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Automatic damage assessment of Beira, Mozambique, following the tropical cyclone Idai in March 2019: In DLR's Data4Human project, damage to buildings in settlement areas is recorded using intelligent data processing methods from the field of remote sensing. This data is then made available to humanitarian aid organisations.

HIGH-TECH HELPING HAND

A DLR initiative is developing new technologies for humanitarian aid

By Bernadette Jung

Every night, one in nine people go to bed with an empty stomach. The consequences of climate change, natural disasters and armed conflicts threaten the livelihood of many. However, the number of people receiving little to no help is constantly on the rise. Germany is one of the world's largest providers of humanitarian aid and is renowned for its dedicated, professional work. These qualities are in urgent demand within the global community, as the need for humanitarian aid has been growing for years. Aid organisations are now increasingly turning to technological support in order to make their measures more effective and sustainable. DLR has long served as a partner in this field and is now intensifying its commitment.

In May 2019, DLR's Space Research and Technology Directorate launched an initiative that places humanitarian technology needs at the heart of its research. The Humanitarian Technologies initiative draws upon DLR's expertise for humanitarian purposes. In this project, cutting-edge technologies are being further developed and deployed for humanitarian purposes.

The initiative connects DLR experts, both internally across different disciplines and institutes, and externally with humanitarian aid organisations, political decisionmakers and other stakeholders. Achieving successful outcomes requires interdisciplinary and international cooperation between those involved with humanitarian aid, stakeholders within the affected countries and the research sector. The network partners exchange experiences and identify needs. These range from logistical support for people and relief supplies, to monitoring of the humanitarian situation and the status on the ground, dealing with the causes and consequences of climate change, avoiding the root causes of migration, and providing a decentralised energy supply in disaster-stricken regions. The results of this close dialogue are used to develop tailor-made technologies.

"It is good to see that the humanitarian community is so open to technological innovation," says Stefan Voigt, Coordinator of the Humanitarian Technologies initiative. "Since the launch of the initiative, new non-governmental organisations and stakeholders have been approaching us with questions and requests. We have already come up with lots of good ideas for new projects as a result." The first two projects of the initiative – the mobile greenhouse 'MEPA' (see info box) and the data service 'Data4Human' – were launched at the beginning of this year.

Innovation from adversity

In acute crisis situations, reliable data and information are important for assessing the overall situation and initiating appropriate actions and measures. Often, however, this information is simply not available to aid organisations. Telecommunication networks within the crisis-stricken regions may be damaged or even fully destroyed. In addition, it is sometimes difficult or impossible for humanitarian NGOs to use large information mechanisms, such as the International Charter 'Space and Major Disasters', which provides rapid satellite data for emergency management free of charge in the event of a disaster. This means that they need to find other ways of assessing the situation.

With that in mind, the Data4Human project team is developing a data service for humanitarian aid. Data4Human combines conventional remote sensing data from satellites, aircraft and drones with web-based information. Social media, news portals and other freely available web services can serve as up-to-date data sources. By combining these different data sources, stakeholders can get a sense of the overall situation quickly, reliably and with insights at a local, regional and even global level. DLR is combining Earth observation and web technologies for this purpose. The individual tools and functionalities of the data service are being developed by scientists from DLR's Earth Observation Center (EOC) and the DLR Institute of Data Science together with the United Nations World Food Programme (WFP), the German Red Cross, the Humanitarian OpenStreetMap Team and Human Rights Watch.

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In the event of a disaster, DLR provides fast and reliable situation assessment based on up-to-date satellite data. In future, Earth observation data will be increasingly combined with information from the Internet.

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In the Data4Human project, DLR scientists are working with users to develop a data service that is tailored to the needs of humanitarian aid organisations.

WHAT IS HUMANITARIAN AID?

The overarching goal of humanitarian aid is to provide needs-based assistance to people in emergency situations or at risk of finding themselves in acute hardship due to crises, conflicts, natural disasters and other causes. The aim is to enable those affected to survive with dignity and security, to alleviate the suffering of those who are unable to overcome their acute emergency on their own, and to provide these people with future prospects. This work is often conducted in difficult political circumstances, in poor security situations, and often under huge time pressure. Maintaining the humanitarian principles of humanity, impartiality, neutrality and independence is therefore a key prerequisite for humanitarian aid. As the number of humanitarian emergencies increases, and with them their duration, the need for humanitarian aid continues to grow. Today, more people than ever depend on humanitarian aid.

Humanitarian mission in the Dominican Republic: In July 2018, the DLR Institute of Flight Systems conducted flight tests to transport relief supplies to hard-to-reach areas with the unmanned helicopter superARTIS. The flights were planned and monitored from the mobile ground control station.

The small unmanned helicopter superARTIS (Autonomous Rotorcraft Testbed for Intelligent Systems) is operated as an experimental carrier by the DLR Institute of Flight Systems. Its range, robustness and payload capacity make it well suited for humanitarian missions.

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With each flight, the unmanned helicopter transported up to 25 kilograms of food, water and medicine, six kilometres over the Enriquillo salt lake, safely dropping the payload boxes on the other side.

The combination of Earth observation data from space and analysis from the Internet is new and is driving research at DLR. Although the field of humanitarian technology is still relatively young, it offers huge potential for innovation, and DLR is one of its pioneers. Approximately 20 years ago, EOC experts began processing satellite data for disaster management purposes. Today this expertise is in high demand and is being further developed for humanitarian applications. The WFP has already used it to create its Spatial Risk Calendar, which is intended to more accurately assess and predict the spatial patterns of recurring natural disasters to ensure global food supply. Since 2019, the world's largest humanitarian organisation and DLR have been working together to develop and implement technologies to assist the United Nations in achieving the 'Zero Hunger' sustainability goal.

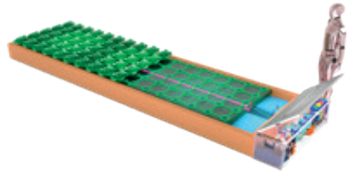
Earth observation data for emergency aid

The Data4Humanproject includes the development of automated mapping of damage to infrastructure and buildings in the wake of natural disasters. The EOC uses and continues to develop its own data processing methods from the fields of big data and machine learning. Rapid, interactive maps of disaster areas are also being generated in cooperation with the Humanitarian OpenStreetMap Team. As part of the project, the scientists are also working on the possibility of using remote sensing data to detect and document human rights violations such as the displacement of the Rohingya people in Myanmar. Knowing when particular villagers were forced to leave their homes is important to Human Rights Watch and their ability to present a well-founded documentation and research accordingly. Other possible applications include monitoring migration or the support of transitional development assistance, such as by observing how quickly reconstruction progresses following a disaster. The humanitarian partners should be able to use these operational data services from late 2021 onwards.

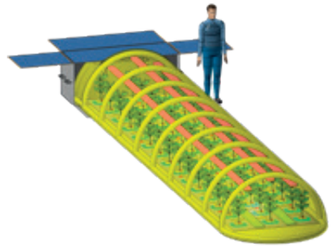
An important part of the current innovation is driven by technology transfer from DLR space research, but is not limited to this field. One example is the use of unmanned aerial vehicles to drop relief supplies in disaster-stricken regions that are difficult to access. DLR tested this technology successfully with an unmanned helicopter in the Dominican Republic in 2018. Other successful DLR research projects with a humanitarian focus include the treatment of drinking water using solar power, the development of warning systems and the detection of land mines by radar. In future, technological developments for humanitarian search and rescue operations or robotics applications could also be used in life-saving missions.

MEPA – MOBILE GREENHOUSES

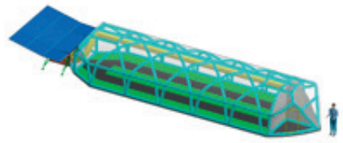
MEPA offers the possibility of cultivating fresh food in disaster-stricken regions. It is one of the first projects of the Humanitarian Technologies initiative. Experts from the DLR Institute of Space Systems and the Institute of Aerospace Medicine have developed three concepts for this purpose. All plant cultivation units have a few things in common: they do not require any soil, are reusable, can be used individually and easily, allowing fast plant production, with the first harvest after just four to six weeks.



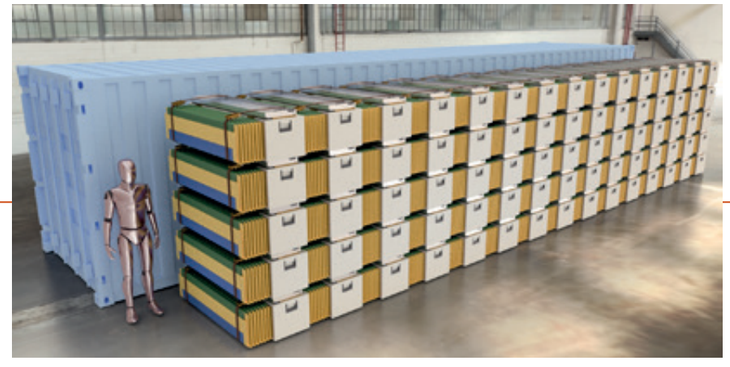
The **'basic system'** is based on hydroponics in open water tanks. The cultivation area is seven square metres and can yield 85 heads of lettuce, weighing around 42 kilograms in total, in each harvesting cycle. The system is equipped with an automated solar-powered support unit.



The **'hybrid system'** has an area of approximately 20 square metres and is suitable for growing small plants. The inflatable greenhouse is just under one metre tall and houses a seed-cultivation mat that can be illuminated with LED strips. The semi-closed system allows water to be recovered and is powered with solar energy.



A **'closed-loop system'** has been devised for tall-growing or larger varieties of vegetables such as tomatoes and cucumbers. The walk-in greenhouse is three metres wide and 17 metres long. It offers a cultivation area of roughly 30 to 40 square metres. Irrigation, ventilation, temperature control and energy supply create a closed circulation system and are controlled by support modules. Up to 21 units can be transported in a freight container, providing a total harvest area of 350 square metres.



When folded, up to 75 MEPA basic system units can be transported in one container.

Bridges to a better future

"We are involved in an exciting field of research and are just starting to harness the true potential of applying DLR technology to humanitarian tasks," says Voigt. "It is fascinating to see the level of motivation and commitment that the scientists and humanitarian organisations are bringing to the initiative. Being able to support humanitarian aid with our research and thus providing relief to people in need is very rewarding. It makes our work more meaningful."

When DLR satellite experts created the first emergency maps 20 years ago, few people had a laptop and only one in seven people owned a mobile phone. There are now more mobile phone connections than people on Earth, and on average almost every other household in developing countries has internet access. Technological progress has also improved the scope for humanitarian aid in such regions. Yet as the growing demand shows, the situation is not improving fast enough. Plans are currently underway for the next batch of DLR Humanitarian Technologies projects, due to begin in autumn 2020, so that help can be provided where there is the greatest need.

Bernadette Jung is an editor at the DLR site in Oberpfaffenhofen.