

**CEOS WGD LANDSLIDE DEMONSTRATOR**  
**“EO-based Landslide services:**  
**Paving the Way for Landslide Risk Management Products”**

**Implementation Plan**

Version 1.0 - 3 March 2021

**PIs:** Jean-Philippe Malet (CNRS/EOST), Dalia Kirschbaum (NASA)  
Corey Froese (BGC), Clément Michoud (Terranum srl)

**Partnership:**

- *Academic/Science participants:* Olivier Dewitte (RMCA), Odin Mac (CNRS/GET), Giovanni Crosta (UNIMIB), Canada Centre for Remote Sensing (CCRS) and others to be discussed with colleagues once the draft is approved.
- *Private market participants:* BGC Engineering, Terranum, SAGE, SNCF Réseau, BP Pipeline Group, TerraDue, Pembina Pipelines, Canadian Natural Resources, Enbridge Gas
- *Space agencies participants:* DLR, CSA, CNES, ASI, ESA, NASA, CNSA (and possibly other to be finalized during data discussions)
- *International organizations:* World Bank, FSEC (Morocco), LandAware Consortium, World Landslide Forum.

**1. Overview and Objectives**

The **CEOS LANDSLIDE Demonstrator** builds on the outcomes of the **CEOS LANDSLIDE Pilot**, which had the primarily results of establishing guidelines and relevant criteria for the operational use of EO (satellite) data for landslide detection, mapping and monitoring at several spatial scales, for several landslide types, and several landscape conditions (mountain ranges, volcanoes, tropical areas) (Malet et al. *in preparation*). As part of these efforts, several pilot study areas were established to demonstrate the effective application of remote sensing data for landslide hazard assessment, mapping and analysis. The primarily findings of the LANDSLIDE Pilot are that:

- EO satellite data can effectively support the estimation of relevant landslide parameters (location, size, velocity, triggers) over large spatial domains;
- the combination of Synthetic Aperture Radar (SAR), multispectral and microwave satellite data can improve classical landslide modelling approaches;
- EO satellite data can provide first order estimates of landslide hazard where local ground-based observation capacity is limited, making it highly suitable for applications in developing countries.

The **LANDSLIDE Demonstrator's primary goals** are to:

- Demonstrate the usefulness of satellite data for *operational applications of landslide disaster risk management (DRM)* with the ultimate goal to increase resilience against landslide disasters. Specifically the goals of this work are:
  - the use of satellite data for landslide disaster assessment and mitigation along linear transportation and energy corridors crossing landslide-prone terrains, with both the goal of establishing local monitoring of areas of possible danger with regularity and consistency of observation, and of facilitating the assessment of the future evolution of these slopes. This goal is tailored by operational needs of geological engineering

- companies (BGC, SAGE), pipeline operators (BP and a Canadian consortium) and SNCF RESEAU (French Railway network), among others) in charge of landslide monitoring and mitigation at local scales [*Application 1*];
- the use of satellite data for establishing landslide risk financing products (country or region risk profiles, hazard and risk maps). This goal explores opportunities for advancing this topic, working specifically with the World Bank Disaster Risk Financing and Insurance Program (DRFIP) and potentially other groups in the future [*Application 2*].
- Demonstrate the usefulness of satellite data for *landslide science* at global scale, with the systematic documentation of large landslide disasters triggered by intense rainfall and/or high magnitude earthquakes in terms of standardized inventories of different complexity (landslide location, landslide surface, landslide typology, landslide triggers). This goal is in full complementarity of recent efforts of the landslide science community in developing automatic landslide detection methods, and in sharing publicly landslide catalogues (e.g. NASA catalogue <https://landslides.nasa.gov/viewer>) to facilitate the use development of hazard assessment models [*Application 3*].
- Demonstrate the *usefulness of tailored services* combining EO data access/provisioning to data processing on High Performance clusters and platforms, and products sharing. This goal makes use of existing services and exploitation platforms such as ESA's GEP. This is of high interest to international organizations such as, for instance, the [LandAware](#) network, focusing on Landslide Early Warning systems.
- Develop a plan for *sustainable use* of satellite imagery and processing services for the landslide science and risk mitigation community.

The **LANDSLIDE Demonstrator's main tasks** are to:

- Showcase satellite tailored services and products for the 3 thematic applications over relevant areas of interest for the 2021-2023 period;
- Document the data and services with the creation of on-line demonstration/dissemination materials in order to extend the use of the data and services to a larger partnership of *landslide DRM stakeholders* for regular use of satellite imagery, on-line processing services and derived products;
- Value the Landslide Demonstrator multi-sectorial partnership by providing timely support (in best-effort mode) to the 3 thematic applications in terms of facilitating the provision of satellite-derived products, the access to processing resources, and the support of the use of the services.

The LANDSLIDE Demonstrator PIs will monitor the overall process, but for each application a smaller group of persons will act as Application Leader. The Application Leaders are (tentative list):

- [*Application 1*]: Jean-Philippe Malet (CNRS/EOST), Corey Froese (BGC)
- [*Application 2*]: Clément Michoud (Teranum) and ? (to be defined).
- [*Application 3*]: Dalia Kirschbaum(NASA), Jean-Philippe Malet (CNRS/EOST) and Olivier Dewitte (RMCA).

A final report after the three-year demonstration period will document the successes, challenges and lessons learned during the process. The LANDSLIDE demonstrator is a project that is implemented by volunteer contributions and is without a dedicated budget for the execution of the work. Work is performed on a 'best-efforts' basis, supported by in-kind contribution of partners. For [*Application 1*], the demonstrator builds on dedicated in-kind efforts of private engineering companies and, for the European Alps use case, on the ESA EO4Alps and ALCOTRA Interreg projects. For the Canadian use case, both Natural Resources Canada and the Canadian Space Agency have indicated that they would provide support in terms of access to data and processing resources. For

[Application 2], the demonstrator builds on a partnership with the World Bank and the FSEC/Morocco, and links will be established with ADB. For [Application 3], the demonstrator builds, partly on the newly established LandAware consortium seeking to advance the sharing of landslide data related to early warning systems, and the EO4Alps project seeking to construct and update consistent landslide inventories for quantitative hazard modelling and assessments.

The LANDSLIDE Demonstrator Implementation Plan is presented to the CEOS plenary for approval in the first months of 2021.

## 2. Demonstrator Description

The frequency and impact of landslide disasters continue to rise in many regions of the World resulting from changes in the meteorological regimes and increased exposures of the population by high rates of urbanization. This situation calls for effective disaster risk management, innovative risk financing solutions, and better knowledge on the space and time distribution of landslides (e.g inventories) and of their triggers at the local, country and global scales. In response to these challenges, the LANDSLIDE Demonstrator targets the demonstration of the usefulness of EO satellite imagery and of on-line processing services and platforms for three applications where relevant stakeholders expressed high interest.

### **[Application 1]: Operational Landslide Monitoring EO Products for increasing the resilience of transportation and energy corridors**

Highway, railway and pipeline operators face numerous operational challenges from landslides. Current monitoring solutions used by industry and private engineering offices include mostly in-situ observation and instrumentation (ranging from boreholes to in-situ geodetic surveying, and frequent site inspections). Important limitations of these methods include difficulties in obtaining spatially continuous, high-accuracy measurements over large areas, including areas far outside of the exposed asset (road, rail track, pipeline) and early and accurate identification of developing unstable slopes. The recent access to high resolution and high temporal frequency SAR satellite imagery, in combination with very-high resolution multispectral data, and progress in image processing technologies (SAR interferometry, SAR and optical image correlation and offset tracking) to quantify terrain motion allow to envisage the operational use of EO satellite data, in combination with geomechanical models, to anticipate landslide hazards along the corridors.

The LANDSLIDE Demonstrator, in cooperation with private engineering offices, will demonstrate the operational usefulness of satellite data and processing services to deliver operational information to highways, railways and pipelines owners/operators. The information to be provided ranges from regularly updated terrain motion maps along the corridors, to post-event damage assessment including maps of affected areas, and to better understanding of the processes (linking terrain motion maps to geomechanical models) in terms of causative factors and triggers. The activity will concentrate on the development of services and products over four pilot use cases, but will have flexibility to expand or decrease the number based on level of interest and engagement by users.

- in the European Alps, along the transportation corridor of Grand Saint-Bernard linking Swiss to Italy and France), by combining VHR optical imagery and InSAR derived ground motion maps;
- in Canada, in the Swan Hills region of Alberta, with the integration of InSAR data into geohazards management programs for a large number of pipeline operators with assets crossing deep seated slowly moving landslides.
- in the US/Midwest, in collaboration with the BP Pipeline Safety Group for an InSAR-based landslide hazard characterization along pipelines;

- in China, in the East/Southeast regions of the Tibetan Plateau, by integrating optical, InSAR and UAV LiDAR observations for the assessment of landslide risk along Sichuan-Tibet transportation corridors.

All the development will be generic to be easily transferred to other settings, countries and risk situations. In practice, the application targets:

- the access to relevant EO-based services for the creation terrain motion maps relevant to corridor monitoring,
- the development of a NRT thematic processing application for landslide monitoring (EO4Alps-Landslide App) on the GEP platform,
- assessing the potential to link the data derived from the GEP platform into geohazards risk management platforms utilized by consultants and asset owners,
- the creation of training/dissemination material to support the users of the application.

#### **Deliverables for this application**

- Implement operationally and evaluate the synergistic use/fusion of optical and SAR derived information to obtain a complete picture of the hazard situation along the corridors,
- Foster the use of processing applications and services (GEP, BGC, Terranum) for assets owners,
- Peer-reviewed article that highlights the joint use of EO data and landslide models for corridor management.

#### **[Application 2]: Operational Landslide EO Products for Disaster Risk Financing and Insurance Program**

Disaster Risk Financing (DRF) products strengthen the capacity of governments to take informed decisions on disaster risk finance based on sound actuarial exposure analysis in order to support stakeholders (national and local governments, homeowners, businesses, agricultural producers, and low-income populations) with better risk information and increase financial resilience.

The LANDSLIDE Demonstrator, in cooperation with World Bank and FSEC/Morocco, will develop a methodological concept and access to a processing platform prototype to respond to incipient likely landslide events (in Near-Real Time, NRT) in order to provide estimates of parameters suitable to inform parametric insurance calculations. The activity will concentrate on the development of services and products over a pilot use case in Morocco, but all the development will be generic with the goal of straightforward transferability to other countries and risk situations. In practice, the application targets:

- the access to relevant EO-based services for the creation of products (landslide inventory maps, landslide susceptibility/hazard and exposure/impact maps) relevant to DRF analysis,
- the development of a NRT thematic processing application for DRF analyses on the GEP platform,
- the creation of training/dissemination material to support the users of the application.

This activity will also seek out other opportunities to engage with stakeholder communities and landslide data and model providers on the topic of disaster risk financing, mostly in South East Asia, with connections with the Asian Development Bank (ADB), and in connexion with the GEP operator/Terradue.

#### **Deliverables for this application**

- Promote the use of EO data and landslide models for DRF assessments with relevant training material for insurance companies / state organizations,
- Promote the uptake of the future LHIS Information System to a broad international community,
- Peer-reviewed article that highlights the value of EO data and models for DRF assessments.

### **[Application 3]: Systematic Documentation and Development of Landslide Inventories and Models at Global Scale**

This application of the demonstrator seeks to promote open data and open science (codes) that can be used for landslide model development and evaluation. Relevant data includes landslide occurrence (location, timing, type of failure, triggering mechanism) and impacts (fatalities, damages, costs), as well as inputs needed for innovations in landslide early warning models (soils, vegetation, rainfall, soil moisture, seismic activity, etc.). Using several on-going initiatives (LandAware working group, EO4Alps-Landslide project, EGM Service) and the amount of information provided by the landslide activation of the International Disaster Charter, we will advance these topics with a specific focus on growing the open availability of landslide data. These initiatives will help in highlighting the availability, quality and access to landslide and other data supporting both Landslide Early Warning Systems (LEWS; <https://www.landaware.org/wgs/wg-lews-data/>) and Landslide Quantitative Hazard Assessment (LQRA).

A key component of this application is the joint and collaborative evaluation of landslide inventories and landslide mapping/detection codes to advance landslide mapping efforts by the community. By establishing reference/benchmark datasets and providing a framework to share inventories across countries, research groups, and practitioners we will seek to create benchmark datasets that will support and advance landslide modeling for the community. The goals of this application are:

- Propose standards for creating and publishing an EO-based landslide inventory
- Advance open systems and/or repositories to publish landslide inventories (e.g. <https://landslides.nasa.gov>), but with the goal of providing a system curated by a consortium (rather than an individual group).
- Increase access to on-line systems (or at least to open source algorithms) to detect and map landslides from SAR and multispectral data, leveraging public code archiving systems,, and linking them to processing resources (e.g. GEP Thematic App Landslide, future GEP EO4Alps-Landslide Information System - <https://geohazards-tep.eu> ).
- Support disaster response for landslide events when there is a need from the community and imagery is available. We will develop criteria for when and how to engage in this type of effort during Year 1 of this demonstrator.

#### **Deliverables for this application**

- Contribute to a Virtual Workshop on open landslide data and open science to encourage the community to share landslide information
- White paper on the need for and potential to develop an open landslides database and best practices for developing inventories based on need/purpose.
- Peer reviewed summary article that highlights opportunities and challenges of accessing, utilizing and advancing data related to landslide inventory development, analysis and use.

### **3. Demonstrator Schedule**

Our vision for the development of the LANDSLIDE Demonstrator project over the next three years is:

#### **Year 1 (June 2021 – June 2022):**

- Definition of landslide services and products requirements for the three applications.
- EO-satellite database creation for the geographical use cases.
- Consolidation of resources (persons, data, IT processing).

#### **Year 2 (June 2022 – June 2023):**

- Demonstration of the landslide services for some use cases and reporting;
- Concept of the prototype demonstration App on GEP for the three applications.

### **Year 3 (June 2023 – June 2024):**

- Implementation of the prototype demonstration App on GEP for the three applications;
- Training and dissemination on-line user-oriented material for the three applications.
- Final Demonstrator reporting

## **4. Demonstrator Outcomes**

### **Key outcomes:**

- Three thematic information systems (e.g. “Thematic App”) on GEP for the three Demonstration application.
- Recommendation for synergistic use of optical and SAR imagery and EO derived products for DRM (transportation and energy corridor monitoring), DRF (landslide risk financing assessment) and Science (causes and triggers of large landslide disasters) applications.
- Peer-reviewed research articles and training/dissemination on-line material (targeted to categories of users). If possible, a specific outreach activity will be organized at the end of the Demonstrator period.

### **High level outcomes:**

- Increased uptake of satellite imagery, processing services and platforms for users in the target use cases.

### **Key pilot outputs/deliverables:**

- Guidelines of landslide services and products for transportation corridor monitoring from satellite imagery.
- Guidelines of landslide services and products for risk financing products creation from satellite imagery.
- Lessons-learned and sustainable plan for uptake of the Demonstrator outcomes for other users.

## **5. Key User Communities and Benefit**

As defined by the DEMONSTRATOR consortium, the **users** of the LANDSLIDE Demonstrator are research scientists, staff from engineering geology and risk analysis companies, and technical operators from international organizations in charge of landslide DRM.

The **beneficiaries** of the Landslide Demonstrator will encompass a broader group of operators including:

- Geological Surveys and Environmental Agencies in charge of landslide DRM, and which have, most of the time, the task to operate landslide inventories and to provide hazard assessments at regional/national scales. In this context, having access to standardized assessment procedures and EO-based landslide services might be relevant for their daily work;
- Engineering Geology and Risk Analysis companies which support local and regional authorities for the operational management of landslide risks, providing specialized consultancies in the geological, geomatics, geotechnical and civil engineering fields with the aim to provide to their end-users clients the necessary information for risk mitigation purposes;
- Governmental authorities in charge of landslide risk management, which consist of administrations with several roles, such as a) public operators responsible for natural hazard regulation whose job is to prepare land-use regulatory documents, b) civil protection, relief and emergency services, whose job is to prepare contingency plans, c) public/private

operators responsible for facility (building, critical infrastructure) planning and management whose task is to draft regulations/codes of practice for construction ensuring that adequate protection is provided at minimum cost;

- Insurance and reinsurance companies that are seeking additional information on historic landslide information or would like to advance their models to better characterize landslide risk, which is a growing area of interest for this community.

The LANDSLIDE Demonstrator recognizes that users of the services and products may be different according to global / regional / local use case, and to the legal risk framework in the country. The training/dissemination material will be tailored to the user's needs in order to build stronger relationships with all categories of beneficiaries.

## 6. EO data requirements

### EO satellite data:

The EO satellite data requests consists:

- For [Application 1] and [Application 2], to archive and new regular acquisitions over relevant AOIs, time intervals and time period in Morocco [Application 1], and Swiss/Italy/France, Canada, the US, and China (possibly) for [Application 2];
- For [Application 3], to archive and new acquisitions of pre/post disaster imagery at global scales for relevant landslide disasters. The team will define criteria to select landslide disaster to analyze for this application. If possible, the disaster might be similar to those used for response by the International Disaster Charter, the Copernicus EMS Rapid Mapping, the CNES CIEST2 Activation program, or any other relevant initiatives.

The EO satellite data must be provided both at Level 1C and at Level “analysis ready” for optimal use of the landslide processing services, and easy integration into user systems. The derived products will be designed with open standards to encourage transmission and sharing across organizations and regions. The EO data requirements include both archived and new image data from the satellite missions of CEOS member agencies (e.g., Radarsat-2 and RCM, COSMO-SkyMed, TerraSAR-X, TanDEM-X DSM, Landsat-8, Pléiades, SPOT-6/7, Sentinel-1 and 2, and others).

The details of the data provision plan has to be coordinated with the WGDisasters Data Coordination Team (DCT) and relevant member agencies, and should be established by 30 April 2021.

### Target sites for the Demonstration Activity



#### **CEOS Landslide Demonstrator**

- Application 1 / Corridor (1a: Canada/Alberta – Swan Hills, 1b: France-Italy-Swiss - Aosta/Wallis/Arve , 1c: US – Midwest)
- Application 2 / DRF (2a: Morroco / Rif-Tetouan-Tanger, 2b: Indonesia)
- Application 3 / Inventories

#### **Processing resources:**

- Access to GEP services and processing resources (using NoR mechanism) for running rapid mapping algorithms for landslide detection (e.g. that could be scalable and deployable for specific events).
- Access to CNES/CNRS ForM@Ter EO-based services and data repositories for on-line image processing webservices.
- Access to NASA processing platforms (e.g. ArcGIS application on <https://landslides.nasa.gov>)

## **7. Partner Contributions**

CEOS, through the LANDSLIDE Demonstrator co-lead NASA, 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) data from satellites (archive and new acquisitions), including higher spatial resolution satellite observations pre/post landslide disaster, and/or acquired over a specific AOI for a given revisit time and a time period;
- (b) coordination of access to landslide processing services and calculation facilities for the partners;
- (c) ad hoc support to capacity building in the beneficiary country;
- (d) support to legacy planning by developing relationships for long-term sustainability of demonstrator successes;
- (e) project management support to oversee implementation and reporting for the demonstrator.

The following organizations envisage a contribution to the LANDSLIDE Demonstrator:

#### **CEOS Agencies**

- **ASI:** Cosmo-SKYMED imagery for the use case. They have agreed to participate but the data provision plan needs to be defined.
- **CNES:** CNES will provide Pléiades and SPOT imagery for the use case linked to Activity 1, 2 and 3 on specific use cases (in French Alps and Canada/Swan Hills for Activity 1, in Morocco for Activity

2, worldwide on a case by case basis and linked to the Charter/Ciest activations for Activity 3). In addition, CNES might provide access to relevant processing resources (e.g. ForM@Ter on-line webservices) and ad-hoc codes on a case by case / user by user initiative). Data provision to be defined.

- **CNSA:** Chinese space agency has agreed to participate - **data provision plan to be defined.**
- **CSA/CCMEO:** The Canadian government, through the Canadian Space Agency (CSA) and the Canada Centre for Mapping and Earth Observation (CCMEO) will provide support to task and acquire RCM and Radarsat-2 data over the Canada/Swan Hills study area. In addition, CCMEO has indicated that they would be able to provide staff resources to support processing of the RCM data **(NEED TO BE CONFIRMED)**
- **DLR:** TerraSAR-X imagery and TanDEM-X related-DSM for the use cases ..... **NEED TO DISCUSS WITH DLR**
- **ESA:** access to the ESA GeoHazard Exploitation Platform (GEP; see 11. Appendix for further information) and its resources for a defined list of users, using the Network of Resources mechanism.
- **NASA:** NASA will provide access to all data and model products relevant for this purpose that are publicly accessible via NASA Github (<https://github.com/nasa>) and the NASA Distributed Active Archive Centers (<https://earthdata.nasa.gov/eosdis/daacs>). NASA will provide coordination support across the three Applications, where needed, for data requesting and tasking from other agencies as well as development of reports and publications.

**The landslide Demonstrator community has a real interest in using the following sensor data:**

- **Priority 1: JAXA:** To be engaged on this topic - the North American sites and the Alpine site would greatly benefit from L-Band
- **Priority 2: CONAE -Argentinian Space Agency - Potential for L-band SAOCOM**
- **Priority 3: PNOTS - Spanish Space Agency:** potential interest for X-band PAZ

**Other agencies and organizations**

- World Bank / GFDRR: sponsor of the LHIS-P project over Morocco
- Industry groups: (Transportation-US, Transportation Research Board, Pipeline Research Council International / PRCI)
- Landslide Technical Groups and Research Societies: JTC-1, WLF, LandAware

## **8. Suggested Evaluation Criteria**

The LANDSLIDE Demonstrator will be evaluated after its three-year project period and this evaluation will seek to determine:

- The usefulness of satellite-based landslide products as compared to before the LANDSLIDE Demonstrator;
- The Increased benefits of user-tailored information systems (e.g. Thematic App) to improved and more efficient work and decision-making of the Demonstrator's users and beneficiaries;
- The willingness of landslide DRM partners to explore sustainable approaches to increased satellite use.

## **9. Governance and Risk Management**

The LANDSLIDE Demonstrator will be managed on a best effort basis by the project partners. We will convene a working group for each of the 3 Applications depending on the goals, objectives and timeline of the efforts. The working groups will be: open to anyone involved in the community, led by the representatives identified in Section 1, report back semi-annually on progress as well as provide updates for the CEOS Disaster WG meetings.

## **10. Outreach and Dissemination**

The LANDSLIDE Demonstrator team will identify specific events (e.g. Understanding Risk 2022, ISL, ISPRS, IGARSS, EGU, AGU, industry meetings) at which presentations or side session discussion may promote the work of the LANDSLIDE Demonstrator and increase the ability to identify partners for sustainability. The LANDSLIDE Demonstrator team members will seek to attend these events in order to promote the demonstrator outputs.

## **11. Appendix**

### **ESA / Geohazards Exploitation Platform (GEP)**

GEP is a Cloud-based environment to process imagery and share EO-based products within a community of users. It allows both on demand and systematic processing to address AOI-specific analysis as well as common information layers needs. It supports massive processing on multi-tenant computing resources on the Cloud and provides a development environment for processor integration and testing, and a framework for Cloud provisioning. The tight integration of the development and processing environment with the metadata catalogue supports chaining and orchestration of integrated applications. Thanks to its long-term collaboration with CEOS and with the International Disasters Charter, it has extensive capabilities to ingest and catalogue a growing number of EO/non-EO data sources hosted locally or at remote repositories and federated via interoperability standards and protocols. The Cloud-bursting capabilities of the platform allow scaling and accessing external Cloud resources: some of the GEP Production Centers are currently deployed on public/commercial Cloud vendors (e.g. CREODIAS, ONDA, EOSC-Hub and Amazon AWS) and/or deployed on University/Research large HPC-based Datacentres (Grid Tier 1.5 of Univ. of Strasbourg/A2S HPC). The GEP has currently a Service Catalogue of more than 30 EO processing services with about 50% focusing on ground motion. The platform provides through the so-called thematic applications a generic graphical working environment, equipped with tools for ingestion and visualisation of several ground motion products, types and formats , that can be easily tailored to the needs of the user. The GEP has been in operation since August 2018 and today counts about 1800 users from 104 countries worldwide. More than 120 organisations are carrying out projects on the platform via the Early Adopters programme. It is being on-boarded in the Platform Services Layer of the NoR initiative with a complete service offer including data processing, user algorithm hosting, value added products provision, interactive development and user support. All these characteristics make the GEP an ideal environment for the demonstration of one or more of the Application topics being proposed.

### **LandAware Consortium**

LandAware is a multi-disciplinary, knowledge-based, non-profit network of individuals (e.g. managers, researchers, stakeholders) who are interested in cooperating for addressing and promoting issues related to Landslide Early Warning Systems (LEWS). The primary purpose of LandAware is to share experiences, needs and innovations among LEWS experts and to develop and promote guidelines and best practices for upcoming LEWS. The actions of the network are carried out by means of [working groups](#) that operate on the basis of predetermined working

objectives.

#### **EO4Alps-Landslide Information System (ESA)**

EO4Alps-Landslide is an ESA Regional ExpPro+ initiative targeting the creation of harmonized and advanced landslide inventories and susceptibility maps over the European Alpine Massif, based on the operational demonstration of the pro/cons of EO satellite data (combined with other geospatial datasets), of dedicated user-oriented information services for ground motion detection, and of susceptibility/hazard models embedded in the user-driven GeoHazards Exploitation Platform (GEP). EO4Alps-Landslide will develop its strategy:

- on the Western part of the Alpine Massif over a representative territory of ca 45.000 km<sup>2</sup> in Italy, Switzerland and France for the demonstrator use cases;
- using a Tier-based analysis approach with a focus of developing services and products for region (Tier 1), municipality (Tier 2) and slope (e.g. landslide; Tier 3) scale analysis;
- through a tight and active involvement of many landslide users (with several responsibilities and using several working practices);
- making extensive use of EO (Copernicus and other missions), existing ground motion services and landslide models (available on GEP and at the consortium partners), and of scalable processing resources.

#### **LHIS - Information System for Landslide Disaster Risk Financing (World Bank / FSEC)**

Disaster Risk Financing (DRF) products strengthen the capacity of governments to take informed decisions on disaster risk finance based on sound actuarial exposure analysis in order to support stakeholders (national and local governments, homeowners, businesses, agricultural producers, and low-income populations) with better risk information and increase financial resilience. In order to support Landslide Disaster Risk Financing priorities using Earth Observation”, LHIS-P is an initiative of the World Bank to propose a methodological concept and the development of a processing platform to respond to incipient landslide events in Near-Real Time ( NRT). The system should be able to provide estimates of parameters suitable to inform parametric insurance calculations, through the development of databases, maps and tailored processing services. The fist use case is Morocco in relation with the FSEC / Fonds de Solidarité contre les Événements Extrêmes.