



## **CEOS Disasters WG – Recovery Observatory Oversight Team (ROOT)**

### **Lessons Learned from Cyclone Pam Rapid Assessment Effort**

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#### Purpose and Background

The purpose of this document is to present the lessons learned from the Recovery Observatory collaboration on the Vanuatu/Cyclone Pam event in March 2015. Ultimately, no work was conducted to generate rapid assessment products, but significant effort was deployed to understand the need for such products and to assess the ability of satellite imagery to support rapid assessments studies conducted by the World Bank. This document presents this analysis and makes recommendations for future rapid assessment/PDNA support.

On 14 March, UNOCHA published the following article outlining the expected impact of Cyclone Pam:

“Severe Tropical Cyclone (TC) Pam struck Vanuatu (population 234,000), affecting the capital of Port Vila, as an extremely destructive category 5 cyclone on the evening of 13 March at around 11 p.m. local time. The cyclone’s eye passed close to Efate Island, where the capital is located, and winds are estimated to have reached 250kmph with gusts peaking at around 320kmph. Information from colleagues and partners indicates that the cyclone was stronger than expected, and Port Vila has experienced widespread damage with debris strewn in the streets.

There are six confirmed fatalities, although the death toll is expected to rise as communication is reestablished with outer islands. The entire country has likely been affected, to some extent, by the extremely damaging winds, heavy rainfall, storm surges and flooding. There is concern for the southern-most islands of Tafea Province (total population 32,540), which was directly struck by the eye wall and is

without communication. The northern islands of Sanma, Penama and Torba Provinces (population 86,000) are also expected to have been heavily impacted as the cyclone headed south-southwest towards the capital. Communication was cut for many hours but some phone lines and internet access are becoming available. The airport is closed to commercial flights and some roads are impassable. Although badly damaged, the main hospital in Port Vila is operational. A state of emergency was officially declared today for Shefa Province, which includes the capital Port Vila, and will be expanded to other provinces following aerial assessments in coming days. Early estimates from Efate are that 90 per cent of structures are either damaged or destroyed, with over 1,500 people in more than 25 evacuation centres. There are a further 430 people seeking emergency shelter in Torba and Penama. Shelter is likely to be a major immediate need, as is drinking water and food. The logistical challenges will be significant, particularly in terms of communications, transportation and needs assessments. Pre-positioned stocks across all provinces are likely to have been damaged, in which case there will be an urgent need to bring in more supplies. Priority is establishing communication, especially with outer islands, to obtain urgently needed information about the situation outside Efate. “

Source: [www.reliefweb.int](http://www.reliefweb.int), UNOCHA.

The International Charter was activated on 12 March by UNITAR/UNOSAT on behalf of UNOCHA, the day before the event, and began planning the acquisition of very high-resolution optical imagery to derive emergency mapping of damage to key areas of Efate, and some other areas.

(<https://www.disasterscharter.org/web/guest/activations/-/article/cyclone-in-vanuatu>)

This work continued for several weeks, ultimately generating a complete built area damage assessment and identification of damage to roads and transport infrastructure.

[http://www.unitar.org/unosat/node/44/2189?utm\\_source=unosat-unitar&utm\\_medium=rss&utm\\_campaign=maps](http://www.unitar.org/unosat/node/44/2189?utm_source=unosat-unitar&utm_medium=rss&utm_campaign=maps)

<http://www.unitar.org/unosat/node/44/2194>

<http://www.unitar.org/unosat/node/44/2191>

#### Request for Support from GFDRR

On March 17<sup>th</sup>, GFDRR contacted CEOS and JRC, and met with Andrew Eddy and Delilah Al-Kudhairy to formally request support for rapid assessment in Vanuatu. The Area of Interest was indicated as the main island (Efate) and the windward islands north of Efate, along the line of approach of the cyclone. The type of information requested was identified as “five areas of relevance to EO: housing, transport, agriculture, hospitals and education facilities”.

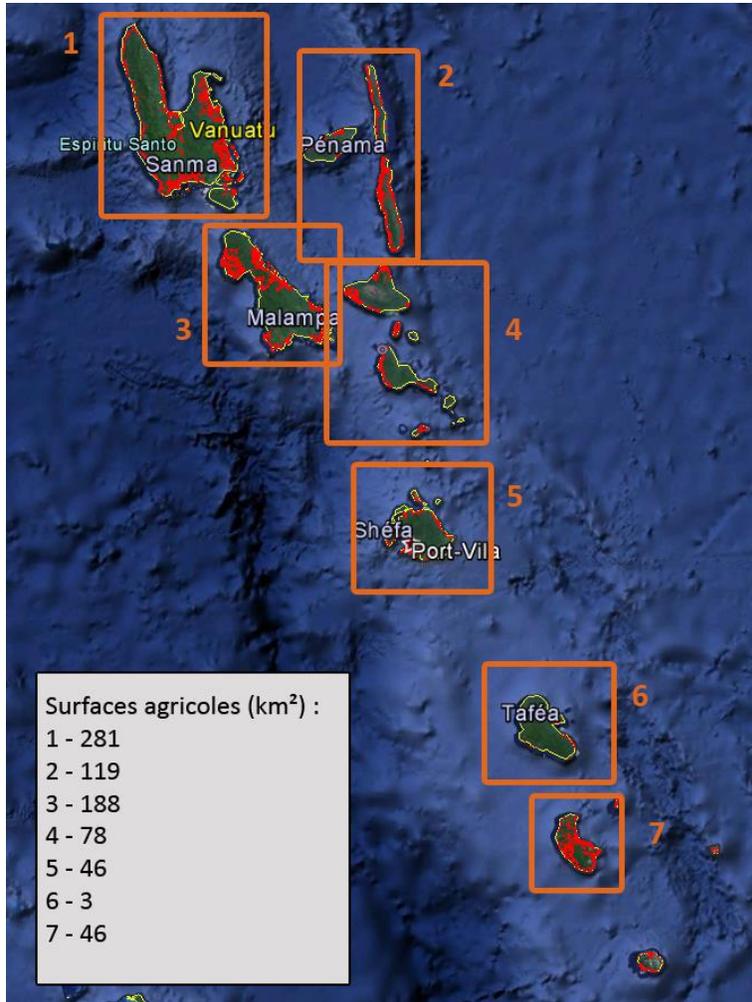
### CEOS Support

On March 19<sup>th</sup>, CEOS made a formal request to GFDRR for written confirmation of the area of interest and the type of information required. This was particularly urgent because GFDRR had indicated that the areas imaged by the Charter were too limited and that a global impact assessment was required. At that time, GFDRR indicated that the area of interest was the entire archipelago, and that the information was not detailed information but a change detection product based on the existing baseline data and changes relating to the main sectors identified for the entire area. GFDRR also indicated orally at the Sendai meeting they could fund this activity up to an amount of about \$US 50k.

On 21 March, CEOS sent GFDRR copies of proposals from value-added providers to perform assessments over the areas of interest, based on availability of archived imagery from before the event. This included SPOT and Pleiades-based products (optical), and CSK-based products (radar). The optical work was to be focused on a single island, and the radar work was to be conducted on several parts of several islands. The next step was identified as confirmation of the budget by GFDRR and approval to go forward with the proposals.

On 24 March, GFDRR requested that, given the Charter work conducted by UNOSAT as Charter project manager on housing and infrastructure, CEOS should focus on agricultural impact. The ultimate objective was identified as “to obtain a product that estimates with a good degree of accuracy the % damage to crops in Vanuatu (e.g. image 80% of crop area and estimate % damage and extrapolate for whole country based on expected impact across area)”. CEOS agreed with this, and GFDRR asked that JPL be integrated into the team of value-adders with the objective to generate ALOS-based products for agricultural applications.

On 25 March, GFDRR sent CEOS the exposure files constituting the baseline in Vanuatu, and requested that CEOS address also the housing impact in areas not covered by the UNOSAT Charter work, in addition to the agricultural work. At this time, GFDRR also indicated a strong preference for radar-based work, as a complement to the optical work being conducted more routinely.



On 26 March, CEOS sent GFDRR a detailed assessment of the state of satellite imagery and the extent of agricultural areas in order to clearly show which areas could be worked on effectively. The decision was taken to focus on radar work over Ambrym and Epi islands (area 4) and optical work over Tanna island, the main agricultural area (see figure 1, below).

On 30 March, GFDRR indicated that there were issues with regard to the funding mechanisms, and that a funding decision was delayed.

On 1 April, GFDRR sent a proposal for work to be performed which extended the areas to be covered beyond the previously discussed areas, and requested that zones covering entire districts (multiple islands) be given priority. At this time, GFDRR also indicated that the radar work proposed was experimental and may not be covered by GFDRR funding (which cannot by virtue of its mandate fund science activity).

On 3 April, GFDRR requested confirmation that the restated requirement was acceptable to CEOS, and indicated that the budget while still forthcoming would likely be in the 40k range as opposed to 50k, and asked for confirmation that a satisfactory contractual mechanism could be put in place, especially with regard to JPL.

On 7 April, CEOS wrote to GFDRR indicating CEOS did not agree with the revised requirements, and highlighting a series of concerns including: areas of interest, nature of work (science vs operations) and proposed budget versus objectives. The

same day GFDRR responded indicating the available budget would now likely be 20k. The same day, JPL indicated they had secured internal NASA funding and would be pursuing their analysis independently from the CEOS RO.

On 11 April, GFDRR indicated it could no longer guarantee funding would be available, and raised the prospect of not pursuing the proposed work. GFDRR suggested that if analysis was going to focus on only a few islands, perhaps the Copernic EMS services could be used and that this might be a mechanism to access value-added funding for European value adders.

On 14 April, GFDRR wrote to CEOS indicating that the rapid assessment work was being concluded within the next 48 hours and that a decision not to proceed with the agricultural assessment had been taken within the Bank.

Also on April 14<sup>th</sup>, GFDRR activated Copernicus EMS with the following request : we require building by building damage assessment of houses on Tanna island using a three tier damage grading - destroyed, partially damaged and no visible damage.

## Issues

- **Type of support to be provided:** the purpose of the CEOS support to PDNAs is to build institutional relationships between DRM stakeholders (GFDRR, UNDP and EC/JRC) and CEOS agencies through preparatory work for the Recovery Observatory. Target products should be focused on near and long-term recovery, as opposed to response products which are generated according to very short timelines and respond to different imperatives. Rapid assessment work required after Cyclone Pam, while useful for recovery planning, was in fact focused on understanding the immediate impact quickly. The mechanisms envisaged by CEOS and GFDRR to support rapid assessment were not designed for such short timelines (days as opposed to weeks).
- **Early articulation of need and jointly agreed definition, including areas of interest:** there was significant confusion around what type of product was required and over which areas. The exact area of interest changed several times and it was challenging to come to a quick agreement on which islands were to be covered and which sectors were of interest. Several days were lost because of this confusion as value-added providers work on estimates for products over areas that were not relevant, or examined archived imagery from before the event over areas not covered by the eventual AoI. Establishing the correct AoI is critical, early in the process. This is necessary to acquire the correct data sets to support rapid assessments and PDNAs, and also to establish a post-event baseline for the future RO. While the main products of an RO may not be required for many weeks, data necessary to generate these products must be acquired at the outset of the response and is often not the same type of data acquired by the Charter or other purely response initiatives. A faster selection process for the RO might allow parallel acquisitions. Some agencies could also acquire large area coverages after major events in anticipation of potential RO use. This may however cause conflicts with Charter acquisitions.
- **Timeliness requirement & area covered/interaction with International Charter:** CEOS RO collaboration is designed on a best efforts basis, and is not set up for 24/7 responsiveness. While in the early days of satellite tasking it is possible to provide intensive support, the types of products targeted should be delivered over a period of several weeks. For response products, the need should be clearly identified and a recommendation can be jointly drafted by the ROOT (CEOS agencies and DRM stakeholders) and presented to the International Charter for consideration. Similarly, DRM stakeholders require broad area coverage to rapidly assess the areas most impacted, while

Charter activations (and Copernicus EMS activations) focus on small areas with high damage. If no imagery is acquired at the time of the disaster, it is not possible to perform these broad area assessments, which are useful even much later for purposes of indemnification or recovery planning. There is a need for increased coordination between Charter acquisition planning and CEOS RO acquisition planning. Furthermore, in some cases, it is not clear that Charter images acquired will be made available to the RO. In the event they are not, this has a strong detrimental impact on the ability of the RO to generate good products.

- **Value-added support:** the level of support possible is heavily dependent on the level of value-added support provided. In the first days of planning, GFDRR indicated that a budget of 50k would be available to support product generation. CEOS worked with value-added providers to provide cost estimates for specific products based on this budget. Ultimately, the decision to release the budget was delayed, then the budget reduced and ultimately no budget was available. Understanding at the outset what budget is available and committing to that budget is critical. If no budget is available, this is also critical, as agencies will then be asked what is possible on a best efforts basis without any support. This will change the nature of the products and changes the scope of work.
- **Science vs. Operations:** The Recovery Observatory aims to demonstrate operational EO-based methodologies for rapid assessment and recovery monitoring. However, it is clear from the Vanuatu experience that some promising methodologies are still under development and would warrant further scientific investigation before being demonstrated in an operational context. This was the case for L-bands and X-band SAR assessment of agricultural damage after Cyclone Pam. GFDRR has no mandate to conduct or otherwise fund science activities. While these applications are not ready for use in the Recovery Observatory, they require support from organisations such as CEOS to be further developed and refined.

## Recommendations

1. An agreement between DRM stakeholders and the CEOS agencies on the nature and scope of PDNA/rapid assessment work is required, and should be brokered in the context of the ROOT. A starting point might be: near-real time response work should be undertaken in the context of the Charter or Copernicus-EMS, SA.... CEOS RO support will focus on medium and long-term work, though some NRT imaging may be required to support this. Science work is outside the scope of the RO collaboration, which aims to demonstrate operational mechanisms for future uptake by recovery specialists.

2. The ROOT needs to engage other agencies active in satellite response and recovery work more directly, especially the International Charter and the Copernicus EMS. Work in the context of the RO should be closely coordinated with these agencies to avoid overlap, avoid confusion, increase synergies, and leverage mutual resources. In particular, RO imaging requirements from end users should be shared with these agencies so they are aware of the opportunity to increase the relevance of their own response products; a typology of information products and their respective timeliness should be agreed with end users and shared with the Charter and Copernicus EMS with a view to determining whether these agencies are developing these products or not and how they can be used in the longer term in an RO over several years; finally, the RO should avoid operating in NRT rapid response mode in potential conflict with other response agencies.
3. The ROOT should request that the CEOS WG Disasters ask member agencies if there is interest in demonstrating innovative EO-based approaches in support of Recovery objectives, perhaps through a joint AO from interested agencies.
4. For future collaboration on PDNAs and rapid assessments, priority should be given to products and needs that are likely to be relevant for the Observatory. A clear statement of needs, including listing of products to be generated and specific areas of interest (polygons) should be established by the DRM stakeholder and agreed to by CEOS before collaboration begins. Ideally, this joint statement should be drafted within three days of the request for CEOS support.
5. A clear value-adding strategy is required at the outset of the collaboration. The work plan must be developed based on the available resources, and the exact source of these resources must be identified before the plan is finalized. If resources cannot be confirmed at the outset, then a less ambitious plan of action should be developed. Work should not be planned based on hypothetical resources. Overstating available resources at the outset has a detrimental impact on the ability to effectively plan work.
6. An analysis of the work requested versus work performed should be conducted to further improve on mechanisms for collaboration.

## Conclusion

Effective communication between CEOS and GFDRR was maintained throughout the Vanuatu planning, including nearly daily telcons and numerous e-mail exchanges.

Despite this frequent communication, a clear plan of action was not developed early in the effort due to changing priorities, changing actors/organizations, uncertain funding and unclear deadlines/objectives. In order to ensure that future collaboration is successful, these issues need to be addressed at the outset. In the event of uncertainty, a less ambitious but feasible project should be defined to demonstrate success, even at a more modest level. The issue of financing the value-added work needs to be addressed directly before the next planned collaboration, and the issue of better coordination with the International Charter and Copernicus EMS should also be addressed at the next available meeting.

First draft report: A. Eddy, 22 May.

Revised by: C. Proy (26 May), A. Eddy (2/3 June), K. Saito (17 June), A. Eddy (18 June).

## **Annex 1 – Background Information on Vanuatu/Cyclone Pam (from International Charter)**

### **Cyclone Pam in Vanuatu**

Thursday, 12 March 2015

**Type of Event:**

Cyclone

**Location of Event:**

Vanuatu

**Date of Charter Activation:**

12 March 2015

**Time of Charter Activation:**

14:14:52

**Time zone of Charter Activation:**

UTC+01:00

**Charter Requestor:**

UNITAR/UNOSAT on behalf of UNOCHA

**Project Management:**

UNITAR/UNOSAT

### **Description of the event**

Cyclone Pam passed over Vanuatu on 13 and 14 March 2015, killing at least eleven people, and leaving devastation in its wake.

The destruction from the storm has been described as the worst disaster in Vanuatu's history. Vanuatu is an island nation in the south Pacific, composed of 82 islands.

Pam passed close to the island of Efate, upon which is located Vanuatu's capital city, Port Vila, on 13 March. At the time the storm was at Category Five strength, the highest on the Saffir-Simpson Scale.

From there, the storm moved south, over Erromango and Tanna islands, and passed Aneityum island on 14 March.

The President of Vanuatu made an appeal on 14 March for international aid, describing the devastation wrought by the storm. It is reported that 90% of Port Vila has been destroyed, and that almost every house in the city has suffered at least some damage. While early warnings of the impending cyclone meant that residents had time to take shelter in emergency centres, the storm's powerful winds through wooden homes and power lines and left debris scattered across the area.

Recovery efforts began shortly after the storm passed, and international aid has been arriving in the archipelago. Tens of thousands of people are known to have been left homeless. But the southern islands are of great concern to emergency

workers, as communications were severed with them by the storm. The full extent of the situation on these islands is unknown, and flooding from the cyclone has made it difficult or impossible for planes to land on the islands.

On 17 March, aid began to reach the other affected islands, and emergency workers are assessing the needs of residents there. They found that 80% of buildings on Tanna Island, which is home to 30,000 people, had been either destroyed or damaged by Cyclone Pam.

Satellite image detected damage estimates in Vanuatu

Download the [full report](#)

**Source:** WorldView-1 / WorldView-2 / Pleiades

**Acquired:** WorldView-1: 17/03/2015

WorldView-2: 15/03/2015, 16/03/2015, 18/03/2015

Pleiades: 15/03/2015, 16/03/2015, 17/03/2015, 19/03/2015

**Copyright:** WorldView-1 and 2 © DigitalGlobe Inc.

Pleiades © CNES 2015 - Distribution: Airbus Defence and Space, all rights reserved

Report produced by UNITAR/UNOSAT

[Higher resolution version](#)

Potentially damaged zones in Epi Island, Shefa Province, in Vanuatu

**Source:** WorldView-1

**Acquired:** 17/03/2015

**Copyright:** DigitalGlobe Inc.

Map produced by [UNITAR/UNOSAT](#)

[Higher resolution version](#)

**Other Result**

Analytical result of Cyclone Pam in Vanuatu

Download the [full report](#)

**Source:** ALOS-2/PALSAR-2

**Acquired:** 15/11/2014, 24/01/2015, 21/03/2015

**Copyright:** RESTEC / JAXA  
Report created by JAXA

### Higher resolution version

Potentially damaged areas in southeastern Tanna Island, Vanuatu

**Source:** WorldView-2  
**Acquired:** 18/03/2015

**Copyright:** DigitalGlobe Inc.  
Map produced by [UNITAR/UNOSAT](#)

### Higher resolution version

Potentially damages zones in southern Efate Island, Vanuatu

**Source:** Pleiades / WorldView-2  
**Acquired:** Pleiades: 15/03/2015 and 16/03/2015  
WorldView-2: 15/03/2015

**Copyright:** Pleiades © CNES 2015 - Distribution: Airbus Defence and Space, all rights reserved  
WorldView-2 © DigitalGlobe Inc.  
Map produced by [UNITAR/UNOSAT](#)

### Higher resolution version

Potentially damaged areas in north Efate Island, Vanuatu

**Source:** WorldView-2  
**Acquired:** 16/03/2015

**Copyright:** DigitalGlobe  
Map produced by [UNITAR/UNOSAT](#)

### Higher resolution version

Damaged zones in Ambae Island, Penama Province, in Vanuatu

**Source:** Pleiades  
**Acquired:** 19/03/2015

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Map produced by [UNITAR/UNOSAT](#)

### Higher resolution version

Potentially damaged areas in eastern Tanna Island, Vanuatu

**Source:** Pleiades

**Acquired:** 17/03/2015

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Map produced by [UNITAR/UNOSAT](#)

### Higher resolution version

Potentially damaged zones in western Tanna Island, Vanuatu

**Source:** Pleiades / WorldView-2

**Acquired:** Pleiades: 15/03/2015 and 17/03/2015

WorldView-2: 15/03/2015

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WorldView-2 © DigitalGlobe Inc.

Map produced by [UNITAR/UNOSAT](#)

### Higher resolution version

Potentially damaged zones in Port Vila, southwest Efate Island, Vanuatu

**Source:** Pleiades

**Acquired:** 15/03/2015 and 16/03/2015

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Map produced by [UNITAR/UNOSAT](#)

### Higher resolution version

Potentially damaged zones in western Tanna island, Vanuatu

**Source:** Pleiades

**Acquired:** 15/03/2015

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Map produced by [UNITAR/UNOSAT](#)

### Higher resolution version

Potentially damaged zones in Tanna island, Vanuatu

**Source:** Pleiades

**Acquired:** 15/03/2015

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Map produced by [UNITAR/UNOSAT](#)

### Higher resolution version

Potentially damaged zones in Port Vila, Vanuatu

**Source:** Pleiades

**Acquired:** 16/03/2015

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Map produced by [UNITAR/UNOSAT](#)

### Higher resolution version

Destruction in the Lenakel area, Tanna island, in Tafea Province, Vanuatu, after Cyclone Pam.

**Source:** Pleiades

**Acquired:** 15/03/2015

**Copyright:** CNES 2015 - Distribution: Airbus Defence and Space, all rights reserved

Map produced by [UNITAR/UNOSAT](#)

### Higher resolution version

MTSAT view of the eye of Cyclone Pam on 13 March 2015, south of Port Vila.

Read more about the image in EUMETSAT's [case study](#).

**Source:** MTSAT / MetOp

**Acquired:** 13/03/2015

**Copyright:** EUMETSAT

### [Higher resolution version](#)

MTSAT view of Cyclone Pam on 12 March 2015 off the coast of Vanuatu.

Read more about the image in EUMETSAT's [case study](#).

**Source:** MTSAT / MetOp

**Acquired:** 12/03/2015

**Copyright:** EUMETSAT

[Higher resolution version](#)