EXERCISE BALIKATAN 2012
TECHNOLOGY INSERTION

QUICK LOOK REPORT

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This Quicklook Report provides initial observations on sixteen humanitarian assistance/disaster relief technologies that were inserted in the annual, bilateral Exercise Balikatan 12. Included were: seven water purification technologies, one water testing system, three situational awareness-communications-logistics systems, two maritime domain awareness capabilities, a photo-voltaic power system, an energy monitoring system, and a rapid building construction capability.

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This Quicklook Report provides short descriptions and initial impressions of sixteen humanitarian assistance/disaster relief related technologies introduced in Exercise Balikatan 12 as part of the ongoing experimentation engagement and partnership between the United States Marine Corps Forces, Pacific (MARFORPAC) Experimentation Center (MEC) and the Armed Forces of the Philippines (AFP) National Development Support Command (NADESCOM). This document provides feedback and observations gathered by the MEC, and does not necessarily represent the formal position of the Marine Corps or the Department of the Navy.

The MEC especially wishes to recognize the collaboration, support, and encouragement provided by Major General Carlos Holganza and the AFP National Development Support Command.

Shujie Change, P.E.
Director, MEC
May 2012

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EXECUTIVE SUMMARY

As part of the US Pacific Command (PACOM) Science and Technology (S&T) Theater Campaign Strategy, MARFORPAC Experimentation Center (MEC) was designated executive agent for S&T engagement with the Armed Forces of the Philippines (AFP). In 2011, the MEC established a partnership with the AFP National Development Support Command (NADESCOM) to develop and conduct experiments that test technologies of mutual interest. During Exercise BK 12, sixteen HA/DR-related technologies, in a number of focus areas, were tested by US personnel and their Philippine counterparts.

Three situational awareness, communications, and logistics systems were inserted into Exercise BK 12; HADR C&C, MARCIM, and HELP. Humanitarian Assistance Disaster Relief Coordination and Communication (HADR C&C) provides cell phone, WIFI hotspots, radio and VoIP cross-banding, communications management, and applications software which can provide multiagency support in a devastated area. HADR C&C operated in two locations supporting US and Philippines military communications, civil agencies, and higher authority. MARCIM provides smart phone applications that support data collection, aggregation, and dissemination to a variety of disaster responders. MARCIM was used on Palawan to collect and consolidate Humanitarian Civic Action (HCA) activities information. HELP, still in early development, will provide user-friendly visibility of humanitarian assistance/disaster relief supplies being moved to a disaster area utilizing a web based interface for data entry and retrieval. HELP operated out of Subic Bay on Luzon and port and HCA locations on Palawan.

Two maritime domain awareness technologies operated in conjunction during Exercise BK12. The HFDR radar was used to detect ships up to 100 miles at sea, while the Stalker UAV was used to follow up on selected targets and provide video. The HFDR radar detected numerous ships in the channel from Manila and Subic Bay to northeast Asia, about 20 miles offshore. The HFDR radar was left behind for future operations and data collection.

Eight water technologies were inserted into the exercise. Three technologies were capable of purifying water for 500 to 1,200 individuals. The Aspen 2000 and Aspen 5500 provided water for troops at Crow Valley and Ft Magsaysay. The First Response Water Purification System, provided water at Camp Crow and Camp Aguinaldo with sufficient throughput to support about 1,200 individuals. Three small scale purification systems; the UH Portable Reverse Osmosis System, Tulip Filter, and LifeStraw systems were demonstrated at multiple locations. The UH Slow Sand Filter was set up at Ft. Magsaysay and Palawan State University (PSU), and was left behind to support future data collection. Finally, the AQUAPATH, a set of buoys which can quickly and accurately assess water quality, detected Coliform and E.Coli at Ft Magsaysay Pahingahan Dam and Puerto Princessa within 20-30 minutes of deployment.

Two power and one shelter construction technology were inserted in Exercise BK 12 as well. The STAESS photo-voltaic system provided consistent usable power at several locations. The REACHE power monitoring system was employed at Crow Valley to determine occupancy and power utilization in a number of tents. The SABS technology was used to construct two permanent buildings of expanded polystyrene panels covered with a thin layer of cement, sand, fiberglass, and other additives. A permanent 200 sq ft building with windows and a door was constructed at Camp Aguinaldo. A similar smaller 100 sq ft building was constructed at Bicol University.

Overall, Exercise BK12 was a successful event for technology insertion and partner nation S&T collaboration efforts. The data collected from each of the experimentation events will help shape continued technology development for our warfighters and future HA/DR efforts. The UH Slow Sand Filters, SABS, and HFDR radar will remain in the Philippines and will continue to support collaboration efforts and future experimentation.

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INTRODUCTION

Purpose

The purpose of experimentation in Exercise Balikatan is to introduce leading edge technologies and CONOPS to the Exercise BK12 training audience, assess candidate technologies, and provide operational feedback to the science and technology community. This Technology Insertion Quicklook report covers the technologies that were tested and assessed at the CPX, FTX, and HCA sites in Exercise Balikatan 12 in the Philippines during the period early March through late April 2012.

Technologies participated in Exercise BK12 in one of four ways:

- **Exercise Mission Support –** Technologies inserted into the play of the exercise
- **Assessments -** Formal experiment, test or evaluation of mature technology
- **Demonstrations -** Actively employ emerging technology without a formal assessment
- **Static Displays -** Technology on display, with a limited table top demonstration

Background

As part of the US Pacific Command (PACOM) Science and Technology (S&T) Theater Campaign Strategy, the MARFORPAC Experimentation Center (MEC) was designated to be the executive agent for S&T engagement with the Armed Forces of the Philippines (AFP.) In 2011, the MEC established a partnership with the AFP National Development Support Command (NADESCOM) to develop and conduct experiments that test technologies of mutual interest. During Exercise Balikatan 2011, several water purifications technologies were tested and assessed in support of the Pre-Positioned Expeditionary Assistance Kits (PEAK) Joint Capability Technology Demonstration (JCTD) operational utility assessment (OUA.)

During Exercise Balikatan 2012, sixteen technologies in a number of focus areas were tested. Three technologies focused on situational awareness, communications, and logistics visibility; two technologies focused on maritime domain awareness; eight focused on water purification and testing, a priority area of mutual US – Philippines interest; two focused on power – one on solar photo-voltaic generation and the other on power consumption monitoring; finally there was a technology focused on rapid building construction.

Locations

Luzon

- Naval Education and Training Command, Zambales: HFDR and Stalker UAV
- Subic Bay Fire Station No. 4: HADR C&C
- Crow Valley: Aspen 2000, First Response Freshwater Purifier, STAESS, REACHE
- Ft. Magsaysay: Aspen 2000, UH Slow Sand Filtration System, UH Portable Reverse Osmosis System, Tulip Filter, AQUAPATH, STAESS
- Camp Aguinaldo: HADR C&C, Aspen 5500, First Response Freshwater Purifier, UH Portable Reverse Osmosis System, Tulip Filter, LifeStraw, STAESS, SABS
- Bicol University, Albay Province: SABS

Palawan

- At HCA sites: MARCIM and HELP
- At Palawan State University: UH Portable Reverse Osmosis System, UH Slow Sand Filter, AQUAPATH

Figure 1: Exercise BK12 Experimentation venues

Technology Descriptions

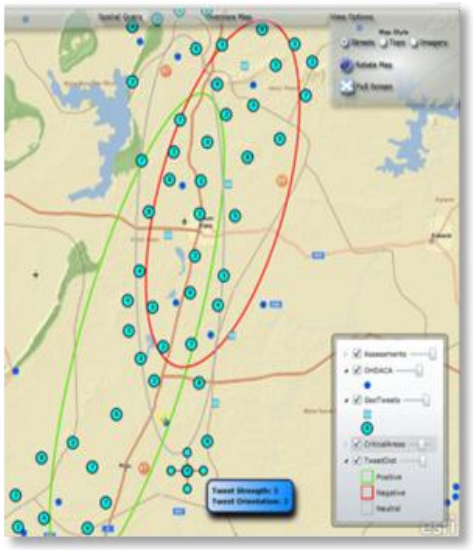
Situational Awareness, Communications, and Logistics

The HADR C&C system evolved from a series of mobile warfighting situational awareness and communications capabilities. HADR C&C provides local cell phone, WIFI hotspots, and cross-banding which can be linked to commercial satellite communications with the outside world. MARCIM provides a smart phone interface to enter data – such as patient information or local disaster situation – and then transmit it to a central site where it is merged with other similar information and made available to operational users. HELP accepts information on non-military humanitarian and disaster supplies in transit and at locations and will make the information available to users via the internet in an easily understood format.

Humanitarian Assistance Disaster Relief Coordination and Communication (HADR C&C) provides a communication hub for civil and military first responders. The main components of the system include a 3G control system, an associated WIFI capability, radio and VoIP cross-banding. The 3G system consists of an antenna mast and a set of sleeves that connect users into the network using their organic WiFi capable handheld or laptop devices. During the Balikatan exercise, the HADR C&C leveraged a BGAN terminal for backhaul capability out to the Internet and also leveraged a satellite phone as a voice link to the public telephone system. The HADR C&C system hosted an applications store at the control system and served the VoIP application. HADR C&C is equipped to accept various power inputs. The system was shipped in five cases with the following size and weights: Case 1 (RF Shelf): 2’ x 2’ x 2’6”; 149 lbs Case 2 (Server Case w/UPS): 2’ x 2’ x 3’4”; 285 lbs Antenna Mast: 4’6” x 1’6” x 1’3”; 125 lbs, Coax Cable: 2’6” x 2’ x 1’; 35 lbs, Power Module: 3’ x 2’ x 1’; 192 lbs.

Marine Civil Information Management (MARCIM)

MARCIM automates field civil data collection and web-based semantic and geospatial collaboration and analysis. Data collection is conducted in the course of civil military operations using smartphones and the iForms commercial, structured forms software “app” that communicates with its back-end data base hosted at the Naval Postgraduate School. The iForms database supplies data to two Office of Naval Research funded programs: Semantic Wiki, a Wikipedia-style web-based knowledge management, collaboration and discovery capability and the International Stability Assessment and Analysis Capability (ISAAC), a web-based geospatial modeling and analysis capability for humanitarian assistance measures of effectiveness.



Humanitarian Expeditionary Logistics Program (HELP)/Humanitarian Asset Visibility Experiment (HAVE). HAVE consists of logistics software on a DLA server in CONUS and a kit deployable to a disaster response site. The kit has laptops for analyst data entry and report generation, a router, paper and bar code printers, and a BGAN satellite communication system. The kit operates on 110V or 220V power. A primary and a back-up kit are shipped in 10 cases. The heaviest is the printer at 65 lbs. The total weight is 400 lbs. HELP is a Joint Capability Technology Demonstration (JCTD) candidate that will provide near-real-time situational awareness of relief supplies for disaster responders through user friendly web-based access to HAVE data.

Maritime Domain Awareness

The Maritime Domain Awareness (MDA) Projected conducted a limited demonstration using available technologies to demonstrate the capabilities and to assess the potential solution for a low cost MDA capability. The technologies involved in this demonstration included the High Frequency Doppler Radar (HFDR) developed by the University of Hawaii at Manoa, the Stalker XE240 Unmanned Aerial Vehicle (UAV) developed by Lockheed Martin and communications systems provided by the MEC and Naval Postgraduate School, Monterey, CA.

The **High Frequency Doppler Radar (HFDR)** operated at 16MHZ with an effective range of about 120km. The transmit array consisted of 4 antennae with direct connection to the radar transceiver via low loss cable. The receive array consisted of 8 antennae each with a direct connection to the radar electronics.

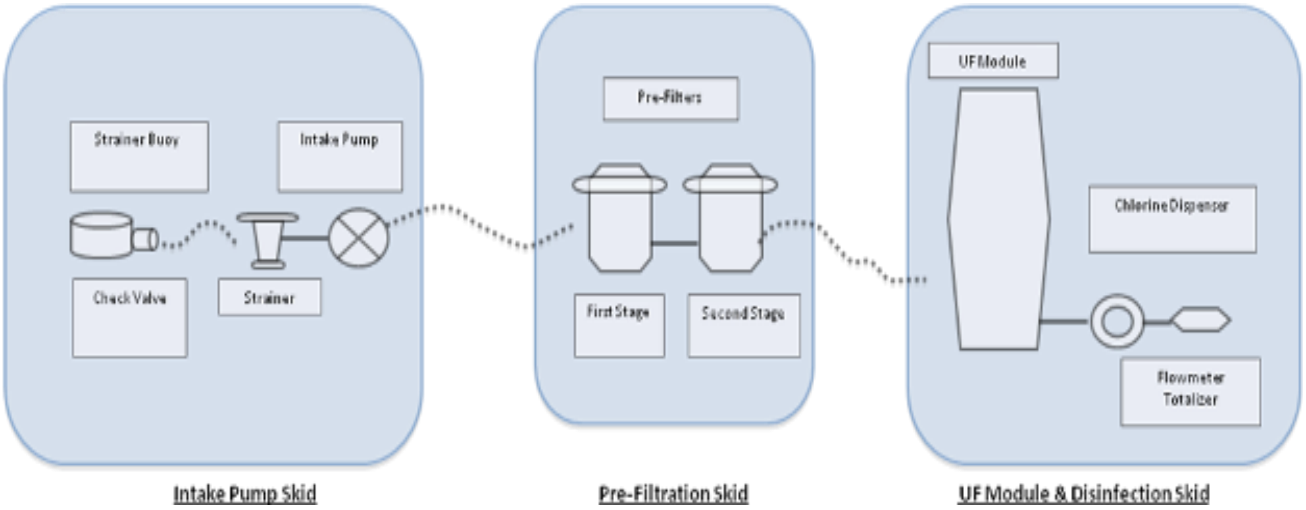
The **STALKER XE240 UAV** is a 22-pound, bungee launched, fuel cell powered, UAV capable of operations out to 20km and endurance up to 8 hours, 14 flights/landings on the same air frame and fuel cell, high altitude launches and flight, adverse weather flight, rapid turnaround between landing and re-launch, day/night flight, and cold start capability.

Water

A number of water focused systems were demonstrated and/or assessed during Exercise BK12. The larger purification systems included the Aspen 2000, the Aspen 2000, and the First Response Water Purification System. The smaller purification units included the UH Portable Reverse Osmosis System, Tulip Filter, and LifeStraw. The UH Slow Sand Filter is a low technology, zero-energy-required leave-behind system that takes a week or two to become effective. Water was tested by staff deployed from Naval Environmental Preventive Medicine Unit 6 in Pearl Harbor. AQUAPATH is a buoy system to test water quality.

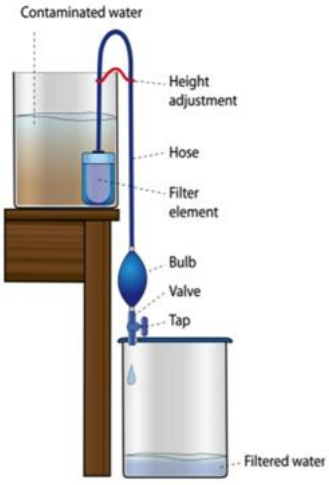
Aspen 2000DM is a commercial product from Aspen Water Inc. in Richardson, Texas. It is a full Reverse Osmosis Water Purification Unit (ROWPU) tested by the US Military. Testing at Aberdeen Proving Ground was successfully completed in Jan 2010 and testing by the National Sanitation Foundation completed Feb 2010. The system effectively treats any water source. The Aspen 2000DM can purify up to 2000 gallons a day of fresh, brackish, or heavy sea water with high turbidity. The system operates on average of 900 Watts using any form of single phase AC from 90 to 260 volts, 50/60 Hertz or with a cable from Military/NATO connector to function on 24 volts. Dimensions: 48.5”x 36”x 26”, 420 lbs.

Aspen 5500M is a two stage filtration water purification unit. Stage one removes sand, dirt and very fine particles to 5 microns in size. The second stage removes harmful microorganisms such as paramecium, amoeba, giardia, cryptosporidium and other small matter down to 1 micron. The system effectively treats fresh water sources. The Aspen 5500M can purify up to 5000 gallons a day of fresh water with high turbidity. The system averages 300 Watts using any form of single phase AC from 90 to 260 volts, 50/60 Hertz or with a cable from Military/NATO connector to function on 24 volts. This system has an internal battery that will operate the system for 3 hours. It is fully charged while operating the machine for 5 hours. Dimensions: 43”x 28”x21”, 199lbs.



The **First Response Water Purification System** is a prototype system developed specifically for the US military and non-government organizations (NGO) operating in remote, rural areas to treat biologically contaminated water in locations were only a simple, compact, and lightweight unit can be transported and operated.

The **UH Portable Reverse Osmosis Filter** is a highly portable, light weight, small, low pressure RO filtration system used to purify fresh or brackish water. There are six stages of filtration: a 5 micron sediment filter, 2 5 micron carbon filters, a 0.001 micron RO filter and a carbon block filter with UV disinfecting light. All components are off the shelf and easily available. The system is capable of purifying up to 36-45 gallons per day (GPD).



The **Tulip Water Filter** is a small, commercially-available water purification system. It is a candle-type water filter which uses gravity siphon pressure to force water through a ceramic filter element with a flow rate of approximately 1.2 gallons per hour. The filter is impregnated with silver in order to increase the bacterial removal efficiency of the filter and to reduce the recontamination risk of stored filtered water. The filter element is placed in a container with contaminated water, situated about 2.5 feet above the clean water container. The siphon is started by squeezing the rubber bulb. The siphon pressure forces the water through the filter element, ensuring flow of filtered water. When the flow rate is reduced because of clogging, the filter element can be cleaned.

The **LifeStraw Family** is a small commercially-available water purification system. When untreated water is poured into the feed water bucket, the textile prefilter removes coarse particles larger than 80um (micrometer). Gravity pushes the water with particles finer than 80um to flow down the plastic hose towards the purification cartridge. The purification cartridge contains an ultrafiltration membrane which stops all particles larger than 20nm including all microbes: protozoan parasites, bacteria and viruses. Turbidity particles are also stopped by the membrane by size exclusion. Purified water can be collected from the blue tap. When the cleaning bulb is squeezed, dirt particles on the dirty side of the membrane are lifted by backpressure and then removed by flushing through the exit valve. Since all microbes are stopped by the 20nm membrane, the purified water complies with the US EPA requirements of LOG 6/4/3 reduction of microbes concentrations for water purifiers.

UH Slow Sand Filter system consists of four stages of filtration: The first stage is a sedimentation tank that stores source water and allows large debris, suspended solids, dirt, etc to settle out at the bottom. The second uses a 55 gallon drum partially filled with 3/8" gravel and topped with 0.20-0.35 mm silica sand. Atop the sand, a biological layer called Schmutzdecke is formed by the microorganisms present in the water. This bio layer absorbs any dissolves biological material in the source water, only allowing cleaned water through the sand. The final stage of the system is the carbon filter and a UV light which remove unwanted taste and kills any residual pathogens.

Autonomous Querying Threat Agent Sensor for Potable Water Handling (AQUAPATH) is a cluster of bio-sensing water quality systems with fluorescence-based biotechnology and optical reporting as sensor modality. It detects pH, conductivity, luminescence dissolved oxygen, turbidity, temperature (air/water) and waterborne pathogen indicators: Coliforms, E. coli, Bacillus, and Cholera. AQUAPATH reports results in a geospatial wireless network. It can be developed for any pathogen if antibodies are available. The detection time is ~20 min (presence/absence) to 2½ hours.

Power

In Exercise BK12 two technologies focused on power generation, consumption, and efficiency. STAESS provided power in multiple locations across the Philippines. The REACHE technology operated in Crow Valley and was focused on collecting data on power consumption, asset usage, and climate and weather data at the camp

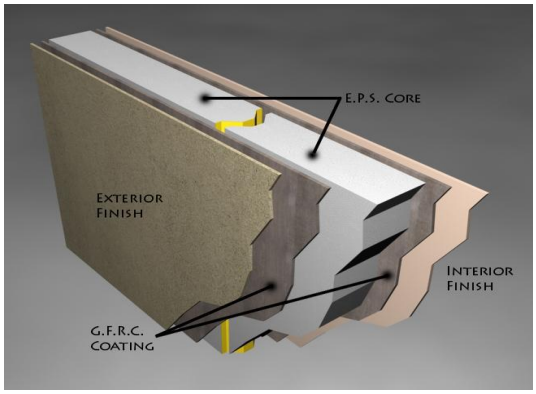


The **Soldier Transportable Alternative Energy Storage System (STAESS)** consists of efficient foldable photo-voltaic panels and battery packs to provide power. The STAESS, developed by Green Path Technologies, is a soldier-portable, rapid-charging photo-voltaic renewable energy system that is modular and expandable to allow for simple set up, transport, and easy operation. The size, efficiency, and power output vary depending on the configuration of modules.

Renewable Energy, Architecture, Culture and Human Environments (**REACHE**) REACHE is an energy consumption monitoring system with numerous sensors and recording equipment. REACHE is an Office of Naval Research (ONR) sponsored project conducted by MKThink to evaluate energy usage using experimental software supported by professional services to provide a broad view of energy use and user productivity across related sites and facilities.

Shelter

Utilizing the SABS technology, two small permanent buildings (200 sqft and 100 sqft) were constructed in conjunction with Exercise BK 12, one at NADESCOM at Camp Aguinaldo and one on the campus of Bicol University in Albay Province.



Saebi Alternative Building System (SABS) is a rapid permanent modular building construction capability made of an EPS core ranging from 4 –16 inches depending on structural requirements and design criteria. SABS is a Fusion of 2 Components; EPS: Expanded Polystyrene 1.5# density pre-cut panels and GFRC -Glass Fiber Reinforced Concrete Structural coating (Fiberglass Mesh, Portland Cement, Silica Sand, Copolymer, and Additional Admixtures.)

EXECUTION AND OBSERVATIONS

This section provides information on technology insertion events conducted during Exercise BK12. In some cases preliminary data and observations were available for publication and have been included in the section below.

Situational Awareness, Communications, and Logistics

Humanitarian Assistance Disaster Relief Coordination and Communication (HADR C&C) HADR C&C is supported by Office of Naval Research Code 30 and executed by Lockheed Martin Company. A Limited Objective Experiment (LOE) was conducted during Exercise Balikatan 12. HADR C&C is easily connected to a satellite communications system or other means of providing internet access. During Exercise Balikatan 12 it was connected via BGAN.

During Exercise Balikatan 12, HADR C&C was deployed to two separate locations: Fire Station 4 in Subic Bay and a burned out building at Camp Aguinaldo in Quezon City, Metro Manila. The system supported Hawaii National Guard participating in the FTX, Philippine Navy, Philippine Fire Department, and Philippine Red Cross and enabled communications among them and to higher headquarters. Participants used Skype, email, chat, Web, and FTP to report information and collaborate (Figure 2).

The biggest challenge for HADR C&C was obtaining stable power. During the exercise it used Philippine grid power, generators, and photo-voltaic. A number of possible improvements were noted. The Uninterruptable Power Supply (UPS) is very heavy and should be shipped separate from other components. US military and many commercial radios easily integrate with the HADR C&C system; the Philippine Fire Department radios had different physical interfaces and could not be easily integrated. The cell phone sleeves did not provide full functionality for all cell phone devices brought by the Philippine responders. VSAT rather than BGAN is likely a better choice for actual operations to provide greater satellite bandwidth.

Figure 2: HADR C&C end users connected into the network

Marine Civil Information Management (MARCIM)
MARCIM is a collaboration between the US Marine Corps Center for Irregular Warfare Integration Division (CIWID), Marine Corps Systems Command MAGTF C2 Systems Program Office and the Office of Naval Research (ONR) to develop a civil-military operations (CMO) and HADR information gathering, management, collaboration and utilization capability. MARCIM is supported by the MEC, Army Geospatial Center Special Projects Office and the Naval Postgraduate School (NPS) Common Operational Research Environment (CORE) Lab.

On Palawan, the MARCIM program supported the Combined Joint Civil Military Operations Task Force (CJCMOTF) throughout the HCA portion of the exercise. Each maneuver element within the CJCMOTF was equipped with smartphone devices to conduct field information reporting. The CJCMOTF C-9 Civil Military Operations staff section used the MARCIM knowledge management and collaboration tools to consolidate tactical field reporting into planning materials that could be used to support the commander's decision making process (Figure 3). Additionally, the ONR Demonstration and Assessment Office conducted a limited operational assessment of the MARCIM capability.

To effectively use MARCIM among collaborating civil and military responders requires sufficient internet bandwidth. The use of MARCIM on Palawan and tailoring it to individual and CJCMOTF staff element needs raised several standardization issues: if CJCMOTF task organizations can be standardized and MARCIM reporting requirements can be standardized with common elements, participants will better understand what information is required and the collected information will be more useful to a wider range of responders.

Figure 3: Marines review notes on the MARCIMS during Exercise BK 12.

Humanitarian Expeditionary Logistics Program (HELP)/Humanitarian Asset Visibility Experiment (HAVE).
HAVE is a Defense Logistics Agency (DLA) capability to improve throughput and visibility of non-DoD disaster relief and humanitarian assistance supplies. HELP is a Joint Capability Technology Demonstration (JCTD) candidate that will provide near real time situational awareness of relief supplies for disaster responders through user friendly web-based access to HAVE data.

A Technical Demonstration (TD) of HAVE was conducted and requirements generated for HELP. The project was executed at Subic Bay, Luzon and at Puerto Princesa and ENCAP sites on Palawan. HAVE demonstrated the capability to enter, track, and report containers, rolling stock, and commodities shipped through Subic Bay and Puerto Princesa by the military as well as non-standard relief-type supplies obtained commercially on Palawan (Figure 4). There were no reliability, maintainability, or interoperability issues during the HAVE assessment. Interviews with military and civilian decision-makers, potential system users, and DLA personnel operating HAVE developed HELP requirements, including reports and queries for disaster responders.

Figure 4: HAVE bar-coded containers off-loaded at Puerto Princesa

Maritime Domain Awareness

High Frequency Doppler Radar (HFDR) and STALKER XE240 UAV

The HFDR was used to detected objects at sea. Initially, the HFDR operators obtained the raw radar data that contains information on currents, waves, and objects. Subject matter experts from the University of Hawaii, University of the Philippines, and University of Baja California analyzed raw radar data to determine object location and heading. The data was then posted on Google Earth and provided to the UAV team for processing and air tasking. The process was manual. UAV Operators identified an intercept flight plan and tasked the UAV. Once the object was identified, the UAV would proceed to an altitude of 500 Ft in order to positively identify the object and provide video. The video received from the UAV was processed at the Operations Center and a Live Stream Video was shared on line using the BGAN Satellite Communication System.

The HFDR for this demonstration was selected to enable a rapid deployment. The decision to use this system was based on the funding and to reduce the logistical requirements during the demonstration. Its limitation is that it detects objects at a range of approximately 120km and the workflow in the identification of objects is almost completely manual.

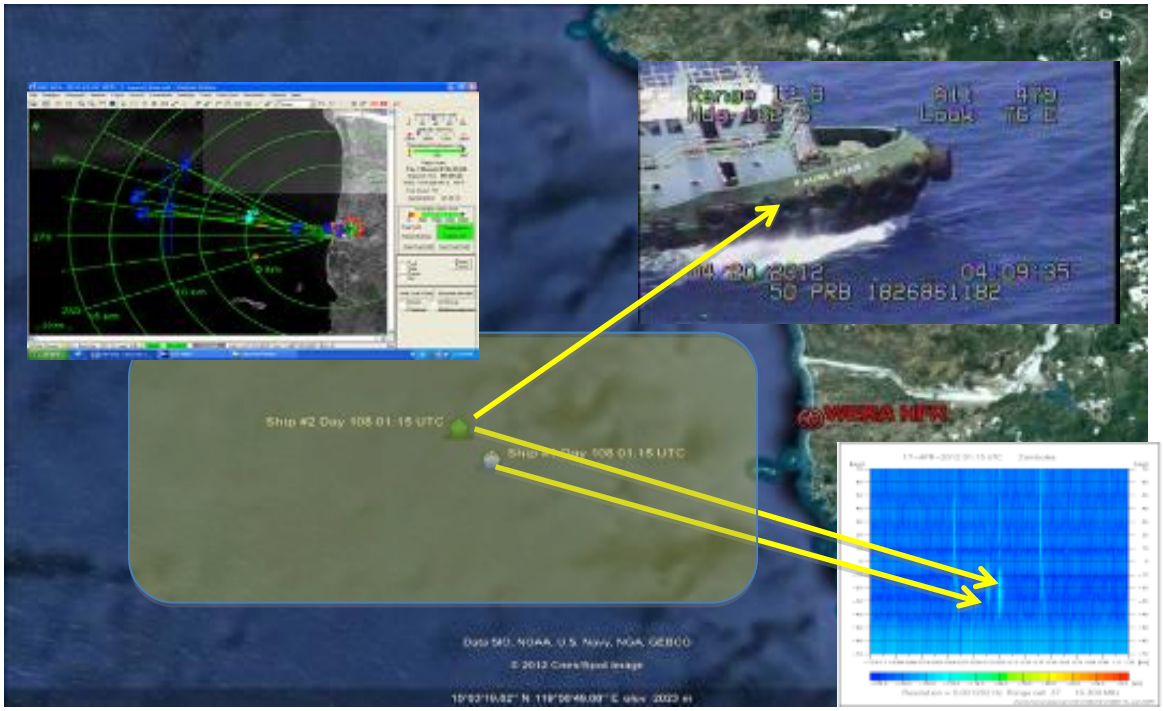


Figure 5: HFDR Detections plotted on Google Earth

Figure 5shows the HFDR detections (lower right) plotted on a Google earth background. The UAV operator's screen is upper left and a still from the UAV at upper right. The MDA demonstration validated that the HFDR is capable of identifying Man Made Objects (MMOs) in excess of 40ft. Additional research and experimentation is required to refine the identification, analysis, and reporting procedures. Early indications are that this process can be both refined and automated. Improvements to the HFDR's accuracy and reduced information latency will improve utilizing a tandem radar approach. The use of a UAV in collaboration with the HFDR allowed the demo team to positively identify MMOs both reported and not reported via the maritime Automatic Identification System for all ships. In future experimentations, a UAV with the capability to fly and loiter equivalent to the full range of the radar system is desired. Greater satellite bandwidth than BGAN provided will be necessary in the future if video is to be shared. It is recommended to proceed with a long-term HFDR assessment, develop concepts of operations, tactics, techniques, and procedures, and integrate software to automate radar detection and MMO analysis and tracking procedures. The Stalker flew multiple sorties over 6 hours in duration during the demonstration. A newer version of the Stalker XE UAV will possess water resistant feature that will enable it to operate in light rainfall.

Water

Aspen 2000DM and Aspen 5500M

The two Aspen systems were included in Exercise BK 12 to provide water for troops and to gain extended insight into system operations and reliability. The Aspen 5500 was deployed to Crow Valley in support of the US Marines' water requirements. The Aspen 2000 in Figure 6 was deployed to Ft Magsaysay in support of the US Army's water requirements.

Figure 6: Aspen supporting water purification for troops during Exercise BK12

First Response Water Purification System

First Response Water Purification System is a prototype system developed by Global Water in Oxnard, California and sponsored by the Office of Naval Research (ONR) and Naval Facilities Engineering Service Command (NFESC). The system was developed specifically for the US military and non-government organizations (NGO) operating in remote, rural areas to treat biologically contaminated water in locations were only a simple, compact, and lightweight unit can be transported and operated. The system consists of three components connected by hoses: the pump, a dual filter unit, and the membrane unit with several filters. As a prototype system, First Response was shipped in a single wooden crate.

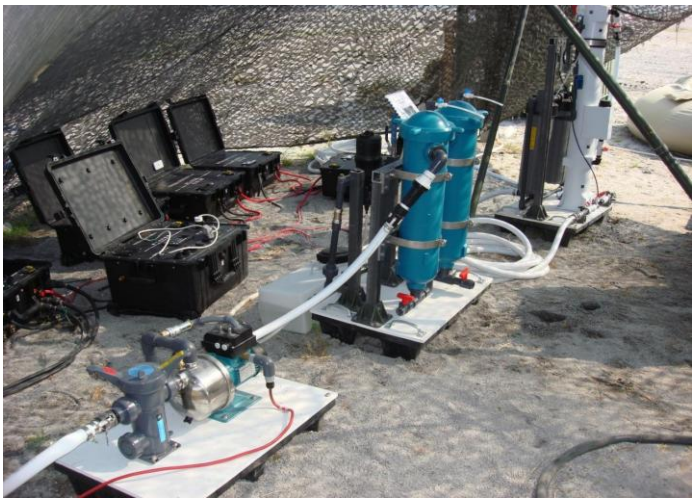


Figure 7: STAESS supporting the First Response Water Purifier at Crow Valley

The pump consumes about 700 watts. There are no electronics. During Exercise Balikatan 12, the system was operated using grid, generator, and solar power. The feedback for the system Limited Objective Experiment (LOE) was provided by US Marine Corps and Armed Forces of the Philippines personnel. The system, shown in Figure 7 was operated at Camp Crow from 16 to 18 April and Camp Aguinaldo from 23 to 26 April.

The First Response continuously produced approximately 3.45 gallons of water per minute, enough water to support the basic needs of 1200 people per day. The system's product water met the quality standards established in Technical Bulletin Med 577 and SPHERE guidelines. The Marines felt the First Response was easy to operate and maintain. Due to its compact size, several water stations could be established reducing the logistics of water distribution and time in the cue for people during disaster response missions. The capability could also be deployed to support small units, such as an advanced party. Although no maintenance issues were noted during the LOE, the system will need additional protective packaging if put into production. Power consumption may be reduced by using a smaller water pump.

UH Portable Reverse Osmosis Filter

A single RO unit was tested at three locations: Ft Magsaysay dam 17-20 Apr, Palawan State University well water 23-24 Apr, and Camp Aguinaldo municipal water 25 Apr. Set up time for RO system is <5 min with one person. The maximum flow rate for the system was measured at 45 GPD when the collection bottle was not attached. The system consumes about 25 watts of power.

No identifiable problems with the system were discovered, as it operated smoothly. Demonstrations of this system, shown in Figure 8, were given to members of the Philippine Army at Ft. Magsaysay, to engineering students at PSU, and to Gen. Holganza, commander of National Development Support Command at Camp Aguinaldo. The general was interested in increasing the flow rate of the system to 200-500 GPD and combining it with the renewable energy system for off the grid water purification. The PSU students were very eager to create their own system especially since most the internal components can be procured locally. The results of the water testing showed the RO system to be negative for E. Coli across all tests and positive for coliforms only once. This positive result may have been due to contamination during the sampling, since all results for the day showed positive coliforms presence.

Figure 8: UH Portable Reverse Osmosis Filter Demonstration at PSU

Tulip Water Filter

The system was operated at Fort Magsaysay on 20 April and Camp Aguinaldo on 25 and 26 April. The filter was soaked overnight IAW instruction to condition the ceramic filter prior to being used on 18 April to purify water from a highly contaminated fresh water source. On 25 and 26 April, the Tulip Water Filter was demonstrated (Figure 9) at the Camp Aguinaldo CPX Headquarters using water from a spigot meeting TB Med 577 standards. It is recommended that further testing be conducted utilizing a more realistic/challenge water source to best determine the efficacy of the ceramic filter on a contaminated water source.

Figure 9: LtCol Martin Lindsey demonstrating the Tulip Water Filter

LifeStraw Family

The system, shown in Figure 10, was operated at Fort Magsaysay on 18 April and Camp Aguinaldo on 25 and 26 April. On 18 April the LifeStraw was utilized to purify water from a highly contaminated fresh water source at Fort Magsaysay. On 25 and 26 April, the LifeStraw was demonstrated at the Camp Aguinaldo CPX Headquarters. On 26 April a flowrate test was performed, it was calculated that the LifeStraw produces approximately 2.4 gallons per hour of fresh water. It is recommended that further testing be conducted utilizing a more realistic/challenge water source to best determine the efficacy of the ultrafiltration membrane on a contaminated water source.

Figure 10: LifeStraw demonstration at Camp Aguinaldo

UH Slow Sand Filter

For the demonstration preformed at Exercise BK12, all materials were acquired in-country at local markets. The Slow Sand Filter was set up in two locations: Ft. Magsaysay Pahingahan dam and Palawan State University (PSU) between the College of Nursing and the College of Science buildings, below their existing water tank tower. The system at Magsaysay (Figure 11) was operated from 17 Apr – 20 Apr. Due to clogging in the flow meters and direct sun exposure, the system ran dry and no bio layer formed on the sand. The flow meters were bypassed and a mesh screen was placed over the barrel. Even though the bio layer was not fully developed, product water samples were taken daily for bacterial presence testing.

The system at PSU was operated from 23 Apr to 26 Apr. It also showed no signs of a bio layer atop the sand. This is most likely due to high concentration of dissolved metals in the source water that inhibited the growth. The metals may be cadmium, zinc, or mercury due to the galvanized storage tank and/or the nearby mercury mine. A test was conducted to determine presence of metals in the water, and the results showed positive for heavy metals but unable to determine which elements. Samples were taken daily and analyzed for presence of bacterial coliforms and E. Coli. The results for the first two days at Magsaysay showed positive for coliforms and negative for the next two. Every product sample was negative for E. Coli. At Palawan, there was no E. Coli presence in the source water, therefore no presence in the product either. Results were negative for coliforms in product samples. Flow rates of the system were measured to be 120 L/day (low flow) and 570 L/day (high flow) depending on height of product water output tube.

Figure 11: UH Slow Sand Filter deployed at Magsaysay

Autonomous Querying Threat Agent Sensor for Potable Water Handling (AQUAPATH)

AQUAPATH is sponsored by US Army Engineer Research and Development Center (ERDC). The Aquapath bouys were deployed at Ft. Magsaysay Pahingahan Dam, 17-19 April 2012, to test the fresh water source for Coliform and E.Coli contamination. Traces of Coliform and E.Coli were detected within 20-30 minutes after the bouy were deployed to the water (Figure 12). Aquapath was moved to Puerto Princesa, Palawan, 23-26 April 2012, and deployed at Marina De Bay to analyze salt water source for Coliform and E.Coli presence. Approximately twenty

minutes after after the Aquapath bouy were deployed, it detected presence of Coliform and E. Coli.

Figure 12: AQUAPATH sample collection

Power

Soldier Transportable Alternative Energy Storage System (STAESS)

STAESS is sponsored by the Office of Naval Research (ONR) and Hawaii Technology Development Venture (HDTV). For the Exercise BK12 exercise, the STAESS system consisted of a primary module that provided 3000Wh and an alternate module that provided 1000Wh. The primary module comprised three photovoltaic arrays of eight sets of panels each, four battery cases of 100 aH of life Mn PO4 batteries and two control and distribution cases. The photo-voltaic arrays folded accordion-like into very small packages. Dimensions: Battery cases (26.6" x 21.7" x 15.7", 100 lbs each), and Controller Case (24.6"x 19.7"x 11.7', 65 lbs) Inverter/distribution case (24.6"x 19"x13.8", 95 lbs) and Pelican cases 20.29"x 20.42"x 19.25", 95 lbs) containing 11 STORMS (foldable solar panels).

Figure 13: STAESS supporting the Hawaiian US Army National Guard

The intent of the STAESS Limited Objective Experiment (LOE) was to characterize the technical performance of the system in the hot and humid environment of the Republic of the Philippines. Due to technical difficulties with the data logging equipment, the amount of objective data was limited. US Army and US Marines provided subjective data on the suitability of the system to support their missions as well as recommendations for other missions the system could potentially support.
The primary module was initially set up to power a water purification system at a US Marine FOB at Camp Crow. The system was moved to Camp Aguinaldo (Figure 13) to power a water purification and communication system as part of a simulated HA/DR mission. The alternate module was used to provide power to other technologies participating in the Exercise BK12 exercise and the US Army Range In A Box (RIAB) weapons training system at Fort Magsaysay.

During the LOE, the amount of power drawn from the STAESS was such that during most days the solar panels were able to generate enough power to operate the equipment and recharge the batteries. STAESS demonstrated the ability to reliably provide a significant part of the power required by the FOB.

The Marines would like to see a demonstration of a 2 panel system that could recharge the radio batteries of a small team. The US Army soldiers from the 196th Infantry Brigade would like to integrate the STAESS into their RIAB, which would make their system self-sustainable for 6 days without interruption or cause for an additional power source. The STAESS should continue to be assessed in other operational environments and in support of other military and HA/DR missions.

Renewable Energy, Architecture, Culture and Human Environments (REACHE)
REACH was an energy generation and consumption data collection project conducted between 5 and 28 April 2012. REACHE operated at Crow Valley, Philippines base camp operated by the 3D Marine Division. REACHE personnel deployed to Crow Valley on 6 April during base camp set-up and installed sensors in unclassified areas in and near the Combat Operations Center (COC), galley, and selected billeting tents (Figure 14). MKThink collected energy consumption, asset usage, and climate and weather data at the camp. The Crow Valley base camp provided a valuable operational environment that enabled MKThink to gather important operational energy information. This information should provide MKThink the ability to refine the broad picture of energy use and user productivity within base camps.

Figure 14: REACHE ADVON team installs automated sensors

Shelter

Saebi Alternative Building System (SABS)

SABS is a technology executed by Green Path Technologies, Inc of Honolulu, HI and sponsored by ONR and HDTV. Concrete pads were poured about a week ahead of building construction at both NADESCOM and Bicol University. The SABS building at NADESCOM (Figure 15) took three days to complete including installation of standard doors and windows, and the one at Bicol University (Figure 16) took two days. Painting will follow in a few weeks after the surface has cured. The NADESCOM building was about 200 sq ft and the one at Bicol University was about 100 sq ft. Walls were constructed from 6 inch thick panels, typically about 4 by 8 feet, and roofs were 8 in thick panels. The quarter inch thick coating was applied by trowel. Virtually all materials including the EPS panels were acquired locally in the Philippines.

Figure 15: SABS 200 Sqft building construction at Camp Aguinaldo

Figure 16: SABS 100 Sqft building constructed Bicol University, Legaspi City