Scientific & technical applications

National Services of Observation (SNO)

<table>
<thead>
<tr>
<th>Seismology</th>
<th>Magnetism</th>
<th>Volcanism</th>
<th>Slope instabilities</th>
<th>Geodesy &amp; Gravimetry</th>
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</tbody>
</table>

Main applicant *(Family name, First name, position)*:
Grasso jean-robert, Physicien cEX ISterre, OSUG Grenoble

Involved observatories (please indicate the person in charge):
EOST, (J-P Malet), OCA-geoazur (T. Lebourg) OSU Theta-Besançon (C. Bertrand),

Other involved structures (please indicate the person in charge):
UMR 1114 EMMAH, Avignon (V. Marc)

Management committee if there is any (please indicate the contact):
should be operated by the end of 2014

Summary of the tab (15 lines):
The Multidisciplinary Observations of Versant Instabilities, the SNO-OMIV monitors four slow on-going landslides which are representative of the mechanisms involved in the French Alps (hard/soft rock, slow/fast moving slope). On each sites, the SNO-OMIV provides continuous open access recording of the landslide kinematics, its seismic response, and the hydro-geochemistry characteristics of the slope. These data sets are unique example worldwide. OMIV observatory, a SO_INSU label since 2007 is labeled for :
- 4 sites in the French Alps (Avignonet, La Clapière, Séchilienne, Super-Sauze)
- 3 observables on each site : i) The displacement kinematics using tiltmeters, extensiometers, GPS sensors, satellite imaging; ii) the landslide seismic patterns (endogeneous seismic signals (micro-earthquakes rockfalls, exotic signals) and landslide response to régional earthquakes); iii) The hydraulic response to weathering forcing (hydro-geochemistry measurements)
It corresponds to 13-GPS, 60 Tachometrics benchmarks, 50_1C and 14-3C seismic sensors. This open access data base for slow moving landslides are also analogues to near surface fault creep as dominated by aseismic slip.
All data are open accessible through a single [http://omiv.osug.fr/donnees.html](http://omiv.osug.fr/donnees.html) portal

Number of involved people (give the percentage in equiv.-researcher/equiv.-engineer) for this tab
(you could provide an excel file for such update; please fill it carefully in close relation with the PI of the SNO; activity should be described in details through 2-3 explicit sentences)

Physicist/Assistant Physicist:

<table>
<thead>
<tr>
<th>Family Name</th>
<th>First Name</th>
<th>Activity</th>
<th>Percentage in full time equivalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grasso</td>
<td>jean-robert</td>
<td>Phys-Isterre / management and seismic signals analysis</td>
<td>30%</td>
</tr>
</tbody>
</table>

Researcher or (Assistant) Professor:

<table>
<thead>
<tr>
<th>Family Name</th>
<th>First Name</th>
<th>Activity</th>
<th>Percentage in full time equivalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bertrand</td>
<td>C.</td>
<td>MC Chrono-Environnement, Besançon/Scientist in charge of Hydro-geochemistry (hard – rock slides)</td>
<td>25%</td>
</tr>
<tr>
<td>Bièvre</td>
<td>G.</td>
<td>MC Isterre /Scientist in charge of Avignonet site</td>
<td>20%</td>
</tr>
<tr>
<td>Helmstetter</td>
<td>A.</td>
<td>CR Isterre / Scientist in charge of Séchilienne site</td>
<td>50%</td>
</tr>
<tr>
<td>Lebourg</td>
<td>T.</td>
<td>MC GéoAzur / SNO-coresponsability</td>
<td>15%</td>
</tr>
<tr>
<td>Malet</td>
<td>J.-P.</td>
<td>CR EOST / Scientist in charge of Super Sauze site</td>
<td>30%</td>
</tr>
<tr>
<td>Marc</td>
<td>V.</td>
<td>MC EMMAH, avignon / Scientist in charge of Hydro-geochemistry (soft –rock slides)</td>
<td>20%</td>
</tr>
<tr>
<td>Remaître</td>
<td>A.</td>
<td>MC Geogr. / Data analysis</td>
<td>10%</td>
</tr>
<tr>
<td>Tric</td>
<td>E.</td>
<td>MC GéoAzur / Scientist in charge of La Clapière site</td>
<td>15%</td>
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</table>

Engineer (Research structure/Universities):

<table>
<thead>
<tr>
<th>Family Name</th>
<th>First Name</th>
<th>Activity</th>
<th>Percentage in full time equivalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regent</td>
<td>B</td>
<td>Tech Besançon/ E contribution to hydro-geochem. analysis</td>
<td>15%</td>
</tr>
<tr>
<td>Ullrich</td>
<td>P</td>
<td>AI EOST / IPGS Engineer in charge of Super Sauze site and in charge of GPS data acquisition and validation for the 4 sites</td>
<td>50%</td>
</tr>
</tbody>
</table>
Vial
B
AI isterre/ Engineer in charge of Avignonet and Séchilienne sites
25%

Vidal
M
IE GeoAzur Engineer in charge of La Clapiere site
50%

Number of new necessary permanent human resources (related to this tab) needed in person.month while mentioning if this is a new position or a renewal as well as the time table for such hiring (to be high-lighted in the presentation):

<table>
<thead>
<tr>
<th>Family Name</th>
<th>First Name</th>
<th>Activity and position (new or replacement)</th>
<th>Percentage in full time equivalence</th>
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</thead>
<tbody>
<tr>
<td>XX</td>
<td>x</td>
<td>IE, Geophysicist Engineer in charge of seismic data acquisition, validation and diffusion for the 4 sites</td>
<td>100%</td>
</tr>
<tr>
<td>YY</td>
<td>y</td>
<td>IE, Engineer in charge of GPS data acquisition, validation and diffusion for the 4 sites</td>
<td>50%</td>
</tr>
<tr>
<td>ZZ</td>
<td>z</td>
<td>IE, Engineer in charge of Hydro-geochemistry data acquisition, validation and diffusion for the 4 sites</td>
<td>25%</td>
</tr>
</tbody>
</table>

Number of necessary temporary human resources (related to this tab) needed in person.month while mentioning the financial source (to be high-lighted in the presentation):

<table>
<thead>
<tr>
<th>Family Name</th>
<th>First Name</th>
<th>Activity</th>
<th>Percentage in full time equivalence</th>
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</thead>
<tbody>
<tr>
<td>Janex</td>
<td>G.</td>
<td>IE-CDD-insu/ Engineer in charge of seismic data acquisition and validation and diffusion for the 4 sites</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Summary of the Global financial plan of the Project**
Please provide the total amount of funds related to this project and solicited from different sources (other national calls, specific equipment, and internal support of different organisms or laboratories …), European funds, and international funds.

<table>
<thead>
<tr>
<th>Firm and solicited financial funds from ST-INSU as a SNO</th>
<th></th>
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</table>
Equipment : 22 kE  
Consumables : 15 kE  
Temporary human resources : 43 kE  
Travels : 5 kE  
Total : 85 kE

Firm and solicited financial funds from ORGANISM « EOST »

Equipment : 6 kE  
Consumables : 2 kE  
Total : 8 kE

Firm and solicited financial funds from ORGANISM « OCA »

Equipment : (12) kE see other funding section  
Consumables :  
Temporary human resources :  
Total : (12) kE

Firm and solicited financial funds from ORGANISM « OSUG »

Equipment : 5 kE  
Consumables : 4.5 kE  
Temporary human resources : AI 6 mths (14.5 kE) / see other funding section  
Total 24 (9.5) kE

(repeat this table for each involved structure)

Firm and solicited financial funds from ORGANISM « OSU-THETA »

Equipment : 2 kE  
Consumables : 6.5 kE  
Total : 8.5 kE

Other financial supports (firm and/or potential : please precise) in connection with this tab

(be short)  
CNRS/INSU  
(outside SNO)  
Ministry  
Specific funds : ANR SAMCO, ANR ASTERIX 10 k€ (EOST), 14.5 k€ labex OSUG,  
County and territory fundings : CG06 12 k€ (OCA)  
Other structure  
Total : 36.5 k€

Please, use bold characters for already firm financial funds

For equipment requests (including material renewals), give the maintenance cost induced by this equipment (eventually the saving in maintenance)
1. Scientific interest of such observation in short and long terms and current international state of research
Landslides are a major threat to human life, property and constructed facilities, infrastructure and natural environment in most mountainous and hilly regions of the world (e.g. Petley, 2012). In the last century, Europe has experienced the second highest number of fatalities and the highest economic losses caused by landslides compared to other continents (EM-DAT, 2003): at least 16,000 people have lost their lives because of landslides and the material losses amounted to over € 1400 M in Europe during the 20th century. Apart from human casualties, most of landslides impact widespread disruption to roads and buildings. It corresponds to direct and indirect economic costs. Actual losses produced by landslides in France highlight the lack of a risk mitigation program including the short-term prediction of rapid landslides and integrated early-warning systems.

As a consequence of climate change and increase in exposure, the risk associated with landslides is growing. In areas with high demographic density, protection works when possible to be built are not demonstrated to be efficient because of either economic or environmental constraints (e.g. gorges de la Bourne, Vercors Massif).

The mechanisms that drive the landslide triggering and their dynamics are numerous. Their couplings result in complex patterns that induced large uncertainty in the prediction of both the landslide size and their time of occurrence.
This context induces worldwide a misfit between the scientific community knowledge, the responsibility of technical persons in charge of the risk management and the expectation of societal citizens.
Contrarily to other natural hazards (earthquake, river flood, volcano eruptions…) there are a few data sets that relate the evolution toward collapse for landslides. This lack of available data set worldwide in more striking in the continental French context where landslides induce economical and societal costs that largely overpass the one induced by earthquakes.

(a) La Salle en Beaumont, soft rock (clay) landslide (Isère) 1,3 * 10^6 m^3, 1994, 4 casualties   (b) Vercors, 2004, rockslide, 2000 m3, 2 casualties. In both cases, retrofitting the roads were major societal costs.

Therefore the objectives of the OMIV observatory is to provide the scientific community the data sets that will allow (i) to identify the physical processes that control the slope instabilities, (ii) to be able to model them (iii) and to extract from the observables the patterns that may characterize a change in the land-sliding mode.
There is now an important gap, both at the French level and worldwide, between the ability to simulate numerically or physically conceptual slope movements and to specifically reproduce data from past case studies or ongoing landslides. Moreover, when a given empirical law is a-posteriori adjusted on pre-instability observations, it is rarely validated by multi-parameter observations. As example, the power law divergence of displacements suggested by Voight, (1988, 1989) are reported for displacement values only, without possible tests on the corresponding seismicity data. Similarly, the power law divergence of seismicity rate and energy observed by Amitrano et al. (2005) before a cliff collapse cannot be tested against displacement data, because these latter were not monitored on this site.

Back in 2007’s, both at the French national and at the worldwide level, there was no active slope sliding on which long lasting continuous records, for sensitive range of observables (displacement, seismology, hydro-geochemistry) were either recorded or available.

At the national level during the late 1990’s and the early 2000’s, the major projects merged towards 4 ongoing landslides. The projects, which were recurrently funded by regional and national funding (e.g. PGRN, PNRN, ACI ‘CatNat’, ACI ‘Changement Climatique’, ACI ‘Reliefs de la Terre’, ANR ECCO, ANR CTT), gathered investment of several teams on La Clapière, Super-Sauze et Séchilienne sites. These projects result (i) to a progressive long term monitoring of the landslide displacements, (ii) to built up short term experiment which constrain the geometry and the kinematics and the water circulation within the moving landslide.

To stabilize recurrent long lasting data recording and to homogenize the measurements on these 4 test sites, 3 teams merge to federate through the OMIV observatory since 2007. Two others groups joined the OMIV federation since January 2013 (Chrono-Envirrt, Besancon and EMMAH, Avignon) are in charge of the hydro-geochemistry measurement on hard rock and soft rock site, respectively.

**Objectives for the landslide observatory:**

Within the context described above, the SO-OMIV targets are defined as:

1. to stabilize and sustain over time the recording of 3 observable classes (kinematics, seismology, hydro-geochemistry of slope) on representative ongoing landslides;
2. to homogenize measurements on the four landslides (parameter types and space and time sampling);
3. to archive the data and to provide free real time open access to the data for the wide scientific community;
4. at a longer term target, to provide the users specific software and algorithms through a WEB base plateform. These software are tools to analyze and process OMIV data as well as numerical models to simulate the geomechanical processes and associated signals that are able to reproduce the observed signals.

These observations aims to contribute to (i) identify the key control parameters that allow to analyze different type of slope instabilities (i.e. soft/hard rock, cohesion/friction, slip/fracture, localized/diffuse damage,…).and (ii) to follow its evolutions through time and space (slowing down or accelerating up, sliding-flow transition,…)

Going beyond some existing case studies in Europe, the key aspect of the French OMIV observatory is embedded in the multi-parameters monitoring and the open access data for the worldwide community. More specifically, when compared to ongoing monitoring in Italy (Rosone, Tessina, Corvara, sites among others), Spain (e.g Vallecebre, Casas), Switzerland (e.g. La Frasse, Falli-Hölli) and England (e.g. Roughs, St Catherine Point), the French case studies selected by OMIV shares on the four sites, (i) a long history of data monitoring (ii) for landslides typical of mechanisms that affect alpine versants. These points are relevant for the involved material as well for the volume and velocity of the moving masses.
The OMIV observatory monitors 4 active landslides in the French Alps (Avignonet, Super-Sauze, La Clapière, Séchilienne), each of them having a minimum of 10 years of data history, in 2007 when the SO-OMIV was first INSU labeled for a 2 year period. Possible extension to monitor the peculiar case study of volcano slope, non available within inland France, will be discussed with the (SC) Scientific Council for OMIV as soon as the monitoring and data accesses for the 4 sites will be in a routine phase. One may not as possible, yet well monitored, site the cliff rock-falls at Piton de la Fournaise as monitored by OVPF, Réunion Island, networks and the response of volcano slope to strong earthquake at La Guadeloupe, Island).

The logic that builded up the OMIV observatory converges with the aims of recently national and EC funded projects to observe and to understand and to model slope instabilities (e.g. ANR ECCO PNRH ‘Ecou-Pref: Ecoulements Préférentiels dans les versants marneux’ (2006-2008) ; ANR CTT TRIGGERLAND ‘Triggering mechanisms of Landslides: analysis and modelling’ (2006-2009); 6ème PCRD TACKLING complexity in Science ‘Triggering of Instabilities in Materials and Geosystems : earthquakes, landslides and snow avalanches’ (2006-2010); 6ème PCDT Research Training Network Marie Curie ‘Mountain Risk’ (2007-2010), ANR SISCA, ANR Slams 2009-2012).

“Added value” for SO-OMIV –

The major input of SNO-OMIV is to provide a global homogeneous monitoring that apply to both the soft - and the hard- rock landslide classes. This approach was first successfully tested during ACI ‘CatNat’ SAMOA (2002-2004, C. Delacourt, O. Maquaire & D. Amitrano) project. The OMIV approach also gains momentum from bringing together 3 types of instrumental monitoring expertise with the scientific know-how of communities who did not used to interacts on landslide study, before SO-OMIV started. Accordingly the SO-OMIV bring together geo-morphologists, geologists and hydro- geologists, geo-physicists and geo-chemists, rock, soil and fluid physicists working either at lab scale or in-situ or as modeling experiments. Such a multidisciplinary group is well fitted to understand the complex patterns of slope instabilities where soft and hard rocks interact with fluid within a wide range of fracture patterns.
From a broad scientific perspective, the knowledge derived from the complex coupling between fluid pressure – air and rock temperature – stress/strain within heterogeneous media with measurement close to the sliding surface and away from it may also be of major interest to understand the mechanics of rupture and sliding which is the key issues at all scale within the earth crust. As an example the shallow sliding surface can be a proxy for slow slip faulting as advertise on numerous deeper fault in the recent years.

As a more practical implication, groups in charge of alerts and risk assessment for landslides (RTM, Restauration des Terrains en Montagne (RTM), and regional IFSTAR-CETE, local representatives) will appreciate new data and tools (methodology and models) that are efficient and that can be used to improve the decision process for risk management. Most of the empirical methods used by these groups, in France and abroad, are expert based tools which build up on a large number of case studies. For all these current techniques to quantify the uncertainties remains a very difficult task. One the major contributions of the SO-OMIV is to transfer new technical and quantitative approaches to the person in charge of the risk mitigation.

**Originality of a French approach** – As compared to other region worldwide the landslides in France occurs at a weak rate within moderate climate and low seismicity forcing, respectively. This context allow for slow slope movement which map the route for (1) accurate and continuous sampling of the pre-catastrophic phase ; (2) several interactions and feedback between model outputs and updated data inputs;

These two points are the basis for a comprehensive analysis of the physical processes that drive the transition from slow stable slips to fast catastrophic failure.

The analysis of such a pre-failure phase are impossible in area for the strong forcing (rain, earthquake) squeezes to acceleration phases beyond most monitoring techniques worldwide. The advantages of the slow moving slopes, as summarized above, may also turn to possible drawback when the time to failure is never reached or is too far away for any scientific feedback.

Whenever the catastrophic slip velocity is reached, the follow up on the slipping dynamics allows for a long lasting monitoring of geophysical slips in a context of weaker confining pressure that the one where seismogenic slip localizes. This way the moving slopes emerge as in situ analog to, more easy to observe than, seismic slips.

**Added value of OMIV federation** – As a new National service for INSU observatories the specificities of the SO-OMIV is grounded in the multi-lab team structure that merge as a federation. The 3 lab involved since 2007 imply 3 observatory and 2 new lab enter the OMIV federation next January. It allow for a unique consortium to work together as merging together multidisciplinary data for multidisciplinary groups. The cross correlated analysis of the data will enhance any of the single analysis of one observables.

The internal organization relies on 2 structures. Per site persons in charge (one for ITA, and one research) are twinned to per observable type person/lab in charge (displacement, seismology, hydro-geochemistry) . This way GPS data are validated/ stored/ made available through IPGS group. The seismology data are validated/ stored/ made available through Isterre group. The hydro-geochemistry data are validated/ stored/ made available through Geo-Azur group.
2. Net evaluation of the observation and/or development/analysis performed the last year (current year for this writing) (the tab could be involved in some of the next following items)

- Measurement characterization (where, what, how) and quality control

**Avignonet (ISterre)**

+ **seismology** (AVP site)
  - retro-fitting for water protection using IP68 box and non grounded device
  - Increase of battery power (100 Ah => 240 Ah)
  - Change of noisy connectors between sensors and digitizers
+ **displacement** (AVP site)
  - retro-fitting for water protection using IP68 box and non grounded device
  - Increase of battery power (100 Ah => 240 Ah)
+ **hydro-geochemistry**
  - retrofitting of the structure
+ **Télémétrie / Energy**:
  - new Wifi connection for all AVP measurements (sismo, hydro, GPS & météo)
  - new wifi modem for AVN (GPS) bug damage
La Clapiere (OCA)

+ hydro-geochemistry
- Resistivity meter sensor: switch from Syscal Pro switch 48 to Iris Instruments
- New site for water sampling at site Spring15

Télémétry / Energy:
- new batteries and regulators at CLP3

Séchilienne (Isterre)

+ seismology:
- new OMIV RAP velocimeter 3C+ accelerometer 3C at Mt Sec (stable reference site)
- retro-fitting the Galerie external antenna: damaged sensors and damaged connection cables
- real time telemetry for all high flux seismicity data (3 antenneas)
- temporary record from microphone for rockfalls/local failure discrimination

+ hydro-geochemistry
- new sampling point for water geo-chemistry in the gallery
- new OTT sensor in the main gallery (continuous measurements for electric conductivity and temperture)
- 2sd pluviometer in G710 gallery

+ Télémétry / Energy:
- new solar panel on the 3 seismic antennas

Super-Sauze (EOST)

+ displacement:
- 3rd camera (Canon EOS Rebel XS, remote control by PC; internal solution by EOST)
- Change of PC for all camera (Raspberry-Pi -> Beaglebone + robust)
- 6 ground LiDAR acquisition
- Installation of 4 coins reflectors for Radar calibration of observations Radar Sentinel 1 satellite (interférométry)

postponed:
- low cost Geocube GPS (IGN) induced by Kelia corp dela ; new contact with Infraz-Survey for another solution of GPS (GEOMON)

+ hydro-geochemistry
- 3e pluviometer (ARG100 Campbell) – Western edge of landslide
- 2e snow depth sensor (SR50) – located at GPS SAZ2

+ Télémétry / Energy:
- “solar field” (8 x 85W) outside the landslide, and 48V (250 m) electric connection towards Sismo SAZ-B and GPS-SAIZ2 sites
- Telemetry for solar field to follow up internal production parameter and battery status

Data mining for new observables

+ seismology:
- temporary records from joint microphone and seismometer: impact for rockfalls/landquake discrimination

+ displacement:
- low cost Geocube GPS (IGN) array: new contact with Infraz-Survey for another solution of GPS (GEOMON)
due to operationality delay

Data modeling for improving reference models

2014 advanced (pre-processed) data per observable

+seismology (Isterre)
- automatic real time event detection and on line diffusion of endogeneous (rockfall + local landquake) events
catalogues for Sechilienne and La Clapiere hard rock site
- access for all continuous records (3/4 sites) through RECIF portal.

+ displacement (Eost):
- new daily routine for GPS solution (Gamit/GlobK) J+1: GINS prototype (PFE (ESGT) Master, P. Maisse.
- new automatic solution for camera imaging as inputs for MNT models and displacement fields
Hydro-geochemistry (Avignon, Besancon Nice):
- new website data availability for the Four OMIV sites
3. Use of these observations (and related mining and modeling) through scientific publications (underlines authors and their connection with the tab), through security and safety implication as well as for territory management. Outreach for training, sensibilisation and widespread information. Please, mention other uses (traffic controls, for example).

Publications and impacts

+ scientific publications using OMIV data (2010-2014)
  more than 6 publications/ys in peer reviewed research papers and 3 PhD thesis/ys

- Technical collaboration, benchmarking:

  - Monitoring of snow avalanches: testing the OMIV protocols for location and follow up of moving sources (rockfalls, Lacroix, Helmstetter, 2010) on snow corridors in the French Alps (partnership Centre Etude de la Neige, Météo France). This project was funded by Pole Grenoblois Risque Naturels 2009-2010).
  - Interaction with Infra-Survey corporation (Neuchâtel, Suisse): development of a low cost GPS system, GEOMON (EOST)
  - Interaction with Alert Solution corp. (Delft, Pays-Bas): prototyping and testing multi parameters measurements for hydrology Geobeads (EOST)
  - Collaboration with CNES for Pleiades images (correlation of optical satellite images on OMIV sites) (EOST)
  - Interaction with university of Firenze for calibration test of infrasound array for rockfalls detection (Isterre)
  - Interaction with the operational service in charge of the alarm/security system for Séchilienne landslide: The role effective rain concept as defined and analysed on sechilienne displacement data set to remove ‘noise’ on data (Vallet et al. 2014) is now implemented by Cete-Ifstaar as a new tools for displacement monitoring. (Besancon)
  - Fast response to earthquake triggered landslide: In connection with regional and worldwide real time earthquake alerts we currently test protocols that provide immediate location on the area with the largest probable landslide rate. Prototype is expected to be running at the National and European scale (2015). The prototype architecture was developed using the worldwide case studies for which earthquake-landslide interactions are documented. Ongoing partnership with LdG-CEA (France).

Training:

- Numerous field studies for Eost (and others) students on Super Sauze site (Eost)
- Spring school on landslides monitoring techniques: Séchilienne and Avignonet site, for Nancy Geology Engineer School 2014 (Isterre)
- Teaching class at Politecnico Milano on multi-disciplinary monitoring of landslides: the example of the INSU OMIV French Observatory; 2014- (Isterre)

NEEDED MEANS FOR THE ACHIEVEMENT OF THIS SNO TAB

Specify means to be needed for reaching objectives of the next year: this has to be compatible with the table of the first page as well as the final financial demand.

1- instrumental effort for 2015

+ Displacement:
  - array of 7 low cost GPS sensors (5 Super-Sauze, 2 Sechilienne)
  - Replacement of old GPS by TrimbleNETR9 device (CLP1, La clapiere)
  - Installation of new GPS close the new seismic antenna CLP4
  - paired satellite images (Super-Sauze)
+ Seismology:
- seismic digitizer (upgrading the old obsolete devices) Séchillenne
- Seismic station needed as a spare station (lot of pb these past years with obsolete Agecodagis device that were installed since 2006): Nanometrix digitizer (Centaur 3 componants) + Trillium 120s velocimeter (Avignonet)
- water proofing for all 1C sensors of seismic Antenna CLP2, (La Clapiere)
- Installation of new seismic antenna CLP4, (La Clapiere)

+Hydro-geochemistry:
- Installation of new weather station close the new seismic antenna CLP4, (La Clapiere)
- change from Davis (damaged tools), to Campbell weather station (Avignonet)

2 – Data integration, data validation and data diffusion 2014:

Current status:
For each OMIV groups, all the technical aspects for each site instrumentation are in charge of AI-IE that are both CDD and CDI persons, as funded by each of the SO-OMIV partners.
For the 3 observables SO-OMIV is labeled for, there are three main steps in data processing
- measurement controls (transmission - validation)
- diffusion of raw data through web based data access
- diffusion of advanced data set and tools for data analyses
All of these three tasks are supported by non-stabilized man-powers for all the Seismic, GPS and Hydro-geochemistry observables.

For these 3 SO-OMIV observables the corresponding data complexity and data volume are as listed below.
- seismology: 1 TB of data per year (>80 chanels, 250-500hz sampling rate range)
- GPS: < 1GB of data per year (10 chanels, 30s- 1s sampling rate range)
- Hydro-geochemistry: < 10’s MB of data per year (<10 chanels, 10’- few month sampling rate range).

On this basis we synthesized the current status and the priority for SO-OMIV ITA engineer task force. The identification, the extraction, the validation of the seismic signals, the diffusion of signals and advanced data processing for seismic catalogues are performed by a CDD-IE position. The corresponding charge is part of the SO-OMIV annual budget. Improvement toward Automatic processing is build up since 2010, and it allows us to reduce the initial 1.5 IE per year before 2010 to 1 IE since 2011.
The seismic data-base-oriented storage and the IE working site are located at ISterre, OSUG Grenoble, where the national database for earthquake signals is also located. OMIV seismological data are now part of Recif Node A and it is the task of the IE_CDD to recurrently achieve the data transfer to RECIF. The first priority for manpower for SO-OMIV remains since 2010 a recurrent stabilized IE position for identification, the extraction, the validation and diffusion of the seismic signals.

Similarly to the seismological data organization, the identification and the extraction and the validation of the GPS data sets are performed at IPGS. It corresponds to an ½ AI (P Ulrich) charge for the 4 OMIV sites. A specific scheme to resolved displacements within short aperture GPS network was developed by EOST team and is also on-line available through the OMIV web-site. This way the second priority for SO-OMIV ITA is the low cost transformation of AI to IE position (P Ulrich) as a partnership with the the SO-Renag (1/2 AI Renag, ½ AI OMIV).

The third priority is related to 1/4 AI position at Geoazur-OCA, for the identification, the extraction, the validation of the hydro-geochemistry measurements and database.

2015 task force request:

+Engineer and technical staff:
- 1 IE for the identification, the extraction, the validation, diffusion of the seismic signals, (OMIV-Isterre).
- AI ->IE transform, for the identification, the extraction, the validation and the diffusion of the GPS signals (1/2 RENAG- ½ OMIV, (IPGS)).

Physicist/Assistant Physicist:
- Asst Physicist, seismologist for the extraction, the validation and advanced catalogues on the 4 sites
Please, provide information on the system for the dissemination of data, transformed data (observables) and models of this SNO as well as workflows for these transformations and modelings.

The relatively young SO-OMIV is not yet explicitly involved in providing data modeling to users. At the current stage of the SO-OMIV evolution, the objectives are to stabilize the observations and to improve the quality of the data we provide to the users. Two types of advanced data set are provided to the users apart from the raw data. First a refined displacement data set of values (developed by EOST partner) is available online for the GPS measures that are operated on the 4 sites. Second, the SO-OMIV web site gives access to the endogenous seismic signals (micro-earthquake, rockfalls, exotic source) and the corresponding catalogue (type, size, time, location). These later seismological catalogues are available on the 2 hard rock landslides sites (Séchilienne, La Calpiere) and in development on the 2 others. These catalogues allow the non seismologist users to compare and to correlate displacement data, seismicity rate, and hydro-geochemistry data.

As a medium term target (2) year we expect to build up benchmark workshops during which the 3 observable data set will be provided to different groups to be able to extract robust change in landslide patterns through time. The other benchmarking, that started with IGN collaboration for the new geo-cube GPS sensors, is to advertise the OMIV sites as platform to test new instruments in a context of dense and multi-parameters monitored landslides. The best test example for multidisciplinary test is currently the Super-sauze site, whereas for seismology data the Séchilienne test is the reference for benchmarking (e.g. Ineris-Cete groups tested seismic monitoring devices against the ongoing OMIV monitoring in the context of the ANR slams. An ongoing test with the university on Firenze aims to calibrate the ability of infra-sound array to record high frequency rockfalls in the near field.

The following page ([http://omiv.osug.fr/](http://omiv.osug.fr/)) corresponds to the organization of data per sites which the common use for a multidisciplinary observables worldwide (see for example WOVO (worldwide organization of volcano observatory))

Then for each sites there are global and local time line specific to the history of available observables. Bullet points on the time lines explicit any events that impact the way data are qualified (change in geometry measurements, change in sensors, failure to record, etc…)

The comprehensive data set is available online for raw continuous records (GPS and seismic). For the GPS data the OMIV portal provides access (transparent to the users) to the EOST plate-form where all GPS data are archived and stored for real time open access. For the raw continuous seismic records the OMIV portal provides access (transparent to the users) to the RESIF plateform where all the national seismic data are archived and stored for real time open access. Since 2014, OMIV seismology data sets are formally part of RESIF node. Advanced processed data are available for both GPS and seismic data. Fast local displacement for small aperture GPS network are made available. For seismic signals the SO-OMIV provide records of i) landslide responses to regional earthquake shaking, (RESIF data base) ii) endogeneous events (i.e. micro-earthquake within the landslide and rockfalls); iii) catalogues for location, size and time of endogeneous events. Data for endogenous events are not RESIF protocols. They are processed and provided through the OMIV websites, by the IE CDD in charge of seismology data. These catalogues are now available for Séchilienne and La Clapière landslide. Ongoing work for data
assimilation on Avignonet and Super-Sauze aims to deliver catalogues for these 2 sites. As example, the data flow for OMIV seismology correspond to 1Tb volume/yrs, i.e. close to the RENASS service.

The main target for 2014-2015 is to achieve a comprehensive, homogeneous, real time data sets availability for the 4 SO-OMIV sites. Missing data released currently involved Super-Sauze seismicity, seismicity catalogue for Avignonet.

Two publications on the comparative patterns between the 4 OMIV sites using the 3 observable are planned in 2015 to advertize the data set in a large geophysical community. One will focus of the local responses to regional earthquake of moving slope, including the possible variations in time and space. The second will focused on the analysis of cross-correlation between rainfalls, rockfalls, local micro-earthquakes, and displacements.

Data validation is performed on the OMIV server for all data (4 sites). In the example below we highlight the 2014 achievement for seismic data; Automatic validation is now running on the OMIV web site. Daily validation is critical to quality-control the acquisition chain and data continuity in the landslide context (instruments are particularly exposed to mudflows, rockfalls, ground movement that may tilt a sensor). The long cables (50m) connecting each sensor to the digitizer in the case of seismological antennas also make damages more likely, affecting data quality and completeness.

Previously, only the state of health of the digitizer and recording continuity were monitored, which occasionally resulted in long periods (months) with unusable data.

The data validation methods described below are currently in use for all OMIV data, and can run with limited connectivity to the digitizers (transfer of a few minutes of data per day).

**Method 1: Noise correlation plots** for the vertical channels of each seismological antenna
- Excludes horizontal channels and single-sensor stations.
- Runs on a short ambient noise window (1 minute in the example below), so can run at any time.
- Uses low-pass filtered signal and nearby sensors (e.g., f<20 Hz and d<100 m) so that noise should be well correlated.
- Automatically runs daily, updated on http://omiv.osug.fr/DATA_VALID/seismo.html

A low correlation for many days likely indicates an instrument issue.

**Method 2: Inspection of regional earthquake extractions**
- Includes all channels, all stations.
- Focuses on an earthquake time window, so this is not necessarily run daily. However, there is typically 1 or 2 suitable earthquakes per week.
- Soon to be automated and posted on http://omiv.osug.fr/DATA_VALID/seismo.html

Clearly shows significant recording issues (e.g. dead or noisy channel)
OUTREACH OF COLLECTED DATA AND PREVIOUS ANALYSIS

1. List of publications using these data or induced data or models in the last five years (please, put in red those from other research teams than those involved in this SNO tab).

2008


2009


2010


Guglielmi Y. and F. Cappa, Regional-scale relief evolution and large landslides: Insights from geomechanical analyses in the Tinée Valley (southern French Alps), Geomorphology 117 (2010) 121-129


2011

Bièvre G., Jongmans D., Winiarski T. And Zumbo V., Application of geophysical measurements for characterizing fissures in clay landslides and understanding their role in water infiltration (Trièves area, French Alps), Hydrological processes, in press.

2014


Vallet A., Varron D., Bertrand C & Mudry (2014) Hydrogeological threshold using support vector machines and effective rainfall applied to a deep seated unstable slope (Séchilienne, French Alps). G Lollino et al. (Eds). Engineering Geology for Society and Territory, Vol 2, DOI: 10.1007/978-3-319-09057-3_384

2. List of signed contracts in the last three years on this SNO tab (outside financial support of SNO from INSU).

+ Research projects building on OMIV sites and data (2010-2014):
+ National funded project :
+ EC funded projects: 
  Mountains risks (FP6, 2007-2010)
  TRIGS, (FP7, 2008-2010)
3. Other outreach initiatives.

BUDGET

Please, detail financial information of the first page for a better understanding and analysis.

Aside the financial funds solicited from INSU as an SNO tab, provide the connected financial supports for this SNO tab at the national level as well as European and international levels. Please, note that any funding related to confidential data acquisition could not be considered here.

1. Small equipment (<15k Euros HT):

There is now more than 6 years that most of the measurement points are running on the slope OMIV monitors. With the second seismic antenna that will operate on La Clapiere in late 2014, all the site are running a minimum of 3 continuous measurement for displacement, seismic records and hydro-geo-chemistry measurements. This way the OMIV protocols are fulfilled.

Now that the early measurements are more than 6 years olds, we experienced failure for the instrument due to either technical defects or harsh outdoor context such as thunder storms, temperature, humidity, etc. (GPS collapse, 2 hydro stations, seismic sensors) or rocksfall-mudslides on the moving slope (2 GPS, 3 seismic sensors)

Note that the overall budget for 2015 SO-OMIV is the same amount as the 2014 request. For all expenses, the specificity per site for 2015 are listed below.

+ super sauze:
  Increase in GPS measurement point using low cost GPS solution (priority location on seismic sensors and a 2nd humidity sensor)
  - 5 GEOMON-GPS: 5 x 1000 € -> 5 k€
  - 2 ThetaProbe humidity device: -> 2 k€
  - stereo paired images (Pléiades (programmation ISIS)): 2 k€

+ Sechilienne:
  Analogue/digital converter for seismic stations are old and obsolete Agecodagis devices (2008), 1/yr replacement rate and upgrading for the next years, is planned. Also as a follow up from ANR-SLAMS array of low cost GPS sensor are planned (Eost solution)
  - seismic station (Centaure 6+3 components) : 10.3 k€
  - 2 GEOMON-GPS: 2 k€

+ Avignonet:
  Seismic station needed as a spare station (lot of pb these past years with obsolete Agecodagis device that were installed since 2006)
  - Nanometrix digitizer (Centaure 3 components) + Trillium 120s velocimeter (Avignonet): 10 k€
  - change from Davis (damaged tools), to Campbell weather station Avignonet), 2 k€

+ La Clapiere:
  - Replacement of old GPS by TrimbleNETR9 device (CLP1, La clapiere)
  - Installation of new GPS close the new seismic antenna CLP4 6 k€
  - water proofing for all 1C sensors of seismic Antenna CLP2, (La Clapiere)
  - Installation of new seismic antenna CLP4, (La Clapiere) 4 k€

After 6 years of SO-OMIV experience, we expect for an average 10-12 k€ yearly costs for “small equipment”. This cost is driven by the harsh condition on which the OMIV networks operate (high elevation, north facing slopes, narrow valley)

2. Consumables:
The necessary turnover for solar panels, batteries and some sensors on each site, including data transmission (5 kE per site). Part of this budget is from the “small equipment” and part of it from the consumables hereafter:

- Avignonet: 2 kE (solar panel, batteries, local disk storage, transmission)
- La Clapièrè: 3.5 kE (hydro-geochemistry analysis (Besançon team) + 2 kE installation/mission
- Séchilienne: 3.5 kE (hydro-geochemistry analysis (Besançon team) + 2 kE seismology PC
- Super-Sauze: 3.5 kE (hydro-geochemistry analysis (Avignon team) + 2 kE installation/mission

After 5 years of SNO for OMIV experience we expect for an average 10.5 kE yearly costs for consumables per site. Overall for both “small equipment” and including consumables we reach a steady level of 35-40 kE for the SNO-OMIV. For 2013 we were at the lower 32 kE bound. For 2014 and 2015, the 42 kE we request are based the under evaluation on both the damage cost we have to face through time and the cost for geochemistry analysis. We expect to keep this cost stable with the optimization through times for the technical solutions.

3. Travels:

Travel expenses for SNO-OMIV:
- On sites maintenance: 2 kE
- Internal meeting for coordination: 1 kE
- National and international scientific meeting to advertise the data availability for SNO-OMIV, 1 kE

4. Temporary human resources:

1 IE-CDD for 2 main tasks

- Validation of seismic signal quality, data archiving, for all the signals for the 4 OMIV sites.
- Integration of continuous data base to RECIF data hub
- Open access diffusion for the 4 sites, for
  - continuous raw data
  - seismic response of landslide slope to regional earthquake: It corresponds to the automatic signal extraction using regional catalogues. These tools had been developed in the lasts 2 years in partnership with the SO-RAP.
- Definition, Extraction and classification of endogenous events. It involve seismic signal processing to sort local earthquake missed by regional networks, micro-earthquake within the moving masses induced by internal strain, and rock-falls. The advanced tools were developed on Séchilienne landslide by Helmstetter and Garambois (2010). Transfer to others OMIV sites are part of the IE development tasks. Preliminary analyses were performed on La Clapièrè site. As extrapolated from ongoing test on Avignonet and Super-Sauze, catalogues of endogenous events (time, location size) should be available by the end of 2013. It critically depends on the stabilization of the IE CDD through time. A change in the previous IE-CDD last spring delayed the catalogue analysis. Such changes reset the learning time for the person in charge to be efficient on these complex signal recognition patterns.

The financial cost of 43 kE corresponds to a one year salary charge starting January 2015.