From crisis management to humanitarian technology - a European perspective

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***Abstract*— The European Union (EU) Member States and the European Commission (EC) are investing substantial funds in research and development (R&D) on technologies and innovative solutions for European and international disaster management, risk reduction as well as general crisis preparedness and response. The German Aerospace Center (DLR) has intensively been working in these R&D programs for many years and has developed its own research agenda in support of crisis and disaster management. In recent years, R&D activities within DLR are beginning to increasingly address also technological and operational needs of humanitarian relief actors who are providing assistance to people most in need. In this paper we report how major EC funded R&D programs and projects, including the current DRIVER project, the Copernicus Emergency Management Service (EMS) as well as DLR cooperation activities with the World Food Program (WFP), SOS Children's Villages International, the German Agency for Technical Relief (THW), the Red Cross and others are increasingly leading to a "humanitarian technology" support. With these activities DLR is aiming to help bridging the operational gap between laboratory scale and humanitarian field operations.**

Keywords*— *humanitarian technology, satellite based emergency mapping, Europe, innovation

I. INTRODUCTION

The European Union (EU) Member States and the European Commission (EC) are among the largest humanitarian donors globally and are investing substantial funds in research and development (R&D) for technologies and innovative solutions for European and international disaster management, risk reduction as well as general crisis preparedness and response. In cooperation with the EC Directorate General "European Civil Protection and Humanitarian Aid Operations" (DG ECHO) and Member State agencies several European technology programs have been tailored to increasingly provide technological support for crisis preparedness and response: The European COPERNICUS and GALILEO programs as well as the EU's program for research and innovation (Framework Programs and Horizon 2020), to name the most important ones.

While a dedicated focus on strengthening technological tools and capacities of actors in the humanitarian relief domain has been missing for many years, this seems to be slowly changing. With the R&D for civil protection and crisis management within Europe progressing there has also been an increasing technology support for humanitarian relief, addressing technical solutions and enhancements in international relief activities and assistance.

DG ECHO in cooperation with Member State agencies are increasingly tailoring European technology programs towards providing technological support also for humanitarian purposes in developing countries, including crisis preparedness and response. A current example is given by the FP7 DRIVER project, demonstrating the use of new technological solutions within disaster and crisis management domain, however, increasingly also targeting humanitarian relief work and humanitarian assistance internationally [1].

As a major research facility in Europe, the German Aerospace Center (DLR) has intensively been working in these EU programs for many years and has developed its own research agenda in support of crisis and disaster management. In recent years, R&D activities within DLR are beginning to address also technological and operational needs of humanitarian relief actors, providing technical solutions for humanitarian actors. Working with Non-Governmental Organizations (NGOs), the United Nations (UN) and other relief organizations for years - and building on impulses like the World Disaster report 2013 [2] of the International Federation of Red Cross and Red Crescent Societies (IFRC) or the World Humanitarian Summit held in Istanbul 2016 - several technology developments are initiated in DLR to increasingly support the humanitarian sector with state of the art technology.

In this paper the term "humanitarian technology" refers to any technological development or dedicated customization of existing technical solutions boosting humanitarian relief capacities for countries with extremely reduced coping capacity and economic distress or suffering from ongoing crisis and conflict situations.

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II. SATELLITE BASED EMERGENCY MAPPING – AN INNOVATIVE TECHNOLOGY SUCCESSFULLY SUPPORTING HUMANITARIAN OPERATION

Satellite based mapping in case of a crisis or disaster situation and humanitarian risk analysis serve as an excellent example of how a technology domain has come from "rocket science" to every day operationally support in humanitarian action at global scale. While ten to fifteen years ago humanitarian actors did not want to engage in satellite mapping, today, they even build up their own satellite mapping capacities in order to fulfill their missions more efficiently. How did this happen?

While in the early 2000s access to and analysis of satellite imagery was mainly focusing on military or scientific applications, many different developments have changed this situation and have turned the access to satellite imagery into something more common and affordable [3]. Still, early mechanisms for improving the access to satellite imagery for emergency mapping have focused on major natural disasters, yet excluding the cases of humanitarian relief situations, as they are often related to political and security related crisis situations [4]. Today's satellite mapping capacities, e.g. Copernicus Emergency Management Service (EMS) [5], increasingly support also the analysis of humanitarian emergencies.

The European Space Agency (ESA) funded RESPOND project (2004-2008) was among the first European satellite mapping projects aiming at the development of services to support humanitarian organizations and operations. First requirement definitions, a product portfolio and a large number of operational examples for satellite based humanitarian mapping were developed. Later within the Risk-EOS project funded by ESA as well as the BOSS4GMES, the SAFER (EC Framework Program 6/7) and the linkER project contracted by the EC, experiences on both sides: The Earth Observation community as well as the Civil Protection and Humanitarian Relief community further deepened and expanded. Experiences from these precursor projects were used to define, set-up and implement what today is called the Copernicus Emergency Management Service (EMS). Still the majority of the Copernicus EMS activations address natural or technical disaster situations within Europe. However, with an increasing number of refugee/ internally displaced people (IDP) camp mapping and monitoring activations, the humanitarian dimension of satellite mapping technologies is continuously being strengthened.

Beyond the European setting, also bilateral services and research activities for DLR with NGOs, UN and other humanitarian organizations show an increasing demand for satellite technologies in support of humanitarian situational awareness, preparedness, early warning and response. In the early years of setting-up and operating DLR's Center for Satellite Based Crisis Information (DLR/ZKI) [6], it got clear that constant training and consulting of DLR/ZKI users like NGOs, UN, governmental and international organizations was essential in order to strengthen the understanding within the humanitarian community on how to use satellite based mapping products in daily operations. Training not only included educating about the potentials and limits of Earth observation but also about how to get best possible DLR/ZKI services whenever satellite based mapping was requested. During the last years, different settings of cooperation have helped expanding the use of satellite based mapping services in humanitarian organizations:

A first example can be given from experiences with a governmental service contract granted to DLR/ZKI by the German government for providing emergency mapping services to go

vernmental organizations. In this context the international branch of the German Agency for Technical Relief (THW) requested satellite based mapping support when deployed to support the operators of the Al Zaatari Refugee Camp in Jordan. In this case DLR/ZKI generated a series of satellite maps and geospatial monitoring products in form of printed/PDF maps as well as GIS ready data sets for use in field and headquarters (see Fig 1). This activity was governed by a standard emergency mapping portfolio defined within the framework contract and was complemented by additional advanced analysis derived for the given situation. It demonstrates a high level of standardization and routine in using well defined work flows and service levels.

Fig. 1. Refugee Camp Al Zaatari, Jordan, 03/01/2013 - Emergency mapping product according to the DLR/ZKI mapping portfolio.

As a second example a DLR consultancy and organizational capacity building activity for SOS Children's Villages International (SOS CV) can be mentioned. In the frame of setting up an emergency management unit and a related technology innovation process, DLR was contracted by SOS CV to help identifying specifications and customizing geospatial components of an incident/emergency management tool and to help explore best ways in setting up an SOS CV specific satellite based emergency mapping and satellite based early warning capacity. In the frame of this project, DLR provided SOS CV not only with the knowhow and expertise to define and set in place the geospatial capacities, but moreover provided ad-hoc emergency mapping and near real time satellite based situation awareness to support for humanitarian emergencies affecting SOS CV, e.g. when forest fires burned

in Chile (see Fig. 2) and e.g. when a tropical cyclone hit Mozambique. These consultancies and actual pilot cases for humanitarian mapping helped paving the way towards building up SOS CV an operational satellite based emergency mapping service and finding the best suitable balance between in-house building of expertise and out-sourcing of information services to expert centers.

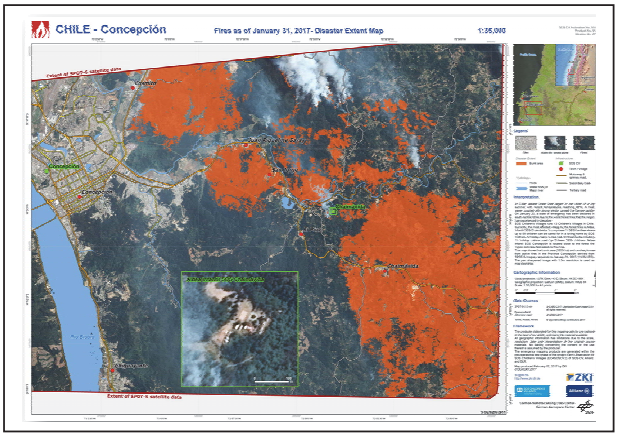

Fig. 2. Mapping of forest fires in the vicinity of an SOS Children's Village to support humanitarian operations.

A third example for advancing the use of satellite based mapping technology for humanitarian purposes is documented through a long term partnership between DLR and the United Nations World Food Program (WFP). It started with a cooperation in the frame of the International Charter Space and Major Disasters [7], continued in several of the above mentioned Copernicus and precursor projects and led to a closer cooperation supporting the work of the WFP humanitarian innovation accelerator (based in Munich Germany, e.g. triggering WPF internal scaling-up of satellite monitoring capacities). Recently, a project on using global satellite observations for jointly validating and improving WPFs global humanitarian risk mapping approaches has started.

This list of examples could be extended through similar cases in helping to bring satellite based mapping into humanitarian operations of other organizations such as the German Red Cross (DRK) or Médicines Sans Frontièrs (MSF). They all have in common that, since the use of satellite imagery and satellite based mappings have become more common in emergency and disaster management, also major humanitarian actors are engaging increasingly and substantially in adopting this source of operational information gathering for their purposes.

III. Ready for more innovative technologies

With an increasing global connectivity and the uptake of technological tools in our everyday working environments, also the humanitarian sector opens up and increasingly seeks innovation and new ways of increasing efficiency of their work. As information requirements, communication systems, and requirements for situational awareness get more complex, more technology branches need to be combined to serve these needs. For example, to set-up an integrated global incident management system or to use social media information in combination with satellite monitoring data and other information sources for global for crisis early warning requires integration of many different techniques and data sources. As a consequence, DLR is starting to network different technologies available in-house with the requirements of humanitarian actors to generally strengthen and increase "humanitarian technology" support by making best use of the relevant synergies. This aims at bridging the operational gap between technology developments at laboratory scale and the reality of humanitarian (field) operations. Topics such as solar/green energy, fleet management and navigation, communication, aeronautics, unmanned aerial vehicles (UAVs)/ swarm exploration, autonomous driving and others are of great interest and contain a high potential for operations.

The EC funded DRIVER project [1] is one of the current frames at EC scale within which crisis management technologies are developed, tested and integrated at European level. It is building on trials testing concrete field support activities, state of the art technology developments like satellite based monitoring, telecommunications, fleet management, IT solutions and many more to advance the synergy of different technologies. It also bares great potential to yield relevant outcomes to support humanitarian operations and to foster technological support for humanitarian missions. Generally, such research and demonstration projects addressing societal challenges of the EU, with practical applications and direct involvement of user organizations, help to overcome gaps between the technology providers and the Civil Protection/ Humanitarian Relief community. This actually helps leading to concrete "humanitarian technology" support and meaningful results. This direct involvement of user organizations and the practical involvement in exercises and trials help bridging the operational gap between laboratory scale and humanitarian field operations.

IV. Experiences in getting technologies on the ground

As stated above, the climate for innovation in humanitarian organizations has changed from "aversive" to "adoptive and inclusive", not only for satellite technologies, but also for many other technological domains. Assumingly, the World Disaster Report 2013[2] with its focus on technology in humanitarian settings has contributed to this readiness for innovation and also the World Humanitarian Summit in Istanbul 2016, providing a platform for presentations and exchange for many technological innovations, added to an open mind-set in humanitarian originations towards technological developments and upgrades.

Experiences show that best cooperation and uptake of innovations is achieved through joint exercises and trials exposing relief

workers and decision makers to new solutions and approaches which make their work more easy and cost-effective. It is an absolute must of any technology provider to communicate the potentials as well as the limits of each technical solution at the same time: Do not oversell. Do provide the best possible services.

At least for the domain of satellite based mapping it can be stated that many organizations building their own capacities nourishes the assumption that a critical mass, combined with ease of access was needed to fuel the wider spreading of this technology among the humanitarian organizations.

Working with different NGOs, governmental and UN organizations for many years, it can be seen that reluctance to adopt new technology is decreasing and a spirit of innovation is increasingly adopted. This cannot be generalized for all organizations and all technologies of course. Nobody questions the use of telephones, e-mails or the internet, presuming the efforts to adopt these technologies are very low and the operational benefit that can be achieved through them is very high.

When trying to categorize the applicability and operational value of "humanitarian technologies" figure 3 attempts to group different technology fields and to illustrate estimated qualitative operational impact and estimated qualitative efforts for respective adoption. While e.g. technologies like mobile communication and satellite phones can be implemented relatively easy, e.g. robotics or big data applications are not yet possible. This graph is absolutely qualitative in character and it is based on experiences gathered during many dialogs and consultations with different humanitarian relief organizations.

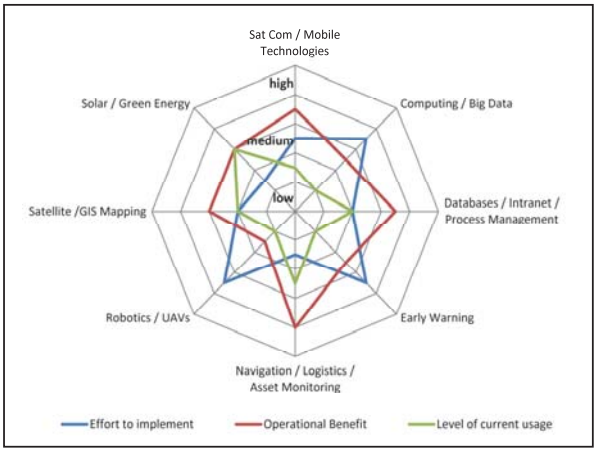

Fig. 3. Technology domains characterized by qualitative estimates of efforts for implementation, operational benefit and current level of usage.

In the domain of Earth observation the evolution from dedicated R&D projects preparing the operational tendered services in the fully operational Copernicus services helped bridging the gaps, especially since there was a long term strategy as well as supportive activities like the International Charter Space and Major Disasters and the International Working Group on Satellite Based Emergency Mapping [8] at global scale.

V. Conclusion and Outlook

Experiences show an increasingly openness of the humanitarian sector to technological innovations. At least the European R&D programs such as Framework Programs FP6, FP7 or Horizon 2020 are not yet explicitly geared towards support of "humanitarian technology" developments. However, indirectly by supporting the disaster and crisis management research and by involving also different user organizations from the humanitarian domain, an implicit technology support to the humanitarian domain can be observed. In Europe, DG ECHO has an important role in providing respective guidance and helping to shape the respective research agendas of the general programs and major research projects in particular.

How can the broader GHTC community benefit from these technologies? By also broadening its scope and by seeking to explore and promote relevant synergies of different technological fields and by thus strengthen the networking and cooperation among the different technology domains. Generally one cannot speak of one single European perspective towards humanitarian technology per se. In this paper we laid out one view on how European research programs generate synergies in improving technology support for humanitarian actors. It can be observed that a consequent involvement of the user communities in defining and conducting technology/research programs, as it is done in Europe since many years, results in a strong uptake and involvement by the users. In the global perspective it has to be concluded that there is a large diversity in dispersal of different technologies. Satellite communication and mobile technologies (such as mobile money) for example are much more intensively being used e.g. in Africa as compared to Europe. Thus, any humanitarian technology development and solution should try to reflect this diversity and should tailor solutions to what base technology is broadly used and operated in a given area or region to be successful and cost-effective.

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