

Personal, situational, and social factors
influencing the current and future use of
SODIS in Nicaragua:

A quantitative pilot study

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1. Introduction

Nicaragua is one of the poorest countries in Central America and clean drinking water is one of its many problems. According to COSUDE Nicaragua (the Swiss Agency for Development and Cooperation) 60 % of households outside of urban centers have no safe drinking water¹. Sources of water are often contaminated by bacteria, viruses or parasites. The existing techniques to purify water are either costly or complicated in their usage and thus are rarely utilized, which may lead to severe health problems. It is important to provide these households with a simple technology to disinfect their drinking water. SODIS is such a technology. It is straightforward in its application and does not require any large investment. The process to improve the quality of drinking water takes advantage of the capacity of solar radiation to destroy pathogenic microorganisms that cause waterborne diseases such as diarrhea. Water is filled into transparent plastic bottles and is exposed to the sun for 6 hours, at which time the water is safe to drink. Although this technology is considered easy to execute, there are still few households applying it. The underlying question of this research project is why, despite its simplicity, not more households utilize SODIS to disinfect their water. The present research is an exploratory pilot study, attempting to identify the factors that influence a family's decision to purify their water with SODIS.

In order to identify these factors theories of social psychology have been used. Social psychology proposes that the intention to apply a new technology depends on trusting the new technology, reasons that might make the application difficult, the opinion of the person applying it, available alternatives, as well as many other factors. In order to identify the importance of these factors in the application of SODIS, a psychological approach is used by recording subjective factors as they are perceived by the interviewed person. The following figure depicts the factors that were studied.

¹ <http://www.cosude.org.ni/Pages/PageAguaNica.htm> (4.1.2004)

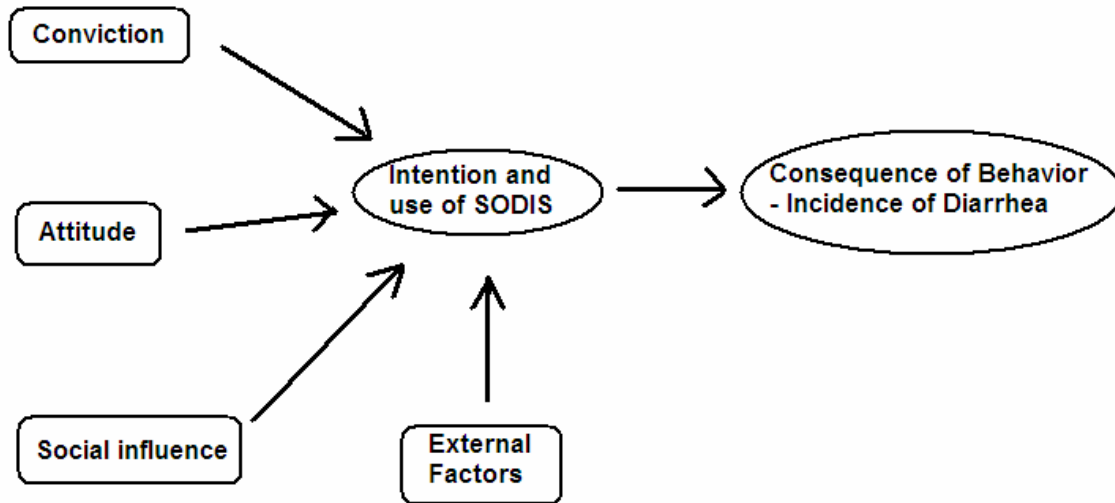


Figure 1: Depiction of the factors influencing the use of SODIS

Figure 1 shows the different factors that are believed to influence the intention to use SODIS in the future as well as the current use of SODIS and in turn the consequences of this behavior, which in the case of SODIS is the reduction of the reported incidence of diarrhea. Conviction stands for the knowledge about how SODIS functions, beliefs about the connection between diarrhea and water contamination, as well as convictions regarding the cleanliness of their source of water. Attitude on this other hand is a more emotional reaction to the technology, measuring whether the interviewee thinks SODIS is something good or not. Social influence is the behavior of those surrounding the interviewee. External factors concern the more practical aspects of the application of SODIS, such as the availability of bottles in the communities.

The investigation visited two projects and took place over the course of two months in August and September 2003. The projects of two partner organizations which promote SODIS in Nicaragua were visited. The project of CEPS (Centro de educación y promoción social) involving SODIS takes place near the capital in the municipality of La Paz Centro (see map in figure 2). PIS (Programa integral de salud) promotes SODIS in the municipality of Waslala (see map in figure 2).



Figure 2: Map of Nicaragua

PIS has been promoting SODIS since January 2002, whereas CEPS only started in June 2003. The promotion process is very similar and the majority of the PET-bottles were provided by the promoters in both projects. In a first phase the promotion was based on community meetings and workshops and then, in a second phase, promoters visited individual households to supervise the application of SODIS. Given the geographical layout of the communities in the project of CEPS it was possible for the promoter to visit every single household, whereas in the project of PIS the promoter could only visit those families that had declared an interest in SODIS at meetings. It is physically almost impossible for one promoter to visit every household in Waslala (PIS), in order to visit every house a significant investment in manpower would be necessary as houses are widely spread in difficult terrain. A promotion activity that only took place in Waslala (PIS) are contests taking place at schools during which children write poems, make short performances and exhibit drawings, all with the topic of SODIS. At the end of the day the best of each category is rewarded with a small present.

CEPS works in an area with a short rainy season and very little cloud cover. Their projects in the municipality of La Paz Centro involve building latrines and promoting the use of vegetable gardens as well as raising chickens. SODIS is their fourth project in this area. Of the three communities currently involved in the project two were visited for this

investigation, namely Las Fuentes and Tecuaname. Their source of water is exclusively wells as during most of the year there are no superficial water sources. See table 1 for a summary of the characteristics of the two projects.

	PIS	CEPS
Municipality	Waslala	La Paz Centro
Start of SODIS project	January 2002	June 2003
Number of participating communities	7	3
Approximate percentage of households using SODIS	20%	80 – 90%
Main water sources	Creeks	Wells
Duration of rainy season	June – February	May – October
Distance to Managua	240km	80km

Table 1: Summary of the characteristics of the projects

PIS has been working in the municipality of Waslala for many years. Their projects aim to improve the general health of the population and involve workshops on a variety of health issues, training of health leaders in many of the communities, and a number of other health-related projects. Seven communities of the municipality are thus far involved in the project of SODIS. The present study took place in two of those, namely in Yaró Central and San Martín las Vallas. A long rainy season and frequent cloud cover during this time make the use of SODIS difficult at times. The sources of water are superficial, consisting of creeks and small rivers (see table 1). The communities in Waslala are much more isolated and remote than those in La Paz Centro; access to many communities is only possible on foot or horse back.

Living conditions are basic in both projects with people reside in houses with dirt floors. They often share their living space with animals such as chickens, ducks, pigs, and dogs, which adds to the dirt. But nonetheless cleanliness is an important value and women spend an important amount of time daily cleaning the house, floors are swept regularly and water is used to clean the dirt floor. Showers are very important, as no one will go

out without having taken a shower. In the area of PIS most people wash themselves in the river, whereas in La Paz Centro people use a bucket to pour water over their head. Even though cleanliness is important, hygiene under these conditions is low.

2. Method

2.1. The sample and the questionnaire

The participating families were chosen more or less by chance and there was certainly no bias regarding accessibility since I interviewed families in very remote locations as well as those living closer to the center of the community. From the project of CEPS 40 families participated in the investigation and 41 took part from PIS. In each community 10 non-SODIS users (in Yaró Central there were 11) and 10 families using SODIS were interviewed as the following figure illustrates.

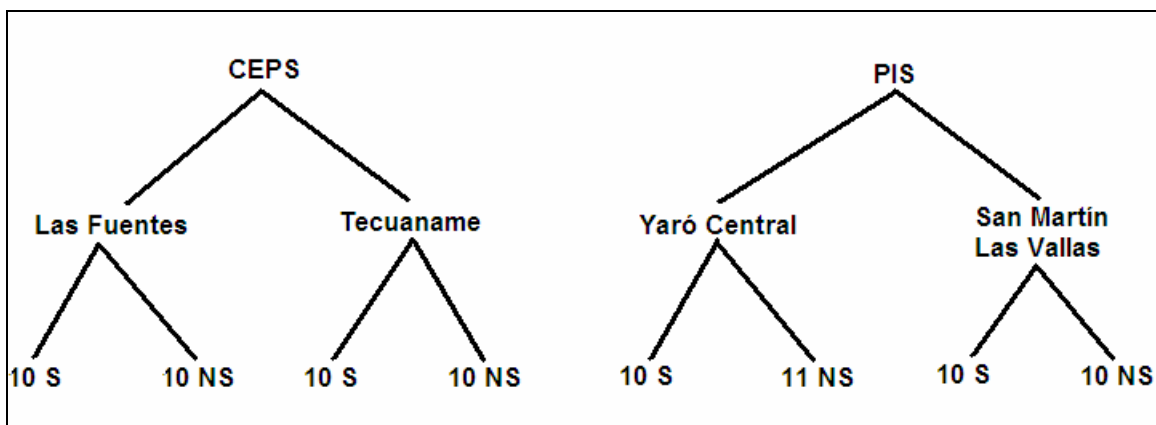


Figure 3: Distribution of interviewed families according to project and community (NS = Non SODIS users, S = SODIS users)

Figure 3 details the distribution of the interviews in the two projects and in the four communities.

The questionnaire covers a range of topics from the basic technical understanding of SODIS, to the number of household members, to their intention to use SODIS in the future. The wide range of questions was necessary in order to explore different factors

which could be responsible for the intention to use the technology. The questions were open and no choice of answers was given in order not to influence the interviewees. The questionnaire was administered in the home of the families with as many members present as possible. Following is a list of the aspects that were studied based on the factors from the model that was explained in the introduction (see figure 1). The item numbers in parentheses refer to the number of the question and the page on which it can be found in the questionnaire (see annex 1).

Convictions

- Trust in the technology (2.2.1.1.4, p.9): This question concerned whether the interviewee trusts that SODIS disinfects the water or not.
- Knowledge about diarrhea (2.2.1.1.1, p.8): the person was asked to explain what causes diarrhea.
- Understanding of the functioning of SODIS (2.2.1.1.1. & 2, p.8): We asked the person to explain how SODIS works.
- Hygiene (1.2.3.3, p.6): in order to obtain a measure of the effort that is made to maintain a certain level of hygiene, the person was asked how much they enforce that their children wash their hands.
- Assessment of the water source (2.1.3.1a, p.17): As part of the question about why they do not treat their water, the comment that their source of water is clean was recorded.

Attitude

- Attitude towards the technology (2.2.2.2.1, p.17): at the end of the part of the questionnaire regarding SODIS, an overall evaluation of SODIS was requested. We asked the person whether they think that overall SODIS is something good or bad.

Social influence

- Social network (3.1.1, p.21-24): the social network includes the number of intensive contacts in the neighborhood, community and project area, as well as the amount of contacts who are using SODIS, the amount of conversations about SODIS, and the assessment of how many people would be willing to help

applying SODIS. These questions were all structured in the same way. The interviewee was asked to indicate how many frequent contacts he or she has with neighbors, community members and people living in the wider project area, then he or she was asked to indicate how many of those use SODIS, again by indicating approximate numbers. The same was done for the other questions in this section.

- Suggestion to purify water (2.2.3.2.1a, p.16): This question asked about whether the person had told others to use some form of water purification.
- Sources of news (3.2.1, p.20): The question read: Where do you hear about news (be it gossip or news items)?
- Source of knowledge about SODIS (2.1.1.4a, p.7): This was a question to determine who had first told the person about SODIS.

External factors

- Water source (1.1.12, p.3): The question read: what is your source of drinking water?
- Water quality (1.2.2.2.1.1, p.4): This question was used to determine how cloudy the water used for SODIS is.
- Information regarding bottles: The assessment of their availability (2.2.5.1.1, p.9) asked whether the amount of bottles available to them is sufficient or whether it influences how much water they can treat with SODIS. The number of bottles (0.3.2, p.1) was assessed by the interviewer by asking to see them.
- Water use and alternative purification methods (1.2.1, p.3): in order to assess the amount of water and the different purification methods used by one household a water inventory was carried out. The family was asked to indicate how much SODIS, chlorine treated, boiled, or untreated water they drink per day. It was also noted how long ago they started to use their purification methods.

Intention

- Intention to continue or to start using SODIS (2.2.4.3.1, p.13): The person was asked to say whether they intend to continue using SODIS or, if they are not a user, whether they think they will try it out or not.

Consequence of behavior

- Reported incidence of diarrhea (1.2.4.2, p.6): The interviewees were asked to indicate how many members of the household had had diarrhea in the past month.

2.2. Socio-demographic description of the sample

The sample consisted of 81 families, all were asked for consent and no family refused to be interviewed. 86% of the persons carrying the main responsibility for the water are women; only 11 men (14%) claimed to be responsible in a significant way. All age groups were represented, the youngest person being 18 and the oldest person 71 years old, not including children.

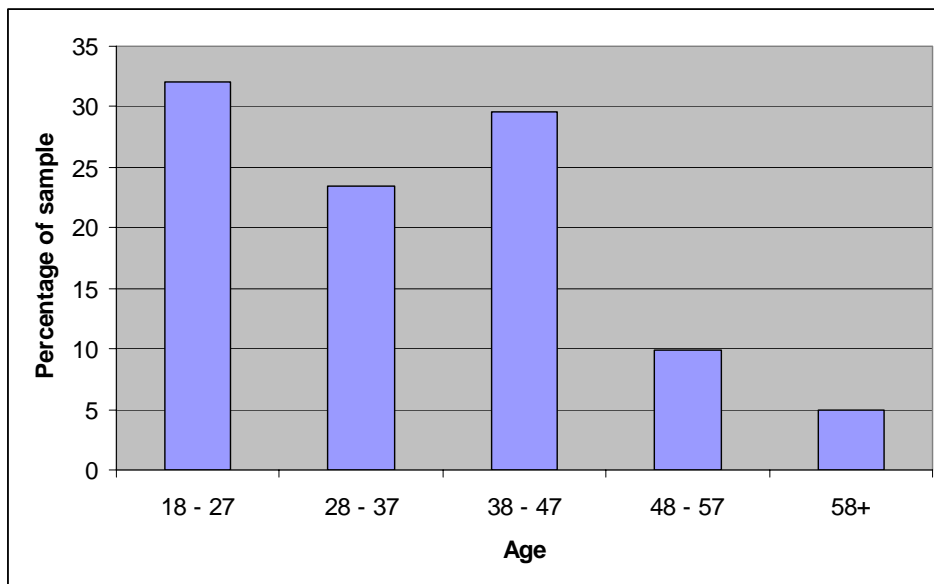


Figure 4: Percentage of the sample pertaining to different age groups

Figure 4 shows that the adult interviewees include all ages. The mean age of the sample is 35 years, not counting the children.

The level of education is low, most people in these areas do not finish their primary school; the average amount of years of schooling is three. 53% of adults living in the project of CEPS have never completed the first year of school nor have 22% of those living in the project of PIS.

Employment is rare in both areas, only 4% of the interviewees mentioned holding a formal or semi-formal job. 80% of the interviewed were housewives (this is related to 86% of the interviewed being women) and 15% were farmers working in their own fields. The few day laborers earn 25 Cordobas per day (approximately 1.60 US Dollars). These jobs are not formal; men are hired based on need. In comparison to this income, a Coca-Cola or Pepsi bottle suitable for SODIS costs 12 Cordobas for 1.5 liters and 14 Cordobas for 2 liters, obviously a significant investment.

The majority of families (64%) had between 4 and 7 members. The maximum amount of members was 12 whereas the smallest household consisted of just two people. 19% had 1 to 3 members and 17% counted with 8 or more members. Some households consisted of more than one family, in this case only one of the two families was interviewed and their use of the water was assessed independently of the second family.

2.3. Analysis of the data

The methods used for the analysis are crosstabulations with two and several fields, correlations, and regressions. Crosstabulations oppose two nominal variables and allow studying their relationship. It is possible to test the relationship between the two variables using the chi-square test. Crosstabulation is for example used to study the relationship between smoking (smoker vs. non-smoker) and lung cancer (yes/no); the test will allow the researcher to say whether there is a significant relationship or not between the two variables. Correlations display the data in a table of several fields and study whether two variables are connected. An example of a correlation could be the more cigarettes a person smokes the more likely he or she is to suffer from lung cancer at some point in his or her life. Last but not least regression looks at the relationship between a dependant variable and one or several independent variables in an attempt to explain their relationship. This procedure is used to determine which factors influence the dependant variable. In the case of SODIS, a regression can indicate which factors influence the use of SODIS and which do not play an important role.

The statistical calculations used in this report to test the correlations or relationships between different variables are chi-square and lambda. The chi-square (χ^2) tests the hypothesis that the row and column variables of a crosstabulation are independent. It does not indicate a strength or direction of the dependency if there should be one. Lambda (λ) measures how well an independent variable predicts a dependent variable. A measure of '1' means that the variable is perfectly predicted, whereas '0' signifies that the independent variable is no help in predicting the dependent variable.

Every time a calculation (chi-square or lambda) is carried out, the probability (p) of the hypothesis being wrong is also indicated. If p equals 0.5 this signifies that there is a 50% chance of wrongly accepting the hypothesis. If p is equal or smaller than 0.05 it is considered as significant, however the smaller the probability to be wrong the better.

The next indicator is N, which is the number of cases used for the calculations. This is important as some statistical calculations require a certain amount of cases in order to be valid. And finally there is the degree of freedom (df) which is a test statistic that is used to determine the observed significance level in the case of the chi-square.

3. Results

3.1. The use of SODIS

A variety of information on the technology of SODIS and its practical application was recorded. These factors play an important role in the decision to use and also in a sustained use of SODIS. Both water quality (it not being too cloudy) and the availability of enough sunny surfaces were never considered a problem. In the project of CEPS the water sources are wells with fairly clear water, in the mountains of Waslala (PIS) the water may be cloudy after rainfalls, but the families either run it through a cloth or they wait until it clears by itself. A major requirement for the use of SODIS is the PET-bottles. Since they are scarce it is important to know how long they last in the use of every day. This question was only asked in the communities of PIS because the project of CEPS was too recent for the families to have to change bottles.

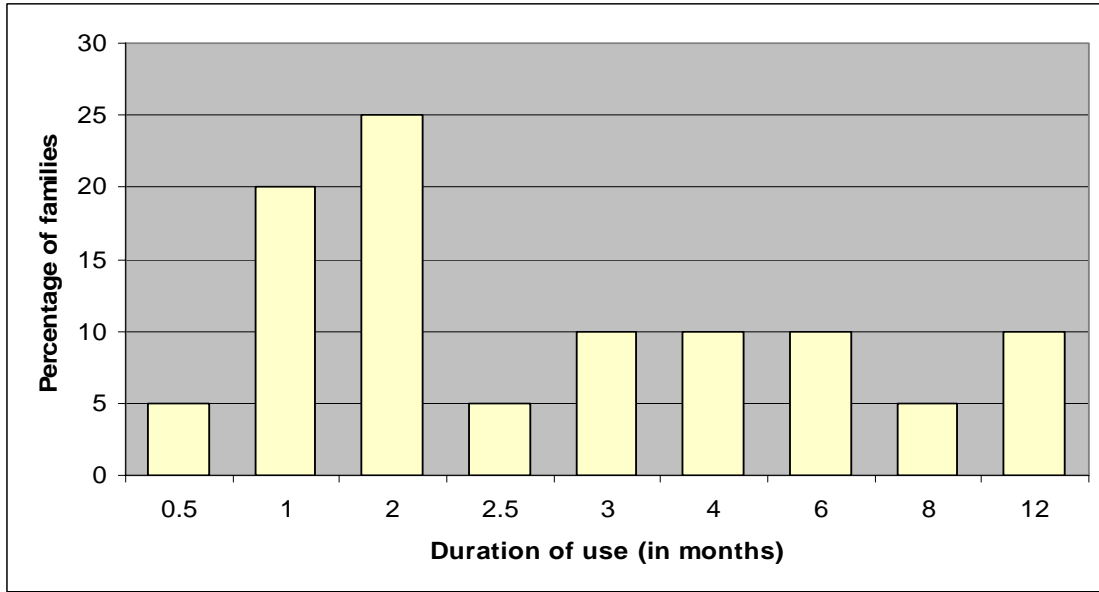


Figure 5: Duration of use of SODIS bottles in months

Figure 5 depicts the answers to the question of how long a SODIS bottle lasts. Half of the families said 2 months or less. Few indicated durations of usage of more than 6 months; the maximum mentioned was 12 months.

The number of bottles owned by one family is insofar interesting as it influences the amount of SODIS water that is consumed. It also gives an indication as to how available bottles are to the families.

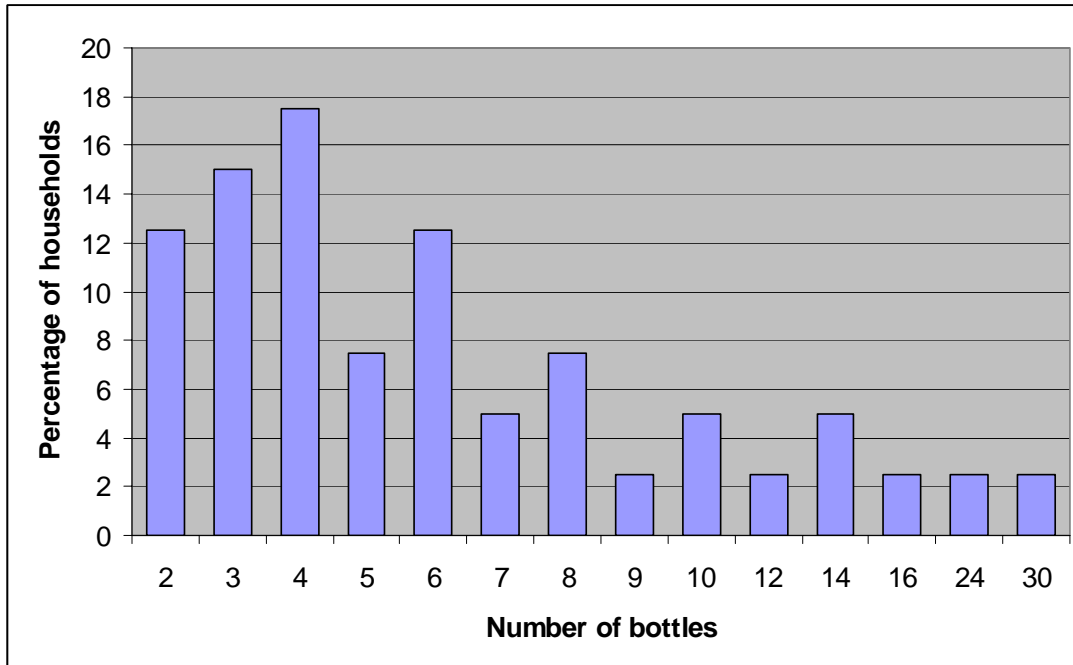


Figure 6: Number of bottles per household

Figure 6 shows the number of bottles per family. Only few families have more than 8 bottles. Most households own between 2 and 6 bottles. The families with 24 and 30 bottles are both families of promoters.

Since not all families are the same size it is also necessary to calculate the number of bottles per person. On average a family has 1.25 bottles per person (standard deviation 0.91). Some families have as little as 0.38 bottles (which is just slightly more than 1/3 of a bottle per person) whereas others have as many as 4.5 bottles per person. Each bottle used for SODIS contains between 1.5 and 2 liters. If we assume they use 1.5l bottles, and have 1.25 bottles per person, each person can drink 1.875 liters per day. Those families who subjectively evaluate bottles as more available are using more bottles for SODIS than those who feel that they are very difficult to obtain ($r=0.443$, $p=0.004$, $N=40$).

In the project of PIS data was collected on both the amount of bottles owned by the family and on how long they last in the daily use. Those who had more bottles also use them for a longer period of time ($\lambda=0.406$, $p=0.002$, $N=21$).

3.2. Knowledge about SODIS

The understanding of the functioning of SODIS is one factor that influences to some extent the trust in the technology and thus also its use. The question required the family to explain how SODIS works, what in fact cleans the water.

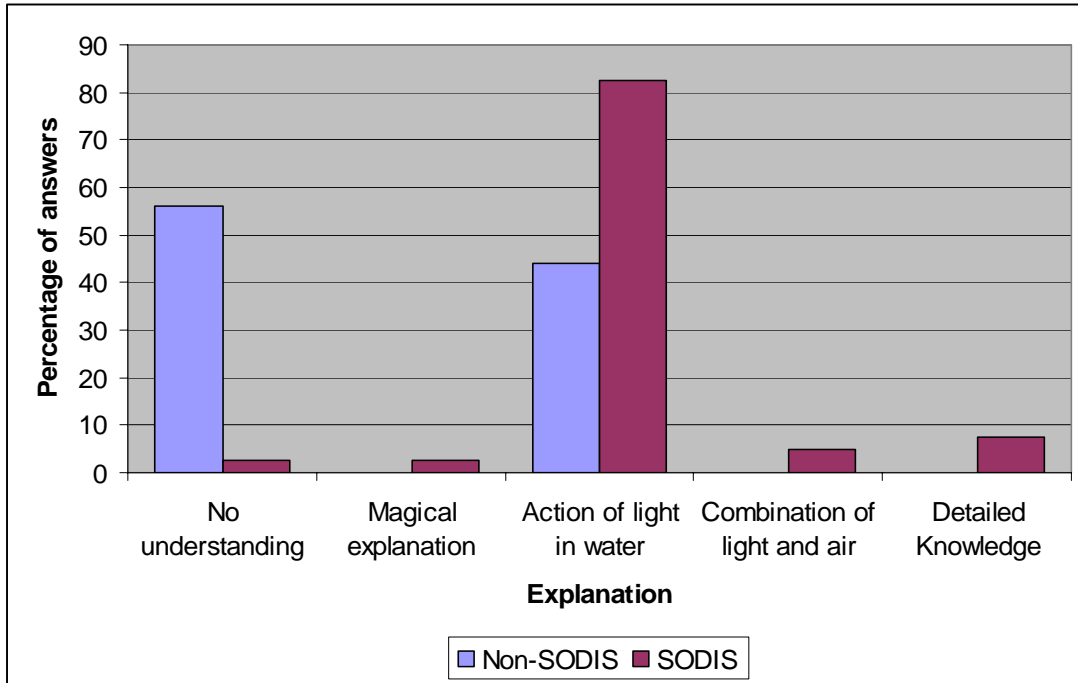


Figure 7: Understanding of the functioning of SODIS by users and non users (in percent)

Figure 7 illustrates the answers given to the question of how SODIS functions according to their knowledge. This question was asked of both SODIS users and non users alike. The figure also depicts the differences between the two. 56% of non SODIS users do not know how the technology works whereas 44% have a basic understanding. Most of the interviewed understand that it is the sun that cleans the water, but only very few have a more detailed knowledge. Although non users demonstrate a fairly good understanding, the knowledge is significantly higher when the interviewed is a SODIS user ($r = 0.596$, $p < 0.000$, $N = 81$).

Commentaries, again from the entire sample, as to how they think SODIS works were also recorded and the following were the most frequent comments:

- “rayos matan” (22 times) – “rays of sunlight kill”
- “no sé” (20) – “don’t know”
- “el sol” (9) – “the sun”

Usually the commentaries concerned rays of sunlight. A few compared it to boiling water (3), one person explained that it is clean because the bottle is closed by the cap and nothing can get in. No one mentioned UV-A rays.

3.3. Convictions and external factors influencing the use of SODIS

Several factors influence the use of SODIS, one of these factors is the possible alternative for water disinfection. The alternatives that are available in the two projects in Nicaragua are buying bottled water, using chlorine and boiling water. Buying bottled water is not feasible for most families in rural areas as the water is expensive and the families have very little income. In the more remote areas bottled water is not even available. Chlorine, on the other hand, is distributed at times by the Ministry of Health (MINSAL). Of the 81 families interviewed 26% use chlorine from time to time. Boiling water is usually not considered an alternative as there are many difficulties to implement it. Most fireplaces only have two positions for pots. The diet is based on rice and beans, which already requires two spots on the fireplace and does not leave room for a pot to boil water. The second problem is that the families own very few pots and therefore they do not have a special pot for boiling water. Generally they either use the pot for the beans or the one for coffee, which gives a distinct taste and coloring to the water. Finally ashes and insects fall into the water and add to the discoloration and particular taste of the water.

Beside these alternatives, other factors more directly related to the application of SODIS also influence its use. The assessment of the availability of bottles is one of them. If there are no bottles available even those willing to use the technology cannot apply it or at least not as much as they would like to.

Assessment of availability of bottles	SODIS users	Non SODIS users
no bottles are available	0	41
very few bottles are available	73	27
enough bottles are available	17	32
An unlimited amount of bottles are available	10	0

Table 2: Assessment of the availability of bottles as evaluated by SODIS users and non users (in percent)

Table 2 shows that those who do not apply SODIS evaluate the availability of bottles as lesser than those who are using SODIS ($\lambda=0.333$, $p=0.005$, $N=77$).

In order to show what factors influence the intention to use SODIS a regression was done. Trust in the technology and the attitude towards SODIS were considered independent variables and their influence on the intention to use SODIS (dependent variable) has been calculated. The attitude was determined by a question regarding the overall feeling toward SODIS by the interviewee. Trust was recorded by asking about how persuaded they are that SODIS purifies the water and measures whether the person considers the water always safe to drink after it has been treated by SODIS or not.

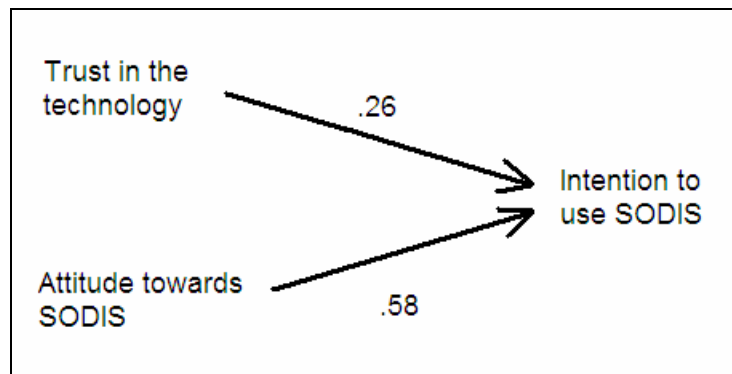


Figure 8: Regression of the influences of attitude and trust on the intention to use SODIS

The regression in figure 8 allows determining how much effect the two independent variables (trust and attitude) have on the dependant variable (intention). The regression

shows that the attitude influences the intention ($\beta=.58, p<0.000$) much more than trust ($\beta=.26, p=0.019$), which means that trust in the technology is less important in the decision to use SODIS than the attitude towards it. In other words, to find SODIS something good is more important than to trust that it really makes water safe to drink.

3.4. Knowledge influencing the future use of SODIS

The decision to use a new technology is influenced by several factors some of which were already treated in the previous chapter, namely trust, the attitude towards the technology and its understanding. An additional factor is whether a connection is made between contaminated water and diarrhea. This is an important aspect as it functions as a motivator to undertake the additional work in order to avoid illness. If this connection is not made, it may also be more difficult to convince the person to use a form of water disinfection as the necessity is not recognized.

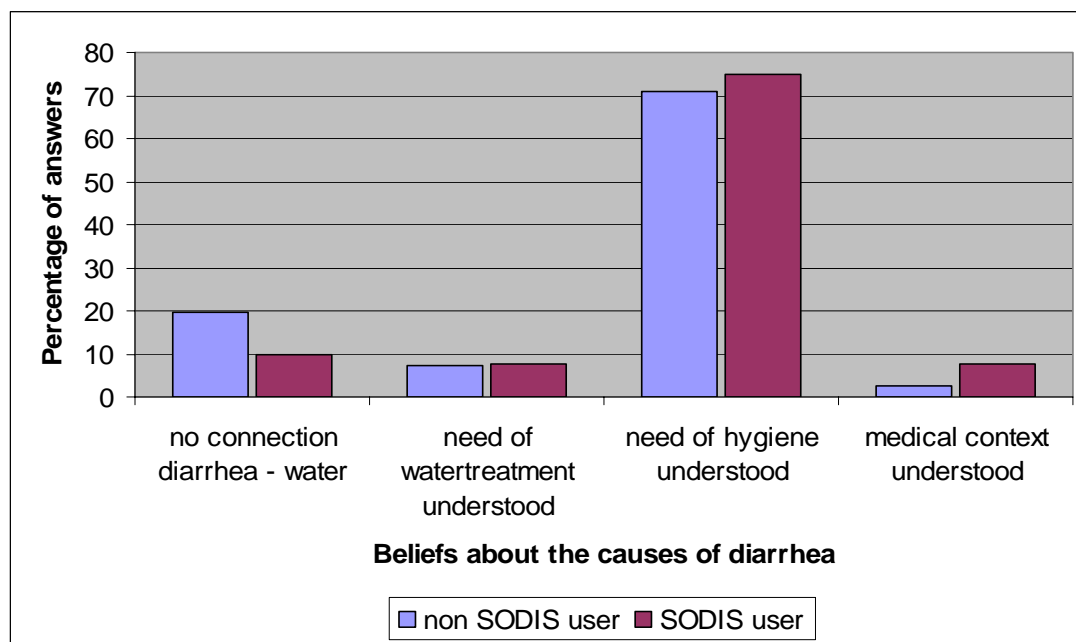


Figure 9: Beliefs about the causes of diarrhea of SODIS users and non SODIS users (in percent)

Figure 9 shows that most families understand the connection between basic hygiene and diarrhea. Basic hygiene includes washing hands and a certain understanding of the fact

that contaminated water can produce diarrhea. 71% of non SODIS users and 75% of users understand this connection. Only very few families understand the theory of bacteria and parasites that can be the cause of diarrhea. A large amount of families who mentioned contaminated water also listed flies (23 families) as the cause of diarrhea. Two declared that it just happens for no reason, one mentioned that a cold can cause diarrhea. It appears that the importance of hygiene and the fact to have clean water do not directly influence the intention to use SODIS in the future ($r=0.201$, $p=0.076$, $N=79$).

Given the families make a connection between contaminated water and diarrhea, they still might not use any form of water disinfection since they believe their water source is clean. This is illustrated with the following figure.

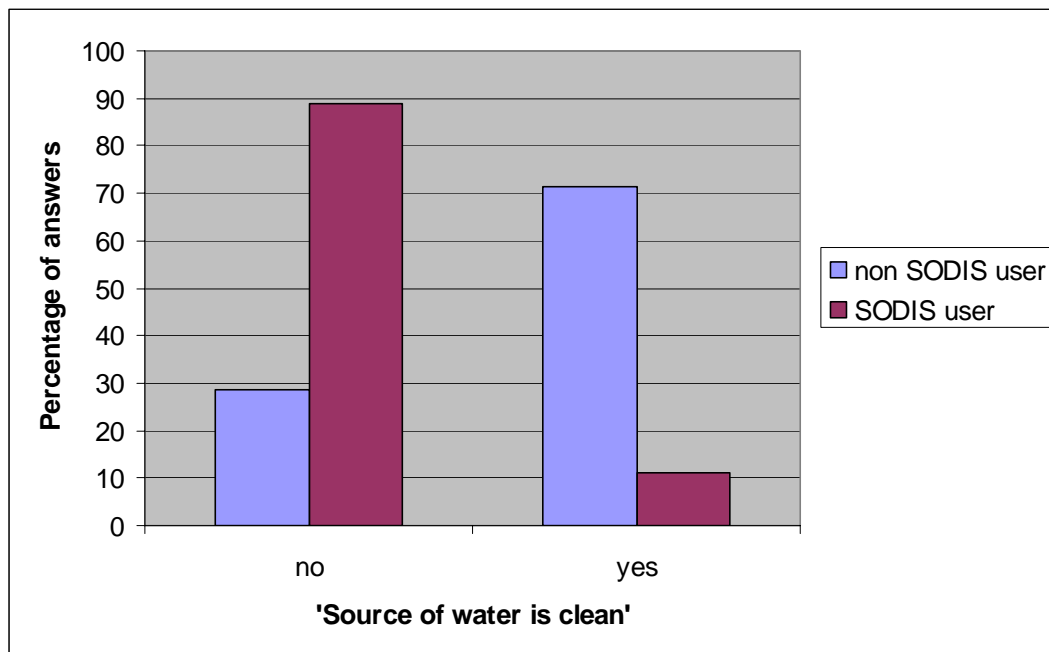


Figure 10: Assessment of the cleanliness of the source of water in relation to SODIS use (in percent)

Figure 10 shows that those who do not use SODIS often believe that their water source is clean; whereas SODIS users are more often persuaded their water is unsafe. It is interesting to note that four SODIS users believe their water is clean and nonetheless they use the technology. Some of those not using SODIS, who admitted that their drinking

water is not clean, were using chlorine and some mentioned laziness as a reason not to use any method to make their drinking water safe. There is a significant relationship between the belief about the cleanliness of the source of water and the use of SODIS. Those who believe the water is clean, use SODIS less than those who believe it is contaminated ($\lambda = 0.259$, $p = 0.013$, $N=44$).

3.5. Influences of SODIS on health

The ultimate objective of the promotion of SODIS is to improve the health situation of families living in areas, which have no access to safe drinking water. The present study shows that SODIS diminishes the reported incidence of diarrhea in a significant way. The calculation of the correlation between the incidence of diarrhea and the use of SODIS shows that those who use SODIS indicate to have a significantly lower incidence of diarrhea than those who do not use SODIS ($r=-0.217$, $p=0.052$, $N=81$).

According to the present data hygiene does not directly affect the incidence of diarrhea incidence ($r=2.954$, $df=2$, $p=0.228$, $N=81$). This means that hygiene is not a distinguishing factor of those using SODIS in comparison to those who do not, or that the lower reported incidence of diarrhea is related to better hygiene than the use of SODIS.

3.6. Spreading the information about SODIS

It is important to evaluate the diffusion of SODIS as this will allow improving future promotion activities. In order to study the diffusion a certain amount of information on the communication patterns and the social network needs to be collected. In a first step the amount of intensive contacts of the person was established in order to find out who they communicate with and to have an indication as to their mobility. An intensive contact was defined by a frequency of almost daily contacts.

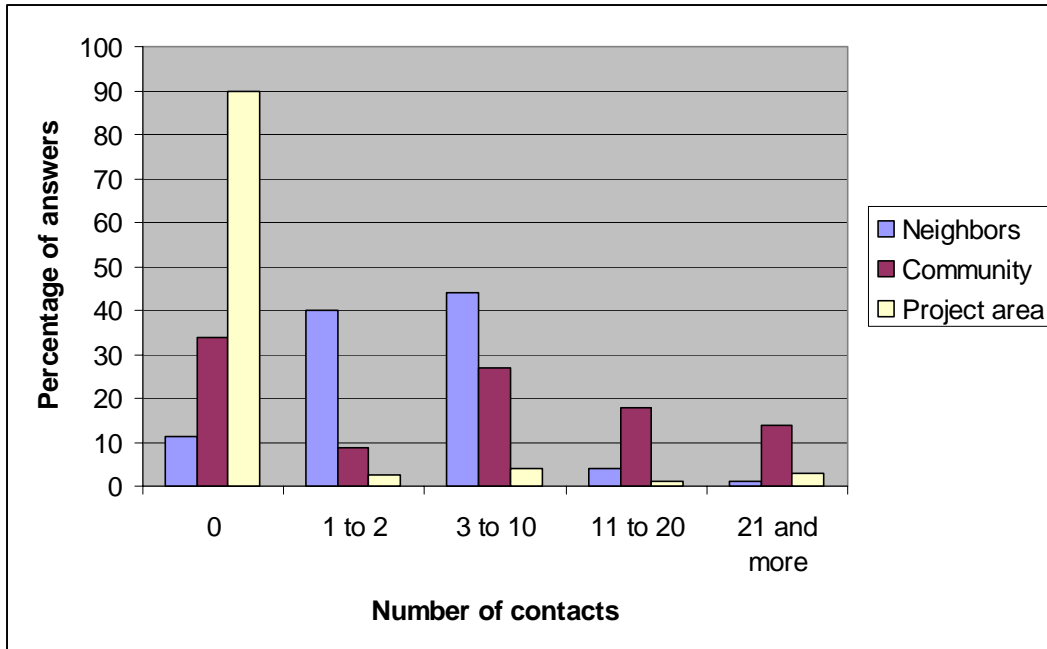


Figure 11: Number of intensive contacts of interviewee (percentage of answers)

Figure 11 illustrates that the most intensive contacts are with neighbors and that most families have very few contacts overall. There are very few exchanges beyond the community level, the project area being defined by all communities involved in the SODIS project (3 communities in the case of CEPS and 7 in the case of PIS). Those who have few contacts with neighbors also have few contacts in the community ($\lambda=0.157$, $p<0.000$, $N=81$).

The evaluation of how many frequent contacts also SODIS is interesting since they might be influenced by their neighbors. SODIS users consistently have more contacts who also use SODIS than those who do not (see table 3).

Contact	SODIS user	non SODIS user
Neighbor	64	34
Community	60	38
Project area	93	51

Table 3: Percentage of contacts SODIS users and non users who also use SODIS

Table 3 shows that those who use SODIS also know more people who apply the technology. Those who do not use SODIS have nearly half as many contacts that also use SODIS.

The hoped for auto-diffusion in the communities has unfortunately not taken place. The diffusion of the technology is almost exclusively done by promoters; 96% of the interviewed say they first heard about SODIS from a promoter, only 4% of the interviewees mentioned first hearing about it either from a friend (2 interviewees) or at school (1). The non SODIS users in Waslala mentioned fewer house visits than those in La Paz Centro.

	SODIS Promoter	MINSAs	Total households visited
CEPS	80	5	85
PIS	38	14	52

Table 4: Percentage of non SODIS user households visited by promoters (MINSAs=Ministry of Health)

Table 4 shows that notably more households were visited in the project area of CEPS than in the area of PIS. Only half of non SODIS users living in the area of Waslala were visited by either a promoter from the Ministry of Health (MINSAs) or from SODIS ($\lambda=0.783$, $p<0.000$, $N=28$).

In order to attain a sustainable application of SODIS it may be important to have a good social network of people who can help to use the technology. Only 32% have helped others with a bottle and this includes the promoters who distribute bottles collected by the project partner. Of the actual users only approximately 10% have given others a bottle. The following figure indicates the number of people who, according to the perception of the interviewee, would be willing to help applying the technology.

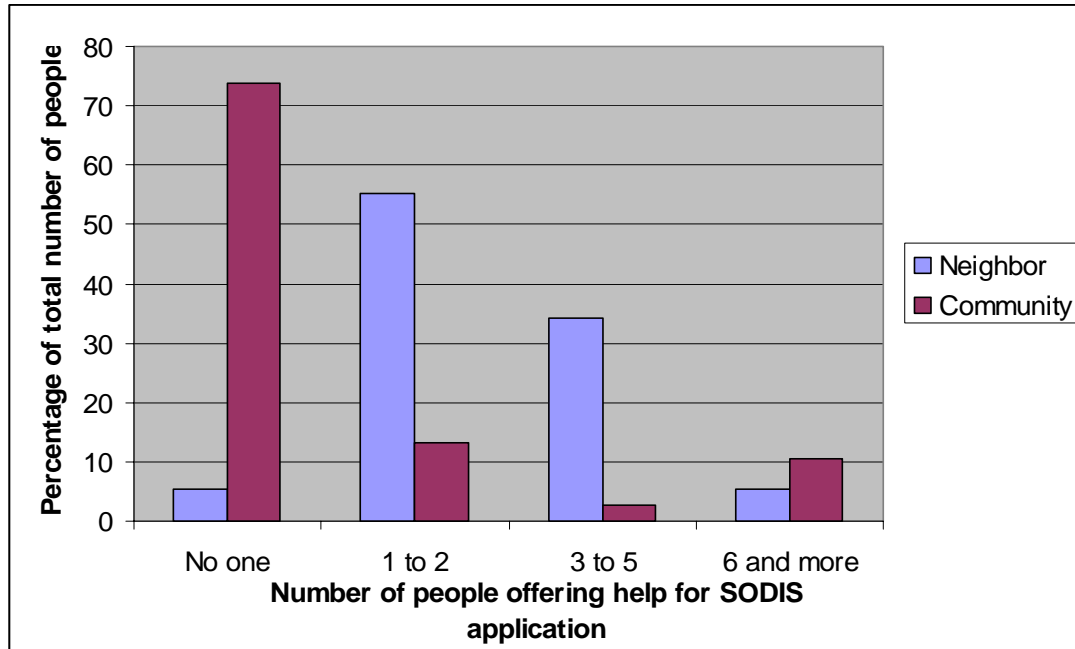


Figure 12: Number of people (neighbors and community members) offering help for the SODIS application (in percent) (nobody mentioned that members of the wider project area would help them, thus they do not appear in the figure).

Figure 12 illustrates the availability of people who would help to apply the SODIS technology should the need arise. This means that the interviewee thinks this person would help him or her to fill the bottles, to put them on the roof, etc. It is not necessarily help with bottles themselves. The figure shows that generally neighbors are perceived as more readily available to help than members of the communities who live further away. This is also connected to the fact that the frequent and intensive contacts are mainly with neighbors and not with community members who live further away.

Conversations about water disinfection and, more in particular, about SODIS are important for the diffusion. Only slightly more than half of the interviewed have suggested to others the use of some form of water purification (54%) in the past, this number includes both users and non-users. The following figure concerns the number of conversations about SODIS on different levels (neighbors, community members, and people from project area).

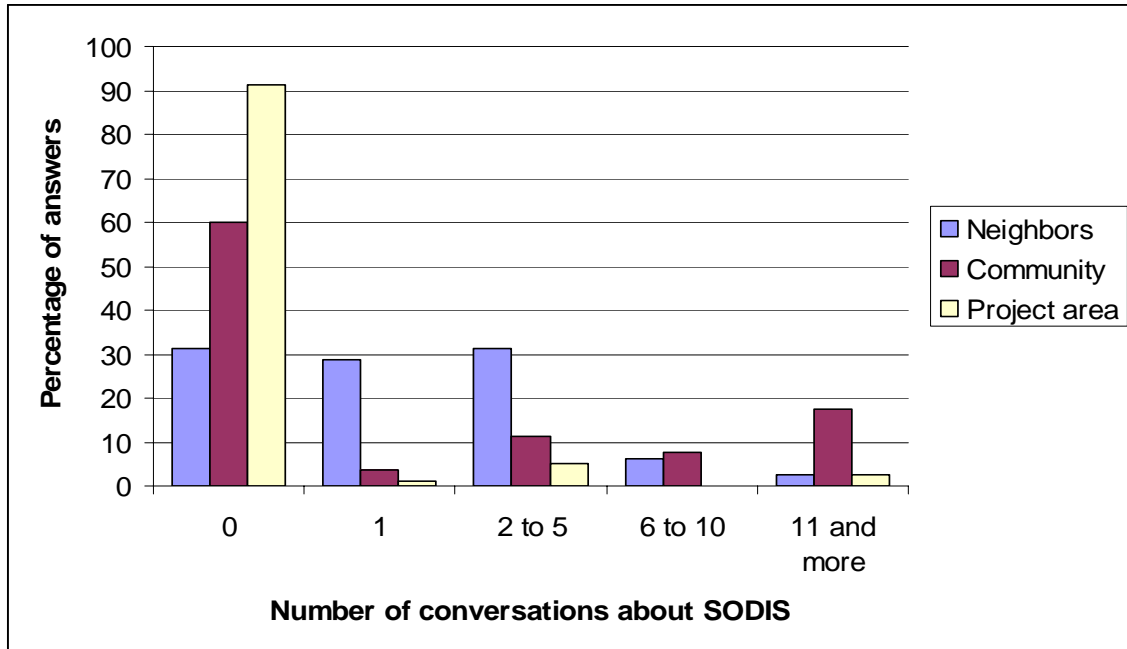


Figure 13: Conversations about SODIS with neighbors, in the community and the project area (percentage of all answers)

Figure 13 shows that most families do not talk very much about SODIS and if they do, they generally talk to their neighbors. The project area is defined as all the communities taking part in the SODIS project (for PIS it is 7 communities and for CEPS 3). The few that indicated 11 or more conversations are mostly promoters for SODIS.

In order to establish the source of news, which could potentially be used to promote SODIS in the future, a question was asked about where the interviewees obtain their news. The following table is a summary of those sources that were mentioned.

	Yes	No
Neighbor	96	4
Friends/relatives	93	7
Radio programs	91	9
Church	15	85
Work colleagues	11	89
Community meetings	10	90

SODIS promoter	6	94
School	2	98

Table 5: Sources of news (in percent)

Table 5 shows that the main sources of news are neighbors, friends and relatives, as well as the radio. The other possible sources are rarely mentioned. Work colleagues are rare because most people work on their own fields or at home and have very little contact with other workers. Formal or semi-formal jobs are scarce, generally they only concern teachers. Radio programs are the source of general news. PIS has used the local radio station in Waslala to promote SODIS. Nobody mentioned newspapers as they do not reach these rural communities, nor do they mention pamphlets or posters which were used in neither project.

3.7. Differences distinguishing the two projects

There is no difference between the two project areas regarding the assessment of the availability of bottles ($\lambda=0.026$, $p=0.731$, $N=77$). In other words the families in both project areas evaluate the bottles equally as available. There is, however, a tendency for households in the projects of PIS to have slightly more bottles, on average 2 bottles more, than those in CEPS ($\lambda = 0.226$, $p = 0.059$, $N = 40$).

One obvious distinction between the two projects concerns the sources of water. In the project area of CEPS the inhabitants exclusively use wells, whereas in the area of Waslala (PIS) everybody uses superficial sources of water, such as rivers and creeks.

	Source of water is clean	
	No	Yes
CEPS	50	50
PIS	28	72

Table 6: Percentage of families per project who think their water source is clean

Table 6 shows that 72% of the interviewees living in the project of PIS say their water is clean, as do 50% of those living in the project area of CEPS. This difference between the

two projects is not significant ($\lambda = 0$, $p=1$, $N=44$). In the case of PIS some of these sources may really be uncontaminated as they come directly from the mountain with no apparent sources of contamination – an analysis of the water would be necessary to establish the level of contamination in those cases. The inhabitants of the municipality of La Paz Centro use wells tapping into ground water, which are likely to have a similar amount of contamination.

The intention to continue using SODIS in the future or to begin using it is slightly higher in La Paz Centro (CEPS) than in Waslala (PIS), this is, however, only a tendency ($\lambda=0.169$, $p=0.125$, $N=44$). However, the most important difference is probably the response to the promotion. In the project of CEPS, at the time of the evaluation, approximately 80% of the families were using SODIS – this after only 2 months of promotion. In the project of PIS only about 20% of the families are using the technology even though PIS has been working in the area for 18 months.

4. Conclusions

4.1. Summary of the results

The most important results concerning the use of SODIS:

- PET-bottles necessary for the use of SODIS last, according to half the families, 2 months or less. On average a family has 1.25 bottles per person at their disposal.
- 56% of non users do not know how the technology works.
- SODIS users assess bottles as more available than those not using SODIS.
- Trusting SODIS is less important than the overall attitude toward it.
- Most families understand the connection between contaminated water and diarrhea. But very few understand the theory of microbiology (bacteria, viruses and parasites).
- Over 70% of non SODIS users are convinced their source of water is clean and those who believe their source of water is clean use SODIS significantly less often than those who believe their source of water is contaminated.
- The use of SODIS significantly diminishes the reported amount of diarrhea cases, even if other measures to improve hygiene are taken into account.

The acceptance of SODIS is important. SODIS is being used and it is being used for some time. It does not seem to be important to know exactly how the technology works, but it seems to be important to deem SODIS something good. The main obstacle to not use SODIS is when the person believes his or her source of water is clean or when he or she thinks that bottles are difficult to come by. The use of SODIS appears to reduce the number of reported incidences of diarrhea; independently of the family's other efforts at hygiene. The effect could be even stronger if more bottles per person were made available.

The most important results regarding the diffusion of SODIS:

- 96% of the interviewed first heard about SODIS from a promoter.
- 10% have provided others with a bottle to help them use SODIS.
- In the family's perception, mostly neighbors would be willing to help them apply SODIS, and then usually only 1 or 2.
- 54% have suggested the use of some form of water disinfection to others (this includes the promoters who were interviewed).
- Very few conversations about SODIS have taken place and then almost only with neighbors.

The promotion activities alone do not lead to the use of SODIS, the other factors of the SODIS application have to be taken into account for the diffusion as well. The auto-diffusion of SODIS through neighbors, friends, and relatives has not yet been used, although possibilities do exist.

The most important results regarding the distinguishing factors between the projects:

- In both projects the interviewees assess the availability of the bottles as the same, saying that bottles are difficult to obtain.
- The sources of water in Waslala are creeks and small rivers, whereas in La Paz Centro they are wells.

- The intention to continue using SODIS in the future or to start using it is slightly higher in La Paz Centro than in Waslala.
- More households were visited by SODIS promoters in La Paz Centro than in Waslala.

The differences between the two projects are not as important as expected. The main differences are geographical in nature, besides the response to the promotion, and not so much based on the factors regarding the use of SODIS.

4.2. Remarks

Nicaragua is one of the poorest countries of Central America and the inhabitants of the rural areas, in which the SODIS take place, live in very basic conditions. Houses mostly have dirt floors, animals share the living space and there is no running water, and only some families have latrines. Nonetheless there is a strong culture of cleanliness. Women spend a large amount of time cleaning the house and the surrounding area daily, they carefully wash clothes and nobody leaves the house for the day without having taken a shower (either in a river or using a bucket). Despite these efforts hygiene is not very good, which is partly due to contaminated drinking water and this is where SODIS becomes an important factor to help improve these family's lives.

The present study has shown that the basis for the application of SODIS is present, the families have access to more or less clear water (cloudy water making it difficult or impossible for the sun to destroy the microbes) and there are enough surfaces to lay the bottles in the sun. To obtain the bottles themselves is a problem. Even though bottles are available for purchase only very few families have enough money to actually buy them. Employment is rare and income is low, which forces them to rely on the partner organizations to collect bottles in cities and to distribute them in the communities. This has worked fairly well so far in both projects, but it may not be sustainable indefinitely. Alternatives to SODIS are rarely used for a variety of practical reasons. Boiling is an unviable option because of the lack of room on the stove and the lack of an appropriate pot. Using chlorine is done sporadically when the Ministry of Health provides chlorine

for free. Most of the families who are non users do not utilize any other form of water disinfection. Those who use SODIS often commented to me that they like it because it is very quick and basically requires no work, referring to the fact that it only takes a few minutes to fill the bottles. Nobody complained about the amount of time they have to wait until the water is safe to drink, namely about 6 hours, although it seems that this could be a large hindering factor. A comment that was often made about SODIS is also that the water tastes delicious; some even attributed 'healing' qualities to it.

The knowledge about the functioning of the technology is very basic. SODIS users and non users, as well as promoters lack a detailed knowledge of the mechanism that purifies the water. This, however, does not affect the use of the technology as trust based on the understanding of how SODIS works is less important than the overall attitude toward it. Contrary to the approach in our western culture, trust seems not to be the most important factor when deciding to use a new technology. The question to be asked is how sustainable a positive attitude is or how long it is going to motivate the person to invest the necessary time to prepare the bottles. Perhaps an approach that makes sure the deeper necessity for the purification of water is understood as well might help people to stay motivated longer, it is however possible that the overall attitude is sufficient. The present study can not provide an answer to this question as a longitudinal study would be necessary.

The spreading of the information about SODIS depends on the geographical layout of the communities, the more houses are spread out the fewer can be visited by a promoter in a day's work. This is a very important factor since promoters seem so essential in the diffusion of SODIS. Another influence on the diffusion might be how much people talk about water and contamination. In the project area of PIS many interviewees commented that water is simply no topic of conversation, thus making it more difficult for SODIS to spread without the help of a promoter. In the case of CEPS people said that they often talk about water. This might be due to the fact that in La Paz Centro (CEPS), a dry area, a large effort has to be made in order to obtain water, whereas in Waslala (PIS) plenty of creeks and rivers are near. It could be possible that in La Paz Centro an auto-diffusion

would have taken place, but all households were visited by a promoter in the first two months of the project, informing every family of the new technology, thus the auto-diffusion is neither necessary nor possible anymore. An interesting comment made by a few non users was that they never had ‘official’ training to use SODIS and therefore could not use it. This indicates that they have a respectful view of the technology and do not think themselves to be capable of applying it without proper training. This fact might reduce the impact of the diffusion of the information about SODIS, because if they do not use SODIS as long as they have not had an official workshop, the auto-diffusion is unsuccessful.

The obtained results regarding the reported incidences of diarrhea are certainly very encouraging in view of the fact that a significant reduction in the incidence of diarrhea illnesses has been demonstrated in those families using SODIS. This all the more positive since some of these families probably also drink some contaminated water when they run out of safe water to drink. This result should be an encouragement to continue promoting SODIS as it has a great potential to improve the health of many families.

4.3. Recommendations

In order to achieve a higher level of auto-diffusion, people attending workshops on SODIS should be encouraged to teach their neighbors. Conversations could be held about how to convince others of the advantages of the technology; maybe even role plays could take place. There is certainly potential for auto-diffusion, even if there is low mobility in the communities and people have few contacts, they still talk to their neighbors and relatives.

In order to reduce the respect of the technology that might keep people from using SODIS, this issue should be addressed during training sessions as well. An attempt to make them more comfortable with training others could help to increase the auto-diffusion of SODIS.

I also suggest a more systematic distribution of collected bottles as it seems to me that they happen at random and it looks like favoritism at times. I would suggest that families with only 2 bottles receive an additional bottle, until every family has at least three bottles, then everybody receives an additional bottle, etc. until all families have as many bottles as they need.

5. Appendix

5.1. The Questionnaire