

ABSTRACT

Title of Dissertation: A MEMETIC/PARTICIPATORY APPROACH
FOR CHANGING SOCIAL BEHAVIORS
AND PROMOTING
ENVIRONMENTAL STEWARDSHIP
IN JALISCO, MEXICO.

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This dissertation addressed the issue of sustainable development at the level of individual behaviors. Environmental perceptions were obtained from people living around the biosphere reserve Chamela-Cuixmala in Jalisco, México. Several environmental issues were identified by the people, such as garbage and grey water on the streets, burning plastics, and the lack of usage of recreational areas. All these issues could be addressed with a change in behavior by the villagers.

Familiarization activities were conducted to gain people's trust in order to conduct a community forum. These activities included giving talks to school children and organizing workshops.

Four different methodologies were generated using memetics and participation to test which would ameliorate those environmental issues identified by the people through a change in behavior. The methodologies were 1) Memes; 2) Participation and Memes; 3) Participation; 4) Neither Participation nor Memes.

A meme is an idea expressed within a linguistic structure or architecture that provides it with self-disseminating and self-protecting characteristics within and among the minds of individuals congruent with their values, beliefs and filters.

Four villages were chosen as the treatments, and one as the control, for a total of five experimental villages. A different behavior was addressed in each treatment village (garbage, grey-water, burning plastics, recreation.) A nonequivalent control-group design was established. A pretest was conducted in all five villages; the methodologies were tested in the four treatment villages; a posttest was conducted on the five villages. The pretest and posttest consisted in measuring sensory specific indicators which are manifestations of behavior that can either be seen, smelled, touched, heard or tasted.

Statistically significant differences in behavior from the control were found for two of the methodologies 1) Memes ($p=0.0403$) and 2) Participation and Memes ($p=0.0064$). For the methodologies of 3) Participation alone and 4) Neither, the differences were not significant ($p=0.8827$, $p=0.5627$ respectively).

When using memes, people's behavior improved when compared to the control. Participation alone did not generate a significant difference. Participation aided in the generation of the memes. Memetics is a tool that can be used to establish a linkage between human behavior and ecological health.

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by

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DEDICATION

To my parents

To my family in Old Greenbelt

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It is a cliché to say that one could not have accomplished this work without the help of others, but it is totally true. Without the advice of my committee members, the cooperation of the people in the Chamela region, the support of my parents and friends, there is no way you would be reading this dissertation.

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TABLE OF CONTENTS

List of Tables	xii
List of Figures	xiii
1 Problem Statement	1
1.1 Background and significance of the problem	1
1.2 Purpose of the study	6
1.3 Research Questions	7
1.4 Operational Definitions	10
1.5 Contribution to the Field	11
1.6 Limitations of the Study	12
1.7 Organization of the Study	13
2 Review of Related Literature	17
2.1 Sustainable Development	17
2.1.1 Operational Definition	17
2.1.2 Historical background	19
2.1.3 Sustainable Development and Ecological Economics	22
2.1.4 The bottom-up approach, People first	25
2.2 Memetics	27

2.2.1	Definition and Antecedents	27
2.2.2	Memes and the Environment	32
2.3	Participatory Development	34
2.3.1	Historical Background	34
2.3.2	Participatory Development and Sustainable Development .	38
3	Methods and Results	40
3.1	Methods Phase I. Assessment of environmental perceptions	42
3.1.1	Choosing a region. The tropical dry forest	42
3.1.2	The Tropical Dry forest	43
3.1.3	Choosing a locality	45
3.1.4	Assessment of environmental perceptions	49
3.1.5	Census information	53
3.2	Results Phase I	54
3.2.1	Interview results	54
3.2.2	Census results	65
3.3	Methods Phase II. Setting up the Experiment	65
3.3.1	Familiarization	66
3.3.2	Indicators	70
3.4	Results Phase II	72
3.4.1	Familiarization results	72
3.4.2	Indicator results	72
3.5	Methods Phase III. Pretest	73
3.6	Methods Phase IV. Treatments	76
3.6.1	Community Forum	78
3.6.2	Making the memes	83

3.7	Methods Phase V. Posttest and Statistical Analysis	85
3.7.1	Statistical analysis	86
3.8	Results Phase III, IV and V	87
3.8.1	Participation and memetics treatment. Garbage indicator. .	88
3.8.2	Memetics, no participation treatment. Recreation indicator. .	91
3.8.3	Participation, no memetics treatment. Grey water indicator. .	96
3.8.4	No participation, no memetics treatment. Fires indicator. .	98
4	Discussion	101
4.1	Assessment of environmental perceptions	101
4.2	Familiarization	113
4.3	Experiment	114
4.4	Concluding Comments	119
4.5	Further Research and Action	124
A	Appendix. Migratory bird talks	127
A.1	Talks in English	127
A.2	Talks in Spanish	130
B	Appendix. Bird drawings	134
C	Appendix. Cookbook	143
C.1	Recetas de Chamela	143
C.1.1	Introduction	144
C.1.2	Ensaladas	145
C.1.3	Verduras	148
C.1.4	Carbohidratos y Proteinas Vegetarianas	153

C.1.5	Pescado y Pollo	162
C.1.6	Postres y Panes	170
D	Appendix. Templates to measure indicators	179
E	Appendix. Raw data and SAS code	184
E.1	Raw data	184
E.1.1	Garbage	184
E.1.2	Grey water	190
E.1.3	Recreation	196
E.1.4	Fires	200
E.2	SAS code. Garbage	206
E.2.1	Villa	206
E.2.2	Pérula	213
E.2.3	San Mateo	216
E.2.4	Zapata	220
E.3	Gray water	223
E.3.1	Zapata	223
E.3.2	Pérula	226
E.3.3	San Mateo	229
E.4	Recreation	232
E.4.1	Pérula	232
E.4.2	Villa	235
E.4.3	Zapata	239
E.5	Fires	242
E.5.1	San Mateo	242

E.5.2	Villa	245
E.5.3	Pérula	248
E.5.4	Zapata	251

Bibliography	253
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LIST OF TABLES

3.1	Sex of the dominant person in the interview. In most interviews it was a female that tended to answer most of the questions and give more input to the conversation.	57
3.2	Age groups	58
3.3	Origin of interviewed people and their parents	59
3.4	Environmental issues identified by the respondents	61
3.5	Solutions proposed by the respondents	62
3.6	Knowledge of biological station	64
3.7	XII 2000 Census Information	65
3.8	Garbage Scale	75

LIST OF FIGURES

1.1	Memetics/Participation figure. Each village (A to D) received a different treatment. Four behaviors were addressed, one in each village. A fifth village (E), was the control.	3
1.2	Nonequivalent control-group design as implemented in this work. Five villages were chosen -out of seven- as the experimental villages. The pretest was conducted on those five villages. The treatment was conducted on four villages, leaving the control out. Then the posttest was conducted on the five villages again.	8
2.1	Tools and approach used in this Sustainable Development experiment.	18
2.2	The three spheres, from Passet, 1979. Here it is made explicit that the economy is a subsystem of the social human sphere, and the social sphere is a subsystem of the biosphere.	19
2.3	The finite global ecosystem relative to the economic subsystem. Notice how in the second world, the economic subsystem has grown to the capacity of the global ecosystem. Figure adapted from Costanza et al.(1997).	25
2.4	Building Development, where personal development is the base, and necessary to support the rest of the sustainable development building. Figure adapted from Burkey (1996).	28

3.1	Map of México with different ecological zones.	43
3.2	The Biological station IB-UNAM is part of the Biosphere reserve. . . .	44
3.3	Tropical dry forest in the dry season. Hawks are curious and follow people along the trails in the biosphere reserve.	45
3.4	Location of the Biosphere Reserve Chamela-Cuixmala.	46
3.5	Tropical dry forest in the dry season. All the trees lose their leaves. . .	48
3.6	Tropical dry forest in the rainy season. All the trees are lush green. . .	49
3.7	Pre-hispanic pieces found along the San Nicolas river.	50
3.8	Nonequivalent control-group design as implemented in this work. Phase I of the experiment outlined. Open ended interviews were conducted in seven villages to assess people's environmental perceptions.	51
3.9	Typical main plaza with a gazebo at the center. Here we were in the town of Zapata playing hide and go seek with some local kids.	54
3.10	Town of Chamela. Typical houses of wood sticks or adobe.	55
3.11	Town of Villa. House made of bricks, nicely painted and decorated. . .	55
3.12	Nonequivalent control-group design as implemented in this work. Phase II of the experiment outlined. Activities for the familiarization period were conducted, and indicators were identified for the five experimental villages.	66
3.13	Fifth grade children in the town of Villa showing their drawings of migratory birds.	69
3.14	Birthday party for Alvaro. His wife, Leonor; sister in law; and mother in law are in the picture. He painted the piece that can be seen on the wall.	70

3.15	Nonequivalent control-group design as implemented in this work. Phase III of the experiment outlined. The pretest is conducted by visiting all five villages in the experiment. The four indicators are measured in each village.	74
3.16	Nonequivalent control-group design as implemented in this work. Phase IV of the experiment outlined. The different treatments were applied to the four treatment villages only, following the memetics/participation diagram.	76
3.17	The Memetics/Participaton diagram delineates which village received which treatment, and which behavior was be addressed in each village.	77
3.18	Forum in Zapata. The outcome formulation questionnaire was written out on big pieces of paper.	81
3.19	Young women that attended the forum in Villa. They helped to create the language of the memes.	84
3.20	Researcher posting the memes in the local stores.	85
3.21	Nonequivalent control-group design as implemented in this work. Phase V of the experiment outlined. The posttest was conducted in all five experimental villages. All four indicators were measured in each village.	86
3.22	Garbage means comparing the pretest and posttest in every village. Quémáro was the control. Villa was the treatment with participation and memetics.	89
3.23	Differences of the means for each town. The mixed procedure in SAS compares the difference of the control, Quémáro, to the differences of the other villages. The only statistically significant differences were those of Villa and San Mateo.	90

3.24	Recreation means comparing the pretest and the posttest in every vil- lage. Quémáro was the control. Pérula was the treatment with memetics.	92
3.25	Differences of the means for each town. The mixed procedure in SAS compares the difference of the control, Quémáro, to the differences of the villages. There was a statistically significant difference for the town of Pérula.	93
3.26	Grey water means comparing the pretest and the posttest in every village. Quémáro was the control. Zapata was the treatment with participation.	97
3.27	Differences of the means for each town. The mixed procedure in SAS compares the difference of the control, Quémáro, to the differences of the other villages. There were no statistically significant differences. .	98
3.28	Fire means comparing the pretest and the posttest in every village. Quémáro was the control. San Mateo was the treatment.	99
3.29	Differences of the means for each town. The mixed procedure in SAS compares the difference of the control, Quémáro, to the differences of the other villages. There were no statistically significant differences. .	100
4.1	Three generations of women in the town of Ranchitos. Notice their adobe home and ornamental plants.	103
4.2	This house in the town of Zapata was littered with papers, plastic bags, and bottles. A close up of the bushes to the right is in the next figure.	104
4.3	Close up of trash along the road. It is not uncommon to see streets littered like this.	105
4.4	Kids hanging out and looking for chacales in the town of villa, Cuixmala river.	108

4.5	Cuixmala river.	109
4.6	Cows coming home in the evening. Town of Zapata. Notice the dirt roads and brick buildings typical of the area.	111
4.7	Relative location of the villages to one another. The arrows indicate connections or disconnections between the villages.	117
4.8	Ecological economics is the intersection of society, economy and ecology.	120
4.9	The intersection of society, economy and ecology can be viewed at different scales.	121
4.10	Sustainable development figure. The intersection of society, economy and ecology can be viewed at different scales and through time.	122
4.11	Outing on San Nicolás stream with some kids from the town of Quémaro at the end of the research period.	125
B.1	Baltimore Oriole.	135
B.2	Orchard Oriole.	136
B.3	Eastern Blue Bird.	137
B.4	Least Fly Catcher.	138
B.5	Tecolote llanero. <i>Athene cunicularia</i>	139
B.6	Chipe rojo. <i>Tangara rojinegra</i>	140
B.7	Colibri gorjirrubio. <i>Archilochus colubris</i>	141
B.8	Colibri.	142
C.1	Doña Eva.	145
C.2	Doña Elena.	146
D.1	Template for garbage pretest and posttest.	180
D.2	Template for burning plastics pretest and posttest.	181

D.3	Template for grey water pretest and posttest.	182
D.4	Template for recreation pretest and posttest.	183

Chapter 1

Problem Statement

You must be the change you want to see in the world.

Gandhi

1.1 Background and significance of the problem

The human population has reached a size that makes imperative a reconsideration of natural resource use. As human beings, we are encroaching on all ecosystems of the planet, crowding out or exploiting other species. We are using renewable resources at rates that make it impossible for nature to replenish them. We are dumping wastes into nature at higher rates than nature can process. We are using non-renewable resources much faster than we are discovering viable alternatives. In sum, our behavior, on average, is not sustainable in the long term (Sachs, 2001; Costanza et al., 1997; Daly and Townsend, 1994).

“The concepts of diversity and sustainability have the drawback that they limit freedom, as presently understood. Most people will not accept such limits without understanding that freedom was never intended as license; rather it entails *personal restraint* and the exercise

of duties to the larger community... There can be no freedom amid social chaos or in a state of ecological ruin. This level of sophistication requires that people understand the linkages between *human behavior* and *ecological health*, and thereby comprehend how the world works as a system” (Orr, 2003).

Our wellbeing and existence, as well as the wellbeing and existence of future generations, is being compromised by our careless behavior. Addressing the issue of behavior as it relates to the environment is one means of confronting the challenge of sustainability. The present dissertation explores a methodology based on memetics and participatory development with the objective of addressing this global problem of environmental degradation at the local level of villages in the Chamela-Cuixmala region of Jalisco, México.

This study set out to inquire about the environmental perceptions of the habitants of seven small villages around the Chamela-Cuixmala biosphere reserve. Based on that initial assessment, four villages were selected to receive different treatments utilizing a different permutation for each village of the combination of memetic and participatory techniques (Figure 1.1). Village A (Villa) was treated with memetics and participation addressing behavior A (Garbage on the streets). Village B (Pérula) was treated with memetics but not participation addressing behavior B (Recreation). Village C (Zapata) was treated with participation and no memetics addressing behavior C (Grey water on the streets). Village D (San Mateo) was treated with neither memetics nor participation addressing behavior D (Burning plastics). Village E (Quémaro) was not treated with anything and no behavior was addressed. The researcher had no contact with the control except on the initial interviews, the pretest and the posttest.

	Memetics	No Memetics	
Participation	Village A Villa	Village C Zapata	
No Participation	Village B Perula	Village D San Mateo	Village E Quemaro

Figure 1.1: Memetics/Participation figure. Each village (A to D) received a different treatment. Four behaviors were addressed, one in each village. A fifth village (E), was the control.

A different behavior was addressed in each village. The researcher was interested in possible leakages of behaviors from one village to another. The different treatments were aimed at changing careless behaviors toward the environment and replacing them with more friendly behaviors¹. Four environmental concerns were conveyed, one to each village, in a participatory or non participatory way; using memetics or not using memetics.

The four environmental concerns addressed in the experiment were selected based on the initial household interviews conducted in the area and on the familiarity with the region. The results of the household interviews indicated the most pressing environmental issues for each village. The concerns shared by the people were tallied. The issues that were mentioned by a high proportion of people (between 67 and 100 percent) were considered to be major. Those issues that could be addressed with a change in behavior on behalf of the residents, and that were mentioned by the majority of the people, were chosen to be addressed by the experiment.

¹In this dissertation the term “environmentally friendly behavior” will be used in reference to a behavior that *the people* denote as being better for their environment and that does not cause pollution. This term will be further defined in the “Operational Definitions” section.

The theories of memetics and participatory development were tested in their ability to aid behavioral change. Memetics studies memes². Memetics is an applied tool for cognitive change. A meme is an idea imprinted in the mind and expressed in the behavior of the individual. Memes enter the cognition of an individual and are reflected in the form of behavior. Participatory development is development generated with the help of the population in question.

Based on the theory of memetics it was expected that the villages treated with memes (village A and B) would change their behaviors to more environmentally friendly ones. However, the researcher was not sure about the impact that a participatory technique might have in changing behavior. Perhaps it was the participation and not the memes that aided people in ameliorating their behaviors. Perhaps having both memes and participation would yield the most positive change in behavior, hence the use of the memetics/participation diagram for testing all permutations of memetics and participation.

The rationale behind choosing villages around the Biosphere Reserve Chamela-Cuixmala rests on the importance of the tropical dry forest which is the main ecosystem of the region. Of the tropical forests, the tropical dry forest is the one disappearing at the fastest rate (Ceballos and Garcia, 1995; Mittermeier et al., 1999). In order to save what is left of the tropical dry forest, the lands that now comprise the reserve were set aside. However, the reserve by itself is not enough to preserve this ecosystem, hence the need for the villages around the reserve to be aware of the importance of the tropical dry forest and to change their behaviors to environmentally friendly ones (Ceballos and Garcia, 1995).

²All terms will be further defined in the operational definition section, and will be discussed in the literature review.

As the first phase of this study, an assessment of environmental perceptions and behaviors was conducted in seven villages around the biosphere reserve Chamela-Cuixmala. Ninety households were interviewed in order to assess the usage of natural resources and the environmental perceptions of the villagers around the biosphere reserve. The results of the interviews were somewhat perplexing. Whereas the biosphere reserve deems the problem of loss of animal and plant diversity, together with erosion, to be the the most important environmental issues in the region (Ceballos and Garcia, 1995; Ayala, 1998), the people in the villages deemed the problem of garbage and waste on the roads, lack of sewage alternative, burning plastics, and not being able to use the streams recreationally as the major environmental problems.

The scientists and the people, therefore, do not have the same hierarchy of environmental problems. Although they both mention the same problems, the order of importance is very different. This study addressed the environmental problems that *the people identified as being an issue to them* utilizing participatory and memetic methods in combination or by themselves. The purpose of this study was to test which permutation of the memetics/participation figure was most efficient in encouraging people to change their behaviors.

1.2 Purpose of the study

Based on the initial assessment of the environmental perceptions of villages around the Biosphere reserve Chamela-Cuixmala, the purpose of this study was to examine the impact of an experimental approach utilizing memetics and/or participatory development techniques, to change environmentally careless behaviors, *identified by the subject villages*, to environmentally friendly behaviors. This study was carried out in five villages in the Chamela-Cuixmala region. The study also ascertained whether the changes that occurred in one village were adopted by members of the other villages.

The experiment was carried out in the Chamela-Cuixmala region utilizing memes. A meme is an idea, belief, or memory containing a specific substantive message, such as “good client service at a grocery store is to give plastic bags with every purchase”. But not all ideas are memes. A meme is an idea expressed within a structure or architecture that provides it with self-disseminating and self-protecting characteristics within and among the minds of individuals, congruent with their values, key beliefs, and filters (de Bivort, 2001; Dugatkin, 2000). Self-disseminating means that people tend to verbalize this idea or act in a certain way so that the idea gets copied by another individual, and the new individual in turn verbalizes the idea or acts in a certain way so that another individual copies the idea, and so on. Self-protecting means that those individuals that have the meme will reject new conflicting ideas (de Bivort, 2001; Jeffreys, 2000; Brodie, 1996; Blackmore, 1999; Dugatkin, 2000).

Four villages were selected as the treatment villages where the different permutations of the memetics/participation diagram were carried out. A different environmental behavior was addressed in each village. A fifth village was se-

lected as the control. Changes in behavior were assessed via sensory specific indicators³ recorded before and after the experiment, following a “nonequivalent control-group design”. Even though each village was addressed with a different behavior, the indicators for all four behaviors were recorded in all five villages in order to be able to measure the possible dissemination of ideas or memes among villages.

1.3 Research Questions

The first question for this work was to identify people’s perception of their environment and natural resource use in order to identify which people’s needs could be addressed by a simple change of their behavior.

The second question for was whether there was a difference in behavior in each of the four treatment populations, when each of them is exposed to a different permutation of the memetics/participation diagram. The general hypothesis was that the populations exposed to memes would demonstrate a change in the behavior addressed, whereas the populations exposed to non-memetic ideas would not demonstrate a change in the behavior addressed. The third question for this work was whether the memes would diffuse to other populations.

To test the memetics/participation permutation, a “nonequivalent control-group design” experiment was conducted. Figure 1.2 shows the approach taken in this work. The nonequivalent control-group design is a popular approach to quasi-experiments in which the treatment groups (A to D) and the control group (E) are selected without random assignment. All groups take a pretest and a

³Sensory specific indicators are manifestations of behavior that can either be seen, smelled, touched, heard or tasted.

posttest. Only the treatment groups receive the treatments (Creswell, 1994).

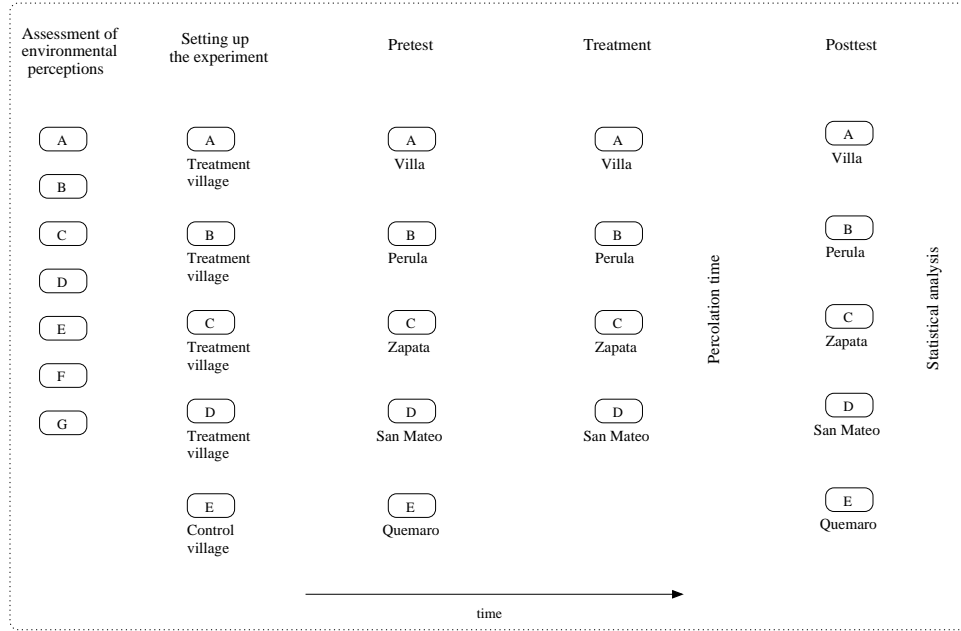


Figure 1.2: Nonequivalent control-group design as implemented in this work. Five villages were chosen -out of seven- as the experimental villages. The pretest was conducted on those five villages. The treatment was conducted on four villages, leaving the control out. Then the posttest was conducted on the five villages again.

For this dissertation several null hypothesis (H_0) were tested. Each null hypothesis is coupled with an alternative hypothesis (H_a). Null hypothesis one: In village A (Villa), where a meme was generated in a participatory manner, there would be no change in the environmental behavior addressed in that village (garbage on streets) before and after the treatment.

Alternative hypothesis one: In village A (Villa), where a meme was generated in a participatory manner, there would be a change in the behavior addressed (garbage on streets) before and after the treatment.

Null hypothesis two: In village B (Pérula), where a meme was generated in a non-participatory manner, there would be no change in the environmental behavior addressed in that village (use of recreational site) before and after the

treatment.

Alternative hypothesis two: In village B (Pérula), where a meme was generated in a non-participatory manner, there would be a change in the behavior addressed (use of recreational site) before and after the treatment.

Null hypothesis three: In village C (Zapata), where a non-memetic idea⁴ was conveyed in a participatory manner, there would be no change in the environmental behavior addressed in that village (grey water on streets) before and after the treatment.

Alternative hypothesis three: In village C (Zapata), where a non-memetic idea was conveyed in a participatory manner, there would be a change in the environmental behavior addressed in that village (grey water on streets) before and after the treatment.

Null hypothesis four: In village D (San Mateo), where a non-memetic idea was generated in a non participatory manner, there would be no change in the environmental behavior addressed in that village (burning plastics) before and after the treatment.

Alternative hypothesis four: In village D (San Mateo), where a non-memetic idea was generated in a non-participatory manner, there would be a change in the environmental behavior addressed in that village (burning plastics) before and after the treatment.

Null hypothesis five: There would be no indication of dissemination of environmentally friendly behaviors from one village to another.

Alternative hypothesis five: There would be indication of dissemination of

⁴A non-memetic idea is an idea expressed in a linguistic structure that has no memetic intent. That is, it has no intent of self-replication nor self-protection.

environmentally friendly behaviors from one village to another.

1.4 Operational Definitions

Memetics is a relatively new field and there is some debate as to the exact definition of meme (Blackmore, 1999; Dugatkin, 2000; Dawkins, 1982). For the purposes of this study, a meme is an idea expressed within a structure or architecture that provides it with self-disseminating and self-protecting characteristics within and among the minds of individuals congruent with their values, key beliefs and filters (de Bivort, 2001). This study hypothesized that memes might be used as an efficient way to create effective behavioral change in individuals.

Participatory assessment is defined as a method by which certain information about a population is collected with the help of the population in question. The population participates in the provision of the information and the processing of the data. This study hypothesized that memes generated in a participatory manner might be the most effective in generating behavioral change.

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their needs (Brundtland, 1987). This study tried to ascertain if one or more of the methodologies tested can be used to help people meet their present needs by addressing their perceived environmental concerns.

An environmental behavior is an interaction between a person and his or her environment. In this study environmental behaviors were identified by the people as being good or harmful for themselves and/or for the environment.

Environmentally friendly behaviors are those that tend to protect natural capital (air, soil, water, ecosystems). An environmentally friendly behavior is the

most benign way to behave with respect to the natural environment. For instance, garbage on the streets was identified as negative for the environment. Throwing garbage on the streets was identified as an environmentally unfriendly behavior. Not throwing garbage on the streets (collecting it at home) was identified as an environmentally friendly behavior.

1.5 Contribution to the Field

This study is intended to contribute to the fields of sustainable development and of memetics. It aims to identify and tackle, at a grassroots level, certain behaviors which are not environmentally friendly and thus do not lead to environmental sustainability. According to Burkey (Burkey, 1996), sustainable development is like a building where its base is human or personal development. Without addressing the base of the building first, he claims, no successful further development can be done. I agree with Burkey, and thus attempted in this work, to test whether memetics and participation can be utilized as a tool to strengthen the base of the sustainable development building. In doing so, this study also shed some light on the field of memetics by comparing the effectiveness of the different treatments (the permutations of the memetics/participation diagram) on behavioral change in four populations.

Information gathered in seven villages as phase one of this study, identified the people's perceived environmental problems that could be ameliorated by a change in behavior. Four villages were then used to test the four treatments of the memetics/participation diagram. In each village, one previously identified environmental behavior was addressed utilizing one of the different permutations. A "nonequivalent control-group design" was followed. A pretest was done in five

populations, the different treatments were performed in four of the populations, and a posttest was performed in all five populations.

This research was intended to test whether a viable alternative for generating behavioral change towards environmental stewardship can be developed in a rural village.

1.6 Limitations of the Study

The first limitation to this study is the fact that it is exploratory. To my knowledge, memes have not yet been constructed with the help of the subject population in order to generate environmentally friendly behaviors. The theory of memetics is relatively new and has not been extensively tested.

This study is also limited in that it deals with a small area in one country. It tackles one behavior at a time, one small community at a time. Also, it does not deal with government policies, nor the impact of large corporations on the environment. Thus, this study addresses only the most local level, that of the individual and his or her behavior. While it has a local scope, the expectation is that, with some modifications, this methodology might be applied in localities elsewhere.

Another limitation is the fact that the definition for an environmentally friendly behavior is a subjective one. What might be considered benign for the environment in some cases, might be considered harmful in other cases. However, for this study, the behaviors in question are very basic and there is not much dispute as to what the better alternative would be. It is important to mention that this might not be the case in other situations or in more complex circumstances.

1.7 Organization of the Study

The first objective for this study was to identify people’s environmental perceptions and environmental concerns that could be ameliorated with a change in behavior. Open-ended interviews were conducted to achieve this goal. Ninety households were interviewed in seven villages. Each household interview consisted in four to six people participating in the conversation.

Based on this initial assessment of people’s environmental perceptions, the second objective of this study was to conduct a “nonequivalent control-group design” experiment to see whether environmental stewardship memes had an effect on the individuals exposed to them. The third objective was to see if the memes spread throughout the treatment population and then later to neighboring populations. The “nonequivalent control-group design” (Figure 1.2) is a popular approach to quasi-experiments in which the treatment groups (A to D) and the control group (E) are selected without random assignment. All groups take a pretest and a posttest, and only the experimental groups receive the treatments (Creswell, 1994).

The memetics/participation diagram was followed (Figure 1.1). In each village, a different behavior was addressed. This allowed the researcher to ascertain whether a behavior addressed in one of the villages disseminated into other villages. The behaviors were analyzed via sensory-specific indicators. Since there are four villages, there were four behaviors to be addressed, and thus four indicators. All four indicators were measured in all the villages (A to D), including the control (E). According to the “nonequivalent control-group design” methodology, the indicators were measured before and after the experiment.

SAS mixed procedures were utilized to conduct the statistical analysis. T tests

were conducted on the continuous data (garbage on the streets, burnt plastics) and logistic analysis was performed on the categorical data (grey water on the streets, lack of usage of recreational site) in order to indicate significant differences of the behaviors before and after the experiment.

This study was divided in five Phases, with several steps to each phase. Following is an outline of these steps.

Phase I. Assessment of environmental perceptions

The objective of this phase was to choose a region and locality in which to work, and to conduct an assessment of people's environmental perceptions and behaviors towards the environment. Choosing the locality was done based on the interests of the researcher and on the relevance of the area. The assessment interviews were made in order to establish the degree of environmental awareness of the people of the region, to identify people's behaviors that damage the environment, and to contrast their perceived environmental problems with those of the biological station.

Another objective of this phase was to further research census information of the villages. Based on that knowledge, the experimental villages were chosen and the environmental behaviors that could be modified were identified.

Phase II. Setting up the Experiment

Within phase II, a period of familiarization was established in the populations. Familiarization is a very important step in the methodology of participatory development (Bustillos and Vargas, 1996; Medellin Morales, 2001; Gran, 1983). Also, appropriate indicators for this study were selected (Hart, 1999).

Phase III. Pretest

In this phase, the five populations (A:Villa, B:Pérula, C:Zapata, D:San Mateo,

E:Quémáro) were visited in order to observe whether the chosen sensory-specific indicators of stewardship behavior were appropriate. All four indicators were measured in all five villages. People were interviewed regarding the best days and times to measure certain indicators. And on the towns where participation was to occur, people were interviewed regarding the best way to convoke people to a forum.

Phase IV. Treatments

In this phase, the four treatment populations (A:Villa, B:Pérula, C:Zapata, and D:San Mateo) each received its treatment following the memetics/participation diagram (Figure1.1).

Village A (Villa) was gathered in a forum and a meme of environmental stewardship – addressing the behavior of throwing garbage onto the streets – was generated with the help of the population in a participatory manner. After the forum, the generated memes were posted in all the village stores, and in the school, using posters.

Village B (Pérula) was exposed to an environmental meme – addressing the behavior of recreational use– generated by the researcher without the help of the population. Posters were made with the meme and posted in all the local stores and at the school.

Village C (Zapata) was gathered in a forum and the behavior of grey water on the streets was discussed with the help of the population in a participatory manner. No meme was constructed. Posters were made informing the people of the theme discussed with no intent of memetic architecture, and posted in all the local stores and school.

Village D (San Mateo) was exposed to a different environmental issue (burning plastics) with no participation. No meme was constructed. Posters were made and posted in the local stores and school.

Phase V. Posttest and Statistical Analysis

In this phase, a posttest was made to see whether there were changes in the environmental behaviors of the experimental populations. The evaluation was made via the indicators to see whether there was a change of the target behaviors and to observe whether the memes or ideas diffused to other villages.

Chapter 2

Review of Related Literature

This dissertation draws ideas from different theories and methodologies, and utilizes them to carry out research on sustainable development. Figure 2.1 shows the tools and approach utilized. Sustainable development, alongside the theories and methodologies of memetics and participatory development, forms the basis of the following discussion. Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their needs (Brundtland, 1987). This dissertation addresses the present needs of a group of villages surrounding a biosphere reserve in the hope that the natural capital will be available for future generations as well. The methodology here developed utilizes ideas from participatory development and memetics.

2.1 Sustainable Development

2.1.1 Operational Definition

As mentioned in previous sections, sustainable development is development that meets the needs of the present without compromising the ability of future gener-

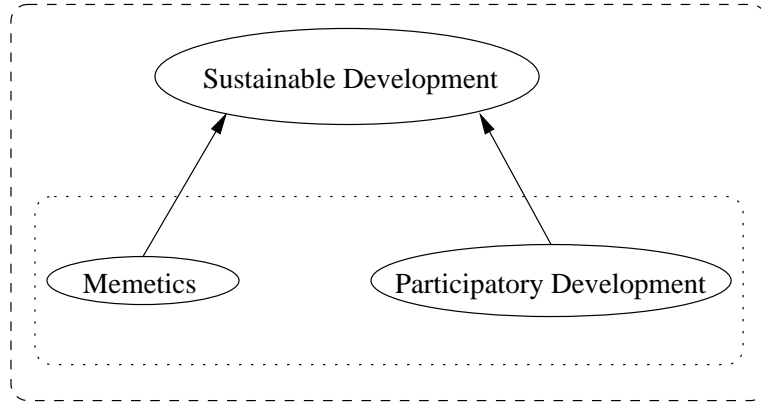


Figure 2.1: Tools and approach used in this Sustainable Development experiment.

ations to meet their needs (Brundtland, 1987). In this sense, sustainable development is the amelioration of the human condition without degrading the natural resources that allow for our existence and that of our descendants. The field of economics studies how humans utilize scarce resources, how they are distributed and allocated. Ecological economics considers the human subsystem as a part of the greater natural system. Thus, sustainable development can be defined as a form of economic development in which the environmental consequences of economic activity are fully taken into account (Costanza et al., 1997). Sustainable development is based on the use of resources that can be replaced or renewed and therefore are not permanently depleted. It represents a process of changes in economic structure, organization and activity, where human needs are met indefinitely without degrading the biosphere (Braat, 1995). It represents a process of changes that must begin with a change of human behavior at all levels: personal, economical, political and social (Burkey, 1996).

Sustainable development is the maintenance of the total natural-capital stock at or above current levels. If humans are to achieve sustainability, the economy must be viewed in its proper perspective, that is, as a subsystem of the larger eco-

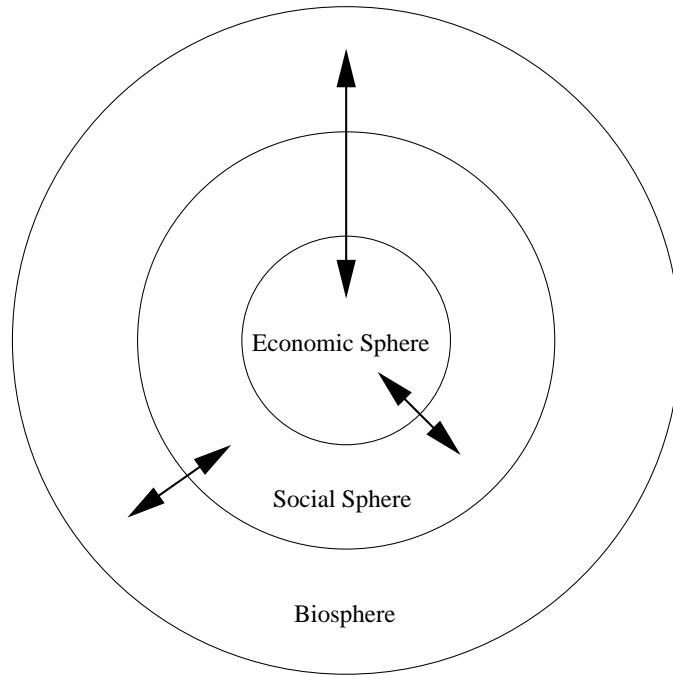


Figure 2.2: The three spheres, from Passet, 1979. Here it is made explicit that the economy is a subsystem of the social human sphere, and the social sphere is a subsystem of the biosphere.

logical system of which it is a part (Costanza and Daly, 1992). Passet's (1979) concentric spheres (Figure 2.2) show the shift of paradigm *from* traditional economics *to* sustainable development and ecological economics, where the economic sphere is within the realms of the social sphere, which in turn is within the biosphere.

2.1.2 Historical background

In recent years the concept of sustainable development has attracted academic, political and popular attention; it was the focus of the Earth Summit in Rio de Janeiro in June, 1992; and it was the focus of the Rio + 10 conference in Johannesburg 2002. Before that, the term sustainable development was mentioned in the Cocoyoc conference in 1974 (Weber, 1995), but was formally brought to

the attention of the international community by the ‘Brundtland Report’ in 1987 (Brundtland, 1987), and was defined as “...development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

In the past, awareness of and respect for the earth and all living things can be traced back to the 5th century B.C. and the teachings of Empedocles who said that the earth is matter and all matter is living. In ancient Greece, governors of provincial properties would be rewarded or punished according to the condition of the land in their jurisdiction; eroded lands could be the cause of exile, whereas well managed lands would warrant praise (Cornwell, 1997). Many cultures around the world have praised their environment and have used it in a sustainable manner thanks to the implementation of rules and traditions on the usage of certain resources. Some authors have studied common land and have researched case studies from around the world that show how small-scale common property systems have been -and continue to be- successful and durable (Bromley, 1992).

The realization that human activities cannot overstep the constraints imposed by the natural environment is the foundation of the concept of sustainability (Cornwell, 1997). In Europe, scientific writings pertaining to environmental constraints on development can be dated to the fifteenth century (Cornwell, 1997). In Japan, constraints on the usage of natural resources to avoid over-exploitation can be documented back to the twelfth century, but the practices are believed to have occurred for at least on thousand years before that (McKean, 1992).

The evolution of economic thought cannot be disassociated from the evolution of the perception that people have with respect to nature, and hence of sustainable

development (Passet, 1979). Awareness of the limits of the natural environment on development became more prevalent in eighteenth century Europe. For the physiocrats (for instance Quesnay and Turgot), humans were dominated by the natural order, and society should respect this order because richness comes from nature (Locatelli, 2000).

For the classical economists (for instance Smith, Malthus, Ricardo, Mill and Say), natural resources were abundant; what was important was the reproduction of the economic system (Locatelli, 2000). Nonetheless, the book “An inquiry into the Nature and Causes of the Wealth of Nations” (1776) written by Adam Smith (1723-1790) is considered the starting point of modern economics and the academic concern about the relationship between people’s living standards and their physical environment (Colander and Coats, 1993; Cornwell, 1997). Furthermore, at the end of the eighteenth and beginning of the nineteenth century Robert Malthus (1766-1834) made explicit the fact that if human populations increase faster than the food supply, there will be inevitable disastrous consequences including war, famine, and disease that act as checks. To avoid those calamities, he proposed, the increase in population can be reduced by moral restraint (Colander and Coats, 1993). Malthus’ predictions were made palpable in 1846 with the collapse of the Irish population due to potato crop failing¹ (Cornwell, 1997).

¹The collapse of the Irish population is just one of the fairly recent examples of large scale environmental constraints on humans. Other examples include the collapse of the Mayan population around 900 A.D., apparently due to overpopulation in the tropical rain forest of Mesoamerica and to agricultural practices that were not sustainable (Hooker, 1999); or the collapse of the first literate human society around 1800 B.C. in Mesopotamia, most likely due to the irrigation practices that led to salinization and waterlogging (Cornwell, 1997). The advocates of sustainable development want to avoid the calamities that result of the misuse of

For the neoclassic economists of the latter half of the nineteenth century (Warlas, Jevons), however, the market was their main theme of focus (Locatelli, 2000). All the way into the 1960's natural resources and environment are *not* conspicuous in economic theory (that is more than one hundred years!). But from the 1970's on there is a surge in environmental awareness as well as a surge of development theories. After the optimism of the decades of the 50's and 60's regarding the economic growth of underdeveloped countries as a solution to poverty and hunger, the 70's were more sceptical: the debts of the poor countries were increasing and the social inequalities had grown; the pollution of the environment and the over-exploitation of natural resources were rampant; all in a context of great demographic growth (Locatelli, 2000). In 1972, the Club of Rome put out a report entitled "Limits to growth" in which the exhaustion of the stocks of natural resources is predicted if population growth and consumption patterns continue (Van Dieren, 1995). Development in terms of economic growth was not solving the problem; a shift had to be made towards development in terms of getting better, towards sustainable development (Daly and Townsend, 1994).

2.1.3 Sustainable Development and Ecological Economics

The origins of sustainable development are found in three main theoretical bodies: ecodevelopment, ecological economics, and neoclassical economics (Godard, 1994).

Ecodevelopment emerged in the 70's as a reaction against the "bad development" of previous decades². Its proponents wanted harmony between man and natural resources.

² "maldeveloppement" in French, from Sachs, 1980 cited in (Locatelli, 2000).

nature, but they proposed extremely radical rules that marginalized the theory (Godard, 1994; Locatelli, 2000).

For the neoclassic economists, the degradation of the environment is considered a capital loss. But to them, the loss of natural capital is not viewed as a problem if there are substitution mechanisms, and if the efficiency of the usage of natural resources is improved. According to Godard (1994), this type of sustainability would be called “weak”.

According to ecological economics, the total natural-capital stock should be maintained at or above current levels (Locatelli, 2000; Costanza and Daly, 1992). If there is an environmental degradation, it should be compensated by the rehabilitation of other natural capital elements. This type of sustainability would be called “strong” (Godard, 1994), and it is supported by the precautionary principle, and the notions of incertitude and irreversibility. Ecological economics posits that in order to have sustainable development, limits to the size of the economy must exist (Daly, 1994).

The promotion of sustainable development requires a trans-disciplinary approach involving an organized and cooperative team-effort with participants from many fields. The field of ecological economics points out the diversity of disciplines needed for sustainable development and state four points of consensus that form the basis to achieve a sustainable-development-oriented policy (Costanza et al., 1997). These points of consensus are:

1. The earth is a thermodynamically closed and non-materially growing system, with the human economy as a subsystem of the global ecosystem. There are limits to “biophysical throughput” of resources from the ecosystem, through the economic sub-system, and back to the ecosystem as

wastes. The throughput is defined as the population number multiplied by the per capita resource consumption, that gives the total flow (throughput) of resources from the ecosystem to the economic subsystem and back to the ecosystem as waste.

2. Given the limited nature of resources, the field recognizes the importance of a fair distribution for both humans and other species.
3. Fundamental uncertainty is significant and irreducible when analyzing flow of energy or matter through complex systems like the Earth at all space and time scales. Certain processes are irreversible.
4. Institutions and management should result in simple, adaptive and implementable policies based on a sophisticated understanding of the underlying systems which fully acknowledges the underlying uncertainties.

Costanza *et al.*(1997) point out that

The current dilemma for our species can be summarized in ecological terms as follows: we have moved from an early successional “empty world” (empty of people and their artifacts, but full of natural capital) where the emphasis and rewards were on rapid growth and expansion, cutthroat competition, and open waste cycles, to a maturing “full world” (see Figure 2.3) where the needs, whether perceived by decision makers or not, are for qualitative improvement of the linkages between components (development), cooperative alliances, and recycled “closed loop” waste flows.

In sum, ecological economics proposes that mankind can develop towards a better life or a higher degree of welfare without having population growth nor

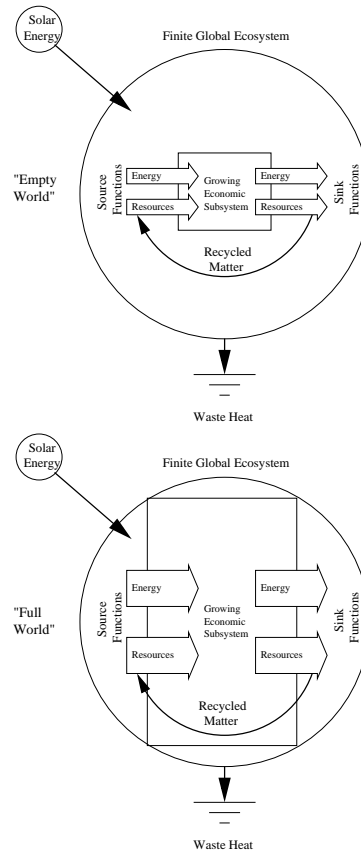


Figure 2.3: The finite global ecosystem relative to the economic subsystem. Notice how in the second world, the economic subsystem has grown to the capacity of the global ecosystem. Figure adapted from Costanza et al.(1997).

throughput growth, within the constraints of the earth as a thermodynamically closed and non-materially growing system. Ecological economics posits that the earth has a “limited capacity for sustainably supporting people and their artifacts determined by combinations of resource limits and ecological thresholds” (Costanza et al., 1997).

2.1.4 The bottom-up approach, People first

In order to reach sustainability all people need to have a shared vision of the way the world functions and a shared vision of the sustainable society we wish to cre-

ate. Having everyone accept the sustainability ‘pre-analytic vision’ or ‘paradigm’ is important in order for people to have a dialog on everyday behaviors and on the policies to be followed, agree on them, and thus achieve the goal of sustainable development (Daly and Townsend, 1994; Costanza et al., 1997).

It would be safe to say at this point in time, that the majority of the people in the world do not share the same pre-analytical view posed by ecological economics. This likelihood raises a fundamental question: how do we achieve a practical, shared vision of both the way the world works, and of the sustainable society in which we wish to live? How can we share with people the propositions of sustainable development and ecological economics? How can everyone’s behavior be in accordance with these ideas?

There are many ways of answering these questions, and many approaches and methodologies can be employed. This research confronts this issue from a grassroots perspective with the intention of bringing about change from the ground up. The aim of this dissertation is to effect behavioral change with an approach that combines different ideas, that of memetics and participatory development embedded in sustainable development.

Burkey (1996) has envisioned a diagram of the different kinds of development needed in order to achieve sustainable development. This diagram is helpful in defining the scope of this dissertation, that is, how to attain a shared vision of the way the world functions and a shared vision of the society in which we wish to live in order to effect behavioral change. In his diagram, Burkey makes evident the importance of developing from the bottom up - people first. He explicates that development in any meaningful sense must begin with, and within, the individual. “Unless motivation comes from within, efforts to promote change will

not be sustainable by that individual” (Burkey, 1996).

Figure 2.4 represents Burkey’s (1996) idea of sustainable development. It is the figure of a building. There are two columns, a roof and a base. One column represents economic development, the other political development. The roof represents social development and the base, human (personal) development. All types of development - together - yield sustainable development, but without the base of human and personal development, the other types of development can not occur. This dissertation focuses on behaviors identified by the four experimental villages as being problematic for their environment. By adopting these behaviors, the community has strengthened the base of its sustainable development building.

The metaphor of the sustainable development building is useful in that it emphasizes the importance of having a community that is aware and empowered about the issues that pertain to them. That is the base for all sustainable development. However, the image of a building to denote sustainable development is too static. There are feedbacks occurring between the different components in a dynamic way. Human, economic, political and social development are constantly interacting with one another. The modification of one will affect all others.

2.2 Memetics

2.2.1 Definition and Antecedents

Richard Dawkins, in his 1976 “The Selfish Gene” postulates the idea of a “replicator” whose sole function is to be copied. Genes are an example of such a replicator. He proposes that ideas or behaviors that get copied from one person

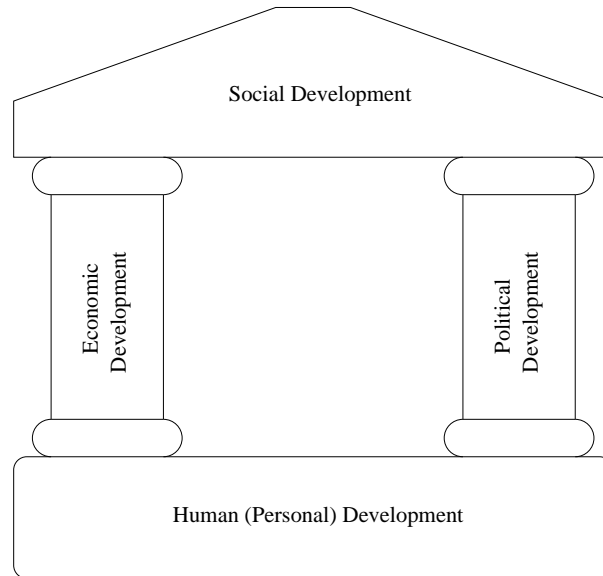


Figure 2.4: Building Development, where personal development is the base, and necessary to support the rest of the sustainable development building. Figure adapted from Burkey (1996).

to another, are another example of a replicator. He called these idea/behavior replicators “memes”³.

Based on Dawkins (1976) and Dennet (1991), I propose an analogy between memes and life. Just like the earth and all its ancestral chemical properties provided the medium in which the *emergent property* of life arose, our brains have provided the necessary elements for the emergent properties of memes to arise.

Emergent properties are not rare occurrences in our daily lives. For instance, if you mix a metal (Na) and a poisonous gas (Cl), you get an edible product that humans consume on a daily basis (Sodium plus Chlorine mixed on a 1:1

³Dawkins (1976) made the word “Meme” up from a Greek word “Mimeme”: to imitate, but wanted the new word to sound like “gene”, so he shortened the original word from mimeme to meme

ratio make salt). It would be impossible to guess the properties of salt based on its components. Emergent properties are well recognized in chemistry and biology at many levels. The emergent properties of compounds, like salt, are classic examples (Campbell et al., 1999). At a larger scale, ecosystems and their functions can be explained as emergent properties of species arrangements with specific abiotic components (Odum, 1997). For instance, the tropical dry forest is much more than the addition of all the species that live in it. The delicate proportions and relationships of all living and non living elements of the dry forest give it the emergent property of an ecosystem. The emergent properties of ecosystems are so complex, that humans have yet to duplicate them in spite of efforts such as Biosphere 2.

With respect to memetics, it can be said that the selection of certain genes that originally made us an intelligent species, paved the way for the origin of another replicator. Our brains have provided the primeval soup in which this new replicator emerged: the meme (Dawkins, 1976; Dennet, 1991). The existence of memes can thus be explained as an emergent property of neural arrangements, of sophisticated minds with the capacity to be aware of present, past and future.

But what exactly is a meme? The concept “gene” has many definitions⁴. In the same way, the idea of “meme” is equated to slightly different concepts. For instance, Brodie (1996) defines the meme as a contagious idea that replicates like a virus, passed on from mind to mind. He states that memes function the

⁴A gene can be defined as a discrete unit of inheritance that affects a phenotypic character. Or as a locus. Or as a specific nucleotide sequence along the length of a DNA molecule. Or as a sequence of DNA that codes for a specific polypeptide chain Campbell et al. (1999). For more gene definitions and why they are all useful depending on the context in which they are being studied, consult the cited text page 314.

same way genes and viruses do, propagating through communication networks and face-to-face contact between people (Brodie, 1996).

Blackmore (1999) declares that whenever someone imitates someone else, something is passed on. “This *something* can then be passed on again, and again, and so take a life of its own.” This thing can be an idea, an instruction, a behavior, a piece of information. This thing is what we call a meme. Everything one has learned by imitation is a meme. All the words in our vocabulary, skills, habits acquired from someone else, songs, games, are memes. Memes replicate and spread themselves around whether they are useful, neutral, or harmful to us (Blackmore, 1999).

The Memetics List (2001) from the “Journal of Memetics” explicates that memes are culturally heritable patterns (heritable as in copyable). They are semantic (meaningful) patterns which are communicated between people via showing, telling or writing.

Dawkins (1982) and Dugatkin (2000) agree on the concept of a meme as a unit of cultural inheritance, hypothesized as analogous to the particulate gene, and as naturally selected by virtue of its “phenotypic” consequences on its own survival and replication in the cultural environment.

According to Blackmore (1999), the power to imitate is exactly what makes us different from other animals⁵, not intelligence, consciousness, or the belief of having a soul (Blackmore, 1999). Because of our power to imitate, we humans have become the vehicles for this new replicator, the meme. However, not all ideas and thoughts are memes:

⁵Blackmore uses a very strict definition of imitation. Other authors prefer to use a more relaxed definition, for instance Dugatkin (2000)

“Our immediate perceptions and emotions are not memes because they are ours alone, and we may never pass them on. We may imagine a beautiful scene from memory, or fantasize about sex or food, without using ideas that have been copied from someone else. We may even, in principle, think up a completely new way of doing something without using any memes from anyone else. However, in practice, because we use memes so much, most of our thinking is colored by them in one way or another. Memes have become the tools with which we think” (Blackmore, 1999).

For the purposes of this study, a meme is defined as a unit of cultural transmission containing a specific substantive message. Memes are ideas that are self-disseminating and self-protecting and that have a certain architecture to their presentation. Both the content of the idea and the architecture of its presentation are important in constructing memes (de Bivort, 2001).

Scientists and other scholars of memetics would now postulate that we are not only vehicles for genes, but also for memes (Discussion-List, 2001; Dawkins, 1982; Blackmore, 1999; Brodie, 1996). Our genetic and memetic pool, and the interaction with our environment, make us who we are. Memes and genes have coevolved, and the result is human beings with very big brains that cannot stop thinking, or talking, or imitating one another. Much of what we copy has to do with our basic biological needs for food, sex, and fighting. Memes that propagate easily usually tap into those “buttons” of our basic needs and emotions (Brodie, 1996; Blackmore, 1999; Dugatkin, 2000).

When someone sees someone else do something, or say something, and we imitate it, or adopt it, something has been passed on to us. That something is a

meme. Memes compete within our brains for space and attention. Those memes that seem to take care of our basic human needs like food, sex, security, etc. will be more successful in capturing our brain power. Our behavior will be modified so that the meme becomes conspicuous to others and this will promote imitation.

2.2.2 Memes and the Environment

Since memes are naturally selected by virtue of their “phenotypic” consequences on their *own* survival and replication in the cultural environment, memes do not necessarily have a positive effect on the biological survival of the person that provides the medium for the meme. Thus, many memes may actually jeopardize our existence, and the existence of our planet (Blackmore, 1999) . For instance, SUVs are being marketed by tapping on the “reptilian needs”⁶ of consumers (Rapaille, 2003 in Safer, 2003). The advertisements make emphasis on power and size, this makes the consumers “feel safe” when in reality SUVs have a higher probability of turnover, and they damage the environment by burning more fossil fuels into the atmosphere (Safer, 2003).

Daly and Townsend (1994) talk about the “insatiable hunger” in the material realm that humans nowadays feel (Daly and Townsend, 1994). I believe that “hunger” is in part the result of marketing memes (Harris, 2000). The whole whirlwind of “acquire more money to buy more things” might be largely due to memes replicating out of control. Daly and Townsend (1994)⁷ put it this way:

⁶Reptilian needs are defined by Rapaille (2003) as those most basic animal needs we all have of food, security, shelter, acceptance, etc.

⁷Page 155, emphasis in original

“Turn those stones into bread, urges Satan, and modern man sets to it, even to the extent of devising energy-intensive schemes for grinding up ordinary rock for materials - to eat the spaceship itself! But Jesus’ answer to the same temptation was more balanced: man does not live by bread alone. The proper object of economic activity is to have *enough* bread, not a world turned into bread, not even vast storehouses full of bread. The infinite “hunger” of man, his moral and spiritual hunger, is not to be satisfied, is indeed exacerbated, by the current demonic madness of producing more and more things for more and more people. Afflicted with an infinite itch, modern man is scratching in the wrong place, and his frenetic clawing is drawing blood from the life-sustaining circulatory systems of his spaceship, the biosphere” (Daly and Townsend, 1994).

Within the pre-analytical point of view of sustainable development we can use the theory of memetics and participatory development to generate behavioral change to foster sustainability. People can take the principles of how memes spread and use these principles to generate memes that are good for the environment and the people. And that leads to the objective of this dissertation, that is, to test a methodology that includes the generation of environmentally friendly memes in order to assess how best to meet the needs of the people with respect to their environment.

2.3 Participatory Development

2.3.1 Historical Background

In order to better understand the importance of participatory development within the context of Sustainable Development, some of the history of development needs to be mentioned.

Before the ending of the Second World War, in July of 1944, the economic leaders of the time gathered at Bretton Woods, New Hampshire. The objective of this meeting was to create institutions that would promote “a world united in peace through prosperity” (Korten, 1996). Part of the vision for this meeting was a global economy dominated by US corporate interests. These ideas go back to the US Council on Foreign Relations held in the 1930’s where it was assessed that, at a minimum, the “US national interest required free access to the markets and raw materials of the Western Hemisphere, the Far East, and the British Empire” (Korten, 1996).

World-wide financial institutions would be needed for stabilizing currencies and facilitating programs of capital investment for constructive undertakings in backward and underdeveloped regions (Sachs, 2001; Sklar, 1980). At the Bretton Woods conference, the World Bank (WB) and the International Monetary Fund (IMF) were founded; and the groundwork was laid for the formation of the General Agreement on Tariffs and Trade (GATT). The conference’s tone and spirit was set by the then US Secretary of the Treasury and president of the conference, Henry Morgenthau. He “envisaged the creation of a dynamic world economy in which the peoples of every nation will be able to realize their potentialities in peace and enjoy increasingly the fruits of material progress on an earth infinitely

blessed with natural riches. He called on participants to embrace the elementary economic axiom... that prosperity has no fixed limits. It is not a finite substance to be diminished by division” (Korten, 1996).

The WB and IMF have worked to date under the framework laid at Bretton Woods. They have promoted economic growth and globalization under the assumption that these will benefit all people. They have promoted economic growth under the assumption that the planet has no limits. After the war, the world, guided by the economic powers (the “core” or the “North” vs. the “periphery” or the “South”), started on a way towards “development”. The decade beginning with 1960 was declared by the UN as the first Development Decade. Ivan Illich (1981) poignantly describes what the world-system understood by development:

“Development implies the replacement of widespread, unquestioned competence at subsistence activities by the use and consumption of commodities; the monopoly of wage-labor over all kinds of work; redefinition of needs in terms of goods and services mass-produced according to expert design; finally, the rearrangement of the environment in such fashion that space, time, materials, and design favor production and consumption while they degrade or paralyze use-value oriented activities that satisfy needs directly. And all such world-wide homogeneous changes and processes are valued as inevitable and good” (Illich, 1981).

In the mid seventies and early eighties, after two decades of “development”, many academicians, politicians, humanists, and social workers among others, started to debate the paradigm of development and growth imposed by the core countries. In spite of all the money being pumped into developing countries, and

the many roads, dams, and other types of infrastructure that had been built, it was still apparent that the world's poor were not getting any better, that the gap between rich and poor had widened, that there was still social injustice, and that the environment was deteriorating (Sachs, 2001; Henderson et al., 2000; Gomezjara, 1977; Gran, 1983; de Camino Velozo, 1987).

By the mid eighties, the quality of life for the world poor had not improved. Development from the top down had failed with respect to the poor. Furthermore, the third world countries were now largely indebted and there was unnecessary influence of donor countries in the internal policies of the developing countries (Gran, 1983; Poostchi, 1986; Burkey, 1996; Mander and Goldsmith, 1996). At the same time, when some people, such as Ivan Illich, were realizing that the status-quo of growth-oriented development was only benefiting the already rich, there were still advocates for the traditional way of doing development in which the opinion and real needs of the poor were not taken into account.

For instance, documents such as the Peace Corps "Remote Areas Development Manual" (Corps, 1981) first published in 1964 and reprinted in 1969, 1980 and 1981 contain such outrageous language as:

"Let CDCS (Community Development Counseling Service) help to improve living standards for all remote area populations throughout the world. This effort must be carried on if the *affluent fraction of humanity* is to obtain and keep the good will of the majority" (my emphasis).

Throughout the manual the authors talk about "introducing projects" and "homogeneous primitive societies" instead of "proposing projects", or having people "develop their own projects", and "heterogeneous rural societies". The

techniques the Peace Corps propose seem useful if the population they are trying to “help” want such techniques. The feeling of the whole manual is paternalistic and explicitly attributes superiority to Western society and values.

Johnston and Clark’s book (1986) continues with the same type of rhetoric. No mention of participation of the people in the planning of projects; no conscientisation nor empowerment of the people were considered. Everything is decided at the top and imposed on the people. Furthermore, there is no mention of environmental degradation as a major concern of this growth-oriented top-bottom development (Johnston and Clark, 1986).

Poostchi (1986) seems to be making a transition between the purely top-bottom approach to one in which people’s opinion and welfare are actually taken into account. He mentions a UNESCO (United Nations Educational, Scientific, And Cultural Organization) statement in which the goals, objectives and the aims of development are:

“not to develop things but to develop men...development must be aimed at spiritual, moral and material advancement of the whole human being, both as a member of society and from the point of view of individual fulfillment.”

However he still makes the assumption that everyone must acquire the same level of life and consumption as that of the developed nations and does not mention environmental degradation as a possible concern (Poostchi, 1986).

The conventional view of development was further criticized in 1987 by the United Nation’s Brundtland commission. They brought to light many of the faults occurring with the traditional development practices that had been implemented so far, and proposed a shift in the development paradigm towards a

development that would be socially more participatory, sustainable with respect to the environment, and economically viable (GEAC, 1993; Cornwell, 1997).

2.3.2 Participatory Development and Sustainable Development

One of the most widely used definitions of sustainable development is the one proposed in the Brundtland report: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland, 1987).

In the closing of the eighties, the third development decade was coming to an end and rural development, conceived in terms of *economic* development and *growth*, had failed. The Brundtland Commission foundered in that they proposed the expansion of the world economy by a factor of five to ten (in spite of dwindling world resources) (Brundtland, 1987). As a result, “sustainable growth” was being used as synonymous with “sustainable development”. Many scientists have been opposed to that analogy, and for instance, Daly (1994) has been vocal in pointing out the differences, mainly, that to “grow” means to get big, while to “develop” means to get better (Daly, 1994).

Economic growth implies “the physical accretion or assimilation of materials within the economy” while economic development “deals with expanded and realized potentialities of human achievement without material growth” (Daly, 1994). Nevertheless, the Brundtland report, is the benchmark upon which all subsequent work on sustainable development is based. It offered a global, goal oriented framework for sustainable development that took social issues and political implications into consideration, as well as the environment.

For instance, in the “process of development for land use management strategies”, the Brundtland Commission posits several imperatives: to protect biodiversity through conservation and managing a system of protected areas, or core refugia, and to better incorporate scientific information into this planning process as well as more effective citizen participation (Cornwell, 1997).

This dissertation tested a methodology to aid in behavioral change towards environmentally friendly behaviors. The methodology included participation by the people and memetics.

Chapter 3

Methods and Results

The underlying pre analytical view for this work, is that of the bottom up approach to sustainability. One main characteristic of this kind of approach is participation (Burkey, 1996; Gran, 1983; Medellin Morales, 2001; Poostchi, 1986). Therefore, people's opinions helped shape some of the procedures for this dissertation. This work was divided in five phases (Figure 1.2). In phase one, the needs of the present in the villages of the Chamela-Cuixmala region were assessed by the people, and communicated to the researcher via open ended interviews.

The findings of Phase I determined how the rest of the experiment was set up. In other phases of this work, the findings on the previous phase were necessary to shape the subsequent phase. In those cases, the results will follow the methods for that phase. Therefore, since they are intermingled, this will be a "methods and results" section.

This study examined the impact of an experimental approach utilizing memetics and participatory development techniques. Based on these methodologies and on the initial assessment of the environmental perceptions of villagers around the biosphere reserve Chamela-Cuixmala, an experiment was conducted to test which methodology would be efficient in modifying the environmental careless behaviors

identified by the subject villages to environmentally conscious behaviors.

The initial assessment of environmental perceptions was obtained by conducting open ended group-interviews. Each “group” was a household that consisted of three to eight people. The opinions of all the people in the household were recorded. A total of ninety households were interviewed. The five villages that were chosen to be part of the experiment were selected based on the homogeneity of various factors such as number of inhabitants, housing materials, socioeconomic status of the inhabitants, and mention of the same environmental concerns.

The experiment was carried out in five villages in the Chamela-Cuixmala region. A “nonequivalent control-group design” experiment was conducted. This type of design is an approach to quasi-experiments in which the treated group A and the control group B are selected without random assignment. Both groups take a pretest and a posttest, and only the treatment group receives the treatment. Four villages (A:Villa, B:Pérula, C:Zapata, D:San Mateo) were chosen as the treatment villages, where a different treatment was applied to each village according to the memetics/participation diagram. And a fifth village (E:Quémaro) was chosen as the control.

The four treatment villages each received a different treatment. Village A (Villa) was exposed to an environmental meme generated in a participatory manner. Village B (Pérula) was exposed to an environmental meme that was generated by the researcher only. Village C (Zapata) was exposed to an environmental idea with no memetic structure, in a participatory manner. Village D (San Mateo) was exposed to an environmental idea with no memetic structure, and with no participation. Finally, the fifth village, village E (Quémaro) served as the control, in which the population was not exposed to an environmental idea.

The methodology has been divided into five phases. Each phase is described in detail subsequently. As mentioned previously, in this methods and results section, some of the method phases will be followed by a result section, since the results for some phases were critical in the developing of the following methodological phase.

3.1 Methods Phase I. Assessment of environmental perceptions

3.1.1 Choosing a region. The tropical dry forest

The rationale for choosing a region in which to conduct the field work for this dissertation was the following. An interesting ecosystem that would benefit from behavioral changes was to be selected, an ecosystem with high biodiversity and in need of conservation.

Within México there are several areas of interest. Ecosystems that are threatened by over-use of natural resources include the tropical rain forest, tropical moist forest, tropical dry forest and some desert regions. Figure 3.1 shows a map of México with different ecological zones (Toledo and Ordoñez, 1993).

A trip was made to México in January 1998 to visit different ecosystems and the people living in them. This would provide first-hand information on the human populations and a “feel” for a good place to work. After reviewing the literature on different ecosystems and having visited them, it was decided that the work would be conducted in the tropical dry forest. This ecosystem is rich in biodiversity, not only in a taxonomical sense, but also regarding the

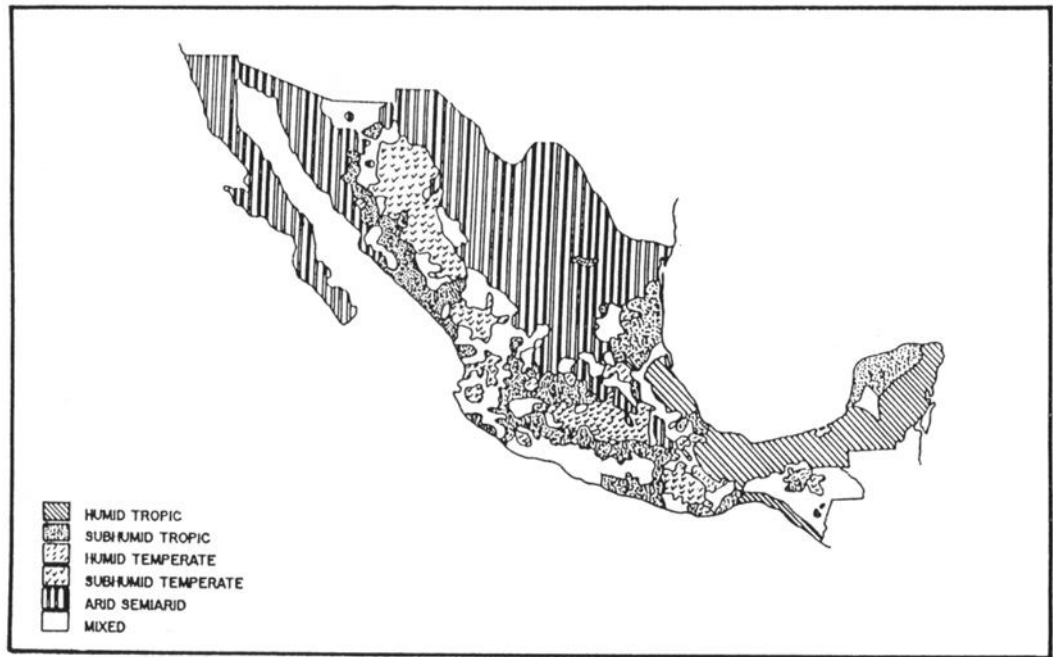


Figure 3.1: Map of México with different ecological zones.

number of interactions among all the plant and animal species living there. It is also the fastest disappearing ecosystem in America (Janzen, 1988; Toledo and Ordoñez, 1993; Mittermeier et al., 1999). Furthermore, a biosphere reserve has recently been created to try to save this ecosystem (Figure 3.2), and Ceballos and Garcia (1995) encourage the involvement of the people living near the reserve in the preservation effort. Also, the communities around the reserve seemed of an appropriate size for the kind of work to be undertaken in this dissertation.

3.1.2 The Tropical Dry forest

Tropical deciduous forests, or dry forests, are very diverse and have an extremely high number of endemic species (Rzedowski, 1978; Lott et al., 1987; Toledo and Ordoñez, 1993; Ceballos and Garcia, 1995; Mittermeier et al., 1999). Dry forests in the American continent are distributed from México to northern Argentina



Figure 3.2: The Biological station IB-UNAM is part of the Biosphere reserve.

(Ceballos and Garcia, 1995). According to Janzen (1988), when the Spaniards arrived in México, there were 550,000 Km^2 of dry forest on the Pacific coast of Mesoamerica, but today only 0.09 percent of that region has remained unaltered by human activities.

The largest remaining dry forests north of the Equator are found in western México. The tropical dry forest off the coast of Jalisco is considered a *hotspot*, and therefore, an area of top priority for conservation (Mittermeier et al., 1999). Here, at least 824 species of terrestrial vertebrates can be found (32 percent of the national total of México) along with approximately 38 percent of the nation's endemic species. The invertebrate group is also very important in this vegetation type, 2194 species have been found in this area, and it is believed that this number represents less than 10 percent of the invertebrates in the region (Noguera et al., 1992). In this area, 1120 species of plants have been registered. The Leguminosae family is the most represented with 155 species, followed by the Euphorbiaceae family, with 91 species (Lott, 1993) (Figure 3.3).

Unfortunately, the dry forest is being threatened by deforestation due to development for tourism, cattle ranching and agriculture (Ceballos and Garcia,



Figure 3.3: Tropical dry forest in the dry season. Hawks are curious and follow people along the trails in the biosphere reserve.

1995). The conservation of such diverse sites is of crucial importance (Janzen, 1988; Toledo and Ordoñez, 1993; Mittermeier et al., 1999). A step towards protecting the tropical dry forest in México has been taken by the creation of the Chamela-Cuixmala Biosphere Reserve in the state of Jalisco (Ceballos and Garcia, 1995). However, reserves are not enough to protect the dry forest and its diversity in a long term basis; in order to do so, the natural resources outside of the reserves have to be used wisely (Ceballos and Garcia, 1995). The conservation and sustainability of this life zone depend on the economic health and stability of the society that lives in it (Janzen, 1988; Mittermeier et al., 1999).

3.1.3 Choosing a locality

The area of study was narrowed down from the tropical dry forest in general, to a series of small villages surrounding the Biosphere Reserve Chamela-Cuixmala. The Biosphere Reserve Chamela-Cuixmala (Figure 3.4), is located in the state of Jalisco, México.

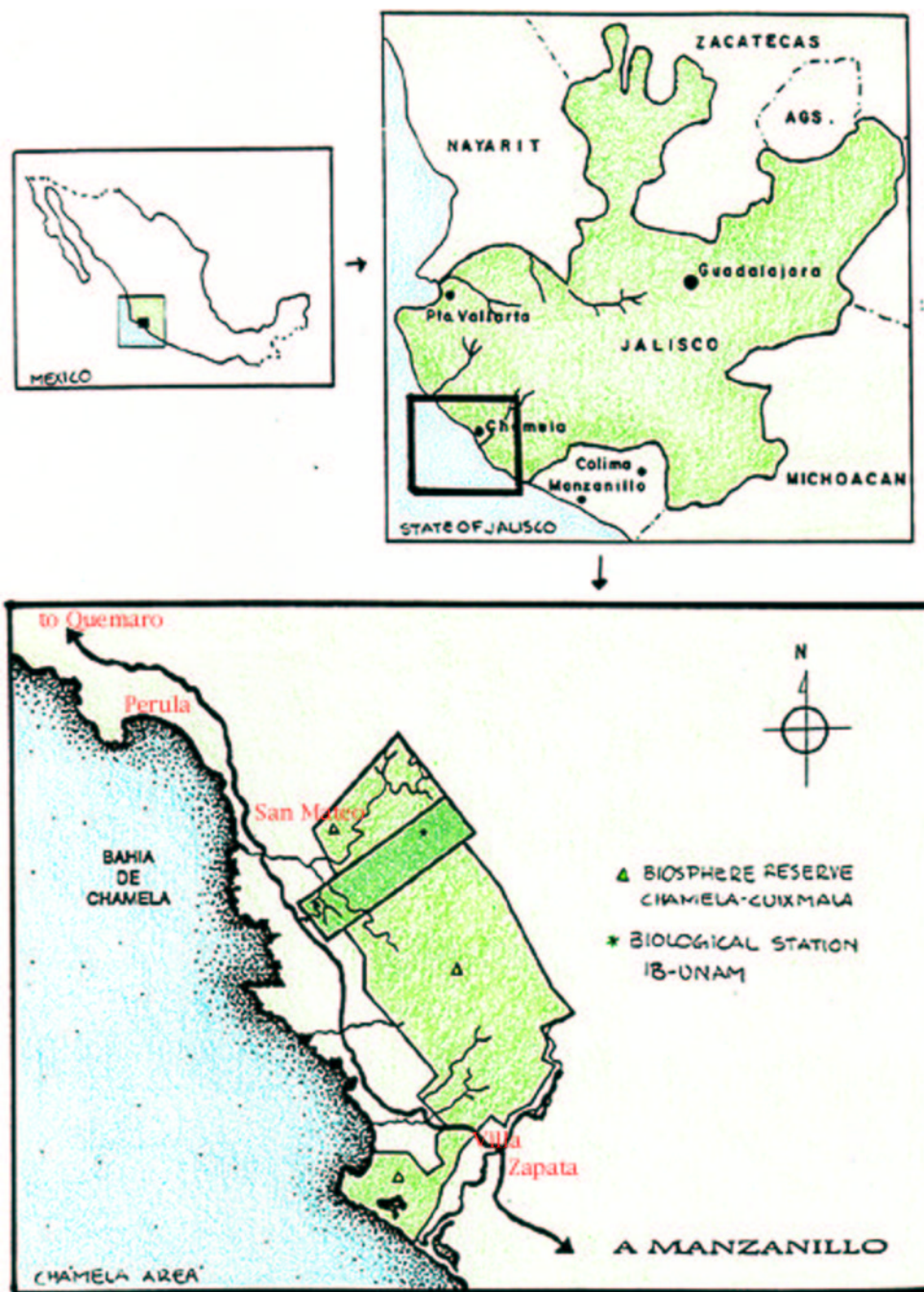


Figure 3.4: Location of the Biosphere Reserve Chamela-Cuixmala.

The villages around the reserve are located within the municipio (county) of La Huerta. Seven villages (A to G) were identified as potential work sites, Chamela, Los Ranchitos, Pérula, Quémaro, San Mateo, Francisco Villa, and Emiliano Zapata. The reserve is two kilometers from the coast adjacent to the Chamela Bay. It is on the kilometer 59 of the federal road 200 from Barra de Navidad to Puerto Vallarta. Its coordinates are between $19^{\circ} 29'$ and $19^{\circ} 34'$ of latitude North; and $104^{\circ} 58'$ and $105^{\circ} 04'$ of longitude West (Barajas Morales and Perez Jimenez, 1990). The reserve encompasses 13,200 ha of undulating terrain, with an altitude range of 70 to 580 meters above sea level. Nine major vegetation types are represented, including the dry and semidry forest, wetlands, riparian forests and matorral (Barajas Morales and Perez Jimenez, 1990; Ceballos and Garcia, 1995; Luna Robledo, 1997). In Koeppen's system the climate of the region is classified as Aw. It is the driest of the warm subhumid climates. The annual precipitation average is 707 mm (approx. 3 in) and the mean annual temperature is $24.9^{\circ}C$, with a marked rain season from July to November, during which more than 80 percent of the total annual precipitation occurs (Lott, 1985; Barajas Morales and Perez Jimenez, 1990; Luna Robledo, 1997) (Figure 3.5, Figure 3.6).

The federal road 200 was paved in 1971. The land adjacent to the road had been parcelled out into "ejidos" and the government encouraged people to move from other locations into this land. Most of the villages around the biosphere reserve are thus fairly new, except some of the costal villages like Chamela, which date of pre-columbian times (SGGJ, 1982; CNDMJ, 2000; Corona Núñez, 1978). There are remnants of native cultures in this area (burials with pottery, and other artifacts. Figure 3.7.), most likely of Nahuatl origin (dating as early as 200



Figure 3.5: Tropical dry forest in the dry season. All the trees lose their leaves.

B.C to 200 A.D.), with some later influence (600-700 A.D.) from the Toltecs and Teotihuacans.

The evidence of settlements is scant right around the biosphere. There are no remnants of big establishments nor ceremonial sites. In the early 1500's the first Spanish expeditions were sent to the Jalisco area (SGGJ, 1982; CNDMJ, 2000; Corona Núñez, 1978). The people that live around the biosphere reserve are thus mixed, mestizo people, whose mother tongue is Castillian. Most of the adults that live here now came from other parts of the state of Jalisco or from adjacent states (Michoacan and Colima). The young people are thus, the first generation around the reserve. Now as before, the area is considered highly marginalized (INEGI, 2000; CNDMJ, 2000).



Figure 3.6: Tropical dry forest in the rainy season. All the trees are lush green.

3.1.4 Assessment of environmental perceptions

Figure 3.8 shows the now familiar design of the experiment with the delineation to be addressed in Phase I. In accordance with the “nonequivalent control-group design”, an assessment of people’s environmental perceptions and behaviors towards the environment was conducted via open ended group-interviews.

The interviews were conducted in seven villages (A to G) and they enlightened the researcher as to the most important *perceived environmental problems for the villagers*. The interviews provided the information on which to base the experimental part of this work, they shed light on which environmental problems the people feel they need to address and how they want to do it. Walking around



Figure 3.7: Pre-hispanic pieces found along the San Nicolas river.

the villages corroborated the environmental problems mentioned, and provided a basis for a system of sensory specific indicators. It also provided information as to the natural features of the villages that people use as recreation (or used as recreation in the past).

In August of 1998, ninety *households* (in the seven villages A to G) were interviewed in order to identify people's awareness of their natural environment, to identify people's behaviors that damage the environment, and to contrast their perceived environmental problems with those of the biological station. The interviews were group-interviews, where each group was a household that consisted of three to eight individuals. The opinions of all individuals were recorded.

These interviews were the assessment of the environmental awareness, problems, and needs of the populations. They provided the necessary information to identify the *perceived environmental problems that people considered important*. The interviews were informal, with a set of open ended questions (Gomezjara, 1977; Mosher, 1978; Rocheleau et al., 1989; Creswell, 1994; Hurtado Leon and Toro Garrido, 1997).

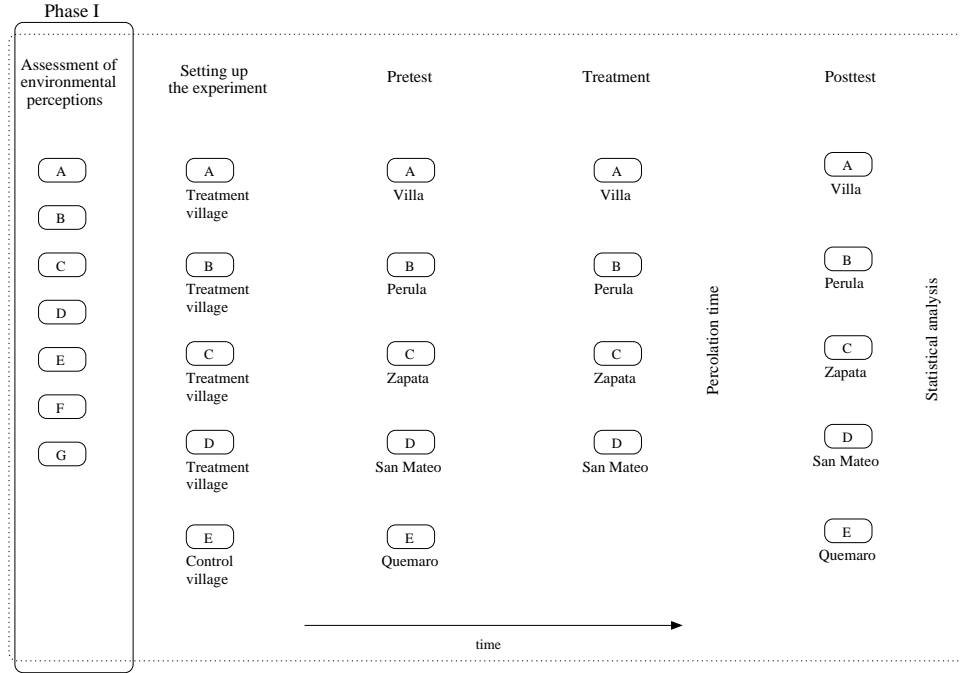


Figure 3.8: Nonequivalent control-group design as implemented in this work. Phase I of the experiment outlined. Open ended interviews were conducted in seven villages to assess people’s environmental perceptions.

The discussions were centered around 4 main points: 1) The utilization of natural resources in their yards (local knowledge at home), 2) the utilization of natural resources in the “common” areas (local knowledge close to home), 3) the identification of environmental problems, 4) and the proposition of behavioral solutions for these concerns.

The interviews were made between 9:30 am and 9:00 pm, mostly on week days; they lasted from 45 minutes to two hours depending on the disposition of the persons involved and the amount of information they wanted to share. Other points that were touched upon were the interviewee’s knowledge of the Instituto de Biología, Universidad Autónoma de México (IB-UNAM) biological station situated within the Biosphere reserve Chamela-Cuixmala, and how long had the interviewed people been living on the area. The questions that were used

to *guide* the discussions follow. The sex and age of the dominant person(s) in the interview were also noted. By “dominant person” is meant the person that most actively participated in answering the questions and in the discussions.

Guiding interview questions¹:

1. What is the name of the community in which you live? What are your names? Were you born here? How long have you been in the area? Where are your parents from?
2. From the forest, what plants do you use? How do you use them? What animals do you use? How do you use them?
3. From the rivers, what plants do you use? How do you use them? What animals do you use? How do you use them?
4. What plants do you have in your yard? How many of each? How do you use them? What is the area of your yard?

¹The questions were, of course, made in Spanish. The translated English version is on the main text. The original Spanish version follows: 1) ¿Cómo se llama la comunidad en la que vive? ¿Cómo se llama usted? ¿Nació aquí? ¿Cuánto tiempo lleva viviendo en ésta area? ¿De dónde son sus padres? 2) Del monte, ¿qué plantas utiliza? ¿Cómo los utiliza? 3) Del monte, ¿qué animales utiliza? ¿Cómo los utiliza? 4) ¿Qué plantas tiene en su solar? ¿Cuántas de cada una? ¿Cómo las utiliza? ¿Cuál es el area de su solar? 5) ¿Qué animales tiene en su solar? ¿Cuántos de cada uno? ¿Cómo los utiliza? 6) ¿Qué tipo de problemas ambientales tiene su comunidad? 7) ¿Tiene alguna idea de cómo solucionarlos? 8) ¿Qué cree que pueda hacer usted, personalmente, para solucionarlos? ¿Qué cree que puedan hacer las gentes del pueblo para solucionarlos? 9) ¿Ha escuchado de ó conoce la Estación de Biología? Si no ha escuchado de ella, ¿le gustaría visitarla? ¿Qué tipo de cosas le gustaría conocer?

5. What animals do you have in your yard? How many of each? How do you use them?
6. What kind of environmental problems do you think your community has?
7. Do you have an idea on how to solve them?
8. What can you personally do to solve them? What can the people in the village do to solve them?
9. Have you heard of, or have you been to the Biological Station? If you have not visited it, would you like to? What things would you like to get to know?

Having a better knowledge of some of the communities living around the biosphere reserve Chamela-Cuixmala provided some of the necessary tools to identify the experimental (A to D), and the control (E) communities for this dissertation. Another needed tool was the information gathered by the census.

3.1.5 Census information

Having chosen a group of villages to explore (A to G), and having made the assessment interviews, still more information was needed in order to select the five specific villages for the experiment (A to D for the treatments and E as a control). Information from the “National Institute of Statistics and Geography” in México (INEGI) was collected for this purpose.

The assessment interviews were made in seven villages. From those seven, four were chosen as the treatment villages and one as the control. The criteria to choose the experimental populations was that they be close to one another

and that they have about the same number of people. Also, if possible, that they have similar demographic characteristics, like housing building materials and socioeconomic level. Furthermore, it was required that they have similarities such that all indicators chosen could be measured in all villages. The information provided by the census, plus the information gathered from the interviews was sufficient in order to choose the four experimental villages and the one control.

3.2 Results Phase I

3.2.1 Interview results

The seven villages that were visited had similar layouts in the typical Spanish style. All of them except Ranchitos had a main plaza with a gazebo at the center (Figure 3.9); and a church, or school or municipal building (or all three) around the plaza. Dirt roads grid out from the main square. All roads in all towns are made of dirt, except for Quémaro, which has some cobble-stoned streets.



Figure 3.9: Typical main plaza with a gazebo at the center. Here we were in the town of Zapata playing hide and go seek with some local kids.

Houses are generally made of bricks, or cinder blocks and cement, except in the town of Chamela and Ranchitos, where a large proportion of the houses are made of woven sticks, palm fronds and mud (Figure 3.10, Figure 3.11).



Figure 3.10: Town of Chamela. Typical houses of wood sticks or adobe.



Figure 3.11: Town of Villa. House made of bricks, nicely painted and decorated.

All houses have electricity and water. There is no sewage system, but most people have a rudimentary septic system under their toilet that consists of a hole in the ground layered with bricks and rock. Very few people let their black waters

out into small streams. In most villages, the grey water is discarded onto gardens or onto the streets. There is no postal service in the area, and radio A.M. signals are weak. No F.M. signals can be captured. There is no cell phone signals either. Only a few people have land phones in their houses. The Chamela IB-UNAM Biological Station has a postal box in the town of San Patricio which is one hour drive south on the Federal Road 200.

A summary of some of the characteristics of the people interviewed can be seen in the following tables. Table 3.1 gives a distribution of the sex of the most outspoken person within each household interviewed. In most of the households (78 percent) a female was the most outspoken person. In eleven percent of the households both male and female shared the conversation. In eight percent a male was most outspoken, and in three percent of the households the whole family participated equally.

The ages of the interviewed people are normally distributed around five ranges. As can be seen in Table 3.2, three percent are ages 10 to 17; 37 percent are ages 18 to 35; 36 percent 36 to 55 years old; 20 percent 56 to 75; and three percent are 76 and older.

Pertaining people's origin, in general, 16 percent of the interviewed were born in the area, and 84 percent were born somewhere else. Of the parents of those interviewed 10 percent were from the area and 90 percent were born in different places within the state of Jalisco, or in different states. The percentages of people that where born in the village in which they were being interviewed can be seen in Table 3.3, as well as the states where they were born if they came from somewhere else. The table shows the percentages of parents that were born in the area, versus other states.

Table 3.1: Sex of the dominant person in the interview. In most interviews it was a female that tended to answer most of the questions and give more input to the conversation.

Sex	Chamela	Pérula	Quémaro	Ranchitos	San Mateo	Villa	Zapata	Total	Total %
Interviews	3	15	12	13	16	16	15	90	100
Female, female with children, female with siblings	3	8	9	11	13	13	13	70	78%
Male, male with children, male with friends		5	2					7	8%
Male and female		2	1	1	2	2	2	10	11%
Whole family				1	1	1		3	3%

Table 3.2: Age groups

Age	Chamela	Pérula	Quémaro	Ranchitos	San Mateo	Villa	Zapata	Total	Total %
Interviews	3	15	12	13	16	16	15	90	100%
10 to 17		1		1		1		3	3%
18 to 35		4		6	7	4	9	33	37%
36 to 55	1	5	6	4	5	7	4	32	36%
56 to 75	1	4	3	2	3	3	2	18	20%
76 and more	1	1				1		3	3%

Table 3.3: Origin of interviewed people and their parents

Origin	Chamela	Pépula	Quémaro	Ranchitos	San Mateo	Villa	Zapata	Total								
Interviewees	3	15	12	13	16	17	15	91								
Local	1	33%	1	7%	5	42%	2	13%	3	18%	1	7%	15	16%		
Jalisco	2		10		7		8	11			9	7				
Colima			1									2				
Other			2					1				2				
\sum not local	2	67%	14	93%	7	58%	11	85%	14	88%	14	82%	14	93%	76	84%
Interviewees' parents																
Local		0%		0%	5	42%	2	15%	2	13%		0%		0%	9	10%
Jalisco	3		9		6		8		11		7		7			
Michoacán			3		1		3		2		7		4			
Colima											2		3			
Other			3						1		1		1			
\sum not local	3	100%	15	100%	7	58%	11	85%	14	8%	17	100%	15	100%	82	90%

From the interviews, twelve environmental issues were identified by the respondents of the seven villages (Table 3.4). Garbage on the streets was the major environmental issue, mentioned by 80 percent of the people. Lack of sewer system or other alternative, and burning plastics were mentioned by 36 percent of respondents. Grey water on the streets were identified by 31 percent. Not using the recreational site by 30 percent of the people. Non-potable water was mentioned by 24 percent. Other issues that people noted were: reduction of wild fauna (19 percent), pests (14 percent), erosion (12 percent), poor drainage of their “solares” or home gardens (6 percent), lack of a health center in town (3 percent), and deforestation (one percent), among other things.

In the discussions the respondents proposed several solutions and ideas that addressed the issues they had identified with respect to the environment. For the garbage problem four specific solutions were proposed (Table 3.5). Establishment of regular truck service was the most common solution with 35 percent of the interviewed households mentioning it. Other solutions for the garbage issue were: to burn it individually (27 percent); no dumping on the streets (21 percent); and to clean the streets (14 percent).

Table 3.4: Environmental issues identified by the respondents

Issues	Chamela	Pérula		Quémaro		Ranchitos		San Mateo		Villa		Zapata		Total		
Interviews	3	15		12		13		16		16		15		90		
Garbage on the streets	1	33%	13	87%	11	92%	8	62%	10	63%	16	100%	13	87%	72	80%
Lack of sewer system		0%	1	7%	8	67%	1	8%	11	69%	2	13%	9	60%	32	36%
Non-potable water		0%	8	53%	3	25%	3	23%	3	19%	2	13%	3	20%	22	24%
Gray water on streets	1	33%	4	27%	3	25%	1	8%	8	50%		0%	11	73%	28	31%
Burning plastics		0%	4	27%	4	33%		0%	11	69%	4	25%	9	60%	32	36%
Not using recreational site		0%	10	67%	5	42%		0%	5	31%	3	19%	4	27%	27	30%
Erosion		0%		0%	3	25%	5	38%	2	13%	1	6%		0%	11	12%
Reduction of wildlife		0%	1	7%	4	33%	2	15%	3	19%	3	19%	4	27%	17	19%
Pests	1	33%	3	20%	1	8%	1	8%	4	25%	1	6%	2	13%	13	14%
Lack of health center		0%		0%		0%		0%	3	19%		0%		0%	3	3%
Poor drainage in “solares”		0%		0%		0%		0%	1	6%	3	19%	1	7%	5	6%
Deforestation		0%		0%		0%		0%		0%		0%	1	7%	1	1%

Table 3.5: Solutions proposed by the respondents

Solutions	Chamela	Pérua	Quémáro	Ranchitos	San Mateo	Villa	Zapata	Total
Interviews	3	15	12	13	16	16	15	90
Garbage truck service	0%	4	4	2	7	5	10	32
Household burning of garbage	0%	2	6	3	5	4	5	25
		13%	50%	23%	31%	25%	33%	35%
No garbage dumping	1	33%	4	2	2	8	0%	19
Clean the streets	0%	2	0%	0%	2	8	1	13
Civil organization to make rules on how water and garbage should be managed	0%	7	3	2	5	2	2	21
		47%	25%	15%	31%	13%	13%	23%
No dumping dirty water	0%	2	4	2	2	7	7	24
Separate garbage, no burning of plastics	0%	2	0%	0%	6	5	2	15
Government construction of sewer system or alternative	0%	0%	5	1	8	1	7	22
		0%	42%	8%	50%	6%	47%	24%
Avoid hunting	0%	1	2	1	1	2	1	8
Fill gullies with sand. Put rocks and trunks to avoid erosion	0%	0%	1	4	1	1	0%	7
Installation of water pumps and reservoirs	0%	0%	1	2	15%	0%	0%	3
Build better animal facilities	0%	0%	0%	0%	0%	2	0%	2
Government building of health center	0%	0%	0%	0%	2	0%	0%	2
Educate people	0%	0%	0%	0%	2	0%	0%	2

Twenty-three percent of the people thought they should establish a civil organization to make rules on how water and garbage should be managed in the area. For the grey water problem, twenty six percent of the interviewed people suggested that no water should be dumped into the streets. For the burning of plastics issue, people (16 percent) suggested to separate garbage and not burn the plastics. Twenty-four percent of the people would like the government to build a sewage system or some alternative. For the non-potable water three percent of the people suggested the government install pumps or build reservoirs. For the reduction of wild fauna, some respondents said that they should avoid hunting (9 percent). For the soil erosion problem, very local, micro-scale solutions were proposed (8 percent) such as filling in the gullies with sand, or putting rocks and tree trunks in the slopes of their gardens.

Two percent of the people mentioned that the cause of all environmental problems was lack of education, and that people should be educated. However, most respondents (64 percent) felt that it was the responsibility of the government to solve the environmental problems that they identified in the interview, like having a garbage truck, or installing sewage. When asked what they (personally) could do to solve the problems, most interviewees looked surprised by the question.

Asked if they had heard of the biological station IB-UNAM situated in the biosphere reserve, 93 percent of the people answered positively (Table 3.6). However, 73 percent had never visited it nor did they know that the station could be visited. None of the respondents saw the biological station as either a source of solutions or as a source of problems, except one man who said he was bothered by the fact of not being allowed to hunt on the biosphere reserve's land and that this was unfortunate since there are many deer in the reserve's forest.

Table 3.6: Knowledge of biological station

Knowledge		Chamela	Pérula	Quémaro	Ranchitos	San Mateo	Villa	Zapata	Total	Total %
Interviews		3	15	12	13	16	16	15	90	100%
Have you heard of the biological station?	yes	3	14	12	11	16	16	12	84	93%
	no		1		2			3	6	7%
Have you visited the biological station?	yes		5	2		6	6	5	24	27%
	no	3	10	10	13	10	10	10	66	73%
Would you like to visit the biological station?	yes	1	13	10	11	13	14	13	75	83%
	no	2	2	2	2	3	2	2	15	17%

3.2.2 Census results

Census information was researched in the Instituto Nacional de Estadística, Geografía e Informática (INEGI). The latest census was conducted in the year 2000. The population numbers can be seen in table 3.7.

Table 3.7: XII 2000 Census Information

Village	Total	Men	Women
Chamela	112	57	55
Los Ranchitos	171	84	87
Pérula	661	340	321
Quemáro	140	63	77
San Mateo	600	300	300
Francisco Villa	863	434	429
Emiliano Zapata	993	489	504

The information provided by the census, plus the information gathered on the interviews was sufficient in order to choose the four experimental villages and the one control. The experimental villages are A: Francisco Villa, or Villa; B: Pérula; C: Emiliano Zapata, or Zapata; and D: San Mateo. The control village is E: Quemáro.

3.3 Methods Phase II. Setting up the Experiment

Following the diagram of the experimental design, Figure 3.12 shows the delineation of the tasks for Phase II.

Phase I yielded information regarding the villages, the people, their environmental awareness and behaviors, infrastructure, and natural areas. The five villages to participate in the experiment were selected.

In Phase II, the period of familiarization was started. Several activities were performed to gain the trust of the people, including giving talks at the schools, organizing cooking and canning classes, and participating in social activities.

The last step in setting the experiment was to develop the indicators to be utilized as a way to measure people's behaviors.

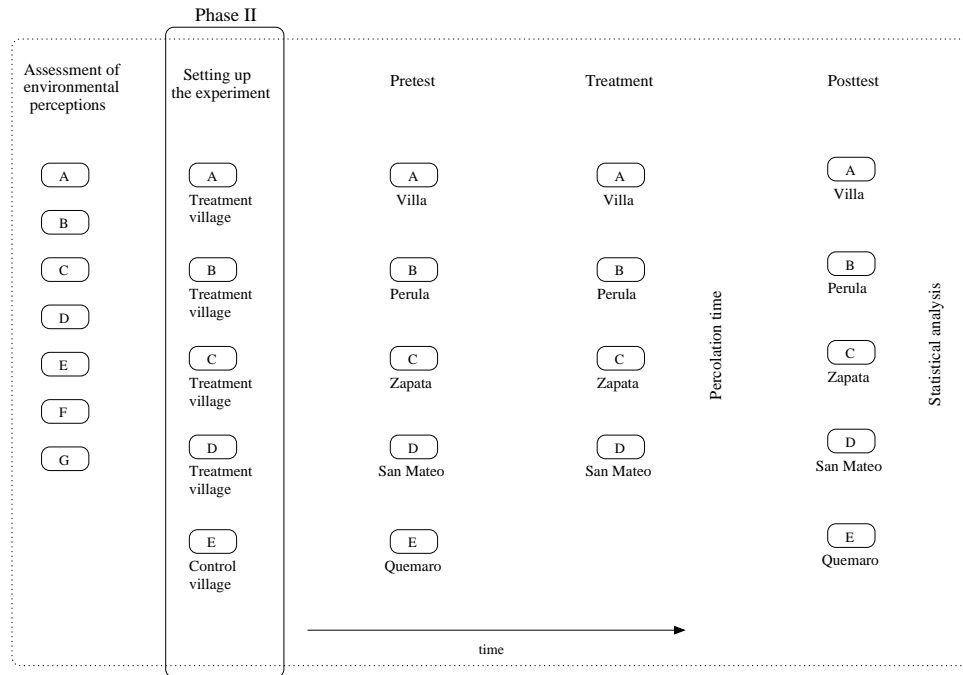


Figure 3.12: Nonequivalent control-group design as implemented in this work. Phase II of the experiment outlined. Activities for the familiarization period were conducted, and indicators were identified for the five experimental villages.

3.3.1 Familiarization

Having chosen the five villages for the experiment, it was important to get to know the people of the villages better, especially for the villages in which forums were

to be conducted. (At this point in time, however, the villages in which participation was to occur had not been selected). It is common to find in the bottom-up sustainable development literature, that emphasis is on the familiarization period, also called the insertion period. This is part of the traditional process of participative development, in which the researcher makes oneself known to, and trusted by, the community (Burkey, 1996; Bustillos and Vargas, 1996; Dick, 1993; Gelifus, 1997; Gomezjara, 1977; Gran, 1983; Greenwood and Levin, 1998; GEAC, 1993; Gusfield, 2000; Hurtado Leon and Toro Garrido, 1997; Medellin Morales, 2001; Poostchi, 1986).

Introducing oneself into the community is a necessary step towards further assessing the villages and to achieve participation from the people in possible future projects. It consists in situating the researcher within the community to win their trust. This requires being with the people and becoming familiar with their problems, with their behaviors, and with the natural surroundings. While in the process of insertion the researcher discretely acquires information about the community by simple observation (Medellin Morales, 2001; Bustillos and Vargas, 1996; Hurtado Leon and Toro Garrido, 1997).

It is recommended that the researcher spend some time with the people of the community during this period. Medellin (2001), Bustillos and Vargas (1996), and Hurtado Leon and Toro Garrido (1997), encourage researchers to take advantage of informal situations, like parties and informal gatherings, to gain the initial trust of the people.

Different levels of familiarization might be desired depending on the type of research being conducted, the objectives of the research, the composition and capabilities of the researching team, the level of participation expected from the

community, and available time and money, among other things. After the desired level of familiarization has been achieved, the researcher can proceed as a facilitator of organized activities, like a community forum.

As part of the familiarization activities for this work, the children in the fifth grade, of the four treatment villages, were asked to participate in the “Bridging the Americas” program (before called “partners in art”). This program is sponsored by the Smithsonian Institution and it consists of linking schools in the temperate zone with schools in the tropical zone. Just like the migratory birds fly North in the Spring and South in the Fall, the children of the schools would make drawings of migratory birds and send them to their partner school at the appropriate times.

The Chamela Biological Station was contacted to inquire about the disposition of the teachers to participate in the program. The Smithsonian Institution was contacted to recognize the Mexican schools as part of the program, and to link them with schools in Maryland. In the late Spring of 1998 the Smithsonian Institution provided the first set of drawings to be brought to the Chamela region.

A thirty minute slide show of general information about migratory birds was given to all the participating groups (in México and in Maryland). The slide show was provided by Cornell Publishing and includes general facts about migratory birds such as different species and their routes, trends in their populations, reasons for population declines and suggestions of how one might contribute to bringing the bird populations to healthier levels.

Three full migratory cycles were followed, bringing back and forth the drawings of the birds, and presenting the slide shows to the various participating groups (Figure 3.13). This interaction allowed the researcher to meet many of

the children in the villages, and through them, their parents. On the last cycle other projects were started as further familiarization activities.



Figure 3.13: Fifth grade children in the town of Villa showing their drawings of migratory birds.

Other familiarization activities included writing a cookbook with local recipes often prepared at the biological station and at people's homes. That activity involved talking to women in the villages, and encouraging them to share their recipes with the researcher. The researcher helped organize a series of cooking classes that were given by Mrs. Campos, as well as a canning class given by Mrs. Gargollo. The researcher also attended evening gatherings, a couple of birthday parties, and a big celebration for the Mexican Independence day² (Figure 3.14).

The familiarization activities were restricted to University vacation periods, that is, to the month of January and the Summer (sometimes including late

²Contrary to popular belief in the United States, Independence day in México *is not* May 5, but September 16.



Figure 3.14: Birthday party for Alvaro. His wife, Leonor; sister in law; and mother in law are in the picture. He painted the piece that can be seen on the wall.

Spring or early Fall). After the familiarization activities, the researcher had made connections in all the treatment villages and the support for a community forum was present. Familiarization activities were not conducted in the control village (Quémáro), only the initial interviews, pretest and posttest. The objective was to have the list amount of contact with the control so as to not influence the behavior of the people.

3.3.2 Indicators

Indicators give evidence of, or serve as ground for a valid or reasonable inference. That is, indicators serve as a sign or symptom pointing to an inference or action, stressing a general connection between subject and object. Indicators quantify and simplify information in a matter that facilitates understanding (Segnestam,

1999). Indicators deal with the application of statistics to the measurement of environmental, social and economic conditions over time (Henderson et al., 2000). “An indicator is something that helps you understand where you are, which way you are going, and how far you are from where you want to be” (Hart, 1999).

Knowing what a community wants to become is one important element of a successful project. Knowing how to reach that goal is a second element. Indicators are a tool that can help determine whether the decisions being made are increasing or decreasing the overall health of the community (Hart, 1999). When measuring the performance of a project or experiment, indicators are used to assess how project activities affect the *direction* of change, and to measure the *magnitude* of that change (Segnestam, 1999).

Indicators must be practical and realistic. They have to be closely related to project objectives, and be clearly defined. “Indicators, and the information they provide, are only as good as the data from which they are derived. If the *ideal* indicator to measure a problem is based on unreliable data, it is common to depart from the *ideal* indicator and use proxies instead” (Segnestam, 1999; Henderson et al., 2000). It is a good practice to limit the number of indicators. A small set of well chosen indicators tends to be the most effective approach.

For this work, four indicators were chosen based on the assessment interviews and on the knowledge gained through the familiarization period. These indicators will be outlined in the results section ahead.

3.4 Results Phase II

3.4.1 Familiarization results

As part of the familiarization methods several activities were conducted. Slide shows of migratory birds were presented to the fifth graders of the treatment villages. The script of the slide show is included in Appendix A. The fifth graders also participated in the “Bridging the Americas” program of the Smithsonian Institution. The children of Maryland and México exchanged drawings of migratory birds imitating the migration times. A sample of the bird drawings is included in Appendix B.

Another familiarization activity was the generation of a cookbook, cooking classes, and canning classes. The cookbook is included in Appendix C.

3.4.2 Indicator results

Based on the perceived environmental problems of the villagers taken from the baseline interviews, and, based on noted observations while performing the interviews, a set of indicators was developed in order to assess if the people actually change their behaviors after the introduction of the memes and/or participation. These sensory specific indicators are:

1. The amount of garbage per street segment. Each segment is the length of a block. Fifteen segments per town were measured. The units are garbage score per street segment. The garbage score is based on pieces of garbage on the segment.
2. The number of fires and fire spots with burning plastics in them per deter-

mined area. The area was a whole block. Fifteen blocks were assessed per town. The units are number of fires with plastics per block.

3. Presence or absence of dirty refuse water on the streets, per street segment. Fifteen segments were assessed per town. The units are percentage of water per street segment.
4. The number of people that use the local stream recreationally in a given time period. A two hour period was chosen within the times identified by the people as the most popular for going to the spot. The units are number of attendants per time segment. An additional interview was made of twenty children per town, ages eight to fifteen, to assess whether they use the recreational site or not.

3.5 Methods Phase III. Pretest

Following the diagram of the experimental design, Figure 3.15 shows the delineation of the tasks for Phase III. In this phase, the pretest was conducted. The indicators were fine tuned by walking through the five experimental villages making measurements and observations. Once appropriate scales were developed the taking of the data was performed.

Tables were made for each indicator and for each village. There were four indicators that were being measured, and five villages in the experiment for a total of twenty templates to be filled. The templates can be found on Appendix D.

For the indicator of “garbage on the streets”, 15 street segments were measured. A scale of one to ten would indicate the amount of garbage on each

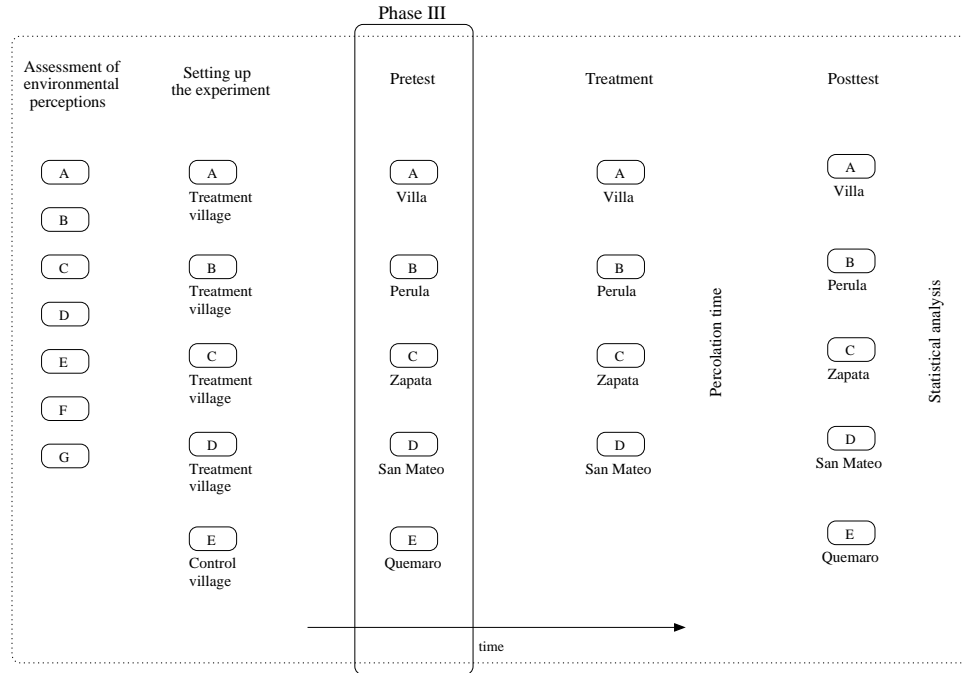


Figure 3.15: Nonequivalent control-group design as implemented in this work. Phase III of the experiment outlined. The pretest is conducted by visiting all five villages in the experiment. The four indicators are measured in each village.

segment. A score of zero, meant no garbage at all for that segment, whereas a score of ten would indicate more than 26 pieces of garbage at that segment. The scale was constructed as such because, for the size of segment selected (one block) , 26 pieces of garbage or more, looked definitely dirty; whereas less than 26 pieces of garbage could be categorized as somewhat dirty, moderately dirty, etc. However, a quantitative scale was used following table 3.8. The data collected by this indicator is continuous.

For the indicator of “burning plastics”, 15 blocks were assessed. The number of fires or number of fire spots in which there was clear evidence of plastic burning were counted per block. The data collected by this indicator is continuous.

For the indicator of “grey water on the streets”, 15 street segments were measured. This rendered “yes” or “no” type answers, thus the data collected by

Table 3.8: Garbage Scale

Score	Pieces of garbage per segment
0	0
1	1 to 2
2	3 to 5
3	6 to 8
4	9 to 11
5	12 to 14
6	15 to 17
7	18 to 20
8	21 to 23
9	24 to 25
10	26 and more

this indicator is categorical.

For the indicator of “use of recreational site” two types of measurement were employed. For one of the measuring tools, twenty local youngsters (ages ranging from 8 to 15) in each village were interviewed as to their usage of the recreation spot. If they had used the spot more than once in the past month, a “yes” would be registered, otherwise it would be a “no”. When conducting the interviews it was also asked when the recreational spot was most in use, days and times. Based on the most likely times and days to find people at the spots, random time segments were selected for each village in order to make actual observations of the recreational site. The second measuring tool was to conduct actual observations of people utilizing the recreational site. Two hour slots were selected from the most

likely times for each village. Within those two hour slots, fifteen minute intervals were used to assess whether the site was being used (yes or no, categorical data), and how many people were using it.

The pretest entailed walking around the villages making careful counts of all the indicators. Once the pretest was finished the treatment part of the experiment could be conducted.

3.6 Methods Phase IV. Treatments

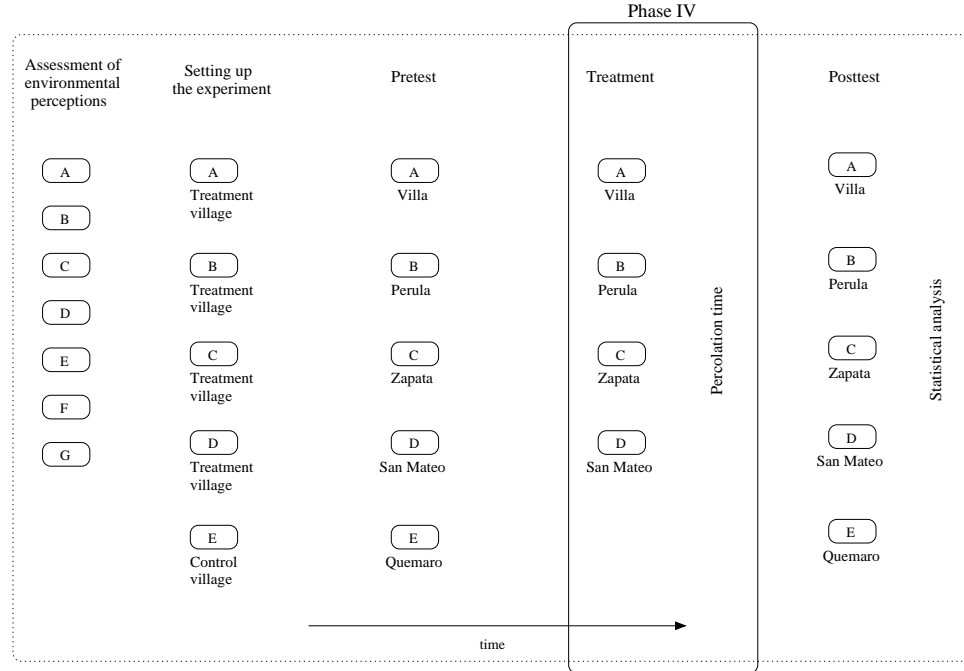


Figure 3.16: Nonequivalent control-group design as implemented in this work. Phase IV of the experiment outlined. The different treatments were applied to the four treatment villages only, following the memetics/participation diagram.

Following the diagram of the experimental design, Figure 3.16 shows the delineation of the tasks for Phase IV. In this phase the four villages received their treatments following the memetics/participation diagram 3.17.

	Memetics	No Memetics	
Participation	Village A Villa Garbage	Village C Zapata Grey water	
No Participation	Village B Perula Recreation	Village D San Mateo Burning plastics	Village E Quemaro

Figure 3.17: The Memetics/Participaton diagram delineates which village received which treatment, and which behavior was be addressed in each village.

Village A, Villa, generated a meme in a participatory manner at a community forum. Here the issue of garbage on the streets was addressed.

Village B, Pérula, was exposed to a meme generated by the researcher. Here the issue of utilizing the recreational spot was addressed.

Village C, Zapata, participated in a community forum, but no explicit effort was made to generate a meme. Here the issue of grey water on the streets was addressed.

Village D, San Mateo, was not convoked to a forum, and the researcher had no explicit intent to generate a meme. Here the issue of burning plastics was addressed.

Both villages A (Villa) and C (Zapata) held a community forum. In general, forum's objectives are to prioritize community problems, to look for human and material resources that are available, and to try to find a solution (Hurtado Leon and Toro Garrido, 1997; Bustillos and Vargas, 1996; Gran, 1983; Medellin Morales, 2001; Gelifus, 1997; Gomezjara, 1977). For this work, the forum's objective was to analyze one problem only, but still look for human and material resources, and to try to find a solution to the problem. Following is a section on how *both* forums (in Villa and Zapata) were conducted. For village A

(Villa), however, there were additional steps of participatory meme generation. These steps of meme generation were not taken for village C (Zapata).

Both villages A (Villa) and B (Pérula) were exposed to a meme. However, village A generated its own meme; whereas for village B, it was the researcher that constructed the meme. Following is a section on how a meme might be constructed.

3.6.1 Community Forum

Both villages (Villa and Zapata) in which a forum was conducted were visited ahead of time in order to obtain a small survey to figure out when it would be the best day, time, and place, to have the forum. In the survey it was also asked what would be the best way to let people know about the forum so that the most people could attend.

For this survey twenty people were interviewed in each town. Ten of those were not selected randomly, they were people that have a certain leadership role in their town. For instance, the school principal, some teachers, “tiendita”, “papelería”, and “tortillería” owners, were interviewed. The other ten people in the survey were selected randomly on the street.

In the town of Villa, it was unanimously agreed that the school would be the best place to conduct the forum. In the town of Zapata, it was unanimously agreed that the “Comité” would be the best place. For both towns, everyone suggested that posters in all the stores, and flyers given out in the “plaza”, would be the best way to get the most attendance at the forum. Also, it was recommended to serve “agua de jamaica” (Hibiscus flower ice infusion) and cookies, and to mention them in the poster. As for the day and time, everyone suggested

any weekday after five in the afternoon.

Since by this time the researcher was familiar with the people in the villages it was very easy to get permission to hold the forums. The principal of the school in Villa lent the keys to the big classroom, and “La Jefa” of Zapata lent the keys to the “Comité”. Poster paper was bought at the “papelería”. Ten posters per town were made announcing the forum and posted in the major stores. Some villagers helped with the wording of the poster so as to entice the most people possible. Thirty fliers were made for each town and distributed to people in the plaza and on the streets.

The posters and fliers for the town of Villa were as such³:

Toda la gente - niños, mamás y papás -
están invitados a participar en una plática
para que cuidemos nuestro pueblo de la basura.
Luisa Fernanda Robles (maestra del medio ambiente)
quiere platicar con todos.
Ven a LA ESCUELA el Lunes 8 de Julio a las 7:00 pm.
Habrá aguas frescas y galletas. :-)

³In English it would be something like this: Everybody - kids, mothers, and fathers - are invited to participate in a discussion about taking care of our town regarding the trash. Luisa Fernanda Robles (the environmental teacher) wants to chat with everyone. Come to the school on Monday, July 8th at 7:00 pm. Refreshments and cookies will be served. :-)

The posters and fliers for the town of Zapata were as such⁴:

Toda la gente - niños, mamás y papás -
están invitados a participar en una plática
para que cuidemos nuestro pueblo del agua sucia.
Luisa Fernanda Robles (maestra del medio ambiente)
quiere platicar con todos.
Ven al COMITÉ el Martes 9 de Julio a las 7:00 pm.
Habrá aguas frescas y galletas. :-)

The forums were conducted two days after the posters and fliers had been passed out. Hibiscus flower infusion was made, cookies and cups were bought. A person in the village lent two 25 liter glass carafes to contain the beverages, ladles, and trays for the cookies. For the town of Villa, fifty-seven people attended the forum, which accounts for 7 percent of the population. The school came equipped with a black board and chalks. For the town of Zapata, forty people attended the forum, which accounts for 4 percent of the population. A white board was borrowed from the local government and dry erase markers were provided by the researcher. Other materials were gathered in preparation. Now everything was ready for the forum (Bustillos and Vargas, 1996; Gelifus, 1997; Jara, 1998).

The first step in the forum was to greet the people and remind them of the objective of the meeting. That is, to talk about one of the environmental

⁴In English it would be something like this: Everybody - kids, mothers, and fathers - are invited to participate in a discussion about taking care of our town regarding the dirty water. Luisa Fernanda Robles (the environmental teacher) wants to chat with everyone. Come to the comite on Tuesday, July 9th at 7:00 pm. Refreshments and cookies will be served. :-)

concerns that they had previously identified in the interviews. Then, an “outcome formulation” (de Bivort, 2001) questionnaire was conducted. This questionnaire helped people think about the environmental concern, how they feel about it and what they are willing to do in order to change the situation. The questions had been previously written on poster size pieces of paper. The facilitator would read the question out loud, allow for some thinking time, and then asked the people to participate. The field assistant took notes of what people said (Figure 3.18).



Figure 3.18: Forum in Zapata. The outcome formulation questionnaire was written out on big pieces of paper.

Following is the “outcome formulation” questionnaire used in the forums. This was a participation oriented discussion.

1. What do you want with respect to the identified environmental concern?
Stated in positives.
2. How would you know if you got it? In sensory specific indicators. Make

sure it is an outcome they want. Micro-behaviors. What would it look, sound (what people are saying - tonal; and digital - literal sound), feel, taste, smell like?

3. What is stopping you from getting this outcome?
4. What do you need to get your outcome? (dialogue)
5. If you achieved your outcome doing it as described above, would anything bad happen? Undesired consequences?
6. What can you do so that those bad consequences do not happen?
7. Would it be worthwhile for you to do these things to achieve your outcome? (desirability to follow with this)
8. What do you have to do to get started to implement this effort?
9. If you do these things, how will it be for you? (look for sensory responses of question 2. Avoid buyers remorse. We want desirability and feasibility through all sensory channels. You internalize so that you can feel it. We want to avoid “it looks good, but it does not sound right”).
10. Are you prepared? When do you want to start?

Note that these questions included many comments in parenthesis. Those comments were not written on the big pieces of paper, just the questions. The facilitator guided the participants through the questions and helped them obtain sensory type responses. As mentioned earlier, both villages (Villa and Zapata) went through the exercise of the “outcome formulation”. In Villa, the issue of garbage on the streets was discussed, whereas in Zapata, the issue of grey water

on the streets was discussed. In Zapata, once all the questions had been talked about and imagined, once there were no more comments on behalf of the people, the forum was adjourned. In Villa, the meme construction period began.

3.6.2 Making the memes

A meme is an idea that is self-disseminating and self-protecting. Both the content of the idea and the architecture of its presentation are important in constructing memes. In order to make memes, the target population has to be known. The values, triggers, and filters of the people have to be taken into account. Meme building has been made analogous to marketing (Brodie, 1996), but de Bivort (2001) suggests that marketing is to memes just like a hatchet is to an automated cutting device, or a chunk of charcoal is to a pen. However, similarities can be found between meme building and advertising making (Harris, 2000).

Following the memetics/participation diagram, it can be seen that for the town of Villa, the people will make their own meme, whereas for the town of Pérula, the meme was made by the researcher. The same logic to meme building was employed in both cases, but for the town of Villa it was the people themselves identifying their values, triggers, etc., whereas for the town of Pérula, it was the researcher that had to identify those factors based on the interviews and on the familiarization period.

In Villa, in order to make the memes in a participatory manner, a line of questioning was employed. The facilitator asked the participants, after having finished the “outcome formulation” exercise, in light of our new discussions, what kind of phrase could they come up with, so that they themselves would actually be prompted into action to do the things we had talked about, and that would at

the same time help other people prompt into action as well (Figure 3.19). This phrase would have to show their values, and would have to be worded so that something inside was touched and would trigger them to action and to share the phrase with others. The language had to be familiar and relevant to the participants. The participants were asked if there was anything about the phrase that might generate a negative reaction from someone, and in that case, what could be added, or taken out, to avoid that reaction. Then, a small catchy name was asked to be given to this phrase (the new meme).



Figure 3.19: Young women that attended the forum in Villa. They helped to create the language of the memes.

After coming up with phrases, perfecting some, and discarding others, for the town of Villa, three memes were selected (see the results) , and one name was given to all of them. For the town of Pérula, the researcher came up with one meme, and gave it the same name as the memes for Villa.

The memes were written on big pieces of paper, posted in all the stores, and in the library room of the schools (Figure 3.20). The memes were written in letter-size pieces of white paper using different fonts and colors. The percolation

period for the memes was started. This is the period in which the memes start disseminating themselves. A percolation period of four months was given.

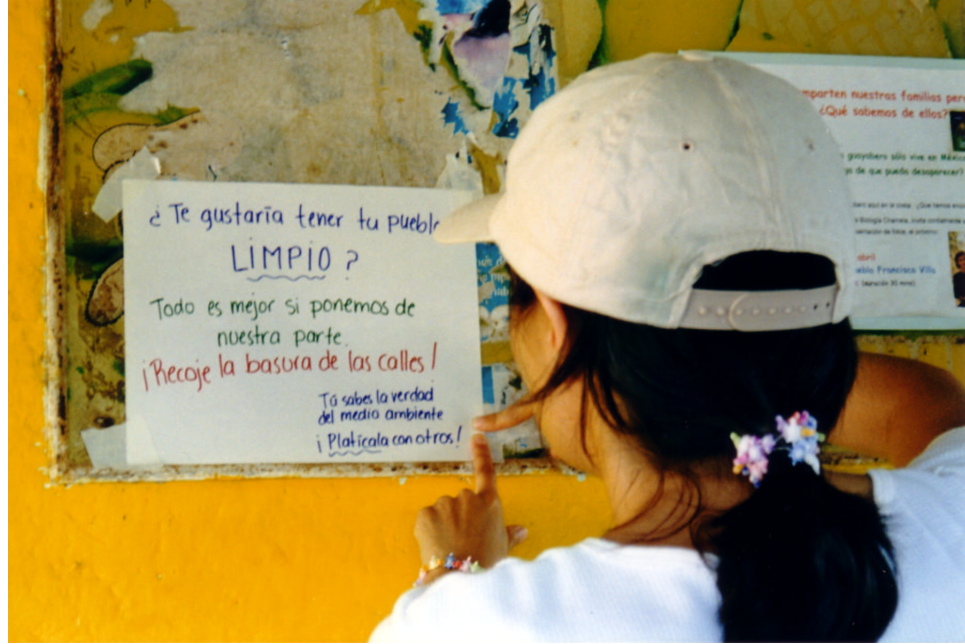


Figure 3.20: Researcher posting the memes in the local stores.

3.7 Methods Phase V. Posttest and Statistical Analysis

Following the diagram of the experimental design, Figure 3.21 shows the delineation of the tasks for Phase V. In this phase, the five experimental villages were visited and the posttest was conducted. The posttest consisted of measuring all four indicators in all five villages. The same charts that were used in the pretest were used in the posttest (Appendix D). The data was paired, that is, for instance, for the garbage data, “street one” on the pretest is exactly the same as “street one” on the posttest. That is the case for all other indicators.

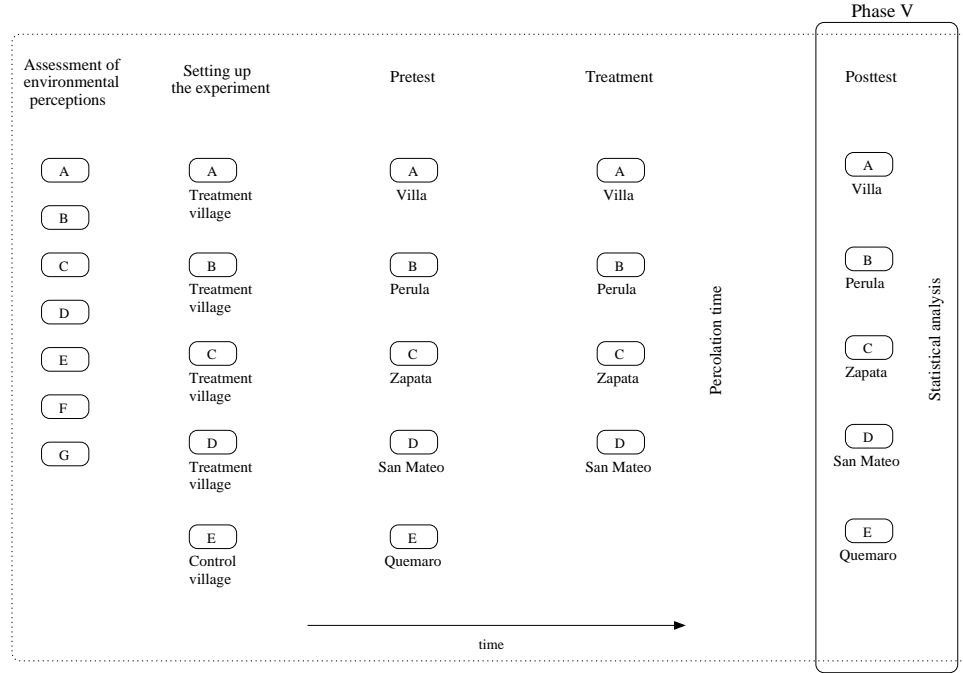


Figure 3.21: Nonequivalent control-group design as implemented in this work. Phase V of the experiment outlined. The posttest was conducted in all five experimental villages. All four indicators were measured in each village.

3.7.1 Statistical analysis

After collecting all the data, for each indicator, the differences in values between the pretest and the posttest of the experimental villages were compared to the differences between the pretest and the posttest in the control village. For all indicators, assumptions of normality and homogeneity of residual variance were examined.

For the indicators with continuous data (Garbage and Fires) a general linear mixed model analysis of variance techniques was used to model both the fixed effects and the random variability (SAS, version 8.2). The fixed portion of the model included the effects of town, date and the town*date interaction. The random portion included the variation among streets or blocks, these were used

as elements of pseudo-replication. Bayesian Information Criterion (BIC) was used to identify the variance-covariance matrix that adequately fit the variance heterogeneity. T values were used to identify significant differences at the 5 per cent level of significance.

For the indicators with categorical data (Grey water and Recreation) a generalized linear mixed model utilizing a ‘Glimmix’ macro was used. The error distribution used was ‘binomial’ which uses the link ‘logit’ by default. The fixed portion of the model included the effects of town, date and the town*date interaction. The random portion included the variation among streets or times, these were used as elements of pseudo-replication. T values were used to identify significant differences at the 5 per cent level of significance.

The models generated to analyze the data in SAS are in Appendix E.

3.8 Results Phase III, IV and V

The objective of this dissertation was to address some of the needs of the present generation that lives around the biosphere reserve Chamela-Cuixmala, without compromising the ability of future generations to address their needs. People’s perceptions of the environment were investigated via open ended interviews. Based on the environmental concerns of the people, four issues were identified to be addressed through a change in behavior. Memetics and participation were utilized in an experiment to identify which methodology would be most effective in aiding people to change their behaviors towards environmentally friendly behaviors. The memetics/participation diagram was utilized to assign treatments to four villages. A fifth village participated as the control.

3.8.1 Participation and memetics treatment. Garbage indicator.

Five villages participated in an experiment. Four villages were treated and one village served as the control. Village A, Villa, was treated with memetics and participation. The behavior of dumping garbage on the streets was addressed since 100 percent of the population identified this as a major problem in their village and it is an issue that could be addressed with a change in behavior.

In the second part of the forum, the participants came up with several memes, after much deliberation, they could not decide for one of them, so they chose the three best, which I write below⁵.

1. ¿Te gustaría tener tu pueblo limpio?

Todo es mejor si ponemos de nuestra parte.

Recoge la basura de las calles!

Tu sabes la verdad del medio ambiente,
pláticala con otros.

2. En tu casa no tiras basura.

El pueblo es tu casa.

No tires basura.

⁵The translation would be something like: 1) Would you like to have a clean town? Everything is better if we make an effort. Pick the garbage off the streets. You know the truth about the environment, talk to others about it. 2) In your house you do not throw garbage. The town is your house. Do not throw garbage. You know the truth about the environment, talk to others about it. 3) Without laziness you can achieve anything. Keep your town clean. Pick the garbage up. You know the truth about the environment, talk to others about it.

Tu sabes la verdad del medio ambiente,
platícala con otros.

3. Sin flogera se puede todo.

Mantén tu pueblo limpio.

Recoge la basura.

Tu sabes la verdad del medio ambiente,
platícala con otros.

The data taken for the garbage on the streets indicator were continuous. The average for the control village (Quémaro) for the pretest was 5.46 units of garbage score per street segment. The average for the posttest was 7 units of garbage score per street segment. Figure 3.22 shows the means for the pretest and the posttest of every town.

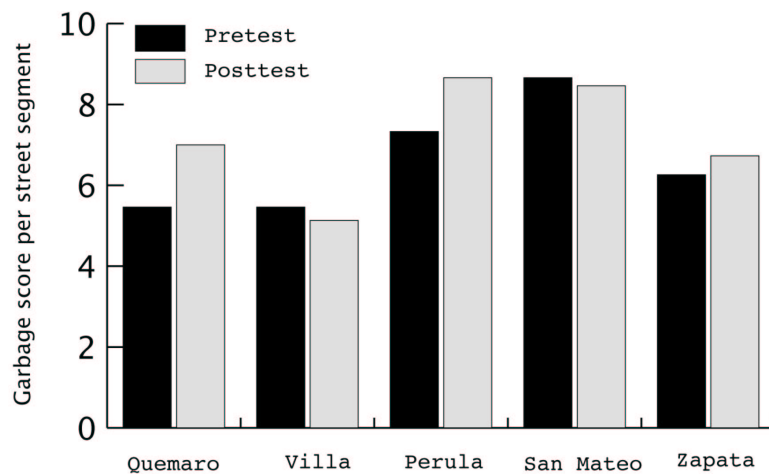


Figure 3.22: Garbage means comparing the pretest and posttest in every village. Quémaro was the control. Villa was the treatment with participation and memetics.

The difference between the averages of the control was taken and compared to the difference of the averages of the different treatments. Figure 3.23 shows the differences of the averages of the pretest and the posttest for every town.

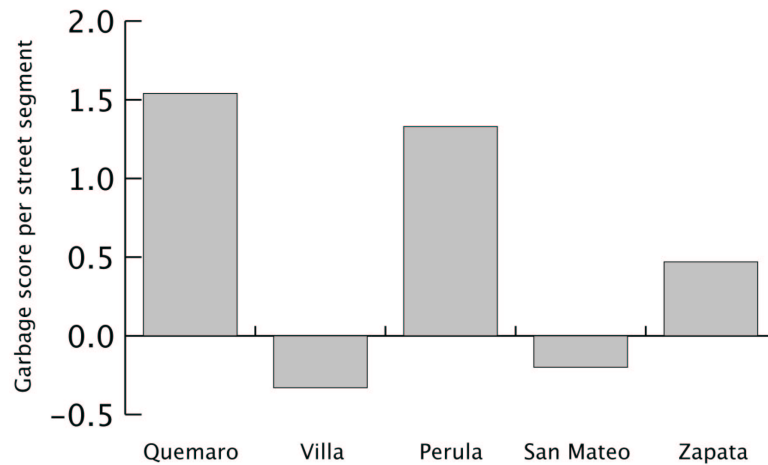


Figure 3.23: Differences of the means for each town. The mixed procedure in SAS compares the difference of the control, Quémaro, to the differences of the other villages. The only statistically significant differences were those of Villa and San Mateo.

For Villa, the average for the pretest was 5.46 units of garbage score per street segment. The average for the posttest was 5.13 units of garbage score per street segment. Notice that there is only a very small reduction in the average for garbage when comparing pretest and posttest (5.46 vs 5.13). However, seasonal differences have to be taken into account. This was done by comparing this difference with the difference of the control village. When comparing to the control, statistically significant differences were found ($p=0.0064$), thus we reject the null hypothesis of no effect. The treatment of participation and memetics aided people in changing their behavior of throwing garbage on the streets to throwing less garbage on the streets.

Another objective of this dissertation was to ascertain whether the behaviors would be transmitted to other villages. For this specific behavior it can be seen

that it was transmitted to the village of San Mateo only. The average of San Mateo for the pretest was 8.66 units of garbage score per street segment. The average for the posttest was 8.46 units of garbage score per street segment. When comparing to the control we see that the difference is statistically significant ($p=0.0066$), thus we reject the null hypothesis of no effect. The behavior was transmitted aiding people in changing their behavior of throwing garbage on the streets to throwing less garbage on the streets.

For the village of Pérula, the averages of the pretest and posttest were 7.33 and 8.66, respectively. When comparing to the control, the difference was found to be not significant ($p=0.8043$), thus the null hypothesis of no effect is accepted. For the village of Zapata, the averages of the pretest and posttest were 6.26 and 6.73, respectively. When comparing to the control, the difference was found to be not significant ($p=0.2455$), thus the null hypothesis of no effect is accepted. The behavior of throwing less garbage on the streets was not transmitted to these villages.

3.8.2 Memetics, no participation treatment. Recreation indicator.

Village B, Pérula, was treated with memes only. The behavior addressed was that of not using the recreational site which had been identified as an issue by 67 percent of the people, and this is a behavior that can easily be changed.

The researcher came up with a meme for this population. Since the villages have many things in common it was assumed that it would be beneficial to use a similar style of meme as was selected by the people in the town of Villa. The

meme generated and posted was⁶:

El estero es nuestro.

¡Disfruta de su flora y fauna!

Tu sabes la verdad del medio ambiente,

pláticala con otros.

The data for the recreational indicator were categorical, thus the logistic analysis performed in SAS takes the percentages of positive answers (or means) and transforms them to logit means. Then, SAS back transforms the means in order to be interpreted. The back transformed mean for the control village of Quémáro, for the pretests was 90 percent of the sampled time the recreational site was in use, and for the posttest was 92 percent of the sampled time the recreational site was in use. Figure 3.24 shows the back transformed means for every town.

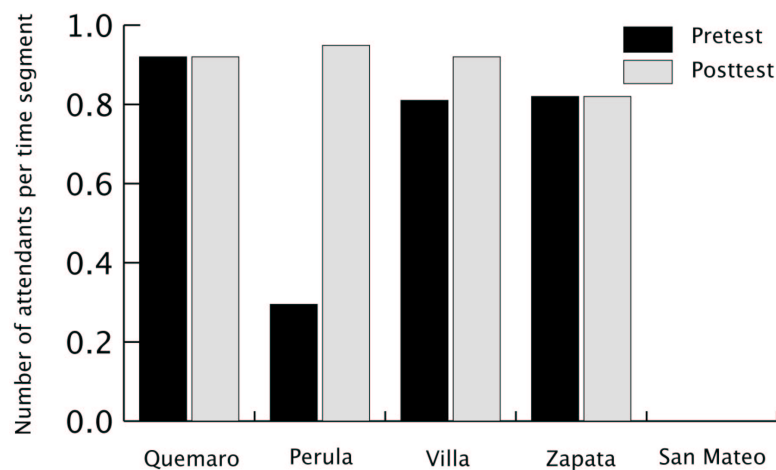


Figure 3.24: Recreation means comparing the pretest and the posttest in every village. Quémáro was the control. Pérula was the treatment with memetics.

The differences were compared between the control and the treatment village.

⁶Translated to English: The estuary is ours. Enjoy it's flora and fauna! You know the truth about the environment, talk about it with others.

Figure 3.25 shows the difference between the back transformed means of the pretest and the posttest for every town.

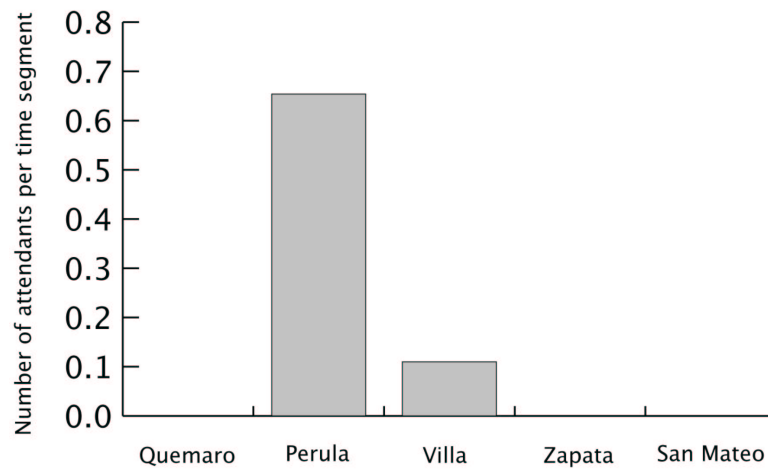


Figure 3.25: Differences of the means for each town. The mixed procedure in SAS compares the difference of the control, Quémáro, to the differences of the villages. There was a statistically significant difference for the town of Pérula.

The back transformed means for the town of Pérula were 29 percent and 94 percent of the sampled time the recreational site was in use. When comparing the differences with the control the difference was found to be significant ($p=0.0403$), thus, the null hypothesis of no effect can be rejected and the alternative hypothesis accepted. The memes helped people change their behavior from not using the recreational site to using the recreational site.

In order to see whether this behavior was transmitted to the other populations, the differences of the averages of the populations were compared to those of the control village. For Villa, the back transformed means for the pretest and the posttest were 81 percent and 92 percent of the sampled time the recreational site was in use, respectively. As can be seen, there is an increase of the usage of the recreational site (from 81 to 92 percent of the time), however, the differences when comparing to the control were not statistically significant ($p=0.5184$), thus the

null hypothesis of no effect is not rejected. The behavior of using the recreational site was not transmitted to the town of Villa.

For the village of Zapata, the back transformed means for the pretest and the posttest were 82 percent and 82 percent of the sampled time, respectively. There was no statistically significant difference in the usage of the recreational site before and after the experiment ($p=1.0$). The null hypothesis of no effect is accepted. The behavior was not transmitted.

For the village of San Mateo, the back transformed means for the pretest and the posttest were zero percent and zero percent of the sampled time, respectively. There was no statistically significant difference in the usage of the recreational site before and after the experiment ($p=1.0$). The null hypothesis of no effect is accepted. The behavior was not transmitted.

For the recreation indicator, some descriptive statistics were also collected. Twenty youth from each town were interviewed in a pretest and posttest as to their usage of the recreational site. The youth had to live on the town, and have had to use the recreational site at least once in the last month in order to record a positive answer.

In the control village, Quémaro, 13 out of 20 (65 percent) of the interviewed said they did use the recreational site on the pretest interview, and 17 out of 20 (85 percent) said they used the recreational site on the posttest. There was an increase of 30.7 percent of the people who answered positively. This increase is due to temporal effects. The posttest was conducted in the winter when more people reside in the area and temperatures are more amenable for outdoor recreation. The pretest was conducted in the summer when less people reside in the area, and temperatures do not foster outdoor activities.

In the town of Pérula, which was treated with the recreation meme, 8 out of 20 (40 percent) of the youth said they used the recreational site on the pretest, and 16 out of 20 (80 percent) said they used it on the posttest. In this case there was an increase of 100 percent of the people who answered positively after the treatment, usage doubled. This is an increase of 70 percent of users over the increase of the control. Some of the total increase was due to temporal effects, but some was due to the recreational meme, as the previous analysis suggested.

In San Mateo, 5 out of 20 (25 percent) of youth claim to have used the site on the pretest and 10 out of 20 (50 percent) on the posttest. A difference of 100 percent. The people that said they used the recreational site doubled, but they are still a very small percentage of the interviewed people. This is consistent with the fact that the recreational site for San Mateo yielded no visual observations on the chosen times.

In Zapata, 16 out of 20 (80 percent) used the site on the pretest and 17 out of 20 (85 percent) on the posttest, a 6 percent increase, much lower than the control. In Villa, 14 out of 20 (70 percent) said they used the site on the pretest and 15 out of 20 (75 percent) on the posttest, a 7 percent increase, similar to Zapata, but less than the control.

When looking at the increase of the people that claimed to use the recreational site, it can be seen that some villages improved more than others. Pérula and San Mateo doubled their usage. Zapata and Villa improved very little. However, when looking at the total percentage of people interviewed that claim to use the recreational site San Mateo had 50 percent usage at the posttest whereas the rest of the villages had above 75 percent usage. The results found in the interviews are consistent with the results found in the observations.

3.8.3 Participation, no memetics treatment. Grey water indicator.

Village C, Zapata, was treated with participation only. The behavior of dumping grey water on the streets was addressed since 73 percent of the population identified this as a major problem in their village, and it is an issue that could be ameliorated with a change in behavior.

No memes were generated in Zapata, but to keep variables as constant as possible, after the forum, posters were placed in the stores informing the people of the forum topic. No conscious effort was made to make a meme. The posters read as such⁷:

El martes 9 de Julio,
la gente se reunió en el Comité
para platicar del agua sucia.

The indicator of gray water was collected with categorical data. A logistic analysis was performed with SAS. The reported means are back transformed from ‘logit’ means. For the control, Quémaro, the back transformed mean for the pretest was 27.9 percent of street segments with grey water present, and for the posttest the mean was 3.1 percent of street segments with grey water. Figure 3.26 shows the back transformed means of the pretest and posttest for every town.

Figure 3.27 shows the differences between the pretest and the posttest for every town.

In Zapata, the back transformed mean for the pretest was 60.3 percent, and for the posttest, 13.8 percent. When comparing to the control it was found that the differences were not statistically significant ($p=0.8827$), thus the null hypothesis

⁷On Tuesday, July 9, the people gathered in the comite to talk about the dirty water.

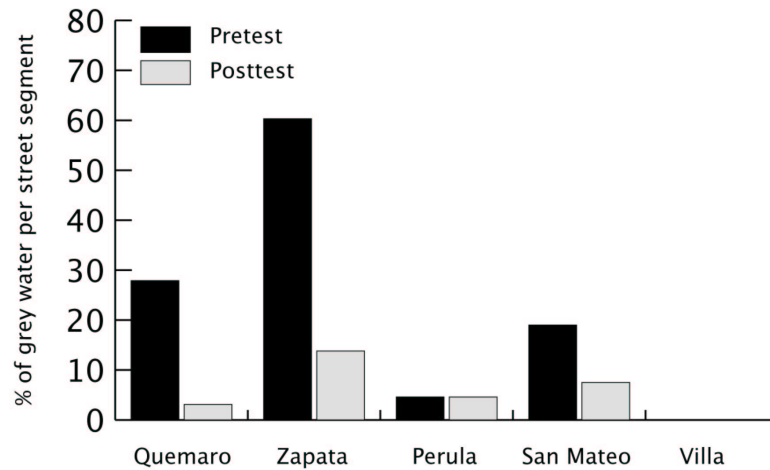


Figure 3.26: Grey water means comparing the pretest and the posttest in every village. Quémáro was the control. Zapata was the treatment with participation.

of no effect is accepted. Talking about a problem with only participation does not encourage people to change their behavior toward not dumping dirty water onto the street.

When comparing the other villages for possible dissemination of behavior it was found that none of them showed a statistically significant difference from the control. Pérula had averages for the pretest and the posttest of 4.6 percent and 4.6 percent of grey water on the street segments, respectively ($p=0.0774$). San Mateo had averages for the pretest and the posttest of 19 percent and 7.5 percent, respectively ($p=0.3023$). In both cases the null hypothesis of no effect is accepted. The behavior of not throwing grey water onto the streets was not transmitted to the other villages.

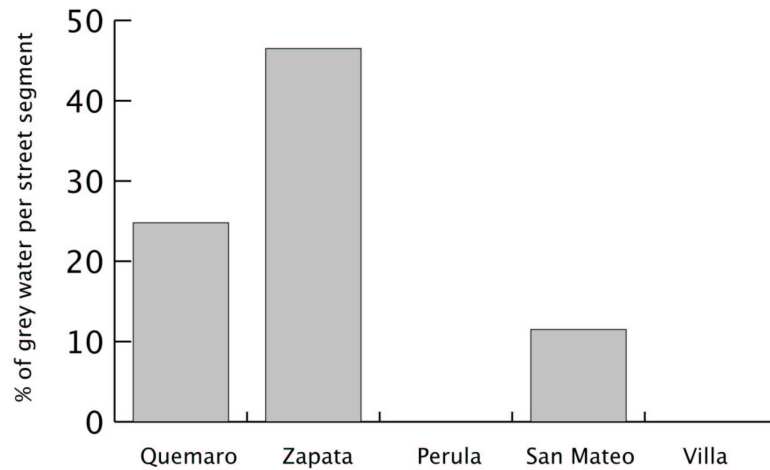


Figure 3.27: Differences of the means for each town. The mixed procedure in SAS compares the difference of the control, Quémáro, to the differences of the other villages. There were no statistically significant differences.

3.8.4 No participation, no memetics treatment. Fires indicator.

Village D, San Mateo, was treated with no memetics and no participation. The behavior of burning plastics was selected since 69 percent of the population identified this as a major problem in their village and it is an issue that could be ameliorated with a change in behavior.

No memes were generated in San Mateo, but to keep variables as constant as possible, posters were placed in the stores informing the people of the environmental issue. No conscious effort was made to make a meme. The style of warning labels in cigarettes and alcoholic beverages was chosen since they provide with information without being alarmist and they do not seem to affect peoples behavior with regards to the consumption of the product. The posters read as such⁸:

⁸Burning plastics might be dangerous to one's health.

Quemar plásticos

puede ser nocivo para la salud.

The data collected for this indicator were continuous. The mean for the control town of Quémáro was 0.77 fires containing burning plastics per block for the pretest, and 1.33 fires containing burning plastics per block for the posttest. Figure 3.28 shows the means for the pretest and the posttest of every town.

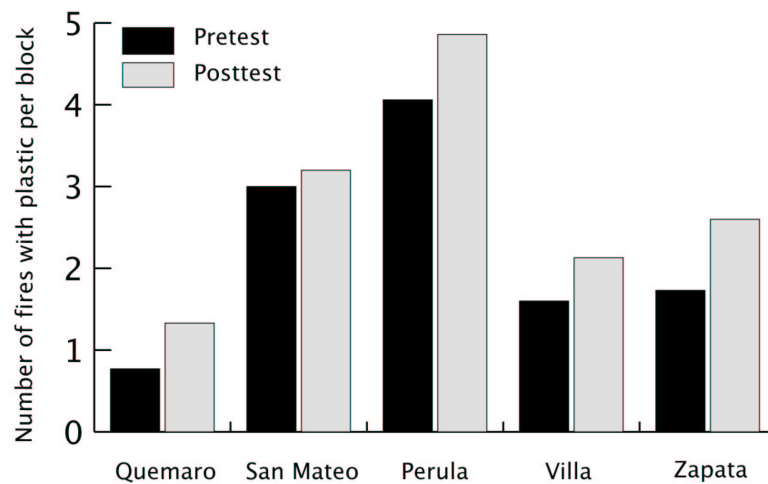


Figure 3.28: Fire means comparing the pretest and the posttest in every village. Quémáro was the control. San Mateo was the treatment.

Figure 3.29 shows the difference between the pretest and the posttest of every town.

For the town of San Mateo, the average for the pretest and the average for the posttest were 3.0 fires and 3.2 fires containing plastics per block, respectively. When comparing the differences of these means with the differences of the control means, it can be seen that the differences are not statistically significant ($p=0.5627$). The null hypothesis of no effects is accepted. There was no change in behavior from burning plastics to burning less plastics.

For all other villages the null hypothesis of no effects was accepted as well.

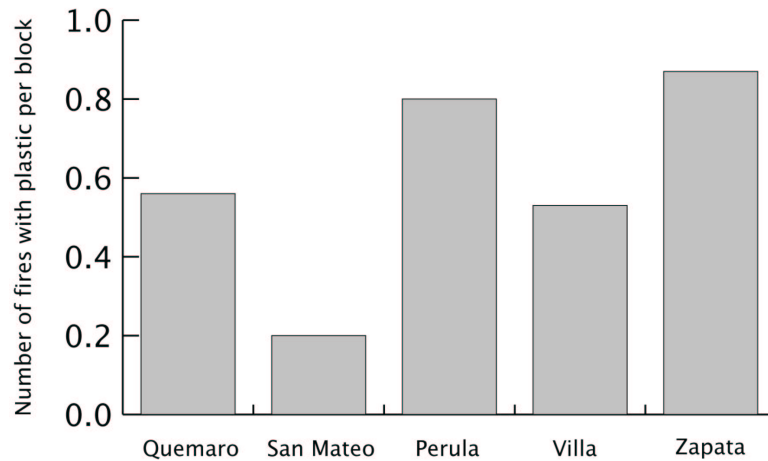


Figure 3.29: Differences of the means for each town. The mixed procedure in SAS compares the difference of the control, Quémáro, to the differences of the other villages. There were no statistically significant differences.

In Pérula, the means for the pretest and posttest were 4.06 and 4.86 fires with plastics, respectively ($p=0.7374$). In Villa, the means for the pretest and the posttest were 1.60 and 2.13 fires with plastics, respectively ($p=0.9757$). And for Zapata, the means for the pretest and the posttest were 1.73 and 2.60 fires with plastics, respectively ($p=0.6696$). There was no change in behavior from burning plastics to burning less plastics in any of the villages.

Chapter 4

Discussion

4.1 Assessment of environmental perceptions

The basic tenets of sustainable development and ecological economics are to address the needs of the present without compromising the ability of future generations to address their needs, and to address those needs while taking into consideration the productive and absorptive capacities of the earth (Costanza et al., 1997). This dissertation aimed to address those tenets at their most basic level, at the smallest scale, that of what each individual does, how each individual behaves with respect to their environment. The tool used to encourage people to change their behavior was that of memetics.

There is a certain kind of urgency in wanting to generate the awareness that we are in a “full world” now -as Daly (1994) calls it-. The whole world, everyone would benefit from this awareness. However, for this dissertation a smaller subset of the world had to be chosen in order for it to be handled by a work of this type. The tropical dry forest, being a hot spot (Mittermeier et al., 1999), and being an ecosystem that is disappearing at alarming rates seemed an appropriate place to start (Ceballos and Garcia, 1995). Villages around the biosphere

reserve Chamela Cuixmala were interviewed in order to assess their perceived environmental concerns.

The perceived environmental concerns of the people were to guide the rest of the study. It was interesting that even though some people mentioned the environmental concerns of the biological station (loss of biodiversity, erosion), most people mention other concerns (garbage on streets, grey water, burning plastics) as being more important to them. The immediate environmental concerns of the people are thus different from those of the academicians. This dissertation, wanting to focus on participatory development, made a priority the needs of the people, as told by the people (Gran, 1983; Burkey, 1996). The rest of the methodology was based on the feedback from those initial interviews and from getting to know the people better while on the familiarization period.

Around the Chamela Cuixmala biosphere reserve, most people live in very humble settings, but the basic needs of food, shelter and sanitation are covered. Even though INEGI (2000) considers this region as one of extreme marginalization, the images of the people here are not like the images of under developed countries portrayed by the media (for instance, very thin children with pot bellies; or half naked, undernourished people laying on the ground). The people of this area look healthy and strong. The children have easy white smiles. Every household has a home garden in which vegetables and fruits are grown all year round. Many people also grow ornamental plants, indicating leisure time (Figure 4.1).

The villages surrounding the biosphere reserve are comprised mainly of relatively new immigrants to the area. Eighty four percent of the interviewed people were not born in their villages. Most people come from other states or from more



Figure 4.1: Three generations of women in the town of Ranchitos. Notice their adobe home and ornamental plants.

populated areas within the state of Jalisco. There is no ancient knowledge of the usage or the natural resources of this area. Although some of the immigrants do come from areas that have a similar natural environment, and thus there is some species overlap. In those cases, there does seem to be an old knowledge of the usage of certain plants and animals.

The age of the interviewed people was normally distributed with 73 percent of the people of ages 18 to 55. Most of the interviews were dominated by a female speaker (78 percent). Most of the females tend to stay at home during the day while the males work on the fields or in nearby luxury hotels. However, the interviews were conducted from 9:30 am to 9:00 pm, mostly on week days, and some interviews were conducted over the weekend as well. This would have given ample opportunity for the males to participate. The fact that in only 8 percent of the interviews it was a male that was the prominent speaker, is consistent

with Medellín's (2001) finding that males tend not to participate in surveys, or in communitarian activities.

Twelve environmental issues were identified by the respondents. In all villages except San Mateo, garbage on the streets was the major issue, and this was the over all most mentioned issue with 80 percent of interviewees bringing it up in the discussions. I think indeed, that this is the most pressing issue in the area with respect to the villages. In most villages there are considerable amounts of garbage on some streets, and piles of garbage on corners (Figure 4.2, Figure 4.3). This generates unsanitary conditions by fostering rodents, mosquitoes¹, and other insects.



Figure 4.2: This house in the town of Zapata was littered with papers, plastic bags, and bottles. A close up of the bushes to the right is in the next figure.

¹The coast of Jalisco is a Dengue area. Dengue is an acute infectious disease caused by an arbovirus, transmitted by the aedes mosquito, and characterized by headache, severe joint pain, and a rash.



Figure 4.3: Close up of trash along the road. It is not uncommon to see streets littered like this.

There are several garbage dumps lining the federal road 200 (I counted 17 from Barra de Navidad to Pérula). These dumps are not regulated, people dispose of all kinds of refuse, including old tires, batteries, oil etc. The garbage piles often catch on fire. It is common to see plumes of smoke on the hill sides. On beach towns like Pérula, and Tenacatita (not a part of the study), it is common to find baby diapers buried in the sand, especially after the tourist season.

In order to solve the problem of garbage on the streets, 35 percent of the interviewees suggested to organize for a garbage truck service. After the initial interviews and the pretest, in the towns of Villa and Zapata, a private garbage collection pick up was established. The towns of San Mateo and Pérula established municipal garbage trucks. These actions aid with the issue of garbage on the streets, but the issue of unregulated garbage dumps remains.

Fourteen percent of the interviewees suggested organizing to clean the existing

garbage on the streets. Twenty one percent suggested to just stop throwing garbage on the streets. Instead of indiscriminately throwing wrappers, bottles, cans, etc., on the streets, people should take it home. But then what do you do with the garbage at home? Twenty seven percent of the people suggested the burning of garbage at the household level. Burning garbage at home is a very common practice. If done in the evenings it aids as a mosquito repellent. However, some people burn plastics with their garbage ensuing the release of carcinogenic chemicals into the atmosphere, not to mention the horrible odor. At the scale of these villages, burning or composting yard-type debris, organic matter, and paper, would probably be a good alternative to collecting piles of garbage. The ashes or soil can then be used as fertilizer. To this effect, sixteen percent of the people suggested to separate the garbage before burning it.

Lack of a sewer system, and burning plastics at home garbage piles were the second most important issues, with 36 percent of all the interviewees mentioning them. Even though there is no sewer system in the area, people build rudimentary septic systems or outhouses. However, some people are concerned about possible contamination of the groundwater since their drinking water often comes from wells. Twenty four percent of the people suggested that the government should build a sewer system in the area. Perhaps having regulations regarding the construction of the septic systems, or building composting toilets might be more viable options to ensure sanitation and clean groundwater, than building a sewer system.

Composting toilets have been constructed and installed in other Mexican villages (Arizpe, 2001). The making of the toilets provides an occupation and income for several people, and human refuse is not mixed with the scant water

in the region. Developing the knowledge in this area to start a small composting toilet operation might be an interesting sustainable development project for the future.

Thirty six percent of the interviewees were aware of the fact that burning plastics produces chemicals that are detrimental to one's health. But only 16 percent suggested to separate the garbage and not burn the plastics. Separating recyclable plastics might be an alternative to burning them. The nearest recycling facility is in Manzanillo, several hours away from the villages. Some people make a trip to the big city about once a month in order to buy goods that can not be found in the villages. These trips are often made in pick up trucks. People could organize and have their recyclables taken to Manzanillo. Perhaps the driver could keep the money from the operation, or give some percentage to the people providing with the plastics. A couple of people are already doing this with aluminum cans, which seem to be more profitable than plastic.

Grey water on the streets was an environmental concern for 31 percent of the interviewees. Fifty percent of the people in San Mateo identified this as an issue, and 73 percent of the people in Zapata did the same. Twenty six percent of the people suggested not dumping dirty water on the streets to solve the problem. Grey water on the streets is an issue because the water sometimes stands and fosters the growth of mosquitoes and other pests. The turbid water develops smelly environments with algae, and other organisms growing in them. Furthermore, the streets start to develop gullies making it harder for vehicles to get around. Some people do not let their used water flow into the streets, they have a section of their garden with plants that withstand soapy water. People that have this rustic "rain gardens" suggest all people can implement this technique.

Not using the recreational site was identified as an environmental concern by 30 percent of the interviewed people. On the informal talks people reminisced on times in which the family would go on picnics to the stream or the estuary. They have many tales of fishing “chacales” (a local freshwater shrimp) in the streams, or crabbing in the estuary. Some people would talk about the abundance of wildlife they liked to observe, including birds, mammals and reptiles. When asked why they stopped recreating outdoors in such manners they said they did not know. They just stopped. So the proposed solution was easy: to just go and start enjoying nature again (Figures 4.4 and 4.5).



Figure 4.4: Kids hanging out and looking for chacales in the town of villa, Cuixmala river.

Non potable water was identified as an issue by 24 percent of the interviewees. The suggestion for the solution of this problem was government intervention. The



Figure 4.5: Cuixmala river.

people felt that it is the government's duties to provide with potable water. Some people (23 percent) suggested making a civil organization that would make rules on how water and garbage should be managed. Three percent of the people suggested the installation of water pumps and reservoirs. To cope with the problem of non potable water, people either boil the water, buy drinking water in big glass containers, or install a filter.

Nineteen percent of the people identified reduction of wildlife as an environmental concern. Reduction of wildlife is ranked seventh among the twelve environmental issues identified by the interviewees. This is of interest since the biological station identifies loss of biodiversity and erosion as number one problems in the region. Even though people recognize this as a problem, it is not a priority. Sustainable development projects, if they are to be truly sustainable, should address the people's needs first. In order to solve the problem of wildlife

reduction, nine percent of the people suggested to avoid hunting. Many species are banned from hunting in this area, including the white tail deer, the green iguana, the wild boar, all felines, and many species of birds. People still hunt. For many people, hunted meat is an affordable way of obtaining protein. Poachers often enter the biosphere reserve's land in order to hunt deer. Iguanas are often killed whenever there is a sick person in the family as it is believed to have medicinal properties.

Pests were an issue for 14 percent of the interviewees. Most people were referring to mosquitos when talking about this problem. Apparently, when the first modern settlers arrived to this area back in the nineteen seventies, the mosquitos were a horrible pest problem. Now the villages have reduced the mosquito population (mainly by wetland drainage), but some people would want to see them gone all together. Some people were referring to loose animals on the streets when talking about pests. Some cows escape their confinements and eat other peoples gardens. Sometimes chickens and turkeys do the same. To solve that problem, the affected people suggested that the owners of the animals build better facilities for them.

Erosion was mentioned as an environmental problem by 12 percent of the people interviewed. This is one of the issues that the biological station mentions as being of utmost importance for the region, but it is on 9th place out of the 12 environmental issues that the people identified. According to Ayala (1998), most of the erosion is due to cattle ranching. Barren hills, with zigzagging cow paths are conspicuous along the road. Most villages own communal land called "ejidos". Each village is in charge for the management of their ejido. At night, the cows are kept in an enclosure close to the house; and during the day, the

cows are taken to the hills for grazing (Figure 4.6). The soils are very shallow making grazing unsustainable even at low cow densities. When talking about erosion, people thought of the issue at a more localized level, that of their yards, the road, or really close to home. To that effect, eight percent of the interviewees suggested to fill gullies with sand, and to put rocks and tree trunks in certain areas in order to avoid erosion. No one mentioned the more generalized problem of erosion in the region due to cattle ranching. Awareness about this issue might be another interesting sustainable development project for the future.



Figure 4.6: Cows coming home in the evening. Town of Zapata. Notice the dirt roads and brick buildings typical of the area.

Six percent of the people mentioned poor drainage of their “solares” as an environmental issue. Some of the villages are settled on top of now drained

wetlands, so in the rainy season, standing water is very common on people's yards and on the streets. Villa and Zapata have a ditch that helps drain the water. No one had any suggestions to ameliorate this problem.

Three percent of the people mentioned the lack of a health center as an environmental concern. All of the people that mentioned this issue were from San Mateo. There is a health center in Careyes, which is closer to Villa and Zapata, than San Mateo. Two percent suggested that the government should build a health center in their village. There are small clinics and health centers in the area, but these facilities can only take care of minor emergencies and diseases. The clinics are fully stocked with scorpion sting serum, dengue medicine, and the remedies for the common maladies of the area. However, for illnesses such as cancer or diabetes people have to be treated in Manzanillo or other near by larger cities.

One person from the town of Zapata mentioned the issue of deforestation as an environmental concern. The biological station groups loss of wildlife and deforestation as one category, that of loss of biodiversity. Even though mentioned by the people, these are not pressing issues for the villagers. If the sustainable development building is to be built, the issues concerning the people have to be addressed first. That was the aim of this dissertation. Once the needs of the people have been met we can then address the other pressing issues of the area. Two people from the town of San Mateo mentioned "educating people" as a solution to all environmental problems. I agree that if people were to be aware of the impact their actions have on the environment and on the welfare of their children, that they would try to behave differently. Memes can help generate that awareness and aid people in changing their behaviors.

4.2 Familiarization

The familiarization period was very rewarding for the researcher because it allowed an opportunity to get to know the people better, to know the region better. When the migratory bird talks were given the children were very excited about the presentation and about the awareness that their community and its surrounding habitat were very important.

The drawing exchange was also important because it made a connection between schools in the US and México. It made people realize that what we do with our environment might have consequences far away. The children in both countries were very excited about having contact with children abroad.

Starting the familiarization period in the schools was a good way to begin acquainting oneself with the community because the activities were fun and interesting. The children would comment with their parents about the migratory birds and about the “biology teacher”. Many things being political in México, this allowed for neutrality on part of the researcher. The people would know that the researcher was genuinely interested on the environment and how they perceived their environment, and not in their internal disputes.

Once the people in general started to feel comfortable with the presence of the researcher in their towns due to the familiarity with the children, then it was easier to approach the women and ask them about their cooking. This was done partly as a form of empowerment. Someone from afar being interested in them and in the knowledge they might share made the women have a higher sense of pride. Often, at the beginning of a conversation the women would be shy and say they do not know anything, they did not finish school and what could they share with me. But pretty soon they were feeling comfortable and giving recipes on

how to cook iguana, or on really good local remedies for the kidneys.

After the good experience with collecting recipes and local know-how of herbs and animals, some workshops were easy to organize. Mrs. Campos started cooking classes, and Mrs. Gargollo gave a canning workshop. The researcher learned a great deal from these activities and other women seemed to have enjoyed them as well. The camaraderie prompted invitations to birthday parties and to the local independence party. These were great honors that indicated the desired level of comfort between the people and the researcher in order to organize the forums for the experimental part of the project.

From the initial interviews and the familiarization period it was decided which would be the behaviors to be treated in the experiment. The indicators to measure the behaviors were also developed. Emphasis was made on the indicators being sensory specific since respondents often give biased opinions if they know the researcher.

4.3 Experiment

For the experimental part of the project, convoking for the forums was very easy due to the familiarity of the researcher with the people. Access to the schools and public properties was given without hesitation. People were willing to help in the organization and to participate in the activities. It is interesting to note that there were mostly women and youth at the forums and at all of the organized activities. According to Medellín (2001) and Arizpe (2001) it is typical in small villages in México, to have the men be very apathetic about any kind of extracurricular activity. Men usually do not participate in forums or in any organized event to further the wellbeing of the community, they think it a “waste

of time” (Medellin Morales, 2001).

The experience that Medellin had in another biosphere reserve in México (“El Cielo”, Tamaulipas), the men were not interested in any of the activities unless there were a lot of typical dishes, like mole; and were certainly not interested in undertaking any project unless the women had tried it first and it worked (Medellin Morales, 2001, 1997).

In the forums, the outcome formulation questionnaire, guided the discussion about one environmental problem. The guiding questions were posted on big pieces of paper. The answers were brain stormed and written on the board. The questionnaire helped the participants imagine in sensory terms how their town would be if they could address the identified problem: how it would feel like, smell like, how it would look, to have a town that is clean. It was interesting to see how people’s face would light up when imagining such a place. In the town of Villa, where memes were generated in a participatory manner, it was a nice flow between the questionnaire and the making of the memes. Having a phrase that they came up with, that they agreed would prompt them into action was a nice ending for the forum. Whereas in Zapata, where the forum was conducted but no meme was formed, the end of the questionnaire was the end of the forum and it seemed to have an abruptness to it. A feeling of “what now? that’s it?”.

For the town of Pérula, the researcher came up with a meme with no participation. However, the meme for this town was constructed after having had the experience of constructing the meme with the town of Villa. The researcher took some of the cues from that experience and implemented them when building the meme.

For the town of San Mateo it was hard to treat the village with the envi-

ronmental issue of burning plastics and not make it be a meme. So the posted message tried to not push any buttons, however, it might have pushed some people's buttons unintentionally. This village is not the control. The control is the town of Quémáro in which no environmental issues were dealt with and no familiarization activities were performed. The only contact with the town were the initial assessment interviews, the pretest and the posttest.

The results with respect to the change in behavior were as expected. The town of Villa, which was treated with participation and memetics did have a significant lowering of the garbage on the streets when compared to the control ($p=0.0064$). The null hypothesis was rejected. Participation, in combination with memetics helped people ameliorate a behavior that they identified as wanting to change, in this case, having too much garbage on the streets.

With respect to the transfer of the behavior from one town to another, it was found that only the town of San Mateo had a significant decrease in garbage when compared to the control ($p=0.0066$). Thus the meme of not throwing garbage on the streets was transmitted to this population. This makes sense in light of knowing the people of the area. Figure 4.7 shows the position of the villages with relation to each other and the biosphere reserve. Even though Villa and Zapata are closer to each other, they have many disputes with one another. There is an ongoing feud between the two villages. On the other hand, the people of Villa have a good rapport and many friendships with the people of San Mateo making the meme easier to travel in that direction. Except for the two feuding towns, all the other treatment villages have some contact with each other. They are all off the main road. Quémáro, the control, is a bit more isolated, and has less contacts with the four treatment villages.

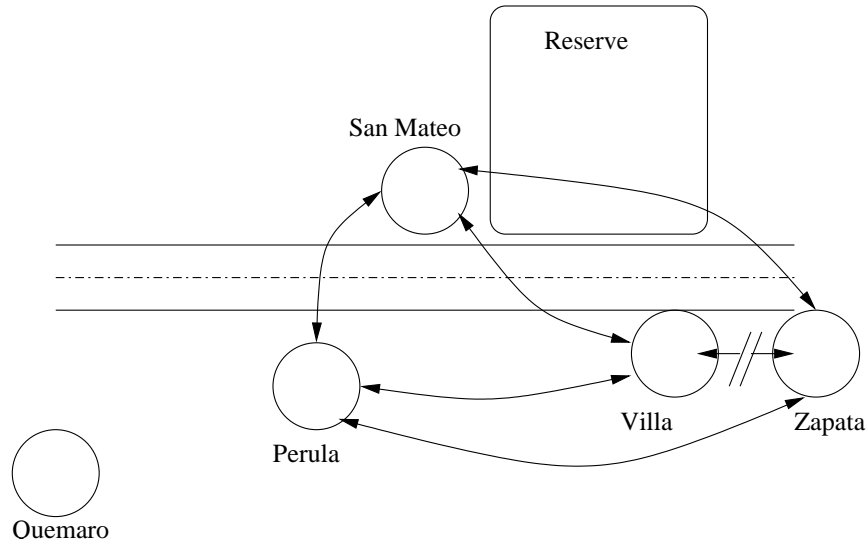


Figure 4.7: Relative location of the villages to one another. The arrows indicate connections or disconnections between the villages.

The town that was treated with memes only, Pérula, also had significant differences when compared to the control ($p=0.0403$). The behavior that was addressed is that of using the recreational site. People used the site more after being exposed to the meme. It was quite surprising that when sitting at the site making the counts of people, a boy came and asked if I was the one that had posted all the signs that encouraged the use of the recreational site. He said he read it and that since then he makes a point of visiting the place and of telling friends about it. Just now he was with some friends and he wanted to show me an estuarine crab.

Regarding the transmission of this behavior to other populations, it was found that no other differences were statistically significant. The behavior of using the recreational site was not transmitted to other populations.

In the town of Zapata, a forum was conducted but there was no effort to create memes. The behavior addressed at the forum, that of not dumping grey

water on the streets, was not ameliorated by just having a forum ($p=0.8827$). Even though the differences were not statistically significant, at least two people did change their behavior. In the forum someone suggested making a hole on the ground for the water to collect and seep slowly into the ground, and plant some vegetation around it (i.e. a rain garden). A couple of such water detention (or retention) constructions in a couple of homes were seen by the researcher. It is feasible that if memes had been generated along with the forum talks, more people would have implemented the solution they found for their environmental concern. There was no transmission of this more environmentally friendly behavior to other populations.

In the town of San Mateo, an environmental idea was posted without intent of it being a meme. The issue addressed was that of burning fires. As expected, there were no significant differences between this town and the control ($p=0.5627$). The behavior of burning plastics was not ameliorated. The behavior was also not transmitted to other villages.

The results of the experimental part were as expected. The villages in which memes were created demonstrated a significant amelioration on the behaviors being addressed. The village that had participation only did not experience an amelioration of the behavior, and the village that had no memes and no participation did not experience a change in behavior either. It would be interesting to design another experiment in which the magnitude of the change could be measured so that we could test the hypothesis of which methodology generates a greater change, memes alone, or memes with participation. That is a question that this study did not address, since we used different behaviors that are not comparable to one another because we wanted to test whether the behaviors

would be transmitted from one village to another.

Regarding the transmission of behaviors between villages, it was observed that only one behavior was transmitted to one other village.

4.4 Concluding Comments

This dissertation contributes to the field of ecological economics by addressing, at a very basic level, the confluence of society, ecology and economics. It addresses society because it deals directly with human behavior and how it affects the rest of the community. It addresses economics because it deals with choices as consumers, for instance people who chose to produce less garbage, consumed products with less packaging. It addressed ecology because in modifying behavior people also modify what and how they take things from the natural capital and what and how they return the wastes to the ecosystem.

Ecological economics is increasingly a dialogue on values. This dissertation addresses the issues at the most basic level, at the smallest scale, that of the individual. Ecological economics is often represented by a Venn diagram of three circles intertwined with one another (Figure 4.8), where all the points of contact are the issues addressed by the field (Patterson et al., 2002). This dissertation addressed directly the intersection between society and ecology, and in an indirect way, it addressed the intersection of the three circles. But it did it at the smallest possible scale.

The diagram of ecological economics can be viewed as three dimensional, once we add the concept of scale to it (Figure 4.9). At the bottom we have the individual, above that, the family, the community, the county, the state, etc. The upward arrows denote the increase in scale. The downward arrows denote

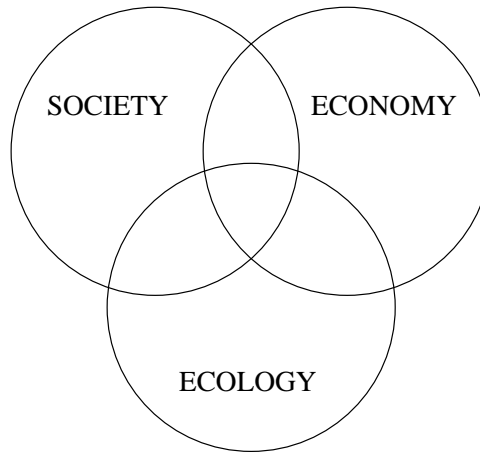


Figure 4.8: Ecological economics is the intersection of society, economy and ecology.

the fact that there are connections among all the different scales, and that these connections are dynamic.

With the three dimensional diagram we can see that different issues can be addressed at many different levels. The ideal would be to address one issue, coming from the same pre-analytical point of view, at all possible scales, while also thinking of the fourth dimension of time. The tetra dimensional model makes patent the issue of sustainability, since time has to be taken into account, making us reflect upon future generations. However, there is a caveat to these diagrams. Having the three circles separated from one another gives the illusion that society, economy, and ecology exist independently of each other, when in reality only the ecosystem can exist independently of the other two.

A better representation would be Passet's (1979) three spheres diagram in which the economy is embedded into the society, and the society is embedded into the ecosystem (Figure 2.2). The traditional Venn diagram, I think is useful because of the way we separate the disciplines of study, and in that sense it clearly explains the overlap of the disciplines; whereas Passet's diagram is more

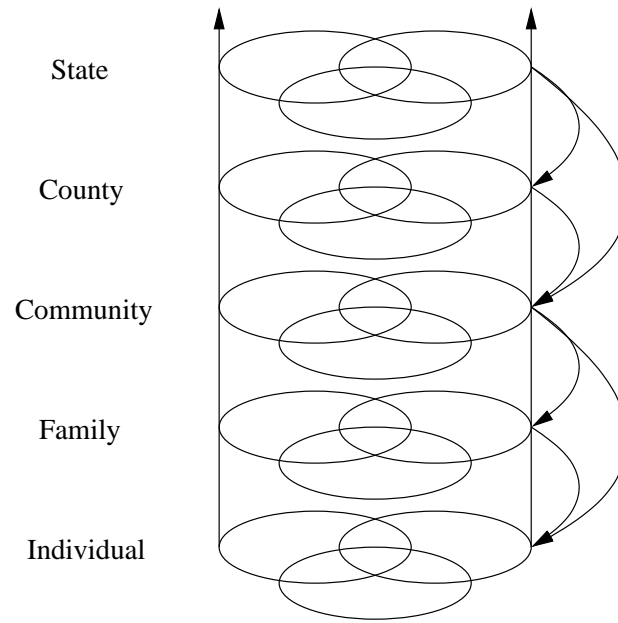


Figure 4.9: The intersection of society, economy and ecology can be viewed at different scales.

representative of the natural reality of the world. Putting it all together, Figure 4.10 shows Passet's three spheres denoting the biosphere and society and economy embedded in it (area). Then we have all of the different scales going up and down and being interactive and dynamic with each other, and finally we have the component of time. This figure would be my representation of sustainable development.

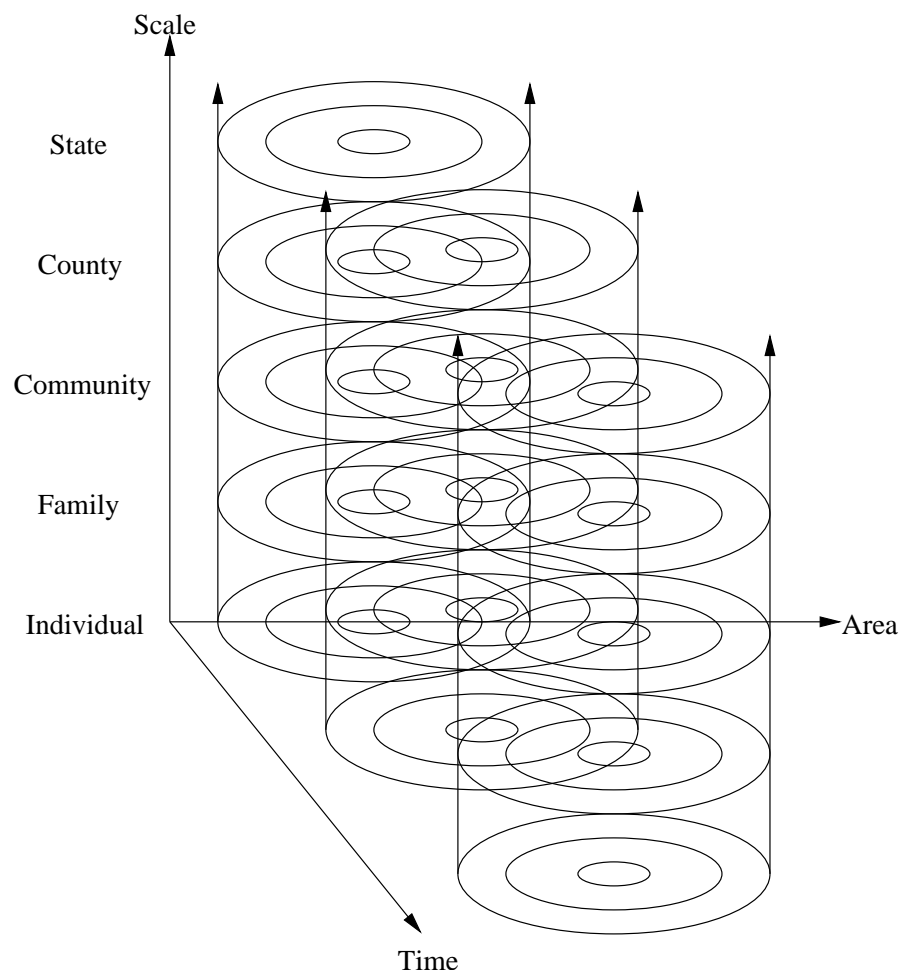


Figure 4.10: Sustainable development figure. The intersection of society, economy and ecology can be viewed at different scales and through time.

Thinking about Burkey's (1996) diagram of sustainable development (Figure 2.4), we can see some representation of scales by the fact that the personal development is at the bottom of the building and the social development is the roof held by the columns of economic and political development. This diagram also represents the differentiation of the disciplines. What I like about this diagram is that it stresses the necessity to address human development first, since this is the base of the building. This dissertation contributes to the development of that base by aiding people to change their behavior towards a more environmentally friendly behavior, thus improving their surroundings in ways that the people deemed important. However, the building analogy seems very static. In reality there is feedback between the different components, and there is time. Sustainability is a dynamic process.

It was found in this dissertation that from the methodologies that were tested, the tool that was the most successful in aiding people to change their behaviors was memetics. In both villages where memes were generated, there was a significant change in behavior when compared with the control. Villa reduced the amount of garbage on the streets, and Pérula increased the usage of the recreational site. Encoding an idea in a linguistic structure, taking into account the values, beliefs and filters of the population to be aided, served as a useful methodology with potential to contribute to similar grassroots projects. It must be said, however, that the construction of an effective meme would have been harder without the help of the population. Prior to the forum in Villa, some possible memes were generated as an exercise in meme making. The perceived values, beliefs and filters of the population were being taken into account. It was surprising to note the difference between the memes generated by the researcher and the memes

generated by the forum participants. The choice of words and triggers were very different. The researcher had chosen positive triggers such as pride, whereas the villagers chose triggers of embarrassment, such as laziness. Taking the style of the memes generated in a participatory manner aided the researcher to generate the meme for the town of Pérula in a non participatory manner.

Memetics proved useful in aiding the villages around the biosphere reserve to address the needs of the people while taking into account the needs of future generations. However, more sustainable development projects are needed in the area if the tropical dry forest is to continue to function as an ecosystem that is able to support a great variety of biodiversity and its relationships. Composting toilets, local production of local fruit preserves, nature trails for ecotourism, and organizing the community to recycle, are examples of various activities that could be undertaken in order to foster awareness, pride of place, and sustainability.

Besides the excitement of finding statistical differences for the towns in which memetics were used, the most rewarding part of this dissertation was the contact with the people. Getting to meet individuals and knowing that a positive difference was made in the lives of some of them (Figure 4.11).

4.5 Further Research and Action

Given the fact that the amelioration of behaviors was statistically significant when using memes, I would recommend to use this type of methodology in similar grassroots sustainable development projects. Memes could be a low cost alternative to other environmental education options.

Follow up to this research could be performed in which the indicators are measured in subsequent time periods in order to observe whether the memes are



Figure 4.11: Outing on San Nicolás stream with some kids from the town of Quémaro at the end of the research period.

still active, have faded away, or if they have disseminated to other villages. This would be testing the longevity and strength of the memes through time.

Another experiment that could be conducted is one in which “do a positive” (use the recreational site) is tested against “don’t do a negative” (don’t throw garbage) in order to establish whether a meme of one kind might spread more easily than the other.

I would be interested in going back to the communities in order to address the identified environmental concerns using memes in a participatory manner. This dissertation investigated people’s environmental perceptions and tested different methodologies to identify which one would achieve the desired results, but it did not tackle the environmental issues *per se* in order to solve them. Now that it has been established which methodology would be more efficient in bringing about behavioral change, a project to actually try to ameliorate the situation in the villages would be of interest. Memetics has proven to be an efficient way to effect change towards sustainability.

Other sustainable development projects could stem from this work. Several

opportunities to generate income from improving the environment have been identified. For instance, the creation of a composting toilet company, which has already proven successful in other parts of México, could easily be implemented in this area. Establishing a business of taking recyclables into the city is another example of a feasible enterprise. Building small “rain gardens” to contain the grey water, could be another way of generating some income. Making preserves, jams and marmalades from the excess fruit in the home gardens could save money from not having to buy these products, and could generate some money if they are sold in the local stores or in the hotel gift shops (which already carry some local artworks).

Spreading the memes of sustainable development and ecological economics through our individual behavior is a good way to tackle the environmental and social problems we now face. Such behavior, while it is best re-enforced by community commitment and by government policy, at the individual level it is also able to promote conservation and sustainable development, and should not be underestimated as an important contribution to the management of natural resources.

Appendix A

Appendix. Migratory bird talks

As part of the familiarization period, different activities were conducted as a tool to acquaint the researcher with the people in the experimental villages of Villa, Zapata, San Mateo and Pérula. The general script of the talks given in the schools in the US and in México follows. The numbers at the beginning of the paragraphs indicate the slide number from Cornell's migratory bird audiovisual package.

A.1 Talks in English

1.-Today we are going to talk about migratory birds. But first who can tell me what does migratory means?

To migrate, to move from one country, place, or locality to another. To pass periodically from one region or climate to another for feeding or breeding.

And now, where are the birds moving to? To which places are they migrating? And when?

In winter birds go south to warmer places. In the spring they come back to build their nests and raise their young. In the autumn the birds fly back south

to México, Central, and South America.

2.-This is a Wood Thrush, here we can see where it spends the winter and the summer.

3.-The Wood Thrush sets up territories in eastern North America, builds nests, raises young and prepares for the autumn journey back to the wintering grounds.

4.-Unfortunately, during the last decade, the number of Wood Thrushes that return in the spring is decreasing. Every spring we have a smaller number of birds returning to raise their young.

5.-Other migratory birds like the Bobolink are also decreasing in numbers.

6.-Other examples are, the Painted Bunting

7.-The Prairie Warbler,

8.-And the Yellow-Breasted Chat.

9.-All these birds are known as Neotropical migratory birds. That is, birds that breed in North America and winter in México, the Caribbean, Central and South America.

10.-Neotropical birds represent a large percentage of North American species so biologists, and people in general, are worried about the declines in these birds.

Why are they declining? There are many reasons.

12.-One reason might be tropical deforestation.

13.-People in the tropics burn parts of the forest so that they can cultivate the land for food. This technique is called slash and burn.

15.-The wintering region used by many birds is small compared with the breeding area used in North America.

19.-Another reason for the decline in bird numbers is the use of pesticides in

North America and Latin America. The toxins of the pesticides concentrate in the bird's fat reserves and this affects their reproduction and survival.

21.-When birds are migrating, sometimes they fly over water. They need resting areas where they can feed to be able to fly for long distances. Coastlines are very important stop over areas, but many of them have been developed.

23.-Another reason for the declining number of birds is that the forests in the United States in which they breed have also been destroyed or fragmented.

25.-Fragmented forests allow intrusions by predators normally found in open areas. Like the crow, which feeds on the birds and their nestlings.

26.-Suburban development also fragments forests, and people bring cats with them. The cats eat many birds.

27.-Neotropical birds tend to build open nests which can easily be predated by crows, cats, raccoons and other animals.

28.-The brown headed cowbird used to live in grasslands, but now with the forest fragmentation, they are everywhere. This birds parasite other birds.

29.-The cowbird female do not build nests. They lay their eggs in the nests of other birds.

30.-The other birds do not recognize the alien eggs and they feed the cowbird chick instead of their own.

33.-Some of the birds that are affected by the cowbird are: the yellow warbler.

34.-The Least Bell's Vireo.

35.-And the Nashville warbler.

41.-What happens when tropical birds decline? Many of them are valuable because they consume enormous quantities of agricultural pests.

42.-Or, they are valuable to people because of their beauty.

44.-What are we doing to prevent the Neotropical migratory birds from declining? An international cooperation began in 1990, it's called Partners in Flight.

45.-Partners in Flight wants to: determine all the causes of Neotropical migratory bird declines; maintain stable populations; reverse declining population trends through habitat restoration and enhancement.

50.-What can we do to prevent the Neotropical migratory birds from declining? Public groups are important to the success of Partners in Flight.

51.-You can take part in bird counts.

53.-You can support national and international conservation groups.

54.-You can become involved in educational programs that teach bird appreciation and conservation.

56.-Neotropical migratory birds are part of your cultural and biological heritage. The loss of all these birds would be a tragedy. Can anyone tell me what bird this is? A Northern Oriole!

57.-We can do many things to help solve the issue of the Neotropical migratory birds.

A.2 Talks in Spanish

2.-El día de hoy vamos a hablar de aves migratorias. Este es un Wood Thrush o Zarzalito maculado y es un ave migratoria, esto es, pasa el invierno aquí en México y la primavera y verano en USA. Migrar quiere decir que pasa periódicamente de una región o clima a otro para alimentarse y reproducirse.

3.-El Zarzalito maculado se va al este de Norte América en la primavera. Construye su nido, pone sus huevos, cuida d sus crías y se preparan para regresar en el otoño a México.

4.-Desafortunadamente, en la ultima decada, el numero de aves migratorias ha disminuido.

5.-Otras aves migratorias tambien han disminuido en número, como el Bobolink o Tordo arrocero.

6.-Otro ejemplo es el Painted bunting o Colorín sietecolores.

7.-El Prairie warbler o Chipe pradeño.

8.-Y el Yellow breasted chat o Gritón pechiamarillo.

9.-Todas estas aves son conocidas como aves neotropicales migratorias, esto es, aves que se reproducen en Norte America y pasan el invierno en México, el Caribe y Centro y Sudamerica.

10.-Las aves migratorias neotropicales representan un gran porcentaje de las especies de aves que tenemos en México. Es por esto que los biólogos estamos preocupados en la disminución de estas aves. ¿Y porque están disminuyendo en número estas aves?

12.-Una razon puede ser la deforestación.

13.-En algunos lugares, como aqui en México, se practica la tala y roza, se quema el bosque para poder sembrar.

15.-Otra razón puede ser que el área donde las aves pasan el invierno es mucho menor que el área donde pasan la primavera.

19.-Otra razón por la cual las aves han disminuido en número es el uso de pesticidas. Las toxinas de los pesticidas se concentran en las reservas de grasa de las aves y esto afecta su fecundidad y supervivencia.

22.-Cuando las aves van migrando, algunas veces vuelan sobre agua. Necesitan lugares de descanso en la costa, pero muchos lugares en la costa tienen ahora edificios en vez de árboles y las aves ya no pueden descansar y alimentarse ahí.

23.-Otra razón de la disminución de números, es que en los EU también se han destruido bosques o están fragmentados, las aves migratorias no viven bien aquí.

26.-El desarrollo urbano también fragmenta los bosques, y la gente trae gatos, que comen muchas aves.

27.-Las aves neotropicales construyen nidos abiertos que pueden ser fácilmente depredados por cuervos, gatos, mapaches, y otros animales.

28.-Un ejemplo de cómo son afectadas las aves migratorias es el del Brown headed cowbird o Vaquero cabecicafé. Estas aves parasitan a las aves migratorias cuando hay fragmentación de bosques.

29.-Las hembras del Vaquero cabecicafé no construyen nidos. Ponen sus huevos en los nidos de otras aves.

30.-Las otras aves no reconocen los huevos extraños y alimentan al pollo Vaquero cabecicafé como si fuese suyo.

33.-Algunas de las aves afectadas por el Vaquero cabecicafé son el Yellow warbler o Chipe amarillo (verdín).

34.-El Least Bell's vireo o Verdín de Bell.

35.-Y el Nashville warbler o Chipe de Nashville.

41.-¿Por qué son valiosas las aves migratorias? ¿Qué pasa cuando disminuyen en número? Las aves son importantes porque comen moscos y orugas, que son plagas para la agricultura.

56.-También son importantes por su valor estético, porque son bonitas y alegran la vida de la gente (Oriole, Calandria).

44.-¿Qué es lo que nosotros estamos haciendo para evitar la disminución de las aves migratorias? Una cooperación internacional comenzó en 1990, se llama Aves

de las Américas, y se dedica a hacer investigación de aves, a restaurar habitats, y a educación ambiental.

49.-¿Que pueden hacer ustedes para ayudar a las aves migratorias? No matarlos con resorteras, cuidar los árboles, no tirar basura. El público en general es importante.

51.-Pueden participar en conteos de aves.

53.-Pueden apoyar a grupos de conservación.

54.-Pueden platicar con otras personas acerca de las aves migratorias y porque son importantes.

42.-Las aves migratorias son parte de nuestra cultura y de nuestra herencia biológica. La pérdida de estas aves sería una tragedia. ¿Me podrían decir qué ave es ésta? Ruby throated hummingbird o Chupaflor rubí o Colibí gorjirro-bio. Acuérdense que ustedes pueden hacer muchas cosas para salvar a las aves migratorias.

Appendix B

Appendix. Bird drawings

The participation in the “Bridging the Americas” project of the Smithsonian Institution served as a tool to familiarize the researcher with the people in the experimental villages as a preparation for the community forums.

Students in Mexico and in Maryland made drawings and exchanged them according to the migration times of the birds. Following are just a few samples of the art created by the children.



Figure B.1: Baltimore Oriole.



Figure B.2: Orchard Oriole.



Figure B.3: Eastern Blue Bird.



Figure B.4: Least Fly Catcher.



Figure B.5: Tecolote llanero. *Athene cunicularia*



Figure B.6: Chipe rojo. *Tangara rojinegra*



Figure B.7: Colibri gorjirrubio. *Archilochus colubris*



Figure B.8: Colibri.

Appendix C

Appendix. Cookbook

The development of this cookbook served as a tool to familiarize the researcher with the women in the experimental villages. Sharing of knowledge by the women empowers them and encourages them to participate in the community forums.

C.1 Recetas de Chamela

RECIPES FROM CHAMELA

INDEX

Introduction.....	2
Salads.....	3
Vegetables.....	5
Carbohydrates and Vegetarian proteins.....	9
Meats, Fish and Chicken.....	16
Desserts and Breads.....	23

RECETAS DE CHAMELA

INDICE

Itroduccion.....	2
------------------	---

Ensaladas.....	3
Verduras.....	5
Carbohidratos y Proteinas Vegetarianas.....	9
Carne, Pescado y Pollo.....	16
Postres y Panes.....	23

C.1.1 Introduction

Chamela is an ancient fishing village situated by the Mexican Pacific Ocean, in the state of Jalisco, south of Puerto Vallarta and north of Manzanillo. In 1971 a road bordering the coast was inaugurated (Federal Road # 200). This new road allowed the immigration of people from different states and the establishment of new towns. Around this time, the National Autonomous University of México (UNAM) established a biological station in the area in order to study the local flora and fauna, and their interactions. Different groups of national and international students visit the biological station to conduct research. A kitchen was established as part of the services that the station provides to the students and researchers. The menus take into account the seasonal produce, nutritional content and balance, and the expertise and preferences of the cooks. Everything is made from scratch and all food groups are represented in every meal: fruits and vegetables, carbohydrates, proteins (of animal or vegetable origin) and fats. Traditionally, in México, breakfast is a moderately big meal and is served in the morning. Lunch, "la comida," is the main meal and is served between 2:00 and 4:00 pm. Dinner is light and served around 8:00 pm. At the biological station there is always fresh seasonal fruit as an appetizer for breakfast. One might enjoy any combination of several tropical fruits like pineapple, mango, papaya, water-

melon, bananas, cantaloupe and nances. After every meal hot coffee or herbal teas (typically chamomile or mint) are served with sweet breads. This book is a compilation of the favorite recipes from various women that live in the towns around the biological station, including the two most prominent cooks of the biological station, Evangelina Robles Jimenez otherwise known as "Doña Eva" (Figure C.1) and Maria Elena Santana Mariscal alias "Doña Elena (Figure C.2)."



Figure C.1: Doña Eva.

C.1.2 Ensaladas

Ensalada jardín

- 1/2 lechuga
- 1 pepino
- 2 jitomates



Figure C.2: Doña Elena.

- 2 apios sal limón
1. Se lavan muy bien la lechuga y el jitomate, se cortan en pedazos pequeños. Se pela el pepino y se corta en rebanadas. Se deshebran los apios y se pican.
 2. Se agrega sal y limón de manera que quede todo bien cubierto. Se mezcla bien.

Ensalada con jícama

- 1/2 lechuga
- 1 pepino
- 1 jitomate
- 5 zanahorias ralladas

- 1 jícama pelada

- sal

- limón

1. Se lavan muy bien la lechuga y el jitomate, se cortan en pedazos pequeños.
Se pela el pepino y se corta en rebanadas. Se corta la jícama en cuadritos.
Se añade la zanahoria rallada. Se mezcla todo muy bien.
2. Se agrega sal y limón de manera que quede todo bien cubierto. Se mezcla bien.

Ensalada de col con nuez

- 1/2 col

- 1 zanahoria

- 1 piña rebanada

- 1/2 tasa nuez

- 1/2 tasa crema

- pizca de sal

- 1 cucharada azúcar

1. Se pica la col finita. Se ralla la zanahoria. Se pica la piña en cuadritos. Se pica la nuez.
2. Se mezcla todo con la crema, se añade el azúcar y la pizca de sal.

C.1.3 Verduras

Calabazitas con elote

- 1 Kg de calabazitas
- 1 lata de elotitos
- 2 jitomates
- 1 cebolla
- 1 chile serrano
- 1 cucharada de aceite vegetal
- 1 cucharadita de sal

1. Se pica todo en crudo.
2. Se pone en sartén con una cucharada de aceite vegetal. Se agrega la sal. Se tapa y cocina a fuego lento.

Calabazitas rellenas de queso

- 10 calabazitas
- 4 huevos
- 4 jitomates
- 2 dientes de ajo
- 1 cebolla
- harina

- oregano

- cilantro

- sal o consomé

1. Se hierve agua. Se dejan hervir las calabazas unos dos o tres minutos. Se corta la punta y cola. Con el trazo de un tenedor se sacan las semillas.
2. Se rellenan las calabazitas de queso. Se enharinan y se cubren con huevo batido.
3. Se pica y acitrona la cebolla. Se muelen los jitomates con el oregano, ajo y cilantro. Se añaden a la cebolla. Cuando el caldillo hierva se agregan las calabazas y se dejan unos 10- 15 minutos.
4. Con las tripitas se mezcla huevo, queso y harina. Se vierten sobre el caldillo caliente y se dejan hasta que cuajen.

Verduras de Doña Eva y Delia

- 2 chayotes

- 2 zanahorias

- 1 coliflores

- 4 calabazitas 3 papas aceite de olivo sal o knor suiza

1. Se pone a calentar el aceite bajito.
2. Se pica todo. Primero se añaden los chayotes, las zanahorias y la coliflor, se dejan 10 minutos con la cazuela tapada.

3. Se añaden las calabazitas y las papas, se dejan 10 minutos mas.
4. Se sazona con sal o knor suiza.

Nopalitos

- 5 pencas de nopal tiernitas
- 1 y media cebolla
- 1 jitomate
- 1 lechuga
- sal y limón

1. Se pelan y pican los nopales.
2. Se hierven en agua con sal y media cebolla. Se les escurre el líquido.
3. Se pica el jitomate, la cebolla y la lechuga.
4. Se mezcla con los nopales. Se añade sal y limón.

Vinagreta para ensalada de verduras

- 1 taza de aceite de olivo
- 1 cucharada de mostaza
- 1 cucharadita de pimienta molida
- 1 taza de vinagre de manzana
- 6 hojas de albahcar

- sal al gusto
1. Se pican las hojas de albahcar finitas.
 2. Se mezcla todo muy bien en un recipiente tapado.
 3. Se vierte al gusto sobre ensaladas.

Verduras estilo ensalada

- 3 zanahorias
 - 3 calabazitas
 - 2 chayotes chicos
 - 1/2 coliflor
 - vinagreta (ver vinagreta)
1. La coliflor se corta en cuadritos. Las zanahorias se cortan longitudinalmente (a lo largo) y luego transversalmente formando medias lunas. La calabaza y el chayote se cortan de la misma manera.
 2. Se pone a hervir agua sin sal (para que la calabaza quede verde). Primeramente se añade la zanahoria y se deja hervir unos tres minutos, posteriormente se añade la coliflor y se deja hervir durante unos dos minutos, finalmente se añaden la calabaza y el chayote, se dejan hervir unos cinco minutos mas. En total la zanahoria debe hervir alrededor de diez minutos. Se escurre el agua.
 3. Se añade la vinagreta, se mezcla todo muy bien.

Chayote con crema

- 4 Chayotes
- 1/2 barra de Mantequilla
- 1 taza de crema
- sal al gusto
- pimienta al gusto

1. Se hierva el chayote picado en agua con sal. Cuando este suave se escurre.
2. Se vacía el chayote caliente sobre la mantequilla en cuadritos.
3. Se agrega la crema, sal y pimienta. Se mezcla todo.

Calabacitas al vapor

- 12 calabazitas
- 1/2 barrita de margarina
- 2 cucharadas de perejil picado
- 1 cucharadita de cebolla picada
- 1 taza de queso rallado
- sal al gusto pimienta al gusto

1. Se lavan las calabazitas y parten en rodajas. Se ponen en una cacerola con la margarina, el perejil y la cebolla.

2. Se añade sal y pimienta; se espolvorean con el queso.
3. Se tapan y cuecen sin agua a fuego bajo, hasta que estén tiernas.

C.1.4 Carbohidratos y Proteínas Vegetarianas

Sopa de lentejas

- 2 tazas de lentejas
- 1 cebolla
- 2 jitomates
- 3 cucharadas de aceite
- 1 cabeza de ajo
- granulado de verduras o pollo
- 1/2 taza de cilantro
- 1 plátano macho

1. Se pica la cebolla, ajo y jitomate. Se prepara el recaudo friendo estos ingredientes en el aceite y dejándolos reposar unos minutos hasta que el jitomate haya ablandado.
2. Se añaden las lentejas y el granulado. Se deja freír todo por unos 3 o 4 minutos.
3. Se agrega agua hasta que quede todo cubierto y el agua sobrepase las lentejas por unos 3 cm. Se deja hervir hasta que las lentejas estén casi suaves.

4. Se agrega el cilantro y el plátano macho picados y se deja cocer hasta que las lentejas estén listas.

Chilaquiles verdes

- 12 tortillas
- 12 tomates verdes
- 2 dientes de ajo
- 1 rama de epazote
- chile serrano al gusto
- aceite para freir
- sal
- 1/2 taza de crema
- 1/2 taza de queso fresco desmoronado
- 1 cebolla en rebanadas

1. Se cortan las tortillas en cuadritos y se doran en aceite. Se escurre la grasa.
2. Se licuan los tomates, los chiles y el ajo.
3. Se frie hasta que sazoneen. Se añade sal y epazote. Se agregan tres tazas de agua.
4. Cuando la salsa este hirviendo se añaden las tortillas; se dejan un momento, para que no se ablanden demasiado. Se apaga el fuego.
5. Se sirve con queso desmoronado, crema y rebanadas de cebolla.

Nopales con huevo

- 1 Kg de nopales
 - 3 jitomates
 - 1 cebolla
 - 2 cucharadas de cilantro
 - 4 huevos
 - 1 cucharada de aceite
 - sal al gusto
1. Se pican los nopalitos en crudo. Se hierve agua y se agregan los nopales con sal y un pedazo de cebolla. Una vez cocidos se cuela y tira el agua.
 2. Se pica el jitomate, cebolla, chile, cilantro.
 3. Se frie todo en el aceite, se agrega sal y se añade el huevo también. Se bate todo hasta que el huevo esté cocinado.

Huevos con papa

- 2 papas
- 3 cucharadas de aceite
- 1 jitomate
- 1 cebolla
- 1 chile jalapeño

- 6 huevos

- sal al gusto

1. Se pican las papas crudas y se frien en el aceite en una sartén.
2. Se pican el resto de los ingredientes y se frien junto con las papas.
3. Se batien los huevos y se añaden al sartén junto con todo lo demás, se agrega la sal que se desee y se cocina hasta que los huevos estén al gusto. Se sirven calientitos con tortillas.

Arroz a la naranja

- 3 cucharadas de aceite
- 2 cucharadas de cascara de naranja rallada
- 1 1/2 taza de jugo de naranja
- 1 taza de agua
- 1 1/2 cucharada de sal
- 1 taza de arroz

1. Se calientan las tres cucharadas de aceite en una cazuela. Se añade la cáscara de naranja, la taza de jugo, el agua y la sal. Se deja que dé un hervor.
2. Se añade la taza de arroz. Se tapa bien y se deja al fuego durante unos 25 minutos.

Arroz rojo

- 3 cucharadas de aceite
- 1 taza de arroz
- 3 jitomates
- 1 cebolla
- 5 dientes de ajo
- 1 cucharada de sal
- 1 taza de agua

1. Se dora el arroz en el aceite.
2. Se licuan la cebolla, el jitomate, el ajo y la sal con el agua. Se vierte la mezcla sobre el arroz dorado.
3. Se deja que llegue a un hervor y se baja el fuego. Se cubre la cazuela y se deja cocinar durante unos 20 minutos.

Chilaquiles en salsa verde

- 10 tortillas
- 10 tomates
- 1 cebolla
- 1/2 taza de cilantro fresco
- 1 cabeza de ajo

- sal al gusto
- crema al gusto
- queso fresco al gusto

1. Se pican las tortillas en cuadritos de unos 3x3 cm y se frien.
2. El tomate, cebolla, cilantro y ajo se licuan junto con la sal que se desee formando una salsa.
3. Se colocan los cuadritos de tortillas fritas en un recipiente, se vierte la salsa sobre las tortillas, que queden bien mojadas. Se adorna con la crema y el queso fresco desmoronado.

Frijoles refritos (version simple)

- 2 tazas de frijoles
- 2 tazas de agua
- sal
- aceite para freir

1. Se cocen los frijoles en olla express con sal.
2. Se traspasan a una casuela con aceite, se frien y machacan. Se sirven calientitos, o se utilizan en otras recetas.

Tostadas

- 10 tortillas o tostadas
- 2 tazas de frijoles refritos (ver frijoles refritos)
- 1 taza de carne deshebrada (opcional)
- 1/2 col o lechuga picada
- 1 jitomate picado
- 1/2 cebolla picada
- 1 taza de queso fresco desmoronado
- 1/2 taza de crema
- chile serrano picado

1. Para hacer la carne deshebrada, se compra carne en trozo, de pollo, rez o puerco, que no tenga grasa. Se cueze y deshebra.
2. Se frien las tortillas o se compran las tostadas hechas.
3. Se untan los frijoles sobre la tostada, cubiendo bien toda la superficie. Se añade la carne deshebrada. Se adorna con la lechuga, jitomate, cebolla, crema y queso. Se añade chile serrano picado al gusto.

Molletes

- 6 bolillos
- 1 taza de frijoles refritos (ver frijoles refritos)

- 1/2 taza de queso rallado
- 1 jitomate
- 1/2 cebolla
- 4 cucharadas de cilantro picado
- 1 aguacate
- 1/2 barra de margarina
- chiles serranos picados

1. Se parten los bolillos en mitades y se les quita algo del migajón.
2. Se untan las mitades primero con margarina y luego con frijol. Se espolvorean con queso.
3. Se hornean a fuego medio durante 10 minutos.
4. Se pica el jitomate, la cebolla, el chile, el cilantro y el aguacate. Se mezcla bien y se añade sobre los molletes.

Taquitos dorados de lo que sea

- tortillas
- requesón
- frijoles
- papa
- rajas

- jamón

- pollo etc.

1. Se rellena la tortilla al gusto con el ingrediente de preferencia.
2. Se enrolla la tortilla y se frie en aceite muy caliente hasta que dore.
3. Se sirve caliente con la salsa de su preferencia.

Tostadas de ceviche de soya

- 1/4 Kg de soya granulada
- 2 hojas de laurel
- cebolla
- 2 zanahorias
- 2 jitomates
- 1 puño de cilantro
- 10 limones
- 10 tostadas

1. Se hierva agua, se vacia la soya y las hojas de laurel. Se dajan 2 minutos.
Cuando enfrie se exprime el agua y se añade el jugo de 5 limones.
2. Se pica la cebolla y se le pone el jugo de los otros 5 limones.

3. Se exprime la soya nuevamente se pican las verduras restantes y se mezcla todo con la cebolla. Se deja reposar unos 5 minutos. Si hay exceso de liquido se tira.
4. Se pone la mezcla sobre tostadas.

C.1.5 Pescado y Pollo

Bistecs con cerveza

- 6 Bistecs (bola, aguayón o diezmillo)
- 1 vaso de cerveza
- 1/2 cebolla rebanada
- 1 cucharada de puré de jitomate
- 1 cucharada de harina
- aceite para freir
- sal y pimienta al gusto

1. Se pone sal y pimienta a los Bistecs y se frien hasta que se doren un poco.
2. Se mezcla la cerveza con las rebanadas de cebolla, el jitomate, la harina y una taza de agua.
3. Se agrega esta mezcla a la carne, se tapa la sartén y se deja cocer durante media hora. Se sirve caliente.

Tortas de carne

- 1/2 Kg de falda de res
- 3 huevos
- 1 trozo de cebolla
- 1 diente de ajo
- 1 cucharada de harina
- aceite para freir
- sal y pimienta al gusto

1. Se cuece la carne en 6 tazas de agua con la cebolla y el ajo. Ya cocida, se escurre, se deja enfriar y luego se deshebra.
2. Se baten las claras de huevo a punto de turrón y luego se agregan las yemas y el harina. Se mezcla.
3. Se vierte la carne deshebrada, se añade sal y pimienta sobre la mezcla. Se revuelve un poco.
4. Se frie en una sartén, con aceite muy caliente, cucharadas de la mezcla anterior y se aplanan un poco para formar las tortas.
5. Se sirve con salsa mexicana o en caldillo de jitomate.

Milanesas de ternera

- 6 milanesas de bola de ternera

- 2 huevos batidos
- 1 taza de pan molido
- aceite para freir
- sal y pimienta al gusto

1. Se pasan las milanesas por huevo batido y luego por el pan revuelto can sal y pimienta, se sacude el exceso de pan.
2. Se frien las milanesas hasta que estén ligeramente doradas.
3. Se quita el exceso de grasa con una servilleta de papel. Las milanesas se pueden servir con puré de papa o con col cocida.

Mancha manteles

- 3/4 Kg de lomo en rebanadas
- 2 plátanos maduros de castilla o machos
- 3 rebanadas de piña fresca
- 1/2 cebolla
- 1/2 cabeza de ajo
- 1 raja de canela
- 6 pimientas negras
- 4 clavos de especia
- 1/2 cucharada cafetera de azúcar

- chile ancho al gusto

- aceite para freir

- sal

1. Se frie la carne y las rebanadas de plátano. Se apartan.
2. Se asa el ajo, cebolla y chiles. Se ponen los chiles a remojar, Cuando estén suaves se licuan con las especias. El ajo y la cebolla. Se frie la mezcla a fuego lento en la cazuela hasta que sazone.
3. Se regresa la carne, añade 1/2 taza de agua, el azúcar y la sal. Cuando la carne este casi cocida, se agrega la piña cortada en trocitos y los plátanos fritos, deje 10 minutos mas.

Enchiladas Zacatecanas

- 18 tortillas
- 1/4 Kg de lomo de puerco
- 6 chiles poblanos
- 1 taza de queso fresco desmoronado
- 1 taza de crema
- 1 lechuga

1. Se cuece la carne; se deja enfriar, se deshebra y frie ligeramente.

2. Se asa, desvena, pela y muelen los chiles; se mezclan con crema, se agrega la mitad del queso desmoronado y se pone la mezcla al fuego. Cuando hierva, se retira y se pone en un lugar donde no se enfríe.
3. Se frien ligeramente las tortillas, se mojan en la salsa, se rellenan con la carne deshebrada y se doblan.
4. Se acomodan las enchiladas en un platón; se vierte encima la salsa que sobro. Se adornan con las hojas frescas de lechuga y queso. Se sirven muy calientes.

Chuletas al chipotle

- 4 chuletas de puerco gruesas
 - 1 latita de chiles chipotles adobados
 - 6 cebollitas de cambray
 - 1 diente de ajo
 - 1/2 taza de crema espesa
 - 1 cucharada de consomé granulado de res o pollo
 - aceite
 - sal y pimienta
1. Se salpimientan las chuletas, se corta la cebollita y se licua con crema, ajo y uno o dos chiles chipotles, al gusto.

2. En una cacerola con poco aceite se frie ligeramente la salsa sazonando con el granulado. Cuando suelte el hervor se retira del fuego.
3. Se doran las chuletas en poco aceite y cuando estén cocidas se bañan con la salsa. Se sirve con ensalada de lechuga y jitomate.

Tiritas de pescado

- 750 gr de pescado
- 1 1/2 taza de harina
- 1/2 cerveza
- 1 huevo
- 2 cucharadas de consomé
- pimienta al gusto

1. Se licuan el huevo, el harina, el consomé y la pimienta. Se añade la cerveza lentamente. Debe quedar consistencia como harina para hot cakes.
2. Se corta el pescado en tiritas y se remojan en la mezcla.
3. Se frien en aceite caliente y se ponen a escurrir en servilletas de papel.

Milanesas de pescado

- 6 filetes de pescado (huachinango, robalo)
- 1 huevo
- pan molido

- aceite para freir

- sal y pimienta

1. Se lavan los filetes en agua fría, se secan con un trapo y se espolvorean con sal y pimienta.
2. Se bate el huevo.
3. Se bañan los filetes en el huevo batido y se revuelven en pan molido.
4. Se frien los filetes uno a uno en aceite no demasiado caliente, hasta que tomen un color dorado. Se pueden servir calientes acompañados de ensalada verde, o fríos cubiertos de mayonesa.

Huachinango a la Veracruzana

- 1 huachinango entero (aproximadamente de kilo y medio)
- 4 jitomates
- 12 aceitunas deshuesadas partidas a la mitad
- 6 chiles largos
- 1 cebolla rebanada
- 2 dientes de ajo picados
- 2 hojas de laurel
- 1 pizca de orégano
- 2 cucharaditas de jugo de limón

- aceite para freir

- sal

1. Se limpia y lava el pescado sin cortar la cabeza ni la cola. Se pica por ambos lados con el tenedor y se unta con sal y jugo de limón. Se deja reposar 30 minutos.
2. Se prepara la salsa de jitomate: se frie durante 10 minutos la cebolla, el ajo, el jitomate, el laurel, el orégano y se añade sal.
3. Se coloca el pescado en un refractario y se agrega la salsa de jitomate, los chiles las aceitunas y la cebolla rebanada. Se hornea a fuego medio hasta que se cueza el pescado (unos 20 minutos).
4. Sirva con arroz blanco.

Torta de papas con atún o sin atún

- 3 papas grandes
- 1 lata de atún (opcional)
- 2 huevos
- 1 cucharada de harina
- sal al gusto
- aceite para freir

1. Se cuecen y pelan las papas. Se machacan y revuelve con el atún, los huevos, el harina y la sal.

2. Se hacen las formas de torta tomando porciones pequeñas, haciendo bolitas y aplanandolas. Se frien en aceite caliente hasta que estén doradas

Pollo en su jugo

- 1 pollo grande cortado en piezas
- 2 tazas de caldo de pollo
- 4 cucharadas soperas de vinagre
- 1 cebolla rebanada
- tomillo
- aceite para freir
- sal

1. Se lava bien el pollo y se seca. Se añade sal y se dora en aceite muy caliente. Se saca. En el mismo aceite se frie bien la cebolla.
2. Se regresa el pollo a la cacerola y se añade el vinagre, el caldo, tomillo y sal. Se tapa la cacerola y se cuece hasta que este tierno.
3. Se sirve con ensalada de lechuga o verdura cocida.

C.1.6 Postres y Panes

Pan de vainilla Do a Elena

- 2 barras de mantequilla
- 1 1/2 tazas de azúcar

- 1 cucharada de vainilla
- 4 huevos
- 2 tasas de harina de trigo
- 1 cucharada de royal
- 1 taza de leche

1. Se bate la mantequilla y el azúcar. Se añaden los huevos. Se cierne el harina con el royal. Se aaden a la mezcla de mantequilla.
2. Se engrasa el molde con mantequilla. Se mete al horno caliente (150-200C) durante 30-40 minutos, o hasta que al meter un palillo este salga limpio.

Pan de zanahoria y piña

- 4 huevos
- 2 tazas de azucar
- 1 taza de aceite
- 2 tazas de harina
- 2 cucharaditas de royal
- 1 pizca de carbonato
- 3 tazas de zanahoria rayada
- 2 tazas de piña en cuadritos
- 1 puño de pasas

- 1 puño o de nuez
- 3 cucharadas de canela molida

1. Se pone a calentar el horno.
2. Se baten los huevos, el azucar, el aceite, el harina, el royal y el carbonato.
Se a ade la zanahoria, pi a, pasas, nuez y canela.
3. Se engrasa un molde, se vierte la mezcla y se hornea en horno bien caliente por 40 minutos.

Pan de calabaza

- 3 margarinas
- 4 huevos
- 1 leche condensada y endulzada (Nestle)
- 1 cucharada de azucar
- 2 cucharadas de royal
- 1 puño de pasas
- 2 tazas de harina
- 1/2 Kg de calabazitas

1. Se bate la margarina y se a ade el azucar. Se agregan los huevos uno a uno.
Se a ade la leche.
2. Se agrega el harina, las calabazas rayadas y el royal.

3. Se coloca la mezcla en un molde engrasado y enharinado. Se pone en horno mediano durante media hora.

Pastitas Do a Elena

- 800 g de harina
- 600 g de mantequilla
- 300 g de nuez
- 2 cucharaditas de royal
- 2 cucharaditas de vainilla
- 200 g de azúcar
- canela en polvo al gusto

1. Se cierne el harina en la tabla de amazar con el royal. Se hace un cerro con un orificio al centro.
2. Se añaden el resto de los ingredientes en el orificio. Se amasa con la mano. Se hacen bolitas y se aplanan un poco.
3. Se colocan en hojas ligeramente engrasadas y se hornean. Al sacarlas se bañan con azúcar y canela.

Galletas de maíz Doña Eva

- 1 Kg de Mazeca
- 3 tiras de canela

- 2 tazas de nata/ aceite vegetal/ manteca de puerco
 - 3 margarinas/ mantequillas
 - 3 tazas de azucar
 - leche para ablandar
1. Se mezcla todo hasta dar una consistencia como harina para tortillas.
 2. Se torteo una gordita y se cortan rueditas con un molde para galletas.
 3. Se ponen en una charola sin engrasar en horno mediano precalentado durante unos 15 minutos.

Tortillas dulces de comal

- 1 Kg de harina
 - 1/2 Kg de azúcar
 - 5 barras de 90 g de mantequilla o 1/2 Kg de natas
 - 1 cucharada de royal
 - 4 huevos
 - canela al gusto
 - vainilla al gusto
 - 1/2 cucharada de sal
1. Se amasa bien todo junto. Se hacen bolitas en la tortilladora y se aplastan.
 2. Se calientan en comal. Se doran al gusto.

Galletas de Nuez

- 4 tazas de harina
- 1 cucharada de royal
- 2 margarinas
- 1 taza de azúcar
- Nuez al gusto

1. Se revuelve todo hasta que quede una pasta suave. Si queda dura se ablanda con leche.
2. Se hacen las galletas y se hornean a 150 C durante unos 20 minutos hasta que este dorada la orilla. Se voltean las galletas y se dejan 5 minutos mas.

Postre de canela y piña

- 2 camotes
- 1/2 piña
- 3 tazas de azúcar
- 1 paquete de galletas Maria
- 3 cucharadas de jerez dulce
- nueces para adornar

1. Se cuecen los camotes en un poco de agua. Se licuan con la piña.

2. Se disuelve el azúcar en una taza de agua y se hierve hasta obtener una miel ligera. Se retira del fuego.
3. Se aparta 1/2 taza de miel, se agrega el jerez y se mezcla. En la miel que queda se agrega la pi a y el camote licuados. Se hierve hasta que se vea el fondo de la olla, moviendo constantemente.
4. En un platón se colocan sucesivamente una capa de galletas mojadas en la miel con el jerez y una capa de pasta de fruta. Se termina con la pasta, se adorna con las nueces. Se enfria antes de servir.

Flan

- 1 litro de leche de vaca
- 4 huevos
- 1 lata de leche Nestlé condensada
- 4 cucharadas de azúcar
- 2 cucharaditas de azúcar
- 1 cucharada de vainilla concentrada

1. Se queman las 4 cucharadas de azúcar en una sartén y se vacía en uno o en varios moldes refractarios.
2. Se licua la leche, los huevos, 2 cucharaditas de azúcar, la vainilla.
3. Se vierte en el molde o moldes, se mete al horno a ba o Maria durante una hora y media a 300 grados. Se saca y se deja enfriar.

Gelatina de guayaba

- 1 lata de leche Nestlé
- 1 litro de agua
- 5 guayabas
- 4 cucharadas de grenetina

1. Se disuelve la grenetina en un poco del agua fría. Se pone a baño María hasta que se deshagan los grumos. Se añade el resto del agua.
2. Se licuan la leche y las guayabas. Se cuelean y se añade el líquido al agua con grenetina. Se mezcla todo muy bien. Se deja enfriar hasta que cuaje.

Pan Do a Elena

- 2 barras de mantequilla
- 2 tazas de azúcar
- 2 tazas de harina
- 4 huevos
- 1 cucharada de vainilla
- 1 cucharada de Royal
- 1 taza de leche

1. Se cernen el harina y el Royal. Se mezcla la mantequilla con el azúcar, los huevos enteros, y los demás ingredientes.

2. Se engrasa un molde y se pone la mezcla. Se mete al horno a 150 grados durante unos 30 minutos o hasta que un palillo salga limpio.

Appendix D

Appendix. Templates to measure indicators

As part of the nonequivalent control-group design a pretest and a posttest were conducted in which sensory specific indicators were measured. Four behaviors were assessed with four different indicators. Each template addresses one behavior/indicator. All behaviors were measured in all villages.

Poblado: _____ Fecha: _____

Indicador 1 - Basura

calificación lugar

1) 0 1 2 3 4 5 6 7 8 9 10

2) 0 1 2 3 4 5 6 7 8 9 10

3) 0 1 2 3 4 5 6 7 8 9 10

4) 0 1 2 3 4 5 6 7 8 9 10

5) 0 1 2 3 4 5 6 7 8 9 10

6) 0 1 2 3 4 5 6 7 8 9 10

7) 0 1 2 3 4 5 6 7 8 9 10

8) 0 1 2 3 4 5 6 7 8 9 10

9) 0 1 2 3 4 5 6 7 8 9 10

10) 0 1 2 3 4 5 6 7 8 9 10

11) 0 1 2 3 4 5 6 7 8 9 10

12) 0 1 2 3 4 5 6 7 8 9 10

13) 0 1 2 3 4 5 6 7 8 9 10

14) 0 1 2 3 4 5 6 7 8 9 10

15) 0 1 2 3 4 5 6 7 8 9 10

① Nada ③ 6-8 ⑥ 15-17 ⑨ 24-25
 ⑦ 1-2 ④ 9-11 ⑦ 18-20 ⑩ 26 →
 ② 3-5 ⑤ 12-14 ⑧ 21-23

Figure D.1: Template for garbage pretest and posttest.

Poblado _____

Fecha _____

Indicador 2 - plásticos quemados

de fogatas con plástico
por cuadra / lugar
















1) 	8) 
2) 	9) 
3) 	10) 
4) 	11) 
5) 	12) 
6) 	13) 
7) 	14) 
	15) 

Figure D.2: Template for burning plastics pretest and posttest.

Poblado: _____

Fecha: _____

Indicador 3- aguas grises/negras?

segmentos de 2 cuerdas

# de segmento	agua?	lugar.
1	si/no	
2	si/no	
3	si/no	
4	si/no	
5	si/no	
6	si/no	
7	si/no	
8	si/no	
9	si/no	
10	si/no	
11	si/no	
12	si/no	
13	si/no	
14	si/no	
15	si/no	

Figure D.3: Template for grey water pretest and posttest.

Poblado: _____

Fecha: _____

Indicador 4 - recreation

	cada 15 minutos	recreación?	# gente
1	Hora inicio _____	si/no	_____
2	_____	si/no	_____
3	_____	si/no	_____
4	_____	si/no	_____
5	_____	si/no	_____
6	_____	si/no	_____
7	_____	si/no	_____
8	_____	si/no	_____

¿ Usan el sitio de recreación?

si

no

(Entrevista
20 personas)

Figure D.4: Template for recreation pretest and posttest.

Appendix E

Appendix. Raw data and SAS code

E.1 Raw data

E.1.1 Garbage

Town	Date	Street		Garbage
Perula	July	1	10	
Perula	July	2	3	
Perula	July	3	7	
Perula	July	4	9	
Perula	July	5	10	
Perula	July	6	10	
Perula	July	7	5	
Perula	July	8	10	
Perula	July	9	2	
Perula	July	10	9	
Perula	July	11	10	
Perula	July	12	7	

Perula	July	13	9
Perula	July	14	6
Perula	July	15	3
Perula	January	1	10
Perula	January	2	7
Perula	January	3	7
Perula	January	4	7
Perula	January	5	10
Perula	January	6	10
Perula	January	7	9
Perula	January	8	10
Perula	January	9	4
Perula	January	10	10
Perula	January	11	10
Perula	January	12	6
Perula	January	13	10
Perula	January	14	10
Perula	January	15	10
Quemaro	July	1	2
Quemaro	July	2	5
Quemaro	July	3	2
Quemaro	July	4	1
Quemaro	July	5	10
Quemaro	July	6	3
Quemaro	July	7	9

Quemaro	July	8	6
Quemaro	July	9	7
Quemaro	July	10	10
Quemaro	July	11	1
Quemaro	July	12	3
Quemaro	July	13	10
Quemaro	July	14	3
Quemaro	July	15	10
Quemaro	January	1	6
Quemaro	January	2	9
Quemaro	January	3	6
Quemaro	January	4	3
Quemaro	January	5	9
Quemaro	January	6	6
Quemaro	January	7	10
Quemaro	January	8	7
Quemaro	January	9	8
Quemaro	January	10	10
Quemaro	January	11	1
Quemaro	January	12	3
Quemaro	January	13	9
Quemaro	January	14	8
Quemaro	January	15	10
Villa	July	1	3
Villa	July	2	5

Villa	July	3	8
Villa	July	4	3
Villa	July	5	10
Villa	July	6	3
Villa	July	7	4
Villa	July	8	2
Villa	July	9	2
Villa	July	10	4
Villa	July	11	10
Villa	July	12	10
Villa	July	13	5
Villa	July	14	3
Villa	July	15	10
Villa	January	1	3
Villa	January	2	5
Villa	January	3	9
Villa	January	4	4
Villa	January	5	10
Villa	January	6	3
Villa	January	7	4
Villa	January	8	1
Villa	January	9	1
Villa	January	10	6
Villa	January	11	10
Villa	January	12	9

Villa	January	13	3
Villa	January	14	2
Villa	January	15	7
Zapata	July	1	5
Zapata	July	2	10
Zapata	July	3	7
Zapata	July	4	7
Zapata	July	5	7
Zapata	July	6	7
Zapata	July	7	9
Zapata	July	8	1
Zapata	July	9	6
Zapata	July	10	6
Zapata	July	11	10
Zapata	July	12	3
Zapata	July	13	2
Zapata	July	14	5
Zapata	July	15	9
Zapata	January	1	6
Zapata	January	2	8
Zapata	January	3	10
Zapata	January	4	4
Zapata	January	5	8
Zapata	January	6	5
Zapata	January	7	10

Zapata	January 8	2	
Zapata	January 9	3	
Zapata	January 10	10	
Zapata	January 11	10	
Zapata	January 12	7	
Zapata	January 13	7	
Zapata	January 14	7	
Zapata	January 15	4	
SanMateo	July	1	8
SanMateo	July	2	8
SanMateo	July	3	10
SanMateo	July	4	7
SanMateo	July	5	2
SanMateo	July	6	10
SanMateo	July	7	10
SanMateo	July	8	10
SanMateo	July	9	10
SanMateo	July	10	10
SanMateo	July	11	9
SanMateo	July	12	10
SanMateo	July	13	6
SanMateo	July	14	10
SanMateo	July	15	10
SanMateo	January 1	7	
SanMateo	January 2	8	

SanMateo	January 3	10
SanMateo	January 4	7
SanMateo	January 5	2
SanMateo	January 6	10
SanMateo	January 7	10
SanMateo	January 8	10
SanMateo	January 9	10
SanMateo	January 10	10
SanMateo	January 11	10
SanMateo	January 12	10
SanMateo	January 13	4
SanMateo	January 14	10
SanMateo	January 15	9

E.1.2 Grey water

Town	Date	Street	GreyWater
Perula	July	1	0
Perula	July	2	1
Perula	July	3	0
Perula	July	4	0
Perula	July	5	1
Perula	July	6	0
Perula	July	7	0
Perula	July	8	0
Perula	July	9	0

Perula	July	10	0
Perula	July	11	0
Perula	July	12	0
Perula	July	13	1
Perula	July	14	0
Perula	July	15	0
Perula	January	1	0
Perula	January	2	1
Perula	January	3	0
Perula	January	4	0
Perula	January	5	1
Perula	January	6	0
Perula	January	7	0
Perula	January	8	1
Perula	January	9	0
Perula	January	10	0
Perula	January	11	0
Perula	January	12	0
Perula	January	13	0
Perula	January	14	0
Perula	January	15	0
Quemaro	July	1	0
Quemaro	July	2	0
Quemaro	July	3	0
Quemaro	July	4	0

Quemaro July	5	0
Quemaro July	6	1
Quemaro July	7	1
Quemaro July	8	0
Quemaro July	9	1
Quemaro July	10	1
Quemaro July	11	0
Quemaro July	12	1
Quemaro July	13	0
Quemaro July	14	0
Quemaro July	15	0
Quemaro January 1	0	0
Quemaro January 2	0	0
Quemaro January 3	0	0
Quemaro January 4	0	0
Quemaro January 5	0	0
Quemaro January 6	0	0
Quemaro January 7	1	1
Quemaro January 8	0	0
Quemaro January 9	1	1
Quemaro January 10	1	1
Quemaro January 11	0	0
Quemaro January 12	1	1
Quemaro January 13	0	0
Quemaro January 14	0	0

Quemaro	January	15	0
Villa	July	1	0
Villa	July	2	0
Villa	July	3	0
Villa	July	4	0
Villa	July	5	0
Villa	July	6	0
Villa	July	7	0
Villa	July	8	0
Villa	July	9	0
Villa	July	10	0
Villa	July	11	0
Villa	July	12	0
Villa	July	13	0
Villa	July	14	0
Villa	July	15	0
Villa	January	1	0
Villa	January	2	0
Villa	January	3	0
Villa	January	4	0
Villa	January	5	0
Villa	January	6	0
Villa	January	7	0
Villa	January	8	0
Villa	January	9	0

Villa	January	10	0
Villa	January	11	0
Villa	January	12	0
Villa	January	13	0
Villa	January	14	0
Villa	January	15	0
Zapata	July	1	1
Zapata	July	2	0
Zapata	July	3	1
Zapata	July	4	1
Zapata	July	5	1
Zapata	July	6	0
Zapata	July	7	1
Zapata	July	8	0
Zapata	July	9	1
Zapata	July	10	0
Zapata	July	11	1
Zapata	July	12	0
Zapata	July	13	0
Zapata	July	14	0
Zapata	July	15	0
Zapata	January	1	1
Zapata	January	2	0
Zapata	January	3	1
Zapata	January	4	0

Zapata	January 5	1	
Zapata	January 6	0	
Zapata	January 7	1	
Zapata	January 8	0	
Zapata	January 9	1	
Zapata	January 10	0	
Zapata	January 11	1	
Zapata	January 12	0	
Zapata	January 13	0	
Zapata	January 14	0	
Zapata	January 15	0	
SanMateo	July	1	0
SanMateo	July	2	1
SanMateo	July	3	1
SanMateo	July	4	0
SanMateo	July	5	0
SanMateo	July	6	0
SanMateo	July	7	1
SanMateo	July	8	0
SanMateo	July	9	1
SanMateo	July	10	1
SanMateo	July	11	0
SanMateo	July	12	0
SanMateo	July	13	0
SanMateo	July	14	0

SanMateo	July	15	0
SanMateo	January	1	0
SanMateo	January	2	0
SanMateo	January	3	1
SanMateo	January	4	0
SanMateo	January	5	0
SanMateo	January	6	1
SanMateo	January	7	1
SanMateo	January	8	0
SanMateo	January	9	1
SanMateo	January	10	0
SanMateo	January	11	0
SanMateo	January	12	0
SanMateo	January	13	0
SanMateo	January	14	0
SanMateo	January	15	0

E.1.3 Recreation

Town	Date	Time	PeopleYN	People#
Perula	July	1	0	0
Perula	July	2	0	0
Perula	July	3	0	0
Perula	July	4	0	
Perula	July	5	0	0
Perula	July	6	1	0

Perula	July	7	1	0	
Perula	July	8	1	1	
Perula	July	Total			1
Perula	January	1	0	0	
Perula	January	2	1	5	
Perula	January	3	1	6	
Perula	January	4	1	4	
Perula	January	5	1	9	
Perula	January	6	1	6	
Perula	January	7	1	4	
Perula	January	8	1	4	
Perula	January	Total			20
Quemaro	July	1	0	0	
Quemaro	July	2	1	9	
Quemaro	July	3	1	9	
Quemaro	July	4	1	9	
Quemaro	July	5	1	9	
Quemaro	July	6	1	4	
Quemaro	July	7	1	3	
Quemaro	July	8	1	3	
Quemaro	July	Total			9
Quemaro	January	1	1	6	
Quemaro	January	2	1	2	
Quemaro	January	3	0	0	
Quemaro	January	4	1	6	

Quemaro	January	5	1	10	
Quemaro	January	6	1	10	
Quemaro	January	7	1	10	
Quemaro	January	8	1	10	
Quemaro	January	Total			12
Villa	July	1	1	2	
Villa	July	2	1	2	
Villa	July	3	1	2	
Villa	July	4	0	0	
Villa	July	5	0	0	
Villa	July	6	1	4	
Villa	July	7	1	2	
Villa	July	8	1	4	
Villa	July	Total			8
Villa	January	1	1	2	
Villa	January	2	1	2	
Villa	January	3	1	3	
Villa	January	4	1	3	
Villa	January	5	1	3	
Villa	January	6	1	2	
Villa	January	7	1	1	
Villa	January	8	0	0	
Villa	January	Total			5
Zapata	July	1	0	0	
Zapata	July	2	0	0	

Zapata	July	3	1	8	
Zapata	July	4	1	8	
Zapata	July	5	1	8	
Zapata	July	6	1	8	
Zapata	July	7	1	12	
Zapata	July	8	1	4	
Zapata	July	Total			12
Zapata	January	1	0	0	
Zapata	January	2	1	3	
Zapata	January	3	1	4	
Zapata	January	4	1	4	
Zapata	January	5	1	6	
Zapata	January	6	1	1	
Zapata	January	7	0	0	
Zapata	January	8	1	6	
Zapata	January	Total			15
SanMateo	July	1	0	0	
SanMateo	July	2	0	0	
SanMateo	July	3	0	0	
SanMateo	July	4	0	0	
SanMateo	July	5	0	0	
SanMateo	July	6	0	0	
SanMateo	July	7	0	0	
SanMateo	July	8	0	0	
SanMateo	July	Total			0

SanMateo	January 1	0	0	
SanMateo	January 2	0	0	
SanMateo	January 3	0	0	
SanMateo	January 4	0	0	
SanMateo	January 5	0	0	
SanMateo	January 6	0	0	
SanMateo	January 7	0	0	
SanMateo	January 8	0	0	
SanMateo	January Total			0

E.1.4 Fires

Town	Date	Block	Fires
Perula	July	1	2
Perula	July	2	5
Perula	July	3	9
Perula	July	4	3
Perula	July	5	3
Perula	July	6	8
Perula	July	7	4
Perula	July	8	9
Perula	July	9	4
Perula	July	10	0
Perula	July	11	2
Perula	July	12	4
Perula	July	13	2

Perula	July	14	4
Perula	July	15	2
Perula	January	1	5
Perula	January	2	5
Perula	January	3	9
Perula	January	4	4
Perula	January	5	8
Perula	January	6	9
Perula	January	7	4
Perula	January	8	10
Perula	January	9	4
Perula	January	10	0
Perula	January	11	4
Perula	January	12	1
Perula	January	13	4
Perula	January	14	4
Perula	January	15	2
Quemaro	July	1	1
Quemaro	July	2	0
Quemaro	July	3	0
Quemaro	July	4	0
Quemaro	July	5	1
Quemaro	July	6	0
Quemaro	July	7	0
Quemaro	July	8	1

Quemaro	July	9	4
Quemaro	July	10	
Quemaro	July	11	
Quemaro	July	12	
Quemaro	July	13	
Quemaro	July	14	
Quemaro	July	15	
Quemaro	January	1	2
Quemaro	January	2	0
Quemaro	January	3	1
Quemaro	January	4	0
Quemaro	January	5	1
Quemaro	January	6	1
Quemaro	January	7	3
Quemaro	January	8	3
Quemaro	January	9	1
Quemaro	January	10	
Quemaro	January	11	
Quemaro	January	12	
Quemaro	January	13	
Quemaro	January	14	
Quemaro	January	15	
Villa	July	1	0
Villa	July	2	1
Villa	July	3	0

Villa	July	4	2
Villa	July	5	3
Villa	July	6	3
Villa	July	7	3
Villa	July	8	1
Villa	July	9	1
Villa	July	10	1
Villa	July	11	5
Villa	July	12	1
Villa	July	13	2
Villa	July	14	1
Villa	July	15	0
Villa	January	1	0
Villa	January	2	2
Villa	January	3	0
Villa	January	4	2
Villa	January	5	2
Villa	January	6	5
Villa	January	7	2
Villa	January	8	2
Villa	January	9	1
Villa	January	10	5
Villa	January	11	5
Villa	January	12	1
Villa	January	13	4

Villa	January	14	1
Villa	January	15	0
Zapata	July	1	1
Zapata	July	2	2
Zapata	July	3	3
Zapata	July	4	4
Zapata	July	5	1
Zapata	July	6	3
Zapata	July	7	1
Zapata	July	8	1
Zapata	July	9	2
Zapata	July	10	1
Zapata	July	11	1
Zapata	July	12	1
Zapata	July	13	1
Zapata	July	14	1
Zapata	July	15	3
Zapata	January	1	1
Zapata	January	2	1
Zapata	January	3	3
Zapata	January	4	3
Zapata	January	5	8
Zapata	January	6	5
Zapata	January	7	1
Zapata	January	8	2

Zapata	January 9	3	
Zapata	January 10	1	
Zapata	January 11	1	
Zapata	January 12	2	
Zapata	January 13	3	
Zapata	January 14	2	
Zapata	January 15	3	
SanMateo	July	1	0
SanMateo	July	2	3
SanMateo	July	3	5
SanMateo	July	4	4
SanMateo	July	5	8
SanMateo	July	6	2
SanMateo	July	7	4
SanMateo	July	8	3
SanMateo	July	9	4
SanMateo	July	10	1
SanMateo	July	11	5
SanMateo	July	12	3
SanMateo	July	13	4
SanMateo	July	14	0
SanMateo	July	15	0
SanMateo	January 1	1	
SanMateo	January 2	7	
SanMateo	January 3	5	

SanMateo	January 4	6
SanMateo	January 5	5
SanMateo	January 6	3
SanMateo	January 7	3
SanMateo	January 8	2
SanMateo	January 9	6
SanMateo	January 10	1
SanMateo	January 11	4
SanMateo	January 12	3
SanMateo	January 13	1
SanMateo	January 14	1
SanMateo	January 15	0

E.2 SAS code. Garbage

E.2.1 Villa

```

title1 Luisa Robles-Diaz-De-Leon;
dm 'log; clear; out; clear;';

options ls=96 ps=33 pageno=1;

proc import
    file='h:\phd_proposal\researchdata.xls'
    out=garbage
    dbms=excel97

```

```

        replace;
sheet=SHEET1;
getnames=yes;
quit;
/*
title2 Print of Garbage Data;
proc print;
quit; */

title2 Analysis of Pseudoreplication Garbage Data using Street as
        Replicate;
proc mixed data=garbage covtest scoring=5;
class town date street;
model garbage = town date town*date / ddfm=kr outp=resids;
random street(town);
*
        BIC (smaller is better)
        667.0
;
repeated / group=town;
*
        BIC (smaller is better)
        656.0
;
*repeated / group=date;
*
        BIC (smaller is better)
        669.5
;

```



```

                                * Perula Quemaro SanMateo Villa Zapata;

estimate '(Q,V)*date'
            town*date    0  0   1 -1      0  0      -1  1  0  0 / divisor=2;
estimate '(P,Q,S,Z vs V)*date'
            town*date    1 -1   1 -1      1 -1      -4  4  1 -1 / divisor=8;


lsmeans town date town*date;

quit;


/*

proc plot data=resids;
plot resid*pred
            resid*town
            resid*date / vref=0;
quit;


proc sort data=resids;
by town;

proc univariate data=resids normal plot;
by town;
var resid;
quit;
*/


data garbage;

```

```

set garbage;
if town='Villa' then trt='Expt';
    else trt='Cntl';
run;

proc sort data=garbage;
by town trt date;
proc means data=garbage noprint;
by town trt date;
var garbage;
output out=meangarbage mean=MeanGarbage;
quit;

title2 Print of Garbage Data Means for Towns;
proc print data=meangarbage;
quit;

title2 Analysis of Garbage Data Town Means using Towns as
    Replicates;
proc mixed data=meangarbage covtest;
class town trt date;
model meangarbage = trt date trt*date / ddfm=kr outp=resids;
random town(trt);
lsmeans trt date trt*date;
quit;

```

```
title1 Luisa Robles-Diaz-De-Leon;
```

```
dm 'log; clear; out; clear;';
```

```
options ls=96 ps=33 pageno=1;
```

```
proc import
```

```
    file='h:\phd_proposal\researchdata.xls'
```

```
    out=garbage
```

```
    dbms=excel97
```

```
    replace;
```

```
sheet=SHEET1;
```

```
getnames=yes;
```

```
quit;
```

```
/*
```

```
title2 Print of Garbage Data;
```

```
proc print;
```

```
quit; */
```

```
title2 Analysis of Pseudoreplication Garbage Data using Street a
```

```
    Replicate;
```

```
proc mixed data=garbage covtest scoring=5;
```

```
class town date street;
```

```
model garbage = town date town*date / ddfm=kr outp=resids;
```

```
random street(town);
```

```
*                                BIC (smaller is better)                667.0
```

```

;
repeated / group=town;
*
BIC (smaller is better) 656.0
;
*repeated / group=date;
*
BIC (smaller is better) 669.5
;

* Perula Quemaro SanMateo Villa Zapata;
estimate '(Q,V)*date'
town*date 0 0 1 -1 0 0 -1 1 0 0 / divisor=2;
estimate '(P,Q,S,Z vs V)*date'
town*date 1 -1 1 -1 1 -1 -4 4 1 -1 / divisor=8;

lsmeans town date town*date;
quit;

/*
proc plot data=resids;
plot resid*pred
resid*town
resid*date / vref=0;
quit;

proc sort data=resids;

```

```

by town;

proc univariate data=resids normal plot;

by town;

var resid;

quit;

*/

data garbage;

set garbage;

if town='Villa' then trt='Expt';

    else trt='Cntl';

run;

proc sort data=garbage;

by town trt date;

proc means data=garbage noprint;

by town trt date;

var garbage;

output out=meangarbage mean=MeanGarbage;

quit;

title2 Print of Garbage Data Means for Towns;

proc print data=meangarbage;

quit;

```

```

title2 Analysis of Garbage Data Town Means using Towns as
      Replicates;
proc mixed data=meangarbage covtest;
class town trt date;
model meangarbage = trt date trt*date / ddfm=kr outp=resids;
random town(trt);
lsmeans trt date trt*date;
quit;

```

E.2.2 Pérula

```

title1 Luisa Robles-Diaz-De-Leon;
dm 'log; clear; out; clear;';

options ls=96 ps=33 pageno=1;

proc import
      file='h:\phd_proposal\researchdata.xls'
      out=garbage
      dbms=excel97
      replace;
sheet=SHEET1;
getnames=yes;
quit;
/*
title2 Print of Garbage Data;

```

```

proc print;
quit; */

title2 Analysis of Pseudoreplication Garbage Data using Street as
      Replicate;
proc mixed data=garbage covtest scoring=5;
class town date street;
model garbage = town date town*date / ddfm=kr outp=resids;
random street(town);
*
      BIC (smaller is better)      667.0
;
repeated / group=town;
*
      BIC (smaller is better)      656.0
;
*repeated / group=date;
*
      BIC (smaller is better)      669.5
;

      * Perula Quemaro SanMateo Villa Zapata;
estimate '(Q,P)*date'
      town*date   -1  1   1 -1   0  0   0  0  0  0 / divisor=2;

lsmeans town date town*date;
quit;

```

```

/*
proc plot data=resids;
plot resid*pred
      resid*town
      resid*date / vref=0;
quit;

proc sort data=resids;
by town;
proc univariate data=resids normal plot;
by town;
var resid;
quit;
*/

data garbage;
set garbage;
if town='Perula' then trt='Expt';
   else trt='Cntl';
run;

proc sort data=garbage;
by town trt date;
proc means data=garbage noprint;

```



```

by town trt date;
var garbage;
output out=meangarbage mean=MeanGarbage;
quit;

title2 Print of Garbage Data Means for Towns;
proc print data=meangarbage;
quit;

title2 Analysis of Garbage Data Town Means using Towns as
      Replicates;
proc mixed data=meangarbage covtest;
class town trt date;
model meangarbage = trt date trt*date / ddfm=kr outp=resids;
random town(trt);
lsmeans trt date trt*date;
quit;

```

E.2.3 San Mateo

```

title1 Luisa Robles-Diaz-De-Leon;
dm 'log; clear; out; clear;';

options ls=96 ps=33 pageno=1;

proc import

```

```

file='h:\phd_proposal\researchdata.xls'

out=garbage

dbms=excel97

replace;

sheet=SHEET1;

getnames=yes;

quit;

/*

title2 Print of Garbage Data;

proc print;

quit; */


title2 Analysis of Pseudoreplication Garbage Data using Street as
      Replicate;

proc mixed data=garbage covtest scoring=5;

class town date street;

model garbage = town date town*date / ddfm=kr outp=resids;

random street(town);

*                               BIC (smaller is better)           667.0
;

repeated / group=town;

*                               BIC (smaller is better)           656.0
;

*repeated / group=date;

*                               BIC (smaller is better)           669.5

```

```

;

                                * Perula Quemaro SanMateo Villa Zapata;

estimate '(Q,S)*date'
      town*date    0  0   1 -1   -1  1     0  0  0  0 / divisor=2;


lsmeans town date town*date;
quit;


/*
proc plot data=resids;
plot resid*pred
      resid*town
      resid*date / vref=0;
quit;


proc sort data=resids;
by town;
proc univariate data=resids normal plot;
by town;
var resid;
quit;
*/

```

```

data garbage;
set garbage;
if town='SanMateo' then trt='Expt';
    else trt='Cntl';
run;

proc sort data=garbage;
by town trt date;
proc means data=garbage noprint;
by town trt date;
var garbage;
output out=meangarbage mean=MeanGarbage;
quit;

title2 Print of Garbage Data Means for Towns;
proc print data=meangarbage;
quit;

title2 Analysis of Garbage Data Town Means using Towns as
    Replicates;
proc mixed data=meangarbage covtest;
class town trt date;
model meangarbage = trt date trt*date / ddfm=kr outp=resids;
random town(trt);
lsmeans trt date trt*date;

```

```
quit;
```

E.2.4 Zapata

```
title1 Luisa Robles-Diaz-De-Leon;
```

```
dm 'log; clear; out; clear;';
```

```
options ls=96 ps=33 pageno=1;
```

```
proc import
```

```
    file='h:\phd_proposal\researchdata.xls'
```

```
    out=garbage
```

```
    dbms=excel97
```

```
    replace;
```

```
sheet=SHEET1;
```

```
getnames=yes;
```

```
quit;
```

```
/*
```

```
title2 Print of Garbage Data;
```

```
proc print;
```

```
quit; */
```

```
title2 Analysis of Pseudoreplication Garbage Data using Street as
```

```
    Replicate;
```

```
proc mixed data=garbage covtest scoring=5;
```

```
class town date street;
```

```

model garbage = town date town*date / ddfm=kr outp=resids;
random street(town);
*                               BIC (smaller is better)           667.0
;
repeated / group=town;
*                               BIC (smaller is better)           656.0
;
*repeated / group=date;
*                               BIC (smaller is better)           669.5
;

                                * Perula Quemaro SanMateo Villa Zapata;
estimate '(Q,Z)*date'
          town*date   0  0   1 -1   0  0   0  0  -1  1 / divisor=2;

lsmeans town date town*date;
quit;

/*
proc plot data=resids;
plot resid*pred
      resid*town
      resid*date / vref=0;
quit;

```

```

proc sort data=resids;
by town;
proc univariate data=resids normal plot;
by town;
var resid;
quit;
*/

```

```

data garbage;
set garbage;
if town='Zapata' then trt='Expt';
    else trt='Cntl';
run;

```

```

proc sort data=garbage;
by town trt date;
proc means data=garbage noprint;
by town trt date;
var garbage;
output out=meangarbage mean=MeanGarbage;
quit;

```

```

title2 Print of Garbage Data Means for Towns;
proc print data=meangarbage;

```

```
quit;

title2 Analysis of Garbage Data Town Means using Towns as
      Replicates;
proc mixed data=meangarbage covtest;
class town trt date;
model meangarbage = trt date trt*date / ddfm=kr outp=resids;
random town(trt);
lsmeans trt date trt*date;
quit;
```

E.3 Gray water

E.3.1 Zapata

```
%let drv = H:\PhD_Proposal\;
title1 Luisa Robles-Diaz-De-Leon;
dm 'log; clear; out; clear;';

options ls=96 ps=33 pageno=1;

proc import
      file="%drv.researchdata.xls"
      out=GreyWater
      dbms=excel97
      replace;
```



```

sheet=SHEET3;
getnames=yes;
quit;

/*
title2 Print of GreyWater Data;
proc print;
quit; */

data greywater;
set greywater;
if town='Villa' then delete;
run;

%include "&drv.glimmix8.mac";

title2 Analysis of Pseudoreplication GreyWater Data using Street as
      Replicate;
%glimmix(data=greywater,
      stmts=%str(
          class town date street;
          model greywater= town date town*date / ddfm=kr solution;
random street(town);
                                     * Perula Quemaro SanMateo Zapata;
estimate '(Q,Z)*date'

```

```

            town*date    0  0    1 -1        0  0        -1  1 / divisor=2;
estimate '(P,Q,S vs Z)*date'

            town*date    1 -1    1 -1        1 -1        -3  3 / divisor=6;

lsmeans town date town*date / cl diff;
),
    error=binomial

)

run;

proc print data=_lsm;
quit;

data GreyWater;
set GreyWater;
if town='Zapata' then trt='Expt';
    else trt='Cntl';
run;

proc sort data=GreyWater;
by town trt date;
proc means data=GreyWater noprint;
by town trt date;
var GreyWater;

```

```

output out=meanGreyWater mean=MeanGreyWater;

quit;

title2 Print of GreyWater Data Means for Towns;

proc print data=meanGreyWater;

quit;

title2 Analysis of GreyWater Data Town Means using Towns as
      Replicates;

proc mixed data=GreyWater covtest;

class town trt date;

model GreyWater = trt date trt*date / ddfm=kr outp=resids;

random town(trt);

lsmeans trt date trt*date;

quit;

```

E.3.2 Pérula

```

%let drv = H:\PhD_Proposal\;

title1 Luisa Robles-Diaz-De-Leon;

dm 'log; clear; out; clear;';

options ls=96 ps=33 pageno=1;

proc import

      file("&drv.researchdata.xls"

```

```

        out=GreyWater
        dbms=excel97
        replace;
sheet=SHEET3;
getnames=yes;
quit;

/*
title2 Print of GreyWater Data;
proc print;
quit; */

data greywater;
set greywater;
if town='Villa' then delete;
run;

%include "&drv.glimmix8.mac";

title2 Analysis of Pseudoreplication GreyWater Data using Street as
        Replicate;
%glimmix(data=greywater,
        stmts=%str(
                class town date street;
                model greywater= town date town*date / ddfm=kr solution;

```

```

random street(town);

                                * Perula Quemaro SanMateo Zapata;

estimate '(Q,P)*date'

        town*date   -1  1   1 -1       0  0       0  0 / divisor=2;

lsmeans town date town*date / cl diff;

),

        error=binomial

)

run;

proc print data=_lsm;
quit;

data GreyWater;
set GreyWater;
if town='Perula' then trt='Expt';
    else trt='Cntl';
run;

proc sort data=GreyWater;
by town trt date;

proc means data=GreyWater noprint;
by town trt date;

```

```

var GreyWater;

output out=meanGreyWater mean=MeanGreyWater;

quit;

title2 Print of GreyWater Data Means for Towns;

proc print data=meanGreyWater;

quit;

title2 Analysis of GreyWater Data Town Means using Towns as
      Replicates;

proc mixed data=GreyWater covtest;

class town trt date;

model GreyWater = trt date trt*date / ddfm=kr outp=resids;

random town(trt);

lsmeans trt date trt*date;

quit;

```

E.3.3 San Mateo

```

%let drv = H:\PhD_Proposal\;

title1 Luisa Robles-Diaz-De-Leon;

dm 'log; clear; out; clear;';

options ls=96 ps=33 pageno=1;

proc import

```

```

        file="&drv.researchdata.xls"

        out=GreyWater

        dbms=excel97

        replace;

sheet=SHEET3;

getnames=yes;

quit;

/*

title2 Print of GreyWater Data;

proc print;

quit; */

data greywater;

set greywater;

if town='Villa' then delete;

run;

%include "&drv.glimmix8.mac";

title2 Analysis of Pseudoreplication GreyWater Data using Street as
        Replicate;

%glimmix(data=greywater,

        stmts=%str(

                class town date street;

```

```

        model greywater= town date town*date / ddfm=kr solution;
random street(town);

                                * Perula Quemaro SanMateo Zapata;

estimate '(Q,S)*date'
        town*date    0  0    1 -1        -1  1    0  0 / divisor=2;

lsmeans town date town*date / cl diff;
),
        error=binomial

)

run;

proc print data=_lsm;
quit;

data GreyWater;
set GreyWater;
if town='SanMateo' then trt='Expt';
        else trt='Cntl';
run;

proc sort data=GreyWater;
by town trt date;
proc means data=GreyWater noprint;

```



```

by town trt date;
var GreyWater;
output out=meanGreyWater mean=MeanGreyWater;
quit;

title2 Print of GreyWater Data Means for Towns;
proc print data=meanGreyWater;
quit;

title2 Analysis of GreyWater Data Town Means using Towns as
      Replicates;
proc mixed data=GreyWater covtest;
class town trt date;
model GreyWater = trt date trt*date / ddfm=kr outp=resids;
random town(trt);
lsmeans trt date trt*date;
quit;

```

E.4 Recreation

E.4.1 Pérula

```

%let drv = H:\PhD_Proposal\;
title1 Luisa Robles-Diaz-De-Leon;
dm 'log; clear; out; clear;';

```

```

options ls=96 ps=33 pageno=1;

proc import
    file("&drv.researchdata.xls"
    out=Recreation
    dbms=excel97
    replace;
sheet=SHEET4;
getnames=yes;
quit;

/*
title2 Print of Recreation Data;
proc print;
quit; */

data recreation;
set recreation;
if town='SanMateo' then delete;
run;

%include "&drv.glimmix8.mac";

title2 Analysis of Pseudoreplication Recreation Data using time as
    Replicate;

```

```

%glimmix(data=recreation,
  stmts=%str(
    class town date time;
    model recreation= town date town*date / ddfm=kr solution;
random time(town);

                                * Perula  Quemaro  Villa  Zapata;
estimate '(Q,P)*date'
    town*date   -1  1    1 -1    0  0    0  0 / divisor=2;
estimate '(Z,Q,V vs P)*date'
    town*date   -3  3    1 -1    1 -1    1 -1 / divisor=6;

lsmeans town date town*date / cl diff;
),
  error=binomial

)

run;

proc print data=_lsm;
quit;

data Recreation;
set Recreation;
if town='Perula' then trt='Expt';
  else trt='Cntl';

```

```

run;

proc sort data=Recreation;
by town trt date;
proc means data=Recreation noprint;
by town trt date;
var Recreation;
output out=meanRecreation mean=MeanRecreation;
quit;

title2 Print of Recreation Data Means for Towns;
proc print data=meanRecreation;
quit;

title2 Analysis of Recreation Data Town Means using Towns as
      Replicates;
proc mixed data=Recreation covtest;
class town trt date;
model Recreation = trt date trt*date / ddfm=kr outp=resids;
random town(trt);
lsmeans trt date trt*date;
quit;

```

E.4.2 Villa

```
%let drv = H:\PhD_Proposal\;
```

```

title1 Luisa Robles-Diaz-De-Leon;

dm 'log; clear; out; clear;';

options ls=96 ps=33 pageno=1;

proc import
    file("&drv.researchdata.xls"
    out=Recreation
    dbms=excel97
    replace;
sheet=SHEET4;
getnames=yes;
quit;

/*
title2 Print of Recreation Data;
proc print;
quit; */

data recreation;
set recreation;
if town='SanMateo' then delete;
run;

%include "&drv.glimmix8.mac";

```

```

title2 Analysis of Pseudoreplication Recreation_Villa Data using
      time as Replicate;
%glimmix(data=recreation,
      stmts=%str(
      class town date time;
      model recreation= town date town*date / ddfm=kr solution;
random time(town);

      * Perula  Quemaro  Villa  Zapata;
estimate '(Q,V)*date'
      town*date    0  0    1 -1    -1  1    0  0 / divisor=2;
estimate '(Z,Q,P vs V)*date'
      town*date    1 -1    1 -1    -3  3    1 -1 / divisor=6;

lsmeans town date town*date / cl diff;
),
      error=binomial

)

run;

proc print data=_lsm;
quit;

data Recreation;

```

```

set Recreation;
if town='Villa' then trt='Expt';
    else trt='Cntl';
run;

proc sort data=Recreation;
by town trt date;
proc means data=Recreation noprint;
by town trt date;
var Recreation;
output out=meanRecreation mean=MeanRecreation;
quit;

title2 Print of Recreation Data Means for Towns;
proc print data=meanRecreation;
quit;

title2 Analysis of Recreation Data Town Means using Towns as
    Replicates;
proc mixed data=Recreation covtest;
class town trt date;
model Recreation = trt date trt*date / ddfm=kr outp=resids;
random town(trt);
lsmeans trt date trt*date;
quit;

```

E.4.3 Zapata

```
%let drv = H:\PhD_Proposal\;
title1 Luisa Robles-Diaz-De-Leon;
dm 'log; clear; out; clear;';

options ls=96 ps=33 pageno=1;

proc import
    file="%drv.researchdata.xls"
    out=Recreation
    dbms=excel97
    replace;
sheet=SHEET4;
getnames=yes;
quit;

/*
title2 Print of Recreation Data;
proc print;
quit; */

data recreation;
set recreation;
if town='SanMateo' then delete;
run;
```



```

%include "&drv.glimmix8.mac";

title2 Analysis of Pseudoreplication Recreation_Zapata Data using
      time as Replicate;
%glimmix(data=recreation,
      stmts=%str(
          class town date time;
          model recreation= town date town*date / ddfm=kr solution;
random time(town);

          * Perula  Quemaro  Villa  Zapata;
estimate '(Q,Z)*date'
          town*date    0  0    1 -1    0  0    -1  1 / divisor=2;
estimate '(V,Q,P vs Z)*date'
          town*date    1 -1    1 -1    1 -1    -3  3 / divisor=6;

lsmeans town date town*date / cl diff;
),
      error=binomial

)

run;

proc print data=_lsm;
quit;

```

```

data Recreation;

set Recreation;

if town='Zapata' then trt='Expt';
    else trt='Cntl';

run;


proc sort data=Recreation;
by town trt date;

proc means data=Recreation noprint;
by town trt date;
var Recreation;
output out=meanRecreation mean=MeanRecreation;
quit;


title2 Print of Recreation Data Means for Towns;

proc print data=meanRecreation;
quit;


title2 Analysis of Recreation_Zapata Data Town Means using Towns as
    Replicates;

proc mixed data=Recreation covtest;
class town trt date;
model Recreation = trt date trt*date / ddfm=kr outp=resids;
random town(trt);

```

```
lsmeans trt date trt*date;
quit;
```

E.5 Fires

E.5.1 San Mateo

```
title1 Luisa Robles-Diaz-De-Leon;
dm 'log; clear; out; clear;';
```

```
options ls=96 ps=33 pageno=1;
```

```
proc import
    file='h:\phd_proposal\researchdata.xls'
    out=fires
    dbms=excel97
    replace;
sheet=SHEET2;
getnames=yes;
quit;
/*
title2 Print of Fires Data;
proc print;
quit; */
```

```
title2 Analysis of Pseudoreplication Fires Data using Block as
```

```

Replicate;
proc mixed data=fires covtest scoring=5;
class town date block;
model fires = town date town*date / ddfm=kr outp=resids;
random block(town);
*
BIC (smaller is better) 544.6
;
*parms 2, 3, 3, 3, 3, 3;
*repeated / group=town;
*
BIC (smaller is better) 557.9
;
*repeated / group=date;
*
BIC (smaller is better) 546.9
;

* Perula Quemaro SanMateo Villa Zapata;
estimate '(Q,S)*date'
town*date 0 0 1 -1 -1 1 0 0 0 0 / divisor=2;
estimate '(P,Q,V,Z vs S)*date'
town*date 1 -1 1 -1 -4 4 1 -1 1 -1 / divisor=8;

lsmeans town date town*date;
quit;

/*

```

```

proc plot data=resids;
plot resid*pred
      resid*town
      resid*date / vref=0;
quit;

proc sort data=resids;
by town;
proc univariate data=resids normal plot;
by town;
var resid;
quit;
*/

data fires;
set fires;
if town='SanMateo' then trt='Expt';
   else trt='Cntl';
run;

proc sort data=fires;
by town trt date;
proc means data=fires noprint;
by town trt date;
var fires;

```

```
output out=meanfires mean=MeanFires;
quit;
```

```
title2 Print of Fires Data Means for Towns;
proc print data=meanfires;
quit;
```

```
title2 Analysis of Fires Data Town Means using Towns as Replicates;
proc mixed data=meanfires covtest;
class town trt date;
model meanfires = trt date trt*date / ddfm=kr outp=resids;
random town(trt);
lsmeans trt date trt*date;
quit;
```

E.5.2 Villa

```
title1 Luisa Robles-Diaz-De-Leon;
dm 'log; clear; out; clear;';
```

```
options ls=96 ps=33 pageno=1;
```

```
proc import
    file='h:\phd_proposal\researchdata.xls'
    out=fires
    dbms=excel97
```

```

        replace;
sheet=SHEET2;
getnames=yes;
quit;
/*
title2 Print of Fires Data;
proc print;
quit; */

title2 Analysis of Pseudoreplication Fires Data using Block as
        Replicate;
proc mixed data=fires covtest scoring=5;
class town date block;
model fires = town date town*date / ddfm=kr outp=resids;
random block(town);
*
        BIC (smaller is better)
        544.6
;
*parms 2, 3, 3, 3, 3, 3;
*repeated / group=town;
*
        BIC (smaller is better)
        557.9
;
*repeated / group=date;
*
        BIC (smaller is better)
        546.9
;

```

```

                                * Perula Quemaro SanMateo Villa Zapata;

estimate '(Q,V)*date'

        town*date    0  0    1 -1    0  0    -1  1    0  0 / divisor=2;


lsmeans town date town*date;

quit;


data fires;

set fires;

if town='Villa' then trt='Expt';

    else trt='Cntl';

run;


proc sort data=fires;

by town trt date;

proc means data=fires ;

by town trt date;

var fires;

output out=meanfires mean=MeanFires;

quit;


title2 Print of Fires Data Means for Towns;

proc print data=meanfires;

quit;

```



```

title2 Analysis of Fires Data Town Means using Towns as Replicates;
proc mixed data=meanfires covtest;
class town trt date;
model meanfires = trt date trt*date / ddfm=kr outp=resids;
random town(trt);
lsmeans trt date trt*date;
quit;

```

E.5.3 Pérula

```

title1 Luisa Robles-Diaz-De-Leon;
dm 'log; clear; out; clear;';

options ls=96 ps=33 pageno=1;

proc import
    file='h:\phd_proposal\researchdata.xls'
    out=fires
    dbms=excel97
    replace;
sheet=SHEET2;
getnames=yes;
quit;
/*
title2 Print of Fires Data;
proc print;

```

```

quit; */

title2 Analysis of Pseudoreplication Fires Data using Block as
      Replicate;
proc mixed data=fires covtest scoring=5;
class town date block;
model fires = town date town*date / ddfm=kr outp=resids;
random block(town);
*
      BIC (smaller is better)      544.6
;
*parms 2, 3, 3, 3, 3, 3;
*repeated / group=town;
*
      BIC (smaller is better)      557.9
;
*repeated / group=date;
*
      BIC (smaller is better)      546.9
;

      * Perula Quemaro SanMateo Villa Zapata;
estimate '(Q,V)*date'
      town*date   -1  1   1 -1   0  0   0  0   0  0 / divisor=2;

lsmeans town date town*date;
quit;

```

```

data fires;

set fires;

if town='Perula' then trt='Expt';
    else trt='Cntl';

run;


proc sort data=fires;
by town trt date;

proc means data=fires ;
by town trt date;

var fires;

output out=meanfires mean=MeanFires;

quit;


title2 Print of Fires Data Means for Towns;

proc print data=meanfires;

quit;


title2 Analysis of Fires Data Town Means using Towns as Replicates;

proc mixed data=meanfires covtest;

class town trt date;

model meanfires = trt date trt*date / ddfm=kr outp=resids;

random town(trt);

lsmeans trt date trt*date;

quit;

```

E.5.4 Zapata

```
title1 Luisa Robles-Diaz-De-Leon;

dm 'log; clear; out; clear;';

options ls=96 ps=33 pageno=1;

proc import
    file='h:\phd_proposal\researchdata.xls'
    out=fires
    dbms=excel97
    replace;
sheet=SHEET2;
getnames=yes;
quit;
/*

title2 Print of Fires Data;

proc print;
quit; */

title2 Analysis of Pseudoreplication Fires Data using Block as
    Replicate;

proc mixed data=fires covtest scoring=5;
class town date block;
model fires = town date town*date / ddfm=kr outp=resids;
random block(town);
```

```

*                                BIC (smaller is better)            544.6
;
*parms 2, 3, 3, 3, 3, 3;
*repeated / group=town;
*                                BIC (smaller is better)            557.9
;
*repeated / group=date;
*                                BIC (smaller is better)            546.9
;

                                * Perula Quemaro SanMateo Villa Zapata;
estimate '(Q,V)*date'
          town*date   0  0   1 -1   0  0   0  0   -1  1 / divisor=2;

lsmeans town date town*date;
quit;

data fires;
set fires;
if town='Zapata' then trt='Expt';
   else trt='Cntl';
run;

proc sort data=fires;
by town trt date;

```

```

proc means data=fires ;
by town trt date;
var fires;
output out=meanfires mean=MeanFires;
quit;

```

```

title2 Print of Fires Data Means for Towns;
proc print data=meanfires;
quit;

```

```

title2 Analysis of Fires Data Town Means using Towns as Replicates;
proc mixed data=meanfires covtest;
class town trt date;
model meanfires = trt date trt*date / ddfm=kr outp=resids;
random town(trt);
lsmeans trt date trt*date;
quit;

```

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