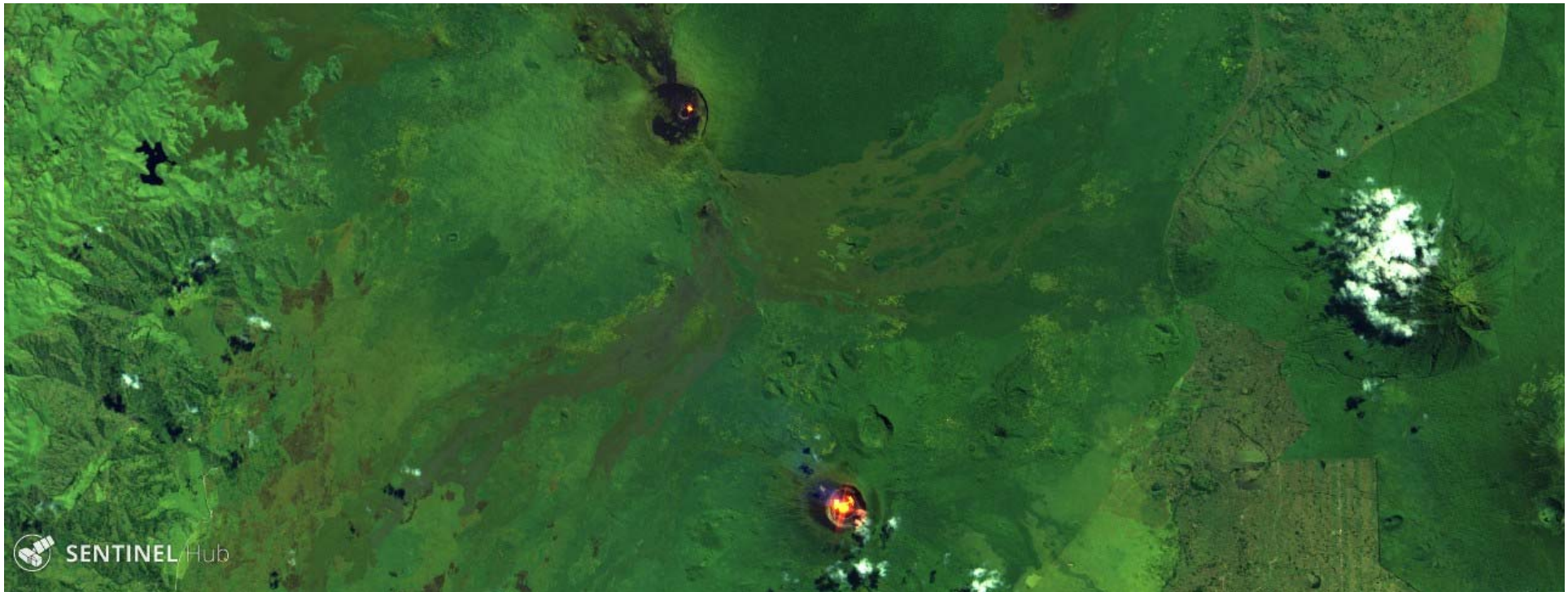


Virunga Supersite: Implementation status, Preliminary results and future challenges



Charles Balagizi
Goma Volcano Observatory



NAPOLI - ITALIA 2018
CITIES ON VOLCANOES 10

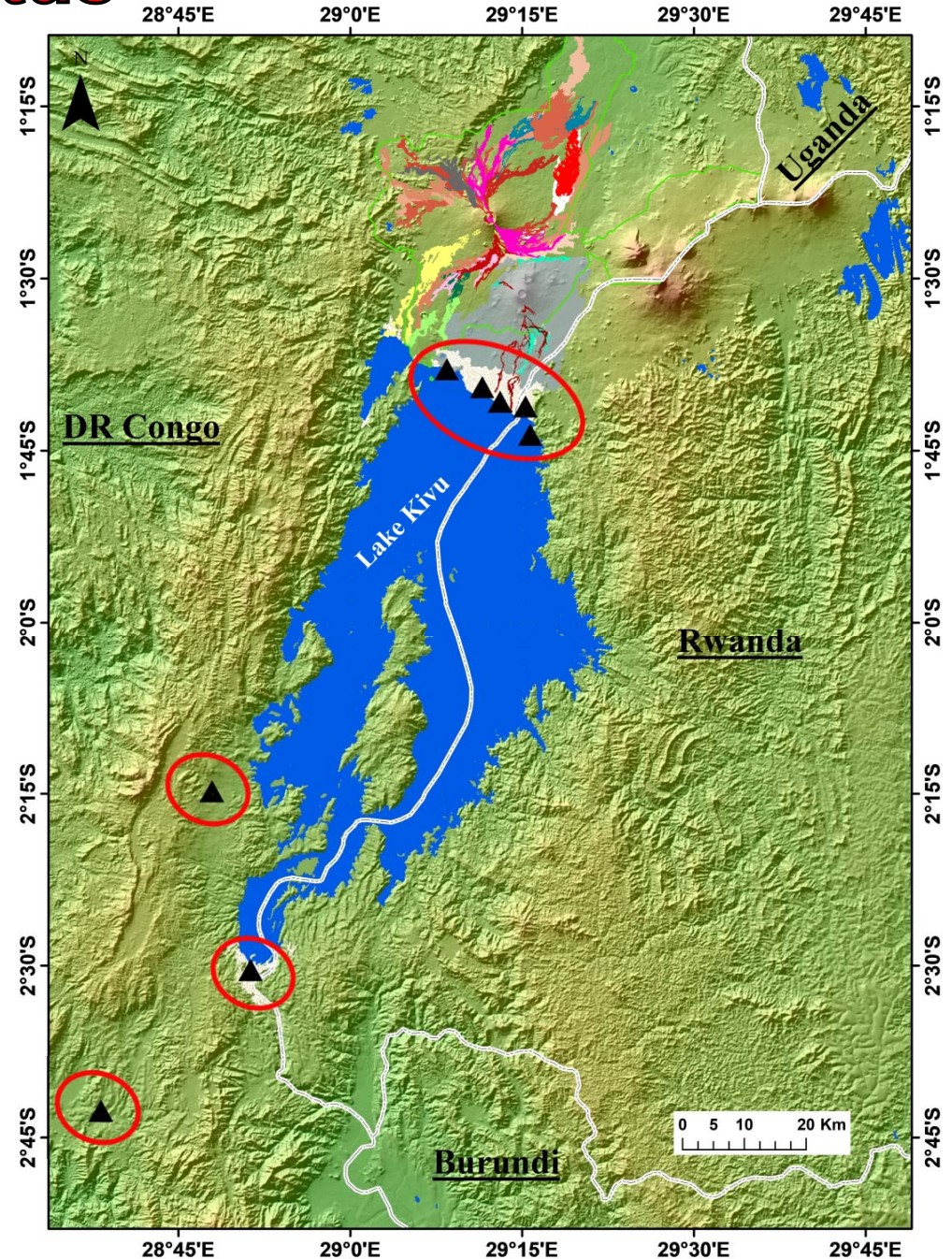


1. Implementation Status

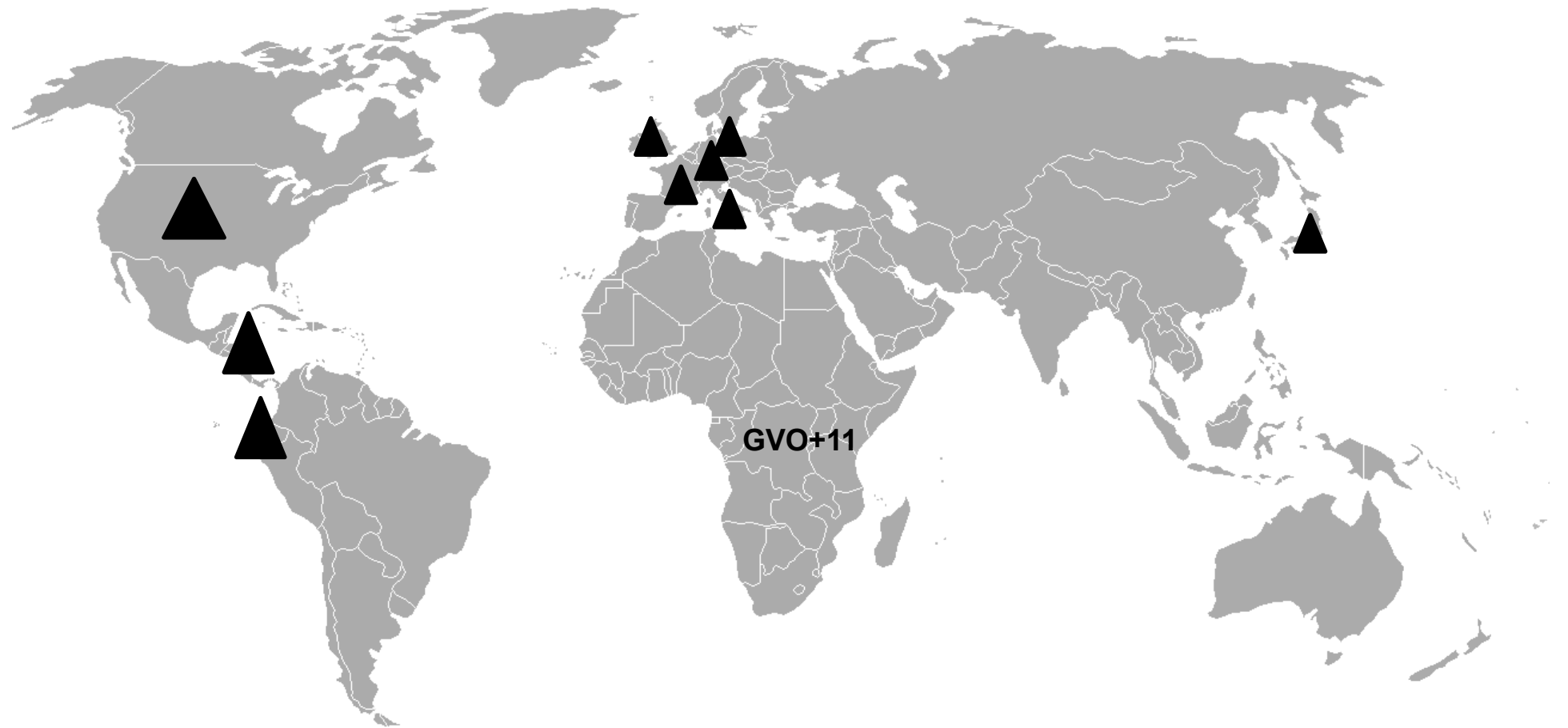
Local-Regional network

The Virunga supersite is now a network of local scientists from 7 institutions (Universities and Research Centers)

- 5 in DR Congo
- 2 in Rwanda



International network



+ 5 international agencies

2. Preliminary results

2.1. Copernicus: Emergency and Management Service Risk & Recovery Mapping

The screenshot shows the Copernicus Emergency Management Service - Mapping website. The header includes the European Commission logo and the Copernicus logo with the tagline "Europe's eyes on Earth". The main navigation bar contains links for Home, What is Copernicus, EMS - Mapping, EMS - Early Warning System, and News. A search bar is also present. The main content area features a news article titled "EMSN047: Volcanic risk in Democratic Republic of the Congo". The article includes details such as Event Type (Other (Volcanic hazard)), Activation Time (UTC) (2018-03-30 00:00), Activation Status (Closed), and Affected Countries/Territories (Democratic Republic of the Congo). It also lists the Area Descriptor (Goma, Congo) and the Authorized User (European Commission, DG ECHO, Emergency Response and Coordination Center (ERCC) on behalf of Goma Volcano Observatory). A map of the Democratic Republic of the Congo is shown, highlighting the location of Goma. Below the map are social media sharing options for Twitter and GeoRSS. The article text describes the purpose of the mapping and the results of the assessment.

EMSN047: Volcanic risk in Democratic Republic of the Congo

Event Type: Other (Volcanic hazard)
Activation Time (UTC): 2018-03-30 00:00
Activation Status: Closed
Affected Countries/Territories:
Democratic Republic of the Congo
Area Descriptor: Goma, Congo
Authorized User: European Commission, DG ECHO, Emergency Response and Coordination Center (ERCC) on behalf of Goma Volcano Observatory

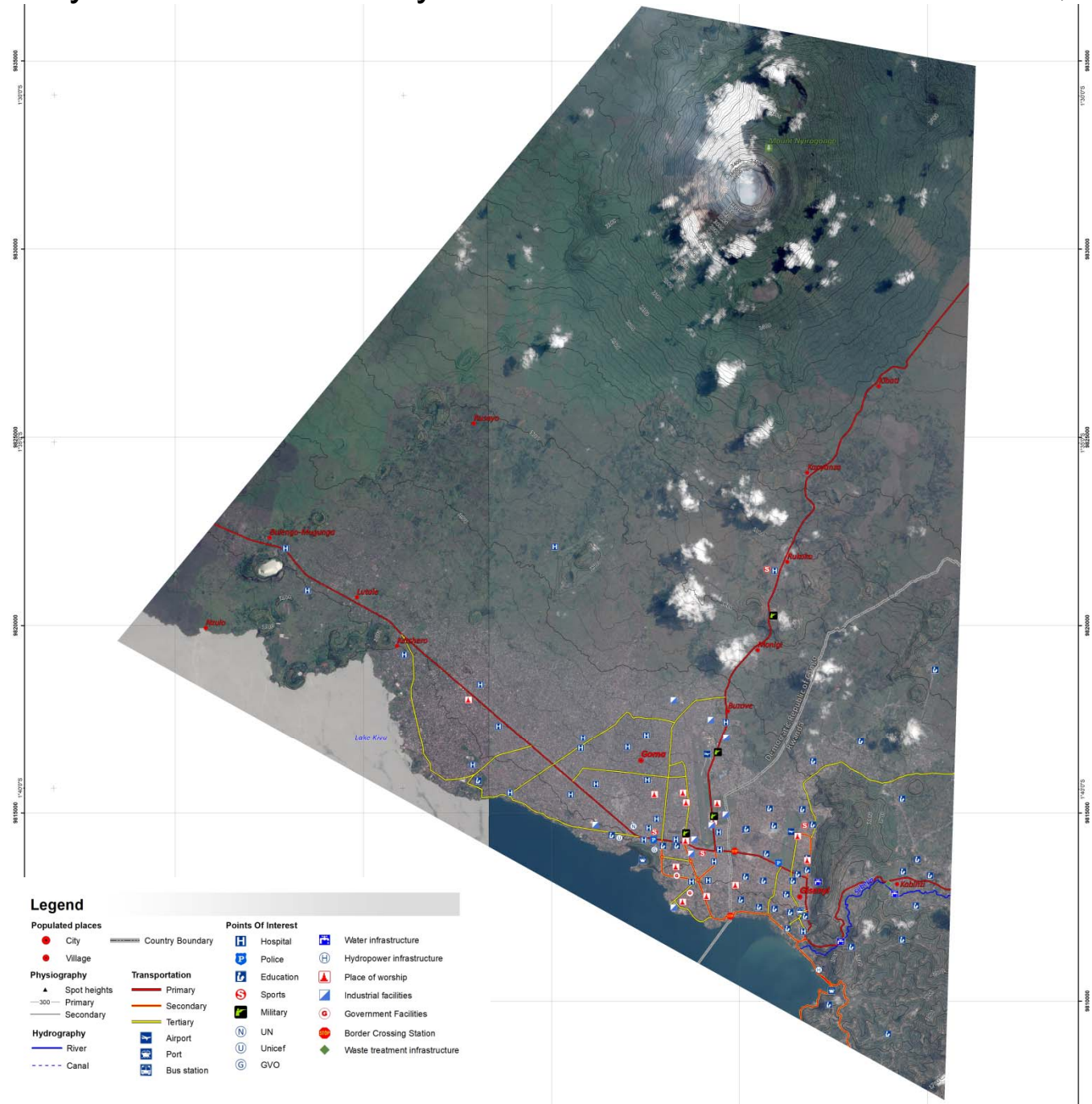
[Show Activation Overview](#)

The purpose of the requested mapping is to generate comprehensive knowledge through performing pre-disaster situation analysis, concerning a potential eruption of the Nyiragongo volcano located near to Goma, capital of the Democratic Republic of Congo (DRC).

The results refer to background information as well as to the assessment of the impact of a potential volcano activity on the surrounding urban agglomerations and infrastructures; detailed Digital Elevation Model (DEM), hazard, exposure and vulnerability. These products intend to support informed decision making of the involved stakeholders with reference to disaster preparedness and disaster management. An evacuation plan has also been produced.

The Copernicus successfully activated risk analyses with a focus on volcanic hazard, and produced:

1. Reference Map



Dissemination/Publication
 The products (maps) are available through the EMS Copernicus Portal at the following URL: <http://emergency.eu/mapping/risi-cfcomponents/47>.
 Delivery formats are GeoPDF, GeoJPEG and vectors (ESRI GDB format).
 No restrictions on the publication of the mapping apply.

Contact
 The map was produced under the Service Contract nr. 259811 of the European Commission) on 30/03/2018 by GEOAPIKONISIS (EL) – NOA (EL) – CIMA (IT) – TRE ALTAMIRA (ES).
 Name of the release inspector (quality control): JRC.
 E-mail: ems-risk-recovery-mapping@ec.europa.eu
<http://emergency.copernicus.eu/mapping>



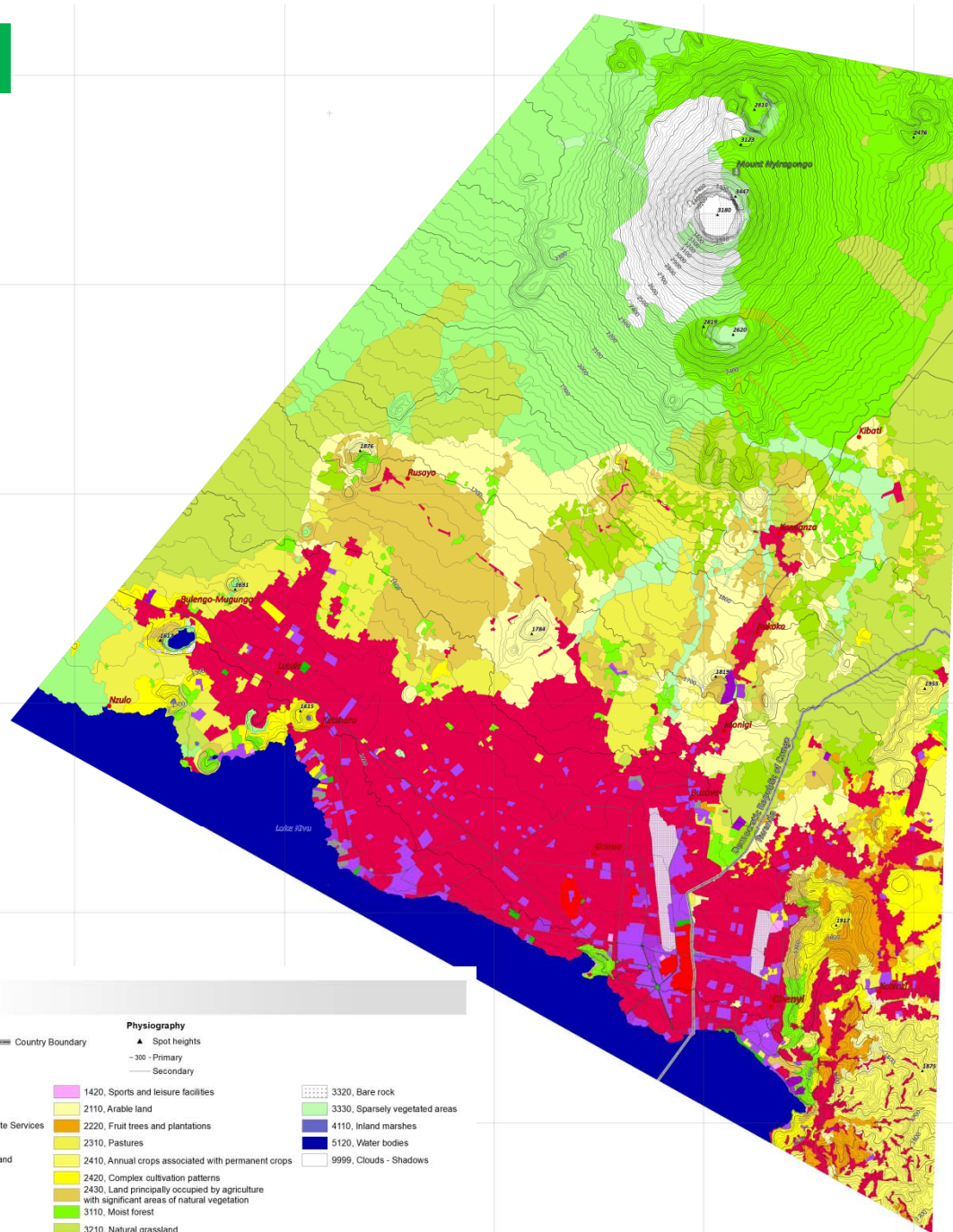
Glide Number: N/A Activation ID: EMSN-047
 Product N.: 01NYRAGONGO_v1, English

Nyiragongo - Democratic Republic of the Congo
Volcanic Risk Assessment
Reference Map - Overview
 Production date: 30/03/2018

Cartographic Information
 1:50,000 Full color A1, high resolution (300dpi)

Grid: WGS 84 / UTM zone 35S map coordinate system
 Tick marks: WGS 84 geographical coordinate system

2. Land Use and Land Cover Map



755000 81

Dissemination/Publication

The products (maps) are available through the EMS Copernicus Portal at the following URL:
<http://emergency.eu/mapping/list-of-components/047>
 Delivery formats are GeoPDF, GeoJPEG and vectors (ESRI GDB format).
 No restrictions on the publication of the mapping apply.

Contact

The map was produced (under the Service Contract nr. 259811 of the European Commission) on 30/03/2018 by GEOAPIKONISIS (EL) – NOA (EL) – CIMA (IT) – TRE ALTAMIRA (ES).
 Name of the release inspector (quality control): JRC.
 E-mail: ems-risk-recovery-mapping@jrc.ec.europa.eu
<http://emergency.copernicus.eu/mapping>



Glide Number: N/A

Activation ID: EMSN-047
 Product N.: 01NYIRAGONGO, v1, English

Nyriragongo - Democratic Republic of the Congo Volcanic Risk Assessment

Land Use and Land Cover Map - Overview

Production date: 30/03/2018

Cartographic Information

1:50.000

Full color A1, high resolution (300dpi)

0 0,5 1 2 3 4 Km N

Grid: WGS 84 / UTM zone 35S map coordinate system
 Tick marks: WGS 84 geographical coordinate system

29°5'0"E

735000

Legend

Populated places		Physiography		
● Town	▲ Spot heights	— Country Boundary	-300 - Primary	
● Village	— Secondary			
Land Use - Land Cover				
1110, Continuous Urban Fabric	1420, Sports and leisure facilities	3320, Bare rock		
1120, Discontinuous urban fabric	2110, Arable land	3330, Sparsely vegetated areas		
1211, Commercial Public and Private Services	2220, Fruit trees and plantations	4110, Inland marshes		
1212, Industry and Utilities	2310, Pastures	5120, Water bodies		
1221, Main roads and associated land	2410, Annual crops associated with permanent crops	9999, Clouds - Shadows		
1230, Port areas	2420, Complex cultivation patterns			
1240, Airports	2430, Land principally occupied by agriculture with significant areas of natural vegetation			
1310, Mineral extraction sites	3110, Moist forest			
1330, Construction sites	3210, Natural grassland			
1340, Abandoned land	3220, Bushes and Shrubs			
1410, Green urban areas	3240, Transitional woodland/shrub			

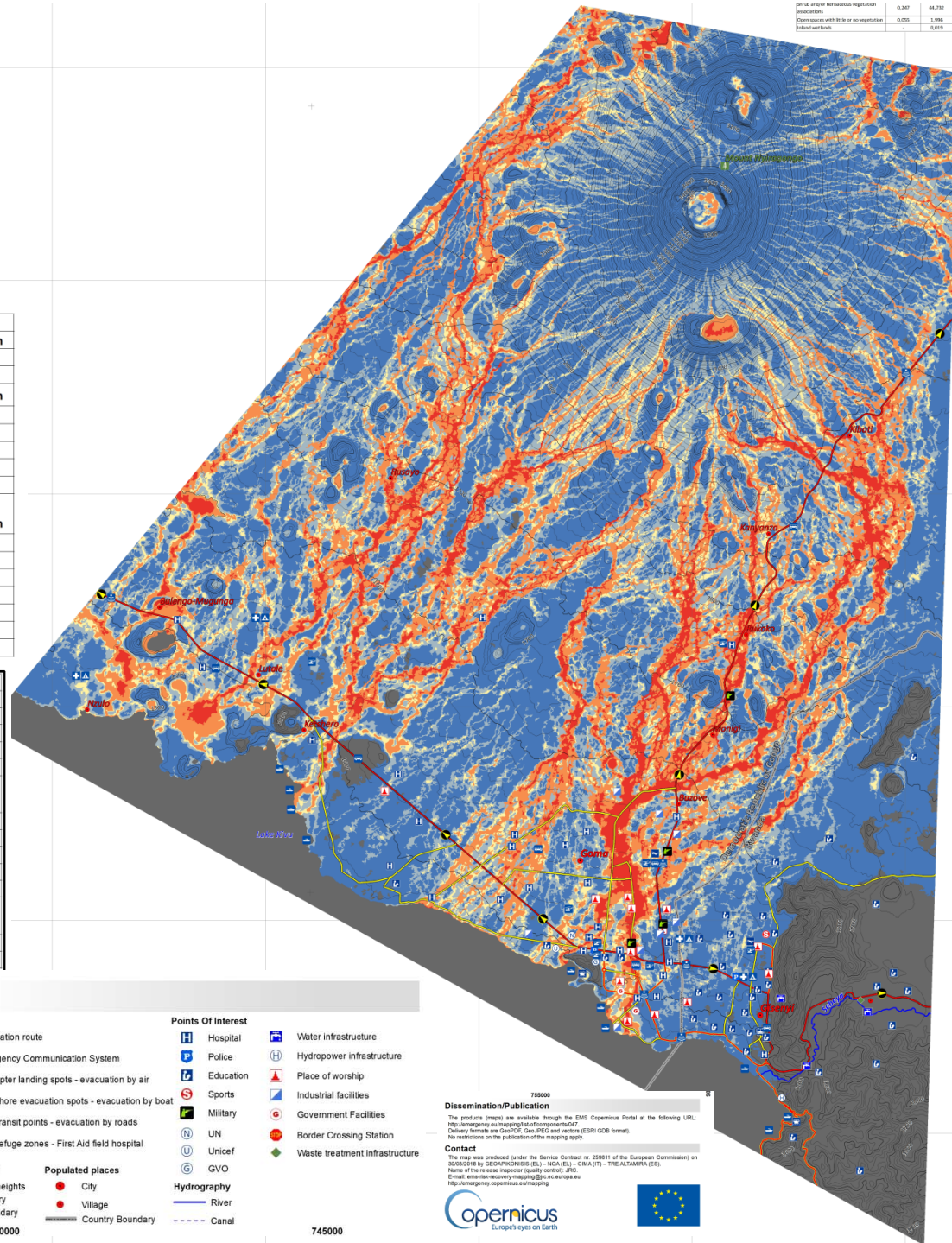
740000

29°10'0"E

745000

3. Lava Flow Hazard Map

Shrub and/or herbaceous vegetation associations	0,247	44,732	29,316	9,909	17,094
Open spaces with little or no vegetation	0,055	1,996	1,103	0,649	2,229
Inland wetlands	-	0,019	0,008	-	0,015



Consequences within the AOI	Lava Flow Hazard Level					
	No Hazard	Very Low	Low	Medium	High	Very High
Population (No of people)	88704	430577	289821	107947	214779	87798
Build-up areas (sqkm)	8,430	34,265	18,086	6,295	12,786	5,224
Assets (Nr)	No Hazard	Very Low	Low	Medium	High	Very High
Airport	-	5	1	10	7	-
Port	3	-	6	-	6	-
Commercial Public and Private Services	89	334	132	47	108	68
Industry and Utilities	13	65	66	69	68	25
Place of worship	-	8	1	1	2	2
Other	6927	68124	36856	12120	26535	11967
Transportation Network (km)	No Hazard	Very Low	Low	Medium	High	Very High
Primary	8,055	9,981	8,971	4,163	9,270	4,033
Secondary	6,553	7,486	2,291	1,544	1,207	1,399
Tertiary	1,999	16,149	7,774	3,933	7,663	7,816
Local and service	69,741	466,343	311,527	99,086	191,820	89,015
Other	19,507	40,262	28,272	11,518	25,911	9,829
Bridges (Nr)	8	1	-	-	-	-
Tunnel (Nr)	-	3	-	-	-	-

Consequences within the AOI	Lava Flow Hazard Level					
	No Hazard	Very Low	Low	Medium	High	Very High
LU/LC (sqkm)	-	0,190	0,100	0,039	0,047	0,031
Abandoned land	-	0,190	0,100	0,039	0,047	0,031
Urban fabric	7,517	29,000	15,691	5,310	10,683	4,464
Industrial, commercial and transport	0,766	4,611	2,137	0,904	1,983	0,717
Mine, dump and construction sites	0,131	0,174	0,071	0,021	0,041	0,006
Artificial, non-agricultural vegetated areas	0,016	0,291	0,086	0,020	0,033	0,006
Arable land	1,030	10,946	6,250	2,109	4,651	1,614
Permanent crops	4,453	0,802	0,048	0,022	0,030	0,007
Pastures	0,429	7,669	6,117	2,246	5,191	1,525
Heterogeneous agricultural areas	16,811	12,434	6,912	2,533	6,544	2,098
Forests	1,392	27,931	14,593	3,002	4,377	0,614
Shrub and/or herbaceous vegetation associations	0,247	44,732	29,316	9,909	17,694	4,483
Open spaces with little or no vegetation	0,055	1,996	1,103	0,649	2,229	1,949
Inland wetlands	-	0,019	0,008	-	0,015	-

Slide Number: N/A Activation ID: EMSN-047
 Product N.: 01NYIRAGONGO, v.1, English

Nyiragongo - Democratic Republic of the Congo

Volcanic Risk Assessment

Lava Flow Hazard Map - Overview

Production date: 30/03/2018

Cartographic Information
 1:50.000 Full color A1, high resolution (300dpi)

0 0,5 1 2 3 4 Km

Grid: WGS 84 / UTM zone 35S map coordinate system
 Tick marks: WGS 84 geographical coordinate system

735000

Legend

- Lava Flow Hazard**
 - Null
 - Very Low
 - Low
 - Medium
 - High
 - Very High
- Evacuation**
 - Evacuation route
 - Emergency Communication System
 - Helicopter landing spots - evacuation by air
 - Lakeshore evacuation spots - evacuation by boat
 - Safe transit points - evacuation by roads
 - Safe refuge zones - First Aid field hospital
- Transportation**
 - Primary
 - Secondary
 - Tertiary
 - Airport
 - Port
 - Bus station
- Physiography**
 - Spot heights
 - Primary
 - Secondary
- Populated places**
 - City
 - Village
 - Country Boundary
- Points Of Interest**
 - Hospital
 - Police
 - Education
 - Sports
 - Military
 - UN
 - Unicef
 - GVO
 - River
 - Canal
- Water infrastructure**
 - Water infrastructure
 - Hydropower infrastructure
 - Place of worship
 - Industrial facilities
 - Government Facilities
 - Border Crossing Station
 - Waste treatment infrastructure

740000

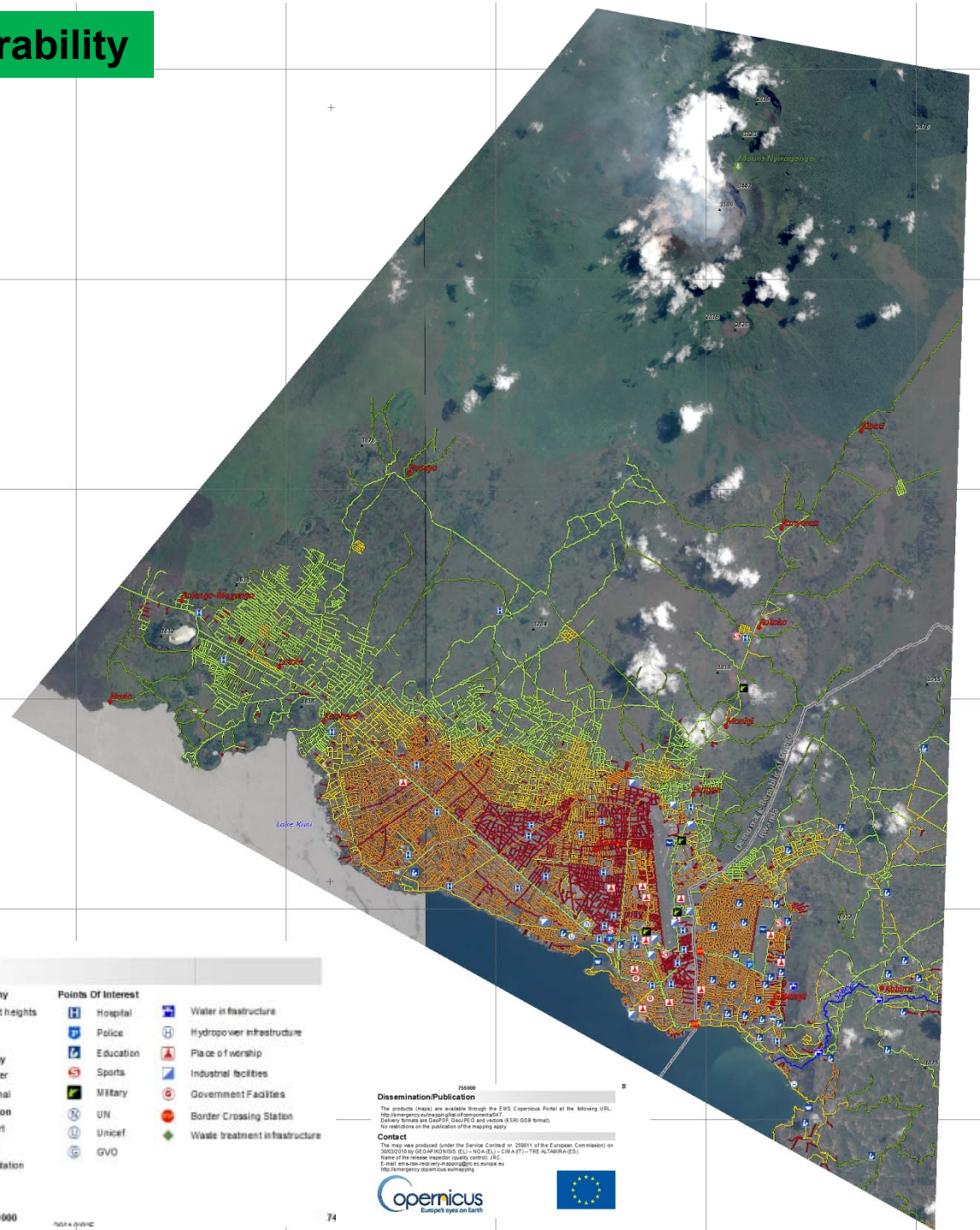
745000

Dissemination/Publication
 The products (maps) are available through the EMS Copernicus Portal at the following URL:
<http://emr.emergency.eu/mapping/infocomponents/047>
 Delivery formats are GeoPDF, Geo-PDF and vector (ESRI GDB format).
 No restrictions on the publication of the mapping apply.

Contact
 The map was produced under the Service Contract nr. 259911 of the European Commission on 30/03/2018 by GEOAPRONIS (EL) - NDA (ES) - CIMA (IT) - TRE ALTAIRRA (ES).
 Name of the release responsible (quality control): JAC.
 E-mail: emr-ma-responsible-mapping@ec.europa.eu
<http://www.emergency.eu/mapping>

Opencius
 Europe's eyes on Earth

4. Transportation Network Vulnerability



Consequences within the AOI	Vulnerability Level				
Transportation Network (km)	Very Low	Low	Medium	High	Very High
Primary	7,670	34,546	1,230	0,936	0,091
Secondary	-	10,835	9,085	0,364	0,196
Tertiary	0,979	7,498	29,985	6,507	0,365
Local and service	15,869	369,387	219,737	407,923	214,617
Other	89,755	42,715	1,578	0,829	0,421
Bridges (Nr)	1	3	4	1	-

Slide Number: N/A
 Activation ID: EM SN-041
 Product N.: 01NYRAGONGO_v1_English

Nyiragongo - Democratic Republic of the Congo

Volcanic Risk Assessment

Transportation Network Vulnerability to disruption Map - Overview

Production date: 30/03/2018

Cartographic Information

1:50.000 Full color A1, low resolution (100dpi)

Grid: WGS 84 / UTM zone 35S map coordinate system
 Tick marks: WGS 84 geographical coordinate system

Legend

Vulnerability Level	Physiography	Points Of Interest
Very low (green line)	Spot heights (+)	Hospital (H)
Low (yellow line)	River (blue line)	Police (P)
Medium (orange line)	Canal (dashed blue line)	Education (E)
High (red line)	Transportation	Sports (S)
Very High (dark red line)	Airport (A)	Military (M)
	Port (P)	UN (U)
	Bus station (B)	Unicef (U)
		GVO (G)
Populated places		Water infrastructure
City (red circle)		Water infrastructure (blue square)
Village (red dot)		Hydropower infrastructure (blue circle)
Country (black line)		Place of worship (blue triangle)
Boundary (black line)		Industrial facilities (blue square)
		Government facilities (red circle)
		Border Crossing Station (red circle)
		Waste treatment infrastructure (green diamond)

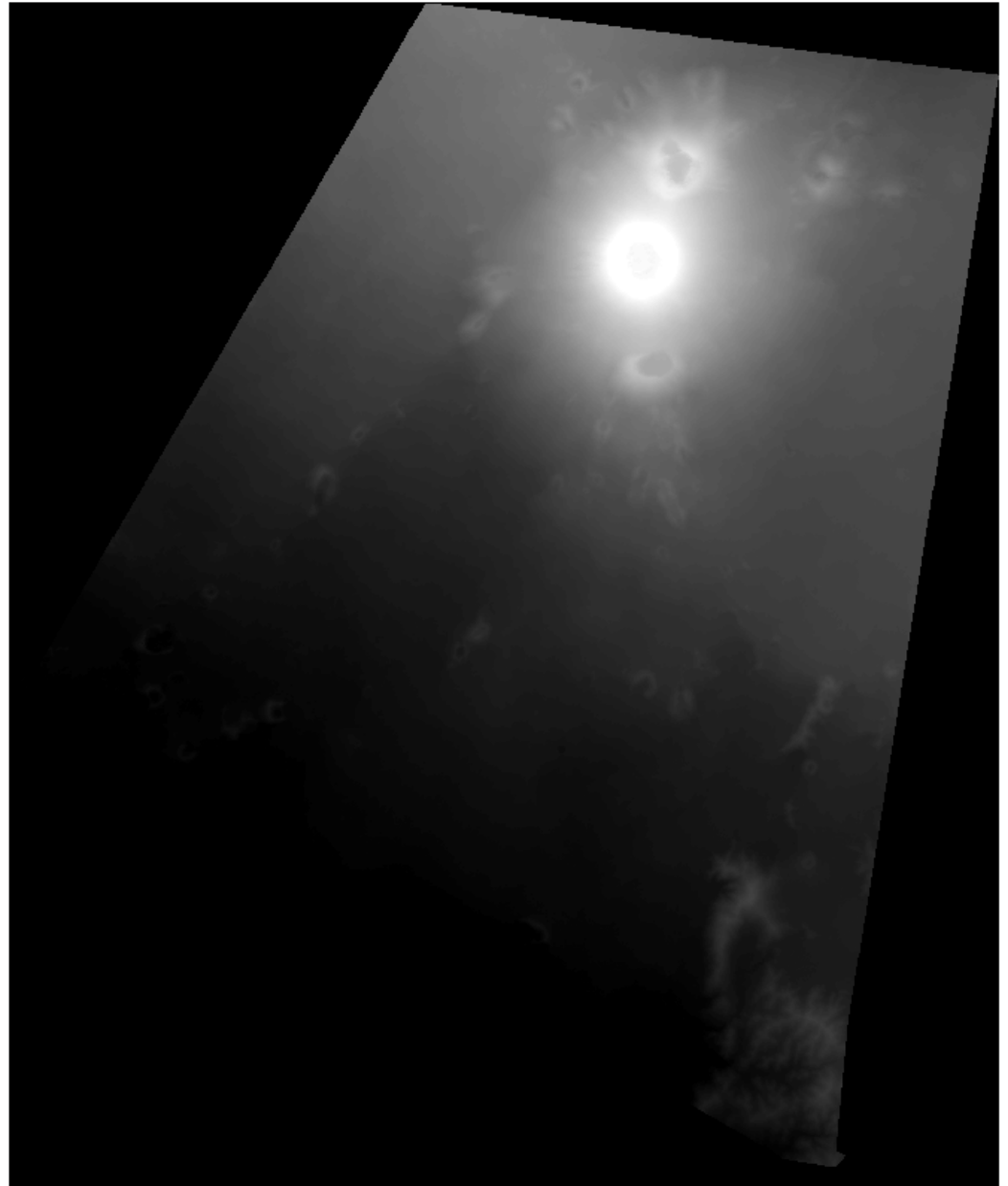
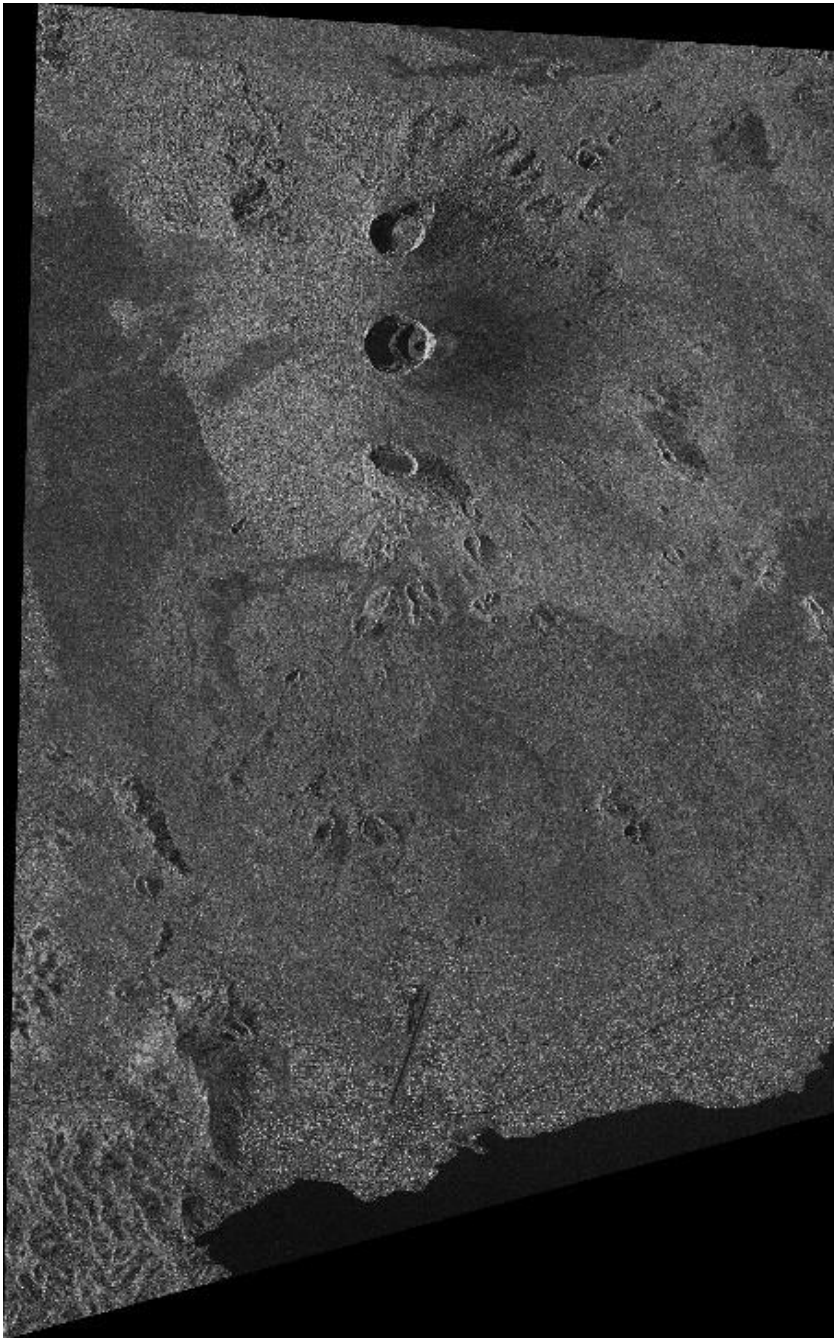
Dissemination/Publication

The products made are available through the EMS Copernicus Portal at the following URL:
<https://emergency.europa.eu/geo/infocentre/0447>
 Delivery formats are GeoPDF, GeoTIFF and native ESRI (SDE format)
 No restrictions on the publication of the mapping data.

Contact

The map was produced under the Service Contract n. 288011 of the European Commission on 30/03/2018 by GEOGRAPHICO (EU - NGA (EU) - CMA IT) - TRÉ ALTAVIRA (ES).
 Name of the contract manager: GeoInfo - GIC
 E-mail: emr-geo@ec.europa.eu
<http://emergency.europa.eu/emergency>

5. Very High Resolution DEM to simulate lava flow pathways for future eruptions



2.2. Field data were acquired in collaboration with Rwanda

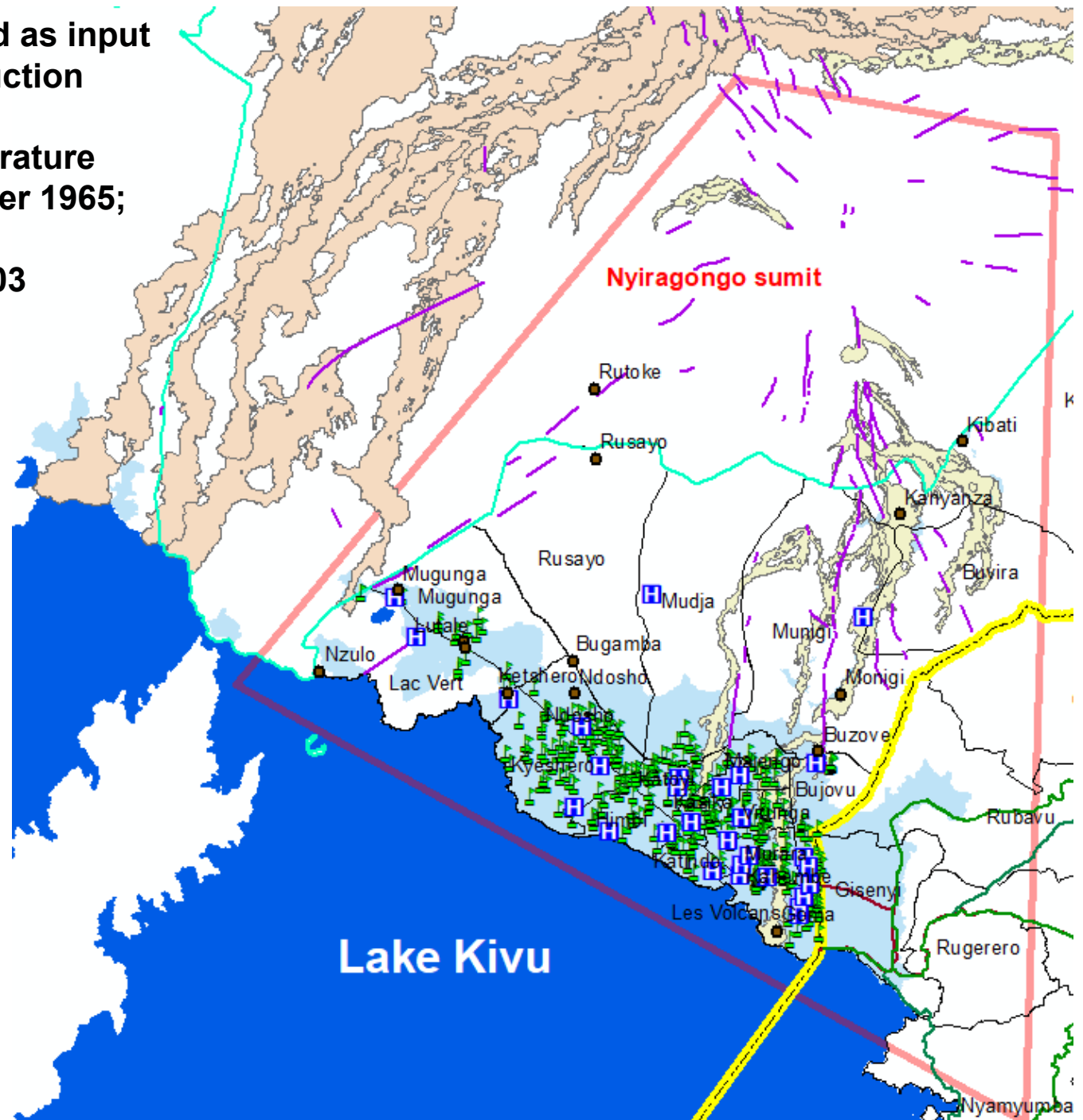
1. Available Geospatial Data for Nyiragongo Volcano:

- a. Nyiragongo and Nyamulagira historical (1938 to present) lava flows shapefiles
- b. Nyiragongo and Nyamulagira eruptive fissures
- c. Nyiragongo 1977 and 2002 eruptions eruptive vents
- d. Road Network for both Goma (DR Congo) and Gisenyi (Rwanda) cities and surroundings
- e. Urban area shapefiles for both Goma and Gisenyi cities and surroundings villages
- f. Hydrographic Network in the study area
- g. Fuel stations location
- h. Hospitals location in both Goma and Gisenyi cities
- i. Schools (primary, secondary and university) location in both Goma and Gisenyi cities
- g. Administrative limits shapefiles for Goma and villages around, and Gisenyi

Map of field data to be used as input in the volcanic maps production

Some data are from the literature

- e.g. -Thonnard and Denaeyer 1965;
- Smets et al. 2010
- Komorowski et al. 2003







2. Ground Control Points for the High Resolution Image

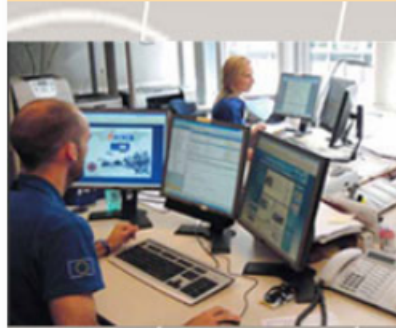
Overview of the five (5) Differential GCPs



Overview of the six (6) extra GCPs



- Map of Activations of Other Organizations
- Map Coverage Planner
- Meetings, Workshops
- Citation Guidelines
- Citations
- Press Mentions
- Calls for Tender



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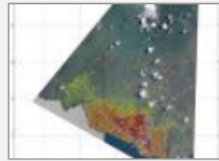
Activation Factsheet:  [EMSN047-Factsheet.pdf \(new\)](#)

Activation Final Report:  [EMSN047-Final_Report.pdf](#)

Download:  [EMSN047_UTM35S_V03.gdb_.rar](#),  [EMSN047_GOMA_DEM_5m.rar](#)

Filter by map type: · [ALL](#) · [TRANSPVULNERABILITY](#) · [LAVAFLOWHAZARD](#) · [LULC](#) · [REFERENCE](#)

[EMSN047] Nyiragongo: Transportation Network Vulnerability to disruption Map - Volcanic Risk Assessment (Overview)



Published: 2018-03-30 00:00:00 (UTC)

Product version: v1

Map scale: 1:50000

Status:

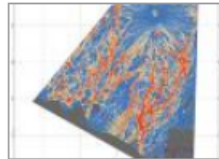
Production finished

Downloadable items

PDF: [100 DPI](#) [300 DPI](#)

JPEG: [100 DPI](#) [300 DPI](#)

[EMSN047] Nyiragongo: Lava Flow Hazard Map - Volcanic Risk Assessment (Overview)



Published: 2018-03-30 00:00:00 (UTC)

Product version: v1

Map scale: 1:50000

Status:

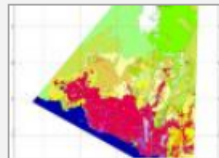
Production finished

Downloadable items

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JPEG: [100 DPI](#) [300 DPI](#)

[EMSN047] Nyiragongo: Land Use and Land Cover Map - Volcanic Risk Assessment (Overview)



Published: 2018-03-30 00:00:00 (UTC)

Product version: v1

Map scale: 1:50000

Status:

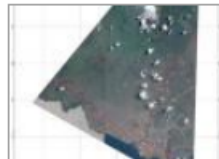
Production finished

Downloadable items

PDF: [100 DPI](#) [300 DPI](#)

JPEG: [100 DPI](#) [300 DPI](#)

[EMSN047] Nyiragongo: Reference Map - Volcanic Risk Assessment (Overview)



Published: 2018-03-30 00:00:00 (UTC)

Product version: v1

Map scale: 1:50000

Status:

Production finished

Downloadable items

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Displaying 1 - 4 of 4

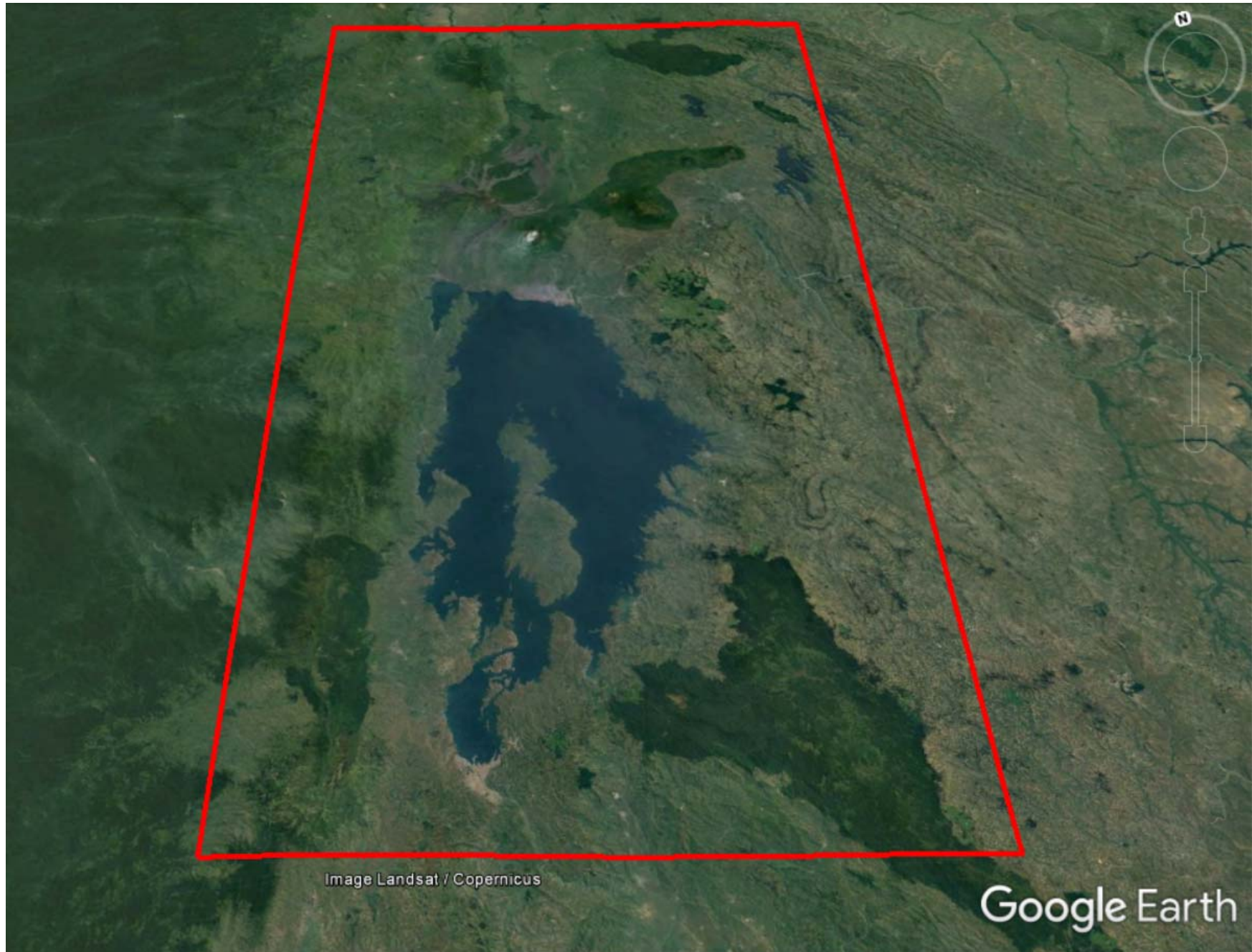
See also [obsolete products](#) of this activation

Online, free download

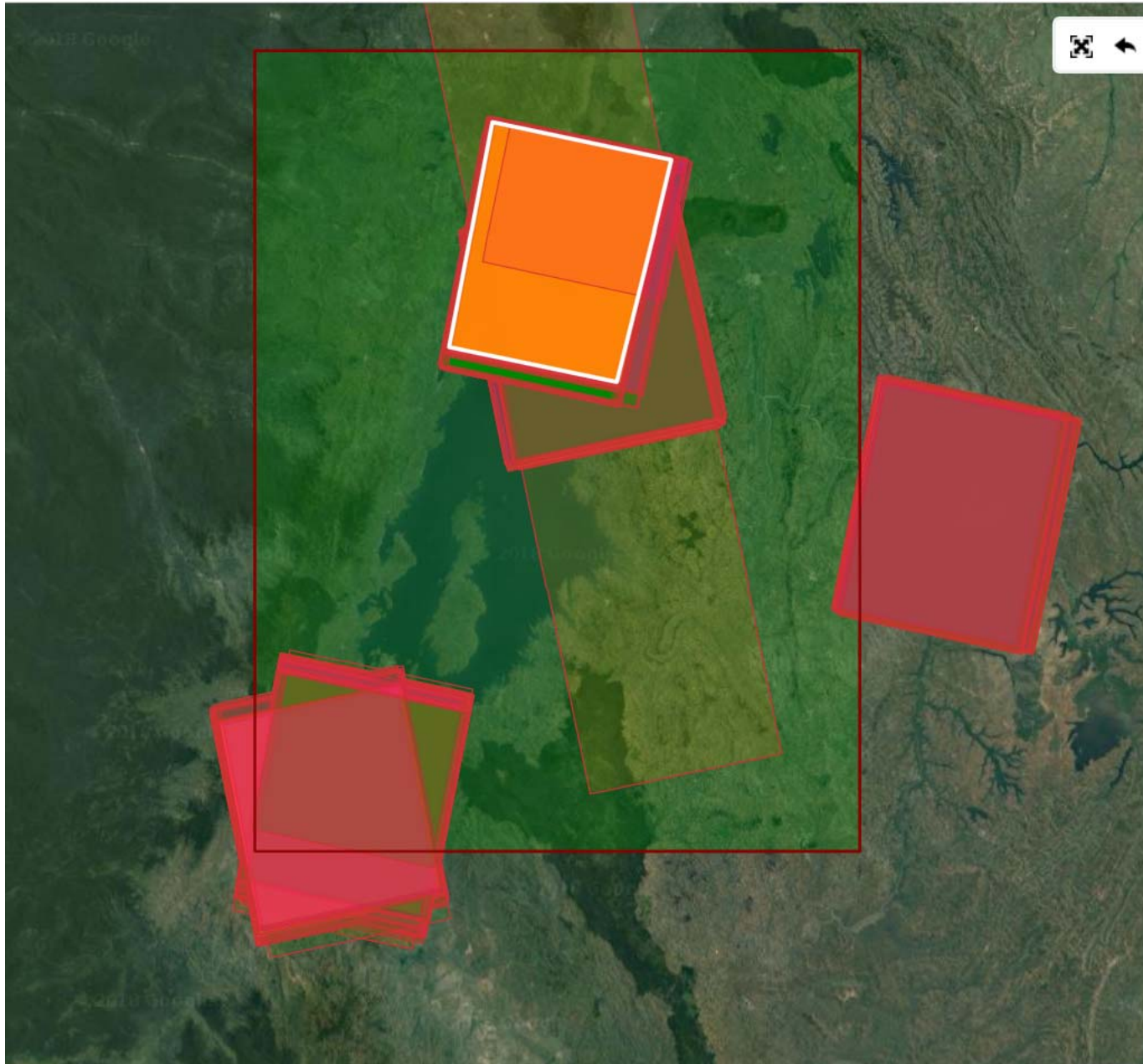
2.3. The CEOS supports the Virunga Supersite with COSMO-SkyMed and Pleiades

Agenzia Spaziale Italiana (ASI)	COSMO-SkyMed: entire archived imagery over the AOI + 100 new products/year for a period of 2 years
Centre National d'Etudes Spatiales (CNES)	Pleiades: quota of 9 images tristereo (on the basis of one Pléiades monoscopic scene 400km ²) / year which is roughly equivalent to 3.600km ² of tristereo acquisitions / year, for a period of 2 years. Total ~22.000 km ² .

Pleiades data has been ordered



COSMO-Skymed data ordering is ongoing



Archives:

More than 300 images
for each frame

New acquisition for annual quota (100 products/year)

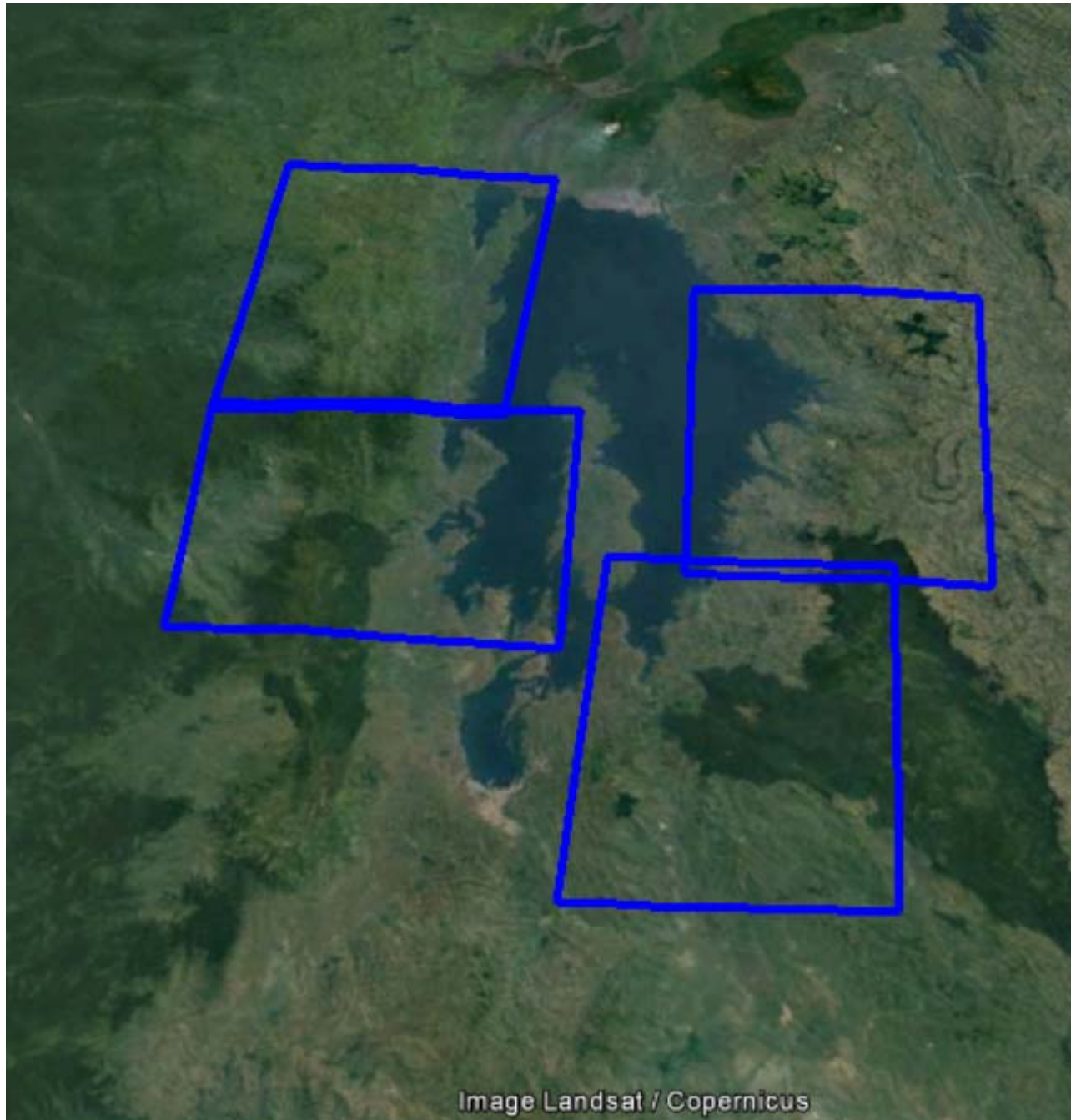


Image Landsat / Copernicus

The InSAR data team:

#	Name	Institution	Country
1	Bagalwa Rukeza Monfort	Goma Volcano Observatory	RD Congo
2	Charles Balagizi	Goma Volcano Observatory	RD Congo
3	Sandra M. Nzamu	Goma Volcano Observatory	RD Congo
4	Fikiri Migabo	Goma Volcano Observatory	RD Congo
5	Jonathan Kavuke	Goma Volcano Observatory	RD Congo
6	King Iragi	Goma Volcano Observatory	RD Congo
7	Gentil Balezi	Goma Volcano Observatory	RD Congo
8	Rigobert Bahati Birembano	Institut Supérieur Pédagogique de Bukavu	RD Congo
9	Richard Birindwa Cubwe		RD Congo
10	Gustave Byabuze	Institut Géographique du Congo	RD Congo
11	Fiama Bondo Silvanos	CRSN/Lwiro	RD Congo
12	Guy Shungu	University of Goma	RD Congo
13	Mike Poland	USGS	USA
14	Michael Lisowski	USGS	USA
15	Estelle Chaussard	State University of New York at Buffalo	USA
16	Mauro Coltelli	INGV	Italy
17	Mario Matia	INGV	Italy
18	Diego Copolla	Università di Torino	Italy
19	Mariarosaria Manzo	Consiglio Nazionale delle Ricerche (CNR)	Italy
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22	Nicolas d'Oreye	NMNH/ECGS	Belgium
23	Dominique Derauw	CSL/ECGS	Belgium
24	Ludivine Libert	CSL	Belgium
25	Adriano Nobile	MRAC	Belgium
26	Antoine Dille	MRAC	Belgium
27	Halldor Geirson	ECGS	Belgium


2.4. Natural hazards assessment in the Virunga and Lake Kivu basin

Nat Hazards (2018) 93:31–66
<https://doi.org/10.1007/s11069-018-3288-x>



ORIGINAL PAPER

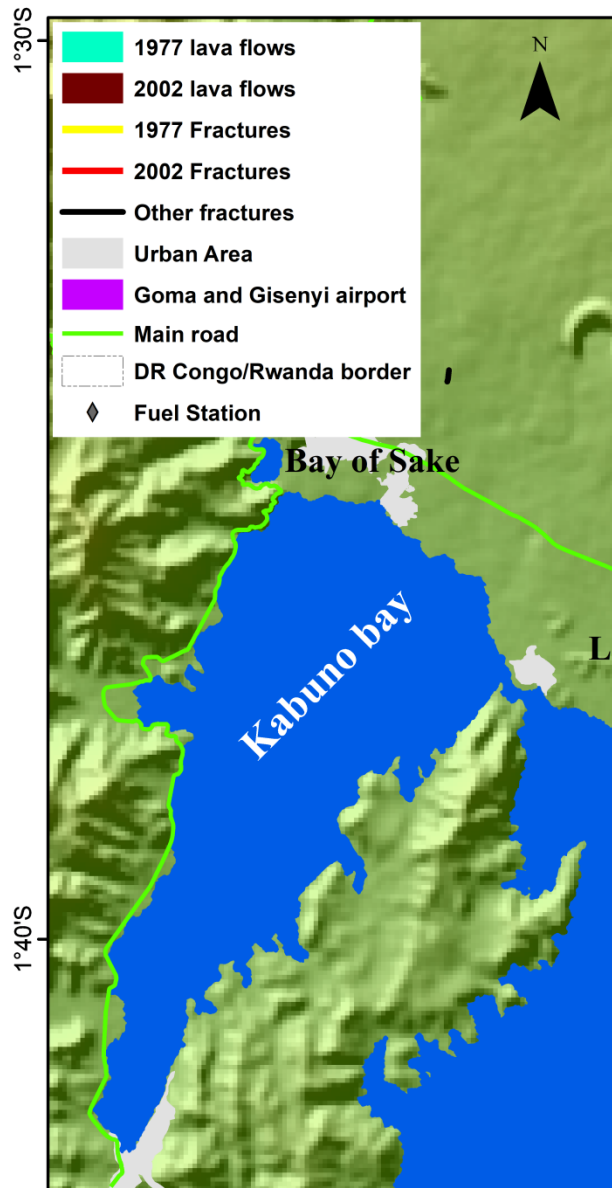
Natural hazards in Goma and the surrounding villages, East African Rift System

Charles M. Balagizi¹  · Antoine Kies² · Marcellin M. Kasereka¹ ·
Dario Tedesco³ · Mathieu M. Yalire¹ · Wendy A. McCausland⁴

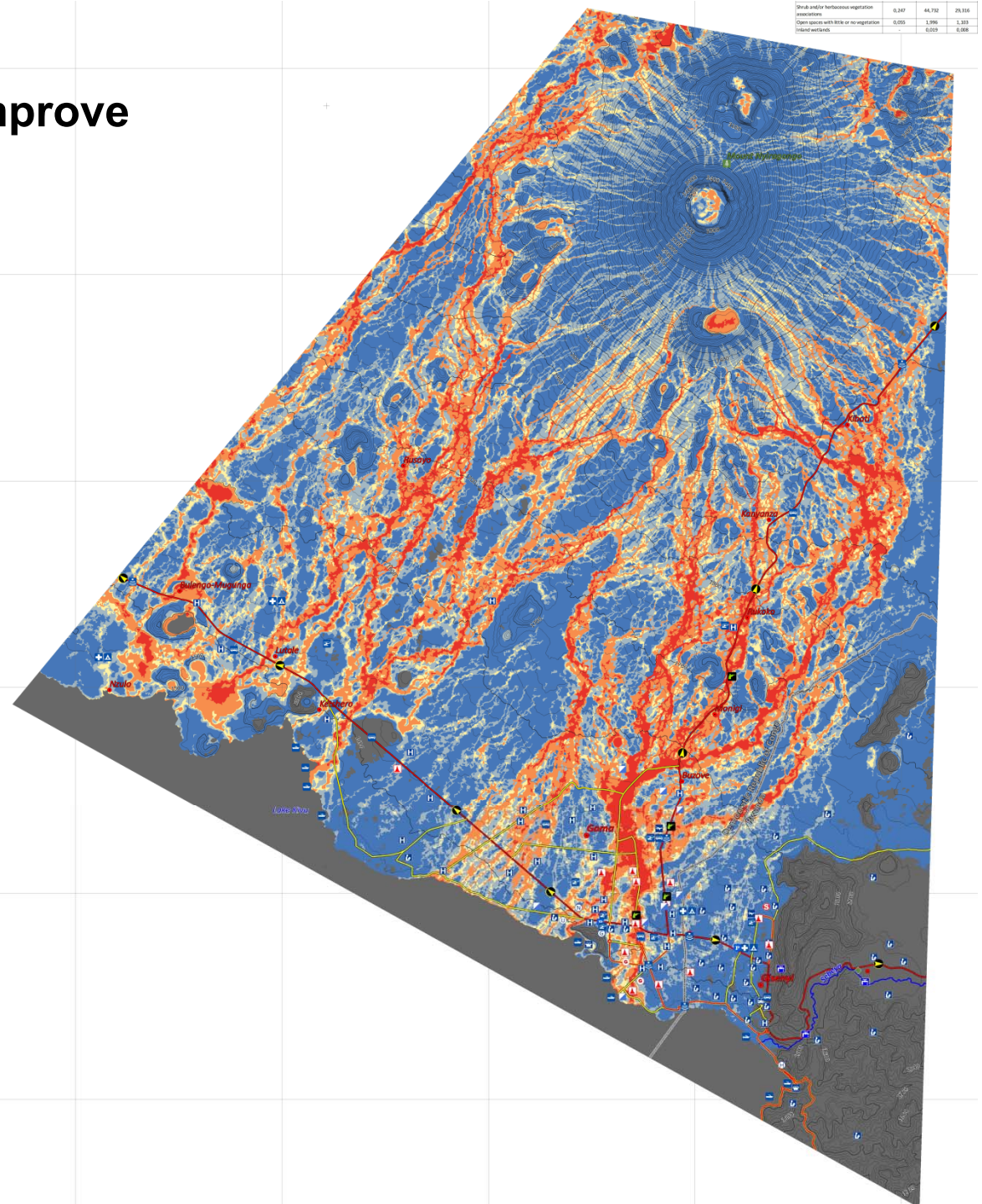
Received: 30 September 2016 / Accepted: 25 March 2018 / Published online: 31 March 2018
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Abstract The city of Goma and its surrounding villages (Democratic Republic of the Congo, DRC) are among the world's most densely populated regions strongly affected by volcanic hazards. In 2002, Nyiragongo volcano erupted destroying 10–15% of Goma and forced a mass evacuation of the population. Hence, the ~ 1.5 million inhabitants of Goma and Gisenyi (Rwanda) continue to live with the threat of new lava flows and other eruptive hazards from this volcano. The current network of fractures extends from Nyiragongo summit to Goma and continues beneath Lake Kivu, which gives rise to the fear that an

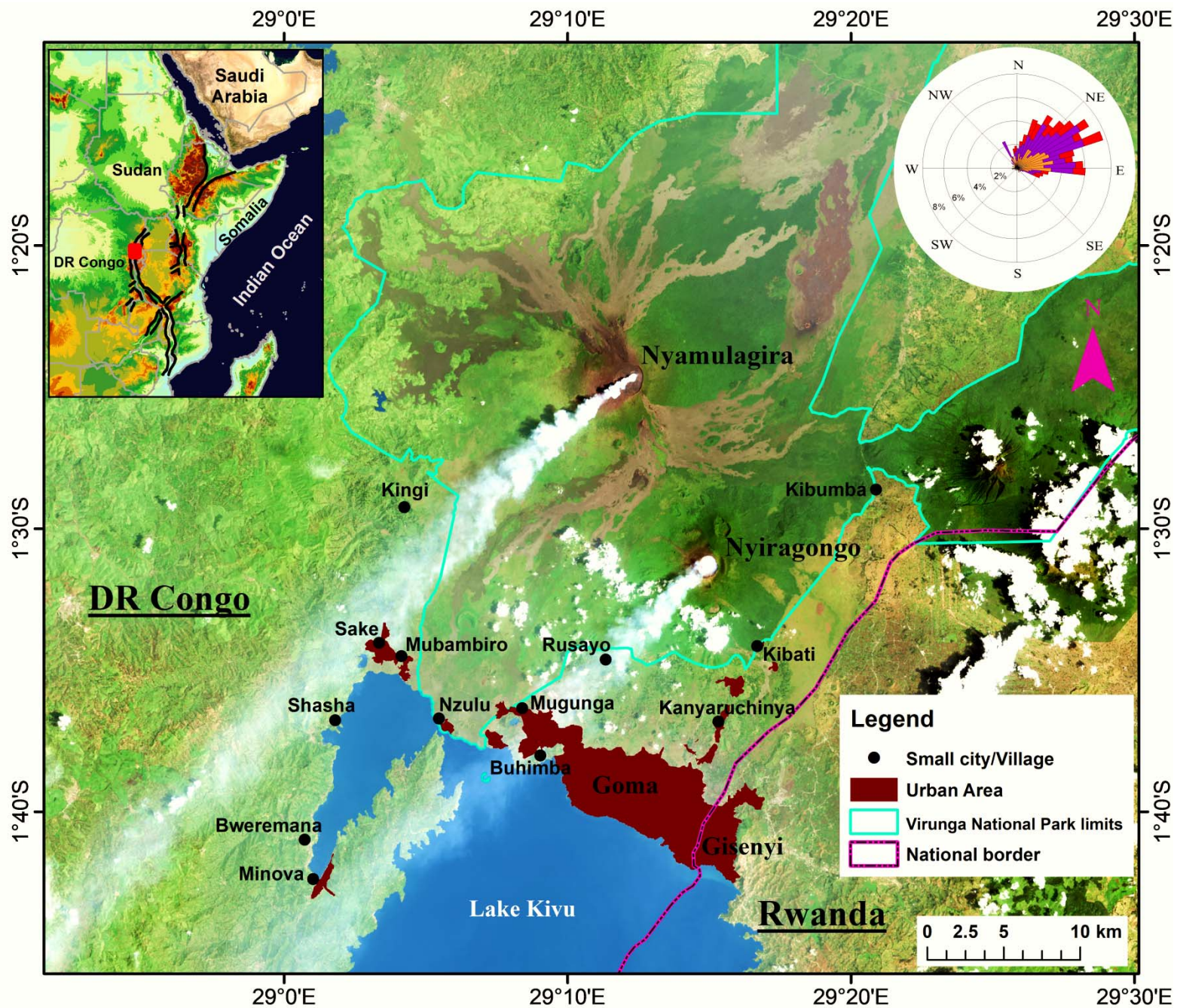
Lava flows hazard



Improve



Gas plume and ash emissions





Nyirangongo

Nyamulagira



Nyirangongo

Nyamulagira

Rainwater represents an important water resource



Water pollution





Contents lists available at [ScienceDirect](http://www.sciencedirect.com)

Applied Geochemistry

journal homepage: www.elsevier.com/locate/apgeochem



Rain-plume interactions at Nyiragongo and Nyamulagira volcanoes and associated rainwater hazards, East Africa



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^b *Dipartimento di Scienze e Tecnologie Ambientali, Biologiche e Farmaceutiche, Seconda Università Degli Studi di Napoli, Via Vivaldi 43, 81100 Caserta, Italy*

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Keywords:

Nyiragongo volcanic plume

Rainwater chemistry

Acid-driven ash dissolution

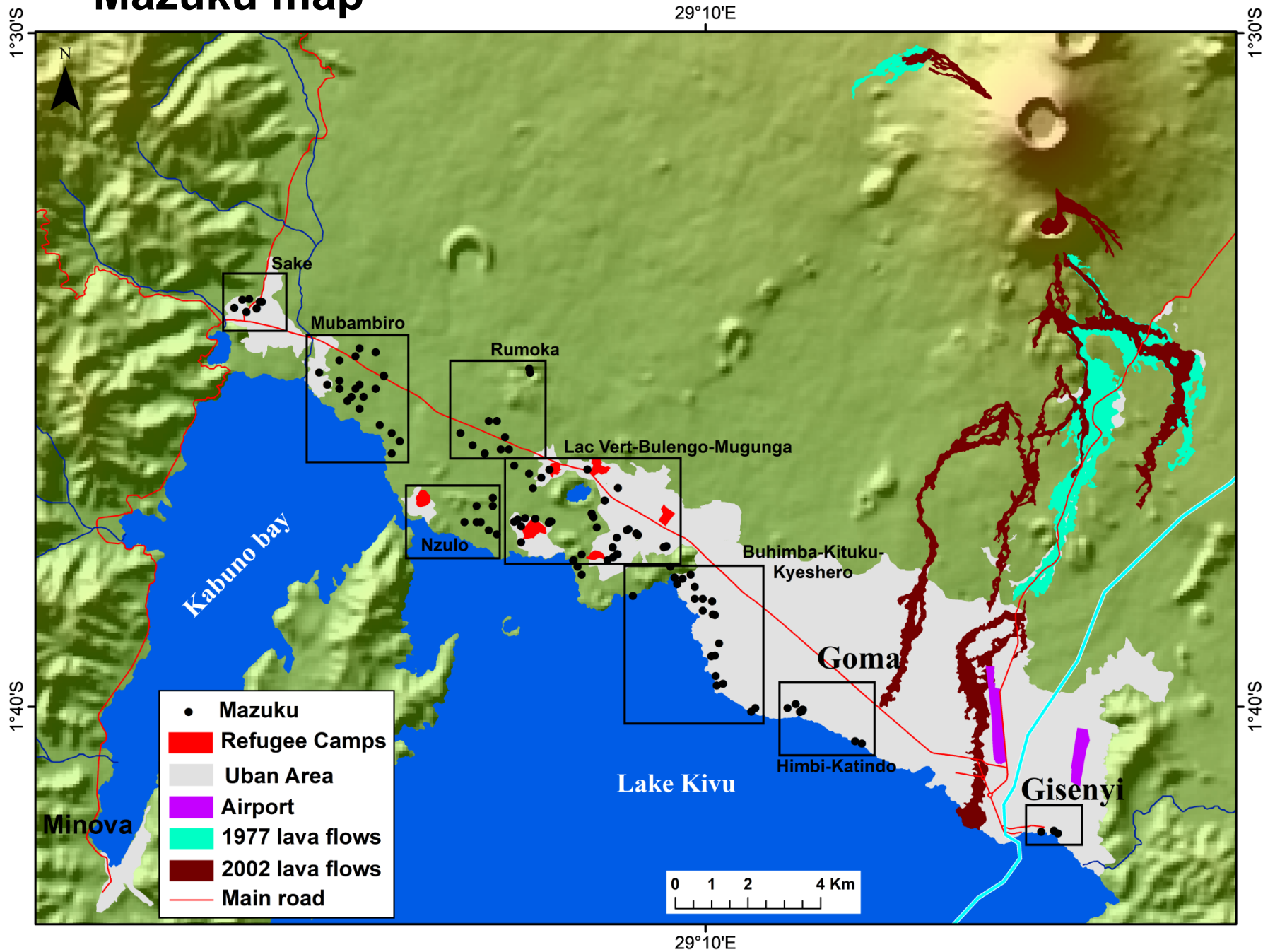
Rainwater quality

Dental fluorosis

ABSTRACT

A rain-gauge network consisting of 13 stations was installed on the volcanic fields around Nyiragongo and Nyamulagira volcanoes, as well as in the surrounding villages and Goma city (DR Congo) from December 2013 to October 2015. The rain gauges were then sampled on a monthly basis in order to evaluate the influence of volcanic emissions on rain chemistry and rainwater quality. This is the first temporally distributed dataset of rain chemistry from this densely populated region, where the two Africa's most active volcanoes, 14 km apart, continuously eject gases and ash to the atmosphere and where rainwater represents an important water resource. The results revealed that volcanic emissions are the primary source of the dissolved loads. Wind-blown dust dissolution is in fact occasionally the dominant source of major cations at cities and villages that are remote with respect to the volcano summits. A few sites located in the forested Virunga National Park are neither significantly impacted by volcanic emissions nor wind-blown dust. The combined contribution of volcanic gases and the dissolution of volcanic ash and soil dust determined the pH of the rainwater. Thus, areas with limited volcanic impact showed higher pH values (up to 7.6), while those that experience major volcanic impact showed lower pH values (as low as 3.1), as a consequence of the continuous input of acidic volcanic gases. The

Mazuku map



3. Present and future challenges

Capacity building and equipment for ground based data collection !!!!

(1) Capacity building of local scientists

(1) – 1 USGS-VDAP- could support GVO's capacities for InSAR data analysis and interpretation for volcano monitoring

(1) – 2 INGV will support GVO's capacities for SAR data analysis and interpretation for volcano monitoring.

– INGV will also provide 2 kinematics GPS stations and Ion Chromatograph and provide training for their use.

(2) Acquisition of ground based data to be shared among the Supersite scientific community.

=> You have an equipment that may help, please contact us!

(3) We have written a project to support the supersite activities

➔ looking for funding sources.

Thanks to our partners



Thanks for your attention