AAPG2021	OSMOSE	PRC
Coordinated by	Eric Calais	48 months
Humans-Environment Interactions		

OSMOSE: tOward a multi-stakeholder Socio-seisMological Observation network for Seismic risk rEduction in Haiti

FDS = Faculté des Sciences, FASCH = Faculté des Sciences Humaines, UEH = Université d'Etat d'Haïti, BME = Bureau des Mines et de l'Energie, CP = Collège Catts Pressoir, ESIH = Ecole Supérieure d'Infotronique d'Haïti, UCA = Université Côte d'Azur, OCA = Observatoire de la Côte d'Azur, IRD = Institut de Recherche pour le Développement, LAM = Les Afriques dans le Monde (Sciences Po Bordeaux), EMSC = European-Mediterranean Seismological Centre, CNRS = Centre National de Recherche Scientifique.

I. Context, positioning, and objectives

Research hypotheses and objectives

Over the past 50 years, earthquakes have cost about US$ 800 billions – mostly in so-called developed countries – and 1.3 million human lives – mostly in so-called developing countries. Faced with these figures, which show no sign of inflection with time, the classic approach consists in formulating a scientific explanation of the natural phenomenon and adapting it to the public and decision-makers in order to trigger changes in behavior, or regulations, that should protect people and property. However, each major earthquake shows that these changes are slow, or even nonexistent, in particular in developing countries (e.g., Bilham, 2013; Tucker et al., 2013). This "top-down" approach indeed comes up against a set of local limiting factors linked to political governance, scientific capacity, socio-economic conditions, confidence in the State, cultural and religious elements, etc. (e.g., Hurbon et al., 2019; Abbott and White, 2019).

Our working hypothesis is that disseminating knowledge while placing citizens and communities at the heart of the mechanism of scientific information production and usage can improve earthquake awareness and promote grassroots protection initiatives. We propose to reverse the top-down model for a "bottom-up" approach to determine under which conditions a community of citizens can, in a development context, collect and share information on earthquakes while producing data useful to seismologists. Ultimately, could one envision a relationship of trust between citizens and scientists where each recognizes that they need the other to achieve their goals? Can such a relationship be sustainable and under which conditions?

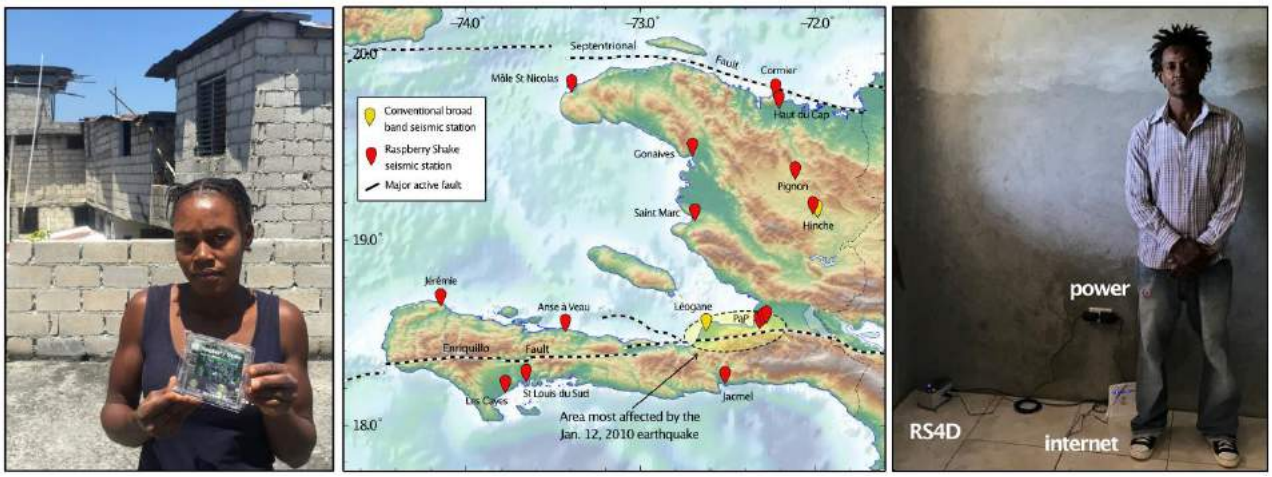

Figure 1. Left: A Raspberry Shake (RS) seismometer held by a host in Port-au-Prince, amidst a built environment clearly not designed to withstand earthquake shaking. Middle: Map of Haiti showing the main active faults (dashed lines), the location of operational conventional broadband seismic stations, and the location of RS seismic stations installed to date within the S2RHAI project. RIght: A Raspberry Shake station installed in Jérémie with its host M. Guild Mézile, a local farmer. The instrument is placed on the ground floor of his home, with good access to electricity—thanks to a local generator—and to the internet.

We shall test this hypothesis through **a participatory seismology experiment in Haiti, a country which was the scene of a major seismic disaster on January 12, 2010**[1] (e.g., Calais et al., 2010; Hurbon et al., 2019). The

[1] It claimed ~200,000 lives and resulted in an economic loss of $ 10 billion, ~100% of the country's GDP.

planned work capitalizes on ongoing research as part of the S2RHAI[2] pilot project (Calais et al., 2019, 2020; Fallou et al., 2020), whose partners participate in this proposal along with new collaborators.

We shall use low-cost and low-maintenance "Raspberry Shake" (RS) seismological stations, successfully tested in the framework of S2RHAI (Figure 1), which allow us to insert simple but scientifically useful seismological observation into the homes of citizens and develop a partnership with them to investigate their modes of appropriation of scientific information. **This research-action project aims not only to advance our knowledge of earthquakes and their perception, but also to improve the operationality of fundamental knowledge towards stakeholders.**

Our **general objective** (Figure 2) is to determine the conditions under which it may become possible to develop a useful, efficient, and sustainable monitoring network of which all stakeholders feel to be a partner. This project therefore aims to test a paradigm shift: in fine, **the seismological network is no longer just a set of seismometers but becomes a network of multiple stakeholders who revolve around these sensors and the information they provide, and are committed together to reduce vulnerabilities.**

Figure 2. OSMOSE's general and specific objectives.

Our **specific objectives** (Figure 2) are to (1) produce scientifically validated seismological information with low-cost sensor involving citizens and the civil society, (2) understand perceptions, representations, and needs in relation with the earthquake problem within the local socio-cultural context, (3) co-construct, with citizens, solutions for the production and dissemination of information that are relevant to them, and (4) promote local ownership and sustainability of this multi-stakeholder information system.

OSMOSE will achieve these goals through (1) an integrated approach to the relationship between society and earthquakes that **brings together specialists of environmental and socio-anthropological fields**, and (2) direct interactions with **citizens and the multiple stakeholders** involved in earthquake risk reduction.

The key **expected result** of OSMOSE is a definition of the conditions that allow for the development and sustained support of an earthquake information system that empowers stakeholders by associating them to the information chain. **At the intersection of seismological and social sciences, the project will advance current research on citizen sciences** that aim to strengthen the link between environment and society, and between fundamental knowledge and operational action.

Position of the project within the state-of-the-art

The concept of **citizen science** (Irvin, 1995) emerged in response to the tension between professional expertise in the fields of environmental science and democratic governance (Fisher, 2000). Indeed, understanding most environmental issues – seismic hazard being one of them – requires training or time that is beyond what most citizens can afford, while the technical expertise required is more and more often perceived by citizens as biased toward implementing risky solutions to the advantage of business and political elites. The participation of citizens in the production of scientific information and in its usage to influence policies is, in theory, a way to reconcile these two propositions.

[2] *« Socio-sismologie du risque en Haïti »*, programme Risques Naturels, CNRS (MITI) and IRD, 2019-2021.

Social media are now accelerating citizen science (Wehns and Evers, 2015), to the point that **community-based monitoring and information systems** (CBMs) have emerged where citizens, government institutions, the private sector, or academics can "*collaborate to monitor, track and respond to issues of common concern*" (Whitelaw et al., 2003). Wehn and Almomani (2019) show that the success of CBMs "*depends on the constellation of key stakeholders (citizens, scientists/data aggregators, and policy/decision makers) and, more specifically, on the extent to which their collective expectations, efforts, perceived pressures, capacities and opportunities in a given context are complementary, compatible and 'adding up'*". Successful CBMs therefore requires research to understand the motivations, incentives, and barriers for participation and long-term commitment of all stakeholders (Wehn et al., 2016). This, more than anything, justifies **OSMOSE's approach, inclusive of all stakeholders and their perceptions and motivations within their socio-cultural system, while enhancing the rigor and usefulness of the technical information – seismological here – produced and disseminated**.

In seismology, early efforts to bridge basic research with the broader public in a systemic way took place in the framework of **earthquake education programs in schools** (e.g., Cantore et al., 2003; Levy and Taber, 2005; Courboulex et al., 2012; Berenguer et al., 2020; Subedi et al., 2020). These programs paved the way for the design of affordable and low-maintenance seismic instruments, as well as for the realization of the scientific value of the data they produce (e.g., Anthony et al., 2018; Calais et al., 2019; Schlupp et al., 2019; Winter et al., 2021). But the contextualization of such efforts in the broader scheme of risk perception, socio-economic development, or public policies is rarely accounted for in seismology-driven projects.

That community participation in data or knowledge production enhances risk perception – although it is a tenet of most citizen-science projects – is of course not granted. Enhancing risk perception is at the core of international efforts as it should help develop a "culture of risk" (e.g., UNISDR, 2015) and stimulate individuals and communities to take appropriate protective actions (Twigg, 2004). However, this apparently simple logic is challenged by the **highly variable values and priorities of people and communities exposed to environmental hazards across cultures, socio-economic classes, genders, etc.** (e.g., Löfstedt and Frewer, 1998; Solberg et al., 2010; Jabeen and Johnston, 2013).

This clearly points to the importance of implementing CBMs in a demand-driven way, such that their products fit the needs of the stakeholders and provide them with concrete incentives to maintain their commitment over the long-term (When and Almomani, 2019). In OSMOSE, beyond the deployment of a citizen-based seismic monitoring system, **understanding the incentives and barriers to achieve long-term involvement, empowerment, and ownership of all stakeholders require a multidisciplinary project that brings together seismologists, geologists, sociologists, anthropologists, geographers from France and from Haiti.**

Contributions of project partners

Seismologists from **Géoazur, BME, and URGeo have been involved in several collaborative projects** since the 2010 Haiti earthquake. **Géoazur, EMSC, and Haitian partners from UEH, BME, and URGéo have been working together since 2019 on the "S2RHAI" project**, which allowed us to test the concepts developed in OSMOSE and propose followed-up activities based on real-world observations in Haiti. The **LAM and PRODIG laboratories, both with strong research ties to Haiti**, and the **Higher School of Infotronics of Haiti (ESIH)** are included in the consortium to strengthen its humanities and new technologies components. No-cost collaborator **College Catts-Pressoir** is a long-term collaborator of Géoazur's seismo-education group.

Most project partners are part of the **CARIBACT Joint International Laboratory**, a 5-year program funded by IRD (starting date 1/1/2021) to co-construct with Haitian partner URGéo a long-lasting multidisciplinary research program on environmental hazards and their transfer to decision-makers and the civil society. One of the research axes of CARIBACT aims at bringing together experimental sciences and humanities to explore the dynamic nature of the exposure and the vulnerability of populations, how they perceive environmental hazards and protect themselves, as well as their perception of scientific information.

AAPG2021	**OSMOSE**	PRC
Coordinated by	Eric Calais	48 months
Humans-Environment Interactions		

Within OSMOSE, **Géoazur** will lead activities aiming at augmenting RS deployments and increasing robust earthquake detection capabilities in order to increase interactions with various stakeholders, **LAM** will lead the socio-anthropological mapping and perception analysis of the stakeholders using sociological survey techniques, **EMSC** will use this seismological and sociological information to define the nature, temporality, and communication channels of the earthquake information most adapted to the actual needs of citizens, and **PRODIG** will lead the work on transferring the research products to stakeholders in the institutional and education arena as well as amongst the civil society. As described below, each of these partners will be **partnering with Haitian collaborators** to ensure that the activities and solutions developed within OSMOSE (1) are respectful of the local context, (2) understand – and make use of – citizen's perceptions, and (3) promote a sustainable, multi-stakeholder information system anchored in its cultural landscape.

Results achieved within S2RHAI and lessons learned for OSMOSE

OSMOSE follows from the S2RHAI pilot project (Calais et al., 2019, 2020; Fallou et al., 2020), which set the first building blocks to test whether public involvement in a seismo-scientific project in Haiti could improve earthquake awareness and promote grassroots protection initiatives, while producing data useful to seismologists. Within an 18-month time frame, thanks to efficient collaborations between French and Haitian partners, S2RHAI was able to deliver the following blocks:

1. The **installation of 15 low-cost, internet-connected, RS seismometers** at citizen's homes in straightforward locations (living room, office, etc.) so that they would not be a nuisance to them, with the implication that ambient noise was not necessarily minimized (Figure 1);
2. The development and tuning of **"ayiti-seismes[3]", a real-time earthquake detection system operational 24/7**, based on RS seismometers and low-noise "conventional" regional seismic stations;
3. A **large-audience survey** (1500 participants) to collect information on the perception and expectations of citizens, with the 2010 earthquake in the short-term background (Fallou et al., 2020);
4. **In-depth interviews with RS hosts** aimed at obtaining feedback on their experience and needs in order to help define avenues for improvement with an augmented citizen seismology project.

Although access to electricity and the internet can be an issue in Haiti, **we easily found volunteers motivated to host a RS instrument**, even though there was no financial support from our side. In October-November 2019, when political instability and insecurity locked-up Haiti causing schools, universities, and most governmental institutions to close – hence official seismic data streams to stop – data from citizen seismometers were flowing at rate no different from average. Citizen seismology can therefore be a viable means to alleviate such difficulties and provide continuity in seismological information even under duress.

The seismological analysis of the data shows that **having more RS stations is important because redundancy is crucial**. This is one of OSMOSE's motivations for significantly increasing the number of RS instruments. A second motivation is to diversify (socio-economically) the population of RS hosts with whom we can interact and who can reach their community. This will help us gain finer insight into risk perception and investigate how to best co-construct information and knowledge that is relevant to a wide range of citizen users.

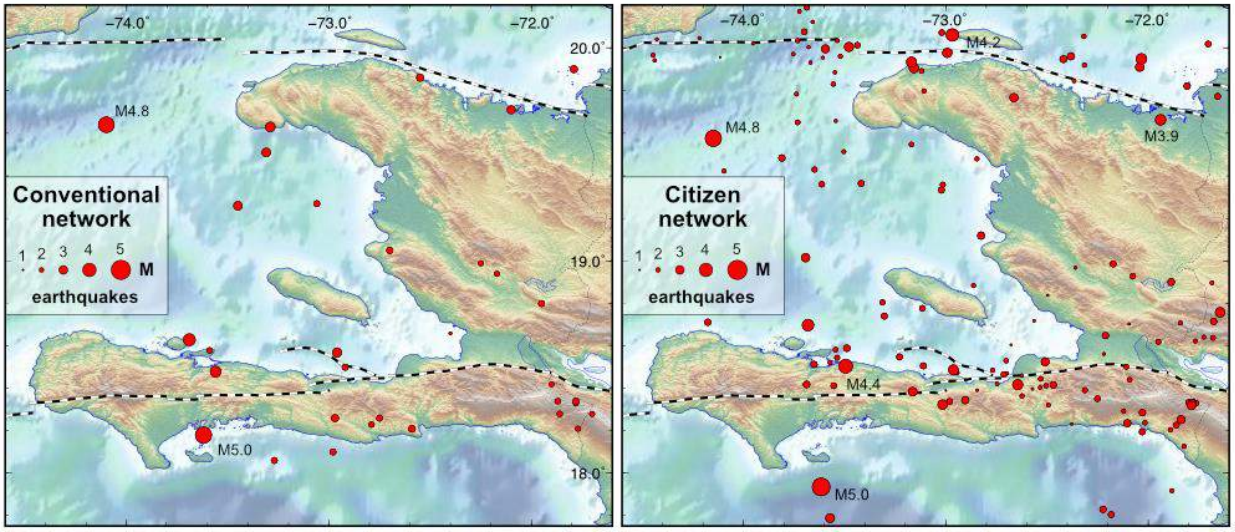

Figure 3. The earthquakes located from August to December 2019 are represented by red dots. Dashed lines show the main active faults. Using the conventional network only 31 earthquakes were detected (left). Using the Citizen network in addition, 146 earthquakes were detected (right), including many small magnitude events that are important to interact with RS hosts (see text).

We quantified the usefulness of low-cost RS seismometers to monitor local earthquakes and hence to complement the conventional seismic network. **Figure 3 demonstrates that RS instruments significantly increase earthquake detection and characterization capabilities** (see also Calais et al., 2020). We now

[3] http://ayiti.unice.fr/ayiti-seismes/

understand the limitations of RS instruments in a high noise environment and with interrupted data flow. This allows us to propose new avenues to enhance RS signals through Artificial Intelligence (AI) techniques to augment the number of earthquakes detected, with the benefit of (1) improved understanding of the regional seismic hazard, (2) opportunities for more frequent interactions with citizens, and (3) reliable and real-time information to interact with citizens in the case of a felt event.

The ayiti-seismes earthquake detection platform is operational, portable to Haiti, and scalable to hundreds of stations (RS and other types), so that **we can now work on how to best interface it with RS hosts and the general public**, beyond a simple web interface with a seismicity map. Designing such a system will require joint efforts from seismologists and sociologists, informed by in-depth surveys and interviews of end-users.

The large-audience survey performed within S2RHAI (Fallou et al., 2020) shows a genuine interest in earthquake information and an appetite for actionable information (protection measures). Interviews of current RS hosts show a pride of being part of a collective endeavor, of feeling "useful" We heard comments such as ***"I had no idea there were earthquakes every day in Haiti!"***, indicating (1) an increased level of understanding of earthquakes, and (2) the importance of being able to deliver reliable information. We also observed a desire for a better understanding of what an RS actually does or what the data mean – for hosts but also to inform visitors, friends, and their family. This opens the perspective to investigate how RS hosts could become "ambassadors" of earthquake information within their communities.

S2RHAI therefore shows that a demand for earthquake information exists and that one can use RS instruments to establish a dialog with citizens. However, much work remains to be done, for instance on topics such as the importance of the magical/religious dimension (e.g., Abbot and White, 2019), on the inclusion in our research of lower social classes, often poorly educated, or more generally on a social mapping of perceptions and mentalities beyond the RS host and across social classes (e.g., Hurbon et al., 2019). Pursuing in that direction requires integrating reliable and robust earthquake information from seismologists together with the sociological analysis of the population's perceptions, needs, and expectations.

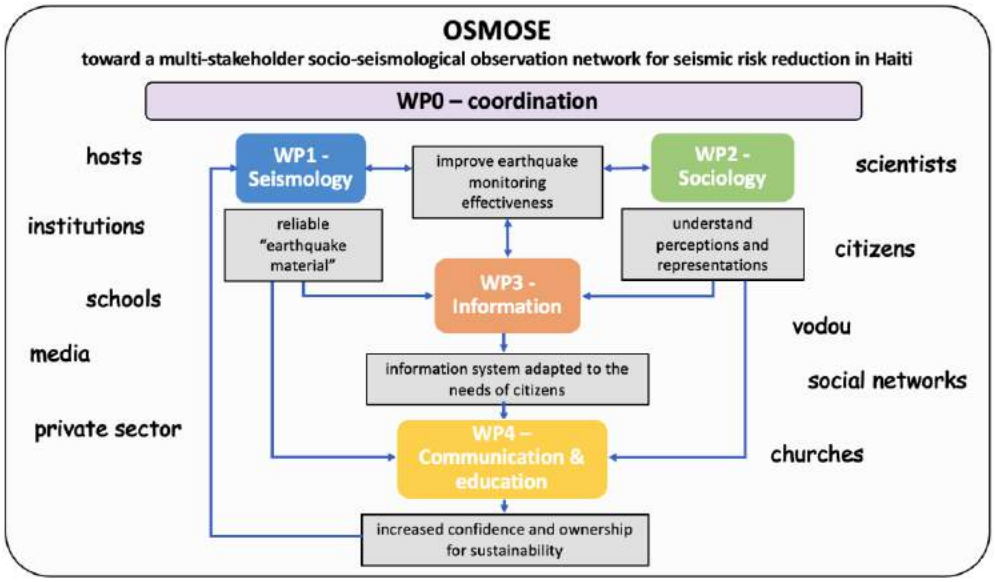

Figure 4. OSMOSE will deliver robust earthquake data through seismo-citizens (WP1). Understanding the context, perceptions, and needs based on a socio-anthropological approach (WP2) is a prerequisite to co-construct an information system that pertinent to citizens (WP3), sustainable over the long term, and anchored in the Haitian landscape (WP4).

Methodology and risk management

WP0: Project coordination and communication
Coordination: Eric Calais and all WP leaders
Objectives: We seek to (1) coordinate the management and execution of the 4 WPs described below, (2) monitor project advancement, (3) ensure optimal communication and interaction between WPs, (4) ensure proper communication of the project results, (5) ensure reporting to ANR, and (6) capitalize on OSMOSE's

approach to reflect on our research practices. Figure 4 summarize in a schematic way the information / interaction flow between OSMOSE's work packages.

Tasks:

T0.1: Create a steering committee and organize bi-annual meetings with WP leaders, in presence or through videoconference in order to monitor WPs' progress, results, or difficulties. The committee will be composed of WP coordinators and of representatives of the Haitian partner institutions.

T0.2: Organize an initial workshop that will be the project kickoff meeting, with current RS hosts invited. An important goal will be to define a strategy for selecting future RS hosts -- see task 1.1. This initial workshop will include a 2-hour workshop on gender equity in research led by a consultant (IRD, or CNRS or external).

T0.3: Organize yearly workshops that bring together seismologists and sociologists, are focused on disciplinary intersections, involve RS hosts (including schools), and include interactions with the media.

T0.4: Communicate on the project and its results via interviews with local media, use of digital media including a Web site, social media, WhatsApp, etc.

T0.5: Coordinate scientific and financial reporting, as requested by the ANR.

T0.6: Foster epistemological and methodological reflection across disciplines. The "bottom-up" approach advocated for in OSMOSE considers that scientists are no longer the only "entrepreneurs of knowledge". In addition, they are not exempt from representations themselves! Involving seismo-citizens in information production and dissemination, establishing a dialog to understand their perceptions and representations in a mutual learning process - and in a dialogue between disciplines - are not natural research pathways for most scientists. We will use OSMOSE's approach for an epistemological and methodological reflection on research practices among researchers of this multidisciplinary, citizen-science program. This will take place during dedicated work sessions at our yearly workshops (T0.3) during which we shall also reflect on gender biases in our approaches. We will invite colleagues from other multidisciplinary projects such as RAVEX[4], current work in Mayotte (another island context where local perceptions are key to propose adapted solutions[4]) or educational RS-based activities in Nepalese schools (Subedi et al., 2020).

Deliverables:

D0.1: A co-defined strategy for selecting RS hosts.
D0.2: Meeting notes shared with all project members reporting on project progress, results, and issues.
D0.3: OSMOSE website and global presence through social (Facebook, Twitter, etc.) and regular media.
D0.4: Reporting as required by the ANR.
D0.5: A publication of the epistemological lessons learned during OSMOSE.

Risks:

The main risks are a prolonged COVID-19 pandemic and political issues in Haiti. Fall-back solutions will include interactions via video-conference tools, as we have routinely been doing within the S2RHAI project.

WP1: Improving and Strengthening the Citizen Seismic Network in Haiti

Coordination: Françoise Courboulex (Géoazur) / Steeve Symithe (URGéo)

Objectives: We seek to improve the detection capabilities and stability of the citizen-RS network in Haiti to provide more "earthquake material" for WPs 2, 3, and 4 in the form of more RS hosts and more earthquakes detected. This will lead to a more complete catalog and more interaction opportunities with RS hosts and the general population (WPs 3 and 4). Specifically, we aim at (1) improving the detection ability of the ayiti-seismes platform, (2) strengthening the robustness of the location and magnitude determination, and (3) converting low-cost RS data into high-quality sensor data using AI techniques.

Tasks:

T1.1: Augment the number of RS and hosts (Symithe, Calais, Paul (PhD), Clouard, de Lépinay, Fallou, Chèze, Peix). We have observed that the current 15-station RS network has a number of limitations. In terms of seismology, we currently lack geographic coverage to ensure robust earthquake detection and characterization capabilities. In terms of sociology, we want to diversify the socio-economic profile of our hosts while aiming for gender diversity as well, and reach schools in order to ensure proper

[4] https://www.ipgp.fr/fr/revosima/reseau-de-surveillance-volcanologique-sismologique-de-mayotte

representativeness for the sociological studies we are planning to conduct. Motivations will also be taken into account for host recruitment. This task will be performed through (1) the definition of a RS distribution strategy, with input from all project partners and current RS hosts, which will take place during the project initial workshop (T0.2), and (2) field trips to install stations and interact with hosts, in collaboration with sociologists and education scientists of the project.

T1.2: Improve the reliability of automatic earthquake detections (Paul (PhD), Monfret, Courboulex, Delouis, Deschamps, Bertrand, Chèze, Peix):
(1) The ayiti-seisme platform currently uses the global IASPEI seismic velocity model although recent studies show significant deviations from this model as a result of crustal-scale structures in Haiti (e.g., Douilly et al., 2013; Possee et al., 2019). We will start from these new models to determine a velocity model that is representative of the regional crustal structures to improve earthquake locations;
(2) Accurate magnitudes are important for realistic estimates of seismic hazard, but also for proper communication with citizens, who get confused and may lose confidence when large discrepancies exist between local and international magnitude estimates, as witnessed within S2RHAI. The attenuation relation currently used for the magnitude determination on ayiti-seismes, taken from California, must be reconsidered to account for local crustal structures. Here also, we will start from recent results (Possee et al., 2019) to determine the optimal attenuation relation while paying specific attention to the heterogeneity of instruments that make up the detection network (RS, short periods, broadbands, etc.);
(3) In association with task 1.3, we will use the AI-augmented RS data to improve earthquake detection and characterization capabilities. To do so, we will automatize the earthquake characterization through the use of recently developed AI algorithms (e.g., Ross et al., 2018, Moussavi et al., 2020) that can pick the arrival time of P and S waves (the only remaining manual task in the process) in a fully automated way.
Task 1.2 will be carried out in the framework of the PhD thesis of Sylvert Paul, a Haitian student from the Geohazards master of UEH (2021-2024, funding acquired outside ANR) who will work half time in Nice (Géoazur) and half time in Port au Prince (URGéo).

T1.3: Denoise RS data using Artificial Intelligence (Bletery, Ampuero, Monfret, Courboulex, postdoc). Although the sensor placed in RS instruments is of sufficient quality for regional earthquake detection (Anthony et al., 2019), RS are usually installed in noisy environments since we seek (1) to minimally disturb hosts, and (2) free internet and power, both of which typically imply installations in cities. As a result, many earthquakes that could be detected with the same sensors in quieter environments are hidden in the ambient noise. We will develop a method of "denoising" RS data using Artificial Intelligence (AI) techniques to extract earthquake signals from the ambient noise and produce RS data of a quality comparable to conventional seismometers. The training database will be composed of 5 years of continuous data from collocated RS and low-noise instruments collected by the RS manufacturer (OSOP) and publicly available on FDSN[5], plus one RS station that we recently co-located with a permanent low-noise station near Port-au-Prince. The input data will be the RS signal cut in 1-min time-windows, the output data will be the signal recorded during the same time-windows by the high-quality co-located sensor. Once trained, the permanent station can be removed, and the AI algorithm should be able to convert continuous RS data into high-quality data. Furthermore, once sufficiently trained, the AI model can be applied to any other RS station to convert its signals into denoised data. We hope to demonstrate that this AI post-processing can turn a low-cost seismometer into a viable alternative to costly low-noise instruments. This task will be carried out at Géoazur by a postdoctoral fellow placed in the group of 6 postdoctoral fellows and doctoral students set up by Q. Bletery as part of his EARLI[6] project (ERC) on enhanced detection of seismic signals using AI.

Deliverables
D1.1: 30 new RS stations are operational in Haiti, with a socio-economically diverse group of new hosts;
D1.2: Real-time earthquake detection capabilities are significantly enhanced – we expect reaching a completeness magnitude close to 1 (currently on the order of 2.5 in the current 15-station network);

[5] manual.raspberryshake.org/bru2.html#bru2comparison

[6] https://cordis.europa.eu/project/id/949221, https://sites.google.com/site/quentinbletery/tohoku-earthquake-1/ai-seismology

D1.3: Monthly seismicity maps are communicated in a manner that accounts for the findings of WP2 and 3;
D1.4: Accurate catalogs and maps of earthquakes are available for citizens and education;
D1.5: A new AI algorithm allows us to produce standard quality data from low-cost RS stations.

Risks:

R1.1: A prolonged COVID-19 pandemic. The COVID situation is mild in Haiti and is not restricting field work.
R1.2: Political and security issues in Haiti. Experience shows that fieldwork in the provinces is rarely an issue, although leaving the capital by road can sometimes be restricted. Within S2RHAI we have accomplished part of our field work using private airplanes and the many airstrips available throughout the country.
R1.3: The AI task runs the risk that the characteristics noise of RS data is not exhaustively sampled in our training dataset, possibly limiting the accuracy of the denoising. The addition of the dataset collected by OSOP significantly mitigates the risk by drastically augmenting the training dataset. Furthermore, this task is also potentially high-gain: if successful it could make low-cost RS sensors a viable alternative to costly present seismic instrumentation worldwide.
R1.4: False detections or false magnitude determinations could make citizens lose confidence in our products. This will be limited by work done in T1.2 as well as through the communication plan described in WP3.

WP2: Socio-anthropology of seismic risk in Haiti

Coordination: Alice Corbet (LAM) / Laennec Hurbon (FASH)

Objectives: We seek to better understand local perceptions through an analysis based on approaches from the human sciences that will inform WP3 and WP4. Its specific objectives are to understand the perceptions, representations, and needs of RS hosts and the general public, and to map the stakeholders of the seismic risk reduction chain (scientists, civil society, governments, international, moral authorities, etc.). WP2 is based on feedback from the field for a co-construction of conclusions, between Haitian citizens and scientists, and will provide socio-cultural guidelines to other WPs. Based on the theories and the anthropological method, it also crosses notions of sociology, political science, geography, even development economics, to understand local daily life, in all the diversity of populations in Haiti (urban environment, rural, poor, having experienced the 2010 earthquake or not, etc.). Thanks to iterative and qualitative surveys, the links between the social uses of seismic risks and the perceptions associated with them, for example with the differences in beliefs (including vodou) or the instruments of control of the territory (architectural adaptation for example), will allow WP3 and 4 to better respond to the context.

Tasks:

T2.1: Analysis of perceptions and representations of RS hosts (Corbet, Hurbon, Calixte, PhD student, Fallou, Calais). Interviews with RS station hosts during the S2RHAI project showed a genuine commitment linked to the pride and satisfaction of participating in “science” and in a collective project for their country. We will consolidate our interactions with RS hosts by:
(1) Providing rapid input to T3.1 by (1) deepening the analysis of the S2RHAI interviews obtained with current RS hosts, and (2) analyzing outputs from the initial workshop (T0.1);
(2) Using OSMOSE’s yearly workshops (T0.2) to organize sessions involving RS hosts and scientists to express and analyze how everyone’s needs can be accounted for and through what forms of communication;
(3) Initiate interviews with “new” RS hosts (T1.1) to create a baseline of motivation and knowledge which we will update on a yearly basis to determine their evolution path within the project;
(4) Organize focus groups centered on some of the RS hosts to better understand their socio-economic environment, confront their perception with the reality of that environment, and determine how representative they may actually be. This will help us understand the impact they may have for other WPs.

T2.2: Analysis of perceptions and representations of the population (Corbet, Hurbon, PhD student, Fallou, Calais, Théodat, Guerrier). Beyond RS hosts, we aim at reaching the general population – across its social, economic, and cultural diversity, as much as possible – in order to understand perceptions, beliefs, communication habits (radio, WhatsApp, newspapers, etc.) and address questions such as: Who are the people disseminating information and who are the most followed and listened to (capital of confidence)?

Which vocabulary is the most effective? Which are the supports that are best understood (for example, is a geographical map a good support)? We will do this through:
(1) In-depth qualitative surveys with participant observation, a minimum of 20 survey results per year;
(2) Individual interviews with program scientists, local scientists, and political leaders at different levels of responsibility (~30 total) in key institutions in relation with WP3 and WP4 (see T4.4);
(3) Observation and interviews in the educational environment, in relation with WP4 (T4.5, ~10 in total);
(4) Focus groups with key actors of the society, including very low-income neighborhoods, with a special attention to religious diversity, including vodou. We will target communities in cities recently affected by earthquakes such as Port-au-Prince, Léogane and Jacmel (for the 2010 earthquake), Anse à Veau, and Cap Haitien. These places not only allow us to address the seismic question, but also integrate other hazards such as climate change, mudslides or landslides, or extreme weather (droughts and hurricanes). This will provide us with a more general framework of the perception and management of natural risks in Haiti and of the place of earthquakes within it;
(5) In some cases, to be determined on the basis of our early observations, we will consider installing a RS with charismatic religious figures to understand how they and their community interact with the instrument and interpret seismic issues. We will follow them through the project to determine whether and how the presence of the RS and discussions around it may impact their perceptions. We already identified a rural community in central Artibonite (Ségur) where we have a privileged contact with a charismatic vodou priest who agreed to open his community to us;
(6) Qualitative, conversational, interviews with the general population (streets, public transportations, etc.). This participant observation will allow us to better understand the insertion and relevance of our approach in Haitian society as a whole;
(7) Special attention will be paid to the gender issue. For example, are there gender differences in perceptions of the earthquake? Do gender beliefs or social roles influence people's interpretations? Are women more distant from scientific practices?

T2.3: Mapping of stakeholders (Corbet, Hurbon, PhD student, Fallou, Calais, Théodat, Guerrier, Symithe).
This mapping, whose results will feed into WP3 and WP4, will be performed via:
(1) Interviews with the different actors will make it possible to know who deals with what (gender relations, for example), who relays information and how (on what media, with what vocabulary, using what media, etc.). This descriptive analysis will be one of the supports of WP4;
(2) Interviews with political and institutional leaders in order to understand how they manage seismic prevention;
(3) Interviews with local and international scientists, and with organizations of risk prevention and solidarity (such as protection civile or local and international NGO) in order to understand which tools they use for communication and evaluate if it works or not.

WP2 will benefit from a PhD student fully dedicated to its 3 tasks, in collaboration with other WPs. He/she will grasp the general context of risks in Haiti, approaching the theme at the crossroads of disciplinary cultures: in particular political science (who are the actors, are we in “marronage” of the state or what are the state’s prerogatives), anthropology (for example religious aspects, rural or urban differences -- see Abbott and White, 2019), cultural geography (with a very concrete approach such as architectural adaptations related to the risks in the country; but also on the diversity of the perception of lived and used space). He/she will therefore work on risk, its local measurement and social interpretations and adaptations, and how SRs interact with this environment. He/she will put these data into perspective in the special context of an experience where we seek to understand local representations, but also the motivations to get involved in science and to trust it in a cross-dynamics between scientists and citizens. His/her approach will feed into research on disaster studies, risk studies, expert and NGO studies, applied to the specific case of Haiti. This PhD student will be a central element of OSMOSE, as he/she will link across the WPs. He/she will be assisted by selected students from the URBATER master (FDS).

Deliverables

D2.1: 30 in-depth interviews with RS hosts leading to a presentation and a paper describing our understanding of their perceptions, representations, practical needs, and their evolution during the project;
D2.2: 15 in-depth interviews with local institutional leaders leading to a presentation and a paper describing our understanding of their perceptions, representations, and expectations;
D2.3: 10 focus groups and systematic participant observation leading to a presentation and a paper describing our understanding of their perceptions, representations, and practical needs with a particular attention to the environments surveyed and the issues of gender and social classes;

Risks:

R2.1 & R2.2: same as WP1. An additional mitigation measure here is the ability to communicate with RS hosts and citizens through social media such as WhatsApp newsgroups and to perform interviews over the phone or via videoconference as we did during S2RHAI with RS hosts.
R2.3: Inability to reach a diverse section of the population, especially since RS instruments require internet access, therefore electricity and financial support. This risk is minimized thanks to the engagement of our local partners in Haiti who know the socio-economic situation, will guide us through difficulties in the field, and advise us on how to dodge these difficulties or rebounds.
R2.4: Misunderstanding between scientists and hosts or citizens for cultural reasons or different approaches to science and knowledge. This risk is minimized by the awareness of the risk and the presence of many actors from all backgrounds, French and Haitian, in the project.

WP3: Co-construction of an effective citizen information system

Coordination: Laure Fallou (EMSC) / Nixon Calixte (FASCH)

Objectives: WP3 takes advantage of the results of WP1 and WP2, to produce seismological information adapted to the needs of citizens and to the seismological reality. Several levels of communication will be considered: (1) with the RS hosts, (2) with the general public, and (3) between the RS hosts and their community. This will be achieved through 4 specific objectives: (1) understand the nature, temporality, and channels for the information expected by citizens; (2) determine the feasibility of the developments required to meet their expectations; (3) implement those solutions through existing communication channels; (4) evaluate the possibility of using Virtual Reality or gamification activities for risk prevention.

Tasks:

T3.1: Assessment and analysis of RS hosts' information needs (Fallou, Calixte, Monfret, Ampuero). We will analyze outcomes from the initial workshop held under WP0 to assess RS hosts' needs for seismic, scientific and technical information. We will determine (1) the nature, form and timing of the information they wish to receive (real-time, risk and protective measures, scientific information, etc.), (2) the channels through which they wish to receive and / or exchange information (social networks, WhatsApp, mobile application, website, newsletter etc.) and (3) the barriers and incentives that we can work on in order to enhance their participation and ensure their motivation in participating in the project. For instance, do citizens want to see a map with an earthquake location, or simply its distance to the 3 closest cities? Is the depth of the earthquake relevant to them? Are they interested in ShakeMaps? In an aftershock forecast[7]? A specific attention will be payed to all cultural factors that may impacts these needs (eg. gender, age, religious beliefs, trust level, etc.).

T3.2: Development of a strategy and tools to communicate with RS hosts (Fallou, Calixte, Roussel, Corradini, Monfret, Ampuero, Bossu). Following the assessment of RS hosts information needs (Task3.1), we will establish with project partners the scientific, technological (WP1) and socio-anthropological (WP2) conditions to best meet these expectations. This work will take place during joint workshops with WP1 and WP2. Instead of developing a new App, we will first analyze the utility and use of already existing channels (ayiti-séismes site, Lastquake application, the WhatsApp group, etc.) in order to complement and adapt the existing offer to best match the needs and usage of citizens.

[7] www.richterx.com/?go=forecast

T3.3: Development of communication tools to support the RS hosts in their ambassador role towards their community (Fallou, Calixte, Corradini, Monfret, Ampuero, Bossu). In coordination with WP2 (Task 2.1) and WP4 (T4.1 and T4.5) we will co-construct communication tools in order to support RS hosts in their ambassador role. These tools will take into account the general seismic risk perception in Haiti, religious belief and scientific culture. They will aim for instance at explaining the RS role, raise risk awareness without creating additional fear, or providing resources for those seeking additional information. RS hosts will have a key role in co-designing these tools and support to ensure that they meet their needs and those of their communities. Experts in science pedagogy (WP4) will also contribute to this co-construction. The actual implementation of the material developed here will take place within T4.1.

T3.4: Development of a communication strategy towards the general public (Fallou, Calixte, Corradini, Ampuero, Bossu, Roussel). In coordination with WP1, WP2 and WP4 we will develop a strategy for communication with the general public. It will aim at informing on earthquakes detected, at raising risk awareness & preparedness and at staying attuned with the community needs, taking into account cultural factors (including gender). This strategy will take into account information needs and expectations (WP2), available data (WP1), and to whom this information is distributed (WP4). It will be based on improving existing tools (e.g., ayiti-séismes platform and Lastquake application) by making them more visible and accessible. We will also study the possibility to create a WhatsApp bot to inform the general public, as this messaging service is a key element in Haitiens' information routine and has proven helpful during S2RHAI to collect eyewitness testimonies after felt earthquakes. We will also determine whether the safety instructions developed by the EMSC could be disseminated as part of the information on earthquakes, after being adapted to the local context and whether there is interest for a citizen seismology forum developed by the EMSC and called LastQuakers[8]. In coordination with T4.2, all materials will be made accessible in Creole.

T3.5: Development of a "felt earthquake" activity at the interface between seismology and sociology (Attié, Calais, Courboulex, Monfret, Deschamps, Guerrier, Symithe, Fallou). Here we will test simple Virtual Reality (VR) activities targeting, in particular, the younger population in low-income neighborhoods where traditional learning paths and methods are only marginally relevant. This action will be a meeting point and multidisciplinary activity with all the project partners. We will seek to "gamify" an earthquake experience – with varying magnitude and effects – in a playful context that however allows for effective learning of protective reflexes and earthquake knowledge in general as the game progresses. We will pay particular attention to gender biases in the effectiveness of a VR/gamified approach. We will test how using haptic vests and other locomotive equipment can be used to analyze real-time reactions (biometric parameters that can be measured during these activities such as heart rate and pupil movement). We will perform qualitative surveys in order to measure the effectiveness of a VR experience compared to a classic "in class" approach. This work will be carried out in accordance with the rules of professional ethics, in particular by ensuring that the tests take into account management of the trauma they could cause.

T3.6: Communication strategies assessment (Fallou). In collaboration with WP2 and WP4, the communication tools described above will be regularly assessed, through interviews with their users (WP2) or through quantitative indicators (such as the number of visits on websites). This will inform strategies developed in WP4 to support the project's sustainability.

Deliverables

D1: Internal report on communication strategy with RS hosts, to circulate across all project members;
D2: Improved communication tools with RS hosts (websites, WhatsApp group, etc..);
D3: Co-constructed communication tools to support RS hosts in their ambassador role;
D4: Communication tools dedicated to the general public, most likely via a social medium;
D5: A pilot VR activity tested with users, and conclusions on its effectiveness;
D6: A communication strategy assessment.

Risks:

R3.1 & R3.2: same as WP1.

[8] www.lastquakers.eu

R3.3: Misunderstandings between scientists and hosts or citizens for cultural reasons or different approaches to science and knowledge. This risk is minimized by the awareness of the risk and the presence of many actors from all backgrounds, French and Haitian, in the project.

WP4: Sustainability through two-way communication and education
Coordination: Jean-Marie Théodat (PRODIG) / Kelly Guerrier (URGéo)
Objectives: We seek to develop and test strategies to sustain a multi-stakeholder seismic network in Haiti, in relation with the lessons learned from WP1 (technical), WP2 (sociological), and WP3 (operational). The specific objectives are to (1) convert RS station hosts to earthquake-citizen ambassadors, (2) ensure that linguistic compatibility is at the core of all OSMOSE communication activities, (3) establish a dialog with national institutional stakeholders, and (4) insert earthquake risk activities in educational curricula.
Tasks:
T4.1: Support and accompany earthquake-citizen ambassadors (Guerrier, Monfret, Fallou, Haiti master students). We will deploy the material developed in T3.3 to support RS station hosts in becoming earthquake-citizen ambassadors within their local networks, and link everyone to the overall project. This support will be provided by students of the URBATER and Géorisques masters who will act as relays between scientists and earthquake-citizen ambassadors. We will also leverage RS hosts' motivation and competencies in order to maximise the chance of sustainability of the seismic network.

T4.2: Ensure linguistic and cultural compatibility (Théodat, Guerrier, Hurbon, Haiti master students). We will seek to promote impact, participation, and long-term ownership by co-developing material with stakeholders in a language that is relevant and useful to them. To do so we will:
(1) systematically translate and culturally-adapt material into creole at all stages of communication – collection of information, sharing of information, and dissemination of knowledge – with input from non-scientist project participants such as RS hosts or focus groups;
(2) co-create, with project's stakeholders, a Creole lexicon for the main concepts / words used in earthquake seismology and risk reduction in a format that ensures actual ownership of the concepts by citizens.
This task will benefit from information and inputs from WP2 on issues such as perception of the territory and its usage, mental cartography of one's environment, etc.

T4.3: Identify indigenous knowledge relevant to environmental hazards (Théodat, Guerrier, Corbet, Fallou, Calais, Haiti master students). It is well known that indigenous, empirical knowledge may contain elements that lead to protective measures against hazards, as long-term observations of one's immediate environment and the transmission of those observations across generations can develop a local "reference frame" (e.g., Hikuroa, 2017; King et al., 2018). Whether such indigenous knowledge concerning earthquakes is present in Haiti is unclear, since damaging events have been infrequent in recent times -- though they were not in the 18th century (e.g., Scherer, 1912)! Other natural hazards such as floods, hurricanes, or drought are likely to have left a shorter-term imprint in the collective memory. As for T4.3, does integrating local knowledge in our dialog with citizens improve their trust in the scientific approach? Here we will use the interviews, questionnaires and focus groups mentioned above (WP2) to try and extract that knowledge in the context of earthquakes and more generally geohazards in Haiti. We will then investigate (1) how useful that knowledge actually is, (2) how it compares with "scientific" knowledge, (3) what impact may indigenous knowledge have on "scientific" knowledge, (4) how integrating indigenous knowledge in our interactions with the general public may -- or may not -- lead to greater confidence, (5) whether gender biases / differences exist, and (6) how scientists could eventually make use of that indigenous knowledge. This work will be performed with the participation of FASCH students as part of their final graduate studies dissertation.

T4.4: Ensure a dialog with national institutional stakeholders (Guerrier, Theodat, Momplaisir, Prépetit, Bétonus, Boisson). We will carry out at least one 2-day workshop every two years, in connection with the mapping carried out in WP2, with national institutional stakeholders. These include, in particular, the Directorate General of Civil Protection, the National Hydrographic Service, the National Building Laboratory, the international organizations that support them (UNDP, WB, EU, etc.), NGOs, and the private sector. We will seek information on the expectation of these stakeholders to define the best strategy to motivate

sustained interest and develop synergies. Pending on their interests, we will carry out workshops with relevant NGOs to help them adapt their risk reduction practices to local socio-cultural conditions.

T4.5: Co-develop educational activities (Etienne, Rathon, Bérenguer, Balestra, Courboulex, Théodat, Ampuero). Haiti has a young population that one can use as a gateway to disseminate information to older generations. The proposing team has extensive experience in educational seismology in Haiti through Catts Pressoir and Géoazur, who have been working together since 2010 to enhance earthquake literacy -- and more generally science literacy -- in Haitian schools. We will co-develop and offer educational activities on earthquakes and the associated risk, access to resources, and integration into existing international educational networks. We will pay specific attention to gender biases so that girls are incentivized as much as their male counterparts. We shall take advantage of two existing and already structured network of schools where we will install RS stations:
(1) The "*lycées connectés*" ("connected high schools") network, spearheaded by Haitian partner Catts Pressoir and supported by the private sector[9]. These schools, equipped with solar panels, batteries, and internet, are an ideal target as they are distributed throughout the country, including in low-income provincial areas, with referent teachers who are clearly identified. We will work with 2 high schools in St Jean du Sud and in Jacmel where connection equipment is already in place;
(2) The "EDUSEIS network", led by GEOAZUR and supported by the French Embassy in Haiti, which comprises 3 schools, some of which are already hosting a low-cost, slinky seismometer 'TC1'. We are planning to work with schools in Saint Marc (Lycée Jean-Baptiste Pointe du sable), in Cap Haitien (Lycée Simone de Beauvoir), and in Les Cayes (Lycée Odile-Joseph).
We will investigate how to convert some of the pupils from these school networks into cartographers of environmental hazards with a linkage to RS hosts. Here we hypothesize that mapping one's immediate environment in the face of natural hazards is a way to improve the understanding of these hazards and of the existing prevention solutions. We will develop an activity dedicated to the mapping of areas exposed to environmental hazards and of the resources available for emergency response and preparedness[10] (safe meeting points, people with first-responder skills or tools, etc.).

Deliverables
D4.1: At least 5 RS hosts are accompanied as "earthquake-citizen ambassadors";
D4.2: A creole lexicon for the main concepts / words of risk reduction is produced;
D4.3: 4 final graduate studies dissertations on indigenous knowledge relevant to environmental risks;
D4.4: 4 workshops with institutional stakeholders, with written conclusions and recommendations;
D4.5: 5 RS instruments are installed in selected schools ("*lycées connectés*" and EDUSEIS schools);
D5.6: An earthquake risk module, first element of a broader DRR curriculum, is developed;
Risks:
R4.1 & R4.2: same as WP1. Working with the "lycées connectés" will allow for video-interaction with schools.
R4.3: Vandalism of equipment will be minimized by securing the RS seismometers in locked enclosures.
R4.4: Staff demobilization will be minimized thanks to the long-term involvement of Catts Pressoir, together with the EDUSEIS project, in seismo-education in Haiti.

GANTT CHART

		semester							
WP	Task	1	2	3	4	5	6	7	8
0	0.1. Create steering committee								
	0.2. Organize initial workshop								
	0.3. Organize yearly workshops								
	0.4. Communicate on the project								
	0.5. Coordinate scientific and financial reporting								

[9] www.pressoir.org/lycéesconnectés.html, www.cpressoir.org/images/Sponsors.pdf
[10] e.g., https://mil.wa.gov/map-your-neighborhood

	0.6. Foster reflections across disciplines								
1	1.1. Augment the number of RS deployed								
	1.2.1. Optimize velocity model								
	1.2.2. Improve attenuation model								
	1.2.3. Integrate AI into earthquake detection system								
	1.3. Denoise RS data with AI								
2	2.1. Analyze perception/representations of RS hosts								
	2.2. Analyze perception/representations of the population								
	2.3. Map stakeholders								
3	3.1. Assessment of RS hosts' information needs								
	3.2. Develop a strategy to communicate with RS hosts								
	3.3. Develop communication tools for RS hosts								
	3.4. Develop communication strategy for general public								
	3.5. Test "felt earthquake" activity using VR								
	3.6. Communication strategies assessment								
4	4.1. Accompany citizen ambassadors								
	4.2.1. Translate and culturally-adapt material								
	4.2.2. Develop Créole lexicon								
	4.3. Identify indigenous knowledge								
	4.4. Dialog with institutional stakeholders								
	4.5. Co-develop educational activities								
	4.6. Engage students to risk mapping								

II. Organization and implementation of the project

Scientific coordinator and consortium

The project will be coordinated by E. Calais (UMR Géoazur, IRD/CNRS/UCA/OCA), who has been working on seismic risk in Haiti since 2003 with Haitian scientists and international stakeholders of disaster risk management. He has led many international projects, including in Haiti, where he currently coordinates the S2RHAI project (CNRS/IRD), the WP3 of the Interreg PREST project, the CARIBACT LMI, and the GEOACT project (ACP/Europaid). He worked in Haiti as an expert for the World Bank, the Inter-American Development Bank, the United Nations Development Program and the European Union. He co-chaired the United Nations "Haiti seismic task force" after the destructive earthquake of January 12, 2010 and worked for two years in Haiti as scientific advisor to the United Nations from 2010 to 2012. He will coordinate the project and bring together seismological and sociological approaches while ensuring close interactions with local actors. He is currently in delegation with IRD for four years, stationed in Haiti with partner URGéo.

Géoazur has been involved in seismology in Haiti since 2010. A GET researcher (UMR 5563), Valérie Clouard, involved in seismology in Haiti since 2010 and responsible within the Interreg Caribbean PREST project for supporting the Haiti national seismological network, will be associated with Géoazur for this project. Géoazur will work primarily on the RS stations data quality and their use to improve earthquake detections with the objective of increasing the amount and quality of information one can share with RS hosts and the population. Two engineers from Géoazur are in charge of developing and maintaining the ayiti-séismes platform. A Haitian doctoral student (Sylvert Paul) will be fully dedicated to OSMOSE with funding acquired from the French Embassy and the Université Côte d´Azur. Géoazur hosts the EARLI ERC project (2021-2025) led by Q. Bletery which focuses on using Artificial Intelligence to improve earthquake detection. OSMOSE will piggyback on EARLI to "comb" noisy RS data in a smart way and extract earthquake signals hidden in the ambient noise. Géoazur hosts an education unit that brings together staff from the Université Côte d'Azur and teachers from the Académie de Nice. This unit regularly intervenes as "education and outreach" support in research projects, such as the former NERA and SERA (EC projects), and the on-going Mars InSight and Mars2020 (NASA), SEAFOOD (Idex UCA Jedi, ANR, First), RITMICA (Idex UCA Jedi), and ITEC (ANR) projects.

LAM is a multidisciplinary social sciences laboratory hosted at Sciences Po Bordeaux with a large library on Haiti, development, and humanitarian aid. It has field experience based on qualitative approaches involving NGOs in a research-action context. A. Corbet, anthropologist, has worked in Haiti on the community approach in the slums, the socio-cultural analysis of epidemics, and the relations between NGOs, State, and citizens. LAM is a partner of ANR ELIPS (Equality in Personal Statuses). LAM hosts an "African Diaspora" Chair dedicated to strengthening knowledge on the African diasporas. The hosting of LAM at Sciences Po Bordeaux allows its researchers, including A. Corbet, to participate in the activities of an integrated France-Caribbean program with the Universities of the Antilles and of the West Indies. LAM is a partner of the French Association for Caribbean Studies (Afdec) which emerged from this France-Caribbean program.

PRODIG, hosted at Université Paris 1, works at the intersection of societal and environmental issues using approaches from humanities and natural sciences to analyze the processes and trajectories of economic and urban development at various scales, in particular in developing countries, in connection with contemporary global changes. Jean-Marie Théodat, a Haitian geographer, was a professor at the State University of Haiti, a country he knows perfectly well and where he has carried out much of his research. He was the first academic coordinator of the URBATER[11] Master's program at the Faculty of Sciences of the State University of Haiti.

The **Euro-Mediterranean Seismological Center (EMSC)**, which has NGO status, has been developing innovative approaches to citizen seismology, including the LastQuake application (1.4M users) which was translated into Haitian Creole as part of S2RHAI. Rémy Bossu (seismologist) and Laure Fallou (sociologist specialized in social networks) will contribute their experience of the interface between society and seismological science. M. Corradini will bring her expertise in earthquake communication and F. Roussel on IT and code development EMSC has an extensive experience in European projects involving citizen seismology and communication related to earthquakes (Rise, Turnkey, Carismand).

The **State University of Haiti (UEH)** will be represented by two of its faculty:

- The Faculty of Human and Social Sciences (FASCH) hosts a group of leading sociologists and geographers involved in the analysis of the perception of seismic risk in Haiti, coordinated by L. Hurbon. It will be the key local actor of the sociology part of the project (WP3 and WP4). In collaboration with LAM, they will lead sociology field work in Haiti (seminar, workshops, surveys, focus groups). FASCH contributes to the URBATER master program, whose students will be involved in the sociology activities of OSMOSE.
- The Faculty of Sciences (FDS) hosts the Geosciences Research Unit (URGéo), the national academic leader in Geosciences in Haiti. URGéo has been collaborating for many years with Géoazur and is the formal local partner of CARIBACT, the structure which will host the OSMOSE project. URGéo will work with Géoazur on the seismological use of RS data, with EMSC on the use of information disseminated via social networks, with FASH on the implementation of socio-seismology activities in Haiti.

The **Higher School of Infotronics of Haiti (ESIH)**[12] trains students at the bachelor's and master's level in the fields of computer science. ESIH hosts a VR/AR laboratory (Tainos Visual Arts[13]) with four 3D designers and developers, fiber Internet access and all associated hardware (Cyberith Virtualizer locomotion platform, 4 Oculus Quest/Quest 2 head mounted displays, and associated desktop and laptop computers). ESIH recently received much coverage for its immersive project "Women's contribution to World Heritage[14]" and its virtual exhibition "Museums and Collections of Haiti[15]".

The **Bureau of Mines and Energy of Haiti** is a government institution under the Ministry of Public Works, in charge of seismological monitoring. It has been collaborating with Géoazur and URGéo on various projects, including S2RHAI, for nearly 10 years. It owns 7 Nanometrics broadband seismic stations with VSAT communication, 2 of which currently operational, constituting the core of the national "conventional"

11 "Urbanism and territory"
12 www.esih.edu
13 https://tainosvisualarts.com
14 https://matrimoine.art
15 http://icom-haiti.mini.icom.museum/salon-virtuel/

seismic network. It owns accelerometers and velocimeters for temporary deployments and mobile GPS stations for precise tectonic deformation measurements.

The **College Catts Pressoir**[16] is a private elementary/high school that continually integrates science and technology discoveries into its teaching strategies. This inspiring educational approach makes it possible to analyze the characteristics and needs of Haitian society in a context of globalization and to transform students into changemakers. By articulating development models with reality, the College is able to have a significant social impact on the Haitian society. The College, equipped with a seismological station since 2011 and two professional meteorological stations, develops educational activities in partnership with the EduMed Observatory (at Géoazur) and the "EDUSISMO[17]" global network. It leads the "Lycées connectés" platform that allows all of the lab classes to be delivered virtually to other high schools in the country and is part of the "Learning Planet" initiative.

Implication of coordinator and partner's scientific leader in on-going project(s)

Researcher	P.mo	Call, agency, grant allocated	Project's title	Scientific coordinator	Start - End
Eric CALAIS	1	Interreg Caraibes, 4 ME	PREST	J.B. de Chabalier	2017-2022
Eric CALAIS	1	CNRS / IRD, 20 KE	S2RHAI	E. Calais	2019-2021
Eric CALAIS	4	ACP / Europaid, 4.2 ME	GEOACT	E. Calais	2021-2024
Eric CALAIS	2	IRD, 200 KE	CARIBACT	D. Boisson, E. Calais	2021-2025
Alice CORBET	8	IRD, 200 KE	CARIBACT	D. Boisson, E. Calais	2021-2025
J.-M. THEODAT	4	CNRS / IRD, 20 KE	S2RHAI	E. Calais	2019-2021
Laure FALLOU	5	H2020 GA No.821115	RISE	S. Wiemer (ETH Zurich)	2019-2022
Laure FALLOU	5	H2020, GA No 821046	TURNKEY	J. Schweitzer, (NORSAR)	2019-2022
Laure FALLOU	8	H2020, GA No 101021746	CORE	A. Rossi Filangieri (UNISA)	2021-2024
F. COURBOULEX	1	IRD, 200 KE	CARIBACT	D. Boisson, E. Calais	2021-2025
F. COURBOULEX	4	H2020, EU, 10ME	SERA	D. Giardini	2018-2021
F. COURBOULEX	5	UCA/Idex, 270 KE	RITMICA	J.X. Dessa	2019-2021
F. COURBOULEX	1	CNRS / IRD, 20 KE	S2RHAI	E. Calais	2019-2021

III. Impact and benefits of the project

OSMOSE is, by design, a research-action project with, at its core, the promotion of scientific culture to the general public with direct impacts and benefits to the populations and all stakeholders of the earthquake information, communication, and prevention chain in Haiti. Here we would like to highlight some key impacts of OSMOSE that reach much beyond the classic academic boundaries. OSMOSE will:

- Work directly with all stakeholders (civil society, private sector, educational sector, institutions, etc.) through repeated workshops to establish an understanding of their needs and expectation (T2.3, T4.4);
- Define and produce earthquake information adapted both to the needs of citizens and to the seismological reality (WP1, WP2, WP3);
- Deliver that information via channels adapted to the technical expectations and needs of citizens (T3.4), while ensuring linguistic and cultural compatibility (T4.2);
- Turn citizens into ambassadors of earthquake risk reduction within their communities (T3.2, T3.3, T4.1);
- Develop and deliver educational activities to schools - already identified - to promote ownership of the seismo-citizen network (T3.5, T4.4, and T4.6)
- Feature its educational products at science festivals in Haiti and internationally, as part of the Catts Pressoir/EDUSEIS regularly science promotion activities;
- Organize media meetings during annual project workshops (T0.3) and maintain communication with them throughout the project (T0.4).

[16] www.cpressoir.org
[17] www.edusismo.org

IV. References related to the project *(* indicates open access)*

Abbott, R.P., & White, R.S., Narratives of Faith from the Haiti Earthquake, Routledge, 2019.
Anthony, R. E., et al., Seismol. Res. Lett. 90, 1-10, 2018.
*Berenguer, J.-L., et al., Geosci. Commun. Discuss., 2020.
Bilham, R., Tectonophysics 584, 166–173. doi:10.1016/j.tecto.2012.03.023, 2013.
Bossu, R., et al., International Journal of Disaster Risk Reduction, 28, 32–42, 2018.
Calais, E. et al., Nature Geoscience, 3, 1-6, 2010.
Calais, E., Science et conscience dans la Post-urgence du Séisme d'Haïti, L'Harmattan Ed., Paris, 98 p, 2017.
*Calais. E., et al., A Socio-Seismology Experiment in Haiti, Front. Earth Sci., vol. 8, p. 122, 2020.
*Calais, E., et al., Monitoring Haiti's Quakes with Raspberry Shake, EOS, vol. 100, 2019.
Cantore, L., et al., Seismol. Res. Lett. 74, 596-602, 2003.
Courboulex, F., et al.,Seismol. Res. Lett. 83 (5), 870-873, 2012.
*Corbet, A., Journal of Refugees Studies, 29, 2016.
Douilly et al., Bulletin of the Seismological Society of America, 103, 2305–2325, 201).
Fallou, et al., Citizen Science- SDG conference, Berlin, 14-15 Oct. 2020.
*Fallou L., et al., Frontiers in Communication, 2020.
Frankel, A., et al., Seismic Hazard Maps for Haiti, Earthquake Spectra, vol. 27, no. 1, pp. S23–S41, 2011.
Hurbon, L., Catastrophes et environnement, Haïti, séisme du 12 Janvier 2010, Editions de l'EHESS, 2014.
*Hicks, J., et al., Front. Earth Sci., vol. 7, p. 165, 2019.
Hickey, S., and Mohan, G., London, UK: Zed Books, 2004.
Hikuroa, D., Journal of the Royal Society of New Zealand, 47(1), 5–10, 2017.
Irwin, A., London, UK: Psychology Press, 1995.
Jabeen, H., and Johnson, C., iCities at risk. Advances in natural and technological hazards, Vol. 33, 2013.
Johnston, D. M., et al., in Cities at risk: Living with perils in the 21st century, 131-148, 2013.
King, D.N., et al., Natural Hazards and Earth System Sciences, 18(3), 907-919, 2018.
Lacassin, R., and S. Lavelle, Earth Science Reviews, vol. 155, pp. 49–59, 2016.
Levy, G., and Taber, J., Earth Sci. 21 (2), 28-29, 2005.
Lofstedt, R., and Frewer, L., London, UK: Earthscan/James & James, 1998.
Mousavi, S. M., et al., Nature communications, 11(1), 1-12, 2020.
Possee, D., et al., Tectonics 43, 237–18, 2019.
Ross, Z. et al., Journal of Geophysical Research: Solid Earth, 123(6), 5120-5129, 2018.
Roult, R., et al., Seismological Research Letters 81 (3): 427-452, 2010.
Rouet-Leduc, B., et al., Geophysical Research Letters, 47(4), e2019GL085870, 2020.
Scherer, J., Bulletin of the Seismological Society of America 161–180, 1912
Schlupp, A., et al., Geophys. Res. Abstr. 21., 2019.
Solberg, C., et al., Nat. Hazards Earth Syst. Sci. 10, 1663-1677, 2010.
Subedi, S., et al., Frontiers Earth Sci 8, 73, 2020.
Symithe, S. J, et al., Bulletin of the Seismological Society of America, 103, 4, 2326–2343, 2013.
Théodat, J.M., Haiti 2010: les leçons d'une catastrophe. EchoGéo, 1-5, 2010.
Tucker, B.E., Reducing Earthquake Risk, Science, 341, 6150, 1070–1072, 2013.
Twigg, J., London, UK: Overseas Development Institute, Humanitarian Practice Network, 2004
UNISDR, The Sendai framework for disaster risk reduction 2015-2030, 2015.
Wehn, U., Environ. Sci. Policy 48, 225–236, 2015.
Wehn, U. & Evers, J., in Local Flood Risk Management, Technology in Society, pp. 187–198, 2015.
Wehn, U., et al., 2016. Ground Truth 2.0 – Environmental Knowledge Discovery of Human Sensed Data, 2016.
Wehn, U. & Almomani, A., Environ Sci Policy 101, 341–357, 2019.
Whitelaw, G., et al., Environ. Monit. Assess. 88, 409–418, 2003.
Winter, K., et al., R., Seismol Res Lett, doi:10.1785/0220200483, 2021.
Vera, C., et al., CONGREMET XIII, 16-19 octubre 2018, Rosario, Argentina, 2018.
Yamori, K., Cities at risk: living with perils in the 21st century, 73-92, 2013.