Natural-disaster mathematical aid systems are presented to NGOs

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The Haitian people up makeshift tents after the earthquake that devastated the country in January 2010. Credit: United Nations Development Programme

A team of mathematicians from the Complutense University of Madrid (UCM) has developed a computer application that estimates the magnitude of natural disasters and helps NGOs in the decision making process. The researchers have also presented an on-site humanitarian aid distribution model. Both could have been applied in the case of the recent Haiti earthquake.

"The Sistema Experto para el Diagnóstico en Desastres (SEDD) (Expert System for Disaster Diagnosis) is a natural-disaster diagnosis and prediction computer tool to help NGOs in strategic decision making", Begoña Vitoriano, co-author of a study published this month in the *Knowledge-Based Systems Journal,* and professor of the Statistics and

Operative Research Department of the UCM Mathematics Faculty, explains to SINC.

The program starts by taking information about the type of disaster (earthquake, flood, hurricane, tsunami, fire, etc.), quantifiable units (Richter scale for earthquakes, wind speed for hurricanes, etc.) and a vulnerability measurement of the area. To obtain a vulnerability measurement, which is the most difficult to do, the scientists use the Human Development Index provided by the UN per country, and they modify it according to the situation of the affected region.

With these data, the computer application estimates the magnitude of the consequences of the catastrophe "in terms of fatalities, injuries, homeless people, others affected and cost", which is very useful information for NGOs. These variables have been chosen from the Disaster Epidemiology Research Centre database of Lovaina University (Belgium), which is a WHO collaborating centre.

To manage the highly imprecise and uncertain nature of the data gathered in these cases, the researchers work with fuzzy logic, a mathematical tool that operates with numerical intervals (not with exact figures) to try to quantify "the highest or lowest" magnitudes as the number of injured or affected people.

Juan Tinguaro Rodríguez, also a member of the UCM team, points out to SINC that "The decision aid system that we propose could have been applied perfectly following the recent Haiti earthquake, as it is centred around the assessment of the consequences of disasters such as this, where primary information is scarce, unreliable or, in general, of low quality".

The most effective distribution of aid

Another application developed by these mathematicians and that has just been published in the Journal of Multi-Criteria Decision Analysis, is a humanitarian aid distribution systems (HADS).

The tool is based on the use of a logistics map of the territory, with nodes (localities) and connections (streets and roads). The "graph" includes aid demand in some nodes (affected populations), supply in others (airports, ports or stores), availability and characteristics of vehicles (type, capacity, speed, cost), as well as data on connections (distances, condition of roads, risk of attack).

"The complex problem of choosing the most suitable distribution routes is a matter that needs to be resolved as quickly as possible and through a multi-criteria decision approach", as it is important to consider aspects such as response time, budget, shipment arrival reliability, risk of attack, fairness of distribution or the priority of reaching certain areas", Begoña Vitoriano points out.

The expert recognises that by presenting the problem in this way, "it is much more difficult to resolve, but is much more real and useful for organisations". The team continues to improve both models in order to provide a free access service via the Web to NGOs involved in humanitarian logistics efforts. To do this, they rely on the support of the IMath-Consolider public financing programme, within the R&D&i National Plan.

More information:

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