from the 21st June to 26th July 2006.

The answers from the piloted draft of questionnaire were analysed with the other questionnaires obtained in 2006. This was to maximise the amount of data collected during the field work as 25 questionnaires were piloted in a limited geographic area. If this data had not been used, crucial information about this area would have been lost. The main difference between the piloted draft and Questionnaire 1 were the reordering of questions, the addition of 'other' category to some questions and the removal of superfluous questions (as seen in Appendix 6). The data collected in the piloted draft was of the same quality as the data collected in Questionnaire 1, as there were very few problems with the relevant questions during piloting. This data was therefore use in this thesis.

An adapted version of Questionnaire 1 was used in 2007 (named Questionnaire 2 and given in Appendix 7). The changes to this questionnaire included the removal of the personal information section as the same respondents were re-interviewed. Also, the question used to collect data on hand cleanliness was omitted from Questionnaire 2. This was due to many of the respondents being engaged in activities which caused their hands to be dirty. The cleanliness of their hands therefore did not reflect their general handwashing practices. The field assistants were also uncomfortable with collecting this data.

No changes were made to the remainder of Questionnaire 1, so a comparison of the answers could be made. This was done so that possible differences between dry and rainy season could be identified. However, some questions were added after the results gained from Questionnaire 1 were analysed. It was felt that certain topics such as drinking water storage, household drinking water treatment, and sanitation, required further exploration. The additional questions added have been translated and listed below:

> If you store your households drinking water, how long do you store it for? (hours/days)
>
> If you use chlorine from the medical post (to treat your drinking water), when they don't have chlorine do you treat your drinking water (yes/no). If yes, how do you treat it?
>
> How important is it for you to have good toilets? (seven point scale)
>
> What is the most important WASH intervention, rank the following on from 1 to 5 (1= most important, 5 =least important): good quality

drinking water, sufficient drinking water, sufficient water for cleaning and good hygiene, good toilets.

Questionnaire 2 was administered from 22nd October 2007 to 28th November 2007.

3.3.3 The use of field assistants

The field assistants were initially trained on their first day prior to administering the questionnaires. The training included reading through the questionnaires and explaining the topics highlighted on the training sheet (included in Appendix 8). The training took approximately 30 minutes. The field assistants were already familiar with the questionnaire since they were involved in the development of the questionnaire, discussed in the previous section. They were both re-trained after the piloting period (15/6/2006 and 16/6/2006) due to the field assistants having conceptual problems with forced ranking questions.

All questionnaires were administered by a field assistant who was accompanied by the researcher. The reason behind this is discussed in Section 3.4. Field Assistant 1 was only used for four days, due to reasons stated in Section 3.4. Field Assistant 2 was used on both of the field trips (2006 & 2007). He built a good rapport with the interviewees and the researcher. He would often bring out valuable information on drinking water practices that were not included in the questionnaire, but were noted in the field diary. He was very easy to train and proved to be a highly competent field assistant. Field Assistant 2 was also used for interviews, translation and visits.

3.3.4 Sampling strategy

Criterion sampling strategy was used as the person responsible for the water management in the household was targeted for the questionnaire (Almedom and Blumenthal, 1997). It was understood that they may not have been the head of household. This strategy was used because this person would be undertaking the daily household water management activities, so they would have firsthand knowledge of their household’s practices, while the head of the household may not.

It was therefore thought that the data that the household water manager supplied would be more valid. This strategy has been used by other authors when investigating drinking water practices (Quick *et al.,* 1999).

The questionnaire was administered between the hours of 3 pm and 6 pm, from Monday to Thursday, which was just after the siesta period when people were generally relaxing in their homes[26], as in the mornings people were busy doing their household chores or working. The choice of not administering questionnaires on a Friday was due to two failed attempts (16/7/2006 and 23/7/2006). After enquiring, it was found that this was the day and time when rent, bill and debt collectors call on residents, so they generally do not answer their doors. If sampling had continued on a Friday a lower response rate would have been gained, which would not have reflected the community's willingness to participate in this study. Every third house was targeted, as this enabled a representative sample to be gained within the time spent in the field. If no response was gained from a house, then the next house was targeted, this was repeated until a response was gained. All non responses were noted in the field diary and this was used to calculate the response rates in the subsequent section.

No questionnaires were administered on days when there was heavy rain. Many houses had corrugated iron roofs and the noise of the rain meant that the residents could not hear people knocking on their door[27].

The first sampling period spanned 15th June 2006 to 26th July 2006 including the piloting period. Between two and six questionnaires were administered per day, with a mean of five questionnaires per day. This number was limited by the concentration needed to administer the questionnaire correctly and the environmental conditions (it was very hot and humid).

[26] This information was gained from general observation and conversations with the Gatekeeper (13/6/2006 & 23/6/2006)
[27] General observation 7/11/2007

During the second field visit in 2007, the household water managers that had previously responded to the questionnaire were re-interviewed. The questionnaires were administered at the same time and during the same days of the week. This strategy was used so that any changes from the first to second sampling period could be identified. The second sampling period spanned 22nd October 2007 to 28th November 2007. Between two and five questionnaires were administered in a day, with a mean of four being administered daily. A lower number of questionnaires were administered in a day compared to 2006 due to the difficulty associated with targeting specific individuals.

3.3.5 Response rates

In the first field visit in 2006, 147 households were asked to complete the questionnaire. A total of 117 completed questionnaires were obtained for this period, giving a response rate of 80%. In 2007, the strategy was to re-interview those who had completed the questionnaires in 2006. A total of 96 household water managers were re-interviewed, giving a response rate of 82%. The response rate in 2007 was not due to people being unwilling to complete the questionnaire a second time, but due to them moving out of the less established areas in Bellavista Nanay. These areas include Pasaje San Isidoro (only two out of the original five household water managers were re-interviewed), Urabanizacion Popular Nuevo Bellavista Nanay (only one out of the original four household water managers were re-interviewed) and Las Amacizaz and Los Claveses (only one out of the original five household water managers were re-interviewed). These areas were established six years ago in low lying areas close the river (as seen in Figure 3.3, page 72) which flooded during the rainy season. These residents had moved to the 'Carreterra', which is highland running alongside the road between Nauta and Iquitos. This land was given away free by the local government. In this thesis only the data from the household water manager that completed the questionnaire in both years is presented and discussed, that is a total of 96 questionnaires. This was so that any seasonal changes in drinking water practices and the perception of drinking water quality could be reflected upon.

In the 2006, there was a high response to all questions in the survey, with 63% of the questions having a response rate of 100%. During the piloting period (15/6/6 and 16/6/6) the field assistant had conceptual problems with the section covering Quality of Drinking Water. Over these two days there were several missing responses for Questions 5.1 and 5.5. The field assistants were given extra training sessions to address this, which subsequently solved the problem of the low response rates. In 2006, some data was lost due to a photocopying error (questionnaires for respondents 6 to 11 and 14 to 20). This problem was addressed by introducing a more thorough quality control procedure for photocopying the questionnaires. In 2007, there was a 100% response rate to all of the forced answer questions. This was due to the field assistant's training and familiarity with the questionnaire from the previous year.

3.4 Field Assistants

Local field assistants were used in this research for a number of reasons. One was to maximise the amount of data collected, for example, when the field assistant administered the survey the researcher was able to make additional observational notes. They were also used to gain access to the respondents, as Bellavista Nanay was a small close knit community. A general disadvantage of using local field assistants is that respondents may not want to disclose information which they deem as sensitive to another member of their community. In order to try to address this, a statement on page one of the questionnaire was read out to all respondents which stated "...the answers given will be treated in a confidential manner and no members of your community will know your replies to these questions[28]".

Before the field work was undertaken the Gatekeeper was informed that the researcher would be employing field assistants (they were paid US$ 2.00 per hour[29]). To save time the Gatekeeper had pre-arranged the employment of two local field assistants. Their background is outlined below.

[28] Translated from Spanish, source: page one of the questionnaire
[29] A figure discussed with the Gatekeeper

Field Assistant 1: A female university student[30] aged 22, lived with her family in the community. Her mother owned a shop in the community was very active in the Catholic Church and her father worked for EPS Sedaloreto S.A. (the local water treatment company). This field assistant's family were originally from Lima, but had moved to the community about 22 years ago.

Field Assistant 2: A male college student, aged 22, lived with his family in the community. His mother was a housewife who had recently become active in the Catholic Church. This field assistant had many family members living in the community which included cousins, uncles, aunts and grandparents.

Two afternoon discussions were initiated with the field assistants to explain the study objectives, after which a date was arranged for them to start. Initial work included checking the questionnaire and the terminology used. Before interviews were undertaken or the questionnaires were administered a discussion was held with the field assistant. It was originally thought that Field Assistant 1 would be preferable due to the gendered nature of this issue and because those interviewed would be mainly women. Field Assistant 1 however only worked for four days (15/6/2006, 16/6/2006, 22/6/2006 and 23/6/2006). She did not build a rapport with the respondents and the respondents expressed some suspicions about her motives, as her father worked for the local drinking water treatment company[31]. During the rest of the first and all of the second field trip the researcher worked exclusively with Field Assistant 2. He built a good rapport with the respondents and was confident in this work, which was possibly due to his background in business studies and marketing.

Bellavista Nanay was visited twice, primarily to capture any changes in drinking water practices, perception and quality with changing season. It was also beneficial as returning to Newcastle University allowed initial data analysis (Furlong and

[30] This was very unusual, discussed with the Gatekeeper

[31] On 16/06/2007 one respondent recognised Field Assistant 1 and is quoted in saying "...your dad works for the Sedaloreto"

Paterson, 2008, Furlong *et al.,* 2007) and the researcher gained perspective on the field situation. It allowed for reflection on the progress made. It allowed for the identification and development of themes which could be explored during the second field trip, such as the media study. This led to further development of the qualitative aspects of this thesis and enabled the researcher to reflect on the approaches chosen.

3.5 Statistical analysis

All statistical analysis was carried out using SPSS 15.0 on the quantitative data collected using the questionnaire (the raw data can be found in Appendices 9 and 10) and from the analysing the water samples (the raw data can be in Appendices 11 to 14). The statistical tests used were chosen due to the type of data generated (e.g. scale, interval, ordinal, nominal or dichotomous) and the null hypothesis. The scale data from the questionnaire and samples were analysed for normal distribution using the Shapiro-Wilk (S-W) test, which is considered more accurate than the Kolmogorov-Smirnov test (Field, 2003). Only non parametric tests were used as all data collected was either not measured at a scale level or not normally distributed.

To assess if the samples were drawn from the same population, an example of this is if the chlorine levels were the same in tankered and standpipe samples the Mann Whitney U test was used (the details of this test can be found in Table 3.8).

To test the differences between the sampling periods the following paired tests were used: Wilcoxon signed-rank test, Sign test and McNemar (see Table 3.8 for details of these tests). These tests were used to assess seasonality, as it can play an important role in drinking water practices and quality (Herbst *et al.,* 2009; Howard and Bartram, 2003; Hoque *et al.,* 2006; Giannoulis *et al.,* 2003; Gelinas *et al.,* 1996; Katsi *et al.,* 2007;; Machingambi and Manzungu, 2003; Nyong and Kanaroglou, 2001). When exploring the relationship between different variables single variant correlations were used, this was because of the multiple data types excluded the use of multivariate analysis. The reason behind the choice of statistical tests used for measuring association needs to be explained in greater depth. Chi-squared (X^2) test was used in conjunction with Cramer's V and Phi (Φ). Yates' correlation (also called continuity correction) was used with X^2 if the table was two by two and the number in a cell was less than 5. If a larger table was being analysed and either the cells frequencies were below the expected frequency or no values were in the cells the exact function was used. Cramer's V was used for tables larger than two by two and when tables were two by two then Φ was used. Mann-Whitney U was also to test whether there was an association when one variable was dichotomous and the other was ordinal or above. As with a dichotomous grouping variable if a correlation is found between this variable and the other variable, it is the same as saying there is a statistical difference between the two data sets (Forshaw, 2007). Again details of these tests can be found in Table 3.8.

Only the results from the tests which make a specific contribution to this thesis are reported. The details of these tests, including the significance level and probability value gained, can be found in the footnotes of this thesis. The sample size (*n*) for all the data referred to in this thesis is 96 unless stated otherwise. Associations were deemed to be strong if they were at the 95% significance level or weak at the 90% significance level.

Table 3.8: Statistical tests used

Name of test	Data type	Null hypothesis	Explanation of test
Mann Whitney U (MWU)	Ordinal or above	The samples are drawn from the same population	Tests whether two independent samples are from the same population. It is more powerful than the median test since it uses the ranks of the cases. Requires an ordinal level of measurement. U is the number of times a value in the first group precedes a value in the second group, when values are sorted in ascending order.
Wilcoxon signed-rank test (WSR)	Interval or above	There was no difference between the responses gained from the same respondent in 2006 and 2007	This test takes into account information about the magnitude of differences within pairs and gives more weight to pairs that show large differences than to pairs that show small differences. The test statistic is based on the ranks of the absolute values of the differences between the two variables.
Sign test (ST)	Ordinal or above		The differences between the two variables for all cases are computed and classified as either positive, negative, or tied. If the two variables are similarly distributed, the numbers of positive and negative differences will not be significantly different.
McNemar	Dichotomous		Tests for changes in responses using the chi-square distribution. Useful for detecting changes in responses due to experimental intervention in "before-and-after" designs.
Eta	Nominal by ordinal or above	There was no association between the two sets of variables	A measure of association that ranges from 0 to 1, with 0 indicating no association between the row and column variables and values close to 1 indicating a high degree of association. Eta is appropriate for a dependent variable measured on an interval scale (for example, income) and an independent variable with a limited number of categories (for example, gender). Two eta values are computed: one treats the row variable as the interval variable, and the other treats the column variable as the interval variable.
Kendall' tau c (KTC)	Ordinal by ordinal or above		A measure of association for ordinal variables that ignores ties. The sign of the coefficient indicates the direction of the relationship, and its absolute value indicates the strength, with larger absolute values indicating stronger relationships. Possible values range from -1 to 1, but a value of -1 or +1 can be obtained only from square tables.
Phi (Φ) and Cramer's V (CV)	Nominal or above		Phi is a chi-square-based measure of association that involves dividing the chi-square statistic by the sample size and taking the square root of the result. Cramer's V is a measure of association based on chi-square. Phi is the same as Crammer's V when a you have two nominal variables

3.6 Embedding of research

The research project was fully disclosed to the participants in a number of ways. The researcher's presence and the scope of the project were announced over the local radio situated in the town square and during church services attended by approximately 100 people. It was also explained to the individual questionnaire respondents.

While in Bellavista Nanay no boundaries to the researcher's field work were set, and she was immersed in the field. This was partly due to the *in-situ* analysis of water samples, as this work was undertaken early in the morning (before breakfast) and relatively late at night (9 to 11 pm), due to the preparation required for the microbiological analysis. The researcher was also highly aware of the limited time she was spending in the field which necessitated the blurring of boundaries.

The study was purposely embedded in the community. The researcher lived in the community during both the field trips. She attended church, shopped, went to fiestas, meetings and bingo nights in the community. For a short period she volunteered at the local nursery. This approach allowed for maximum participant observations to be undertaken. The community was extremely welcoming and friendly to the researcher as they were used to the presence of 'outsiders', which is discussed later in this section.

The knowledge gained from this work was fed back to the community. After each field trip a short report (in Spanish) was sent to the respondents explaining the preliminary results. A poster was also sent which was displayed outside the church. This was done so that the knowledge and information gained would be returned back to the community. It gave the participants ownership of the information they supplied. A final report will be sent to the respondents and a local environmental group once the researcher has completed her thesis. A copy of the thesis will also be sent to local universities. Feeding back knowledge to the community aided the second field trip as the community remembered the researcher and the project, often showing her the report, the photo or the thank you card from the previous visit. It was thought that this approach is partly responsible for the high questionnaire response rate during the second field trip. Initially a 'Gatekeeper' was used to gain access to the community. It is acknowledged that negotiating access was an ongoing issue (Burgess, 1993) and that many individuals in the Bellavista Nanay granted access for this research. There were therefore many gatekeepers, but for simplicity in this thesis the term 'Gatekeeper' is used to identify this one specific individual.

The Gatekeeper was a male Catholic Priest aged 37, who lived and worked in the Bellavista Nanay. His positionality in this study was important as he was originally from the North East of England where he had been ordained. He was therefore a white European male of a higher educational and economic status than a majority of the participants in this study. This influenced his perception of the world around him. He had worked in the community for seven years at the start of this study (2006) and was the only priest for the Parroquia San Pedro Pescador, which included Bellavista Nanay.

The Gatekeeper introduced the researcher to the community, through his activities in the Church of San Pedro Pescador situated in the heart of Bellavista Nanay on Avenida la Marina. The church held a well attended (over 100 people) mass every Sunday and organised other activities such as bingo and youth groups. Funding for the Church and its associated sports ground and nursery were gained through the Hexham and Newcastle Peru Mission (United Kingdom). This connected Bellavista Nanay to the North East of England and due to this the parish had received many visitors from this area in the past, making the researcher's presence less conspicuous.

It was originally thought that the Gatekeeper's religious standing may have biased the study, as other religions had a visible presence in the community. On Avenida la Marina for example there were also Jehovah Witnesses Kingdom Hall and Evangelical Church. However, the population in Peru and specifically this area is predominately Catholic. 78% of the population of the province of Loreto state Catholicism as their religion (Instituto Nacional de Estadistica e Informatica, 1993). As an 'outsider', religion did not seem to be a contentious issue in Bellavista Nanay. Examples of this are that several of the church leaders in Bellavista Nanay socialised together, such as the Gatekeeper and the Evangelical pastor. Another example is that family members sometimes attended different churches. There was a sense of respect for other people's religion and choices. Many people asked the researcher her religion and were not shocked that she was an atheist. No one refused to be interviewed due to the researcher's affiliation to the Catholic Church or the researcher's beliefs. It was noted that most of the questionnaire respondents attended or were associated with the Catholic Church, so this affiliation may actually have aided participation in the study.

The Gatekeeper's standing in the community meant that he was able to introduce the researcher to an assortment of interesting people such as the local environmental group leader, doctors, the Director of the Human Rights Commission, local artisans and most importantly the community. These introductions snowballed which allowed the researcher to gain access to areas such as the nursery and drinking water treatment plant.

The researcher rented a room in a compound attached to the church and lived with the Gatekeeper, a local trainee nurse and a local 'right-hand-man'. During the second field trip another non-native Catholic priest (the Gatekeeper's uncle) who was the retired rector of the seminary in Iquitos and had been living in Iquitos for 20 years, also lived in the compound. All of these people held a wealth of information and were willing and valuable participants in this research. The compound provided higher living standards than most, but not all, of the surrounding houses. The conditions in the house separated the researcher from normal community living and conditions, affecting the researcher's positionality.

As the researcher is female, it was felt that the researcher's gender would aid the study. The topic under investigation is a highly gendered issue and the participants were mainly women. The respondents welcomed the researcher and the main field assistant (who was male) into their homes and answered questions on water and sanitation openly. It was felt that the combination of the gender of the researcher and the personality of the Field Assistant 2 allowed for ease of approach to the sensitive subjects encompassed in water and sanitation.

The researcher is in her early 30s, which is around the average age of the household water managers in this study (see Section 5.1). Being of this age rather than younger seemed to put the respondents at ease. The respondents often asked the researcher personal questions which she answered. This form of disclosure and honesty meant that the researcher was able to build a rapport with the participants.

While the white British researcher stood out in Bellavista Nanay as the community was made up of native Amazon and *mestizo*[32] people. As stated before, the Gatekeeper had links to the North East of England and received visitors on a regular basis. In 2006 a couple from the North East of England lived in the household for a month and taught English in the community. A Master's student from Newcastle University who was undertaking field work stayed for three weeks (Milius, 2006) and a Spanish lay preacher visited for a month. In 2007, a priest from Manchester visited with a friend, visiting the community several times, but staying in the centre of Iquitos. Many participants mentioned a previous survey on Malaria that had been undertaken in Bellavista Nanay by a university from the USA. No literature had been found on this study and no results had been fed back to the community. The researcher's presence in Bellavista Nanay, although conspicuous due to her looks, was not therefore completely unusual.

The power dynamics in the field work changed depending on the situation. The status gained from being a wealthy well educated 'outsider' with the means to leave the field, was the main power the researcher held. The researcher was of course completely dependent on the Gatekeeper, field assistants and all of the participants, as the information they gave made this thesis possible. The researcher had a reasonable grasp of Spanish which she gained from working in México and studying in the UK, but she was fully aware that her spoken Spanish was poorer than her other Spanish skills. In some aspects the researcher's lack of fluency in spoken Spanish shifted the power dynamics as often she felt that the respondent, interviewees and participants felt sorry for her inability to express herself.

The researcher cannot ignore her positionality in this research, as her personality, education, gender, age, ethnicity, sexual orientation and religion affected what she deemed as significant, and therefore the information gathered and the questions asked. It also influenced how the researcher interacted with participants. While positionality should not

[32] Refers to people of mixed European and Amerindian ancestry.

preclude carrying out this type of research (Chacko, 2004), it should be acknowledged, as situated knowledge results from it (Rose, 1997).

The political situation in Peru (as discussed in Section 1.0.4) encroached on this study in many ways. The researcher entered Peru in 2006 on the eve of the general election and due to predicted political unrest left Lima the following day for Iquitos. She was in the country while the extradition of Fujimori was being sought and was there to witness his return in 2007. The media in 2007 was dominated by Fujimori's trail (as described in Section 8.0). Also while she was staying in Bellavista Nanay, the trial of Ollanta Humala (another presidential candidate in the 2007 election) was being partly heard in Iquitos. This had special relevance for the region where this study was undertaken, as during his military career he was stationed in Iquitos. The alleged atrocities where undertaken close to the study area. This led to the researcher's field work being terminated slightly earlier than planned in 2007, due to the threat of reprisals over the Catholic Church's involvement.

3.7 Chapter summary

This chapter achieved the objectives set which were to critically analyse different approaches, and to justify the approach and methods used in this thesis.

There are many advantages of using a mixed methodology approach that have been highlighted by different authors. In this thesis examples of all of the stated advantages of this approach can be seen. The qualitative methods used were chosen to either gain specific information or to corroborate information gained from quantitative methods. The main advantage in using these methods was that they provided rich, thick, descriptive data which could not be gained from the quantitative methods. The quantitative methods were used to gain a broad picture of shared experiences in Bellavista Nanay. The specific methods were chosen due to their appropriateness for the situation and *in-situ* use.

The questionnaire method used was a field assistant administered questionnaire, mainly based on closed questions. The reasons for using this method were its appropriateness for the use in this community. A highly detailed questionnaire was required as there was a lack of information on Bellavista Nanay in the literature. Also, household drinking water practices, quality and perception cannot be explored in isolation, but must be studied in the wider context of socioeconomic factors, education, WASH and health.

The research and researcher were actively embedded in the community and a Gatekeeper and local research assistants were used. This approach aided the collection of a large amount of data in a short period of time and allowed for ease of approach on the sensitive subjects encompassed in water and sanitation.

The data generated from these methods was used in the subsequent chapters to baseline the community (Chapter 4), explore drinking water practices (Chapter 5), investigate actual drinking water quality (Chapter 6), explore external influences on perceived drinking water quality (Chapter 7) and to investigate the factors which influence perceived drinking water quality (Chapter 8).

Chapter Four: Context

The objectives of this chapter are to gather and analyse data on the community of Bellavista Nanay, their living and WASH conditions, illness rates and how the respondents associated water with diarrhoea. This is important because drinking water quality cannot be removed from its context, as without an understanding of the environment, practices and people, the information gained will be invalid.

This chapter builds on the knowledge gained from the literature discussed in Section 1.0 on the study area of Bellavista Nanay. The study area and the reasons for choosing it have already been discussed in Section 1.0. Water and sanitation issues in the greater Iquitos area were discussed in these sections, but only limited data was available for Bellavista Nanay, hence the need for more detailed information contained in this chapter.

WASH need to be considered holistically from a development perspective (as discussed in Section 2.1). Therefore drinking water practices and perceptions cannot be removed from the WASH web. WASH interventions play an important role in reducing illness in communities, especially diarrhoea. Due to this fact, illness in the community and the association of water and diarrhoea are discussed in this chapter.

The results from the questionnaire (raw data can be found in Appendices 9 and 10), observations (Section 3.1.1), interviews (Section 3.1.2) and other document sources (Section 3.1.3) are presented in this chapter. All of the factors discussed in this chapter can influence perception and drinking water practices as seen in Chapter 2 and these relationships will be explored in greater detail in Chapter 8.

4.0 Housing, assets and wealth

In this section the housing in Bellavista Nanay is explored because it can influence drinking water supply and be an indicator of wealth (discussed in Sections 2.4.2 and 3.1.1). The permanence, construction and ownership of houses and land influence the sources of drinking water available to households. Wealth is one of the main factors that influence people’s ability to pay for their water supply (as discussed in Section 2.4.2). Measurement of wealth was discussed in detail in Section 3.1.1. Assets including having piped water service and inside sanitation are explored not only to gauge the wealth of the households, but to reflect on the importance placed on these services and assets by householders. This theme is then continued in the following section on WASH in the Community.

4.0.1 Housing materials

All of the respondents reported that they owned their houses. The construction of housing varied widely in this community (as seen in Figure 4.1), as did the materials of construction.

Photo 1: Avenida la Marina

Source: Claire Furlong 2007

Photo 2: Calle or Pasaje Mariatequi

Source: Claire Furlong 2007

Photo 3: Pasaje 11 de Abril

Source: Claire Furlong 2007

Figure 4.1: Photos housing of and streets in Bellavista Nanay

From the questionnaire results from both years, it can be said that the average house would be one with wooden walls and floor, and a metal roof (as in Figure 4.1, Photo 3). The houses away from the main tarmac road, Avenida la Marina (which can be located on Figure 3.3) were generally built of wood, and constructed on stilts, due to regular flooding (as in Figure 4.1, Photos 2 and 3). Housing materials remained relatively consistent between the years, although the average HQI (as defined in Section 3.3.1) dropped slightly from 6.6 in 2006 to 6.5 in 2007. This slight drop can be attributed to the decrease in wall quality, which was probably due to recording error, as people were unlikely to replace brick walls with wooden walls. The roof and floor quality rose slightly, there was an increase in roofs constructed of metal (from 80% in 2006 to 85% in 2007, *n=96* for both years) and a decrease in earthen floors (from 15% in 2006 to 11% in 2007, *n=96* for both years). This indicated that building and housing improvements had been undertaken between field trips.

In Bellavista Nanay the level of earthen floors (25% in 2007, *n=96*) was the same as the levels found in Punchana (25%) and only slightly higher than the levels found in the city of Iquitos (23%) (Instituo Nacional de Estadistica e Informatica, 2005). The high level of wooden floors in this community (60% in 2007, *n=96*) compared to Punchana (29%) and Iquitos (7%) was not indicative of greater wealth in this community, but due to the physical need to build houses on stilts as the area floods in the rainy season (Instituo Nacional de Estadistica e Informatica, 2005).

4.0.2 Asset ownership

All self reported and observed assets had increased from 2006 to 2007, except tap water. This was due to the community's piped water supply being terminated in 2007. The largest increase in assets were in the ownership of ornaments (increased by 25 households) and telephones (increased by 24 households), followed by electricity connections and inside toilets (both increased by 7 households). From the questionnaire results it can be seen that the sanitation had improved between the first and second field trip (see Section 4.2.1). This was reflected in the average AI (defined in Table 3.7) increasing from 5.7 to 6.4. This increase in AI was found to be statistically significant[33].

An insight into the importance placed on water and sanitation in this community can be gained from the services households subscribed to and assert ownership. The numbers of connections to the water network were compared to the number of connections to the electricity network. Only 12% of the households that took part in the questionnaire had piped water supply compared to 89% that had electricity connections (data from 2006, *n=96*). When inside toilet ownership is compared to television ownership, only 53% of households owned an inside toilet compared to 78% of household that owned a television. From the comparison of services subscribed to and assets owned, it can be seen that formal connections to water supply and sanitation have a low priority in this community.

The number of electricity connections in Bellavista Nanay (89% in 2006,*n=96*) was higher than the coverage for Punchana (74%), but slightly lower than the average for Iquitos (90%)

[33]SW, significance level 95%: AI 2006 $p = 0.035$, AI 2007 $p = 0.005$. WSR, two tailed, significant level 95%: $p = 0.000$

(Instituo Nacional de Estadistica e Informatica, 2005). The community also had higher inside toilet ownership (53%, *n=96*) compared to the Punchana (44%), but a lower level compared to Iquitos (80%) (Instituo Nacional de Estadistica e Informatica, 2005). It should be noted that the census data quoted for Punchana and Iquitos was from 2005 and although a 2008 census has been reported on, a detailed database was not available at the time of writing.

From the data in this study it can be seen that changes in housing quality, asset ownership and services are occurring constantly. Taking this into consideration, it can still be said that the community of Bellavista Nanay has a higher asset ownership and connection to services compared to Punchana, but has a lower level compared to the city of Iquitos.

4.0.3 Wealth

It was noted on the second field trip in 2007 that Iquitos and Bellavista Nanay seemed visibly more affluent than in 2006. There were more cars on the roads and expensive consumer goods were easier to find in the shops. In Bellavista Nanay, in addition to the increased assets noted in Section 4.0.2, four houses had been or were in the process of being rebuilt. The local shops stocked a larger variety of goods and were better stocked, as was the small market[34]. This increase in wealth can be attributed to the decreased strength of the US dollar in 2007, which is particularly relevant to households receiving foreign remittances.

The respondents' housing quality and assets were assessed to see if this was reflected in a statistically significant change in the income proxy (defined and discussed in Section 3.3.1). Wealth (measured using the income proxy) in the community had statistically significantly increased from 2006 to 2007[35], which can be attributed to an increase in asset ownership rather than increased housing quality (see Sections 4.0.1 and 4.0.2).

The wealth of a household has been related to the household's WTP for water (Nyong and Kanaroglou, 2001) and with increased wealth comes an increased choice in drinking water sources (Israel, 2007). As Israel (2007) found in Bolivia, households purchasing water from

[34] General observations
[35] WSR, two tailed, significance level 95 %: $p = 0.007$

private water vendors were on average poorer than households with piped water (Israel, 2007). In Bellavista Nanay, an association between wealth and payment for water was found in 2006[36], but not in 2007. This can be explained by the change in the availability of tap water seen in 2007. From these results, an association between the main drinking water source and wealth might be expected for the data collected in 2006, but none was found[37]. This could be due to the non continuous nature of all main drinking water sources and the ability of wealthier households to change source, as discussed in Chapter 5.

4.1 Populations demographics and estimated population

A comparison of the household demographics from the seasons can be seen in Table 4.1. The average household size was seven, which consisted of five adults, one child and one infant. There was some change in household demographic from 2006 to 2007. These changes were probably caused by a combination of factors such as the seasonal migration to and from households maintained in the rainforest, increased mobility in the rainy season due to increased river levels, and the aging of infants and children. Household demographics are especially important in this study as the presence of children and infants has been found to influence drinking water practices in Paris (Euzen, 2003). This behaviour is possibly caused by the relationship between perceived quality and risk, which was discussed in Section 2.3.3 and is explored further in Section 8.4.

Table 4.1: Household demographics

	2006			2007		
	Total	**Mean**	**Range**	**Total**	**Mean**	**Range**
All people	644	6.71	2 - 15	662	6.90	2 - 14
Adults	396	4.13	1 - 11	439	4.57	1 - 10
Children	136	1.42	0 - 7	117	1.22	0 - 5
Infants	111	1.16	0 - 5	105	1.09	0 - 6

Combining the information on the number of households asked to participate in this study (which can be found in Section 3.3.5), the sampling strategy (as seen in Section 3.3.4) and the average size of the households, the population of Bellavista Nanay is estimated to be 2,866. This is approximately 1,000 people lower than the Gatekeepers estimate (Section

[36] Eta, two tailed, significance level 95 %: 2006 $p = 0.023$, 2007 $p = 0.233$
[37] Eta, two tailed, significance level 95 %:2006 $p = 0.129$

1.0). The over estimation of the population in the community highlights the value of using a mixed methodology, as data gained from one method can be checked using another method (Triangulation). No official population data for this community could be found.

4.2 WASH in the community

WTP for other WASH interventions such as sanitation have also been linked to wealth (Jenkins and Curtis, 2005). Other socioeconomic factors such as education may also influence their choice of WASH interventions. Due to the holistic approach taken in this thesis, any WASH intervention cannot be explored separately, hence the need for the information presented below.

4.2.1 Sanitation and pollution

In 2006 approximately half of the respondents had an inside toilet[38] (53%), 31% of the respondents used public or private latrines[39] and 16% of the respondents defecated in the open air (as seen in Figure 4.2). In 2007, the toilet situation in Bellavista Nanay had changed for the better with more respondents using public and private latrines and having toilets in their households (as seen in Figure 4.2). This difference was found to be statistically significant[40]. The change was self initiated, householders had invested in better sanitation. It is worth noting that although their standard of sanitation had increased significantly, there were no sewers or wastewater treatment in the community. The sewage from toilets was discharged into the river close to the house during rainy season and on to land during the dry season. Type of sanitation was found to be associated with wealth in both years[41], so it could be said that the increase in wealth caused the increase in sanitation quality in 2007.

The sanitation situation in the nursery was observed. Three latrines were contained in the complex, which were not working during the researcher's voluntary period (2007). The children urinated in the gutters down the side of the complex and defecated in the unfunctioning latrines. When children urinated on the floor of the nursery or other places

[38] A toilet inside a house, but this would not be connected to a sewerage system as none were present in the community

[39] Latrines were situated outside the house in the yard and were simple pit latrines

[40] ST, two tailed, significance level 95%: $p = 0.040$

[41] KTC, two tailed, significance level 95%: 2006 $p = 0.000$, 2007 $p = 0.000$

such as the church hall, it was not cleaned up. Literature is available on how children's waste products are seen to be of a lower risk and less disgusting than adults (Curtis and Brian, 2001, Curtis *et al.,* 1997), which may explain this behaviour.

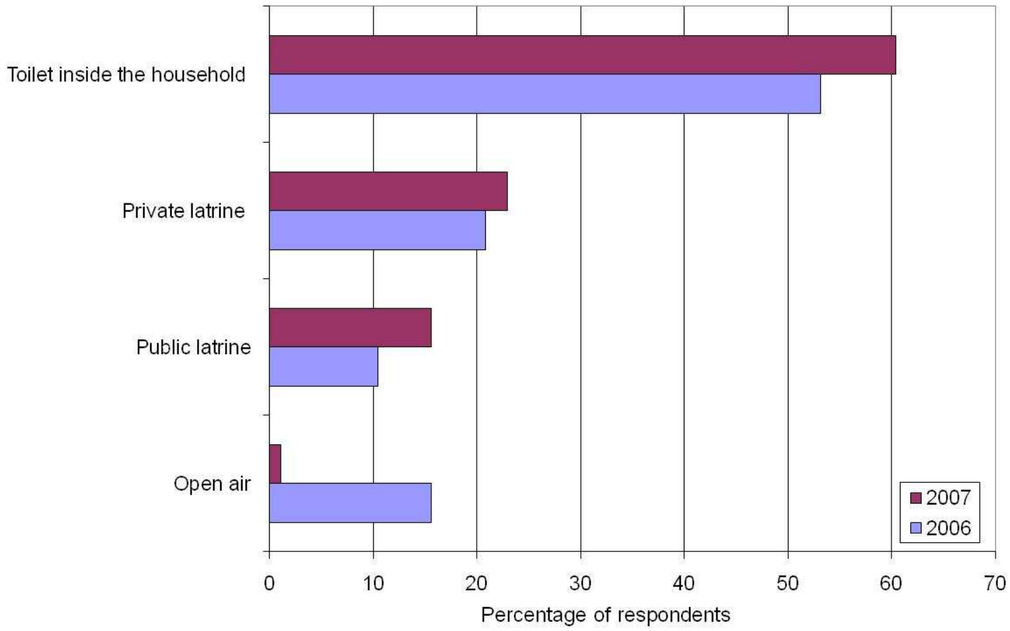

Figure 4.2: Comparison of sanitation types in respondents households in 2006 and 2007 (*n=96* for both years)

All of the questionnaire respondents were aware of the potential effects on drinking water sources that could result from their sanitation method. A majority of the respondents judged the risk of pollution from their sanitation method on drinking water sources as either large or very large in both years (93% in 2006 and 97% in 2007, *n=96* in both years). There was a decrease in the number of respondents who judged the risk to be very large from 2006 (27%, *n=96*) to 2007 (4%, *n=96*), which was found to be statistically significant[42]. It was thought that the decrease in estimated risk may have been associated with the increase in sanitation levels, but no statistical relationship was found[43]. Another explanation is that in 2007 the data was collected in the rainy season, which may have caused areas that received this waste to be cleansed. This may have caused respondents to perceive the risk to the environment to be lower.

[42] WSR, two tailed, significance level 95%: $p = 0.012$
[43] KTC, two tailed, significance level 95%: 2006 $p = 0.576$, 2007 $p = 0.093$

4.2.2 Hygiene and handwashing

The general hygiene of the residents of Bellavista Nanay was observed. The environment in Bellavista Nanay was either dusty and dry or wet and muddy. In this environment it proved challenging to keep clothes and exposed areas such as fingernails clean. It was noted that the residents of Bellavista Nanay were able to maintain a high level of hygiene compared to visitors to the community, even under these conditions.

In 2006, the field assistants were asked to rate the respondents hand cleanliness. Just over half of the respondents hands were judged as being neither clean nor dirty (56%, *n=96*), but a higher number of respondents' hands were judged to be clean or very clean (27%, *n=96*) compared to dirty (16%, *n=96*). In general those judged with having dirty hands had just stopped some kind of activity such as cooking or fixing a car in order to answer the questionnaire. A discussion about this question and why it was omitted from the second questionnaire can be found in Section 3.3.3.

In 2006 all of the respondents reported to either always washing (93%,*n=96*) or nearly always washing (7%, *n=96*) their hands after visiting the bathroom or before preparing food or eating. When the data collected in 2006 was compared to that of 2007 (*n=96* for both years) it was seen that these figures had fallen to 88% and 1%. This decline in handwashing practices was found to be statistically significant[44]. The drop in handwashing practices were probably due to the changes in the water situation in the community (discussed in Chapter 5) which led to less clean water being available for hygiene practices. This hypothesis is expanded in Chapter 8 which relates the situation in 2007 to the importance of water for hygiene.

In 2006, 99% (*n=96*) of the respondents reported always using soap when washing their hands, which dropped to 88% (*n=96*) in 2007. This drop in reported practice was found to be statistically significant[45]. Soap was readily available in the community and the wealth of the community increased from 2006 to 2007, so availability and wealth do not account for the drop in soap usage. An alternative explanation is that the lower handwashing activity would

[44] WSR, two tailed, significance level 95%: $p = 0.007$
[45] WSR, two tailed, significance level 95%: $p = 0.005$

mean that handwashing was less automatic and therefore more memorable. This in turn may have caused the respondents to reflect on handwashing in greater detail, so that reported soap usage in 2007 was lower, but possibly more accurate.

Reviewing the results in this section it can be said that the high level of handwashing and soap usage in 2006 explains the high standard of hand cleanliness observed in this year. The reported behaviour in the questionnaire was supported by observations. This suggests that the respondents were not just reporting what they thought they should say or what they thought we wanted to hear.

Handwashing procedures were also observed at a local nursery in 2007. Before morning break the infants were instructed to wash their hands (using harvested rain water), but not always with soap. This was not a regulated activity, so all children did not participate. After the children had gone to the toilet they did not wash their hands nor were they instructed to do so by the staff. The nursery nurses that accompanied the children to the toilet were not witnessed washing their hands either. Although handwashing practice was being taught at this nursery it was not being enforced and there was a lack of handwashing after visiting the toilet. This data contradicts the data collected using the questionnaire, where handwashing and soap usage was high. The observed lack in infant handwashing and handwashing of those assisting infants, can be explained by the known phenomenon of the lack of risk or disgust attributed by adults to urine and faeces from children (Curtis and Biran, 2001). The pattern of not handwashing with soap after aiding a child to defecate, but handwashing after the person has defecated themselves has been recorded in Ghana (Scott *et al.,* 2007) and the UK (Curtis *et al.,* 2003).

4.3 Illness in the community

In 2006 there was a high rate of self reported illness in the respondents' households. Forty percent (*n=96*) of households had a member who had been ill within the last seven days. This fell to 31% (*n=96*) in 2007, although no statistical difference was found between the two data sets[46].

[46] McNemar, two tailed, significance level 95%: $p = 0.286$

Five respondents reported in 2006 that more than one member of their household who had been ill within the last seven days. This dropped to only three households in 2007. Due to inequalities in household demographics (as described in Section 4.1), the percentage of those ill in each age group was calculated, and can be seen in Table 4.2.

Infants in this community had the highest level of self reported illness in both sampling periods. This was expected as they are one of the most vulnerable groups. It should be noted that there was no separate category in the questionnaire for the elderly, another classically vulnerable group. The fall in household self reported illness from 2006 to 2007 can be attributed to the fall in infant illness in this period, since self reported illness for children and adults increased slightly (as seen in Table 4.2).

Table 4.2: Comparison of self reported illness and age groups 2006 and 2007

Illness % / **Year**	**Households**	**Household population**	**Infants**	**Children**	**Adults**
2006	**39.9** (*n=96*)	**5.9** (*n=643*)	**10.8** (*n=111*)	**4.4** (*n=136*)	**3.1** (*n=396*)
2007	**31.3** (*n=96*)	**5.1** (*n=661*)	**6.7** (*n=105*)	**6.0** (*n=117*)	**4.6** (*n=439*)

Self reported illness was expected to increase from 2006 to 2007, due to the questionnaire in 2007 being completed in the rainy season, when water-related diseases such as malaria are more prevalent. There was a slight increase in self reported illness for children and adults in the rainy season possibly due to this. This was overshadowed by the decrease in self reported illness in infants which may be related to the increase in wealth in the community and better sanitation, although this theory was not supported by the statistical analysis[47]. This would imply that a multitude of factors caused the drop in infant illness.

All of the households in 2006 that used river water as their main drinking and cooking water source had a household member who was ill. There was a lower level of self reported illness in respondents' households that that used standpipe or tap water and tankered water for

[47] Eta, two tailed significance level 95%: IP & infant illness 2006 $p = 0.138$, 2007 $p = 0.185$ sanitation type & infant illness 2006 $p = 0.180$, 2007 $p = 0.051$

their main source of cooking and drinking water, but self reported illness was recorded by the consumers of all drinking water sources. Therefore it was no surprise that no statistically significant relationship was found between main drinking and cooking water sources and self reported household illness[48].

4.4 Association of water and diarrhoea

The Director of the local medical post stated that the most common diseases in this area were parasites, diarrhoeas, hepatitis A, bacterial skin infections and cholera (in order of decreasing importance), which are all considered to be water-related diseases[49]. When the medical establishments were visited (detailed in Section 3.1.2), no information such as pamphlets or displays were seen on any water-related diseases. The Director of the medical post stated that this type of information was only supplied to the public when national or regional campaigns were in progress.

A discussion on the information the respondents received on drinking water, including water-related diseases, can be found in Chapter 7. Respondents recorded receiving information on water-related diseases in both years. There was high media coverage of this topic in 2007, which is discussed in Chapter 7, and information on water-related diseases was widely available.

In 2006, respondents were questioned on the cause of diarrhoea: although 36% (*n=96*) did not think that there was a relationship between water and hygiene and diarrhoea (as seen in Figure 4.3), a majority (64%,) of respondents did make this connection. This included the 19% of the respondents who understood it in a medical context e.g. mentioned bacteria in their answer. In 2007, there was an increased awareness of the causes of diarrhoea, as only 2% (*n=96*) of respondents did not think that a relationship between water and hygiene and diarrhoea existed. However, in this period a lower level of respondents (3%) used medical terms in their answer (as seen in Figure 4.3). Even with these differences, no statistically significant difference in respondents' awareness between the two years was found[50]. The

[48] CV, two tailed, significance level 95%: 2006 $p = 0.053$, 2007 $p = 0.777$
[49] Interview 20/9/2007
[50] WSR test, two tailed, significance level 95%: $p = 0.161$

increase in awareness from 2006 to 2007 may have been linked to the high media coverage of this topic (as discussed in Chapter 7).

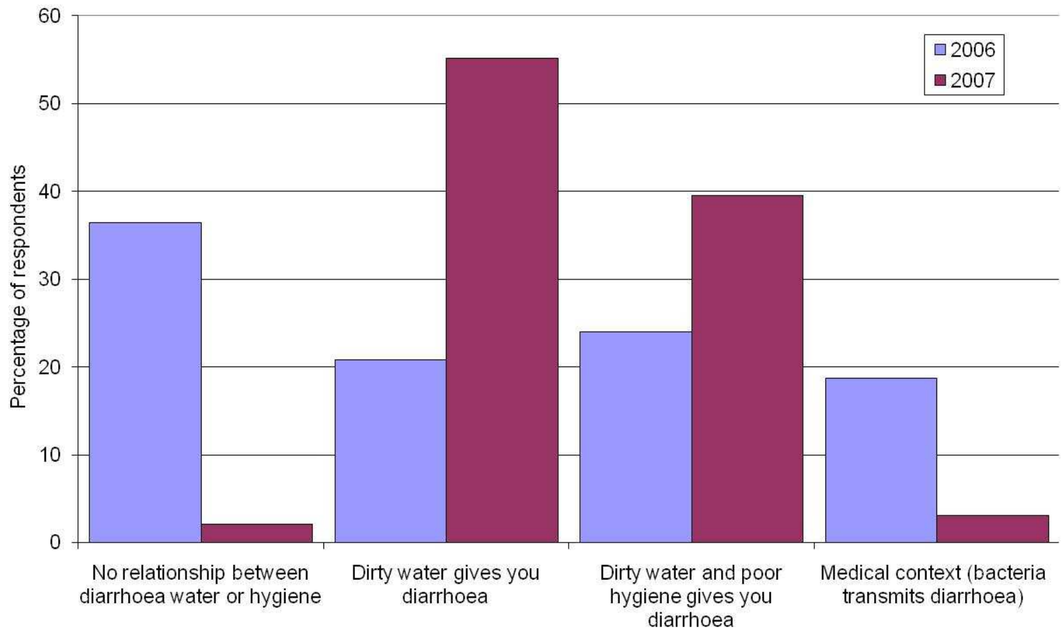

Figure 4.3: Comparison of why respondents think they get diarrhoea in 2006 and 2007 (*n=96* for both years)

The respondents were then asked if drinking crude water was an important factor in contracting diarrhoea. In 2006, a majority of the respondents (92%, *n=96*) thought that drinking crude water was either an important or very important factor in contracting diarrhoea. This figure increased slightly to 96% (*n=96*) in 2007, but no significant difference was found between the two years[51]. In this community there a high awareness that drinking crude water was an important factor in contracting diarrhoea, which may explain the importance placed on drinking water quality and influence respondents' choice of drinking water.

The respondents were asked to judge the gravity of their family contracting diarrhoea. In 2006, just over half of the respondents (51%, *n=96*) thought the effect was serious and 22% of respondents felt it was very serious, as seen in Figure 4.4. However, 14% of the respondents felt that the effect of getting diarrhoea was either trivial or somewhat trivial, (as seen in Figure 4.4). The pattern changed slightly in 2007, as no respondent thought that

[51] WSR test, two tailed, significance level 95%: $p = 0.362$

diarrhoea had a very serious effect on their family and a higher percentage (34%, *n=96*) thought that the effect of diarrhoea on their family either trivial or somewhat trivial. The data from the two sampling periods was found to be statistically different[52]. The effect of diarrhoea on the respondents' households was judged overall to be less serious in 2007 compared to 2006 (Figure 4.4). This could be linked to the overall lower of levels of self reported illness in the community in 2007. Another explanation is that in 2007 respondents main health concerns may not have been diarrhoea, but other diseases such as malaria due to the change in season.

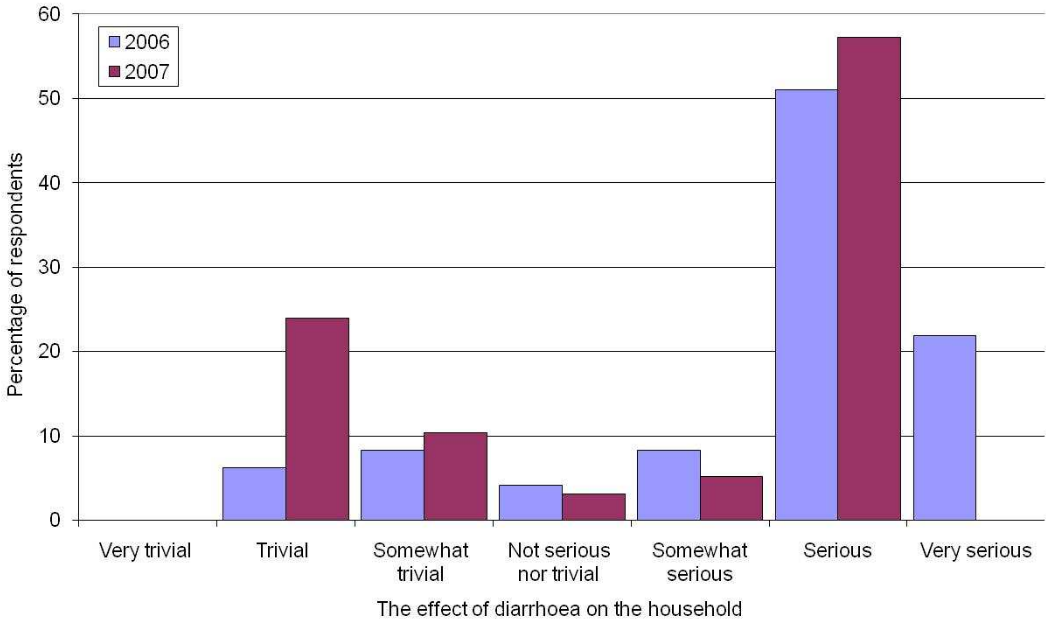

Figure 4.4: Comparison on the effect of the gravity of diarrhoea on respondents' households in 2006 and 2007 (*n=96* for both years)

4.5 Chapter summary

This chapter achieves the objectives set of baselining the community in order to analyse their living and WASH conditions, illness rates and how the respondents associated water with diarrhoea. The main findings of this chapter are summarised below.

It can be said that an average house in Bellavista Nanay would be constructed of wooden walls and floor, and have a metal roof. Residents that lived in this community were more likely to be connected to the electricity supply than to have an inside toilet or connected to

[52] WSR test, two tailed, significance level 95%: $p = 0.000$

the municipal water supply. Respondents placed a low priority on WASH interventions compared to other assets and services.

Wealth in Bellavista Nanay was found to have increased from 2006 to 2007. It was found through indicators of wealth that Bellavista Nanay was wealthier than Punchana, but was less wealthy than Iquitos. Wealth was linked to payment for water and type of sanitation. Wealth therefore influenced the choice of water available to the respondents and was linked to increased sanitation quality.

The respondents were generally aware of the pollution risks associated with their form of sanitation, although this awareness was lower in 2007. In the nursery setting a disregard to the risks associated with children's waste products was witnessed.

Hygienic practices were reported by the respondents including high levels of handwashing and soap usage, which supported the structured observations made in 2006. The drop in handwashing and soap usage in 2007 can be explained by the changed water situation causing a lack of water for cleaning and hygiene. Observations of children's handwashing practices contradicted the respondents self reported handwashing practices. This supports the earlier argument that there was a lack of disgust associated with children's waste products.

Incidences of self reported illness were high in the community in 2006, but fell in 2007, due to a reduction in reported illness in infants. This could not be explained by the increase in wealth and sanitation quality alone. There was an increase in self reported illness in the children and adults from 2006 to 2007, which was expected as more diseases are prevalent in the rainy season.

Diarrhoea was the second most prevalent disease in Bellavista Nanay. In general it can be said that the respondents had a good understanding of the link between water, hygiene and diarrhoea. They also showed a good understanding of the link between drinking crude water and diarrhoea. The perceived gravity of the effects of diarrhoea on the household were also in general considered grave, although in 2007 just over a third of the respondents reported the perceived effects as being either trivial or somewhat trivial. This was explained by the possibility that diarrhoea was not being considered a health priority compared to other diseases for which incidences increase in the rainy season.

The data discussed in this chapter is drawn on throughout the subsequent chapters. Wealth has already been shown to influence drinking water and sanitation choice, but is also referred to in Chapter 7 in relation to drinking water practices. WASH and its importance are discussed in detail in Chapter 8. Illness in the community is discussed in relation to drinking water practices in Chapter 5 and drinking water quality in Chapter 8. The association of water and diarrhoea is elaborated on in Chapter 7 and discussed in detail with respect to perceived drinking water quality in Chapter 8.

Chapter Five: Drinking water practices

The objectives of this chapter are to present and discuss the data from the questionnaire (raw data can be found in Appendices 9 and 10), interviews (Section 3.1.2), observations (Section 3.1.1) and other documents (Section 3.1.3) that pertain to drinking water practices in Bellavista Nanay.

This chapter builds on the literature reviewed in Chapter 2 and on the WASH conditions reported in Chapter 4. An in-depth investigation was required on drinking water practices in Bellavista Nanay because little data was available, as can be seen in Section 1.0, and drinking water practices are pivotal to this study. The raw data collected in the questionnaires can be found in Appendices 9 to 10.

Drinking water quality is influenced not only by the quality of the sources (discussed in Chapter 6) and its availability, but also by drinking water practices such as collection, storage and household treatment (Wright *et al.,* 2004, Jenson *et al.,* 2002, Sobel *et al.,* 1998, Quick *et al.,* 1999, Brick *et al.,* 2004), which were discussed in Sections 2.0 to 2.2. Some drinking water practices such as choice of water source or household drinking water treatment may be driven by the perception of drinking water quality, as discussed in Section 2.3.1 and hypothesised in Figure 1.2 (page 12). The relationship between drinking water practices and actual drinking water quality are discussed in Chapter 6. These factors are explored in relation to the perception of drinking water quality in greater detail in Chapter 8.

5.0 Household water managers

The person in charge of water at a household level is referred to in this study as the 'household water manager'. This is the person that the questionnaire was aimed at. The profile of the household water manager was investigated, since gender and education may influence their perceptions of drinking water quality and drinking water practices (Turgeon *et al.,* 2004, Andreson *et al.,* 2007).

The mean age of the household water managers was 39, but their ages ranged from 17 to 79 years, as seen in Figure 5.1. The majority of the household water managers were female (83%, *n= 96*), but 17% were male. Gender of household water managers depends on the customs and culture of the local community (Nyong and Kanaroglou, 2001) therefore in assuming this task to be a solely female activity, valuable data would have been lost.

It was observed that when water was collected by female water managers they were often aided by male members of their household in order to carry the large volumes required. This practice was related to the availability of water sources (Table 5.2) and storage time (discussed in Section 5.2.5).

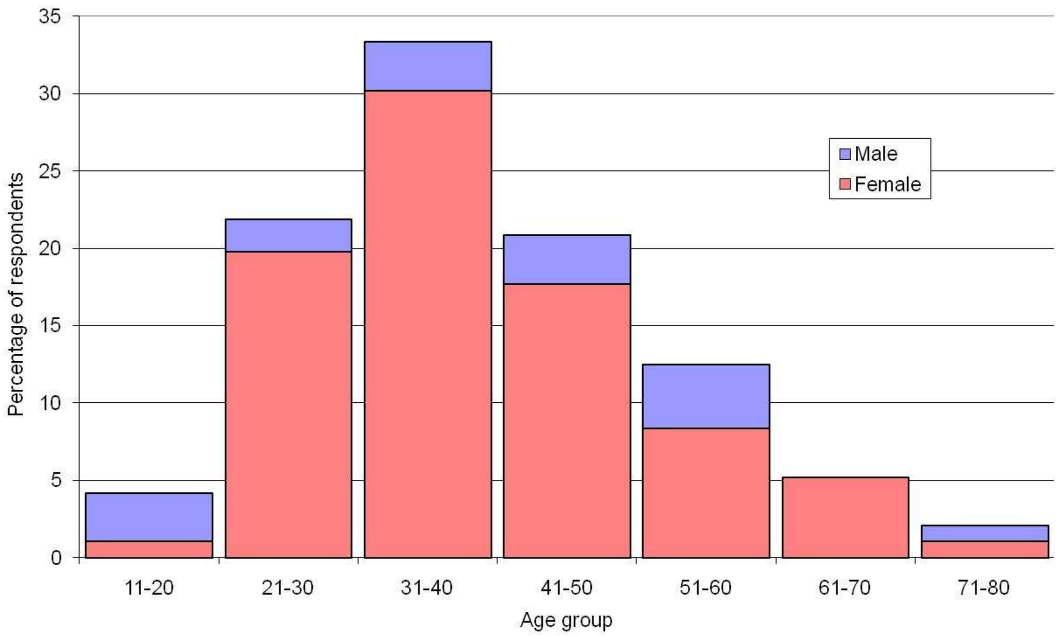

Figure 5.1: Age and gender of the respondents 2006 (*n=96*)

In Figure 5.2 it can be seen that male water managers were represented in all but the 61-70 age group. There were no specific age groups where male household water managers were more prevalent. Just over half of the respondents classified themselves as housewives (66%, *n=96*), although many worked at home, ran small businesses or worked part-time. The occupation of the male water managers was spread across all categories. This can be seen in Figure 5.2.

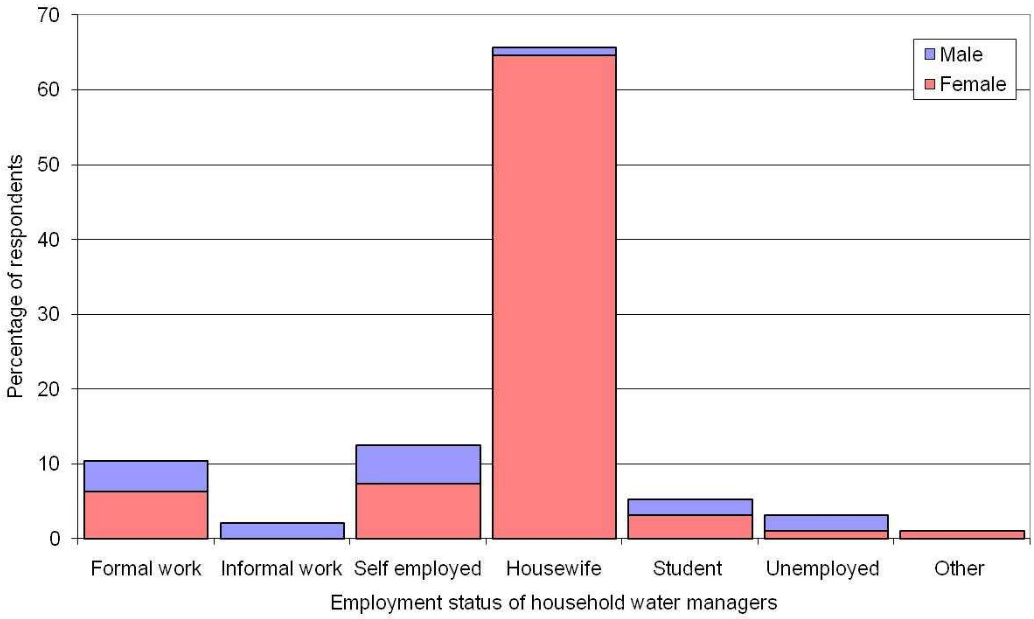

Figure 5.2: Employment status of household water managers and their gender (*n=96*)

In terms of education, 42% (*n=96*) of the household water managers had completed their secondary education. This was higher for male household water managers (56%) compared to female water managers (39%). From Table 5.1 it can be seen that the percentage of male and female water managers that had completed their secondary education was slightly higher than the level recorded nationally and for District of Punchana. Fewer female water managers had completed their secondary education compared to the general female population of Iquitos. This could be due to the Iquitos census being undertaken in 2005 compared to the study data which was collected in 2006 and 2007.

In Table 5.1 it can be seen that nationally, regionally and locally, a lower percentage of females completed their secondary education in 2005 compared to males. This gender disparity in education at all levels in Peru is commonly found in developing countries.

Table 5.1: Percentage of inhabitants who had completed their secondary education by gender (Instituo Nacional de Estadistica e Informatica, 2005)

	% of inhabitants who had completed their secondary education		
Area	**Peru**	**City of Iquitos**	**District of Punchana**
Male	39	49	39
Female	35	42	35

When the respondents were re-interviewed in 2007, it was assumed that their age, gender, education and occupation remained the same. Associations were found between age and education, younger household water managers being more likely to have completed their secondary education than older household water managers[53]. Education was also related to professional status[54]. Female education level has been correlated with household education level in rural India and was found to be a significant factor in the choice of safe water in rural India, whereas income was found to be unimportant (Asthana, 1997). These associations are explored in detail in Chapter 8.

5.1 Water sources in Bellavista Nanay

Initially it was reported by the Gatekeeper that there were three sources of water available to the community: rain water, river water and municipally treated water (as discussed in Section 1.1). When household water managers were asked to identify the types of water available to them for washing clothes, cleaning, hygiene, cooking and drinking, a total of seven water sources were identified, as seen in Figure 5.3.

In 2007, the study subdivided the category of purchased bottled water into delivered, purchased sealed and unsealed water and shop purchased bottled water, because these distinct water sources were identified by observations during the field work in 2006. A summary of the observational data can be seen in Table 5.2, which includes definitions of the terms used to distinguish between different water sources in this thesis. Additional descriptive information such as the cost and availability of the water sources is also included in this table. The three types of purchased bottled water were then combined when comparing data from 2006 and 2007, as in Figure 5.3. No other water sources were identified by respondents.

[53] MWU, two tailed, significance level 95%: $p = 0.003$, based on means ranks yes = 38.44 no = 55.96.
[54] Eta, two tailed, significance level 95%: $p = 0.002$

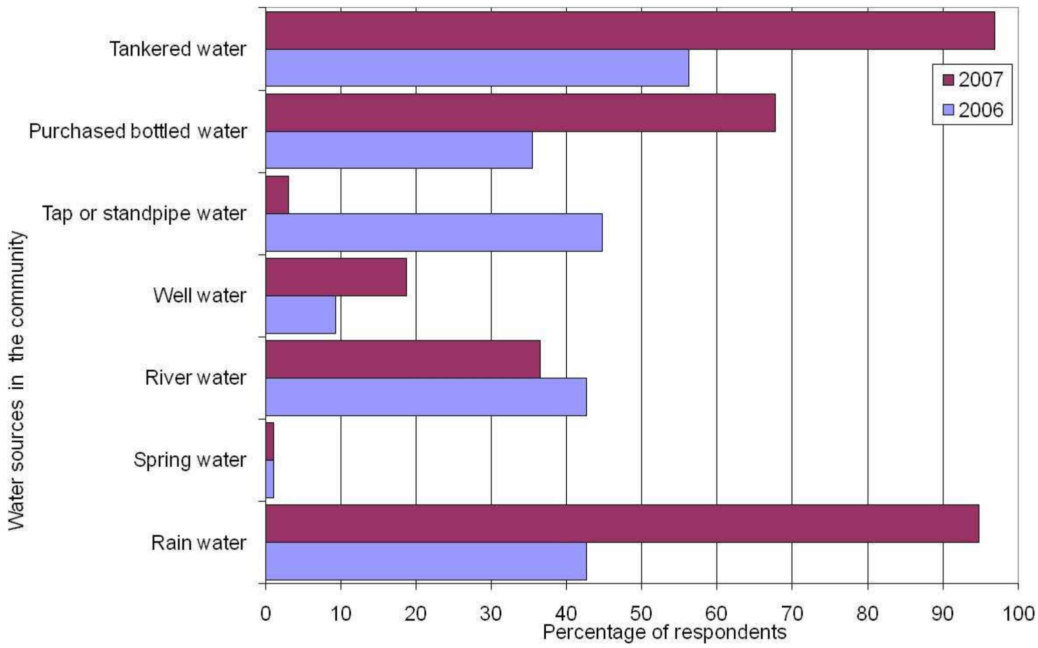

Figure 5.3: Respondents' identification of available water sources in Bellavista Nanay 2006 and 2007 (*n=96* in both years)

Statistically significant changes in the self-identification of four of the water sources in the community were found between the two sampling periods (rain water, tap or standpipe water, purchased bottled water and tankered water[55]) and are reflected in Figure 5.3. There were two reasons for these changes, the first being a seasonal change. The field work in 2007 was undertaken during the rainy season. Rain water was more abundant leading to the identification of rain water as a water source by a larger number of respondents during this period. The second change was the termination of the tap or standpipe water sources in the community (which is discussed in detail in Section 5.2). This was reflected in a decrease in the identification of this water source (seen in Figure 5.3). This factor led to the respondents looking for other water sources and therefore more respondents identifying water from tankers and purchased bottled water in the community.

Even though all sources were present in the community, respondents did not appear to be knowledgeable about certain sources. An example of this was that the Gatekeeper did not know that there were artisan wells in the community (as described in Table 5.2).

[55] McNemar, two tailed, significance level 95%: $p = 0.000$ for all tests stated

Another factor was the interpretation of the question asked[56]. It was noted that respondents did not interpret the term 'community' as intended, i.e. as the wider community of Bellavista Nanay, but rather as a more localised community of their neighbours which extended to only a few houses[57]. A discussion about the terminology was undertaken with the field assistants, but the conclusion of which was that this would not change the results gained as people would still interpret community to mean near neighbours not Bellavista Nanay as a whole. The respondents' concept of community did not appear to influence the gathering of information as all of the water sources available in Bellavista Nanay were identified in the questionnaire data seen in Table 5.2.

It is interesting to note that spring water was identified by one respondent as being a water source in both years. No evidence of a spring was found[58] and no respondents stated that they specifically used spring water in their household (as seen in Figure 5.4). Spring water was therefore deemed not to be available to the community.

[56] What type of water is available in your community for washing clothes, drinking, cooking and hygiene?
[57] Observation 4/7/2006
[58] Observational data, exploring of the area, and questioning of the Gatekeeper and Field Assistants

Table 5.2: Summary of observational data on the water sources available in Bellavista Nanay

Water source	Definition	Additional information	Supply information	Cost (data from 2006)
River water	Water collected from a river	River water was generally collected from two points on the river in large barrel-like containers called "bidones" or "baldes".	Available at all times. Less than 250 metres from all houses	Free
Rain water	Water collected in vessels from rain	Rain water was normally collected from the runoff from a roof into an open vessel (e.g. bucket, bowl). Some households had intricate collection systems that allowed water to be collected inside the house.	Only available when the weather permitted usually rained at least once a week.	Free
Well water	Water collected from a well	Approximately 10 artisan wells were identified within the community, all were covered. Most had a bucket and string for manual water collection. One was connected to a pump that delivered water to the household above.	Available at all times.	Free
Tap or standpipe water	Water collected from either a standpipe or tap	No distinction was made between standpipes or taps. These could be internal or external. They ranged from a simple valve on a pipe, to a tap over a ceramic sink. Treated water from the municipal water treatment plant.	Available 3 hours per day usually during the early morning 2-5 am.	S/. 20.00 per month (UK£3.00)

Purchased bottled water	Water purchased in a container	Different forms of purchased water were available. 1. Purchased sealed water was delivered by van in 20 litre sealed containers. 2. Purchased unsealed water was delivered by bicycle in 18 litre containers from an undetermined source. 3. Purchased shop water was sealed in bottles of various sizes.	1. Once the company is informed it is supplied either on the same day or the next day. 2. Sold daily on the streets, delivered to the door 3. Can be purchased daily at local shops	1. S/.2.00 per 20 litres (UK£0.30) 2. S/. 0.50 – 0.75 per 18 litres (UK£0.08 – 0.11) 3. S/.2.00 per 2 litres (UK£0.30)
Tankered water	Water delivered by a tanker	Treated water was delivered twice a week from the municipal water treatment plant.	In 2006 the tanker delivered water to the community twice a week. In 2007 the tanker delivered water to the community daily. The water was not delivered at a specific time or at a specific destination.	Free

5.2 Household drinking water practices

After considering the water available for all purposes in the previous section, this section concentrates on sources of water used for drinking and cooking. As mentioned before, household drinking water practices can be linked to drinking water quality, socioeconomic status and perception of drinking water quality.

The respondents were questioned about their normal and present drinking water sources. Their normal drinking water source was the source that the household habitually used and more than one source could be stated. The present water source was the source they were using at the time that the questionnaire was administered. This line of questioning was used to ascertain availability of sources and flexibility in practices.

5.2.1 Normal drinking and cooking sources

Six drinking and cooking water sources were identified as being normally used in households in 2006 and 2007, which are shown in Figure 5.4. In 2006, 14 respondents reported using only one drinking and cooking water source in their household, which increased to 29 in 2007. Multiple drinking and cooking water sources were therefore used by a majority of the respondents due to the availability of sources (recorded in Table 5.2). This highlights the flexible approach used by household drinking water managers. In 2007, the 29 respondents using only one source all gained their water from the tanker, due to no tap water being available in the community. The consequence of increased dependency on tanker water led the community to organise a demonstration which included blocking Avenida la Marina on 29th August 2007, which was reported in La Región[59].

[59] Article published in La Región on the 29/08/2007

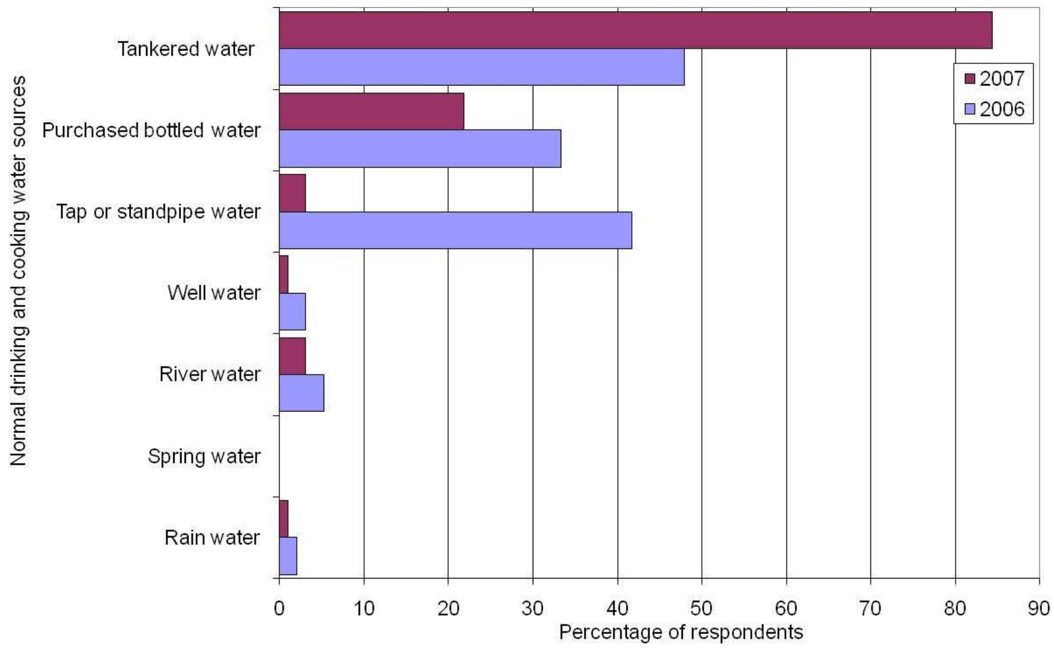

Figure 5.4: Respondents' identification of their normal drinking and cooking water sources in 2006 and 2007 (*n=96* in both years)

It was thought that the abundance of rain in 2007 due to the sampling period occurring in the rainy season would increase the use of this source of water, especially for drinking and cooking. However, the number of respondents identifying rain water as a normal drinking and cooking water source decreased from two in the dry season (2006, *n=96*) to one in the rainy season (2007, *n=96*), as seen in Figure 5.4. No respondents were using rain water as their present source of drinking or cooking water in either period (Figure 5.5).

Rain water was collected during wet periods, but this water was used for laundry and cleaning purposes only[60]. The main method of rain water harvesting was to put bowls out in the street to collect runoff from the roof. However, several households had metal guttering and some had intricate rain water harvesting systems. This included one house which had a collection system that went inside the house.

One respondent said "…they drink rain water on the border"[61], which was said in a way that implied that rain water was dirty and the people that drank it were not 'civilised'. This

[60] General observation
[61] Quote from a respondent 8/11/2007

attitude could explain why rain water was not used as a drinking and cooking water source in this community.

Other authors have found that households that have installed a private tap are likely to be wealthier, better educated and more conscious of hygiene compared with their neighbours (Cairncross and Valdmanis, 2004). In this community, wealth has already been found to be related to payment for water (as discussed in Section 4.05). Other relationships, discussed by Cairncross and Valdmanis (2004), are explored in Chapter 8.

5.2.2 Present drinking and cooking water sources

The respondents were asked to identify their present source of drinking and cooking water at the time that the questionnaire was administered, as seen in Figure 5.5. There was a statistically significant change in respondents' present drinking and cooking water sources between the two sampling periods[62].

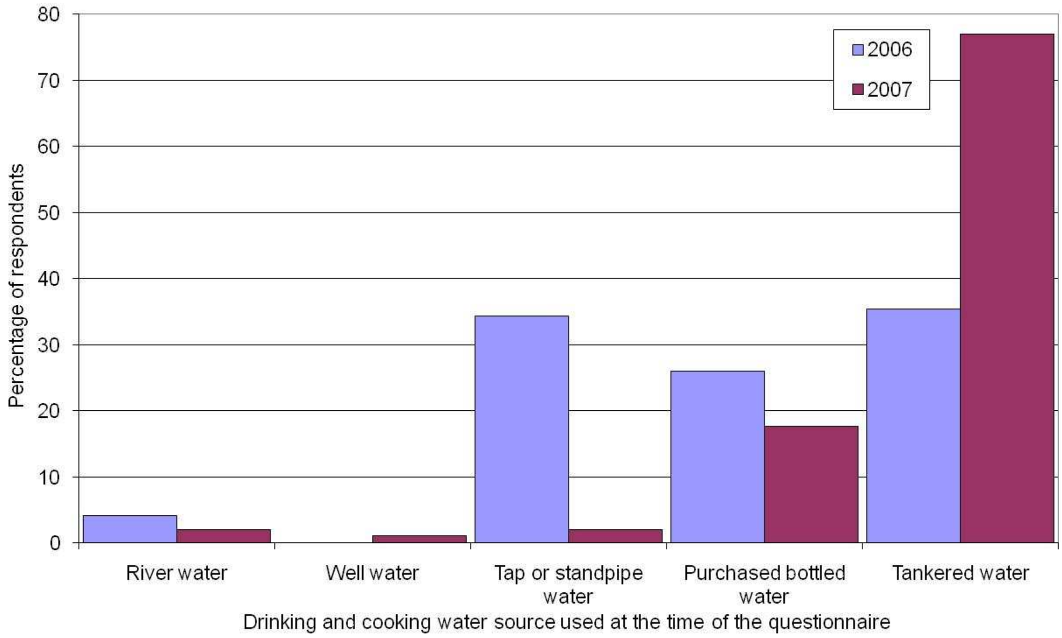

Figure 5.5: Respondents identification of their present drinking and cooking water source at the time the questionnaire was undertaken in 2006 and 2007 (*n=96* in both years)

Fifty one respondents changed their present drinking and cooking water source between 2006 and 2007. The largest change was in the fall from 34 respondents who had used tap or

[62] ST, two tailed, significance level 95%: $p = 0.000$

standpipe water in 2006 to only two 2007. Those 32 respondents switched to using water tanker, purchased bottled water or well water in 2007.

In 2007, a total of 41 respondents had switched from their present drinking and cooking water source in 2007 to tankered water, increasing the community's dependency on this drinking water source. The change to tankered water was economic and supply driven: tankered water was free and the price of purchased unsealed water increased in 2007 (discussed in Section 5.2.3). In 2006, the free tankered water was delivered twice a week, normally during the day. In 2007, the water tanker was supposed to deliver daily. Deliveries in 2007 were made either during the evening, night or very early morning. The disconnection of the municipal supply in conjunction with the increase in water tanker delivery, the changed delivery time and the water being free, increased the community's reliance on this water source in 2007.

Water bladders were installed in the community when the municipal water supply was terminated. It was planned that the bladders would be filled with water when the tankers arrived at the community at the times mentioned above. Then the residents would be able to collect water at more convenient times during the day. As seen in Figure 5.6, these water bladders were never observed to contain any water during the field trip period in 2007.

In identifying the normal and present drinking and cooking water sources used by the household water managers, it became apparent that they were able to switch drinking water sources. The household water managers' strategies were highly flexible and were adapted to situations as they arose. A typical example was when a water tanker did not arrive; a household water manager would then purchase water from a vendor. This flexibility was demonstrated when the researcher asked a local woman if she had tap water. She replied… "I have not had tap water for five days, so I buy water or get water from the tanker when it comes"[63].

[63] Local woman interviewed on 07/07/2006

Figure 5.6: Photo of empty water bladder in Bellavista Nanay
Source: Claire Furlong

When the normal drinking and cooking water sources (as seen in Figure 5.4) are compared to the sources of water available in Bellavista Nanay (as seen in Figure 5.3) it can be seen that all water sources are identified in both questions except spring water, which is discussed in Section 5.2.1. Rain water was readily used for other purposes, but was never recorded as a present drinking water source (as seen in Figure 5.5) in either period. This information points to the practices that were witnessed in the community. Water for drinking and cooking, and for other purposes was obtained from different sources. A local shop owner had a tap water supply in her living quarters, but used purchased sealed water for drinking[64]. The practice of collecting river water at dusk witnessed by the Gatekeeper was initially mistaken for the collection of drinking water. In fact this water was actually used for other purposes such as hygiene and washing clothes, rather than drinking. In all households, this separation of water for drinking and cooking, and water for other purposes was witnessed, although this practice was not fully uncovered by the questionnaire data.

[64] Information supplied by a questionnaire respondent on 17/7/2006

The disparities between access to different types of drinking water in rural and urban Peru have been highlighted in Section 1.0.1. When this data is compared to data in Table 5.3, more inequalities are seen. Bellavista Nanay had lower coverage of improved drinking water sources (defined in Section 2.4.1) than the Department of Loreto, the District of Punchana and the City of Iquitos (as seen in Table 5.3) and this coverage fell from 34% (2006, *n=96*) to 2% in (2007, *n=96*). This was due to the community's reliance on tankered water which is not classified as an improved drinking water source. These disparities were not apparent in national and departmental figures, as demonstrated in Table 5.3. The situation in 2007 in Bellavista Nanay was shocking when it is considered that Peru is set to meet the MDG for water by 2015. When the quality of the drinking water sources were assessed, it brings into question the definition of an improved drinking water source (this is discussed in Section 2.4.1 and Chapter 8).

Even before the municipal water source was terminated in Bellavista Nanay, this area had lower municipal connections and was more dependent on tankered water than the Department of Loreto, the District of Punchana or the City of Iquitos (as seen in Table 5.3). The statistics from the 2005 Peruvian census (Instituto Nacional de Estadistica e Informatica, 2005) do not acknowledge the use of vended water (purchased bottled water), which has been classified as 'other' in the data for Bellavista Nanay. This was a valuable source of drinking water for a large number of the respondents.

Table 5.3: Comparison of drinking water sources in Loreto, Punchana and Bellavista Nanay

	Department of Loreto[1] (%)	**Punchana[1] (%)**	**City of Iquitos[1] (%)**	**Bellavista Nanay 2006[3] (%)**	**Bellavista Nanay 2007[3] (%)**
Improved drinking water sources[2]	37.4	60.6	86.4	34.4	2.1
Water tanker	0.9	4.9	0.1	35.4	77.1
Well	21.0	18.6	5.7		1.0
River, stream or spring	34.8	9.3	1.1	4.2	2.1
Other	5.9	6.4	6.7	26.0	17.7

[1](Instituo Nacional de Estadistica e Informatica, 2005)
[2] The sum of all municipal networked drinking water sources
[3] Data taken from Figure 29

5.2.3 Payment and cost of drinking water

In Section 4.0.3 it was found that wealth was associated with payment for drinking water in 2006 only. In Figure 5.7, it can be seen that in 2006 over half of the respondents (51%, *n=96*) paid for their drinking water. The majority of these households were supplied by a standpipe or tap, the remainder were supplied by purchased bottled water, and one household water manager reported paying for tankered water.

Payment for water can lead to the argument that the time of the household water manager (generally a woman, as discussed in Sections 2.4.4 and 5.0) is valuable and through payment for water a monetary value can be attributed to their time (Cairncross and Valdmanis, 2004). In Bellavista Nanay this was only recognised by the wealthier households.

If people collected water from the tanker it was free, but when a household ordered a whole tanker to fill either an underground or above ground reservoir, EPS Sedaloreto S. A. charged approximately S/.200 (~UK£30.03) per tanker (approximately 8000 litres). The respondent who stated that they paid for the tankered water did not have large water tanks to fill and paid only S/.20 (~UK£3.00) per month for this water, so the above information does not explain this. Either the information they provided was incorrect or they paid someone else to collect this water from the tanker.

Of the respondents who did not pay for their drinking water in 2006, 77% (*n=49*) gained their water supply from the tanker, the remainder from purchased bottled water, standpipe or tap water or river water (as seen in Figure 5.7). There was a marked difference in the situation in 2007 which can be seen in Figure 5.7, as 77% (*n=96*) of the respondents used tankered water which was free. This was why the percentage of respondents who did not pay for their drinking water increased from 49% in 2006 to 80% in 2007 and why the link between payment for water and wealth is lost. This could also be attributed to the relative lack of choice imposed on the community in 2007.

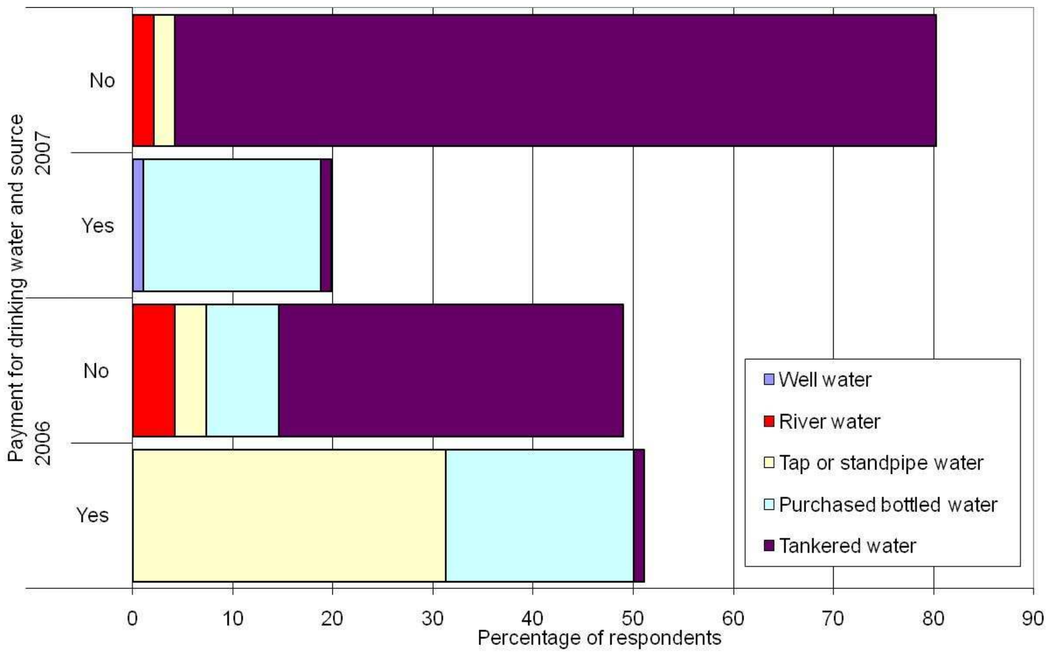

Figure 5.7: Comparison of payment for drinking and cooking water sources in 2006 and 2007 (*n=96* in both years)

A practice of gifting of water was discovered through the layering of questions. Those with a municipal water source would give water for free to relatives. The relative gifting the water was not necessarily from the community: in 2007 two households were obtaining their water from a relative 10 km away[65], as discussed in Section 5.2.4.

The reported costs of each drinking water supply varied slightly. In general, water from the river or water tanker was free. The cost of tap or standpipe water varied from household to household. In 2006, three households that gained their drinking water from a tap or standpipe did not pay for their water, which can be explained by the gifting of water.

An informal trade in water was uncovered by the use of layering of questions, other documentation and interviews. The cost of directly supplied tap water was identified through studying household water bills[66]. Combining this information with that gained from the questionnaire it could be seen that only 15 of the households paid EPS Sedaloreto S. A. directly for their tap water. The cost ranged from S/.19.00 per month (~UK£2.85) to S/.33.00

[65] Quote from respondents 30/10/2007 and 13/11/2007
[66] Information taken from household water bills for September 2005, October 2005, November 2005 and January 2006

per month (~UK£4.95). The remainder of the respondents (15) purchased this water from their neighbours or family at a cost of between S/.0.10 per 5 litres (~UK£0.015) to S/. 10.00 per month (~UK£1.50).

Tap and standpipe water was not metered[67], so the cost per litre cannot be calculated for this supply, which confirms the findings of Furukawa in 2005. On the water company bills[66] there is a minimum charge of S/.20.00 per month (~UK£3.00) for a volume of 20 m^3 of water. This is approximately 4% of the S/.500 (~UK£75.08) minimum monthly wage in Peru for 2006[68]. The World Bank sets a ceiling benchmark of 4% of the households disposable income for water services and this may be how this figure was set (Fujita *et al.,* 2005). In Bellavista Nanay, estimating household income was difficult and is discussed in detail in Section 3.3.1. A majority of the community were living on significantly less than the minimum wage. People would thus be using more than 4% of their disposable income to pay for tap water. In Peru, low income urban inhabitants generally pay the most for their drinking water (4.2% of income, as seen in Table 1.2, page 4). Realistically, the inhabitants of Bellavista Nanay were paying far more than this for their tap water. Added to the monthly bill there is also an initial connection charge of S/.95 (~UK£14.26) and the householder is also expected to buy the parts for connection[69]. So for initial connection, 19% of the monthly minimum wage is required, which is outside the means of many members of this community. These findings contradict other research undertaken in Iquitos which found the average monthly household income to be S/.825 (~UK£123.87) and estimated that residents paid 2.44% of their income for their water supply (Fujita *et al.,* 2005). This highlights the importance of using a case study approach when investigating such matters: central Iquitos is only 5 km away from the community, but the socioeconomic and WASH conditions are dramatically different to those in this community.

Tap water supply was not continuous in Bellavista Nanay and households did not receive the minimum 20 m^3 per month as stated on the bill (as seen in Table 5.2). The community only received municipal water supply for a maximum of three hours per day, which agrees with

[67] Interview with Local Man 25/7/2006
[68] The minimum wage in Peru increased to S/.550 (~UK£82.58) in 2007
[69] Interview with Local Man 25/7/2006

the findings of Furukawa (2005). Even this limited supply was not reliable: for two weeks during the field study period in 2006, no tap or standpipe water was available in Bellavista Nanay. A more realistic amount of water delivered via tap to a household has been estimated in Table 5.4 (this was calculated using a figure of 80 litres per day for 30 days[70]). The estimated cost of tap water per litre is eight times higher than if you assume the volume received is 20m^3 per month, but this is still the cheapest source when available.

From Table 5.4, it can be seen that the only drinking water source which rose in price from 2006 to 2007 was purchased unsealed water. This was the least regulated drinking water source (explained in Table 5.2). The price rise appeared to be opportunistic, due to the municipal supply being cut off in 2007. This can be compared to purchased sealed bottled water was which did not increase in price (as seen in Table 5.2), as this water source was centralised and regulated (explained in Table 5.2).

Table 5.4: Comparison of the cost of drinking water in 2006 and 2007 gained through observational data

Water source	Volume (litres)	Price 2006 (S/.)	Price 2007 (S/.)	~S/. per litre (2006)
Shop purchased bottled water	2.5	2.00	2.00	0.800 (~UK£0.12)
Purchased sealed bottled water	20	2.00	1.5 - 2.00	0.100 (~UK£0.15)
Purchased unsealed bottled water	18	0.50 - 0.75	0.5 - 2.00	0.028 (~UK£0.0042)
Municipally supplied water (according to bills)	20,000	20.00	N/A	0.001 (~UK£0.0002)
Municipally supplied water (estimated actual volume and cost)	2,400	20.00	N/A	0.008 (~UK£0.0012)

Although the community was established in the 1960s (discussed in Section 1.0) and all of the respondents owned their house (as discussed in Section 4.0.1), it was surprising that the water and sanitation conditions faced by this community are similar to those in squatter settlement in other regions. This can be seen in the comparison of the water supply situation in a peripheral squatter settlement outside Cancun (Mexico), where the

[70] General observations in 2006

community was dependent on free tankered water, shallow wells and vended water (Aguilar and de Fuentes, 2007).

5.2.4 Collection of drinking water

It can be seen in Figure 5.8, that 82% (*n=96*) of respondents in 2007 collected their drinking water. This was a rise from 69% (*n=96*) in 2006 and this change in practice was found to be statistically significant[71]. The increase in the number of respondents collecting their water can be attributed to more respondents using tankered water as their present drinking and cooking water source in 2007.

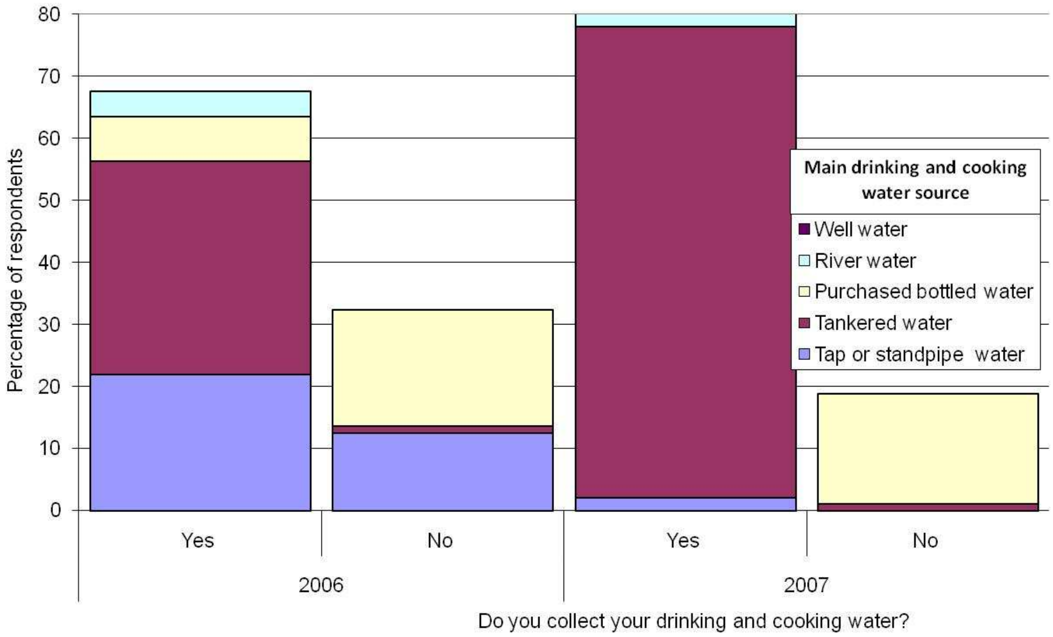

Figure 5.8: Comparison of drinking water collection and present drinking and cooking water source in 2006 and 2007 (*n=96* in both years)

The time spent and distance travelled to collect drinking and cooking water is displayed in Table 5.5. Due to the non parametric distribution of the data for these variables, the mean was not an accurate measure of central tendency. Therefore in Table 5.5, the mode and median have been calculated for the two variables. Time and distance were compared for respondents who collected their drinking water in both sampling periods (*n=55*), and no significant difference was found in the amount of time spent collecting drinking water between 2006 and 2007[72], but a significant difference was found in the distance travelled to

[71] McNemar, two tailed, significance level 95%: $p = 0.037$
[72] WSR test, two tailed, significance level 95%: $p = 0.097$

collect water[73]. Respondents were collecting their water from farther away in 2007 (as seen in Table 5.5).

Table 5.5: Distance and time spent collecting water

Sampling period	**2006**		**2007**	
	Distance (metres) *(n=64)*	**Time (minutes) *(n=63)***	**Distance (metres) *(n=79)***	**Time (minutes) *(n=79)***
Median	12.5	30.0	50.0	30.0
Mode	5.0	30.0	10.0	30.0
Range	0-7,000	0-179	2-10,000	1-60

The increase in distance of water collection can be partly attributed to the increase in household water managers collecting water from outside of the community. A limit of 1 km or more was used to define 'outside of the community' for water collection and is the normal limit used to define reasonable access to water (Cairncross and Valdmanis, 2004). Using this limit, one household[74] in 2006 and an additional three households in 2007[75] were collecting water from outside the community. This increase was due to the termination of standpipe or tap water, since previously two of those households were gaining their drinking and cooking water from the informal trade in this water. The reason that these households were able to collect water from outside the community was that they were vehicle owners and were able to easily travel these distances.

Other authors have found that in both rural India (Asthana, 1997) and Nigeria (Nyong and Kanaroglou, 2001) preference for water as influenced by proximity. In could be argued that proximity to the source does not play a major role in this community, as some people leave the community to collect their water. River water is readily available and close to all houses, but is not being chosen due to perceived poor quality. Therefore in this community, preference for water sources was more related to availability and perceived quality than proximity.

[73] WSR test, two tailed, significance level 95%: p = 0.001
[74] Quote from respondent 11//7/2006
[75] Quotes from respondents 29/10/2007 and 30/10/2007

On a scale which ranged from less than once a day to more than three times a day, just under half of the respondents who collected their drinking and cooking water collected it once a day or less (49%, *n=65*). It can be said that those who collected their water from the water tanker generally collected it less than once a day (82%, *n=33*) and those who collected their water from a standpipe or tap generally collected it once a day (76%, *n=21*). No respondents collected their water more than three times a day in either sampling periods. The main change in frequency of collection was that the number of respondents collecting their drinking water less than once a day had risen from 32 in 2006 to 52 in 2007, due to the community's increased reliance on tankered water.

Just over half (56%*, n=64*) of the respondents who collected their drinking water in 2006 felt that the area around the source was dangerous or very dangerous and no respondent found the area to be very safe. Over half (57%, *n=21)* of those who collected their water from a standpipe or tap water thought that the area was safe. None of the respondents thought that any of the collection areas were very safe.

What was interesting is that a majority (81%, *n=32*) of those who collected their water from the water tanker thought that the surrounding area was dangerous or very dangerous. Danger associated with the collection of tankered water was due to road safety. Before the sampling period in 2006 a member of the community's foot had been crushed when a water tanker had rolled over it and in 2007 a boy from the community had been run-over by a bus which heightened the community's sense of danger associated with the road.

The number of respondents who collected their drinking and cooking water, and thought that the collection area was either very dangerous or dangerous rose from in 36 in 2006 to 57 in 2007. The relationship between perceived safety of the collection area was statically linked to respondents' present drinking water in 2006 only[76], due to the increased reliance on tankered water in 2007. The increase in perceived danger was linked to the increase in tankered water collection in 2007.

[76] CV, two tailed, significance level 95%: 2006 $p = 0.002$, 2007 $p = 0.082$

In 2006, no respondents who collected their drinking and cooking water classified the collection area as very clean or very dirty, although a majority (42%, *n=65*) found the water collection area clean. All of the respondents collecting their drinking water from the river thought that the area was a little dirty. The cleanliness of the collection area was found to be statistically linked to the present drinking water source in 2006[77] only, due to the respondents' reliance on tankered water in 2007. In 2007, an increase in respondents using tankered water as their present water source led to a rise in the number of respondents rating the water collection area as clean.

Animals are linked to the contamination of drinking water at household and source level through faecal-oral routes of contamination (as discussed in Section 2.1). Animals were highly visible in the community, as 62% of household in 2006 and 66% of households in 2007 owned animals (*n=96* for both years). No large animals were kept in the community. The most popular animals in 2006 were dogs (73%, *n=59*) followed by cats (34%, *n=59*) and chickens (20%, *n=59*). More exotic animals from the rainforest were also kept as pets in three households. All of these animals were generally allowed to roam around the house, yards and streets. The reasons given for the high number of dog owners was security. In the rainy season when the river is high, houses are robbed by canoe. Householders cannot hear the canoe approach, due to the sound of the rain on the metal roofs, but dogs can sense the approach of the burglars.

Even with high animal ownership, few respondents (8%, *n=65*) believed that animals were present close to the drinking water source in 2006. In 2006, most of the respondents who collected their drinking water from a standpipe or tap believed that no animals were present at the source (86%, *n=21*). In 2007, there was a general increase in those who thought that their water collection was animal free, from 52% (*n=64*) in 2006 to 72% (*n=79*) in 2007. Those who collected water from the tanker in 2007 felt that the area was animal free (73%, *n=74*), although dogs were witnessed in the collection area, as seen in Figure 5.9 and recorded in the sanitary surveys (see Section 3.2.1). A statistical relationship was found between present drinking water source and presence of animals[78]. This underestimation of

[77] CV, two tailed, significance level 95%: 2006 $p = 0.009$, 2007 $p = 0.744$
[78] CV, two tailed, significance level 95%: 2006 $p = 0.008$, 2007 $p = 0.023$

animals by water sources may be linked with the term 'animal', which respondents may have interpreted to be wild animals rather than domestic animals and pets.

Figure 5.9: Photo in front of water tanker in Bellavista Nanay
Source: Claire Furlong

Collection of drinking water can be a social event in many cultures as household water managers collect water with friends and relatives. The use of certain drinking water sources may be passed down from one generation to the next. In Bellavista Nanay in 2006, a majority of respondents collected their water from a source that other family members used (71%, *n=65*). In 2007, a statistical relationship was found between present drinking and cooking water source and collection of water from sources used by other family members[79]. The increase in respondents collecting their water from a source used by other family members (from 70% *n=64* to 90% *n=79*) was probably due to the increased reliance on tankered water as the present source of drinking and cooking water.

In this section it can be seen that the present drinking water source was associated with the perceived safety and cleanliness of the area and presence of animals. All of these may feed into perceived drinking water quality through perceived contextual indicators as hypothesised in Figure 1.2 (page 12).

[79] CV, two tailed, significance level 95%: 2006 $p = 0.119$, 2007$p = 0.005$

5.2.5 Storage of drinking water

In both sampling periods, all of the respondents stored their water in some kind of vessel. Only two households surveyed had large storage tanks. The majority of households stored their drinking water in buckets or large bins (98% in 2006, 100% in 2007, *n=96* for both years), which could be covered or uncovered. One respondent did state that they used a different drinking water storage vessel from those stated on the questionnaire. They stored their drinking water in a filtration device (this is discussed in more detail in Section 5.2.6).

Due to the importance of storage in the contamination of water, a new question was introduced to the questionnaire in 2007, on the length of storage. This ranged from 0.2 to 7.0 days, with a mean storage time of 3.0 days. From Figure 5.10 it can be seen that the respondents who used tankered water stored this water for longer compared with those gaining their water from other sources. This was due to availability (see Table 5.2). Longer storage periods equate to a higher chance of contamination of the water before consumption (which is discussed in Section 2.1).

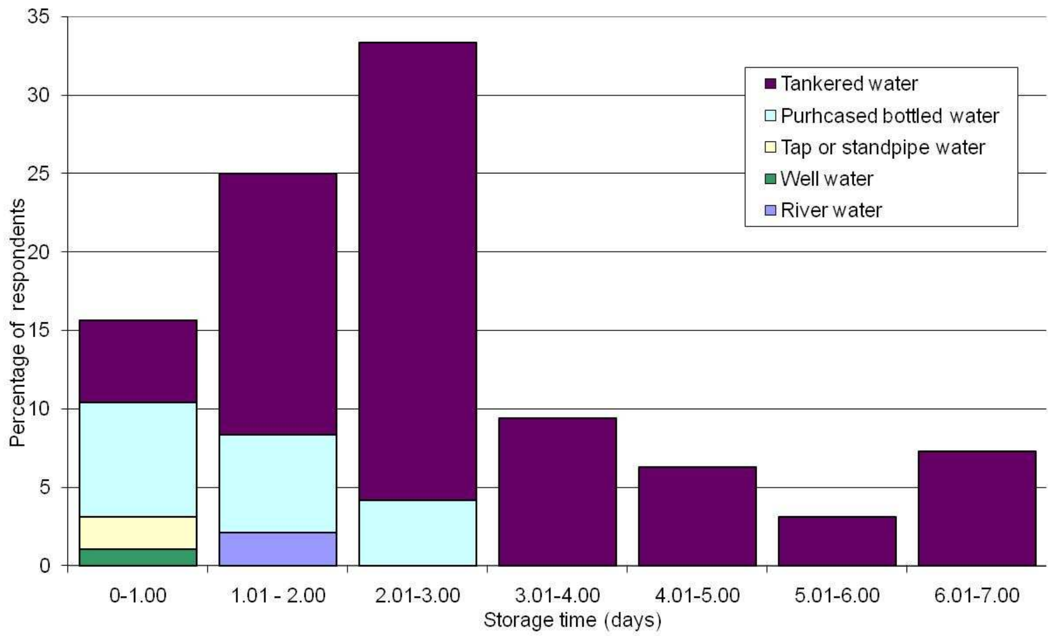

Figure 5.10: Present drinking water sources versus storage times in 2007 (*n=96*)

5.2.6 Household drinking water treatment

In 2006, over half of the respondents (52%) were treating their drinking water in their household, but this fell to 37% in 2007. In both years, chlorination was the most popular method of household water treatment (70% (*n=54*) in 2006, 67% (*n=42*) in 2007), followed by boiling (28% (*n=54*) in 2006, 31% (*n=42*) in 2007). One household was using filtration to treat their drinking water this was a ceramic filter device.

The household that used this device was inhabited by African missionary nuns and the filter unit was made in Switzerland. Suggesting that household filtration is not indigenous to this community. Nevertheless, one respondent who was using river water as their present cooking and drinking water source and initially stated that they were not treating their water in their household later revealed, when questioned further, that they let their water settle and then filtered it through cloth to remove the sediment and impurities. This was therefore an example of filtration being used by a indigenous member of the community.
These finding highlights that those 'treating' their water in their household were underestimated by the questionnaire survey. This respondent did not consider the process of sedimentation and cloth filtration as a treatment method, probably due to its passive nature. The term 'treatment' was associated with processes that required a noticeable financial input and a technology, such as boiling, chlorination and ceramic filtration.

No relationship was found between the present source of drinking and cooking water and whether the respondents used household drinking water treatment, in either sampling period. However, the proportion of the respondents not treating their water in their household, but using tankered water as their present source of drinking and cooking water increased from 44% (*n=34*) in 2006 to 64% (*n=74*) in 2007.

When these people were questioned about treating their drinking water in the household, they expressed on numerous occasions and without probing that "…we do not treat our water because it has already been treated"[80]. This explains the decrease in household treatment in 2007, as more people were reliant on chlorinated tankered water. It also

[80] Quote from respondent 25/10/2007

shows an awareness that this source of water has already been treated, but also that respondents were unaware that water can become contaminated during storage. This is discussed further in Chapters 7 and 8.

One questionnaire respondent whose present source of drinking water was river water said "…we are not ill, so we do not treat our water[81]". This statement implies that household drinking water treatment is responsive and that the incentive for treatment is related to becoming ill. The responsive treatment of water due to illness has also been found in India (Banda *et al.,* 2007). The relationship between self reported illness (as discussed in Section 4.4) and household treatment was explored statistically, but no relationship was found[82].

In 2006 and 2007 respondents who treated their drinking water in their households were asked why they used specified methods. The themes from the statements were analysed and a total of eleven themes were discovered, as seen in Appendices 15 and 16 and Figure 5.11. The most common statements in both years were those pertaining to prevention of disease (2006 33% $n=49$, 2007 37% $n=35$) and specifically singling out bacteria (2006 27% $n=49$, 2007 23% $n=35$).

In 2006 several interesting statements were made. One respondent alluded to the time and cost of the treatment: "…because it is economic and fast"[83]. Two respondents stated that it was due to former health campaigns: "...because we were given instructions by the health visitors"[84] and "…because it is recommended"[85]. A further two respondents treated their water due to inadequate initial treatment: "… because it is not treated properly"[86] and "…because I do not have confidence in how the water is treated"[87]. Recontamination due to storage was not mentioned in either sampling period.

[81] Quote from respondent 23/10/2007
[82] McNemar, two tailed, significance level 95%: 2006 p = 0.141, 2007 p = 0.560
[83] Quote from respondent 26/6/2006
[84] Quote from respondent 4/7/2006
[85] Quote from respondent 15/6/2006
[86] Quote from respondent 11/7/2006
[87] Quote from respondent 17/7/2006

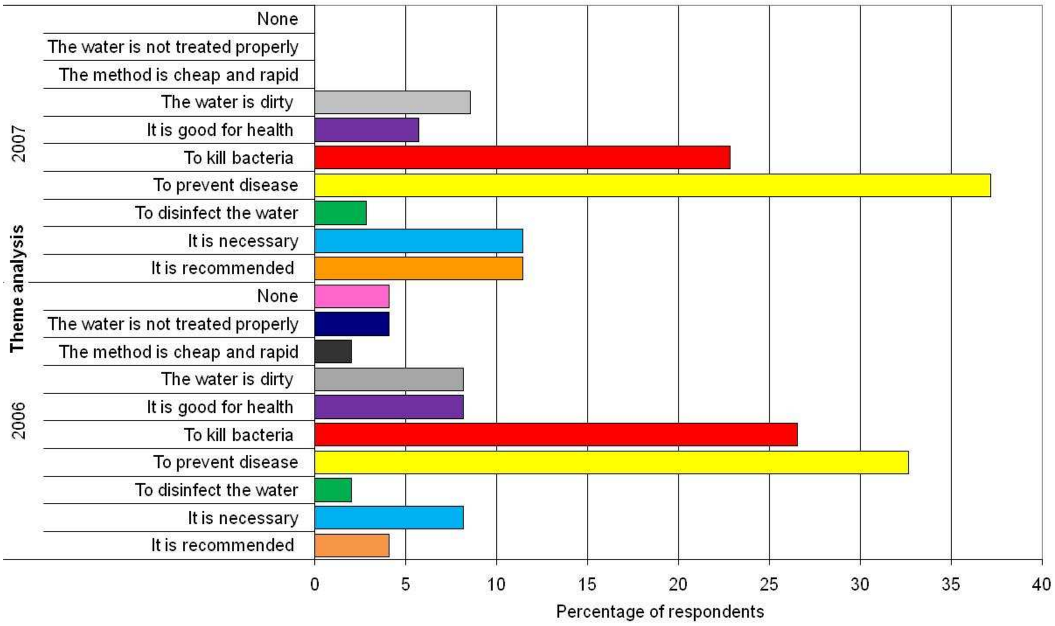

Figure 5.11: Theme analysis of why people treat their drinking water 2006 and 2007 (*n=49* in 2006, *n=35* in 2007)

In 2007, the respondents that used chlorine as a household drinking water treatment were asked what they did if no free chlorine was available at the medical post. A majority (64%, *n=25*) reported that they used household bleach (lejia), while 20% (*n=25*) reported not using any household drinking water treatment in these circumstances. This contradicts the statement made by a local woman and the information given by the shop keeper, (which are discussed in Section 7.4).

The treatment of drinking water before consumption has been linked to education in a developing countries context (Andreson *et al.,* 2007). However, in this study no link was found between the self reported use of household drinking water treatment and educational status[88] age[89], profession[90] or wealth[91]. In Anderson's study, a larger sample size (*n=26*,214) was used which encompassed greater socioeconomic diversity compared to this study. Therefore a link between educational status and household drinking water treatment may have been found if the study had encompassed a larger area.

[88] Phi, two tailed, significance level 95%: 2006 $p = 0.369$, 2007 $p = 0.859$
[89] MWU, two tailed, significance level 95%: 2006 $p = 0.968$, 2007 $p = 0.945$
[90] CV, two tailed, significance level 95%: 2006 $p = 0.739$, 2007 $p = 0.958$
[91] MWU, two tailed, significance level 95%: 2006 $p = 0.165$, 2007 $p = 0.190$

5.2.7 Amount of drinking water

In Figure 5.12, it can be seen that in 2006, 76% (*n=94*) of households surveyed were drinking less that the recommended minimum of 2 litres of water per person per day, which increased to 83% (*n=95*) in 2007. It should be noted that other beverages were available in the community such as refrescos (fruit juice and water drinks), carbonated drinks and beer. The increase in wealth in 2007 (as described in Section 4.0.3) could have enabled the residents to purchase more expensive beverages therefore decreasing their water intake.

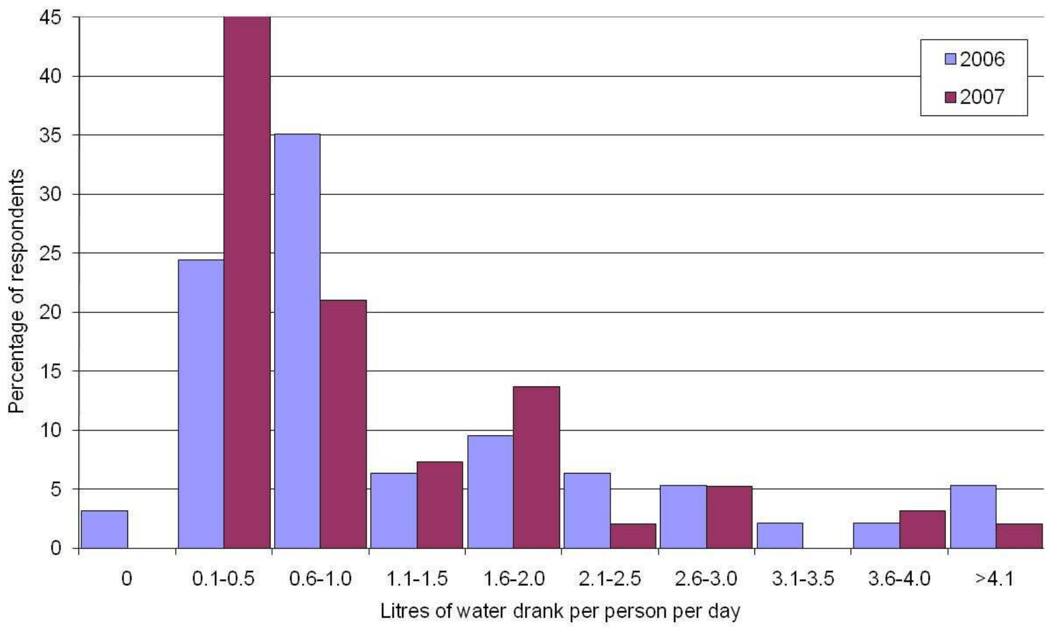

Figure 5.12: Comparison of litres of water drunk in litres per person per day in 2006 and 2007 (*n=96* for both years)

No statistically significant difference between the amounts of water drunk between the two time periods was found[92]. Between these two sampling periods the present drinking and cooking water sources significantly changed (as seen in Section 5.2.1), therefore the amount of drinking water was not related to source. This hypothesis is confirmed by statistical results[93].

5.3 Chapter summary

This chapter achieves the objectives set of presenting and discussing the results of the questionnaire, interviews, observations and other document sources in relation to drinking

[92] WSR, two tailed, significance level 95%: $p = 0.163$
[93] Eta, two tailed, significance level 95%: 2006 $p = 0.282$, $p = 0.187$

water practices in Bellavista Nanay. The main findings of this chapter are summarised below.

Household water managers were generally women who were often helped by male household members when collecting water. A majority of the household water managers classified themselves as housewives, although they had employment and $^{2}/_{5}$ had completed their secondary education. Associations were found between education and age (younger household water managers being more likely to have completed their secondary education) and between education and profession.

The respondents identified seven sources of water that were used for laundry, cleaning, hygiene, drinking and cooking. This contradicted the initial information supplied by the Gatekeeper. Six of those water sources were stated as being a normal drinking and cooking sources by the respondents, but only five were being used when the questionnaire was being undertaken.

Some seasonality in drinking water practices were witnessed in the community, due to the abundance of rain water, but this seasonality was overshadowed by the greater changes in practices caused by the termination of tap and standpipe water in the community in 2007.

Drinking water practices in Bellavista Nanay were found to be driven by water availability in the community. This included storage and the way that water managers were able to change sources when a source became unavailable. Water for drinking and water for other purposes was normally obtained from different sources and a clear distinction between these two types of water was made by all household water managers.

Four drinking water sources were free to the respondents, including municipally treated tankered water. In Chapter 4, wealth was linked to payment for drinking water in 2006, while no relationship was found in 2007 due to the lack of tap or standpipe water in the community and the community's reliance on tankered water. The cheapest source of potable water was municipally treated piped water which was estimated to cost above 4% of the disposable income of the respondents.

A gifting and informal trade in water was uncovered. This practice extended beyond the community limits, as people collected water from family members in different districts. All of the respondents stored their water in some kind of vessel and storage times were dictated by water availability. Water storage ranged from below one day to above seven days, with tankered water being stored for the longest periods of time.

When the municipal water supply was terminated, a majority of the respondents collected their water from outside of their household. Respondents were collecting their water less frequently in 2007, which has implications on drinking water storage and quality (explored in Chapter 6). Present drinking water sources were found to be related to how the respondents rated the safety, cleanliness and presence of animals in the collection area. All of these factors are known to feed into perceived drinking water quality, and cleanliness and presence of animals can also affect actual drinking water quality.

The main reasons given for practicing household drinking water treatment related to disease prevention. An interesting point was that this practice in some households was reported to be responsive to household illness. A certain amount of trust was placed in the quality of centralised chlorinated water, which respondents felt would not need further treatment. A general lack of understanding was found in the community about the recontamination of drinking water.

Some interesting problems were encountered with the terminology used in the questionnaire. The term 'community' was interpreted to mean near neighbours, not the community of Bellavista Nanay. This was deemed not to have affected the results gained. The term 'treatment' used in the context of household water treatment was considered to mean a process which included noticeable financial input and a technology, which caused the questionnaire to underestimate those carrying out household treatment.

Data discussed in this chapter is drawn on throughout the subsequent chapters. The relationship between drinking water practices and drinking water quality is discussed in Chapter 6. The influence of external information and knowledge on drinking water practices is reviewed in Chapter 7. In Chapter 8 the influence of the perception of drinking water quality on drinking water practices is discussed.

Chapter Six: Actual drinking water quality

The objectives of this chapter are to discuss the results of the microbiological water quality analysis at source and household level, which is classified in this thesis as actual drinking water quality. Physicochemical analysis including aesthetic quality such as colour and turbidity are also discussed. The raw data from these analyses can be found in Appendices 11 to 14. Further objectives of this chapter are to investigate the seasonal changes in drinking water quality and to relate household drinking water quality to the practices documented in Chapter 5.

Samples were taken directly from the source and from households that participated in the questionnaire, so that the quality of water at the source and household level could be assessed. Samples were also analysed for the aesthetic qualities of the main drinking water sources, since they can influence the use of the source (as discussed in Section 2.3.2).

In addition to the collection of samples structured observations (sanitary inspections as described in Section 3.2.1) were made. This enabled the major causes of contamination to be identified around a source and these can be considered perceived contextual indicators (as defined in Sections 1.1 and 2.3.1). This data can then be compared with the data from the respondents' ratings of danger, cleanliness and the presence of animals (described in Section 5.2.4). The sources were sampled both in 2006 and 2007 to investigate whether the source quality was affected by the season.

Household samples were also used to assess the effects of the drinking water practices uncovered in Chapter 5 on drinking water quality. This was done by comparing the quality at source to the quality of household samples.

The source and household drinking water quality analyses also feed into the discussion of the relationship to perceived drinking water quality in Chapter 8.

6.0 Source analysis

Samples were analysed from all water sources that were available to the community (which are defined in Table 5.2), so a comparison can be made with those taken at household level, because it is known that water can become contaminated when collected, transported and stored (Wright *et al.,* 2004, Trevett *et al.,* 2005, Quick *et al.,* 1999, Sobsey *et al.,* 2003). Therefore drinking water quality at source may not be representative of the quality of drinking water consumed.

The microbiological water quality of the source was compared to the sanitary inspection data to identify potential sources of pollution. The results from the sanitary inspection were used to assess the perceived contextual indicators of specific sources.

Thirty five samples (*n=35*) were taken directly from the drinking water sources available to the community in 2006 and seventy (*n=70*) were taken in 2007. The results of the analysis can be seen in Table 6.1 and Table 6.2. The microbiological results were interpreted using the WHO classification of risk for thermotolerant coliforms in water supplies (WHO, 1997b).

6.0.1 Source samples 2006

The river water at the Point (as defined in Section 3.2.4 and Figure 3.3 sampling point 1) was less biologically contaminated, less turbid and had less colour than the river water taken from a sampling point behind the houses (sampling point 2 on Figure 3.3) as seen in Figure 6.1 and Table 6.1.

There was a large variation in the microbiological results gained from the river water and well water samples (Table 6.1). Only 50% of the tap water, tankered water, sealed bottled and unsealed bottled water conformed to WHO guidelines for microbiological water quality compared to 100% of the shop purchased water. Overall only 44% of the samples conformed to the WHO guidelines and 34% of samples were classified as high or very high risk, as can be seen in Figure 6.1. Those samples that were classified as high or very high risk were either taken from the well or the river.

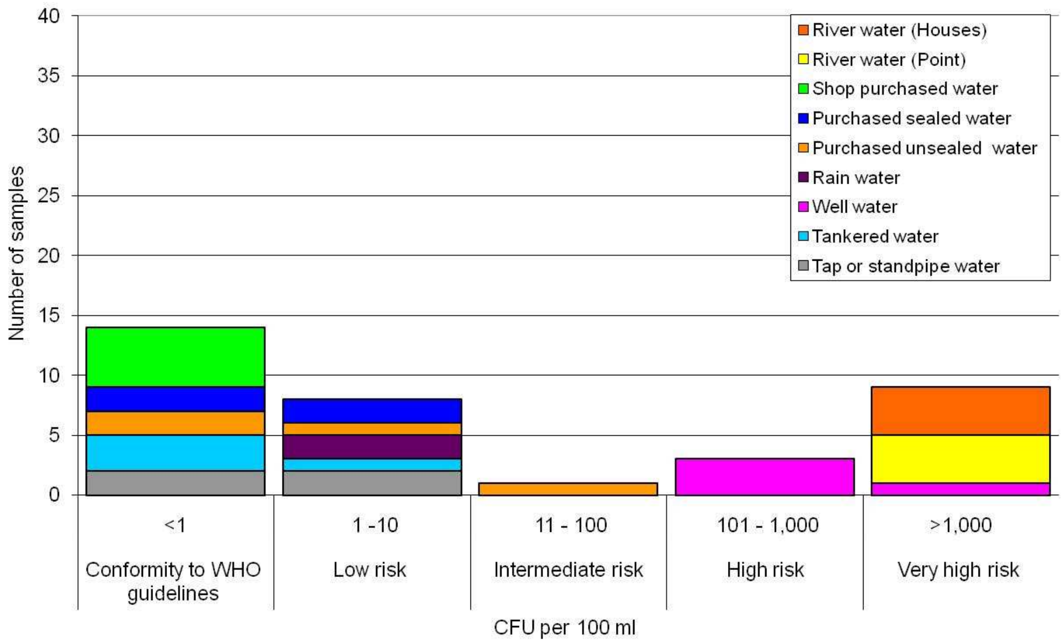

Figure 6.1: WHO risk categories based on thermotolerant coliform levels in source waters in 2006 (*n=35*)

In Table 6.1 it can be seen that the tankered water samples had more consistent and higher levels of chlorine compared to samples taken directly from the tap. The pH of the tankered water was higher than other water samples (as seen in Table 6.1). Also in this table it can be seen that all of the samples of purchased unsealed bottled water contained low levels of chlorine. This would indicate that the vendors were either selling tap or tankered water, or treating the water with low levels of chlorine prior to vending. The presence of chlorine was related to the source of the sample, but the levels of chlorine were not[94].

[94] Eta, two tailed, significance level 95%: free chlorine $p = 0.826$,combined chlorine $p = 0.803$, total chlorine $p = 0.890$, Phi, two tailed, significance level 95%: presence of chlorine $p = 0.000$

Table 6.1: Results from the analysis of the samples taken directly from the source in 2006

Water Type	Thermotolerant coliforms (CFU per 100 ml)	Total chlorine (mgl^{-1})	Apparent colour (Hazen)	Turbidity (NTU)	pH (using initial method)
River water Point (*n=4*)	7,850 (sd*=4,968)	<0.1 (sd=0.00)	206.25 (sd=31.46)	24.25 (sd=5.38)	<6.80 (sd=0.00)
River water Houses (*n=4*)	19,725 (sd=6,370)	<0.1 (sd=0.00)	243.75 (sd=12.50)	94.75 (sd=47.51)	<6.80 (sd=0.00)
Tap water (*n=4*)	3 (sd=5)	1.05 (sd=1.03)	10 (sd=9.13)	<5 (sd=0.00)	7.00 (sd=0.10)
Tankered water (*n=4*)	<1 (sd=1)	2.50 (sd=0.59)	<5 (sd=5.00)	<5 (sd=0.00)	7.15 (sd=0.10)
Well water (*n=4*)	1,096 (sd=1,204)	<0.1 (sd=0.00)	35.00 (sd=5.77)	9.88 (sd=3.66)	6.80 (sd=0.00)
Rain water (*n=2*)	7 (sd= 2)	<0.1 (sd=0.00)	<5 (sd=0.00)	<5 (sd=0.00)	6.80 (sd=0.00)
Purchased unsealed water (*n=4*)	22 (sd=50)	0.23 (sd=0.12)	10 (sd=8.66)	<5 (sd=0.00)	6.85 (sd=0.00)
Purchased sealed water (*n=4*)	2 (sd=2)	<0.1 (sd=0.00)	3.75 (sd =2.50)	<5 (sd=0.00)	<6.80 (sd=2.00)
Shop purchased water (*n=5*)	<1 (sd=0)	<0.1 (sd=0.00)	<5 (sd=0.00)	<5 (sd=0.00)	7.0 (sd=0.00)

*sd= standard deviation

It was known that the municipal drinking water treatment plant supplied water for the tanker, tap and standpipes. When the total chorine levels and the microbiological water quality were investigated, the results were consistent with the samples originating from the same source[95]. The specified standard for chlorine levels in all water leaving the water treatment plant was a residual free chlorine level of above 0.50 mgl^{-1}. In Figure 6.2it can be seen that only one sample of tap water taken at source had levels of free chlorine above 0.5 mgl^{-1}, compared to the samples taken from the tanker. The predominant form of chlorine present was free chlorine (as seen in Figure 6.2), which is unstable and reactive. This confirmed the information gained at the water treatment plant on the type of chlorine used.

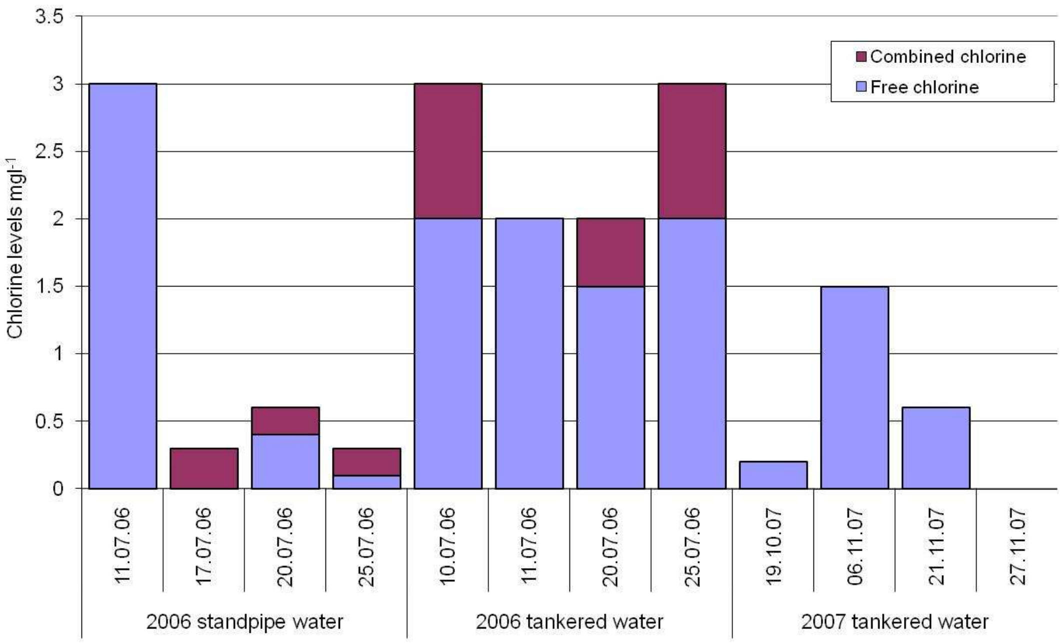

Figure 6.2: Chlorine levels in standpipe samples and tankered source samples

Low pressure in the distribution system and infiltration of organics were problems highlighted by Tickner and Gouveia-Vigenant (2005). This, coupled with the reactivity of free chlorine, accounts for the lower levels of chlorine found in the tap water samples compared to tankered water samples in 2006. Other evidence which supports this theory is that standpipe water had higher levels of apparent colour and

[95] MWU, two tailed, significance level 95%: thermotolerant coliforms $p = 0.850$, total chlorine $p = 0.134$

thermotolerant coliform levels compared to tankered water (as seen in Table 6.1). The water was therefore contaminated during distribution, indicated by a higher level of apparent colour leading to the formation of combined chlorine in the distribution system (as seen in Figure 6.2). The community of Bellavista Nanay knew that the water became contaminated in the pipes: one respondent said "…it is the pipes which are dirty"[96].

The main drinking water sources in 2006 were river water, tap or standpipe water, purchased water and tankered water. It can be seen in Table 6.1 that the aesthetic qualities (colour and turbidity) of these sources, excluding river water, are extremely good, with no measurable turbidity and colour levels within the WHO guideline values (as seen in Table 3.4, page 63). Apparent colour in the source samples was found not to be related to sample source[97]. Turbidity and pH were not explored due to the lack of variation in the results gained.

6.0.2 Source samples 2007

The river water at the Point as on average more biologically contaminated, turbid and coloured compared to the river sample from behind the houses, as seen in Figure 6.3 and Table 6.2. This a reversal of the situation found in 2006, details of which can be found in Table 6.1. The average pH of the samples was very similar, as seen in Table 6.2. In this table it can be seen that tankered water had the highest and most consistent levels of chlorine of all of the water sources: 75% of samples contained chlorine. Only free chlorine was found in the samples and only one sample of the purchased unsealed bottled water contained chlorine. As in 2006, chlorine levels were not found to be related to sample source, but the presence of chlorine was[98].

In 2007, 43% of samples conformed to WHO guidelines for microbiological water quality, (as seen in Figure 6.3). It can be seen that all of the tankered, shop

[96] Quote from respondent 4/6/2006
[97] Eta, two tailed, significance level 95%: 2006 $p = 0.972$
[98] Eta, two tailed, significance level 95%: free chlorine $p = 0.471$, combined chlorine not present in samples , total chlorine $p = 0.683$, Phi, two tailed, significance level 95%: presence of chlorine $p = 0.000$

purchased, and purchased sealed water reached the required standard, but only 30% of the purchased unsealed bottled water samples and 50% of the rain water samples conformed to these guidelines.

There was not only large variation in the microbiological quality of the river water and well water samples, but also in purchased unsealed water, as seen in Table 6.2 and Figure 6.3. In 2007, 77% of the respondents were reliant on tankered water as their present drinking water source (as discussed in Section 5.2.2). Tankered water contained no turbidity at source (as seen in Table 6.2), and chlorine had significantly decreased[99] compared to the samples taken in 2006. Apparent colour[100] and pH[101] levels were not found to be related to sample source. Turbidity was not explored due to the lack of variation in the results gained.

[99] MWU, two tailed, significance level 95%: $p = 0.019$
[100] Eta, two tailed, significance level 95%: $p = 0.982$
[101] CV, two tailed, significance level 95%: $p = 0.832$

Table 2: Results from the analysis of the samples taken directly from the source in 2007

Water Type	Thermotolerant coliforms (CFU per 100 ml)	Total chlorine (mgl^{-1})	Apparent colour (Hazen)	Turbidity (NTU)	pH
River water (point) (*n=10*)	81,223 (*sd=101,579)	<0.1 (sd=0.00)	232.50 (sd=16.87)	37.60 (sd=11.11)	6.66 (sd=0.25)
River water (houses) (*n=10*)	27,262 (sd=23,178)	<0.1 (sd=0.00)	210.00 (sd=34.64)	29.20 (sd=13.42)	6.67 (sd=0.17)
Tankered water (*n=4*)	<0 (sd=0.00)	0.58 (sd=0.66)	33.75 (sd=35.44)	<5 (sd=0.00)	6.44 (sd=0.47)
Well water (*n=10*)	29,452 (sd=37,516)	<0.1 (sd=0.00)	75.50 (sd=31.40)	13.80 (sd=7.83)	6.41 (sd=0.09)
Rain water (*n=6*)	2 (sd= 4)	<0.1 (sd=0.00)	<5 (sd=0.00)	<5 (sd=0.00)	6.70 (sd=0.09)
Purchased unsealed water (*n=10*)	1,769 (sd=2,905)	0.03 (sd=0.09)	23.50 (sd=19.75)	0.60 (sd=1.80)	6.33 (sd=0.99)
Purchased sealed water (*n=10*)	<0 (sd=0)	<0.1 (sd=0.00)	<5 (sd =0.00)	<5 (sd=0.00)	6.83 (sd=0.27)
Shop purchased water (*n=10*)	<0 (sd=0)	<0.1 (sd=0.00)	<5 (sd=0.00)	<5 (sd=0.00)	6.97 (sd=0.11)

*sd = standard deviation

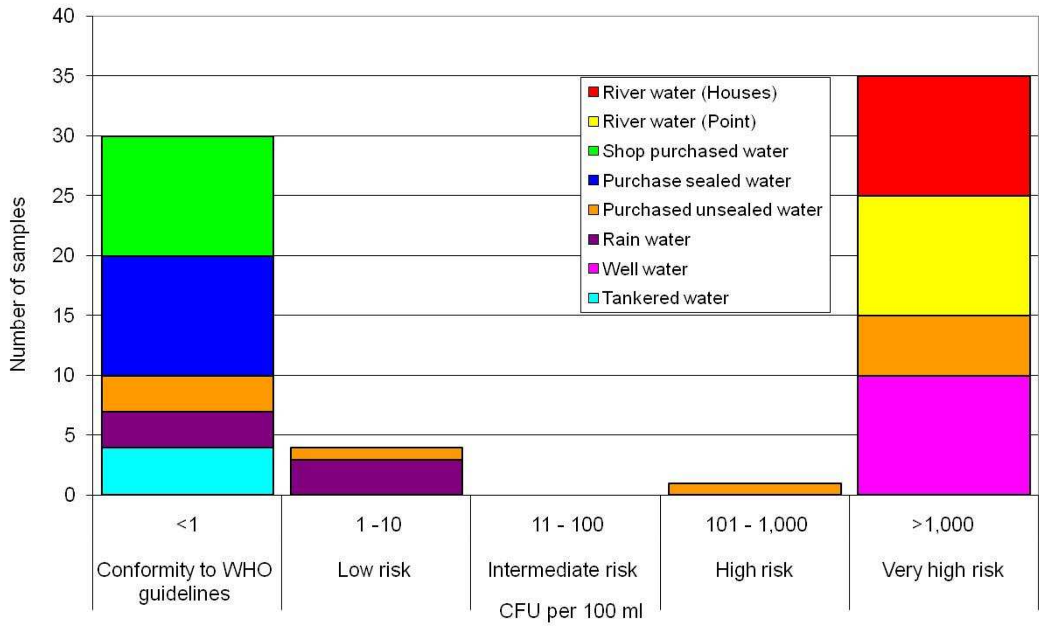

Figure 6.3: WHO risk categories based on thermotolerant coliform levels in source waters 2007 (*n=70*)

6.0.3 Seasonality

Higher levels of microbiological contamination were found in both river water samples (found to be statistically significant at the Point only[102]) and well water samples[103] (Table 6.1 and Table 6.2) in 2007 as compared to 2006. This would indicate that more faecal contamination and therefore thermotolerant coliforms were being washed into these water sources by the increased rainfall. This increase in microbiological contamination in shallow ground water sources, due to the onset of the rainy season has also been found to occur in Kampala, Uganda (Howard *et al.,* 2003), Conakry, Guinea (Gelinas *et al.,* 1996) and North western Greece (Giannoulis *et al.,* 2003).

The Point river sampling point contained more thermotolerant coliforms during the rainy season compared to the sampling point behind the houses, which was a reversal of the scenario found during the dry season. This suggests that the predominant thermotolerant coliform contamination of the river in the dry season came from the community itself and during the rainy season from the city of Iquitos, as neither area have wastewater treatment facilities. In Bellavista Nanay seasonal changes in river water and well water quality occurred, but these water sources were not generally used for drinking or cooking.

[102] MWU, two tailed, significance level 95%: $p = 0.014$
[103] MWU, two tailed, significance level 95%: $p = 0.005$

The quality of tankered water differed between the sampling periods, although in both periods it originated from the municipal water treatment plant. In 2007 tankered water had lower and less consistent amounts of chlorine[104] and higher levels of colour[105] than those samples taken in 2006. It is assumed that the water leaving the treatment plant reached the set standard; therefore the water was being contaminated in the tanker. This was probably due to poor maintenance, caused by the increased demand for tankered water in 2007 (as discussed in Section 5.2.2).

The purchased unsealed bottled water had lower levels of chlorine[106] in 2007. The lack of chlorine would indicate that the vendors are using an alternative water source due to the lack of tap water across the city in 2007 or not chlorinating the water.

Microbiological quality of purchased sealed water increased in 2007[107], with all samples reaching WHO guideline values. This could be result of the tightening regulations in the beverage sector which is discussed in Section 7.3.2.

The change in the quality of water sources used specifically for drinking and cooking were not seasonal, but contextual as when situations changed in the community and city, the quality of the main sources of drinking water changed. This would indicate poor monitoring and lack of regulation of these sources.

6.0.4 Sanitary inspection

The risk of faecal contamination of water at the source was assessed using sanitary inspections (no sanitary inspections were carried out for bottled or purchased water). The average sanitary inspection scores and associated risk level are presented below in Table 6.3. An association was found between sanitary scores and the microbiological water quality of the source samples[108]. Sanitary inspection can be used as an indicator of microbiological contamination of the sources, although these inspections did not capture the seasonal variation in microbiological water quality discussed in the previous section.

[104] MWU, two tailed, significance level 95%: $p = 0.019$
[105] MWU, two tailed, significance level 95%: $p = 0.037$
[106] MWU, two tailed, significance level 95%: $p = 0.004$
[107] MWU, two tailed, significance level 95%: $p = 0.020$
[108] KTC, two tailed, significance level 95%: $p = 0.000$

Table 6.3: Average sanitary inspection scores and their associated risk levels for water sources in 2006 and 2007

Source	Average sanitary inspection scores	Associated risk level
Tankered water (filling underground tank)	1/7	Low
Tankered water (collected by people)	3/7	Intermediate
River (the point)	8/10	High
River (the houses)	8/10	High
Rain water collection	4/10	Intermediate
Well	9/11	Very high

The data collected on source drinking water quality and through the sanitary inspection can be used to complete a risk assessment which prioritises remedial action for planning purposes.

Data on perceived contextual indicators (defined in Section 1.1) was taken from the sanitary inspections and the questionnaire data (discussed in Section 3.2.1 and 5.2.4) and is discussed further in Chapter 8.

When data from the questionnaire (detailed in Section 5.2.4) and the sanitary inspections was compared. It could be seen that the respondents in general overestimated the cleanliness of the collection areas and underestimated the presence of animals close to the source. This relates to the lack of awareness of recontamination of water once it is collected, which was highlighted in Section 5.2.6. This point is contradicted by the high risk of water contamination that the respondents associated with their sanitation methods (as discussed in Section 4.2.1). This contradiction could be explained as the respondents may have assumed that the risk of contamination is to river water, which very few respondents used as a source of drinking water.

6.1 Household sample analysis

Samples were taken at the household level since water is known to become contaminated when collected, transported and stored (Wright *et al.,* 2004, Trevett *et al.,* 2005, Quick *et al.,* 1999, Sobsey *et al.,* 2003), and the link between attitude and behaviour can be explored for household treatment.

In 2006, 58 household water managers were asked to supply samples of water that they used for drinking and cooking. Only 51 household water managers were able to provide samples of their drinking water in this period, due to availability. One sample of well water was collected, but the household water manager stressed that they did not use this water for drinking, therefore the results from the analysis of this sample were not included in this section. In 2007, 96 household water managers were ask to supply samples, and in this period 91 were able to do so. There was a slight increase in the number of households that were able to supply samples from 90% in 2006 to 95% in 2007.

When the availability of different supplies was investigated further using data collected in 2006, it could be seen that 4% (*n=26*) of those who gained their drinking and cooking water from a standpipe or tap, could not supply a sample compared to 11% (*n=19*) of those who gained their drinking and cooking water from a tanker and 23% (*n=13*) who purchased bottled water, which illustrates that the availability of the sources differed. In 2007 this changed, as only 5% (*n=74*) of those gaining their water from a tanker and 14% (*n=17*) of those gaining their water from a sealed bottle supply were unable to supply a sample.

Also in 2006, 25 households supplied samples that originated from a standpipe or tap. This adds to the evidence of gifting or informal trade in this type of water, as only 13 of those whose samples originated from a standpipe or tap officially had access to this source. A total of 50 households were able to provide samples in both sampling periods.

6.1.1 pH

In 2006, the method used to measure pH was limited to a range of pH 6.8 to 7.2. As only 39% (*n=51*) of samples were found to be above pH 6.8 in 2006 the data from this year could not be analysed and the method used for measuring pH was changed for the subsequent years field work (as discussed in Section 3.2.2).

In 2007, the pH of the household samples ranged from 4.6 to 7.1. A total of 44% (*n=91*) of household samples had a pH below the Peruvian standard (as seen in Table 3.4, page 63). A comparison of pH and source for data collected in 2007 can be seen in Figure 6.4. Samples which did not conform to Peruvian standards were from multiple sources and pH was not found to be statistically associated to sample source in 2007[109].

When the household sample results are compared to the results from the source (in Table 6.2), it can be seen that the average pH of source samples from tankered, well and purchased unsealed bottled water were below the Peruvian standard (as seen in Table 3.4, page 63). The low pH of these household samples may be due to the pH of the source water. It may also be attributed to the low pH of well water from outside this community[110]. This could explain the results for the samples that are classified as well and purchased unsealed water in Figure 6.4. The low pH could also be explained by the common practice of using lemon juice to 'treat' drinking water, which was uncovered during the questionnaire work[111].

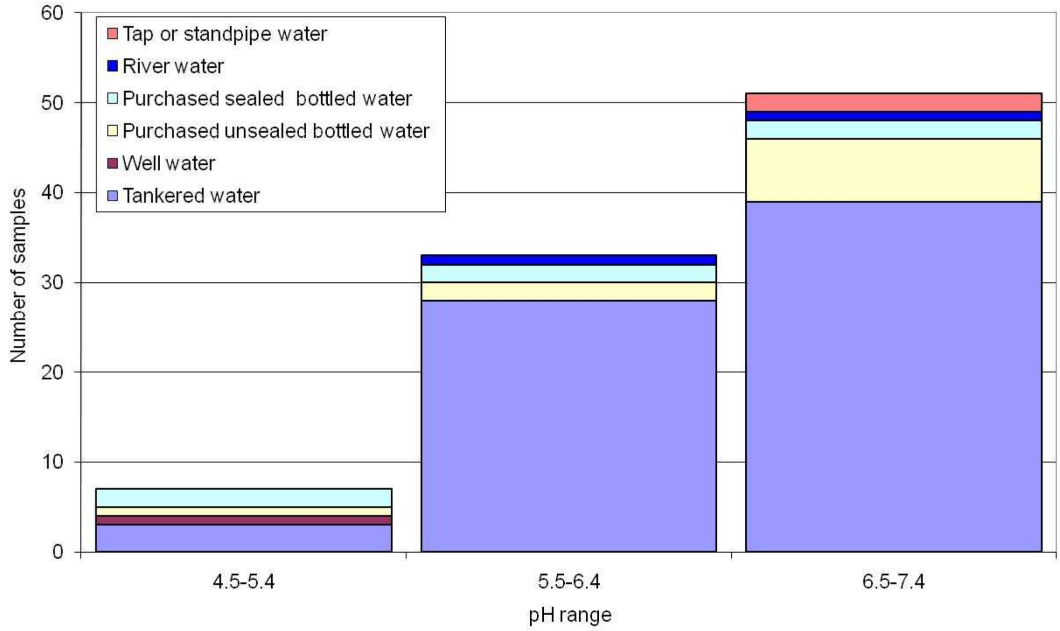

Figure 6.4: pH of household samples 2007 (*n=51*)

6.1.2 Turbidity

The Peruvian standard for turbidity is 5 NTU (as in Table 3.4, page 63). In 2006 all samples except one conformed to this standard. In 2007 two samples did not conform to the

[109] Eta, two tailed, significance level 95%: $p = 0.437$
[110] Well water in outside the community was recorded to be pH 4.78 by the author
[111] Quote from a respondent 26/7/2006

Peruvian standard. The original source of these samples was the river water (5 NTU) and tankered water (7 NTU). Due to the low variance in sample turbidity no further statistical analysis was undertaken.

6.1.3 Apparent colour

Many people spoke of the tankered water as being yellow[112]. The WHO guideline for colour is that water is generally acceptable to humans at levels below 5 Hazen (see Table 3.4, page 63). In Figure 53 it can be seen that 42% (*n=51*) in 2006 and 23% (*n=91*) in 2007 of samples conformed to this guideline standard. The colour in household samples significantly increased from 2006 to 2007[113].

The average colour of source samples taken from main drinking and cooking water sources ranged from <5 to 10 Hazen in 2006 to <5 to 34 Hazen in 2007 (as seen in Table 6.1 and Table 6.3). In Table 6.4 the mean values for the source sample were compared to the mean values for the household samples. It can be seen that higher mean colour values were found in samples taken from the homes of respondents. This would imply that water was being contaminated in the household. The apparent colour of source water increased from 2006 to 2007, indicating that water was of poorer quality in 2007. Apparent colour in household samples was not found to be related to source[114], which was expected as the same was found in the source sample analysis.

[112] Three respondents mentioned this on 26/6/2006.
[113] WSR test, two tailed, significance level 95%: p = 0.000
[114] Eta, two tailed, significance level 95%: 2006 p = 0.463, 2007 p = 0.454

Table 4: Comparison of mean apparent colour in source and household samples

	Mean apparent colour (Hazen)			
Source	**2006 Source**	**2006 Household**	**2007 Source**	**2007 Household**
Tankered Water	<5 (*n=4*)	17.86 (sd=13.68) (*n=15*)	16.67* (sd=11.55) (*n=3*)	25.86 (sd=24.75) (*n=70*)
Standpipe or tap water	10.00 (sd=9.13) (*n=4*)	13.06 (sd=8.43) (*n=25*)	N/A	22.50 (sd=24.75) (*n=2*)
Purchased water	6.88 (sd=5.58) (*n=13*)	10.00 (sd=5.00) (*n=8*)	11.75 (sd=9.86) (*n=30*)	21.09 (sd=25.08) (*n=16*)

*outlier of 85 Hazen removed from the analysis

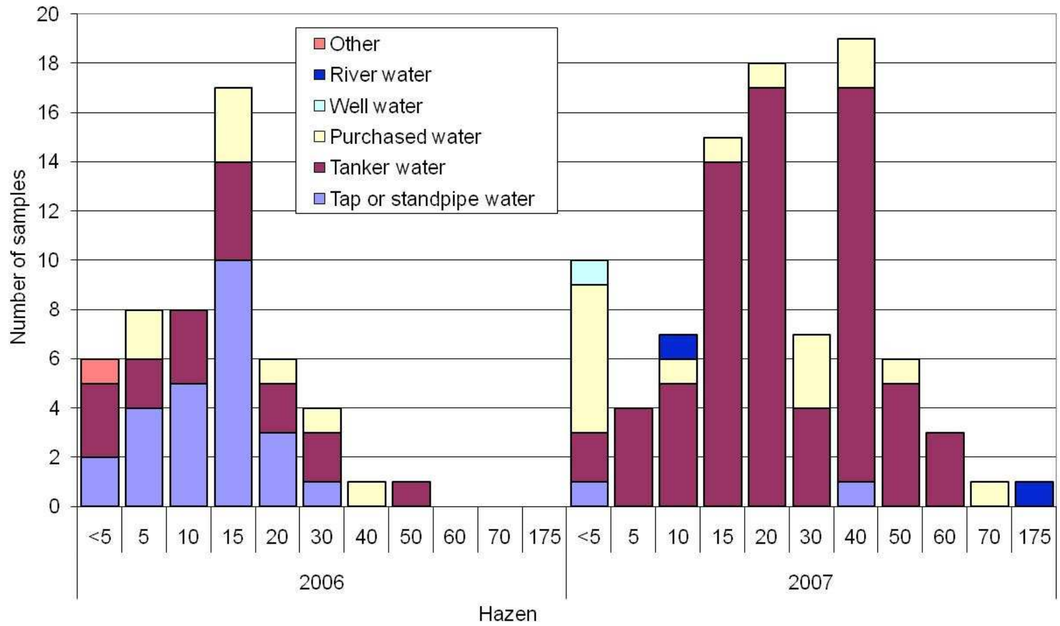

Figure 6.5: Colour of household water samples in 2006 and 2007 (*n=51* in 2006, *n=91* in 2007)

6.1.4 Chlorine

Only 41% (*n=52*) of household samples taken in 2006 and 29% (*n=91*) of household samples taken in 2007 contained chlorine. Only 36% (*n=42*) of household samples that originated from the municipal water treatment plant (tankered and tap water) contained chlorine in 2006, which dropped to 19% (*n=72*) in 2007. When water leaves the drinking water treatment plant it was assumed to contain free chlorine residual of above 0.5 mgl^{-1}. In

Figure 6.6 it can be seen that only 11% (*n=42*) of samples in 2006 and 3% (*n=72*) of samples in 2007 contained this total chlorine concentration ($\geq$ 0.5 mgl^{-1}).

When chlorine levels in household samples are reviewed in Figure 6.6, it can be seen that there was less chlorine in the samples taken in 2007 compared to 2006. This drop in chlorine levels was found to be statistically significant[115]. This was not unexpected as the chlorine levels in the samples taken at source had also dropped (as discussed in Section 6.0.3). The drop in chlorine levels from source to household was due to additional household contamination after collection, prolonged storage, and poor water handling practices, which have been recorded by many authors and discussed in Section 2.3.

The relationship between the presence of chlorine and water source in household samples was only investigated in the data set from 2006, due to the predominance of tankered water in 2007. In Sections 6.0.1 and 6.0.2, a relationship was found between the sample source and presence of chlorine, but when household samples were investigated, no association was found[116]. This adds to the argument that the drinking water was being contaminated during collection, transport and storage, or possibly that the water was being additionally treated with chlorine, which caused the quality difference between sources to disappear.

Chlorination was the most widely used household drinking water treatment in the community (as seen in Section 5.2.6): 48% of households who supplied a sample in 2006 stated that they used this method compared to only 20% in 2007, which can be seen in Figure 6.7. This decrease in household chlorination has been discussed further in Section 5.2.6. The associations between self reported chlorination, the presence and levels of chlorine in household samples were investigated[117], but no associations were found in either data set. Therefore it can be said that the presence of chlorine in household samples

[115] WSR test, two tailed, significance level 95%: total chlorine p = 0.001, free chlorine p = 0.003, combined chlorine p = 0.017

[116] Phi, two tailed, significance level 95%: p = 0.695

[117] Phi, two tailed, significance level 95%: 2006 p = 0.764, 2007, p = 0.050, MWU, two tailed, significance 95%: 2006 free chlorine p = 0.942, combined chlorine p = 0.774, total chlorine p = 0 942, 2007, free chlorine p = 0.482, combined chlorine p = 0.441, total chlorine p = 0.211

was influenced by household contamination of drinking water, more than self reported chlorination or the presence of chlorine in the source water.

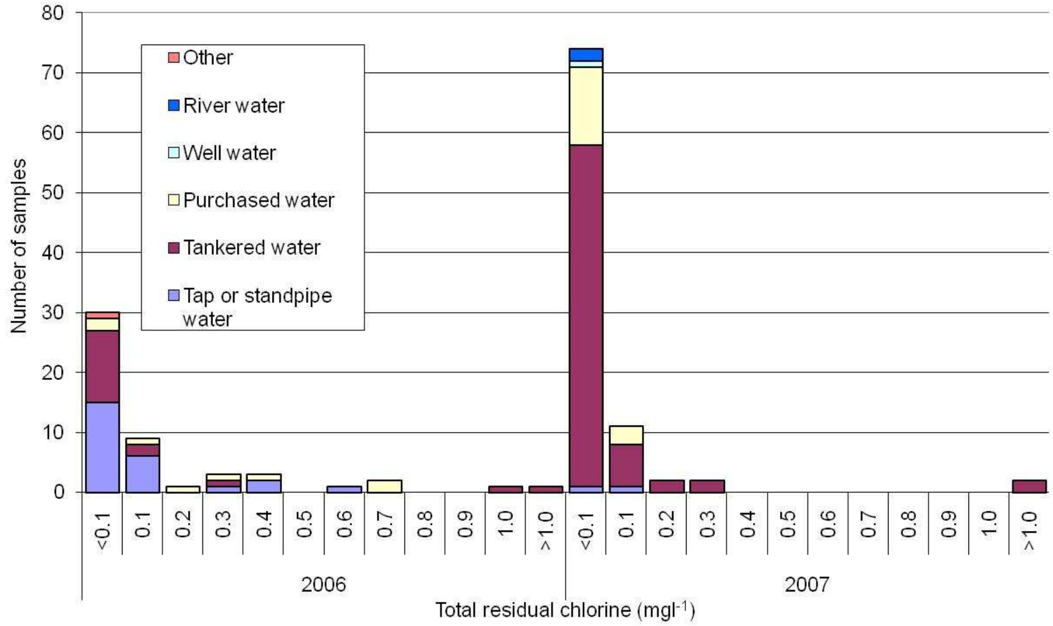

Figure 6.6: Total residual chlorine in household samples from 2006 and 2007 (*n=51* in 2006, *n=91* in 2007)

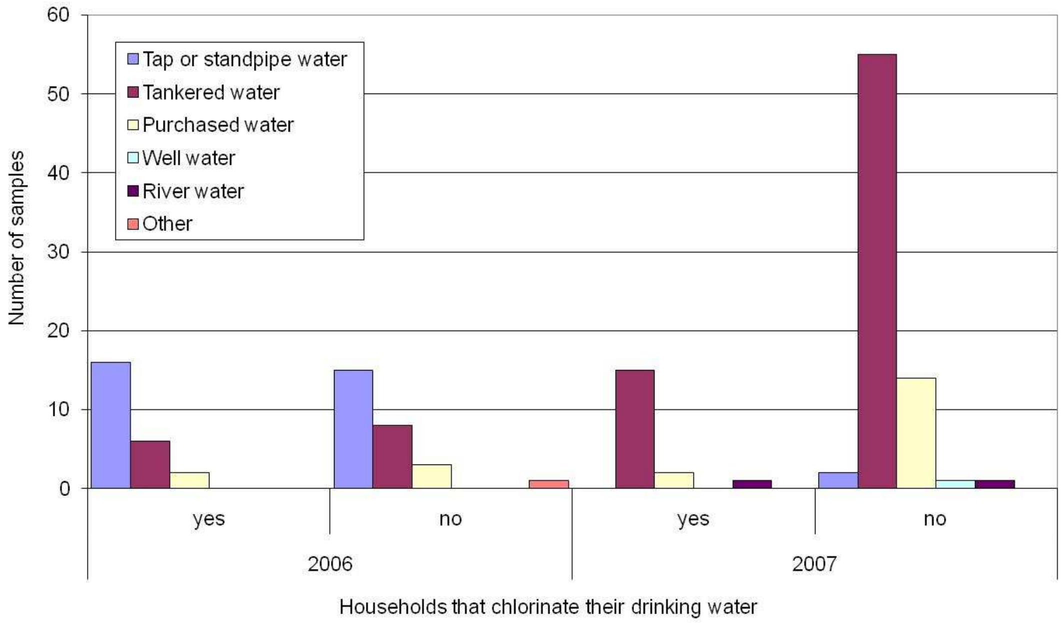

Figure 6.7: Source of household samples and self reported household chlorination (*n=51* in 2006, *n=91* in 2007)

6.1.5 Microbiological water quality

In Figure 6.8 it can be seen that 25% of household samples were classified as very high risk, compared with 31% that conformed to the WHO guidelines in 2006. In 2007 this changed, as 46% of households were classified as very high risk and only 20% conformed to the WHO guideline, as seen in Figure 6.8. The household drinking water quality decreased significantly from 2006 to 2007[118].

The quality of drinking water at household level declined, due to the predominance of tankered water and the associated increase in storage times in 2007.

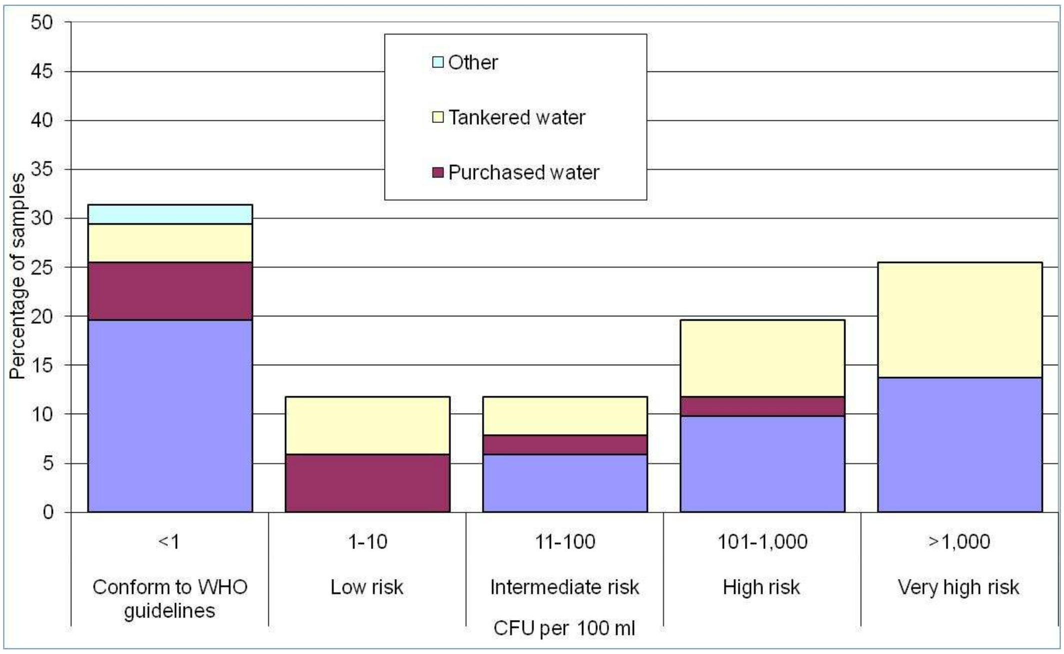

Figure 6.8: WHO risk categories based on thermotolerant coliform levels in household drinking water 2006 (*n=51*)

In 2006, 44% (*n=32*) of samples taken at source conformed to the WHO guidelines compared to only 31% (*n=52*) of samples taken at household level. This was highlighted in the statistically significant difference in the thermotolerant coliform levels of samples taken at source compared to those taken at household level for tankered water[119]. This was not investigated for other data sets due to the limited data.

[118] WSR test, two tailed, significance level 95%: $p = 0.002$
[119] MWU, two tailed, significance level 95%: $p = 0.018$

Again, in 2007 higher levels of conformity to WHO guidelines were found in the samples taken at source 43% (*n=70*), compared to those taken from households 20% (*n=91*). Tankered water samples contained statistically significant differences in levels of thermotolerant coliforms at source compared with the samples taken from households[120].

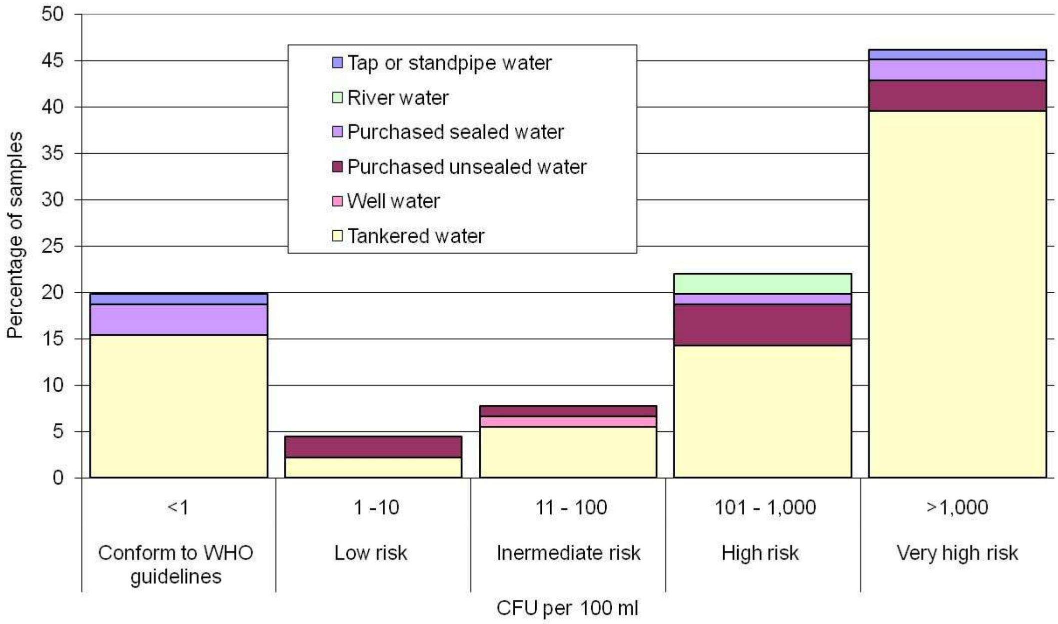

Figure 6.9: WHO risk categories based on thermotolerant coliform levels in household drinking water 2007 (*n=91*)

This indicates that in both years, thermotolerant coliform concentration in tankered water increased after collection, due to contamination during collection, transport and storage. This complies with the findings of a systematic review of 57 studies which found that the bacteriological quality of water significantly declines after collection in a number of settings (Wright *et al.,* 2004).

Noncompliance to WHO guidelines was extremely high in household samples: 63% in 2006 and 80% in 2007. This was lower than non compliances level of 95% found in peri-urban Lima and Bolivia (Gilman *et al.,* 1993, Quick *et al.,* 1999). The level of thermotolerant coliforms in the household samples was extremely high, the maximum recorded CFU level

[120] MWU, two tailed, significance level 95%: p = 0.007

for each year being 11,750 CFU per 100 ml and 27,500 CFU per 100 ml. These are similar to the levels found in untreated river and well water in the community (as seen in Section 7.0) and found in untreated polluted surface water sources (WHO, 2004b). This level of contamination has been recorded by other authors, namely Quick *et al.* (1999) who found household samples containing *E. coli* with median concentrations of 9,200 to 80,000 CFU per 100 ml in Bolivia.

In order to investigate contamination during storage further, in 2007 respondents were asked to quantify the length of time they stored their drinking and cooking water. The mean storage time for household drinking was 3.0 days.

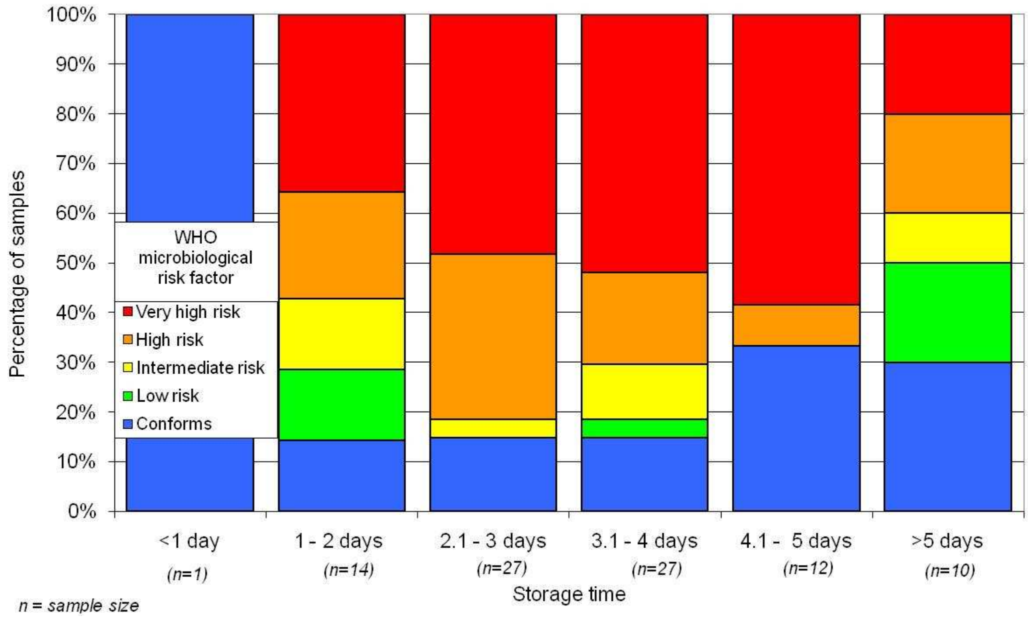

Figure 6.10: Storage time compared WHO microbiological risk factors associated with household samples

In Figure 6.10 it can be seen that the thermotolerant coliform contamination increased with storage from 1 to 5 days and then decreased after 5 days. Therefore a direct relationship was not found between microbiological drinking water quality and storage time[121]. The increase in bacterial growth after water collection and storage is linked to contamination due to handling practices, but the decrease is possibly linked to the die off of this bacteria as they compete for resources such as oxygen and nutrients (Wright *et al.,* 2004). These two processes can be used to explain the results seen in Figure 6.10.

[121] KTC, two tailed, significance level 95%: $p = 0.890$

In both years microbiological quality of household drinking water was not statistically related to drinking water source in 2007[122]. This is due to the effect of household contamination, which has previously been discussed.

6.2 Chapter summary

This chapter has achieved the objectives set. The microbiological water quality is discussed alongside other physicochemical parameters that were analysed in samples. These results were related to seasonal changes and drinking water practices. The main findings of this chapter are highlighted below.

The microbiological quality of the main sources of drinking water used in the community either conformed to WHO guidelines or were considered to be low risk. The aesthetic quality of the samples mainly fell within the guidelines for drinking water. Evidence supports the theory that drinking water was becoming contaminated after municipal treatment, in the distribution system in 2006 and in the tanker in 2007.

Seasonal variation in water quality was found in river water and well water, with sources being more contaminated in the rainy season as contamination was washed into these systems. The results support the theory that the main source of river contamination in the dry season is the community itself, while in the rainy season it is the city of Iquitos. It should be noted that these sources of water were only used by a low percentage of the community as their main drinking water source. Sanitary inspections reflected the contamination of the source waters, but were unable to capture the seasonal changes in water quality uncovered by the microbiological analysis.

The quality of purchased unsealed and sealed water and tankered water also changed from 2006 to 2007. These changes were identified as being contextual and due to the changing situation in the community rather than seasonal. They were also indicative of poor monitoring and lack of regulations in the water sector.

[122]KTC, two tailed, significance level 95%: 2006 $p = 0.316$, 2007 $p = 0.150$

From the ability of the respondents to provide samples it could be said that the availability of drinking and cooking water increased from 2006 to 2007. This was thought to be due to the reliance on tankered water and the change in strategy in delivering this supply in 2007.

As at source, the turbidity of nearly all of the household samples was below 5 NTU and the pH of household samples fell below the Peruvian standard of pH 6.5. The low pH of household samples can be explained by the low pH of source samples and the use of lemon juice to 'treat' drinking water.

The apparent colour of household samples was higher than at source level. It had also significantly increased from 2006 to 2007 in household samples. No relationship was found between apparent colour and the source of the sample.

Chlorine levels in the household samples had significantly decreased from 2006 to 2007. It should be noted that chlorine levels had also dropped at source. No association was found between the presence and levels of chlorine and sample source in household samples. No relationship was found between self reported chlorination and the levels or presence of chlorine in household samples. It can be said that the presence and levels of chlorine in household samples was influenced by household contamination, more than self reported chlorination or the level or presence of chlorine in the water source.

In general, household samples were considerably more microbiologically contaminated than the samples taken at source in both years. The microbiological contamination of water at household level had significantly increased from 2006 to 2007. No other relationships were found between these parameters and the source of the samples. When the relationship between storage and contamination was investigated it was found that microbiological contamination increased when water was stored for 1-5 days, but bacterial die off occurred when water was stored for longer than 5 days.

Due to the lack of relationships found between results gained and the sources of the samples, it can be said that the initial quality of the source water had little influence on the quality of the water drunk in the community. It can therefore be said that in both years the drinking and cooking water became contaminated during and after collection, due to drinking water practices, even when sources were originally chlorinated. A majority of the respondents were drinking water which was deemed to be of high or very high risk to health by the WHO. Many people were drinking highly contaminated water in Bellavista Nanay. The drinking water quality at household level decreased from 2006 to 2007, due to changes in source and practices, such as longer storage time.

This chapter establishes that drinking water practices greatly influence drinking water quality in this community. This chapter is therefore intrinsically linked to Chapter 5. The results from this chapter feed into Chapter 8, where the relationship between actual drinking water quality and perceived drinking water quality is explored.

Chapter Seven: Exploring external influences on the perception of drinking water quality

The objective of this chapter is to explore the external influences that can affect people's perception of drinking water quality. In this chapter the role of the media especially newspapers, other information that is available to the community, the community's trust of supplier, and the community's knowledge of water treatment, are discussed.

This chapter builds on the literature reviewed in Chapter 2 and also on the drinking water practices documented in Chapter 5. An in-depth investigation is required, as it has been highlighted in Section 2.3.2 that information and knowledge can play an important role in the perception of drinking water quality. This is why it was incorporated in to the hypothesised model in Figure 1.2 (page 12).

The questionnaire (raw data can be found in Appendices 9 and 10), observations (Section 3.1.1), interviews (Section 3.1.2) and other document sources (Section 3.1.3) are used to explore external influences which may affect perceived drinking water quality in Bellavista Nanay. These factors may feed into perceived drinking water quality discussed in Chapter 8.

7. 0 Media

The media was studied during the field trip in 2007. During this period the media was completely dominated by the deportation and trial of Fujimori, the ex-president of Peru.

Locally, before the study period in 2007 the drinking water treatment plant and infrastructure were being modernised with investment from the Japan Bank for International Cooperation (JBIC) using a Brazilian engineering company (Odebrecht). Suspicions of the engineering company were voiced in the media, which was probably due to the nationality of the company, as Peru shares a boarder with Brazil and this boarder is relatively close to Iquitos.

Rumours of private investment in EPS Sedaloreto S.A. had been circulating since before the first field trip visit to Bellavista Nanay in 2006[123]. The sensitivity of private investment in EPS Sedaloreto S.A. of the respondents in Bellavista Nanay is explored in Section 7.3.1. The upgrading and private investment in EPS Sedaloreto S.A. was highly relevant to this study, as the community's tap water supply was terminated in April 2007 and had not been reinstated by the time the second field visit ended in December 2007. A sign was erected in the community on the 18th September 2007 and was then updated to carry the information about the investors on the 11th October 2007. The upgrading and funding of the project was part of the President's (Alan García's) campaign "Water for All" and the sign states, "without water there is no democracy".

7.0.1 Media in the community

The questionnaire results showed that newspapers were the third most popular source of general information for the respondents in 2006 and 2007 (as in Figure 7.1). Newspapers were the focus of the media study in 2007, as discussed Section 3.1.3. The increase in television as a source of information from 2006 to 2007 may have been linked to the increase in television ownership and wealth over this period.

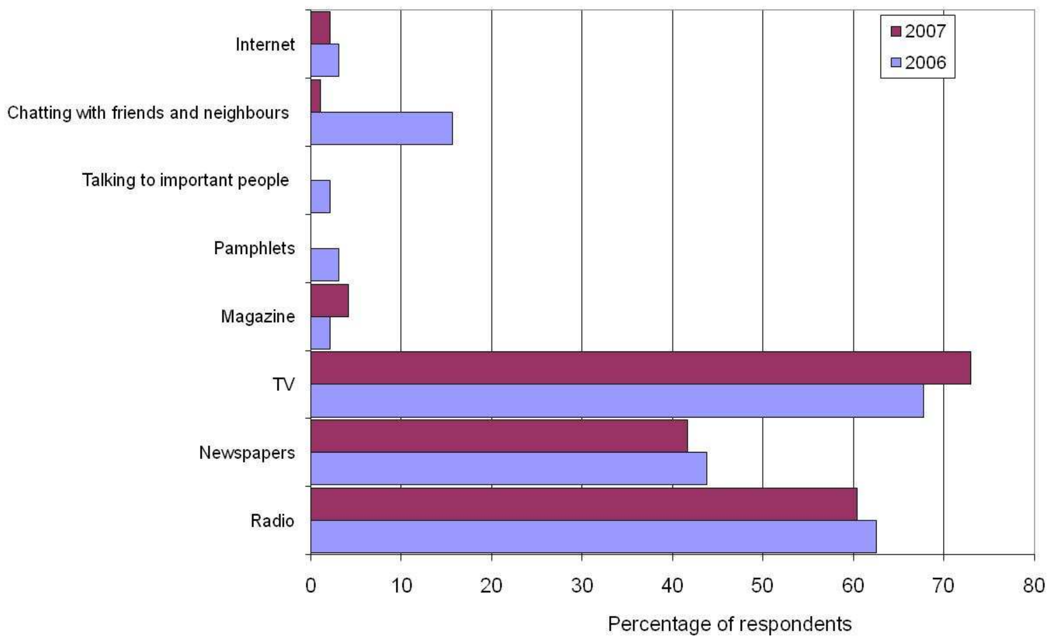

Figure 7.1: Sources of information used by the respondents in 2006 and 2007 (*n=96* for both years)

[123] Conversation with the Gatekeeper 10/6/2006

The respondents were asked to rate whether they trusted information from these different media sources. This was used to assess if they would believe water related information from these sources. In Figure 7.2 the trust rating of the three most popular media sources can be seen. In general it can be said that all media types were trusted by the respondents. The community placed more trust in the information gained from more 'technically advanced' media sources in both years, as seen in Figure 7.2. This could also be due to literacy levels in the community, but many of the respondents had completed their secondary education (as discussed in Section 5.0) and the Department of Loreto has a literacy rate of 92% (Ministero de Economia y Finazas, 2006). The internet is not included in the trust analysis due to low usage by respondents (*n=2* 2006, *n=3* 2007). The other pattern that can be seen in Figure 6.2 is that trust in all sources declined from 2006 to 2007. No explanation can be given for this. A possible theory is that it may have been linked to a media scandal which happened between the two field sampling trips, which the researcher was unaware of.

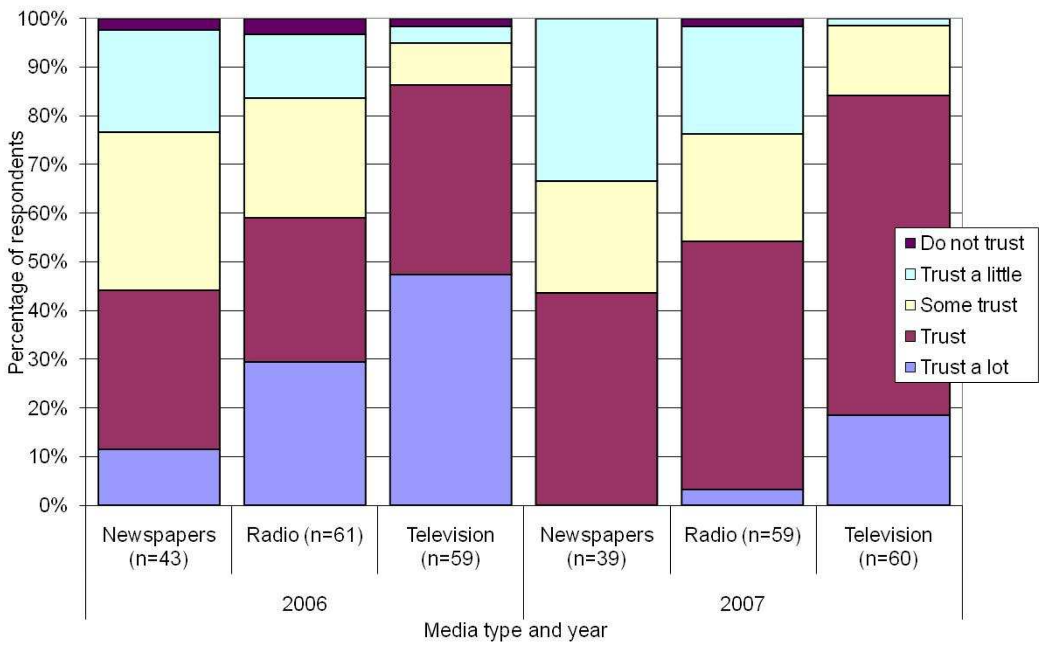

Figure 7.2: Trust in information gained from the three most popular media types in 2006 and 2007

7.0.2 Information received by the media on drinking water

The number of respondents that had received information on drinking water by media sources significantly decreased[124] from 62 in 2006 to 41 in 2007. This used as a filter

[124] McNemar, two tailed, significance level 95%: $p = 0.005$

question: respondents were asked to specify what kind of information they had received in an open ended question. The respondents' statements were analysed for common themes and topics, as seen in Figure 7.3. It can be seen in Figure 7.3 that a wide range of themes and topics emerged, ranging from the general importance of water: "…because it is important"[125], to the more specific: "…because we have to treat our water"[126]. In the topic designated 'other', statements were made which indicated the way the information was gained rather than giving an actual theme.

More themes and topics occurred than statements, due to multi-themed statements. An example of a multi-themed statement was "…I treat the water in my house because often the water is dirty and contains lots of bacteria"[127], which was analysed as containing the two themes water treatment and water quality. All statements and themes can be found in Appendices 3 and 4.

In 2006 the dominant theme was illness and health, which was mentioned by 46% (*n=71*) of the respondents. The kind of statements that were made under this theme were "[information on]… the prevention of illness"[128]. The predominance of this theme may have been due to major health campaigns which ran at the time of the questionnaire in 2006, such as those recorded in 2007 in Section 7.2. Unfortunately in 2006 no specific data was collected on health campaigns, due to time restraints, except on a dengue fever awareness and treatment campaign[129]. In 2007 it was noted that health campaigns were common and that they utilised the local media (discussed in Section 7.2). It was highly likely that this type of information influenced the respondents' response to this question in 2006.

[125] Quote from respondent 25/7/2006
[126] Quote from respondent 8/11/2007
[127] Quote from respondent 16/6/2006
[128] Quote from respondent 12/7/2006
[129] 26/6/2006

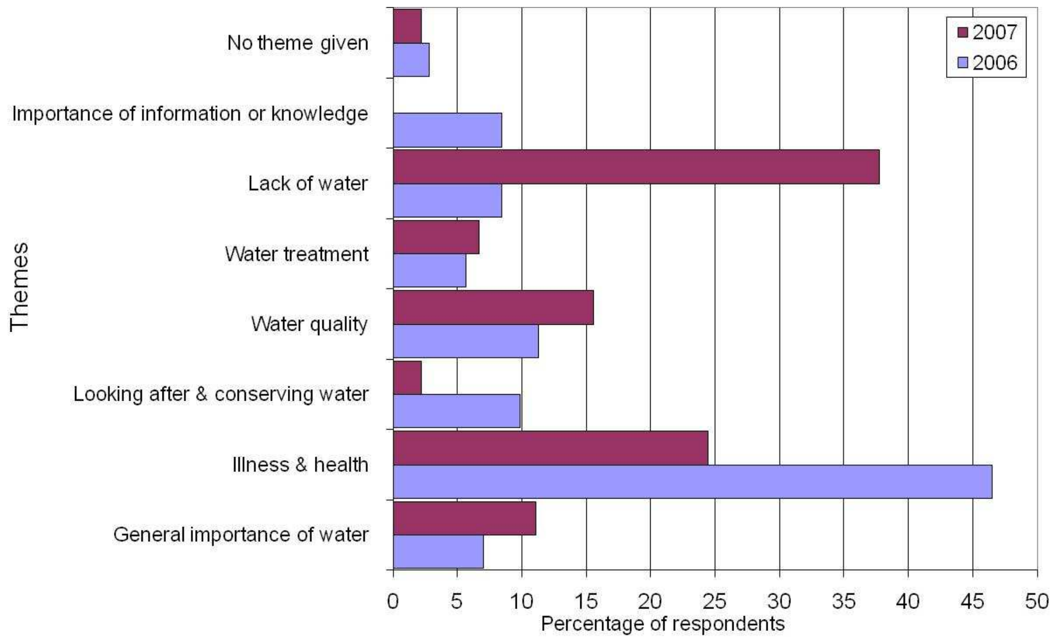

Figure 7.3: Theme analysis of the information respondents gained from the media relating to drinking water in 2006 and 2007 (*n=71* in 2006, *n=45* in 2007)

In 2007 the most common theme had changed to lack of water (38%, *n=45*). This change reflected the situation in the community as the municipal water supply was terminated in April 2007[130]. An example of a statement on this theme is "[information on]...why we don't have water now."[131] The complete lack of tap water in Bellavista Nanay in 2007 was a highly emotive issue which led to a street protest on 29th August 2007, and was covered by La Región, the local newspaper[132]. The outcome of this protest was increased delivery of free tankered water and the installation of water bladders in the community.

7.1 Newspaper coverage of water issues

A media study was undertaken using newspapers, as described in Section 3.1.3. It was noted that newspapers were the third most popular form of media and less trusted than TV and radio, as seen in Figure 7.1. The raw data from this study can be found in Appendices 1 and 2.

[130] Information gained from the Gatekeeper 21/9/2007
[131] Quote from respondent 23/10/2007
[132] Reported in La Región 29/8/2007

Newspapers were widely available in Bellavista Nanay[133], but they were relatively expensive [134] and once purchased, newspapers were read by neighbours in the community[135]. There were seven days when the newspapers were not fully analysed for this study[136], as none were available in Bellavista Nanay or in central Iquitos, due to either printing or distribution problems.

There were 112 articles in the local newspaper, La Región, which covered the areas of Iquitos and Nauta compared to 30 in the national newspaper, La República, as seen in Figure 7.4. This reflects the higher media importance of water on a regional level compared to a national level. The most common articles in both newspapers were those associated with general drinking water (La Región 80 articles *n=112*, La República 15 articles *n=30*). These included those relating to the work being undertaken in the city and water shortages. The second most frequently recorded article theme in both newspapers was water and disease (La Región 14 articles *n=112*, La República 5 articles *n=30*), which can be seen in Figure 7.4. This high level of coverage highlights the national and local importance of water in Peru and the work being done on the prevention of water-related diseases (further discussed in Section 7.2).

The themes identified in the newspaper articles were not entirely the same as the themes identified by respondents, but similar themes were recorded, which can be seen when Figure 7.3 and Figure 7.4 are compared. The two most popular themes that the respondents recalled in 2007 were also the most numerous themes occurring in both newspapers. People in Bellavista Nanay were therefore gaining information on water related issues from newspapers and the media in general. The newspaper analysis therefore appears to give a

[133] Vendors delivered them to the door daily and sold them in the morning at the market from 8 am to 10 am.
[134] The local newspaper, La Región cost S/. 0.50 (~UK£ 0.08) and the national newspaper La República cost S/. 1.50 (~UK£0.23). Newspapers were relatively expensive as S/. 0.50 was the bus fare into the centre of Iquitos and if a person purchased La República daily for a year it would cost just below the monthly national basic wage S/. 550, which many people, even government officials, did not receive. The basic wage was increased to S/. 550 in 2007, which was reported in La República 21/9/2007.
[135] The newspapers that the researcher had purchased could be seen being read by other people outside her household. They were identified due to the holes cut out of them where articles had been removed for analysis.
[136] 19/9/2007 both papers, 9 &10/11/2007 both papers, 18 to 20/11/2007 La República and 20/11/2007 La República.

good reflection of the information the respondents gained from the media in general, which supports the findings of Driedger (2007).

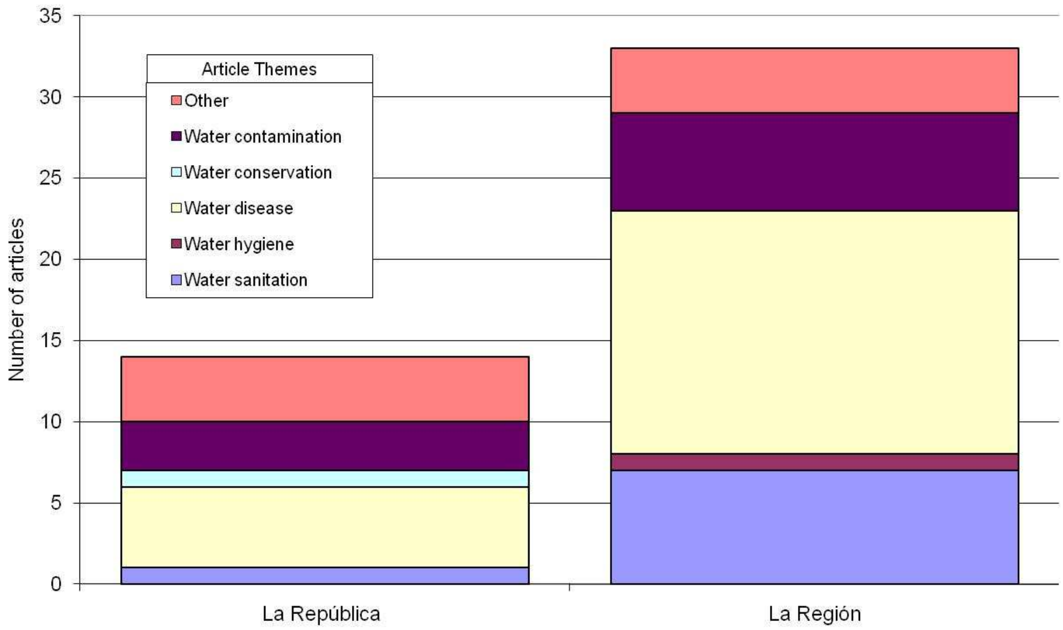

Figure 7.4 : Theme analysis of articles from La República and La Región

On the water-related disease theme, there were three articles on dengue fever and one article on yellow fever in La República and four articles on hepatitis A, three on yellow fever, two on dengue fever and one on malaria in La Región. This reflects the higher importance given to water-related diseases in the local area compared to the nation as a whole. An absence of articles on diarrhoea was noted in the two newspapers. Diarrhoea, although a major killer, is a less glamorous disease than many others and lacks not only national and local, but also international media coverage.

7.2 External information on water

In 2006 illness and health issues related to water were the most popular theme recalled by respondents and its popularity dropped to the second most popular theme in 2007 as seen in Figure 7.4. This water-related disease topic was the second most popular theme identified in both the national and local papers. The respondents drop in recognition of this theme may be due to the lower levels of illness in the community in 2007. The link between media and the information recalled by respondents has been established in the previous section. The respondents were also exposed to other external information on this topic, such as the information gained from medical campaigns.

During the study period in 2006 a dengue fever awareness and treatment campaign was undertaken in Bellavista Nanay. Health visitors undertook house to house visits, inspecting water vessels and treating any clean water sources with bags containing "minerals"[137]. These bags were later identified as containing "abate". Abate is the trade name for temephos (or temefos), an organophosphate larvicide, which is used to control dengue fever, after treatment each house was issued with a certificate. Only one respondent in each year identified the dengue treatment that was occurring in their household. They stated in response to the question, why they treated their drinking water "…to kill the lava [of the mosquitoes]"[138] and "…to prevent dengue"[139].

The dengue control programme was managed in a top down manner, leaving the household members with no control or power over how the programme was implemented in their household or community. Having a lack of control and being passively involved in the programme may have led to the lack of recognition of the programme. Participatory dengue control programmes have been implemented successfully in other parts of the world (Toledo Romani *et al.,* 2007) and knowledge of dengue fever has been linked to good prevention strategies in the home (Koenraadt *et al.,* 2006).

In 2007, three health campaigns occurred during the study period: a health visitor led dengue campaign[140] (as in 2006), a hospital led yellow fever vaccination campaign, and a hepatitis awareness campaign.

A free yellow fever vaccination campaign was run in Loreto which aimed to vaccinate 100% of those living in the area. Free vaccinations were available outside the community at the Ana Stahl (Seventh Day Adventist) Clinic, on Avenida la Marina. Free vaccinations at this clinic were available from 3rd September to 30th October 2007, which was publicised by a

[137] The answer given by the health visitor when asked what the bags contained
[138] Quote from respondent 22/6/2006
[139] Quote from respondent 22/11/2007
[140] The health visitor came to the researcher's residence on the 18/10/2007

huge banner that spanned the road. Three newspaper articles (28/9/2007, 14/10/2007 and 23/11/2007) appeared in La Región that claimed 90% vaccination coverage had been reached.

Information on this campaign was readily available to the community, because when residents from Bellavista Nanay travelled by the main and only road into the city centre during the campaign period they would pass under this banner.

A Hepatitis A awareness campaign was covered by La Región (four newspaper articles 12, 15, 16 and 18/9/2007). This was a responsive campaign due to 35 cases of Hepatitis A being recorded in June 2007[141]. The first article linked Hepatitis A to poor hygiene, a theme which continued through subsequent articles in La Región. These articles had titles like: "All against Hepatitis A"[142], which was an informative article that listed questions about Hepatitis A with answers.

Due to these well publicised campaigns it was thought that more people would have gained information on water related issues from the media in 2007, but this was not the pattern found in Section 7.0.2.

Another highly publicised event in Iquitos area was the "Drinking Water Week" which was reported in La Región as being "Drinking Water Month"[143]. The aim of the campaign was to publicise people's rights and inform people about water conservation[143]. An event to start the campaign was advertised to take place on 4th October 2007 in the centre of Iquitos, which was then followed by a parade for school children[144]. The inaugural event was attended by press and children from two private schools. The event was aimed at children with plays on water conservation and knowing your rights. Information and promotional materials (rulers and stickers) were given out at this event. A number of these were taken to the community by the researcher and distributed in the Nursery. The nursery nurses were unaware of this campaign. No school children from the community were present at this event and the campaign did not have a high profile in Bellavista Nanay.

[141] Information from the article in La Región 12/9/2007
[142] Article from La Región 16/9/2007
[143] Information from the article in La Región 30/9/2007
[144] Information from the article in La Región 6/10/2007

7.3 Trust of suppliers

It is widely accepted that trust of supplier plays a major role in the perception of drinking water quality. This is discussed in depth in Section 2.3.1. It should be noted however that the work cited has all been undertaken in the developed world. In this study trust of supplier was investigated from two angles: the municipal water supplier and shop purchased water through brand knowledge and loyalty.

7.3.1 Municipally treated water

The respondents who had access to tap or standpipe water were asked who owned the drinking water company. This was to gauge the level of knowledge of water company ownership. If the public and private water debate was a highly emotive issue in Bellavista Nanay, a high level of knowledge about company ownership would be expected. Respondents were then asked if they drank this water without treatment, to ascertain their trust in the company and the perceived quality of the water supplied by the company. Data could only be collected for 2006 as no households in Bellavista Nanay had access to tap or standpipe water in 2007.

A majority of respondents (60%, *n=20*) incorrectly attributed ownership of the municipal drinking water treatment plant to the private sector. This would infer that the private sector involvement in the drinking water domain in Bellavista Nanay was not emotive or important, as people already believed the private sector was involved in the running of their drinking water treatment plant.

When trust in the drinking water treatment company was explored, an equal spilt in those who treated and those who did not treat their water before consumption was found across all ownership categories. It can therefore be stated that perceived ownership and trust of supplier did not influence whether respondents treated their drinking water before consumption. This implies that trust in supplier did not influence perceived drinking water quality. This could not be investigated further due to the small sample size (*n=20*).

7.3.2 Shop purchased bottled water

In both years over 30% of the respondents stated that they purchased bottled water from shops (40% in 2006, 36% in 2006, *n=96* for both years). Further investigation into brand awareness, company ownership and brand loyalty was used to determine trust of supplier and its importance to the respondents. It was assumed that a high level of brand knowledge and company ownership combined with brand loyalty would be indicative of the importance of supplier.

It was expected that there would be an increase in respondents' purchasing of bottled water from the shops in 2007, due to the increase in wealth and the lack of tap water, but the opposite occurred. Only 17 of the respondents reported buying bottled water from shops in both years and only one stated that they purchased the same brand in both years. The respondents were therefore not loyal to a particular brand of water.

In 2006 bottled water company ownership was attributed solely to local companies, but a larger number of water brands were named (as seen in Figure 7.5). Only two water brands (San Luis and Agua Selva) were listed in both sampling periods. In Figure 7.5 it can been seen that fewer drinking water companies were named in 2007, but their ownership was attributed to a wider range of company types. After the field work study in 2006 there was a local crack down on water bottling companies, when they were found to be in breach of health and safety regulations[145]. This could have led to the decrease in the number of local drinking water companies named, as they may have either gone out of business or the respondents had chosen not to purchase water from these companies. There was a noticeable increase in television adverts for drinking water in 2007 with San Luis and Celio campaigns being most noticeable. This may have influenced people's choice of shop purchased water, as there was a high level of television ownership in this community, which may have led to San Luis and Celio being the brands most reported to have been bought by the respondents.

[145] Conversation with the Gatekeeper 26/9/2007

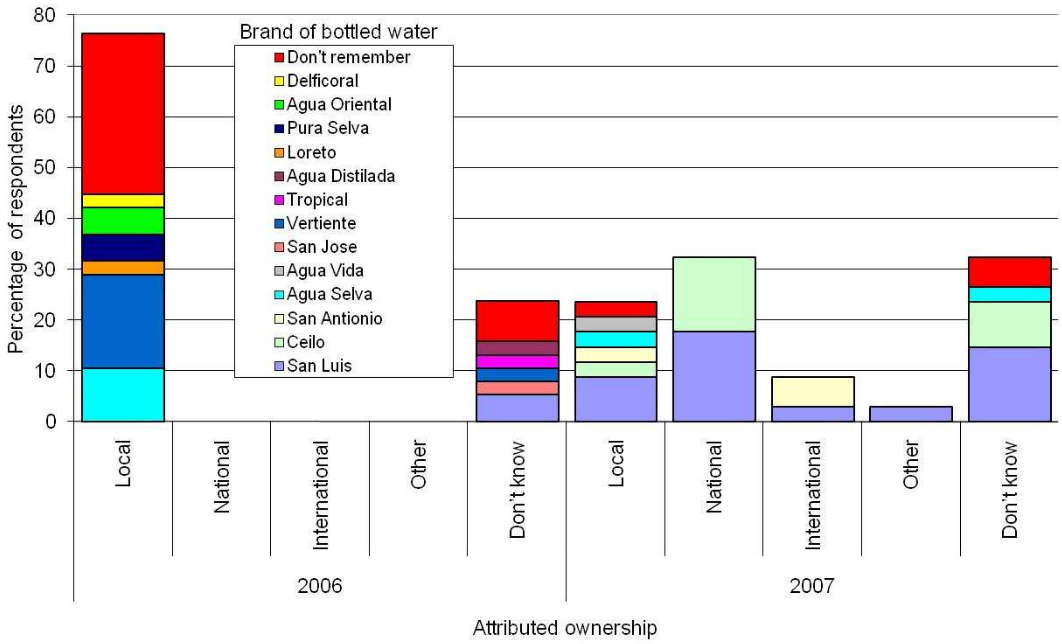

Figure 7.5: Attributed bottle water ownership broken down by brand drank in 2006 and 2007 (*n=38* in 2006, *n=34* in 2007)

The data collected in the questionnaire from 2007 was compared to the data collected and analysed from the labels on shop purchased bottled water (Table 7.1). Only three brands of bottled drinking water (see Table 7.1) were readily available in Bellavista Nanay and central Iquitos during the field study in 2007. Only two of these brands were identified by the questionnaire respondents in this year. The company ownership (national, international or local) was clearly displayed on all labels. The three other brands (Agua Selva, San Antonio and Agua Vida) were not available in the community during this period. Information found on the internet about Agua Vida showed that it is nationally produced bottled water[146].

With the information from Table 7.1 and Figure 7.5 it can be seen that only 20% (*n=34*) of respondents correctly identified the type of company their specified bottled water came from. The respondents showed no brand loyalty towards shop purchased water and low awareness of the company ownership status. This again illustrates that trust of supplier was not an important factor in the choice of drinking water and therefore the perception of drinking water quality.

[146] www.donjorge.com.pe

Table 7.1: Details of bottled drinking water purchased from shops in Bellavista Nanay and central Iquitos in 2007

Brand of water	Cielo (sky or heaven)	Agua de Mesa (table water)	San Luis
Name of company	AJEPER S. A.	Persa	The Coca-Cola company
Type of company	national (Lima)	local (Iquitos)	international (Lima)
Wording on label	agua natural (natural water), Cielo, sin gas (without gas)	agua de mesa (table water), pura y natural (pure and natural) sin gas (without gas), purified drinking water without gas (in English), sell by date	sin gas (without gas) San Luis, The Coca-Cola Company
Description given of water	treated and purified water	none	treated water with added magnesium sulphate, potassium chloride, sodium chloride
Other information given	ISO 9001, client information number	none	bottled in Lima, ISO 9001, ISO 14001, client information number
Words used to describe water	natural, treated, purified	table water, pure, natural, purified, drinking water	treated, table water

7.4 Community's knowledge of water treatment

Knowledge based questions were included in the questionnaire to see how much the respondents knew about water related issues. This is important as it is known to influence choice and practices through influencing perception of drinking water quality, as discussed in Section 2.3.1 and hypothesised in Figure 1.2 (page 12).

From literature, visiting the municipal drinking water treatment plant, and interviewing the plant technician, it was known that the treatment processes at this plant included chlorine disinfection. The chlorine levels in the water leaving the plant must meet the national standard of above 0.5 mgl^{-1}[147].

[147] EPS Sedaloreto S.A. visited 19/9/2007

Household treatment was also being practiced in Bellavista Nanay (as discussed in Section 5.2.6). During the field study period in 2006 chlorine tablets were freely supplied by the medical post, which then supplied liquid chlorine in 2007[148]. The Director of the medical post indicated that the funding for the supply of chlorine was sporadic and came from the regional government (Salud de Loreto)[149]. The Director stated that this chlorine was to be used for treating well water and rain water. Chlorine was used because "…the people know about chlorine"[149]. In this statement he implied that chlorine was an accepted form of drinking water treatment in Bellavista Nanay.

Chlorine was also available in Bellavista Nanay as Clorox, a brand of household bleach. Clorox was available at all shops in Bellavista Nanay in 2007[150]. The Clorox label contained instructions for its use in the treatment of drinking water. When the shop keepers were asked: "Do you sell 'anything' to treat drinking water?" They all said no and four directed me to the Medical Post to get chlorine. This issue was investigated further with a local woman[151] who did not know that household bleach could be used to treat drinking water. She also said that people did not buy or use it to treat their drinking water when there was no free chlorine at the medical post. This contradicts the information given by the respondents (discussed in Section 5.2.6), as one respondent in 2006 and six in 2007 specifically stated in the 'other' category that they used 'leja' which translates as bleach, to treat their drinking and cooking water. This shows that the respondents did not consider 'leja' a form of chlorination, but another treatment method, pointing to a lack of understanding of how household bleach makes drinking water safe.

In 2007 all respondents believed that their drinking water was treated, compared to 96% in 2006. There was a slight increase in awareness of drinking water treatment in Bellavista Nanay in 2007. This was probably due to a number of factors such as changes in water availability and storage (discussed in Section 5.2) which heightened peoples interest in drinking water, coupled with high media coverage and an increased awareness fuelled by the previous year's field work. The questionnaire respondents were asked where their

[148] General observations
[149] Interview 20/9/2007
[150] 16 shops were visited and shop keepers questioned 18/09/2007 & 1/10/2007
[151] Questioned 1/10/2007

drinking water was treated and what kinds of water treatment were available. 78% of the respondents in both years believed that their drinking water was being treated outside the community, which was true for municipally treated water. It was interesting that the respondents' definition of community differed from the intended definition (this is discussed in Section 5.1). Fifty two percent of respondents in 2006 and 37% of respondents in 2007 reported treating their water in their household in answer to an earlier question (see Section 5.2.6). However, the respondents themselves did not recognise this when asked where their drinking water was treated, as only 3% of respondents in 2006 and 2% of respondents in 2007 reported that water was being treated at household level, which can be seen in Figure 7.6. This adds to the evidence and theory developed in Section 5.3 that household drinking water treatment was underestimated in this survey due to the understanding of the term 'treatment'.

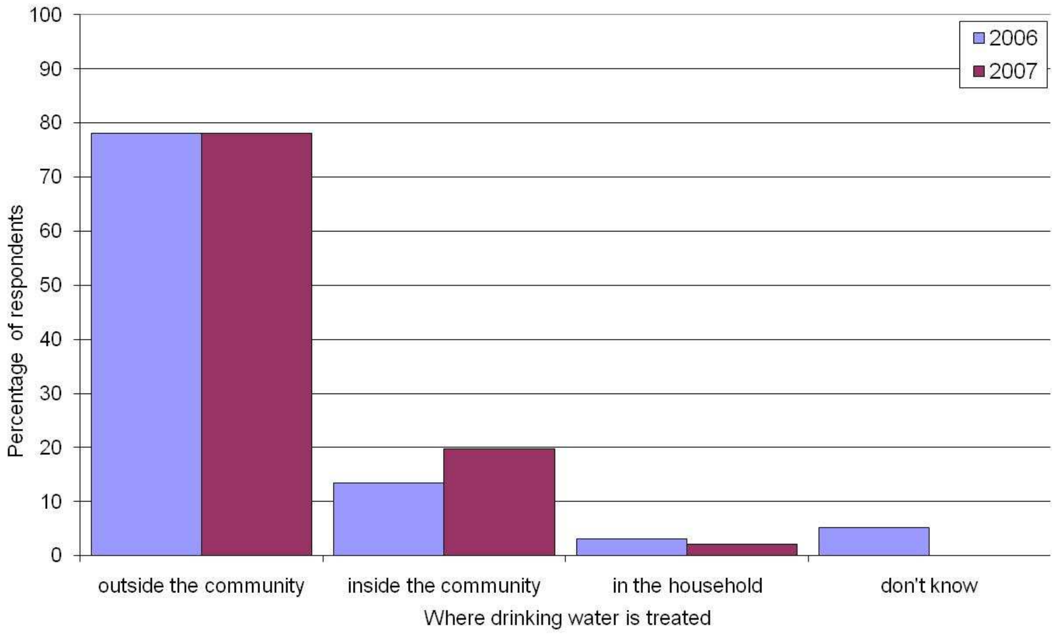

Figure 7.6: Where respondents thought that their drinking water was treated in 2006 and 2007 (*n=96* in both years)

Not only was there a general increased awareness of drinking water treatment in 2007, but more drinking water treatment options were mentioned by respondents and fewer respondents were unable to state a type of treatment (Figure 7.7). This increased awareness meant that more respondents were aware of more than one treatment type being used in the community. The respondents believed that chlorination was the main drinking water treatment used in both years, as shown in Figure 7.7. This was true, as chlorination was being used both at the centralised (as discussed earlier in this section) and household level (as discussed in Section 5.2.6). As seen in Figure 7.7 there was an increased awareness of the use of boiling water as a treatment method. Boiling of water was a treatment method that was practiced at household level and the second most popular household treatment method used by the respondents (discussed in Section 5.2.6). This increase in awareness was not supported by an increase in this self reported practice and contradicts other findings on the awareness of household drinking water treatment. Increased awareness may be due to the change in the drinking water situation in Bellavista Nanay in 2007, which was discussed in Section 5.2.

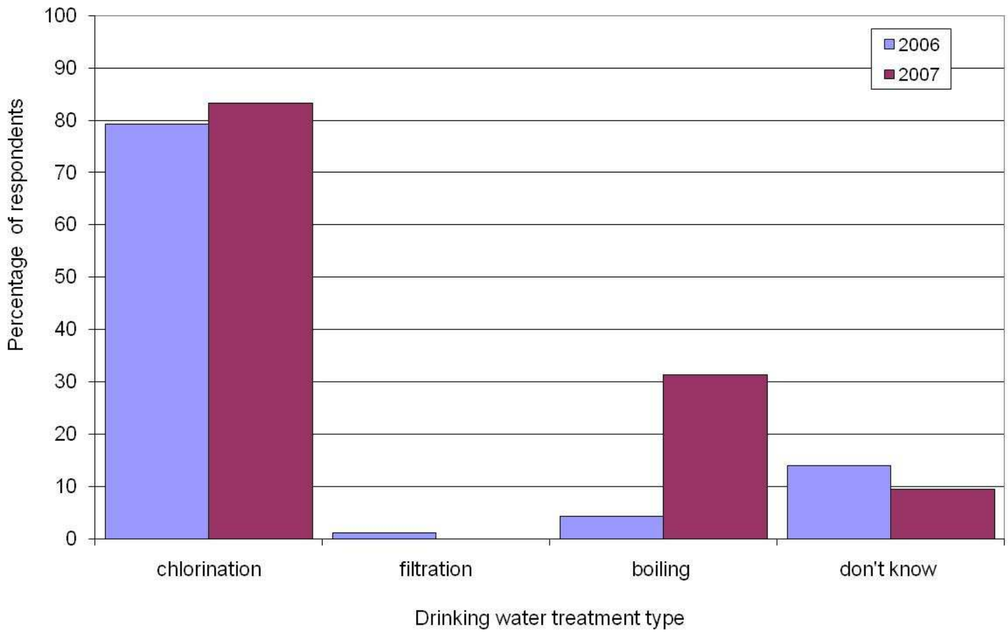

Figure 7.7: The types of treatment the respondents believed that their drinking water received in 2006 and 2007 (*n=96* for both years)

7.5 Chapter summary

This chapter achieves the objective of exploring the external influences that may affect people's perception of drinking water quality. Respondents gained their information from a wide range of sources, the most popular being television, radio and newspapers. The information from these sources was generally trusted by the respondents. There was a drop in the number of respondents that had received information on drinking water from these media sources in 2006 to 2007. The major themes that respondents' reported obtaining information on changed from illness and health in 2006 to lack of water in 2007, which reflected the local conditions.

The newspaper based media study reflected the higher status of water related themes at a local level compared to nationally. The themes of articles found in newspapers matched the themes stated by the respondents. Therefore people in Bellavista Nanay were gaining information on water related issues from the media. Health related campaigns were also a source of information.

Through exploring municipally supplied water and shop purchased bottled water, trust of supplier was dismissed as a major influence on the perception of drinking water quality in Bellavista Nanay. It was also discovered that private investment in the public water sector was not an emotive issue in Bellavista Nanay.

The questionnaire respondents were knowledgeable about centralised drinking water treatment, but did not acknowledge the role of household treatment in their community, even though it was readily practised. Chlorine was seen as an accepted drinking water treatment method and was readily available in this community. Chlorination was being used centrally at the water treatment plant and at the household level, which was acknowledged by the respondents. There was a general increase in the awareness of drinking water treatment and the treatment options available to the respondents in 2007 compared to 2006. This was probably due to the change in the drinking water supply in 2007. It also adds to the argument formed in Chapter 5 that drinking water practices were driven by supply and household drinking water management was highly flexible in Bellavista Nanay.

These results are examined further in Chapter 8, where other factors which may influence perceived drinking water quality are explored.

Chapter Eight: Perceived drinking water quality

The objectives of this chapter are to discuss the importance of perceived drinking water quality in Bellavista Nanay and to explore the relationship between the factors that feed into perceived drinking water quality in the context of Bellavista Nanay, as hypothesised in Chapter 1. Also the relationship between drinking water practices and perceived drinking water quality are explored. To achieve these objectives this chapter draws heavily on data and discussion from Chapters 2, 4, 5, 6 and 7. All the exploratory analysis was undertaken for both years separately due to the dramatic changes in the water situation in Bellavista Nanay.

8.0 Importance of drinking water quality

The importance of drinking water quality is explored in this section and compared to other WASH interventions. Authors have argued in relation to diarrheal disease that this WASH intervention is the least effective (Esrey *et al.,* 1991). This may be the case, but if people believe drinking water quality is the most important intervention then it becomes the most *sustainable* and *appropriate* intervention to target. It is hypothesised that people rate drinking water quality as the most important intervention, due to the immediate acute risk associated with drinking contaminated water.

In 2006, the majority of respondents thought that gaining sufficient water for cleaning and good hygiene (99%, *n=96*), sufficient water for drinking (54%, *n=96*) and drinking water quality (87%, *n=96*) was either very important or important. Overall in 2006, the importance of gaining sufficient water for cleaning and good hygiene was judged to marginally more important than the importance of drinking water quality by the respondents. This changed when the water situation changed in 2007. In this period the importance of gaining sufficient water for drinking increased[152] and the importance of drinking water quality

[152] WSR, two tailed, significance level 95%: p = 0.000

remained the same[153], but the importance of gaining sufficient water for cleaning and good hygiene decreased[154].

The changes in the importance of WASH interventions were related to the changes in the water situation. Changes in importance of WASH interventions have not been documented in literature, but do support the findings of Nyong and Karaoglou (2001) who documented the prioritisation of water use during water scarce periods in rural Africa. They first gave up water for household cleaning, then washing their clothes and finally bathing. This behaviour was caused by changing WASH priorities such as those recorded in this study, but it is worth noting that the importance of drinking water is not mentioned in their study.

From the data collected in 2006 it was difficult to definitively rank the importance of WASH interventions, therefore a forced ranking question was introduced in 2007. The respondents were asked to rank the parameters from the most to the least important, it can be seen clearly in Figure 8.1 that they ranked drinking water quality as the most important WASH parameter.

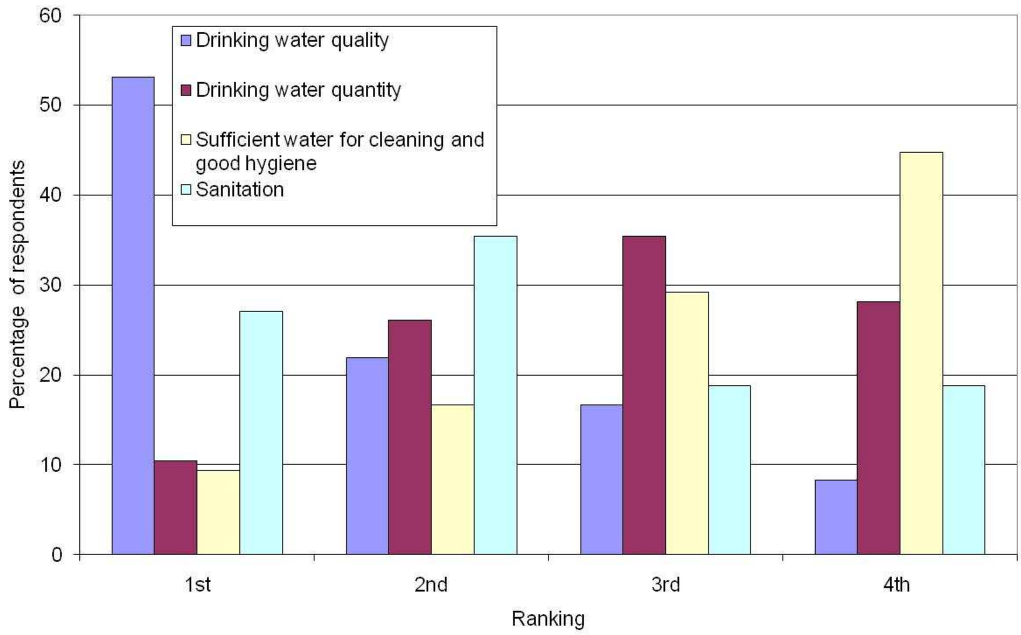

Figure 8.1: Respondents' ranking of drinking water quality and quantity, sufficient water for cleaning and good hygiene and sanitation in 2007 (*n=96* for all parameters)

[153] WSR, two tailed, significance level 95%: $p = 0.407$
[154] WSR, two tailed, significance level 95%: $p = 0.005$

Drinking water quality was found to be the second most important WASH parameter in 2006, but the most important WASH parameter in 2007. The interesting findings were that the importance of drinking water quality remained consistent and the importance of drinking water quantity increased in 2007, when people prioritised the importance of water for drinking over water for other uses.

8.1 Perceived drinking water quality

In 2006, 56% (*n=96*) of the respondents perceived their drinking water as either good or very good, which remained approximately the same in 2007 (57%, *n=96*). This suggests the argument that the respondents' perception of drinking water quality was not related to their present drinking water source, as drinking water sources changed significantly from 2006 to 2007. It was hypothesised that perceived drinking water quality was related to aesthetical estimations, perceived risk, physicochemical and actual water quality which then influence drinking water practices (as seen in Figure 1.2 , page 12). These associations are explored in this section.

Perceived drinking water quality was associated with the respondents' perception of temperature, colour, turbidity, odour and taste in 2006[155] and with temperature, colour, odour and taste in 2007[156]. The association of odour and taste with perceived drinking water quality may be explained by the link respondents made between chlorine and good quality water. Respondents linked the smell of chlorine to good drinking water quality, one respondent stated "…it smells good because it smells of chlorine"[157]. This produced the linkage between aesthetical estimations and perceived drinking water quality, as hypothesised in Figure 1.2. This association between good and clean drinking water and the smell and taste of chlorine contradicts all the literature on this theme which has explored

[155] KTC, two tailed, significance level 95%: 2006 temperature $p = 0.001$, colour $p = 0.000$, turbidity $p = 0.013$, odour $p =0.024$, taste $p = 0.008$
[156] KTC, two tailed, significance level 95%: 2007 temperature $p = 0.000$, colour $p = 0.001$, turbidity $p = 0.013$, odour $p = 0.028$, taste $p =0.016$
[157] Quote from respondent 23/10/2007

this in developed and developing world contexts (Biswas *et al.,* 2005; Lou *et al.,* 2007; Piriou *et al.,* 2004; Turgeon *et al.,* 2004; Bruvold, 1970; Dillehay *et al.,* 1967).

The direct relationship between the physicochemical results (level or presence of chlorine, pH (2007 only), and apparent colour[158]) and perceived drinking water quality were explored, but no relationships were found, this contradicts the hypothesised model.

No relationships were found between physicochemical results gained from the household water samples and aesthetical estimators (the respondents' classification of colour, odour, temperature, turbidity and taste), therefore this supports the hypothesis in Figure 1.2.

Associations between the perception of specific aesthetical estimators and the physicochemical water qualities of household samples were investigated. The respondents' perception of taste was associated with the pH[159] in household samples in 2007 and so was the respondents' perception of odour[160]. This creates a link from the physicochemical parameters to aesthetical estimations, again as hypothesised in Figure 1.2.

It was surprising that no direct association were found between the presence and levels of chlorine and aesthetical estimations or between physicochemical water quality and perceived drinking water quality. This can be explained when the data in Chapter 6 is reflected upon. In Chapter 6 it was found that the presence of chlorine in household samples was not related to source, but to drinking water practices. This means a water source may be judged to be of 'good' quality due to the presence of chlorine through smell or taste, but if poor drinking water practices exist or if the water is stored for a prolonged period the chlorine levels will be reduced or become undetectable. When this household water is consumed or sampled there may be a lack of chlorine in the water, the association between chlorine and perception aesthetical estimators is lost. Household and not source

[158] pH in 2006 was not explored due to the method used as explained in Section 6.1.1 and turbidity was not explored due to the lack of variation in the samples as explained in Section 6.1.2

[159] KTC, two tailed, significance level 95%: taste $p = 0.027$

[160] KTC, two tailed, significance level 95%: odour $p = 0.026$

samples were used for this analysis as these samples more accurately reflected the water drunk in the household at the time the questionnaire was undertaken.

As expected actual drinking water quality (microbiological water quality) was related to physicochemical water quality through the levels of chlorine in the water in both years and apparent colour in 2007[161], establishing a link between actual drinking water quality and physicochemical water quality which supports the hypothesis.

A surprising finding was that actual water quality (microbiological drinking water quality) was directly linked to the respondents' perception of their drinking water quality in both years[162]. This link was not hypothesised in Figure 1.2 and this produces the linkage between perceived drinking water quality and actual drinking water quality in Figure 8.2. This relationship was independent of the aesthetical estimators of the drinking water as no statistical relationships were found between the respondents' perception of colour, turbidity, odour, temperature or taste and actual drinking water quality in both years.

No relationships were found between perceived drinking water quality and drinking water practices (main drinking water, collection of drinking water, payment for water, the use of household drinking water treatment and storage time (2007 only)) in both years. This would indicate that perceived drinking water quality was not affecting drinking water practices and therefore the behaviour of the respondents which contradicts the hypothesised model. A model was developed off the associations found between perceived and actual drinking water quality in Bellavista Nanay, this can be seen in Figure 8.2. This model is applicable for both years even when the water situation in Bellavista Nanay changed dramatically, this would suggest that these relationships were not dependent on specific situations and may be fixed or ingrained.

[161] KTC, two tailed, significance level 95%: microbiological water quality and 2006 total chlorine $p = 0.000$, free chlorine $p = 0.000$, combined chlorine $p = 0.000$, 2007 total chlorine $p = 0.000$, free chlorine $p = 0.000$, combined chlorine $p = 0.001$, colour $p = 0.001$

[162] KTC, two tailed, significance level 95%: 2006 $p = 0.004$, 2007 $p = 0.014$

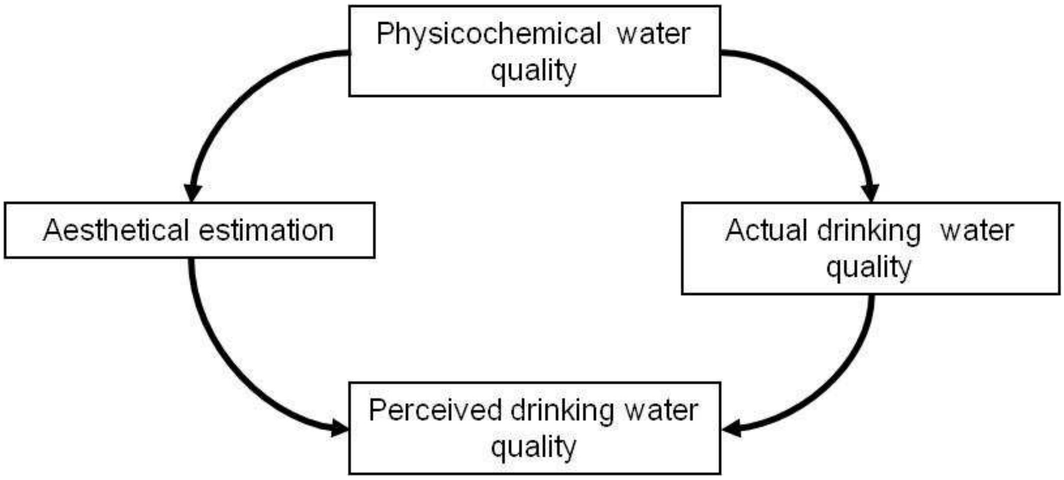

Figure8.2: Model of the associations found between perceived and actual drinking water quality in Bellavista Nanay

In the following sections the associations between perceived drinking water quality and perceived risk, perceived contextual indicators, and socioeconomic status are explored. Both perceived contextual indicators and risk are included in the hypothesised model (Figure 1.2, page 12). Many authors have found that socioeconomic status has affected the perception of drinking water quality and drinking water practices (Andreson *et al.,* 2007; Doria *et al.,* 2006; Turgeon *et al.,* 2004). This also includes how the presence of children influence perceived drinking water quality (Euzen, 2003). It was found that in Bellavista Nanay, trust of supplier (which was explored in Chapter 7) did not play a major role in the respondents' perception of drinking water quality, so this factor will not be explored further.

The association between the 23 variables were investigated for statistical associations with the perceived drinking water quality. The variables were grouped under four headings. Water and illness encapsulates nine variables, which relate to memorability, the link between water and illness and the receipt of external information on water. Socioeconomic status utilises six variables, (gender was not included due to the lack of variation as 83% of the respondents were female). Drinking water practices included five variables. Perceived contextual indicators were analysed using a subset of data from the respondents who collected their water from outside their home, this included three variables.

8.2 Factor affecting the perception of drinking water quality

The existing perceptions explored are those around the topic of perceived risk. This includes the data from nine questions from the questionnaire (receiving information on water, self reported illness, pollution caused by sanitation, gravity of diarrhoea, why people get diarrhoea, link between dirty water and diarrhoea, importance of sufficient water for drinking, sufficient water for cleaning and good hygiene, and drinking water quality).

In 2006, strong associations were found between perceived drinking water quality and the reported importance of drinking water quality[163]. A weak association was found between perception of drinking water quality and self reported illness[164]. For the perceived contextual indicators (cleanliness, safety and the presence of animals), only a weak association was found, between the perceived drinking water quality and the cleanliness of the drinking water collection area[165].

Socioeconomic status included six variables (age, education and professional status of the household water manager, number of children and infants in the household and income proxy). In 2006 a strong association was found between the number of infants in a household and perceived drinking water quality[166]. This would indicate that the presence of infants in the household was making the water managers more aware of the quality of their drinking water; this relationship has been reported in the literature by (Euzen, 2003). A summary of the model for 2006 can be seen in Figure 8.3

[163] KTC, two tailed, significance level 95%: $p = 0.019$
[164] MWU, two tailed, significance level 90%: $p = 0.066$
[165] KTC, two tailed, significance level 90%: $p = 0.089$
[166] KTC, two tailed, significance level 95%: $p = 0.046$

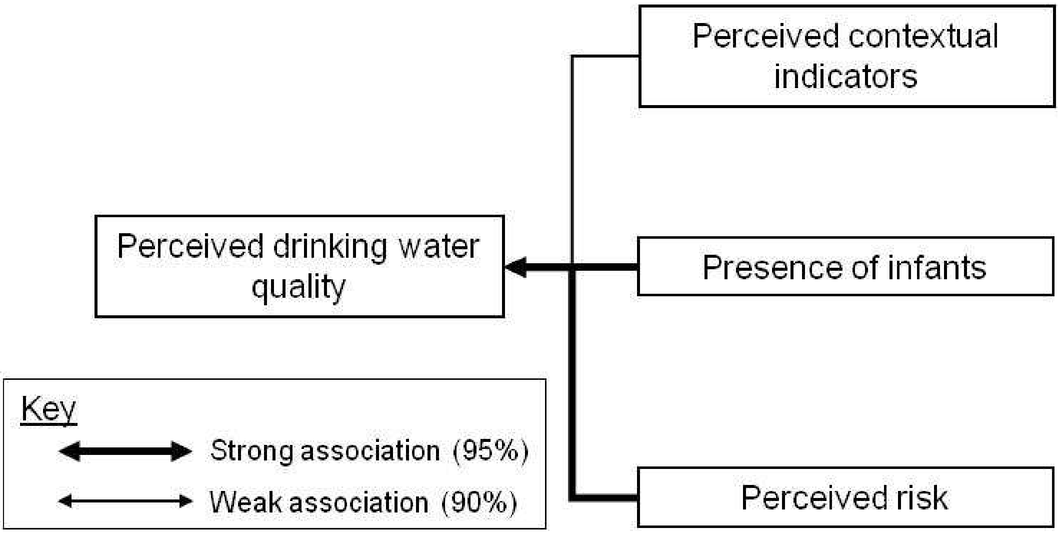

Figure 8.3: Model of the factors which have been found to be associated with perceived drinking water quality in 2006.

In 2007 no associations were found between the perception of drinking water quality and any of the above variables. This was probably due to the change in the drinking water situation in Bellavista Nanay in 2007.

This shows that unlike the factors in Figure 8.2 the factors that influence the perception of drinking water quality in Figure 8.3 were not fixed. As the water situation changed from 2006 to 2007 the relationship between the factors in Figure 8.3 disappeared. This means even a model valid for a particular community can change over a short time period due to changing circumstances. No link was found between drinking water practices and the factors explored in Section 8.1 and 8.2, so other factors must be influencing drinking water practices directly.

8.3 Association of water and illness with drinking water practices

No direct associations were found between perceived drinking water quality and drinking water practices in Section 8.1 or 8.2, which was unexpected. The relationship between the factors encapsulated under water and illness and those summarised under drinking water practices were therefore explored.

In 2006, household water managers who reported that their households drank less water[167], and those that paid for their drinking water[168], gauged the gravity of diarrhoea to be more important. This was evidence of averting behaviour, as people reported drinking less water and purchasing water due to the risk of diarrhoeal diseases.

The household drinking water managers who collected their drinking water ranked the possibility that their sanitation method could pollute a drinking water source as higher, compared to those that did not collect their drinking water[169]. This could be explained by either the possibility that these water managers had greater connection to the place where the pollution occurred due to collecting their water, or the possibility that they were poorer and had poorer levels of sanitation that caused the pollution.

Households that reported drinking more water placed more importance on the link between the consumption of dirty water and diarrhoea[170], possibly due to their reliance on water for their liquid intake, which would increase the risks of consuming dirty water and the possibility of contracting diarrhoea.

Households that drank more water placed a higher importance on gaining sufficient water for cleaning and good hygiene[171]. Those households that were more reliant on water for their liquid intake were poorer and therefore not paying for their drinking water. This would mean that their water supply was less reliable. This was supported by the result that those who did not pay for their drinking water attached more importance to obtaining sufficient water for drinking[172]. This is related to the reliability of water and the flexibility which comes from having the money to pay for a water source.

In 2007, only one association was found between drinking water practices and the factors that associate water with illness. Those reporting to treat their water in their household

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[167] KTC, two tailed, significance level 95%: $p = 0.028$
[168] MWU, two tailed, significance level 90%: $p = 0.098$
[169] MWU, two tailed, significance level 90%: $p = 0.053$
[170] MWU, two tailed, significance level 90%: $p = 0.053$
[171] KTC, two tailed, significance level 95%: $p = 0.005$
[172] MWU, two tailed, significance level 95%: $p = 0.011$

were more informed as to how diarrhoea is contracted[173]. This association was not found in 2006 and its importance may have increased with the decrease in general drinking water quality.

In 2006, six associations were found between the factors that link water with illness and drinking water practices, which decreased to only one in 2007. This would indicate that these factors directly affect drinking water behaviour, outside the hypothesised model, possibly due to their importance for survival. Drinking water practices (behaviour) were less influenced by the factors that associate water with illness in 2007. The change in the water situation had caused the respondents to prioritise the importance of these factors which then influenced their drinking water practices.

8.4 Association of socioeconomic status and drinking water practices

As other authors have found that drinking water practices were related to socioeconomic status the relationship between these parameters was explored.

In 2006 associations were found between the age of the household drinking water manager and the collection of water[174]. Older drinking water managers were more likely to be collecting their drinking water, compared to younger drinking water managers. The payment for drinking water was linked to education and professional status.

In 2007 household drinking water treatment was associated with the number of infants within a household[175]. When this was explored further it was found that households that contain more infants are less likely to treat their water, this could be due to the draw on the household water managers time if she/he is the main carer for the infants in the household. Income proxy was related to the collection[176] and payment for water[177]. Households that were wealthier were less likely to collect their water, but more likely to pay for it. A model was drawn for the results gained in Section 8.3 and 8.4, Figure 8.4.

[173] MWU, two tailed, significance level 90%: $p = 0.053$
[174] Eta, two tailed, significance level 95%: $p = 0.025$
[175] MWU, two tailed, significance level 95%: $p = 0.042$
[176] MWU, two tailed, significance level 95%: $p = 0.033$
[177] MWU, two tailed, significance level 95%: $p = 0.019$

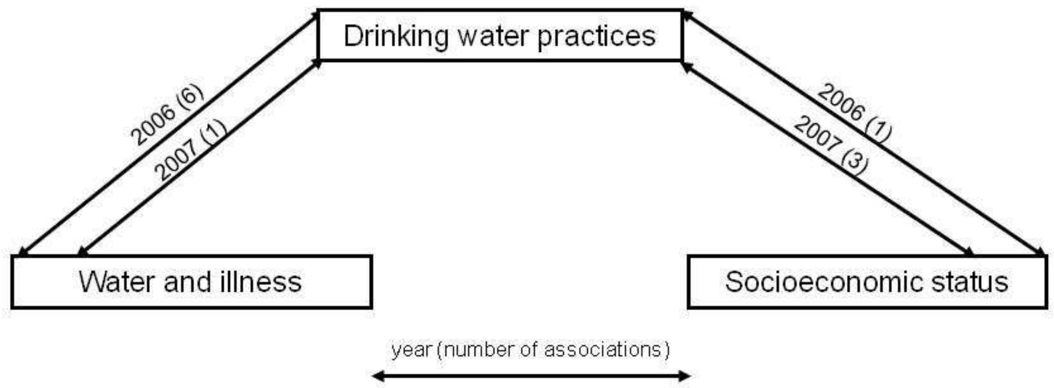

Figure 8.4: The factors which were associated with drinking water practices in Bellavista Nanay

What becomes clear in Figure 8.4 is that drinking water practices in Bellavista Nanay are directly affected by perceived risk (water and illness) and socioeconomic status, rather than perceived drinking water quality as hypothesised. This is possibly due to the hypothesised model being based on literature predominately from a developed world context, therefore inappropriate for Bellavista Nanay. It should also be noted that no other authors have explored the relationship between perceived drinking water quality and drinking water practices, so until this study this relationship was only hypothetical. Also in Figure 8.4 it can be seen that more associations were found between drinking water practices and water and illness than socioeconomic status in 2007, but the opposite was found in 2007. This would indicate that although both socioeconomic status and perceived risk directly affect drinking water practices, when the water situations becomes more stressed, socioeconomic factors play a more important role.

8.5 Chapter summary

This chapter achieves the objectives set to discuss and explore the relationship between perceived drinking water quality and other factors in Bellavista Nanay. A number of factors that feed into perceived drinking water quality have been identified, as have associations between drinking water practices and socioeconomic factors and perceived risk (factors associated with water and illness).

Respondents prioritised the importance of different WASH interventions as the water situation in Bellavista Nanay changed. The importance of gaining sufficient water for cleaning and hygiene decreased while the importance of gaining sufficient water for drinking increased and the importance of drinking water quality remained consistent. The respondents rated drinking water quality as the most important WASH parameter in 2007.

The hypothesis in Figure 1.2 was tested. It was found that aesthetical estimators were linked to perceived drinking water quality and physicochemical water quality as hypothesised. The link between physicochemical and actual drinking water quality also fit with this hypothesis. Surprisingly actual drinking water quality is also linked directly to perceived drinking water quality possibly due the levels of chlorine in the samples used to test this theory. This outcome differs from the hypothesised model. As the model was the same for both years, even when the water situation changed dramatically, this would suggest that these relationships are not dependent on specific situations and may be fixed or ingrained. The other factors in the model such as perceived contextual indicators, perceived risk and socioeconomic status were only associated with perceived drinking water quality in 2006, indicating that these are not fixed and vary as the situation changes. Also no links were found between perceived drinking water quality and drinking water practices. This would indicate that perceived drinking water quality was not influencing drinking water practices, which means other factors were directly influencing behaviour.

In both years drinking water practices were found to be directly related to perceived risk (factors that associated water with illness) and socioeconomic factors. When the water situation changed in Bellavista Nanay the importance of socioeconomic factors increased and those related to perceived risk decreased. This would indicate that in water stressed situations socioeconomic factors play a larger role in drinking water practices.

Chapter Nine: Conclusions

This thesis sets out to explore the link between perceived and actual drinking water quality in Bellavista Nanay. It is situated in the nexus between environmental engineering, human geography and development studies and addresses the call for engineers to become inter-disciplinarians, so that they adopt engineering approaches that take into account perceptions of drinking water quality.

Perceived and actual drinking water quality have been explored separately in developed countries (as discussed in Section 2.3.1), but the connection between these parameters have been largely ignored by academia. Fewer studies have explored these separate topics in a developing countries context even when it has been acknowledged that they play an important role in the success of drinking water improvement schemes (as discussed in Section 2.3). As drinking water quality cannot be explored in isolation, but must be studied in the context where it occurs, baselining and using a case study approach are important aspects of this research.

The principal objective of this chapter is to answer the following research questions which were set in Chapter 1:

- *What factors are related to the perception of drinking water quality in Bellavista Nanay?*
- *Do people know how safe/dirty or clean/unclean their drinking water is?*
- *Is perceived drinking water quality linked to actual drinking water quality?*

Before the above research questions could be answered the following additional questions were addressed:

- *What is the current water and sanitation situation in Bellavista Nanay?*
- *What is the current drinking water quality in Bellavista Nanay?*

As drinking water practices and quality are known to be affected by seasonality (Herbst *et al.,* 2009; Katsi *et al.,* 2007; Hoque *et al.,* 2006; Howard and Bartram, 2003 Giannoulis *et al.,* 2003; Gelinas *et al.,* 1996; Machingambi and Manzungu, 2003; Nyong and Kanaroglou, 2001) comparisons are made between the two seasons.

Additional objectives of this chapter are to draw together the conclusions from previous chapters, to reflect on the approaches used, to explore the applications of this research and to make recommendations for future work.

10.0 Conclusions

Data collected on the drinking water sources in Bellavista Nanay highlight that even when national statistics are very optimistic (Peru is set to meet the MDG target for water by 2015), local situations may be significantly different. In 2007, only 2% of those surveyed in Bellavista Nanay were using improved drinking water sources. This situation was hidden in the Department, District and City statistics (as seen in Table 5.2.2). This demonstrates how 'official' figures hide important differences. This has implications for policy and the targeting of resources. If the official figures are to be believed, there is not a lack of access to clean drinking water in Peru. These 'official' figures, however, are often estimated (as in the MDGs) and do not capture seasonal variations or supply availability. A majority of people were reliant on tankered and vended water in Bellavista Nanay, which are unimproved water sources. This research challenges the assumption that improved drinking water sources provide water that is of higher quality than unimproved sources, and questions the global focus and definition of these two terms.

In the present debates water was connected to money in a number of ways. In Bellavista Nanay wealth was found to be connected to households' ability to pay for their drinking and cooking water. The water which is charged for is delivered directly to people homes it can therefore be stated that the time of the household water manager had a monetary valuable (Cairncross and Valdmanis, 2004). The respondents were generally living on significantly less than the Peruvian minimum wage and were paying significantly more than 4% of their disposable income on water services. This contradicts the finding of Soares *et al.,* 2002 who calculated that low income urban households paid 4.2% of their disposable income for their drinking water in Peru and Fujita *et al.,* 2005 who calculated that 2.44% of peoples' disposable income was spent on water services in Iquitos. Again this demonstrates how difference statistics can mask differences in the figures and why data cannot be transposed from nearby areas. Even with the poor water services private investment in the water sector was not found to be emotive issue in Bellavista Nanay, even while it occurred in 2007.

As many other authors and reports have noted water is a highly gendered topic Gender and Water Alliance, 2003; Langford, 2005 Soussan, 2006WHO/UNICEF, 2008). In the context of Bellavista Nanay this is also true, as 83% of the household drinking water managers were women. This thesis therefore explores women's knowledge, attitudes and practices surrounding the issue of drinking water quality and as such is talking a feminist engineering approach.

The drinking water and sanitation situations in Bellavista Nanay were more complex than originally thought. A clear distinction was made between water for drinking and water for other practices. This is a distinction that developed countries are now making, due to the need to conserve water. Many water improvement schemes aim to provide large amounts of water to a drinkable standard, something developed countries are now moving away from. This, together with the fact that quality of water at source does not guarantee the quality of water drunk, and more water is required for cleaning and good hygiene than for drinking, would suggest that the fundamental aims of drinking water improvement projects need to be reassessed. The findings of this thesis suggest that increased quantity of lower quality water, together with household drinking water treatment and safe storage would provide a sustainable strategy for improving drinking water quality.

Although the community was actively choosing its drinking water, the fundamental thread that linked the drinking water practices together was availability and supply. The continuity of a drinking water supply, how it impacts on practices, and the quality of water have been ignored in the MDGs and literature (O'Hara *et al.,* 2008; Sutton, 2008), yet this case study highlights the importance of continuity of supply.

Household water managers were very knowledgeable about how water was treated, but in general did not recognise that they were treating their drinking water. This was because the term 'treatment' was associated with processes that required 'technology'. This, together with the community's greater trust in information from technologically advanced media forms, and the trust placed in the quality of the water from the centralised municipal drinking water treatment plant, meant that there was an underlying theme of trust in technology running through this research.

Chlorinated water was widely available in the community and household chlorination was the most popular method of household drinking water treatment. Household drinking water treatment was practised mainly due to health concerns related to drinking unclean water. Even given this knowledge, there was a general lack of understanding about the recontamination of water during and after collection, which may stem from the trust placed in 'technology'.

Some seasonality in drinking water practices were witnessed, but they were overshadowed by the greater changes in practices caused by the termination of tap and standpipe water in the community in 2007. These changes in practices and situations could prove essential when trying to improve drinking water quality. The only way to capture this kind of knowledge is by undertaking baseline work and covering all seasons. This level of detail cannot be found in other baseline material such as larger surveys or census results.

Samples taken from the main drinking water sources contained between 0 and 10 thermotolerant coliforms per 100 ml of sample, which either conformed to WHO guidelines or were considered of low risk to health (WHO, 1997b). The aesthetic quality of the samples was generally good. It was found that water was being contaminated during transport, in the distribution system in 2006 and in the tankers in 2007. Seasonal variation of surface water sources were found, with sources being more contaminated in the rainy season, as contamination was washed into these systems, this pattern has also been found to occur in Kampala, Uganda (Howard *et al.,* 2003), Conakry, Guinea (Gelinas *et al.,* 1996) and North western Greece (Giannoulis *et al.,* 2003).

The water quality of vended and tanker water also changed from 2006 to 2007. These changes were identified as being contextual, due to changing situations in the community, rather than seasonal. They were indicative of poor monitoring and lack of regulation in this sector.

A majority of people in Bellavista Nanay were drinking water that contained between 101 and >1,000 thermotolerant coliforms per 100 ml of sample. This water is deemed to be of high or very high risk to health by the WHO guidelines (WHO, 1997b). The quality of the source water had little influence on the quality of the water drunk in the household, as in both years drinking water became contaminated during and after collection, which supports the findings of other authors in this field (Hoque *et al.,* 2006; Trevett *et al.,* 2005; Trevett *et al.,* 2004; Wright *et al.,* 2004).This brings into question the focus of the MDG target on improved drinking water sources, as the focus is on quality at the point of delivery. In this study it can be seen that this does not guarantee clean drinking water at the point of consumption. The drinking water quality at household level decreased further from 2006 to 2007 as drinking water sources and practices changed.

The prioritisation of the different WASH interventions in response to changing water situations was identified in Bellavista Nanay. No academic literature exploring this theme has been found, although Nyong and Karaoglou (2001) did document the prioritisation of water in rural Africa during water scarcity. Interestingly, drinking water quality was rated as the most important WASH intervention and its importance remained consistent, even when the water situation changed significantly.

In both periods, relationships between physicochemical water quality, actual water quality, perceived drinking water quality and aesthetical estimations were found. People in this community knew how clean or dirty their drinking water was. This fundamental relationship can be attributed to chlorine being associated with 'good' drinking water. This emphasises the need to consider the role of local knowledge and the importance of a case study approach. This finding contradicts all literature on the taste of chlorine and again adds to the debate on trust in technology. The produced model differed significantly from the hypothesised model as actual drinking water quality was directly linked to perceived drinking water quality. This model Figure 8.3 was applicable for both years even when the water situation changed significantly, this would suggest that this was these relationships were not dependant on specific situations and may be fixed or ingrained. The model also differs from the one devised by Doria *et al.,* 2005, as flavour was found to be the only critical parameter influencing perceived drinking water quality.

A further novel finding of this research was that the factors that influenced the perception of drinking water quality were not fixed, but were responsive to changes in the water situation. When the water situation in the community was more ‘normal’, factors such as the perceived risk, perceived contextual indicators and socioeconomic status were associated with perceived drinking water quality. When the water situation changed and the conditions became harsher, none of these factors were associated with perceived drinking water quality. This indicates that these factors play a secondary role in the perception of drinking water quality compared to more internal factors.

No relationship was found between perceived drinking water quality and drinking water practices as hypothesised. The hypothesised model was devised from literature nearly exclusively from a developed countries context i.e. Doria *et al.,* 2005, as very little literature had been published on this topic from a developing countries perspective, this could explain this finding. Also Doria *et al.,* 2005 did not explore the link between drinking water quality and drinking water practices within their model, so the connection has only been hypothesised to date. In the context of this study it would suggest that other factors are directly influencing drinking water practices.

Direct relationships between factors associated with water and illness and socioeconomic status were found to directly influence drinking water practices. In 2006 the factors that link water and illness were associated with drinking water practices and there was strong evidence supporting averting behaviour. This changed in 2007 as the water situation changed in the community. These issues were then more often associated with socioeconomic factors such as wealth and education. This seems to be a fundamental underlying relationship which only comes to light in harsher environments.

The quantity, quality and depth of data produced and the insight gained can be attributed to using a mixed methodology. From this thesis it can be seen that the approach taken was highly applicable to the subject explored. This thesis is an argument for the use of this approach when exploring drinking water practices and the perception of drinking water quality.

The hypothesised model (as seen in Figure 1.2) used as a starting point for this research, draws on research from different contexts, and can provide a framework to explore these themes in other settings.

10.1 Refection on approaches used

From the above discussion and Chapters 4 to 8, it can be seen that the mixed methodology was highly successful in obtaining data that could be used in this study. Whilst this knowledge gained cannot be transposed, the approach used can be recommended for other studies in this field.

The successful collection of a relatively large amount of data over a short period of time can be attributed to the approach adopted. Approaching the sensitive subjects encompassed within water and sanitation was eased by embedding the research and researcher in the community. The respondents were familiar with her presence and knew her before the questionnaire was undertaken. It also highlights the importance of talking to the household water manager to gain data on drinking water practices, rather than other members of the community or general observations. Valuable data was collected by using the questionnaire to gain access to people's homes. This also allowed people to feel comfortable when being interviewed and changed the power dynamics of the situation.

It needs to be stressed that it was the symbiosis of methods that enabled an 'outsider' to gain a comprehensive overview of the drinking water practices in this community compared with using a single method. This approach allowed for validation of data through triangulation which proved highly valuable when exploring situations as an 'outsider'. This study shows clearly that if only one data collection method had been used, the results gained would have been much more subjective.

Feeding the knowledge gained back into the community played an important role in this work. It was especially important as the researcher revisited the community and this kept the study at the forefront of the participants' minds. Under the methodology it is important to return the knowledge to the community, as this knowledge could possibly be used for capacity building.

10.2 Application of the research

From the detailed study of drinking water practices in Bellavista Nanay a number of suggestions for improving drinking water quality in an *'appropriate'* and *'sustainable'* manner could be developed in conjunction with the community. It is recognised that all WASH interventions are very important for health and quality of life. The findings of this thesis highlight that the main WASH concern for household water managers was drinking water quality. Therefore it is recommended that any WASH programme use this topic as a way into the community and develops a holistic WASH programme from this point.

From drinking water practices, source and household samples it was seen that water was being contaminated or recontaminated at the household level. This was due to water being stored for prolonged periods as well as storage and handling practices. As drinking water practices in Bellavista Nanay were found to be supply driven, a more reliable and constant source of drinking water would dramatically change lives in this area. This could be achieved in many different ways such as: water tankers that deliver daily at a specified hour, a more continuous tap water supply or several standpipes that have a continuous supply.

If increasing the reliability of drinking and cooking water is not possible, the increased use of household chlorination could be championed. Unlike other places, 'good' water was associated with the smell and taste of chlorine in the source water. This method was partially used in the community when the medical post had free chlorine, but many people were unaware that household bleach (which was cheap and readily available) could be used to treat their drinking water. Added to this, there was little understanding of recontamination of drinking water. Household drinking water quality could therefore be further improved by increased education and marketing of household chlorination and recontamination of water.

The household drinking water managers were educated and had a good understanding of the relationship between dirty water and disease, but as mentioned before there was a general lack of understanding of the recontamination of drinking water. The community was getting its information from the media such as television, radio and newspapers and people generally trusted information from these sources. Therefore a campaign on the recontamination of water in conjunction with a household chlorination campaign using these media forms would have the maximum impact.

A majority of household water managers were women and a link was found between education and the overall understanding of the importance of WASH interventions, pollution and disease. A lower percentage of female household water managers had completed their secondary education compared to their male counterparts. Therefore it is crucial that girl children continue to be educated to secondary level, so that this base of understanding can be built upon when the issues surrounding recontamination of water are addressed. Capacity built through the knowledge generated in this thesis, together with a simple monitoring tool such as the hydrogen sulphide test, could be used to address the problems of recontamination of water, poor monitoring and lack of regulation that were highlighted in this research.

This thesis poses a strong argument for the use of a mixed methodology approach in baselining WASH in developing countries. Not only will it give a good baseline to measure the gains from improving WASH in a community, but when used in conjunction with questions about the importance of WASH interventions and the association of water with illness, it can be used to formulate '*appropriate'* and '*sustainable'* improvement plans. The researcher would urge planners, engineers, researcher and NGOs to embrace a mixed methodology approach when trying to baseline a community, especially if working as 'outsiders'. As stressed earlier, a case study approach also needs to be adopted for each community because each the knowledge generated is situated and should not be automatically transposed to other communities, no matter how similar they may seem.

10.3 Recommendations for future work

A number of interesting themes were revealed by this research which could be explored through participatory methodologies in Bellavista Nanay. These include recontamination of drinking water, trust in technology, the low recognition of household drinking water treatment and the status attached to having an in-house tap water supply.

As the perception of drinking water is a pivotal factor in the success of drinking water improvement schemes, it is vital that the link between perceived and actual drinking water quality is explored at a community level in different developing countries. The relationship found in Bellavista Nanay hinged on the presence of chlorine. It is of academic interest to explore these themes in areas that are reliant on unchlorinated water. The factors that feed into the perception of drinking water quality change depending on the environmental context. This is of academic and practical interest as it affects drinking water practices and, while currently ignored in the MDGs, would be a vital step in ensuring safe drinking water for all.

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Appendix 1: Theme analysis from La Región

Date	Drinking water	Water sanitation	Water hygiene	Water disease	Water conservation	Water contamination	Other	Information
12/09/2007	0	0	1	1	0	0	0	Hep A, construction of a laudrary
13/09/2007	2	0	0	0	0	0	0	code of practice for drinking water, the need for more water tankers
14/09/2007	1	0	0	0	0	0	0	turning off of water in the centre of town for 4 hours
15/09/2007	2	0	0	1	0	1	0	Hep A, drinking water project plus Peru, drinking water protest over the lack of water, contamination of water by petrol Per
16/09/2007	1	0	0	1	0	0	0	Hep A, water project funded by petrol Peru
17/09/2007	0	0	0	0	0	0	0	
18/09/2007	0	0	0	1	0	0	0	Hep A
Week 1	**6**	**0**	**1**	**4**	**0**	**1**	**0**	
19/09/2007								No papers
20/09/2007	0	0	0	0	0	0	0	
21/09/2007	0	0	0	0	0	0	0	
22/09/2007	0	0	0	0	0	0	0	
23/09/2007	0	0	0	0	0	0	0	
24/09/2007	0	0	0	0	0	0	0	
25/09/2007	0	0	0	0	0	0	1	advert for concessions in small cafes
Week2	**0**	**0**	**0**	**0**	**0**	**0**	**1**	
26/09/2007	0	0	0	0	0	0	1	advert for concessions in small cafes
27/09/2007	0	0	0	0	0	0	0	
28/09/2007	1	1	0	1	0	0	0	cross sector meeting on development of sanitation, yellow fever, management of the water system in the centre of town
29/09/2007	0	0	0	0	0	0	1	contamination of bathing water in swimming pools and lagoons
30/09/2007	1	0	0	0	0	0	0	SUNASS drinking water day
01/10/2007	0	0	0	0	0	0	0	
02/10/2007	0	0	0	0	0	0	0	
Week3	**2**	**1**	**0**	**1**	**0**	**0**	**2**	
03/10/2007	0	0	0	0	0	0	0	
04/10/2007	1	0	0	0	0	0	0	criticism of the replacement of drinking water pipes in Iquitos
05/10/2007	3	1	0	0	0	0	0	water and sanitation project, well project, water company boss interviewed
06/10/2007	4	0	0	0	0	0	0	defence of the water company, month of drinking water, x2 drinking water company
07/10/2007	1	0	0	0	0	0	0	selling of illegal water
08/10/2007	0	0	0	0	0	0	0	
09/10/2007								No papers
Week 4	**9**	**1**	**0**	**0**	**0**	**0**	**0**	
10/10/2007								
11/10/2007	0	0	0	0	0	0	0	
12/10/2007	2	0	0	0	0	0	0	corruption in water for all project, water pipes broken in Cardozo
13/10/2007	2	0	0	0	0	0	0	water company boss, water company supporting school students
14/10/2007	0	0	0	2	0	0	0	yellow fever, dengue
15/10/2007	0	1		0	0	0	0	public toilets
16/10/2007	0	0	0	0	0	0	0	
Week5	**4**	**1**	**0**	**2**	**0**	**0**	**0**	
17/10/2007	4	1	0	0	0	0	0	water company bills to be paid, well project, Odebrecht road, water and sanitation Nauta
18/10/2007	1	0	0	0	0	0	0	water company bills
19/10/2007	2	0	0	0	0	0	0	water company bills, pump project
20/10/2007	1	0	0	0	0	0	0	water company bills
21/10/2007	0	0	0	0	0	0	0	Census no papers
22/10/2007	3	1	0	0	0	0	0	water company
23/10/2007	3	0	0	0	0	0	0	water company bill, denunciation of water boss, well project
Week 6	**14**	**2**	**0**	**0**	**0**	**0**	**0**	
24/10/2007	0	0	0	0	0	0	0	
25/10/2007	0	2	0	0	0	0	0	sanitation and water in San Juan, sanitation
26/10/2007	1	0	0		0	1	0	bills, 2xwater pollution and oil companies
27/10/2007	1	0	0	0	0	2	0	water project, contamination
28/10/2007	1	0	0	0	0	0	0	drinking water company and pavements
29/10/2007	1	0	0	0	0	1	0	SODIS endorsement
30/10/2007	0	0	0	0	0	0	0	
Week 7	**4**	**2**	**0**	**0**	**0**	**4**	**0**	
31/10/2007	2	0	0	0	0	0	0	SODIS , SEDALoreto
01/11/2007	1	0	0	1	0	0	0	water network St Thomas, Dengue and Malaria
02/11/2007	3	0	0	0	0	0	0	lack of basic services for poor x2, SUNAS advert,
03/11/2007	0	0	0	0	0	0	0	
04/11/2007	0	0	0	1	0	0	0	yellow fever
05/11/2007	2	0	0	0	0	0	0	lack of water in Punchana, basic rights
06/11/2007	0	0	0	0	0	0	0	
Week 8	**8**	**0**	**0**	**2**	**0**	**0**	**0**	
07/11/2007	1	0	0	1	0	0	0	fumigation programme, reservoirs
08/11/2007	3	0	0	0	0	0	0	change in policy, article on this and denounce of odebtrect
09/11/2007	1	0	0	0	0	0	0	wells project Frequent
10/11/2007	2	0	0	0	0	0	0	water bills, increase in water prices
11/11/2007	1	0	0	0	0	0	0	denounce de Odebtrect
12/11/2007	2	0	0	1	0	0	0	Anniversary of SEDALoreto, works
13/11/2007	0	0	0	0	0	1	0	pollution of a river,
Week 9	**10**	**0**	**0**	**2**	**0**	**1**	**0**	
14/11/2007	2	0	0	0	0	0	0	basic services, polluted wells
15/11/2007	2	0	0	1	0	0	0	2 well projects, 1 dengue
16/11/2007	0	0	0	0	0	0	0	
17/11/2007	0	0	0	0	0	0	0	
18/11/2007	1	0	0	0	0	0	0	service interruptions SEDLoreto, odebretch
19/11/2007	1	0	0	0	0	0	0	odebrecht
20/11/2007	2	0	0	1	0	0	0	lack of water in Punchana, sedaloreto bills, malaria outbreak
Week 10	**8**	**0**	**0**	**2**	**0**	**0**	**0**	
21/11/2007	4	0	0	0	0	0	0	3 Sedaloreto, right to water
22/11/2007	3	0	0	0	0	0	0	2 Sedaloreto, 1SUNASS
23/11/2007	1	0	0	1	0	0	0	sedaloreto advert, yellow fever
24/11/2007	2	0	0	0		0	0	sedaloreto advert, broken pipes
25/11/2007	1	0	0	0	0	0	0	road improvements mean the water tanker can reach communities
26/11/2007	3	0	0	1	0	0	1	SED, problems with pipe laying, HR to water, fumigation, climate change and water
27/11/2007	1	0	0	0	0	0	0	problems with pipes
Week 11	**15**	**0**	**0**	**2**	**0**	**0**	**1**	

Appendix 2: Theme analysis from La República

Date	Drinking water	Water sanitation	Water hygiene	Water disease	Water conservation	Water contamination	Other	Information
12/09/2007	0	0	0	0	0	0	0	
13/09/2007	0	0	0	0	0	0	0	
14/09/2007	0	0	0	0	0	1	0	pollution of water by mining companies
15/09/2007	0	0	0	0	0	0	0	
16/09/2007	0	0	0	0	0	0	0	
17/09/2007	0	0	0	0	0	0	1	Problems caused in Iquitos due to new infrastructure
18/09/2007	1	0	0	0	0	0	0	Factory taking water from grid in Lima
Totals	**1**	**0**	**0**	**0**	**0**	**1**	**1**	
19/09/2007	0	0	0	0	0	0	0	No paper
20/09/2007	0	0	0	0	0	0	0	
21/09/2007	0	0	0	0	0	0	0	
22/09/2007	0	0	0	0	0	0	0	
23/09/2007	0	0	0	0	0	0	0	
24/09/2007	0	0	0	0	0	0	0	
25/09/2007	0	0	0	0	0	0	0	
Totals	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
26/09/2007	0	0	0	0	0	0	0	
27/09/2007	0	0	0	0	0	0	0	
28/09/2007	0	0	0	0	0	0	0	
29/09/2007	0	0	0	0	0	0	0	
30/09/2007	0	0	0	0	0	0	0	
01/10/2007	0	0	0	0	0	0	0	
02/10/2007	0	0	0	0	0	0	0	
Totals	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
03/10/2007	0	0	0	0	0	0	0	
04/10/2007	0	0	0	0	0	0	0	
05/10/2007	0	0	0	0	0	0	0	
06/10/2007	0	0	0	0	0	0	0	
07/10/2007	0	0	0	0	0	0	0	
08/10/2007	0	0	0	0	0	0	0	
09/10/2007								No paper
Totals	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
10/10/2007								
11/10/2007	0	0	0	0	0	0	0	
12/10/2007	0	0	0	0	0	0	1	record rain recorded in Loreto
13/10/2007	0	0	0	0	0	0	0	
14/10/2007	1	0	0	0	0	0	0	business investment in water industry Lima
15/10/2007	0	0	0	0	0	0	0	
16/10/2007	0	0	0	0	0	0	0	
Totals	**1**	**0**	**0**	**0**	**0**	**0**	**1**	
17/10/2007	0	0	0	0	0	0	0	
18/10/2007								No paper
19/10/2007								No paper
20/10/2007								No paper
21/10/2007	0	0	0	0	0	0	0	
22/10/2007	0	0	0	0	0	0	0	
23/10/2007	0	0	0	0	0	0	0	
Totals	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
24/10/2007	0	0	0	0	0	0	0	
25/10/2007	0	0	0	0	0	0	0	
26/10/2007	0	0	0	0	0	0	0	
27/10/2007	1	0	0	0	1	0	0	water conservation, water conflict
28/10/2007	0	0	0	0	0	0	0	
29/10/2007	0	0	0	0	0	1	0	oil companies pollution
30/10/2007	0	0	0	0	0	0	0	
Totals	**1**	**0**	**0**	**0**	**1**	**1**	**0**	
31/10/2007	0	0	0	0	0	0	0	
01/11/2007	1	0	0	1	0	0	0	malaria, water bills
02/11/2007	0	0	0	0	0	0	0	
03/11/2007	0	0	0	0	0	0	1	right to water book buy online
04/11/2007	0	0	0	1	0	0	0	dengue
05/11/2007	0	0	0	0	0	0	0	
06/11/2007	1	0	0	0	0	0	0	drinking water bills
Totals	**2**	**0**	**0**	**2**	**0**	**0**	**1**	
07/11/2007	1	0	0	0	0	0	0	increase in drinking water prices
08/11/2007	0	0	0	0	0	0	0	
09/11/2007	1	0	0	0	0	0	0	basic services
10/11/2007	0	1	0	0	0	0	0	sanitation in Iquitos
11/11/2007	2	0	0	0	0	0	0	drinking water bills, increase in water prices in Iquitos
12/11/2007	1	0	0	0	0	0	0	Odebtrect
13/11/2007	0	0	0	1	0	0	0	yellow fever vaccinations
Totals	**5**	**1**	**0**	**1**	**0**	**0**	**0**	
14/11/2007	1	0	0	0	0	0	0	sedapal interruption of services
15/11/2007	0	0	0	1	0	0	0	dengue epidemic
16/11/2007	0	0	0	0	0	0	0	
17/11/2007	0	0	0	0	0	1	0	lead pollution
18/11/2007	2	0	0	0	0	0	0	Odebtrect, interruption of service
19/11/2007	1	0	0	1	0	0	0	investment in infrastructure, dengue
20/11/2007								No paper
Totals	**4**	**0**	**0**	**2**	**0**	**1**	**0**	
21/11/2007	0	0	0	0	0	0	0	
22/11/2007	0	0	0	0	0	0	0	
23/11/2007	0	0	0	0	0	0	0	
24/11/2007	0	0	0	0	0	0	0	
25/11/2007	1	0	0	0	0	0	0	human right to drinking water
26/11/2007	0	0	0	0	0	0	1	MDG
27/11/2007	1	0	0	0	0	0	0	San Salvador
Totals	**2**	**0**	**0**	**0**	**0**	**0**	**1**	

Appendix 3: Types of information people received on drinking water 2006

		Theme assigned							
Respondent	Statement in Spanish	Illness & health	Water treatment	Water quality	Other	Lack of water	Looking after & conserving water	No theme given	General importance of water
P003E	Si por que esta en continua relacion con sus vecinos, la posta tambien les dan charlas sombre como cuidar el agua						1		
P006E	Con charlas para poder conservar su agua en un buein estado			1			1		
P007E	En centro labora (medicos) porque trabaja con medicos y biologos				1				
P009E	Como trator el agua en su casa, por que muhas veces, el agua puede estar sucia y tener muchas bacterias		1	1					
P010E	De la posta (como tratar el agua)		1						
P013A	Por que nos ayuda y nos ensena								1
P014A	Para informarnos mejor				1				
P015A	Para prevenir	1							
P016A	Para comunicar a los vacinos				1				
P017A	Para protegernos de la enfermedad	1							
P018A	Para prevenir las enfermedades	1							
P019A	Para orientar a la famitia?				1				
P022A	para evitar enfermedades	1							
P023A	Para que la poblacion auide su salud	1							
P024A	Para audar el agua, por que es importante						1		1
Q026E	cuando tiene curso de capacutacion sobre el agua			1					
Q028E	Sobre reclamos porque no tienen agua potable					1	1		
Q030E	propagandas, como conservar el agua, como envitar alugas enformedades	1					1		
Q035E	Cuando hacen reclamos sobre el agua porque mucho gento no dispone de esto					1	1		
Q038A	para envitar enfermedades	1							
Q040A	para pevenir las enfermedades	1							
Q041A	por que se necesita tener informacion				1				
Q042A	para preventir de enfermedades	1							
Q043A	por que velan par la salud	1							
Q045A	para tener conocimiento				1				
Q047A	para prevenir enfermedades	1							
Q049A	para prevenir enfermedades	1							
Q051A	por que es importante para la salud	1							
Q052A	por que necesitamos tratar el auga		1						
Q053A	para evitar enfermedades	1							
Q054A	para prevenir enfermedades	1							
Q055A	para prevenir enfermedades	1							
Q057A	por que es necesario saber								1
Q058A	para preventir las enfermedades	1							
Q059A	por que prevenir enfermedades	1							
Q061A	para cuidar la salud y audar las enfermedades	1							
Q062A	para prevenir enfermedades	1							
Q063A	para prevenir enfermedades	1							
Q065A	para prevenir enfermedades	1							
Q068A	no se (don't know)							1	
Q069A	por pue no hay agua					1			
Q070A	para prevenir enfermedades	1							
Q072A	por que no hay agua en la comunidad					1			
Q074A	did not write answer							1	
Q076A	para tener limpo el agua		1						
Q077A	para prevenir enfermedades	1							
Q078A	por que les interesa que se viva sano	1							
Q079A	por que es necesario								1
Q081A	Para prevenir las enfermedades	1							
Q082A	Para envitar enfermedades que se puede oasionas por beber agua potable cruda	1		1					
Q084A	Para no enfermarnos cuando tomamos el agua potable	1		1					
Q086A	Para envitar enfremedades	1							
Q087A	Por que no estan bien los tanques de agua			1					
Q088A	Por que nos informan la razon de que no hay agua					1			
Q089A	Para cuidar la salude	1							
Q090A	Por que no habia agua					1			
Q091A	Para prevenir las enfermedades	1							
Q105A	Para proteger de enfermedades	1							
Q109A	Por que es importante para la var los alimentos								1
Q110A	Para tener cuidado						1		
Q111A	Para preventenir de enfermedades	1							
Q116A	Por que el aqua potable no es limpia			1					
	Totals	33	4	7	6	6	7	2	5

Appendix 4: Types of information people received on drinking water 2007

		Themes asigned							
Respondent	**Statement in spanish**	**Illness & health**	**Water treatment**	**Water quality**	**Other**	**Lack of water**	**No theme given**	**General importance of water**	**Looking after & conserving water**
P002E	para prevenir de las enfermedades	1							0
P003E	Es importante para la salud	1							0
P005E	por que, debemos tener buena salud	1							0
P006E	por que debemos tener agua	0						1	0
P007E	ahora por que no hay agua	0				1			0
P008E	Por que no hay agua	0				1			0
P009E	Por que no hay agua	0				1			0
P016A	Para estar sanos	1							0
P020A	para prevenir la salude	1							0
P024A	para mantener el agua tratado	0	1						0
Q026E	por que falta agua	0				1			0
Q027E	No se	0					1		0
Q028E	por que hay aqua sucia y no hay agua	0		1		1			0
Q029E	para cuidar el agua	0		1					0
Q030E	Por que no hay agua	0				1			0
Q031E	por que hay enfermedades	1							0
Q032E	por que habra agua dentro de 2 anos	0				1			0
Q033E	por que habra agua	0				1			0
Q036E	por que falta agua	0				1			0
Q037A	por que hay enfermedades	1							0
Q040A	si por que esta contaminada el agua	0		1					0
Q042A	Por que no hay agua	0				1			0
Q043A	por que agua es vida	0						1	0
Q045A	por que la obra que hacen hara que el agua llegue a la comunidad	0				1			0
Q046A	por las enfermedades	1							0
Q047A	por que tiene que tratarse el agua	0	1						0
Q049A	por que es contaminado el agua	0		1					0
Q050A	Por que no hay agua	0				1			0
Q051A	por que no se tiene agua	0				1			0
Q053A	por que debemos tratar el agua	0	1						0
Q055A	por que nos hacen ver la situacion del agua	0				1			0
Q057A	por que es necesario mantenerlo	0				1		1	0
Q065A	para prevenir enfermedades	1							0
Q070A	por que contaminado por la busara	0		1					0
Q076A	por que el agua potable es buena	0		1					0
Q078A	por que es la forma de trabajo de las autoridades del pueblo	0							1
Q080A	por que no tenemos agua en casa y hay que conocer que agua tomar	0				1			0
Q085A	por que hay enfermedades como la malaria y colera	1							0
Q086A	por que necesario saber	0		1				1	0
Q092A	Por que no hay agua	0				1			0
Q105A	por que es necesario prevenir	1						1	0
	Totals	**11**	**3**	**7**	**0**	**17**	**1**	**5**	**1**

Appendix 5: Questionnaire 1

Please note: This document has been translated from the original document used which was written and developed in Spanish

Interview about drinking water

Questionnaire

For the interviewer to complete

Your name:………………………… Questionnaire Number:………………
Date of interview:…………… Time of interview:......................

Community: **Bellavista Nanay**
Name of interviewer:…...…….
House number and street:
....

Introduction

Hello, my name is………. ……………..... We are studying the water which you drink in your home. I would like to ask you questions about your drinking water practices. We will also question other families in the community and the results of this interview will be used in a project at Newcastle University in England.

The person reasonable for water (household water manager)

In this household who is the main reasonable for preparing water? **(Write their name)**

The person ....helped by................................

Do you have 20 minutes to answer some questions?

If this person is not present or does not have time:

When can we return? Where can we find this person?

If the person reasonable for water is present:

We are grateful for their participation. We want to stress that we will treat all of their answers in a confidential manner, which means that no person in this community will know what they say.

After the person has participated give them the small gift and thanks them for their participation.

1.0 General information

Observations

1.1 The walls are made of?

Brick/ cement 1.❑	Straw 2. ❑	Metal 3. ❑	Wood 4. ❑	Other................ 5. ❑

1.2 The roof is made of?

Tiles 1.❑	Straw 2. ❑	Metal 3. ❑	Leaves 4. ❑	Wood 5. ❑	Other………… 6. ❑

1.3 The floor is made of?

Cement 1.❑	Earth 2. ❑	Wood 3. ❑	Other .... 4. ❑

1.4 Do they have these things in their household?

Decorative ornaments 1.❑	Electricity 2. ❑	Telephone 3. ❑	TV 4. ❑	Radio 5. ❑

Question the interviewee

1.5 How many rooms are there in this household?

One 1.❑	Two 2. ❑	Three 3. ❑	Four 4. ❑	Five or more 5. ❑

1.6 Does your household own any animals?

❑ Yes ❑ No

1.6.1 If yes, how many animals do you have?

1. Cows :………………….	2. Donkeys:…………………..	3. Llamas :………………….
4. Horses :………………..	5. Goats:………………….	6. Sheep:………………….
7. Chickens :…………………	8. Dogs:………………………	8 Cats:……………………
9. Others:…………………………………………………………………………………		

1.7 Does your household own any vehicles?

❑ Yes ❑ No

1.7.1 If yes, how many vehicles do you own? ***(More than one answer may be given)***

1. Car …………	2. Motocylce/ Motocaro ……….	3. Bicycle/ Tricycle ………...	4. Canoe ………...	5. Boat …………	7.Other......... .... ………….

1.8 How many children 5 or under live in this household?
Number:………..

1.9 How many children from 6 to 15 live in this household?
Number:………..

1.10 How many people above the age of 16 live in this household?
Number:………..

1.11 What is the total number of people living in this household?
Number:………..

1.12 How long have you lived here?
- ❑ 1 = 5 years or less
- ❑ 2 = above 6 years

1.13 Do you own or rent this property

Own	Rent	Other......................... ....
1.❑	2. ❑	3. ❑

2.0 Media and communication

Question the interviewee

2.1 How do you obtain information? ***(More than one answer may be given.)***

1. ❑ Radio	2. ❑ Newspapers	3. ❑ Television
4. ❑ Magazines	5. ❑ Leaflet	6. ❑ Talking with important people
7. ❑ Chatting with people	8. ❑ Internet	9. ❑Other…………………………

2.2 How much trust do you have in the information from these sources?

	Trust a lot	Trust	Medium trust	Trust a little	Don't trust
1. Radio	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
2. Magazines	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
3. Television	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
4. Newspapers	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
5. Leaflets	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
6. Talking with important people	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
7. Chatting with people	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
8. Internet	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
9. Others…………………..	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑

2.3 Have you received any information on drinking water from these sources?
Yes ❑ No ❑

2.3.1 If yes what?
………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………

3.0 Water in your community

Question the interviewee

3.1 What type of water is available in your community, to wash clothes, drink, cook and clean? ***(More than one answer may be given.)***

Rain water	Spring water	River water/ stream lagoon/ lake water	Well water	Standpipe/ tap water	Water purchased in bottles and barrels	Tankered water	Other……. ……………. ……………. ……….
1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7.❑	8.❑

3.2 Where is drinking water treated? ***(More than one answer may be given.)***

Outsider your community	In the community	In the house	It is not treated
1.❑	2. ❑	3. ❑	4. ❑

3.3 What type of water treatment is available in your community?***More than one answer may be given.)***

Aeration	Sediment ation	Coagulation	SODIS	Chlorination /chemical treatment	Filtrat ion	Boiling	Other…… …………	Don't know
1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑	8. ❑	9. ❑

4.0 Your drinking water

Question the interviewee

4.1 What type of water do you normally use for drinking and cooking? ***(More than one answer may be given.)***

Rain water	Spring water	River water/ stream lagoon/ lake water	Well water	Standpipe/ tap water	Water purchased in bottles and barrels	Tankered water	Other……. ……………. ……………. ……….
1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7.❑	8.❑

4.2 What water source are you using now for drinking and cooking?

………………………………………………………………………………………

4.3 Do you collect your water for drinking and cooking from outside your house?

❑ Yes ❑ No

If yes ask the following questions
If proceed to Question 4.4

4.3.1 How far is your major drinking and water source
………………………………… meters

4.3.2 How long does it take you to collect your water for drinking and cook per day?

.... minutes

4.3.3 How many times per day do you collect your water for drinking and cooking?

Less than once	Once a day	Twice a day	Three times a day	More than three times a day
1.❑	2.❑	3. ❑	4. ❑	5. ❑

4.3.4 Do you collect your drinking and cooking water from the same source throughout the year?

❑ Yes ❑ No

If no, please explain

…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………

4.3.5 How secure is the area that you collect your drinking and cooking water from?

Very secure	Secure	A little secure	Not secure nor dangerous	A little dangerous	Dangerous	Very dangerous
7.❑	6. ❑	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑

4.3.6 How clean is the area that you collect your drinking and cooking water from?

Very dirty	Dirty	A little dirty	Not dirty nor clean	A little clean	Clean	Very clean
1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑

4.3.7 Are there animals close to the area that you collect your drinking and cooking water from?

No	Yes there are animals more than 10 m from the water source	Yes there are animals less than 10 meters from the water source
3.❑	2. ❑	3. ❑

4.3.8 Do you collect your water with other members of your family? ***(More than one answer may be given.)***

Yes ❑ No ❑

4.3.8.1 If yes, who?

Mother	Aunt	Cousin	Sister	Grown up children	Children	Other........ ....
1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑

4.4 Do you pay for your drinking water?

Yes ❑ No ❑

4.4.1 If yes how much does it cost ....per……….

4.5 Why do you use this drinking and cooking water source?
…………………………………………………………………………………………
…………………………………………………………………………………………

4.6 How do you store your drinking water in your household ***More than one answer may be given.)***

❑ 1. barrels	❑ 2. Underground tanks	❑ 3. Above ground tanks
❑ 4. sinks outside the house	❑ 5. buckets	❑ 6. bottles
❑ 7. cans	❑ 8. canteens	❑ 9. other :……………………

4.7 Do you treat your drinking water in your house?

Yes ❑ No ❑

If yes answer the below questions
If proceed to question 4.8

4.7.1 What method(s) do you use? ***(More than one answer may be given.)***

❑ 1. Don't know	❑ 2. Aeration	❑ 3. Sedimentation
❑ 4. Coagulation	❑ 5. SODIS	❑ 6. Chlorination/chemical treatment
❑ 7. Filtration	❑ 8. Boling	❑ 9. Other:……………………

4.7.2 How long does it take to treat your water every day?
.... minutes

4.7.3 Why do you use this method
....
....
....

4.8 How much water do you consume in your household every day?
.... litres

4.9 How important is it for you to obtain sufficient drinking water?

Very important	Important	Somewhat important	Not important not unimportant	Somewhat unimportant	Unimportant	Absolutely not important
7.❑	6. ❑	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑

4.10 Do you have access to a standpipe or tap?

Yes ❑ No ❑

If yes answer the below questions
If proceed to question 4.11

4.10.1 Who owns the drinking water company?

Government	Local company	International company	Other:………… …………………	Don't know
1.❑	2.❑	3.❑	4.❑	5.❑

4.10.2 Do you drink water from this company without treating it?
Yes ❑ No ❑

4.10.3 If no, why?
…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………

4.11 Do you purchase bottled water?
Yes ❑ No ❑

If yes answer the questions below
If no proceed to question 4.12

4.11.1 What is the name of the bottle water?
……………………………………………………………………

4.11.2 Who owns the bottled water company?

Government	Local company	International company	Other…………… …………………	Don't know
1.❑	2.❑	3.❑	4.❑	5.❑

5.0 Quality of your drinking water

Question the interviewee

5.1 How would you classify your drinking water?

Very good	Good	Somewhat good	Not good nor bad	Somewhat bad	Bad	Very bad
7.❑	6. ❑	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑

5.2 How important is drinking water quality?

Very unimportant	Unimportant	Somewhat unimportant	Not important nor unimportant	Somewhat important	Important	Very important
1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑

5.3 How would you classify the following characteristics of your drinking water?

	Very bad	Bad	Somewhat bad	Not good nor bad	Some what good	Good	Very good
Temperature	1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑
Colour	1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑
Turbidity	1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑
Odour	1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑
Taste	1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑

5.4 How important are the following characteristics of your drinking water?

	Very important	Important	Somewhat important	Not importa nt not unimpo rtant	Somewh at unimport ant	Unimport ant	Very unimportan t
Temperature	7.❑	6. ❑	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑

Colour	7.❑	6. ❑	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
Turbidity	7.❑	6. ❑	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
Odour	7.❑	6. ❑	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
Taste	7.❑	6. ❑	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑

5.5 What characteristics of water are most important to you? In a range of 1 to 5 *(1= most important, 5 = least important)*

Temperature	Colour	Turbidity	Odour	Taste
❑	❑	❑	❑	❑

6.0 Association between water and illness

<u>Question the interviewee</u>

6.1 Why does a person get diarrhoea?

4.❑	Understood the medical context
3.❑	Understood the importance of hygiene
2.❑	Understood the significance of treating water
1.❑	No relationship between diarrhoea and water or hygiene

6.2 How large is the risk of contracting diarrhoea from drinking raw water to you and your family?

Very important	Important	Somewhat important	Not important not unimportant	Somewhat unimportant	Unimportant	Very unimportant
7.❑	6. ❑	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑

6.3 When your or you family gets diarrhoea, how seriously does it affect on your or their health?

Very trivial	Trivial	Somewhat trivial	No serious nor trivial	Somewhat serious	Serious	Very serious
1. ❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7.❑

6.4 Have any members of your family been ill in the last seven days? Have they had a temperature, diarrhoea, stomach ache or vomited?

❑ Yes ❑ No

6.4.1 If yes, who?

Name	**Age**
1.	
2.	
3.	
4.	
5.	
6.	
7.	

7.0 Water and hygiene

Question the interviewee

7.1 How important is it that you obtain sufficient water for cleaning and good hygiene?

Very unimportant	Unimportant	Somewhat unimportant	Not important nor unimportant	Somewhat important	Important	Very important
1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑

7.2 Do you wash your hands after visiting the toilet and before eating and preparing food?

Never	Once in a while	Normally	Nearly always	Always
1.❑	2.❑	3.❑	4.❑	5.❑

7.3 Do you use soap?

Always	Nearly always	Normally	Once in a while	Never
5.❑	4. ❑	3. ❑	2. ❑	1. ❑

Interviewers observation

7.4 Observation of the hands

Very dirty	Dirty	Not dirty nor clean	Clean	Very clean
1. ❑	2. ❑	3. ❑	4. ❑	5. ❑

8.0 Sanitation

Question the interviewee

8. 1 Where is your toilet

Toilet inside house	Private latrine	Public latrine	Open air	Other..................... ....
5. ❑	4. ❑	3. ❑	2. ❑	1. ❑

8.2 How large is the risk that your excrement could contaminate a drinking water source?

Very large	Large	Somewhat large	Not large not small	Somewhat small	Small	Very small
1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑

9.0 Information Personal

Question the interviewee

9.1 How old are you?
……………………..years

9.2 What is your gender? ***(please mark)*** M/F

9.3 What level of education have you completed? ***(Mark the highest level of education)***

None	Primary school	Secondary school	Technical institute	University
1.❑	2. ❑	3. ❑	4. ❑	5. ❑

9.4 What is your occupation?

1. ❑ None	2. ❑Housewife	3. ❑ Farmer	4. ❑Informal work
5. ❑ Formal work	6. ❑Self employed	7. ❑ Student	8. ❑ Other…………

10.0 Drinking water samples

Question the interviewee

Thank them for their time, give them the card and pen from Newcastle University.

10.1 Is it possible to gain a sample of your drinking water (400ml) for analysis?

Yes ❑ No ❑
If no proceed to question 10.2

10.1.1 Sample number**………………………**

10.1.2 What is the source of this water?

Standpipe/ tap	Container with lid	Container without lid	Barrel/ Bottle closed	Barrel/ Bottle open	Other........	Don't know
1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑

10.2 I would like to take a photo of you in your house?
Yes ❑ No ❑

10.2.1 Photo number**………………………**

Appendix 6: Piloting notes

Changes to Questionnaire Draft 21/6/2006

Questionnaire draft was amended for grammatical and local vocabulary errors by my field assistant, in total the questionnaire consisted of 14 pages. When piloted it took approximately 40 minutes. The interviewees were noticeably restless when the questionnaire was piloted (15-21/6/2006 Questionnaires 1-25).

Several sections were moved to make the questionnaire flow more smoothly see the table below.

Draft	Questionnaire 1
1.0 General Information	1.0 General Information
2.0 Water in Your Community	2.0 Media and Communications
3.0 Your Drinking Water	3.0 Water in Your Community
4.0 Water Quality	4.0 Your Drinking Water
5.0 Association of Water and Illness	5.0 Water Quality
6.0 Water and Hygiene	6.0 Association of Water and Illness
7.0 Sanitation	7.0 Water and Hygiene
8.0 Media and Communications	8.0 Sanitation
9.0 Sample of Drinking Water	9.0 Personal Information
	10.0 Sample of Drinking Water

Questionnaire draft was piloted doubled sided, the Field Assistant found this awkward so Questionnaire 1 was printed single sided.

Additional response boxes were added to Questions 1.6 after piloting. This was due to the number of people having dogs to guard their property and cats as domestic pets.

An additional question was added to Questionnaire 11 which was how many people above 15 live in this household.

Question 1.10 was completely removed as I decided that the information from this question was superfluous and would not be required for the analysis.

All questions ascertaining to the personal details were moved to the end of the questionnaire as advised by Oppenheim.

Question 2.3 a don't know category was added, originally I wanted this question to give a forced choice answer but this need not seem possible.

Question 3.2.2 the units for the question were changed from hours to minutes due to the answers given in the pilot.

Question 3.2.3 an additional category of less than once as day was added. This was due to people using water delivered by tanker which generally came twice a week.

Question 3.2.7 the ordering of the boxes were changed from 1. No, 2. more than 10 meters from the source, 3. Yes, less than 10 metres from the source.

Question 3.7 proved very complicated and time consuming in the pilot, this was changed to: How much water does your household drink normally in a day?

Question 4.5 the concept of ranking the given water quality parameters proved incredibly hard for the field assistants and the respondents to understand during the piloting period. After an intensive meeting with the field assistants where I explained the question and type of answers which should be gained. The question was reworded.

In the piloting stage constant answers were given during for the section 6.0 Water and Hygiene (Agua y Higiene), due to these results questions 6.3 and 6.4 were deleted.

Question 7.2 was changed from an observation to a question. This was due to the field assistant asking the questions throughout the piloting stage, rather than making a judgement on observation.

The answer form in question 8.1 was changed from giving information on the frequency form e.g. daily, monthly, weekly to a check box yes/no answer form.

These changes reduced the questionnaire from 14 pages to 10 pages and the time taken from 40 minutes to 20 minutes.

Appendix 7: Questionnaire 2

Entrevista sobre del agua potable

Para ser completado por el entrevistador

Los detalles acerca del hogar

Su Nombre:………………………… Número del cuestionario:………………
Fecha del la entrevista:…………… Tiempo de la entrevista:.......................

Comunidad / barrio: **Bellavista Nanay**
Nombre del entrevistador:……...…….
Número de la vivienda / nombre de la calle:
....

Introducción

Saludo y presentación

Me llamo ……………..........Muchas gracias por su tiempo y ayuda el año pasado. Este año estamos haciendo un estudio sobre los cambios en sus hábitos de agua potable. Me gustaría hacer algunas preguntas sobre su consumo y sus hábitos de agua potable. Preguntamos también a otras familias en su comunidad y los resultados de esa entrevista serán utilizados para un proyecto en la Universidad de Newcastle en Inglaterra.

1.0 Información General

Observación del entrevistador

1.1 ¿Tipo de vivienda?

Ladrillo/ Cemento	Paja	Metal	Madera	Otro................
1.❑	2. ❑	3. ❑	4. ❑	5. ❑

1.2 ¿Materiales del techo?

Teja	Paja	Metal	Hojas	Madera	Otro…………
1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑

1.3 ¿Materiales del piso?

Cemento	Tierra	Madera	Otro ....
1.❑	2. ❑	3. ❑	4. ❑

1.4 ¿Tiene esta cosas su vivienda?***(Más de una respuesta puede ser dada)***

Decorativo de adorno	Electricidad	Teléfono	TV	Radio
1.❑	2. ❑	3. ❑	4. ❑	5. ❑

Pregunta del entrevistador

1.5 ¿ Cuántos cuartos tienen en la vivienda?

Un cuarto	Dos cuartos	Tres cuartos	Cuarto cuartos	Mas de cuarto cuartos

1.❑	2. ❑	3. ❑	4. ❑	5. ❑

1.6 ¿Posen animales en su familla casa?

❑ Sí ❑ No

1.6.1 En caso de que sí ¿cuántos animales tienen?

1. Vacas:………………….	2. Burros:…………………..	3. Llamas:………………….
4. Caballos:………………..	5. Cabras:………………….	6. Ovejas:………………….
7. Pollos:…………………	8. Perros:………………………	8. Gatos:……………………
9. Otro:……………………………………………………………………………………………...		

1.7 ¿Posen vehículos de transporte en su familla casa?

❑ Sí ❑ No

1.7.1 En caso de que sí ¿cuántos vehículos de transporte tienen? ***(Más de una respuesta puede ser dada.)***

1. Coche	2. Moto/ Motocarro	3. Bicicleta/ Triciclo	4. Canoa	5. Barco	7.Otro........... ....
………..	……….	………...	…………...	…………	………….

1.8 ¿Cuántos niños menores de 5 años viven en esta vivienda?
Número:………...

1.9 ¿Cuántos niños tienen 6 a 15 años viven en esta vivienda?
Número:………...

1.10 ¿Cuántos personas tienen mas de 15 años viven en esta vivienda?
Número:………...

1.11 ¿Número total de las personas que viven en la vivienda?
Número:………...

1.12 ¿Desde hace cuanto han vivido aquí?

❑ 1 = 5 años y menos de 5 años
❑ 2 = Más de 6 años

1.13 ¿Son propietarios, arrendatarios o inquilinos?

Propietarios	Inquilinos/Arrendatarios	Otros.............................. ....
1.❑	2. ❑	3. ❑

2.0 Medios de comunicación

Pregunta del entrevistador en esta sección

2.1 ¿Dónde obtiene la información? ***(Más de una respuesta puede ser dada.)***

1. ❑ La radio	2. ❑ Los periódicos	3. ❑ El TV
4. ❑ Las revistas	5. ❑ Los folletos	6. ❑ Habla con gente importante
7. ❑ Charla con gente	8. ❑ El Internet	9. ❑Otros…………………………

2.2 ¿Cuanto confían en la información de los orígenes siguientes?

	Mucha confianza	Confianza	Mediana confianza	Poca confianza	No confianza
1. La radio	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
2. Los periódicos	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
3. El TV	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
4. Las Revisitas	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
5. Los folletos	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
6. Habla con gente importante	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
7. Charla con gente	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
8. El Internet	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
9. Otros…………………..	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑

2.3 ¿Ha recibido siempre información sobre el agua potable de estos medios?

Sí ❑ No ❑

2.3.1 ¿Sí, porque?

……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………

3.0 Agua en su Comunidad

3.1 ¿Que tipo de aguas están disponible en su comunidad? Para lavar las ropas, tomar, cocinar, higiene. ***(Más de una respuesta puede ser dada.)***

Agua de lluvia	Agua de manantial	Agua de rió/ arroyo/ laguna/ largo	Agua de pozo	Agua de tubería/ grifo	Agua comprado en botellas de la tienda	Agua comprado en botellones sellando	Agua comprado en botellones sin sellando	Agua de cisterna	Otro...............................
1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑	8. ❑	9.❑	10.❑

3.2 ¿Donde esta el agua potable tratado? ***(Más de una respuesta puede ser dada.)***

Fuera de la comunidad	En la comunidad	En la vivienda	No se trata
1.❑	2. ❑	3. ❑	4. ❑

3.3 ¿Que tipo tratamientos para del aguas potables están disponible en su comunidad?***(Más de una respuesta puede ser dada.)***

Aireación	Sedimentación	Coagulación	SODIS	Cloro/trata química	Filtro	Hervida	Otro...................	No se
1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑	8. ❑	9. ❑

4.0 Su Agua Potable

4.1 ¿De dónde traen normalmente los aguas que usan para tomar y cocinar? ***(Más de una respuesta puede ser dada.)***

Agua de lluvia	Agua de manantial	Agua de rió/ arroyo/ laguna/ largo	Agua de pozo	Agua de tubería/ grifo	Agua comprado en botellas de la tienda	Agua comprado en botellones sellando	Agua comprado en botellones sin sellando	Agua de cisterna	Otro... ....
1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑	8. ❑	9.❑	10.❑

4.2 ¿Ahora qué es su mayor fuente del agua que usan para tomar y cocinar?
……………………………………………………………………………………

4.3 ¿Recoge su agua que usan para tomar y cocinar fuera de vivienda?
❑ Sí ❑ No

<u>En caso de que sí hacer las preguntas abajo</u>
<u>En caso de que no, ir a la pregunta 4.4</u>

4.3.1 ¿Hasta donde esta la mayor fuente del agua que usan para tomar y cocinar?
.... metros

4.3.2 ¿Cuánto tiempo toma para recoger el agua que usan para tomar y cocinar por un día?
.... minutos del día

4.3.3 ¿Cómo recoge a menudo el agua que usan para tomar y cocinar?

Menos una vez al día	Una vez al día	Dos veces al día	Tres veces al día	Mas de tres veces al día
1.❑	2.❑	3. ❑	4. ❑	5. ❑

4.3.4 ¿Recoge su agua que usan para tomar y cocinar de la misma fuente todas el año?
❑ Sí ❑ No

Si es no, explique por favor
……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………

4.3.5 ¿Qué seguridad tiene el área alrededor está del fuente de agua?

Muy seguridad	Seguridad	Algo seguridad	Medio/ No sé	Algo peligroso	Peligroso	Muy peligroso
7.❑	6. ❑	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑

4.3.6 ¿Cuán limpia está el área alrededor del fuente de agua?

Muy sucia	Sucia	Algo sucia	No limpia/No sucia	Algo limpia	Limpia	Muy limpia
1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑

4.3.7 ¿Tiene animales cerca del fuente de agua?

No	Si, hay animales mas de10 metros de la origen	Si, hay animales menos de 10 metros de la origen

4.3.8 ¿Otros miembros de su familia recogen el agua de esta fuente?
(Más de una respuesta puede ser dada.)

Sí ❑ No ❑

4.3.8.1 ¿Sí, quién?

Madre	Tía	Prima	Hermana	Hijas del adultos	Hijas	Otro......... ....
1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑

4.4 ¿Tiene que pagar esta agua potable?

Sí ❑ No ❑

4.4.1 En caso de que sí, ¿Cuantos cuesta? ....por……….

4.5 ¿Cuál es la razón principal fuente del agua que usan para tomar y cocinar?
……………………………………………………………………………………………
……………………………………………………………………………………………

4.6 ¿Cómo guarda el agua que toma en la vivienda? ***(Más de una respuesta puede ser dada.)***

❑ 1. barilles/turilles	❑ 2. tanques en la tierra	❑ 3. tanques elevados
❑ 4. piletas fuera de la vivienda	❑ 5. baldes/bidones	❑ 6. botellas
❑ 7. latas	❑ 8. cántaras	❑ 9. otros :……………………

4.6.1 Si, guarda el agua que toma en la vivienda, ¿para cuantos tiempos guarda?

.... horas/días

4.7 ¿Trata su agua potable en su vivienda?

Sí ❑ No ❑

En caso de que sí hacer las preguntas abajo
En caso de que no, ir a pregunta 4.8

4.7.1 ¿Si trata su agua, que método(s) usa? ***(Más de una respuesta puede ser dada.)***

❑ 1. No Se	❑ 2. Aireación	❑ 3. Sedimentación
❑ 4. Coagulación	❑ 5. SODIS	❑ 6. Cloro/trata química
❑ 7. Filtro	❑ 8. Hervida	❑ 9. Otros :……………………

4.7.2 En caso de que sí ¿Cuánto tiempo toma para trata su agua para un día?

.... minutos

4.7.3 ¿Por qué usted utiliza este método?
....
....
....

4.7.4 Si, usa cloro de la posta médica, cuando no hay cloro de la posta medica, ¿trata su agua potable? (Sí/ No) ¿Sí, como trata?
....
....
....

4.8 ¿Cuánta agua para tomar consume en su vivienda normalmente por día?
.... litros

4.9 ¿Qué tan importante es para usted obtener suficiente agua para tomar?

En absoluto no importante 1.❑	No importante 2. ❑	Poco importante 3. ❑	Regular (mediano) 4. ❑	Algo importante 5. ❑	Importante 6. ❑	Muy importante 7. ❑

4.10 ¿Tiene acceso de su agua de tubería y grifo?

Sí ❑ No ❑

<u>En caso de que sí hace el preguntas abajo</u>
<u>En caso de que no va a pregunta 4.11</u>

4.10.1 ¿Qué compañía abastece el agua en su área?

Gobierno 1.❑	Compañía local 2.❑	Compañía internacional 3.❑	Otro………….. ………………… 4.❑	No se 5.❑

4.10.2 ¿Bebe el agua de esta compañía sin tratamiento?
Sí ❑ No ❑

4.10.3 ¿Si no, porque?
………………………………………………………………………………….
………………………………………………………………………………….
………………………………………………………………………………….

4.11 ¿Compra el agua en botella de tiendas?

Sí ❑ No ❑

<u>En caso de que sí hacer las preguntas abajo</u>
<u>En caso de que no, ir a pregunta 4.1</u>

4.11.1 ¿Como se llama el agua que toma?
……………………………………………………………….

4.11.2 ¿Quién posee la compañía en botella del agua?

Gobierno 1.❑	Compañía local 2.❑	Compañía internacional 3.❑	Otro………….. ………………… 4.❑	No se 5.❑

5.0 Calidad de Agua Potable

5.1 ¿Cómo clasifica la calidad de su agua potable?

Muy buena 7.❑	Buena 6. ❑	Poca buena 5. ❑	Regular 4. ❑	Poco mal 3. ❑	Mal 2. ❑	Muy mal 1. ❑

5.2 ¿Qué tan importante es la calidad de agua potable?

Muy importante	Importante	Algo importante	Regular	Poco importante	No importante	En absoluto no importante
7.❑	6. ❑	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑

5.3 ¿Cómo clasifica las siguientes características de su agua potable?

	Muy mal	Buena Mal	Poco mal	Regular	Poca buena	Buena	Muy buena
Temperatura	1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑
Color	1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑
Turbiedad	1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑
Olor	1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑
Gusto	1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑

5.4 ¿Qué tan importante son las siguientes características del agua de su agua potable?

	Muy importante	Importante	Algo importante	Regular	Poco importante	No importante	En absoluto no importante
Temperatura	7.❑	6. ❑	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
Color	7.❑	6. ❑	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
Turbiedad	7.❑	6. ❑	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
Olor	7.❑	6. ❑	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑
Gusto	7.❑	6. ❑	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑

5.5 Cual de las siguientes características del agua es mas importante para usted. En un rango del 1 al 5. *(1= mas importante, 5 = menos importante*)

Temperatura	Color	Turbiedad	Olor	Gusto
❑	❑	❑	❑	❑

6.0 Asociación del agua con alguna posible enfermedad

6.1 ¿Por qué le pueden dar diarrea?

4.❑	Entendió contexto médico (ciertas bacterias transmiten diarrea...)
3.❑	Entendió importancia de la higiene (diarrea es causada cuando algo sucio llega al cuerpo, como manos sucias, agua sucia o comida sucia)
2.❑	Entendió el significado del tratamiento del agua (agua sucia da diarrea')
1.❑	No hacen relación / conexión entre diarrea y agua o higiene

6.2 ¿Que grande parece para usted y su familia el riesgo si consume agua cruda le da diarrea?

Muy importante	Importante	Algo importante	Regular (mediano)	Poco importante	No importante	En absoluto no importante
7.❑	6. ❑	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑

6.3 ¿Si tienen diarrea, la diarrea afecta la salud de su familia de una manera grave?

En absoluto no grave	No grave	Poco grave	Regular (mediano)	Algo grave	Grave	Muy grave

1. ❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7.❑

6.4 ¿Algún miembro de su familia ha estado enfermo en los últimos siete días? ¿Hubo alguien resfriado, diarrea, dolores de barriga o hubo vomito?

❑ Sí ❑ No

6.4.1 En caso de sí ¿quién?

Nombre	**Edad**
1.	
2.	
3.	
4.	
5.	
6.	
7.	

7.0 Agua y higiene

7.1 ¿Qué tan importante es para usted de obtener suficiente agua para limpiar y una buena higiene?

En absoluto no importante	No importante	Poco importante	Regular (mediano)	Algo importante	Importante	Muy importante
1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑

5.2 ¿Se lavan las manos después de ir al baño y antes de comer o de preparar la comida?

Nunca nos lavamos las manos	Nos lavamos las manos de vez en cuando	Nos lavamos los manos normalmente	Nos lavamos las manos casi siempre	Nos lavamos las manos siempre
1.❑	2.❑	3.❑	4.❑	5.❑

5.3 ¿Usan jabón?

Siempre usamos jabón	Casi siempre usamos jabón	Normalmente usamos jabón	De vez cuando usamos jabón	Nuca usamos jabón
5.❑	4. ❑	3. ❑	2. ❑	1. ❑

6.0 Higiénicos

6. 1 ¿Dónde está su baño?

Baño que está alcantarillado	Letrina privada (pozo ciego)	Letrina pública	Al aire libre	Otro...................... ....
5. ❑	4. ❑	3. ❑	2. ❑	1. ❑

6.2 ¿Qué tan importante es para usted de tener servicios higiénicos buenos?

Muy importante	Importante	Algo importante	Regular	Poco importante	No importante	En absoluto no importante
7.❑	6. ❑	5. ❑	4. ❑	3. ❑	2. ❑	1. ❑

6.3 ¿Que grande es el riesgo de los heces / excrementos cuando contaminan el fuente del agua potable? El riesgo que los excrementos contaminen del fuente del agua potable es:

Muy grande	Grande	Algo grande	Medio/ No sé	Algo pequeño	Pequeño	Muy pequeño
1.❑	2. ❑	3. ❑	4. ❑	5. ❑	6. ❑	7. ❑

6.4 Cual es más importante para usted. En un rango del 1 al 4. *(1= mas importante, 4 = menos importante*)

bueno calidad del agua potable	suficiente agua para tomar	suficiente agua para limpia y una buena higiene	bueno servicios higiénicos
❑	❑	❑	❑

7.0 Muestra del agua potable

Muchas gracias por su tiempo, darle una tarjeta y biografía de la Universidad de Newcastle.

7.1 Me gustaría tomar una muestra de su agua potable (400 ml) para análisis. ¿Es posible?

Sí ❑ No ❑

<u>En caso de que no, ir a la pregunta 7.2</u>

7.1.1 El número de muestra es:**……………………….**

7.2 Me gustaría tomar una foto de su vivienda. ¿Es posible? Se lo Mandaré, cuando regrese a Inglaterra.

Sí ❑ No ❑

7.2.1 El número de foto es:**……………………….**

Appendix 8: Training notes translated into English

Please note: This document has been translated from the original document used which was written and developed in Spanish

Information for the interviewer

- This interview has questions and observations
- Please mark the appropriate box
- When it is written "*more than one answer may be given*" you can mark more than one box
- When it is written "Other" please write the information supplied in the space below
- If an open question is used write the answer word for word
- Below are some definitions to help you with the interview:
    - Water treatment a process which makes water clean and safe to drink.
    - Aeration a process which adds air to water e.g. shaking water in a bottle.
    - Sedimentation a process where the particulates settle out e.g. when water is left over night.
    - Coagulation a rapid process of sedimentation caused by adding a substance to water.
    - SODIS (solar disinfection) a process using the radiation and heat from the sun to treat water e.g. leaving plastic bottles of water in the.
    - Chlorine and chemical treatment a process where a disinfectant is added to the water.
    - Filtration a process where the particles are separated from the water using a filter. The filter can be made from cloth, ceramic or other materials.
    - Boiling a process where water is heated to boiling and boiled for one minute.
    - Diarrhoea is defined as three or more bowel liquid bowel movements.

Appendix 9: Raw data from the questionnaires administered in 2006

1.0 General information

1.1 The walls are made of?

Brick/ cement	Straw	Metal	Wood	Other
32	**0**	**1**	**63**	**0**

1.2 The roof is made of?

Tiles	Straw	Metal	Leaves	Wood	Other
1	**2**	**77**	**16**	**0**	**0**

1.3 The floor is made of?

Cement	Earth	Wood	Other
27	**14**	**55**	**0**

1.4 Do they have these things in their household?

Decorative ornaments	Electricity	Telephone	TV	Radio
15	**85**	**23**	**75**	**71**

1.5 How many rooms are there in this household?

One	Two	Three	Four	Five or more
21	**30**	**18**	**21**	**6**

1.6 Does your household own any animals?

Yes **59** No **37**

1.6.1 If yes, how many animals do you have?

Cows : **0**	Donkeys: **0**	Llamas : **0**
Horses: **0**	Goats: **0**	Sheep: **0**
Chickens :**12** households have between 1 and 22 chickens	Dogs: **34** households have between 1 and 5 dogs	Cats: **20** households have between 1 and 3 cats
Others: **4** housholds owned other animals, 2 pigs, , 1 monkey. 1 achuni (a wild rainforest animal), 1 duck.		

1.7 Does your household own any vehicles?

Yes **43** No **53**

1.7.1 If yes, how many vehicles do you own?

Car	Motorcycle/ Motocaro	Bicycle/ Tricycle	Canoe	Boat	Other
0	**19** households owned between 1 and 3	**7** households owned between 1 and 2	**16** households owned 1	**3** households owned 1	0

1.8 How many infants 5 or under live in this household? **60** households had between 1 and 5 infants

1.9 How many children from 6 to 15 live in this household? **64** households had between 1 and 7 children

1.10 How many adults above the age of 16 live in this household? **96** households had between 1 and 11 children

1.11 What is the total number of people living in this household? **96** households had between 2 and 15 people

1.12 How long have you lived here?

18 = 5 years or less
78 = above 6 years

1.13 Do you own or rent this property

Own	Rent	Other
95	**0**	**1**

2.0 Media and communication

2.1 How do you obtain information?

60 Radio	**42** Newspapers	**65** Television
2 Magazines	**3** Leaflet	**2** Talking with important people
15 Chatting with people	**3** Internet	**0** Other

2.2 How much trust do you have in the information from these sources?

	Trust a lot	Trust	Medium trust	Trust a little	Don't trust
1. Radio	**18**	**18**	**15**	**8**	**2**
2. Magazines	**0**	**0**	**0**	**1**	**0**
3. Television	**28**	**23**	**5**	**5**	**1**
4. Newspapers	**5**	**14**	**14**	**9**	**1**
5. Leaflets	**0**	**0**	**0**	**1**	**0**
6. Talking with important people	**0**	**1**	**1**	**0**	**0**
7. Chatting with people	**5**	**4**	**1**	**2**	**2**
8. Internet	**0**	**1**	**2**	**0**	**0**

2.3 Have you received any information on drinking water from these sources?

Yes **62** No **34**

2.3.1 If yes what? **Information can be found in Appendix 3**

3.0 Water in your community

3.1 What type of water is available in your community, to wash clothes, drink, cook and clean?

Rain water	Spring	River	Well water	Standpipe/	Water	Tankered	Other........

	water	water/ stream lagoon/ lake water		tap water	purchased in bottles and barrels	water	
59	**1**	**41**	**9**	**43**	**34**	**54**	**0**

3.2 Where is drinking water treated?

Outsider your community	In the community	In the house	Is treated but don't know where
75	**13**	**3**	**1**

3.3 What type of water treatment is available in your community?

Aeration	Sediment ation	Coagulation	SODIS	Chlorination /chemical treatment	Filtrat ion	Boiling	Other	Don't know
0	**0**	**0**	**0**	**76**	**1**	**4**	**1** household bleach	**14**

4.0 Your drinking water

4.1 What type of water do you normally use for drinking and cooking? (

Rain water	Spring water	River water/ stream lagoon/ lake water	Well water	Standpipe/ tap water	Water purchased in bottles and barrels	Tankered water	Other
2	**0**	**5**	**3**	**40**	**32**	**47**	**0**

4.2 What water source are you using now for drinking and cooking?

Rain water	Spring water	River water/ stream lagoon/ lake water	Well water	Standpipe/ tap water	Water purchased in bottles and barrels	Tankered water	Other
0	**0**	**4**	**0**	**33**	**25**	**34**	**0**

4.3 Do you collect your water for drinking and cooking from outside your house?

Yes **66** No **30**

4.3.1 How far is your major drinking and water source

0 to 7,000 meters

4.3.2 How long does it take you to collect your water for drinking and cook per day?

1 to 180 minutes

4.3.3 How many times per day do you collect your water for drinking and cooking?

Less than once	Once a day	Twice a day	Three times a day	More than three times a day
33	**27**	**5**	**1**	**0**

4.3.4 Do you collect your drinking and cooking water from the same source throughout the year?

Yes **48** No **18**

If no, please explain

Explanations given:
because the water tanker do not arrive and we buy water in large bottles
we buy or collect water from the river
when the tanker does not arrive we buy water in large bottles
when the tanker does not arrive we buy water
when the tanker does not arrive we buy water
because the tanker does not always arrive
because the tanker does not always arrive
because we do not have tap water
because we do not have water
because we do not have tap water
in summer we don't have water
because sometimes we do not have tap water
because the tanker does not always arrive
because we do not have tap water
because we do not have tap water
because we do not have tap water
no explanation given
no explanation given

4.3.5 How secure is the area that you collect your drinking and cooking water from?

Very secure	Secure	A little secure	Not secure nor dangerous	A little dangerous	Dangerous	Very dangerous
0	**16**	**2**	**6**	**4**	**36**	**1**

4.3.6 How clean is the area that you collect your drinking and cooking water from?

Very dirty	Dirty	A little dirty	Not dirty nor clean	A little clean	Clean	Very clean
0	**10**	**11**	**6**	**11**	**27**	**0**

4.3.7 Are there animals close to the area that you collect your drinking and cooking water from?

No	Yes there are animals more than 10 m from the water source	Yes there are animals less than 10 meters from the water source
34	**25**	**6**

4.3.8 Do you collect your water with other members of your family?

Yes **46** No **19**

4.3.8.1 If yes, who?

Mother	Aunt	Cousin	Sister	Grown up children	Children	Other.
8	**5**	**3**	**7**	**10**	**4**	**19**

Others: Whole family 12, Grandmother 1, Sister in law 1, niece 1, husband 1, wife 1, neighbours 1, friends 1.

4.4 Do you pay for your drinking water?

Yes **49** No **47**

4.4.1 If yes how much does it cost? Between 10 and 33 soles (dependent on source)

4.5 Why do you use this drinking and cooking water source?

No answer given **4**
Question misinterpreted **75**

Statements
because it is clean
because it is better and clean
because it is clean and a better source
because we do not have drinking water in the house (tap water) therefore we have to buy water in bottles
it is our only option as we do not have drinking water (tap water)
because it is clean
because we do not have drinking water (tap)
because we do not have drinking water (tap)
because it is the only method of obtaining clean water
because it is the only supply
because we do not have drinking water (tap) in the house
because we need water and we do not have access to other supplies
because we do not have a water service (tap)
because we do not have drinking water (tap) in our house
because we do not have drinking water (tap)
because we do not have any other method
because we do not have a drinking water service (tap)

() = term is inferred rather than stated

4.6 How do you store your drinking water in your household

2 barrels	**1** underground tanks	**1** above ground tanks
0 sinks outside the house	**92** buckets	**1** bottles
0 cans	**2** canteens	**0** other

4.7 Do you treat your drinking water in your house?

Yes **50** No **46**

4.7.1 What method(s) do you use?

0 Don't know	**0** Aeration	**0** Sedimentation
0 Coagulation	**0** SODIS	**36** Chlorination/chemical treatment
1 Filtration	**16** Boling	**3** Other:1 dengue treatment, 2 household bleach

4.7.2 How long does it take to treat your water every day?

Between 1 and 300 minutes

4.7.3 Why do you use this method?

Statement
because it is recommended
to disinfect and remove disease
not treated
to kill microorganisms , because sometimes this water contains mosquitoes and some small insects
to disinfect the water
so we do not get ill in our house
to protect us from disease
so we can drink and not get ill
to drink
so that we do not get ill
because the water is not clean
to kill the bacteria
to prevent illness
to kill the bacteria
to kill the bacteria in the water
to kill the bacteria in the water
because it is economic and rapid
to protect against disease
to protect health
to prevent illness
to protect against disease
for our health
because it is necessary for protection and health
because we were instructed by the health visitors to do this
because it is necessary to treat the water
so we can drink it without problems
because I don’t drink crude water
to prevent water related diseases
for hygiene
because it is important and safe
to prevent diseases
to prevent diseases
because it is necessary to prevent disease
because it is not treated well
to eliminate the bacteria
so we do not get ill
so we don’t get ill
to protect us from bacteria
to eliminate bacteria
because you have to treat water before you consume it
because I do not trust the treatment of water
to eliminate microbes and bacteria
so we do not get ill
to eliminate microbes
to eliminate microbes
to make sure the water is treated
to eliminate microbes

to eliminate bacteria
to prevent illness
to clean the water

4.8 How much water do you consume in your household every day?

Between 0 and 60 litres per day

4.9 How important is it for you to obtain sufficient drinking water?

Very important	Important	Somewhat important	Not important not unimportant	Somewhat unimportant	Unimportant	Absolutely not important
13	**39**	**5**	**8**	**6**	**10**	**2**

4.10 Do you have access to a standpipe or tap?

Yes **17** No **79**

4.10.1 Who owns the drinking water company?

Government	Local company	International company	Other	Don't know
7	**4**	**6**	**0**	**0**

4.10.2 Do you drink water from this company without treating it?

Yes **8** No **9**

4.10.3 If no, why?

Statement
no answer given
because I treat it in my house
no answer given
because it is necessary to prevent disease
because we have to boil our water
because we buy treated water
because we have to boil our water
no answer given
because it is better to treat drinking water

4.11 Do you purchase bottled water?

Yes **38** No **58**

4.11.1 What is the name of the bottle water?

Brand	**Number of response**
San Luis	2
Ceilo	0
San Antionio	0
Agua Selva	4
Agua Vida	0
San Jose	1

Vertiente	8
Tropical	1
Agua Distilada	1
Loreto	1
Pura Selva	2
Agua Oriental	2
Delficoral	1
Don't remember	15

4.11.2 Who owns the bottled water company?

Government	Local company	International company	Other	Don't know
0	**27**	**0**	**0**	**10**

5.0 Quality of your drinking water

5.1 How would you classify your drinking water?

Very good	Good	Somewhat good	Not good nor bad	Somewhat bad	Bad	Very bad
1	**53**	**4**	**32**	**1**	**4**	**1**

5.2 How important is drinking water quality?

Very unimportant	Unimportant	Somewhat unimportant	Not important nor unimportant	Somewhat important	Important	Very important
0	**0**	**0**	**11**	**2**	**74**	**9**

5.3 How would you classify the following characteristics of your drinking water?

	Very bad	Bad	Somewhat bad	Not good nor bad	Some what good	Good	Very good
Temperature *(n=92)*	**1**	**2**	**2**	**40**	**5**	**40**	**2**
Colour *(n=96)*	**1**	**2**	**1**	**27**	**2**	**59**	**4**
Turbidity *(n=94)*	**0**	**15**	**3**	**36**	**6**	**33**	**1**
Odour *(n=95)*	**0**	**4**	**2**	**17**	**4**	**61**	**7**
Taste *(n=95)*	**1**	**3**	**1**	**19**	**5**	**58**	**8**

5.4 How important are the following characteristics of your drinking water?

	Very important	Important	Somewhat important	Not importa nt not unimpo rtant	Somewh at unimport ant	Unimport ant	Very unimportan t
Temperature *(n=94)*	**2**	**66**	**3**	**11**	**3**	**9**	**0**
Colour *(n=95)*	**7**	**74**	**5**	**5**	**1**	**3**	**0**
Turbidity *(n=94)*	**4**	**33**	**2**	**12**	**4**	**39**	**0**
Odour	**8**	**63**	**1**	**9**	**2**	**11**	**0**

(n=94)							
Taste *(n=95)*	**11**	**72**	**3**	**7**	**0**	**2**	**0**

5.5 What characteristics of water are most important to you? In a range of 1 to 5 *(1= most important, 5 = least important*)

	1st	2nd	3rd	4th	5th
Temperature	**6**	**4**	**18**	**33**	**31**
Colour	**10**	**38**	**19**	**16**	**7**
Turbidity	**3**	**6**	**14**	**14**	**51**
Odour	**3**	**25**	**32**	**21**	**4**
Taste	**71**	**14**	**4**	**3**	**0**
n=	**93**	**87**	**87**	**87**	**93**

6.0 Association between water and illness

6.1 Why does a person get diarrhoea?

18	Understood the medical context (mentioned bacteria)
23	Dirty water and poor hygiene
20	Dirty water gives you diarrhoea
35	No relationship between diarrhoea, water or hygiene

6.2 How large is the risk of contracting diarrhoea from drinking raw water to you and your family?

Very important	Important	Somewhat important	Not important not unimportant	Somewhat unimportant	Unimportant	Very unimportant
17	**71**	**3**	**1**	**2**	**2**	**0**

6.3 When your or you family gets diarrhoea, how seriously does it affect on your or their health?

Very trivial	Trivial	Somewhat trivial	No serious nor trivial	Somewhat serious	Serious	Very serious
0	**6**	**8**	**4**	**8**	**49**	**21**

6.4 Have any members of your family been ill in the last seven days? Have they had a temperature, diarrhoea, stomach ache or vomited?

Yes **38** No **58**

6.4.1 If yes, who? Ranging from 6 months to 87 years

7.0 Water and hygiene

7.1 How important is it that you obtain sufficient water for cleaning and good hygiene?

Very unimportant	Unimportant	Somewhat unimportant	Not important nor unimportant	Somewhat important	Important	Very important
0	**0**	**0**	**1**	**0**	**70**	**25**

7.2 Do you wash your hands after visiting the toilet and before eating and preparing food?

Never	Once in a while	Normally	Nearly always	Always
0	**0**	**0**	**7**	**89**

7.3 Do you use soap?

Always	Nearly always	Normally	Once in a while	Never
95	**0**	**1**	**0**	**0**

7.4 Observation of the hands

Very dirty	Dirty	Not dirty nor clean	Clean	Very clean
0	**14**	**54**	**27**	**1**

8.0 Sanitation

8. 1 Where is your toilet?

Toilet inside house	Private latrine	Public latrine	Open air	Other
51	**20**	**10**	**15**	**0**

8.2 How large is the risk that your excrement could contaminate a drinking water source?

Very large	Large	Somewhat large	Not large not small	Somewhat small	Small	Very small
26	**64**	**4**	**1**	**0**	**1**	**0**

9.0 Information Personal

9.1 How old are you? Ages ranged from 17 to 79

9.2 What is your gender? Male **16** Female **80**

9.3 What level of education have you completed?

None	Primary school	Secondary school	Technical institute	University
3	**59**	**21**	**11**	**2**

9.4 What is your occupation?

3 None	**63** Housewife	**0** Farmer	**2** Informal work
10 Formal work	**12** Self employed	**5** Student	**1** Other

10.0 Drinking water samples

10.1 Is it possible to gain a sample of your drinking water (400ml) for analysis?
Yes **52** No **44**

10.2 Can I take a photo of you in your house?
Yes **81** No **15**

Appendix 10: Raw data from questionnaires administered in 2007

1.0 General information

1.1 The walls are made of?

Brick/ cement	Straw	Metal	Wood	Other
23	**0**	**1**	**72**	**0**

1.2 The roof is made of?

Tiles	Straw	Metal	Leaves	Wood	Other
0	**0**	**81**	**15**	**0**	**0**

1.3 The floor is made of?

Cement	Earth	Wood	Other
24	**11**	**60**	**1**

1.4 Do they have these things in their household?

Decorative ornaments	Electricity	Telephone	TV	Radio
39	**92**	**48**	**79**	**77**

1.5 How many rooms are there in this household?

One	Two	Three	Four	Five or more
20	**31**	**23**	**17**	**5**

1.6 Does your household own any animals?

Yes **63** No **33**

1.6.1 If yes, how many animals do you have?

Data not analysed

1.7 Does your household own any vehicles?

Yes **44** No **52**

1.7.1 If yes, how many vehicles do you own?

Car	Motocylce/ Motocaro	Bicycle/ Tricycle	Canoe	Boat	Other
0	**28** households owned between 1 and 3	**10** households owned 1	**20** households owned between 1 and 2	**0**	**0**

1.8 How many infants 5 or under live in this household? **62** households had between 1 and 6 infants

1.9 How many children from 6 to 15 live in this household? **69** households had between 1 and 5 children

1.10 How many adults above the age of 16 live in this household? **96** households had between 1 and 10 children

1.11 What is the total number of people living in this household? **96** households had between 2 and 14 people

1.12 How long have you lived here?

19 = 5 years or less
77 = above 6 years

1.13 Do you own or rent this property

Own	Rent	Other
96	**0**	**0**

2.0 Media and communication

2.1 How do you obtain information?

58 Radio	**40** Newspapers	**70** Television
4 Magazines	**0** Leaflet	**0** Talking with important people
1 Chatting with people	**2** Internet	**1** Other: Books

2.2 How much trust do you have in the information from these sources?

	Trust a lot	Trust	Medium trust	Trust a little	Don't trust
1. Radio	**2**	**30**	**13**	**13**	**1**
2. Magazines	**1**	**1**	**0**	**0**	**0**
3. Television	**1**	**46**	**10**	**13**	**0**
4. Newspapers	**0**	**17**	**9**	**13**	**0**
5. Leaflets	**0**	**0**	**0**	**0**	**0**
6. Talking with important people	**0**	**0**	**0**	**0**	**0**
7. Chatting with people	**0**	**1**	**0**	**0**	**0**
8. Internet	**1**	**1**	**0**	**0**	**0**

2.3 Have you received any information on drinking water from these sources?

Yes **41** No **55**

2.3.1 If yes what? **Information can be found in Appendix 4**

3.0 Water in your community

3.1 What type of water is available in your community, to wash clothes, drink, cook and clean?

Water source	Number of respondents

Rain water	**91**
Spring water	**1**
River water/ stream lagoon/ lake water	**35**
Well water	**18**
Standpipe/tap water	**3**
Purchased shop water	**20**
Purchased sealed water	**30**
Purchased unsealed water	**45**
Tankered	**93**
Other	**0**

3.2 Where is drinking water treated?

Outsider your community	In the community	In the house	Is treated but don't know where
75	**19**	**2**	**0**

3.3 What type of water treatment is available in your community?

Aeration	Sediment ation	Coagulation	SODIS	Chlorination /chemical treatment	Filtrat ion	Boiling	Other	Don't know
0	**0**	**0**	**0**	**80**	**0**	**30**	**4** househ old bleach	**9**

4.0 Your drinking water

4.1 What type of water do you normally use for drinking and cooking?

Water source	**Number of respondents**
Rain water	**1**
Spring water	**0**
River water/ stream lagoon/ lake water	**3**
Well water	**1**
Standpipe/tap water	**3**
Purchased shop water	**0**
Purchased sealed water	**10**
Purchased unsealed water	**12**
Tankered	**81**
Other	**0**

4.2 What water source are you using now for drinking and cooking?

Water source	**Number of respondents**
Rain water	**0**
Spring water	**0**
River water/ stream lagoon/ lake water	**2**
Well water	**1**
Standpipe/tap water	**2**
Purchased shop water	**0**
Purchased sealed water	**7**
Purchased unsealed water	**10**
Tankered	**74**
Other	**0**

4.3 Do you collect your water for drinking and cooking from outside your house?

Yes **78** No**18**

4.3.1 How far is your major drinking and water source

2 to 10,000 meters

4.3.2 How long does it take you to collect your water for drinking and cook per day?

1 to 60 minutes

4.3.3 How many times per day do you collect your water for drinking and cooking?

Less than once	Once a day	Twice a day	Three times a day	More than three times a day
52	**22**	**3**	**2**	**0**

4.3.4 Do you collect your drinking and cooking water from the same source throughout the year?

Yes **78** No **1**

If no, please explain

Explanations given:
Because we had tap water

4.3.5 How secure is the area that you collect your drinking and cooking water from?

Very secure	Secure	A little secure	Not secure nor dangerous	A little dangerous	Dangerous	Very dangerous
0	**11**	**0**	**7**	**4**	**54**	**3**

4.3.6 How clean is the area that you collect your drinking and cooking water from?

Very dirty	Dirty	A little dirty	Not dirty nor clean	A little clean	Clean	Very clean
0	**4**	**3**	**22**	**5**	**45**	**0**

4.3.7 Are there animals close to the area that you collect your drinking and cooking water from?

No	Yes there are animals more than 10 m from the water source	Yes there are animals less than 10 meters from the water source
57	**3**	**19**

4.3.8 Do you collect your water with other members of your family?

Yes **71** No **8**

4.3.8.1 If yes, who?

Mother	Aunt	Cousin	Sister	Grown up children	Children	Other.
9	**4**	**3**	**21**	**30**	**3**	**15**

Others: whole family 12, grandmother 1, husband 10 wife 3, brother 3, neighbour 1, niece 4, father 2

4.4 Do you pay for your drinking water?

Yes **17** No **79**

4.4.1 If yes how much does it cost?

Between 0.10 and 2 soles (dependent on source)

4.5 Why do you use this drinking and cooking water source?

No answer given	**0**
Question misinterpreted	**3**

Statements
because we do not have (tap) water in our community
because tankered water is better
because we do not have water
because we do not have (water) and we use water every day
because it is necessary
because we do not have tap water
because it is treated
because it is necessary to have water
because it is clean
because we do not have water in the community
because we do not have water (tap)
because we do not have water (tap)
because we do not have tap water
because we do not have water (tap) and it is necessary
we don’t have water (tap)
because we do not have water (tap)
because we do not drink river water
because we do not have water (tap)
we don’t have water (tap)
because of the incapacity of the authorities
because we do not have tap water
because tankered water is the only source
because we do not have water (tap)
because it is necessary
because we do not have water in our house
because it is necessary
because it is necessary
because we do not have (tap) water nor a connection to the network
because we do not have water (tap)
because it is drinking water
because it is necessary and we do not have water (tap)
because we do not have tap water
because it is secure and not contaminated
because tap water and river water are dirty, and tankered water is well treated and good water
because we do not have water (tap)
because we do not have water (tap)
because we do not have another source of water
because it is the only source we have
because we do not have water (tap)
because we do not have tap water
because we do not have tap water
because we do not have tap water
because we do not have tap water in our house

because we do not have water (tap)
because we do not have piped water
because we do not have water (tap)
because we do not have water (tap)
because they cannot carry water from the river
because we do not have tap water
because we do not have (tap) water in the house
we do not have water (tap)
because we do not have (tap) water in our house
because tankered water is not clean
because we do not have tap water in our house
because although we are connected to piped water we do not have any water
because we do not have resources to buy treated water
because it is necessary for cooking and life
because we do not have water in our house
because it is treated water
because the tap water is treated by SEDALORETO
because we do not have a service from SEDALORETO
because we do not have (tap) water in our house
because we do not have tap water
because we are without (tap) water
because we do not have tap water
because it is good drinking water
because it is clean
because it is necessary
because we do not have much water
there is no water in the pipes
because it is necessary to have water to live
because we do not have water in our house taps
because we do not have (tap) water
because there is no water in the pipes or taps and we need water for cooking and other uses
because there is not water in the pipes
because we do not have water in our house
because we not have much water
because it is better
because there is not water in the pipes or network
because there is no water in the pipes
because there is no (tap) water
because there is no water where we collect it from
because there is no water in the pipes
because there is no water in the pipes
because water is necessary
because we do not have much water
because we do not have tap water
because we do not have (tap) water
because we do not have much water
because they have water
because we do not have (tap water)
because we do not have (tap) water
because water in 'progongos' is cleaner than well water

() = the term is inferred rather than stated

4.6 How do you store your drinking water in your household

9 barrels	**0** underground tanks	**0** above ground tanks
0 sinks outside the house	**93** buckets	**1** bottles
0 cans	**0** canteens	**23** other: 23 pans

4.7 How long do you store your water in your house? Between 0.2- 7 days

4.8 Do you treat your drinking water in your house?

Yes **34** No **62**

4.8.1 What method(s) do you use?

0 Don't know	**1** Aeration	**0** Sedimentation
0 Coagulation	**0** SODIS	**21** Chlorination/chemical treatment
1 Filtration	**13** Boling	**7** Other: 7 household bleach

4.8.2 How long does it take to treat your water every day?

Between 0 and 120 minutes

4.8.3 Why do you use this method?

Statement
because the water is dirty
to prevent (illness)
because of health, as water contains bacteria
to prevent illness
because it is necessary to boil (water)
because it is safely treated
so we have clean water
to prevent illness
because it is safer and so we do not get illnesses
to kill the bacteria
to eliminate the microbes
water is not available
because it is better and for protection
to clean the bacteria
because the people at the medical post told us to
because we have to use this water (for drinking)
for eliminating illness
to eliminate illness
because we drink the water and it is disinfected
so that the water is not contaminated
to kill the bacteria
we have to, to eliminate diarrhoea
because it is safer
because we are taught to
because there are bacteria
because it is healthier
to prevent illness

to prevent illness
because we are taught to treat our water
to prevent illness
because we were told to by the (medical) post
to prevent illness
to prevent bacterial disease
to prevent dengue (fever)

() = the term is inferred rather than stated

4.9 How much water do you consume in your household every day?

Between 0.5 and 40 litres per day

4.10 How important is it for you to obtain sufficient drinking water?

Very important	Important	Somewhat important	Not important not unimportant	Somewhat unimportant	Unimportant	Absolutely not important
12	**83**	**0**	**1**	**0**	**0**	**0**

4.11 Do you have access to a standpipe or tap?

Yes **96** No **0**

4.12 Do you purchase bottled water?

Yes **34** No **62**

4.12.1 What is the name of the bottle water?

Brand	**Number of response**
San Luis	16
Ceilo	9
San Antionio	3
Agua Selva	2
Agua Vida	1
Don't remember	3

4.11.2 Who owns the bottled water company?

Government	Local company	International company	Other	Don't know
0	**8**	**3**	**11**	**12**

5.0 Quality of your drinking water

5.1 How would you classify your drinking water?

Very good	Good	Somewhat good	Not good nor bad	Somewhat bad	Bad	Very bad
1	**54**	**0**	**38**	**0**	**1**	**0**

5.2 How important is drinking water quality?

Very unimportant	Unimportant	Somewhat unimportant	Not important nor unimportant	Somewhat important	Important	Very important
0	**1**	**0**	**5**	**0**	**87**	**3**

5.3 How would you classify the following characteristics of your drinking water?

	Very bad	Bad	Somewhat bad	Not good nor bad	Some what good	Good	Very good
Temperature	**0**	**3**	**0**	**29**	**0**	**64**	**0**
Colour	**0**	**2**	**0**	**24**	**0**	**70**	**0**
Turbidity	**0**	**18**	**1**	**26**	**0**	**51**	**0**
Odour	**0**	**4**	**0**	**18**	**0**	**73**	**1**
Taste	**0**	**3**	**0**	**24**	**0**	**67**	**2**

5.4 How important are the following characteristics of your drinking water?

	Very important	Important	Somewhat important	Not importa nt not unimpo rtant	Somewh at unimport ant	Unimport ant	Very unimportan t
Temperature	**1**	**82**	**1**	**4**	**0**	**8**	**0**
Colour	**0**	**90**	**0**	**4**	**0**	**2**	**0**
Turbidity	**0**	**50**	**0**	**5**	**0**	**41**	**0**
Odour	**0**	**70**	**0**	**7**	**0**	**11**	**0**
Taste	**1**	**88**	**0**	**5**	**0**	**2**	**0**

5.5 What characteristics of water are most important to you? In a range of 1 to 5 *(1= most important, 5 = least important*)

	1^{st}	2^{nd}	3^{rd}	4^{th}	5^{th}
Temperature	**4**	**11**	**25**	**39**	**17**
Colour	**11**	**29**	**22**	**27**	**7**
Turbidity	**5**	**7**	**8**	**12**	**68**
Odour	**4**	**37**	**31**	**15**	**4**
Taste	**72**	**12**	**10**	**3**	**0**

6.0 Association between water and illness

6.1 Why does a person get diarrhoea?

3	Understood the medical context (mentioned bacteria)
38	Dirty water and poor hygiene
53	Dirty water gives you diarrhoea
2	No relationship between diarrhoea, water or hygiene

6.2 How large is the risk of contracting diarrhoea from drinking raw water to you and your family?

Very important	Important	Somewhat important	Not important not unimportant	Somewhat unimportant	Unimportant	Very unimportant
5	**87**	**0**	**0**	**0**	**4**	**0**

6.3 When your or you family gets diarrhoea, how seriously does it affect on your or their health?

Very trivial	Trivial	Somewhat trivial	No serious nor trivial	Somewhat serious	Serious	Very serious
0	**23**	**10**	**3**	**5**	**55**	**0**

6.4 Have any members of your family been ill in the last seven days? Have they had a temperature, diarrhoea, stomach ache or vomited?

Yes **30** No **66**

6.4.1 If yes, who? Ranging from 2 to 70 years

7.0 Water and hygiene

7.1 How important is it that you obtain sufficient water for cleaning and good hygiene?

Very unimportant	Unimportant	Somewhat unimportant	Not important nor unimportant	Somewhat important	Important	Very important
0	**0**	**0**	**0**	**0**	**88**	**8**

7.2 Do you wash your hands after visiting the toilet and before eating and preparing food?

Never	Once in a while	Normally	Nearly always	Always
0	**5**	**6**	**1**	**84**

7.3 Do you use soap?

Always	Nearly always	Normally	Once in a while	Never
84	**2**	**8**	**2**	**0**

8.0 Sanitation

8. 1 Where is your toilet?

Toilet inside house	Private latrine	Public latrine	Open air	Other
58	**22**	**15**	**1**	**0**

8.2 How important is it that have adequate sanitation?

Very unimportant	Unimportant	Somewhat unimportant	Not important nor unimportant	Somewhat important	Important	Very important
0	**0**	**1**	**0**	**0**	**84**	**11**

8.3 How large is the risk that your excrement could contaminate a drinking water source?

Very large	Large	Somewhat large	Not large not small	Somewhat small	Small	Very small
4	**90**	**2**	**0**	**0**	**0**	**0**

8.4 Please rank the below WASH interventions from the most to least important? In a range of 1 to 5 *(1= most important, 5 = least important*)

	1st	2nd	3rd	4th
Drinking water quality	**50**	**20**	**17**	**8**
Drinking water quantity	**10**	**26**	**32**	**28**
Water for hygiene	**9**	**16**	**29**	**41**
Sanitation	**27**	**34**	**18**	**19**

10.0 Drinking water samples

10.1 Is it possible to gain a sample of your drinking water (400ml) for analysis?
Yes **91** No **0**

10.2 Can I take a photo of you in your house?
Yes **72** No **24**

Appendix 11: Household sample results 2006

Date	Source	TTC (CFU/100ml)	Notes	Turbidity (NTU)	Colour (Hazen)	Free Cl (mgl^{-1})	Total Cl (mgl^{-1})	Cl Combined (mgl^{-1})	pH*
27.06.2006	water tanker	<1	10 ml filtered	<5	<5	0.1	0.3	0.2	6.8
27.06.2006	water tanker	3100		<5	10	<0.1	<0.1	<0.1	6.8
27.06.2006	San Luis**	<1		<5	<5	<0.1	<0.1	<0.1	7.0
03.07.2006	standpipe tap water	1200		<5	5	<0.1	<0.1	<0.1	7.0
03.07.2006	water tanker	5800	pH <6.8	<5	<5	<0.1	<0.1	<0.1	6.7
03.07.2006	water tanker	215		<5	5	<0.1	<0.1	<0.1	6.8
03.07.2006	other	<1	100 ml filtered, pH <6.8	<5	<5	<0.1	<0.1	<0.1	6.7
03.07.2006	San Luis**	<1		<5	<5	<0.1	<0.1	<0.1	6.8
04.07.2006	standpipe tap water	<1		<5	20	0.30	0.40	0.1	7.0
04.07.2006	standpipe tap water	<1	1 ml filtered	<5	15	<0.1	<0.1	<0.1	6.8
04.07.2006	water tanker	185		<5	30	<0.1	<0.1	<0.1	6.8
04.07.2006	water tanker	30		<5	15	0.10	0.10	<0.1	6.8
04.07.2006	water tanker	1365		<5	20	<0.1	<0.1	<0.1	6.8
04.07.2006	San Luis**	<1		<5	<5	<0.1	<0.1	<0.1	7.0
05.07.2006	standpipe tap water	11750		<5	15	<0.1	<0.1	<0.1	6.8
05.07.2006	water tanker	860		<5	<5	<0.1	<0.1	<0.1	6.8

05.07.2006	water tanker	1300		<5	15	<0.1	<0.1	<0.1	7.0
05.07.2006	water tanker	2	100 ml filtered	<5	5	2.0	2.0	<0.1	6.8
05.07.2006	water tanker	15	10 ml filtered	<5	20	<0.1	<0.1	<0.1	6.8
05.07.2006	San Luis**	<1		<5	<5	<0.1	<0.1	<0.1	7.0
06.07.2006	standpipe tap water	8000		<5	30	<0.1	<0.1	<0.1	6.8
06.07.2006	brought bottled water	4		<5	30	0.3	0.4	0.1	6.8
06.07.2006	brought bottled water	<1		<5	15	0.6	0.7	0.1	6.8
06.07.2006	brought bottled water	<1		<5	40	0.1	0.3	0.2	6.8
06.07.2006	San Luis**	<1		<5	<5	<0.1	<0.1	<0.1	6.8
10.07.2006	standpipe tap water	<1		<5	15	<0.1	0.1	0.1	6.8
10.07.2006	standpipe tap water	195		<5	15	<0.1	<0.1	<0.1	7.0
10.07.2006	water tanker	1		<5	15	0.6	1.0	0.4	7.0
10.07.2006	San Luis**	<1		<5	<5	<0.1	<0.1	<0.1	7.0
11.07.2006	standpipe tap water	3450		<5		<0.1	<0.1	<0.1	6.8
11.07.2006	standpipe tap water	155		<5	20	<0.1	<0.1	<0.1	7.0
11.07.2006	brought bottled water	<1	100 ml filtered	<5	5	0.6	0.7	0.1	6.8

11.07.2006	San Luis**	<1		<5	<5	<0.1	<0.1	<0.1	7.0
12.07.2006	standpipe tap water	<1	100 ml	<5	15	0.1	0.1	<0.1	7.0
12.07.2006	standpipe tap water	77		<5	10	0.10	0.10	<0.1	7.0
12.07.2006	standpipe tap water	20		<5	15	<0.1	<0.1	<0.1	6.8
12.07.2006	water tanker	2550		<5	15	<0.1	<0.1	<0.1	7.2
12.07.2006	water tanker	<1	100 ml	<5	10	0.10	0.10	<0.1	6.8
12.07.2006	San Luis**	<1		<5	<5	<0.1	<0.1	<0.1	7.0
14.07.2006	standpipe tap water	219		<5	5	<0.1	0.10	0.1	6.8
14.07.2006	standpipe tap water	<1	100 ml	<5	10	0.60	0.60	<0.1	7.0
14.07.2006	standpipe tap water	1300		<5	5	<0.1	<0.1	<0.1	6.8
14.07.2006	standpipe tap water	<1	100 ml	<5	5	0.40	0.40	<0.1	6.8
14.07.2006	San Luis**	<1		<5	<5	<0.1	<0.1	<0.1	7.0
17.07.2006	standpipe tap water	2050		<5	15	<0.1	<0.1	<0.1	6.6
17.07.2006	standpipe tap water	485		<5	15	<0.1	<0.1	<0.1	6.8
17.07.2006	standpipe tap water	<1	10ml	<5	10	0.10	0.10	<0.1	7.0
17.07.2006	standpipe tap water	<1	10ml	<5	15	0.10	0.10	<0.1	7.0
17.07.2006	brought bottled water	5		<5	5	<0.1	<0.1	<0.1	7.2
17.07.2006	water tanker	<1	10ml	<5	30	<0.1	<0.1	<0.1	7.0

17.07.2006	San Luis**	<1		<5	<5	<0.1	<0.1	<0.1	7.2
19.07.2006	standpipe tap water	215		<5	20	<0.1	<0.1	<0.1	7.2
19.07.2006	standpipe tap water	1525		<5	10	<0.1	<0.1	<0.1	7.0
19.07.2006	standpipe tap water	40		<5	<5	<0.1	<0.1	<0.1	7.0
19.07.2006	San Luis**	<1		<5	<5	<0.1	<0.1	<0.1	7.0
20.07.2006	standpipe tap water	<1		<5	15	<0.1	<0.1	<0.1	7.0
24.07.2006	brought bottled water	95		<5	15	<0.1	<0.1	<0.1	6.8
24.07.2006	brought bottled water	1		<5	15	0.1	0.2	0.1	6.8
24.07.2006	water tanker	420		<5	50	<0.1	<0.1	<0.1	6.8
24.07.2006	San Luis**	<1		<5	<5	<0.1	<0.1	<0.1	6.8
25.07.2006	standpipe tap water	<1	100ml	<5	10	0.3	0.3	<0.1	6.8
25.07.2006	brought bottled water	505		<5	20	<0.1	<0.1	<0.1	7.0
25.07.2006	water tanker	3450		<5	10	<0.1	<0.1	<0.1	7.0
25.07.2006	San Luis**	<1			<5	<0.1	<0.1	<0.1	7.0

*limited by method used

** San Luis water was used as a standard sample

Appendix 12: Household sample results 2007

Date	source	TTC (CFU/100ml)	Notes*	Turbidity (NTU)	Colour (Hazen)	Free Cl (mgl^{-1})	Total Cl (mgl^{-1})	Cl Combined (mgl^{-1})	pH
28.11.2007	unsealed water	1,001	>1000	<5	70	<0.1	<0.1	<0.1	6.6
28.11.2007	water tanker	1,000	>1000	<5	40	<0.1	<0.1	<0.1	6.7
28.11.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	6.9
27.11.2007	river water	250	1 ml	<5	10	<0.1	<0.1	<0.1	6.4
27.11.2007	unsealed water	600		<5	10	<0.1	<0.1	<0.1	6.5
27.11.2007	water tanker	10300		<5	40	<0.1	<0.1	<0.1	6.4
27.11.2007	water tanker	1001	>1000	<5	5	<0.1	<0.1	<0.1	6.6
27.11.2007	San Luis**			<5	<5	<0.1	<0.1	<0.1	7.1
26.11.2007	unsealed water	131	100ml	<5	<5	<0.1	0.1	0.1	5.6
26.11.2007	water tanker	27500	1 ml	<5	10	<0.1	<0.1	<0.1	5.0
26.11.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	6.9
22.11.2007	water tanker	<0		<5	<5	1.5	1.5	<0.1	6.6
22.11.2007	water tanker	10000	>10000	<5	20	<0.1	<0.1	<0.1	6.7
22.11.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	7.0
21.11.2007	unsealed water	5	1 in 10 ml	<5	30	<0.1	<0.1	<0.1	6.6
21.11.2007	water tanker	<0	in 100	<5	5	0.1	0.1	<0.1	6.5
21.11.2007	water tanker	10000	>10000	<5	15	<0.1	<0.1	<0.1	6.6
21.11.2007	water tanker	10000	>10000	<5	40	<0.1	<0.1	<0.1	6.7

21.11.2007	water tanker	1505		<5	40	<0.1	<0.1	<0.1	6.7
21.11.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	7.0
20.11.2007	sealed water	10000	>10,000	<5	<5	<0.1	<0.1	<0.1	6.3
20.11.2007	water tanker	205		<5	10	<0.1	<0.1	<0.1	6.8
20.11.2007	water tanker	3500		<5	20	<0.1	<0.1	<0.1	6.7
20.11.2007	water tanker	<0		<5	40	<0.1	<0.1	<0.1	6.7
20.11.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	6.9
19.11.2007	unsealed water	334		<5	<5	0.1	0.1	<0.1	6.9
19.11.2007	water tanker	1588		<5	40	0.1	0.1	<0.1	6.8
19.11.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	7.0
17.11.2007	sealed water	580		<5	30	<0.1	<0.1	<0.1	6.8
17.11.2007	sealed water	9950	1 ml	<5	70	<0.1	<0.1	<0.1	6.7
17.11.2007	water tanker	4660	1/2 count	<5	40	<0.1	<0.1	<0.1	6.7
17.11.2007	water tanker	30	10 ml	<5	40	<0.1	<0.1	<0.1	6.8
17.11.2007	water tanker	16550	1 ml	<5	60	<0.1	<0.1	<0.1	7.1
17.11.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	6.9
15.11.2007	sealed water	<0		<5	<5	<0.1	<0.1	<0.1	4.6
15.11.2007	unsealed water	9		<5	30	0.1	0.1	<0.1	6.4
15.11.2007	water tanker	4630		<5	50	<0.1	<0.1	<0.1	6.4
15.11.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	7.1
14.11.2007	unsealed water	2820		<5	40	<0.1	<0.1	<0.1	6.7
14.11.2007	water tanker	2275		<5	40	<0.1	<0.1	<0.1	6.7
14.11.2007	water tanker	3088		<5	40	<0.1	<0.1	<0.1	6.7
14.11.2007	water tanker	745		<5	40	<0.1	<0.1	<0.1	6.7
14.11.2007	water tanker	10000	>10,000	<5	50	<0.1	<0.1	<0.1	6.7
14.11.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	6.9
13.11.2007	standpipe tap water	10000	>10,000	<5	40	<0.1	<0.1	<0.1	6.7

13.11.2007	unsealed water	105		<5	40	<0.1	<0.1	<0.1	6.8
13.11.2007	water tanker	10		<5	60	<0.1	<0.1	<0.1	6.7
13.11.2007	water tanker	3490		<5	40	<0.1	<0.1	<0.1	6.8
13.11.2007	water tanker	1290		<5	40	<0.1	<0.1	<0.1	6.7
13.11.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	7.0
12.11.2007	sealed water	<0	10 ml <10	<5	<5	<0.1	<0.1	<0.1	4.6
12.11.2007	water tanker	145		<5	30	<0.1	<0.1	<0.1	6.1
12.11.2007	water tanker	750		<5	50	<0.1	<0.1	<0.1	6.2
12.11.2007	water tanker	1105		<5	50	<0.1	<0.1	<0.1	6.0
12.11.2007	water tanker	1640	one sample	<5	30	<0.1	<0.1	<0.1	5.9
12.11.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	6.9
10.11.2007	water tanker	<0	10ml	<5	40	0.1	0.1	<0.1	6.9
10.11.2007	water tanker	<0		<5	15	0.2	0.3	0.1	6.6
10.11.2007	water tanker	180		<5	20	<0.1	<0.1	<0.1	6.6
10.11.2007	water tanker	705		<5	<5	<0.1	<0.1	<0.1	6.7
10.11.2007	water tanker	2125		<5	15	<0.1	<0.1	<0.1	6.6
10.11.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	7.1
08.11.2007	sealed water	<0	100 ml	<5	<5	<0.1	<0.1	<0.1	6.4
08.11.2007	water tanker	110	10ml	<5	20	<0.1	<0.1	<0.1	6.5
08.11.2007	water tanker	10450	1 ml	<5	20	<0.1	<0.1	<0.1	6.6
08.11.2007	water tanker	<0	1 ml	<5	40	<0.1	<0.1	<0.1	6.6
08.11.2007	water tanker	20	10 ml	<5	20	<0.1	<0.1	<0.1	6.5
08.11.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	6.9
06.11.2007	water tanker	1001	>1000 in 1 ml	<5	10	<0.1	<0.1	<0.1	6.4
06.11.2007	water tanker	2651		<5	20	<0.1	<0.1	<0.1	6.3
06.11.2007	water tanker	605		<5	15	<0.1	<0.1	<0.1	6.4
06.11.2007	water tanker	10000	>10,000	<5	40	<0.1	<0.1	<0.1	6.4
06.11.2007	water tanker	10300	1 ml	<5	30	<0.1	<0.1	<0.1	6.2

06.11.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	6.9
05.11.2007	water tanker	<0	100 ml	<5	15	<0.1	0.1	0.1	6.2
05.11.2007	water tanker	10000	>10,000	<5	30	<0.1	<0.1	<0.1	5.9
05.11.2007	water tanker	<0	10 ml	<5	20	<0.1	<0.1	<0.1	6.2
05.11.2007	water tanker	<0	10 ml	<5	20	<0.1	<0.1	<0.1	6.3
05.11.2007	water tanker	1945		<5	20	<0.1	<0.1	<0.1	6.0
05.11.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	7.0
31.10.2007	unsealed water	10000	>10,000	<5	20	<0.1	<0.1	<0.1	6.6
31.10.2007	water tanker	2010		<5	15	<0.1	<0.1	<0.1	6.6
31.10.2007	water tanker	160		<5	5	<0.1	<0.1	<0.1	6.7
31.10.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	6.9
30.10.2007	river water	570		5	175	<0.1	<0.1	<0.1	6.5
30.10.2007	standpipe tap water	<0		<5	5	0.1	0.1	<0.1	6.6
30.10.2007	water tanker	<0		<5	10	0.2	0.3	0.1	6.5
30.10.2007	water tanker	<0		<5	10	0.1	0.2	0.1	6.4
30.10.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	7.0
29.10.2007	well water	56		<5	<5	<0.1	<0.1	<0.1	4.8
29.10.2007	water tanker	10000	>10,000	7	60	<0.1	<0.1	<0.1	6.4
29.10.2007	water tanker	960		<5	20	<0.1	<0.1	<0.1	6.3
29.10.2007	water tanker	130		<5	20	<0.1	<0.1	<0.1	6.3
29.10.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	6.9
25.10.2007	water tanker	<0		<5	20	<0.1	0.1	0.1	6.3
25.10.2007	water tanker	20		<5	20	<0.1	<0.1	<0.1	6.2
25.10.2007	water tanker	55		<5	15	<0.1	<0.1	<0.1	6.4
25.10.2007	water tanker	135		<5	15	<0.1	<0.1	<0.1	6.4
25.10.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	6.9
24.10.2007	water tanker	<0		<5	15	0.1	0.2	0.1	6.8
24.10.2007	water tanker	1500		<5	15	<0.1	<0.1	<0.1	6.8

24.10.2007	water tanker	1290		<5	15	<0.1	<0.1	<0.1	6.8
24.10.2007	water tanker	1310		<5	50	<0.1	<0.1	<0.1	6.8
24.10.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	7.0
23.10.2007	unsealed water	70		<5	15	<0.1	<0.1	<0.1	4.7
23.10.2007	water tanker	1040		<5	15	<0.1	<0.1	<0.1	6.4
23.10.2007	water tanker	2595		<5	20	<0.1	<0.1	<0.1	6.4
23.10.2007	water tanker	7440		<5	20	<0.1	<0.1	<0.1	6.3
23.10.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	7.1
22.10.2007	water tanker	<0		<5	5	1.5	1.5	<0.1	5.3
22.10.2007	water tanker	24		<5	20	<0.1	0.1	0.1	6.5
22.10.2007	water tanker	725		<5	15	<0.1	<0.1	<0.1	5.3
22.10.2007	water tanker	3		<5	15	<0.1	0.1	0.1	6.1
22.10.2007	San Luis**	<0		<5	<5	<0.1	<0.1	<0.1	6.9

* volume filtered or estimate numbers

** San Luis was used as a standard sample

Appendix 13: Source sample results 2006

Date	Source	TTC/100ml (CFU/100ml)	Turbidity (NTU)	Colour (Hazen)	Free Cl (mgl^{-1})	Total Cl (mgl^{-1})	Cl Combined (mgl^{-1})	pH
14/06/2006	San Luis	<0	<5	<5	<0.1	<0.1	<0.1	7.00
01/07/2006	San Luis	<0	<5	<5	<0.1	<0.1	<0.1	7.00
07/07/2006	San Luis	<0	<5	<5	<0.1	<0.1	<0.1	7.00
14/07/2006	San Luis	<0	<5	<5	<0.1	<0.1	<0.1	7.00
21/07/2006	San Luis	<0	<5	<5	<0.1	<0.1	<0.1	7.00
07/07/2006	Sealed bottled water	6	<5	<5	<0.1	<0.1	<0.1	<6.80
14/07/2006	Sealed bottled water	1	<5	5	<0.1	<0.1	<0.1	6.80

19/07/2006	Sealed bottled water	<0	<5	5	<0.1	<0.1	<0.1	7.00
21/07/2006	Sealed bottled water	<0	<5	5	<0.1	<0.1	<0.1	<6.80
26/06/2006	Unsealed bottled	<0	<5	15	0.1	0.3	0.2	6.80
07/07/2006	Unsealed bottled	1	<5	<5	<0.1	<0.1	<0.1	6.80
14/07/2006	Unsealed bottled	87	<5	15	<0.1	0.1	0.1	6.80
21/07/2006	Unsealed bottled	<0	<5	10	0.4	0.4	0.0	7.00
27/06/2006	Rain water	10	<5	<5	<0.1	<0.1	<0.1	6.80
13/06/2006	Rain water	4	<5	5	<0.1	<0.1	<0.1	6.80
26/06/2006	Well water	270	7.5	30	<0.1	<0.1	<0.1	<6.80
07/07/2006	Well water	585	15	40	<0.1	<0.1	<0.1	<6.80

14/07/2006	Well water	2,885	10	40	<0.1	<0.1	<0.1	6.80
21/07/2006	Well water	645	7	30	<0.1	<0.1	<0.1	6.80
10/07/2006	Tankered water	<0	<5	10	2.0	3.0	1.0	7.20
11/07/2006	Tankered water	<0	<5	<5	2.0	2.0	0.0	7.20
20/07/2006	Tankered water	<0	<5	<5	1.5	2.0	0.5	7.20
25/07/2006	Tankered water	1	<5	5	2.0	3.0	1.0	7.00
11/07/2006	Tap water	10	<5	<5	3.0	3.0	0.0	6.80
17/07/2006	Tap water	<0	<5	20	<0.1	0.3	0.3	<6.80
20/07/2006	Tap water	<0	<5	5	0.4	0.6	0.2	7.20
25/07/2006	Tap water	3	<5	15	0.1	0.3	0.2	7.00

01/07/2006	River water - Houses	21,900	60	>250	<0.1	<0.1	<0.1	<6.80
07/07/2006	River water- Houses	13,200	59	225	<0.1	<0.1	<0.1	<6.80
14/07/2006	River water– Houses	27,600	100	>250	<0.1	<0.1	<0.1	<6.80
21/07/2006	River water– Houses	16,200	160	250	<0.1	<0.1	<0.1	6.80
26/06/2006	River water – Point	TNTC	75	>250	<0.1	<0.1	<0.1	<6.80
01/07/2006	River water – Point	6,400	25	>250	<0.1	<0.1	<0.1	<6.80
07/07/2006	River water – Point	4,400	17	200	<0.1	<0.1	<0.1	<6.80
14/07/2006	River water – Point	5,400	25	200	<0.1	<0.1	<0.1	<6.80
21/07/2006	River water – Point	15,200	30	175	<0.1	<0.1	<0.1	<6.80

Appendix 14: Source sample results 2007

Date	Source	TTC (CFU/100ml)	Turbidity (NTU)	Colour (Hazen)	Free Cl (mgl^{-1})	Total Cl (mgl^{-1})	Cl Combined (mgl^{-1})	pH
28/09/2007	San Luis	<0	<5	<5	<0.1	<0.1	<0.1	7.20
05/10/2007	San Luis	<0	<5	<5	<0.1	<0.1	<0.1	6.90
12/10/2007	San Luis	<0	<5	<5	<0.1	<0.1	<0.1	6.90
19/10/2007	San Luis	<0	<5	<5	<0.1	<0.1	<0.1	6.90
28/10/2007	San Luis	<0	<5	<5	<0.1	<0.1	<0.1	6.83
02/11/2007	San Luis	<0	<5	<5	<0.1	<0.1	<0.1	6.88
09/11/2007	San Luis	<0	<5	<5	<0.1	<0.1	<0.1	6.95
16/11/2007	San Luis	<0	<5	<5	<0.1	<0.1	<0.1	7.08
23/11/2007	San Luis	<0	<5	<5	<0.1	<0.1	<0.1	7.07
30/11/2007	San Luis	<0	<5	<5	<0.1	<0.1	<0.1	6.95
28/09/2007	Sealed bottled water	<0	<5	<5	<0.1	<0.1	<0.1	7.43
05/10/2007	Sealed bottled water	<0	<5	<5	<0.1	<0.1	<0.1	7.02
12/10/2007	Sealed bottled	<0	<5	<5	<0.1	<0.1	<0.1	6.86

	water							
19/10/2007	Sealed bottled water	<0	<5	<5	<0.1	<0.1	<0.1	6.89
26/10/2007	Sealed bottled water	<0	<5	<5	<0.1	<0.1	<0.1	6.36
02/11/2007	Sealed bottled water	, <0	<5	<5	<0.1	<0.1	<0.1	6.75
09/11/2007	Sealed bottled water	<0	<5	<5	<0.1	<0.1	<0.1	6.73
16/11/2007	Sealed bottled water	<0	<5	<5	<0.1	<0.1	<0.1	6.72
23/11/2007	Sealed bottled water	<0	<5	<5	<0.1	<0.1	<0.1	6.83
30/11/2007	Sealed bottled water	<0	<5	<5	<0.1	<0.1	<0.1	6.7
28/09/2007	Unsealed bottled water	<0	<5	<5	0.3	0.3	<0.1	6.54
05/10/2007	Unsealed bottled water	2,740	<5	20	<0.1	<0.1	<0.1	7.21
12/10/2007	Unsealed bottled water	<0	<5	<5	<0.1	<0.1	<0.1	6.94
19/10/2007	Unsealed bottled water	170	<5	<5	<0.1	<0.1	<0.1	4.29
26/10/2007	Unsealed bottled water	5	<5	15	<0.1	<0.1	<0.1	4.48
02/11/2007	Unsealed bottled water	2,200	<5	30	<0.1	<0.1	<0.1	6.54
09/11/2007	Unsealed bottled water	1,075	<5	30	<0.1	<0.1	<0.1	6.80

17/11/2007	Unsealed bottled water	10,000	6	60	<0.1	<0.1	<0.1	6.84
23/11/2007	Unsealed bottled water	1,770	<5	50	<0.1	<0.1	<0.1	6.87
30/11/2007	Unsealed bottled water	<0	<5	30	<0.1	<0.1	<0.1	6.75
15/10/2007	Rain water	10	<5	<5	<0.1	<0.1	<0.1	6.60
24/10/2007	Rain water	<0	<5	<5	<0.1	<0.1	<0.1	6.71
16/10/2007	Rain water	1	<5	<5	<0.1	<0.1	<0.1	6.66
08/11/2007	Rain water	1	<5	<5	<0.1	<0.1	<0.1	6.88
14/11/2007	Rain water	<0	<5	<5	<0.1	<0.1	<0.1	6.70
14/11/2007	Rain water	<0	<5	<5	<0.1	<0.1	<0.1	6.67
28/09/2007	Well water	5,700	15	85	<0.1	<0.1	<0.1	6.58
05/10/2007	Well water	TNTC	10	70	<0.1	<0.1	<0.1	6.42
12/10/2007	Well water	6,667	27	150	<0.1	<0.1	<0.1	6.46
19/10/2007	Well water	7,208	10	50	<0.1	<0.1	<0.1	6.49
26/10/2007	Well water	12,500	22	70	<0.1	<0.1	<0.1	6.38
02/11/2007	Well water	19,999	15	70	<0.1	<0.1	<0.1	6.32
09/11/2007	Well water	12,700	12	85	<0.1	<0.1	<0.1	6.47
16/11/2007	Well water	9,750	7	60	<0.1	<0.1	<0.1	6.36

23/11/2007	Well water	>100,000*	20	85	<0.1	<0.1	<0.1	6.30
30/11/2007	Well water	>20,000*	<5	30	<0.1	<0.1	<0.1	6.33
19/10/2007	Tankered water	<0	<5	10	0.2	0.2	<0.1	5.85
06/11/2007	Tankered water	<0	<5	10	1.5	1.5	<0.1	6.28
21/11/2007	Tankered water	<0	<5	30	0.6	0.6	<0.1	6.71
27/11/2007	Tankered water	<0	<5	85	<0.1	<0.1	<0.1	6.91
28/09/2007	River water – Houses	25,400	19	150	<0.1	<0.1	<0.1	6.93
05/10/07	River water – Houses	43,333	18	150	<0.1	<0.1	<0.1	6.79
12/10/07	River water – Houses	48,750	30	225	<0.1	<0.1	<0.1	6.54
19/10/2007	River water – Houses	67,575	40	225	<0.1	<0.1	<0.1	6.32
26/10/2007	River water – Houses	2,500	35	200	<0.1	<0.1	<0.1	6.6
02/11/2007	River water – Houses	5,714	15	200	<0.1	<0.1	<0.1	6.6
09/11/2007	River water – Houses	14,234	48	250	<0.1	<0.1	<0.1	6.77
16/11/2007	River water – Houses	3,489	22	250	<0.1	<0.1	<0.1	6.59
23/11/2007	River water – Houses	4,522	50	250	<0.1	<0.1	<0.1	6.76
30/11/2007	River water – Houses	7,100	15	200	<0.1	<0.1	<0.1	6.79

28/09/2007	River water – point	120,000	35	225	<0.1	<0.1	<0.1	6.85
05/10/07	River water – point	161,667	35	225	<0.1	<0.1	<0.1	6.26
12/10/07	River water – point	108,750	42	250	<0.1	<0.1	<0.1	6.6
19/10/2007	River water – point	323,008	50	250	<0.1	<0.1	<0.1	7.02
26/10/2007	River water – point	25,000	42	225	<0.1	<0.1	<0.1	6.25
02/11/2007	River water – point	32,141	28	200	<0.1	<0.1	<0.1	6.63
09/11/2007	River water – point	16,042	50	250	<0.1	<0.1	<0.1	6.7
16/11/2007	River water – point	10,001	19	225	<0.1	<0.1	<0.1	6.6
23/11/2007	River water – point	8,925	50	250	<0.1	<0.1	<0.1	6.85
30/11/2007	River water – point	6,700	25	225	<0.1	<0.1	<0.1	6.85

TNTC = too numerous to count

*estimates

Appendix 15: Why people treat their drinking water in 2006

Respondent	Statement in Spanish	It is recommended	It is necessary	To disinfect the water	To prevent disease	To kill bacteria	It is good for health	The water is dirty	The method is cheap and rapid	The water is not treated properly	None
P002E	Por que recommendable	1									
P007E	Para desinfecatarta y evitar algunas enfermedades				1						
P009E	Por que emata los microbios porque esa agua aveces tiene mosquitos o algunos insectos pequenos					1					
P010E	Para desinfectar el agua			1							
P013A	Para que no hay enfermedad en la casa										
P014A	Para protegernos de enfermedad				1						
P017A	Para tomar y no tener enfermedades				1						
P022A	Para consumer										1
P024A	Para cuidarnos de las enfermedades				1						
Q026E	Por que el agua no viene limpio							1			
Q027E	Por que los bacterias					1					
Q030E	Para prevenir alguna enfermedades				1						
Q034E	Para que mate las bacterias					1					
Q035E	Para matar los microbios que estan en el agua					1					
Q036E	Para matar los bacterias					1					
Q040A	Por que es economico y rapido								1		
Q041A	Para proteger de las enfermedades				1						
Q043A	Para cuidar la salud						1				
Q044A	Para evetar enfermedades				1						
Q045A	Para poteger de enfermedades				1						
Q047A	Para nuestra salud						1				
Q048A	None given										1
Q049A	Por que necesita estar segura and sana		1								
Q050A	Por que siguen las instrucciones de los agentes de salud	1					1				
Q055A	Por que necesitamos tatar el agua		1								
Q056A	Para tomar sin problemas		1								
Q057A	Para no tomar agua cruda							1			
Q059A	Para prevenir epidemias del agua				1						
Q060A	Para la hygiene							1			
Q061A	Por que es important y seguro						1				
Q062A	Para prevenir enfermedades				1						
Q065A	Para pervenir enfermedades				1						
Q069A	Por que necesitamos prevenir				1						
Q073A	Por que no esta bien tratado (porongo)									1	
Q074A	Para eliminar las bacterias					1					
Q076A	Para no enfermarse				1						
Q078A	Para que no haya enfermedad				1						
Q079A	Por que portegemos de las bacterias					1					
Q080A	Para eliminar los microbes					1					
Q084A	Por que es necesario tratarlo para consumirlo despues		1								
Q085A	Por que no se confia el tratmiento que tiene el agua (Agua de grifo)									1	
Q087A	Para eliminar los microbios y bacterias					1					
Q088A	Para que no tenqamos enfermedad				1						
Q089A	Para eliminar los microbios					1					
Q090A	Para eliminar mcirobios					1					
Q091A	Para consumer agua tradada en el hogar							1			
Q101A	Para eliminar microbios					1					
Q103A	Para eliminar microbios					1					
Q108A	Por que descoufia de los enfermedad				1						
Q113A	Por que lo limpia el agua										
	Total statements for each theme	2	4	1	16	13	4	4	1	2	2

Appendix 16: Why people treat their drinking water in 2007

Respondent	Statement in Spanish	It is recommended	It is necessary	To disinfect the water	To prevent disease	To kill bacteria	It is good for health	The water is dirty	The method is cheap	The water is not treated properly	None
P003E	por que el agua esta sucia							1			
P005E	para prevenir				1						
P006E	para cuidar la salud, el agua tiene microbios					1					
P007E	para prevenir las enfermedades				1						
P009E	por que es necesario hervir		1								
P011E	Por que es seguro tratar		1								
P013A	Por que se hace mas limpio el agua							1			
P016A	Para pervenir enfermedad				1						
P020A	Para estar mas seguro y no haya enfermedad				1						
P024A	Por que mueran las bacterias					1					
Q028E	Para que eliminen los microbios					1					
Q030E	Por que no hay disponibilidad de cuidar el agua		1								
Q031E	Por que es major estar protegido		1								
Q037A	Por que es limpia de bacterias					1					
Q042A	Por que revisan si la gente cuida su salud	1									
Q045A	Por que asi se debe usar el agua				1						
Q048A	Para enitar las enfermedades				1						
Q050A	Para evitar contagiarnos de enfermedades				1						
Q055A	Por que se puede tomar al agua ya esta desinfectado			1							
Q057A	Por que no este contaminado el agua							1			
Q059A	Para matar a las bacterias					1					
Q061A	Por que debemos echar para evitar las diarreas				1						
Q062A	Por que es mas seguro						1				
Q068A	Por que asi nos ensenau	1									
Q072A	Por que hay bacterias					1					
Q073A	Por que es saludable						1				
Q076A	Para prevenir las enfermedades				1						
Q077A	Para prevenir de las enfermedades				1						
Q079A	Por que nos ensenan para tartar el agua	1									
Q083A	Para eliminar a los bachos (bacterias)					1					
Q085A	Por las enfermedades que hay				1						
Q088A	Por que nos enseñan en la posta	1									
Q091A	Para preventir de enfermedades				1						
Q101A	Para prevenir de los bichos (bacterias)					1					
Q105A	Para prevenir el dengue				1						
	Total statements for each theme	**4**	**4**	**1**	**13**	**8**	**2**	**3**	**0**	**0**	**0**