Training workshop report

Introduction to Synthetic Aperture Radar (SAR) for Disaster Management

July 31 - August 4, 2017
AmeriGEOSS Week 2017
Universidad de San José
San José, Costa Rica

Figure 1: Participants and in-person instructors for the SAR workshop.

September 2017

CONTENTS

---

1. Summary

In the context of AmeriGEOSS Week 2017, an introductory training workshop on the *Use of Synthetic Aperture Radar (SAR) for Disaster Management* was held at the Universidad de San José, in San José, Costa Rica, from July 31 through August 4, 2017. The workshop was organized by the Committee on Earth Observation Satellites (CEOS)' Working Group on Capacity Building and Data Democracy (WGCapD). It had the participation of instructors from institutions linked to the CEOS WGCapD, including the Argentine National Space Activities Commission (CONAE, in Spanish), Regional Centre for Space Science and Technology Education for Latin America and the Caribbean (CRECTEALC, in Spanish), Friedrich Schiller Universität (FSU) Jena of Germany (presenting on behalf of the German Aerospace Center, the DLR), the National Space Research Institute of Brazil (INPE, in Portuguese), the Indian Space Research Organization (ISRO), the U.S. National Aeronautics and Space Administration (NASA), the U.S. National Oceanic & Atmospheric Administration (NOAA), the South African National Space Agency (SANSA), the Federal University of Santa Maria of Brazil (USFM, in Portuguese), and the U.S. Geological Survey (USGS). The training benefited some fourteen (14) participants hailing from different sectors across Costa Rica (pictured in **Figure 1**). The workshop's sessions were given in two modalities: in-person sessions, as well as virtual presentations and exercises. At the end of the four day training, the participants were familiarized with the range of topics linked to SAR and disasters, including:

- the fundamentals of microwave remote sensing,
- portals for acquiring SAR data,
- applications of polarimetric SAR,
- applications of interferometric SAR,
- use of SAR for flood mapping,
- online educational resources such as SAR-EDU (now EO College: http://eo-college.org), and
- use of cloud-based data processing resources such as Google Earth Engine (GEE).

The workshop agenda can be seen in the Annex to this report.

2. Objectives

The main objective of the workshop was to familiarize participants with the range of applications of SAR for disaster management. Per the various workshop sub-sessions, the specific objectives included:

- Reviewing the fundamentals of microwave remote sensing
- Demonstrating various portals for accessing SAR data
- Learning how to visualize SAR imagery
- Reviewing the range of polarimetric applications of SAR data
- Demonstrating interferometric applications for monitoring land deformation
- Reviewing how SAR data can be used for flood monitoring
- Presenting online educational resources such as SAR-EDU
- Reviewing data analysis & processing using online, cloud-based platforms such Google Earth Engine (GEE)

3. Profile of participants

The 14 participants represented a wide range of sectors from across the government, academia, and private sector of Costa Rica. The vast majority of the participants had experience with geographic information systems (GIS), as well as some level of experience with optical remote sensing, and some participants also had some experience with microwave remote sensing. Slightly over a quarter (28.6%) of the participants came from the private sector, an equal number (28.6%) came from academia, and the remainder (42.9%) came from the government institutions.

4. Instructor list

- **CONAE:** Tomas Zajc
- **CRECTEALC:** Sergio Camacho, Genaro Olivera
- **FSU Jena:** Robert Eckardt
- **ISRO:** Shashi Kumar
- **NASA:** Emil Cherrington, Francisco Delgado, Eric Fielding, Naiara Pinto, Erika Podest
- **NOAA:** Angélica Gutiérrez-Magness
- **SANSA:** Phila Sibandze
- **USFM:** Manoel Araujo Sousa Jr.
- **USGS:** Michelle Anthony

5. Workshop proceedings

The workshop was held over a period of four days between Monday 31 July and Friday 4 August, 2017. Wednesday 2 August 2017 was a free day, as it was a national holiday (Romería) in Costa Rica.

Day 1: Monday 31 July 2017

Pre-workshop

- Prior to the opening of the training, the workshop participants (shown in **Figure 2** with the other participants of AmeriGEOSS Week 2017) participated in the opening session of AmeriGEOSS Week 2017, which featured, among other things, presentations and remarks by dignitaries, highlighting the role of GEOSS in the Americas:

  o Mr. Juan Carlos Fallas, the Director of the National Meteorological Institute (IMN, in Spanish) of Costa Rica, and the GEO Principal for Costa Rica
  o Dr. Omar Franco Torres, Director General of the Institute of Hydrology, Meteorology, and Environmental Studies (IDEAM, in Spanish) of Colombia, and GEO Principal for Colombia
  o Dr. Henning Jensen Pennington, President of the University of Costa Rica
  o Ms. Barbara Ryan, Director of the secretariat for the inter-governmental Group on Earth Observations (GEO)
  o Dr. Angélica Gutiérrez-Magness, NOAA's Office of Water Prediction (OWP), International Hydrology Lead – OWP and Vice-Chair of the AmeriGEOSS Regional Coordination Working Group
  o Dr. Nancy Searby, NASA's Capacity Building Program Manager, and Vice-Chair of the AmeriGEOSS Regional Coordination Working Group
  o Dr. David Green, NASA's Disasters Program Manager

Figure 2: Group photo featuring all of the participants of AmeriGEOSS Week 2017.

- The leads for the three training workshops, organized in conjunction AmeriGEOSS week, also gave brief overviews of the different side sessions:

  o GEOGLAM: Dr. Carlos di Bella (National Agricultural Technology Institute, INTA, Argentina)
  o GEONETCAST: Dr. Bernie Connell (Colorado State University)
  o Synthetic Aperture Radar (SAR): Dr. Emil Cherrington (NASA) – **Figure 3**

Following workshop start

- The workshop began with a virtual presentation by Dr. Sergio Camacho, Secretary General, Regional Centre for Space Science and Technology Education for Latin America and the Caribbean (CRECTEALC), in Spanish). He gave an overview of the CEOS Working Group on Capacity Building and Data Democracy (WGCapD), and its relation to the SAR for disaster management training workshop.
- Mr. Genaro Olivera of CRECTEALC followed with a virtual presentation on the fundamentals of microwave remote sensing. That presentation set the stage for the concepts elaborated in the rest of the workshop.
- Dr. Emil Cherrington of NASA closed the first day with a review of different portals for acquiring SAR data, including the Copernicus Open Access Hub (https://scihub.copernicus.eu/dhus/#/home), and the Alaska Satellite Facility's Vertex portal (https://vertex.daac.asf.alaska.edu/).

Figure 3: Emil Cherrington (NASA) giving an overview of the SAR training workshop during the plenary.

Day 2: Tuesday 1 August 2017

- Day 2 began with a virtual presentation by Mr. Shashi Kumar, on behalf of the Indian Space Research Organization (ISRO), on applications related to polarimetric SAR. Among other things, the use of polarimetry for classifying land cover types was highlighted.
- The morning of the second day was rounded out by a hands-on exercise by Mr. Francisco Delgado of NASA regarding visualization of SAR data using the open source Quantum GIS (QGIS) platform (**Figure**

4). In that exercise, ALOS PALSAR L-band imagery was corrected, and then visualized in QGIS. The exercise was based on a 'Data Recipe' developed by the Alaska Satellite Facility (https://www.asf.alaska.edu/asf-tutorials/data-recipes/view-rtc-in-gis/view-rtc-in-qgis/), and translated into Spanish.
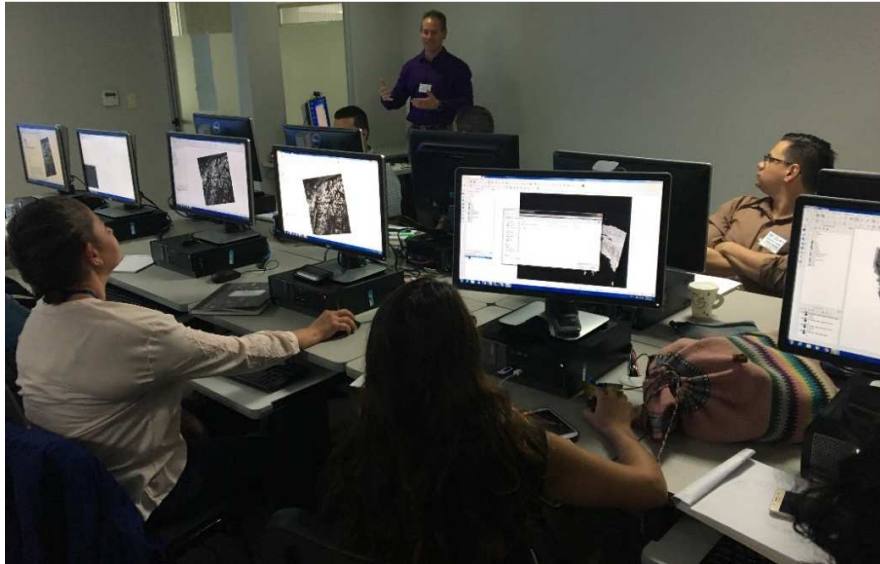

Figure 4: Francisco Delgado (NASA) illustrating data visualization in QGIS.

- The afternoon session of day 2 began with a virtual presentation by Dr. Manuel Araujo Souza Jr. of the Federal University of Santa Maria of Brazil (USFM) regarding flood mapping using Sentinel-1 data. Dr. Souza then led a remote exercise with the participants, illustrating flood mapping techniques using both the Sentinel Application Platform (SNAP) for data processing, and QGIS for visualization.
- The afternoon session was closed out with a virtual presentation by Tomas Zajc of CONAE, regarding the use of interferometry for monitoring land deformation related to both volcanic eruptions and earthquakes.

Day 3: Thursday 3 August 2017

- The third day of the workshop began with a virtual presentation by Dr. Robert Eckardt of Friedrich Schiller Universität (FSU) Jena on SAR-EDU (**Figure 5**). Following a review of the SAR-EDU overview video (https://www.youtube.com/watch?v=wcXOHj9Ynjc), Dr. Eckardt also responded to participant questions, and spoke about the upcoming Massive Online Open Course (MOOC) on radar remote sensing (registration available through https://eo-college.org/register), and potential opportunities for collaboration with Costa Rica.

***Figure 5:** Robert Eckardt (FSU Jena) presenting on SAR-EDU / EO-College.*

- Mr. Phila Sibandze of the South African National Space Agency (SANSA) gave a virtual demonstration of the Water Mask Pro (WaMaPro) software developed by the German Aerospace Center (DLR), which is run in a Linux virtual environment. WaMaPro was shown to allow for masking of water bodies in SAR data by thresholding of radar backscattering coefficient values.
- The afternoon session of the third day featured virtual presentation videos from NASA's Applied Remote Sensing Training (ARSET) program, including accompanying exercises. The videos were sourced from on the "Introduction to Synthetic Aperture Radar" webinar given by NASA ARSET in late June / early July 2017: https://arset.gsfc.nasa.gov/disasters/webinars/intro-SAR.
- A virtual presentation by Dr. Naiara Pinto of the NASA Jet Propulsion Lab, JPL (and narrated in Spanish by Dr. Erika Podest also of NASA JPL) reviewed SAR polarimetry. That video was based on: https://arset.gsfc.nasa.gov/sites/default/files/disasters/SAR-17/Session3-SAR-Spanish.pdf.
- A virtual presentation by Dr. Eric Fielding of NASA JPL (and with Spanish narration by Dr. Erika Podest of NASA JPL) reviewed SAR interferometry. That video was based on: https://arset.gsfc.nasa.gov/sites/default/files/disasters/SAR-17/Session4-SAR-Spanish.pdf. Following a Q&A with Dr. Fielding, the workshop participants also went through the process of interferogram generation using SNAP and Sentinel-1 data over Chile.
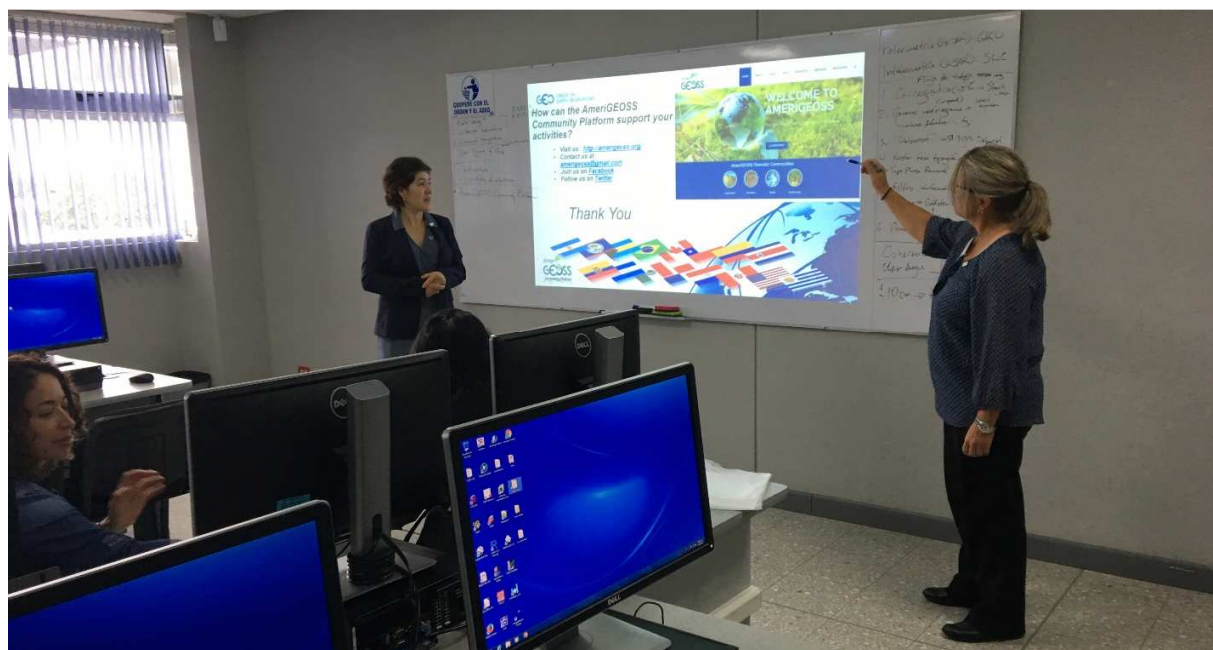
Day 4: Friday 4 August 2017

Figure 6: *Dr. Angélica Gutiérrez of NOAA (left) and Ms. Michelle Anthony of USGS (right) present on the AmeriGEOSS Community Platform.*

- The morning session of the fourth and final day of the workshop featured a presentation by Dr. Angelica Gutierrez of NOAA and Ms. Michelle Anthony of the USGS, about the AmeriGEOSS Community Platform, which has been developed by the USGS, in collaboration with the AmeriGEOSS caucus members (**Figure 6**). That presentation was complemented with a presentation by Mr. Sergio Rodriguez Sanchez of Geotecnologías, S.A., the national ESRI distributor for Costa Rica. Mr. Rodriguez focused on how ArcGIS.com provides features for geospatial processing.
- Rounding out the morning session, Mr. Francisco Delgado (NASA) delivered an introductory presentation on Google Earth Engine (GEE, https://code.earthengine.google.com) as an online, cloud-based resource which allows for analyzing SAR data (**Figure 7**). To date, the entire Sentinel-1A and Sentinel-1B archive is accessible in GEE in the form of radiometrically terrain corrected (RTC) backscatter products. Beyond his presentation, Mr. Delgado also walked the participants through the basics of using GEE's Code Editor, including how to execute simple scripts and how to consult the code documentation accessible through the Code Editor.

Figure 7: *Mr. Francisco Delgado (NASA) presents on the applicability of Google Earth Engine (GEE) to SAR data processing.*

- In the afternoon session, Dr. Emil Cherrington (NASA) led an exercise involving pre-cooked GEE scripts for (i) displaying S1 imagery over Costa Rica (e.g. https://code.earthengine.google.com/697215dc43996ac53597e388f8a8dc3c), (ii) the comparison of SAR imagery with multispectral imagery from Landsat, and (iii) extraction of time series data for Costa Rican land cover types (e.g. https://code.earthengine.google.com/30f0cefb26e1b98a52f49519ea1dfd7a). Workshop participants were also invited to analyze the patterns of intra-annual variation in the backscattering coefficient values from their respective professional perspectives (e.g. agronomy, biology, meteorology). As shown in **Figure 8**, one participant went in front of the class to explain why the radar backscatter over banana plantations on the Caribbean coast of Costa Rica appeared to vary across the year.
- Following the session on GEE, the workshop proceeded to a discussion regarding potential follow-up activities on behalf of the workshop participants. Following that discussion, the workshop closed with delivery of the course completion certificates to the 14 participants.
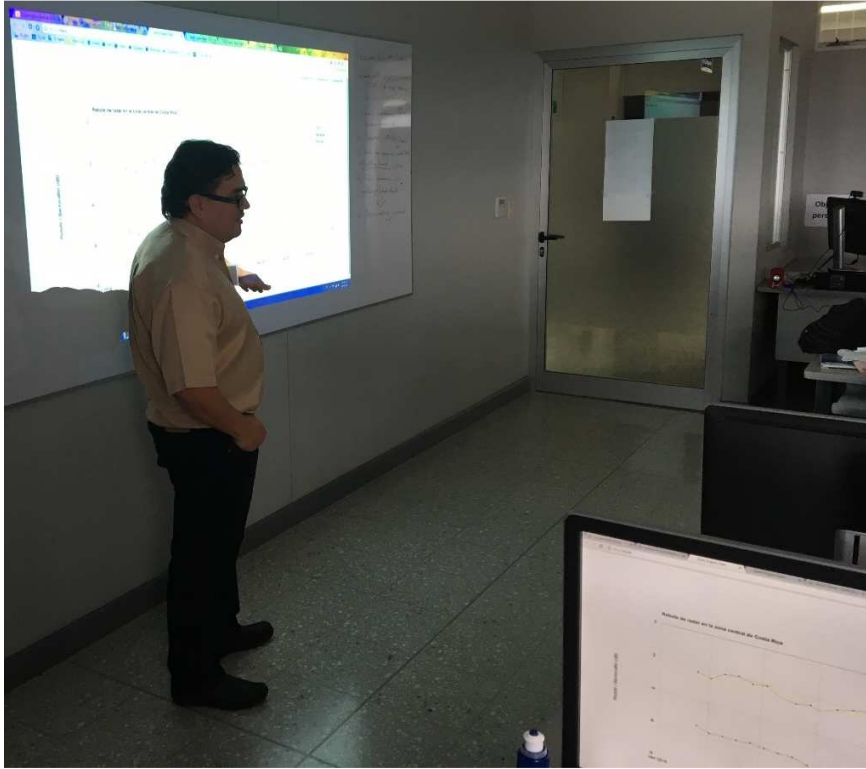
Figure 8: *A workshop participant explaining why backscattering coefficient values over banana plantations vary during the year.*

6. Annex: Workshop agenda

Date / Time	Activity	Presenter
Day 1: Monday 31 July 2017		
9:00-11:45am	Opening plenary	Various
11:45am-1pm	*Lunch break*	
1:00-1:30pm	Course overview / introduction to CEOS and the WGCapD	Sergio Camacho / CRECTEALC
1:30-3pm	Fundamentals of microwave remote sensing	Genaro Olivera / CRECTELAC
3:00-3:15pm	*Coffee break*	
3:15-5pm	Overview of SAR data portals	Emil Cherrington / NASA
Day 2: Tuesday 1 August 2017		
8:50-9:00am	Review of previous day's activities	Emil Cherrington, Francisco Delgado / NASA
9-11:00am	Overview of SAR polarimetry and applications for forestry and biomass	Shashi Kumar / ISRO
11-11:15am	*Coffee break*	
11:15am-12pm	Visualization of SAR data using QGIS	Francisco Delgado / NASA
12-1pm	*Lunch break*	
1-3pm	Application of SAR for flood monitoring	Manoel Souza / UFSM
3-3:15pm	*Coffee break*	
3:15-5pm	Application of SAR interferometry for deformation monitoring	Tomas Zajc / CONAE
Day 3: Thursday 3 August 2017		
8:50-9:00am	Review of previous day's activities	Emil Cherrington, Francisco Delgado / NASA
9-10am	Overview of SAR-EDU	Robert Eckardt / FSU Jena
10-11am	Application of WaMaPro for flood mapping	Phila Sibandze / SANSA
11am-12pm	Rapid Google Earth Engine (GEE) demo	Emil Cherrington / NASA
12-1pm	*Lunch break*	
1-2pm	Introduction to SAR polarimetry	Naiara Pinto / NASA
2-3pm	Introduction to SAR interferometry	Eric Fielding / NASA
3-5pm	SAR interferometry exercise	Eric Fielding / NASA
Day 4: Friday 4 August 2017		
8:50-9:00am	Review of previous day's activities	Emil Cherrington, Francisco Delgado / NASA
9-10:30am	Demo of AmeriGEOSS Community Platform	Angelica Gutierrez / NOAA Michelle Anthony / USGS
10:30am-12pm	Introduction to Google Earth Engine (GEE)	Francisco Delgado / NASA
12-1pm	*Lunch break*	
1-3:30pm	Cloud-based processing of SAR data in GEE	Emil Cherrington / NASA
3:30-4pm	Group discussion	Emil Cherrington, Francisco Delgado / NASA
4-4:15pm	Handing out of certificates / workshop closure	Emil Cherrington, Francisco Delgado / NASA