CEOS DRM Landslide Pilot - Overview
14 October, 2016

CEOS Landslide Pilot Sep 2016 - end 2018 Theme area: LANDSLIDES	**CEOS Proposal Development Lead:** Dalia Kirschbaum, National Aeronautics and Space Administration (NASA), Sigrid Roessner (GFZ German Research Centre for Geosciences), Jean-Philippe Malet (EOST/U. of Strasbourg), Jonathan Godt, U.S. Geological Survey (USGS).
Geographic areas of focus will include a combination of geophysical and human variables. There will be two main focus areas and several experimental regions: - *Main*: Nepal, Pacific Northwest (Washington & Oregon), USA - *Experimental*: Southeast Alaska, China, Caribbean (Haiti and Lesser Antilles), Peru, Indonesia	**Potential User Implementation Leads:** • Regional End User Groups (E.g. ICIMOD, US State-based DOTs, CDEMA) **CEOS Implementation Lead:** NASA, USGS, GFZ, U. of Strasbourg. Regional leads will be assigned for each region. At present, the leads are as follows: **Nepal** – Nick Rosser (Durham U), Sigrid Roessner (GFZ) **Washington & Oregon**, USA – Dalia Kirschbaum (NASA), Jonathan Godt (USGS) **Southeast Alaska, USA** – Jonathan Godt (USGS), Marten Geertsema (UBC) **Southwest China** - Zeng-Guang Zhou (CAS) **Haiti and Lesser Antilles** – Jean-Philippe Malet (EOST/U. of Strasbourg), Enrique Castellanos (Cuba) **Peru** – Jeff Kargel (U of Arizona) **Indonesia** - TBD
Partners: <u>CEOS agencies</u>: NASA, NOAA, Agenzia Spaziale Italiana (ASI), Canadian Space Agency (CSA), European Space Agency (ESA), Centre National d'Etudes Spatiales (CNES), South African National Space Agency (SANSA), United States Geological Survey (USGS), JAXA. <u>Non CEOS agencies</u>: Italian Consiglio Nazionale delle Ricerche (CNR IRPI) [More to be added here]	**Contributing projects:** • GEP (https://geohazards-tep.eo.esa.int) Other relevant projects: • International Charter • Global Disaster Alert and Coordination System (GDACS)
	Pilot objectives: Landslides occur in all continents, play an important role in the evolution of landscapes, and represent a serious hazard in many areas of the world. Despite their importance, it has been estimated that landslide and landslide potential maps cover less than 1% of the slopes in the landmasses, and systematic information on the type, abundance and distribution of existing landslides is lacking. Even in countries where landslide information is abundant (e.g., Italy), the vast majority of landslides caused by meteorological (e.g., intense or prolonged rainfall, rapid snowmelt) or geophysical (earthquake) triggers goes undetected. This paucity of knowledge has consequences on the design of effective remedial and mitigation measures. Systematic use of Earth observations (EO) data and technologies can contribute effectively to detect, map and monitor landslides and landslide prone hillsides, in different physiographic and climatic regions. The CEOS Landslide Pilot aims to demonstrate the effective exploitation of satellite EO across the full cycle of landslide disaster risk management, including preparedness, situational awareness, response and recovery, at global, regional and local scales, with a distinct multi-hazard focus on cascading impacts and risks. The pilot accomplishes this by: • **Objective A** – Establish effective practices for merging different Earth Observation data (e.g. optical and radar) to better monitor and map landslide activity over time and space.

	• **Objective B** – Demonstrate how landslide products, models or services can support disaster risk management for multi-hazard and cascading landslide events. • **Objective C** – Engage and partner with data brokers and end users to understand user and service requirements, user expectations, and to get feedback through the activities described in objectives A & B. **CEOS objectives:** • Leverage and exploit existing imagery, technology for processing data, and expertise provided for the other three pilots, where applicable, for rapid development and application within landslide/multi-hazard pilot activities; • Improve coordination and sharing of satellite acquisitions and data products in support of landslide management across the existing flood, seismic, and volcano pilots to maximize utility of CEOS contributions; • Demonstrate the value of satellite EO in the context of integrated landslide management practices. • Capture and maximize use of lessons learned from other pilots (volcanoes, earthquakes, floods), including the participation of key contributors and end users of the pilots.

Description:
CEOS contribution to pilot: CEOS will act as the coordinating body to ensure the support and participation of member agencies in executing this project. The main contributions of CEOS agencies are: (a) maintenance and improvements to existing global-scale efforts; and (b) coordinate higher spatial resolution satellite observations before, during and after events in the three regions of interest. In some cases, agencies are providing value-added products & services, and modeling support and product validation work. CEOS agencies are providing project management support to oversee the implementation of the landslide pilot.

Key pilot outputs/deliverables:

• Report on recommended practices for the combined exploitation of SAR and Optical imagery and technologies for landslide detection, mapping and monitoring".
• Report on effective methodologies and strategies for considering multi-hazard and cascading aspect of landslides through multi-temporal landslide mapping from multiple triggers (leveraging information/interactions with the volcano, flood and earthquake pilots)
• Landslide event inventory and activity (monitoring) maps produced using optical and SAR imagery and technologies, and their combination, for selected case studies / geographical areas.
• Report on end user engagement strategies and characterize enablers, challenges, barriers to effective transfer of information, knowledge and technologies.

CEOS outputs/deliverables:
• Coordinate satellite EO data acquisitions to support integration of SAR and Optical technologies contributing towards integrated landslide risk management in three regions.
• Plan for satellite data acquisitions to support landslide monitoring beyond 2018.

Key user communities:
- Users: national, regional and local governments, civil protection agencies, meteorological and geological services, land use planning decision makers, disaster risk reduction specialists with NGOs and international organisations, industry (including e.g., insurance, transport, forestry sectors).
- Practitioners: landslide modelers, scientists and engineers in hydrology, water and environment ministries, meteorological and geological services, satellite data providers, volcano observatories, and value added service companies.
- Institutional bodies responsible for communication of risk (gap between technical level and shared information with communities): research institutions with operational responsibilities.
- General public: landslide event information for some of the case studies will be made available to the general public for increased awareness of these hazards and remote sensing capabilities, although the main focus of the pilot is on specialized users.

The pilot recognizes that users of the pilot outputs and products & services may be different according to global / regional / local interests, and will endeavor to build stronger relationships with all categories of users through dedicated outreach activities.

Key outcomes:
1. Establishment of effective practices in the synergistic use of optical and SAR imagery and technologies for landslide inventory analysis, risk assessment, disaster response and recovery
2. Demonstration of capabilities in key study areas through the application of recommended practices in integrated imagery assessment
3. Integration and application of results across pilot areas with specific case studies within the pilot study regions
4. Lessons learned for integrating SAR and Optical data and techniques for a more informative suite of products for assessing disasters, and pilot integration for multi-hazard risk management.

Milestones and schedule:
Year 1: Investigation of SAR and Optical imagery technologies and products, foster dialogue with other Pilots, partner with users and brokers, select and start case studies in selected regions.
- Scoping what is available for optical and SAR imagery and technologies, including their synergistic / integrated use for the detection, mapping and monitoring of landslides, in a multi-threat context.
- Establish case studies in the two main pilot regions (Nepal, Pacific Northwest, USA), define end user partners and discuss their needs and expectations.
- Assemble data and expertise from other pilots and coordinate with relevant experts across these pilots
Year 2: Case Studies in Pilot Regions
- Focus on application of effective practices for optical and SAR imagery use and integration, for the detection, mapping and monitoring of landslides, for selected areas in a multi-threat context.
- Extend case studies to other pilot areas and refine experimental areas
- Continued engagement with brokers and end users to inform needs, obtain feedback, and pipelines for data dissemination.
Year 3: Summarize Case Studies and Lessons Learned with other Pilots
- Complete regional case studies and summarize findings.
- Lessons learned from optical and SAR imagery integration and product development, and how the products & services were used to inform end user decision making in landslide/multi-hazard risk assessment, awareness, response and recovery.

EO data requirements:
The CEOS landslide thematic team will develop detailed EO data requirements, which identify specific polygons of interest and frequency of observations for various satellite types and specific satellite sensors. Data provided must be ortho-rectified and geo-located by the imagery providers for integration into user systems and products, which in turn are designed with open standards to encourage transmission and sharing across regions. The EO data requirements were presented in draft form to the CEOS Disasters Working Group (WGDis) in March 2016, and further defined during the face-to-face meeting in Vancouver, WA in September 2016. Agreement in principal to provide/share certain data reached within CEOS Disasters Working Group in October 2016. Detailed agreements between Landslide Pilot team members

and agency representatives on the Data Coordination Team will be finalized September – November 2016. The EO data requirements include both archived data from past and existing missions (e.g., ERS 1&2, Envisat MERIS and ASAR, Terra and Aqua MODIS, S-NPP, TRMM and GPM, Radarsat-1 and 2, ALOS-1 and 2, COSMO-SkyMed, TerraSAR-X, Proba-V, Landsat-8, EO-1, Pleiades, SPOT-5, SPOT-6/7, Aqua AMSR-E, GCOM-W1 AMSR-2, Sentinel-1, GRACE,) and new data from upcoming missions (Sentinel-2, SMAP). The Landslide Pilot plan will be presented to the CEOS plenary for official approval November 2016.

Main contribution by partner:
- NASA: Lead Pilot Effort. EO-1 and ALI data (free of charge)
- University of Strasbourg: Conduct technical investigations into merging of different image data sources and outlining of best practices, expertise in automated processing chains for landslide monitoring
- GFZ German Research Centre for Geosciences: Support technical elements of data fusion and processing and support regional activities, where relevant, related to the technical elements of case studies
- USGS: Contribute expertise in landslide mapping, imagery interpretation, and landslide science, monitoring, and hazard assessment. Landsat-8 and OLI data (free of charge)
- JAXA: TBD: request up to 500 images total for the 3 years of this pilot from ALOS-2 for demonstration purposes.
- CSA: up to 260 RADARSAT-2 data over some regional pilot areas, leveraging existing scenes
- ESA: all ERS and ENVISAT archived radar data, Sentinel-1 radar data and Sentinel-2 optical data (free of charge), access to GEP platform for EO data processing (to be confirmed within the first 6 months of the pilot starting)
- CNES: 190 SPOT and up to 100 Pleiades data total over the regional pilot areas for the 3 year pilot.
- ASI: up to 400 COSMO-SkyMed images over some regional pilot areas plus access to up to another 225 archive images over the 3 year pilot.
- DLR: up to 560 TerraSAR-X images over the 3 year pilot including archived data.
- Regional end user partners (to be defined in the first year)

User Engagement:
- Engage with users in development and scoping of landslide pilot products, technologies and capabilities
- Deliver the products & services of the landslide pilot to the users, obtain feedback, analyze the feedback.
- Present the scopes and results of the landslide pilot to the scientific / technical communities at global & regional meetings.
- Disseminate the results of the pilot activities through a broad range of users, with specific actions targeted based on the regions selected for case studies in this pilot.

Suggested evaluation criteria:
1. Quality of products & services delivered by the pilot evaluated by (i) key users, (ii) landslide experts, (iii) multi-risk, DRM experts.
2. Number of products & services delivered by the pilot in the lifetime of the pilot.
3. Measure the awareness raised by the landslide pilot on space data and technologies and on landslide problems using target methods & tools.

Potential Pilot Participants/Candidates:
Dalia Kirschbaum (NASA), Sigrid Roessner (GFZ German Research Centre for Geosciences), Jean-Philippe Malet (EOST/U of Strasbourg), Jonathan Godt (USGS), Vern Singhroy (NRCan), David Schmidt (U Washington), Josh Roering (U Oregon), Irina Pavlova (UNESCO), Claudia Notarnicola (EURAC). There are currently 50+ members of the Landslide Pilot including data practitioners, scientists and end users. This list will be better refined within the first 6 months of this pilot starting.