Potential of PLEIADES VHR imagery for risks management and sustainable reconstruction in Haiti: the KAL-HAITI research database example

Delphine Fontannaz[1], Alain Giros[1] and Bernard Allenbach[2]

[1] *CNES, Analysis and Image Products Department, Toulouse, France; Delphine.Fontannaz@cnes.fr;Alain.Giros@cnes.fr*
[2] *SERTIT, Strasbourg, France; Bernard.Allenbach@sertit1.u-strasbg.fr*

Abstract. Following the 12th January 2010 earthquake in Haiti, the French Agence Nationale de la Recherche has funded a project named KAL-Haiti which aims at gathering remote sensing imagery completed as possible with in-situ measurements and exogenous data into a knowledge base. This geo-referenced database, seen as a shareable resource, can serve as a basis for helping the reconstruction of the country, but also as a reference for scientific studies devoted to all phases of risk management. The project main outcome will be a geo-referenced database containing a selection of remotely sensed imagery acquired before and after the disastrous event supplemented with all relevant ancillary data, and enriched with in-situ measurements and exogenous data. The usefulness of the KAL-Haiti project comes true within practical applications and research activities. These studies – further named as projects - are proposed by a community of contributors for a joint involvement of users and scientists. The projects are conducted in the field of global risk management and sustainable reconstruction, from geophysical and societal modeling to image analysis, data processing and information management. The resulting reference database is freely available for research and for reconstruction tasks in Haiti.

Keywords. Very High Resolution images, Risks Management, Reconstruction, Haiti, Database, Research support.

1. Introduction

The earthquake that struck Haiti in January 2010 was amongst the most destructive disasters of recent years. The response of the international community has been unprecedented. Hundreds of data were acquired during the emergency phase: optical and radar satellite images covering various spatial resolutions, aerial photography and in situ measurements. After photo-interpretation, these images were used by the civil protection agencies and rescue teams on the scene.

Too often limited to this « response » phase, the earth observation and in situ data should be available for use by relevant agencies involved throughout the global disaster management cycle: from recovery, mitigation to preparedness.

This paper presents the KAL-Haiti project which has been setup in order to propose a resource freely accessible (in situ measurements, images, maps, models, reports, statistical data) to researchers, developers and final users, for developing and evaluating new solutions in the disaster management cycle.

2. Objectives

Taking into account the humanitarian importance of the Haiti earthquake and the strong demand for helping reconstruction, the principal aim of KAL-Haiti project is to produce and promote the use of a database of earth observation data, in support of research and development activities for global risk management and sustainable reconstruction in Haiti.

The objective is to set up a reference infrastructure containing freely exploitable data, providing an invaluable resource for research into developing methods of analysis for users involved in disaster management from pre-event preparedness to the return to normal after the event, but also during the reconstruction phase currently underway in Haiti. The KAL-Haiti project is built around the applications (i.e. the projects) that jointly selected between the users and the KAL-Haiti project team. Projects are carried out through the implantation of the best scientific and technical practices.

Figure 1. KAL-Haiti main objectives

2.1. Overview of the KAL-Haiti project

The KAL-Haiti project articulates around different components which interact with each other.

- A community of contributors for a joint involvement of users and scientists,
- The database itself which exposes the data to public and registered users,
- The promotion and follow-up of applications of the database.

These elements are described in the following subsections and their interactions are shown in figure 2.

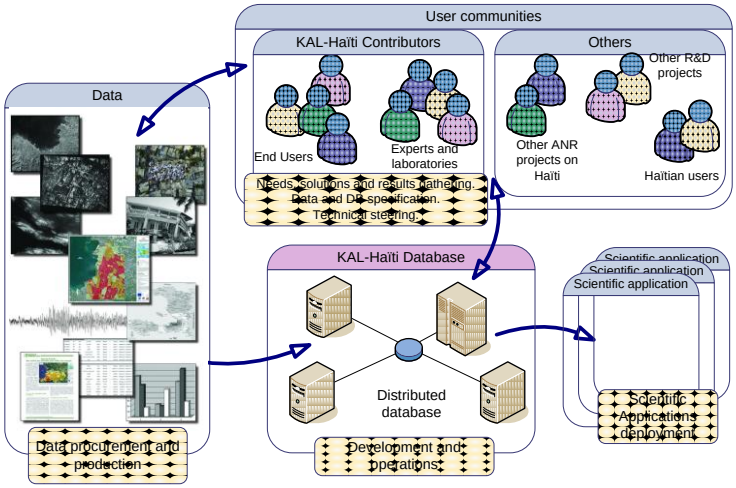

Figure 2. KAL-Haiti main components and interactions

2.2. The community of contributors

One of the main characteristics of the project is the strong user involvement in humanitarian aid (Red Cross), UN organization (UNITAR/UNOSAT) or specialists in urban planning. Starting from January 2011, the project team has recruited several of these organizations acting in Haiti and also research institutes specialized in data analysis, geophysics or risks management. A call for contribution has been issued based on the win/win principle: the contributors give their expertise and express their needs which are in turn taken into account in order to optimize the definition, the content and the validation process of the KAL-Haiti database. This community will be active at least during the development of the project (2010-2014).

Communication within the community of contributors is facilitated by a newsletter, a website and workshops. Three workshops have been organized since 2011. They are the main place to exchange information on available data and existing applications, to express needs in satellite and exogenous data related to the Haiti catastrophe, but also to identify new contributors. A major outcome of these workshops is the identification of new applications which can be carried out within the project framework. A short list of such applications identified since 2011 is given in table 1.

Application	Study area
Follow-up of refugee camps	Port – au – Prince
Planning of urban districts	Martissant (district in Port – au – Prince)
Development of a database to improve territorial management	Jacmel (south of Port – au – Prince)
Management of the risk of flood	Port – au – Prince
Modelling of the risk of runoff	Port – au – Prince
Seismic micro-zoning	Port – au – Prince
DSM generation using Pleiades-HR data	Port – au – Prince
Establishment of a regional cartographic reference table from Pleiades and SPOT images (1:50.000 scale)	Cap Haïtien (northeast of Haiti)
Remote sensing potentialities for quarries cartography and follow up.	Port – au – Prince

Table 1. Some of the applications of the KAL-Haiti database considered so far

2.3. The KAL-Haiti database

The datasets produced within the KAL-Haiti project are stored into a database which is accessible through Internet (KAL-Haiti website). The solution used so far for this implementation is based on the CNES KALIDEOS solution, and allows to query the database using a small number of criteria (area of interest, data type, sensor, etc.) and to retrieve the files containing the data.

The data base will contain multimodal and multisource data: remote sensing and reference data, in-situ measures, statistics, maps and reports. These data are closely related to the study areas as shown in figure 3.

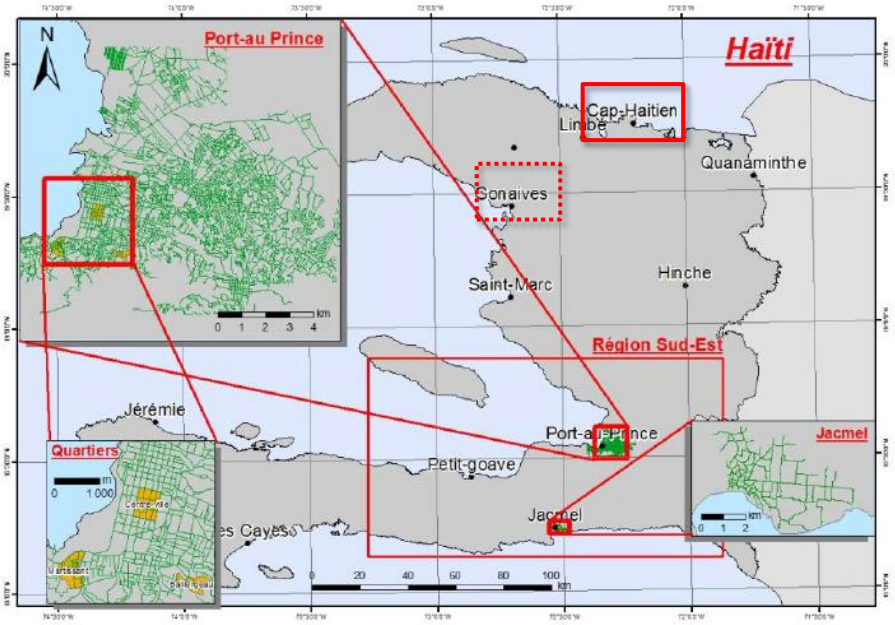

Figure 3. the different study areas

2.4. The promotion and follow up of the applications

Once they have been selected together with the community of contributors, applications are launched by mobilizing either project or external resources. The objective is to propose, for each problem which has been identified, the best possible solution involving end-users with real needs in Haiti and the highest-level scientific laboratories. Involvement of Haitian teams or institutes is also considered in order to favor spin-off on these topics. The selected applications are then followed up as usual scientific and technical developments, except that their outcome (progress, produced data, publications, models, etc.) are systematically provided to the database.

3. Examples of applications

3.1. Remote sensing potentialities for quarries mapping and follow up in the city of Port-au-Prince.

Because urban planning is weak or nearly non-existent in Haiti, urban issues are main thing to consider. This study aims in support of a coherent spatial planning realization taking into account the risk reduction, the geographic space organization (areas to protect, building areas). The objective is to use remote sensing technologies for quarries mapping in Port-au-Prince in the framework of an urban planning.

The project which has just been started will use a 3 along-track Pléiades images (70 cm resolution) acquired on 19/07/2012. Different methodologies approaches will be tested for that purpose (pixel, object classifications and 3D processing).

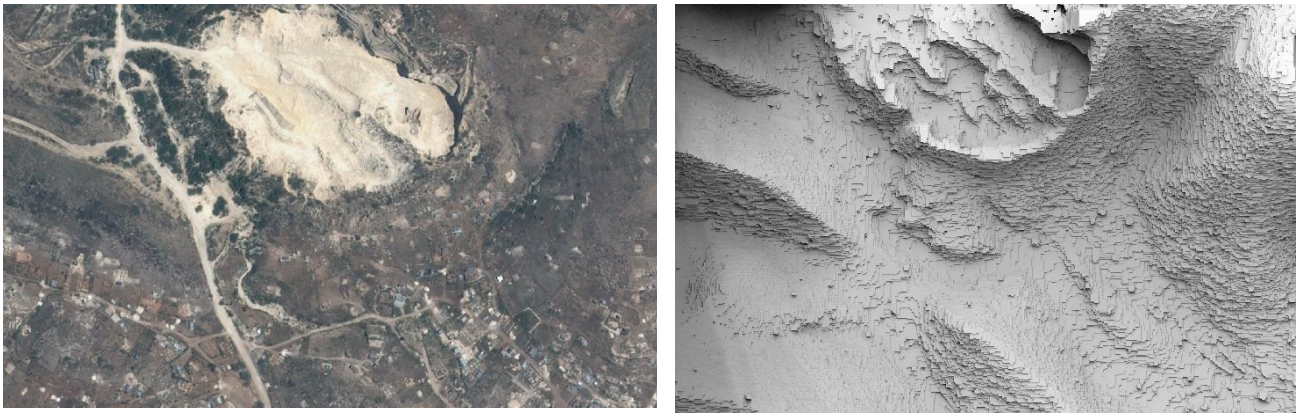

Figure 4. A quarry observed on one Pléiades scene (on the left) / on the DSM Pléiades (on the right)

The second step of the study would be an analysis of the material streams between the different geographic sites. First results are expected by the end of 2013.

3.2. Establishment of a regional cartographic reference from SPOT 5 and Pleiades images

The development of a territory is closely related to its spatial knowledge and requires coherent and coordinated actions in matter of urban planning. This is a decisive way to help people directly affected by poverty to avoid vulnerable peoples and habitats to be hit by future disasters, and to improve living conditions. The exploitation of remote sensing imagery can be a component to answer to this need.

A project of urban planning over the North-East region of Haiti is scheduled. The new landed property and the urban planning dynamics necessitate a specific attention on the evolution of this geographic sector, and thus require undertaking an inventory of fixtures. The study area represents 2000 km² and concerns eight municipalities including the city of Cap Haitien.

The cartographic product that will be performed at 1:50 000 is composed by two main layers:

- The road network from Open Street Map data base
- Land cover/land use from semi-automatic classification

The methodology proposed is based photo-interpretation and object classification on SPOT 5 (2.5 m resolution) and Pleiades (50 cm resampled) images. In a first step the land use classes will be defined at a « global » level (water, vegetation, bare soil, crops, urban) and then refined using the very high Pléiades resolution. This scene could be also used to carry out a product at a bigger scale on Cap Haitien municipality. The objective would be to identify and count the number of buildings of Cap Haitien city. First results of the project which has just beginning are expected by the end of 2013.

Figure 5. Proposal of a regional cartographic reference product – Zoom on Cap-Haïtien city.

4. Perspectives

Besides the applications given as examples in the previous section, KAL-Haiti steadily promotes the proposal of new applications and research activities in the field of global risk management and sustainable reconstruction, from geophysical and societal modeling to image analysis, data processing and information management.

From another perspective, the CNES KALIDEOS programme, in which KAL-Haiti is inscribed, is committed to support such databases and surrounding activities on the long term, thus providing a stable environment for contributors willing to be involved.

Considered together, these arguments shall strengthen the potentialities of the database on the long term. Last but not least, Haiti will of course benefit directly from the KAL-Haiti project. A mirror database will be transferred to Haiti during the course of the project and assistance in exploiting this resource will be proposed with the aim of developing a regularly updated GIS, operated by academic or institutional Haitian bodies.

5. Conclusion

The availability of comprehensive and consistent datasets corresponding to real use cases is a key issue for the development of new methods and algorithms able to solve increasingly complex problems. In line with this assumption, the KAL-Haiti project is a promising initiative which strives to strengthen the global risk management domain which has emerged as an important one, given its societal importance.

Acknowledgements

The KAL-Haiti project is funded by the French Agence Nationale de la Recherche (ANR) under grant number 2010 HAIT 008 01. Contributions of data providers to the database, whose list is available on the Kal-Haiti website, are acknowledged by the KAL-Haiti project team.

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