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

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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 1,839 km roads, streets and paths data, 5,568 buildings or building groups damaged data with the area of 1,861,724.4 m^2, 624 refugee camps of 691,623.44 m^2 during the first week of the disaster. The dataset is archived in the .shp and .kmz data format with the data size of 2.5 MB. 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

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earthquake was very shallow, the earthquake caused destructive damage in this most populated 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.

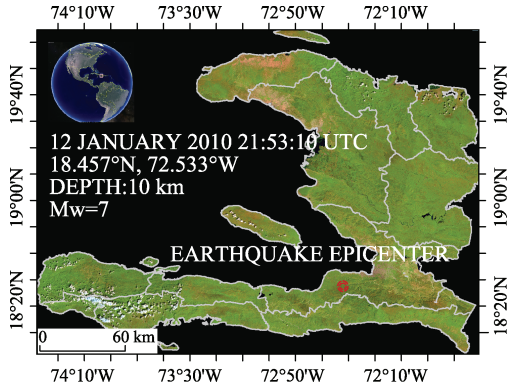


Figure 1 Location of the epicenter of 2010 Haiti earthquake

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 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 Methods

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

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	18.5°N−18.7°N, 72.2°W−72.47°W
Time	2010
Spatial resolution	1 m
Data format	.kmz, .shp, .zip
Data Size	2.5 MB
Data files	The dataset consists of 3 parts: (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 441 KB (2). 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 66 KB (3). HIT_Road.zip，this is the ARC/GIS .shp compressed file of the road in Port-Au-Prince of Haiti. Data size is 842 KB
Foundation(s)	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]

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

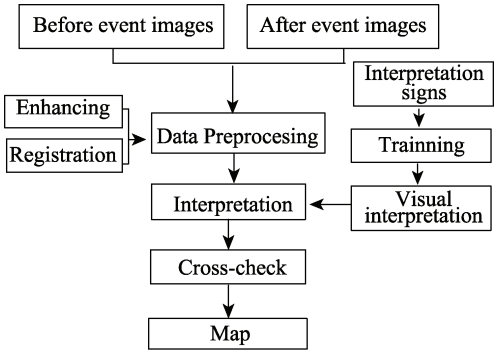


Figure 2 Procedure of HaitiEQ_2010 dataset

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

Figure 4 The comparison of building before and after collapsed

4 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 1,839 km.

Figure 5 The comparison of refugee camps before and after earthquake

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 5,568 damaged buildings or building groups were interpreted with the area about 1,861,724.4 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 m^2 (Figure 9, Table 4).

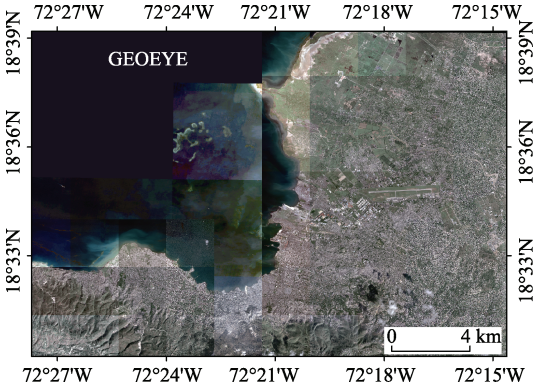


Figure 6 GeoEye-1 images of Haiti earthquake area on Jan. 13, 2010

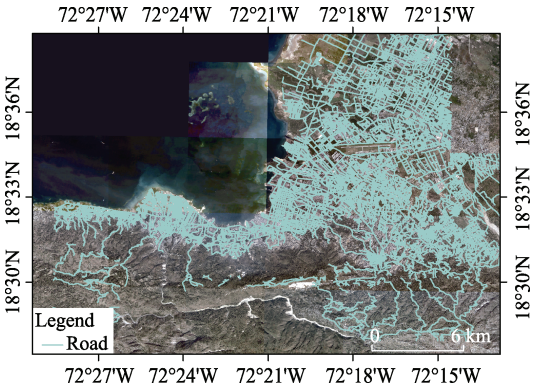


Figure 7 Road data in Port-Au-Prince of Haiti in 2010

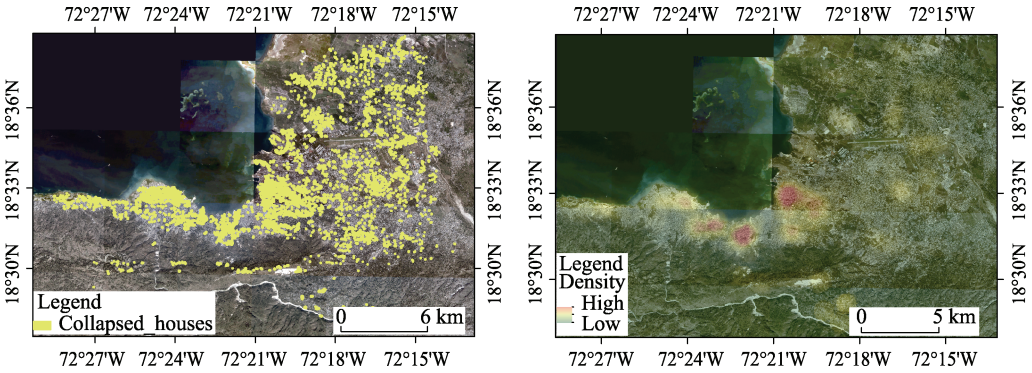


Figure 8 Spatial distribution and density of the damaged buildings in 2010 Haiti Earthquake

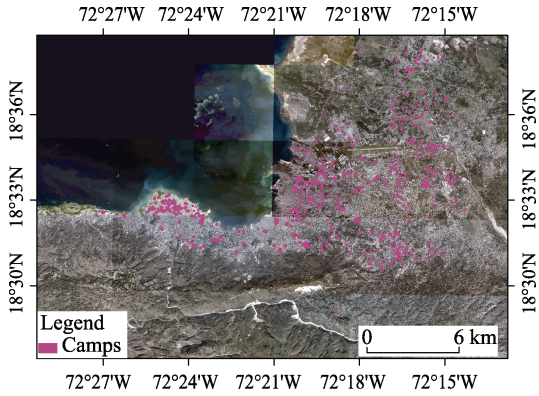
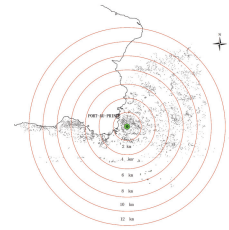


Figure 9 Refugee camp data in Port-Au-Prince of Haiti in 2010

Table 3 Statistics of damaged buildings

Buffer	Number	Area (m^2)
<2 km	919	339,602.5
2–4 km	764	264,156.1
4–6 km	815	333,791.2
6–8 km	1,182	367,465.6
8–10 km	1,032	281,856.4
10–12 km	575	178,810.7
>12 km	281	96,041.92
Total	5,568	1,861,724.4

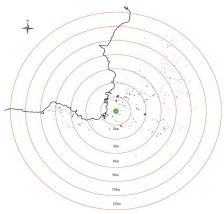


5 Discussion and Conclusion

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, 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.

Table 4 Statistics of refugee camp

Buffer	Number	Area (m^2)
<2 km	46	142,103.47
2–4 km	70	243,372.7
4–6 km	77	143,603.5
6–8 km	176	101,499.9
8–10 km	177	34,584.49
10–12 km	58	23,258.15
>12 km	20	3,201.2
Total	624	691,623.44



Author 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.

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References

[1] USGS Magnitude 7.0—HAITI REGION [R]. http://earthquake.usgs.gov/earthquakes/recenteqsww/Quakes/us2010rja6.php.

[2] Li, P. Rapid Assessment of Bachu Earthquake based on Remote Sensing Technology in Xinjiang on February 24, 2003 [D]. Haerbin: Institute of engineering mechanics, China Earthquake administration, 2004.

[3] Liu, C., Guo, H. D., Lv, T. T., *et al*. Haiti earthquake (2010) remote sensing analysis and quick response to UN datasets [DB/OL]. Global Change Research Data Publishing & Repository, 2014. DOI: 10.3974/geodb.2014.02. 09.V1.

[4] GCdataPR Editorial Office. GCdataPR Data Sharing Policy [OL]. Global Change Research Data Publishing and Repository, 2014 (Updated 2017).

[5] Wang, R. X., Ye, L. Y. Quick Investigation of Seism Disaster Using Remote Sensing Technology [J]. *Journal of Kunming University of science and technology* (*science and technology*), 2003, 28(4):1−5

[6] Wang, Y. The application of remote sensing technology in seismic hazard assessment- taking the "5.12" Wenchuan earthquake as an example [D]. Shanghai: Tongji University, 2009.

[7] Geoeye-1 [DB/OL]. http://www.google.com/relief/haitiearthquake/geoeye.html.

[8] QuickBird [DB/OL]. ftp://ftp.digital global.com.