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SOFTWARE DEVELOPMENT TO SPEED UP DISASTER MANAGEMENT WITH REMOTE SENSING

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ABSTRACT

When a disaster occurs, earth observation specialists must analyze a considerable amount of images as quickly as possible to help rescue teams or to make on-the-fly decisions. As there is currently no remote sensing software that is specific for natural disasters, we propose in this work to determine the basic requirements for such software and develop a test framework for such application. Our approach includes a state of the art review on current earth observation software as well as disaster response needs. We also list requirements based on our review and propose a solution for providing software assistance to photo-interpreters. Finally our test framework is presented.

Index Terms— Disaster response, Open-Source, Remote sensing, Scenarios, Software

1. INTRODUCTION

Software is everywhere and can help people in multiple domains. In the case of crisis management, people must analyze a considerable amount of images as quickly as possible to help rescue teams or to make on-the-fly decisions. There is no remote sensing software that is specific for natural disasters, like flood, wildfire or earthquake and that can do all of it. In the Orfeo Toolbox (OTB), there is no single application for the case of crisis management. Many images must be analyzed in a short period of time so the operator who works for crisis management becomes tired and may miss changes between the image before and after the crisis. The goal of our software program is to provide a centralized repository with all the tools needed to compare those images and the various algorithms adapted to the analysis of natural disasters. The software will take the images before and after the event and automatically compare the images by using change detection algorithms computed at low resolution. In that way, the software will show the major changes between those images and the users will be able to start the detailed disaster analysis from this overview. They will gain precious time by concentrating on other tasks. After getting the information about the change detection, they can go deeper in the analysis of damaged areas and apply some algorithms to roads and buildings detection and other useful things.

2. STATE OF THE ART

We haven't seen in literature applications which integrate all that is needed to respond quickly to a disaster. In [1], while the applications are not for our specific need, it is a good starting point for our software program. In this guide, a graphical user interface named Monteverdi is proposed to manipulate and process images. Monteverdi is built over the OTB kernel described in [2]. OTB is more programmers oriented since it must be coded in C++ to obtain usable modules and applications. When a natural disaster starts, time is short and the rescue teams don't have time to code algorithms to find where the catastrophe is, which roads are practicable, identify damaged areas, and by the meantime produce the required maps.

From our discussions with value-added resellers and from our review of the literature, we have extracted important information on how an integrated tool should be built so that for each disaster type, scenarios will dictate the algorithms and processing steps to be used. Such a tool would help the analysts in reducing the time they need to produce meaningful maps. As can be seen in [3], there have been some improvements in the past years, but there is still plenty of room for more. We thus describe some of the required features for such a tool in the next section.

3. REQUIREMENTS

In order to develop a useful tool, we first establish a list of requirements for an integrated scenario-based disaster image processing software. First, the software should start with specific scenarios for each type of the following disasters: flood, wildfire, earthquake and oil spill. This is important since different disasters lead to different types of damage and rescue needs. Second, since images of different resolution, modality and acquisition parameters can be acquired before and after the event, the proposed tool should be able to cope with these different data types and proposes judicious algorithms accordingly. It is usually accepted that radar images are more useful than optical ones to trace a flood's extent while multispectral images with a near infrared band facilitate the extraction of wildfires and hotspots. Finally, the software tool should offer an easy to use graphical user interface with built-in viewing panes from which an operator can quickly and seamlessly toggle between before and after event images with a slider or with two separate frames.

4. PROPOSED SOLUTION

With the objective of incorporating all the requirements listed in the previous section, we propose to build our tool on top of the OTB library to take advantage of all the image analysis and processing algorithms already developed. The software will use the code of OTB but with a standalone user interface that is not part of Monteverdi. The software will adjust the menus and the types of algorithms depending on the selections by the user and available data. First of all, it will enable high level change detection algorithm with the images acquired before and after disasters. Secondly, the user will be able to go more in details of the changes detected at lower levels. After the change detection the user will be able to use algorithms to find practicable roads, buildings and other meaningful information. Also, as said in [4], "visual interpretation of the damage should be preferred over automated algorithms". In our case the software will show, with a color legend, the damage level for the buildings. At the end, a damage map can be prepared with the help of the software. The diagram of Fig. 1 shows the process used to determine what algorithms and processing to apply depending on the disaster type.

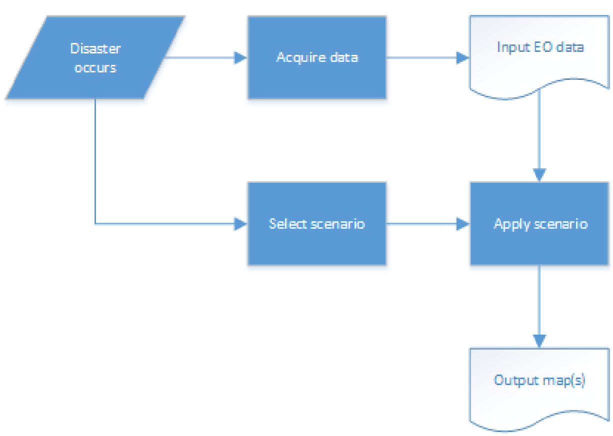

Fig. 1 Disaster map preparation process

In order to select a scenario, a companion software is developed to help photo-interpreters decide what is needed. This software is a simple user interface which asks questions about the type of disaster, the available input data as well as the desired output information. A mock-up is shown in Fig. 2. Once the user has answered the questions, the software shows relevant scenarios or models according to preprogrammed choices built from expert knowledge.

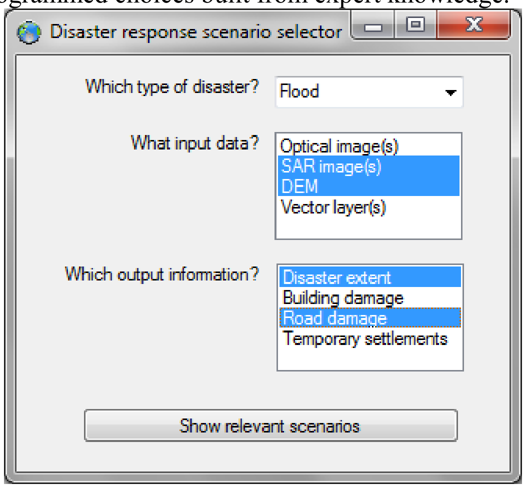

Fig. 2 Disaster response scenario selection example

5. INITIAL APPLICATION

We have chosen to integrate our algorithms as modules in the Quantum GIS (QGIS) open-source software [5]. The main reason we chose this open-source platform is that it already has a processing toolbox plugin incorporating multiple OTB modules. The screenshot in Fig. 3 gives an example of the graphical user interface of QGIS.

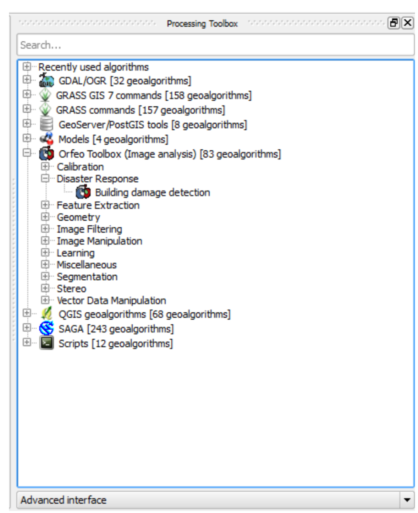

Fig. 3 Processing toolbox with disaster response module example

Another advantage of the processing toolbox is that it comes with a modeler or visual programming interface that facilitate the creation and use of models (preset data flow scenarios). We include an example of this in Fig. 4 where the inputs, processes and outputs of a scenario are presented. This simple example only includes one module but complex models could include multiple chains of modules to obtain the desired output(s).

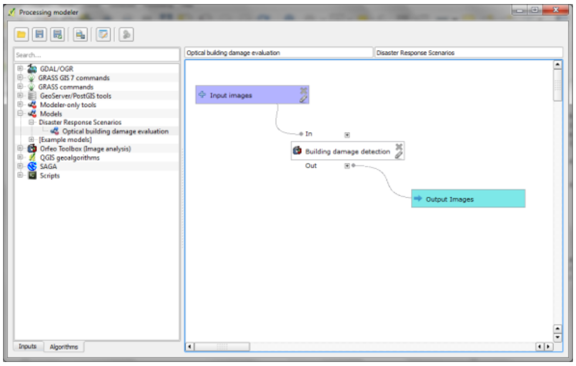

Fig. 4 Scenario model example

The interesting thing about this way of developing preconstructed models is that the end-user just has to input values into the automatically generated parameters graphical user interface to use them. An example interface for parameter input is shown in Fig. 5.

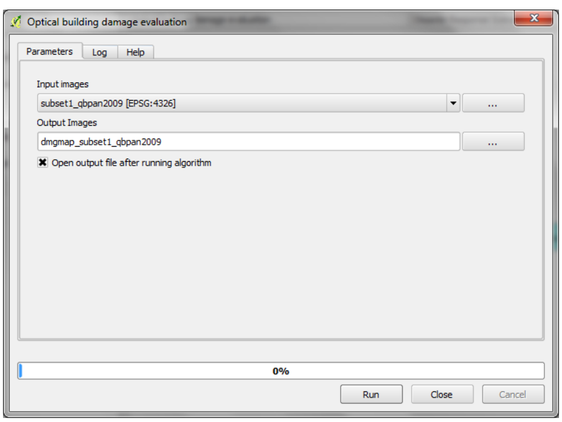

Fig. 5 Scenario parameters input user interface example

6. CONCLUSION

In this paper, we have proposed an integrated software solution to help photo-interpreters when they need to prepare relevant maps as soon as possible after a disaster occurs. We have defined basic requirements for such a tool and have built a prototype according to these prerequisites. This prototype has been integrated as an add-on to the OTB provider of the QGIS processing toolbox for easy use and distribution. We plan to add modules and scenario models gradually as they are developed by our research team.

7. ACKNOWLEDGMENT

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