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Interim Report **IR-08-048**

Banda Aceh—The Value of Earth Observation Data in Disaster Recovery and Reconstruction: A Case Study

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Contents

Abstract

On 26 December 2004, Banda Aceh in Indonesia was at the center of one of the worst natural disasters to affect mankind. Large amounts of international aid poured in to assist in the relief and reconstruction efforts. Amongst this effort, were investments in basic earth observation data from in-situ, airborne and space observations. While the use of this data is assumed to be crucial, few efforts have gone into quantifying the benefits of its acquisition.

The objectives of this study were to interview a cross-section of agencies operating in Banda Aceh and across the province of Nanggroe Aceh Darussalam on the use, sources and quality of earth observation data in the relief/reconstruction effort; and to analyze and quantify the value that earth observation data brings to the relief/reconstruction effort based on the survey results and specific examples.

Key findings from the interviews point to an overall improvement in the spatial data situation since the tsunami. Problems identified included insufficient training, lack of timely data and sometimes poor spatial resolution. Specific examples of the cost-benefits of earth observation data were typically on the order of millions of dollars and involved large time savings.

IIASA is one of 12 partners in the European Union sponsored project "Global Earth Observation—Benefit Estimation: Now, Next and Emerging" (GEO-BENE). Additional GEO-BENE partner countries include Germany, Switzerland, Slovakia, Netherlands, Finland, South Africa and Japan. Within GEO-BENE we are developing methodologies and analytical tools to assess societal benefits of GEO in nine societal benefit areas—one of which is disasters. The tsunami affected province of Nanggroe Aceh Darussalam, and specifically Banda Aceh, has been selected as a case study. Other case studies representing different societal benefit areas include: biodiversity in South Africa, health and climate in Finland, fire in Europe, etc. For more information please refer to: www.geo-bene.eu.

Acknowledgments

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Banda Aceh—The Value of Earth Observation Data in Disaster Recovery and Reconstruction: A Case Study

Ian McCallum, Richard Kidd, Steffen Fritz, Florian Kraxner, and Michael Obersteiner

1 Introduction

On 26 December 2004, Banda Aceh in Indonesia was the scene of one of the worst natural disasters to affect mankind. Because of the extreme nature of the event, large amounts of funding and support were provided on an unprecedented level. According to the RAN (Recovery Aceh – Nias) Database (http://www.rand.brr.go.id/RAND/), as of 10 January 2008 a total of 490 agencies have committed 3.8 billion United States Dollars (USD). Among this vast amount of support are various types of earth observation data (i.e., orthophotos, satellite scenes and the creation of a group—Spatial Information and Mapping Centre (SIM-Centre) to administer this data). It is crucial for the efficient use of the emergency aid funding as well as for the following reconstruction of the infrastructure (roads, harbors, bridges, etc.) that up-to-date geographical information is collected and creates the base for planning the aid program (BlomInfo, 2006).

The use of earth observation data in the area of disaster recovery has been identified as a necessary and indispensable tool. The international charter *Space and Major Disasters* came into effect in 2000 to coordinate space data acquisition and delivery to those affected by natural or technological disasters. Quantifying the benefit of this technology is, however, another matter and remains largely unexplored. Theoretical descriptions include work by Bounfour and Lambin (1999) and Macauley (2006), with PWC (2006) producing a quantitative assessment; however these stop short of offering easily applicable methodologies. Costs are deemed necessary and benefits assumed plenty in this relatively young field of technology, where costs are enormous but dispersed, often shared by governments, private industry and end users.

Within the Global Earth Observation System of Systems (GEOSS), the European Union (EU) funded project Global Earth Observation Benefit Estimation (GEO-BENE; http://www.geo-bene.eu) is charged with estimating cost-benefits of earth observation data for nine societal benefit areas. One of these areas is titled *reducing loss of life and property from natural and human-induced disasters* (GEOSS, 2005). In an effort to better understand the benefits associated with using earth observation data in disaster regions, Banda Aceh, Indonesia was selected as a case study within the EU funded project GEO-BENE.

The objectives of this study were to:

1. interview a cross section of agencies operating in Banda Aceh and across the province of Nanggroe Aceh Darussalam (NAD) on the use, sources and quality of earth observation data in the relief/reconstruction effort, and
2. analyze and quantify the value that earth observation data brings to the relief/reconstruction effort based on the survey results and specific examples.

2 Methodology

In order to capture the varying information available in such a study (data ranging from qualitative to quantitative), various methods have to be used. Unfortunately among the literature, methodologies are lacking which could be applied in the cost-benefit assessment of earth observation data in this context. This study employs a two-step approach: (1) design, implement and analyze a questionnaire; and (2) collect and analyze specific cost-benefit examples.

2.1 Questionnaire

With the help of local partners in Banda Aceh, the SIM-Centre of the Badan Rehabilitasi dan Rekonstruksi (BRR; Agency for Reconstruction and Rehabilitation of NAD and Nias), and the remote sensing and Geographic Information System (GIS) Centre at Syiah-Kuala University (UNSYIAH), a list of 18 groups working in Banda Aceh and using earth observation data was created (see Table 1). This included groups representing national government (2), local government (2), universities (3), the United Nations (UN; 3) and non-governmental organizations (NGOs; 8). In addition, groups and projects using earth observation data were identified using the RAN database),[1] but were not included in this study.[2]

Following this, a questionnaire was designed to be given to each of these groups (see Appendix I). The questionnaire was designed so that it would be applicable to the wide range of groups being visited, easy to translate if required, and quick to complete. The advantage of this approach was that it allowed interviews across a broad cross section of earth observation users; the disadvantage being that results are rather general and sample sizes small.

With groups identified and the questionnaire designed, a field visit was made to Banda Aceh, Indonesia between 4 and 12 December 2007. Each of the groups listed in Table 1 were visited and a short interview was conducted, lasting between 30 to 60 minutes. The questionnaire was used as a basis for the interview. Results from the questionnaire were then compiled for analysis (see Appendix II).

[1] URL last visited on 27 October 2008.

[2] A query of the RAN datasets on 10 January 2008 under the sector *spatial planning and environmental protection* revealed a total of 47 organizations listed with a combined total of 101 million USD committed to the relief effort.

Table 1: Organizations visited in Banda Aceh, Indonesia.

Organization Type	Organization	Contact
National Government	BRR, Pusdatin	Mr. E. Darajat
National Government	BRR, Bakosurtanal[a]	Mr. Darmawan
University	UNSYIAH (GIS and Remote Sensing —RS)	Mr. M. Affan
University	UNSYIAH, Vice Rector	Mr. Dhalan
University	UNSYIAH, TDMRC[b]	Mr. Dirhamsyah
Local Government	BPN[c]	Mr. G. Suprato
Local Government	AGDC[d]	Mr. S. Gan
UN	UN ORC[e]	Mr. H. Busa
UN	UNICEF	Mr. B. Cahyanto
UN	FAO	Mr. Sugianto
NGO	LOGICA[f]	Mr. D. Hurst
NGO	GTZ-SLGSR[g]	Mr. M. Widodo
NGO	ManGEONAD[h]	Mr. T. Rehman
NGO	Leuser International Foundation (YLI)	Ms. D.R. Sari
NGO	Flora Fauna International (FFI)	Mr. Syaifuddin
NGO	ABD-ETESP[i]	Mr. E. Van Der Zee
NGO	Sea Defence Consultants	Mr. J. Kraaij
NGO	Sogreah	Mr. B. Coiron

[a] Badan Koordinasi Survei dan Pemetaan Nasional (National Coordinating Agency for Surveys and Mapping); [b] Tsunami and Disaster Mitigation Research Centre; [c] Aceh Province Land Agency; [d] Aceh Geospatial Data Centre; [e] Office of the United Nations Recovery Coordinator for Aceh and Nias; [f] Local Governance and Infrastructure for Communities in Aceh; [g] Support for Local Governance for Sustainable Reconstruction; [h] Management of Georisk Nanggroe Aceh Darussalam; [i] Asian Development Bank, Earthquake and Tsunami Emergency Support Program.

2.2 Cost-benefit Examples

Several groups were identified from both the interviews and discussions that could provide specific quantitative examples of the value of using earth observation data (see Table 2). These groups were then contacted by email and asked to provide the necessary data to make such comparisons. These examples were analyzed using cost-benefit comparisons where possible and are presented in Section 3.2. Full contact details for the technical experts who provided the responses are provided in Appendix III.

Table 2: Description of quantitative benefit estimation examples in Banda Aceh, Indonesia.

No.	Organization	Contact	Cost-Benefit Example	Report Section
1	USGS[a]	C. Wilson	Cost-benefit of global positioning system (GPS) for community based bathymetric mapping	3.2.1
2	CRS-ITB[b]	K. Wikantika	Comparison of traditional surveying to orthophotos	3.2.2
3	Logica	D. Mate	Use of orthophotos for community based mapping and survey	3.2.3
4	Sogreah	B. Coiron	Banda Aceh water strategy 2007–2030 and short-term action plan	3.2.4
5	Sim-Centre	R. Kidd	Digital orthophoto cost-benefit	3.2.5

[a] United States Geological Service; [b] Centre for Remote Sensing, Institute of Technology Bandung.

3 Results

In total, 18 organizations were interviewed over the course of four days with over 40 people participating in the interviews. Interviews ranged from brief discussions with the aid of an interpreter, to detailed presentations. In addition, various discussions were held with supervisors and administrators which added to the overall impression.

3.1 Questionnaire

Results from the questionnaire are summarized in Appendix II. Several questions in the survey were answered similarly by all groups and were not summarized. In addition, three of the questionnaires were withdrawn from the analysis owing to lack of information. Questions were very general and the group rather diverse, thus the answers are also rather general. However, some clear trends appear and certain individuals provided additional details.

At this point it is clear that most, if not all, participants believe a substantial improvement has occurred in terms of spatial data between the time of the tsunami and the time of the interview (see, Figure 1). Of the 15 respondents, 13 indicated at least an improvement of one category (i.e., a shift from poor to satisfactory, or from satisfactory to good). Associated with this general improvement is a large expenditure—the difficulty arises in attempting to associate a cost-benefit to this.

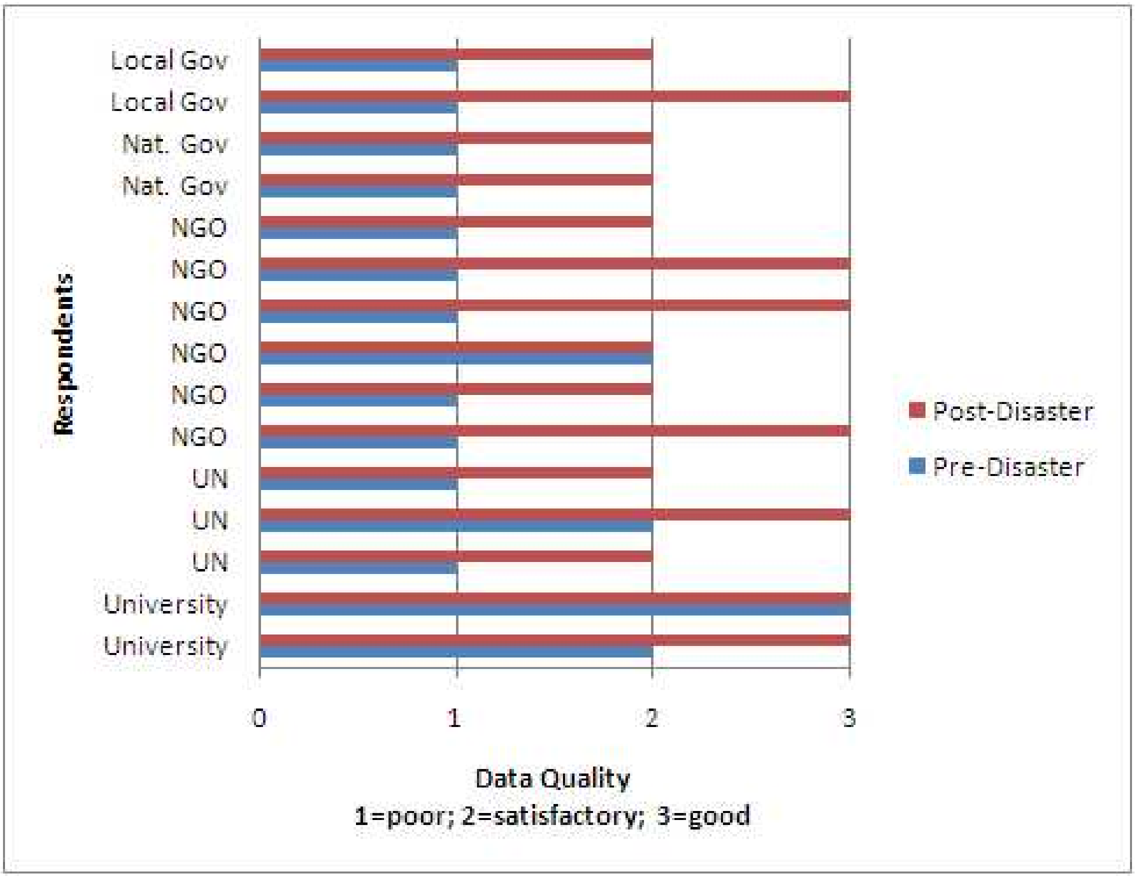

Figure 1: Perception among interviewees on the improvement of earth observation data in the region.

Training is another theme that most respondents agree upon—there needs to be more across all groups. Over half of all respondents indicated the lack of training as hindering their activity. All groups questioned were aware of this issue and were taking various steps to address it, however it remains unsolved. This will likely become problematic as various foreign aid groups leave and data, etc., is passed over to local and national governments.

Finally, the major desire in terms of data improvement among the participants seems to be a faster response time—people need more timely datasets and, in many cases, they are not receiving them. In particular, disaster regions are typified by rapid change. In fields such as reconstruction, groups require accurate and updated data. A lack of this data translates into more hours of field work, greater expenses and delays. This is, however, difficult to quantify based on the results from this questionnaire.

3.2 Cost-benefit Examples

The purpose of the questionnaire was to identify general trends among the earth observation data users in Aceh. In an effort to determine cost-benefit, several examples were identified (see Table 2) from among the groups interviewed. The technologies employed ranged from GPS to aerial photography and digital orthophotos.

3.2.1 Cost-benefit of GPS for Community Based Bathymetric Mapping

Since 1 June 2007, a pilot project has been established in Aceh enabling fishing communities to collect bathymetric data. The primary threat to the majority of fishermen is the lack of documented and accurate information about the location of underwater hazards (Wilson *et al*., 2007). Relatively inexpensive GPS technology is being employed to fulfill this task and, when compared to the avoided costs, results in substantial savings to the fishermen (see Table 3). In particular, damaging a fishing net amounts to 4,000 USD (its loss would cost 20,000 USD) with damage typically happening twice per year (Wilson, 2007). As of 31 March 2008, none of the five boats taking part in the study had damaged their nets (Wilson, 2008), suggesting that the GPS units are having an effect. In addition, the collected information is used to chart the local knowledge of sea mounts, deep reefs, hazards to fishing gear operation, and fishing resources in the region (Wilson *et al*., 2007).

Initial results from the project (Wilson, 2007) have already demonstrated a clear change in pre and post tsunami bathymetry near the main river mouth (Krung Aceh) serving Banda Aceh's main fishing port, cargo and ferry terminals. The port is also the main commercial port for the whole province. Figure 2 shows depth derived from sounding data collected by the fishing communities compared to pre-tsunami national bathymetric data and clearly shows a silting up of the main port entry channel. The benefit associated in providing new information on the status, depth and route of the port entry channel has not been measured. Since April 2008, the project has been expanded to two further port locations in NAD and now includes a further 55 boats.

Table 3: Annual cost-benefit of GPS for sea fishing. Source: Wilson (2007).

Description (USD/year)	Costs of Technology	Avoided Costs	Cost Benefit
Cost-benefit of GPS for sea fishing (5 boats) [a]	4,650	40,000	35,350
Cost-benefit of GPS for boat safety[b]	930	60,000	59,070

[a] Per boat costs of technology: GPS unit 750; installation 30; 3 hours training 150; total costs = 930. Avoided costs per boat refer to: lost income for 1 week of net repair 3000; cost of new repair 1000; total cost of net repair is 4000—on average this occurs twice a year.

[b] This describes one incident where a boat suffered engine damage in a storm and was rescued before sinking because both it and the rescue boats were equipped with GPS units and were able to quickly locate its whereabouts. Avoided costs include only the boat and net and make no attempt to place value on the lives of the 18 fishermen on board. (Also reported on http://www.acehfisheries.org/modules/news/article.php?storyid=18; URL verified on 29 October 2008.)

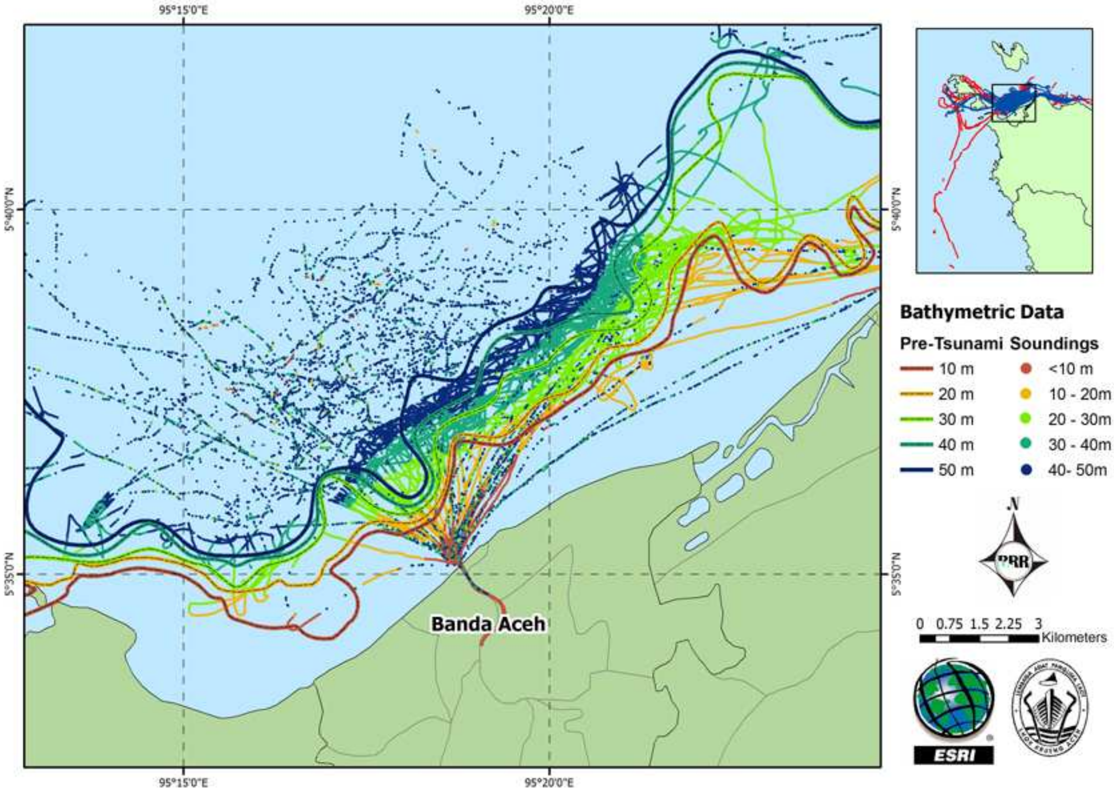

Figure 2: Comparison of pre-tsunami (lines) bathymetric and post tsunami (points) sounding data.

3.2.2 Comparison of Traditional Surveying to Orthophotos

A simple example cost comparison is made here between terrestrial mapping versus aerial photogrammetry (see Table 4) to cover the approximate 1,000 square kilometer (sq. km) tsunami affected area in the province of NAD. The cost calculations are estimated based on 50 centimeters (cm) digital aerial photogrammetry, assume the availability of a reasonable resolution Digital Elevation Model (DEM), and are compared to the effort involved to complete a traditional 1:10,000 scale geodetic survey.

Table 4: Comparison of traditional surveying to orthophotos at scales better than 1:10,000, or 50 cm resolution aerial photography. Source: Wikantika (2008).

	Terrestrial Mapping	**Aerial Photogrammetry (Digital)**
Cost	100 USD/hectare (ha)	12–14 USD/ha
Manpower	5 ha/day/team	50,000 ha/year/company
Damaged Area	100,000 ha	100,000 ha
Time	1 team = 55 years	1 company = 2 years
	1000 teams = 6 weeks	10 companies = 2.4 months
Total Cost	***8.76 million USD***	***1.2 million USD***

It is clear from this comparison that aerial photography offers large cost savings over the traditional approach. Additional benefits also accrue: namely a digital product, a uniform and consistent approach to mapping, and likely faster results. It is assumed that use of satellite products would see further cost reductions however any cost savings would have to be weighed against classification quality.

3.2.3 Use of Orthophotos for Community Based Mapping and Survey

The Australia-Indonesia Partnership for Reconstruction and Development (AIPRD) administered the Local Governance and Infrastructure for Communities in Aceh (LOGICA) program as part of the Australian government's response to the tsunami.

One of the four components of the LOGICA program was to re-establish land ownership. A large part of this was achieved through a series of community based mapping (CBM) projects in collaboration with villagers in the 600 affected communities. The CBM projects resulted in community agreements on land ownership which were documented as simple community maps.

A further action, initiated via LOGICA's Community Housing Assistance Monitoring Program (CHAMP) lead to the conversion (rectification) of the schematically correct community maps into georeferenced maps (corrected cartographic products) at 1:1,500 scale using GIS tools and available high resolution orthorectified aerial photography. An example of the stages of this process is shown in Figure 3. CHAMP also acquired detailed survey information in 203 of the affected communities concerning the status of housing construction. Integrating both the georeferenced maps and survey data in a single GIS provided a tool to allow for spatial planning at the district and provincial levels.

A comparison, in terms of effort, for the acquisition of the information to allow for the creation of this tool via traditional survey methods and via the use of earth observation and GIS techniques can be made.

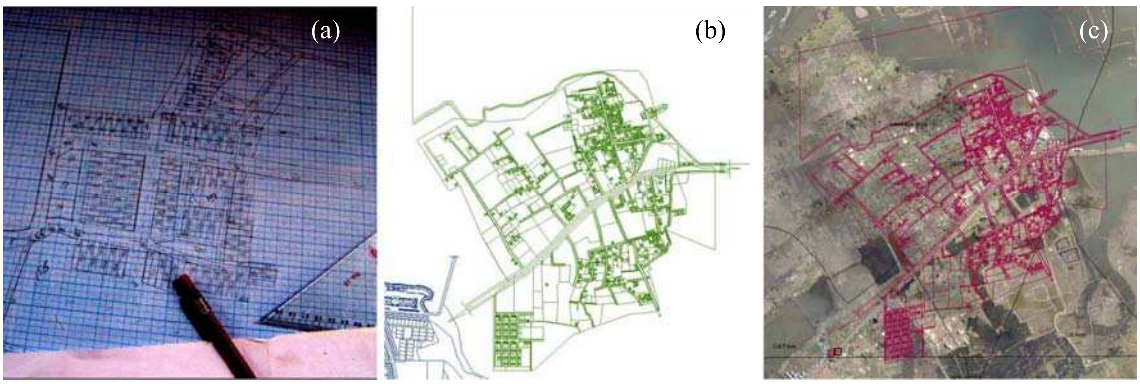

Figure 3: (a) Creation of a simple community based land ownership map (part of); (b) CBM converted to AutoCAD to record land ownership agreement and details; (c) CBM rectified using orthorectified aerial photography.

Traditional Survey:

- Capture and collation of spatial data per community = 3 persons for 1 month;
- Total effort for 600 communities = 1,800 months.

Earth Observation and GIS:

- Capture (digitization), rectification of earth observation derived spatial data, integration of attribute data = 8 persons for 7 months;
- Total effort for 600 communities: 48 months.

In the scope of this project, traditional survey methods are seen to require 36 times more effort to provide the same information.

3.2.4 Banda Aceh Water Strategy 2007–2030 and Short-term Action Plan

The Aceh and Nias Post Tsunami and Earthquake Reconstruction Program (ANTERP) implemented by Sogreah in collaboration with Banda Aceh City Water Utility (PDAM) initially provided engineering design drawings for new roads and drainage to the BRR for prioritization and coordination of reconstruction activities and further provided the BRR with maps comparing construction progress of housing and roads before and after 2007 across the city of Banda Aceh.

The project made use of high resolution, 25 cm, orthorectified aerial imagery acquired in June 2005, available at a scale of 1:2,000 provided at no cost through the SIM-Centre of the BRR. The imagery was used to assess the damage to the piped water and drainage system in Banda Aceh and further to provide city mapping and then to plan engineering designs for new piping networks for the PDAM.

An assessment of construction progress for housing and roads across Banda Aceh city was implemented in November 2007 by a comparison of the city mapping and high resolution Kompsat Imagery (1 meter—m) acquired in May 2007. The imagery was provided at no cost to the program through the SIM-Centre. An example product showing the reconstruction progress of one of the most devastated villages (Ulee Lheue) is given in Figure 4. Reconstruction activities are shown in green.

It is estimated that the information derived from both image sets to support both projects would have cost approximately 100,000 USD to obtain from traditional sources.

A comparison of costs for production of progress mapping (2005–2007) can be provided by considering the effort required to create the map across the sub district Meuraxa in Banda Aceh. The Meuraxa sub district (yellow in inset in Figure 4) has a survey area of 7.5 sq. km.

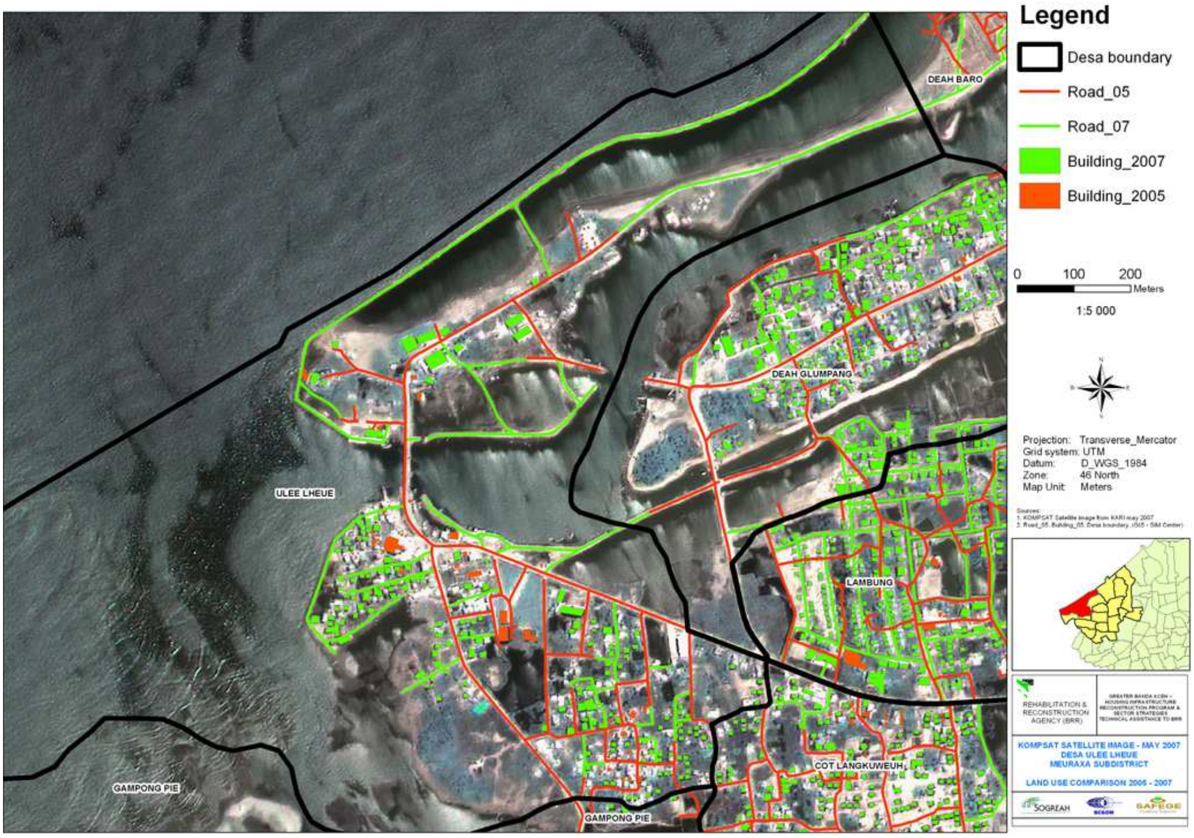

Figure 4: Ulee Lheue village buildings and roads comparison 2005–2007; KOMPSAT satellite imagery of Banda Aceh (22 May 2007), city mapping derived from orthorectified aerial imagery (June 2005).

The cost effort to produce mapping from earth observation and GIS:

- Cost of orthophotos and GIS data showing infrastructure (building and road extent): no cost—donated by the Norwegian government (actual cost is 200 USD sq. km: total cost 1,500 USD).
- Cost of Kompsat Imagery: no cost—donated by Korean space agency (actual cost 14–19 USD sq. km: total cost[3] 105–143 USD).
- Time/Effort: 2 months.

Effort to produce mapping from traditional geodetic survey:

- Geodetic survey at 1:10,000 for a survey of 7.5 sq. km (750 ha), requires a total of 150 days effort for a survey team of three, equating to 20 months total effort for each survey. Two surveys would be required, one each in 2005 and 2007. Total effort = 40 months.

In terms of creating this product, use of traditional survey techniques requires 20 times more effort.

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[3] Assuming minimum area coverage order requirements are met—currently 50 sq. km (SPOT IMAGE, 2008 pricing).

3.2.5 Digital Orthophoto Cost-benefit

In January 2005, at the request of the Indonesian government, the Norwegian Agency for International Development (NORAD) provided a grant for the creation of an orthophoto dataset covering more than 6350 sq. km of Acehnese coastal regions affected by the 2004 tsunami. It was seen as crucial for the efficient use of emergency aid funding, as well as for infrastructure reconstruction (roads, harbors, bridges, etc.) that up-to-date geographical information was collected to create the base for planning the aid program (BlomInfo, 2006). The project was carried out over the period March 2005 to June 2006. The total value of the project amounted to 1,432,994 Euros (€).

The digital orthophoto data set was created by BlomInfo (2006) and final delivery of the products was completed by May 2006 to the Indonesian National Coordinating Agency for Surveys and Mapping (Badan Koordinasi Survei dan Pemetaan Nasional—Bakosurtanal). In late August 2006, the digital orthophoto data set and GIS data was delivered by Bakosurtanal to the SIM-Centre of the BRR for dissemination to the aid and recovery community in NAD. The SIM-Centre and Bakosurtanal were the sole authorized distributors of the data sets, both of whom made the datasets available to the recovery community at no cost.

During the period August 2006 to August 2008, the SIM-Centre distributed the data to 79 users and Bakosurtanal to a further 18, totaling 99 users of the dataset in the recovery and rehabilitation process. In general, the users had sufficient capacity to work with this earth observation and GIS data set. The users came from all aspects of the recovery community and were seen to have the following distribution: national and local government (37%), NGO (28%), UN (14%), others (i.e., university or research groups, or undefined group association—8%), donor (7%), and international organizations (6%).

A detailed analysis of the data usage was initiated in July 2008, by survey of the technical experts who had used the data. The analysis found that over half of the survey respondents who used the orthophoto and GIS data (23 users) claimed that the data was critical to the successful implementation, operation and completion of their projects, and that without the data their projects would not run or be effective. The orthophoto and GIS data set critically supported by 28.4 million € worth of reconstruction projects, whilst further supported (i.e., data used, but not critical to project operation) by a total of 880.73 million € of reconstruction projects. It was further estimated that in order to obtain the same level of information by traditional means by those projects that deemed the data critical, it would have cost a minimum of 3.5 million €.

The majority of the data users (91%) employed the data set at the project planning phase (phase 2 of the normal 5 phase project cycle) and as such the main problem with the provision of the data set was the timeliness of its delivery into the aid and recovery community by Bakosurtanal.

A more detailed analysis of the cost-benefit of the use of the orthophotos provided by this project as well as a complete chronology of the project and related issues is provided in an upcoming report.

3.2.6 Summary of Cost-benefit Examples

In summary, all five of the cost-benefit examples examined in this study describe large cost and time savings with the use of earth observation data (see Table 5). Outstanding among these examples was the acquisition of digital orthophotos with an initial investment of 1.4 million €, which provided large benefits in terms of supporting other projects.

Table 5: Summary table of quantitative benefit estimation examples.

Organization	Example (Report Section)	Estimated Benefit
USGS	Cost-benefit of GPS for community based bathymetric mapping (3.2.1)	94,570 USD
CRS-ITB	Comparison of traditional surveying to orthophotos (3.2.2)	7.56 million USD
LOGICA	Use of orthophotos for community based mapping and survey (3.2.3)	36 fold savings
Sogreah	Banda Aceh water strategy 2007–2030 and short-term action plan (3.2.4)	20 fold savings
Sim-Centre	Digital orthophoto cost-benefit (3.2.5)	*Saved:* 2.1 million (m) € *Benefit (critical):* 28.4 m € *Benefit (supported):* 880.73 m €

4 Discussion

This study outlines the initial data collection and analysis attempting to describe the role that earth observation data plays in disaster relief and reconstruction efforts. The province of Aceh and the Nias Islands in Sumatra, Indonesia have been chosen as the case study region. After the tsunami on 26 December 2004, large amounts of relief effort poured into the affected regions and a necessary part of this relief effort involved earth observation data.

Initially, a questionnaire was designed along with interviews of key organizations in the region to better assess the use and benefits of earth observation data. Key findings from the questionnaire point to an improvement in the data situation since the tsunami, generally from poor to satisfactory or good. This has come about because of large amounts of money being spent in the form of basic data, training, data administration, etc. Problems identified include an insufficient level of staff training in the use of all earth observation related data, waiting too long to receive new data, and often insufficient data resolution. These problems are serious as trained staff is necessary, especially as foreign aid organizations leave the region. In addition, with such rapid change in an area under intensive reconstruction, new and updated information is crucial. Where necessary, this information must also meet spatial resolution requirements.

Further specific cost-benefit examples were provided from the region showing the growing use of earth observation data and the benefits accrued. Especially in post-disaster/reconstruction regions where timeliness is crucial, it appears that the benefits from the application of earth observation data are numerous. Cost-benefits identified in the various examples were typically in the order of millions of dollars, involving large time savings.

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Appendices

Appendix I: Earth Observation Questionnaire

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The International Institute for Applied Systems Analysis (IIASA) is leading the European Union sponsored project "*Global Earth Observation—Benefit Estimation: Now, Next and Emerging*" (GEO-BENE). Within GEO-BENE we are developing methodologies and analytical tools to assess societal benefits of GEO in nine societal benefit areas—one of which is disasters. GEO in this sense refers to all forms of global earth observation—*in-situ*, maps, aerial photos, satellite data, etc.

The tsunami affected province of Nanggroe Aceh Darussalam (NAD), and specifically Banda Aceh, has been selected as a case study. In December 2007, the GEO-BENE project will be visiting Banda Aceh to collect information from users of GEO Data. Working with the SIM-Centre, BRR and the GIS and Remote Sensing Development Centre of UNSYIAH, GEO-BENE has identified your organization as a potential user of GEO data.

We would be very grateful if you could provide a response to the questions found in this questionnaire. (Estimated time to complete: 15 minutes). Your response will be used to generate statistical information about the use and need for GEO data in the response to a disaster, and will be reported upon in a scientific journal article. Please make sure to tick the box if you wish your project to be directly acknowledged in this article, and if you would like to receive a copy of the final article.

Organization Name: ______________________________

Your Name: ______________________________

Title: ______________________________

Length of Employment: ______________________________

Date: ______________________________

Please acknowledge my project in your article ☐ **(Please tick)**

Please send me a copy of your final article ☐ **(Please tick)**

If you have ticked either of the above please provide e-mail address:

1 General Background

1.1 Is your organization currently using any form of GEO data? (Please circle)

- Surveys
- Maps
- Aerial photos
- Satellite data
- Other: ____

1.2 For what purposes are you using this GEO data? (Please circle)

- Health
- Housing and Settlement
- Education
- Governance
- Water/Sanitation
- Environmental
- Other: ____

1.3 From where have you obtained your GEO data? (Please circle)

- National Government (i.e., Bakosurtanal)
- Local Government (Bappeda)
- UN
- BRR
- Other: ____

1.4 Could you operate without this information? Yes / No

2 Baseline GEO Data

2.1 In your opinion, what was state of GEO information when the tsunami struck? (Poor, Satisfactory, Good) (Please circle)

2.2 What is the state of GEO information now? (Please circle) (Poor, Satisfactory, Good)

2.3 Do you believe that GEO data (maps, etc.) have helped thus far with the relief effort? Yes / No

3 Current/Future GEO Data

3.1 How do you expect investments in GEO information will help if another tsunami were to strike in this region? (Please rank)

- Saved lives
- Faster response
- Less damage
- Other: ____

3.2 Which improvement to GEO data would be most useful in your opinion? (Please rank)

- Higher resolution
- Better frequency
- More *in-situ*
- Timely delivery
- Improved access
- Other: ____

4 Resources and Capabilities

4.1 Do you and your group have the capacity (trained staff) and resources (hardware/software) to make use of improved information? Yes / No

4.2 In general, what is more important in your opinion:

- to improve information received, or
- to increase resources to work with information (i.e., training, hardware, software etc.)?

5 Specific Examples

5.1 Please identify specific examples of the areas in which you work that involve the use of ground data, aerial photos, satellite data, maps, etc. (Please circle)

- Tsunami warning
- Environmental monitoring
- Water quality
- Mangrove rehabilitation
- Housing construction
- Other: _______________________________________

5.2 How would you classify yourself in terms of your ability to answer the questionnaire?

(Familiar, Knowledgeable, Expert)

Thank you for taking the time to answer this questionnaire. If you have provided complete contact information on page one you will receive a copy of the results of this study once completed.

Appendix II: Summary of Questionnaire Results

1.1	1.2	1.3	2.1	2.2	3.1	3.2	4.1	4.2	5.1
All	Housing	UN	Poor	Satisfactory	Faster Response	Better Frequency	Yes	Training	Housing
All	Housing; Environmental	All	Poor	Satisfactory	Faster Response	Better Frequency	Yes	Training	Housing; Mangrove
All	Education; Environmental	All;JICA;LAPAN	Satisfactory	Good	Faster Response	Better Frequency	No	Training	All
All	Health; Education; Governance	All	Good	Good	Faster Response	Better Frequency	No	Training	All
All	Certification	BRR	Poor	Good	Problem Resolution	High Resolution	No	Training	Certification
All	All	Sim-C; BRR; JICA	Poor	Satisfactory		High Resolution			
All		Govt; BRR; SPOT	Poor	Good		Better Frequency; Access			
All						High Resolution	Yes		
Surveys; Maps	All	All	Poor	Satisfactory	Faster Response	Access			
All	All	BRR; Quickbird	Satisfactory	Good	Faster Response				
All	Forestry; Fisheries	BRR	Poor	Satisfactory		Better Frequency		Training	
Surveys	Housing	Surveys	Poor	Satisfactory		Better Frequency			
All	Environmental	All	Satisfactory	Satisfactory		Better Frequency		Training	
All	Housing	BRR; SPOT; Radarsat	Poor	Good	Faster Response	Better Frequency		Training	
All	Environmental								
Maps; Photos; Satellite	Environmental	BRR; ADB	Poor	Good		Better Frequency		Training	
All	Water	BRR; SPOT	Poor	Satisfactory		Better Frequency			

Note: Column headings refer to question number as provided in Appendix I; blank cells indicate no response.

Appendix III: Case Study Contact Details

Person/Position	Project/Agency	Contact Details
C. Wilson Project Director	Community Based Bathymetric Survey, Network of Aquaculture Centres in Asia-Pacific (NACA), Asian Development Bank, Earthquake and Tsunami Emergency Support Program, (ADB-ETESP), Banda Aceh, NAD, Indonesia	http://www.panglima.net/ conservation@gmai.com
K. Wikantika Director, Centre for Remote Sensing Chair, Indonesian Society for Remote Sensing (MAPIN)	Center for Remote Sensing, Institute of Technology Bandung (ITB), Indonesia	ketut@gd.itb.ac.id,
D. Mate Program Manager	Australia Indonesia Partnership for Reconstruction and Development (AIPRD), Local Governance and Infrastructure for Communities in Aceh (LOGICA) program	www.logica.or.id, office@logica.or.id
B. Coiron Project Engineer	Sogreah, Water Strategy 2007–2030 and Short-term Action Plan, Aceh and Nias Post Tsunami and Earthquake Reconstruction Program (ANTERP), Greater Banda Aceh—Housing and Infrastructure Reconstruction Program and Sector Strategies—Technical Assistance to BRR	bertrand.coiron@sogreah.fr
Richard Kidd Senior GIS Officer	Spatial Information and Mapping Centre (SIM-Centre), Badan Rehabilitasi dan Rekonstruksi (BRR) NAD-Nias, (Agency for Reconstruction and Rehabilitation of NAD and Nias)	sim.centre@brr.go.id