Mapping the impact of the Typhoon Yolanda with combined approach of remote sensing, field observation and GIS analysis

Shunichi Koshimura (PI)
Erick Mas (presenter)
International Research Institute of Disaster Science (IRIDeS) – Tohoku University, Sendai, Japan

Ruel DM. Belen (PI)
Department of Environment and Natural Resources.
National Mapping and Resource Information Authority

Japan–Philippine Urgent Collaborative Projects
regarding "Typhoon Yolanda" within the J-RAPID Program

Japan Science and Technology Agency

DOST PCIEERD

Outline

1. IRIDeS activities in remote sensing for damage estimation (Assist. Prof. Erick Mas)
2. NAMRIA activities in Yolanda base mapping from satellite images (Dir. Ruel DM Belen)

Republic of the Philippines
Department of Environment and Natural Resources
NATIONAL MAPPING AND RESOURCE INFORMATION AUTHORITY
MAPPING AND GEODESY BRANCH
PHOTOGRAMMETRY DIVISION
Lawton Avenue, Fort Andres Bonifacio, 1634 Taguig City

Initial Report

International Research Institute of Disaster Science (IRIDeS)

17 May 2014

"IRIDeS Fact-finding missions to Philippines"

TOHOKU University
2014

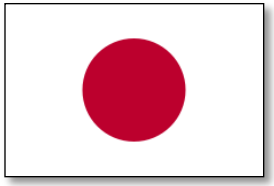
Second Report

International Research Institute of Disaster Science (IRIDeS)

14 March 2015

"IRIDeS Fact-finding missions to Philippines"

TOHOKU University
2015



Project team members

Name	Affiliation
Prof. Shunichi Koshimura (PI)	IRIDeS, Tohoku University
Prof. Fumio Yamazaki	Chiba University
Prof. Osamu Murao	IRIDeS, Tohoku University
Asoc. Prof. Masashi Matsuoka	Tokyo Institute of Technology
Asst. Prof. Erick Mas	IRIDeS, Tohoku University
Asst. Prof. Wen Liu	Chiba University
MSc. Hideomi Gokon	Tohoku University
MSc. Bruno Adriano	Tohoku University

Name	Affiliation
Dr. Ruel DM. Belen	NAMRIA, Mapping and Geodesy (Director)
MSc. Nicandro P. Parayno	NAMRIA, Photogrammetry
Eng. Leo B. Grafil	NAMRIA, Photogrammetry
Eng. Maricel D. Luna	NAMRIA, Photogrammetry

Objectives of the Project

1. Establish **satellite remote sensing method and mapping technology to identify impacts** and vulnerabilities in the 2013 Typhoon Yolanda affected areas and future catastrophic typhoon disasters.
2. Both research teams conduct **satellite image analysis and field survey**. Especially Japan team conducts satellite image analysis to identify the Typhoon Yolanda affected areas. The Philippine team conducts detailed verification of satellite image analysis with their extensive field survey results.

Methodology

- Use of multi sensor satellite images for damage mapping using remote sensing techniques.
- Verify methods with field survey data.
- Develop “storm surge fragility curves” to grasp the relationship between storm surge and structural damage.

Summary of results

1. Inundation Mapping using Normalized Water Difference Index (NDWI)
2. Spectral mixture analysis for inundation mapping
3. Visual Damage Interpretation from Satellite Images
4. Damage investigation using multi-temporal COSMO-SkyMed images
5. Damage detection using Urban Index (UI) in COSMO-SkyMed images
6. Classification of building damage levels using Normalized Difference Correlation Coefficient Index (NDCOI) in COSMO-SkyMed images
7. Phase-based change detection analysis for damage estimation

Inundation Mapping using Normalized Difference Water Index (NDWI)

Method

Normalized Difference Water Index (NDWI) using visible near-infrared (VNIR) imagery from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) enhance water features of pre- and post-event images

Advantages

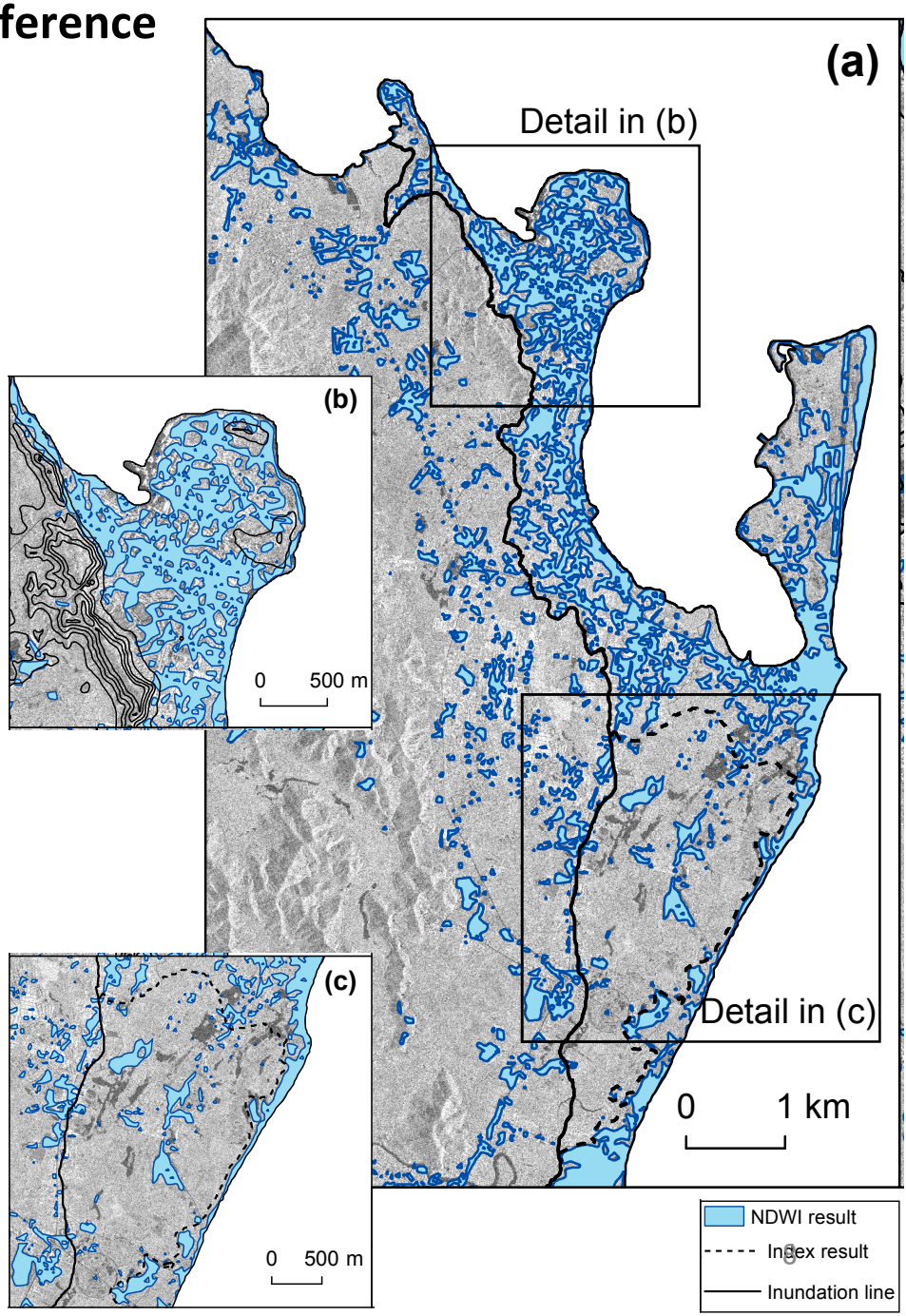
- Discover wetland areas
- Simple and fast for preliminary estimations

Limitations

- Difficult to accurately discretize wet areas due to storm surge, river flood or local rain.
- Requires field survey to confirm storm surge inundation limits.

Published on:

- Adriano, B., H. Gokon, E. Mas, S. Koshimura, W. Liu, M. Matsuoka (2014) "Extraction of damaged areas due to the 2013 Haiyan typhoon using ASTER data" *Proceedings of the International Geoscience and Remote Sensing Symposium IGARSS 2014 and 35th Canadian Symposium on Remote Sensing CSRS, Quebec, Canada, 2014.*



Spectral Mixture Analysis for inundation mapping

Method

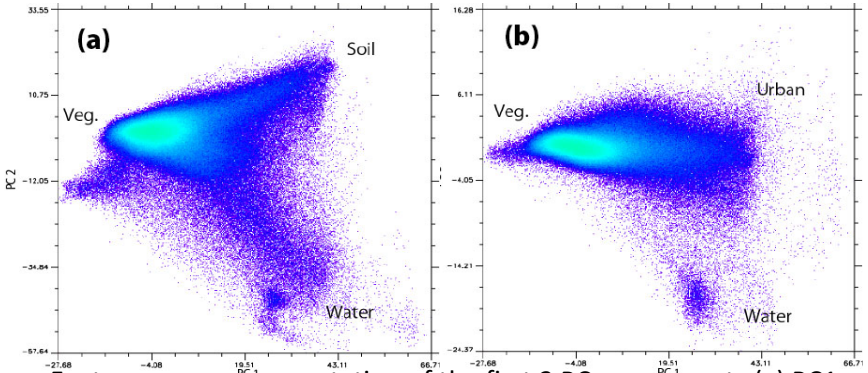
Spectral Mixture Analysis (SMA) aims on resolving the MIXELS assuming a linear combination of the spectral of all end members in a pixel.

$$R = \sqrt{\sum_{b=1}^{N} {R_b}^2}$$

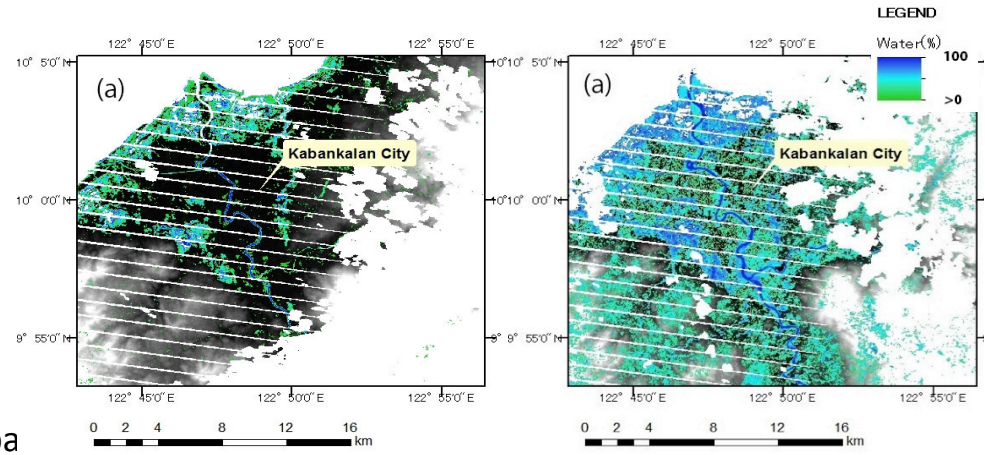
$$\overline{R_b} = \frac{R_b}{R} \times 100$$

1. Reflectance Image
2. Normalization
3. Principal Component Analysis (PCA)
4. Endmember Selection
5. Spectral Mixture Analysis (SMA)
6. Fraction of Endmember

$$\overline{R_b} = \sum_{i=1}^{N} \bar{f}_i \times \overline{R_{i,b}} + e_b$$



Feature space representation of the first 3 PC components (a) PC1 vs. PC2, (b) PC1 vs. PC3.



Distributions of water fraction in pre- and post-typhoon images in Kabanklan overlaid on the ASTER GDEM; (a) 10/28, (b) 11/13.
White area is masks and 0% of water fraction is transparent.
From the pre image, the value of water fraction is high in the only wetlands region and the areas with no water can be expanded widely.

Advantages

−Provides information as continuous values of water occupa within the pixel.

Limitations

−Debris mixed with flood water may produce underestimations.

−Needs to be combined with radar images for better result and avoid cloud influence.

Published on

Shinohara, T., W. Liu, M. Matsuoka (2014). “Spectral Mixture Analysis for Typhoon-Induced Inundation Mapping in Negros and Cebu Islands, the Philippines” *Proceedings of International Symposium on Remote Sensing 2014, B08-3, 4p., CD-ROM, 2014.4.*

Visual Damage Interpretation from Satellite Images

Method

Manual Visual Damage Interpretation **(comparison house by house)** from pre- and post-event satellite images of the affected areas (Tacloban city).

Advantages

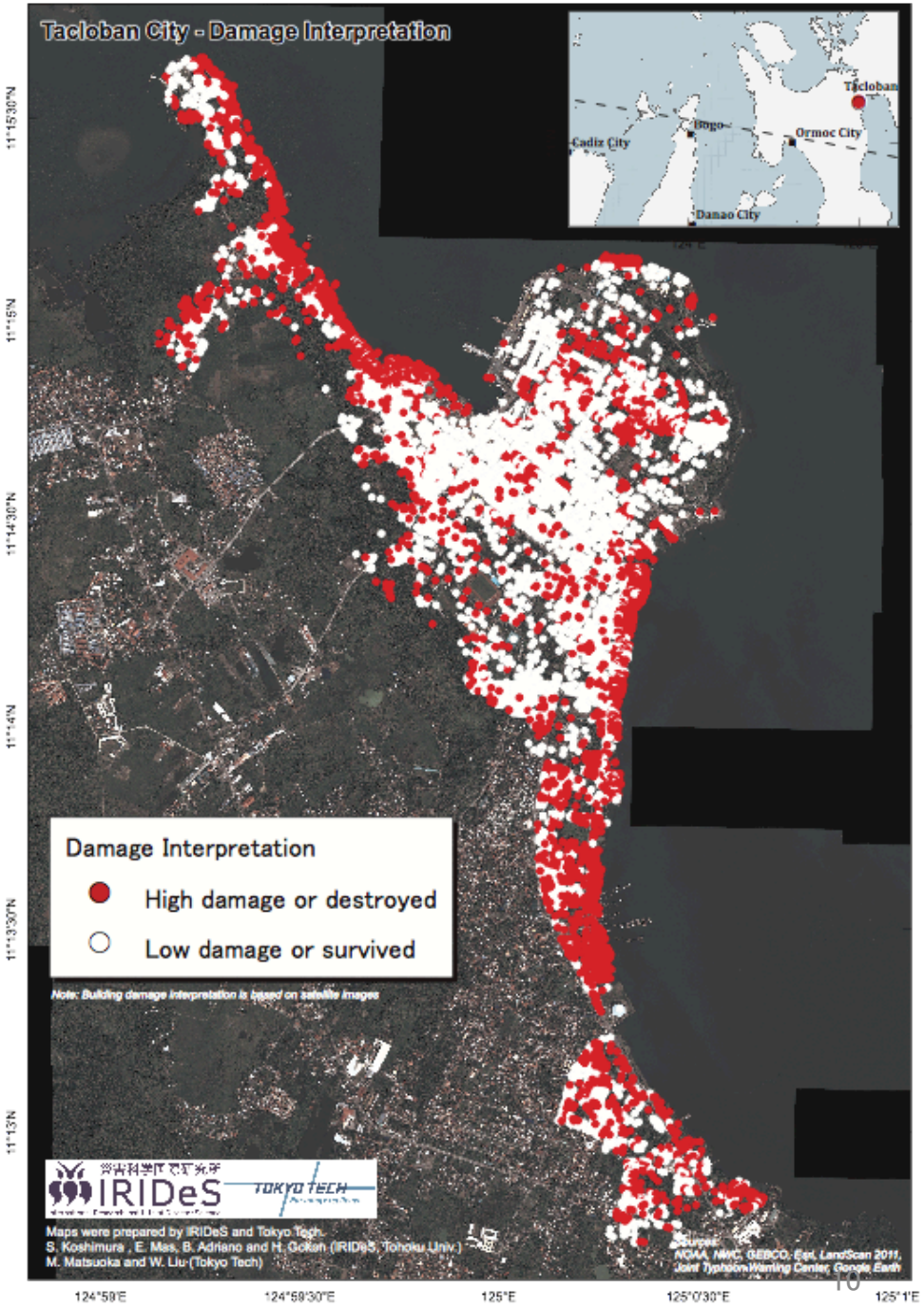
- Straightforward method.
- High accuracy when very high resolution images are used.

Limitations

- Subjective interpretation by the user eye.
- Images depend on weather conditions (lack of visibility due to clouds)
- Time consuming
- Underestimations for first floor damage due to storm surge but no damage on roofs.

Published on:

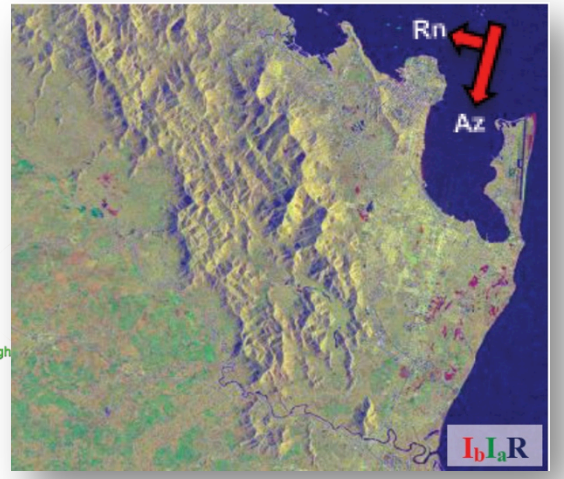
- Mas E., J.D. Bricker, S. Kure, B. Adriano, C.J. Yi, A. Suppasri, and S. Koshimura (2014a). "Field survey report and satellite image interpretation of the 2013 Super Typhoon Haiyan in the Philippines" *Natural Hazards and Earth System Sciences (in press)*
- Mas E., S. Kure, J.D. Bricker, B. Adriano, C.J. Yi, A. Suppasri, and S. Koshimura (2014b). "Field survey and damage inspection after the 2013 Typhoon Haiyan in The Philippines" *Journal of Japan Society of Civil Engineers, Ser. B2 (Coastal Engineering), Vo. 70, No.2, pp.I_1451-I_1455.*

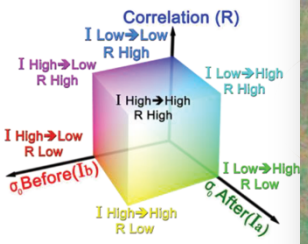


Damage Investigation using multi-temporal COSMO-SkyMed images

Method

Multi Temporal Correlation (MTR) and Hyperboloid Change Index (Δh) yields better visible results than only difference methods (Δd), weight method (Δw) or radius method (Δr) for change detection.





Advantages

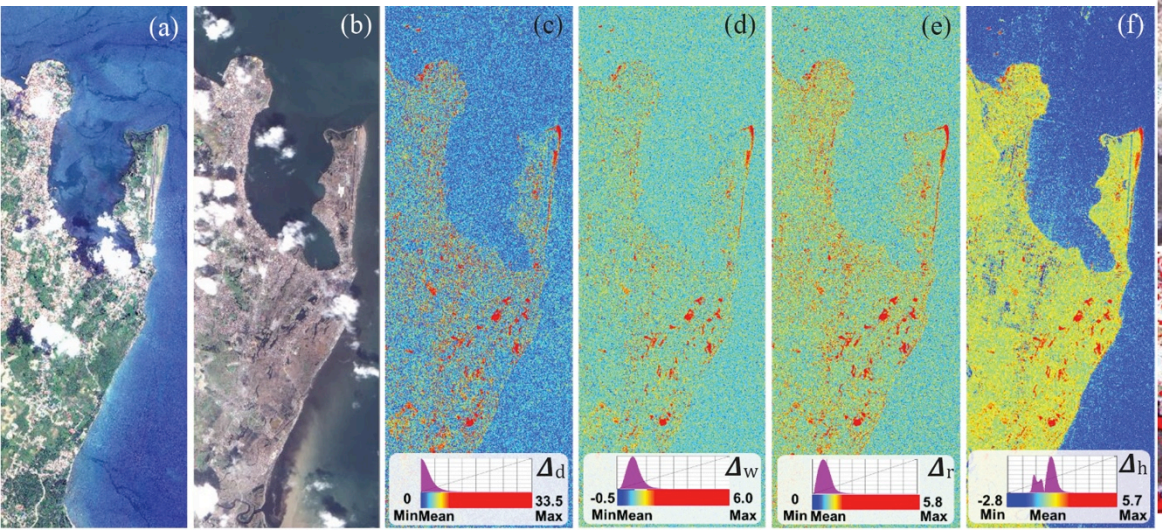
- Suitable for detecting impact of disasters.
- Suitable for detecting vegetation growth.

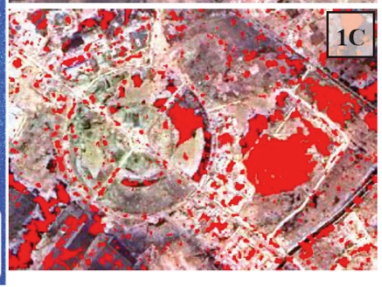
Limitations

- For damage assessment requires a pair of images taken in short time-interval (as in other methods).
- Difficult to separate building damage from debris spreading.

Published on:

- Nakmuenwai, P., F. Yamazaki (2014) "Damage investigation for the 2013 Typhoon Haiyan in the Philippines using multi-temporal COSMO-SkyMed images" *Proceedings of the IEEE 2014 International Geoscience and Remote Sensing Symposium, Quebec, Canada, 2261-2264, 2014.7*





Damage Detection using Urban Index (UI) in COSMO-SkyMed Images

Method

Urban Index (UI) calculated from the pre- and post-event COSMOS-SkyMed intensity images is used to extract severe damaged area.

$$UI = \frac{Int - \mu_{Int}}{\sigma_{Int}} + \frac{SPD - \mu_{SPD}}{\sigma_{SPD}}$$

$$SPD = \frac{\langle \sigma_{Int} \rangle}{\langle \mu_{Int} \rangle} - \frac{1}{C}$$

Int: backscattering intensity

C: number of total looks

Advantages

−Simple and fast for preliminary estimations

−Grasp the damage level

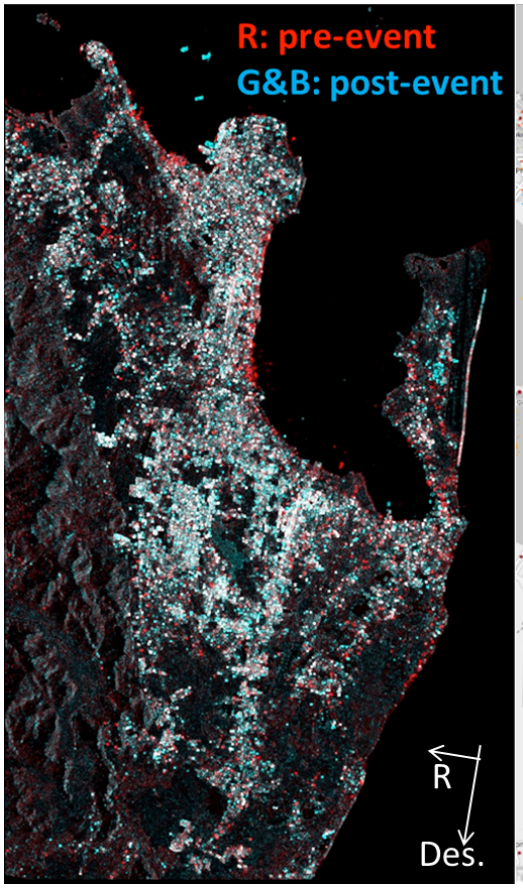
Limitations

−Only work in urban area

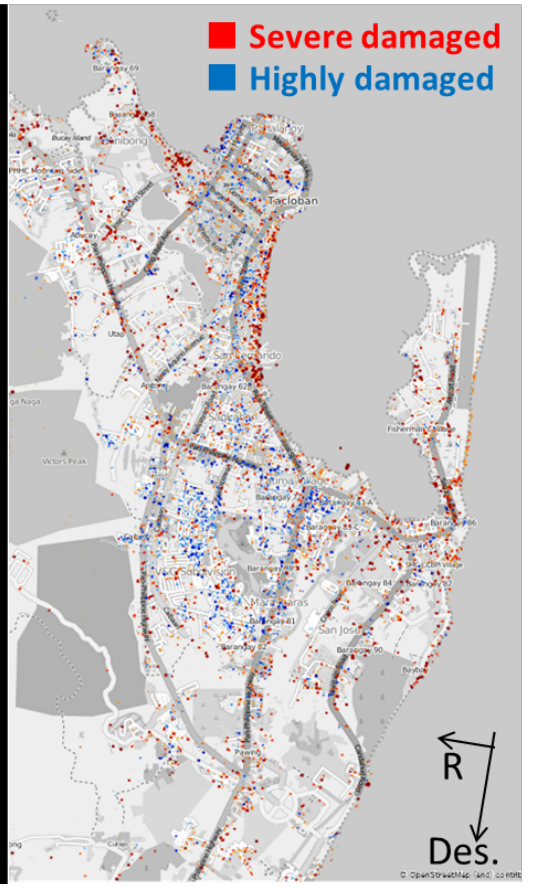
−Difficult for small houses

Published on

Liu, W., M. Matsuoka, B. Adriano, E. Mas, S. Koshimura (2014) "Damage detection due to the Typhoon Haiyan from high resolution SAR images" *Proceedings of the International Geoscience and Remote Sensing Symposium IGARSS 2014 and 35th Canadian Symposium on Remote Sensing CSRS, Quebec, Canada, 2014.*



Color composite of the pre- and post-event *UI*

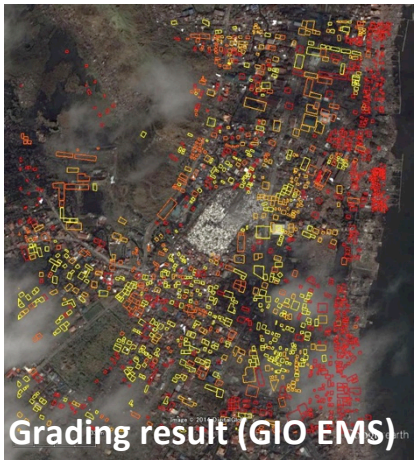


Damage areas extracted by *UI* changes ($|D_{UI}| > 1.5$)

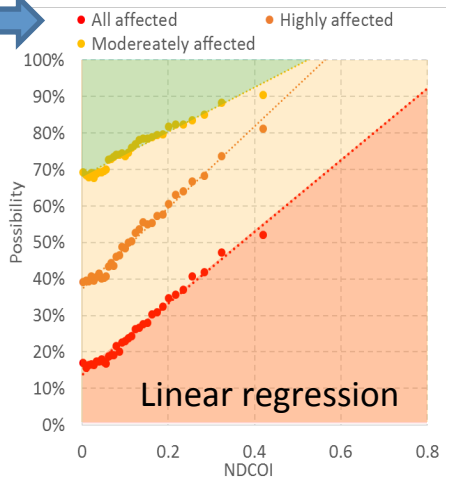
Classification of Building Damage Levels using NDCOI in COSMO-SkyMed Images

■ Totally affected (3,206 buildings)
■ Highly affected (1,101 buildings)
■ Moderately affected (733 buildings)
■ Non or possibly affected (1,082 buildings)

Training data

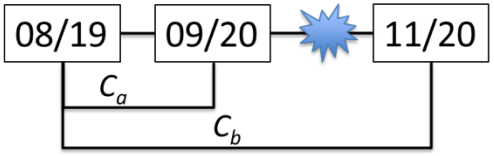


NDCOI model



Method

Normalized difference correlation coefficient index (NDCOI) Model is built for classifying the damage level of individual buildings, by introducing the visual interpreted grading results.

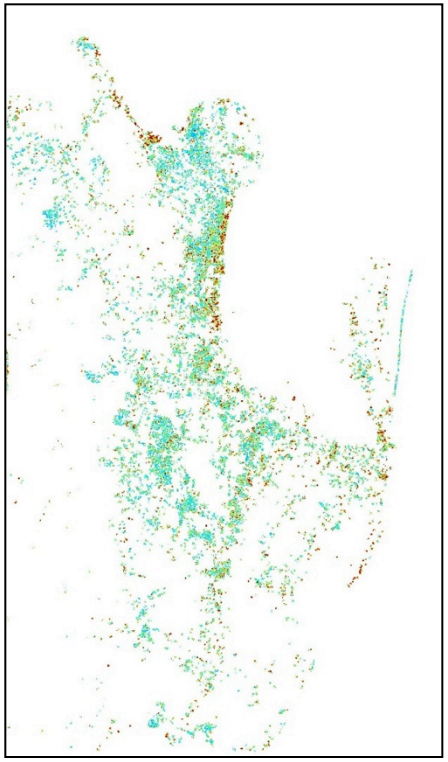


$(-1 \le NDCOI \le 1)$

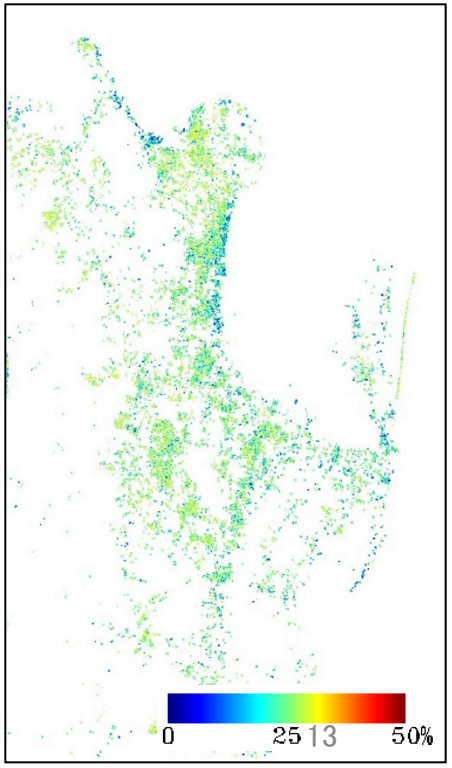
$C_{a,b}$: correlation coefficients

$$NDCOI = \frac{(C_a + 1) - (C_b + 1)}{(C_a + 1) + (C_b + 1)}$$

Possibility of totally affected



Possibility of non or possibly affected



Advantages

−Possibility of the different damage levels can be calculated for each individual building

−The model can be applied to other areas easily

Limitations

−Training data are necessary

−Two pre-event images are needed at least

Published on

Liu, W., M. Matsuoka, B. Adriano, E. Mas, S. Koshimura (2014) "Damage detection due to the Typhoon Haiyan from high resolution SAR images" *Proceedings of the International Geoscience and Remote Sensing Symposium IGARSS 2014 and 35th Canadian Symposium on Remote Sensing CSRS, Quebec, Canada, 2014.*

Phase-based change detection analysis for damage estimation

Method

Phase-based only correlation (POC) for accurate image matching. POC is the 2D Inverse Discrete Fourier Transform (2D IDFT) of the cross-phase spectrum.

$$\hat{R}_{FG}(k_1,k_2) = \frac{F(k_1,k_2)\overline{G(k_1,k_2)}}{|F(k_1,k_2)\overline{G(k_1,k_2)}|} = e^{j\theta(k_1,k_2)}$$

$$\hat{r}_{fg}(n_1,n_2) = \begin{cases} 1 & \text{if } n_1 = n_2 = 0 \\ 0 & \text{otherwise} \end{cases}$$

Advantages

−High accuracy on image matching compared to ordinary correlations.

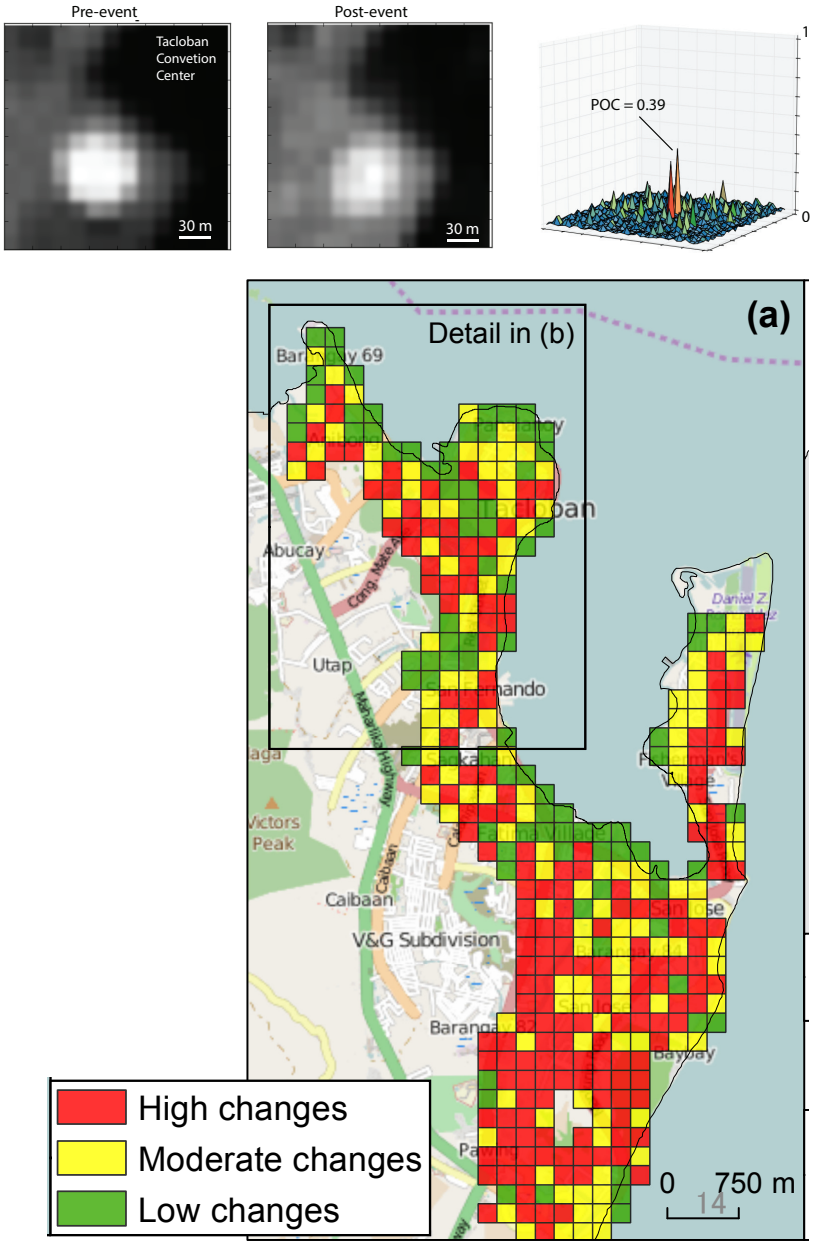
Limitations

−Building damage estimation depends on image resolution. Underestimations result from building representation in low resolution images.

−If applied in optical images, cloud visibility can lead to errors.

Published on

Adriano, B., H. Gokon, E. Mas, S. Koshimura, W. Liu, M. Matsuoka (2014a) "Extraction of damaged areas due to the 2013 Haiyan typhoon using ASTER data" *Proceedings of the International Geoscience and Remote Sensing Symposium IGARSS 2014 and 35th Canadian Symposium on Remote Sensing CSRS, Quebec, Canada, 2014.*



Images used and acquisition time

Type	Sensor	Date	Availability	Application in this project
Pre-	Google Earth (RGB)	23 Feb. 2012	Free	Damage Est.
	ASTER (VNIR)	01 Jun. 2008	Purchased	Inund. Mapp.
	COSMO-SkyMed (CSK-1, SAR)	7 & 19 Aug. 2013	Purchased	Damage Est.
	ThaiChote(THEOS) (TH1, RGB-NIR)	29 Aug. 2013	Purchased	Damage Est.
	COSMO-SkyMed (CSK-1, SAR)	20 Sep. 2013	Purchased	Damage Est.
	Landsat-7 ETM+	28 Oct. 2013	Free	Inund. Mapp.
Post-	Digital Globe [in Google Earth] (RGB)	13 Nov. 2013	Free	Damage Est.
	Landsat-7 ETM+	13 Nov. 2013	Free	Inund. Mapp.
	ThaiChote (THEOS)(TH1, RGB-NIR)	13 Nov. 2013	Purchased	Damage Est.
	ASTER (VNIR)	15 Nov. 2013	Purchased	Inund. Mapp.
	COSMO-SkyMed (CSK-3, SAR)	20 Nov. 2013	Purchased	Damage Est.

Tacloban city was hit by Typhoon Haiyan on 8 Nov. 2013. In this particular case after 5 days damage information could be grasp in the wide affected areas. Less days are possible!

Publications

1. Mas E., J.D. Bricker, S. Kure, B. Adriano, C.J. Yi, A. Suppasri, and S. Koshimura (2015). "Field survey report and satellite image interpretation of the 2013 Super Typhoon Haiyan in the Philippines" *Natural Hazards and Earth System Sciences (in press)*
2. Mas E., S. Kure, J.D. Bricker, B. Adriano, C.J. Yi, A. Suppasri, and S. Koshimura (2014). "Field survey and damage inspection after the 2013 Typhoon Haiyan in The Philippines" *Journal of Japan Society of Civil Engineers, Ser. B2 (Coastal Engineering), Vo. 70, No.2, pp.I_1451-I_1455.*
3. Adriano, B., H. Gokon, E. Mas, S. Koshimura, W. Liu, M. Matsuoka (2015) "Mapping of damaged areas at Tacloban city, Philippines due to the 2013 Super Typhoon Haiyan using moderate-resolution satellite images" *Coastal Engineering Journal, Special Issue (submitted).*
4. Adriano, B., H. Gokon, E. Mas, S. Koshimura, W. Liu, M. Matsuoka (2014a) "Extraction of damaged areas due to the 2013 Haiyan typhoon using ASTER data" *Proceedings of the International Geoscience and Remote Sensing Symposium IGARSS 2014 and 35th Canadian Symposium on Remote Sensing CSRS, Quebec, Canada, 2014.*
5. Adriano B., H. Gokon, E. Mas, S. Koshimura, W. Liu, M. Matsuoka (2014b). "Application of a phase-based correlation Method to extract damage areas, case of Study: 2013 Haiyan Typhoon" *Proceedings of the 14th Japan Earthquake Engineering Symposium, Chiba, Japan.*
6. Adriano, B., E., Mas, H. Gokon, S. Koshimura (2015). "Impact of the 2013 Haiyan event inferred from the change of SAR intensity images" *International Conference on Building Resilience and Developing Sustainability, Cordillera Studies Center, University of the Philippines Baguio. Baguio City, Philippines.*
7. Shinohara, T., W. Liu, M. Matsuoka (2014). "Spectral Mixture Analysis for Typhoon-Induced Inundation Mapping in Negros and Cebu Islands, the Philippines" *Proceedings of International Symposium on Remote Sensing 2014, B08-3, 4p., CD-ROM, 2014.4.*
8. 篠原崇之, リュウ ウェン, 松岡昌志 (2014) "RISAT-1/SARとLandsat/ETM+を用いた台風Haiyanによる浸水域の抽出" *日本リモートセンシング学会第56回学術講演会論文集, pp.23-26, 2014.5.*
9. Liu, W., M. Matsuoka, B. Adriano, E. Mas, S. Koshimura (2014) "Damage detection due to the Typhoon Haiyan from high resolution SAR images" *Proceedings of the International Geoscience and Remote Sensing Symposium IGARSS 2014 and 35th Canadian Symposium on Remote Sensing CSRS, Quebec, Canada, 2014.*
10. リュウ ウェン, 松岡昌志, アドリアノ ブルーノ, マス エリック, 越村俊一 (2014) "COSMO-SkyMed強度画像を用いたフィリピン台風被害の検出" *日本リモートセンシング学会第56回学術講演会論文集, pp.73-74, 2014.5.*
11. Nakmuenwai, P., F. Yamazaki (2014) "Damage investigation for the 2013 Typhoon Haiyan in the Philippines using multi-temporal COSMO-SkyMed images" *Proceedings of the IEEE 2014 International Geoscience and Remote Sensing Symposium, Quebec, Canada, 2261-2264, 2014.7*

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Presentation Outline:

- Background
- Activities
- Coverage Areas
- Image Sources
- Image Processing
- Feature Extraction
- Field Verification/Identification
- Geospatial Database

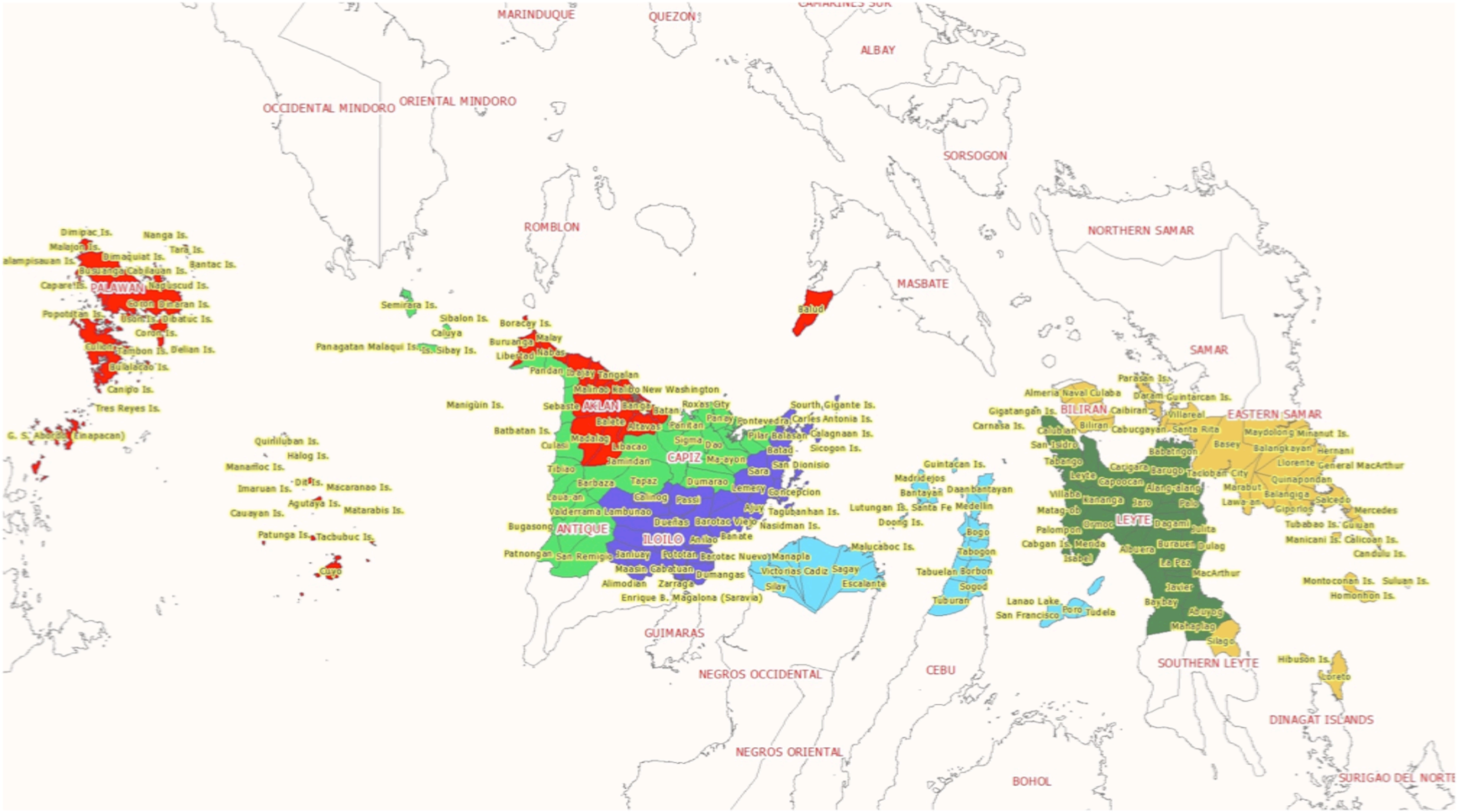
Background

- Unified Mapping Project (UMP) –
  - production of large scale topographic and orthoimage base maps for the entire country;
  - will serve as common base maps for various thematic applications
  - Typhoon Yolanda Corridor as priority area through MOA with Office of the Presidential Assistance for Rehabilitation and Recovery (OPARR)

Activities

- Image Processing
- Feature Extraction
- Field Verification/Identification
- Map Printing

Coverage Areas:



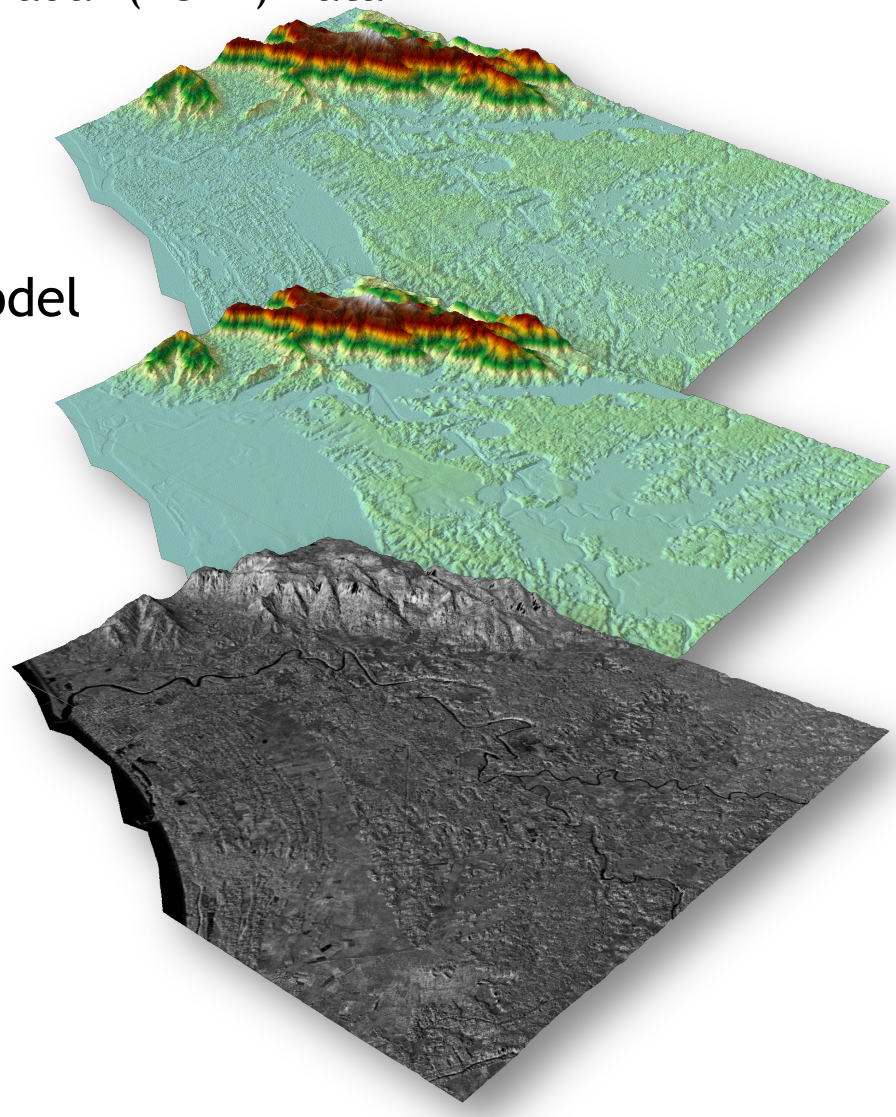
Yolanda affected areas identified by OPARR

11 Cities & 160 Municipalities, approx. 2,365,500 has.

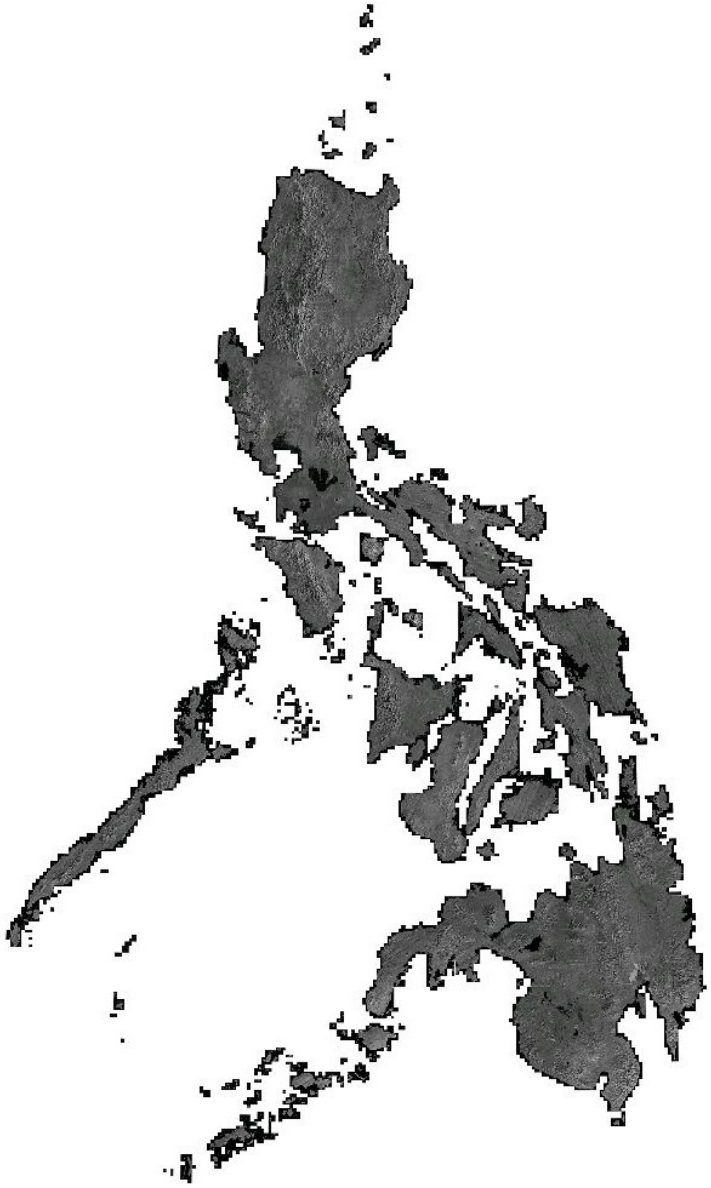
Remote Sensing Data Utilized

1) Interferometric Synthetic Aperture Radar (IfSAR) Data

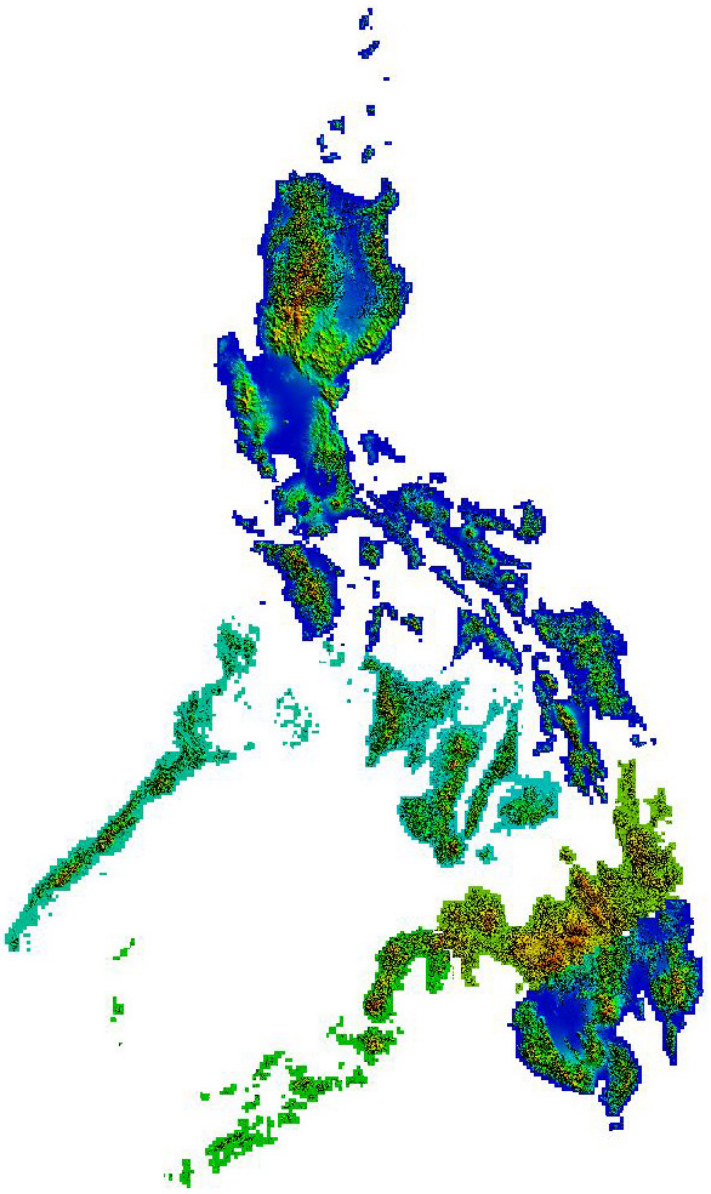
- Acquired 2013
- Nationwide Coverage
- High Resolution Digital Elevation Model
    - Digital Surface Model (DSM)
    - Digital Terrain Model (DTM)
- Orthorectified Radar Image (ORI)
- 5.0m Resolution DEM
- 0.625m Resolution ORI
- 1.0m RMSE Vertical Accuracy
- 2.0m RMSE Horizontal Accuracy



UNIFIED MAPPING PROJECT
IFSAR ORTHORECTIFIED RADAR IMAGE (ORI)



UNIFIED MAPPING PROJECT
IFSAR DIGITAL ELEVATION MODEL (DEM)



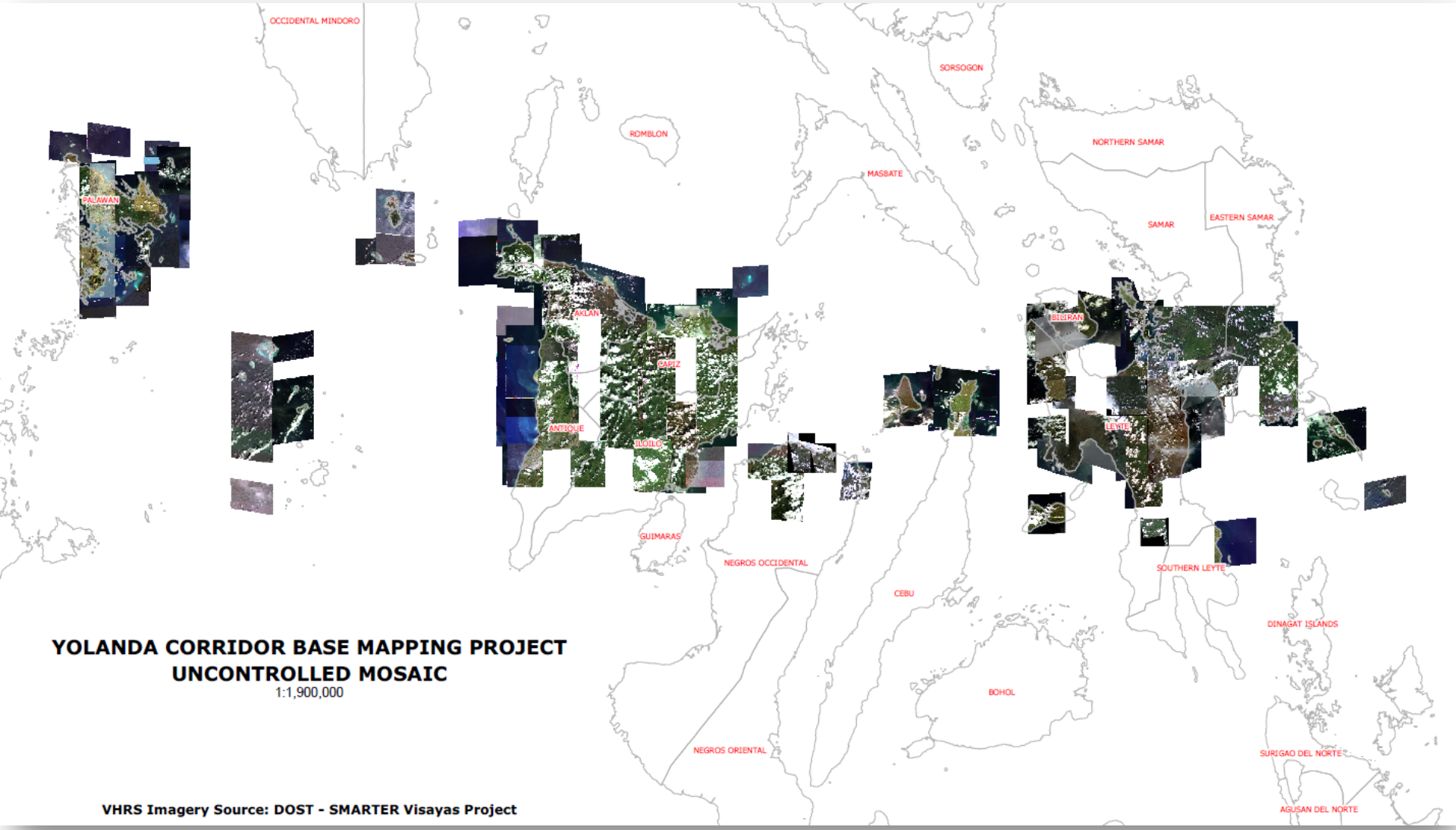
Remote Sensing Data Utilized

2) Very High Resolution Satellite Images

- Pleiades
  - through MOA with JICA

- World View 2 (50 cm resolution)
  - from DOST (satellite tasking for Yolanda corridor)
  - 2nd license agreement with Dept. of Agriculture

Image Source:



WorldView 2 (Post Yolanda)
Satellite Tasking

Image Source:

Pleiades Satellite Images Provided by JICA

Leyte & Eastern Samar Coastline

Extended License From DA

- Covering Entire Country
- WorldView 2
- GeoEye
- Archive Images(from 2010 to 2014)

Image Processing:

Raw VHRS Imagery
Digital Elevation Model

+

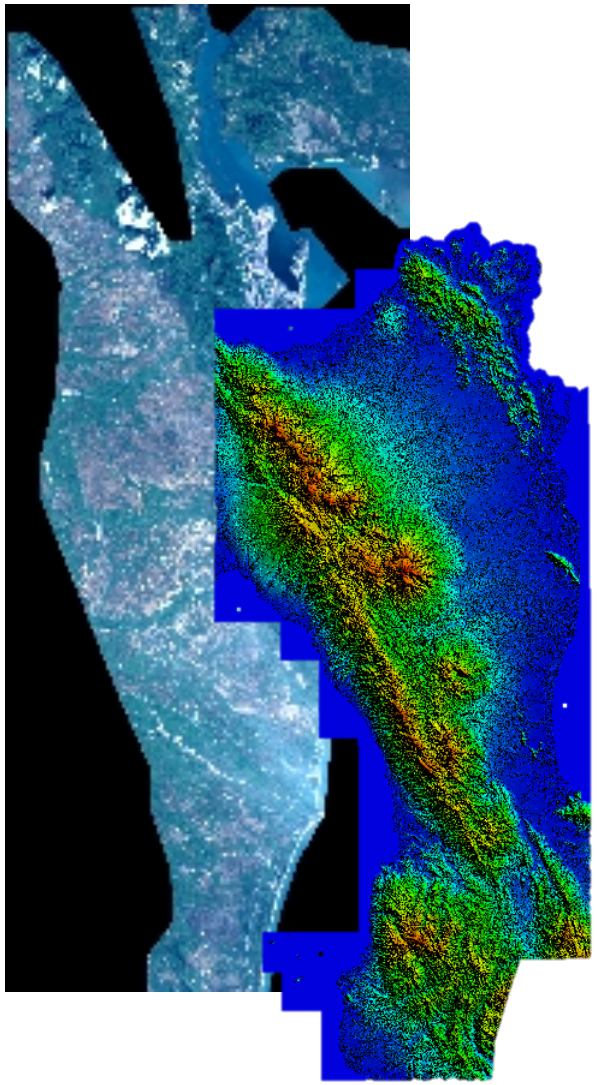
Ground Control
Points

+

ORTHORECTIFY

=

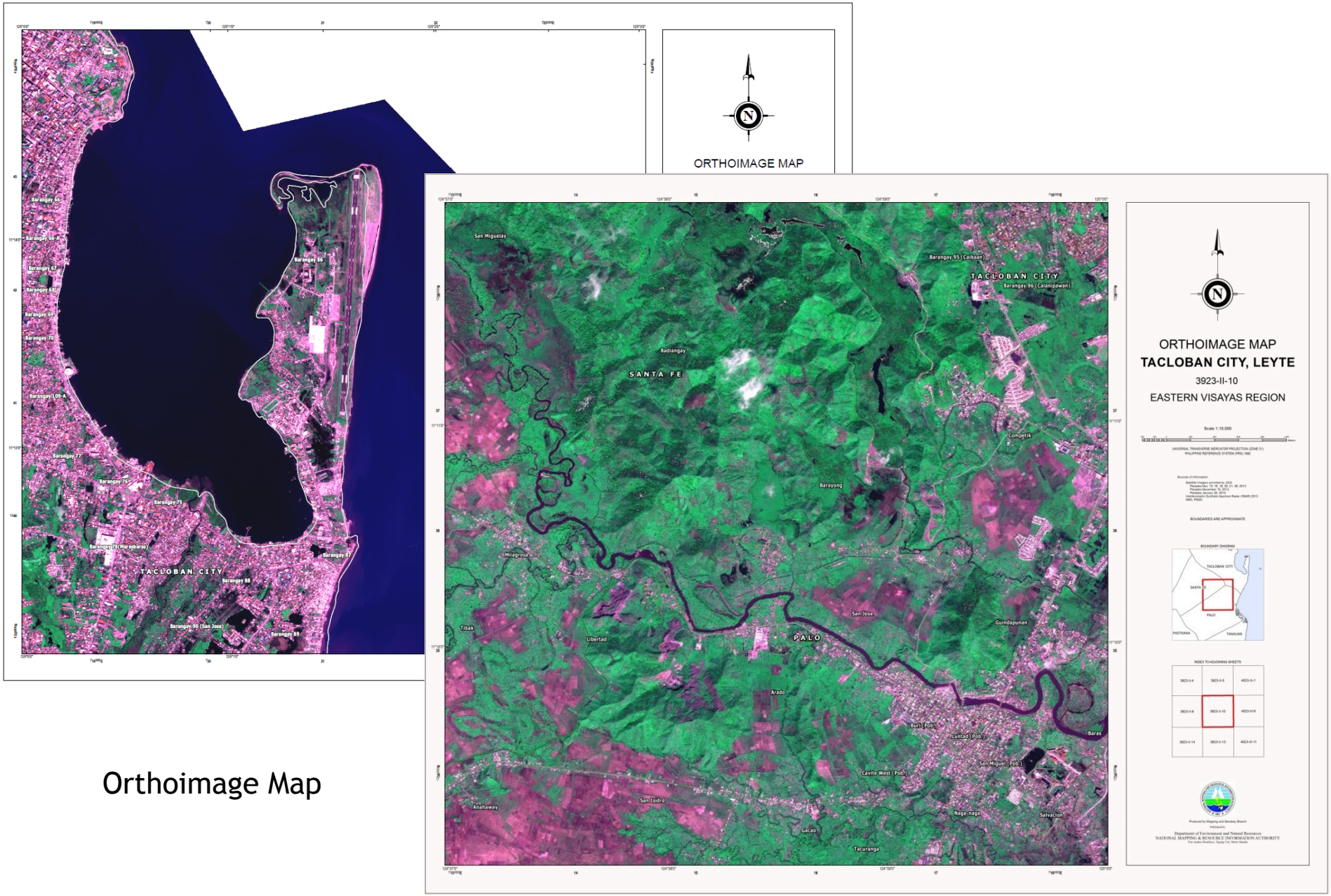
Orthoimage
Pansharpened
Natural Color



ORI

SURVEY

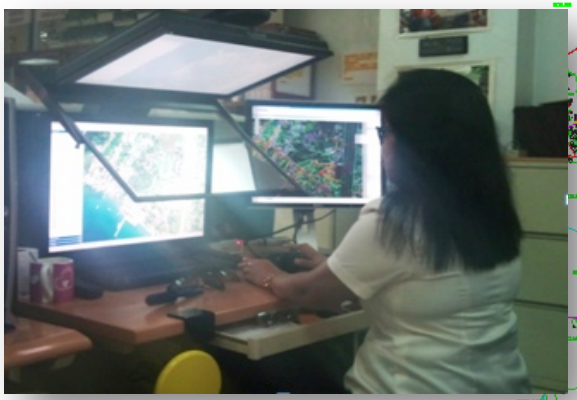
Image Processing:



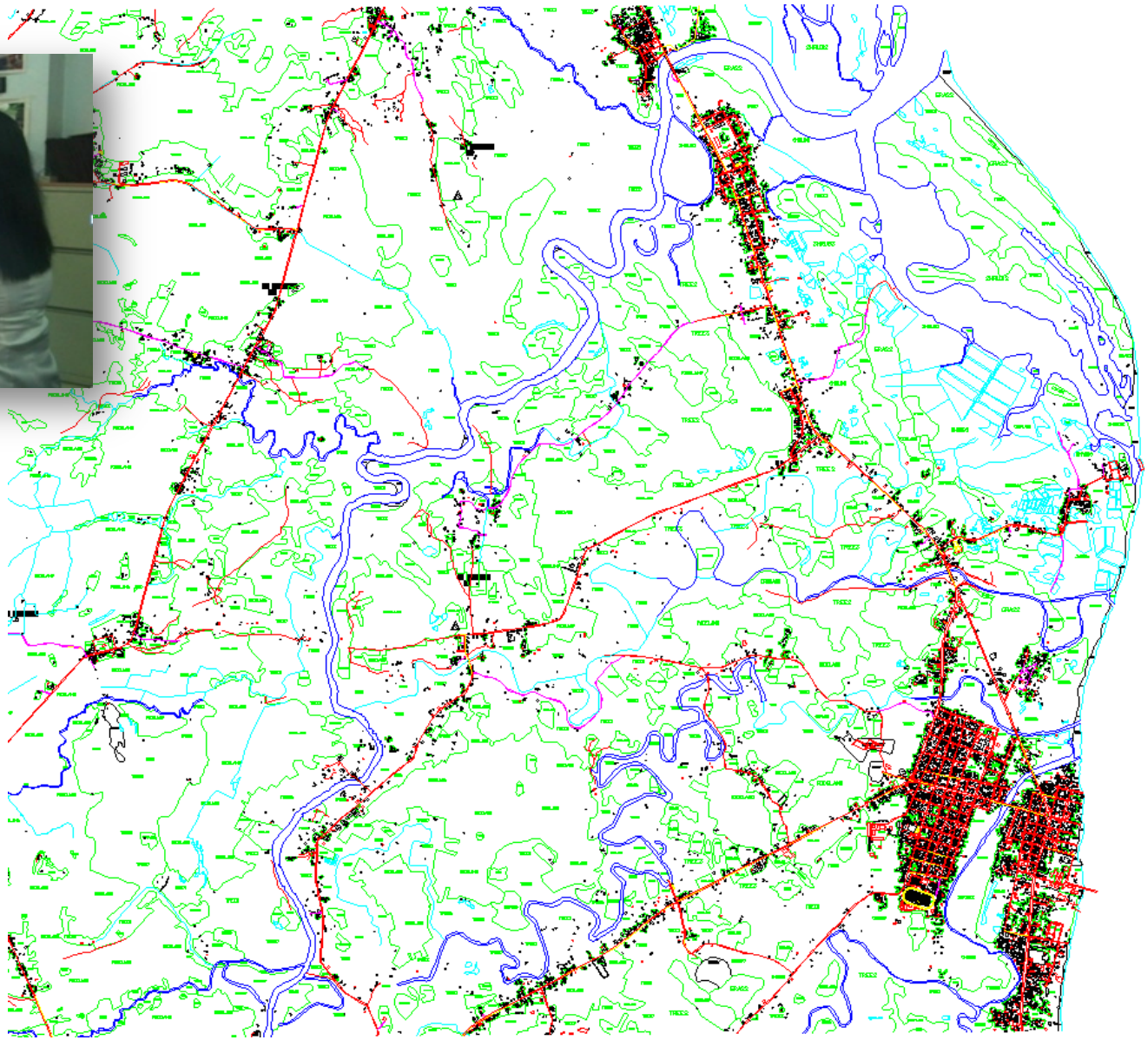
Orthoimage Map

Feature Extraction:

Planimetric Compilation



- Road Network
- River Network
- Buildings / Houses
- Land Cover



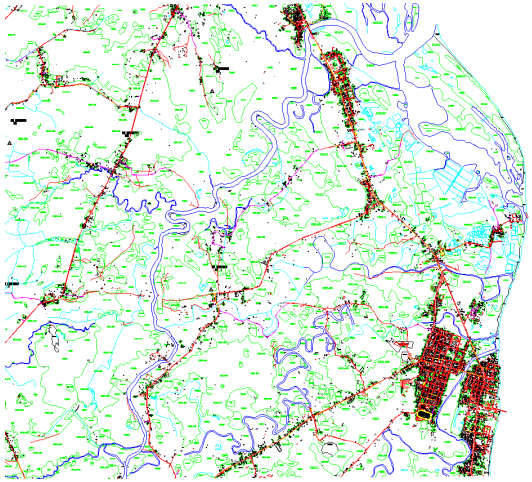
Field Verification/Validation:

Verification & Gathering of Secondary Information

ROAD / TRANSPORTATION
Names of roads/street names, railways, railway stations
Road surface classification as to: Concrete, Asphalt, Earth or Gravel
WATER AND ASSOCIATED FEATURES
Name of river, creek, canal, and lagoon
Name of lake, other water bodies
BRIDGE / TUNNEL
Name of bridges / tunnels
BUILDING
School / University / College
Barangay Hall / Health Center
Church / Chapel / Mosque / Mission / Other religion
Hospital
Police station / military camp – reservation
Other government agencies
Prominent Building / Establishment / Commercial / Industrial
Gasoline Station
Lighthouse
SUBDIVISION / VILLAGE
Name of subdivision / Village / Sitio / Settlement
ADMINISTRATIVE AND GEOGRAPHICAL NAMES, ADMINISTRATIVE BOUNDARIES
Provincial boundary / Province name
City or Municipal boundary / City or Municipal name
Barangay boundary (if available) / Barangay name
VEGETATION
Vegetation Cover, i.e. rice field, crop land / agricultural land, orchard, mangrove, broadleaf, mixed scrub & broadleaf, grass, swamp / marsh, coconut, bushes / scrub
Others
Cemetery / Memorial Park
Pier / Jetty / Port
Bus Terminal / Airport
Monument name / Landmark / Park / Recreation Areas
Mountain Name
Agriculture Farm / Hatchery
Tower / Radio / Communication / Cell Site Name

Geospatial Database:

Extracted Features



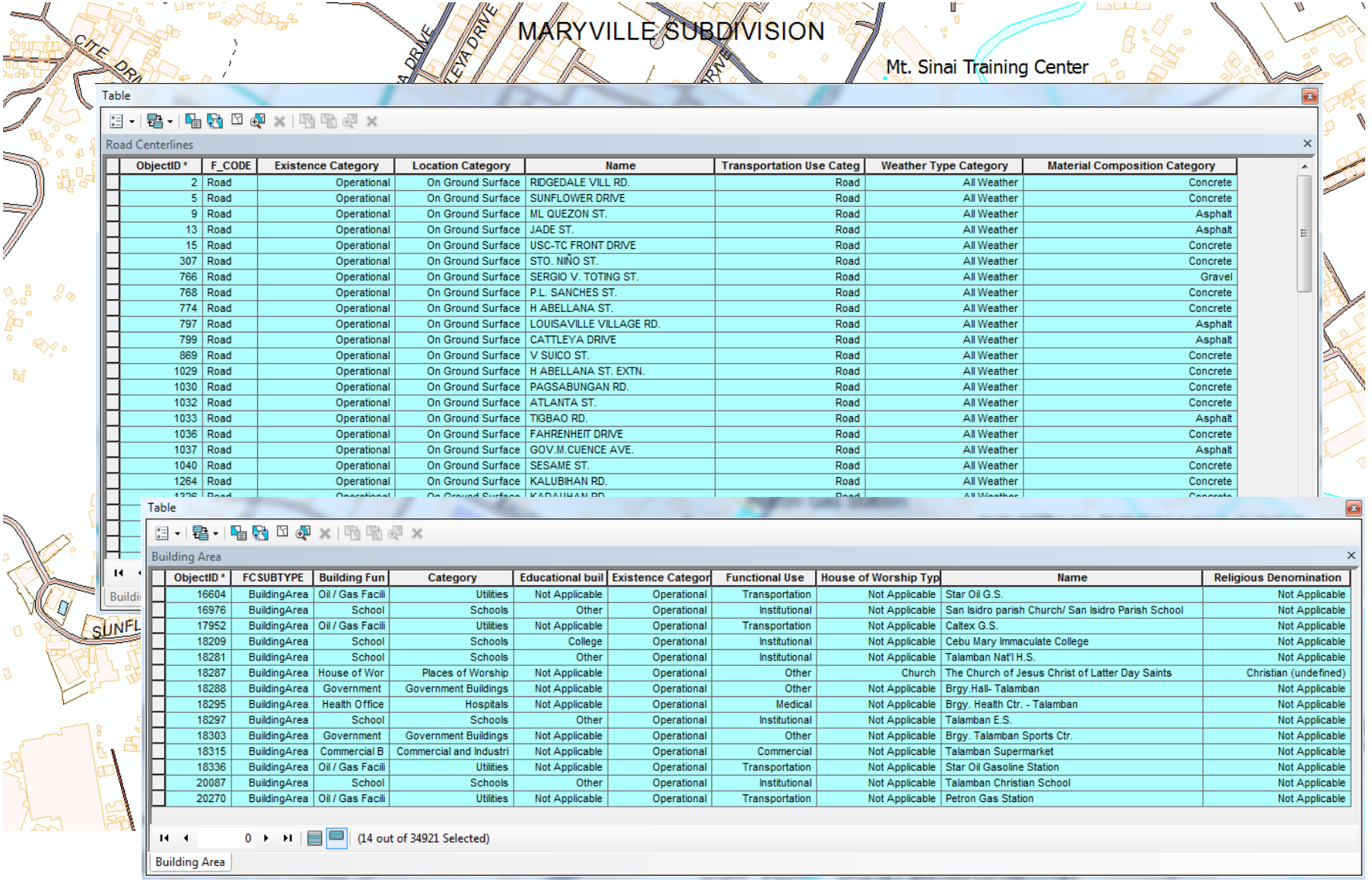
+ Field Data =

Geodatabase

- Data Conversion
- Quality Control
- Topology Check
- Data Validation
- NAMRIA Topographic Line Map

Geospatial Database:

- Spatial data with attributes stored in a database



Road Centerlines

ObjectID *	F_CODE	Existence Category	Location Category	Name	Transportation Use Categ	Weather Type Category	Material Composition Category
2	Road	Operational	On Ground Surface	RIDGEDALE VILL RD.	Road	All Weather	Concrete
5	Road	Operational	On Ground Surface	SUNFLOWER DRIVE	Road	All Weather	Concrete
9	Road	Operational	On Ground Surface	ML QUEZON ST.	Road	All Weather	Asphalt
13	Road	Operational	On Ground Surface	JADE ST.	Road	All Weather	Asphalt
15	Road	Operational	On Ground Surface	USC-TC FRONT DRIVE	Road	All Weather	Concrete
307	Road	Operational	On Ground Surface	STO. NIÑO ST.	Road	All Weather	Concrete
766	Road	Operational	On Ground Surface	SERGIO V. TOTING ST.	Road	All Weather	Gravel
768	Road	Operational	On Ground Surface	P.L. SANCHES ST.	Road	All Weather	Concrete
774	Road	Operational	On Ground Surface	H ABELLANA ST.	Road	All Weather	Concrete
797	Road	Operational	On Ground Surface	LOUISAVILLE VILLAGE RD.	Road	All Weather	Asphalt
799	Road	Operational	On Ground Surface	CATTLEYA DRIVE	Road	All Weather	Asphalt
869	Road	Operational	On Ground Surface	V SUICO ST.	Road	All Weather	Concrete
1029	Road	Operational	On Ground Surface	H ABELLANA ST. EXTN.	Road	All Weather	Concrete
1030	Road	Operational	On Ground Surface	PAGSABUNGAN RD.	Road	All Weather	Concrete
1032	Road	Operational	On Ground Surface	ATLANTA ST.	Road	All Weather	Concrete
1033	Road	Operational	On Ground Surface	TIGBAO RD.	Road	All Weather	Asphalt
1036	Road	Operational	On Ground Surface	FAHRENHEIT DRIVE	Road	All Weather	Concrete
1037	Road	Operational	On Ground Surface	GOV.M.CUENCE AVE.	Road	All Weather	Asphalt
1040	Road	Operational	On Ground Surface	SESAME ST.	Road	All Weather	Concrete
1264	Road	Operational	On Ground Surface	KALUBIHAN RD.	Road	All Weather	Concrete

Building Area

ObjectID *	FCSUBTYPE	Building Fun	Category	Educational buil	Existence Categor	Functional Use	House of Worship Typ	Name	Religious Denomination
16604	BuildingArea	Oil / Gas Facili	Utilities	Not Applicable	Operational	Transportation	Not Applicable	Star Oil G.S.	Not Applicable
16976	BuildingArea	School	Schools	Other	Operational	Institutional	Not Applicable	San Isidro parish Church/ San Isidro Parish School	Not Applicable
17952	BuildingArea	Oil / Gas Facili	Utilities	Not Applicable	Operational	Transportation	Not Applicable	Caltex G.S.	Not Applicable
18209	BuildingArea	School	Schools	College	Operational	Institutional	Not Applicable	Cebu Mary Immaculate College	Not Applicable
18281	BuildingArea	School	Schools	Other	Operational	Institutional	Not Applicable	Talamban Nat'l H.S.	Not Applicable
18287	BuildingArea	House of Wor	Places of Worship	Not Applicable	Operational	Other	Church	The Church of Jesus Christ of Latter Day Saints	Christian (undefined)
18288	BuildingArea	Government	Government Buildings	Not Applicable	Operational	Other	Not Applicable	Brgy.Hall- Talamban	Not Applicable
18295	BuildingArea	Health Office	Hospitals	Not Applicable	Operational	Medical	Not Applicable	Brgy. Health Ctr. - Talamban	Not Applicable
18297	BuildingArea	School	Schools	Other	Operational	Institutional	Not Applicable	Talamban E.S.	Not Applicable
18303	BuildingArea	Government	Government Buildings	Not Applicable	Operational	Other	Not Applicable	Brgy. Talamban Sports Ctr.	Not Applicable
18315	BuildingArea	Commercial B	Commercial and Industri	Not Applicable	Operational	Commercial	Not Applicable	Talamban Supermarket	Not Applicable
18336	BuildingArea	Oil / Gas Facili	Utilities	Not Applicable	Operational	Transportation	Not Applicable	Star Oil Gasoline Station	Not Applicable
20087	BuildingArea	School	Schools	Other	Operational	Institutional	Not Applicable	Talamban Christian School	Not Applicable
20270	BuildingArea	Oil / Gas Facili	Utilities	Not Applicable	Operational	Transportation	Not Applicable	Petron Gas Station	Not Applicable

(14 out of 34921 Selected)

Production of Harmonized Multi-Hazard Maps for Yolanda-Affected Areas

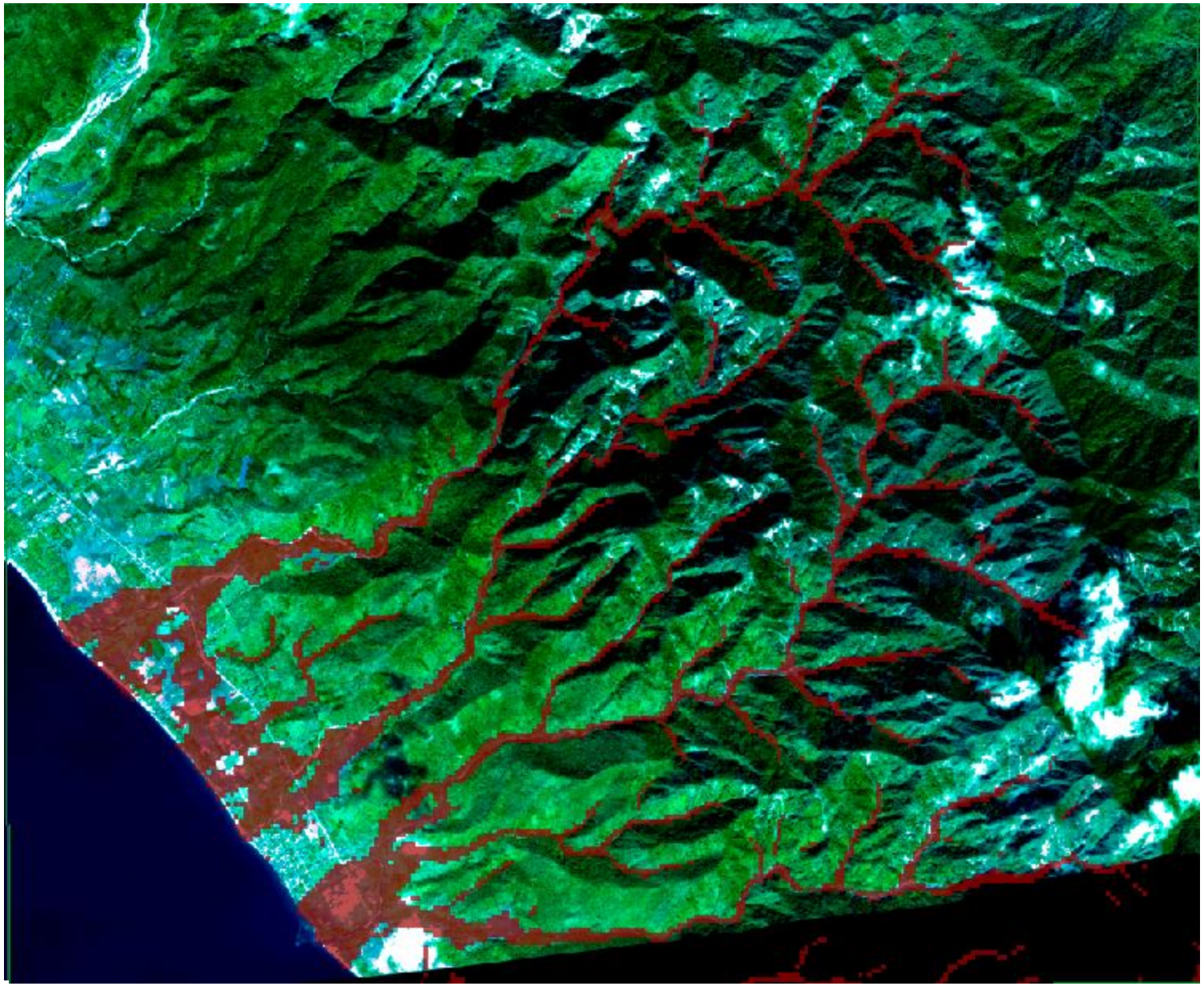
- Joint DENR-DILG-DND-DPWH-DOST
  Memorandum Circular No. 2014-1, dated
  05 November 2014;

- NAMRIA tasked to integrate all hazard maps and make available to all government agencies concerned the multi-hazard maps at scale 1:10,000;

- NAMRIA to establish a segment in the Geoportal for multihazard maps for access of all concerned;

- Status: Harmonized Multi-Hazard Maps continuously being integrated and uploaded in the Geoportal

Portion of Baybay, Leyte (100-Year Flood)



1:40,000

1:10,000

Thank you!

Republic of the Philippines
Department of Environment and Natural Resources
NATIONAL MAPPING AND RESOURCE INFORMATION AUTHORITY
MAPPING AND GEODESY BRANCH
PHOTOGRAMMETRY DIVISION
Lawton Avenue, Fort Andres Bonifacio, 1634 Taguig City