THEMATIC SESSION

Facilitating Recovery and Inclusion through Satellite EO Technology

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Discussion paper

Introduction

A thorough review of how Earth Observation (EO) satellites are used to support recovery from major disasters is overdue. High-profile initiatives such as the International Charter Space and Major Disasters -co-founded by CNES and ESA almost two decades ago- provide ready access to free satellite data during response to major disasters, and indeed have been augmented by partner initiatives such as Sentinel-Asia and the Copernicus Emergency Management Service.

Recovery offers a different set of end users, and a different range of potential products derived from satellite imagery. The recovery phase of disasters has not had the same attention or benefitted from the same resources. And yet, the world has known significant disasters in the last decade which have left lasting damage to buildings, infrastructure and ecosystems. Examples of disasters on this scale come quickly to mind: the Sichuan Earthquake in 2008, Cyclone Nargis in 2008, the Haiti Earthquake in 2010, the East Japan Tsunami of 2011, Typhoon Haiyan in 2013, Hurricane Matthew in 2016, Mangkhut Super Typhoon in the Philippines and the Indonesia earthquake and tsunami in 2018... These large-scale disasters require a holistic approach to recovery that is best offered through systematic use of EO data over the affected area.

Lessons from large scale recovery programmes show that recovery would be implemented more successfully when institutions, policies, personnel and finance are already a part of the Disaster Risk Reduction systems in the country or set up soon after the disaster to lead recovery processes. The same is true for input from the satellite community. Processes to access data and methodologies for transforming data to information products, along with requisite resources, must be identified before the disaster.

As countries experience disasters frequently and people are increasingly aware of the challenges posed by recovery, governments are seeking to enhance their capacities to manage recovery. In response to this demand, governments are placing greater emphasis on being better prepared by strengthening institutional capacity, adopting supportive policies and securing resources for recovery.

This session also seeks to understand how satellite data can enable more inclusive recovery, in particular by proving more information about vulnerability of populations in the affected area.

Background – Satellite EO for recovery and challenges to mainstreaming its use

The experiences gathered in applying EO satellite data to disaster recovery have highlighted several lessons learnt and have also identified several challenges that need to be addressed as we move forward. It is worth stating that there is unquestionably benefit to using satellite data during recovery. While this is true for natural disaster recovery, it is perhaps even more true for conflict situations, where access to the affected area may be problematic in the early recovery period. This benefit to recovery is present at multiple levels, whether only a small amount of data is used, or whether a significant effort is made to integrate satellite data into the full recovery process. More work is required to determine where the most appropriate balance between cost and benefit is achieved, and this balance may be different according to different users or in different disaster situations.

One possibility considered is the establishment on a systematic basis a Recovery Observatory (RO) which would enable easy access to a reference baseline of pre-disaster, disaster, and post-disaster data and information, organised on a sectoral basis and regularly updated along the recovery process.

WHAT IS A RO?

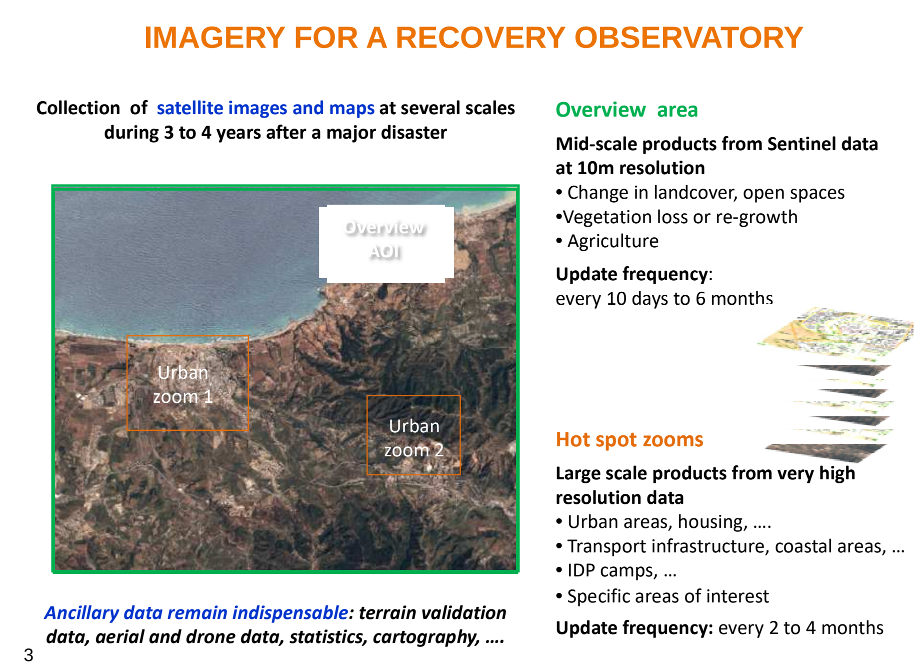

Figure 1. Sample Recovery Observatory coverage at different resolutions over a single area.

The RO would be a database of information, including satellite data and products that document the state of the area before the disaster, after the disaster and during the recovery period, with a view to planning the recovery and monitoring its implementation. CEOS, working in close coordination with the World Bank/GFDRR and UNDP, have already created a first prototype RO in Haiti, following Hurricane Matthew in late 2016. This long-term, four-year effort has allowed agencies to understand challenges in a real context.

INSTITUTIONAL ARRANGEMENTS

Establishing a RO requires clear institutional arrangements and predefined processes *before* the disaster, such as those established in the context of the PDNA Agreement or for the International Charter. For the first RO prototype in Haiti, for example, there was a long lead time to establish the activity: approval in principle of CEOS[1] agencies was granted after 6 weeks, but data allocations and product definition took an additional 5 months. This challenge is tied to the connection between satellite agencies, the international community, and local stakeholders. Local champions and users play a critical role but typically have no dedicated funding in the early recovery; apart from provision of RO geo-information products, they await capacity building for long-lasting effects in the country.

From an institutional perspective, agreements are required between international stakeholders and the national government, but also with satellite data providers. In the CEOS framework (best effort, in-kind contribution) space agencies have difficulty in supporting near real-time operations in early aftermath of disasters, and in general are not equipped to deal with near real-time tasking and delivery for CEOS projects. The PDNA requires very rapid but not near real-time tasking and delivery, and this would require close coordination between PDNA leads and CEOS members. Furthermore, proper support to recovery requires continuity of acquisitions. Finally, given that response end users and recovery end users are not the same, and needs differ for each phase, there is often a disconnection between data collected for Charter and Copernicus activations (generally focussed on people and cities) and data acquired for long-term recovery needs (damage to agriculture, urban planning, land cover change and environmental issues). Satellite data in general is more difficult to use in urban contexts, and this requires more effort that in rural areas, but more importantly, areas of interest for response and recovery may be vastly different in size.

PDNAs and rapid assessments are sectoral and often lack standardization; many agencies and actors can be conducting such assessments at the same time, which poses additional coordination challenges for national disaster management authorities. Sectoral assessments carried out in isolation often lack the recovery and reconstruction considerations necessary to promote early recovery, in comparison to a well-coordinated, asset-based, multisectoral assessment. The existence of arrangements before disasters also facilitates the collection of pre-event baseline data sets which are critical to making rapid assessments of change. The quality of satellite-based products, particularly during the very early recovery period, requires a solid baseline of pre-event satellite data. This is challenging because the volume of data required to properly image all potentially affected areas is high.

There is a clear need for coordination among imaging agencies. The CEOS Working Group on Disasters offers one forum where such coordination can take place, but this requires input from users on the areas most likely to be affected by disasters, so that the appropriate baseline data can be collected across multiple agencies and satellite sensors. Better baseline data acquisition plans would consider which areas are subject to risk but also which areas are liked to be most impacted by potential disasters.

ADDRESSING COST OF DATA AND VALUE ADDING

More and more free and open satellite images are available. But in some cases, the best applicable data is only available commercially, and this involves significant cost. Finding the right mechanism to address this

[1] CEOS : Committee on Earth Observation Satellites

cost is a major hurdle. However, data cost is only part of the problem. Very few risk and reconstruction managers, including in the developed world, have the capacity to fully exploit satellite imagery. This role is played by practioners, from either academia or the commercial sector, who have the capacity to interpret satellite data and generate useful value-added products to inform decision-making. This process is increasingly automated, but remains labor intensive and in some cases expensive. A proper cost-benefit analysis is required to determine which applications are the most valuable in a given recovery situation, and funds must be identified to support the capacity required to turn data into information. Funding for applications and value-adding activity is even more important, and for the most part there are no dedicated budgets for this.

While CEOS agencies have a track record of delivering value through no-exchange-of-funds projects, there is a clear sustainability issue without dedicated funding. In some cases, programs exist to alleviate the cost, such as the Copernicus Emergency Risk and Recovery Program, but in this case the work is carried out by European companies which for the most part are disconnected from local realities and capacity. Finding a means to connect this service and others like it to local capacity would improve the lasting impact of support on resilient recovery. Finally, long-term collaboration requires a dedicated program budget for management, reporting, dissemination, and missions to affected areas.

CAPACITY BUILDING

Working in the developing world with satellite data offers a range of specific challenges tied to local capacities and capacity development. As a starting point, it can be challenging to identify local partners that can serve as a recipient for data and products relating to the event. Generating these products in a disconnected fashion presents technical difficulties (due to lack of familiarity with the local context), but also results in a product that is not endorsed and taken up by local authorities mandated to respond to the disaster and to reconstruct in the aftermath. It is critical that satellite-based products be developed in close cooperation with local authorities and, whenever possible, by local value adders. This requires training to build or strengthen local capacity.

A proper RO is far more than a collection of satellite data and associated satellite-based information products. The RO should provide a forum for exchange and development of science-based products that inform the recovery process. It is a mechanism to engage the scientific community interested in the specific event, and to increase awareness in the operational community of the existence of products that can inform their decisions, as well as to engage them in the validation of those products, and train users to apply solutions without outside assistance.

The ultimate legacy of recovery support should be resilient recovery – the ability for the national agencies to learn from the disaster, to respond more effectively in the future to similar events, and to be less reliant on outside help in addressing disasters. In this respect, capacity building in country is critical to supporting satellite-based applications. Currently, there is no clear mechanism to ensure that support during early recovery and long-term monitoring leads to capacity development.

SATELLITE DATA LIMITATIONS

Satellite data offers a holistic view, with incomparable scope and renewed information at only an incremental cost. How beneficial this is may depend on the type and scale of the disaster. In some cases, flying a drone over an affected area is the most cost effective means to establish a data baseline. For other, larger areas, satellites offer the only cost-effective means of understanding disaster impact and monitoring recovery. When very large areas are flooded for example, satellite data may prove the only way to rapidly assess the scope of the catastrophe and to regularly provide an update on receding waters. In the case of an earthquake in a dense urban environment, while satellite data may initially inform on the extent of damage in different neighbourhoods, in-situ data is better suited to providing a comprehensive picture of the nature and severity of the damage. When disaster strikes over a very broad area, satellites may be better able to pinpoint areas affected requiring intervention. Some applications require regular revisit over long periods – e.g. damage to fragile ecosystems (protected areas). In other cases, the satellite data required is at very high resolution, and when applied to very broad areas is not cost effective.

In addition, there are inherent limitations due to the technical nature of the sensors. Flooding situations often involve clouds, and optical sensors cannot see through the clouds. SAR sensors operate at different bandwidths and have coherence issues with regard to vegetation, water content, or water surface roughness. In each case, a summary cost-benefit is required to assess to what extent satellites might contribute, and which ones are required.

Regardless of resolution, some information cannot be determined by satellite, for example:

- Damages to built-up areas: even at very high resolution, satellites see rooftops but cannot determine the status of a damaged building if its roof has not been damaged; roof damages can be detected in some cases, but only on large roof surfaces, with major damage;
- Changes to vegetation (agriculture or natural vegetation) may require spectral information only accessible at medium scale, when for other cases high or very high resolution is needed over the same area, requiring multiple satellites.

In early damage assessment, satellites are not currently used regularly, even for topics such as agriculture, where a synoptic view would offer valuable complement to in-situ, detailed information (usually these data are collected in situ and an extrapolation is made to establish damage); in this case the hurdle is usually tied to the timeliness requirement, or more simply to the lack of awareness of PDNA managers of what exists, what is possible, or where to obtain it.

Despite a desire for simple, standard products, determining what that standard products should be is challenging; each area affected, each end user, has specific needs and relevant products address these needs and requirements. While it is straightforward to determine the need for baseline data and early assessment products, determining detailed specifications often requires knowledge of the area affected, in the circumstances considered.

While satellites offer incomparable scope and breadth of information, they cannot replace in-situ evaluation for the quality and depth of point-related information. Satellites inform on the built environment, and on natural affects, but are not useful for social impact aspects of the PDNA.
With this in mind, satellites must be integrated into a holistic recovery approach and be used to better guide field observations, which are a critical, necessary complement to the satellite-based products.

Finally, it is worth noting that most very high-resolution satellites have legal restrictions on the access, use, and sharing of data, which in some cases will severely limit the ability to apply a satellite solution.

Panel Discussion :

Hélène de Boissezon	Co-chair, Generic Recovery Observatory ad hoc Team	CEOS/CNES
Boby Piard	Director General CNIGS, Co-chair Haiti RO	Centre national d'information geospatiale (CNIGS), Haïti
Einar Bjorgo	Manager	UNOSAT
Ricardo Zapata-Marti	Consultant	European Union
Moderator : Andrew Eddy President, Athena Global, Secretary Haiti RO		

Questions / Challenges discussed in the session

The panel members have been requested to share their experiences based on the following questions:

- What are the main benefits of using satellite EO for recovery?
- How has satellite imagery been used to ensure inclusion of vulnerable groups in the recovery planning and monitoring?
- How can we increase the use of EO, in order to apply the full range of EO data to recovery challenges?
- What can be expected in the future in terms of technological innovations that will facilitate recovery monitoring?
- Is there a different approach in the use of satellite EO for major disasters than for recurring or protracted crisis?
- How can satellite EO be used to better prepare for disaster recovery? How can inclusive recovery be advanced using these technologies?
- How can early action support prioritization of response and reduce the impact on vulnerable populations?

Conclusions

Improving our recovery efforts, to bring about more resilient recovery, is a critical step towards risk reduction. Building back better will improve the lives of those living with risk, and also reduce the impact of disasters in the future. This session and panel discussion aims to contribute to an on-going debate on how to improve use of satellites for recovery, including using satellite data to facilitate inclusive recovery. The recovery community would like to increase awareness of what is being done today with satellite imagery, and also to raise the profile of opportunities for increased benefit. In some cases, with regard to recovery from conflict for example where key affected areas are simply not accessible, satellite data represent the primary source of information about damage and impact. The use of satellites alone cannot improve recovery. The data collected must be converted to exploitable information, analyzed and then integrated into existing decision and management processes. These unique data offer strong, complementarity information to data currently used, but this benefit can only be enjoyed if satellite data are collected in a timely fashion and used to generate information products. Overcoming the hurdles and challenges of data access is necessary for data integration during the recovery planning and monitoring process. If we are to truly achieve resilient recovery and reduce risk for future disasters, all means available should be harness to benefit, and that includes satellite EO, which remains underexploited in the recovery community.

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