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Washed Away: The Study of Natural Disasters and Weather Stations in the Central Pacific Basin of Costa Rica

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December 10, 2008

Mr. Juan Carlos Fallas, Director
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Dear Mr. Fallas and Herrera:

Enclosed is our report entitled *Washed Away: The Study of Natural Disasters and Weather Stations in the Central Pacific Basin of Costa Rica*. It was written at the Instituto Meteorológico Nacional during the period October 20 through December 10, 2008. Preliminary work was completed in Worcester, Massachusetts, prior to our arrival in San José. Copies of this report are simultaneously being submitted to Professors Vernon-Gerstenfeld and Robertson for evaluation. Upon faculty review, the original copy of this report will be catalogued in the Gordon Library at Worcester Polytechnic Institute. We appreciate the time that you have devoted to us.

Sincerely,

Angel Martinez
Matthew Moreau
Thomas Page

WASHED AWAY:

THE STUDY OF NATURAL DISASTERS
AND
WEATHER STATIONS IN THE CENTRAL PACIFIC BASIN OF COSTA RICA

By Angel Martinez, Matthew Moreau and Thomas Page

Report Submitted to:

Professors Susan Vernon-Gerstenfeld and Thomas Robertson

San José, Costa Rica

By

Angel Martinez ____________________________

Matthew Moreau ____________________________

Thomas Page ____________________________

In Cooperation With

Juan Carlos Fallas, Director
Hugo Herrera Sota, Data Manager

Instituto Meteorológico Nacional

Washed Away: The Study of Natural Disasters and Weather Stations in the Central Pacific Basin of Costa Rica

December 10, 2008

This project report is submitted in partial fulfillment of the degree requirements of Worcester Polytechnic Institute. The views and opinions expressed herein are those of the authors and do not necessarily reflect the positions or opinions of (Agency Name) or Worcester Polytechnic Institute.

This report is the product of an education program, and is intended to serve as partial documentation for the evaluation of academic achievement. The report should not be construed as a working document by the reader.

ABSTRACT

This report addresses the problems in Costa Rican communities during natural disasters and the selection of locations of new weather stations in the Central Pacific Basin. Currently, flash floods and landslides cause a devastating amount of damage, especially to communities that are not warned. Climate change is causing an increase in the number of flash floods and landslides in Costa Rica. There is a need for more weather stations in the Central Pacific Basin to help prevent damage or injury caused by these destructive events. Our goal was to investigate the problems communities face during natural disasters and to choose locations for eighteen new weather stations. This goal was accomplished through interviews and groundtruthing. After completing our objectives we, determined that a new network would, indeed, reduce the impacts of flash floods and landslides. Moreover, we found there were physical and social limitations linked to the site selection process, which we, nevertheless, completed satisfactorily. We conclude the report with a series of recommendations to the Instituto Meteorológico Nacional regarding how to further reduce the impacts of flash floods and landslides and to increase their efficiency in field work.

ACKNOWLEDGEMENTS

The success of our project depended upon the help of many individuals over the past three months. We would like to take the time to thank those individuals.

First, we would like to thank our sponsors, Juan Carlos Fallas and Hugo Herrera, for providing us the opportunity to complete this project for the IMN. We would also like to thank the IMN employees for their guidance and companionship throughout the project. Their friendly attitude created an extremely fun and comfortable working atmosphere. We would like to specially thank Maynor Alfaro, Luis Zumbado, and Julio Sandoval for traveling with us for two weeks to the eighteen locations and also providing useful information and opinions over the past seven weeks. We would also like to thank Sheilly Vallejos for her time and generosity in providing us with information necessary to complete our project.

Special thanks should be given to the community members of the seventeen locations who were willing to place a weather station on their property. Also, we would like to thank those individuals for their time during personal interviews. Thanks is not only due to IMN employees and community members for helping us in our studies, but also for introducing us to the great opportunities that the Costa Rica culture has to offer.

Lastly, we would like to thank our Worcester Polytechnic Institute advisors: Professor Susan Vernon-Gerstenfeld, Professor Tom Robertson, and Professor Isa Baron. Their guidance throughout the past three months has helped improve our project immensely. Their generosity has made the Costa Rica experience more enjoyable.

EXECUTIVE SUMMARY

With a changing global climate, Costa Rica has seen an increase in severe weather. The country's two varying air masses: the Caribbean and the Pacific, clash in the mountainous terrain and dump large amounts of rainfall throughout the country. These heavy rains contribute to the near yearly occurrences of flash floods and landslides in the Central Pacific Basin. As part of their Climate Change Program, The Instituto Meteorológico Nacional (IMN) wants to place a new network of automatic weather stations in the Central Pacific Basin. The goal of this project was to investigate the impacts of flash floods and landslides in Costa Rica and to select locations for weather stations in the Central Pacific Basin.

Objectives and Methodology

In order to achieve this goal, we created two objectives:

1. *Uncover problems communities face during flash floods and landslides in Costa Rica.*
2. *Find Specific locations in the Central Pacific Basin of Costa Rica best suited for weather stations.*

Through interviews with the Comisión Nacional de Emergencias (CNE) and local community members, we collected both quantitative and qualitative data and gained two different perspectives on the same problem. The CNE was able to give us both quantitative and qualitative data on how disaster situations are handled and the problems encountered during relief efforts. Interviews with locals gave us a more personal perspective of disasters and views on the IMN and the CNE.

In order to find specific locations in the Central Pacific Bain to install weather stations, we had to analyze sites before field work, establish communication between sites, and perform groundtruthing. Our pre-fieldwork tasks included studying maps to determine alternate site locations and determine the most time-efficient routes to sites. Once on location, we tested both direct and indirect radio communication between sites. After we established radio communication, we conducted groundtruthing according to World Meteorological Organization (WMO) and Environmental Protection Agency (EPA) guidelines.

Findings

We discovered that new weather stations will have a great impact on early warnings for the CNE and the Central Pacific Basin. We also found that:

1. **More real-time data from new weather stations can reduce community problems associated with flash floods and landslides in the Central Pacific Basin of Costa Rica.** After conducting interviews with members of the IMN and the CNE, they confirmed our assumptions that the new weather stations would be able to provide the necessary rainfall data to provide advanced warnings. Currently, disasters are generally reported to the CNE and IMN after they have occurred, instead of the IMN and CNE alerting communities about possible disasters. Utilizing a warning system, the CNE could mobilize its resources beforehand, which would help reduce the impacts of floods and landslides both economically and socially according to the CNE.

2. **Many communities do not handle methods of disaster relief in an effective manner, creating problem with housing during disaster relief.** Some communities do not trust the IMN and the CNE and ignore their warnings. Not only are warnings ignored, but CNE protocols are not followed as well. In the events of flash floods and landslides, the CNE recommends people seek shelter from friends and family. Unfortunately, many people are unwilling to leave their homes. Adding to the problem, we found that some local CNE committees, which are required by law, do not exist at all. When people do not leave their homes, they are often forced into shelters. In most cases, the shelters are inadequate, leading to health problems from overcrowding and unsanitary conditions.
3. **Physical limitations, such as bad roads, poor communication, dense vegetation and sloping terrain, and social limitations, such as insufficient security and an unwillingness of property owners to accept the responsibility of having a weather station, interfered with the site selection process.** We were unable to place the stations at the theoretical locations, but we suggested locations as close as possible to the theoretical sites. We determined that site-to-site communication was the biggest limitation to site selection. We also found that security played a larger role than expected. On several occasions we had to find new locations because of poor security. While we encountered only one or two limitations at most sites, we were unable to place a station in Naranjo because of a combination of all the limitations.

Recommendations

After compiling our findings, we have three recommendations for the IMN:

1. **To publicize the new network of weather stations.** By publicizing the new network of stations, the IMN can regain the trust it has lost with Costa Rican communities. The IMN needs to primarily target the high-risk areas prone to floods and landslides.
2. **To improve collaboration with the CNE.** The IMN and the CNE should collaborate more often during field work. Enhanced collaboration will not only improve communication between the CNE and local communities, but it will improve communication between the IMN and CNE as well.
3. **To better prepare before conducting field work.** The IMN can obtain current road conditions and updated road maps from the Ministerio de Obras Publicas y Transportes (MOPT) before future field work. The IMN can also call local site contacts to determine any unforeseen local problems. More resources will allow for more efficient routes that will save time and money.

CONTRIBUTIONS

All team members contributed to the project evenly in terms of researching, writing, and editing. Some group members had more skills than others in areas including Microsoft PowerPoint and Spanish interviewing. Tom was primarily responsible for making all PowerPoint presentations. During interviews, Angel, who is fluent in Spanish, was the primary speaker and translator as Matt and Tom were responsible for writing any information given by the interviewee. All group members are content with everyone’s hard work and contribution to the project.

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CHAPTER 1: INTRODUCTION

Changing global weather patterns are bringing more severe weather to Central America, specifically Costa Rica (Trenberth, 2005). Climate change has led to an increase in hurricanes and other tropical systems that create heavy rains, especially during the rainy season. From May to November, these heavy rains spark destructive situations marked by flash floods and landslides. The increase in intensity and frequency of these storms directly relates to the increase in intensity and frequency of flash floods and landslides in Costa Rica. For instance, in October 2007, a deadly landslide struck Atenas, Costa Rica, killing ten people (Reuters, 2007). As recently as October 2008, the town of Parrita and surrounding communities experienced heavy rains consequently causing severe flooding and seven deaths. Flash floods and landslides pose a clear and imminent threat to Costa Rica.

The Central Pacific Basin of Costa Rica experiences flash floods and landslides yearly. These communities are generally very poor as a result of the constant destruction. The poverty was obvious after driving through the towns. Most houses were tin shacks loosely built with any available material, and schools were shut down because of destruction from a recent flood. Ideally, communities should have advanced warnings for destructive weather phenomena in order to mobilize resources or evacuate people to mitigate effects of disasters. However, there is not enough real-time rainfall data in order to provide warnings for the communities. Furthermore, guidelines on how to handle disaster situations are not followed by some local coordinators.

The Instituto Meteorológico Nacional (IMN), Costa Rica's premier source for weather forecasting and meteorological data collection, has created the Climate Change

Program in an attempt to combat the effects of climate change, such as flash floods and landslides in the Central Pacific Basin. The Climate Change Program investigates how demographic, social, economic, and technological problems impact climate change. By using the latest technology and digital models, the future climate can be simulated in various regions with extremely high precision (Herrera & Fallas, 2008).

Our group and the IMN identified two needs in order to help the Central Pacific Basin of Costa Rica to prepare for the destructive events that climate change is bringing. First, more information on the effects flash floods and landslide have on the Central Pacific Basin was needed. According to the Commicion Nacional de Emergencias (CNE), many problems are often ignored by communities during relief efforts. Although the IMN already has weather stations in the country, many are outdated and more are needed, specifically in the Central Pacific Basin, thus leading to the second need: a new system of eighteen automatic weather stations to collect data needed for a better alert system. Without the appropriate rainfall data, the IMN cannot provide warnings to the CNE, resulting in a delayed disaster recovery process. Using the IMN's early warnings, the CNE will be able to mobilize people and resources faster in efforts to reduce the problems in communities during flash floods and landslides.

The goal of our project was to investigate how more real-time data can lessen the socio-economic impacts of flash floods and landslides and to select locations in the Central Pacific Basin of Costa Rica to install eighteen weather stations to transport data to the IMN headquarters.

We pursued two objectives to complete this goal. First, we investigated the social and economic problems of floods and landslides on the Central Pacific Basin. We conducted interviews with the IMN, the CNE and locals at the proposed weather station locations in order to gain different perspectives on the same issue. Second, we found specific locations in the Central Pacific Basin of Costa Rica best suited for weather stations. We determined if there was radio communication between selected sites and if a new repeater was necessary. We sent two teams to separate locations to test both direct and indirect radio communication. Another site was located if communication was not successful. We then performed groundtruthing to determine the best location where obstructions would not interfere with data collection in accordance with Environmental Protection Agency (EPA) and World Meteorological Organization (WMO) standards. This network will communicate the data to the IMN central headquarters where it can be analyzed to provide early warnings for high risk communities.

CHAPTER 2: BACKGROUND

The following background chapter contains information regarding three subjects: 1) Costa Rica's climate, how climate change is affecting it, and weather 2) how flash floods and landslides affect Costa Rica not only physically, but socially and economically as well, and 3) weather station limitations and capabilities, radio communications, and site selection specifications. The following information is essential to understanding the main problem; there is not enough available data in the Central Pacific basin of Costa Rica for the IMN to make strong, reliable predictions in order prevent socio-economic issues.

COSTA RICA'S CLIMATE AND ITS EFFECT ON PRECIPITATION

Understanding a country's climate is essential to weather forecasting. A recent case study of El Niño and the Costa Rican climate was conducted by Doctor Jeffrey R. Jones, who is laboratory chief at the Tropical Agronomic Center for Research and Education in Turrialba, Costa Rica. Jones and other various team members, including Eladio Zarate from the IMN, studied the impacts and responses to the 1997-1998 El Niño event. Included in the case study is a description of Costa Rica's climate.

Jones (2007) states that due to the wide range of topography, Costa Rica's weather can change at any instant, making forecasting extremely difficult. Costa Rica has two tropical climates, the Pacific and the Caribbean, both of which are separated by a volcanic mountain chain in the central part of the country. One climate that is studied is the rainy climate of the eastern Caribbean. In contrast, he characterizes the Northern Pacific climate as having a period of heavy monsoons followed by several months of drought. He also claims that another aspect of Costa Rica's climate that makes it so difficult to forecast is the interaction between ocean and land. Since Costa Rica is bordered by two different oceans, the Pacific and Atlantic, air masses from each tend to clash, causing pressure drops, resulting in a disturbance in the atmosphere. Consequently, this leads to heavy precipitation with intensified rates in the mountains. Torrential rainfall of this magnitude often leads to destructive consequences, such as flash floods and landslides. Jones argues that with increasing evidence for global warming, there are increased chances of destructive weather events that will impact Costa Rica's sensitive climate.

WARMING OF THE CARRIBEAN WATERS AND HURRICANES

With increasing evidence, climate change and global warming are affecting many locations worldwide with alarming consequences. Along with rising temperatures, the increasing number of hurricanes in the Atlantic Ocean is a major impact of climate change (Trenberth, 2005). Hugo Herrera, data acquisitioner for the IMN, states that although hurricanes in the Atlantic Ocean often do not affect Costa Rica directly, there are indirect consequences of tropical systems that pass nearby (personal communication November 10, 2008). Even when a tropical system passes near Cuba, which is approximately nine hundred miles away, it creates instability in Costa Rica's weather pattern, stated Herrera, resulting in increasing chances of heavy precipitation. Many scientists argue that rising ocean temperatures, caused by global warming, directly affects the number of hurricanes that are generated each year (Trenberth, 2005).

Since hurricanes influence Costa Rica's climate, it is important to discuss how global warming increases the number of hurricanes. Kevin Trenberth (2005), who is the head of the Climate Analysis Section at the National Center for Atmospheric Research of the United States, argues that rising sea surface temperatures (SSTs) affect the number of hurricanes each year. Hurricane activity is usually generated in oceans where the SSTs surpass twenty-six degrees Celsius, or about seventy-nine degrees Fahrenheit. Over the past thirty years, there has been a significant upward trend of SSTs in the North Atlantic, shown in Figure 1.

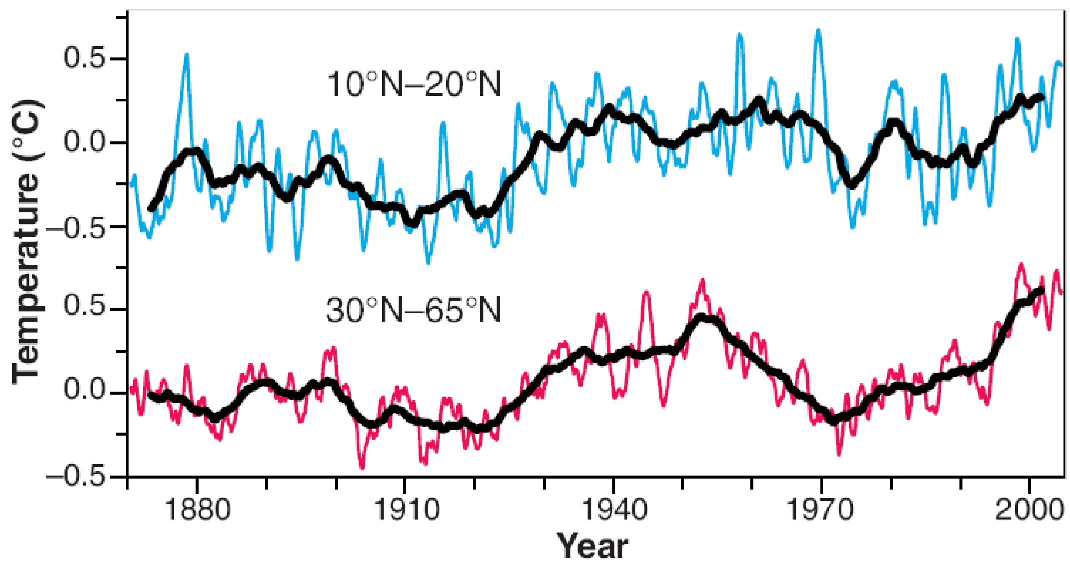

FIGURE 1: ANNUAL MEAN SST ANAMOLIES IN THE NORTH ATLANTIC OCEAN Anomalies from 1880 to 2004 (Trenberth ,2005)

In addition, over the past ten years, there has been a significant increase of hurricanes in the tropical North Atlantic. Trenberth argues that there is a direct relationship between increasing SSTs and increasing hurricane frequency. Figure 2 represents the increasing hurricane activity in the North Atlantic over the past ten years. He also states that there is no way of predicting the number or tracks of hurricanes each year, but there is evidence that hurricanes are changing for the worse. Increased hurricanes in the North Atlantic not only affect the area in which they strike, but they can affect weather patterns and areas indirectly, as observed in Costa Rica.

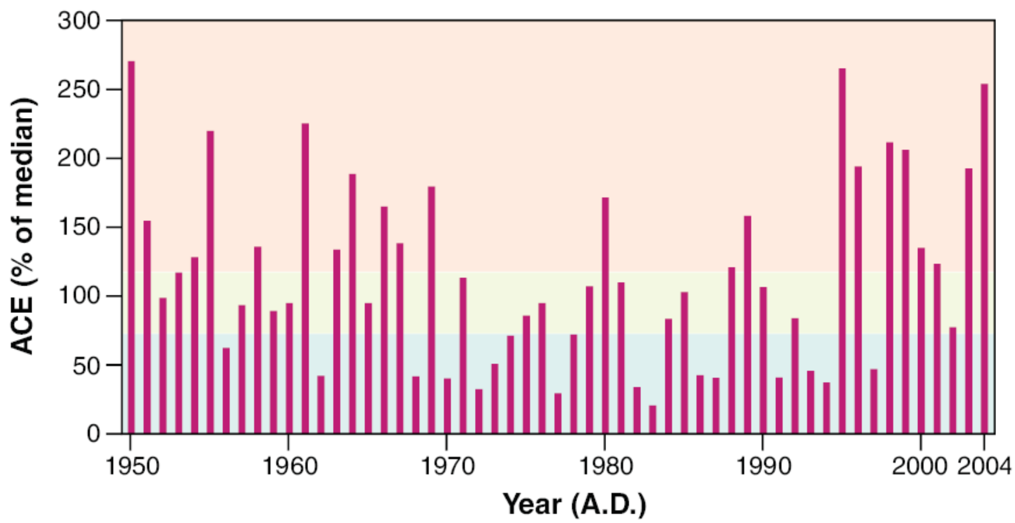

FIGURE 2: HURRICANE: ACE vs. YEAR

The median percentage of hurricanes from 1950 to 2004 against the average number of hurricanes that occurred during that period. ACE, Algebraic multigrid Computation of Eigenvectors, refers to the percent of the median. From 1995 to 2004 there is a jump in the ACE, meaning more hurricanes. (Trenberth, 2005).

Pounds, Fogden, and Campbell (1999), who work at the Monteverde Cloud Forest Preserve and Tropical Science Center in Costa Rica, examined how climate change affects the biological development on Costa Rica's Monteverde. Included in their study is how rising SSTs have altered the climates in mountainous areas of Costa Rica. Pounds et al. (1999) state that atmospheric warming has accelerated due to an increasing amount of evaporation from the warming SSTs, which causes an enhanced amount of water vapor. Due to the increased water vapor levels, the decline in temperature with increasing elevation has simply disappeared, thus creating an amplified warming trend for mountains. Increased temperatures and enhanced water vapor creates an ideal atmosphere for heavy precipitation, especially at greater altitudes where low pressure air cannot hold as much water as higher pressure air (Pounds et al., 1999). Ultimately, global warming greatly affects Costa Rica climate. Intense rainfall combined with complex terrain make Costa Rica extremely vulnerable to flash floods and landslides.

THE IMN'S CLIMATE CHANGE PROGRAM

In 2007, to counteract climate change, the IMN developed the Climate Change Program. The IMN states, "Global warming and the impacts of climate change are imminent." This program was developed to help lessen the impacts of climate change throughout Costa Rica. In order to help mitigate the impacts on Costa Rica, the IMN has theorized climatological models that extend up to one hundred years and focus on various regions of Costa Rica. With these models, national action can be taken to help lessen the socio-economic impacts of climate change. A new network of weather stations will not only help reduce the effects of flash floods and landslides, but it will also aid the IMN in climatological forecasts, which will be extremely important to national decisions in the years to come (http://cglobal.imn.ac.cr/english.html).

COSTA RICA'S COMPLEX TERRAIN, FLASH FLOODS, AND LANDSLIDES

The term "flash flood" indicates a rapid effect of a flooding event, often leading to an increase in water level in a matter of minutes or hours. The major problem of flash floods is the extremely short amount of time it leaves for a warning. Flash floods typically occur from extreme rainfall rates in thunderstorms or a band of tropical showers. There are three ingredients for a flash flood to occur: a large supply of water vapor, a mechanism for uplift in air, and a mechanism that causes precipitation to fall repeatedly in one area (National Research Council, 2005).

The contrasting topography of Costa Rica's Central Pacific basin creates difficulties for local meteorologists. As intense precipitation falls in mountainous areas, gravity pulls the excess runoff to lower elevations and thereby creating water buildup. In an extreme case, water can rise so fast that a flash flood can occur, resulting in injury and damage. A recent case study conducted by the National Research Council shows the effects of complex terrain and flood forecasting at Sulphur Mountain in Southern California. The National Research Council (2007) argues that complex terrain provides another challenge for forecasting flash floods because storm systems often react differently to the topographical barriers. At Sulphur Mountain, the Pacific Ocean creates a large supply of water vapor. Contrasting air masses between land and ocean causes uplift in the air, and the mountain's elevation often creates even more uplift and repeated precipitation over one area. The basis of the study was to improve flash flood forecasting in California by placing NEXRAD (Next Generation Radar) in the most favorable location. Costa Rica's mountains and extreme weather patterns are very similar to those in California. Both have an ocean air mass colliding with a land air mass and contain mountain ranges that are rather close to their respective coastlines.

Although the primary concern for flash floods is water damage, a secondary problem is landslides. Landslides only occur as a result of sudden environmental changes in the land. The USGS (United States Geological Survey) indicates that there are several factors that initiate a landslide. The four major factors include erosion from rivers or oceans, moisture content of the soil, the terrain, and human overdevelopment. Human overdevelopment in Costa Rica includes deforestation and farming. Cultivating coffee and bananas is an integral part of Costa Rica’s economy (Rachowiecki, 2002). Fragmentation from deforestation leads to an increased risk of landslides because trees that once held soil together are removed. When mountainous terrain, heavy rainfall, and human overdevelopment are combined, there is a great risk of a destructive, life changing event occurring (USGS, 2008). The combination of flash floods and landslides create a serious threat to Costa Rican communities and enhances the need for a strong, reliable alert system.

SOCIO-ECONOMIC IMPACTS OF NATURAL DISASTERS IN COSTA RICA

Landslides and floods not only affect the physical landscape, but also impact the socio-economic aspects of the surrounding communities and Costa Rica as a whole. These two weather-related phenomena can cause economic losses that are direct and indirect. Direct losses involve the costs to build, repair, or replace anything that was damaged in an event. Indirect costs represent the decrease in real estate value of homes in vulnerable areas and the funds that are allocated to help prevent further damages to areas. Private costs are also allocated to replace and repair people’s homes, livestock, crops, and businesses where devastation hit. The largest public costs are the repairs that need to be administered to the roads that are destroyed (USGS, 2001). Without adequate roads, entire sectors of the country can lose communication and accessibility from the rest of the country (J. Fallas, personal communication November 10, 2008). As a result of climate change, natural disasters are becoming more prevalent in Costa Rica, therefore putting a larger burden on the governmental associations that respond to landslides and flash floods.

CNE AND NATURAL DISASTERS IN COSTA RICA

In order to investigate the impacts flash floods and landslides have on communities, qualitative and quantitative data must be gathered on past events. The Comisión Nacional de Emergencias (CNE) is responsible for coordinating preventive measures against imminent dangers as well as mitigating and responding to emergency situations. The CNE has various types of data on floods, landslides, and other weather phenomena that impact Costa Rica. The CNE's Centro de Documentación (CEDO) division compiles information on all events that have major socio-economic effects on Costa Rica. This information can indicate whether having an early warning helps lessen the effects a flash flood or landslide can have on an area.

The new network of stations will allow the IMN the opportunity to obtain more data on the Central Pacific region in order to release the quickest and most accurate warning to the CNE in hopes to manage flash floods and landslides more effectively. The current infrastructure of the CNE is comprised of many committees at different levels in society. The system begins with the CNE headquarters which then branches to regional, municipality, and local committees. This system allows information to flow in either direction without major difficulty. Sheilly Vallejos, an employee of the CNE, has stated that this system was the reason why Costa Rica was able to avoid devastating losses during Hurricane Mitch (S. Vallejos, personal communication November, 11 2008). These committees are mandatory according to a law located in Chapter 2 article 9 of the

National Law of Emergency and Risk Prevention that requires all communities to have a committee to manage any hazardous event.

This system operates under two different situations. The first occurs when the IMN releases a warning to the CNE, and the CNE advises the appropriate branches of the committees to prepare and try to prevent any large losses due to a natural disaster. The second happens when an event takes place, and the communal committee contacts higher committees about the disaster until the information reaches the CNE. Appropriate action is then taken in order to manage the damage and attempt to rescue and sustain all affected people in the disaster. The ideal case is the first scenario, in which the CNE is given enough time to prepare provisions for each community. According to Vallejos, every community has a building that houses some supplies to aid in the event of a disaster, but not enough in the case of large losses. The CNE has knowledge of the supplies a community has and what will be needed in a disaster. Prevention and preparation are the most important actions that allow the CNE to deal effectively with a disaster.

WEATHER STATION CAPABILITIES AND LIMITATIONS

Weather stations are composed of different devices and instruments that observe or record meteorological variables. Single weather stations record data at a particular location in routine intervals. A network of stations can provide more general information on a larger area using real-time communication that can be used by meteorologists in tasks such as weather monitoring, forecasting, creating local warnings, and climatic modeling (Campbell Scientific, Inc., 2007). Weather networks have more applications other than strictly meteorological processes. The networks can involve anything from agriculture, utilities, energy, and wind power (Campbell Scientific, Inc., 2007).

Weather stations can be classified into either a full or partial station. The difference between a partial and a full station is that a full station measures or monitors many meteorological variables, while a partial station only measures or monitors a limited number of variables (Ashraf, Loftis & Hubbard, 1997). For certain applications a full station may be impractical if only a few variables are needed to be observed or recorded. A partial station is a cost-effective way of obtaining pertinent information without using excess equipment. The use of one over the other depends on the purpose, function, or application of the station. For the applications in Costa Rica, the IMN is considering partial weather stations that measure only a few variables, such as wind and precipitation. However, depending upon our recommendations, the IMN may contemplate installing either a full weather station or a new headquarters in an appropriate location (H. Herrera, personal communication September 30, 2008).

Weather stations have advantages and disadvantages. The stations are physically located in desired areas and collect raw data that is then relayed to a central location via a communication network. The station can house multiple sensors to measure different variables at the same time. The pitfalls of a weather station are that it is vulnerable to meteorological phenomenon that may damage or destroy the station and that they have to be regularly serviced in order to function properly. A small network of stations may result in gaps of data for certain areas, which require meteorologists to predict what is occurring in between stations. All of these factors require attention in order to create an effective weather station network.

RADIO COMMUNICATIONS THROUGH COMPLEX TERRAIN

The weather stations must communicate effectively in order to design a reliable weather station network. Only with reliable, real-time communication can forecasters issue warnings for severe weather. There are many different systems of transferring data from one location to another, including radio, internet, or satellite. Although these other forms of communication are used throughout the world, the IMN requested the use of a radio repeater-to-internet network, because it is best for Costa Rica's current infrastructure and complex terrain. A radio communication network used in the state of Washington demonstrates how a radio can be used in complex terrain.

Transmitting data through radio communications is widely done in the United States and in Costa Rica. Radio communications allow each individual station to emit its data through particular radio frequencies. The radio waves can only travel to areas with a line of sight, and have a maximum range of approximately twenty-five miles. To counter this limitation, the radio transmissions first travel to a radio repeater. The repeater relays the signal to another repeater until they are received at a centralized location (N. Belk, personal communication September 24, 2008). This system of radio transmitters and repeaters allows data to be transferred virtually anytime the user desires. One negative aspect of using repeaters is that if there are multiple stations transmitting data through one repeater, if that repeater fails, no data can be transmitted until the repeater is fixed. The IMN has stated that if repeaters are needed, they would be able to install them. However, many Campbell weather stations can double as radio repeaters; therefore, lessening the need for installing individual ones (H. Herrera, personal communication September 30, 2008).

Francis J. Pierce and Todd Elliott (2008) created and analyzed such a radio repeater network in Washington State with great success. Washington State, like Costa Rica, has an ocean coastline and mountainous terrain. They placed weather stations on farms throughout the state and linked them using a network of transmitters and repeaters to a main database. The farms were located in areas from the coastline to the mountains. From the main database, the information was sent via internet to where the data was analyzed. This system will be applied to Costa Rica where stations can transmit their data to repeaters, eventually transmitting the information to databases connected to the internet. The IMN's willingness to install repeaters makes this option very appealing. From the internet terminals, the data would travel to the IMN. The network could have up to 60,000 individual weather stations. However, the rate of data transfer from the stations, every fifteen minutes, would limit the number of individual stations to 300, which is more than the IMN's request of eighteen. The fifteen minute transfer rate is very close to real time, and according to the NWS, would be sufficient for real time data analysis (N. Belk, personal communication September 24, 2008).

The AWN200 data logger used for Pierce and Elliot's stations were optimized to use the least amount of power necessary. The data loggers would go into a sleep mode between transmissions to save energy for the spike in power consumption during the time the signal was being sent. Using this method, the weather stations require the least amount battery and solar panel accessories to operate. In turn, costs are lowered and efficiency increased. This system allows for a large number of stations in remote locations to be set up and linked together to send information through one continuous network. The ability of the radio frequencies to be converted to an internet signal would reduce the need for repeaters over large distances and varying terrain. These functions, especially the capability to be set up in remote locations with no direct power source, make the system Pierce and Elliot created an ideal system for Costa Rica because of the country's varying terrain and remote locations.

THE IMPORTANCE OF CORRECTLY PLACING WEATHER STATIONS

The location of a weather station is an important variable that governs the effectiveness and overall reliability of the station. A correctly placed station will gather accurate, reliable data and will relay the information in a desired time frame with no difficulties. The station needs to have a sufficient power source to function and be easily accessible by maintenance personnel. A poorly placed station will not be able to perform its required functions and can cause problems for the meteorologists attempting to interpret the data and make forecasts.

The stations used in the project are made by Campbell Scientific. Campbell Scientific has standards for placing their weather stations based on Environmental Protection Agency (EPA) and World Meteorological Organization (WMO) standards, which can be found in Appendices D and E. These standards may not be followed when dealing with complex terrain.

Not taking the time to place a station in the right location can be disastrous. A study done in Colorado illustrates how sited meteorological equipment that does not follow WMO standards can poorly illustrate regional temperature readings. The study assessed the Cooperative Observer Program (COOP), which is run by the NWS and relies on civilians to install meteorological equipment in their neighborhoods to aid in meteorological data collection (NOAA, Cooperative Observer Program, paragraph 1).

A specific sensor, the Maximum Minimum Temperature Sensor (MMTS), was targeted in the study, which revealed that only a small minority of the devices met the standards described by the WMO. The majority of the sites were situated in areas that had many obstructions and various devices, such as air conditioning units, that skewed temperature readings (Davey and Pelke, 2004). The units were in locations that did not reflect the majority of the environment around them, making the data irrelevant for that region. All the factors presented in the study demonstrate how the functions of a station, in this case a temperature sensor, can suffer due to poor planning.

The overall placement of the stations is vital to predict flash floods by ensuring that the station generates accurate reliable data. The planning of the location must incorporate all standards that the manufacturer specifies. If the station is placed without following proper guidelines and standards, then the overall effectiveness of the station will suffer. The placement of the stations dictates the effectiveness and accessibility of a station.

CHAPTER 3: METHODOLOGY

The overall goal of our project was to investigate how more real-time data can lessen the socio-economic problems of flash floods and landslides and to select locations in the Central Pacific Basin of Costa Rica to install eighteen new automatic weather stations to transport data in real-time to the IMN headquarters. We developed the following objectives to achieve this goals:

1. Uncover problems communities face during flash floods and landslides in Costa Rica.
2. Find specific locations in the Central Pacific Basin of Costa Rica best suited for weather stations.

In order to achieve maximum efficiency, we divided the site selection process into three different trips. From November 3rd to November 7th, we traveled to six points in the Quepos area. On November 13th, we organized a day trip to visit three points southwest of San José. We concluded site selection by visiting the final nine points surrounding the San Marcos area during the week of November 17th. We visited a total of eighteen points.

OBJECTIVE 1: UNCOVER PROBLEMS COMMUNITIES FACE DURING FLASH FLOODS AND LANDSLIDES IN COSTA RICA

In order to investigate the problems communities face during flash floods and landslides, we conducted interviews with experts and locals to obtain qualitative information. In addition, we utilized case studies from past natural disasters in the Central Pacific Basin to retrieve quantitative information.

We interviewed Shelly Vallejos, an employee of the Comisión Nacional de Emergencias (CNE), and an expert on social implications of disasters in Costa Rica. The interview consisted of questions pertaining to the IMN, communities, and problems with disaster relief. The interview questions with Vallejos are located in Appendix C. Additionally, we interviewed community members regarding the problems communities face during disaster relief. The interview questions with community members are located in Appendix B.

Furthermore, and equally as important as the qualitative information, was quantitative information. To access this data, we analyzed case studies that focused on the costs of disaster relief. We concentrated our studies on the Quepos-Parrita area over the last ten years. By analyzing such case studies, we could determine how more weather stations will help decrease the number of community members affected during natural disasters.

OBJECTIVE 2: FIND SPECIFIC LOCATIONS IN THE CENTRAL PACIFIC BASIN OF COSTA RICA BEST SUITED FOR WEATHER STATIONS

We divided this objective into three different tasks:

Analyzing sites before fieldwork. By studying maps, we became familiar with the areas we visited. We used ArcGIS, a geographical information system used for spatial analysis, mapping, and data management, and GoogleEarth. These resources allowed us to brainstorm alternative locations if the theoretical locations, selected by Juan Carlos Fallas and Hugo Herrera, could not be reached. While brainstorming, the proximity of our alternative locations to the theoretical sites was our primary concern. In addition, we analyzed the maps to choose the most efficient routes that would save time and money.

Establishing communication. We split our team into two groups and travelled to two different sites. Each group was equipped with radios that could communicate directly and indirectly. When testing direct communication, a radio sent a signal directly to the other radio. The radio had a range of five kilometers and needed a direct line of sight between the two radios to transmit effectively. When testing indirect communication, the radio sent a signal with a range of twenty kilometers to a radio repeater on El Cerro de la Muerte in the Talamanca Mountain Range. The repeater then amplified and sent the signal to the other radio. This process was repeated for every series of two sites.

Performing groundtruthing. After verifying successful radio communication, we conducted groundtruthing and collected metadata information. Groundtruthing and metadata collection consisted of recording various measurements and obtaining information necessary to our group and the IMN for a thorough description of the site. Metadata sheets, located in Appendix F, are essential to any site because they include information needed for complete site description. Information located in the metadata sheets includes GPS coordinates, personal contact information, and a physical description of the site. We used a Garmin GPS device to measure coordinates and elevations of the site and cameras to capture the surrounding geography in a 360 degree view. We placed particular focus on surface vegetation, slope of the land, overhead obstructions, such as trees and buildings, and any other unforeseen geographical phenomena particular to that site.

CHAPTER 4: RESULTS AND ANALYSIS

Our fieldwork and interviews led to discoveries regarding how new weather stations will aid the IMN and Comisión Nacional de Emergencias (CNE) in providing warnings to communities, the problems communities encounter during flash floods and landslides, and the obstructions to weather station site selection.

FINDING 1:

More real-time data from new weather stations can reduce community problems associated with flash floods and landslides in the Central Pacific Basin of Costa Rica.

Insufficient precipitation data results in too few and inaccurate alerts for flash floods and landslides. Often, the IMN and CNE are informed by communities of disasters after they occur, instead of predicting when and where they will strike. This ineffective warning system does not provide the CNE and communities with sufficient time to prepare for flash floods and landslides, leading to injury, death, and destruction.

The information provided to the IMN by the new weather stations will reduce these problems by allowing for earlier and more accurate alerts to the CNE and local communities. Sheilly Vallejos, an employee of the Centro de Documentación (CEDO) branch of the CNE, confirmed our assumptions that an earlier warning time would allow the CNE to mobilize its people and resources in order to reach the affected areas faster. Not only would an early warning system be beneficial to the CNE, but Bernando Barrantes Mora, a community member of Savegre Abajo, stated that it would give local communities time to prepare themselves and evacuate.

FINDING 2:

Many communities do not handle methods of disaster relief in an effective manner, creating problems with housing during relief efforts.

Because of the community members' mistrust and an ignorance of the CNE protocol, problems arise during flash floods and landslides: inadequate communal shelters, poor nutrition among the displaced population, and psychological problems. These issues are not prioritized highly by the Costa Rican government and are therefore not addressed adequately.

Community Mistrust Towards the IMN. Some communities are skeptical and mistrust the IMN's forecasts. This mistrust developed from inaccuracies and unreliability of the IMN in the past. Often, community members do not pay attention to forecasts and only respond to alerts when conditions become critical. Mistrust has reached such a high level that some Costa Ricans trust the United States National Weather Service more than the IMN (M. Jimenez, personal communication November 24, 2008). In contrast, Jorge Brennes Vargas, the head of Parrita's CNE communal committee, said that the community has full confidence in the IMN and CNE (J. Brennes, personal communication November 24, 2008. The new network of weather stations will help rebuild trust between the IMN, CNE, and the community members.

Ignoring the CNE Protocol. In times of crisis, CNE protocols suggest that people seek shelter from their friends and family. Friends and family provide emotional support and can also tailor care to individual needs. However, the CNE has difficulties evacuating victims because of an unwillingness to leave their own homes.

The unwillingness of individuals to leave their property develops from an attachment to their limited possessions, including their homes. Many of the disaster prone regions of Costa Rica, especially the Central Pacific Basin, are very poor. Because the families have so little, they are reluctant to leave behind what they do own. The fear of theft is a major factor in choosing to stay. The poor do not have enough money to insure their homes or relocate, so they are stuck reliving the same disasters every year. The people are urged to leave their homes and told to go elsewhere, but according to Maritza Jimenez Navarro, some people do not have family to rely on. Instead, CNE personnel attempt to organize the community and gather them into one location for shelter. However, we found some communities do not even have a CNE committee, even though one is required by law (C. Solis, personal communication November 24, 2008).

Inadequate Shelters. Communal buildings, such as schools and churches, are often used for shelter after a disaster. However, many of the schools and churches are vastly inadequate to serve as disaster shelters. They are used only because they can hold the largest number of people. The shelters were not designed to house people, resulting in over-taxed facilities during natural disasters. The lack of sufficient bathrooms and space can have negative impacts on the victims' physical and mental health. After the disaster has subsided, the shelters are left deteriorated and are not restored to their previous condition.

The inadequate facilities of disaster shelters can create both health and psychological problems. Overused bathrooms can cause unsanitary conditions and problems for the property owner. In addition, limited to no shower facilities and close quarters can cause widespread sickness.

Close quarters also create psychological problems. The cramped living conditions create privacy issues, which can cause conflict between victims. Animosity from everyday life in the same communities can come to a head when living together, especially with increased stress levels. Sharing living arrangements in a moment of a crisis can spike emotions that could have an impact on a person's mental health. Many times, psychological help is not offered, only increasing the feeling of despair and sadness. The physical living conditions alone do not account for the entirety of the problem with large shelters.

The cost of housing the victims and providing food becomes the responsibility of the Costa Rican government. Disasters can affect thousands of people and can cost the country up to one billion colones, or approximately $1.82 million (CNE, 2007). The housing the CNE provides is temporary, and is only intended to be used to help a person until the disaster is over and the affected area is stabilized. If the people have time to evacuate, the burden of paying for shelters would be lessened.

FINDING 3

Physical limitations, such as bad roads, poor communication, dense vegetation and sloping terrain, and social limitations, such as insufficient security and an unwillingness of property owners to accept the responsibility of having a weather station, interfered with the site selection process.

We could not place weather stations at any of the exact proposed locations because of physical and social limitations, including:

Poor Roads. A major problem we encountered while groundtruthing was the Costa Rican road system. Often, a theoretical point contained a minimal number of roads. The difference between the roads on the maps studied and the roads we encountered posed a problem for us during our field work. On several occasions, we relied on local knowledge for directions to certain locations because of the discrepancy with the maps. We experienced this problem at all locations, but it was most prevalent at El Caite. When looking at maps at the IMN, we determined that the theoretical point picked by Fallas and Herrera for El Caite was not feasible. The point was located in an extremely mountainous region with limited roads and houses. We found that because the roads in reality did not match the roads depicted by the map, we could not travel to our proposed location.

The road conditions presented us with another problem. Most roads were either dirt or gravel in the mountainous areas, which made for an extremely slow and bumpy ride. Costa Rica's rainy climate combined with its dirt roads can lead to dangerous conditions. Heavy rains can completely alter the roadway, making it impassible. Additionally, evidence of past landslides was clearly visible on all of the roads we traveled. At El Silencio, which is located to the northwest of Quepos, we had to cross a river to get to the other side of the road. There had been so much rain that a river expanded making it close to impassible, as shown in Figure 3.

FIGURE 3: ROAD IN EL SILENCIO
Road covered in water. (El Silencio, November, 2008)

Two workers from the Ministerio de Obras Publicas y Transportes (MOPT), were working vigorously to extend the road on the right side. After speaking with the workers, we were informed that if it started to rain, and we crossed to the other side, we would be stuck until the level of the river dropped. Although this section of the roadway posed accessibility problems on the return trip, we felt it was worth the risk to cross in order to collect critical information on the area. This scenario depicts how fast the roadways can be altered due to heavy rain.

The cost of repairing and fixing the roads in Costa Rica may be overwhelming, but is a necessary public works project because it reestablishes communication and contact to other regions of the country. The Costa Rican government invests approximately seventeen million colones for the sole purpose of helping to repair and mitigate the effects of floods and landslides (CNE 2008). These investments usually involve repairing and upgrading roads that are either damaged or obsolete. The roads demand constant cleaning and clearing of debris, which requires heavy machinery and many laborers to accomplish the task. Many roads can be affected in one meteorological event. For instance, during the week of October 12, 2008 in Parrita, a flash flood cost Costa Rica 226,580,000 colones in sixteen different road repairs.

Ineffective Communication. We found that the ability to communicate with the other stations was the driving force in the site selection process. Luis Fernando Zumbado, a radio communications expert for the IMN, stated that if the stations cannot effectively communicate with the IMN, data will be lost, ultimately rendering the weather stations useless. We were not able to communicate via radio with each other effectively at every site, forcing us to find new locations that not only met the site selection criteria as described in Appendix E, but more importantly, allowed for effective radio communication. We tested direct and indirect communications at all sites. We found that the radios at every site needed to communicate with the repeater located on El Cerro de la Muerte, resulting in indirect communication between all of the stations.

Dense Vegetation and Slopping Terrain. After finding the exact points given to us by the IMN, or at least getting as close as we could without having to leave the road, we found that there were no theoretical sites acceptable to place a weather station. Generally, the sites contained too much vegetation, which did not meet our placement criteria. The trees and surrounding buildings created obstructions to collecting accurate measurements. We traveled around the general area until an acceptable site was found that had enough open space for the stations. We found that schools and houses were the best locations to place the weather stations because of open space and a limited number of obstructions.

For example, in Damas, the given point was in the middle of a palm tree farm. There were no locations within the farm that met our criteria for open space. We found an alternate location that was best suited to sustain a weather station at the Damas School. However, the location at the Damas School was not perfect. Although the obstructions present could cause inaccurate data collection, we felt raising the height of the tipping bucket would minimize the inaccuracies. After searching for alternative spots, we feel confident that the sites chosen are in the best possible locations for collecting precipitation data. Figure 4 shows our placement of the new network of weather stations. Table 1 shows the distances from our recommended sites to the IMN's theoretical sites. We found that our sites have an excellent average of only 1.02 miles from the theoretical sites.

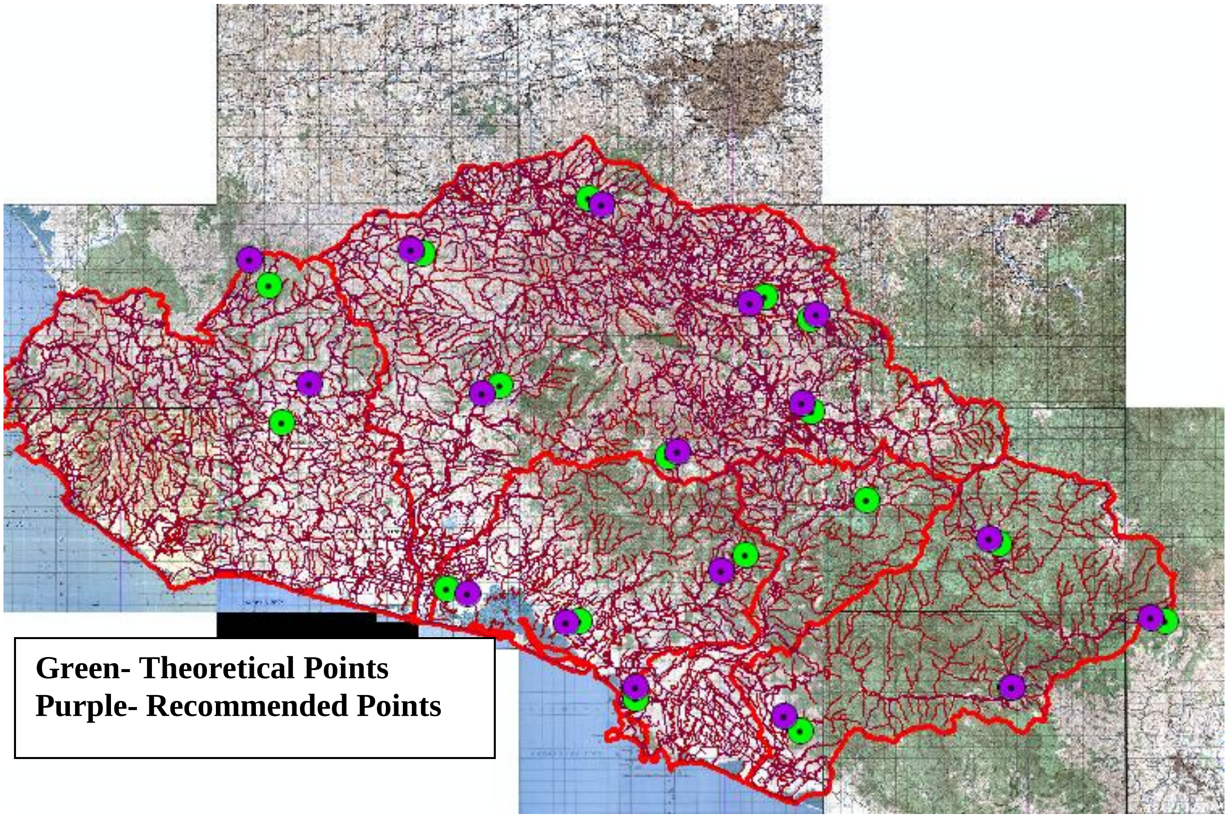

FIGURE 4: THEORETICAL POINTS AND RECOMMENDED POINTS
arcGIS map of the central pacific basin in Costa Rica. (arcGIS, 2008)

TABLE 1: DISTANCES FROM THEORETICAL POINTS TO RECOMMENDED POINTS

Station Name	Approx. Distance (miles)	Approx. Distance (km.)
Albergue-Silencio	1.25	2.01
Candelarita	0.68	1.09
Caspirola	1.16	1.87
Damas	0.85	1.37
Frailes	0.93	1.49
Granja Carmelita	0.86	1.39
La Gloria	2.66	4.28
La Lucha	0.56	0.90
Lanas-Cerro	1.72	2.77
Palmichal	0.85	1.37
Parrita	1.19	1.92
Providencia	0.65	1.05
Quepos	0.59	0.95
Rodeo/San Isidro	1.76	2.83
San Jeronimo	0.65	1.05
San Marcos	0.82	1.32
Savegre Abajo	0.09	0.14
AVERAGE	1.02	1.64

Inadequate Security. During our groundtruthing, adequate security of the weather station was of much importance. In prior years, the IMN has experienced theft and vandalism at some of its other stations. Ultimately, it was a main concern to find a site where the station could be protected at all hours of the day. We found that sites on personal property or at schools provided ample protection for the stations. Many of the homes had fences surrounding them already, and the homeowners agreed to watch the stations for vandalism or theft. The schools generally had better security than the private homes. They all had fences surrounding them. During the day, teachers would be able to watch the stations, and at night, many schools had security guards.

Community Members' Unwillingness to Have a Station. Not only did security factor into our site selection process, but the willingness of the people to inherit the responsibility of having a station was considered as well. Although not as prevalent of a problem as security, an unwilling property owner or school director would completely stop the progress of our site selection process. For the most part, everyone we spoke with was very enthusiastic about having a station on their property. Only in La Gloria did we encounter resistance. A school and a home were both investigated and proved to be good sites for stations, but ironically, the home belonged to the director of the same school. Unfortunately, he did not want the responsibility of having a weather station on his property, at school or at home. We were forced to find an alternative location in La Gloria. As seen in Table 1, the situation in La Gloria caused the greatest disparity in the proposed and selected site location, highlighting the importance of willing community members.

Naranjo. Due to the physical and social limitations listed above, we found that we could not recommend an appropriate site in Naranjo. This location was intriguing because it incorporated most of the impedances we encountered in our fieldwork, whereas other locations only demonstrated one or two restricting constraints. We could not physically reach Naranjo because the road was destroyed by a landslide, as shown in Figure 5.

FIGURE 5: COLLAPSED ROAD IN NARANJO
The road collapsed due seismic activity in the area. (Naranjo, 2008)

We searched for nearby locations, and although we found sites that met our site selection criteria, the sites could not communicate, and there was no way to secure the stations. This site will need to be reassessed by the IMN in order to locate an appropriate site for the station.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

In this chapter, we summarize our key findings and provide practical recommendations for solving problems that developed during our fieldwork. In addition, we suggest areas for further research that could help the IMN become a more efficient organization. Lastly, we offer concluding statements about our project.

SUMMARY OF KEY FINDINGS:

We have discovered and analyzed how more weather stations can greatly affect local communities and the Costa Rican government by diminishing disaster relief problems and decreasing costs. Additionally, we analyzed the limitations regarding the weather station site selection process.

Weather Stations Can Reduce Disaster Relief Problems. More weather stations in the Central Pacific Basin of Costa Rica will give the IMN more data to make short-term forecasts and flash flood alerts. The new network of weather stations will allow the IMN to inform the CNE and community members that a flash flood is occurring, instead of the CNE and community members informing the IMN.

Communities Do Not Handle Disaster Relief in an Effective Manner. Due to their insufficient data and inaccurate forecasts, many communities have developed mistrust towards the IMN. An ignorance of CNE protocols regarding disaster relief formed partly due to the mistrust and the community members' unwillingness to leave their homes. When community members ignore the protocols, problems arise with shelter in communities.

The Site Selection Process had Physical and Social Limitations. Limitations interfered with our site selection process, which caused the inability to select a site for the weather station at Naranjo. Limitations for site selection included poor roads, ineffective communication, dense vegetation, sloping terrain, inadequate security, and the unwillingness of community members to have stations on their property.

RECOMMENDATION 1: PUBLICIZE THE NEW NETWORK

The issue of mistrust is a significant problem that negatively impacts the effectiveness of both the IMN and CNE. This issue should be counteracted by publicizing projects that promote advancements in forecasts and alerts in order to diminish the skepticism that exists. Publicizing the projects will give the IMN positive media exposure and will demonstrate how the organization is making efforts to improve their current meteorological systems. Remote, high risk communities should be the target audience for the IMN because they have the most to lose if forecasts and alerts are ignored. Fortunately, many interviewees were excited about the new network and early alert system, laying the foundation for new trust. Publicizing similar projects will instill enthusiasm and confidence in the communities towards the IMN, which could garner more cooperation from individuals during a disaster. We recommend that the IMN investigate the most effective medium to communicate with their target audience. With more cooperation, communities will hopefully heed the recommendations provided by the IMN and CNE.

RECOMMENDATION 2: IMPROVE COLLABORATION WITH THE CNE

We recommend that the IMN convey to the CNE the need to improve its overall communication to the high-risk areas of the Central Pacific Basin. These towns interact with the CNE only when conditions are critical, and the national committee arrives to provide relief. A more significant presence and constant communication with these regions, even in stable conditions, will give people confidence in the CNE.

In order to improve overall communication, we further recommend that the IMN encourage CNE personnel to travel with the IMN at least once every year during site maintenance. This will allow the CNE to visit and assess a town's condition, verify existing committees, and to inform community members of any updated protocols. Not only would this establish a better relationship between the CNE and the community, but it would also improve the collaboration between the IMN and CNE.

RECOMMENDATION 3: BETTER PREPARE BEFORE FUTURE FIELD WORK

Although the IMN cannot improve the Costa Rican road system, we recommend that they contact the Ministerio de Obras Publicas y Transportes (MOPT) before future field work. A phone call to the MOPT regarding road conditions would not only decrease the risk of injury to the people traveling to the sites, but would also save time and money. In addition, the IMN should contact local site contacts to determine any unforeseen local problems that could delay field work. According to the IMN director, Juan Carlos Falls, the IMN currently receives limited funding from the government. Any money saved by making the site selection process more efficient could be crucial to later projects. Several times during our groundtruthing, we were unable to proceed because of a flooded or collapsed road, causing us to retrace our path and find a new road, thus wasting time and money.

In addition to contacting the MOPT for road conditions, we recommend that the IMN acquire an updated map of Costa Rica's road system. We often found ourselves lost because the maps we used were last updated in the 1970's. Updating old maps would lessen travel time by reducing time lost and correcting inefficient routes, thus saving more time and money.

FURTHER RESEARCH

During our research and fieldwork, our group found areas that the IMN can benefit from with further investigation.

1. **Investigate the origins of mistrust between the IMN and local communities.** Without the trust of communities, the IMN's warnings and forecasts will be ignored. By studying the origins of the mistrust, the IMN can work to fix the specific problems creating the gap in trust.
2. **Investigate ways to gain funding.** As funding becomes more difficult to come by, the IMN needs a supplemental source of money. The IMN should investigate ways of increasing their funding. More money could result in projects that could further help the IMN and protect the safety of Costa Rica's citizens.

PROJECT CONCLUSION

Before completing the fieldwork for the IMN, our project goal was to simply select locations for eighteen new weather stations in the Central Pacific Basin of Costa Rica. While groundtruthing, we found that there was a whole new aspect of selecting sites for weather stations. We discovered that many communities face problems during flash floods and landslides which could be prevented. By providing a better warning system from the IMN and CNE and regaining community members' confidence in forecasts, the new network of weather stations in the Central Pacific Basin will help decrease disaster costs, and more importantly, help decrease injury and save lives.

APPENDIX A: INSTITUTO METEOROLÓGICO NACIONAL

The Instituto Meteorológico Nacional (IMN) was established in 1888 by Director Henry Pittier Dormond. Central headquarters is located in San José. Its purpose is to monitor systems of rain and temperature and study the weather of Costa Rica. The IMN's successes aided in the creation of the Ministerio de Industrias, Energías y Minas (MINEA). MINEA now governs the IMN because it is the highest branch of the government that deals with the environment and the climate of Costa Rica. The IMN has over one hundred years of experience forecasting and studying the Costa Rican climate. They publish regular statistics and studies regarding the nation's weather.

APPENDIX B: INTERVIEW QUESTIONS FOR COMMUNITY MEMBERS

Questions for people that are having stations placed on their property.

First, reintroduce ourselves; ask them if they have a minute to answer a couple of questions. Explain that they're responses could be a part of a report submitted to WPI and the IMN, ask for consent.

Do you know your communities emergency plan in case of a flood or landslide (whichever is appropriate for that area)?

Do you know who the community CNE contacts in your town, and do you know what to do in an emergency?

Do you trust the CNE and the IMN (in case they give an order, will people follow the order)? Why or why not?

What are your personal experiences, or experiences of friends and family, with floods or landslides? How have they directly or indirectly effected you?

Were you ordered to evacuate and did you follow the order? Why or why not?

If placed in a shelter, where was the shelter (church, school, etc.)? How was the food, cleanliness, privacy?

Do you have any questions for us?

APPENDIX C: INTERVIEW QUESTIONS FOR SHEILLY VALLEJOS

When a natural disaster happens, what occurs?
    Response Time?
    Economically?
    How are you alerted?

What is your communication with the IMN?

Are their case studies of any natural disasters in Costa Rica that we could use?

Where do the people go? Do they move back? Do they have insurance?

How does evacuation work?

What do you need to better the disaster recovery process?

Have there been attempts to relocate towns that are continuously hit by natural disasters?

APPENDIX D: WEATHER STATION COMPONENTS

The components that make up a weather station have a specific function and measure certain variables. The primary components make up a full station measure the following: wind speed, wind direction, temperature and temperature difference, atmospheric water vapor, precipitation, pressure, radiation, mixing height (U.S. Environmental Protection Agency, June 1987).

These variables can be measured with different equipment and devices that will provide the information that is desired. The application is the driving constraint that determines which device is more advantageous. These devices have different properties and factors that make them more desirable. Factors such as cost, durability, and accuracy are some that play a crucial part in determining the most efficient device for the application. The device itself is not the only part of the equation, but the systems that support the sensors and instruments must be taken into account as well. All of these systems must work together to create an accurate and efficient station that is cost-effective.

The ability to record and monitor the variable of precipitation will be important in determining the potential of a flash flood occurring in Costa Rica. Heavy precipitation is the cause of flash floods because it raises existing water levels or causes the ponding of water (National Research Council, 2005). The instruments that measure precipitation are tipping buckets and weighing rain gages. Both devices have the ability to measure the total amount of liquid precipitation, but only the tipping bucket measures the rate at which precipitation is falling at. The instruments have their advantages and disadvantages due to their designs and both can send electrical signals in order to relay information to digital processors. The tipping bucket system that consists of two buckets is reliable as long as it is installed properly, measurement errors occur when there is heavy rainfall due to water splashing out or during the dumping action. The weighing gage is able to record data during any type of rainfall due to its design unlike the buckets. The gage has a tendency to give inaccurate readings when there is a strong wind (U.S. Environmental Protection Agency, June 1987).

The functions and capabilities of these instruments vary and could require the need for a combination of both in order to properly gather information to determine possible flash flood conditions.

A secondary variable that IMN desires to investigate would be to gather wind speed and direction information. Wind is simply measured as one vector with magnitude and direction, but both measures are not easily attained. Most stations measure each quantity with its own component.

Wind speed can be measured using a cup anemometer or a propeller anemometer in the majority of cases, other equipment exists for more specialized measurements. The cup anemometer uses three to six cone-shaped cups that spin around an axis when air contacts the cups. Propeller anemometers are made up of two, three, or four bladed propellers that spin around a horizontal shaft that is turned into the wind by a vane. These blades can be made out of different materials that will yield different durabilities and sensitivities to measure wind speeds. A combination of propellers can be used to determine the different components of wind speed and directions of the wind and can be used to determine standard deviations. The propellers are not completely flawless, for example a vertical propeller measuring at an angle to the wind from (80°-90°) can lead to underestimates.

The variable of wind direction is defined as the angle the wind is blowing at, measured in degrees clockwise from true north. Measuring this direction requires wind vanes, U-V, or UVW systems to obtain the data. The most common instrument is the wind vane, which comes in many shapes and sizes. The materials and the configuration of a weather vane depend on the application. The U-V system uses a horizontally orthogonal fixed-mount propeller to measure the direction as the UVW system uses a vertical propeller.

The components that measure wind speed and wind direction all can be connected to their own corresponding transducer that converts the rotation of the component into an electrical signal. These signals can be transmitted to any center that then converts the information into useful data that can be used by meteorologists.

APPENDIX E: SITE SELECTION CONSTRAINTS

The site selection for the weather station is as important as the equipment on the station itself. The incorrect positioning could cause inaccuracies and could lead to an unreliable station. Each component on a weather station has its own set of guidelines on the placement and location on the station as well as the proximity to other surrounding objects.

The primary component to be used is the precipitation component. These components have to be horizontal to the sky and at an optimal position low to the ground, but high enough to avoid splashes from the ground. These instruments must be positioned to collect as much falling rain as possible, but at the same time need to be protected from high wind speeds that could lead to inaccuracies. To prevent this, wind shields could be installed as long as they do not impede the data collection, such as fences or other effective "wind breakers" in front of the device. The obstructions should not be closer than at least two, but preferably four times the height of the obstruction from the station (U.S. Environmental Protection Agency, June 1987).

The secondary components of wind speed and wind direction have certain parameters that enable the best measurements to be recorded. The instruments should be at least 10 meters above the ground and should not be placed within ten times the height of the nearest obstruction. For example, if there is a twenty foot tree, the wind gauge should be at least 200 feet from the tree. In the case of dense vegetation, any wind measurement should be taken at 10m above the vegetation canopy. It is recommended to have several levels of wind measurements to improve wind profile measurements.

The overall location plays a part in the decision on the location of a station. In a complex terrain, the ideal location may not exist, which can cause problems obtaining vital information. The ideal location is a flat area that can yield measurements for all the variables desired. Such locations do not always exist, which leads to compromises in order to achieve maximum effectiveness of the station. The NWS recommends a 400 foot radius of clearance around any type of weather stations. Obstructions and clearances need to be taken into consideration when choosing locations for stations in order to collect accurate data.

APPENDIX F: METADATA SHEETS FOR ALL SITES

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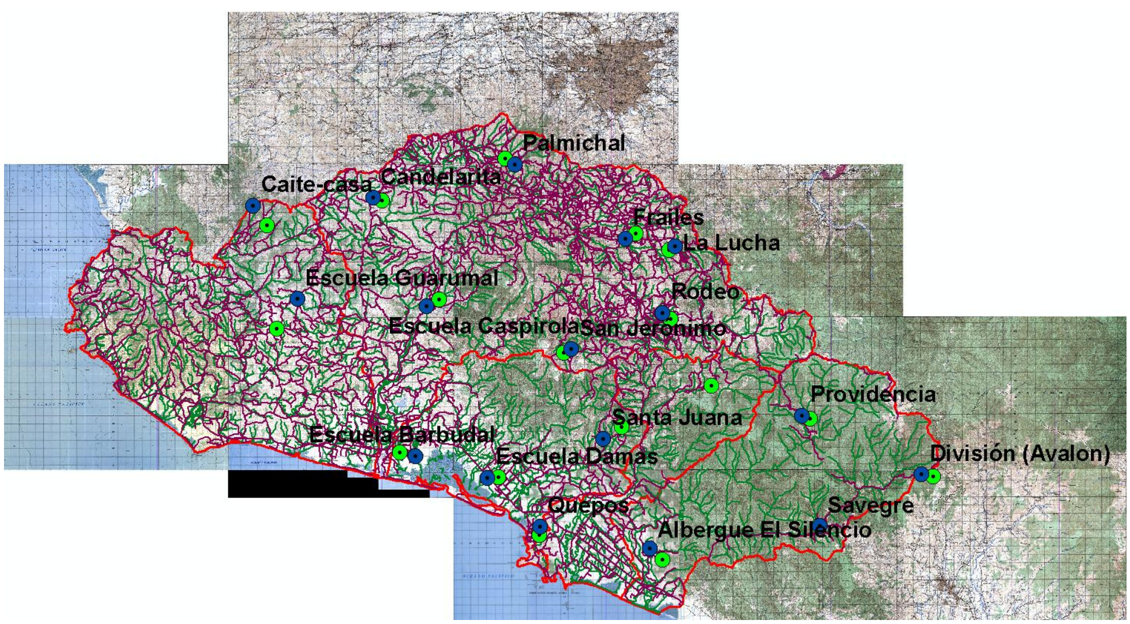

IMN Site Evaluation Metadata Sheet
DIVISION

Surveyor Name: Matt Moreau, Maynor Alfaro, Julio Sandoval

Date of Visit: 11/19/08

Location (City, County, District): Division

Site Contact Information

Contact Name:

Organization:

Address:

Phone:

Fax:

Email:

Prior to Leaving to the Sites

- Have at several sites proposed to evaluate in the general area
- Get general site description and digital pictures, aerial photos, topographic maps, etc.
- Review accessibility and maintenance
- Evaluate current and future uses of the proposed site and area with the IMN

Specific Site Properties

Latitude:

Longitude:

Elevation: 2287 meters (7503 feet)

Type of Property (Private Property, National Park, etc.):

Types of Meteorological or other Scientific Sites in the Area:

N/A

Comments:

Physical Properties of the Site

(**PREPARATION:** Have Topographic Maps for each individual site and one that includes all potential sites in the area. Bring aerial photos.)

Take a 360 degree panoramic picture at the proposed location with multiple pictures

Describe the use of the Land and the General Area (i.e. farm land, lumber field, sports field, etc.)

The use of the land is for housing and farming. XXXX has a small coffee plantation, livestock, and is currently in the process of constructing a tilapia farm.

Give a description of the terrain in words for 360 degrees (i.e. hills, valleys, level plane, distances, directions to the nearest town, ground cover, etc.)

At 7,500 feet the terrain is very hilly. XXXX's groundcover is mostly grass.

Obstructions in the Area 360 degrees (trees, buildings, other structures, distances, and heights)

XXX's property contains many structures but most are only 1 story. His house shown in the first photo is the tallest at 2 stories. His property contains many trees especially towards the front his house. Although there are a lot of trees, XXXX has a lot of space between his two houses, which extremely help the site selection process. XXXX also informed us that we would be able to place the station wherever we would like on his property. Willingness to place weather stations also benefits the site selection process.

Examine Site Meteorological Equipment Constraints
All sensors should be about 1.5 meters from the ground (Assess and Circle the "BEST" Case that matches the site (1 through 5). Include an explanation on the assigned number)

1 = Excellent **2 = Good** **3 = Fair** **4 = Poor** **5 = Very Poor**

Wind Speed (Sensor should be at least ten times the height of nearby buildings, trees, or other obstructions)

1 **2** 3 4 5

The trees will somewhat affect the wind data collection.

Precipitation (Tipping buckets should be no closer than four times the height of an obstruction, the orifice of the gage must be in a horizontal plane, wind shields are recommended

1 2 3 4 5

XXX's property is clear enough in places that precipitation data collection should not be affected by trees or structures.

Review Weather Phenomenon in the Area (i.e. flash floods, land slide, tornadoes, hurricanes, etc.)

This area is at a high risk of landslides and at a low risk for flash floods.

Security and Maintenance of the Site

XXXX's goal is to become completely self-sufficient at his farm, so a person should be there at all times, this is great for security.

Additional Information

Governmental Restrictions (i.e. permits, construction codes, etc.)

N/A

Other:

We recommend placing the weather station on the back left corner of XXXX's main house. It is the clearest spot on his property for rain collection and we want to try and place the station as high as possible for wind data collection. At higher elevations, the trees should not interfere with wind data collection. This site communicated with Providencia.

Further Criteria for the Classifications of Component Constraints

Classification for Wind Speed:

Class 1: Sensor located at a distance of at least ten (10) times the height of the obstacle (elevation angle <5.7 degrees). Object considered an obstacle if seen at angular width >10 degrees. Obstacle is below 5.5m height within a 150m radius and 7m within a 300m radius. Wind sensor located a minimum distance of 15 times the width of thin nearby obstacles (i.e. mast, tree with angular width <10 degrees). Surrounding terrain relief change </= 5m within a 300m radius.

Class 2 (error 10%): Same as Class 1 except terrain change </= 5m within a 100m radius.

Class 3 (error 20%): Same as Class 1 except no obstacles within five times the height of the nearby obstacles (elevation angle <11.3 degrees). Wind sensor located a minimum distance of 10 times the width of thin nearby obstacles. Terrain change </= 1m within a 10m radius.

Class 4 (error 30%): Same as Class 3 except no obstacles within 2.5 times the height of the nearby obstacles (elevation angle <21.8 degrees).

Class 5 (error >40%): Obstacles within 2.5 times the height of the nearby obstacles.

Class 6 (error >50%): Obstacles with a height >10m, seen with an angular width greater than 60 degrees are within a 20m distance.

Classification for Precipitation:

Class 1: Flat horizontal ground surround by a cleared surface with a slope below 1/3 (<19 degrees). Any obstacle must be located at a distance of at least 4 times the height of the obstacle. An obstacle is an object seen from the precipitation gauge with an angular width of =/>10 degrees.

Class 2 (error 5%): Same as Class 1, except an obstacle is located at a distance of at least two (2) times its height.

Class 3 (error 10% to 20%): Ground with a slope below 1/2 (<30 degrees). Any obstacle is located at a distance of at least its height.

Class 4 (error >20%): Ground with a slope >30 degrees. Obstacles located at a distance less than their height.

Class 5 (error > 50%): Obstacles overhanging the gauge.

IMN Site Evaluation Metadata Sheet

EL CAITE

Surveyor Name: Matt Moreau, Maynor Alfaro, Julio Sandoval

Date of Visit: November 13th, 2008

Location (City, County, District): El Caite

Site Contact Information

Contact Name:

Organization:

Address:

Phone:

Fax:

Email:

Prior to Leaving to the Sites

- Have at several sites proposed to evaluate in the general area
- Get general site description and digital pictures, aerial photos, topographic maps, etc.
- Review accessibility and maintenance
- Evaluate current and future uses of the proposed site and area with the IMN

Specific Site Properties

Latitude:

Longitude:

Elevation: 1452 meters (4764 feet)

Type of Property (Private Property, National Park, etc.):

Types of Meteorological or other Scientific Sites in the Area:

N/A

Comments:

The land is owned by XXXX. They have a coffee plantation on one side of the main road And keep livestock on the other side of the road. They said it would be best to call them at Night or during the weekends.

Physical Properties of the Site

(**PREPARATION:** Have Topographic Maps for each individual site and one that includes all potential sites in the area. Bring aerial photos.)

Take a 360 degree panoramic picture at the proposed location with multiple pictures

Describe the use of the Land and the General Area (i.e. farm land, lumber field, sports field, etc.)

The use of the land is for farming. XXXXX own a coffee plantation and keep livestock

Give a description of the terrain in words for 360 degrees (i.e. hills, valleys, level plane, distances, directions to the nearest town, ground cover, etc.)

The terrain is very mountainous, but the ground is flat where the station will be placed. There is only one road through the main town of El Caite and it is all dirt. Rain will be an impedance if anyone were to travel to the site.

Obstructions in the Area 360 degrees (trees, buildings, other structures, distances, and heights)

There is a clearing of around 100 square feet where the weather station will be placed. There are trees to one side that could interfere with the wind readings, but precipitation data collection should not be a problem. As of this moment, the area we selected is all dirt, but XXXX and XXXX stated that they will be building a small house at that location. Putting the weather station on top of the house they will be build would be better not only for wind and precipitation collection, but for security as well. The trees to one side are approximately 30 feet tall.

Examine Site Meteorological Equipment Constraints
All sensors should be about 1.5 meters from the ground (Assess and Circle the "BEST" Case that matches the site (1 through 5). Include an explanation on the assigned number)

1 = Excellent **2 = Good** **3 = Fair** **4 = Poor** **5 = Very Poor**

Wind Speed (Sensor should be at least ten times the height of nearby buildings, trees, or other obstructions)

1 **2** 3 4 5

The wind speed collection should be good at this collection as there are only trees to one side.

Precipitation (Tipping buckets should be no closer than four times the height of an obstruction, the orifice of the gage must be in a horizontal plane, wind shields are recommended

1 2 3 4 5

Precipitation collection should be excellent at this location as the site is very clear.

Review Weather Phenomenon in the Area (i.e. flash floods, land slide, tornadoes, hurricanes, etc.)

Since the area is mountainous, the only concern is landslides. If it rains hard enough the access roads will be a problem because of the steep slopes.

Security and Maintenance of the Site

If the house is built the security of the site will be excellent. If not, then it would only be good as no one is there 24 hours a day. Maintenance should not be a problem as the station would be right on the main road in El Caite.

Additional Information

Governmental Restrictions (i.e. permits, construction codes, etc.)

N/A

Other:

We recommend to the put the station on the house to the corner that is not surrounded by trees. This is the best location for wind and precipitation readings. This site communicated with Candelerita.

Further Criteria for the Classifications of Component Constraints

Classification for Wind Speed:

Class 1: Sensor located at a distance of at least ten (10) times the height of the obstacle (elevation angle <5.7 degrees). Object considered an obstacle if seen at angular width >10 degrees. Obstacle is below 5.5m height within a 150m radius and 7m within a 300m radius. Wind sensor located a minimum distance of 15 times the width of thin nearby obstacles (i.e. mast, tree with angular width <10 degrees). Surrounding terrain relief change </= 5m within a 300m radius.

Class 2 (error 10%): Same as Class 1 except terrain change </= 5m within a 100m radius.

Class 3 (error 20%): Same as Class 1 except no obstacles within five times the height of the nearby obstacles (elevation angle <11.3 degrees). Wind sensor located a minimum distance of 10 times the width of thin nearby obstacles. Terrain change </= 1m within a 10m radius.

Class 4 (error 30%): Same as Class 3 except no obstacles within 2.5 times the height of the nearby obstacles (elevation angle <21.8 degrees).

Class 5 (error >40%): Obstacles within 2.5 times the height of the nearby obstacles.

Class 6 (error >50%): Obstacles with a height >10m, seen with an angular width greater than 60 degrees are within a 20m distance.

Classification for Precipitation:

Class 1: Flat horizontal ground surround by a cleared surface with a slope below 1/3 (<19 degrees). Any obstacle must be located at a distance of at least 4 times the height of the obstacle. An obstacle is an object seen from the precipitation gauge with an angular width of =/>10 degrees.

Class 2 (error 5%): Same as Class 1, except an obstacle is located at a distance of at least two (2) times its height.

Class 3 (error 10% to 20%): Ground with a slope below 1/2 (<30 degrees). Any obstacle is located at a distance of at least its height.

Class 4 (error >20%): Ground with a slope >30 degrees. Obstacles located at a distance less than their height.

Class 5 (error > 50%): Obstacles overhanging the gauge.

IMN Site Evaluation Metadata Sheet
EL SILENCIO

Surveyor Name: Matt Moreau, Minor Hernandez Alfaro, Victor Julio Sandoval

Date of Visit: 11/4/08, 11/6/08

Location (City, County, District): El Silencio

Site Contact Information

Contact Name:

Organization:

Address:

Phone:

Fax:

Email:

Prior to Leaving to the Sites

- Have at several sites proposed to evaluate in the general area
- Get general site description and digital pictures, aerial photos, topographic maps, etc.
- Review accessibility and maintenance
- Evaluate current and future uses of the proposed site and area with the IMN

Specific Site Properties

Latitude:

Longitude:

Elevation: 36 meters (118 feet)

Type of Property (Private Property, National Park, etc.):

Types of Meteorological or other Scientific Sites in the Area:

N/A

Comments:

The IMN used to have a station there 10 years ago.

Physical Properties of the Site

(**PREPARATION:** Have Topographic Maps for each individual site and one that includes all potential sites in the area. Bring aerial photos.)

Take a 360 degree panoramic picture at the proposed location with multiple pictures

Describe the use of the Land and the General Area (i.e. farm land, lumber field, sports field, etc.)

The land is used for a XXXXX. The surrounding area is used for some agriculture and livestock.

Give a description of the terrain in words for 360 degrees (i.e. hills, valleys, level plane, distances, directions to the nearest town, ground cover, etc.)

The terrain is very mountainous. The Albergue has an extremely steep driveway. Once on top the driveway is circular with cabins all around it. The ground cover is mostly dirt and grass with some small trees in the center of the complex. I would say that the Albergue is one of the highest points in El Silencio which makes it a great location for data collection and radio communications.

Obstructions in the Area 360 degrees (trees, buildings, other structures, distances, and heights)

One problem with this location is that there is a lot of trees surrounding the albergue. For buildings, there is a 2 story restaurant/bar and 10 cabins surrounding the driveway. For placement of the weather station, the IMN has to put it on top of the 2 story restaurant/bar because of the surrounding trees. Putting the station on top of the restaurant/bar is great for the collection rain and wind data, but not great for collecting temperature data as tops of roofs tend to give off heat. If temperature were to be a problem, there is a lot of open space in the center of complex. The problem with that spot is some wind data would be altered and the aesthetics of the albergue.

Examine Site Meteorological Equipment Constraints
All sensors should be about 1.5 meters from the ground (Assess and Circle the "BEST" Case that matches the site (1 through 5). Include an explanation on the assigned number)

1 = Excellent **2 = Good** **3 = Fair** **4 = Poor** **5 = Very Poor**

Wind Speed (Sensor should be at least ten times the height of nearby buildings, trees, or other obstructions)

1 **2** 3 4 5

The wind speed would be good on top of the restaurant/bar, but there are still some trees taller than the structure which would alter the collection some what.

Precipitation (Tipping buckets should be no closer than four times the height of an obstruction, the orifice of the gage must be in a horizontal plane, wind shields are recommended

1 **2** 3 4 5

Precipitation collection should be good because it is high up and far enough away from any trees.

Review Weather Phenomenon in the Area (i.e. flash floods, land slide, tornadoes, hurricanes, etc.)

Flash Floods and more importantly landslides are a problem for the El Silencio area.

Security and Maintenance of the Site

Being that there will be always someone at the reception desk for the Albergue, security will not be an issue for this station. Also, it would be high enough that it would be extremely hard to get to without the proper equipment. Maintenance will not be an issue either as the Albergue is right off the main road in El Silencio and there are signs giving directions along the way to prevent someone from getting lost.

Additional Information

Governmental Restrictions (i.e. permits, construction codes, etc.)

N/A

Other:

The Albergue in El Silencio was the best possible site in the area of the theoretical point. It is secure and will be easily maintained. Some trees might alter the data, but not significantly. This site successfully communicated with the Quepos site, so communications will not be a problem. We recommend placing the weather station on top of the almbergue to the side that is closest to the bungalows.

Further Criteria for the Classifications of Component Constraints

Classification for Wind Speed:

Class 1: Sensor located at a distance of at least ten (10) times the height of the obstacle (elevation angle <5.7 degrees). Object considered an obstacle if seen at angular width >10 degrees. Obstacle is below 5.5m height within a 150m radius and 7m within a 300m radius. Wind sensor located a minimum distance of 15 times the width of thin nearby obstacles (i.e. mast, tree with angular width <10 degrees). Surrounding terrain relief change </= 5m within a 300m radius.

Class 2 (error 10%): Same as Class 1 except terrain change </= 5m within a 100m radius.

Class 3 (error 20%): Same as Class 1 except no obstacles within five times the height of the nearby obstacles (elevation angle <11.3 degrees). Wind sensor located a minimum distance of 10 times the width of thin nearby obstacles. Terrain change </= 1m within a 10m radius.

Class 4 (error 30%): Same as Class 3 except no obstacles within 2.5 times the height of the nearby obstacles (elevation angle <21.8 degrees).

Class 5 (error >40%): Obstacles within 2.5 times the height of the nearby obstacles.

Class 6 (error >50%): Obstacles with a height >10m, seen with an angular width greater than 60 degrees are within a 20m distance.

Classification for Precipitation:

Class 1: Flat horizontal ground surround by a cleared surface with a slope below 1/3 (<19 degrees). Any obstacle must be located at a distance of at least 4 times the height of the obstacle. An obstacle is an object seen from the precipitation gauge with an angular width of =/>10 degrees.

Class 2 (error 5%): Same as Class 1, except an obstacle is located at a distance of at least two (2) times its height.

Class 3 (error 10% to 20%): Ground with a slope below 1/2 (<30 degrees). Any obstacle is located at a distance of at least its height.

Class 4 (error >20%): Ground with a slope >30 degrees. Obstacles located at a distance less than their height.

Class 5 (error > 50%): Obstacles overhanging the gauge.

IMN Site Evaluation Metadata Sheet
FRAILES

Surveyor Name: Matt Moreau, Maynor Alfaro, Julio Sandoval

Date of Visit: 11/18/08

Location (City, County, District): Frailes

Site Contact Information

Contact Name:

Organization:

Address:

Phone:

Fax:

Email:

Prior to Leaving to the Sites

- Have at several sites proposed to evaluate in the general area
- Get general site description and digital pictures, aerial photos, topographic maps, etc.
- Review accessibility and maintenance
- Evaluate current and future uses of the proposed site and area with the IMN

Specific Site Properties

Latitude:

Longitude:

Elevation: 1477 meters (4846 feet)

Type of Property (Private Property, National Park, etc.):

Types of Meteorological or other Scientific Sites in the Area:

N/A

Comments:

The school is surrounded by coffee plantations.

Physical Properties of the Site

(**PREPARATION:** Have Topographic Maps for each individual site and one that includes all potential sites in the area. Bring aerial photos.)

Take a 360 degree panoramic picture at the proposed location with multiple pictures

Describe the use of the Land and the General Area (i.e. farm land, lumber field, sports field, etc.)

The use of the land is for school. Directly behind the school there are a bunch of fields used for sports. There are mostly coffee plantations surrounding the school.

Give a description of the terrain in words for 360 degrees (i.e. hills, valleys, level plane, distances, directions to the nearest town, ground cover, etc.)

The general area is very hilly, but the school is located on a level plane. In front of the school across the road there is a sharp increase in elevation of about 20 feet. The school is located in a well populated town. Surrounding the school there is mostly houses and the groundcover is all dirt.

Obstructions in the Area 360 degrees (trees, buildings, other structures, distances, and heights)

The school has 4 one story buildings. There are 2 buildings in the front and two in the back. The buildings in the back are at a slightly lower elevation than the building in the front, because the land does slope a little. There are several trees across the road that may interfere with wind data collection. As seen in the photos, there is a 10'x 8' area of grass that is located at the back right of the school. This area would be great for the weather stations, but the buildings may interfere with accurate data collection. The general area of the school is really clear, so there is a lot of areas in the school property to place the weather station.

Examine Site Meteorological Equipment Constraints
All sensors should be about 1.5 meters from the ground (Assess and Circle the "BEST" Case that matches the site (1 through 5). Include an explanation on the assigned number)

1 = Excellent **2 = Good** **3 = Fair** **4 = Poor** **5 = Very Poor**

Wind Speed (Sensor should be at least ten times the height of nearby buildings, trees, or other obstructions)

1 2 **3** 4 5

The trees and building may make it tough to collect accurate wind data.

Precipitation (Tipping buckets should be no closer than four times the height of an obstruction, the orifice of the gage must be in a horizontal plane, wind shields are recommended

1 **2** 3 4 5

The building may interfere with accurate rain data collection, but should still collect good data.

Review Weather Phenomenon in the Area (i.e. flash floods, land slide, tornadoes, hurricanes, etc.)

This area is at a low risk of flash flooding and at a high risk of a landslide because of the mountainous terrain.

Security and Maintenance of the Site

The security and maintenance will be excellent at this site. The school is surrounded by a Barbed wire fence as seen in the photos and is located on a main road. There will be people at school during the weekdays and some teachers live around the school to check on it during the weekends. The director locks the gate at night and even during school hours.

Additional Information

Governmental Restrictions (i.e. permits, construction codes, etc.)

N/A

Other:

Schools are an excellent place to place a weather station and we are lucky to find one in Frailes. We are recommending on the patch of grass as seen in the first photo at the end of the sheet. It is a fair place for wind data collection, but more importantly it is an good place for rain collection. This site communicated with La Lucha.

Further Criteria for the Classifications of Component Constraints

Classification for Wind Speed:

Class 1: Sensor located at a distance of at least ten (10) times the height of the obstacle (elevation angle <5.7 degrees). Object considered an obstacle if seen at angular width >10 degrees. Obstacle is below 5.5m height within a 150m radius and 7m within a 300m radius. Wind sensor located a minimum distance of 15 times the width of thin nearby obstacles (i.e.
mast, tree with angular width <10 degrees). Surrounding terrain relief change </= 5m within a 300m radius.

Class 2 (error 10%): Same as Class 1 except terrain change </= 5m within a 100m radius.

Class 3 (error 20%): Same as Class 1 except no obstacles within five times the height of the nearby obstacles (elevation angle <11.3 degrees). Wind sensor located a minimum distance of 10 times the width of thin nearby obstacles. Terrain change </= 1m within a 10m radius.

Class 4 (error 30%): Same as Class 3 except no obstacles within 2.5 times the height of the nearby obstacles (elevation angle <21.8 degrees).

Class 5 (error >40%): Obstacles within 2.5 times the height of the nearby obstacles.

Class 6 (error >50%): Obstacles with a height >10m, seen with an angular width greater than 60 degrees are within a 20m distance.

Classification for Precipitation:

Class 1: Flat horizontal ground surround by a cleared surface with a slope below 1/3 (<19 degrees). Any obstacle must be located at a distance of at least 4 times the height of the obstacle. An obstacle is an object seen from the precipitation gauge with an angular width of =/>10 degrees.

Class 2 (error 5%): Same as Class 1, except an obstacle is located at a distance of at least two (2) times its height.

Class 3 (error 10% to 20%): Ground with a slope below 1/2 (<30 degrees). Any obstacle is located at a distance of at least its height.

Class 4 (error >20%): Ground with a slope >30 degrees. Obstacles located at a distance less than their height.

Class 5 (error > 50%): Obstacles overhanging the gauge.

IMN Site Evaluation Metadata Sheet

CASPIROLA

Surveyor Name: Matt Moreau, Maynor Alfaro, Julio Sandoval

Date of Visit: 11/17/08

Location (City, County, District): Caspirola

Site Contact Information

Contact Name:

Organization:

Address:

Phone:

Fax:

Email:

Prior to Leaving to the Sites

- Have at several sites proposed to evaluate in the general area

- Get general site description and digital pictures, aerial photos, topographic maps, etc.

- Review accessibility and maintenance

- Evaluate current and future uses of the proposed site and area with the IMN

Specific Site Properties

Latitude:

Longitude:

Elevation: 397 meters (1302 feet)

Type of Property (Private Property, National Park, etc.):

Types of Meteorological or other Scientific Sites in the Area:

N/A

Comments:

XXX is the director of the school and the president, XXXX, lives next door.

Physical Properties of the Site

(**PREPARATION:** Have Topographic Maps for each individual site and one that includes all potential sites in the area. Bring aerial photos.)

Take a 360 degree panoramic picture at the proposed location with multiple pictures

Describe the use of the Land and the General Area (i.e. farm land, lumber field, sports field, etc.)

The use of the land is for a school. There is a area in the middle of school that is very open.

Give a description of the terrain in words for 360 degrees (i.e. hills, valleys, level plane, distances, directions to the nearest town, ground cover, etc.)

The terrain is hilly. There are some flat spots and then there are some hills. However, the school is on a level plane and the terrain will not be a problem. The school is right in the town of Caspirola.

Obstructions in the Area 360 degrees (trees, buildings, other structures, distances, and heights)

There are 4 structures total that is a part of the school and the president's house furthest right if looking at the school. There are some trees to one side of the school, but they are relatively short and should not interfere with accurate data collection. There are a lot of power and telephone lines that are running through the school. Those lines are only about 10 to 15 feet from the ground. Although there are many structures on the site, they are only 1 story buildings and will not interfere with accurate data collection. The trees are generally 30 feet tall and are located in the back of the school.

Examine Site Meteorological Equipment Constraints
All sensors should be about 1.5 meters from the ground (Assess and Circle the "BEST" Case that matches the site (1 through 5). Include an explanation on the assigned number)

1 = Excellent **2 = Good** **3 = Fair** **4 = Poor** **5 = Very Poor**

Wind Speed (Sensor should be at least ten times the height of nearby buildings, trees, or other obstructions)

1 2 **3** 4 5

The trees may have an impact on accurate wind data collection.

Precipitation (Tipping buckets should be no closer than four times the height of an obstruction, the orifice of the gage must be in a horizontal plane, wind shields are recommended

1 **2** 3 4 5

There should be good rain data collection at this location.

Review Weather Phenomenon in the Area (i.e. flash floods, land slide, tornadoes, hurricanes, etc.)

This area is not mountainous enough to have major landslides, but minor ones still could occur. This site is at a low risk for flash floods and landslides.

Security and Maintenance of the Site

The security and maintenance of the site should be excellent. The school is located on a main road. There are always people there during the weekdays and the president lives next door, so he can monitor the station on the weekends. Also, the school has barbed wire surrounding all of their facilities, which enhance the security of the site even more.

Additional Information

Governmental Restrictions (i.e. permits, construction codes, etc.)

N/A

Other:

This location is an excellent site for data collection. The only problem we had with groundtruthing was the communication. We had to move around a lot at the site in order to achieve strong communication. The site finally communicated with the San Jeronimo. We recommend placing the station on top of the structure that is located nearest to the water tank, as seen in the first photo at the end of the sheet. It is the best location for data collection and Communication.

Further Criteria for the Classifications of Component Constraints

Classification for Wind Speed:

Class 1: Sensor located at a distance of at least ten (10) times the height of the obstacle (elevation angle <5.7 degrees). Object considered an obstacle if seen at angular width >10 degrees. Obstacle is below 5.5m height within a 150m radius and 7m within a 300m radius. Wind sensor located a minimum distance of 15 times the width of thin nearby obstacles (i.e. mast, tree with angular width <10 degrees). Surrounding terrain relief change </= 5m within a 300m radius.

Class 2 (error 10%): Same as Class 1 except terrain change </= 5m within a 100m radius.

Class 3 (error 20%): Same as Class 1 except no obstacles within five times the height of the nearby obstacles (elevation angle <11.3 degrees). Wind sensor located a minimum distance of 10 times the width of thin nearby obstacles. Terrain change </= 1m within a 10m radius.

Class 4 (error 30%): Same as Class 3 except no obstacles within 2.5 times the height of the nearby obstacles (elevation angle <21.8 degrees).

Class 5 (error >40%): Obstacles within 2.5 times the height of the nearby obstacles.

Class 6 (error >50%): Obstacles with a height >10m, seen with an angular width greater than 60
degrees are within a 20m distance.

Classification for Precipitation:

Class 1: Flat horizontal ground surround by a cleared surface with a slope below 1/3 (<19 degrees). Any obstacle must be located at a distance of at least 4 times the height of the obstacle. An obstacle is an object seen from the precipitation gauge with an angular width of =/>10 degrees.

Class 2 (error 5%): Same as Class 1, except an obstacle is located at a distance of at least two (2) times its height.

Class 3 (error 10% to 20%): Ground with a slope below 1/2 (<30 degrees). Any obstacle is located at a distance of at least its height.

Class 4 (error >20%): Ground with a slope >30 degrees. Obstacles located at a distance less than their height.

Class 5 (error > 50%): Obstacles overhanging the gauge.

IMN Site Evaluation Metadata Sheet
PARRITA-BARBUDAL

Surveyor Name: Matt Moreau, Minor Hernandez Alfaro, Victor Julio Sandoval

Date of Visit: 11/4/08

Location (City, County, District): Parrita

Site Contact Information

Contact Name:

Organization:

Address:

Phone:

Cell-Phone:

Email:

Prior to Leaving to the Sites

- Have at several sites proposed to evaluate in the general area
- Get general site description and digital pictures, aerial photos, topographic maps, etc.
- Review accessibility and maintenance
- Evaluate current and future uses of the proposed site and area with the IMN

Specific Site Properties

Latitude:

Longitude:

Elevation: 42 feet

Type of Property (Private Property, National Park, etc.):

Types of Meteorological or other Scientific Sites in the Area:

N/A

Comments:

There is a barbwire fence around the school which will make the station more secure.

Physical Properties of the Site

(**PREPARATION:** Have Topographic Maps for each individual site and one that includes all potential sites in the area. Bring aerial photos.)

Take a 360 degree panoramic picture at the proposed location with multiple pictures

Describe the use of the Land and the General Area (i.e. farm land, lumber field, sports field, etc.)

The use of the land is for a school. There is a sports field just behind the school. The area Surrounding the school is used mostly for agriculture. There is a rice field approximately 100 meters up the road from XXXXXXXXX.

Give a description of the terrain in words for 360 degrees (i.e. hills, valleys, level plane, distances, directions to the nearest town, ground cover, etc.)

Since the location is closed to the coast, there are no hills or valleys. The area which the station will be placed is on a level plane. The ground cover is mostly grass. There is a small river approximately 300 meters down the road from the school.

Obstructions in the Area 360 degrees (trees, buildings, other structures, distances, and heights)

There are a set of trees across the road from the school, but should be far enough away to allow for accurate data collection. The sports field behind the school is perfect for data collection because of the clear space. The school has 3 buildings that are only 1 story of 10’. The height of Buildings will not have an effect on data collection. The location at the school which would be The best to place the station would be around back, because it is furthest away from the trees, Closer to the sports field, and out of visible site to anyone on the road.

Examine Site Meteorological Equipment Constraints
All sensors should be about 1.5 meters from the ground (Assess and Circle the "BEST" Case that matches the site (1 through 5). Include an explanation on the assigned number)

1 = Excellent **2 = Good** **3 = Fair** **4 = Poor** **5 = Very Poor**

Wind Speed (Sensor should be at least ten times the height of nearby buildings, trees, or other obstructions)

1 2 **3** 4 5

The nearby trees and school buildings may make it difficult to collect accurate wind data.

Precipitation (Tipping buckets should be no closer than four times the height of an obstruction, the orifice of the gage must be in a horizontal plane, wind shields are recommended

1 **2** 3 **4** 5

The tipping bucket will be far enough away from the 10' buildings so that accurate data will be collected.

Review Weather Phenomenon in the Area (i.e. flash floods, land slide, tornadoes, hurricanes, etc.)

This area is extremely susceptible to flash floods. XXXX and XXXX explained what happened to this area just a couple of weeks prior to the survey. They stated that an extreme amount of rain fell on the school, which created a serious flood. Water would rise from the nearby river and enter the classroom causing severe flooding inside.

Security and Maintenance of the Site

Since schools are an excellent site for a weather station location, the school offers a secure spot to put a station. The barbwire fence allows for safety and people will regularly be at the location in case anything happens to the station. The school is located on a side road, which is only a 15 minute drive from the main road through Parrita. The feasibly of maintenance will not be an issue.

Additional Information

Governmental Restrictions (i.e. permits, construction codes, etc.)

N/A

Other:

The school is an excellent location for the weather station in Parrita. It is close to the Main road, allows for safety, there are hardly any obstructions, and it is within 2 km of the point That was theoretically located by Hugo Herrera and Juan Carlos Fallas. The Parrita site successfully communicated with the Guarumal Site and the Damas site, so communications will not be a problem. We recommend placing the weather station on top of the furthest structure to the left. It is the best location for wind and precipitation data as it is the furthest from the surrounding trees.

Further Criteria for the Classifications of Component Constraints

Classification for Wind Speed:

Class 1: Sensor located at a distance of at least ten (10) times the height of the obstacle (elevation angle <5.7 degrees). Object considered an obstacle if seen at angular width >10 degrees. Obstacle is below 5.5m height within a 150m radius and 7m within a 300m radius. Wind sensor located a minimum distance of 15 times the width of thin nearby obstacles (i.e. mast, tree with angular width <10 degrees). Surrounding terrain relief change </= 5m within a 300m radius.

Class 2 (error 10%): Same as Class 1 except terrain change </= 5m within a 100m radius.

Class 3 (error 20%): Same as Class 1 except no obstacles within five times the height of the nearby obstacles (elevation angle <11.3 degrees). Wind sensor located a minimum distance of 10 times the width of thin nearby obstacles. Terrain change </= 1m within a 10m radius.

Class 4 (error 30%): Same as Class 3 except no obstacles within 2.5 times the height of the nearby obstacles (elevation angle <21.8 degrees).

Class 5 (error >40%): Obstacles within 2.5 times the height of the nearby obstacles.

Class 6 (error >50%): Obstacles with a height >10m, seen with an angular width greater than 60 degrees are within a 20m distance.

Classification for Precipitation:

Class 1: Flat horizontal ground surround by a cleared surface with a slope below 1/3 (<19 degrees). Any obstacle must be located at a distance of at least 4 times the height of the obstacle. An obstacle is an object seen from the precipitation gauge with an angular width of =/>10 degrees.

Class 2 (error 5%): Same as Class 1, except an obstacle is located at a distance of at least two (2) times its height.

Class 3 (error 10% to 20%): Ground with a slope below 1/2 (<30 degrees). Any obstacle is located at a distance of at least its height.

Class 4 (error >20%): Ground with a slope >30 degrees. Obstacles located at a distance less than their height.

Class 5 (error > 50%): Obstacles overhanging the gauge.


ESCUELA
AMERICA
BARBUDA

IMN Site Evaluation Metadata Sheet
PROVIDENCIA

Surveyor Name: Matt Moreau. Maynor Alfaro, Julio Sandoval

Date of Visit: 11/19/08

Location (City, County, District): Providencia

Site Contact Information

Contact Name:

Organization:

Address:

Phone:

Fax:

Email:

Prior to Leaving to the Sites

- Have at several sites proposed to evaluate in the general area
- Get general site description and digital pictures, aerial photos, topographic maps, etc.
- Review accessibility and maintenance
- Evaluate current and future uses of the proposed site and area with the IMN

Specific Site Properties

Latitude:

Longitude:

Elevation: 1790 meters (5872 feet)

Type of Property (Private Property, National Park, etc.):

Types of Meteorological or other Scientific Sites in the Area:

N/A

Comments:

The name of the contact is the director of the school.

Physical Properties of the Site

(**PREPARATION:** Have Topographic Maps for each individual site and one that includes all potential sites in the area. Bring aerial photos.)

Take a 360 degree panoramic picture at the proposed location with multiple pictures

Describe the use of the Land and the General Area (i.e. farm land, lumber field, sports field, etc.)

The use of the land is for a school.

Give a description of the terrain in words for 360 degrees (i.e. hills, valleys, level plane, distances, directions to the nearest town, ground cover, etc.)

Although this is one of our highest points in our network, Providencia is located in valley and it is surrounded by towering mountains. The general area is hilly. The school is right in the center of the town. The ground cover around the school is generally dirt. The main road through providencia is dirt, which can get really sloppy if it rains. There is a river across the road that the school is on.

Obstructions in the Area 360 degrees (trees, buildings, other structures, distances, and heights)

The area surrounding the school generally does not have any trees. If there are trees, they are No higher than 10 feet. Trees should not interfere with accurate data collection. The school has 3 buildings with 2 in the front and 1 to the back left. All buildings are 1 story buildings. Generally, the area is very clear and excellent for collecting weather data.

Examine Site Meteorological Equipment Constraints
All sensors should be about 1.5 meters from the ground (Assess and Circle the "BEST" Case that matches the site (1 through 5). Include an explanation on the assigned number)

1 = Excellent **2 = Good** **3 = Fair** **4 = Poor** **5 = Very Poor**

Wind Speed (Sensor should be at least ten times the height of nearby buildings, trees, or other obstructions)

1 2 3 4 5

In our recommended location wind data collection should be excellent.

Precipitation (Tipping buckets should be no closer than four times the height of an obstruction, the orifice of the gage must be in a horizontal plane, wind shields are recommended

1 2 3 4 5

It our recommended location precipitation data collection should be excellent.

Review Weather Phenomenon in the Area (i.e. flash floods, land slide, tornadoes, hurricanes, etc.)

Providencia is at a high risk of landslides. However, the school is in a location where it should be safe from any major landslides.

Security and Maintenance of the Site

The security and maintenance of the Providencia site will not be as great as the other weather station locations. As seen in the photos the fence does not wrap all the way around the school and is not barbed wire. Also, Providencia is not located near any major towns or cities in the Central Pacific Basin. The road to get to Providencia are one of the worst roads we were on and if wet it can become extremely dangerous.

Additional Information

Governmental Restrictions (i.e. permits, construction codes, etc.)

N/A

Other:

The area around the school is extremely clear which makes it a great location to collect weather information. We recommend placing the weather station on top of the building that is located right in front of the main gate as seen in the first photo. It is the best place at the school to collect the most accurate data. This station communicated with Naranjo.

Further Criteria for the Classifications of Component Constraints

Classification for Wind Speed:

Class 1: Sensor located at a distance of at least ten (10) times the height of the obstacle (elevation angle <5.7 degrees). Object considered an obstacle if seen at angular width >10 degrees. Obstacle is below 5.5m height within a 150m radius and 7m within a 300m radius. Wind sensor located a minimum distance of 15 times the width of thin nearby obstacles (i.e. mast, tree with angular width <10 degrees). Surrounding terrain relief change </= 5m within a 300m radius.

Class 2 (error 10%): Same as Class 1 except terrain change </= 5m within a 100m radius.

Class 3 (error 20%): Same as Class 1 except no obstacles within five times the height of the nearby obstacles (elevation angle <11.3 degrees). Wind sensor located a minimum distance of 10 times the width of thin nearby obstacles. Terrain change </= 1m within a 10m radius.

Class 4 (error 30%): Same as Class 3 except no obstacles within 2.5 times the height of the nearby obstacles (elevation angle <21.8 degrees).

Class 5 (error >40%): Obstacles within 2.5 times the height of the nearby obstacles.

Class 6 (error >50%): Obstacles with a height >10m, seen with an angular width greater than 60 degrees are within a 20m distance.

Classification for Precipitation:

Class 1: Flat horizontal ground surround by a cleared surface with a slope below 1/3 (<19 degrees). Any obstacle must be located at a distance of at least 4 times the height of the obstacle. An obstacle is an object seen from the precipitation gauge with an angular width of =/>10 degrees.

Class 2 (error 5%): Same as Class 1, except an obstacle is located at a distance of at least two (2) times its height.

Class 3 (error 10% to 20%): Ground with a slope below 1/2 (<30 degrees). Any obstacle is located at a distance of at least its height.

Class 4 (error >20%): Ground with a slope >30 degrees. Obstacles located at a distance less than their height.

Class 5 (error > 50%): Obstacles overhanging the gauge.

IMN Site Evaluation Metadata Sheet
SANTA JUANA

Surveyor Name: Matt Moreau, Minor Hernandez Alfaro, Victor Julio Sandoval

Date of Visit: 11/5/08

Location (City, County, District): Santa Juana

Site Contact Information

Contact Name:

Organization:

Address:

Phone:

Fax:

Email:

Prior to Leaving to the Sites

- Have at several sites proposed to evaluate in the general area
- Get general site description and digital pictures, aerial photos, topographic maps, etc.
- Review accessibility and maintenance
- Evaluate current and future uses of the proposed site and area with the IMN

Specific Site Properties

Latitude:

Longitude:

Elevation: 400 meters (1312 feet)

Type of Property (Private Property, National Park, etc.):

Types of Meteorological or other Scientific Sites in the Area:

N/A

Comments:

Roads are extremely bad, especially if raining.

Physical Properties of the Site

(**PREPARATION:** Have Topographic Maps for each individual site and one that includes all potential sites in the area. Bring aerial photos.)

Take a 360 degree panoramic picture at the proposed location with multiple pictures

Describe the use of the Land and the General Area (i.e. farm land, lumber field, sports field, etc.)

The use of the land is mostly for living purposes. There is some agriculture and livestock, but the town is so small that is nothing major.

Give a description of the terrain in words for 360 degrees (i.e. hills, valleys, level plane, distances, directions to the nearest town, ground cover, etc.)

The selected point is in an extremely mountainous area, with various hills and valleys all around it. The point is right in Santa Juana, but the town is not very big. The ground cover is mostly dirt and grass with a few short trees. There is one road that passes through the town and the point selected is at a house that is right on that road. Around XXXX's house, there is a jump in the elevation, about 15 feet, which will help the data collection. Putting the station on the hill next to his house instead of on his house will really make a difference in the data.

Obstructions in the Area 360 degrees (trees, buildings, other structures, distances, and heights)

Around the exact point which the station will be placed, there are some trees but not very tall. These trees should not interfere with the data at all. XXXX's house has two structures, but they are only one story and will not affect the data collection, since the station will be on the hill. The mountains around the point may obstruct the communication if the station is not placed in a good location on the hill. There are some small trees on the hill, but so small that they should not interfere with the data collection.

Examine Site Meteorological Equipment Constraints
All sensors should be about 1.5 meters from the ground (Assess and Circle the "BEST" Case that matches the site (1 through 5). Include an explanation on the assigned number)

1 = Excellent **2 = Good** **3 = Fair** **4 = Poor** **5 = Very Poor**

Wind Speed (Sensor should be at least ten times the height of nearby buildings, trees, or other obstructions)

1 2 3 4 5

Wind Speed data collection will be excellent at this location, because there are a limited amount

Trees and XXXX's structures are so small that they will not interfere either.

Precipitation (Tipping buckets should be no closer than four times the height of an obstruction, the orifice of the gage must be in a horizontal plane, wind shields are recommended

1 2 3 4 5

Precipitation data collection will also be excellent because of the vast clearing.

Review Weather Phenomenon in the Area (i.e. flash floods, land slide, tornadoes, hurricanes, etc.)

Since the location in the mountains, the heavy rain will be intensified as the less dense air cannot hold the moisture as the air towards the coast can. The heavy rain will also cause the soil to be saturated which will cause landslides. The very steep terrain and heavy rain can cause devastating landslides.

Security and Maintenance of the Site

Since this point will be located on a private property in a small town, security may be more of an issue. On the other hand, there will be someone at the house most of the time to look out for the weather station. The location of the point is in very mountainous terrain, so trekking up the main road for maintenance may be an issue, especially if it is raining. On the positive, the Station will be placed on a main road which makes it a lot easier for maintenance.

Additional Information

Governmental Restrictions (i.e. permits, construction codes, etc.)

N/A

Other:

XXXX's house is an excellent location for data collection. It is clear, with a limited amount trees. The only negatives may be the security and maintenance. Despite the mountainous terrain, this point successfully communicated with the Damas Station, so communication will not be an issue. We recommend to place the station at the flat piece of land as seen the last photo of the Metadata sheet. It will be the best place for wind and precipitation data collection.

Further Criteria for the Classifications of Component Constraints

Classification for Wind Speed:

Class 1: Sensor located at a distance of at least ten (10) times the height of the obstacle (elevation angle <5.7 degrees). Object considered an obstacle if seen at angular width >10 degrees. Obstacle is below 5.5m height within a 150m radius and 7m within a 300m radius. Wind sensor located a minimum distance of 15 times the width of thin nearby obstacles (i.e. mast, tree with angular width <10 degrees). Surrounding terrain relief change </= 5m within a 300m radius.

Class 2 (error 10%): Same as Class 1 except terrain change </= 5m within a 100m radius.

Class 3 (error 20%): Same as Class 1 except no obstacles within five times the height of the nearby obstacles (elevation angle <11.3 degrees). Wind sensor located a minimum distance of 10 times the width of thin nearby obstacles. Terrain change </= 1m within a 10m radius.

Class 4 (error 30%): Same as Class 3 except no obstacles within 2.5 times the height of the nearby obstacles (elevation angle <21.8 degrees).

Class 5 (error >40%): Obstacles within 2.5 times the height of the nearby obstacles.

Class 6 (error >50%): Obstacles with a height >10m, seen with an angular width greater than 60 degrees are within a 20m distance.

Classification for Precipitation:

Class 1: Flat horizontal ground surround by a cleared surface with a slope below 1/3 (<19 degrees). Any obstacle must be located at a distance of at least 4 times the height of the obstacle. An obstacle is an object seen from the precipitation gauge with an angular width of =/>10 degrees.

Class 2 (error 5%): Same as Class 1, except an obstacle is located at a distance of at least two (2) times its height.

Class 3 (error 10% to 20%): Ground with a slope below 1/2 (<30 degrees). Any obstacle is located at a distance of at least its height.

Class 4 (error >20%): Ground with a slope >30 degrees. Obstacles located at a distance less than their height.

Class 5 (error > 50%): Obstacles overhanging the gauge.

IMN Site Evaluation Metadata Sheet
SAVEGRE ABAJO

Surveyor Name: Matt Moreau, Maynor Alfaro, Julio Sandoval

Date of Visit: 11/20/08

Location (City, County, District): Savegre Abajo

Site Contact Information

Contact Name:

Organization:

Address:

Phone:

Fax:

Email:

Prior to Leaving to the Sites

- Have at several sites proposed to evaluate in the general area
- Get general site description and digital pictures, aerial photos, topographic maps, etc.
- Review accessibility and maintenance
- Evaluate current and future uses of the proposed site and area with the IMN

Specific Site Properties

Latitude:

Longitude:

Elevation: 550 meters (1805 feet)

Type of Property (Private Property, National Park, etc.):

Types of Meteorological or other Scientific Sites in the Area:

N/A

Comments:
N/A

Physical Properties of the Site

(**PREPARATION:** Have Topographic Maps for each individual site and one that includes all potential sites in the area. Bring aerial photos.)

Take a 360 degree panoramic picture at the proposed location with multiple pictures

Describe the use of the Land and the General Area (i.e. farm land, lumber field, sports field, etc.)

The use of the land is for housing and farming. XXXX has livestock to the left of his house, and a lot of vegetation to the right of his house.

Give a description of the terrain in words for 360 degrees (i.e. hills, valleys, level plane, distances, directions to the nearest town, ground cover, etc.)

The terrain in Savegre Abajo is very hilly. XXXX's 2 houses are located on the side of a hill. As seen from the photos, the groundcover is most grass and dirt. There is a river located across The road in front of XXXX's lower house. His house is located right in the town of Savegre Abajo.

Obstructions in the Area 360 degrees (trees, buildings, other structures, distances, and heights)

Although there is a lot of vegetation, it is extremely short and there are hardly any trees. There are some trees located throughout his property, but they are only 5-10' tall. Generally, XXXX's property is very clear and a great location to place a station. XXXX has 3 one story buildings. There is a house located at the bottom of the hill and another house and storage shack located further up the driveway. The difference in elevation between the 2 houses is around 20 feet. There is also a small dog kennel up the driveway. Otherwise, there should not be any obstructions that will interfere with accurate data collection.

Examine Site Meteorological Equipment Constraints

All sensors should be about 1.5 meters from the ground (Assess and Circle the "BEST" Case that matches the site (1 through 5). Include an explanation on the assigned number)

1 = Excellent **2 = Good** **3 = Fair** **4 = Poor** **5 = Very Poor**

Wind Speed (Sensor should be at least ten times the height of nearby buildings, trees, or other obstructions)

1 **2** 3 4 5

Since XXXX's house is on the side of a hill, it will keep it from being an excellent place for wind data collection.

Precipitation (Tipping buckets should be no closer than four times the height of an obstruction, the orifice of the gage must be in a horizontal plane, wind shields are recommended

1 2 3 4 5

XXXX's property is extremely clear and will be an excellent place for precipitation collection.

Review Weather Phenomenon in the Area (i.e. flash floods, land slide, tornadoes, hurricanes, etc.)

This location is at a high risk for flash floods and landslides. XXXX told us a story of how the river across the road would rise in extremely heavy rain and would flood his lower house.

Security and Maintenance of the Site

The security and maintenance of the site will not be a problem. XXXX is a very nice man and willing to make sure nothing will happen to the weather station. He stated that someone is usually at his house every day. Also, his house is located right on the main road in Savegre Abajo, so maintenance will not be a problem.

Additional Information

Governmental Restrictions (i.e. permits, construction codes, etc.)

N/A

Other:

We recommend placing the weather station near or on top of the upper house located in the First picture at the end of this sheet. It is the clearest spot on XXXX's property and at a higher position, which is better for wind data collection. This site communicated with Division.

Further Criteria for the Classifications of Component Constraints

Classification for Wind Speed:

Class 1: Sensor located at a distance of at least ten (10) times the height of the obstacle (elevation angle <5.7 degrees). Object considered an obstacle if seen at angular width >10 degrees. Obstacle is below 5.5m height within a 150m radius and 7m within a 300m radius. Wind sensor located a minimum distance of 15 times the width of thin nearby obstacles (i.e. mast, tree with angular width <10 degrees). Surrounding terrain relief change </= 5m within a 300m radius.

Class 2 (error 10%): Same as Class 1 except terrain change </= 5m within a 100m radius.

Class 3 (error 20%): Same as Class 1 except no obstacles within five times the height of the nearby obstacles (elevation angle <11.3 degrees). Wind sensor located a minimum distance of 10 times the width of thin nearby obstacles. Terrain change </= 1m within a 10m radius.

Class 4 (error 30%): Same as Class 3 except no obstacles within 2.5 times the height of the nearby obstacles (elevation angle <21.8 degrees).

Class 5 (error >40%): Obstacles within 2.5 times the height of the nearby obstacles.

Class 6 (error >50%): Obstacles with a height >10m, seen with an angular width greater than 60 degrees are within a 20m distance.

Classification for Precipitation:

Class 1: Flat horizontal ground surround by a cleared surface with a slope below 1/3 (<19 degrees). Any obstacle must be located at a distance of at least 4 times the height of the obstacle. An obstacle is an object seen from the precipitation gauge with an angular width of =/>10 degrees.

Class 2 (error 5%): Same as Class 1, except an obstacle is located at a distance of at least two (2) times its height.

Class 3 (error 10% to 20%): Ground with a slope below 1/2 (<30 degrees). Any obstacle is located at a distance of at least its height.

Class 4 (error >20%): Ground with a slope >30 degrees. Obstacles located at a distance less than their height.

Class 5 (error > 50%): Obstacles overhanging the gauge.

IMN Site Evaluation Metadata Sheet
DAMAS

Surveyor Name: Angel Martinez, Tom Page, Luis Zumbado

Date of Visit: November 4, 2008

Location (City, County, District): Damas, Punterenas

Site Contact Information

Contact Name:

Organization:

Address:

Phone:

Fax:

Email:

Prior to Leaving to the Sites

- Have at several sites proposed to evaluate in the general area
- Get general site description and digital pictures, aerial photos, topographic maps, etc.
- Review accessibility and maintenance
- Evaluate current and future uses of the proposed site and area with the IMN

Specific Site Properties

Latitude:

Longitude:

Elevation: 20 meters

Type of Property (Private Property, National Park, etc.):

Types of Meteorological or other Scientific Sites in the Area:

None

Comments:

None

Physical Properties of the Site

(**PREPARATION:** Have Topographic Maps for each individual site and one that includes all potential sites in the area. Bring aerial photos.)

Take a 360 degree panoramic picture at the proposed location with multiple pictures

Describe the use of the Land and the General Area (i.e. farm land, lumber field, sports field, etc.)

There is a small field in front of the school with small trees and bushes. There is a small concrete soccer field and other small things in the field.

Give a description of the terrain in words for 360 degrees (i.e. hills, valleys, level plane, distances, directions to the nearest town, ground cover, etc.)

The surrounding areas is very flat in all directions. The school is right on the road in the center of Damas. Across the road is an extensive palm field. There are very few trees around the school itself. The ground is covered in grass.

Obstructions in the Area 360 degrees (trees, buildings, other structures, distances, and heights)

The school itself is the biggest obstruction. It is located about 20 meters from the proposed location and is about 5 meters high. There are small trees and shrubs in the immediate area surrounding the proposed location but they are small enough that they should not pose a problem data collection. There is a cluster of thin, tall trees behind the school but they are far enough away to not cause problems with data collection. There are power lines and telephone poles in the area, but they are small enough to not interfere with data collection.

Examine Site Meteorological Equipment Constraints
All sensors should be about 1.5 meters from the ground (Assess and Circle the “BEST” Case that matches the site (1 through 5). Include an explanation on the assigned number)

1 = Excellent **2 = Good** **3 = Fair** **4 = Poor** **5 = Very Poor**

Wind Speed (Sensor should be at least ten times the height of nearby buildings, trees, or other obstructions)

1 2 3 4 5

There are small obstructions that could interfere with wind speed collection, but should not cause too big of a problem. The obstructions impacts can be minimized by placing instruments higher off the ground.

Precipitation (Tipping buckets should be no closer than four times the height of an obstruction, the orifice of the gage must be in a horizontal plane, wind shields are recommended

1 2 3 4 5

The school and trees are not high enough to create interference with precipitation data. The ground is also very level. There should be no problems while collecting rainfall data.

Comments:

None

Review Weather Phenomenon in the Area (i.e. flash floods, land slide, tornadoes, hurricanes, etc.)

Damas is in a flood plane so there is a high risk of flash floods during the rainy season.

Security and Maintenance of the Site

The school has a fence around it and teachers can easily watch the station from their classrooms during the day. At night or when school is not in session, there are security guards that can watch over the station. The security is very good. The school is located along a main highway, accessibility for maintenance will not be a problem.

Comments

None

Additional Information

Governmental Restrictions (i.e. permits, construction codes, etc.)

None

Other:

The station should be placed just to the northwest of a flagpole. The station should be at least 5 meters from the fence and the instruments should be at least as high as the small trees in the field in front of the school. If the station cannot be placed here, then it could go on the southeast side of the small line of trees. If possible, the instruments could be placed higher than the adjacent trees because they will continue to grow and could possibly interfere with data in the future. We were able to successfully communicate with the Parrita site and the Quepos site. This site could support both precipitation and wind instruments.

Further Criteria for the Classifications of Component Constraints

Classification for Wind Speed:

Class 1: Sensor located at a distance of at least ten (10) times the height of the obstacle (elevation angle <5.7 degrees). Object considered an obstacle if seen at angular width >10 degrees. Obstacle is below 5.5m height within a 150m radius and 7m within a 300m radius. Wind sensor located a minimum distance of 15 times the width of thin nearby obstacles (i.e. mast, tree with angular width <10 degrees). Surrounding terrain relief change </= 5m within a 300m radius.

Class 2 (error 10%): Same as Class 1 except terrain change </= 5m within a 100m radius.

Class 3 (error 20%): Same as Class 1 except no obstacles within five times the height of the nearby obstacles (elevation angle <11.3 degrees). Wind sensor located a minimum distance of 10 times the width of thin nearby obstacles. Terrain change </= 1m within a 10m radius.

Class 4 (error 30%): Same as Class 3 except no obstacles within 2.5 times the height of the nearby obstacles (elevation angle <21.8 degrees).

Class 5 (error >40%): Obstacles within 2.5 times the height of the nearby obstacles.

Class 6 (error >50%): Obstacles with a height >10m, seen with an angular width greater than 60 degrees are within a 20m distance.

Classification for Precipitation:

Class 1: Flat horizontal ground surround by a cleared surface with a slope below 1/3 (<19 degrees). Any obstacle must be located at a distance of at least 4 times the height of the obstacle. An obstacle is an object seen from the precipitation gauge with an angular width of =/>10 degrees.

Class 2 (error 5%): Same as Class 1, except an obstacle is located at a distance of at least two (2) times its height.

Class 3 (error 10% to 20%): Ground with a slope below 1/2 (<30 degrees). Any obstacle is located at a distance of at least its height.

Class 4 (error >20%): Ground with a slope >30 degrees. Obstacles located at a distance less than their height.

Class 5 (error > 50%): Obstacles overhanging the gauge.

PICTURES

Station should go to the left of the flag pole

Tall tree in the back, should not interfere with data collection

IMN Site Evaluation Metadata Sheet
CANDELARITA CHURCH

Surveyor Name: Angel Martinez, Thomas Page, Luis Zumbado

Date of Visit: 11/13/08

Location (City, County, District): Candelarita

Site Contact Information

Contact Name:

Organization: N/A

Address: N/A

Phone:

Fax: N/A

Email: N/A

Prior to Leaving to the Sites

- Have at several sites proposed to evaluate in the general area

- Get general site description and digital pictures, aerial photos, topographic maps, etc.

- Review accessibility and maintenance

- Evaluate current and future uses of the proposed site and area with the IMN

Specific Site Properties

Latitude:

Longitude:

Elevation: 1010 meters

Type of Property (Private Property, National Park, etc.): The church is private property that has a board of directors that manage and maintain the church.

Types of Meteorological or other Scientific Sites in the Area: N/A

Comments: The church is located in the center of Candelarita and is on the principal road of Candelarita that lead to the main road, route 239.

Physical Properties of the Site

(**PREPARATION:** Have Topographic Maps for each individual site and one that includes all potential sites in the area. Bring aerial photos.)

Take a 360 degree panoramic picture at the proposed location with multiple pictures

Describe the use of the Land and the General Area (i.e. farm land, lumber field, sports field, etc.)

The area of Candelarita is mostly used for coffee and other crops. The land is generally used for agriculture and has some livestock in the area.

Give a description of the terrain in words for 360 degrees (i.e. hills, valleys, level plane, distances, directions to the nearest town, ground cover, etc.)

The area surrounding the church is mountains. The town is located on a fairly level plane of a mountain. There is a fair amount of vegetation and moderately sized trees near the site. The tallest trees are about 20 feet and are located about 20 feet from the proposed site. The church is located right on the main road that goes through Candelarita and takes you all neighboring towns. The ground cover around the church is either grass or a gravel road. There is a low ground cover that will not impede in any measurements or the foundation of the station. The closest town is Copalar, which is about 2 km away and is located on the main road that the church is located on. The site is located on the upper level of a small mountainous range. There is a slight decline in slope where the church is located. The overall steepness of the surrounding area is fair.

Obstructions in the Area 360 degrees (trees, buildings, other structures, distances, and heights)

There is three trees that will be right next to the station and are about 18 feet high. The church itself is an obstruction and is about 20 feet high at a distance of about 15 feet. There are a row of trees about 20 feet high about 20 feet from the proposed site. There is also a small building that is only about 4 feet tall from the ground level of the site. These obstructions can be overcome by making sure the station is elevated to a height that is about a meter above the obstructions.

Examine Site Meteorological Equipment Constraints
All sensors should be about 1.5 meters from the ground (Assess and Circle the "BEST" Case that matches the site (1 through 5). Include an explanation on the assigned number)

1 = Excellent **2 = Good** **3 = Fair** **4 = Poor** **5 = Very Poor**

Wind Speed (Sensor should be at least ten times the height of nearby buildings, trees, or other obstructions)

1 2 3 4 5

The buildings and the trees nearby require the station to be elevated in order to function, and to have a proper anemometer function the station would have to be raised to an impractical height.

Precipitation (Tipping buckets should be no closer than four times the height of an obstruction, the orifice of the gage must be in a horizontal plane, wind shields are recommended)

1 2 3 4 5

As long as the station is elevated to a height that is higher than nearby obstructions the site will be a very good site to measure precipitation. Without proper elevation the readings the station may gather could be either large over or under estimates.

Comments: The site needs to be elevated to a height that is greater than 20 feet. This will allow the station to be above the obstructions and will also be out of reach of people that would want to damage or vandalize the station

Review Weather Phenomenon in the Area (i.e. flash floods, land slide, tornadoes, hurricanes, etc.)

The area is not prone directly to any of these phenomena within the town, but could lose communication to other towns and road due to landslides. The town is not a high-risk area due to the fact that it is located up high on a mountain with stable soil and fair steepness. The site would help indicate how much rain will fall on the lower areas of the. central Pacific basin

Security and Maintenance of the Site

The site is located on church property that would have surveillance by the board of directors of the church and the help of the community. The station would be highly elevated which would make the station secure and out of reach from anyone that would want to damage the station. Maintaining the station will be fairly easy because the site is fairly accessible because the church is on the main road, which is in fair conditions.

Additional Information

Governmental Restrictions (i.e. permits, construction codes, etc.)

N/A

Other:

The communication to the site was tested and there was moderate amount of interference at ground level. The site had direct communication with the Caite site with some interference. The elevation of the site should improve the communication between this station and the Palmichal station. This site has to be elevated to at least 20 feet in order to obtain accurate data due to the obstructions near the site.

Further Criteria for the Classifications of Component Constraints

Classification for Wind Speed:

Class 1: Sensor located at a distance of at least ten (10) times the height of the obstacle (elevation angle <5.7 degrees). Object considered an obstacle if seen at angular width >10 degrees. Obstacle is below 5.5m height within a 150m radius and 7m within a 300m radius. Wind sensor located a minimum distance of 15 times the width of thin nearby obstacles (i.e. mast, tree with angular width <10 degrees). Surrounding terrain relief change </= 5m within a 300m radius.

Class 2 (error 10%): Same as Class 1 except terrain change </= 5m within a 100m radius.

Class 3 (error 20%): Same as Class 1 except no obstacles within five times the height of the nearby obstacles (elevation angle <11.3 degrees). Wind sensor located a minimum distance of 10 times the width of thin nearby obstacles. Terrain change </= 1m within a 10m radius.

Class 4 (error 30%): Same as Class 3 except no obstacles within 2.5 times the height of the nearby obstacles (elevation angle <21.8 degrees).

Class 5 (error >40%): Obstacles within 2.5 times the height of the nearby obstacles.

Class 6 (error >50%): Obstacles with a height >10m, seen with an angular width greater than 60 degrees are within a 20m distance.

Classification for Precipitation:

Class 1: Flat horizontal ground surround by a cleared surface with a slope below 1/3 (<19 degrees). Any obstacle must be located at a distance of at least 4 times the height of the obstacle. An obstacle is an object seen from the precipitation gauge with an angular width of =/>10 degrees.

Class 2 (error 5%): Same as Class 1, except an obstacle is located at a distance of at least two (2) times its height.

Class 3 (error 10% to 20%): Ground with a slope below 1/2 (<30 degrees). Any obstacle is located at a distance of at least its height.

Class 4 (error >20%): Ground with a slope >30 degrees. Obstacles located at a distance less than their height.

Class 5 (error > 50%): Obstacles overhanging the gauge.

IMN Site Evaluation Metadata Sheet

ESCUELA GUARUMAL

Surveyor's Names: Luis Zumbado, Angel Martinez

Date of Visit: November 5, 2008

Location (City, County, District): Guarumal, Costa Rica

Site Contact Information

Contact Name: N/A The principal of the school was not present

Organization:

Address: N/A

Phone:

Fax: N/A

Email: N/A

Prior to Leaving to the Sites

- Have at several sites proposed to evaluate in the general area
- Get general site description and digital pictures, aerial photos, topographic maps, etc.
- Review accessibility and maintenance
- Evaluate current and future uses of the proposed site and area with the IMN

Specific Site Properties

Latitude:

Longitude:

Elevation: 570 m

Type of Property (Private Property, National Park, etc.): The site is located at a school in the town of Guarumal and is public property.

Types of Meteorological or other Scientific Sites in the Area: N/A

Comments: The school is located right off the main road leading through the town of Guarumal.

Physical Properties of the Site

(**PREPARATION:** Have Topographic Maps for each individual site and one that includes all potential sites in the area. Bring aerial photos.)

Take a 360 degree panoramic picture at the proposed location with multiple pictures

Describe the use of the Land and the General Area (i.e. farm land, lumber field, sports field, etc.)

The area of Guarumal is used for farming and raising livestock. The town farms to sustain itself. The town is located on mountainous terrain that is used to farm crops such as oranges, pineapple, and coffee. The farmers have livestock like cattle and chickens.

Give a description of the terrain in words for 360 degrees (i.e. hills, valleys, level plane, distances, directions to the nearest town, ground cover, etc.)

The terrain is very mountainous with many trees surrounding the area with very little clearance with the exception of small areas. One of these areas is around the school that has some clearance from the low-rise trees in the area. The trees are about 20 feet from the school and they small enough to not affect the readings when the station is place above the roof of the school because they are about only 20 feet themselves and the station will be elevated above ground level. The general ground cover near the school is low grass and a dirt road. To get to another town someone would just have to follow the main road that is right off the road the school is located on. The closest town is Santa Rosa, which is about 2.6 km away north of Guarumal.

Obstructions in the Area 360 degrees (trees, buildings, other structures, distances, and heights)

The obstructions in the area would be mostly trees that are about 20 feet from the proposed location for the station. The trees themselves are about 20 feet from ground level and a sparse. There are small single story buildings nearby, but since the station will be placed above the roofline the buildings will not become an obstruction that can impede accurate measurements. The station will be elevated above ground level about 8 feet, which will avoid any problems with the obstructions in the area.

Examine Site Meteorological Equipment Constraints
All sensors should be about 1.5 meters from the ground (Assess and Circle the "BEST" Case that matches the site (1 through 5). Include an explanation on the assigned number)

1 = Excellent **2 = Good** **3 = Fair** **4 = Poor** **5 = Very Poor**

Wind Speed (Sensor should be at least ten times the height of nearby buildings, trees, or other obstructions)

1 2 3 **4** 5

The area is not open enough to get accurate readings especially because the nearby trees will be obstructions and they are not distanced far enough to compensate.

Precipitation (Tipping buckets should be no closer than four times the height of an obstruction, the orifice of the gage must be in a horizontal plane, wind shields are recommended)

1 2 3 4 5

The site is not optimally distanced four times the height of any obstruction, but it is reasonably distanced to gather information accurately with a distance of about 2.5 times the height of the obstructions. There will be a little error, but not enough to make the readings unreliable.

Comments: The site is suited to have tipping buckets, but should not have anemometers because the site is not far away enough from obstacles in order to gather accurate data for wind variables. The site will allow the collection of precipitation data to function smoothly gathering rain data with the tipping buckets.

Review Weather Phenomenon in the Area (i.e. flash floods, land slide, tornadoes, hurricanes, etc.)

In the area there are heavy rains that lead to landslides. The landslides will not affect the station Itself, but the slides could lead to limited accessibility to the site for maintenance and repairs. The landslides destroy roads that need to be cleared, which can take some time.

Security and Maintenance of the Site

The site is located within a fenced in school that has many students and faculty present during the day and is locked during the evening and night. This provides sufficient security to make sure the equipment is not stolen or damaged. The road the school is located on is right of the main road to get to Guarumal making maintenance fairly easy. A problem can occur during a period of heavy rains that could cause the roads to Guarumal become impassable for an uncertain amount of time.

Additional Information

Governmental Restrictions (i.e. permits, construction codes, etc.)

N/A

Other:

The communication from Guarumal to the nearest station Parrita was conducted on the trip. The stations could communicate using a nearby repeater and using indirect communication. This resulted in the decision to keep the points because they can effectively communicating meaning that the sites can relay information to each other.

Further Criteria for the Classifications of Component Constraints

Classification for Wind Speed:

Class 1: Sensor located at a distance of at least ten (10) times the height of the obstacle (elevation angle <5.7 degrees). Object considered an obstacle if seen at angular width >10 degrees. Obstacle is below 5.5m height within a 150m radius and 7m within a 300m radius. Wind sensor located a minimum distance of 15 times the width of thin nearby obstacles (i.e. mast, tree with angular width <10 degrees). Surrounding terrain relief change </= 5m within a 300m radius.

Class 2 (error 10%): Same as Class 1 except terrain change </= 5m within a 100m radius.

Class 3 (error 20%): Same as Class 1 except no obstacles within five times the height of the nearby obstacles (elevation angle <11.3 degrees). Wind sensor located a minimum distance of 10 times the width of thin nearby obstacles. Terrain change </= 1m within a 10m radius.

Class 4 (error 30%): Same as Class 3 except no obstacles within 2.5 times the height of the nearby obstacles (elevation angle <21.8 degrees).

Class 5 (error >40%): Obstacles within 2.5 times the height of the nearby obstacles.

Class 6 (error >50%): Obstacles with a height >10m, seen with an angular width greater than 60 degrees are within a 20m distance.

Classification for Precipitation:

Class 1: Flat horizontal ground surround by a cleared surface with a slope below 1/3 (<19 degrees). Any obstacle must be located at a distance of at least 4 times the height of the obstacle. An obstacle is an object seen from the precipitation gauge with an angular width of =/>10 degrees.

Class 2 (error 5%): Same as Class 1, except an obstacle is located at a distance of at least two (2) times its height.

Class 3 (error 10% to 20%): Ground with a slope below 1/2 (<30 degrees). Any obstacle is located at a distance of at least its height.

Class 4 (error >20%): Ground with a slope >30 degrees. Obstacles located at a distance less than their height.

Class 5 (error > 50%): Obstacles overhanging the gauge.

Pictures:


SEMANA DE REHABILITACION


MINA


USO OFICIAL

IMN Site Evaluation Metadata Sheet
NARANJO

Surveyor Name: Angel Martinez, Thomas Page, Luiz Zumbado

Date of Visit: 11/13/08

Location (City, County, District): Naranjo

Site Contact Information

Contact Name: N/A

Organization: N/A

Address: N/A

Phone: N/A

Fax: N/A

Email: N/A

Prior to Leaving to the Sites

- Have at several sites proposed to evaluate in the general area
- Get general site description and digital pictures, aerial photos, topographic maps, etc.
- Review accessibility and maintenance
- Evaluate current and future uses of the proposed site and area with the IMN

Missing Site Information

The Naranjo site was unable to be located and confirmed due to difficulties in getting to the town of Naranjo. The road to Naranjo was destroyed and was impassable by motor vehicle. The only way to arrive to Naranjo at the time was either by foot or by horse. The team did not have the sufficient time to travel by foot for about two hours to reach the town. Without the truck the team would not be able to make radio communications. This site needs to be evaluated by the IMN for the placement of a weather station as well as test the communication from Naranjo to Rodeo. We recommend that two trucks make a trip to the confirmed site in Rodeo and attempt to find a viable site in Naranjo to confirm the Naranjo site.

IMN Site Evaluation Metadata Sheet

PALMICHAL

Surveyor Name: Angel Martinez, Thomas Page, Luis Zumbado

Date of Visit: 11/13/08

Location (City, County, District): Palmichal

Site Contact Information

Contact Name:

Organization:

Address:

Phone:

Fax: N/A

Email: N/A

Prior to Leaving to the Sites

- Have at several sites proposed to evaluate in the general area
- Get general site description and digital pictures, aerial photos, topographic maps, etc.
- Review accessibility and maintenance
- Evaluate current and future uses of the proposed site and area with the IMN

Specific Site Properties

Latitude:

Longitude:

Elevation: 1561 meters

Type of Property (Private Property, National Park, etc.):.

Types of Meteorological or other Scientific Sites in the Area: There is an ICE tower nearby it is about 1 km away.

Comments: The road to the finca connects to another road that leads directly to a main highway 209.

Physical Properties of the Site

(**PREPARATION:** Have Topographic Maps for each individual site and one that includes all potential sites in the area. Bring aerial photos.)

Take a 360 degree panoramic picture at the proposed location with multiple pictures

Describe the use of the Land and the General Area (i.e. farm land, lumber field, sports field, etc.)

The land in the surrounding area is used as a coffee plantation. The immediate area is a home that is located in a clearing.

Give a description of the terrain in words for 360 degrees (i.e. hills, valleys, level plane, distances, directions to the nearest town, ground cover, etc.)

The area around the site is very mountainous with many coffee plants on each slope. There are many trees that surround the road through the finca and are of moderate size. Some of the trees could be up to 40 feet high and are located throughout the entire place. The road is made of dirt and stone that winds through the mountainous terrain. The town of Palmichal is about 2 km from the finca and the road connects directly with the main road that runs through the center of Palmichal. The specific area where the station would be placed is level and located in a small clearing with a house located nearby. The station could be placed right next to the hill.The ground cover is low grass and dirt.

Obstructions in the Area 360 degrees (trees, buildings, other structures, distances, and heights)

If the station is placed next to the small hill next to the house there are trees located nearby that are about 20 feet tall. The trees are located at about 20 to 25 feet from the proposed site. There is a small house next to the hill that is only about 12 feet at its highest point. The hill located near the house that is about 20 feet tall. Other than the trees, the house, and the hill there are no other obstructions that would interfere with the gathering of precipitation data.

Examine Site Meteorological Equipment Constraints
All sensors should be about 1.5 meters from the ground (Assess and Circle the "BEST" Case that matches the site (1 through 5). Include an explanation on the assigned number)

1 = Excellent **2 = Good** **3 = Fair** **4 = Poor** **5 = Very Poor**

Wind Speed (Sensor should be at least ten times the height of nearby buildings, trees, or other obstructions)

1 2 3 4 5

This site is inadequate to measure wind speed and direction due to the density of trees in the area. The trees are too high and are located to close to the proposed station site to gather accurate data.

Precipitation (Tipping buckets should be no closer than four times the height of an obstruction, the orifice of the gage must be in a horizontal plane, wind shields are recommended

1 2 3 4 5

The station would be located in a small clearing that was created to build a home and the station should be placed in a place that allows enough distance from the surrounding tree in order to accumulate reliable data. With this taken care of the station should not have many problems recording accurate readings.

Comments: The site can sustain tipping buckets without a large margin of error. The only problem would occur if anemometers were desired because the necessary distance from obstructions is not ideal for wind readings.

Review Weather Phenomenon in the Area (i.e. flash floods, land slide, tornadoes, hurricanes, etc.)

The area is covered with vegetation and trees that make the ground stable, which reduces the risk of landslides. The finca is a low-risk area that would only have to worry about landslides that occur on the nearby road that could disconnect it from the surrounding towns. The site would be used to record and monitor rainfall in higher elevations in order to warn the lower lands if conditions deem it necessary.

Security and Maintenance of the Site

The station would be located within a private coffee plantation that is gated. The station itself would be located next to one of the plantation's caretakers home. The station would have surveillance year round and would be in a private secure area that is guarded.

Comments: The site is deep inside a private coffee plantation right next to a house. The station would be guarded by the plantation workers and would be safe from any intentional damage.

Additional Information

Governmental Restrictions (i.e. permits, construction codes, etc.)

N/A

Other: The station should be located as close to the center of the clearing as possible in order to maximize the distance from the trees that could obstruct readings. The site is very secure and has great communication capabilities due to the high elevation that the site is located at. The station should be suspended at a reasonable height and located as far from obstructions as possible to promote the best recording of data.

The communication at the site was excellent it could communicate directly with the Candelarita weather station site.

Further Criteria for the Classifications of Component Constraints

Classification for Wind Speed:

Class 1: Sensor located at a distance of at least ten (10) times the height of the obstacle (elevation angle <5.7 degrees). Object considered an obstacle if seen at angular width >10 degrees. Obstacle is below 5.5m height within a 150m radius and 7m within a 300m radius.Wind sensor located a minimum distance of 15 times the width of thin nearby obstacles (i.e. mast, tree with angular width <10 degrees). Surrounding terrain relief change </= 5m within a 300m radius.

Class 2 (error 10%): Same as Class 1 except terrain change </= 5m within a 100m radius.

Class 3 (error 20%): Same as Class 1 except no obstacles within five times the height of the nearby obstacles (elevation angle <11.3 degrees). Wind sensor located a minimum distance of 10 times the width of thin nearby obstacles. Terrain change </= 1m within a 10m radius.

Class 4 (error 30%): Same as Class 3 except no obstacles within 2.5 times the height of the nearby obstacles (elevation angle <21.8 degrees).

Class 5 (error >40%): Obstacles within 2.5 times the height of the nearby obstacles.

Class 6 (error >50%): Obstacles with a height >10m, seen with an angular width greater than 60 degrees are within a 20m distance.

Classification for Precipitation:

Class 1: Flat horizontal ground surround by a cleared surface with a slope below 1/3 (<19 degrees). Any obstacle must be located at a distance of at least 4 times the height of the obstacle. An obstacle is an object seen from the precipitation gauge with an angular width of =/>10 degrees.

Class 2 (error 5%): Same as Class 1, except an obstacle is located at a distance of at least two (2) times its height.

Class 3 (error 10% to 20%): Ground with a slope below 1/2 (<30 degrees). Any obstacle is located at a distance of at least its height.

Class 4 (error >20%): Ground with a slope >30 degrees. Obstacles located at a distance less than their height.

Class 5 (error > 50%): Obstacles overhanging the gauge.

IMN Site Evaluation Metadata Sheet
QUEPOS

Surveyor Name: Angel Martinez, Tom Page, Luis Zumbado

Date of Visit: November 4, 2008

Location (City, County, District): Quepos

Site Contact Information

Contact Name:

Organization:

Address:

Phone:

Fax:

Email:

Prior to Leaving to the Sites

- Have at several sites proposed to evaluate in the general area
- Get general site description and digital pictures, aerial photos, topographic maps, etc.
- Review accessibility and maintenance
- Evaluate current and future uses of the proposed site and area with the IMN

Specific Site Properties

Latitude:

Longitude:

Elevation: 52 meters

Type of Property (Private Property, National Park, etc.):

Types of Meteorological or other Scientific Sites in the Area:

None

Comments:

None

Physical Properties of the Site

(**PREPARATION:** Have Topographic Maps for each individual site and one that includes all potential sites in the area. Bring aerial photos.)

Take a 360 degree panoramic picture at the proposed location with multiple pictures

Describe the use of the Land and the General Area (i.e. farm land, lumber field, sports field, etc.)

The land has a home and fields used primarily for livestock. There is some farm land, but not near the proposed station location.

Give a description of the terrain in words for 360 degrees (i.e. hills, valleys, level plane, distances, directions to the nearest town, ground cover, etc.)

The property is just outside of the city of Quepos. The surrounding areas has rolling hills and is mostly used for livestock grazing. The station will be located at the top of a small hill with trees in the vicinity, but at a lower elevation and far enough away as to not cause problems with data collection. The ground the station will be on is covered in dirt and grass. The surrounding land on the hill is mostly tall grass with scattered trees.

Obstructions in the Area 360 degrees (trees, buildings, other structures, distances, and heights)

There is a palm tree within approximately 20 meters, but it does not reach high enough to interfere with data collection. There is a small group of small trees at the top of the hill, but they are not tall enough and are far enough away to not pose any problems. This location has very few obstructions and should be able to collect very accurate measurements for both wind and rain.

Examine Site Meteorological Equipment Constraints
All sensors should be about 1.5 meters from the ground (Assess and Circle the "BEST" Case that matches the site (1 through 5). Include an explanation on the assigned number)

1 = Excellent **2 = Good** **3 = Fair** **4 = Poor** **5 = Very Poor**

Wind Speed (Sensor should be at least ten times the height of nearby buildings, trees, or other obstructions)

1 2 3 4 5

The site is located at the top of a hill with hardly any obstructions around it. The small number of trees in the area are not tall enough to interfere with wind data collection. By placing the instruments at least 1.5 meters above the ground should negate any influence from the nearby trees.

Precipitation (Tipping buckets should be no closer than four times the height of an obstruction, the orifice of the gage must be in a horizontal plane, wind shields are recommended

1 2 3 4 5

Just as with the wind gauges, the tipping buckets should have no problems collecting accurate data. The nearby trees are not high enough to create interference.

Comments:

None

Review Weather Phenomenon in the Area (i.e. flash floods, land slide, tornadoes, hurricanes, etc.)

Quepos is in the same general area as Parrita, which experiences heavy flooding. The is far enough away from Parrita and at a high enough elevation where it should not be affected by weather phenomenon.

Security and Maintenance of the Site

The site is located on private property that is completely enclosed. It is far enough away from the road where it won't be noticeable from the road. There is a secondary barbed wire fence surrounding the driveway that leads to the station. There should be no problems with site security. The site is located just off of a main road outside of Quepos. There station will be located on top of a small hill that a 4X4 truck can climb and then there is a short walk to the peak of the hill. Accessibility for maintenance will not be a problem.

Comments

None

Additional Information

Governmental Restrictions (i.e. permits, construction codes, etc.)

None

Other:

We recommend to put the station at the top of a hill to the southwest of the house. There is a dirt path that leads up to the hill with a barbed wire fence opening. At the top of the hill there is a flat piece of land covered mostly in dirt. The station should be placed at the highest flat spot on the hill. The instruments should be placed at least 1.5 meters above the ground. The site had very good communication with the repeater on Cerro de Muerto We were able to communicate with the Damas and Silencio Stations with no problems.

Further Criteria for the Classifications of Component Constraints

Classification for Wind Speed:

Class 1: Sensor located at a distance of at least ten (10) times the height of the obstacle (elevation angle <5.7 degrees). Object considered an obstacle if seen at angular width >10 degrees. Obstacle is below 5.5m height within a 150m radius and 7m within a 300m radius. Wind sensor located a minimum distance of 15 times the width of thin nearby obstacles (i.e. mast, tree with angular width <10 degrees). Surrounding terrain relief change </= 5m within a 300m radius.

Class 2 (error 10%): Same as Class 1 except terrain change </= 5m within a 100m radius.

Class 3 (error 20%): Same as Class 1 except no obstacles within five times the height of the nearby obstacles (elevation angle <11.3 degrees). Wind sensor located a minimum distance of 10 times the width of thin nearby obstacles. Terrain change </= 1m within a 10m radius.

Class 4 (error 30%): Same as Class 3 except no obstacles within 2.5 times the height of the nearby obstacles (elevation angle <21.8 degrees).

Class 5 (error >40%): Obstacles within 2.5 times the height of the nearby obstacles.

Class 6 (error >50%): Obstacles with a height >10m, seen with an angular width greater than 60 degrees are within a 20m distance.

Classification for Precipitation:

Class 1: Flat horizontal ground surround by a cleared surface with a slope below 1/3 (<19 degrees). Any obstacle must be located at a distance of at least 4 times the height of the obstacle. An obstacle is an object seen from the precipitation gauge with an angular width of =/>10 degrees.

Class 2 (error 5%): Same as Class 1, except an obstacle is located at a distance of at least two (2) times its height.

Class 3 (error 10% to 20%): Ground with a slope below 1/2 (<30 degrees). Any obstacle is located at a distance of at least its height.

Class 4 (error >20%): Ground with a slope >30 degrees. Obstacles located at a distance less than their height.

Class 5 (error > 50%): Obstacles overhanging the gauge.

PICTURES

View from site

View from site


View from site


View from site


View from site

View from site


Place station here on this flat piece of ground.

IMN Site Evaluation Metadata Sheet
SAN JERONIMO

Surveyor Name: Angel Martinez, Thomas Page, Luis Zumbado

Date of Visit: November 17, 2008

Location (City, County, District): San Jeronimo

Site Contact Information

Contact Name:

Organization:

Address:

Phone:

Fax:

Email:

Prior to Leaving to the Sites

- Have at several sites proposed to evaluate in the general area
- Get general site description and digital pictures, aerial photos, topographic maps, etc.
- Review accessibility and maintenance
- Evaluate current and future uses of the proposed site and area with the IMN

Specific Site Properties

Latitude:

Longitude:

Elevation: 1330 meters

Type of Property (Private Property, National Park, etc.):

Types of Meteorological or other Scientific Sites in the Area:

None

Comments:

None

Physical Properties of the Site

(**PREPARATION:** Have Topographic Maps for each individual site and one that includes all potential sites in the area. Bring aerial photos.)

Take a 360 degree panoramic picture at the proposed location with multiple pictures

Describe the use of the Land and the General Area (i.e. farm land, lumber field, sports field, etc.)

San Jeronimo is in the Mountains and has lots of coffee agriculture. The school is in the center of the town. The school is surrounded by buildings, trees and is on a slight decline slope.

Give a description of the terrain in words for 360 degrees (i.e. hills, valleys, level plane, distances, directions to the nearest town, ground cover, etc.)

At the far end of the school (to the west-northwest) there is a slope downward with nothing in the way. The school is about 5 meters high and is directly behind the proposed site location. There are two trees on either side of the school. They are taller than the school but should not cause inaccurate readings. On the other side of the school there is a two story building built into the side of a hill. The slope continues to raise behind this building. Wind readings could be difficult to get because the mountain could block it. The ground behind the school is grass. The school is located in the center of the town.

Obstructions in the Area 360 degrees (trees, buildings, other structures, distances, and heights)

The school is directly behind the proposed location. It is about 5 meters high and about 5 meters from the edge of the school property. There are also trees on both sides of the school that are taller than the school. The trees are approximately 10 meters high and about 15 meters from the school. On the other side of the school there is a two story building with a mountain slope behind it. This slope will not interfere with rain collection, but could block wind. The building should not be an obstruction itself, but the mountain side could pose a problem.

Examine Site Meteorological Equipment Constraints
All sensors should be about 1.5 meters from the ground (Assess and Circle the "BEST" Case that matches the site (1 through 5). Include an explanation on the assigned number)

1 = Excellent **2 = Good** **3 = Fair** **4 = Poor** **5 = Very Poor**

Wind Speed (Sensor should be at least ten times the height of nearby buildings, trees, or other obstructions)

1 2 3 4 5

There are no obstructions that could interfere directly with wind collection, but because of the mountainous terrain, the slope on the other side of the school could block wind. If wind were to be measured here, winds from the east-southeast may be blocked or be inaccurate.

Precipitation (Tipping buckets should be no closer than four times the height of an obstruction, the orifice of the gage must be in a horizontal plane, wind shields are recommended

1 2 3 4 5

As long as the tipping bucket is placed as high as the roof of the school, there should be no obstructions to block precipitation.

Comments:

None

Review Weather Phenomenon in the Area (i.e. flash floods, land slide, tornadoes, hurricanes, etc.)

There are landslides in the areas because of the mountainous terrain. On the ride there, there was evidence of past landslides that blocked the roads, they had since been cleared.

Security and Maintenance of the Site

The school is completely fenced in and the station can be watched by the teachers during the school day. Security should not be an issue. The roads to San Jeronimo are very rough. During the rainy season there may be landslides blocking the road, we saw evidence of old landslides. You should call the school to see if the roads are clear before going to do maintenance.

Comments

None

Additional Information

Governmental Restrictions (i.e. permits, construction codes, etc.)

The school director had to confirm permission with the school board, but she did not foresee any restrictions.

Other:

The station should be placed in the center of the school on the side closest to the church soccer field (see pictures). It should either go on the roof or at least as high as the school. If the station is placed on the room or immediately next to the roof, the sensors need to be at least 1.5 meters from the surface of the roof. By having the instruments this high, it will negate the effect of the trees on the sides of the school and the school itself on measurements. The station was able to communicate with the Caspirola station without any problems.

Further Criteria for the Classifications of Component Constraints

Classification for Wind Speed:

Class 1: Sensor located at a distance of at least ten (10) times the height of the obstacle (elevation angle <5.7 degrees). Object considered an obstacle if seen at angular width >10 degrees. Obstacle is below 5.5m height within a 150m radius and 7m within a 300m radius. Wind sensor located a minimum distance of 15 times the width of thin nearby obstacles (i.e. mast, tree with angular width <10 degrees). Surrounding terrain relief change </= 5m within a 300m radius.

Class 2 (error 10%): Same as Class 1 except terrain change </= 5m within a 100m radius.

Class 3 (error 20%): Same as Class 1 except no obstacles within five times the height of the nearby obstacles (elevation angle <11.3 degrees). Wind sensor located a minimum distance of 10 times the width of thin nearby obstacles. Terrain change </= 1m within a 10m radius.

Class 4 (error 30%): Same as Class 3 except no obstacles within 2.5 times the height of the nearby obstacles (elevation angle <21.8 degrees).

Class 5 (error >40%): Obstacles within 2.5 times the height of the nearby obstacles.

Class 6 (error >50%): Obstacles with a height >10m, seen with an angular width greater than 60 degrees are within a 20m distance.

Classification for Precipitation:

Class 1: Flat horizontal ground surround by a cleared surface with a slope below 1/3 (<19 degrees). Any obstacle must be located at a distance of at least 4 times the height of the obstacle. An obstacle is an object seen from the precipitation gauge with an angular width of =/>10 degrees.

Class 2 (error 5%): Same as Class 1, except an obstacle is located at a distance of at least two (2) times its height.

Class 3 (error 10% to 20%): Ground with a slope below 1/2 (<30 degrees). Any obstacle is located at a distance of at least its height.

Class 4 (error >20%): Ground with a slope >30 degrees. Obstacles located at a distance less than their height.

Class 5 (error > 50%): Obstacles overhanging the gauge.

PICTURES

View from site

View from site


View from site

View from site

View from site

View from site


View from site

Tree next to school.

IMN Site Evaluation Metadata Sheet
SAN MARCOS (RODEO)

Surveyor Name: Angel Martinez, Tom Page, Luis Zumbado

Date of Visit: November 18, 2008

Location (City, County, District): San Marcos (Rodeo)

Site Contact Information

Contact Name:

Organization:

Address:

Phone:

Fax:

Email:

Prior to Leaving to the Sites

- Have at several sites proposed to evaluate in the general area
- Get general site description and digital pictures, aerial photos, topographic maps, etc.
- Review accessibility and maintenance
- Evaluate current and future uses of the proposed site and area with the IMN

Specific Site Properties

Latitude:

Longitude:

Elevation: 1602 meters

Type of Property (Private Property, National Park, etc.):

Types of Meteorological or other Scientific Sites in the Area:

None

Comments:

None

Physical Properties of the Site

(**PREPARATION:** Have Topographic Maps for each individual site and one that includes all potential sites in the area. Bring aerial photos.)

Take a 360 degree panoramic picture at the proposed location with multiple pictures

Describe the use of the Land and the General Area (i.e. farm land, lumber field, sports field, etc.)

The house in a neighborhood with scattered coffee and banana agriculture. The station be placed in the backyard of the house.

Give a description of the terrain in words for 360 degrees (i.e. hills, valleys, level plane, distances, directions to the nearest town, ground cover, etc.)

San Marcos is in mountainous terrain. The area where the house is located is relatively flat. There is a slight slope in the neighborhood but it is not steep enough to interfere with data collection. The city of San Marcos is only minutes away on well maintained roads. The ground in the backyard is mostly dirt.

Obstructions in the Area 360 degrees (trees, buildings, other structures, distances, and heights)

There are very few obstructions near the site. The house is one story and is approximately 5 meters high. There are some trees in the area, but none taller than the height of the house. There is also a fence along the edge of the property.

Examine Site Meteorological Equipment Constraints
All sensors should be about 1.5 meters from the ground (Assess and Circle the "BEST" Case that matches the site (1 through 5). Include an explanation on the assigned number)

1 = Excellent **2 = Good** **3 = Fair** **4 = Poor** **5 = Very Poor**

Wind Speed (Sensor should be at least ten times the height of nearby buildings, trees, or other obstructions)

1 2 3 4 5

If the station is placed at least as high as the house, there are no obstructions in the area that could block wind readings.

Precipitation (Tipping buckets should be no closer than four times the height of an obstruction, the orifice of the gage must be in a horizontal plane, wind shields are recommended

1 2 3 4 5

If the station is placed at least as high as the house, there are no obstructions that could interfere with precipitation readings.

Comments:

None

Review Weather Phenomenon in the Area (i.e. flash floods, land slide, tornadoes, hurricanes, etc.)

There are some landslides in the general area, but there were no signs of landslides in the immediate San Marcos area. The land the neighborhood is in is relatively flat so there shouldn't be any risk of landslide at the site.

Security and Maintenance of the Site

The house is surrounded by barbed wire fencing. There should be no problems with security at the site. The site is easily accessible via well maintained roads so getting there for site maintenance should be easy.

Comments

None

Additional Information

Governmental Restrictions (i.e. permits, construction codes, etc.)

None

Other:

The station should be placed to the southwest of the house towards the fence along the perimeter of the property. The instruments should be at least as high as the height of the house, this will make sure that any obstructions will be negated. The site was not able to communicate with the repeater. We tried many locations in the area, but none were able to communicate with the repeater on Cerro de la Muerta. A new repeater will have to be installed in the area. Direct communication did not work with the other sites either. During installation, try to gain communication with the repeater, it may work if the signal is being sent from higher up.

Further Criteria for the Classifications of Component Constraints

Classification for Wind Speed:

Class 1: Sensor located at a distance of at least ten (10) times the height of the obstacle (elevation angle <5.7 degrees). Object considered an obstacle if seen at angular width >10 degrees. Obstacle is below 5.5m height within a 150m radius and 7m within a 300m radius. Wind sensor located a minimum distance of 15 times the width of thin nearby obstacles (i.e. mast, tree with angular width <10 degrees). Surrounding terrain relief change </= 5m within a 300m radius.

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Class 5 (error > 50%): Obstacles overhanging the gauge.

PICTURES

View from site

View from site

View from site

View from site


Site should go here

IMN Site Evaluation Metadata Sheet
LA LUCHA

Surveyor Name: Angel Martinez, Thomas Page, Luis Zumbado

Date of Visit: November 18, 2008

Location (City, County, District): La Lucha

Site Contact Information

Contact Name:

Organization: N/A (A finca in la lucha)

Address: N/A (A finca in la lucha)

Phone:

Fax: N/A

Email: N/A

Prior to Leaving to the Sites

- Have at several sites proposed to evaluate in the general area
- Get general site description and digital pictures, aerial photos, topographic maps, etc.
- Review accessibility and maintenance
- Evaluate current and future uses of the proposed site and area with the IMN

Specific Site Properties

Latitude:

Longitude:

Elevation: 1835 meters

Type of Property (Private Property, National Park, etc.): A private finca that is very secure and secluded from the rest of the town.

Types of Meteorological or other Scientific Sites in the Area: There already exists a weather station in the area it is a full weather station

Comments: The fact that there already exists a full weather station at the location may not require another station to just record precipitation. This station was located on the other end of the river that flows through the finca and it was recommended to be placed here by XXXX because the behavior of the weather seems to differ on the two sides of the river. This site could be placed on the lawn of a house that belongs to the finca. The station would have to be elevated in order to record accurate measurements. There are tall trees surrounding the area, but with a properly elevated station they should not impact the measurements. Communication is moderate at the site, but should work well enough when elevated. An alternate location could be a small clearing near the house that could even have the capability to record wind data based on the clearance the area has.


MINAE

Alternate Location near the house.

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