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NATIONAL ECONOMIC AND DEVELOPMENT AUTHORITY

PHILIPPINE NATIONAL VOLUNTEER SERVICE COORDINATING AGENCY

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hereby presents this

CERTIFICATE OF APPRECIATION

to

WILLIAM THURMAN NUTT, JR.

of the United States Peace Corps (USPC) for his role in enhancing and promoting international cooperation through dedicated and selfless volunteer service in the Philippines during the period from 31 May 2014 to 5 December 2014.

Given this 2nd day of December 2014 at PNVSCA, Quezon City, Philippines.

JOSELITO C. DE VERA
Executive Director

DESCRIPTION OF SERVICE
UNITED STATES PEACE CORPS RESPONSE
PHILIPPINES

WILLIAM THURMAN NUTT, JR.
MAY 31, 2014 TO DECEMBER 5, 2014

Peace Corps Response Volunteer William Thurman Nutt, Jr. started his service on May 31, 2014 in the Philippines. Following a ten-day orientation in Manila, he began work with the Local Government in Guiuan, Eastern Samar. William was assigned to the Municipal Planning office, in Guiuan, Eastern Samar as a

COMPREHENSIVE ENVIRONMENTAL LAND USE PLANNING AND MAPPING EXPERT.

As member of the Guiuan Recovery and Rehabilitation Group created to coordinate response efforts in the wake of Typhoon Yolanda, William was responsible for mapping and assessing the groundwater resources of Guiuan. He participated in the gathering of local environmental data, and provided technical assistance in data processing, analysis, and geo-spatial presentation.

In this role, he carried out the following duties:

1. Coordinated the ArcGIS geo-referencing and digitizing the blueprint cadastral survey maps and other printed maps of the 60 barangays to produce an accurate political boundary map.

2. Conducted a comprehensive field survey of 37 Rural Barangays, to assess and map the condition of water resources. Survey included 969 wells and pumps as well as locations and condition of barangay and municipal water system access points. Ecologically sensitive areas and watershed aspects such as zones of vulnerability and recharge areas were also identified and mapped.

3. Assessed the wells and pumps on a 10-point scale to rate the improvement aspects of water resources, along with a suggested continuous improvement management plan based on international standards.

4. Provided an analysis of the karst groundwater system, sources of freshwater, and saltwater intrusion, taking into account the geological context of Guiuan and Typhoon Yolanda recovery considerations.

5. Assessed threats to watershed and ecological sensitive landscapes affected by Yolanda and provided recommendations relating to the natural forest succession and recovery process.

6. Prepared Barangay specific maps and descriptions of the water resources that summarized the findings and presented to the municipal planning officials of Guiuan a formal report of survey results.

Assessment of Groundwater Resources: Field Survey Results in Guiuan, Eastern Samar, Philippines

William Thurman Nutt, Jr.

United States Peace Response Volunteer, Municipality of Guiuan, Eastern Samar

December 1, 2014

AKNOWLEDGMENT

First, I would like to thank the government of the United States of America for giving me this opportunity to serve in Guiuan. Ms. Nanayaa Kumi, my recruiter in Washington D.C. helped me at every step in the long and difficult application-approval process. In-country Program Manager, Mr. Milo Cruz, and Ms. Shiela San Jose, Program Assistant, along with the PC-Philippine staff in Manila, all provided support and advice along the way. Everyone was instrumental in making my experience a success. Ms. Lani Berino, who always made travel easy, was especially helpful during my emergency leave in The States.

To my counterparts in the Guiuan Planning office, Ms. Nenita Ecleo, and Mr. Rectito Melquiades, I wish to offer my sincere thanks for the support on the job, hospitality and friendship. I would also like to thank Mr. David Garcia and his UN Habitat staff for their technical and logistical assistance in the office and in the field. Over all I have never worked with a group of more dedicated public servants and talented young professionals such as I have been fortunate to be associated with in Guiuan over the past six months.

An finally I would like to thank Mr. Elysar Sevilla, the student caretaker at my residence who helped me stay safe, secure, well rested, and fed in my comfortable home during my stay in Guiuan.

TABLE OF CONTENTS

TABLE OF CONTENTS vi

PART I: INTRODUCTION 1

Guiuan and Initial Mapping 2

Geology of Guiuan 7

Typhoon Yolanda Recovery Considerations 8

PART II: GROUNDWATER MANAGEMENT 10

Understanding the Groundwater System 11

Salt water intrusion 16

Sources of Freshwater 17

Continuous Improvement 21

A Sample Well Improvement Standard 22

Well Improvement Aspects 23

PART III: ECOLOGICAL CONSIDERATIONS 25

Threats to Watershed 25

Landscapes Affected by Yolanda 26

PART IV: BARANGAY SURVEY RESULTS 30

Methodology 30

Barangay Summaries 32

BIBLIOGRAPHY 70

PART I

INTRODUCTION

William Nutt, Returned Peace Corps Volunteer (RPCV Southern Leyte-Philippines 1979-1981), serving as a Peace Corps Response Volunteer (PCRV), conducted this assessment from mid-June to the end of November 2014. William was assigned to the Municipal Government Planning office, in Guiuan, Eastern Samar as a "Comprehensive Environmental Land Use Planning Expert". Guiuan was the municipality that received the initial and direct impact of Super Typhoon Yolanda November 8, 2013. As a member of the Guiuan Planning and Emergency Recovery team, William participated in the gathering of local environmental data, and provided technical assistance in data processing, analysis, and geo-spatial presentation. This report documents aspects and access of the freshwater resources of the karst aquifer along with other ecological sensitive areas. The volunteer also coordinated the geo-referencing and digitizing in ArcGIS, the blueprint cadastral survey maps and other printed maps of the 60 barangays to produce an accurate political boundary basemap.

This work will be useful in revising the Comprehensive Land Use Plan 2014-2022 that will be used by the local government to build on what has been accomplished post-disaster and achieve long-term planning goals. The leaders and citizens of Guiuan are striving to improve the quality of life of everyone while protecting and conserving the environment and recover its position as a premier location for ecotourism in the Philippines. In this report "the surveyor", "the assessor" or "the volunteer" refers to the Peace Corps Response Volunteer (PCRV).

Local leadership as referred to throughout this report is not an oversimplification. It emphasizes that leadership in any form is a powerful force in improving the environment in our communities. While this all inclusive term refers primarily to elected representatives and executives, appointed officials, and staff members at the municipal and barangay level, local leadership may represent those environmentally inclined leaders, young and old, found in every community: The young man who vigorously protects his spring from contamination when used by his neighbors in Cagdara-o; the

elderly lady in Ward 12 who comes to tears when she speaks of when the spring ran free from litter.

The stresses involved with typhoon recovery have driven home the point that the scenic landscape is also functional and provides valuable environmental services. In addition to their aesthetic qualities, sustainable forest and agricultural practices protect the watershed. Coral reefs, old growth tropical forests and mangroves are nurseries for wildlife and fish and shelter coastal barangays from the effects of storms. As pressures of development, population growth and natural disasters such as Yolanda increase, homegrown Philippine environmentalism in the form of local preservation and conservation movements have emerged.

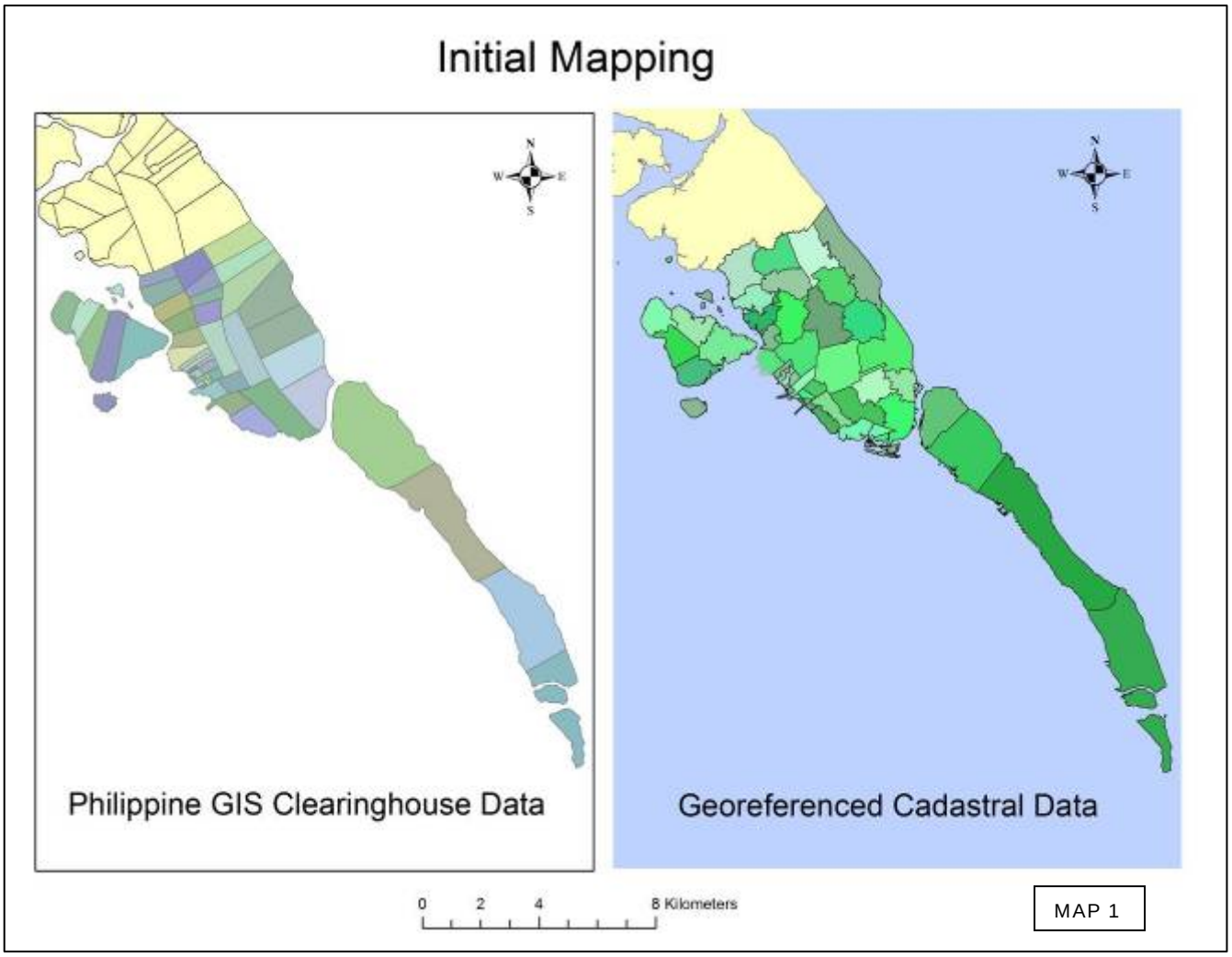
Environmentalism is not simply a matter of recycling, anti-littering campaigns or promoting eco-tourism. These often-heard catchphrases, given lip service by the politicians and development officials, work to deflect the attention from the real issues and true principals of sustainable development. The lush paradise of the Philippines is being ravaged at a rapid pace by mining and logging companies, extensive coastal fish farms, multinational agribusiness, and manufacturing corporations (Broad 1993). Supported by national government policies, economic development is pursued at all cost; however, cost in the form of degradation to the natural environment cannot be sustained. The threat of global climate change is compounding the negative effects of unsustainable growth on the overfished waters, scarce agriculture lands, and disappearing forests. Rural populations are placed in a position of having to fight for their survival. Guiuan is at the forefront in this struggle in the Philippines. Frequent news from Homonhon and Manicani Islands tells us of local revolts where protesters block mining operations, risking their lives (Holden 2012). The people of Guiuan, along with their international partners, are striving to "build back better" and "get it right" when it comes to protecting the environment and ensure sustainable future for everyone.

Guiuan and Initial Mapping Methodology

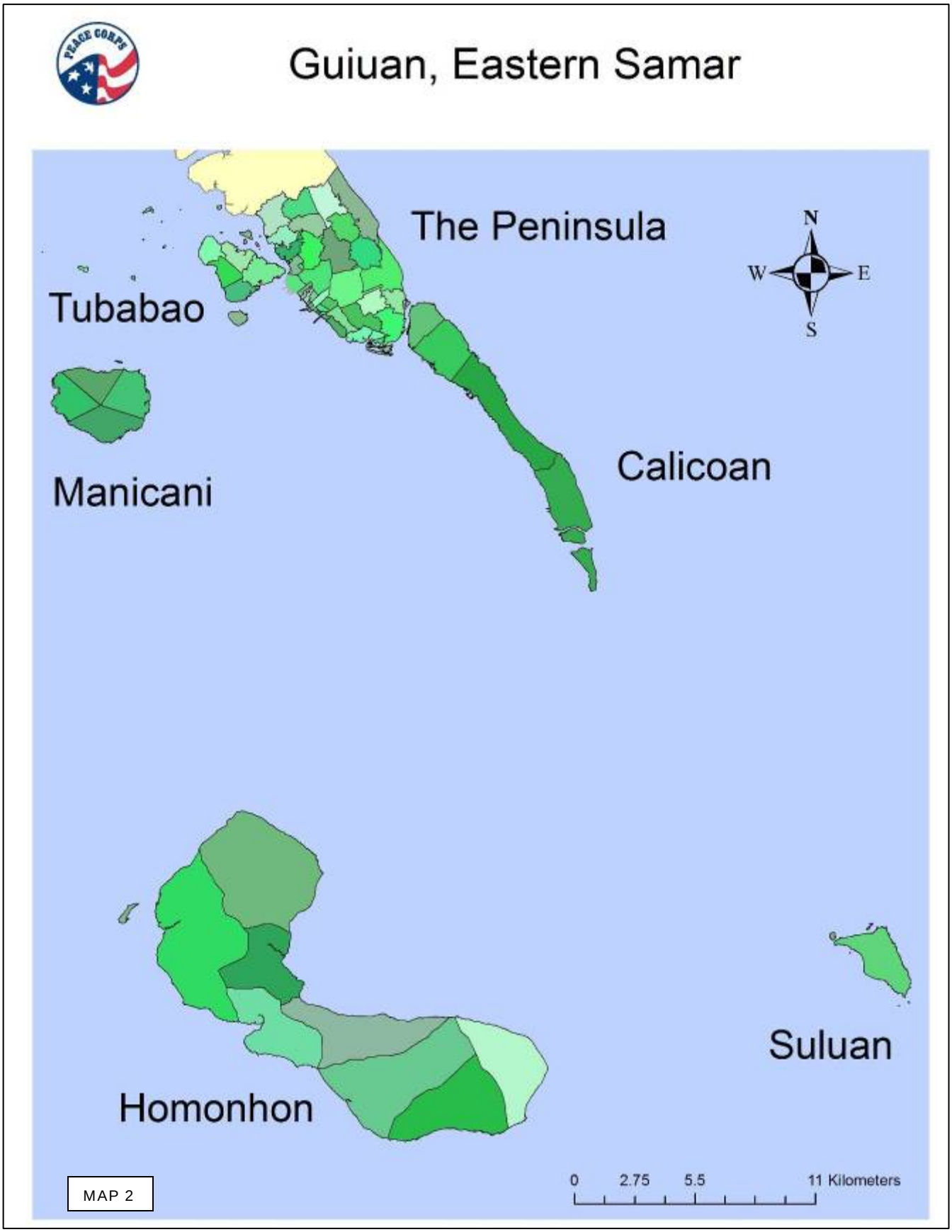
Guiuan is a municipality, or Local Government Unit (LGU), at the southern tip of Eastern Samar and consists of a narrow peninsula surrounded by numerous large islands that make up a substantial part of the total Municipal area. As an essential part of the assessment, the first mapping task was to construct an accurate GIS map of Guiuan. The

existing maps in shapefile (GIS) format available at the Philippine GIS clearinghouse were found to be produced with little consideration for accurate boundaries and were of little use for this study. Surprisingly, while they did not represent the actual boundaries, they were in widespread use by relief agencies currently undertaking rebuilding efforts in Guiuan.

Having a map with spatially accurate barangay boundaries was an initial imperative recognized early on by the LGU recovery team and the regional offices provided cadastral survey maps in scanned, bitmap format. UN staff constructed the first detailed base map by the from a current Google Earth image. This initial map contained high-resolution coastal details and minor outlying islands. The volunteer geo-referenced the cadastral maps using ArcGIS 10.2 onto the coastline base map. Using the coastal data along with open source road shapefiles, the volunteer produced a more accurate barangay map. Where no cadastral data existed of barangays, boundaries the volunteer interpolated borders from neighboring barangays and other printed maps. Further ground confirmation using GPS data points along with local knowledge, improved the accuracy of the base map. Map-1 below shows before and after maps of the improved boundaries. Map-2 and Map-3a to Map-3f present the 60 Barangays of Guiuan.



Road Data. Roads and trails that do not always show up on satellite imagery and were not available in the secondary open source road data connect many of the rural barangays. Wells and other water source aspects are often located very close to these pathways. Necessarily, the volunteer used primary GPS data tracks to construct the by-way routes that accurately represent the water source points as being right or left of the track. Consequently, other road data from secondary sources used for subsequent maps or survey plans may be problematic. In addition, unimproved footpaths are represented the same as barangay and national highways. The standard caution to check locally applies when using road data in this study.


Guiuan, Eastern Samar
The Peninsula
Tubabao
Manicani
Calicoan
N
W
E
S
Homonhon
Suluan
0
2.75
5.5
11 Kilometers
MAP 2


Guiuan Peninsula
Banahao
Bagua
Timberland
Alingarog
Timala
Hagna
Bucao
Cagdara-o
Mayana
Surok
Gahoy
Santo Nino
San Juan
Cogon
Sapao
Lupok
Cantahay
Camparang
Ward 12
Ward 8
Taytay
Tagporo
Ward 6
Ward 4
Salug
Dalaragan
Barbo
Campoyong
Bungtod
Baras
MAP 3a


Tubabao Island
Banahao
Alingarog
Timala
Trinidad
Cagdara-o
San Antonio
Santo Nino
San Pedro
San Juan
Cogon
Lupok
Camparang
Ward 12
MAP 3b


Manicani & Victory Islands
Victory Island
Hamorawon
San Jose
Buenavista
Banaag
MAP 3c


Calicoan Island
Tagporo
Taytay
Barbo
Pagnamitan
Baras
Ngolos
Sulangan
MAP 3d

Geology of Guiuan

A large linear ridge dominates the geology of Guiuan. Two fault lines that generally trend northwest along the southeastern tip of Samar control the ridge, which is an uplifted block of limestone that was formed during Lower to Middle Miocene Age (15-20 million years ago). Formed by the tectonic forces that control the main Philippine Fault System, running the length of the Philippine Islands and bisecting Leyte to the east, the faults are part of the larger system that crisscross Samar. One of these forces is the subduction occurring at the Philippine Trench located to the east of Guiuan and dip to the west. Another zone of subduction lies to the west of the Philippine archipelago. This creates shearing forces causing the block to uplift. Subsequent younger coral formations accumulated around this block of crystallized or "Coralline" limestone and form the rolling hills to the west of the ridge and an almost continuous strip along the east coast. An additional uplift of 40 meters occurred and the subsequent erosion created the karst landscape we see today (Travaglia 1978). In Map-4 below, the fault system and major elevation features are highlighted.


Guiuan Elevations
N
W
E
S
Legend
Elevations 0-5 Meters
Elevations 5-10 Meters
Elevations 90 Meters or Higher
Guiuan Elevation Contours: 5 Meter
Fault Lines
0 0.5 1 2 Kilometers
MAP 4
Elevation Data Source: Philippine GIS Clearinghouse
Fault Lines approximated from Travaglia (1978)

Recognized by its pink color, the newly formed Caloocan Limestone is soft and more porous than the Coralline uplifted area. Another dominant feature of the peninsula and island geology is the red clay or "terra rosa" that is found in most areas and elevations. The coastal regions have sediments and beach deposits typical of those formed by the tidal forces in coral reef environments. Smaller outcrops of large heavily weathered boulders and pillars of limestone make up the elevated areas west of the Pacific Ridge. The field survey found evidence of later (perhaps Quaternary) volcanism at the northwestern tip of Suluan Islands in the form of basaltic pillow lava formations and remnants of cinder cones. On Tubabao Island in San Juan, traces of a volcanic crater and extrusive volcanic rocks (andesitic to basaltic) and boulders are present. The major roads through the barangay are paved with gravel of extrusive volcanic origin.

The terrain of Guiuan consists of highly vegetated karst features typical of tropical landscapes consisting of carbonate rocks. The dramatic Pacific Ridge exhibits striking exposed weathered outcrops along the east coast of the peninsula. The ridge gives way to various depressions and elevations to the west. Because of the extensive vegetated cover, these features are difficult to define and delineate. Geologists generally classify the depressions as sinkholes and more specifically as karren, doline and uvala (Ulrich 2005). In Guiuan, the more expansive and generally linear sink areas are very likely the result of collapsed caves. There is evidence of extensive regions of collapse along and north of the Navy Road in Cogon and along the barangay road in Gahoy, Hagna and Bagua. Also found among the varied and often spectacular weathered landscape are examples pinnacle karst along the northeast Pacific Coast of Calicoan Island in Pagnamitan.

Typhoon Yolanda Recovery Considerations

The typhoon of November 8, 2013 is named Haiyan internationally and Yolanda locally and will be referred to in the report as "the typhoon" or Yolanda. The recovery and rebuilding efforts over the past year by the citizens of Guiuan have been remarkable. Local leaders are single minded in their resolve to "build back better" and are assisted by many Non-government agencies both international and Philippine based. UN agencies, OXFAM, and the Red Cross are among some of the high profile agencies that have made

long-term commitments to the recovery. Credit goes to Operation Blessing and Y'S Men, two faith-based organizations, for restoring water sources in areas with the most critical needs.

In terms of this survey, it was difficult to determine if the current state of the wells was a direct cause of the typhoon or due to natural deterioration. Understandably, there is a lot of work in-progress. Some typhoon effects are obvious such as the widespread and almost complete destruction of the Barangay Water System utilities. Often referred to as "solar tanks" these used advanced technology to power the water pumps. The storm also washed away concrete aprons around wells. Other conditions such as the cause of the apparent abandonment of wells and their collection of debris and trash are less apparent. Jetmatic pumps are of durable construction and would survive many calamities, however many were snapped off by the typhoon debris and falling trees. Others may have been in disrepair and unusable before the storm. Emergency response teams unceremoniously opened wells that were previously covered and secure in the days after the typhoon. Local testimony and evidence supports that this necessity had a widespread effect on the well condition. Consequently, in compiling this survey and assessment there was little for the surveyor to gain in attempting to judge the cause of the current state of the wells and other water resources. By all personal accounts, and supported by the evidence in the field, this was one of the most destructive storms in recorded history and it affected every person and most aspect of their lives in some way.

This inability in determining cause-effect relationships in current conditions makes recommendations concerning specific long-term solutions for improvement difficult. From the standpoint of the individual property owner or resident, the repair or installation of a manual jetmatic pump near their home was a commonly expressed need. The surveyor, however, is not convinced that more jetmatics is a long-term solution. During this survey, one fact became apparent. Manual pumps are convent and desirable but when other priorities or imperatives present themselves, and with a plentiful water supply by the bucket-full just meters away, the pump becomes a luxury and goes unrepaired. Previously protected wells become un-protected and deteriorate because they were not designed for easy and safe access without a pump. Whether breakdown was caused by the typhoon or otherwise, even those who can afford to install a manual pump

in their residences find it difficult to maintain. Where manual pumps were applied in common community areas, provisions for maintenance seemed better.

The surveyor does not consider Jetmatic repair, supply piping placement, faucet repair and other associated maintenance recommendations in any detail in this report. Exposed and obviously temporary piping for barangay and municipal water systems running along the surface and unprotected would appear to be poor practice when compared to more permanent piping placed underground, as in the US. Indeed many placements may be temporary due to emergency response measures post-typhoon. Underground placement of pipes is mainly to protect from freezing in colder climates or for aesthetic reasons. Indeed, maintenance of above ground flexible piping is relatively easy, and improvement in these areas is trivial compared to the magnitude of the rebuilding tasks at hand. These aspects of the water supply deserve the attention of local leadership nonetheless. Leaky pipes and broken faucets, which were observed on occasion along the survey trail, were by no means widespread, perhaps representing a normal level of corrective maintenance. In the not too distant future, through much hard work by local leadership, life will return to post-Yolanda conditions and long term goals will take center stage. The importance of a reliable community water source as a vital and sustaining force in daily life and in times of disaster will remain a central part community life.

PART II: GROUNDWATER MANAGEMENT

Having supply of fresh water for domestic uses is a fundamental human right. It is a traditional responsibility of local leadership to provide adequate and affordable sources. Accordingly, the maintenance of the infrastructure associated with the supply and the protection of the groundwater source requires coordinated community effort to ensure the ongoing security and viability and sustainability of the watershed. The World Health Organization (WHO) defines reasonable access as "availability of at least 20 liters of water per person per day from a source within one kilometer of the user's dwelling". In assessing whether any individual, family or group of residents have "reasonable access" to water as defined by the World Health Organization (WHO), the anecdotal results in the field seem favorable and most Guiuan residents appear to meet this requirement. The

surveyor did not perform any spatial analysis to test this condition. Residents who have to carry their water any distance from a well using the standard 5-gallon "jerry can", indicate that they use one to two cans each day for each person in the household.

Understanding the Groundwater System

In most areas of Guiuan the soil is very thin or absent and the aquifer makes direct contact with the atmosphere. The limestone bedrock has been dissolved to the point where large, open, and interconnected cavities and fractures are present. In this case, a limestone vadose zone would also be highly pours and not impede any contaminants and infiltration would be rapid. In such a hydrogeologic model, we would expect the water table to be relatively flat and minimally influenced by the terrain (Fetter 2001).

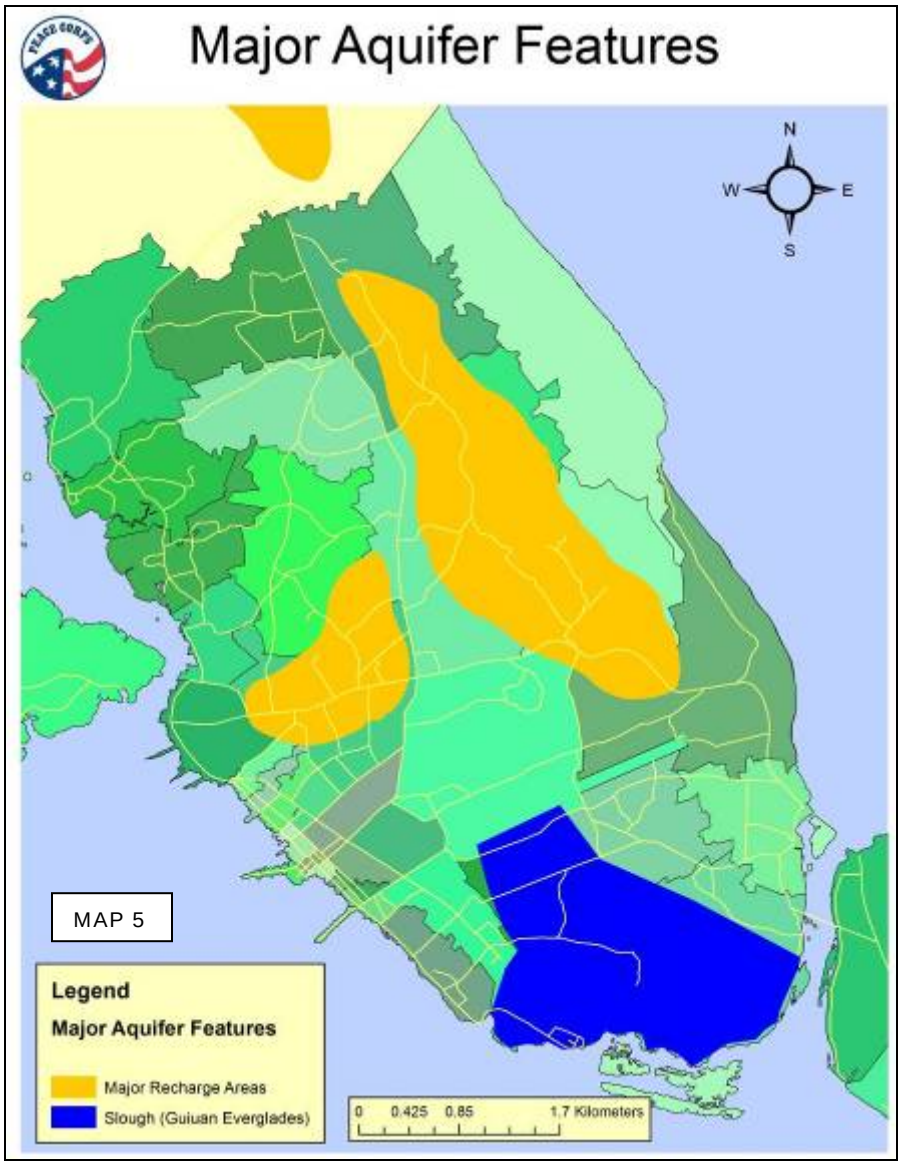
Since karst formations control the underlying geology of the region, modeling the ground water flow is not easy using surface field surveying methods alone and is beyond the scope of this study. Commonly, models are employed to compare areas of the landscape and hydrogeologic settings and assess the relative vulnerability to anthropogenic sources of groundwater contamination. Typically, the vulnerability factors considered in such indexes is depth to the water table, the amount of rainfall, or recharge of the aquifer, the aquifer media, the soil media, topography, impact of the vadose zone, and the hydraulic conductivity. The highest vulnerability values assigned to these factors are associated with karst landscapes (Aller 1987). Indeed the dynamic and open nature of the aquifer is an overriding factor and any detailed study to determine specific localized flows underground may be of limited use to inform local decisions concerning the water resources of Guiuan.

Generally, the aquifer is vulnerable to surface water contamination in most areas and only protected to any extent in areas that have a thicker soil covering such as the islands of Manicani and Tubabao. Even at higher elevations on the peninsula west of the Pacific Ridge, the karst landscape is highly solutionized and susceptible to swallow hole formation and new channels to the water table opening up. In the numerous dolines found throughout the peninsula where there is sufficient fertile soil to favor cultivation, agricultural disturbance favors the formation of channels and has the potential for rapid contamination of the groundwater (Urich 2005). Fortunately, organic farming methods have traditionally been employed in the rural Philippines for centuries. It is encouraging

to see these methods now being supported in Guiuan by NGOs assisting with agricultural projects aiding the recovery. Widespread contamination of water resources due to the overuse of pesticides and herbicides can be avoided in Guiuan if organic methods of farming remain the rule.

Given the intimate relationship between the surface and water table due to the overriding influence of the karst landscape, the surveyor hesitates to delineate any one area as a recharge zone. However based on review of the topographical and other digital elevation data as well as evidence gathered in the field, major areas of recharge are easily located. There are two that would appear as most vulnerable due to elevation and thinness or absence of a soil layer. The first is located between the National Road to Mercedes and the Pacific Ridge. This is roughly the areas in Bagua, Hagna, and Gahoy and adjacent to the road connecting these barangays. The second is the area in Cogon especially to the north of the Navy Road. The two areas were identified earlier in this study as possible collapsed caves. The evidence for these recharge areas and associated ground water flows is the ample (and visible) flows of fresh water along the coastal margins from Alangarog to Bungtod. There is also a dearth of observable freshwater flow to the coastal area east of the Pacific Ridge. Another major recharge area that supplies the peninsular barangays in the northwest are the low areas in Mercedes west of the Pacific Ridge.

A major lowland feature of Guiuan, similar to the Everglades located at the end of the karst landscape of the Florida Peninsula in the southeastern United States, is an extensive slough area that begins below the airstrip in Cantahay and flows mainly through the barangays of Dalaragan, Barbo, and Bungtod. The highly productive aquifer exits the highlands of the peninsula in a slow and widely dispersed flow through this region. As in Florida, this water combines with the tidal forces to provide a diverse, productive, and valuable wetland and estuary. This wetland also provides some of the best wastewater treatment services courtesy of Mother Nature. As is now recognized worldwide, natural wetlands are very efficient at neutralizing pollution flowing from point sources such as septic systems as in addition to as storm water non-point source pollution (IBRD 2010). In addition and best of all, it is a free service and its value should be recognized in planning and land use decisions. The recharge areas and slough feature are identified below in Map-5 below.



Once again the significance of the karst aquifer in Guiuan cannot be overstated. It is open, being recharged most everywhere, and vulnerable most everywhere. Local activity at the surface in any given location can have a direct effect on local wells and generalized modeling of the aquifer may be useful to inform leadership. Local patches of well-vegetated karst features or thicker soil will provide protection of the aquifer and specific wells. This vulnerability not only applies to the peninsula. Calicoan Island, having similar geology but a smaller amount of recharge area is more vulnerable to salt intrusion and the effects of the tides. There may be local effects, due to the probable

occurrence of underground passages and caves traversing any given area for great distances. Common knowledge holds that the water that enters a cave in Timala exits at the spring in Poblation Ward 12. While no specific study to prove or disprove the direct connection exists, it is highly probable when the macro view of the of the aquifer is considered. The interconnectedness of the aquifer and wells needs to be emphasized at every opportunity. If someone fails to maintain a well, it may contaminate neighboring wells.

Examples of contaminated and neglected wells are found throughout Guiuan. One of the most glaring illustrations of this is found in a pair of neighboring wells in Baras (Photo 1). In Kabadlungan, a fishing village to the south of the main population center of Baras, there is a new well that provides drinking water to the residents. Easily recognizable as a recent Operation Blessing installation, it is appropriately adorned with Biblical verses concerning the vital and spiritual force that water gives us (Photo 2). The angelic benefactors were apparently unaware that the devil has set up shop about 10 feet away. The previous well abandoned for some reason and pump in disrepair, is left unsecured and is collecting garbage (Photo 3). If left to fill up with debris the newly installed well will be threatened with contamination also.

Photo 1

Photo 2

Photo 3

Salt Water Intrusion.

In many of the areas near the populated coastal fringes of Guiuan, saltwater intrusion into freshwater aquifers is increasing. This occurs when water draws are in excess of natural recharge. In Guiuan, well water that is normally suitable only for utility purposes becomes unacceptable if the salt content becomes high. In Guiuan freshwater flows out at the coastline or along marine shelf areas and the lack of surface flow in the form of rivers and streams is remarkable in the karst lanscapes of the Peninsula and Calicoan Island. Under normal or equilibrium conditions without drawing or pumping, freshwater discharge to the ocean exerts positive pressure that prevents inland migration of saltwater. In areas with large landmass, the denser saltwater forms a wedge under the freshwater. Saltwater intrusion is usually a direct result of human activity. When water is drawn from a well, the interface between the saltwater and freshwater rises (Scholze 2002). Examples applicable in Guiuan, could take the form of excessive pumping at supply wells or the destruction of natural barriers in the construction of channels in the coral shelf areas.

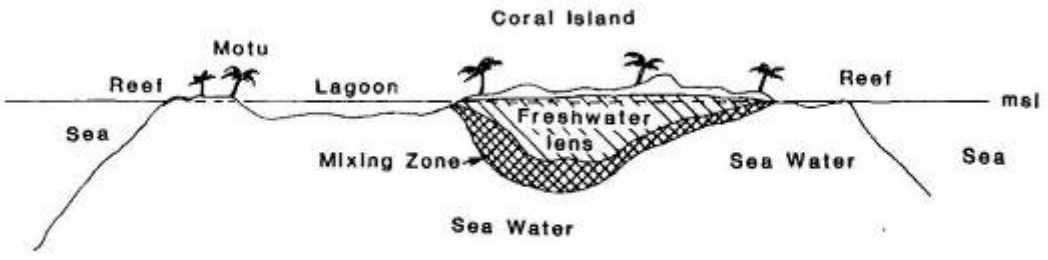


Figure 1

Adapted from Dale (1987) *Coral Island Hydrology*

The fresh water flows to the sea at the coastal margins and the saltwater wedge penetrates into the lower levels of the aquifer. The Guiuan Peninsula and narrow islands this wedge penetrates from the Pacific on the east and Leyte Gulf on the west. Essentially, the Guiuan Peninsula is an island only narrowly connected to Samar. Therefore, the ground water flow fits more the island model than one based on a larger

contiguous land mass. In the insular case, shown above in Figure-1, the two wedges meet and the fresh water is fundamentally a "lens" of fresh water of various depths above the saltwater (Dale 1987). This case is highly probable for the Peninsula and almost certainly the case with the narrow island of Caloocan to the south of the peninsula and other outlying islands.

Local knowledge throughout the barangays helps us understand the different effects of the salt water on the water table. In Sapao along the narrow strip of land east of the Pacific Ridge, village elders note that during high tides, fresh water at their pump is more abundant that at low tide. With a broad coral fringe protecting the aquifer for some distance out to sea, the high tide raises the freshwater lens and the water table to create the abundance. The wells at the southern tip of Calicoan Island were surveyed at low tide and found to be dry. Local residents said that the freshwater would return with the high tide in a few hours. In areas of Lupok that lack a broad coastal fringe and have a coastline that has been extensively engineered and modified by humans over the decades, high tides increase the salinity of the wells nearest the waterline.

Sources of Freshwater

Manually Dug Wells. In many barangays where the water table is close to the surface, shallow wells allow a group of households to dip water for bathing and washing of clothing and other cleaning purposes. These traditional wells are found in central locations with well-trodden pathways leading from multiple directions. Often the natural setting and unimproved condition of the well indicates that the freshwater at the surface may be a natural occurrence. Some of these wells have a reputation for safe and good tasting water and developed as drinking water wells. These wells have obviously been used for generations, and have cultural significance beyond providing water for daily use. The deepest well surveyed is found in Mayana and is more than 60 feet deep.

To minimize the influences of the salt water and septic systems, wells in coastal barangays locate their wells as far inland as possible, and pump the water to residences located along the coastal roads. In barangays with higher elevations, improved wells seem to be evenly distributed to minimize travel distances. A deeper water table means fewer wells and more considered and centralized locations separate from dwellings. In

areas nearer the water table, wells seem to be dug with convenience the main consideration. Consequently, these wells are sited near homes and adjacent to septic systems. In populated areas there is a well for every group of less affluent households, and a dedicated well for larger homes with residents of obvious means.

A common improvement of the community dug well consists of lengths of culvert piping or masonry "hollow blocks" extending above grade of up to a meter and penetrate the aquifer some meters allowing for sufficient quantities of water to be dipped out to support the usage multiple households. These wells often are improved with a concrete aprons and removable covers. Some wells have associated with the water source a manual "jetmatic" pump. This ubiquitous cast iron, positive displacement pump can be configured remotely away from the water source or can be integrated in a concrete complex directly over the source. Because it uses suction pressure to draw water from the source, jetmatic pumps are limited to areas where the distance to the water table is less than ten meters (Mihelcic 2009). The jetmatic allows for a lot of flexibility as to the location of the source. Some sources are sealed with concrete covers. Others are simply the dug well with the connecting pipe fitted over rim and into the water below. Many sources are located directly below the pump or remotely sealed underground. Jetmatics can be located in common community areas or can be used to supply water inside residences.

The extensive use of ground water from unsecure dug wells in Guiuan poses one of the greatest threats of contamination of the water supply. Due to improper design and maintenance, these wells usually two or more feet in diameter and shallow in depth are found to be unlined or lined with open-jointed materials. Many do not have proper covers to seal out debris, animals or insects. Some are not curbed and without aprons to prevent the entry of storm water or water from bathing or clothes and dish washing adjacent to the well. As illustrated above, when newer more convenient sources of water become available, these wells are abandoned without being sealed and secured and collect garbage and litter. With the widespread destruction of the barangay water systems and the temporary interruption and contamination of the municipal supply because of the typhoon, the importance of these traditional and more resilient sources comes into focus in the rural barangays.

Drilled wells. In many locations where the water table exceeds the maximum that can be lifted by a manual suction pump, drilled wells with downhole positive displacement pump applications are used. Locally called "artesian" wells, these pumps have concrete pillars that support long levers and linkages to push the water up. Many of these pumps are in various states of damage, disrepair and disuse. The remnants in the form of the abandoned pillars can be found through out the common areas in barangays and along roads, representing once widespread application of this technology.

Barangay Water System (BWS). Another source of water is the barangay tank. Supplied by pumped water or gravity-fed captured springs, these systems pipe fresh water to residences nearby. Some are stand-alone systems where residents fill their containers at a central location in the barangay. Representing an extensive water improvement project constructed in most barangays, these tanks were once solar powered. They were decimated by typhoon Yolanda. The survey only found two of these tanks, in barangays San Juan and Camparang on Tubabao Island, having been recovered from storm damage. These tanks are otherwise being replaced by various sized plastic tanks on new towers or rehabilitated "solar" tank towers. These solar systems typically had faucet stands through out the denser populated areas of the barangays. Local leaders with their NGO partners have prioritized the recovery of these resources throughout the barangays and the work continues. One such installation in Trinidad, built with Japanese assistance, employs advanced multi-stage filtration. The capacity of these systems is limited to several hours mainly in the early morning until noontime. The supply is unmetered and available to all on a first-come basis. Some water is supplied at the point of use in homes for a flat monthly fee. As a necessary condition recognized by the leadership, a nominal fee is charged to provide for the ongoing operation and maintenance of the new stand-alone system.

Municipal Water System (MWS): Another source of fresh water is the Municipal water supply. The core of the system consists of large concrete tanks with multiple sources and high capacity pumps located at higher elevations on the peninsula in Cantahay, Surok and Timala. One of the tanks is dedicated to supply the Barangays situated on Calicoan Island to the south. This system also supplies the denser populated areas of Guiuan at lower elevations. This water is metered and residents typically pay less

than 1000 pesos a month. Consequently, it is tapped by those residents who can afford it. Where it is available, often the water is offered to the general population at a nominal fee of two pesos for five gallons. Since the typhoon, the MWS has been working at building capacity and improving the quality of the water.

Springs and Creeks: In a few Guiuan peninsular barangays, where spring flow is plentiful, confining structures are built to effectively separate the fresh water from tidal flows or captured at higher elevations. These springs are incorporated into the village landscape for recreational, bathing and laundry purposes. In the locations blessed with such a convenient, plentiful, and refreshing resource of fresh water, pools have been established that vary in configuration from natural areas with simple concrete jumping and access platforms to elaborate concrete structures incorporating culverts to channel rainwater around the pool and retaining walls to constrain the inflow of the tides or othewise control the flow.

The exploitation of springs as a primary water source is more common on the islands of Tubabao and Manicani. Unlike peninsular Guiuan, having retained much of their clay mantle, flowing water is relatively abundant. Springs and their associated creeks, range from unimproved pools along the stream to sturdy concrete spring boxes or other more permanent stream capture methods, providing benefits of improved water quality and access. When these outfows are captured at higher elevations, they are commonly used as the BWS supply. Overflow is managed nearby for bathing and laundry purposes.

Rain Water Collection. As might be expected, where households need to haul water some distances to their homes from the source, rainwater catchment in 55-gallon drums and other containers is common sense. Some community sanitary facilities in areas associated with the temporary living quarters of Yolanda affected families or those associated with barangay school rehabilitation incorporate rainwater catchment extensively in the design.

Bottled Water. Another source of water is the local bottled or "mineral" water refiner. These operations found mainly near town are cottage industry, small business in scale and use reverse osmosis and carbon filtering to "purify" the water for drinking. Supplied in 5-gallon containers, prices are such that most of the population is able to use

this filtered water. Remarkably, the widespread availability of this water has perhaps unjustly condemned the more traditional sources of water as unfit for human consumption. Without any test data or even empirical facts such as the outbreaks of water-born bacterial related ailments, most wells and pump water is judged "un-safe" for drinking.

Continuous Improvement

Water source improvement and development is observed in most locations along the survey trail and every barangay has examples of what could be characterized as "best practice". Examples of innovative designs both traditional and modern are abundant. The following Well Standard is proposed below not to replace any existing program. The surveyor, having some experience in environmental management systems with worldwide application, is suggesting a framework that is successful to achieve continuous improvement. The simple and intuitive approach is applicable at any level of organization and can be applied to improve the water sources in Guiuan.

It is evident throughout the survey trail that barangay leadership is prioritizing specific wells for improvement and newly constructed wells exhibit all the improvements contained in the aspects presented below. Indeed, an important part of any management plan is the dissemination of best and innovative practices and new technologies and in when applied across the board promotes continuous improvement. Apart from new installations, some of the older wells, which have withstood heavy use over the decades, have features that need to be studied. Any improvement program will necessarily take into account available financial, technical resources and other limitations both current and related to the recovery and ongoing resources that can be sustained long term. The improvement plan may apply to one well, a group of wells, or all wells. The program should be administered with the understanding that improvement will occur over many years and is a continuous process. Existing methods of well improvement and existing technologies should be appropriate for the program. Indeed, where practical, resources, such as labor and materials should be procured locally.

Application Note-1: In assessing the improvement of the wells, the surveyor noted the presence of a serviceable jetmatic pump as an improvement, regardless of whether the pump was working or not. The appearance of the pump and the

surroundings may have indicated that residents were not using it; however, this was not generally noted in the results of the survey. Consequently, fixing a pump, while an obvious improvement for the residents, may not be an improvement under the plan. It is a primarily maintenance item.

A Sample Well Improvement Standard

This standard is based on the methodology known as Plan-Do-Check-Act (PDCA). PDCA was based on the quality improvement strategies championed by Edward Deming and is generally credited by Japanese industry for their achievements in manufacturing excellence (ASQ 2014). Specifically, the plan is based on components of the ISO-14001 Environmental Management System, used worldwide to achieve improved environmental performance (ANSI 2004).

Plan: Formulate a policy; establish the objectives and processes necessary to deliver results in accordance with the policy.
Do: Implement the processes.
Check: Monitor and measure processes against policy, objectives, targets, and other requirements, and report the results.
Act: Take actions to continually improve performance of the management system. Repeat the process starting with a new plan, revised policy, etc. using feedback from the previous cycle.

This plan concerns well improvement but also could be applied to improvements in the Barangay Water Systems and Municipal Water Systems. As with most environmental improvement we make general goals aimed at building a sustainable community, however it is the specific goal setting with tasks, measurable milestones and aspect identification that are essential. In addition, when an improvement plan is implemented, early successes are easy. Gathering the "low hanging fruit" in makes everyone feel confident, however, to have a sustained effort is what management standards are aimed at achieving. Plan-Do-Check-Act recognizes that goals in improvement are "stretch goals" only achievable with continuous effort. This is important

because, continuous improvement not only makes things better, but it halts the natural decline in things we build, and systematically sets priorities.

GES-14 Guiuan Environmental Standard: Water Source Management

1. Scope:

This Environmental Standard applies to the wells used by the population of Guiuan for daily use such as washing and bathing.

2. Policy

In order to ensure the safe, secure, sustainable fresh water supply to the barangay residents for domestic use, it shall be the policy of the Barangay leadership to institute and maintain a Well Maintenance and Improvement Program.

3. Requirements

Barangay leadership should maintain a comprehensive list of wells in use within the barangay boundaries. A list of water resources and wells should be inclusive. In addition, as new wells are being constructed, they need to be included in the program. The list needs to be documented, reviewed periodically, and kept up to date.

4. Assessment and Improvement Plan

A method of classifying and evaluating well security, safety, and sustainability should be developed to be applied across all participating barangays. Minimum standards for wells should be formulated and include, provisions for cover, prevention of surface water to flow into wells, safe access, etc. Barangay leadership should institute a system of periodic inspections to ensure the existing condition of wells is maintained.

<u>Well Improvement Aspects</u>

Points

0 -- Well contaminated and abandoned (should be obvious, substantial effort needed to return well to service, otherwise the well should be properly decommissioned and secured)

1 -- Cavity (unimproved)

1 -- Some Wildlife Protection (simple cover netting, etc.)

1 -- Some Runoff Protection from and/or user platforms (simple curbing, coco lumber etc.)

1 -- Improved Shaft (culvert, hollow blocks, concrete, etc.)

1 -- Concrete Apron (should be more than user platform, ideally complete around well)

1 -- Cover (can be simple, heavy duty, may have been adequate but deteriorated)

1 -- Adequate Cover (tight seal, or sealed-not removable)

1 -- Serviceable Cover (Cover tight and Serviceable)

1 -- Secure and Serviceable Cover (Superior designed cover prevents contamination, but can be safely removed and replaced by women, children, and the elderly.

1 -- Pump (manual, electric, etc.)

E--Exempt wells (These are wells, selected by local leadership to be of historical, cultural, and aesthetic significance to deserve preservation in their current state. Improvement can still be applied with appropriate and effective controls and should be designed to ensure preservation of these special wells. This provision should only apply to a few wells.

Application Note 2: The points are assigned depending of the state of improvement and are cumulative assuming that well development is a gradual and continuous process. For example, if a cover is "Secure and Serviceable" they would be assigned a point for being categorized as such. This well would also get three points for "serviceable cover, adequate cover, and cover". Typically this level of improvement may entail an improved shaft, apron, wildlife, and runoff protection and receive points for that aspect also. Improved wells also get a point credit for starting life as a simple cavity. As it relates to cover, this initial evaluation was somewhat lenient. If the residents made a provision for a cover for their well, they were given points. Covers not applied at the time of the survey, received points with the assumption that the cover would be used to secure the well when it was not in use. The standard calls for "tight fitting". Subsequent assessments should evaluate the quality of the fit. The cover should be designed to prevent contamination and allow for easy access. The highest quality covers observed in the field are both secure (tight) and with an easy to remove hatch that can be removed and replace by anyone. The aspect of serviceability is also graded and is applied with wells with easily removable covers. Wells need to be inspected and cleaned periodically. One well improvement that was not included

in the aspects was the installed roofing found applied over many developed water sources. This improvement, of obvious benefit to users, was not common, but should be included in subsequent assessments.

Application Note-3: In calculating averages for barangays, the exempt wells and broken, not accessible wells were not included. Wells that have been abandoned and contaminated without being secured, regardless of the state of development get a grade of "0" and are included in the averages. Obviously along with applying superior designed and tight covers, cleaning up these wells will offer the greatest initial improvement in overall scores.

5. Auditing

Barangay leadership should develop a person or persons to assess and audit well conditions. An auditor may be the person conducting well improvement and periodic inspections for their home barangay, however more importantly, Water Resource Auditors will be responsible for providing impartial audits of the wells of sister barangays. The primary duties for the auditor during the audit: 1) to confirm that the requirements of this standard are being implemented, 2) To evaluate and grade the wells, and, 3) Report the results. Audits should be performed annually and documented. To ensure maximum objectivity, Auditors should rotate so they do not audit the same barangay twice in five years. The auditor will report the results of the audit to the Barangay Captain for approval. If there is a dispute, the auditor is to defer to the Barangay Captain's judgment and note the discrepancy in the report.

6. Review

The results of the Well Improvement Program should be reported to the Municipal Leadership. The report should include results of the audits, number of wells undergoing improvement, problems in implementation, etc. Municipal leadership should give recognition to barangays with most improvement, best or innovative practice, etc. The municipal leadership will ensure the ongoing suitability and effectiveness of this program.

Part III: ECOLOGICAL CONSIDERATIONS

Threats to Watershed

Guiuan is blessed with protected forests and recharge areas lush with vigorous plant growth. The "Timberland" is an area afforded some protection by national legislation and is adjacent to and occupies the Pacific Ridge. This large and intact example of the natural diversity of Guiuan dominates the landscape, but much of the diversity of Guiuan is still found in isolated areas defined by elevated karst formations to the west of the ridge. Some of the sink areas also contain patches of diverse vegetation. Recognizing the value these intact landscapes have in protecting the watershed as well as wetland functions in waste removal should prompt deliberate efforts for protection by local leadership.

Threats to these ecologically significant areas are found through out the rural areas. Small scale quarrying to produce construction aggregate and larger stones from the limestone is a common rural cottage industry. Clearing sunny hillside elevations or flat bottomed sink areas to expose the rich terra rosa for cultivation is also found throughout the municipality. Clearing is also necessary to provide locations for new housing associated with the typhoon. Since the exploitation of these resources is intimately related to the livelihood of individual families it competes with preservation efforts. Creative strategies should be developed to impress on the local citizenry the value that these diversity areas have and the long-term benefits they provide in the larger picture of a sustainable and resilient landscape. Faced with increased disturbance both natural and anthropogenic, the people occupying the rural areas have a pressing need to access their natural resources. Many residents in the areas surveyed have an intuitive understanding of the importance of having healthy plant life above the watershed and the environmental services it provides to ensure a healthy water table and fresh water supplies as well as an appreciation of the natural beauty that is inherent in their unique, diverse and self-sustaining landscape. When they understand the full and inherent worth that these natural areas have, they will hopefully be the innovators in preserving them.

Landscapes Affected by Yolanda

When landscapes undergo a severe disturbance as in the case of a super typhoon, in nature's design there are mechanisms to recover. Much of the vegetative cover was

stripped bare by Yolanda and in other cases uprooted, however, in a tropical environment, the regenerative process is accelerated. As is experienced near Mt. Pinatubo, even landscapes that once lay bare or covered by layers of ash, plant species re-colonize. In less than a decade, areas that seemed incapable of supporting life are once again verdant.

In evaluating vegetative recovery after a disturbance, it is necessary to be able to distinguish between "pioneering" versus "invasive" species of plant. Invasive species are generally imported, colonize an area, and choke out any attempt of other species to thrive in the area. As is common in the Philippines, cogon grass and kudzu are commonly viewed as invasive and have growth patterns that eliminate competing species. In some cases, these species dominate because they are the only species that can grow in the newly disturbed environment. In this sense, they are pioneers. Pioneering species typically are among the early colonizers, and they serve to stabilize the soil and prepare it for later succession to the diverse and stable landscape (Brown 2005). Strictly speaking, invasive species are imported either deliberately or inadvertently by human activity. Pioneering species however, are natives that exploit their new environment and are an essential part of the ecological principle known as forest succession. Throughout the landscape of Guiuan, there is ample evidence of this process taking place.

In Guiuan, particularly in areas difficult to access due to the karst landscape, there are patches of diversity in terms of plant life. As is very apparent in the recovering Guiuan landscape, these areas were more resilient during the onslaught of Yolanda. These are significant in this respect and valuable in many other ways. Seeds originating from these diverse plant communities are transported by the wind or other means and establish themselves in the soil of the surrounding areas. In this sense, when there is a disturbance that upsets the ecological balance of the landscape, these sheltered and diverse patches provide a "seed bank" that will ensure there is a healthy variety of plant species to re-colonize the affected areas (Lin 2008). Longer-lived species such as the hardwood trees found through out the landscape will be last to emerge as the vegetation reaches the last stages of natural forest succession. We can see the results of this process in the Timberland areas un-touched by human agricultural practices. The species best adapted to the transformed environment will succeed at first and then later the gradual

transition to a stable and resilient landscape will occur. Of course, this natural process can be, and is very often altered or accelerated by human intervention. One prominent example in Guiuan of such intervention is the replanting of the mangrove forests in the tidal margins to the south of the peninsula lost during Yolanda. Evidence of humans taking advantage of the disturbance to the landscape is the cultivation among the fallen coconut trees of vegetable gardens. Harvesting of fast growing ipil-ipil for firewood is also commonplace. Invasive or pioneering, papaya trees also dot the landscape throughout Guiuan. They are so abundant at the Taytay-Sapao border near the Airport runway, the observer would think they were intentionally planted.

Coconuts and Ecological Succession. The devastation of the coconut plantings throughout the area wrought by Yolanda is a stark reminder of the effects of the storm. While coconut trees are ubiquitous though out the tropical latitudes worldwide, they are believed by some to be an invasive species imported by man. Native to Africa, studies have shown that coconuts are unable to survive the severe environment of the sea for long times and cannot self-propagate via the ocean currents as once was thought. Human intervention and the mastery of the sea by early settlers can explain the wide distribution of the species in the tropics (Heyerdahl 1950) .

The first mass plantings of coconuts in the Philippines were instituted by the Spanish to be used as ship caulking to support the Galleon trade between the Philippines and Mexico. The coconut industry in the Philippines started as a colonial crop forced on the natives by the Spanish Colonial Governor's edict in 1642, and later expanded by the American colonial administration to support foreign demand for coconut oil. The historical development of the Coconut Industry in the Philippines is a classical case study of how political and economic power of the developed world has had a detrimental effect on the livelihood of individuals in rural areas of the Philippines. When the influences of the global economy are coupled with the centralization by the national government of the control of raw material purchases and marketing abroad, few benefits flow to the majority of the small coconut growers and serves only to enrich a few powerful individuals. Declining prices in the world market for coconut oil due to product substitution have exacerbated the inequalities (Boyce 1992).

Yolanda, by reducing the number of coconut trees has transformed the environment in many ways other than providing a plentiful source of needed lumber for rebuilding efforts. Reducing the number of invasive coconut palms, in addition to the temporary halt of the clearing effects of coconut farmers on grove understory below, expands dramatically the amount of resources in terms of nutrients, water, and sunlight available to native pioneering species. Left to nature's design, a stable, diverse forest, similar to what may have existed in Guiuan before it was widely populated by humans, may contain a balanced and sustainable number of coconut trees along with natural hardwood forest species. Despite the obvious vulnerability of the coconut to powerful storms property owners are busy at restoring their plantations in Guiuan. Those actively involved in the replanting effort reported to the surveyor that a coconut tree planted today would start to yield fruit in 10-12 years. Given the long-term commitment required for coconut production in terms of land and other resources, their vulnerability to disturbance, and the scarcity of arable land in Guiuan planners may give alternative land uses a fresh look. In any case, the value that a stable and diverse ecosystem has in terms of environmental services, facts that the local leadership and residents are well aware, needs to be considered in land use planning.

In another example of the lack of local control and management of the resources within the territory of Guiuan, is the federal government control of the protected timberland along the Pacific Ridge. The local government has little voice in the development and protection of this resource. The forest conservation policy introduced in 1908 by the US Administration has evolved into the Forest Reform Code (PD No: 7051) is largely ineffective in protecting the forest (Reyes 1983). In Guiuan, there is evidence that the effects of the typhoon are pressuring farmers into the higher elevations. This is the case when residents from the lowland areas are displaced and their new homes are located inland bordering the forest areas. Areas critical to watershed and recharge area protection and not well suited to agriculture such as the slopes of hills and mountainsides bordering and contained in the timberland, are being cleared and cultivated.

Like the abundant coconut lumber, a ready supply of hardwood for domestic purposes is available. Groups of individuals can be seen with bundles of well-dried limbs, culled from among the storm debris. Once this windfall source is depleted, and if the fast

growing hardwood species such as ipil-ipil cannot keep up with demand, gathers will go into the higher elevations. Traditionally, lands such as the timberlands in the public domain have been regarded as a community resource and belonging to no one. Thus, taking the forest products or farming in public land for subsistence has been tolerated. Generally, logging of the timberland ecosystem by human activity is protected by the steep grades and generally inaccessibility of the highlands, however logging of high-valued species reaches into the steep and remote locations. In sampling of two paths into the timberland, the surveyor found the path terminates at felled old growth hardwood tree species. One of the trees was fresh cut as indicated by the fresh foliage. Whether the second tree was felled by Yolanda or fresh cut could not be determined.

It is to the benefit of the people of Guiuan that they make best use of all its areas and to avail of the ecosystems many resources in a sustainable way. In the case of critical watershed areas, a realistic multiple use policy must be pursued while ensuring the adverse ecological effects are kept to minimum and acceptable levels. Areas, cleared of invasive or pioneering growth for agriculture could be interplanted with timber species that will take over the area eventually. Fast growing hardwood tree plantations under local control and management could allow for harvesting and immediate replanting, thus reducing the pressures on the existing natural forest areas both inside and outside of the publicly owned areas. Whatever reforestation programs that currently exist or already being undertaken at the national and regional level should be promoted, applied and accelerated by local leadership. Similar to the mangrove replanting along the coast, the model should be applied to the elevated areas. In this way, local leadership can ensure that critical watershed protection, wildlife habitat, and natural beauty of the landscape be restored. Because of the potential of negative long-term effects on sustainability and resiliency, processes in areas are capable of being regenerated naturally should be accelerated.

PART IV: BARANGAY SURVEYS

Methodology.

The barangay surveys were carried out by traversing the various rural locations and population centers on foot. This entailed a short bicycle or motorboat ride followed by going house to house questioning the residents as to where they accessed fresh water for clothes washing and bathing. Once the location of the well was established, a GPS waypoint coordinate was captured using a Garmin GPSmap 76CSx. Digital photos were taken with a Sony Cybershot 12.1 MP Camera to record the condition of the well structure, a vertical image down the well, where possible, to estimate depth to the water table, water condition, the presence of pump piping, among other qualitative data. The surveyor took area photos if location factors were significant for evaluation. Geo-spatial location is established by the source of the well and not the pump. Typically, this is the concrete structure of the well with a remote manual pump a few meters away.

The raw data was imported into the ArcGIS ArcMap 10.2 using DNRGPS Version 6.1.0.6. The file names of the photos were changed to represent the time sequence and location along the survey track and identified serially. The point shape file along was layered onto the Barangay boundary layer and points were superimposed onto the original points in a Well Data shape file. The points were then coded with the serialized photo names. When the time of collection of the spatial field data was encoded within a few days, there was no problem associating by sequence the photos with the points. When data was unclear, the time stamps between the camera and Garmin were used to sort the spatial data out. In some cases where data points were grouped closely together, time stamps were instrumental in matching the qualitative data with the spatial data.

The results of the survey represent a sampling of the wells. In virtually all instances, residents were willing to invite the surveyor on to their property and enthusiastically show their well and explain some of their issues with fresh water. The residents' explanations often indicated pride in their well. In going house to house, an attempt was made to complete a comprehensive survey of the barangay. Individual barangay surveys took two to three hours to conduct and effort was expended to cover most all areas, major roads and paths. Where there were few wells, as in the higher

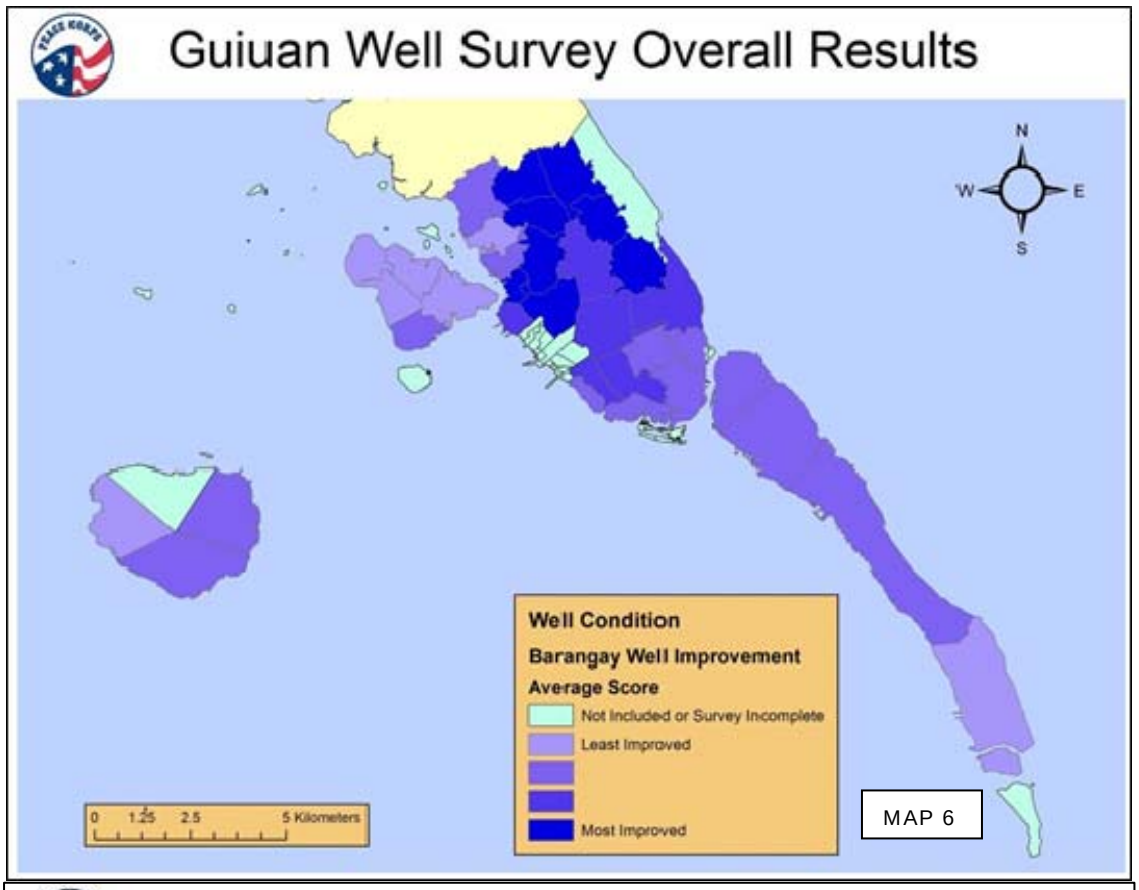
elevations, the survey includes most all of the wells. In denser populated areas, some residents were not home. Especially in the more affluent properties with fences and gates, the water source was not included. Wells in a position to be shared by neighbors whether in common public areas or within private property lines were understandably included more that those behind locked barriers. In many instances, one individual or groups of "young environmentalist" were keen on giving the surveyor a complete tour of the barangay and a comprehensive inventory of the wells. It was particularly beneficial to the purposes of the survey and assessment to identify an individual with extensive knowledge of local water resources and issues. Often an individual was very interested in hearing my concerns about cross-contamination between wells. The survey methodology, while concentrating on collection of specific location and quality data was conducted to allow time to discuss with the residents their concerns and issues related to the environment. If the survey required more time and energy, and if fatigue on the part of the surveyor became a factor in completing a thorough barangay survey, the survey was stopped and picked up the next day at the same location. Often, refreshments were shared at a local store. The relaxed atmosphere facilitated more communication and collection of anecdotal information about the barangay and the current situation. Everywhere along the survey trail, the residents of Guiuan expressed appreciation for the help they are receiving from donors and partners to recover from Typhoon Yolanda. In the face of such destruction and disruption in their daily lives, the people are able to remain optimistic about their future and the future of their children.

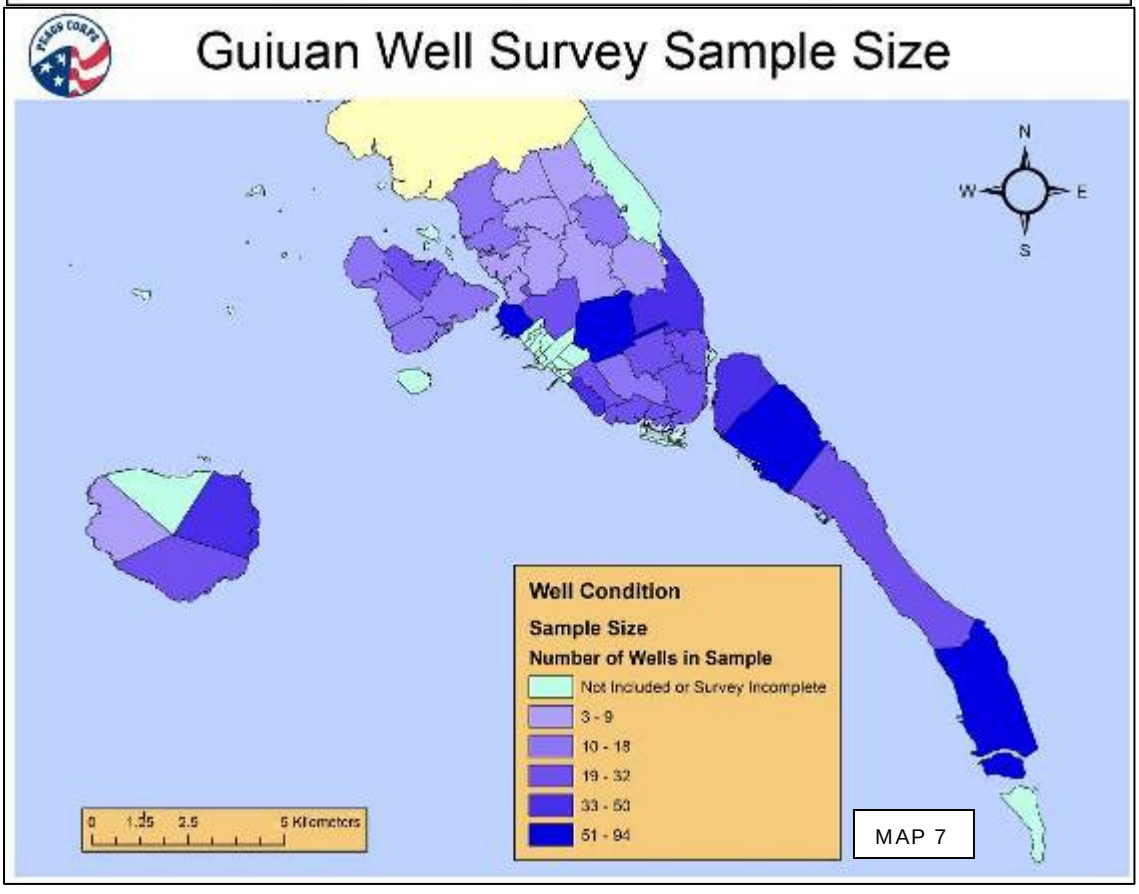
Often when the surveyor visited one of the rural barangays on the weekends and was assisted by a group of "young environmentalists", the surveyor was energized by their insatiable curiosity and infectious enthusiasm. It reinforced the fact that environmental awareness begins at a young age and topics such as environmental protection and respect of nature when taught in the early grades has an effect on educating the adult population as well. Topics such as recycling and littering awareness become almost religion with them and they actually take the lead in changing practices around the home.

The following is a list of barangays included in the survey. The eight barangays on the island of Homonhon and Victory Island were not included. The surveyor also omitted the downtown areas from specific water source GPS mapping; however, there is

no reason that they cannot be included in later assessments and improvement plans. The surveys of barangays of Homorawan and Suluan were incomplete and the qualitative data is not included in the overall results.

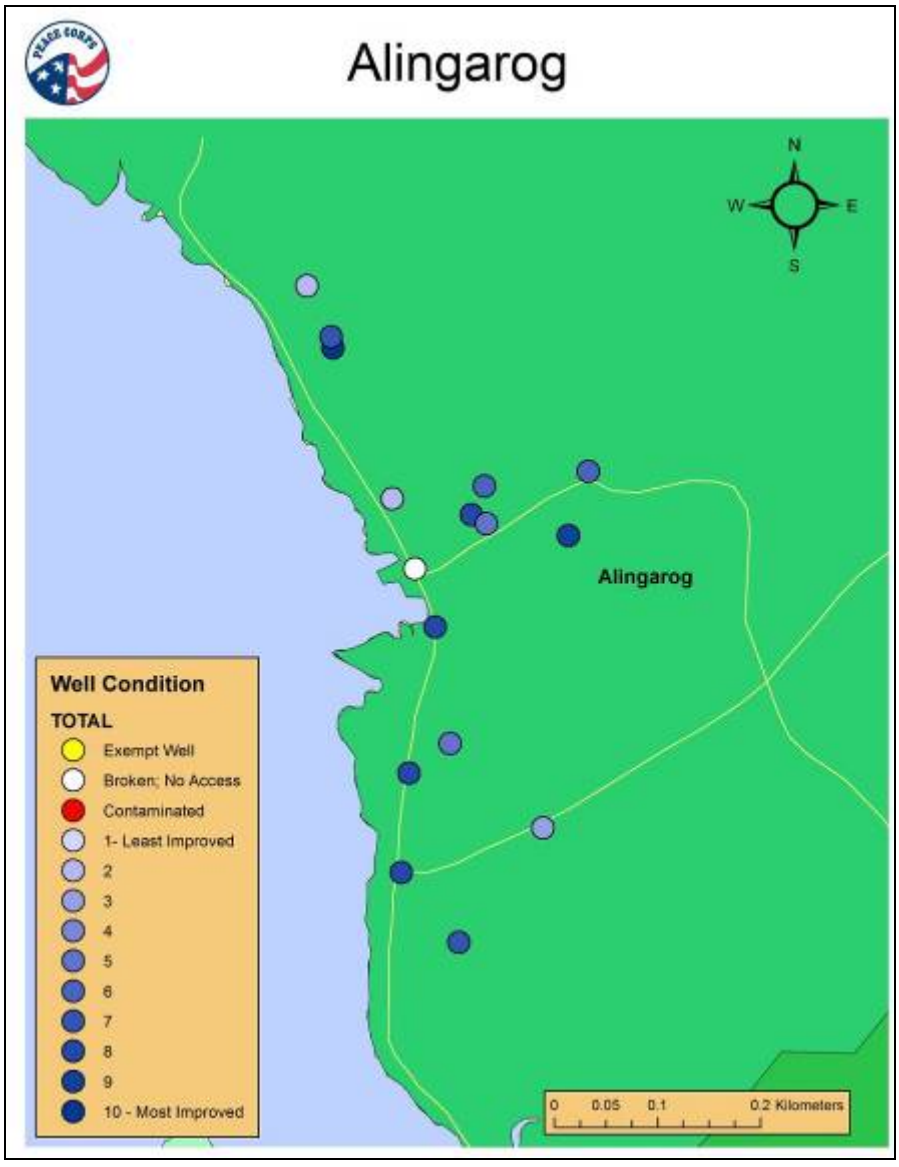
Map-6 presents the overall Sampling results spatially. The highest most improved on average are found in the higher elevations and in barangays with fewer wells. Fortunately, the more improved wells and therefore the most secured are found in the major recharge areas. The sample size is represented in Map-7.


Guiuan Well Survey Overall Results
N
W
E
S
Well Condition
Barangay Well Improvement
Average Score
Not Included or Survey Incomplete
Least Improved
Most Improved
0 1.25 2.5 5 Kilometers
MAP 6

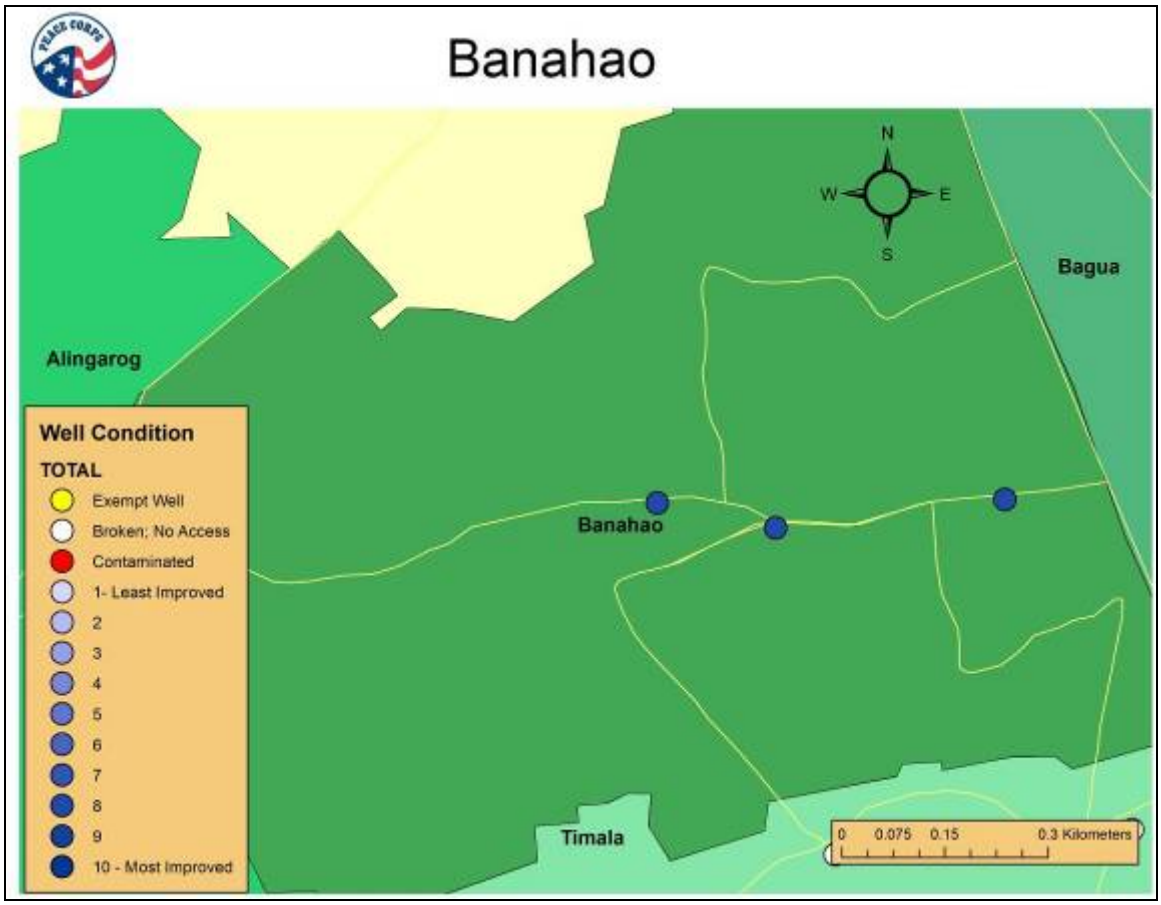

Guiuan Well Survey Sample Size
N
W
E
S
Well Condition
Sample Size
Number of Wells in Sample
Not Included or Survey Incomplete
3 - 9
10 - 18
19 - 32
33 - 50
51 - 94
0 1.25 2.5 5 Kilometers
MAP 7

Survey Summary:

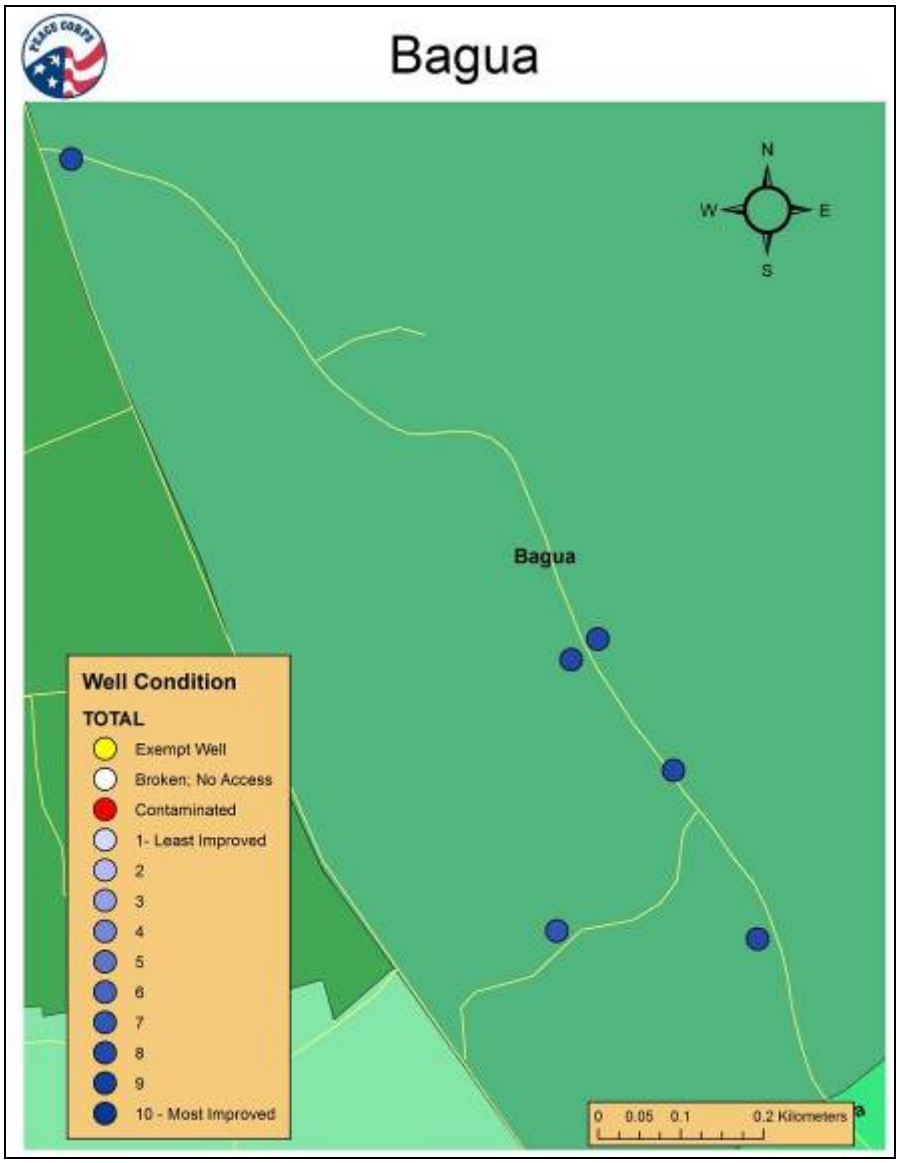
Barangay Name	Date Completed	Count	Mean	S.D
Alangarog	September 15, 2014	15	6.2	2.3
Bucao	September 16, 2014	11	4.2	2.6
Cagdara-o	September 19, 2014	8	6.6	2.3
Mayana	September 22, 2014	9	7.7	0.9
Timala	September 27, 2014	4	8.0	0
Banahao	September 27, 2014	3	8.0	0
Bagua	September 27, 2014	6	7.8	0.4
Hagna	September 27, 2014	13	8.0	0
Gahoy	September 29, 2014	4	8.5	0.5
Cantahay	October 1, 2014	60	7.2	2.2
Sapao	October 2, 2014	51	7.12	2.3
Dalaragan	September 19, 2014	12	7.1	2.9
Bungtod	October 17, 2014	30	5.7	2.6
Baras	September 20, 2014	93	6.1	2.3
Barbo	October 7, 2014	28	6.5	2.6
St.Nino	October 10, 2014	4	7.7	1.6
Sulangan	August 2, 2014	60	4.6	1.9
Suluan	October 14, 2014	Incomplete data		
Tagpuro	October 18, 2014	28	6.5	2.2
Taytay	October 6, 2014	32	5.6	2.7
San Antonio	October 11, 2014	24	3.75	2.8
San Juan	November 13, 2014	11	4.5	2.4
Trinidad	November 8, 2014	13	4.8	2.9
Camparang	November 9, 2014	18	6.5	3.5
San Pedro	November 8, 2014	13	3.2	1.8
San Jose	October 8, 2014	8	4.1	2.0
Banaag	October 8, 2014	25	5.7	2.1
Buenavista	October 10, 2014	35	6.4	2.3
Hamorawon	October 10, 2014	Incomplete data		
Baras	November 11, 2014	94	6.1	2.7
Ngolos	November 15, 2014	26	5.5	2.3
Pagnamitan	November 16, 2014	42	6.3	2.7
Campoyong	November 22, 2014	36	6.0	2.0
Surok	November 23, 2014	7	7.1	3.0
Salug	November 22, 2014	27	7.3	2.0
Cogon	November 24, 2014	22	7.9	0.3
Lupok	November 27, 2014	70	6.8	2.5



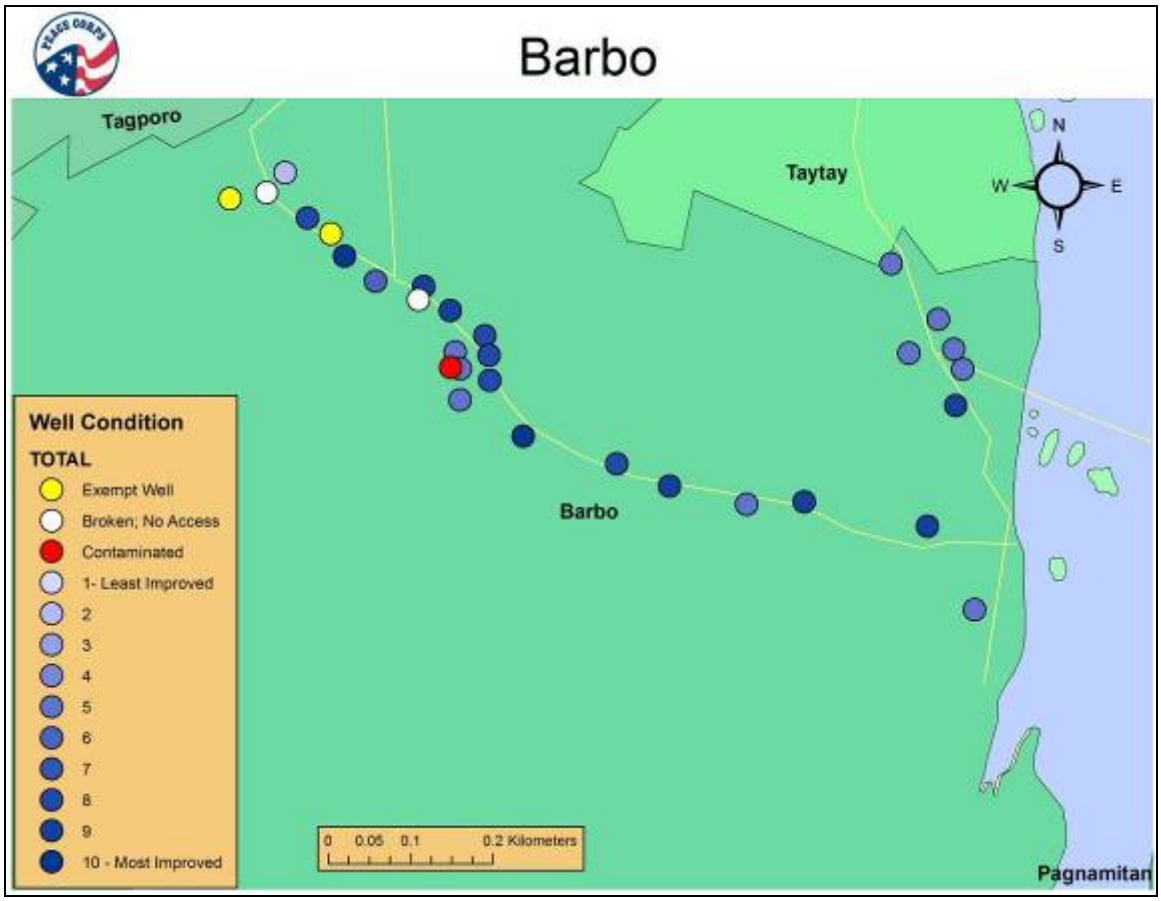
Number of Wells Sampled: 15
Average Improvement Score: 6.2
Issues: Iron in water
Priorities: Replacement of Barangay Water System; Repair Well-07 at Plaza.
Alangarog is in the Northwest corner of the Peninsula along the Leyte Gulf coast. The water table is less than a meter from the surface. The inaccessible well at the plaza is the BWS. Even though the solar pump and tank are destroyed, the residents should still be able to access water at the manual pump



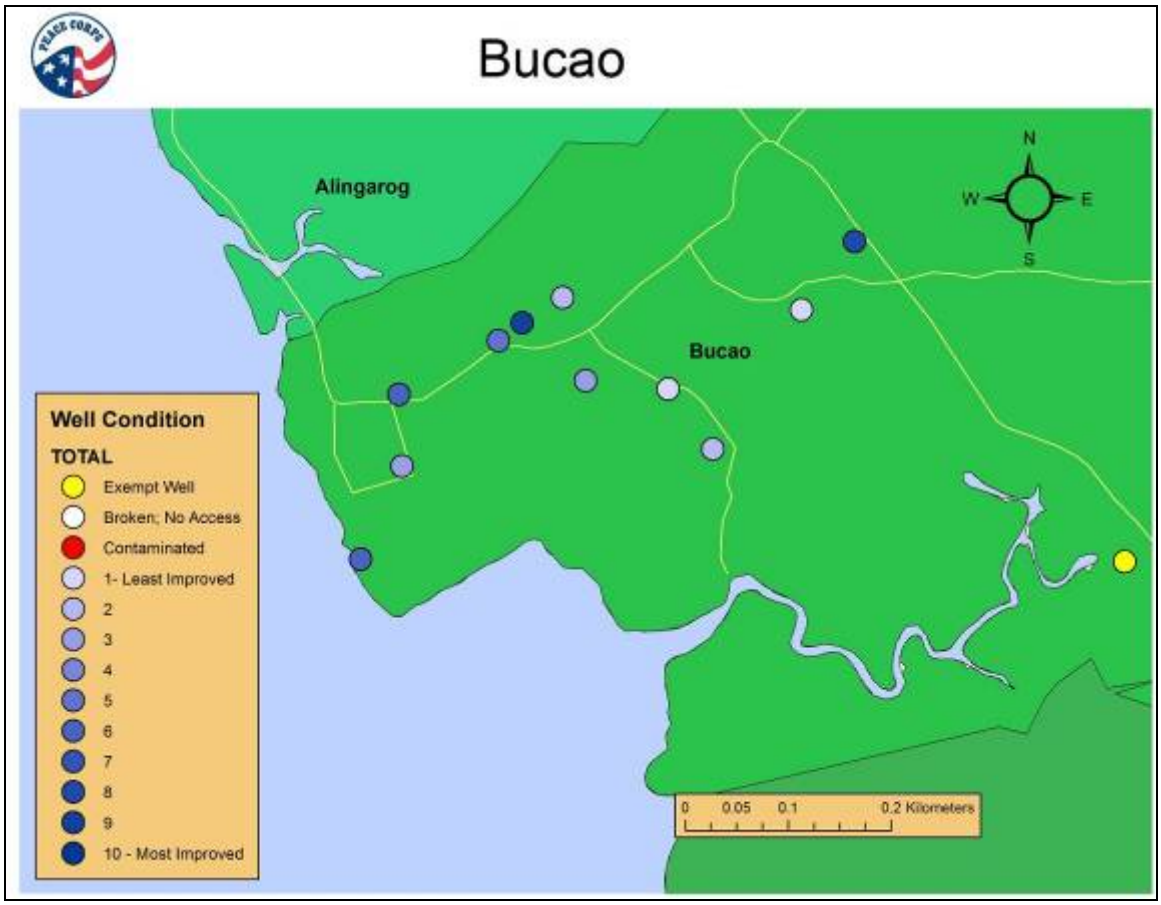
Number of Wells Sampled: 3
Average Improvement Score: 8.0
Issues: Few sources of Water
Priorities: Bring Municipal Water System (Mercedes connection) online.
Banaho is in the north of the Peninsula along the boundary with Mercedes bordering the National Road to the west. It had a newly installed stand-alone Barangay Water System (Y-S Men). There is a MWS line running from Mercedes that as of the survey date had yet to be brought on line.



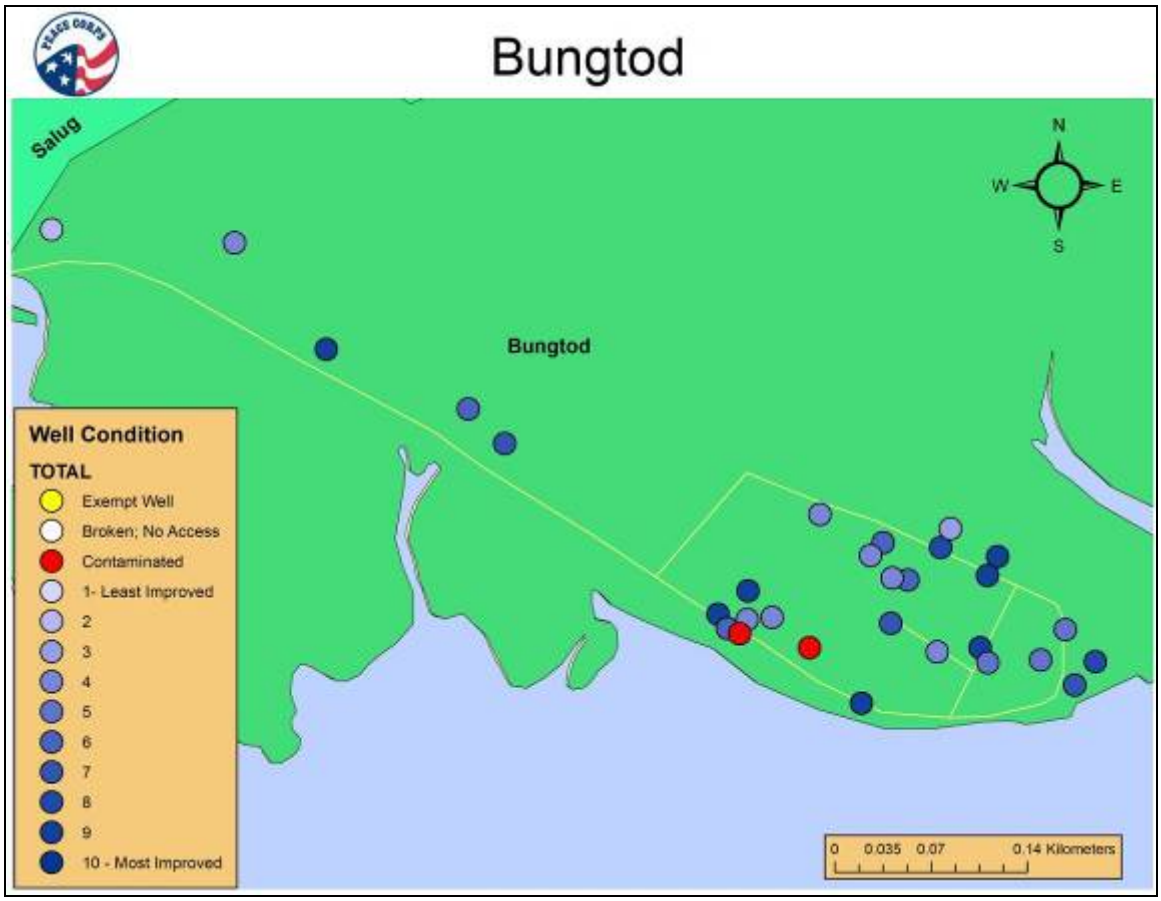
Number of Wells Sampled: 6
Average Improvement Score: 7.8
Issues: Few options for water along highway.
Priorities: Bring Municipal Water System (Mercedes connections) online.
Bagua is in the north of the Peninsula along the boundary with Mercedes with the National Road on the west and the Pacific Coast Ridge to the east. Its wells are mainly of the "artesian" style with a newly installed pump (Operation Blessing) near the Plaza. There are MWS lines running from Mercedes, that as of the survey date (Sept-27), had yet to be brought on line.



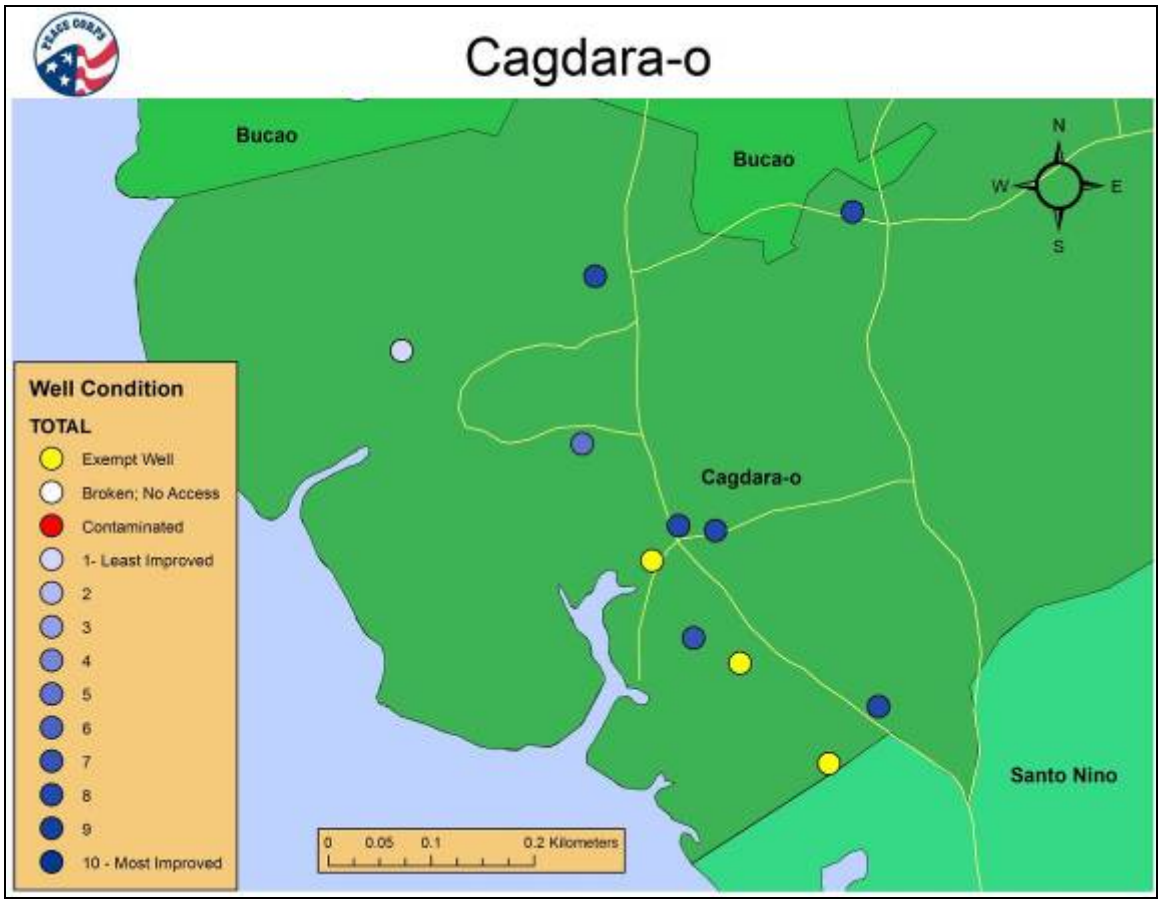
Number of Wells Sampled: 26
Average Improvement Score: 6.6
Issues: Broken pumps in common areas, No BWS, Contaminated Well.
Priorities: Clean Contaminated Well-13; Restore Well-01.
Barbo is at the southern tip of the Peninsula and contains the connecting bridge to Calicoan Island. Wells are mainly of open with "jetmatic" pumps. There are MWS connections along the national road as well as the coastal road to the south. Well-03 (natural setting) and Well-05 (superior construction) are possible candidates for preservation in their current state. Well-18 is remarkable due to its superior designed cover. The barangay captain was instrumental in its improvement.



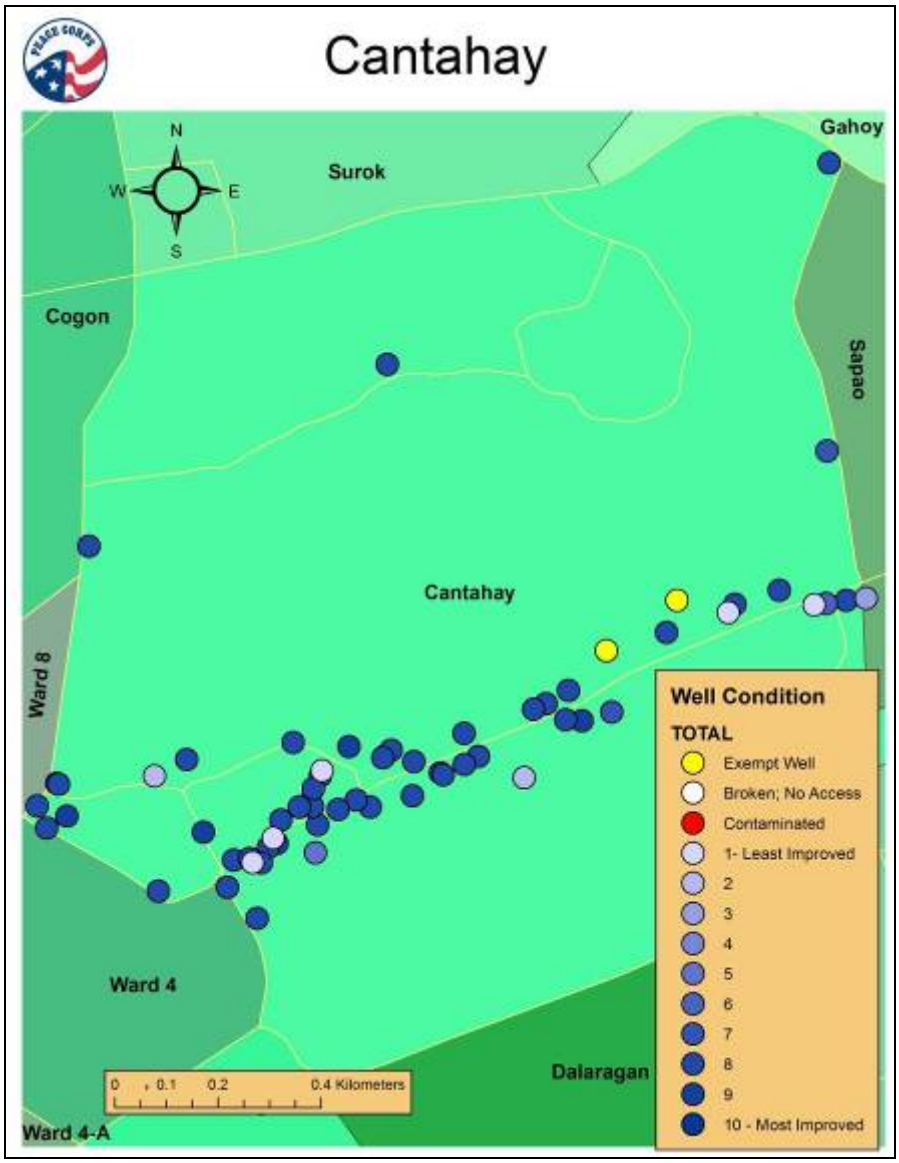
Number of Wells Sampled: 11
Average Improvement Score: 4.2
Issues: Few improved wells. No BWS.
Priorities: Restore BWS. Improve Wells, Clean Litter from spring area.
Bucao is located on the Leyte Gulf side, northwest on the Peninsula. The BWS was destroyed by the Typhoon and has not been replaced. There is one well with a pump that is centrally located that residents rely upon for water for utility purposes. Their is a spring on the way to Cagdara-o with some improvements; however it is only useable at low tide. It is generally trashed.



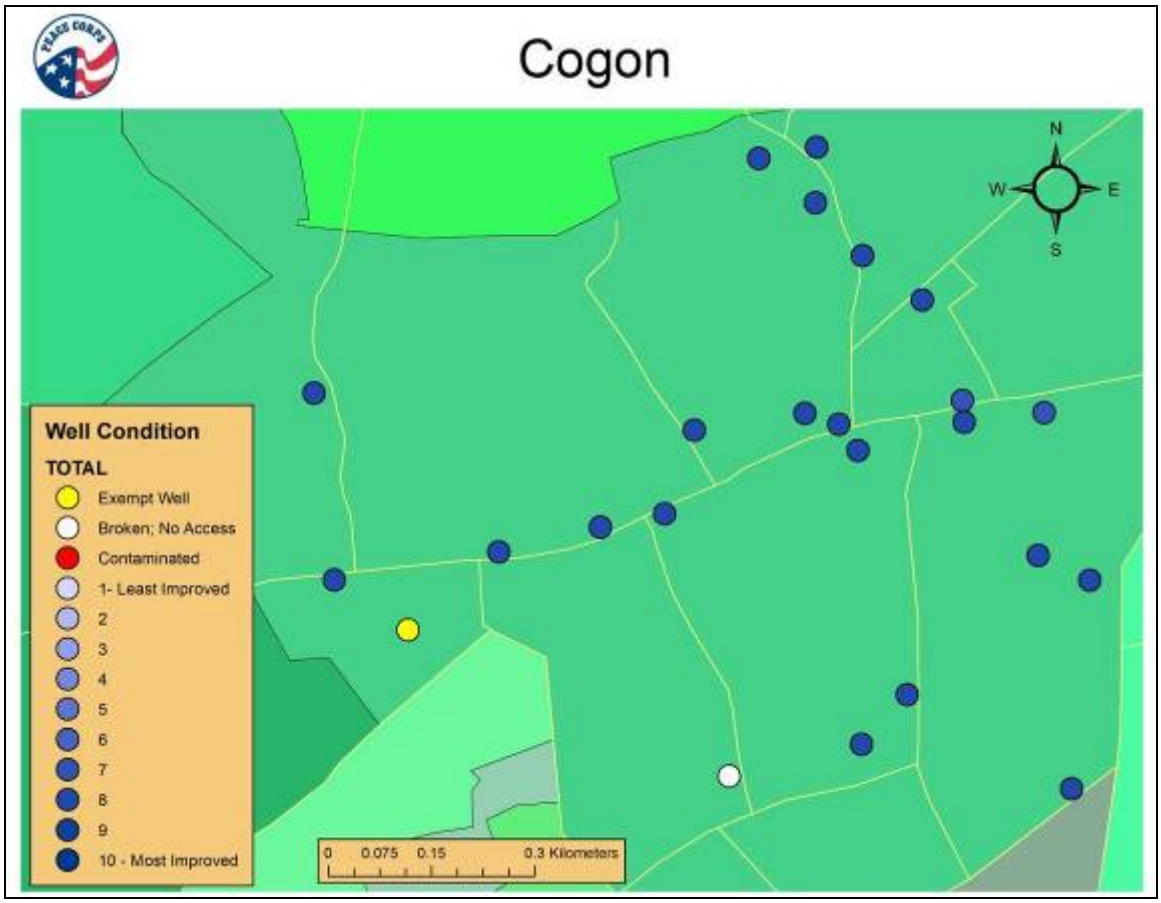
Number of Wells Sampled: 30
Average Improvement Score: 5.7
Issues: Contaminated, Well-17 & Well-19. Extensive erosion at base of wells from Typhoon evident.
Priorities: Clean and restore contaminated wells, well covers and aprons
Bungtod is located at the southern end of the peninsula and is sutuated in an area surrounded by mangroves and nipa. The barangay has both a functioning BWS side-by-side with MWS taps. The two contaminated wells are on Yolanda affected properties.



Number of Wells Sampled: 8
Average Improvement Score: 6.6
Issues: BWS not yet drinkable or reliable source for higher elevations of the barangay.
Priorities: Expand BWS capability to higher elevations.
Barangay is blessed with three spring areas. One is a large swimming pool enjoyed by all age groups, for washing, bathing and recreation. Local leadership has improved the source extensively with a dam to control the flow from the sea and drainage channels to keep surface runoff from contaminating it. Two smaller springs are well maintained and deserve ongoing preservation in their current state.



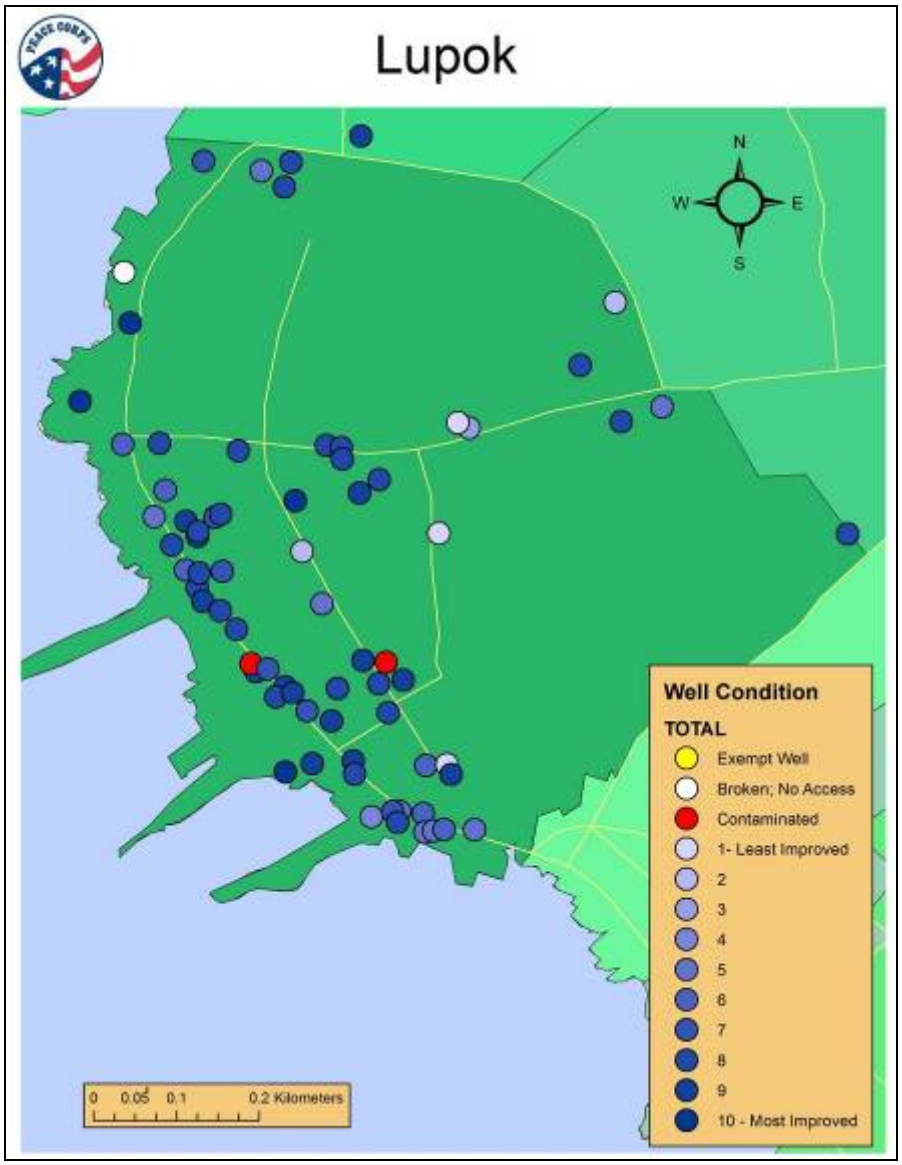
Number of Wells Sampled: 60
Average Improvement Score: 7.2
Issues: High density development along makes well source protection very important.
Priorities: Improve aprons and covers of wells.
Cantahay is located inland on the Peninsula and contains the Airport. Its main development is along the abandoned tarmac of the former US Navy facility and contains the transition area from the elevated karst to the wetlands to the south. Having extensive impervious surfaces, it benefits directly from the recharge areas further north. Wells are generally improved. Two natural water sources (Well-10 & Well-11), very important in the days following Yolanda, are identified as needing special preservation. The area is served by the MWS at the western end along the provincial road and along the Navy Road to the North. Cantahay is home to three high capacity supply pumps that feed the large tanks located in the highlands. The barangay has a dedicated BWS (Well-60) serving the residents along the less densely populated northern road.



Number of Wells Sampled: 22
Average Improvement Score: 7.9
Issues: Minor issues only. Drainage around wells inadequate.
Priorities: Improve aprons around high use wells. Improve drainage and apron around Well-21.

Cogon is an inland peninsular barangay located along the Navy Road. The wells in Cogon are consistently good. Other than the Legacy Well-21 proposed for exempt special preservation status. No open or unsecured water sources were observed in Cogon. Located along a major recharge area, identified by the surveyor as a possible collapsed cave, the water is readily available. Well-11 is a new jetmatic application and does not produce water. The owner speculates that the depth to the water exceeds the maximum effective range of a suction type pump. Cogon is the location of a newly opened settlement of families affected by Yolanda. A well is located at each end of the settlement and a dedicated water system is scheduled to go on line soon.

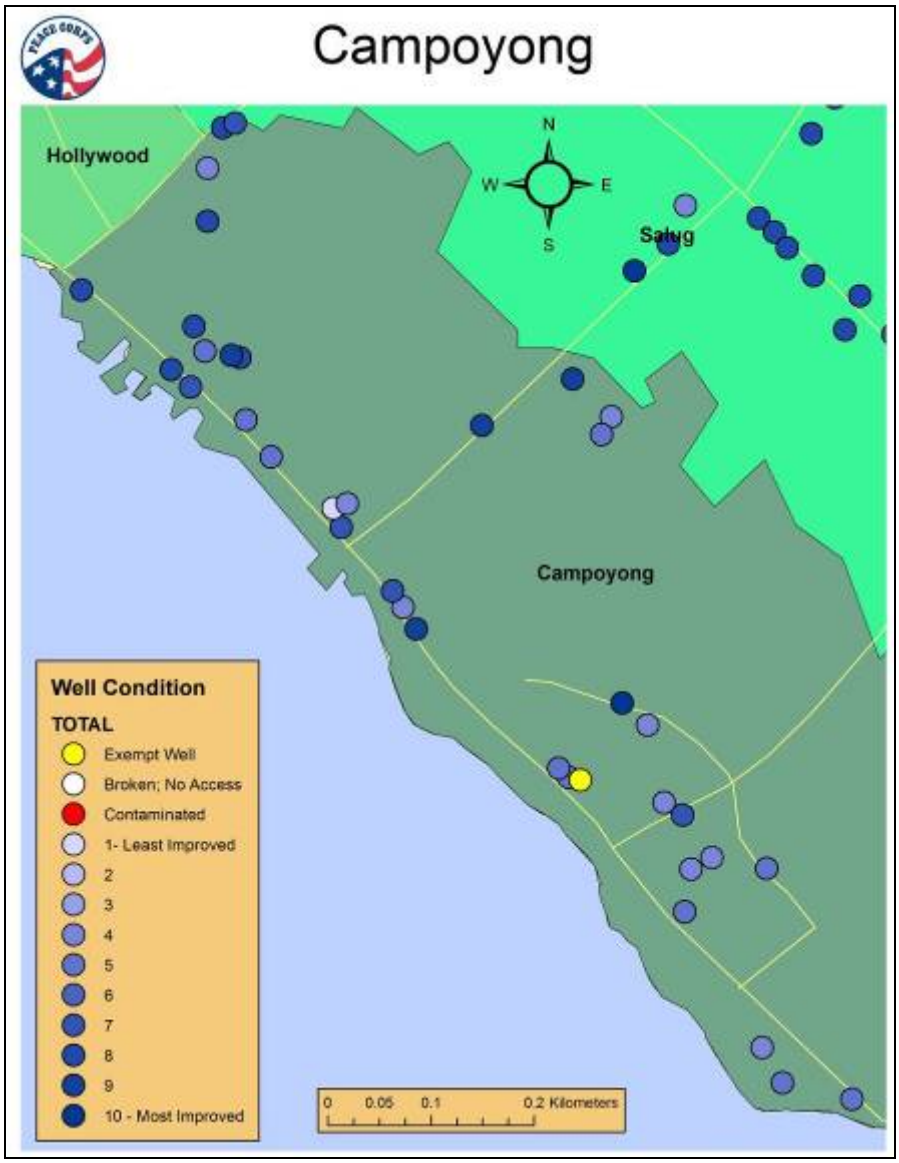
The BWS (solar) was destroyed by Yolanda and has not been replaced. The MWS serves the Barangay along the National Road.



Number of Wells Sampled: 70
Average Improvement Score: 6.8
Issues: Contaminated and Uncovered wells.
Priorities:

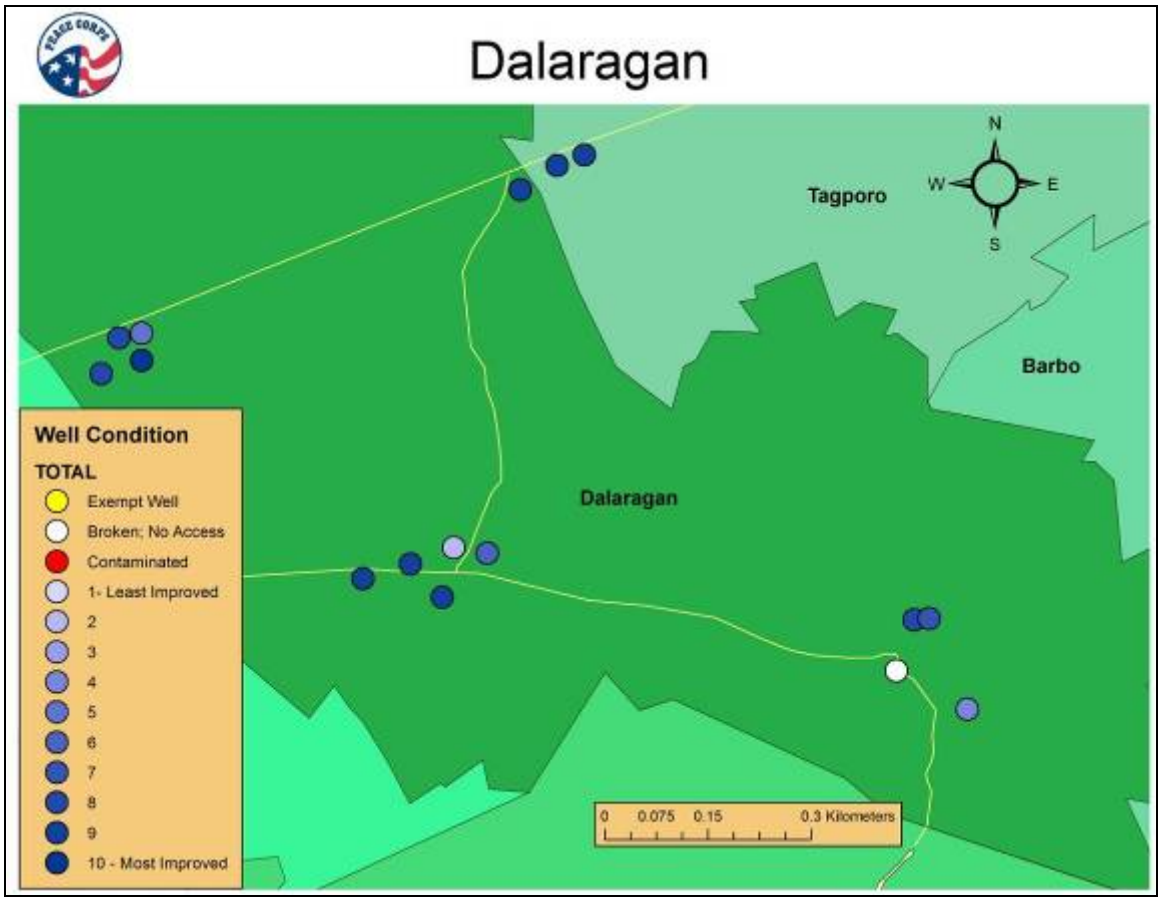
Lupok is home to multi-storied hotels, restaurants, and the port. It has a lot of improved wells, that lifts its overall score, however the number of unimproved wells and poorly secured wells is more than the surveyor expected. Compared to its neighbor Cogon, Lupok is a mess in terms of wells. The surveyor suspects that having extensive coverage of the MWS and easy access to the water table, as is the case in Lupok, does not necessarily lead to improved water sources, but contributes to neglect of open wells.

There is a contaminated well along the main road that is evidently a remaining cleanup task from the Typhoon (Well-34). What appears to be a contaminated well (Well-15) near the elementary school may be a overgrown planter box. The surveyor may be erroneous in counting this as a well. Lupok has one of the best designed wells (Well-20) the surveyor has found on the survey trail.

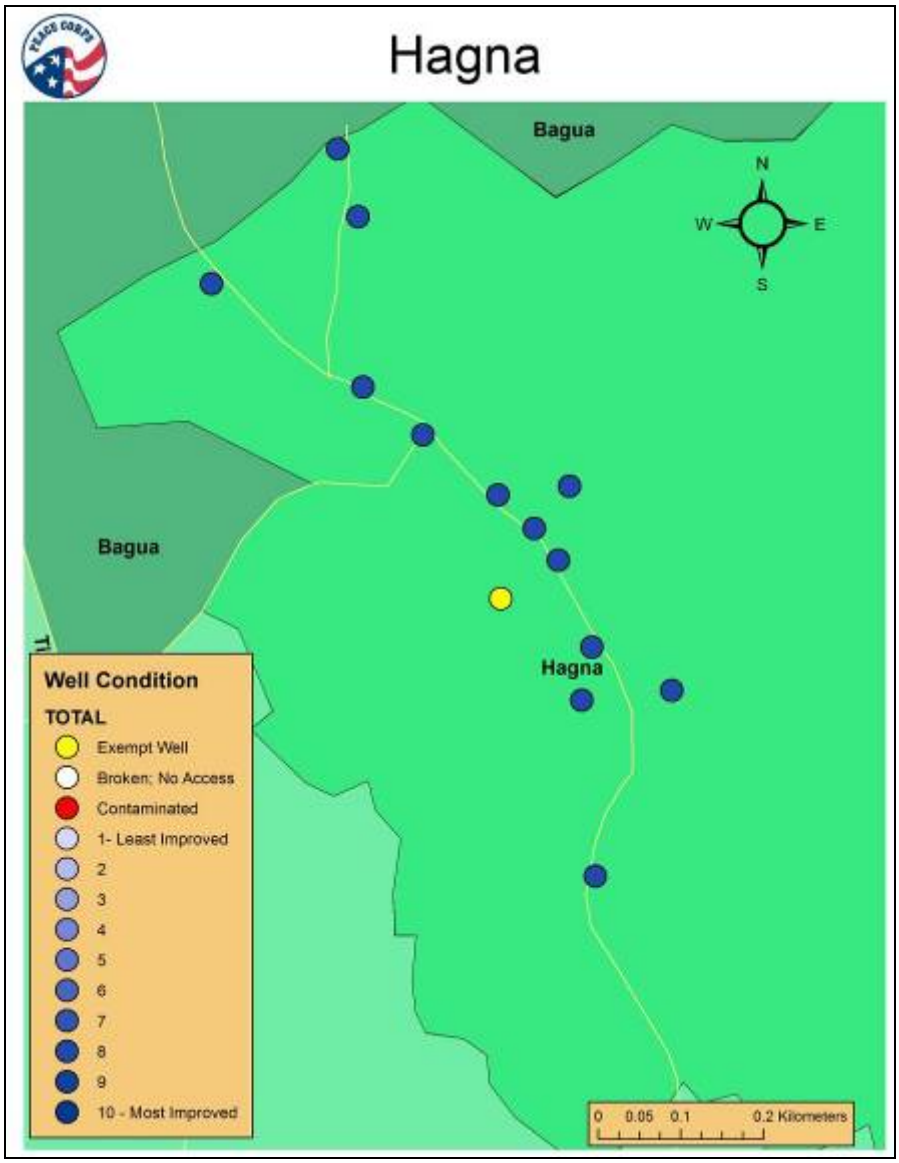


Number of Wells Sampled: 36
Average Improvement Score: 6.0
Issues: Large number of damaged, or deteriorating wells.
Priorities: Implement Continuous Improvement.
Campoyong is located adjacent to the downtown area and transitions from a rural fishing village to dense populated affluent residential streets along the southwest coast of the Peninsula. Consequently the wells are better taken care of as the surveyor goes from south to north. Well-11 is a possible candidate for preservation as is.

Among the wells in Campoyong, are two wells that apparently have been properly closed and decommissioned; something not found elsewhere along the survey trail in Guiuan.

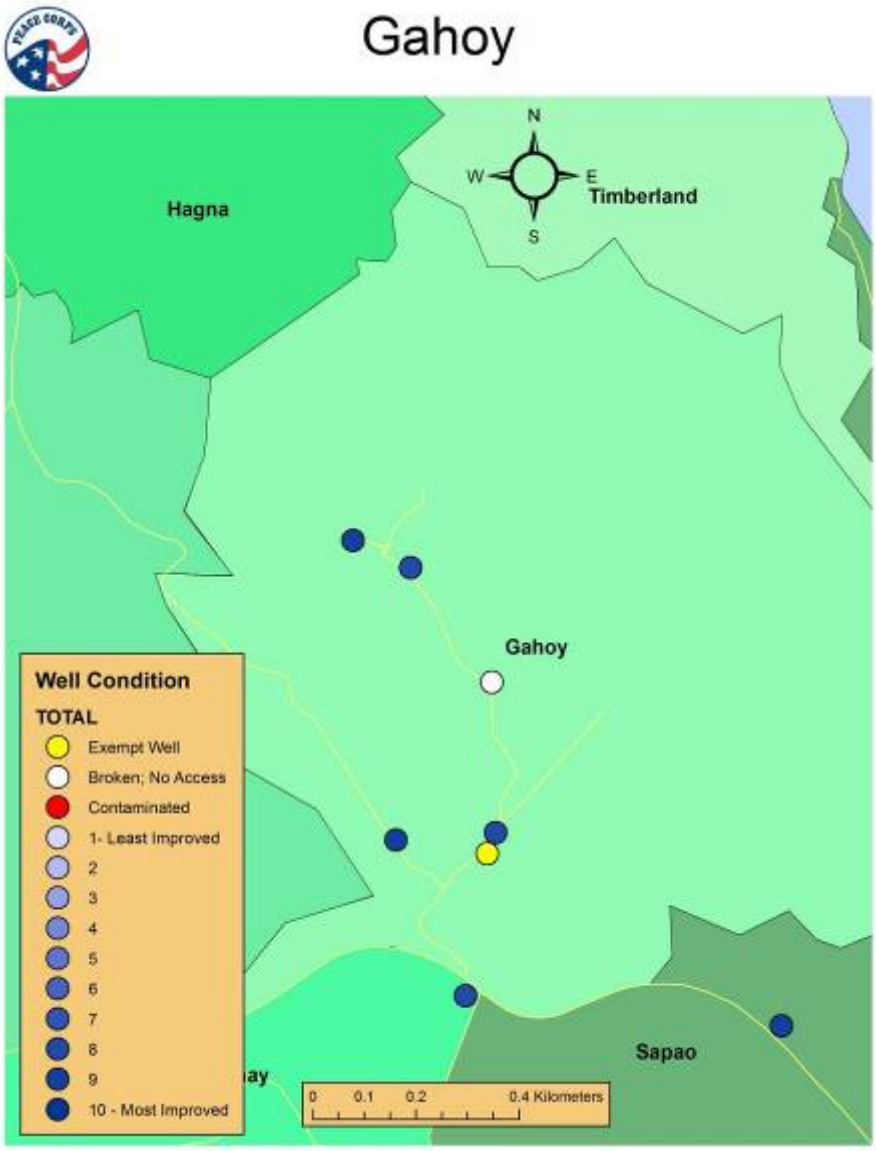


Number of Wells Sampled: 12
Average Improvement Score: 7.1
Issues: no major issues.
Priorities: Maintain Continuous Improvement
Dalaragan consists of three areas of residences that occupy the high spots of an extensive wetland area in the south of the main peninsula. The barangay has a recovered BWS located in the middle groups of residences and extends along the road to the lower main barangay area. The surveyor did not note any problems and water is available in most places at a pump or faucet. The upper group of residences contains one of the best-designed covers of wells found along the survey trail: Well-13.

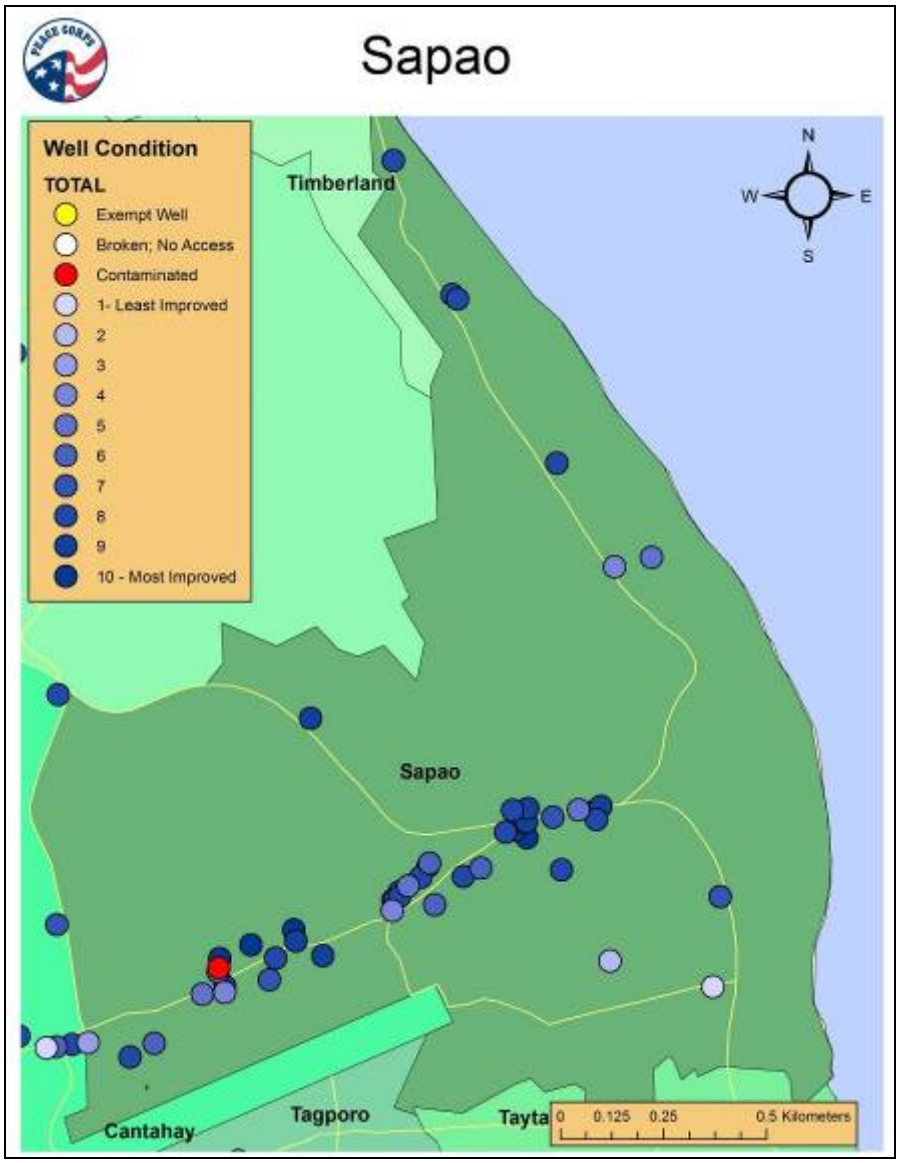


Number of Wells Sampled: 13
Average Improvement Score: 8.0
Issues: Minor improvements to well drainage.
Priorities: Remove papaya trees from Old Well-07.
Hagna is located inland on the peninsula adjacent to the Pacific Ridge. The wells in Hagna are consistently good. The only open well is the well designated for preservation in its present condition. As you go south from the north part of Hagna the elevation drops into a large sink area. The wells in the higher elevations, newer wells provided by Operation Blessing, are of the downhole type. As you go down, the wells transition to the suction type. Well-5 & Well-13 are old artesian installations that have been retrofitted with jetmatics.

Old Well-07 is magnificent. With all the other wells safe and secure in Hagna, this well has a prominent place as a contingent source of water.

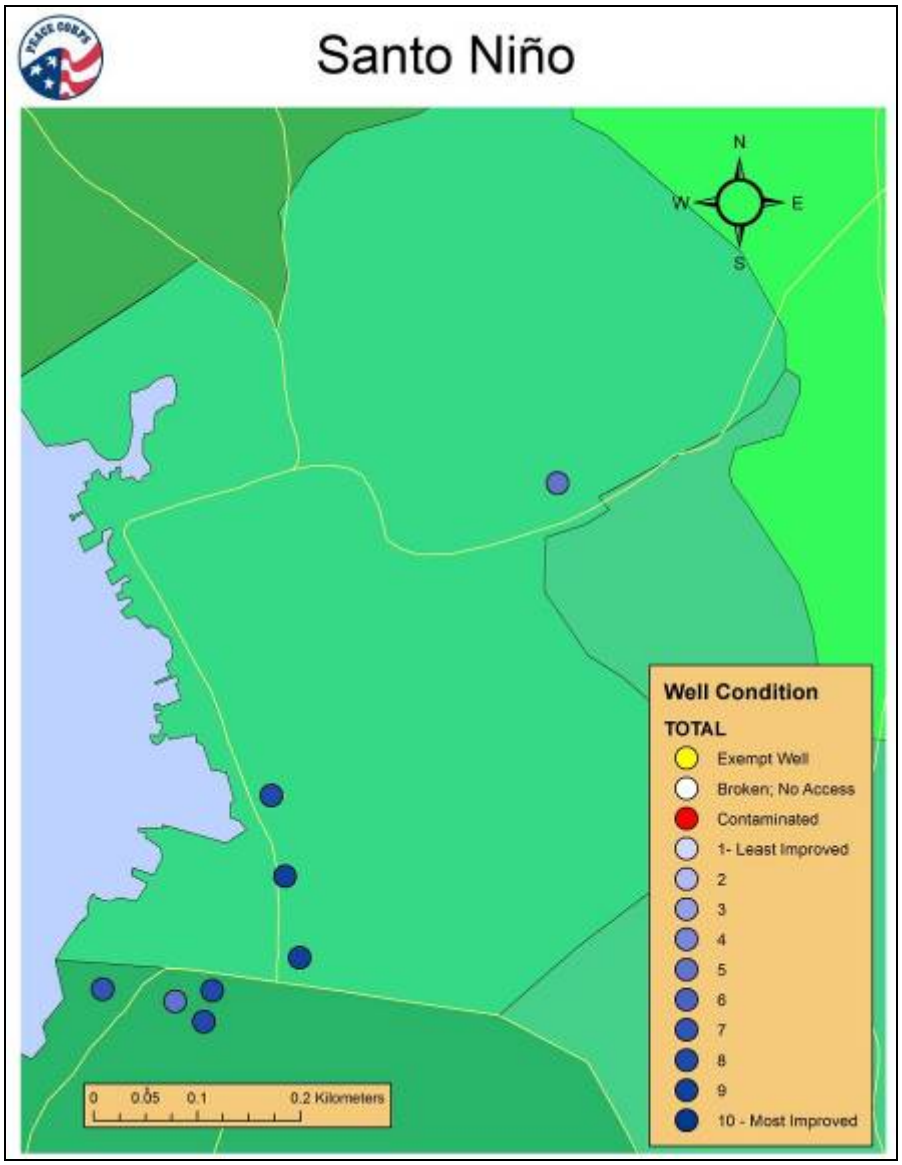


Number of Wells Sampled: 4
Average Improvement Score: 8.5
Issues: Development of sources.
Priorities: none major
Gahoy is served by the MWS so locally supplied water less of an issue. Well-01, is suggested for preservation, however, it still needs to be improved to prevent contamination of the water table. It is located at the end of a major recharge area and protections such as well drained usage areas and other impervious surfaces need to be installed. The private well with the motor on top is inaccessible in its current configuration. Perhaps the property owner can be encouraged to reconfigure the motor and piping to provide for contingent uses in addition to provide for serviceability.



Number of Wells Sampled: 51
Average Improvement Score: 7.1
Issues: Dirty and Uncovered Wells, mis-placed graveyard
Priorities: Clean and secure wells community water sources. Well-50 on the road to Taytay serves 7 families and is in disrepair.

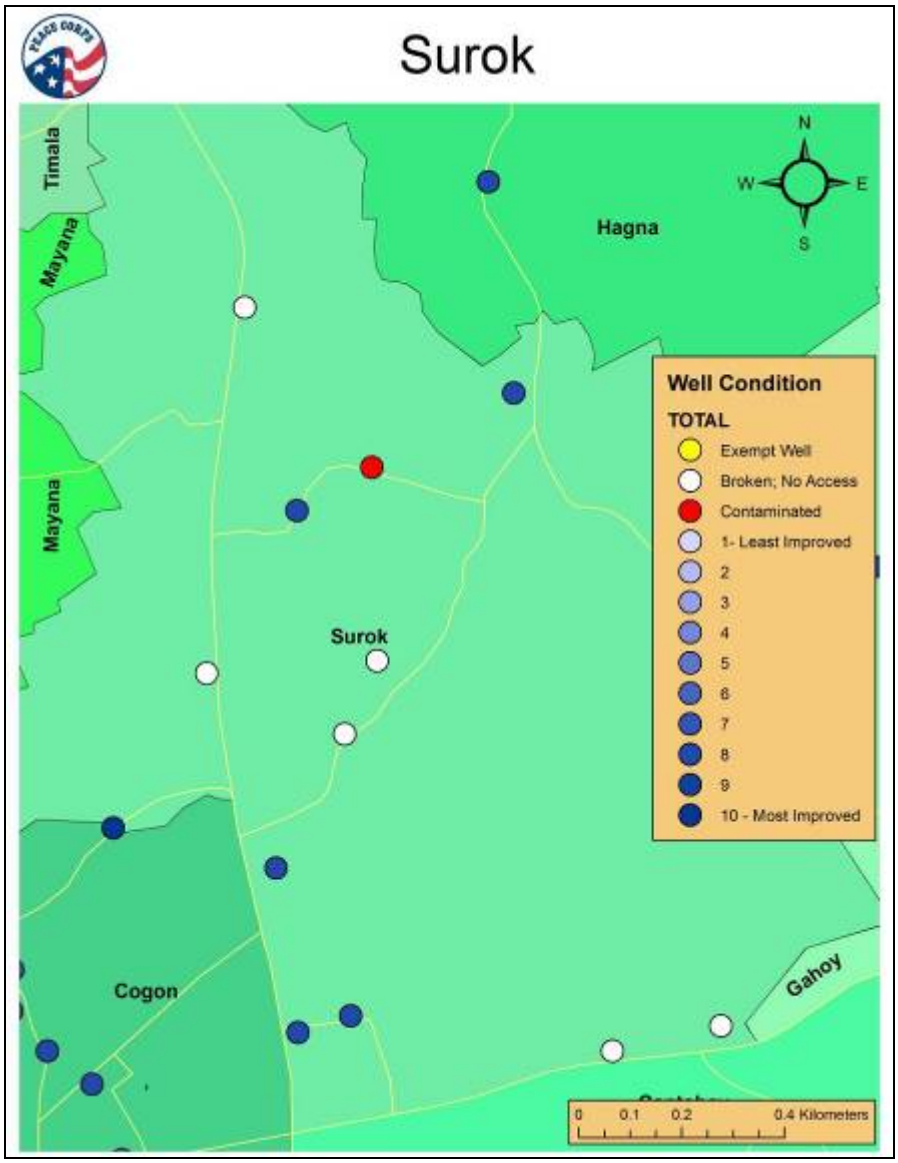
Sapao also has a narrow strip of land that borders the Pacific and is a showcase for the spectacular cliffs of the Pacific Ridge and Timberland. Waterflow and wells are scarce there as is the population. Denser populated areas of Sapao, like Cantahay, also occupy the impervious surfaces associated with the old airfield. Sapao also has extensive sand mining activities near the end of the runway. This convergence of resources supports numerous concrete block operations. The surveyor found Blacksmithing in Sapao. There is an "un-sanctioned" and poorly maintained graveyard at the eastern tip of the runway. Well-12 has been converted to a garbage receptacle. Well-20 has been designated as a drinking water well. A healthy but localized patch of heavily forested highland protects it. Many wells in Sapao are of exemplary design. Some are undeveloped, un-maintained. The MWS serves many residents in Sapao.



Number of Wells Sampled: 4
Average Improvement Score: 7.7
Issues: Land Fill Security
Priorities: None Major

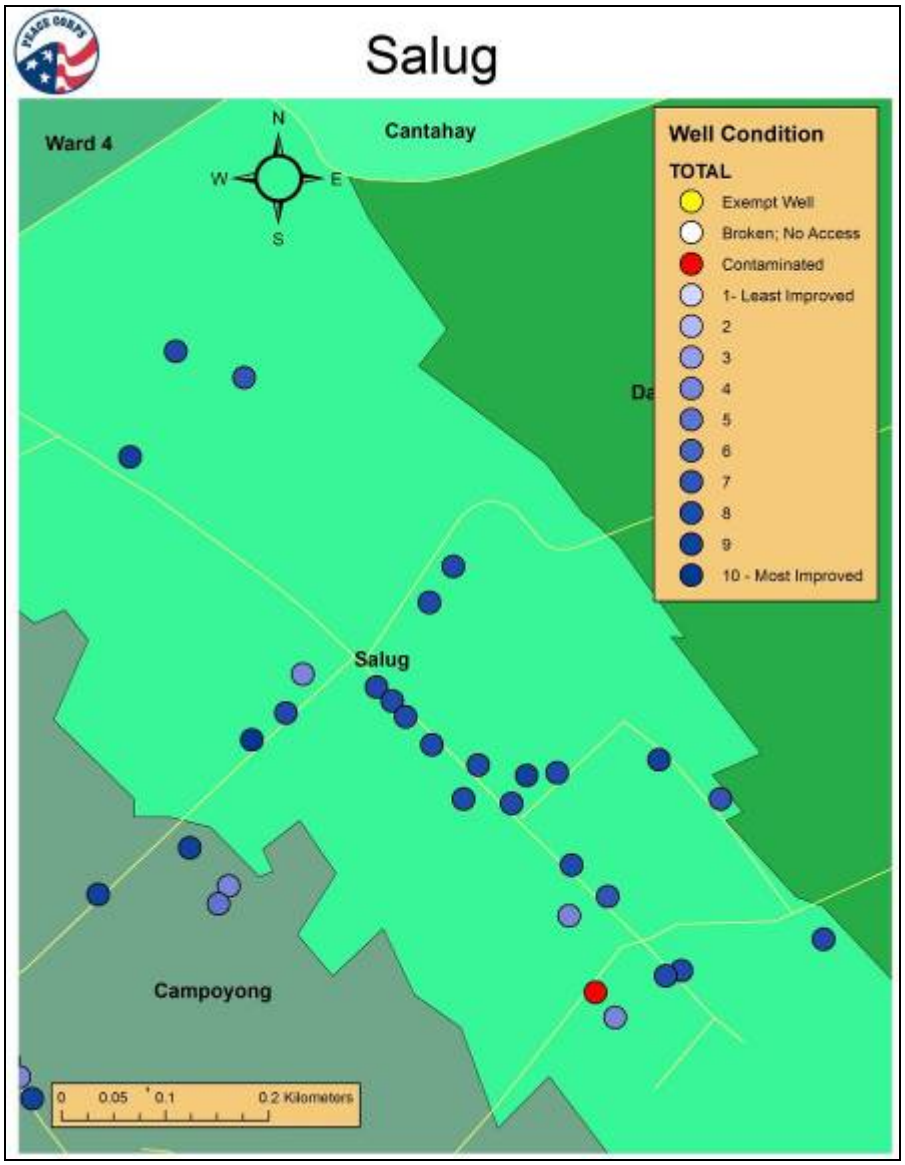
Santo Nino is located on the west coast of the peninsula and is extensively served by the MWS. Three wells are located near the coast and improved. Some are on private property and some associated with the now destroyed BWS. The open well in the sink area occupied by the Municipal Landfill is the only water source used by the community that is threatened. Santo Nino also has a substantial amount of water flow coming out of the highlands to the east and also drains the landfill area. The open well is significant due to the fact that it will be the first place that any contamination from leachate coming from the landfill will be detected.

Santo Nino is also home to a major Bureau of Fisheries Projects. Abalone and other valuable species are grown there for the international market.

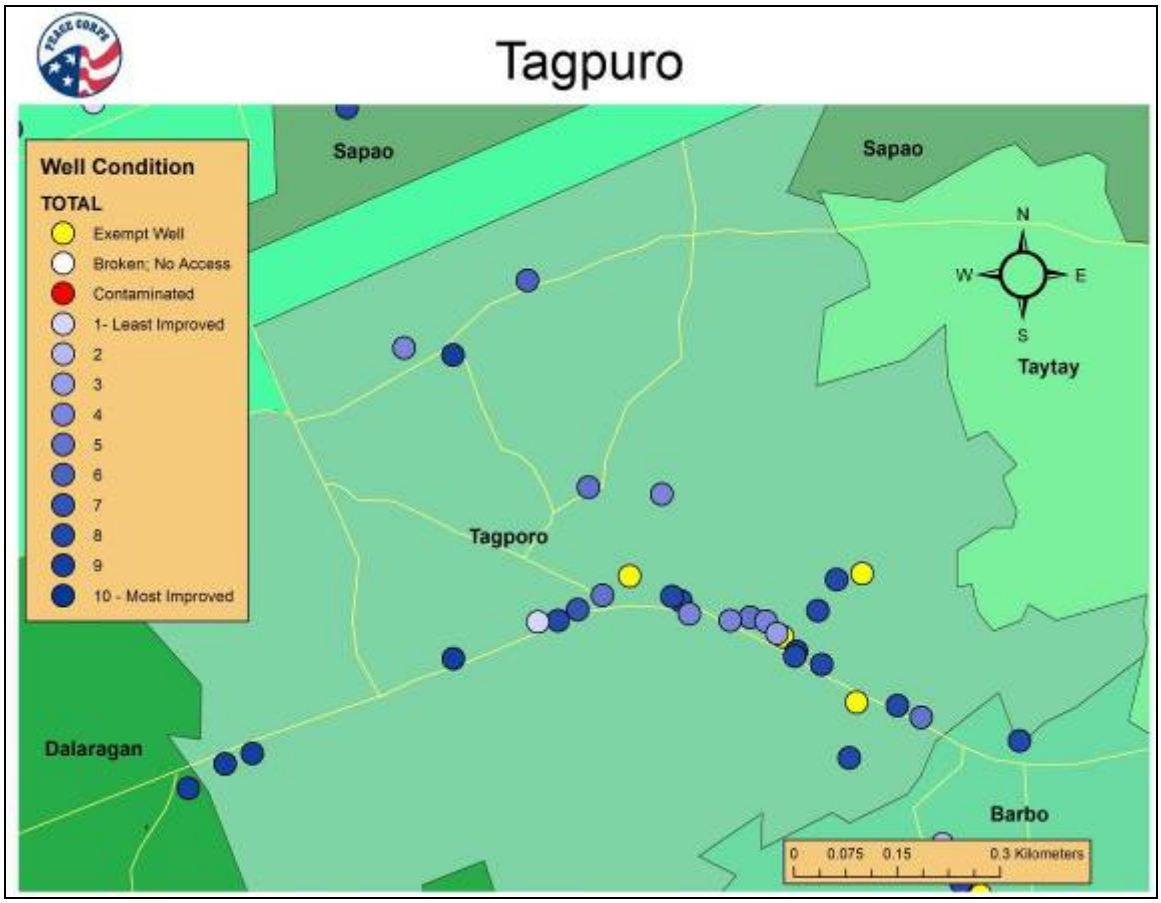


Number of Wells Sampled: 7
Average Improvement Score: 7.1
Issues: High number of out of service wells; contaminated well.
Priorities: Implement Continuous Improvement and recover wells.

Surok has the one of the finest examples of a well that has benefited from continuous improvement: Well-6. A large area with relatively few wells, Surok also has the distinction of having more "artesian" wells that have fallen out of service. These monuments to maintenance failure dot the landscape. A small disused and contaminated well, Well-09, is located in a major recharge area. Surok is home to one of the main pumping stations supplying the water to the tanks in Cantahay and is served by the MWS along the National Road, the lower parts of the road to Hagna, and the Navy Road.

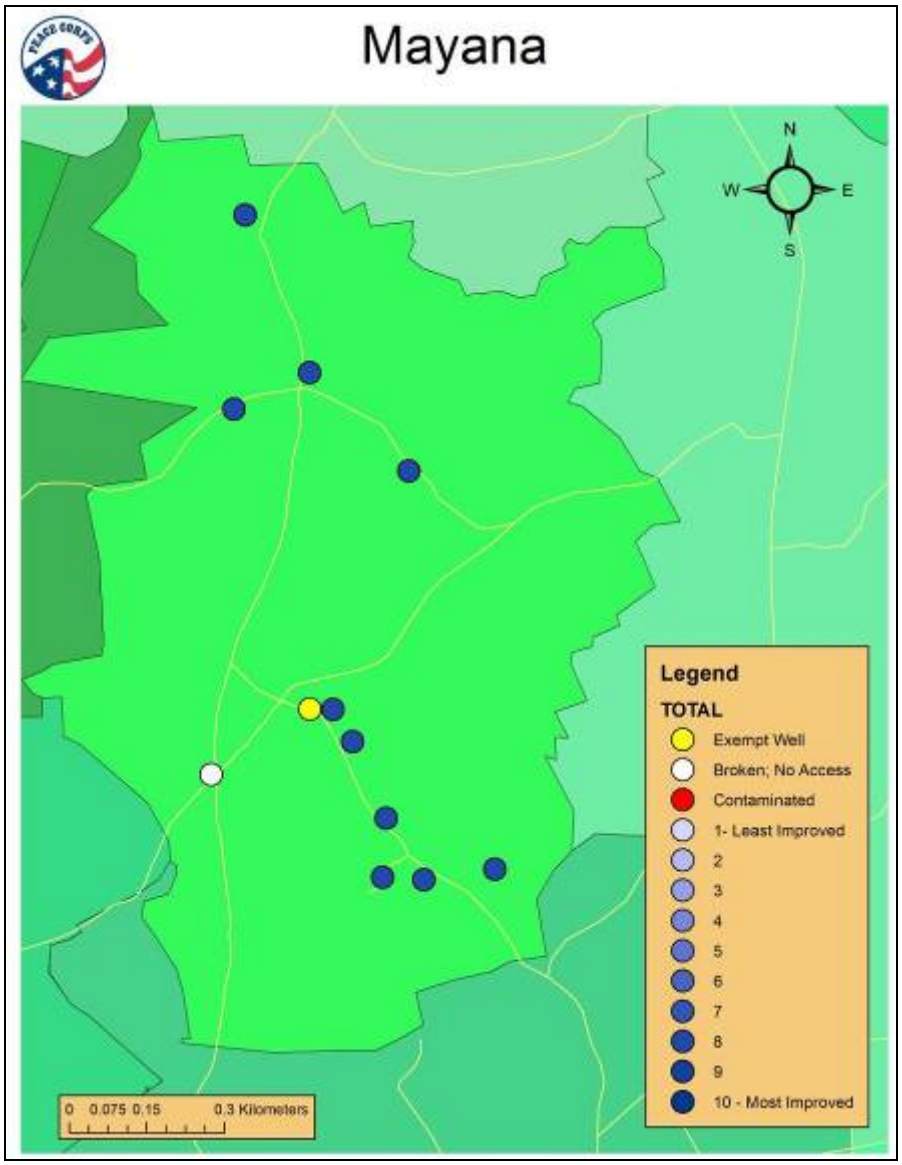


Number of Wells Sampled: 27
Average Improvement Score: 7.3
Issues: no major issues; a contaminated well.
Priorities: Continue with well improvements
Salug has the largest number of superior designed wells in its common areas. It is evident that there is a strong program of well improvement already in place. Near the pair of superior wells next to the Plaza is a large contaminated well. Salug is served by the MWS.



Number of Wells Sampled: 28
Average Improvement Score: 6.5
Issues: None specific
Priorities: Continuing improvement of existing sources

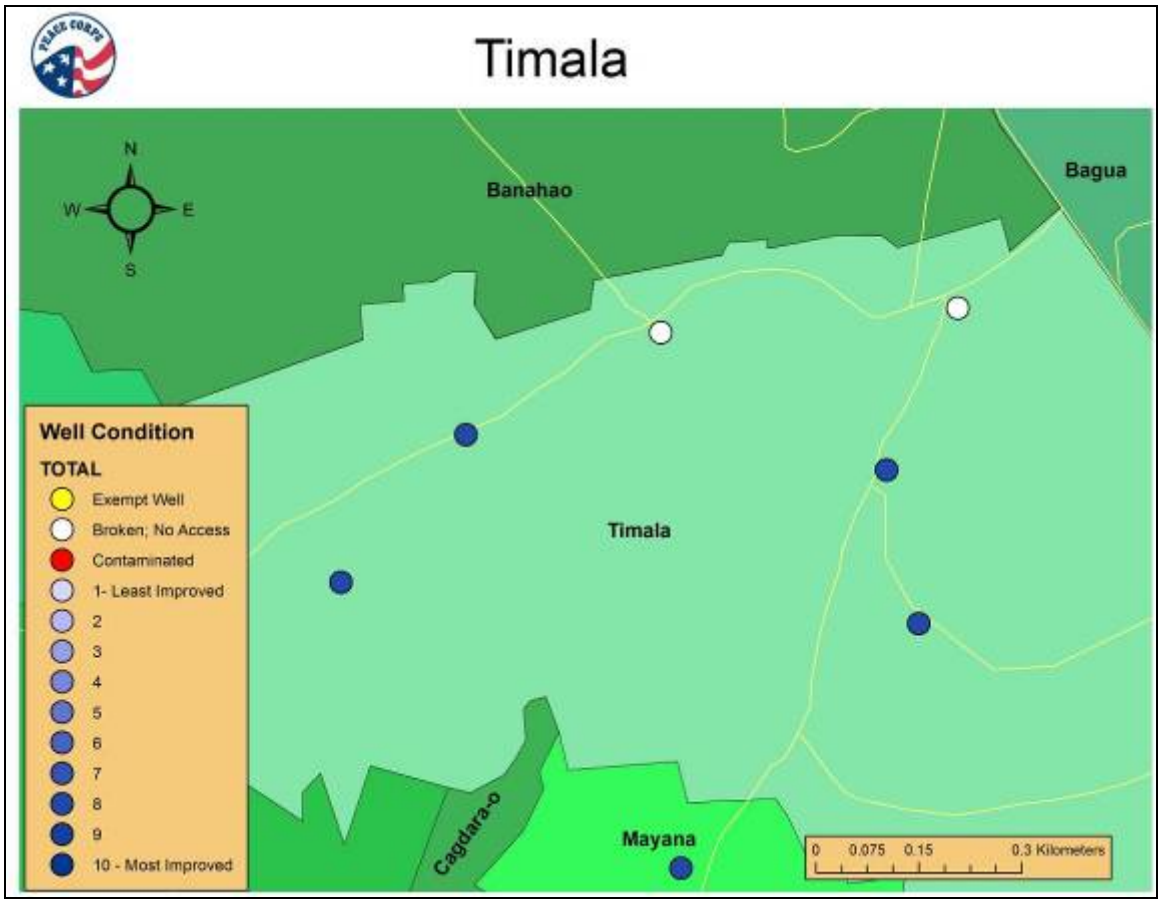
Tagpuro is located on the peninsula below the airport. It is served by a recovered BWS. As with most BWS water supplies, it is only available for a few hours in the morning. The surveyor suggests four wells for preservation mainly due to the natural locations or construction materials. Some relocated storm affecteted families are relocating in areas adjacent to the airport. In addition to the help the families are receiving in constructing their new homes, in some cases they need help in developing their water resources. While the neighboring barangays have access to the MWS, the surveyor found no connections in Tagpuro.



Number of Wells Sampled: 10
Average Improvement Score: 8
Issues: none Major
Priorities: Continue development of Sources

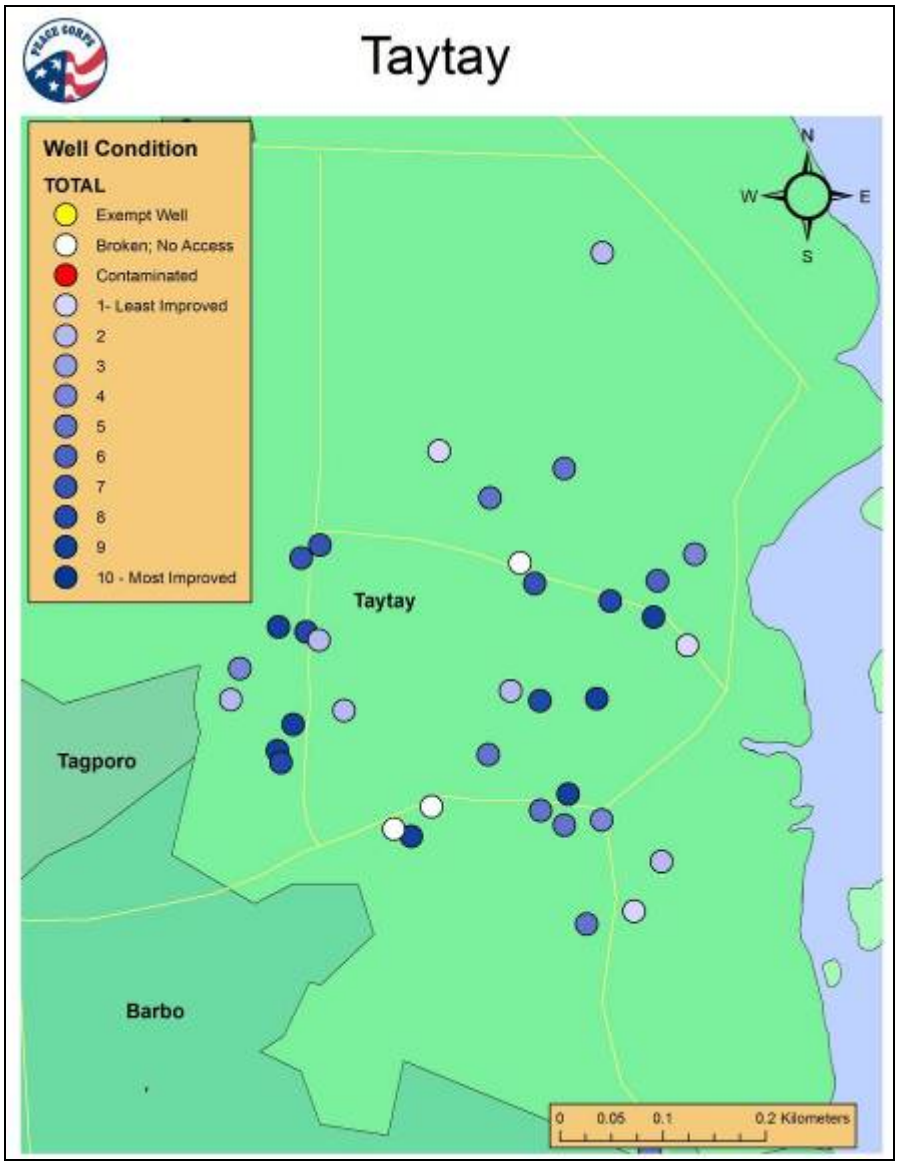
Mayana, like most barangays at higher elevations with limited access to the water table and fewer sources, has excellent wells. Most are of the "artesian" type. One complaint often heard about these wells, is the amount of work it takes to push the water to the surface along with the fact that it takes more pumping for the water to run clear. This may be due to oxidation of piping and linkages.

There is one open well that the surveyor proposes for preservation. It is the deepest open well in Guiuan. Situated beneath a large and tall tree, it dominates the landscape.



Number of Wells Sampled: 4
Average Improvement Score: 8
Issues: Few wells, un-repaired wells
Priorities: Return to service "artesian" wells that are broken

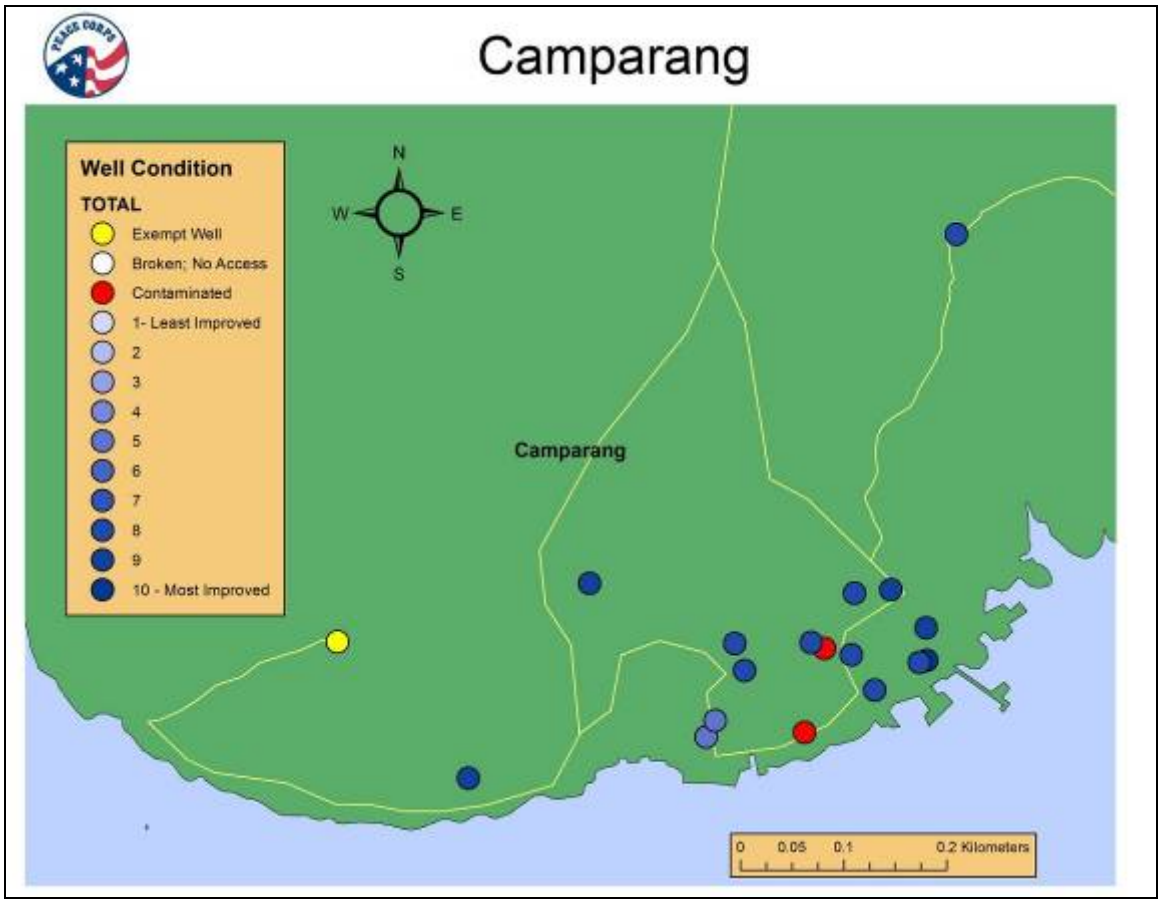
Timala is an inland barangay found at the higher elevations. It boasts a cave locally famous for it's access to the water table. Technically this cave is a contingent source of water but is not included in the survey. The high elevation makes residents dependant on downhole positive displacement pumps to bring the water to the surface. Two of the six wells being off-line is significant. The BWS has been restored with a new tank on the damaged "solar" tower. It was not determined if the MWS extends to the National Road border of Timala. At the Timala - Mayana Border is located also has a MWS tank that is currently off line.



Number of Wells Sampled: 32
Average Improvement Score: 5.6
Issues: None Specific
Priorities: Continuous Improvment; Well-35 appears neglected and without a steward.

Taytay is a peninsular barangay on the southeast coast. Its wells tend to be unimproved with two wells that are at risk becoming contaminated. Well-2 and Well-35 should be secured as a prioity.

Taytay is without a BWS but is served throughout by the MWS.

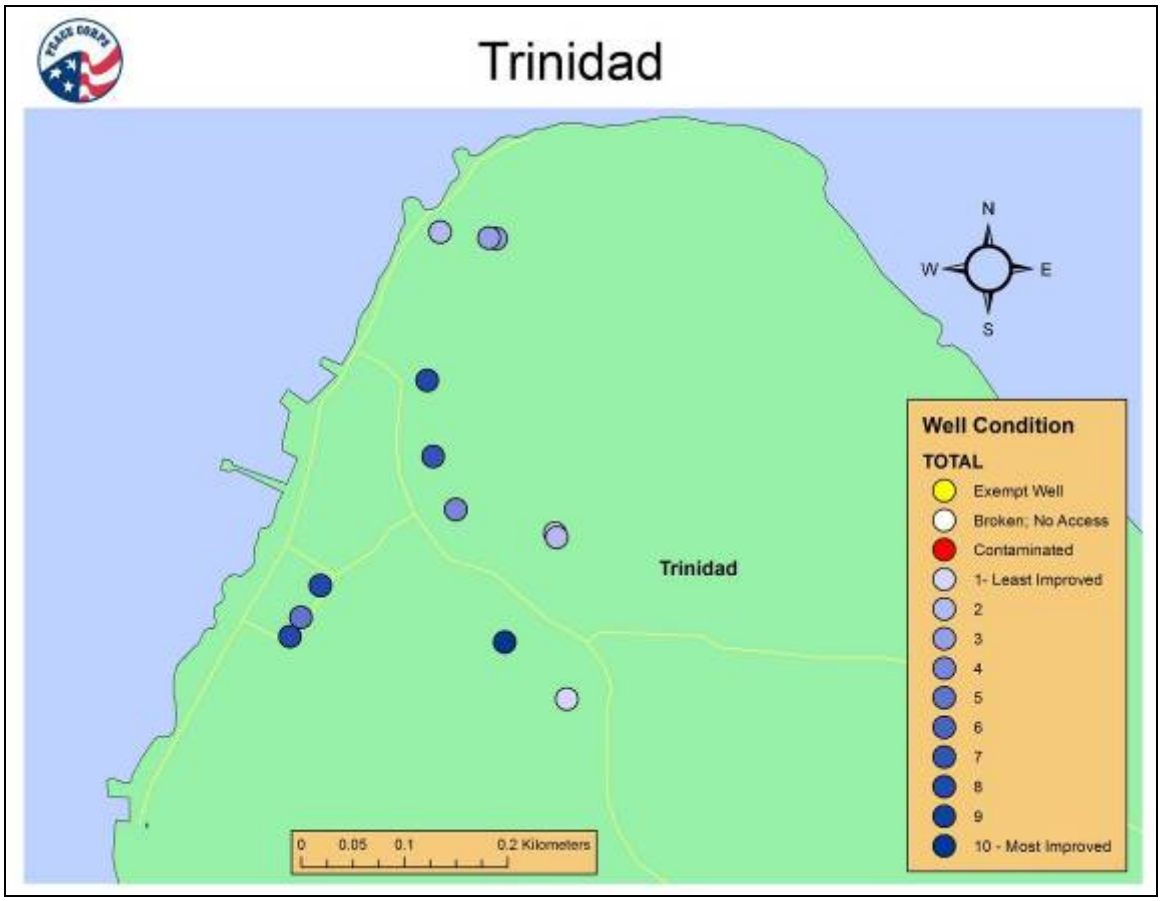


Number of Wells Sampled: 18
Average Improvement Score: 6.5
Issues: BWS not on-line
Priorities: Clean and cover wells, Bring BWS online.

Camparang is found on the southern coast of Tubabao Island and is blessed with a spring and drinking water well. It is also the site of one of the Japanese philanthropic and development projects. There maritime association helped rebuild their school and underwater storm resistant fish cages for lapu-lapu (grouper) culture is being developed.

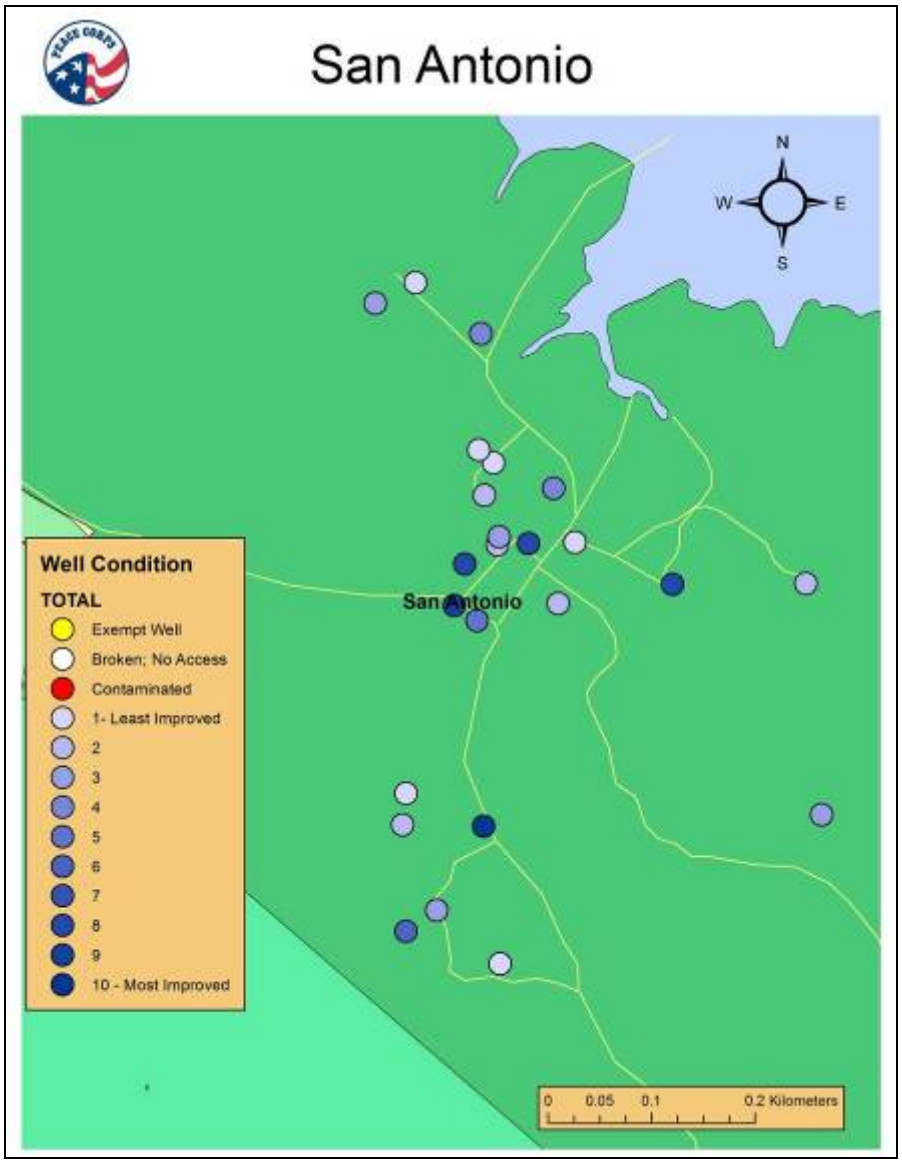
The BWS of Camaparang survived the storm relatively intact, but is not yet on line. Camparang also has the distinction of being a barangay where there were no observance of broken faucets among the BWS standpipes.

Wells are fair with two contaminated wells reducing the overall score. One is storm damaged. The other belongs to an elderly couple who seem not to have help maintaining their well.

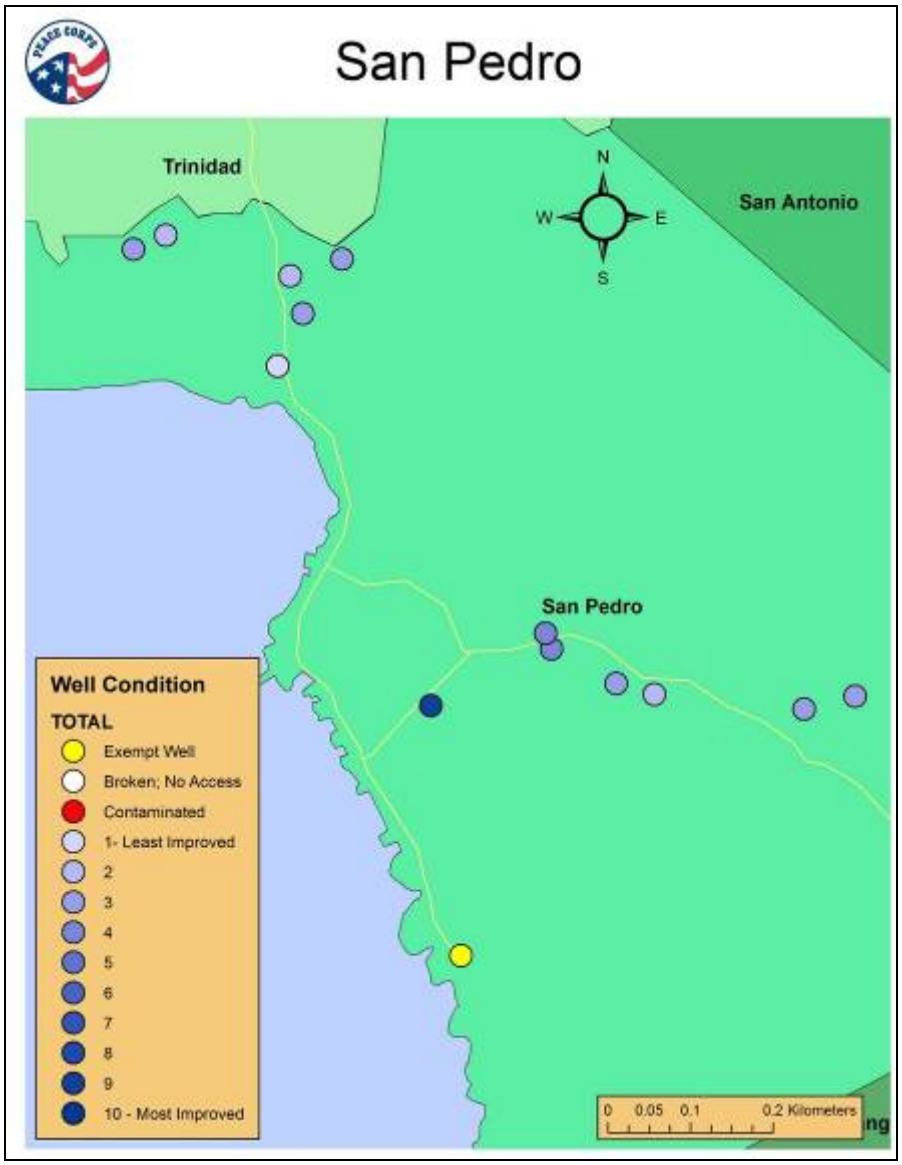


Number of Wells Sampled: 13
Average Improvement Score: 4.8
Issues: Uncovered and unimproved wells.
Priorities: Continuous improvement; cover wells.

Trinidad residents occupy land very near the water table. Their inland wells have multiple jetmatic connections that run some distance to the coastal residents. One of these are a significant source, that once had an improved cover, however it is in a current state of disrepair Trinidad has a stand-alone BWS that was recently installed. Primarily funded by the Japanese, it has a three stage filter that includes a softener stage.



Number of Wells Sampled: 24
Average Improvement Score: 3.8
Issues: Unimproved wells.
Priorities: Implement improvement plan.
San Antonio water table is less than a meter below grade. There are a lot of unimproved wells. One well (Well-6) in San Antonio is a result of Yolanda. When the storm came through, a large tree was up rooted and the resulting hole is being exploited as a well by one elderly gentleman. Their BWS is a stand-alone system at the plaza.



Number of Wells Sampled: 13
Average Improvement Score: 3.2
Issues: Unimproved wells.
Priorities: Implement improvement plan.

San Pedro is home to one of the Yolanda surviving "Solar" tanks. It is also served by piped BWS water throughout the populated areas. It has a very nice traditional well (Well-6) that can accommodate a large laundry day crowd as well as young bathers. The large heavy cover is replaced at night. At the other end of the Coastal Road is a old well in a natural setting that is nominated for preservation (Well-7).

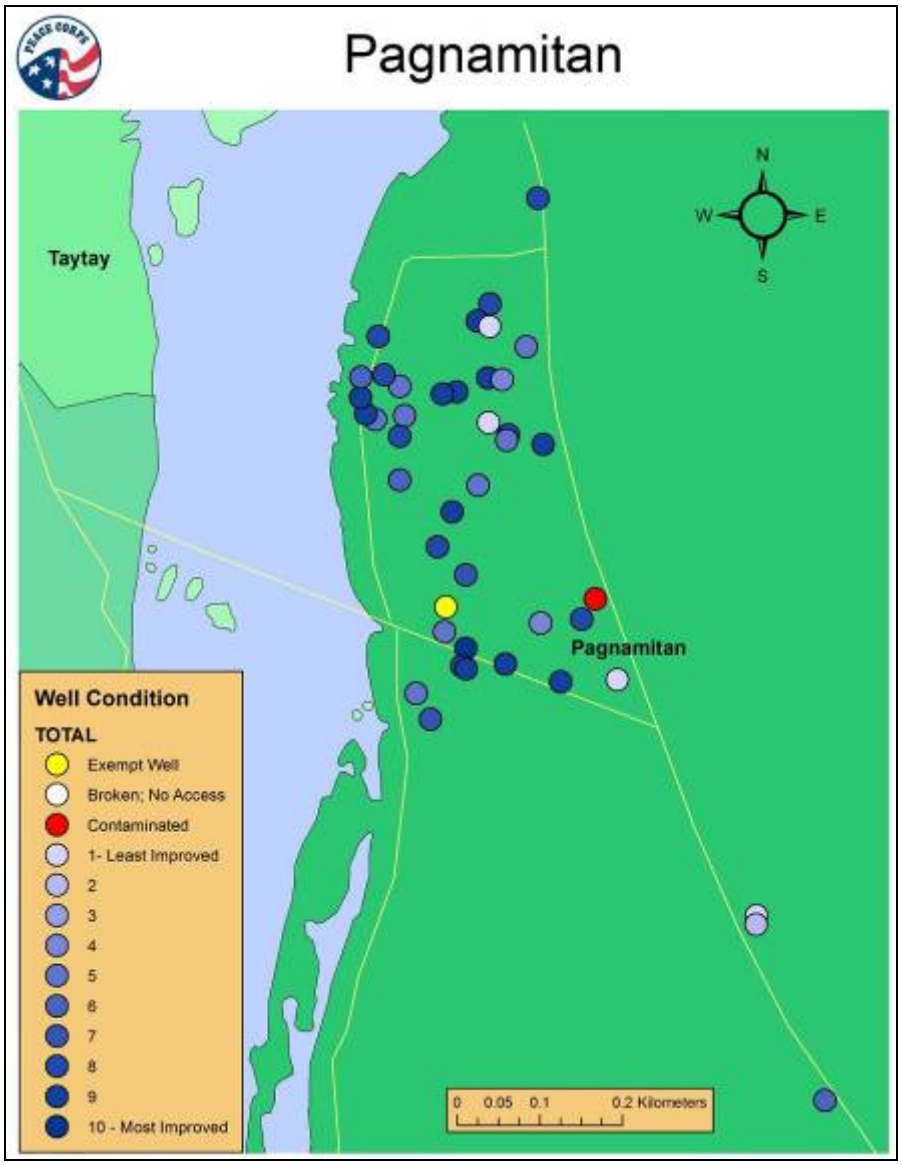
With the water needs of the barangay appearing to be well taken care of, the low score is due to the large number of unimproved wells may be misleading, however a little improvement in these wells will go a long way to improve the water quality of outlying areas.

Also, the BWS extends to a remote group of residences to the south that was not surveyed.

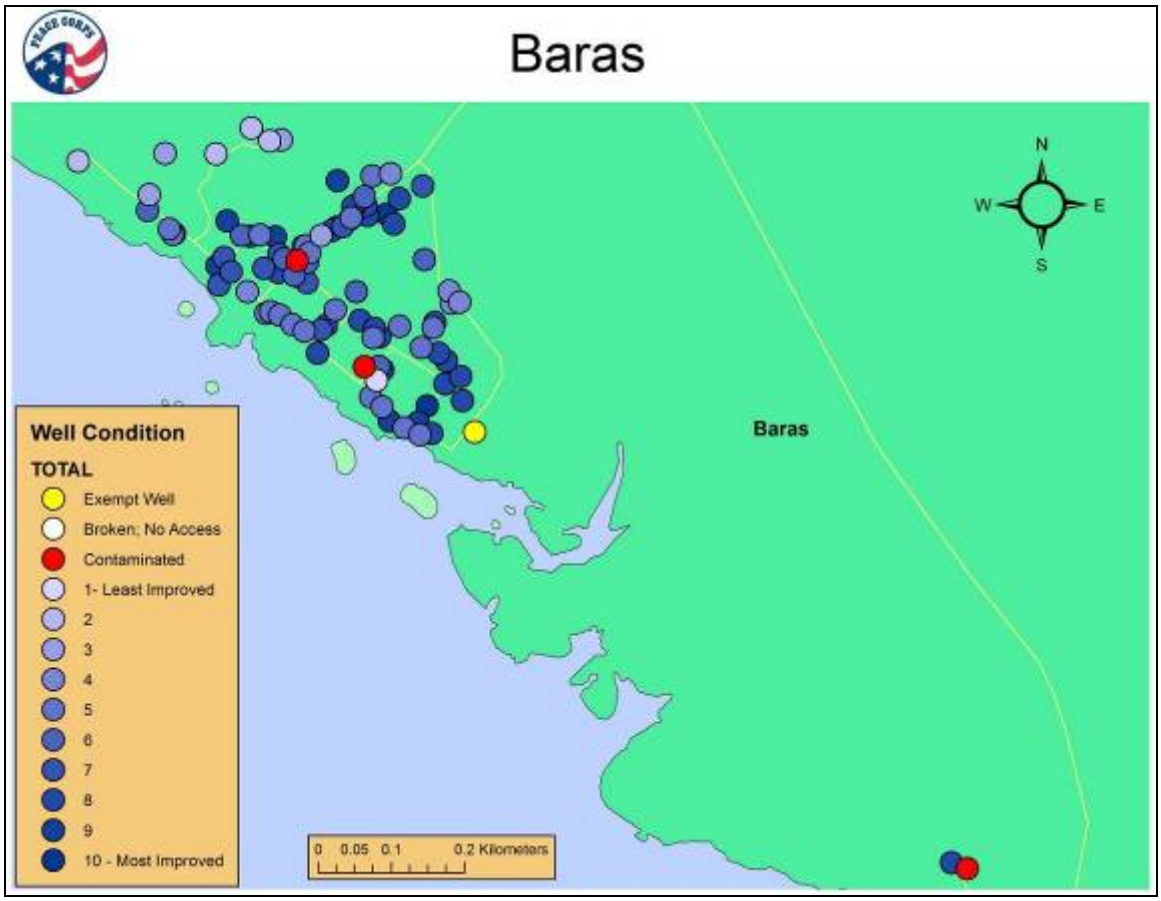
Number of Wells Sampled: 42
Average Improvement Score: 6.3
Issues: Lack of water at higher elevations.
Priorities: General Improvement Plan.

San Juan water sources are found at the lower elevations as dug wells and along the hill sides as creeks and captured springs. Previously the BWS was located at a higher elevation and served the residents that occupied the ridge tops and along the main road going up to the central highland. With that system destroyed by Yolanda, the residents need to haul their water up hill some distance.

San Juan has a drinking water well (Well-4) that has a tap stand facility for the residents. One well slated for preservation, Well-1 is actually a series of spring capture structures. The top is used for drinking and the lower is used for washing. The other spring proposed for preservation is Well-13. This spring is unimproved. Basically springs and creeks do not fit readily into the model proposed by this report, however they can, and often are improved as a water source. Each community should decide on a case-by-case basis how to proceed. Another creek, on the border of Camparang and San Juan was not included in the scoring for the same reason. It is an important water resource with extensive improvements and should be protected or preserved as appropriate.



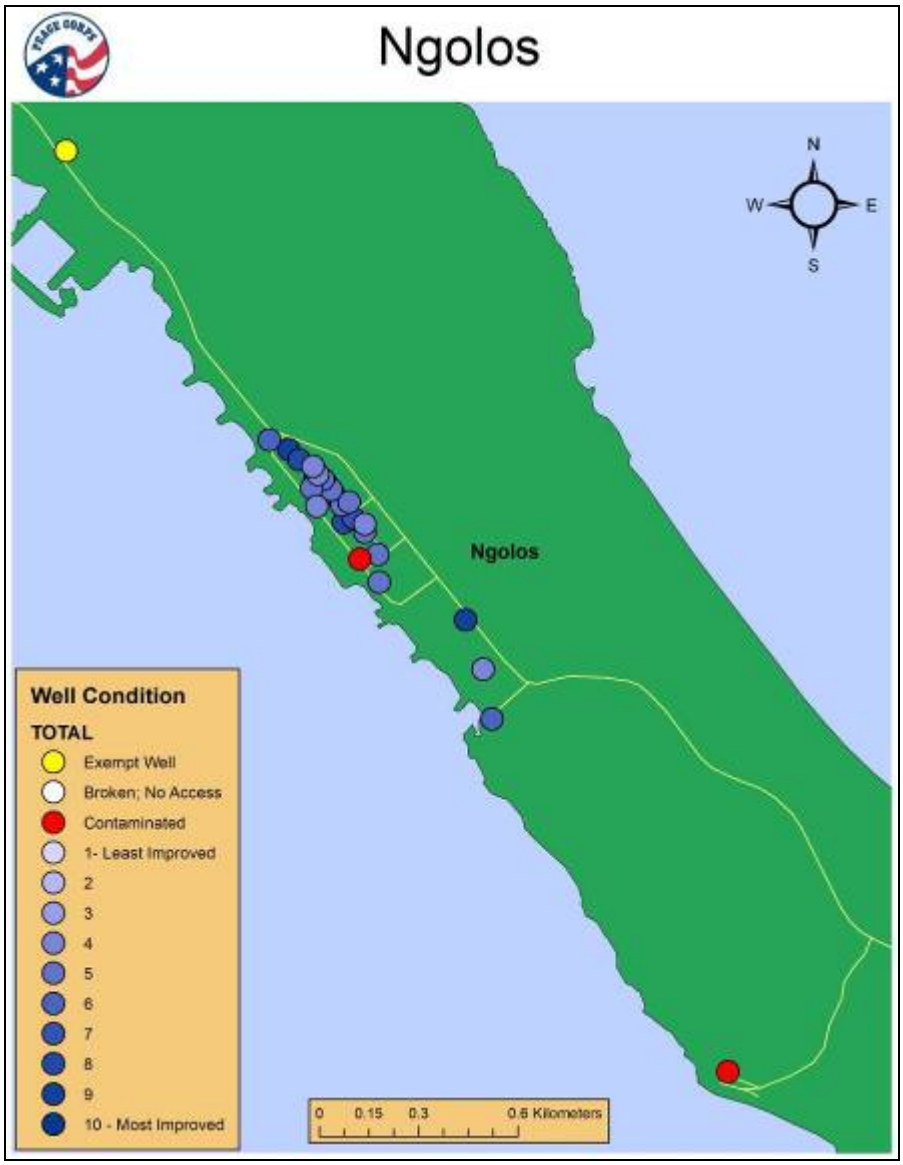
Number of Wells Sampled: 42
Average Improvement Score: 6.3
Issues: none major. One abandoned well.
Priorities: General Improvement Plan.
Pagnamitan is the northern tip of Calicoan Island. The BWS was destroyed by Yolanda and has yet to be replaced. Pagnamitan is served by the MWS along its main avenues. The abandoned (contaminated) well follows the common pattern of filling with trash, and then being taken over by plants.
Some of the low scoring wells are new constructions.



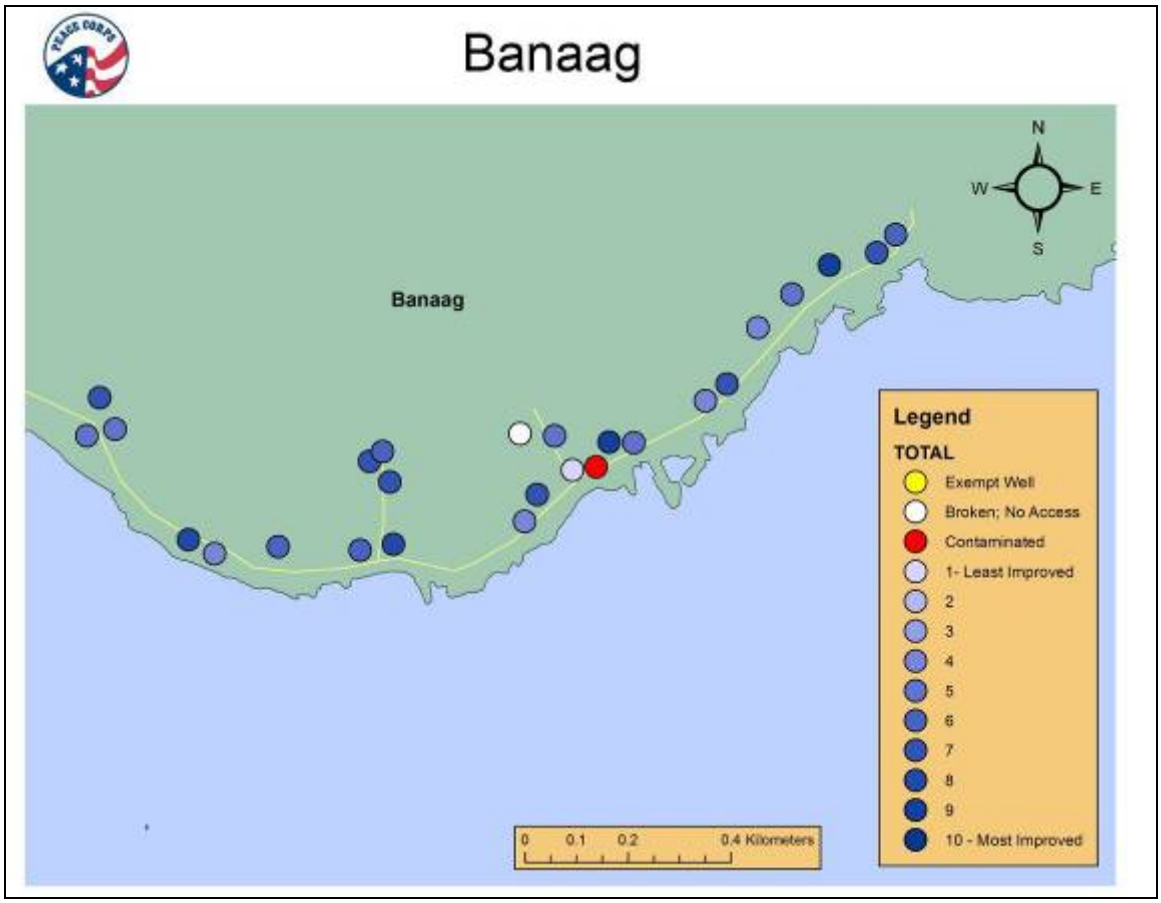
Number of Wells Sampled: 94
Average Improvement Score: 6.1
Issues: none specific; contaminated unsecured wells
Priorities: General Improvement Plan.
In Baras, the surveyor counted over 90 wells, more than any other barangay. The actual total number may be much higher. High water table, easy matrix to excavate may be factors contributing to almost every house having a well.
Overall the well score is low. Covers were not common. With so many wells, this simple improvement will go for to secure the aquifer for. There are three wells that are abandoned and contaminated: Well-24, home left abandoned after Yolanda; Well-78, well at plaza converted to debris container; Well-91, see description in body of report above.

Well-42 and Well-43 have been "improved" with old motorcycle tires. This practice was observed in a couple of other barangays. The problem with old tires stacked one upon another to form a well shaft is that it forms a breeding habitat for mosquitoes. As water is drawn up with a bucket, water will slosh to the side filling the tire with stagnant water that will attract insects and other animals looking for a nook or cranny to occupy. It is better to leave a dug well with its natural matrix walls than to apply old tires.

The well the surveyor nominates for preservation is Well-1. Able to accommodate many washers at a time, it is a community treasure worthy of preservation.



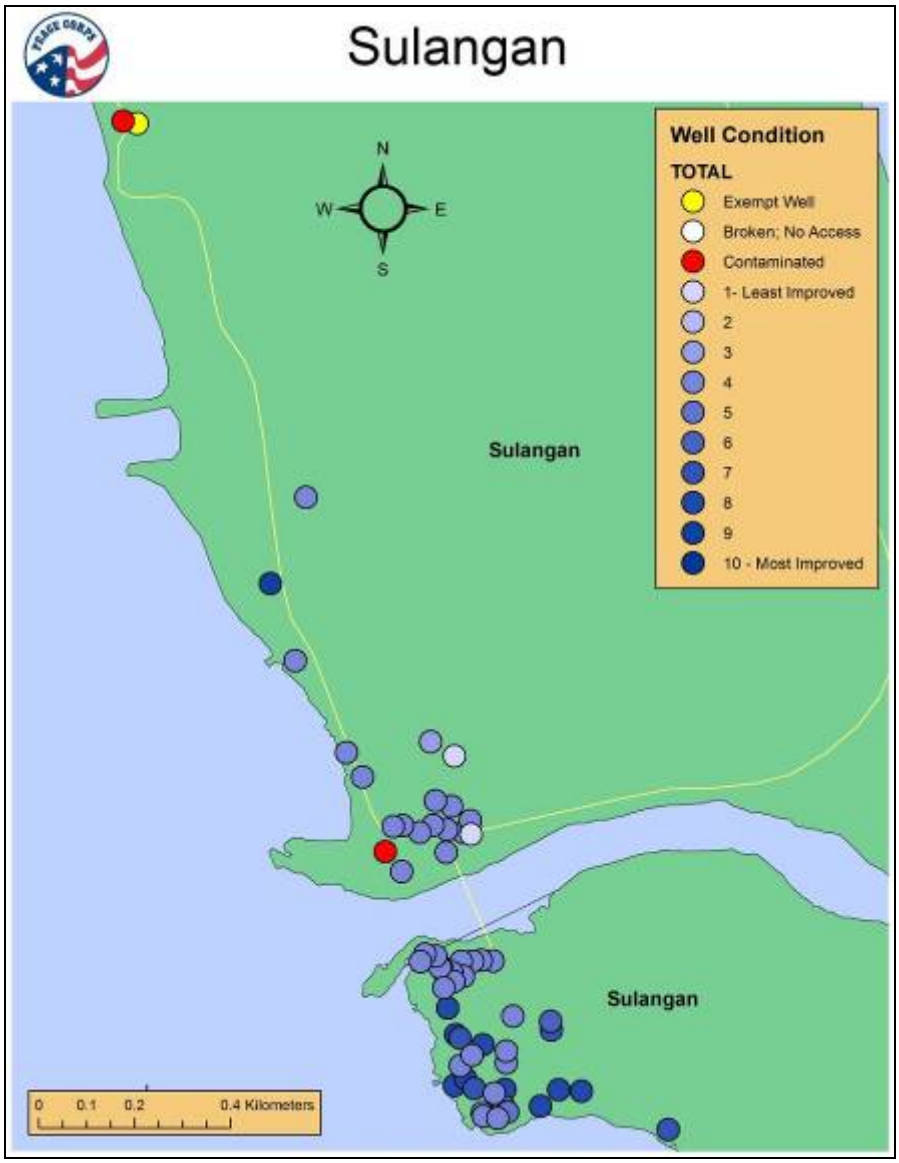
Number of Wells Sampled: 26
Average Improvement Score: 5.5
Issues:
Priorities:
Ngolos is the next barangay on Calicoan Island going south. It is also served by the MWS. There were no wells in Ngolos surveyed that were in an unimproved state. Most wells were with improved shafts, but without covers. Most improvement therefore will be simply securing the source with a cover and improving aprons. Two contaminated wells were noted. One supplied the pump near the elementary school Well-25. Well-1 is in a small fishing village to the south of the main population center. The residents noted that the well was salty and was not used because of the MWS supply taps, five in all. It appears that the residents attempted to close the well with stones and it hasn't gathered much trash. A little clean up with a non-removable secure cover will finish the job. The Barangay is installing a buffer tank positioned on a hill.



Number of Wells Sampled: 25
Average Improvement Score: 5.7
Issues: No water at the elementary school
Priorities: General Improvement plan, get the children some water.
Banaag is on the southern coast of Manicani Island. The BWS at the elementary school was destroyed by Yolanda and has not been recovered. This is unfortunate because it directly supplied the elementary school. The pump is not functioning therefore the children have to carry their water. There is one contaminated well. Looks like the well is collecting only fallen leaves and is not a threat to become a garbage can.

Wells are generally improved with a few newly dug wells associated with temporary housing. There only a few pumps, so improvement will be in the form of better drainage and covers.

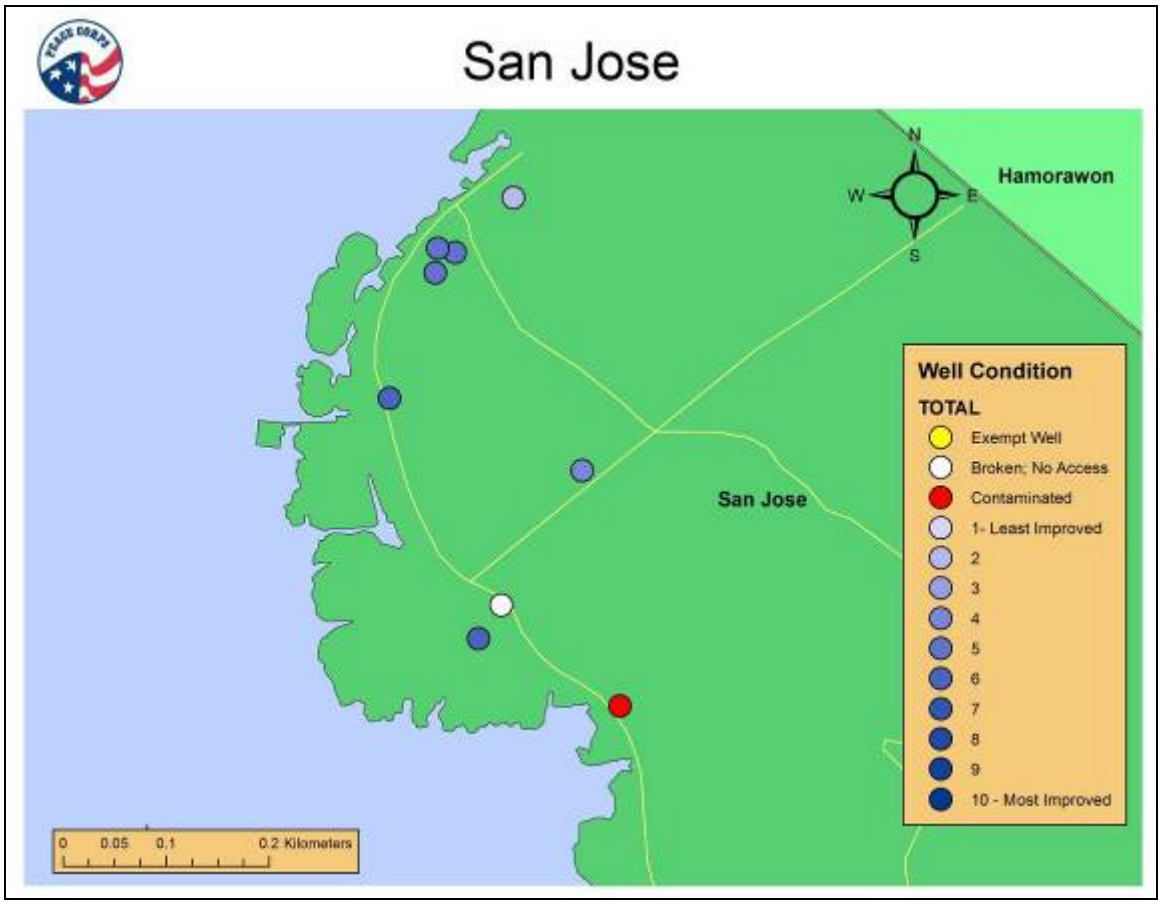
Banaag has a WWII US Navy dam on one of the larger creeks. It only functions as a bridge today. Banaag evidently does not use its flowing water to any great extent for utility purposes.



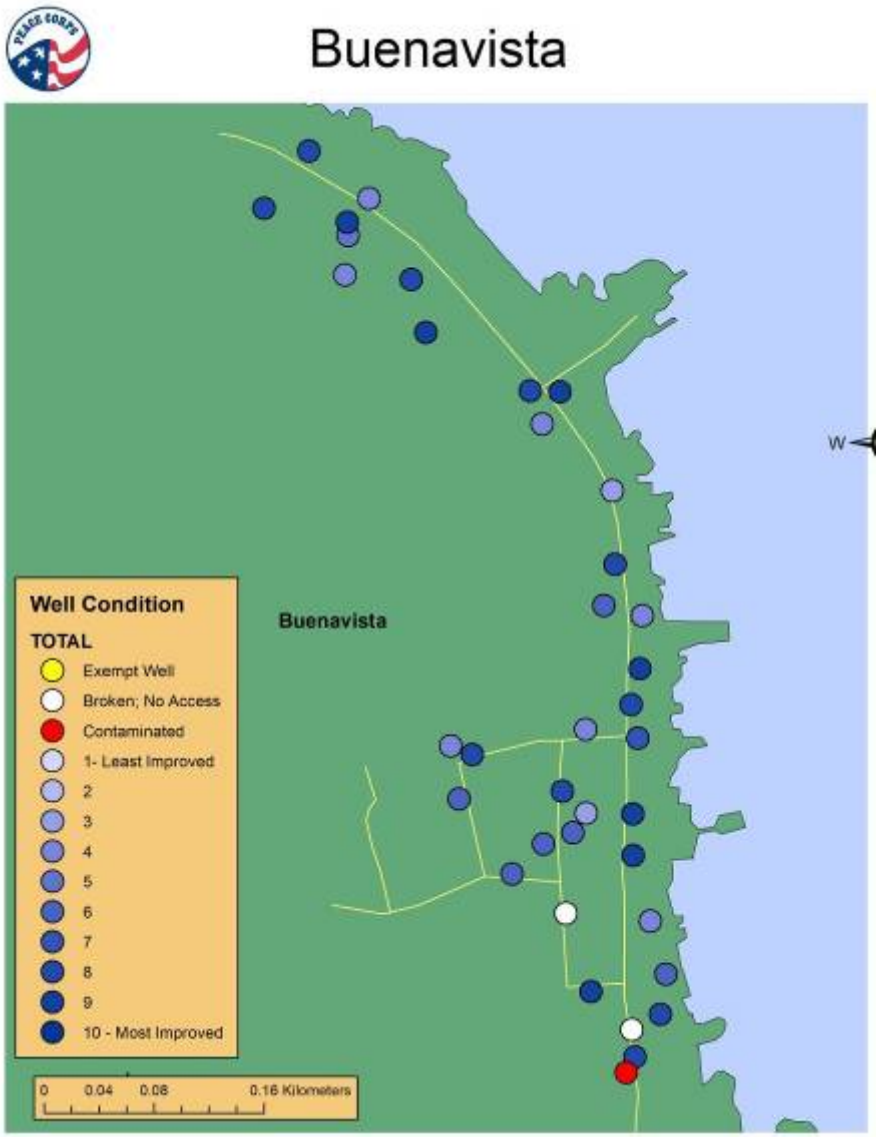
Number of Wells Sampled: 60
Average Improvement Score: 4.6
Issues: Salt water intrusion
Priorities: General Improvement, Cover the wells, etc.

Sulangan is at the southern tip of Calicoan Island and has a large number of improved wells without pumps nor covers. There are two parts to Sulangan, north and south of the bridge. To help decrease the possibility of further salt intrusion the MWS is piped 10 or so kilometers south from the pumping stations in the highlands of the peninsula. The remote supply coupled with a widely dispersed and bucket draw from shallow wells is a best case scenario for minimizing salt intrusion. As noted earlier, the wells north of the bridge, are supplied with fresh water on the high tides. This phenomena may occur south of the bridge, but was not noted by the residents or observed by the surveyor.

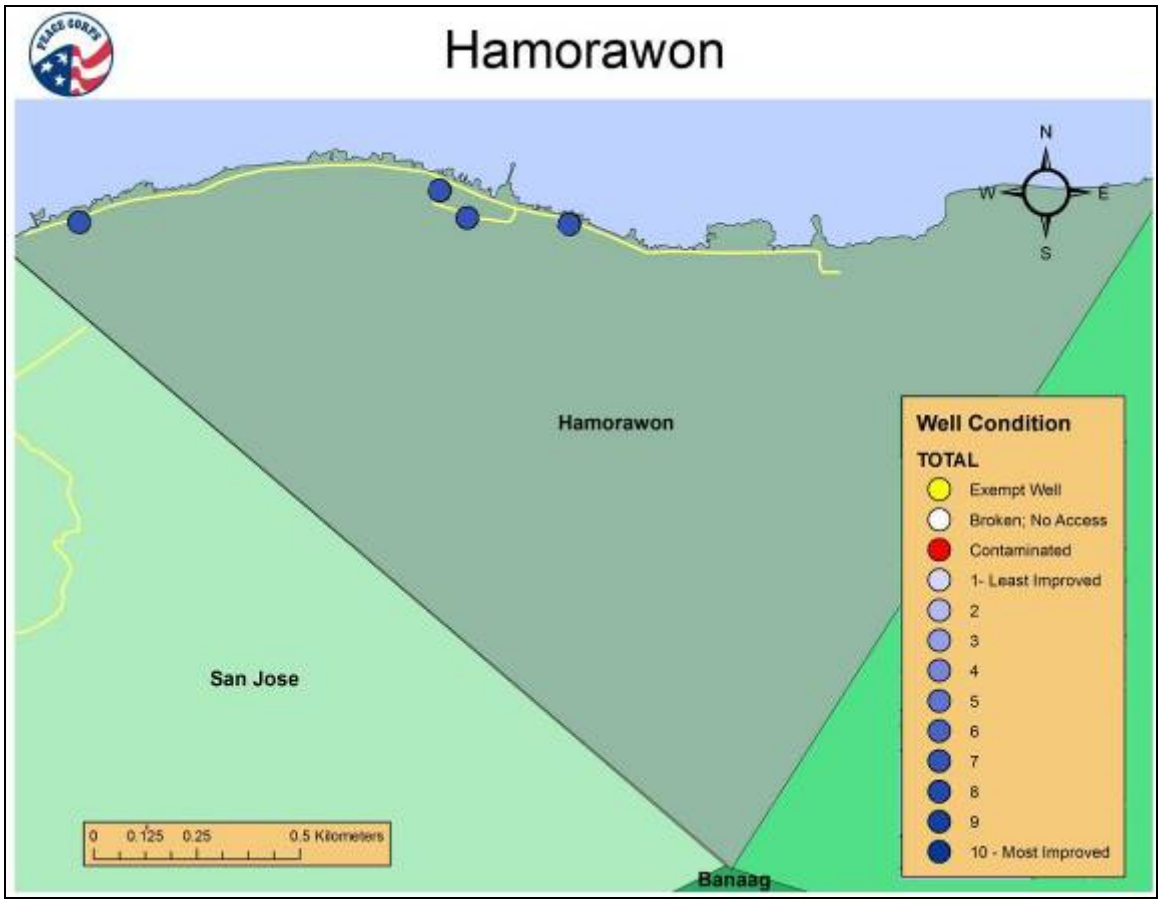
The surveyor found two contaminated wells, both north of the bridge: Well-52 and Well-59. Well-59 is adjacent to the well nominated for preservation.



Number of Wells Sampled: 8
Average Improvement Score: 4.1
Issues: Deterioration in BWS water piping.
Priorities: Fix leaks
San Jose has a spring capture box as a BWS and piping throughout the barangay proper. Consequently there are fewer dug wells as primary water sources. Water is abundant so maintenance of piping doesn't seem to be a problem. The flow of water is controlled by sticking a stopper into the end of a hose. Faucet leaks are repaired with electrical tape etc. As noted earlier, it is difficult to determine whether the condition of the pipes is storm related or just delayed routine maintenance.
One contaminated well (Well-1) was observed at a Yolanda affected residence.



Number of Wells Sampled: 35
Average Improvement Score: 6.4
Issues: none specific
Priorities: General improvement
Buenavista is on the east coast of Mancani and is served by a BWS. There are a few small creeks that run through the town. One abandoned well is abandoned at the southern end of town (Well-9) and is overgrown. Some wells are sporting newly constructed concrete covers. Our visit to Manicani was planned by UN staff so there may have been some preparation. If so, this is an encouraging sign.

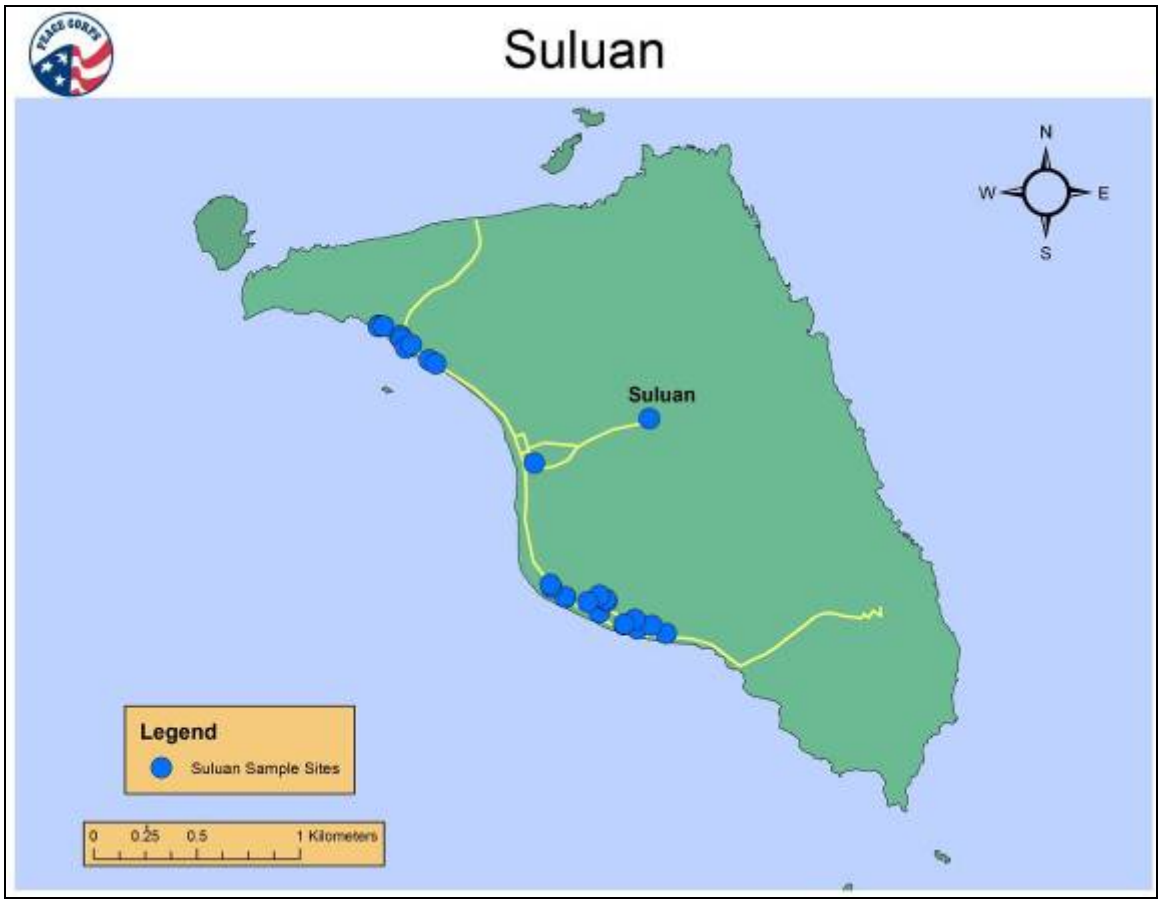


Number of Wells Sampled: 4
Average Improvement Score: N/A
Issues: leaking pipes
Priorities: Control and improve access at streams.

Homorawon has abundant running water. The local leadership needs to consider installing fountains to control and hold the flow for access. Spring capture is taking place at higher elevations and piped to holding tanks along the coast. The BWS is piped to the residents via dual faucet standpipes. Surprisingly the elementary school is without a water source.
The fountain recommendation may be far-fetched, however, at streams the BWS is run by hose to the creekside. The surveyor assumes that the creek provides water for primary washing and rinsing and the hose supplies final rinse water. Minimal improvement to these creeks will help residents with their washing day chores.

As with other locations with a large amount of flexible pipes, routine maintenance is needed. The hose end stopper is not a reliable way to control water flow. Indeed the water is so plentiful in Homorawon that controlling the flow anywhere is not an issue.

Homorawon has a two contaminated wells observed among the few wells surveyed, but since the eastern half of the barangay was not surveyed due to time constraints, averages or scores were not calculated and they are not indicated on the map.



Number of Wells Sampled: 23
Average Improvement Score: N/A
Issues: Salt water intrusion
Priorities: Extend BWS to all areas.
Suluan has a BWS applying spring capture upland a bit, with apparently abundant piped water throughout the population center. The elevation of the supply is not that great, so pressure at the end of the runs is small. Residents have excavated pits to allow for more drop in flow. The Pipe extends to the edges of the rural areas. Since time on the island was limited, only the wells in the rural areas were surveyed. There is a large tidal effect on the wells and salt intrusion is a problem.

Number of Wells Sampled: 0
Average Improvement Score: N/A
Issues:
Priorities:
The downtown areas were not surveyed. It is high density residential served extensively by the MWS. Surface features include a popular spring in Ward 12 enjoyed by young and old. It has a large pool with tidal influences.

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William Thurman Nutt, Jr.

A native of Opp, Alabama, William graduated from the University of Alabama in 1979 with a BS degree in Finance. William first served as a US Peace Corps Volunteer in the Philippines from in 1979 to 1981 assigned to the Mayor's office in Sogod, Southern Leyte as a Small Business Consultant. He transferred mid-service to the Family Health Program with responsibilities for all of Southern Leyte.

After the Peace Corps, William taught English in Japan for five years and went on to have a successful 25 year career as manager with a Japanese electronics manufacturer in Georgia. In response to the Typhoon Yolanda crisis in Region VIII where he first served as a volunteer in the Philippines, William was accepted to the US Peace Corps Response Volunteer Program and was assigned to the Local Government Unit of Guiuan, Eastern Samar. The islands of Samar and Leyte make up Region 8 in the Visayas.

William has a Master of Science degree in Environmental Science from Columbus State University, Columbus, Georgia and a Master of Science in Rural and Small Town Planning from the University of West Georgia. He is currently in the dissertation phase of a Doctor of Public Administration Degree from Valdosta State University in Georgia. William's research concerns environmental land use policy at the county and municipal level and environmental economic considerations. His expected graduation date is in May 2015. He is currently residing in Peachtree City, Georgia working as an Environmental Consultant and ISO 14001 Lead Auditor for Underwriters Laboratory. William speaks Cebuano, Spanish, and Japanese.