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Haiti Earthquake (2010) Remote Sensing Analysis Datasets and Quick Response to UN around Port-au-Prince[1]

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Abstract: The Haiti Earthquake (2010) Remote Sensing Analysis and Quick Response to UN datasets (HaitiEQ_2010data for short) was developed based on the GeoEye, QuickQird and BJ-1 data with high spatial resolution before and after the Haiti Earthquake at 21:53:10(UTC) on January 12, 2010. The damaged buildings data, roads network data and the refugee camps distribution data are included in the HaitiEQ_2010d dataset. From the high resolution remote sensing data analysis, the quick responses analysis results were calculated, including 1839 km roads, streets and paths data, 5568 buildings or building groups damaged data with the area of 1861724.4m2, 624 refugee camps of 691623.44m2 during the first week of the disaster. The dataset is archived in the shp and kmz data format with the data size of 2.5MB. On February 2, 2012, the HaitiEQ_2010 datasets and related statistic report were submit to UN-SPIDER and UNPAN though the Global Alliance for Enhancing Access to & Application of Scientific Data in Developing Countries of UN GAID (e-SDDC) as a references for decision making.

Keywords: **Haiti; earthquake; 2010; roads; damaged buildings**

1 Introduction

The Republic of Haiti occupies the western third of the island of Hispaniola, located in the NE Caribbean. On January 12, 2010, a very strong earthquake with a magnitude of 7.0 Mw struck Haiti at 21:53:10(UTC).The USGS epicenter was 18.457° N, 72.533° W, approximately 25 km west of Port-au-Prince[1], Haiti's capital (Figure 1). Because the depth of this earthquake was very shallow, the earthquake caused destructive damage in this most popu-

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lated region in Haiti.

Soon after the earthquake, many countries and international organizations responded to appeals for humanitarian aid. The International Charter for Space and Major Disasters was activated. Many high-resolution optical satellite imageries covering the earthquake-hit region were acquired a few hours later after the disaster thankfully to the good weather condition.

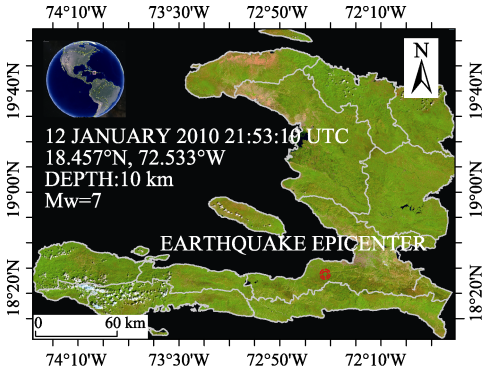


Figure 1 Location of the epicenter of 2010 Haiti earthquake

The consultative project led by CAST and the Chinese Academy of Sciences was approved by UN GAID from 2007 to 2012, titled Global Alliance for Enhancing Access to & Application of Scientific Data in Developing Countries of UN GAID (e-SDDC). So after the disaster UN GAID e-SDDC immediately organized thirty-five experts in remote sensing field to produce damage maps in the disaster-struck area in order to offer decision-making reference for earthquake assessment. By using satellite data such as GeoEye(January 13, 2010 and January 16, 2010),Quick bird (January 10, 2010), BJ-1(January 13, 2010)with spatial resolution ranging from 0.41m to 4m,detailed damage information such as damaged building was produced by comparing pre-earthquake satellite data to post-earthquake satellite data. Although many auto-recognition techniques have been developed to detect damages, the visual interpretation approach was adapted in this research due to its reliability. On February 2, 2012, the ARC/GIS datasets of damaged buildings, road network, refugee camps and related report were submit to UN-SPIDER and UNPAN by GAID e-SDDC. The event of HAITI Earthquake 2010 demonstrates the remote sensing technology with wide coverage, real-time and an unchallenged abilities to access precarious areas is a valuable post-earthquake damage assessment tool[2].

2 Metadata of the dataset

The descriptions of the HaitiEQ_2010data[3] are recorded. These information include the dataset full name, dataset short name, authors, geographical region of the dataset content, year of the dataset, number of the dataset tiles, dataset spatial and temporal resolution, dataset format and size, data publisher, and data sharing policy. Table 1 is the summary of the metadata of the HaitiEQ_2010data.

3 Method

Based on satellite data including GeoEye (January 13, 2010, January 16, 2010), Quick Bird (January 10, 2010) and BJ-1 (January 13, 2010), the damaged buildings, roads, refugee camps were interpreted by comparing pre-earthquake satellite data with post-earthquake satellite data. Table 2 is the technical specification of using remotely sensed data. According to the image characteristics, namely color, spectra, texture, shape, morphological features of the object, remote sensing interpretation signs were established[5,6]. The interpreted results were cross-checked between different work groups. In order to reduce the differences of the result

Table 1 Metadata Summary of the HaitiEQ_2010data

Items	Description
Dataset full name	Haiti earthquake (2010) remote sensing analysis and quick response to UN datasets
Dataset short name	HaitiEQ_2010data
Authors	Liu, C. L-3684-2016, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, lchuang@radi.ac.cn Guo, H. D. G-9388-2017,Institute of Remote sensing and Digital Earth, Chinese Academy of Sciences, hdguo@rad.ac.cn Lv, T. T. R-8978-2016, Institute of Remote sensing and Digital Earth, Chinese Academy of Sciences, lvtt@radi.ac.cn Wang, J. N. E-2431-2017, Institute of Remote sensing and Digital Earth, Chinese Academy of Sciences, jwang@radi.ac.cn Liu, D. S. L-7432-2016, Institute of Remote sensing and Digital Earth, Chinese Academy of Sciences, dsliu@radi.ac.cn Wang, S. X. Institute of Remote sensing and Digital Earth, Chinese Academy of Sciences, wsx@radi.ac.cn Gu, X. F. L-7328-2016, Institute of Remote sensing and Digital Earth, Chinese Academy of Sciences, guxf@radi.ac.cn Qu, G. S. National earthquake response support service, China
Geographical region	N18.5°-18.7°, W72.2°-72.47°
Time	2010
Spatial resolution	1m
Data format	.kmz; .shp; .zip
Data Size	2.5MB
Data files	The dataset consists of six data files: (1). HTI_Damaged_Building.zip, this is the ARC/GIS .shp compressed file of the collapsed building after the 2010 earthquake in Port-Au-Prince of Haiti. Data size is 441KB. (2). HTI_Damaged_Building.kml，Google Earth format file of the collapsed building after the 2010 earthquake in Port-Au-Prince of Haiti .Data size is 1760KB. (3). HIT_Camp.zip，this is the ARC/GIS .shp compressed file of the refugee camps after the 2010 earthquake in Port-Au-Prince of Haiti. Data size is 66KB. (4). HIT_Camp.kmz,Google Earth format file of the refugee camps after the 2010 earthquake in Port-Au-Prince of Haiti. Data size is 84KB. (5). HIT_Road.zip，this is the ARC/GIS .shp compressed file of the road in Port-Au-Prince of Haiti. Data size is 842KB. (6). HIT_Road.kml，Google Earth format file of the road in Port-Au-Prince of Haiti. Data size is 491KB.
Foundation	Chinese Academy of Sciences（CXIOG-D04-03）
Data Publisher	Global Change Research Data Publishing & Repository, http://www.geodoi.ac.cn
Address	No.11A, Datun Road, Chaoyang District, Beijing 100101, China
Data Sharing Policy	The term of the ***Data*** from the Global Change Research Data Publishing and Repository is the definition of metadata, dataset (data product), and data paper (published through *Journal of Global Change Data & Discovery*). The ***Data*** sharing policy includes: (1) the ***Data*** is openly available and can be easily to be downloaded through internet for all; (2) end users are encouraged to use the ***Data*** subject to citation; (3) users, who are value added provider services, are welcome to redistribute the ***Data*** subject to written permission from the GCdataPR Editorial Office for the ***Data*** redistribution license.; (4) for database or new dataset developers who use the ***Data*** to compile new dataset, the "ten per cent principal" should be followed, that is, the picked records from the ***Data*** should not surpass 10% of the new dataset, and the data records source should be clearly noticed in the suitable place in the new dataset[4].

caused by persons training is performed. Interpretation criteria were made during the training. The detailed procedure of the HaitiEQ_2010[7] dataset after the 2010 earthquake in

Port-Au-Prince of Haiti is shown in Figure 2.

Table 2 Technical specification of used remotely sensed data[7,8]

Satellite	Country	Company	Sensor	Spatial resolution	Revisit cycle	Acquisition time	Website
GeoEye-1	USA	GeoEye, Inc. Nasdaq	Panchromatic Multispectral	0.41 m (Nadir) 1.65 m (Nadir)	3 days	Jan. 13, 2010, Jan. 16, 2010	http://www.google.com/relief/haitiearthquake/ geoeye.html
Quick Bird	USA	DigitalGlobe	Panchromatic Multispectral	0.61 m (Nadir) 2.44 m (Nadir)	1–6 days	Jan. 10, 2010,	ftp://ftp.digitalglobal.com
BJ-1	China	Twenty First Century AerospaceTechnology Co.,Ltd.	Panchromatic	4 m (Nadir)	2-3 days	Jan. 13, 2010	

(1) Road (street, path) data development

According to the characteristics of road on remote sensing images with high spatial resolution, such as shape, grey and texture feature, roads in Port-Au-Prince of Haiti were extracted. Figure 3 is the road imagery in Port-Au-Prince of Haiti. From it we can see the road has uniform texture, and the contrast to background is obvious.

(2) Damaged buildings and building groups data development

Earthquake-induced building damage is one of the most critical threats to cities. The imaging features of collapsed or partial collapsed buildings are as followings:

A. The contour shape of the building disappears or be changed.
B. Texture and color of the collapsed or partial collapsed buildings have great difference with the pre-earthquake image.
C. There may be some deposits around the collapsed or partial collapsed buildings.

Figure 4 is the comparison of building before and after collapsed. From it we can see that the geometry and texture features of the collapsed building change greatly and there are a large number of deposits around the target. According to the criteria made in training the damaged buildings should be outlined according to its original footprint.

(3) Refugee camps data development

By comparing the images before and after the earthquake, we can find there are many high brightness and scattered small polygons as shown in Figure 5 occurred in many open areas after earthquake which are many refugee camps. According to the criteria made in

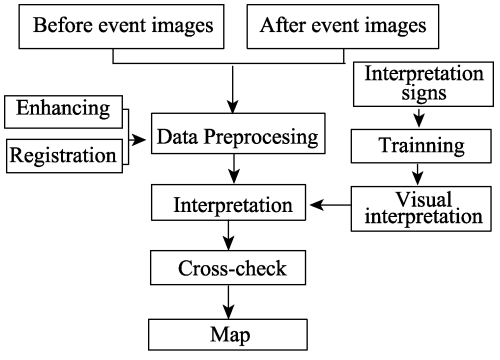


Figure 2 Procedure of HaitiEQ_2010 dataset

Figure 3 Imagery of road in Port-Au-Prince of Haiti

Figure 4 The comparison of building before and after collapsed

training the refugee camps should be outlined according to its maximum spatial distribution.

Figure 5 The comparison of refugee camps before and after earthquake

4 Result of data products

4.1 Road (street and path) data file

Figure 6 shows the mosaic of GeoEye-1 images of Haiti earthquake area on Jan. 13, 2010. Figure 7 shows the final result of road data in Port-Au-Prince of Haiti and total length is about 1839 km.

4.2 Damaged buildings and building groups data file

Figure 8 is the interpreted result of damaged buildings in Port-Au-Pri nce of Haiti. Table 3 is the Statistics of damaged buildings. As shown in table 3, totally 5568 damaged buildings or building groups were interpreted with the area about 18617 24.4 m^2.

4.3 Refugee camps data file

Figure 9 shows the interpreted result of refugee camps in Port-Au-Prince of Haiti. As shown in Table 4, totally 624 damaged buildings were interpreted with the area about 691,623.44

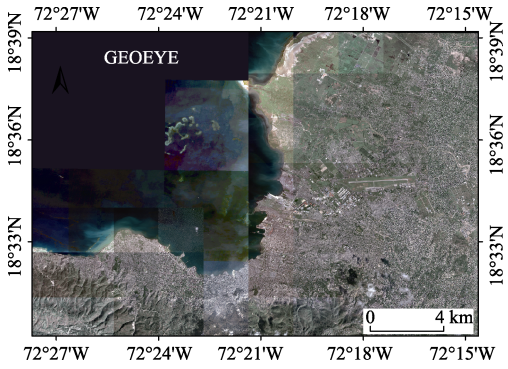


Figure 6 GeoEye-1 images of Haiti earthquake area on Jan. 13, 2010

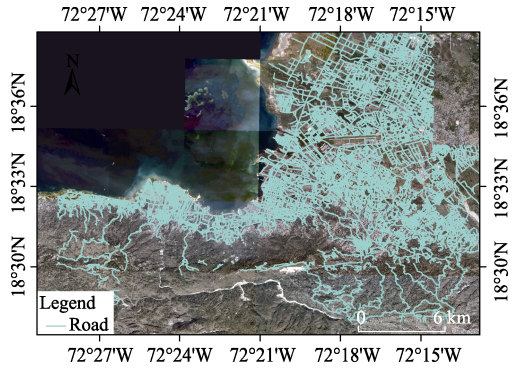


Figure 7 Road data in Port-Au-Prince of Haiti in 2010

m^2 (Figure 9, Table 4).

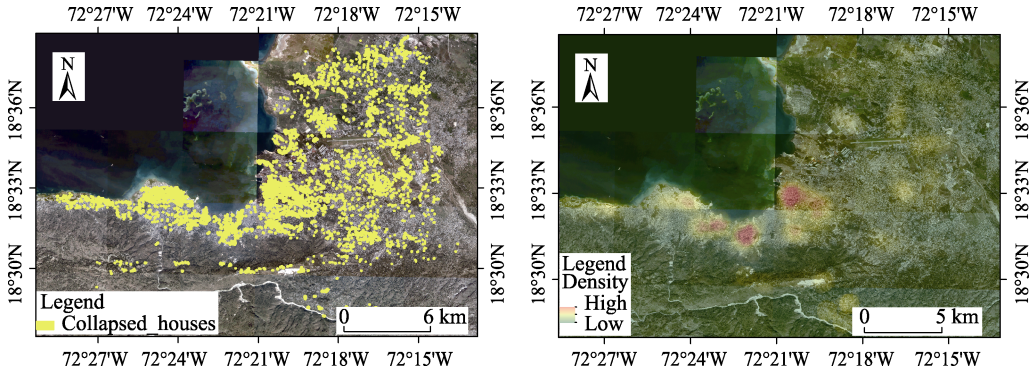


Figure 8 Spatial distribution and density of the damaged buildings in 2010 Haiti Earthquake

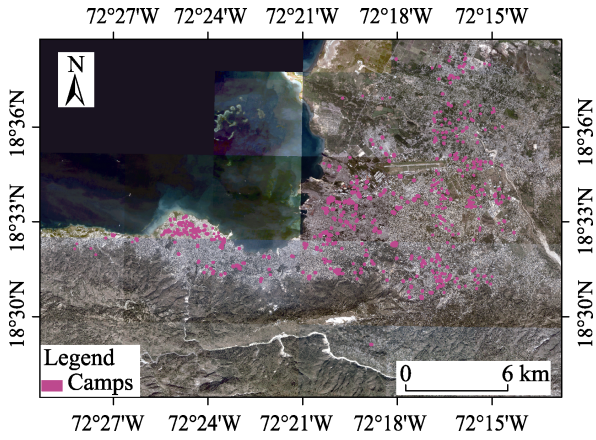
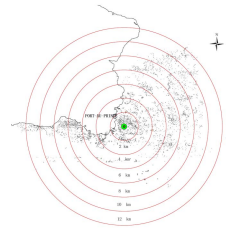


Figure 9 Refugee camp data in Port-Au-Prince of Haiti in 2010

Table 3 Statistics of damaged buildings

Buffer	Number	Area (m^2)
<2 km	919	339602.5
2–4 km	764	264156.1
4–6 km	815	333791.2
6–8 km	1182	367465.6
8–10 km	1032	281856.4
10–12 km	575	178810.7
> 12 km	281	96041.92
Total	5568	1861724.4

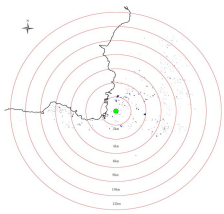


5 Conclusion and Discussion

After an earthquake effective and timely investigation of direct damages from disasters is very crucial. Remote sensing techniques were proved to be useful in detecting, identifying and monitoring the impact and effect of earthquake. Through acquiring, processing, interpreting and analyzing remote sensing data, the ARC/GIS datasets of damaged buildings,

Table 4 Statistics of refugee camp

Buffer	Number	Area (m^2)
<2 km	46	142103.47
2–4 km	70	243372.7
4–6 km	77	143603.5
6–8 km	176	101499.9
8–10 km	177	34584.49
10–12 km	58	23258.15
> 12 km	20	3201.2
Total	624	691623.44



road network, refugee camps and related report on disaster were presented to UN-SPIDER and UNPAN by UN GAID e-SDDC within several days after the earthquake, which will provide help to them to make rapidly decisions on the routes for rescue and disaster relief dispatch.

6 Contributions

Liu, C. Guo, H. D. and Gu, X.F. designed the study, Lv, T. T., Wang, J. N., Liu, D. S., Wang, S. X. and Qu, G. S. finished the data processing and analysis. Lv, T. T. drafted the paper, Liu, C. finalized the paper and reviewed the dataset. Liu, C. submitted the dataset and paper (report) to UN-SPIDER and UNPAN.

Acknowledgement

Many thanks to GeoEye, Quickbird and Beijing Satellite for providing remote sensing images timely though internet. The authors of the paper access to the data above as earlier as January 13, 2010 for BJ-1, images, January 13-16, 2010 for GeoEye and January 10-16, 2010 for Quick bird remote sensing images.

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