



2016 Spider Monkey School Initiative Final Report: Climate Change in Azuero

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Introduction to the Spider Monkey School Initiative

What is Environmental Education?

Environmental education is “the process of recognizing values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the inter-relatedness among humans, their culture and biophysical surroundings. Environmental education also entails practice in decision making and self-formulation of a code of

behaviors about issues concerning environmental quality.”¹ Environmental education is a continuous process with an emphasis on awareness. It should be complemented by a review of one’s value scale and a strengthening of will. It considers the principal of inter- and trans-generational equity, and should be oriented towards action and decision making.

Azuero: A Strategic Area

Azuero Earth Project concentrates on the Azuero peninsula for both scientific and strategic reasons. In fact, though in the past most of the peninsula was covered in dry tropical forest, today less than 7% of that forest remains. Vulnerable species in critical danger of extinction that are unique to Azuero, like the Azuero spider monkey, try to live in isolated patches of forest less than half the size needed for survival.

Therefore, in 2010, Azuero Earth Project developed a school initiative in the 6 rural schools closest to the monkey’s habitat to inform these students--future leaders and owners of rural lands--and their communities about spider monkey conservation in Azuero, as well as about the habitat of these monkeys, which are a unique pride of the region.

History and Context of the Spider Monkey School Initiative

The Azuero Earth Project [www.proecoazuero.org] is dedicated to environmental education, reforestation, and sustainable land use on the Azuero peninsula. Since 2010, we have served as an environmental resource center for Azuero; included among our programs are an environmental library in Pedasí, a youth group called Pro Eco Pelaos, a school initiative about the spider monkey in 6 schools, activities about sustainable farm management, and work with Panamanian and international academic institutions to support scientific research on the peninsula. We have been implementing the Spider Monkey School Initiative in rural schools in the Los Santos area since 2010.

Prior Impacts of the Spider Monkey School Initiative

Since the beginning of the School Initiative in 2010, we have worked with 634 children, 80 volunteers, and 20 teachers. In 2015, we brought 8 environmental education lessons to 7 schools to teach 125 children about biodiversity conservation and watershed preservation. In 2014-2015, in collaboration with primary schools, we planted 220 native and fruit-bearing trees.

¹ Definition from the International Union for the Conservation of Nature, 1970.

Testimonials and anecdotes about the prior impacts of the initiative:

A teacher from Colán, on her own initiative, began a conservation and environmental awareness activity in which she visits each house in Colán to talk about the impacts of irresponsible human actions on the environment. She emphasizes river contamination, the gorges near the community, and the burning of trash, especially plastic. To complement this activity, the teacher asked the Azuero Earth Project for a community theater. At the end of the presentation, she gave a speech about the importance of the actions each person can take to improve his/her community.

Reforestation activities in the countryside were added thanks to the suggestions of the Initiative's teachers, and they took the lead in choosing the sites to use for planting. At the request of the children and teachers of Escuela Oria Arriba, the father of one of the children placed a fence around the trees to prevent horses from hurting the growing seedlings. In 2015, another father repaired the fence to protect the new seedlings, at the request of a child.

In the video "[Kids and Trees: Caring for our Future](#)," the teacher from Oria Arriba and 3 students wrote the script that narrates the video, which was presented at a CIFOR meeting in September 2015.

After working with the School Initiative, the Colán community has participated actively in scientific investigations conducted by the University of Florida to better understand the causes of sustainable management of the peninsula's lands.

The students still have their notebooks from the 2014 initiative, and they measure the seedlings every 2 months to compare these measurements with those taken at the date of planting.

The 2016 School Initiative

In 2016, the Spider Monkey School Initiative worked with the following six rural schools: Bajo Corral, Nuario, Vallerriquito, Oria Arriba, Los Asientos, and Colán. This program seeks to foment critical analysis of environmental problems, as well as environmental awareness among the participants, in order to transform future owners of these lands into protectors of the environment. Working with rural schools strategically amplifies our impact by first allowing us to educate children and then communicating our message to the entire community through a family event in which the children take the lead in explaining why it is necessary to protect their natural surroundings. Thus, we indirectly create environmental awareness among the parents of families and entire communities about the importance of reforestation in building wildlife habitats in the Azuero peninsula.

2016 Acknowledgments

The Azuero Earth Project would like to thank our donors on Global Giving (Help 125

Panamanian Students Act on Climate Change - #24655), the Melinda Gray Ardia Environmental Foundation (<http://www.mgaef.org/grants.htm>) and the Grantham Foundation for their generous support for this initiative. We would also like to thank the Princeton University Language Project (PULP) that translated this report from the original Spanish. We are thankful for the teachers, students, volunteers and communities that have participated throughout the years in this project. A special thank you goes out to Johanna Durget, the Coordinator of the 2016 initiative.

Theme for 2016: Climate Change

Each year, the initiative focuses on a new theme, following a progressive educational logic. This year, we have focused on the important and current topic of climate change. The goal for 2016 was to finish the Spider Monkey School Initiative's curriculum cycle and to connect prior concepts, such as the conservation of biodiversity, the problems and conservation of forests (habitats), water and soil conservation, and the preservation of ecosystems, with the theme of climate change.

Azuero's producers are highly vulnerable to the impacts of climate change and water scarcity, which has powerful impacts on agrarian production and the country's food security. The production levels of these small farms experience a decrease of more than 65% in the pronounced dry season of the region. In 2016, MiAmbiente reported that 30 of the 44 rivers in the region stopped flowing. The Azuero peninsula is part of Central America's dry corridor, a zone recognized as being super vulnerable to global climate change. At the Central American level, more than 1.6 million people have been identified as having insecure food supplies, with 50-90% loss of basic grains and a deficit of \$17 million in this region. The FAO has identified it as being in urgent need of innovation in order to adapt to climate change. Far from being an ephemeral or temporary phenomenon, Azuero's vulnerability has intensified over the past 5 years, and it will continue to be aggravated by climatic changes that prolong the dry period and cause fluctuations in food production and security throughout the country.

Specific Objectives for 2016

Maintain our presence in six strategic schools (Colán, Los Asientos, Nuario, Bajo Corral, Oria Arriba, Vallerriquito) within our primary corridor.

Activity 1: "Pre-education" initiative with student and teacher interviews – April/May and July/August

Activity 2: "Reforestation Week" – August

Activity 3: Lesson 1 from the Spider Monkey School Initiative, "What is climate change?" – September

Activity 4: Lesson 2 from the Spider Monkey School Initiative, Local impacts of climate change – October/November

Activity 5: Community event – Involvement of children, parents, and community members, “Movie Night” or “Stage Play” – December

Activity 6: Final interviews and future planning with teachers – January-March 2017

2016 Program (Theory and Practice)

Schools and Communities that Participated in the 2016 Initiative

School Name	Community	Number of Children
Alejandro González	Nuario	14
Pablo Ballesteros	Los Asientos	72
C.E.B.G Jaime Alberto Alba	Valleriquito	39
Oria Arriba	Oria Arriba	16
Bajo Corral	Bajo Corral	17
Colán	Colán	8
Total schools: 6	Total communities: 6	Total number of student participants: 166

2016 Activities in Escuela de Oria Arriba

The School Initiative’s 2016 theme is climate change, its impacts on the peninsula, and how we can adapt to achieve greater productivity and prosperity while at the same time conserving biodiversity for future generations.

Activity 1: “Pre-education” initiative with student and teacher interviews – April/May and July/August 2016

Activity 2: Reforestation week – August 2016

Environmental education is oriented towards action and decision-making. Reforestation is an important part of this action, and the School Initiative therefore organized Reforestation Week in conjunction with participating schools in August 2016. Parallel with National Reforestation Day in Panama (which took place August 27, 2016), we reforested in the 6 rural schools and communities in the School Initiative. The Million Hectare Reforestation Alliance is an initiative from Panama’s Ministry of the Environment with a goal of reforesting 1 million hectares by 2035. To support this ambitious goal, Azuero Earth Project supported the planting of more than 400 trees at the schools. Reforestation Week was an opportunity to work with the families and communities of the schools. We communicated with each community to choose an appropriate place to reforest.

The objective was to teach the boys and girls of the Los Santos communities the importance of trees to the planet, as well as to relate Azuero's environmental problems with the importance of planting trees. The reforestation activity was accompanied by a short class about reforestation that made connections with Azuero's dry forest. We also painted a wooden sign to place in the reforested area as a reminder for the children and the community. We wrote the date, the name of the school, and, at the children's suggestion, an ecological saying. At the end of the day, we gave each school a reforestation certificate with the quantity of trees planted. This activity taught the children how to plant a seedling and other aspects of reforestation, the importance of plants and trees in an ecosystem, and the relationship between trees and climate change. Furthermore, the children have the responsibility of caring for the seedlings, and the pleasure of seeing them grow.

School/Community	Date	Location of reforestation	Quantity of trees
Oria Arriba	19.08	School	44
Colán	23.08	School and community farm	30
Vallerriquito	24.08	School	70
Los Asientos	26.08	School	70
Pedasí*	26.08	Public community spaces	54
Nuario	05.09	Farm and shoulder of the community highway	55
Bajo Corral	06.09	School, cemetery, and farm	70
Total number of communities: 7			Total trees planted: 447

List of tree/bush species reforested in the 6 schools:

1. *Oria Arriba*: almond, star apple, sour sop, cherry, moringa, oak, tamarind
2. *Bajo Corral*: achiote, star apple, guachapele, sour sop, purple guayacan, oak, tamarind
3. *Colán*: achiote, laurel, star apple, guachapele, purple guayacan, cherry, moringa, oak, tamarind
4. *Vallerriquito*: laurel, almond, star apple, sour sop, moringa, tamarind
5. *Nuario*: achiote, star apple, guachapele, soursop, guayacan, tamarind
6. *Los Asientos*: almond, copaiba, chacotee, guachapele, sour sop, moringa, oak, tamarind

Participants in Reforestation Week:

School Community	Child Participants	Community Members	Number of Volunteers
Oria Arriba	16	0	1
Colán	8	1	1
Vallerriquito	35	4	9
Los Asientos	70	1	7
Pedásí*	10	20	---
Nuario	14	2	1
Bajo Corral	17	3	1
TOTAL	170	31	20

**Pedásí was not one of the six schools in our School Initiative; however, the community participated in Reforestation Week.*

Various volunteers helped us during that week. Thank you to the Peace Corps volunteers from different area communities and to the teachers and community members who participated.

Activity 3: Lesson 1 from the Spider Monkey School Initiative, “What is Climate Change?” – September 2016.

The first lesson was about four hours long, taking place between 8 am and 12-1 pm, with the following schedule:

- 8:00 am: Arrival to the school and welcome.
- 8:15 am: Evaluation questions for the children (Quiz #1).
- 8:25 am: Presentation and talk about the theme of climate change.
- 9:00 am: Drawing activity to understand the concept of the “greenhouse effect.”
- 9:30 am: Team formation and beginning of “eco-games.”
- 11:30 am: Treasure hunt.
- 12:00 pm: Toasts and closing.

To present the concepts to the children, we divided the class into two parts: a theory part and a practical part. The theory part was based on explanatory and didactic slideshows and videos (one of the videos is from MiAmbiente). We reviewed some basic concepts. We explained the concepts of atmosphere, the process of solar heating, the greenhouse effect, greenhouse gases, and activities that emit greenhouse gases.

At the end of the theory section, with the help of a diagram, each child had to draw one element of the greenhouse effect: the planet, the atmosphere, the sun, the sun’s rays, or the gases. After the theory section, we divided the children into teams to begin the practical activity with the treasure hunt and six “eco-games” (see the table of “eco-

games” for further details). With the help of concepts seen in the presentation, the teams of children had to complete six different stations with different games in order to find the hidden treasure in the school’s garden. The “eco-games” were developed by Azuero Earth Project and were made by hand. Their purpose is to give children the tools they need to understand climate change. Each game covers an aspect of the concept and tries to stimulate reflection on the part of the player.

Table of the six “eco-games” from Lesson 1 with descriptions and details

Name of game	Theme and concepts	Objective	Tools	Reflection
1. “Looking for energy”	Energy sources; Fossil fuels; Renewable energy	Become aware of daily energy use.	Flashcards with images of fossil fuels and sources of renewable energy.	How does our current energy model impact the environmental and feed climate change?
2. “We are an ecosystem”	Ecosystem; climatic elements; living beings and nonliving factors	Establish dependency relationships between different natural elements as in a natural ecosystem here in Azuero. Understand the balance of an ecosystem.	A painted canvas representing the ecosystem. Cards representing elements in the ecosystem. A string to show the connections between the elements.	What happens when an element in the ecosystem changes or disappears? How would this affect everything else?
3. “Time: You throw it out today, but when does it go away?”	Decomposition of objects in the soil. Contamination and pollution.	Become aware of the time it takes different objects to decompose in soil. Understand the long-term consequences and threats of throwing trash on the ground.	Objects such as fruit peels, cans, glass bottles, and plastic bags.	How does trash management impact the planet with its contamination? Reflection about the emission of greenhouse gases from trash.
4. “What’s going on with global warming?”	Global warming, contamination, greenhouse gases.	Explain the negative effect of global warming on the environment, human beings, cities, and animal life.	Cards with images of different impacts.	What is an environmental impact? How does it affect climate change? What can we do to reduce these impacts?
5. “The carbon cycle”	Carbon dioxide; burning; oxygen; atmosphere;	Understand the greenhouse effect and the carbon cycle.	Experiment with a pot full of water placed in the sun to	How does the greenhouse effect work? How does

	greenhouse effect.	Make connections between greenhouse gases, the atmosphere, and climate change.	illustrate the greenhouse effect.	burning contribute to climate change?
6. “Video station”	Global warming, greenhouse gases, atmosphere, deforestation, burning of fossil fuels	Understand the different concepts through videos.	Videos.	

Lesson 1 Participants

School/Community	Date	Children	Volunteers
Oria Arriba	30.09	15	1
Colán	05.10	8	1
Vallerriquito	06.10	35	7
Los Asientos	04.10	68	28
Nuario	03.10	14	2
Bajo Corral	29.09	12	2
TOTAL		156	41

Donations

Our 2016 School Initiative thanks the following donors for their contributions to the children, volunteers, and teachers during our activities.

Our donors for Lesson 1 were:

Business	Donation	Date	School
“Panadería Pedasí”	25 cupcakes	29.09	Bajo Corral
“Refresquería Yamileth”, Pedasí	1 sweet for 15 people	03.10	Nuario
“The Bakery”, Pedasí	100 cupcakes	04.10	Los Asientos y Colán
“Café Dalila”, Pedasí	40 empanadas	06.10	Vallerriquito

Activity 4: Lesson 2 from the Spider Monkey School Initiative, Local Impacts of Climate Change – October 2016

In this activity, we emphasized topics about farms and proper farm management in Azuero. This activity also involved painting a mural on a wall of the school. The lesson began with the story “Grandma Paola Maíz,” which talks about the themes of the farm, farm management, and climate change. Afterwards, we divided the children into groups for the “eco-games.”

Lesson 2, like the first lesson, lasted 4 hours and was divided in the following way:

8:00 am: Arrival at the school and welcome.

8:15 am: “The Story of Grandma Paola Maíz” activity, which talks about the carbon cycle, farms and sustainable farm management, and the organic materials cycle.

9:15 am: Team formation and beginning of the “eco-games” and mural painting.

11:30 am: Finish mural painting.

11:50 am: Questions to evaluate the children. (Quiz #2)

12:00 pm: Toasts and closing.

Table of the five “eco-games” from Lesson 2 with descriptions and details

Name of game	Theme and concepts	Objective	Tools	Reflection
1. “Air Mobile”	Oxygen; Carbon dioxide; Air	Identify the producers and consumers of the oxygen and carbon dioxide present in the air.	Game inspired by the “Didactic Guide to Environmental Education – 4th Grade – Meduca”	What is the role of trees and plants in environmental conservation?
2. “We Live on the Same Planet”	Greenhouse gas emissions. Mitigation of climate change.	Identify individual actions to diminish greenhouse gas emissions. Understand what mitigation of climate change is.	A thread to represent the space of the planet. Card with different actions.	What can we do to mitigate climate change?
3. “The Balanced Farm”	Greenhouse gas emissions; sinks; methane; carbon dioxide; atmosphere	Learn where on the farm there are greenhouse gas emissions and sinks.	A farm drawn on a canvas on which are placed various actions/cards.	What is a balanced farm and why is it important to have a farm with more greenhouse gas sinks than emissions?
4. “Two Very Different Farms”	Organic material; Carbon dioxide; Atmosphere	Learn how to manage your farm well and why it is important for adaptation to climate change.	Two opposite farms drawn on a canvas on which cards are placed.	How to adapt to climate change (managing your farm)?

	e; Adaptation to climate change			
5. “Draw your ideal farm”	Mix of all of the concepts seen in prior games.	With the concepts learned throughout the games, draw an “ideal” farm.	Mural activity: draw and paint of a mural of a balanced farm on a wall of the school.	What is a balanced farm? Why is it important?

Participants in the School Initiative

School/Community	Date	Children	Volunteers
Oria Arriba	31.10	16	3
Colán	26.10	8	2
Vallerriquito	24.10	32	5
Los Asientos	28.10	72	8
Nuario	25.10	14	2
Bajo Corral	20.10	12	2
TOTAL		154	22

Donations

Our donors for Lesson 2 were:

Business	Donation	Date	School
“Panadería de Súper Carnes”, Las Tablas	2 packages of 50 sweets	24.10, 25.10, 26.10	Nuario, Colán y Vallerriquito
Restaurante La Maestra, Las Tablas	80 cupcakes	28.10	Los Asientos

Activity 5: Community Event – Involvement of Children, Parents, and Community Members, “Movie Night” or “Stage Play” – December 2016

In this event, we reported the achievements of the initiative to the parents and started a conversation about environmental conservation in the community. We also brought a box of resources for future teachers. The 2016 stage play, titled “Today, We Heal Our Mother Earth.” was written by Johanna Durget and Casey Aviles to conclude the 2016 School Initiative and leave an important last message about climate change for the

children. The play is based on a summit in which representatives from powerful countries, Mother Earth, the summit leader, and a doctor participate. During the summit, the actors speak about Mother Earth’s situation, as she has become ill. As in previous meetings, the members fight and do not allow each other to speak. This time, however, the climate and several children intervene and remind the others of the importance of listening, observing, and working as a team. The meeting ends optimistically: everyone agrees that they must act and work together to save Mother Earth.

Objective: By means of this simple yet appealing educational activity, we sought to raise the awareness of the youth about climate change and the measures they can take to prevent it.

We hoped that at the end of the play, everyone would be committed to a change of attitude to achieve the eco-efficient behavior needed to reduce water, paper, and energy consumption in order to diminish CO2 emissions. We also hope to leave them with a better idea of how to adapt to climate change.

The purpose of this activity is also to bring people together: we want to join children, teachers, parents, and community and family members. This event was the culmination of our school initiative and an important step in our mission. It allowed us to come together to talk with the entire community about the Azuero Project’s new ideas and current goals. Each year, we collaborate with the teachers to plan a community event to end the year. This year, we proposed the play or movie night. The two activities are optional, and we asked that the teachers choose the activity based on their availability and other school commitments. Because of scheduling irregularities in the Initiative that took place late in the school year, the majority of the school opted for the movie night because the play takes a great deal of time and effort from the children at the end of the year.

Table of events chosen by each school, with dates

School/Community	Event	Date	Community Participation	Volunteers
Oria Arriba	Movie Night	09.12	47	2
Colán	Movie Night	19.12	17	1
Vallerriquito	Movie Night	12.12	21	2
Los Asientos	Movie Night	15.12	50	1
Nuario	Movie Night	07.12	33	3
Bajo Corral	Play	14.12	39	2
Total			207	11

Examples of publicity used to gather the community for the event



Activity 6: Final Interviews and Future Planning with Teachers – January-March 2017 (in process)

Evidence of the 2016 Spider Monkey School Initiative’s Impacts

Pre- and Post-Lesson Evaluation Results

To evaluate the Initiative’s impact, we had small evaluations of the children in their schools and spoke with the teachers to find out about their experiences with and perspectives on the impact of the School Initiative. This year, we had two evaluations at each school. This first was at the beginning of Lesson 1. The second was at the end of Lesson 2. The evaluations allow us to see if we have achieved the lessons’ goals: teaching environmental and scientific concepts to the children. For each evaluation, we asked the children fewer than 10 questions out loud. We then allowed the students to write or draw their answers on their papers, according to grade and preference.

The first and second evaluations are comprised of 6 questions each. The first three questions (Q1, Q2, and Q3) of the evaluations are identical; this was done to see clearly the children’s growth between the beginning and end of the classes.

These evaluations were given in 4 schools: Colán, Oria Arriba, Nuario, and Bajo Corral.

Because of the larger student bodies in Vallerriquito (40) and Los Asientos (72), we did not conduct evaluations there.

The following are the questions from the pre-lesson evaluation (before Lesson 1):

- Q1 – *What is the atmosphere?*
- Q2 – *Write or draw what climate change is for you.*
- Q3 – *Give at least one of the causes of climate change.*
- Q4 – *What is reforestation?*
- Q5 – *Give at least one of the causes of deforestation.*
- Q6 – *What does a tree produce?*

And the following are the questions from the post-lesson evaluation (after Lesson 2):

- Q1 – *What is the atmosphere?*
- Q2 – *Write or draw what climate change is for you.*
- Q3 – *Give at least one of the causes of climate change.*

For the first three questions, shared between Lessons 1 and 2, we could see in the following tables the growth of the students in the increase in the number of students who correctly answered the questions (instead of answering incorrectly or failing to answer). Questions 1, 2, and 3 are shown in their respective tables.

- # Children pre-lesson: number of children participating in the first lesson.
- # Children post-lesson: number of children participating in the second lesson.
- # Pre-lesson respondents: number of children who answered the question in the first lesson.
- # Post-lesson respondents: number of children who answered the question in the second lesson.
- # Correct pre-lesson: Number of correct responses in the pre-lesson phase.
- # Correct post-lesson: Number of correct responses in the post-lesson phase.
- % Correct pre-lesson: Percentage of correct responses in the pre-lesson phase.
- % Correct post-lesson: Percentage of correct responses in the post-lesson phase.

Table 1: Question 1 “What is the atmosphere?”

School	# Children pre-lesson	# Children post-lesson	# Pre-lesson respondents	# Post-lesson respondents	# Correct pre-lesson	# Correct post-lesson	% Correct pre-lesson	% Correct post-lesson
Oria Arriba	15	10	1	10	0	7	0%	70%
Colán	5	8	3	8	2	6	40%	75%
Nuario	13	11	6	11	3	10	23%	91%

Bajo Corral	12	13	9	13	5	12	42%	92%
Q1 Total	45	42	19	42	10	35		

The first question, “What is the atmosphere?” was asked before Lesson 1 and after Lesson 2. The concept of atmosphere was explained during the first lesson with the help of videos, drawings in class, and games. We also reviewed the concept various times throughout Lesson 2. We can clearly observe that few children were familiar with the concept of atmosphere before this year’s initiative. In contrast, after Lesson 2, we observed that every child in the four schools attempted to answer the question, and in every case the number of correct answers increased. This indicates not only an increase in knowledge, but also an increase in students’ level of confidence in explaining the concept to others.

Table 2: Question 2 “What does climate change mean to you?”

School	# Children pre-lesson	# Children post-lesson	# Pre-lesson respondents	# Post-lesson respondents	# Correct pre-lesson	# Correct post-lesson	% Correct pre-lesson	% Correct post-lesson
Oria Arriba	15	10	11	10	1	3	7%	30%
Colán	5	8	2	6	0	3	0%	38%
Nuario	13	11	3	11	3	5	23%	45%
Bajo Corral	12	13	10	12	0	3	0%	23%
Q2 Total	45	42	26	39	4	14		

The second question, “What does climate change mean to you?” was also more successful after Lesson 2; as with question 1, more children attempted to respond after Lesson 2. After Lesson 2, we observed that in all cases the number of correct answers and the number of children who answered the question increased. Owing to the abstract nature of this question, it was difficult to grade answers uniformly, which is why percentages appear so low after the initiative, as compared with the other questions from the evaluation.

Table 3: Question 3 “Give at least one of the causes of climate change.”

School	# Children pre-lesson	# Children post-lesson	# Pre-lesson respondents	# Post-lesson respondents	# Correct pre-lesson	# Correct post-lesson	% Correct pre-lesson	% Correct post-lesson
Oria Arriba	15	10	7	10	1	10	7%	100%

Colán	5	8	2	8	0	7	0%	88%
Nuario	13	11	2	11	0	9	0%	82%
Bajo Corral	12	13	6	12	5	11	42%	85%
Q3 Total	45	42	17	41	6	37		

The third question, “Give at least one of the causes of climate change,” was the third question indicating how successfully the initiative communicated messages about climate change. We asked it at the beginning of the lessons and after Lesson 2 in all of the schools. We can observe that, once again, more children attempted to respond, and the proportion of correct responses was much greater after Lesson 2. For instance, in Colán and Nuario, the percentage of correct answers was 0% before the first lesson (pre-lesson) and increased to 88% in Colán and 82% in Nuario after Lesson 2 (post-lesson).

Table 4: Question 4 “What is reforestation?”

School	# Children	# Participants	# Correct	% Correct
Oria Arriba	15	15	15	100%
Colán	5	5	5	100%
Nuario	13	13	11	85%
Bajo Corral	12	12	12	100%
Q4 Total	45	45	43	96%

The purpose of question 4 was to review information conveyed by the School Initiative in years past. Each year, the Azuero Earth Project organizes reforestations in the schools, so the concept of “reforestation” is a clear and familiar one for the children. In addition to talking about the concept, the children themselves carried out reforestation projects in their schools and communities with the Azuero Earth Project. This academic and practical experience with reforestation is apparent in the high proportion of correct responses about reforestation.

Table 5: Question 5 “Give at least one of the causes of deforestation.”

School	# Children	# Participants	# Correct	% Correct
Oria Arriba	15	15	14	93%
Colán	5	5	5	100%
Nuario	13	11	10	91%
Bajo Corral	12	10	5	50%
Q5 Total	45	41	34	83%

As with question 4, the purpose of question 5 was to review information conveyed by

the School Initiative in past years. The great majority of children understood the question well. During Reforestation Week in August 2016, we gave a talk about the concept with slides before going to plant seedlings. During this brief presentation, we thoroughly explained the conception of reforestation and deforestation, as well as the causes and consequences of the latter. The majority of the children had a good understanding of the causes of deforestation, evidenced by the high proportion of answers that correctly cited common causes of deforestation in Azuero.

Table 6: Question 6 “What does a tree produce?”

School	# Children	# Participants	# Correct	% Correct
Oria Arriba	15	15	15	100%
Colán	5	4	4	100%
Nuario	13	11	11	100%
Bajo Corral	12	9	9	100%
Q6 Total	45	39	39	100%

As with questions 4 and 5, the purpose of question 6 was to review information conveyed by the School Initiative in past years. Of all of the questions, question 6 was answered correctly by the highest number of students, with a 100% correct answer rate in every school. The tree is a concept that the students have seen every year with the School Initiative, so it is a clear concept for them. The most common answers students gave were: fruit, shade, fresh air, and air/oxygen.

CONCLUSION

2016 was the final year of a curriculum that we hope to polish and turn into a series of educational activities that will be repeated and modified every 5 years. This series would promote a comprehensive vision of Azuero’s environment and its connections to environmental changes at the national and global levels, beginning with the importance of the spider monkey and other wildlife of Azuero, emphasizing the importance of dry tropical forest, water, and soils to human and ecological communities on the peninsula, and culminating in an exploration of the impacts of and possible strategies for mitigating and adapting to climate change.

In 2017, we will work with teachers, educators, and other community connections in Azuero to polish this curriculum and make it accessible to others, providing an opportunity for the educational community to benefit from these lessons on a wider level and allowing instructors to become multiplying agents of the program.

APPENDIX 1: Stage play

Play: “At Last, A Successful Meeting”

School Initiative 2016

Written by Johanna Durget and Casey Aviles with the much appreciated assistance of Verónica Blohm.

Characters:

1. Director
2. Mother Earth
3. Climate
4. Child 1
5. Child 2
6. Doctor
7. The United Eco-States
8. The Green Union
9. Pana-bio
10. Narrator (Teacher, assistant, or child)

The set is composed of tables organized in a circle, where each member of the Meeting has his/her own chair and a paper with his/her member’s name (Director, The United Eco-States...). There is a whiteboard in the meeting room, but it has never been used (until today!). “The 4000th Meeting of the Most Powerful Countries in the World: What’s Happening to Mother Earth?” is written on a sign/poster. The countries are dressed in plastic, but they have logos and labels saying, for example: 100% bio, super-green...

Narrator: Today is the 4000th meeting called, “What is happening to Mother Earth?” The most powerful countries in the world are meeting *again* to fight about Mother Earth’s situation: she says she’s feeling a little hot. The countries don’t take her seriously and imagine that she is lying, as with the 3999 previous meetings. But this time, unbeknownst to them, the meeting will take a very different direction. Some uninvited character are going to interrupt the meeting, but don’t believe me... Watch for yourselves! (*Signals with hand and moves to one side of the stage*)

Director: Welcome, everyone, to the 4000th meeting, “What is happening to Mother Earth?”

The director greets and shakes hands with all of the members of the meeting. Mother Earth coughs and fans herself vigorously. It seems that she is feeling very hot.

The United Eco-States, *whispering:* I can’t believe we’re here again... This meeting is a waste of time!

The Green Union: You know, Mother Earth, I think you're just exaggerating too much. No one can get so sick so fast.

Pana-bio: Tell us what's happening again, Mother Earth.

Director: Everyone calm down. Let's let Mother Earth speak. This meeting needs to end soon, because I don't want to miss (insert popular book or movie).

Mother Earth, looking tired and sweaty, with her fan: Oh, awful! You can't imagine how poorly I feel. Every day is worse, and I get hotter and hotter. I think I'm getting a fever.

Doctor: Let me take your temperature, Mother Earth.

The Doctor approaches Mother Earth and takes her temperature.

Doctor, scared: Mother Earth! You do indeed have a very high fever! You almost broke the thermometer...

Now, all of the countries are scared, and talk amongst themselves:

The United Eco-States: It wasn't a joke!

Pana-bio: Now what do we do?

The Green Union: Doctor, what do you recommend? Which medicine?

Doctor: To be honest, I have never seen a situation like this before in my life. I think that with only medicine, she won't get better. This is something serious. It could be fatal!

All of the countries panic. The Director intervenes to calm the room.

Director: Shhhh... What other symptoms do you have, Mother Earth?

Mother Earth: Well, I'm also very thirsty and find it hard to breathe.

Everyone gets scared again. Climate enters, running crazily around the circle of the meeting. Behind Climate enters a child.

Climate: I'm going crazy (twice)! Help me! (Climate shouts in desperation, crying.)

The United Eco-States: But... Who are you?

Child 1: That's Climate.

Child 2: Yes, we saw him/her outside all worried and confused, and we couldn't just ignore him/her.

Director, to Climate and the others: Calm this crazy person and get him/her to sit down!

Climate sits and tries to calm down. He/she looks at the members of the meeting fearfully. Suddenly, without letting the children explain the situation, the countries begin to speak rapidly. They get to their feet and start talking about their own problems until nothing can be heard.

The Green Union: Ah, finally! In my country, we want to ask you why it's so hot. We have summers with horrible heat waves, and our winters are getting warmer and shorter.

Pana-bio, *adds:* Well, in my summers, we don't get even a single drop of water. My rivers are drying up! This has never happened before.

The United Eco-States: That's nothing! I have an even bigger problem. There are enormous floods and hurricanes on our coasts that are hurting my beloved cities.

Pana-bio: But my problem is worse! Without water, my crops can't survive and my cows are getting skinny.

Clima: *(lamenting, sadly, with head in hands)* Countries, it's not my fault. I never wanted this, but I lost control!

Mother Earth: Don't worry, Climate. We're old friends. I know that you don't want to hurt me.

The United Eco-States: But now what? (PAUSE) Whose fault is it?

All of the countries begin to argue amongst themselves again, blaming one another.

Director, *interrupting them loudly:* Please, let the children speak!

Now, all of the countries grow quiet and sit down.

Child 2, *timidly approaches the Director and says:* Forgive us for interrupting you, but, hearing your problems and seeing Mother Earth so sick, and knowing that Climate didn't know what he/she was doing... *(looks to the other child)*

Child 1: ...we think we know what's going on here.

Doctor, *looking at the two children curiously:* So explain to us, then, what's going on with Mother Earth and Climate?

Child 1 walks over to the whiteboard, thinks a bit, looks at Child 2, and begins the explanation. While they explain, they draw a simple diagram of the planet and atmosphere with some arrows for the sun's rays.

Child 1: This is our Mother Earth. *(Draws a circle representing her.)*

Child 2: And Mother Earth has a coat called the atmosphere. *(Draws another circle around the first to represent the atmosphere.)*

Child 1: Within this atmosphere are many natural gases, like carbon dioxide (CO₂), nitrogen (N₂), oxygen (O₂), ozone (O₃), and water vapor (H₂O) ... *(Writes the symbols for these gases on the board.)*

Child 2: This coat is very important, because it protects Mother Earth from being burned by the sun. *(Draws the sun and an arrow towards Mother Earth.)*

Child 1: However, we also need a few rays of sunlight to give Mother Earth energy.

Child 2: In fact, when the rays of sunlight touch Mother Earth, she absorbs them.

Niño 1: And then they are reflected back into the atmosphere. *(The child draws another arrows back towards the atmosphere.)* But this isn't a problem; this is how the planet works. It's in balance.

Director: Hm hm, yes, yes, I understand. But then what is the problem?

Child 2: That there is no longer this balance! Look at Climate and Mother Earth--they don't feel well. You can see that something is changing!

Mother Earth, fanning herself faster and faster: Yes, yes, I am so hot...

Child 1: It's because too much heat is trapped in the earth! When her coat, the atmosphere, gets dirty, it becomes too thick, and doesn't allow any heat to escape.

The United Eco-States: But what is causing this disequilibrium?

Child 2: There are too many gases being released from the planet into the atmosphere, and they can't escape. These greenhouse gases contaminate the atmosphere and cause Mother Earth to heat up.

The Green Union: Oh no! *(moving away from Mother Earth)* And is this contagious?

Child 2: Well, if we don't heal Mother Earth, everyone will be affected. We will all get very hot and be very thirsty.

Child 1 (signaling to the children): And it will affect us--the youngest--the most!

Pana-bio: How do these gases contaminate Mother Earth?

Child 1: It happens when we produce too much, buy things we don't need, and throw them away quickly.

Niño 2: It also happens when we cut down or burn soils and trees.

The Green Union: Yes, that's true. Something I feel that we use too much cement to build our houses, and the production of that cement... it does emit a lot of gases.

Pana-bio: Well, here in Pana-bio it is true that we could leave more trees so that they consume more carbon dioxide and give shade to our livestock. They will protect our rivers so that we have plenty of water in the future.

While the countries share these revelations, Mother Earth begins to look slightly better and says hopefully:

Mother Earth: Thank you so much for realizing that I am not exaggerating--I already feel a little bit better!

Doctor: Yes yes yes. I believe that in order to begin to cure Mother Earth, we need to be less selfish and think more about her.

Child 2: We need to listen to her, care for her, and love her.

Climate, (who has regained consciousness): Yes, because I don't like to hurt others.

Pana-bio: So to achieve this, we need to find alternatives...

The Green Union: And, more importantly, act upon them!

Child 1: In reality, there are many alternatives, called sustainable, ecological, or renewable alternatives.

Climate: If we work together, I am sure that we can do this.

Mother Earth: Yes! Even though you may not believe it, I am strong and can get better. But this is a job that can't be done alone: I need everyone's help.

Child 2 (*lovingly touching her arm*): Don't worry, Mother Earth. I'll take responsibility--
from now on, we will take much better care of you.

Child 1: *Because we love you lots!* (Each child plants a kiss on Mother Earth's cheeks.)

Climate: I feel very happy--let's celebrate!

Traditional Panamanian music begins to play, and the actors dance around Mother Earth. Bit by bit, everyone hugs, thanks each other, and calms and cares for Mother Earth. END

APPENDIX 2: Instructions for Lesson 1 Games

Instructions for "Looking for Energy" Game

Players:

Unlimited.

Purpose of the game:

Observe the environment and the objects that need energy to work. Be aware of energy usage. Show the link between energy and climate change.

Materials:

- A sheet of paper for drawing or writing the objects seen by the children
- A pen
- 3 cards with fossil fuels on them (carbon - petroleum - natural gas) and 2 cards with sources of renewable energy (wind energy, solar panels) for reflection

Preparation:

The "game" is an expedition through the school to look for everything related to energy. The goal is NOT to touch the objects, but rather to draw or write what the children observe on a piece of paper.

Please supervise the players carefully to ensure that they don't touch electrical sockets, for instance.

The team's players should pair off into groups of two, for example, so that at the end of the game, everyone can get back together and share their discoveries.

Mental preparation:

Ask the players if they know what energy is.

Ask if they use energy, and what kind of energy they use.

Ask if they know what fossil fuels are.

Game:

HOW TO PLAY

Every pair will go on an expedition throughout the school to note and/or draw every object related to energy/that needs energy. Once they have covered the whole school and filled their paper, the players should come back to the starting point.

AT THE END OF THE EXPEDITION

All of the players meet at the starting point and compare their papers: if one player has an object that another doesn't, that player explains how he/she thinks the object is related to energy. The idea is to

foster discussion among the participants.

- WHERE DOES ENERGY COME FROM? HOW IS ENERGY PRODUCED?

Show the 3 pictures of fossil fuels and ask if the players recognize what they are: carbon, petroleum, natural gas (on the reverse of each is a simple definition of the object in the image).

[Carbon: black rock. One of the main sources of energy. In the process of being used, carbon produces significant environmental damage because when burned it releases large amounts of gas responsible for effects such as: acid rain, greenhouse effect, smog...

Petroleum: Mix of organic compounds. Produced in the earth's interior and extracted through wells.

Natural gas: Natural substance formed from a mixture of fossil hydrocarbons and used as fuel. Found in deposits in the subsoil. The principal component is methane, a gas also produced through activities like rice farming (made by bacteria involved in rice planting) or the digestion/excretion of animals (livestock), trash...]

Our current energy model is based on the use of fossil fuels, and it is becoming exhausted.

Tell players that the **burning of fossil fuels is responsible for the production of greenhouse gases, which cause global warming.**

[A **fossil:** petrified remains (in rock form) of a living organism that died more than 10,000 million years ago.

A **fuel:** any material that, when burned, releases energy in the form of heat (combustion).

Hydrocarbons: substances formed only by carbon and hydrogen.]

TO WIN THE GAME

The player must have carefully observed the environment (the school) and recorded the energy-related objects on his/her paper.

REFLECTION

Energy is part of our daily life. Every day, we use energy almost without realizing it: to make breakfast, in the shower... However, because energy is totally integrated into daily life, and because it's so easy to access, we don't value its importance in supporting our current lifestyle. It's important to begin to understand that without energy, we couldn't do many of the things we do on a daily basis, and to begin to relate this fact with its environmental consequences.

Our energy model is unsustainable and puts our planet at risk: fossil fuels emit greenhouse gases into the atmosphere.

There are sustainable alternatives: renewable energy.

For example:

Energy from the sea: making use of waves (wave power station) or tides (tidal power station).

Wind energy: Obtained from the force of the wind, through wind turbines.

Hydroelectric energy: Through hydroelectric centers: transformation of the mechanical energy of a stream of water.

Solar energy: Obtained from solar radiation.

Questions to think about afterwards:

- What objects did you find?
- Do you think your school uses a lot of energy? A little energy?
- What would be a school that uses a little energy? A lot of energy?
- Where does energy come from? How do we produce it? (Fossil fuels)
- Why is our current energy system dangerous? (Sources of energy are being exhausted. Furthermore, their extraction and usage emit lots of greenhouse gases that cause climate change. In other words, they pollute the air. We need to be more careful of our natural

- resources.)
- What are alternatives to take more care of our energy consumption? (Renewable energies: save energy every day!)

Instructions for Ecosystem Game

Players:

6-10 people

Purpose of the game:

Establish dependency relationships between the different natural elements that make up the ecosystem. Understand the importance of these relationships for the proper functioning of the ecosystem. More specifically, observe the ecosystem in Azuero province. Demonstrate the dangers of contaminating an ecosystem.

Materials:

- 1 ball of yarn
- 10 elements from Azuero's natural surroundings (Charro monkey, tree, livestock, human being, green iguana, sun, precipitation, temperature, soil, wind)

Preparation:

You can ask the players what elements make up climate, and use students' answers to distribute elements to them. Distribute the elements so that every player represents one.

You're going to create an ecosystem. Every player will say out loud what element they have chosen so that everyone knows what elements make up the ecosystem you are creating. Every player will place the card with their element around their neck like a necklace.

Mental preparation:

Ask the players why they chose the element they did, and to say what they know about this element in Azuero.

Ask the players what an ecosystem is. Conclude that an ecosystem is a system formed by interactions among a community of elements (living and nonliving) with their own environment. Ecosystems can be of various scales, such as: global, universal, aquatic, rainforest, a rock.

Game

HOW TO PLAY

1. With a ball of yarn, connect all of the elements (the players).

We put the first element/player in the ecosystem; that is, one player wraps the yarn around him/herself (meaning that element is part of the ecosystem).

We ask the player what he/she needs in order to live. If he/she says, "Water," the player representing precipitation will add him/herself to the ecosystem, wrapping him/herself in the yarn. This process continues until all of the elements are included in the system (wrapped in yarn).

From this point, we observe the different dependency relationships generated between the elements of the ecosystem. Finally, every element will be connected to the others.

→Ask the children to think about how they placed the yarn and how they are all tied together. Tell them that this represents an **ecosystem**.

2. Some of the elements will be impacted, and this will produce ecological disequilibrium: one member of

the ecosystem will be released from the yarn and remain outside the system.

→ We observe how the impacted element that was released from the yarn unbalances the others, affecting elements that did not have a direct relationship with the impacted element. (If the tree disappears, for instance, because there was a large deforestation and the ecosystem's trees disappear, what happens to the other elements? Could they survive? This shows interdependence.)

3. Now, the player who was connected to the affected element can pull on the string until it is tight again. The other elements (players) have to adapt to the new situation.

4. Now, we are going to see what happens when an element changes: for example, if the temperature rises significantly in the ecosystem. This occurs when the player representing precipitation moves the yarn (up and down; side-to-side). The rest of the yarn will move and show that **nature is dynamic** and that natural elements, whether they have direct connections or not, modify each other.

REFLECTION

An ecosystem (= idea of community): is a group of species in a determinate area that interact among themselves and with their environment (nonliving components). The species in the ecosystem, including bacteria, fungi, plants, and animals, depend on each other. The organisms live where they can meet their needs.

The ecosystem should include the community and nonliving things, like the characteristics of the climate, the temperature, the chemical substances present, and the soil conditions (but soil is alive, don't forget!). It is important to understand the relationships between living beings and nonliving factors: the climate acts upon the living species of the ecosystem. Relate this to climate change → a change in climate or temperature → influence on the members of the ecosystem.

TO WIN THE GAME

The players must have understood what happens when an element disappears or changes and when disequilibrium occurs in an ecosystem.

Questions to think about afterwards:

- What kind of ecosystem are you in now? An ecosystem is formed by all of the living things (biotic factors) and nonliving things (abiotic factors) that exist in an area.
- What are the threats to an ecosystem? To Azuero's ecosystem?

Instructions for Time Game

Players:

1-20 people

Purpose of the game:

Learn about the long-term threats of leaving trash on the ground/in the environment. Explain the relationship between garbage and climate change.

Materials:

- 10 objects (If there is time to plan a little bit, the teacher can ask the children to bring in objects from the list with which to play the game):
 1. Fruit peel/rind
 2. Can

3. Plastic bottle
 4. Glass bottle
 5. Plastic bag
 6. Tire (can be imaged or drawn if not available)
 7. Batteries
 8. Gum
 9. Newspaper
 10. Paper
- 10 cards with times on them

Preparation:

Place the 10 objects on the floor. The players will have to match each object with a time card. Based on the number of players and cards, every student can match one object with the time needed for it to decompose. Alternatively, the children can guess as a group.

Mental preparation:

Ask if they throw their trash away. *Do you know what happens to trash if you leave it on the floor?*

Ask the players, "What is trash burning?"

Ask the players, "Do you know if they burn trash in the dump in your town?"

What is trash burning?: The induced or spontaneous incineration of waste, which is made worse because solid domestic waste is accompanied by hospital and industrial waste.

- Waste is burned to reduce its volume, eliminate bad odors, and prevent the spread of diseases produced by decomposition.

- It produces environmental contamination: burning trash produces smoke containing many harmful chemicals → carbon monoxide, carbon dioxide → these are greenhouse gases that cause climate change.

- Burning waste disperses into the air, water, and soil: this accumulation is dangerous for animals, plants, human beings, and the earth.

Game:

WHAT TO DO ON YOUR TURN:

Look at the objects in front of you and try to guess how long it takes each to decompose.

TO WIN THE GAME:

Correctly match each object with the time it takes to decompose.

Answers:

- Fruit peel/rind: 6 months
- Paper: 2 to 5 months
- Newspaper: 1 year
- Gum: 5 years
- Can: 50 to 100 years
- Plastic bag: 450 years
- Plastic bottle: 400 years
- Glass bottle: 4000 years
- Battery: 1000 years
- Tire: Not biodegradable

REFLECTION

All products, materials, and substances decompose when thrown away. Some degrade naturally due to biological agents such as sun, water, bacteria, plants, or animals; these materials are called

“**biodegradable**,” because they return to the earth without causing harm. In other cases, it is necessary to treat the material in order to allow bacteria to do their work at an acceptable speed. In other cases, garbage remains for many years in dumps or wherever it was left, contaminating the earth, air, and water. Although everything decomposes eventually, there is a radical difference in the time it takes biological agents to decompose objects into natural chemicals. In those cases of materials containing toxic substances, such as plastics that, over the years, are reduced to invisible synthetic molecules, those toxins remain present in our surroundings. Therefore, it’s important to realize that “trash” for most people, whose final disposal in a dump seems sufficient, really has a large, very negative, and lamentably lasting effect on our planet.

Questions to think about afterwards:

- What happens when you throw your waste on the floor?
- What are the threats of non-biodegradable waste?
- What is the difference between organic and non-organic waste?
- What happens when we burn trash?
- Do you know of any alternatives to manage trash?
- What does trash burning have to do with climate change?

You can talk about these alternatives:

- Composting: A process of biological decomposition of organic material. The purpose is to transform organic material for use in improving soils for agriculture.
- Reusing materials and/or reducing consumption of objects of short-term use (food containers, plastic cartridges, etc.) and in general.

Instructions for “What’s Going on with Global Warming?” Game

Players:

2-10 people

Purpose of the game:

Explain the negative impacts on global warming on the environment, human beings, cities, and animal life.

Materials:

- 10 impact cards with images (answers on the back; should not be seen by the players)

Preparation:

Join the players in a circle--they may be seated.

Every card has a lower part, under the dotted line, where the answer appears.

Mental preparation:

What is global warming? (an increase in temperature caused by climate change – remember) Think about the negative impacts of global warming for the environment, humans, cities, and animal life.

What are our impacts on the planet? How can we affect climate change?

Game:

HOW TO PLAY

Show the players the different images one by one. For each image, the players have to guess what is

represented and how it happened.

For example, for the “Floods” card, try to have the players guess how this phenomenon occurred: climate change caused glaciers to melt, which caused sea levels to rise and islands and coastal towns to flood (example in Panama: the Guna Yala Islands). The extreme increase in heavy precipitation can also cause floods.

*See Appendix A for all of the explanations of each impact.

REFLECTION

What is an environmental impact? It is the effect produced by humans on the environment. People’s actions of the environment always produce collateral effects. Concern for environmental impact covers various types of actions.

The negative impacts we have on the environment participate in causing climate change and global warming.

And global warming is also creating negative impacts for us and everything else: whether humans, animals, or the environment. We need to be aware of this to avoid negative events like droughts, illnesses (health problems), extreme temperature changes, glacier melting, and animal extinction.

TO WIN THE GAME

Understand every impact and how it is produced.

Questions to think about afterwards:

- What are the negative impacts of climate change?
- What are the impacts at each level: animal, human, environmental?
- What can we do to reduce these impacts?
- Where does global warming come from?

Appendix A.

1. “Negative environmental impact: Forest fires” card

Factors like: heat waves, temperature increases, increased desertification, etc. (the effects of climate change) cause forests to be covered in dry vegetation that becomes fuel for fire. The risk of forest fires is therefore higher with climate change.

Furthermore, climate change increases the virulence (strength) of fires: more is burned in fewer fires.²

2. “Negative impact on people: Higher spending on health problems” card

Our body does not function well when it gets too hot; climate change can provoke dangerous heat waves. Additionally, if our natural resources, such as water, are used up, that puts us in danger. And then there is air pollution. These risks to our health mean more trips to the doctor, pharmacy, or hospital: we spend more money on health.

3. “Negative impact on people: Fewer available natural resources” card

If we don’t take care of our planet and natural resources (which aren’t unlimited!) they will diminish or even disappear. A very important resource for human being is potable water: we have to care for our water sources so they don’t become contaminated

4. “Negative environmental impact: Glacier and ice cap melting” card

² <http://www.greenpeace.org/espana/es/Trabajamos-en/Bosques/Incendios-forestales-en-Espana/Incendios-forestales-y-cambio-climatico/>

The global temperature increase causes glaciers and ice caps to melt. Melting also causes another phenomenon: a rise in sea levels.

90% of ice is found at the South Pole, and it has a thickness of 2.133 meters. In the very long term, this means that, if all of the ice blocks in this area melt, sea levels may rise more than 60 meters.

At the other pole, the North Pole, the ice is not as dense and melts more easily, which means melting is already evident.

Ice melting gravely disturbs the flora and fauna of coastal regions and completely changes life in polar areas. It also changes ocean currents, which can cause adverse climatic events.³

5. “Negative impact on cities: More floods” card

Melting causes sea levels to rise, which can cause floods on islands (a current situation is the Guna Yala Islands on Panama’s San Blas archipelago. The sea level is rising, and it is said that in some 15 years the residents of the islands will no longer be able to live there) and coasts.

Furthermore, melting causes disequilibrium in ocean currents, which can cause extreme climate events such as storms or strong precipitation which can flood or destroy towns and cities.⁴

6. “Negative impact on animal life: Changes affecting flora and fauna” card

The global ecosystem is changing, and this also affects flora and fauna. Animals have to migrate because they no longer have viable conditions: their habitats are disappearing (monkeys lack trees, for example, and therefore must move; the polar bears are losing glaciers...).

7. “Negative impact on people: Greater number of illnesses” card

Our body does not function well when it gets too hot; climate change can provoke dangerous heat waves. Additionally, if our natural resources, such as water, are used up, that puts us in danger. And then there is air pollution.

8. “Negative environmental impact: Extreme temperature changes” card

Climate change is global warming: it means the planet’s temperature is increasing more and more. Excess gas emissions mean the level of gases in the atmosphere is too high, and these gases trap more heat, which heats the earth.

But extreme temperature changes--heat waves or extreme decreases in temperature--can also occur, depending on the place.

9. “Negative environmental impact: Droughts” card

Heat waves and temperature increases produce droughts.

10. “Negative environmental impact: Growth in desert zones” card

Heat waves and temperature increases produce droughts; in the long term, drought-stricken areas can become desert areas.

Instruction for “Carbon Cycle” Game

Players:

Minimum 4 players. No maximum.

The players should be distributed as follows:

³ <http://www.laenergiadelcambio.com/cambio-climatico-y-deshielo-de-los-casquetes-polares-2>

⁴ <http://www.laenergiadelcambio.com/cambio-climatico-y-deshielo-de-los-casquetes-polares-2>

- Some play "carbon dioxide" (CO₂)
- Some play "fires" (1, 2, or 3 children)
- Some play "trees" (1, 2, or 3 children)

Purpose of the game:

Understand what the greenhouse effect is. Associate the sun and CO₂ gas with the causes of the greenhouse effect.

Materials:

The players can write "CO₂" or draw a fire or tree on pieces of paper. These can be attached to their shirts so it is easier to identify them during the game.

Preparation:

With the players, make a list of the sources of carbon in the world: the sea, the air, plant and animal material, and some minerals.

In the sea: 0.05% of the world's total carbon. In the form of bicarbonate ion.

In the air: in the atmosphere. Gas: carbon dioxide.

In plants and animals: carbon dioxide, returned to the water through fish's gills and to the air through the lungs of land animals. Carbon dioxide is absorbed by plants.

Mineral carbon: black rock. Fossil.

Mental preparation:

Speak with the players about carbon dioxide. Remember the consumer and producers of carbon dioxide.

When a tree is burned or cut, carbon dioxide escapes into the atmosphere. This is one of the causes of climate change!

Game:

HOW TO PLAY

Give each player a paper for the game.

The teams will depend on the size of the class.

The players will each be a "character": carbon dioxide/fire/tree. There should be lots of carbon dioxide, one or two fires, and one or two trees.

The players with the carbon dioxide paper run around in a marked area, chased by the trees. The trees try to tag them, and when a carbon dioxide is tagged, he/she must stand still.

→ In this way, you show the plant's role in taking in carbon dioxide from the air and fixing it within itself.

At the same time, the fire can free the carbon dioxide. The fire crawls through the outstretched legs of a carbon dioxide to show that, when fire burns plant material, the carbon dioxide enters the air again until another tree traps it.

This game illustrates the competition between trees and fires for carbon dioxide gas.

AT THE END

Remember that burning frees carbon dioxide and contributes to global temperature increases.

What is the greenhouse effect? How can it be avoided? (plant, don't burn trees; use alternative sources of energy like solar instead of petroleum).

TO WIN THE FAME

Understand how carbon travels.

REFLECTION

Understand how the greenhouse effect works. Make relationships between the sun, gases, the

atmosphere, and climate change.

The **greenhouse effect is a global problem**, and it is related to deforestation. Many scientists believe that the excess carbon dioxide in the atmosphere comes from the burning of substances that contain carbon, such as: firewood, carbon, petroleum, and hydrocarbons. This carbon dioxide doesn't let the sun's heat escape.

Greenhouse effect: phenomenon in which certain gases (greenhouse gases), which are part of the planet's atmosphere, retain part of the energy emitted by the earth after having been heated by solar radiation.

This produces a heating effect similar to what happens in a greenhouse, with an increase in temperature (like our experiment with the container).

Though the greenhouse effect is produced by the action of various components of the atmosphere, the warming process has been heightened in the past decades by human actions, with the emission of carbon dioxide, methane, and other gases.

Attention! The greenhouse effect is essential for the earth's climate. The radical problem is contamination, since, in equilibrium, the quantity of energy taken in by the planet through solar radiation is compensated for by the energy radiated into space; through this mechanism, the earth's temperature remains constant (see the arrow system on the diagram).

This phenomenon prevents solar energy received by the earth from returning immediately to space, producing an effect similar to that seen in a greenhouse, but at the global level. Therefore, the temperature rises: global warming.

Questions to think about afterwards:

- What activities produce greenhouse gases?
- Are these gases pollutants?
- To where do they escape? (The atmosphere)
- The sun's energy arrives at the earth and escapes into the atmosphere. But here there is a disequilibrium--why? (normally, solar radiation and reflected radiation should be about equal. Here, polluting gases keep more solar energy within the atmosphere.)
- What does this disequilibrium cause? (Rise in temperature = global warming).
- What are the threats caused by an increase in temperature? (extreme phenomena: droughts, rising sea levels, meteorological changes, species extinctions, floods...)

Explain at the end that the planet's temperature has been rising for some years and that, if it continues like this, it will increase even more if we don't do anything to confront the problem.

Explain that the consequences are dangerous. We all contribute to the greenhouse effect. We should try to control it for the wellbeing of the whole world.

Instructions for "Air Mobile" Game⁵

Players:

Purpose of the game:

⁵ Game from "Didactic Guide to Environmental Education – Fourth Grade – Meduca" ("Guía Didáctica de Educación Ambiental – Cuarto Grado – Meduca")

- Identify producers and consumers of oxygen and carbon dioxide in the air. Explain the importance of oxygen for living things.
- Recognize the function of trees and wild plants in conserving the environment.

Materials:

- Cardboard / recycled material
- Scissors
- Colored pencils: blue, green, brown, red, orange
- Yarn

Preparation:

Before beginning the activity, show a picture of a mobile as a guide for students.

Mental preparation:

Do you know how respiration (breathing) works?

What do we breathe in? What do we produce when we breathe out?

Where do these gases go?

Why are trees important?

Game:

Give all of the children a piece of cardboard (or other recycled material so that they can make the different parts of the mobile) and nine small pieces of paper on which each student should draw:

1 Air

3 O₂

1 Tree

3 CO₂

1 Animal (bird, monkey... have it be an animal from Azuero!)

1 Fire

Ask them to draw a large cloud representing the air, three small clouds called "oxygen," and three molecules called "carbon dioxide." They should draw a tree to represent plants, and animal, and a fire to represent burning and pollution.

The cloud should be on thick paper that won't bend. The students should write "air" on both sides to identify it.

Underneath, hang two pieces of yarn or string.

On one string, the mobile is made of the following pieces, from top to bottom: a cloud marked "oxygen" (O₂), a tree, and carbon dioxide.

On the other string, connect a small stick/branch at its center.

On one side of the stick should hang a carbon dioxide, an animal, and an oxygen cloud.

On the other side of the stick should hang a carbon dioxide, a fire, and an oxygen cloud.

When the children finish, they should present their mobiles and explain the production and use of carbon dioxide and oxygen.

REFLECTION

When the children finish, they should present their mobiles and explain the production and use of carbon dioxide and oxygen. Discuss with the children that the mobile's tree uses carbon dioxide, showing the cloud from underneath, and produces oxygen, represented by the cloud above. The animal and the fire use oxygen and produce carbon dioxide, represented by the clouds hanging above them. This mobile shows the need for balance between producers (plants) and consumers (animals and fires) of oxygen.

Questions to think about afterward:

- How does the process illustrated by the mobile work?
- Is this the first time you made something with recycled material?
- Why is it important to reuse and recycle objects and materials?
- What balance, shown in the mobile, is necessary for a healthy planet?

Instructions for “We Live on the Same Planet” Game

Players:

Unlimited.

Purpose of the game:

Identify individual actions to reduce greenhouse gas emissions. Understand and apply concepts of mitigation to develop examples of possible citizen actions.

Materials:

- A string representing the space everyone shares (the planet)
- Cards with different daily actions that positively or negatively influence the space in which we live
 1. Your cousin comes to live with you (Positive)
 2. You move from your house to a bigger one, even though it's not necessary (Negative)
 3. You use a lot of air conditioning in your house (Negative)
 4. You reuse plastic containers (Positive)
 5. You heat your home with solar energy (Positive)
 6. You consume a lot of water because you take baths longer than 10 minutes (Negative)
 7. You leave the water running while you brush your teeth (Negative)
 8. You heat your home with a furnace instead of putting on a sweater (Negative)
 9. You run the washer when it's not even full (Negative)
 10. You buy lots of vegetables from a local producer (Positive)
 11. You eat more vegetarian meals (Positive)
 12. You go to the McDonald's in Chitré to eat hamburgers (Negative)
 13. You grow papaya in your garden (Positive)
 14. You exchange your 4x4 car for a more economical and fuel-efficient vehicle (Positive)
 15. You walk to school instead of driving (Positive)
 16. You compost your fruit and vegetable peels (Positive)
 17. You carpool with friends to Las Tablas (Positive)
 18. Your family buys a used car (Negative)
 19. You replace your house's light bulbs for ecologically friendly ones (Positive)
 20. You decide to go biking in the fields with your friends instead of watching TV at home (Positive)
 21. You buy a new refrigerator and leave the old one in the dump (Negative)
 22. You take public transportation to the city (Positive)
 23. You plant lots of trees on your farm for your livestock (Positive)
 24. You save water (Positive)
 25. You always leave the lights on in your home (Negative)
 26. You bring your own cloth bags with you to the supermarket and tell the cashier, “No plastic bags, please!” (Positive)
 27. You use natural cleaning products, like white vinegar, to clean your house (Positive)
 28. You go to a restaurant and ask for takeout that comes in a plastic bag (Negative)
 29. You take too much food, eat half, and throw away the rest (Negative)
 30. You buy apples from the United States (Negative)
 31. You buy a new cellphone and throw the old one in the trash (Negative)

32. You buy secondhand clothes (Positive)
33. You avoid consuming foods packaged in plastic (Positive)
34. You throw away the clothes you no longer wear (Negative)
35. You donate clothes that no longer fit you to the church (Positive)

Preparation:

All of the players find room in the space they share, represented by a string on the floor. Place the players within the string, which should remain on the floor.

Read each card out loud to the players. According to the card, the players must guess if the action is good or bad for the environment: if it is bad, the space they have shrinks (that is, the string becomes smaller and there is less space to stand), and if it is good, the space becomes larger or remains the same (that is, the string is extended and the players have more room). They have to understand the difference between a card with a positive and a card with a negative action on the planet they share.

Students must explain why each action is positive or negative.

Mental preparation:

Remember climate change and its cause: excess greenhouse gases emitted from the earth into the atmosphere.

Remember the human activities that cause greenhouse gas emissions.

Think about the steps we can take to reduce these emissions, and thereby mitigate climate change.

Whether by eating, moving, having a place to live, or managing our waste, the actions we take diminish the natural resources of the planet.

Are we taking more than our planet can offer?

Game:

HOW TO PLAY

The players stand within the space created by the string. The string remains on the floor; it is the space of the planet shared by everyone. During the game, this space will grow and shrink. The players must remain in the string at all times. If a student steps out of the string, he/she may return to the planet (the inside of the string) if he/she correctly responds to the next action card.

Take a card from the container and read it to the players out loud. The players must pay attention and consider whether the action has a positive or negative impact on the environment. They must say out loud what they think, and based on their answer, the supervisor will shrink (negative action) or expand (positive action) the space represented by the string (by moving the string).

(For example, the card "You save water (Positive)" means that the group will have a little more space, because this action shows awareness of the planet, but the card "You go to the McDonald's in Chitré to eat hamburgers (Negative)" means that the group will be in a smaller space, because this action is negative for the planet).

To emphasize this point (and, for example, at the end of the game), read the various "negative cards" one after the other until the players become uncomfortable in the available space. The string will become smaller and smaller, and they will not have much room to stand. While these cards are being read, you can also discuss the solutions we have to act in a way more respectful of our environment and planet.

Ask the players to give their own examples of ways to reduce greenhouse gas emissions. For example, riding a bicycle to school, eating local vegetables, or drinking tap water instead of buying bottled water.

TO WIN THE GAME

Understand our impact on the planet: every one of our actions counts and has repercussions. Understand their relationship to climate change.

REFLECTION

Some ways to act in a more environmentally and ecologically conscious way:

- Food with less meat and more vegetables
- Fresh, local food: seasonal produce
- Drive less: choose vehicles like bicycles or public transportation. For every liter of fuel consumed by your car's motor, about a pound of CO₂ is released.
- Use fewer electronic appliances: play outside more, watch less TV, and use your cellphone less. Read more or play outside with friends, for instance.
- Keep appliances turned off when not in use: by just turning off the TV when not in use, you avoid emitting CO₂ into the atmosphere. Don't leave things in standby (with indicator lights on; disconnect the cables). Don't leave your cell phone charger connected: even when you're not charging your phone, the charger continues to use electricity.
- Buy clothing and other goods secondhand.
- Separate organic waste and compost it.
- Plant a tree.
- Save water.
- Adjust the air conditioning (not so cold).
- Change light bulbs: replace traditional bulbs with bulbs that consume less energy to reduce CO₂ emissions.
- Insulate your house: Insulate your own home. When your house is properly insulated, you can ensure that the heat stays in or out, depending on the season.

Source:

<http://www.miambiente.gob.pa/index.php/es/consejos-para-contribuir-a-mitigar-el-cambio-climatico-en-panama>

Questions to think about afterwards:

- What impact does our energy use have on our environment and society?
- How are people in other parts of the world affected by the increase in energy usage and the decrease in productive lands?
- How can our decisions contribute to a cleaner and healthier environment?
- How can we reduce our impact on the planet? (Solutions that mitigate climate change...)
- Now do you realize that your actions have a real and serious impact?

Instructions for the “Balanced Farm” Game

Players:

There is no maximum number of players, but with more than 12 players, the game is less interactive.

Purpose of the game:

Learn where there are carbon emitters and sinks on a farm.

Materials:

- A canvas with a farm scene and Velcro in appropriate places for carbon emitters and sinks
- Laminated cards saying “greenhouse gases”
- 18 laminated cards with events occurring on the farm
- Laminated images with Velcro depicting the farm's carbon emitters (cows, fertilizers, pickup truck, etc.) and sinks (trees, intact soil)

Preparation:

In this game, we talked about the sources and sinks of greenhouse gases on the farm. The idea is for the children to understand which activities emit climate-change-causing gases, and which remove those gases from the atmosphere, thereby creating a different vision of an ideal farm, one that mitigates climate change.

Mental preparation:

Ask the players which activities on their community's farms they think contribute to climate change.

Ask the players which activities can trap emissions on their community's farms.

Remind the children of the definition of greenhouse gases (see Appendix B).

Game:**HOW TO PLAY**

This game is played in teams. Shuffle the cards and place them in a pile to one side of the farm canvas. The children take turns picking action cards from the pile and placing the corresponding elements and gases on the drawing the farm.

When a player draws a card that is a source of carbon emissions, he/she chooses the correct image (it will have the greenhouse gas attached with Velcro) and attaches it to the appropriate place on the farm. Then, he/she relocates the greenhouse gas card into the atmosphere.

When a player draws a card that is a carbon sink, he/she chooses the correct image from among the sinks and places it in the appropriate place on the farm. Afterwards, he/she moves a greenhouse gas card from the atmosphere to the sink. If there is no gas in the atmosphere to pair with the sink yet, discuss what this means with the children (i.e. that this farm is capturing more carbon than it is emitting, and that this is exactly what we need to reduce climate change, since this farm is capturing the greenhouse gases released by another person and that helps the planet a lot. It would be wonderful if all our farms could be like that.)

If you reach the end of the card pile and there are no greenhouse gases in the atmosphere, you have won the game because the farm captures all of the gases it emits. Even better (if there are more images of sinks than gases), it is helping to reduce the emissions of others.

Carbon emitters:

1. The farm's livestock emits a lot of methane gas (CH₄) in its farts, and that enters the atmosphere.
2. The livestock's manure emits a lot of methane gas (CH₄), which enters the atmosphere.
3. There's a lot of erosion on this farm, and there are many places without grass or plants to cover the soil, so the carbon from the soil enters the atmosphere.
4. The farmer uses many agrochemicals, and the productions of these chemicals (so-called "medicines") requires the emission of many greenhouse gases.
5. The farmer transports his livestock from one pasture to the other in a truck, using a lot of fuel and emitting carbon dioxide into the atmosphere.
6. To clean her pasture, a farmer burns the plants and stubble in it, and that emits a lot of carbon dioxide that goes from the trees and soil to the atmosphere.
7. When fertilized with chemical fertilizers, the bacteria in the soil emit a gas called nitrous oxide.

Carbon sinks:⁶

⁶ <http://www.cambioclimaticocr.com/multimedia/recursos/mod->

1. A farmer plants trees by the side of the river or gully to protect the water.
2. The farmer rotates his livestock so that the grass grows better and sinks more carbon into the soil.
3. A farmer creates live fences with trees that capture more carbon.
4. The farmer plants trees in her pastures to give shade and food to her livestock, while at the same time capturing carbon.
5. The farmer leaves part of his farm as forest that captures carbon and protects wildlife.
6. The farmer plants trees next to the river because he likes to see monkeys and other animals.
7. The farmer plants trees and bushes that provide diversified food sources for the livestock, meaning they don't emit as many gases for the food produced.
8. The farmer reduces the number of times she needs to plow the earth by planting some fruit trees that don't require yearly plowing on part of the farm.
9. The farmer decides to plant a woodlot on part of his land so that he has more wood in the future.
10. The farmer plants trees in the yard by the house to have shade in the summer.
11. The farmer adds organic fertilizer to her soil to improve it and help it capture more carbon.

TO WIN THE GAME

The team wins if there are no greenhouse gases in the atmosphere at the end of the game's rounds.

REFLECTION

Questions to think about afterwards:

- What do greenhouse gases do?
- What actions from the game's cards have you seen in your communities?
- What "sink" actions do you think would be easiest for your communities to implement?
- Why is it important to have a balanced farm, or one with more sinks than sources of greenhouse gases?

Appendix B. Definition of Greenhouse Gases (Excerpted from <http://www.cricyt.edu.ar/enciclopedia/terminos/GasesEffect.htm>)

Greenhouse gases

These are gases present in the Earth's [atmosphere](#) and which lead to the phenomenon called the [greenhouse effect](#). Their atmospheric concentration is low, but they are of fundamental importance in the warming of the air closest to the earth, keeping it in a temperature range appropriate for the existence of life on earth.

The most important greenhouse gases are: water vapor, carbon dioxide (CO₂) methane (CH₄), nitrous oxide (N₂O) chlorofluorocarbons (CFC), and ozone (O₃).

This table lists the natural phenomena and human activities that produce these gases, their concentrations, and their annual growth rates in the atmosphere.

[2/Documentos/NAMA%20Ganaderia.pdf](#)

<http://www.fundesyam.info/biblioteca.php?id=3600>

<http://www.nature.com/news/carbon-sequestration-managing-forests-in-uncertain-times-1.14687>

<https://ecosciencewire.com/2016/06/09/the-hurdles-to-carbon-farming/>

Gas	Source	Current Concentration (ppm*)	Annual Growth (%)
Water Vapor	-evaporation	variable	-
Carbon Dioxide	-burning of fossil fuels (petroleum, gas, coal) and wood -volcanic eruptions	353	0.5
Methane	-Anaerobic decomposition of vegetables in moist environments (swamps, bogs, rice paddies) -burning of biomass -release of natural gas	1.7	0.9
óxido nítrico	-agricultural practices (use of nitrogenous fertilizers) -burning of fossil fuels	0.31	0.8
chlorofluorocarb ons	-synthetic origen (aerosol propellants, refrigeration, foams)	0.00028 - 0.00048	4.0
Tropospheric ozone	-burning of fossil fuels	0.02 - 0.04	0.5 – 2.0

*ppm: parts per million (volume)

Instructions for “Two Very Different Farms” Game

Players:

Purpose of the game:

Understand the needs of a livestock farm in Azuero and, more specifically, understand how a farm with adequate forest management can help with the conservation of the planet and with ecological equilibrium. Show that good resources management on a farm is essential to adapting to climate change and extreme climatic phenomena.

Materials:

- A canvas divided in two, with a farm without trees on the left and a farm with trees on the right
- Element cards (laminated cardstock/cardboard with Velcro)

On the left:

- Deteriorating soil
- Too much trampling = soil damage
- Fires/burning
- Chemical fertilizers
- CO₂ leaving the ground and entering the atmosphere

On the right:

- Healthy grass
- Animals
- Living soil
- Worms and nutrients
- Abundant food
- CO₂ absorption (leaf with CO₂ inside)
- Decomposition of organic material

Preparation:

Place the canvas on a wall and ask the players to first observe the two farms: *what are the differences between the two farms?*

Explain that the two farms are neighbors, so they are located in the same place and have the same climate.

Place the “element” cards in a container and shuffle them. Every player removes a card from the container and shows it to his/her fellow players. The player must place his/her card on the correct side: left or right.

Mental preparation:

Does someone in your family have a farm with livestock?

Do you know what healthy soil is and that it needs protection to avoid possible harm (strong rains, droughts, storms...)?

What are the effects of climate change? (Extreme phenomena, droughts, temperature increases, rising sea levels, glacier melting.) Climate change is therefore a risk for everyone, and it’s dangerous for us, for animals, and for nature, like our production and crops.

What is adaptation? (at the level of the ecosystem, agriculture, water, coasts, health)

We must adapt to climate change: its effects cause damage and disturbances to our climate and planet.

Game:

HOW TO PLAY

- The players must observe the two farms on the canvas: list the differences between the two. The objective is to understand what trees bring to a space, whether a farm or anywhere else on the planet.

Left farm/no trees: dry, deteriorating soil, not fertile, no visible sources of water, no trees, little grass, heavy tramping from the livestock, no wild animals, no shade, the cows are thin

Right farm/with trees: live and fertile soil, green grass, food from the trees, trees, animals, moist, water-retaining soil, river, shade, diverse flora and fauna, healthy livestock

- One by one, the players will take a card from the container and place the element on the appropriate farm. They must place the card on one of the two farms and they must also explain why they placed the card on that farm.
- At the end, once all of the elements have been placed, imagine an extreme weather event occurs on both farms: strong rains and/or drought. Think about how each farm would survive the phenomenon and consider their vulnerability. The players must see and understand which farm is more vulnerable and weak (because of its management) to climatic phenomena caused by climate change.

TO WIN THE GAME

The players must have understood the crucial role of trees on a farm and how their presence improves the entire ecosystem: protected and fertile soil, diverse flora and fauna, controlled water flows, healthier and more productive livestock, more food for animals and people...

They must also understand that the effects of climate change will be more impactful on a farm without trees and that burns waste because that farm is less protected. Good farm management provides farm owners and lands less risk under climate change, as well as many other advantages: greater production (crops and livestock), fewer expenses, water year-round...

REFLECTION

What do the farmer and his/her business gain from having a sustainable, tree-filled farm?

1. Guarantees that their livestock has food year-round (in summer, too!)
2. Increases the capacity of their pastures

3. Produces more meat and milk
4. Improves soil and water quality
5. Ensures that livestock-raising continues to be a good business in the long run

Questions to think about afterwards:

- Now, how would you manage your farm if you had one?
- What does a tree do to keep the soil alive?
- Is it possible to have a farm without chemicals and burning?
- Is the farm to the right, the one with trees, better protected from the effects of climate change and extreme weather phenomena than the farm without trees?

Appendix 3: The importance of soil

Our life depends on agriculture, and agriculture depends on natural resources like soil and rain. As the global population continues growing and natural resources continue diminishing, we should learn to achieve higher production with little land to ensure that there is enough food for everyone, now and in the future, and enough forest for the other living things with whom we share the planet.

There are various ways to increase the production of any parcel of land without using chemical fertilizers and other products requiring large economic investment. These techniques (such as crop rotation, the use of green fertilizer, minimal plowing on sloped lands) increase the quantity of nutrients in the soil, conserve soil, and allow for a larger harvest. With fertile soil, we can avoid the deforestation that results when we need to deforest more land to plant crops.

Soil is a critical element of agriculture. The quantity of nutrients and water, and the soil's consistency, determine the type of plant that will grow best. When you know what the soil is made of, you can more easily determine how to maintain it in good condition or how to improve it. Soil is composed of organic material that has decomposed over time, like: leaves, branches, rocks, manure, etc. Decomposition and the soil's fertility are improved by earthworms, microorganisms, air, water, sun, and time. All of these factors contribute to fertile soil.

Soils depend on organic material to maintain balance and fertility. It is important that people understand the basic components of soil, because that's how to understand how to improve soil.

Appendix 4: What is adaptation to climate change?

Definition:

- **Adaptation to climate change:** Adjustment of human or natural systems to new or changing circumstances. Implies adjustment to the CLIMATE, regardless of whether the climate is the result of climate change, climatic variability, or exceptional events. It's of fundamental importance that countries and communities adopt practical measures to protect themselves from probable damage and disturbance.

Adaptation's principal goal is reducing vulnerability by promoting sustainable development.

For example, here we show an ecological and sustainable model of agriculture and livestock husbandry: diverse flora, more trees, no chemical products.

And how does this help us adapt to climate change?

It helps to maintain a live and protected soil, where all of an ecosystem's elements can live with the natural resources they need, and even better, and abundance of them! And protected soil has a greater capacity to withstand strong climate change. Trees also play a role in maintaining water, absorbing lots of it, which helps to avoid or considerably reduce erosion.

There are many ways to adapt to climate change:

Some of these measures are:

- Implementing “national adaptation programs”: prevention and precaution;
- The restoration of tree cover, wetlands, and meadows to avoid erosion and minimize the damage of storms and floods. This helps the population even when storms continue being normal, and also offers a refuge for wild flora and fauna, in addition to providing aesthetic and recreational benefits.

Adaptation: Ecosystem

- Reduction in the degradation of ecosystem.
- Establishment of new protected areas.
- Establishment of biological or ecological corridors.
- Programs designed to support economic alternatives to excessive wood harvesting.
- Investment in restoration or conservation of ecological infrastructure.

Adaptation: Agriculture

- Agroecological zoning.
- Introduction of high-yield crop varieties.
- Installation of irrigation systems.
- Systems for the control of disease and illness.
- Comprehensive soil management.
- Use of crop simulation models.
- Agroforestry practices.

Source:

http://www.ciifen.org/index.php?option=com_content&view=category&id=102&layout=blog&Itemid=135&lang=es

http://www.miambiente.gob.pa/images/stories/documentos_CC/Esp_Info_V.1_ENCCP_15.12.2015.pdf