BRGM (French Geological Survey)

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Outline

BRGM is France's reference public institution for Earth Science applications in the management of surface and subsurface resources and risks. BRGM ("Bureau de Recherches Géologiques et Minières") is the French Geological Survey. The key objectives for BRGM are: i) Understanding geological processes and associated risks; ii) Developing new methodologies and techniques helpful in geosciences; iii) Producing and disseminating data to support the management of soils, subsoils and resources; iv) Delivering the necessary tools for the management of soils, subsoils and their resources, for risk prevention and for policy responses to climate change.

BRGM's activities are organized around its 5 key roles: scientific research; support to public policy development; international cooperation; mine Safety and training through "ENAG" school. **Scientific research** at the BRGM is focused on furthering geological knowledge and understanding surface and subsurface phenomena. The key issue at stake is to meet the challenges of global change. Over 700 BRGM engineers and researchers - two thirds of its staff - are involved in scientific research. **Support to public policy development** covers all expert appraisals, monitoring and studies such as: surface/subsurface monitoring and disseminating knowledge; methodological studies and synopses to transfer research results to "civil society"; independent expert appraisals; and training or knowledge transfer. **International cooperation** is also one of the major roles: with over 200 projects each year in more than 40 countries, BRGM works across the globe towards enduring protection for people and resources. BRGM provides know-how and expertise in two main areas: i) protecting people and their environment against natural risks; ii) ensuring the permanence and quality of natural water, mineral and (geothermal) energy resources. **Mine Safety**, since 2006, has been entrusted to BRGM by the French State. Monitoring and action to prevent risks and pollution arising from mine closures are part of BRGM's missions. BRGM has state delegated responsibility for all mine safety engineering work. Through **ENAG**, the BRGM disseminates its scientific competences and techniques through a range of courses: higher education diploma courses in the geosciences, through training support and partnerships with higher education establishments; continuing professional training, through some sixty introductory and advanced courses in all geosciences fields.

Building on geology as its core competence, BRGM develops expert knowledge in resource management, risk management and innovative eco-technologies. These activities are organized into 10 main topic areas that address the industrial and social challenges of today: geology, mineral resources, geothermal energy, geological storage of CO2, risks, post mining, water, polluted sites and soils, waste, metrology and laboratories, information systems.

The BRGM was created in 1959. It operates as a public industrial and commercial institution, reporting to the Ministry of Education, Higher Education and Research, the Ministry for Ecology, Sustainable Development and Energy and the Ministry for Economy, Industry and Digital Technology. The BRGM is ISO 9001 certified (quality) since 2004 and ISO 14001 certified (environment) since 2012. Its analytical laboratories are accredited by the Cofrac since 1994. The BRGM is one of the Carnot institutes. BRGM employs 1100 people, including more than 750 researchers and engineers (geologists, geotechnicians, hydrogeologists, geochemists, modelling specialists, geophysicists, IT engineers, etc.), in its 32 agencies in mainland and overseas France. BRGM teams are involved in projects in more than 40 countries. BRGM is also member of the French association for natural disasters prevention and of the French association of earthquake engineering.

Research Achievements and Challenges

As our societies become more urbanized, assessing our exposure to natural risks is coming under increased scrutiny. However, urban vulnerability and resilience remain difficult to assess in a holistic way: multiple spatial and temporal scales are involved for adverse events such as earthquakes, marine flooding, soil and coastal erosion, tsunamis, landslides, shrinking and swelling of clays and urban underground management. In addition, global change is both affecting the Earth as a whole (climate change, sea level rise) and through multiple local impacts of human activities (urbanization, sediment mining, land use changes, etc.).

In this context, BRGM aims at developing methods and tools (observations, modelling, experiments, data analysis, uncertainty analysis) for assessing hazards' levels and their impacts on physical and systemic vulnerabilities. BRGM also aims at improving the understanding of climate and global change and its potential impacts on natural risks. The most recent research achievements in the above mentioned fields were done through different partnerships built during projects funded by French and European research agencies. In the framework of the 2nd Global Summit of Research Institutes for Disaster Risk Reduction, the following achievements are worth to highlight:

Together with the partners of the FP7 SYNER-G project (Systemic Seismic Vulnerability and Risk Analysis for Buildings, Lifeline Networks and Infrastructures Safety Gain, coordinated by the University of Aristotelio Panepistimio Thessalonikis), we aimed at understanding the systemic vulnerability of various societal elements at risk belonging to a human-constructed system (city, region, lifeline network, etc.) and at proposing appropriate methods and tools to consider inter-element and intra-systems interdependencies, including socio-economic features. It promoted the use of modern resources and tools for seismic risk mitigation and it established a European reference for seismic societal and physical vulnerability.

In the same way, through the collaborative FP7 MATRIX project (New Multi-Hazard and Multi-Risk Assessment Methods for Europe, coordinated by GeoForschungsZentrum), we aimed at developing methods and tools to tackle multiple natural hazards within a common framework in order to: i) help future analysts to optimize the risk assessment process; ii) contribute to rationalizing data management for hazards and vulnerability reduction, and; iii) support cost-effective decisions on structural and non-structural mitigation/adaptation measures following a multi-hazard perspective.

BRGM was also a partner of the FP7 SafeLand project (Living with landslide risk in Europe: Assessment, effects of global change, and risk management strategies, coordinated by the Norwegian Geotechnical Institute), composed of 27 institutions from 13 European countries. SafeLand developed generic quantitative risk assessment and management tools and strategies for landslides at local, regional, European and societal scales and establish the baseline for the risk associated with landslides in Europe, to improve our ability to forecast landslide hazard and detect hazard and risk zones.

The recent advances in the use of High Performance Computing (HPC) numerical tools to estimate seismic hazard, especially in a context of complex three-dimensional geological structure in low or moderate seismicity, are worth mentioning. Together with the partners of the project E2V (Euroseistest Verification and Validation, funded and lead by the CEA) we evaluated the reliability of ground motion simulations to predict observed data in a real case for civil engineering design purposes.

In the field of seismic instrumentation, BRGM is investing resources for developing the use of microelectronic accelerometer sensors (MEMS). Miniaturized and much cheaper than conventional sensors, MEMS offer many possibilities for environmental monitoring. In collaboration with the European-Mediterranean Seismological Centre (EMSC) and the local education authority, BRGM has delivered MEMS devices to sixteen schools of the Martinique (French West Indies) so as to develop a local community of the Quake Catcher Network initiated by the Stanford University.

Those research achievements connect back to actual disaster risk reduction goals through the close collaboration between the three BRGM's Directorates which are: the Scientific Research Directorate, the Support to Public Policy Development Directorate and the International Cooperation Directorate. Some of the advances made in the above projects are now routinely proposed to public policy development or commercial calls for mitigating future natural disasters. For instance, the methodology and tools developed during the E2V project were applied on a Swiss city whose complex three-dimensional geology required advanced three-dimensional seismic wave simulations to assess its seismic hazard. BRGM's scientific programs also contribute to the development of climate services in order to transfer best applicable results from research to innovation and finally improve adaptation practices. Another relevant example is our participation to the micro-zonation program in Haiti: this program was decided following the dramatic earthquake in January 2010 and aims to deliver a sharp understanding of local risk. It is funded jointly by the United Nations Development Programme and the Ministry of Public Work in Haiti. It started in September 2011 with the micro-zonation of the capital city, Port-au-Prince and has then been extended to four municipalities in the North of the country. A particular point in this project lies in the strong implication of Haitian teams: in addition to data exchange with Haitian scientific institutes, the project is a real partnership with the Mining and Energy Office and the National Laboratory for Buildings and Public Work. The objective is not only to produce maps describing the potential effects of earthquakes in terms of ground motion or induced effects, and recommendations for risk prevention, but also to share knowledge so that the Haitian colleagues are able to conduct by themselves the last micro-zonation of the project. This illustrates the societal role that we, as scientists, have to play to help developing countries to prepare for and face future disasters.

BRGM's Risks and Prevention Division sets its activities in the context of an evolving world, always denser, more interconnected, and subject to changing climate conditions. Its aim is to deliver the tools and knowledge for building more resilient societies in the face of a multiplicity of natural threats. Major challenges in that perspective include:

- Understanding and quantifying the impacts on natural hazards of climate change and increased human pressure on the environment, in order to build forecasting tools and derive appropriate adaptation strategies;
- Developing approaches for multi-hazard / multi-risk assessment and mapping (between natural hazards: seismic, hydro-meteorological, coastal and volcanic risks, but also to take into account potential cascade effects with triggered industrial or nuclear risk); supporting decision-makers for an informed multi-risk management of land-use in the aim of a sustainable use of urban and rural territories;
- Expanding vulnerability assessment methods and their geographical coverage, including vulnerability assessment of urban / peri-urban systems that take account of functional and geographical interdependencies between buildings, networks and facilities, and time-evolution of vulnerability in response to successive natural aggressions;
- Carrying on the improvement of our capacity to support public authorities and private stakeholders in the management of crises due to natural hazards, through early warning systems and rapid response tools;
- Improving the reliability of computations/simulations (e.g. to better reflect the complexity of phenomena or heterogeneity of the geological medium) and quantifying their uncertainties; in particular, strengthening the capacity to appropriately assess and manage low-probability-high-consequences events;
- Coping with numerous data and computationally intensive models. The growing interest in High Performance Computing, distributed sensors and/or crowdsourcing generates a wealth of data that needs to be appropriately managed, distributed and used.

Additional points, contributing to these challenges, that are worth a highlight include:

- Further development of monitoring devices and improve monitoring networks (seismic, geophysical and geodetic) to better identify key parameters and better quantify their uncertainties;

- Enhancing the reliability of procedures for quantifying risks and their evolution in the short, medium, long terms;
- Launching works on new generation of three-dimensional geological mapping. BRGM is currently working on the “Référentiel Géologique de la France” (RGF). Such 3D information system aims at gathering and distributing all data relative to the subsurface. Significant challenges lie in:
    - An appropriate design of the information system to feed into it all relevant data for studying natural risks;
    - A comprehensive collect of data provided by previous natural risks study, to capitalize on previous works achievements in terms of geophysical and geotechnical characterization;
    - Interoperability concerns, according to international standards as the INSPIRE directive in Europe for instance;
    - The capacity for a joint exploitation of all these data in numerical models.

Suggestions for the Disaster Research Roadmap

In addition to the scientific and technical challenges described above, we believe that Disaster Research Institutes should underline in their Roadmap the need for:

- Multidisciplinary approaches to natural disaster. Beyond the technical assessment of risk, there is a growing interest in socio-economic assessments to:
    - Evaluate the populations’ perception of risk, land use planning policies, mitigation and adaptation strategies;
    - Assess potential costs of natural risks, to balance the cost and benefit of public policies for disaster risk reduction, and support decision-maker in securing appropriate credits;
    - Assess the effectiveness and efficiency of risk reduction strategies for a sustained effort.

  This need to collaborate, in particular with the economics scientific community, includes a closer cooperation with insurance companies, which do develop technico-economic assessments of natural disasters and gather a wealth of data on past disasters.
- Contribution to populations resilience during the crisis and post-crisis phases, through:
    - Developing alert systems, support to emergency aid during crisis and feedback of experiences;
    - Designing tools for systemic risks analysis and predictive modelling, which allow, once updated with real time data, the optimization of the reconstruction plans.
- A repeated investigation of feedback data from past disasters to strengthen models and assessments, including economic assessments from insurance data as mentioned above.
- A constant attention to the translation of scientific progresses and achievements (in terms of data, tools and methods) to the benefit of concrete disaster risk reduction policies. This implies a regular dialog with decision-makers:
    - to explain in practical terms how they can integrate new scientific findings in their tools;
    - to integrate in the planning of natural risks research their concerns resulting from field issues.
- A particular form of the previous point is the capacity to educate populations for an appropriation of risk mitigation actions. Disaster research institutes should strive to communicate in a pedagogical way, every time possible, on their results to reach the public and grow its awareness about risk reduction.
- A closer care to knowledge transfer in less developed countries. For an effective disaster risk reduction worldwide, it is a responsibility of research institutes to help building local competencies, without which no sustained results will be achieved. Knowledge transfer through capacity building workshops, staff or students exchange, or joint projects implementation should be fostered to aim at a harmonized ability level worldwide.
- Expanding the above point, the intensification of scientific exchanges to share results, tools and concerns, but also to share data (e.g. through the “Référentiel Géologique de la France” mentioned earlier) that may be widely used either for specific field applications or to develop generic methods.