

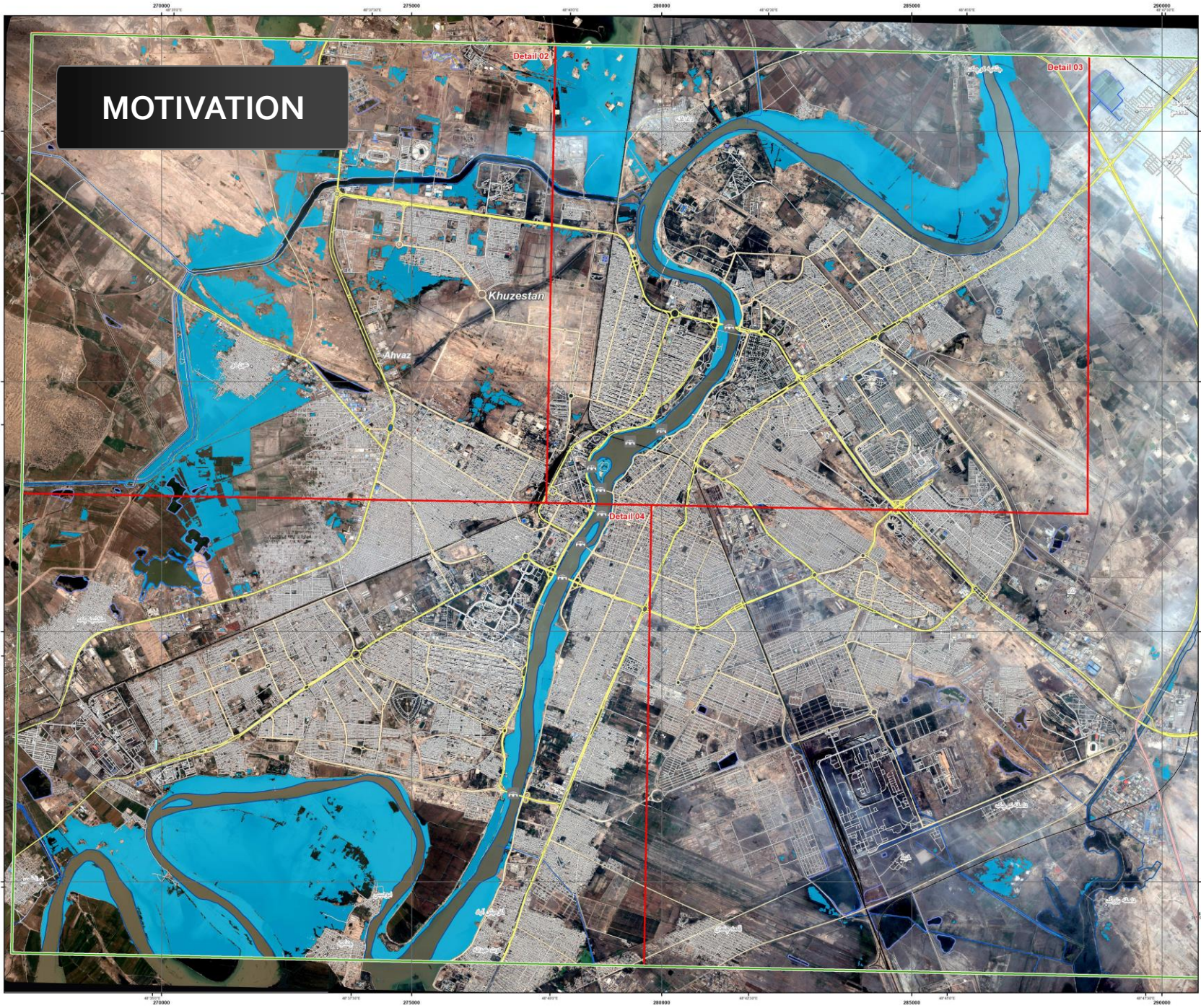
Supporting enhanced disaster management with interactive 3D and Mixed Reality Maps

Master Thesis Defense

Kevin Patrick Helzel

24.09.19





GLIDE number: FL-2019-00022-IRN Activation ID: EMSR252
 IRI Charter call ID: 601 Product N: 08AHVAZ_v2

Ahvaz - IRAN

Flood - Situation as of 11/04/2019

Grading - Overview map 01

Cartographic Information

1:35000 Full color A1, 200 dpi resolution

Grid: WGS 1984 UTM Zone 39N map coordinate system
 Tick marks: WGS 84 geographical coordinate system

Legend

Crisis Information	Hydrography	Transportation
Flooded Area	Lake	Primary Road
Area of Interest	Reservoir	Secondary Road
Detail map	River	Local Road
Place names	Stream	Cart Track
Place name	Transportation	Long-distance railway
Physiography	Stop and elevated highway	Artificial runway
Grading Layers	Grading Layers	Grading Layers

Map Information

Severe flooding in several provinces of Iran since mid-March, has left 70 people dead, 110 000 are displaced, 30 000 in Khuzestan Province. As of 9 April at 8:00 UTC, 1 900 cases have been affected, with Lorestan, Khuzestan and Gilan the worst impacted provinces. 77 schools have been destroyed (55 in Lorestan and 22 in Gilan). There is a significant risk of additional flooding from Karbala dam (Khuzestan Province). Six cities and 215 villages have been evacuated, 61 of which have been flooded. Heavy rain and thunderstorms are forecast in southern provinces, moderate rain in north-western provinces.

The present map shows the damage grade assessment in the area of Ahvaz (Iran). The thematic layer has been derived from post-event satellite images using a semi-automatic approach. The estimated geometric accuracy (RMSE) is 1 m or better, from native positional accuracy of the background satellite image.

Relevant date records (UTC)

Event	Date	Situation as of
Event	25/03/2019 00:00	11/04/2019 07:15
Activation	09/04/2019 15:20	Map production
		10/04/2019

Data sources

Relevant images: Pléiades 1A & 1B © CNES (acquired on 26/03/2019 at 07:27 UTC, the 21/03/2019 at 07:42 UTC, 02/04/2019, 03/04/2019, 04/04/2019, 05/04/2019, 06/04/2019, 07/04/2019, 08/04/2019, 09/04/2019, 10/04/2019, 11/04/2019, 12/04/2019, 13/04/2019, 14/04/2019, 15/04/2019, 16/04/2019, 17/04/2019, 18/04/2019, 19/04/2019, 20/04/2019, 21/04/2019, 22/04/2019, 23/04/2019, 24/04/2019, 25/04/2019, 26/04/2019, 27/04/2019, 28/04/2019, 29/04/2019, 30/04/2019, 01/05/2019, 02/05/2019, 03/05/2019, 04/05/2019, 05/05/2019, 06/05/2019, 07/05/2019, 08/05/2019, 09/05/2019, 10/05/2019, 11/05/2019, 12/05/2019, 13/05/2019, 14/05/2019, 15/05/2019, 16/05/2019, 17/05/2019, 18/05/2019, 19/05/2019, 20/05/2019, 21/05/2019, 22/05/2019, 23/05/2019, 24/05/2019, 25/05/2019, 26/05/2019, 27/05/2019, 28/05/2019, 29/05/2019, 30/05/2019, 31/05/2019, 01/06/2019, 02/06/2019, 03/06/2019, 04/06/2019, 05/06/2019, 06/06/2019, 07/06/2019, 08/06/2019, 09/06/2019, 10/06/2019, 11/06/2019, 12/06/2019, 13/06/2019, 14/06/2019, 15/06/2019, 16/06/2019, 17/06/2019, 18/06/2019, 19/06/2019, 20/06/2019, 21/06/2019, 22/06/2019, 23/06/2019, 24/06/2019, 25/06/2019, 26/06/2019, 27/06/2019, 28/06/2019, 29/06/2019, 30/06/2019, 01/07/2019, 02/07/2019, 03/07/2019, 04/07/2019, 05/07/2019, 06/07/2019, 07/07/2019, 08/07/2019, 09/07/2019, 10/07/2019, 11/07/2019, 12/07/2019, 13/07/2019, 14/07/2019, 15/07/2019, 16/07/2019, 17/07/2019, 18/07/2019, 19/07/2019, 20/07/2019, 21/07/2019, 22/07/2019, 23/07/2019, 24/07/2019, 25/07/2019, 26/07/2019, 27/07/2019, 28/07/2019, 29/07/2019, 30/07/2019, 31/07/2019, 01/08/2019, 02/08/2019, 03/08/2019, 04/08/2019, 05/08/2019, 06/08/2019, 07/08/2019, 08/08/2019, 09/08/2019, 10/08/2019, 11/08/2019, 12/08/2019, 13/08/2019, 14/08/2019, 15/08/2019, 16/08/2019, 17/08/2019, 18/08/2019, 19/08/2019, 20/08/2019, 21/08/2019, 22/08/2019, 23/08/2019, 24/08/2019, 25/08/2019, 26/08/2019, 27/08/2019, 28/08/2019, 29/08/2019, 30/08/2019, 31/08/2019, 01/09/2019, 02/09/2019, 03/09/2019, 04/09/2019, 05/09/2019, 06/09/2019, 07/09/2019, 08/09/2019, 09/09/2019, 10/09/2019, 11/09/2019, 12/09/2019, 13/09/2019, 14/09/2019, 15/09/2019, 16/09/2019, 17/09/2019, 18/09/2019, 19/09/2019, 20/09/2019, 21/09/2019, 22/09/2019, 23/09/2019, 24/09/2019, 25/09/2019, 26/09/2019, 27/09/2019, 28/09/2019, 29/09/2019, 30/09/2019, 01/10/2019, 02/10/2019, 03/10/2019, 04/10/2019, 05/10/2019, 06/10/2019, 07/10/2019, 08/10/2019, 09/10/2019, 10/10/2019, 11/10/2019, 12/10/2019, 13/10/2019, 14/10/2019, 15/10/2019, 16/10/2019, 17/10/2019, 18/10/2019, 19/10/2019, 20/10/2019, 21/10/2019, 22/10/2019, 23/10/2019, 24/10/2019, 25/10/2019, 26/10/2019, 27/10/2019, 28/10/2019, 29/10/2019, 30/10/2019, 31/10/2019, 01/11/2019, 02/11/2019, 03/11/2019, 04/11/2019, 05/11/2019, 06/11/2019, 07/11/2019, 08/11/2019, 09/11/2019, 10/11/2019, 11/11/2019, 12/11/2019, 13/11/2019, 14/11/2019, 15/11/2019, 16/11/2019, 17/11/2019, 18/11/2019, 19/11/2019, 20/11/2019, 21/11/2019, 22/11/2019, 23/11/2019, 24/11/2019, 25/11/2019, 26/11/2019, 27/11/2019, 28/11/2019, 29/11/2019, 30/11/2019, 01/12/2019, 02/12/2019, 03/12/2019, 04/12/2019, 05/12/2019, 06/12/2019, 07/12/2019, 08/12/2019, 09/12/2019, 10/12/2019, 11/12/2019, 12/12/2019, 13/12/2019, 14/12/2019, 15/12/2019, 16/12/2019, 17/12/2019, 18/12/2019, 19/12/2019, 20/12/2019, 21/12/2019, 22/12/2019, 23/12/2019, 24/12/2019, 25/12/2019, 26/12/2019, 27/12/2019, 28/12/2019, 29/12/2019, 30/12/2019, 31/12/2019, 01/01/2020, 02/01/2020, 03/01/2020, 04/01/2020, 05/01/2020, 06/01/2020, 07/01/2020, 08/01/2020, 09/01/2020, 10/01/2020, 11/01/2020, 12/01/2020, 13/01/2020, 14/01/2020, 15/01/2020, 16/01/2020, 17/01/2020, 18/01/2020, 19/01/2020, 20/01/2020, 21/01/2020, 22/01/2020, 23/01/2020, 24/01/2020, 25/01/2020, 26/01/2020, 27/01/2020, 28/01/2020, 29/01/2020, 30/01/2020, 31/01/2020, 01/02/2020, 02/02/2020, 03/02/2020, 04/02/2020, 05/02/2020, 06/02/2020, 07/02/2020, 08/02/2020, 09/02/2020, 10/02/2020, 11/02/2020, 12/02/2020, 13/02/2020, 14/02/2020, 15/02/2020, 16/02/2020, 17/02/2020, 18/02/2020, 19/02/2020, 20/02/2020, 21/02/2020, 22/02/2020, 23/02/2020, 24/02/2020, 25/02/2020, 26/02/2020, 27/02/2020, 28/02/2020, 29/02/2020, 30/02/2020, 31/02/2020, 01/03/2020, 02/03/2020, 03/03/2020, 04/03/2020, 05/03/2020, 06/03/2020, 07/03/2020, 08/03/2020, 09/03/2020, 10/03/2020, 11/03/2020, 12/03/2020, 13/03/2020, 14/03/2020, 15/03/2020, 16/03/2020, 17/03/2020, 18/03/2020, 19/03/2020, 20/03/2020, 21/03/2020, 22/03/2020, 23/03/2020, 24/03/2020, 25/03/2020, 26/03/2020, 27/03/2020, 28/03/2020, 29/03/2020, 30/03/2020, 31/03/2020, 01/04/2020, 02/04/2020, 03/04/2020, 04/04/2020, 05/04/2020, 06/04/2020, 07/04/2020, 08/04/2020, 09/04/2020, 10/04/2020, 11/04/2020, 12/04/2020, 13/04/2020, 14/04/2020, 15/04/2020, 16/04/2020, 17/04/2020, 18/04/2020, 19/04/2020, 20/04/2020, 21/04/2020, 22/04/2020, 23/04/2020, 24/04/2020, 25/04/2020, 26/04/2020, 27/04/2020, 28/04/2020, 29/04/2020, 30/04/2020, 01/05/2020, 02/05/2020, 03/05/2020, 04/05/2020, 05/05/2020, 06/05/2020, 07/05/2020, 08/05/2020, 09/05/2020, 10/05/2020, 11/05/2020, 12/05/2020, 13/05/2020, 14/05/2020, 15/05/2020, 16/05/2020, 17/05/2020, 18/05/2020, 19/05/2020, 20/05/2020, 21/05/2020, 22/05/2020, 23/05/2020, 24/05/2020, 25/05/2020, 26/05/2020, 27/05/2020, 28/05/2020, 29/05/2020, 30/05/2020, 31/05/2020, 01/06/2020, 02/06/2020, 03/06/2020, 04/06/2020, 05/06/2020, 06/06/2020, 07/06/2020, 08/06/2020, 09/06/2020, 10/06/2020, 11/06/2020, 12/06/2020, 13/06/2020, 14/06/2020, 15/06/2020, 16/06/2020, 17/06/2020, 18/06/2020, 19/06/2020, 20/06/2020, 21/06/2020, 22/06/2020, 23/06/2020, 24/06/2020, 25/06/2020, 26/06/2020, 27/06/2020, 28/06/2020, 29/06/2020, 30/06/2020, 01/07/2020, 02/07/2020, 03/07/2020, 04/07/2020, 05/07/2020, 06/07/2020, 07/07/2020, 08/07/2020, 09/07/2020, 10/07/2020, 11/07/2020, 12/07/2020, 13/07/2020, 14/07/2020, 15/07/2020, 16/07/2020, 17/07/2020, 18/07/2020, 19/07/2020, 20/07/2020, 21/07/2020, 22/07/2020, 23/07/2020, 24/07/2020, 25/07/2020, 26/07/2020, 27/07/2020, 28/07/2020, 29/07/2020, 30/07/2020, 31/07/2020, 01/08/2020, 02/08/2020, 03/08/2020, 04/08/2020, 05/08/2020, 06/08/2020, 07/08/2020, 08/08/2020, 09/08/2020, 10/08/2020, 11/08/2020, 12/08/2020, 13/08/2020, 14/08/2020, 15/08/2020, 16/08/2020, 17/08/2020, 18/08/2020, 19/08/2020, 20/08/2020, 21/08/2020, 22/08/2020, 23/08/2020, 24/08/2020, 25/08/2020, 26/08/2020, 27/08/2020, 28/08/2020, 29/08/2020, 30/08/2020, 31/08/2020, 01/09/2020, 02/09/2020, 03/09/2020, 04/09/2020, 05/09/2020, 06/09/2020, 07/09/2020, 08/09/2020, 09/09/2020, 10/09/2020, 11/09/2020, 12/09/2020, 13/09/2020, 14/09/2020, 15/09/2020, 16/09/2020, 17/09/2020, 18/09/2020, 19/09/2020, 20/09/2020, 21/09/2020, 22/09/2020, 23/09/2020, 24/09/2020, 25/09/2020, 26/09/2020, 27/09/2020, 28/09/2020, 29/09/2020, 30/09/2020, 01/10/2020, 02/10/2020, 03/10/2020, 04/10/2020, 05/10/2020, 06/10/2020, 07/10/2020, 08/10/2020, 09/10/2020, 10/10/2020, 11/10/2020, 12/10/2020, 13/10/2020, 14/10/2020, 15/10/2020, 16/10/2020, 17/10/2020, 18/10/2020, 19/10/2020, 20/10/2020, 21/10/2020, 22/10/2020, 23/10/2020, 24/10/2020, 25/10/2020, 26/10/2020, 27/10/2020, 28/10/2020, 29/10/2020, 30/10/2020, 31/10/2020, 01/11/2020, 02/11/2020, 03/11/2020, 04/11/2020, 05/11/2020, 06/11/2020, 07/11/2020, 08/11/2020, 09/11/2020, 10/11/2020, 11/11/2020, 12/11/2020, 13/11/2020, 14/11/2020, 15/11/2020, 16/11/2020, 17/11/2020, 18/11/2020, 19/11/2020, 20/11/2020, 21/11/2020, 22/11/2020, 23/11/2020, 24/11/2020, 25/11/2020, 26/11/2020, 27/11/2020, 28/11/2020, 29/11/2020, 30/11/2020, 01/12/2020, 02/12/2020, 03/12/2020, 04/12/2020, 05/12/2020, 06/12/2020, 07/12/2020, 08/12/2020, 09/12/2020, 10/12/2020, 11/12/2020, 12/12/2020, 13/12/2020, 14/12/2020, 15/12/2020, 16/12/2020, 17/12/2020, 18/12/2020, 19/12/2020, 20/12/2020, 21/12/2020, 22/12/2020, 23/12/2020, 24/12/2020, 25/12/2020, 26/12/2020, 27/12/2020, 28/12/2020, 29/12/2020, 30/12/2020, 31/12/2020, 01/01/2021, 02/01/2021, 03/01/2021, 04/01/2021, 05/01/2021, 06/01/2021, 07/01/2021, 08/01/2021, 09/01/2021, 10/01/2021, 11/01/2021, 12/01/2021, 13/01/2021, 14/01/2021, 15/01/2021, 16/01/2021, 17/01/2021, 18/01/2021, 19/01/2021, 20/01/2021, 21/01/2021, 22/01/2021, 23/01/2021, 24/01/2021, 25/01/2021, 26/01/2021, 27/01/2021, 28/01/2021, 29/01/2021, 30/01/2021, 31/01/2021, 01/02/2021, 02/02/2021, 03/02/2021, 04/02/2021, 05/02/2021, 06/02/2021, 07/02/2021, 08/02/2021, 09/02/2021, 10/02/2021, 11/02/2021, 12/02/2021, 13/02/2021, 14/02/2021, 15/02/2021, 16/02/2021, 17/02/2021, 18/02/2021, 19/02/2021, 20/02/2021, 21/02/2021, 22/02/2021, 23/02/2021, 24/02/2021, 25/02/2021, 26/02/2021, 27/02/2021, 28/02/2021, 29/02/2021, 30/02/2021, 31/02/2021, 01/03/2021, 02/03/2021, 03/03/2021, 04/03/2021, 05/03/2021, 06/03/2021, 07/03/2021, 08/03/2021, 09/03/2021, 10/03/2021, 11/03/2021, 12/03/2021, 13/03/2021, 14/03/2021, 15/03/2021, 16/03/2021, 17/03/2021, 18/03/2021, 19/03/2021, 20/03/2021, 21/03/2021, 22/03/2021, 23/03/2021, 24/03/2021, 25/03/2021, 26/03/2021, 27/03/2021, 28/03/2021, 29/03/2021, 30/03/2021, 31/03/2021, 01/04/2021, 02/04/2021, 03/04/2021, 04/04/2021, 05/04/2021, 06/04/2021, 07/04/2021, 08/04/2021, 09/04/2021, 10/04/2021, 11/04/2021, 12/04/2021, 13/04/2021, 14/04/2021, 15/04/2021, 16/04/2021, 17/04/2021, 18/04/2021, 19/04/2021, 20/04/2021, 21/04/2021, 22/04/2021, 23/04/2021, 24/04/2021, 25/04/2021, 26/04/2021, 27/04/2021, 28/04/2021, 29/04/2021, 30/04/2021, 01/05/2021, 02/05/2021, 03/05/2021, 04/05/2021, 05/05/2021, 06/05/2021, 07/05/2021, 08/05/2021, 09/05/2021, 10/05/2021, 11/05/2021, 12/05/2021, 13/05/2021, 14/05/2021, 15/05/2021, 16/05/2021, 17/05/2021, 18/05/2021, 19/05/2021, 20/05/2021, 21/05/2021, 22/05/2021, 23/05/2021, 24/05/2021, 25/05/2021, 26/05/2021, 27/05/2021, 28/05/2021, 29/05/2021, 30/05/2021, 31/05/2021, 01/06/2021, 02/06/2021, 03/06/2021, 04/06/2021, 05/06/2021, 06/06/2021, 07/06/2021, 08/06/2021, 09/06/2021, 10/06/2021, 11/06/2021, 12/06/2021, 13/06/2021, 14/06/2021, 15/06/2021, 16/06/2021, 17/06/2021, 18/06/2021, 19/06/2021, 20/06/2021, 21/06/2021, 22/06/2021, 23/06/2021, 24/06/2021, 25/06/2021, 26/06/2021, 27/06/2021, 28/06/2021, 29/06/2021, 30/06/2021, 01/07/2021, 02/07/2021, 03/07/2021, 04/07/2021, 05/07/2021, 06/07/2021, 07/07/2021, 08/07/2021, 09/07/2021, 10/07/2021, 11/07/2021, 12/07/2021, 13/07/2021, 14/07/2021, 15/07/2021, 16/07/2021, 17/07/2021, 18/07/2021, 19/07/2021, 20/07/2021, 21/07/2021, 22/07/2021, 23/07/2021, 24/07/2021, 25/07/2021, 26/07/2021, 27/07/2021, 28/07/2021, 29/07/2021, 30/07/2021, 31/07/2021, 01/08/2021, 02/08/2021, 03/08/2021, 04/08/2021, 05/08/2021, 06/08/2021, 07/08/2021, 08/08/2021, 09/08/2021, 10/08/2021, 11/08/2021, 12/08/2021, 13/08/2021, 14/08/2021, 15/08/2021, 16/08/2021, 17/08/2021, 18/08/2021, 19/08/2021, 20/08/2021, 21/08/2021, 22/08/2021, 23/08/2021, 24/08/2021, 25/08/2021, 26/08/2021, 27/08/2021, 28/08/2021, 29/08/2021, 30/08/2021, 31/08/2021, 01/09/2021, 02/09/2021, 03/09/2021, 04/09/2021, 05/09/2021, 06/09/2021, 07/09/2021, 08/09/2021, 09/09/2021, 10/09/2021, 11/09/2021, 12/09/2021, 13/09/2021, 14/09/2021, 15/09/2021, 16/09/2021, 17/09/2021, 18/09/2021, 19/09/2021, 20/09/2021, 21/09/2021, 22/09/2021, 23/09/2021, 24/09/2021, 25/09/2021, 26/09/2021, 27/09/2021, 28/09/2021, 29/09/2021, 30/09/2021, 01/10/2021, 02/10/2021,



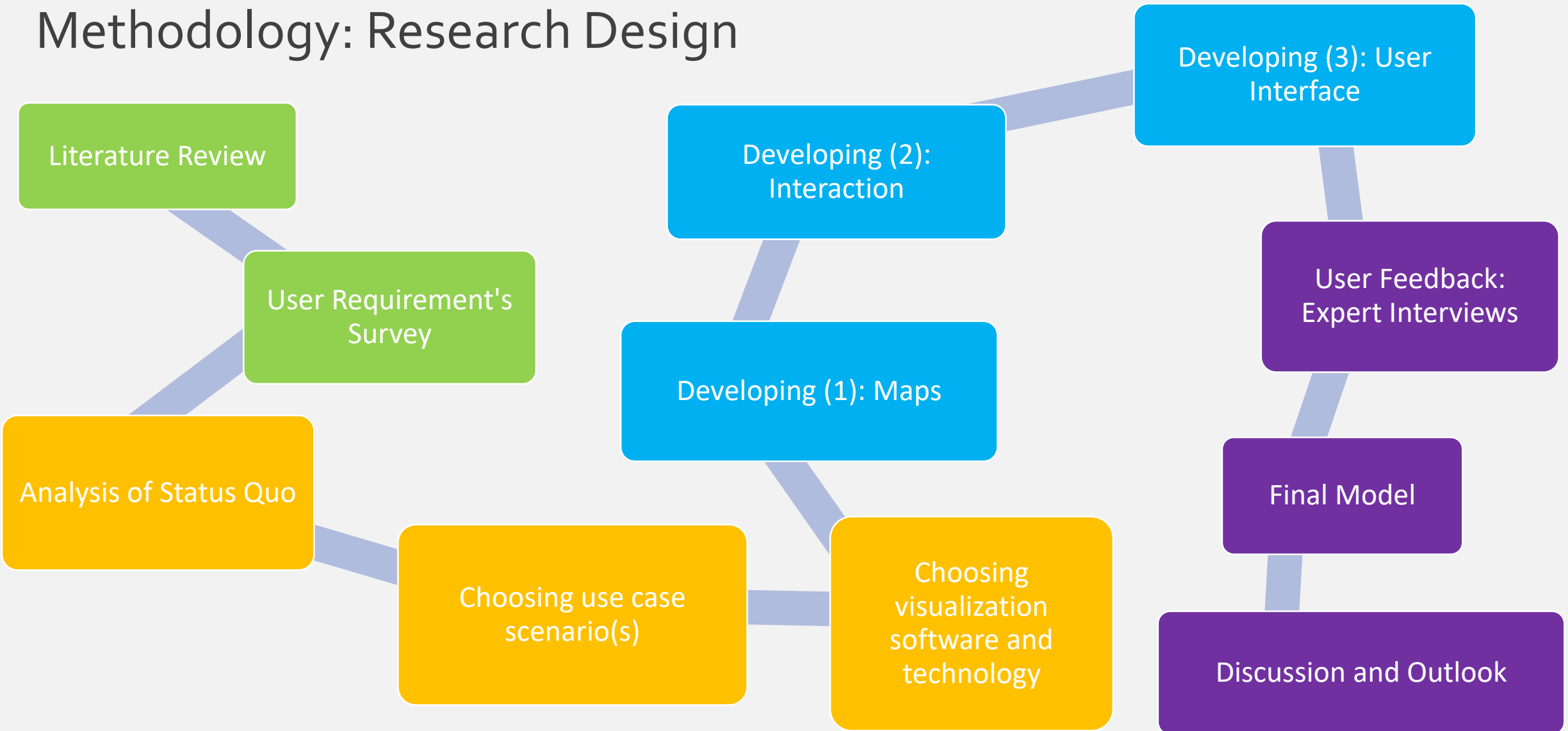
Research Objective

To test and investigate the benefits as well as the usability of 3D and Mixed Reality Maps facilitating crisis communication of disaster information and planning of disaster response during the process of disaster or emergency management.

Hypotheses

- H1:** Present cartographic products in the field of disaster management do not facilitate an effective management of disasters.
- H2:** Mixed Reality and 3D maps are useful tools for disaster visualizations and planning of response during disaster management activities.

Methodology: Research Design



→ Research design based on a *mixed-methods approach* and *user-centred design principles*

Definitions I

→ Reality Technologies: Virtual Reality, Mixed Reality, Augmented Reality

VR



**Digital environments
that shut out the real world.**

AR



**Digital content on top
of your real world.**

MR



**Digital content interacts
with your real world.**

**Fig.2: DIFFERENTIATION
BETWEEN REALITY
TECHNOLOGIES**

SOURCE: adapted from
Valendu, 2018

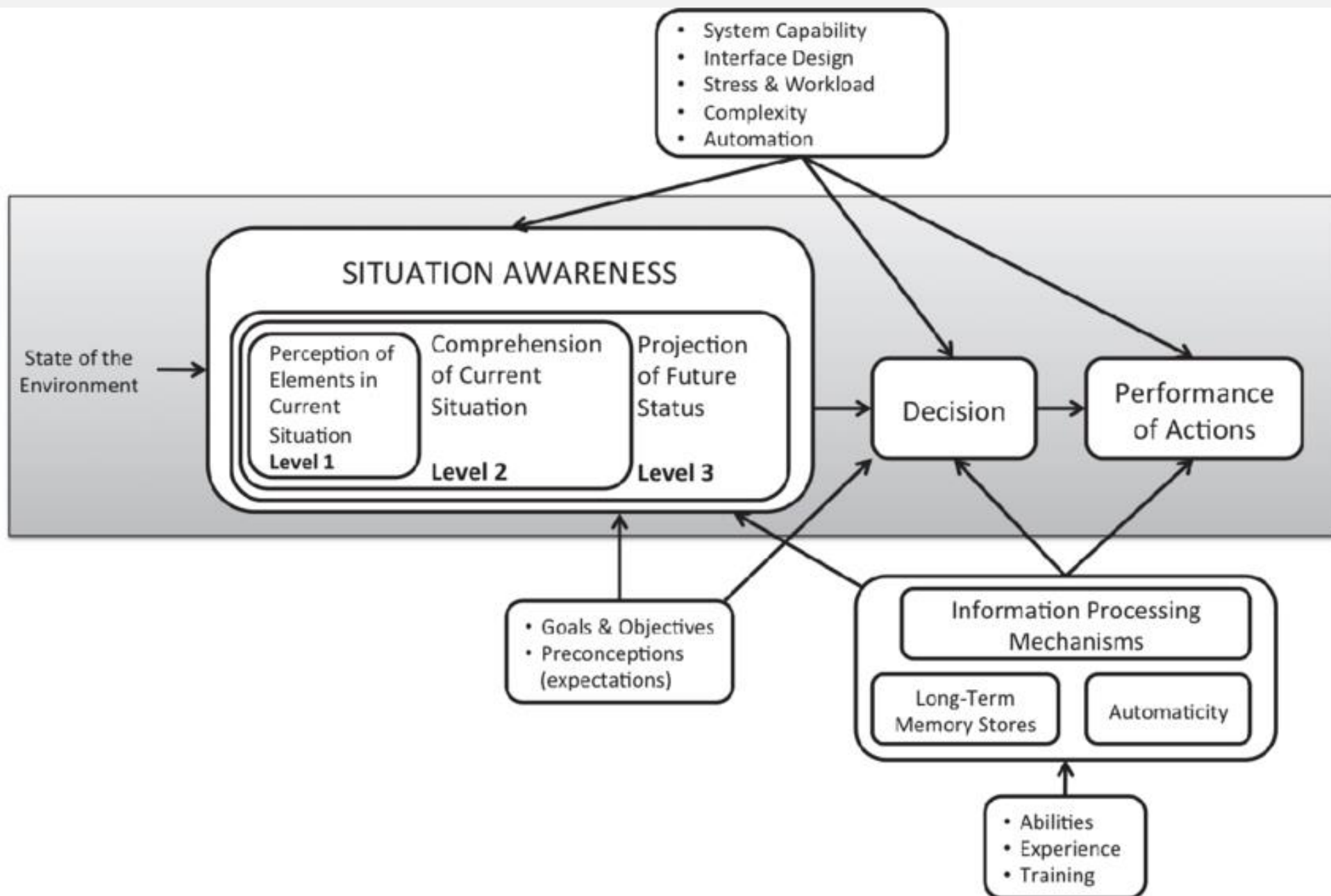


Fig.3: ENDSLEY'S
SITUATIONAL
AWARENESS MODEL
SOURCE: quoted from
Oxstrand et al., 2013

RESULTS I: User Requirement's Survey

Pre-Survey: Emergency Management Questionnaire

conducted via SoSci Survey (online).

4 Parts

- Demography, Profession and Experience
- Current problems and biggest challenges
- Disaster maps, information and technology
- Future vision (potential of Augmented Reality)

→ 40 completed questionnaires (1)

→ 30 filled out 95% of all questions

→ N = 30



SURVEY POPULATION

Map types

→ used during operations for mission planning and/or post-analysis purposes

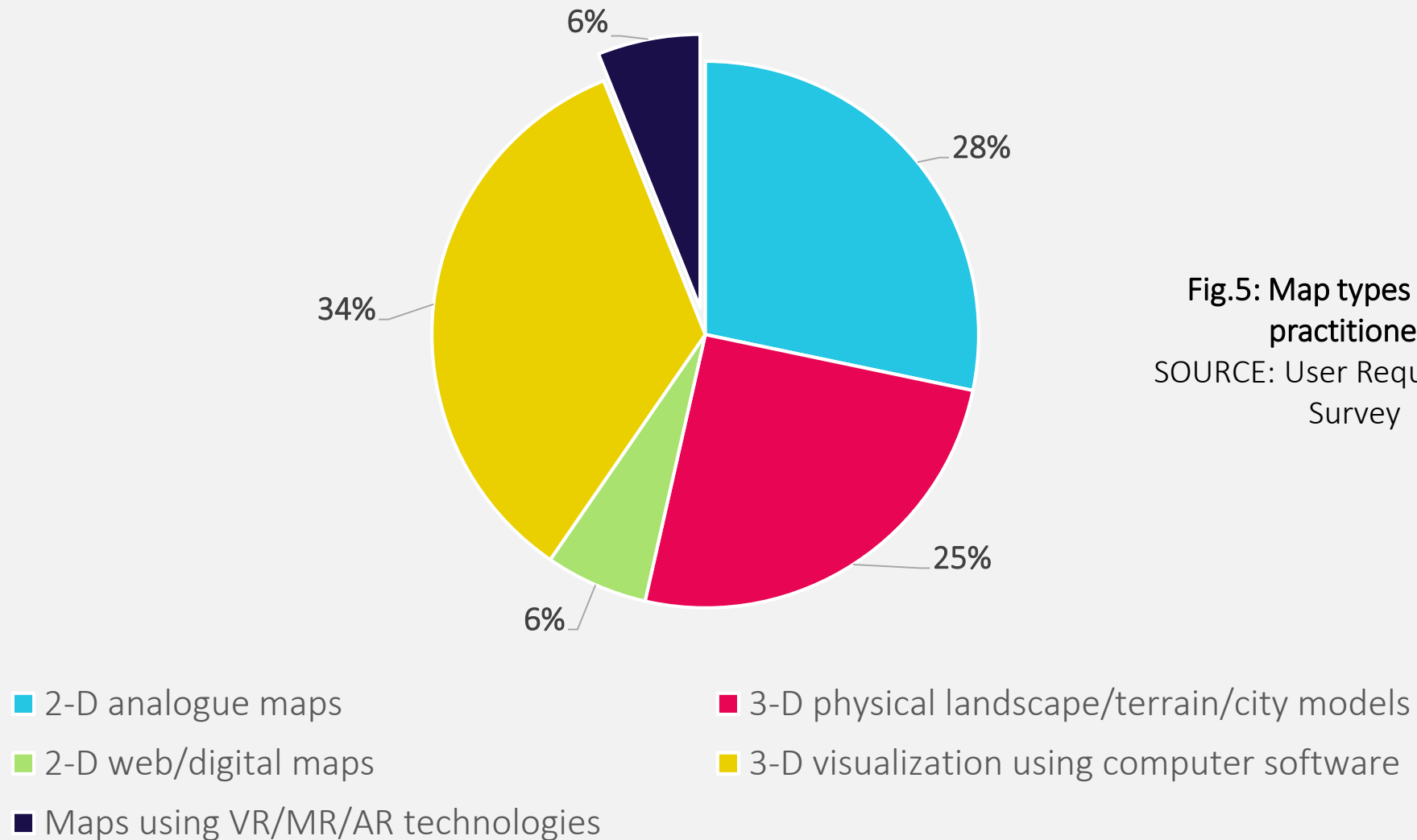


Fig.5: Map types used by practitioners
SOURCE: User Requirement's Survey

Quality Evaluation

→ “How satisfied are you with the general quality and the quality of information you receive from your maps?”

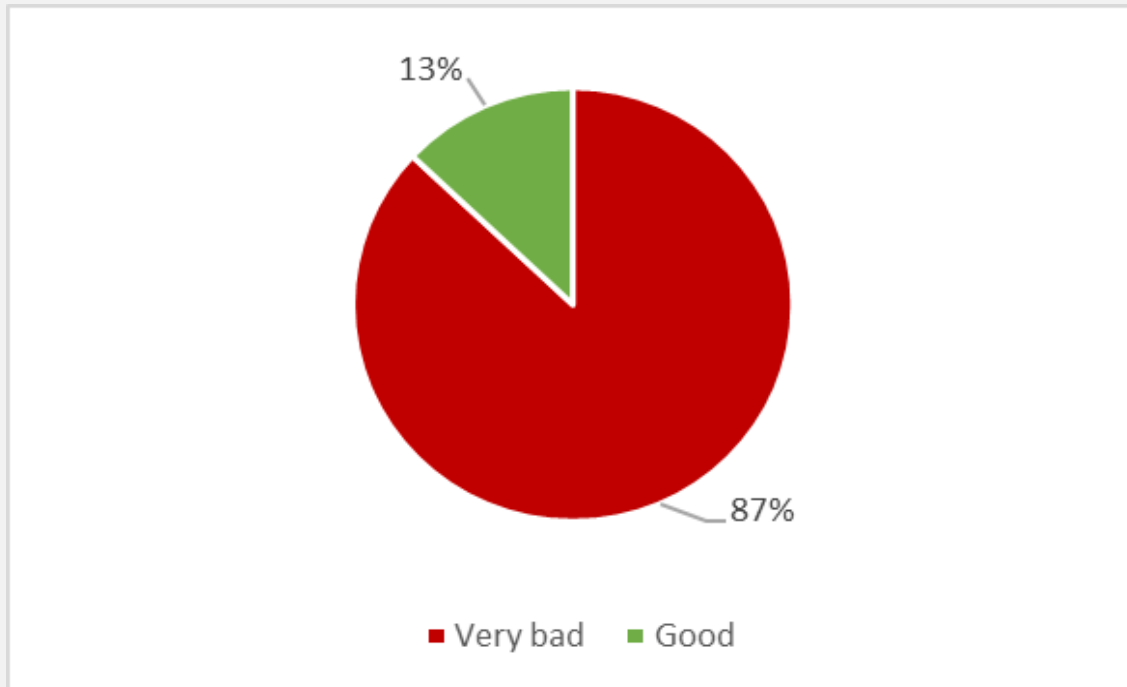


Fig.6: General map quality
SOURCE: User Requirement's Survey

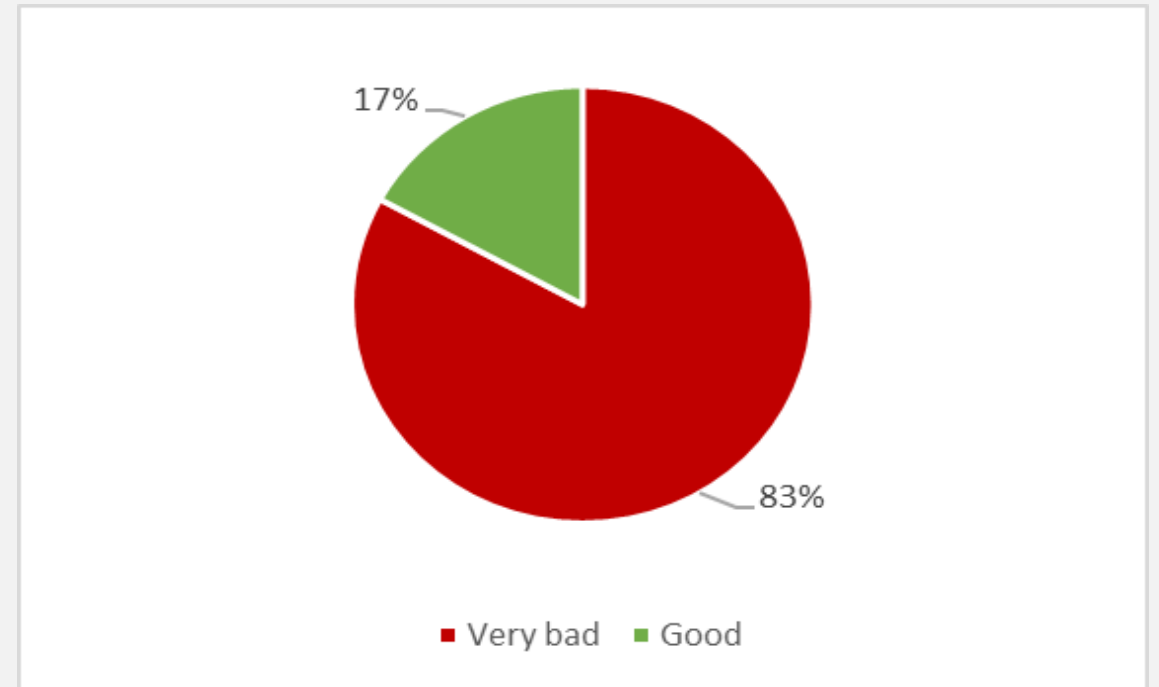


Fig.7: Information quality of maps
SOURCE: User Requirement's Survey

Problem Areas and Challenges

- Facing of *unexpected situations* in *unexpected environments*
- Missing *human* and *financial resources*
- Slow *process of digitalization*
- *Clean communication* without any information loss
- *Lack of acceptance* of EM and disaster protection in politics, society and administration

Information Needs and Requests

Real-time information

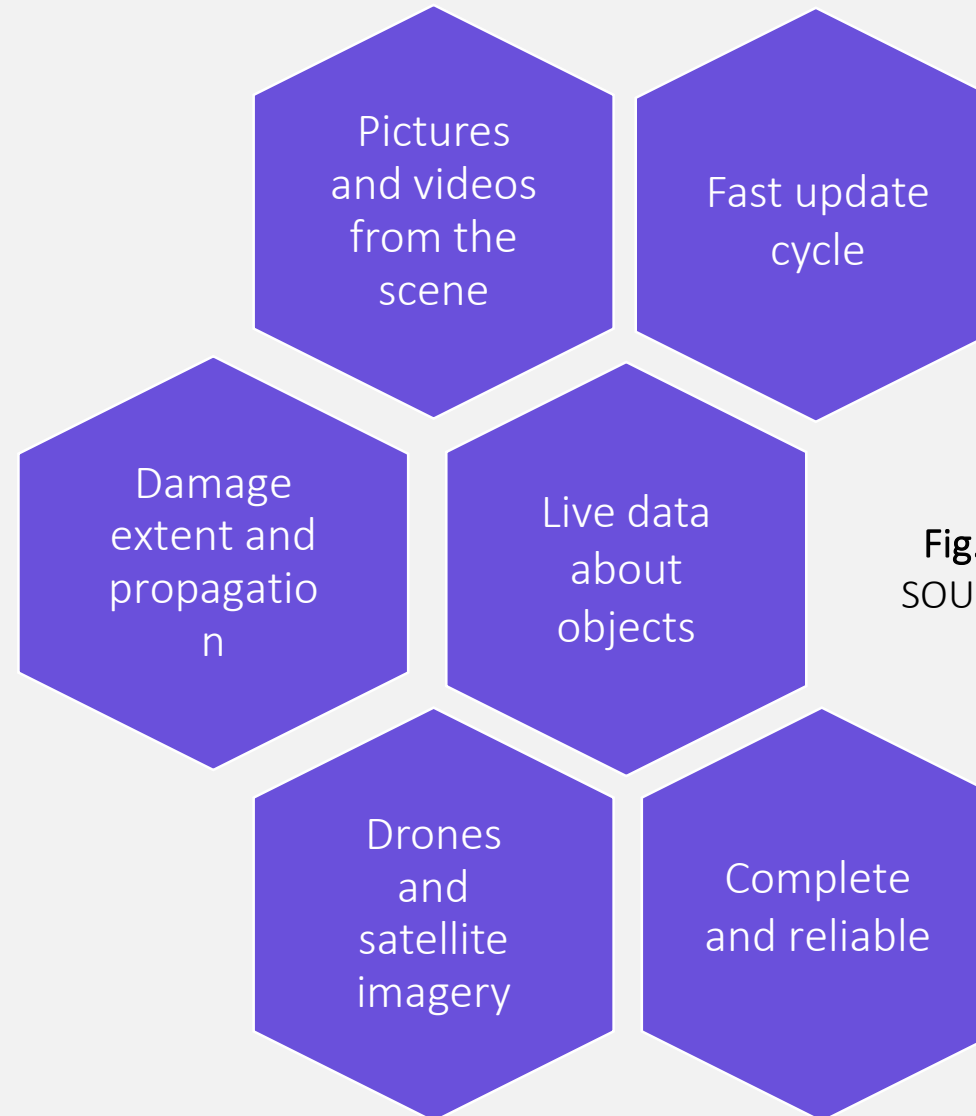


Fig.9: Real-time information needs
SOURCE: User Requirement's Survey

RESULTS II: Use-Case Modelling

Own visualization approach

- **Tabletop-MR application for Android platform**
- Designed for the management and planning of disaster relief activities
- Easily adaptable to other emergency/crisis situation

Software Development

- Developed inside Unity IDE
- Integration of Mapbox Maps SDK
- Integration of WRLD 3D SDK (indoor maps)
- Several AR packages
- End product: Unity Android application package



Fig.10: DiMAN disaster management application

EMSR501: ISTANBUL (TUR)



Event Time (GMT+3:00): 2019-08-12 08:43
Event Type: Earthquake (Ground shaking)

//Activation Status: Open
Last Update: 2019-08-14 22:04



Destroyed



Damaged



Possibly damaged



On Fire

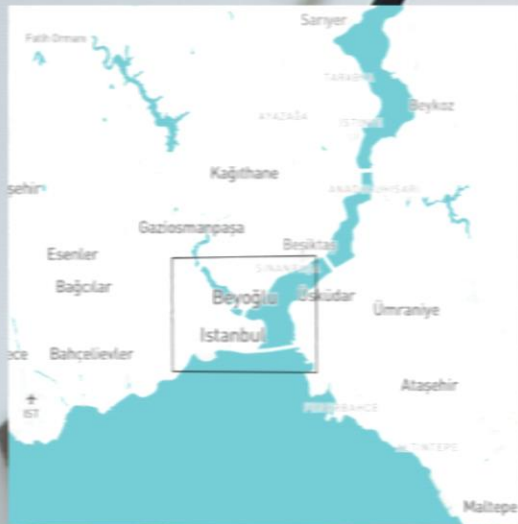


Safe Zones



Hospitals

Select Basemap...



Tabletop-MR-Scene 1: Istanbul (Turkey)

EMSR372: Fire in Castelo Branco



Event Time (GMT+1): 2019-07-20 22:00

Event Type: Fire (Forest Fire)

//Activation Status: Open

Last Update: 2019-07-25 17:05



Area of Interest



Built-Up (Residential)



Rivers & Streams



Burnt Area

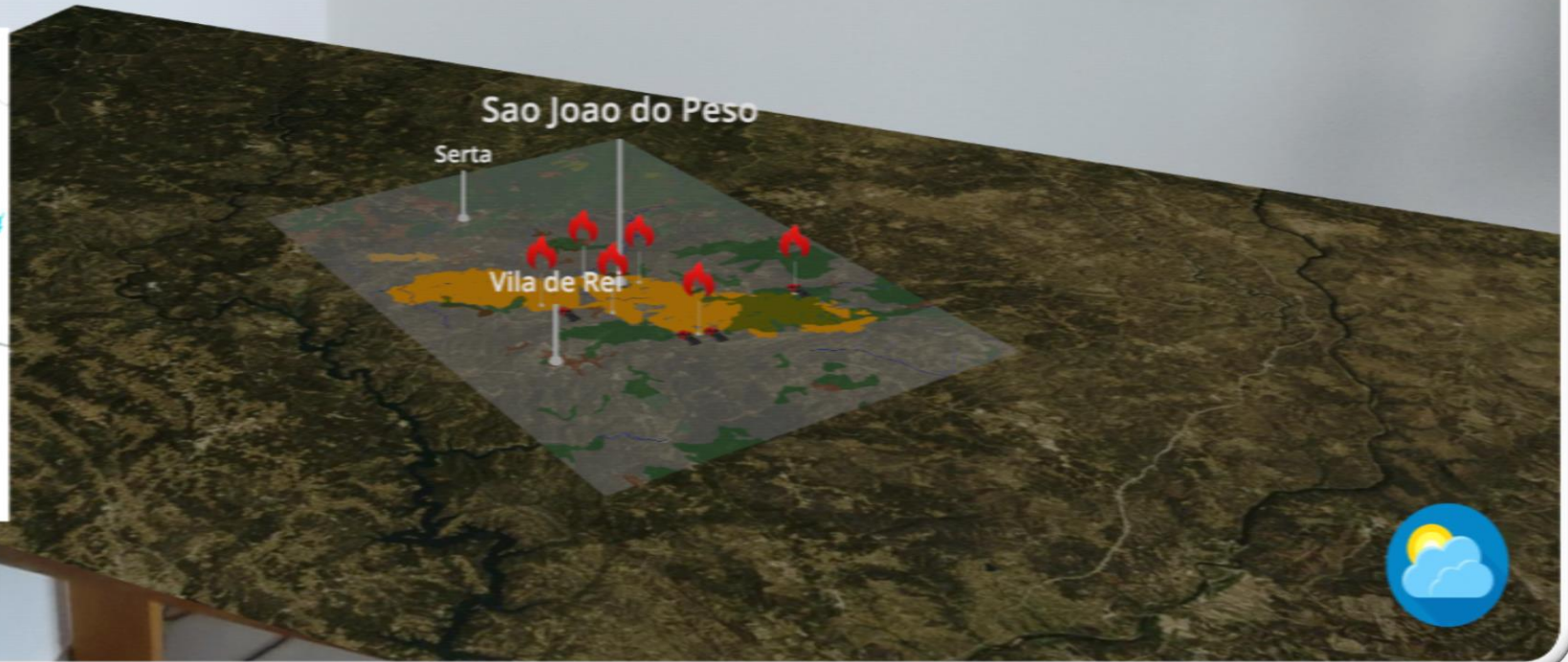


Active Flames



Coniferous Forest

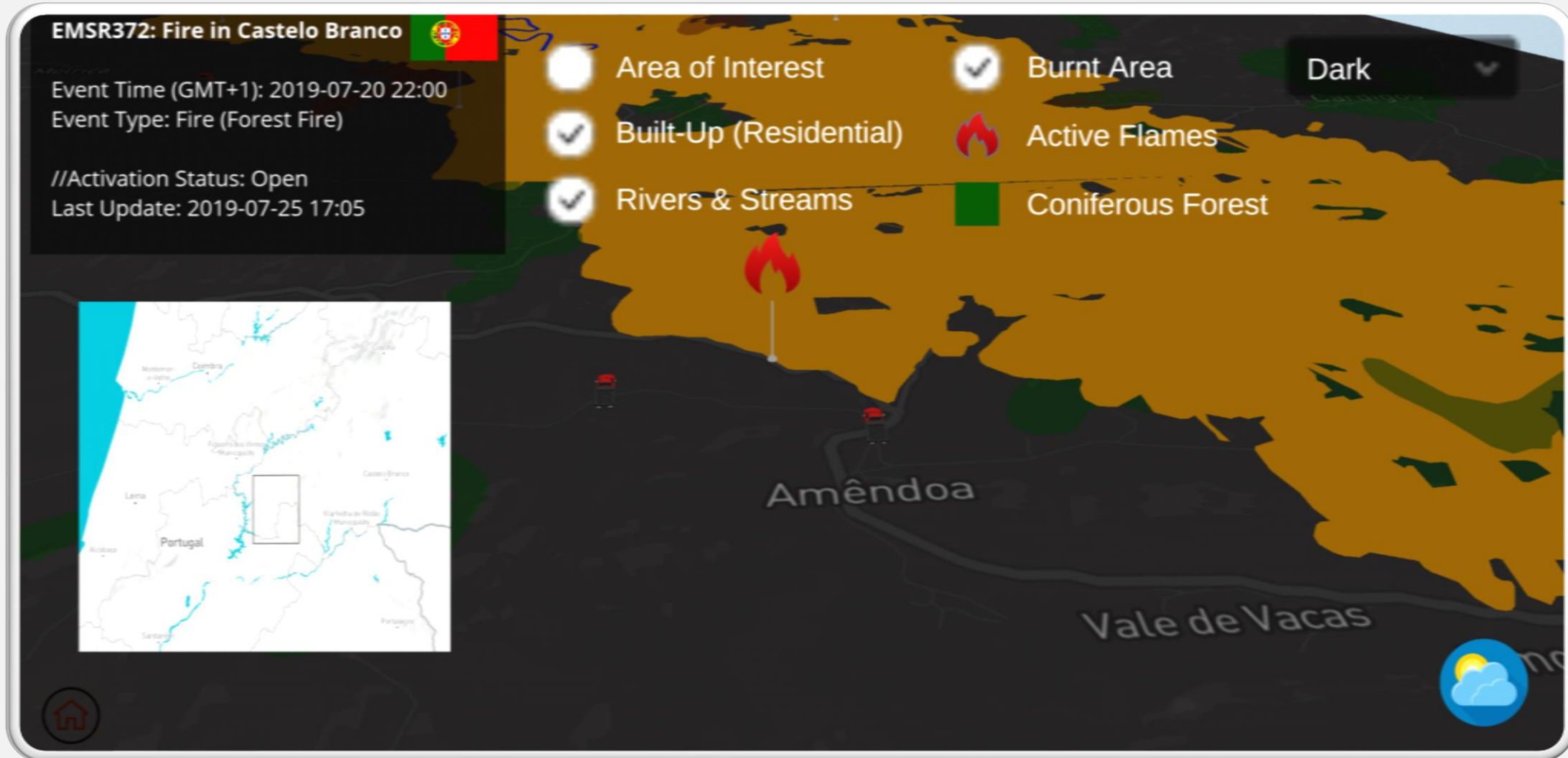
Basemap... ▾



Tabletop-MR-Scene 2: Castelo Branco (Portugal)

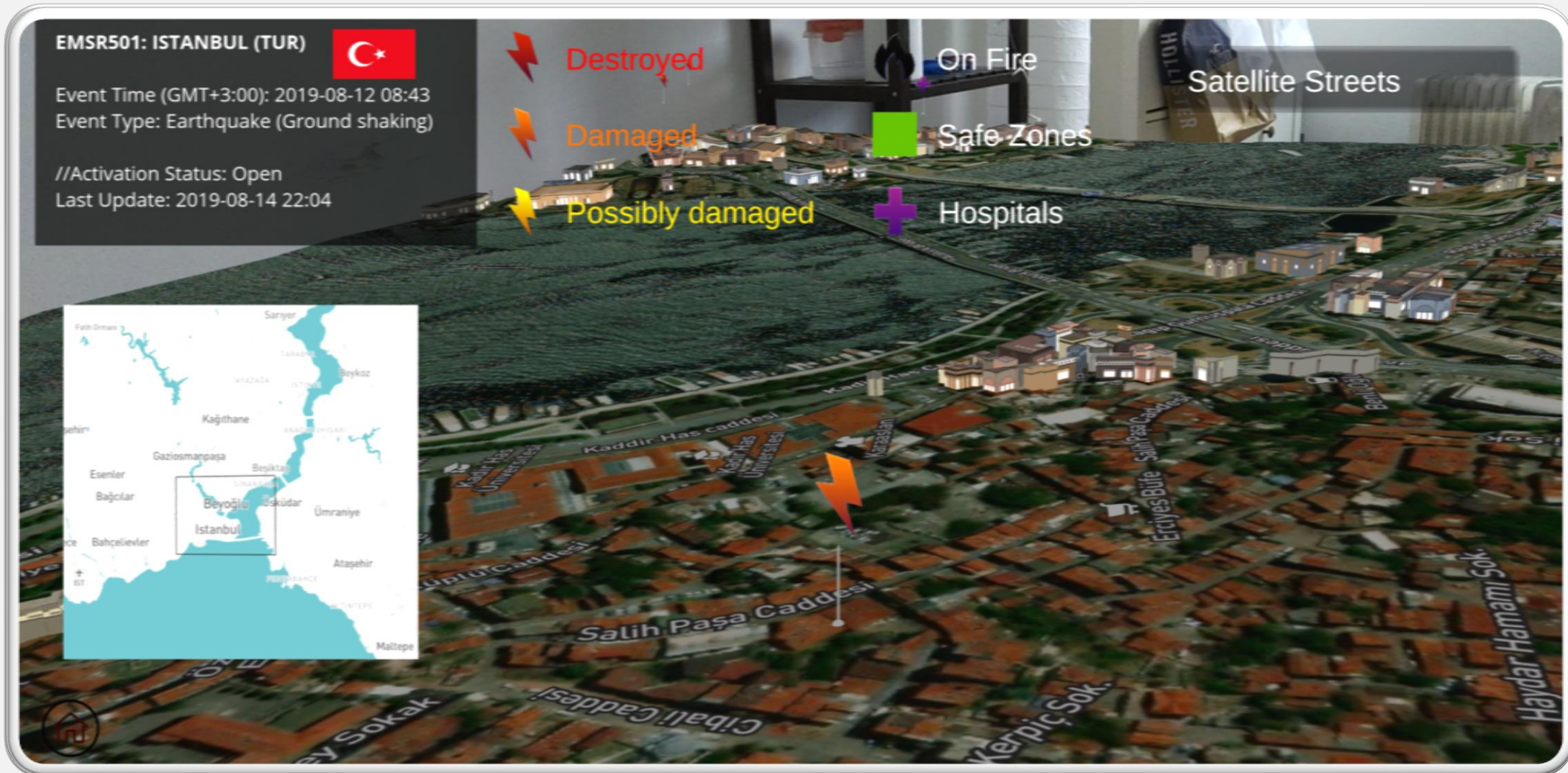
Prototype feature 1

★ Changing of satellite layer/basemap



Prototype feature 2

- ★ Different scales/map sizes possible (Zoom In/Out)



Prototype feature 3

- ★ Pictures/Videos from the scene can be integrated and displayed on touch



Prototype feature 4

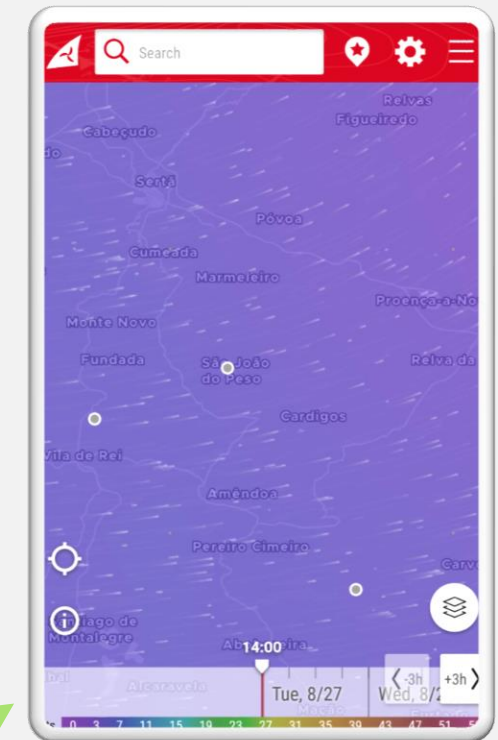
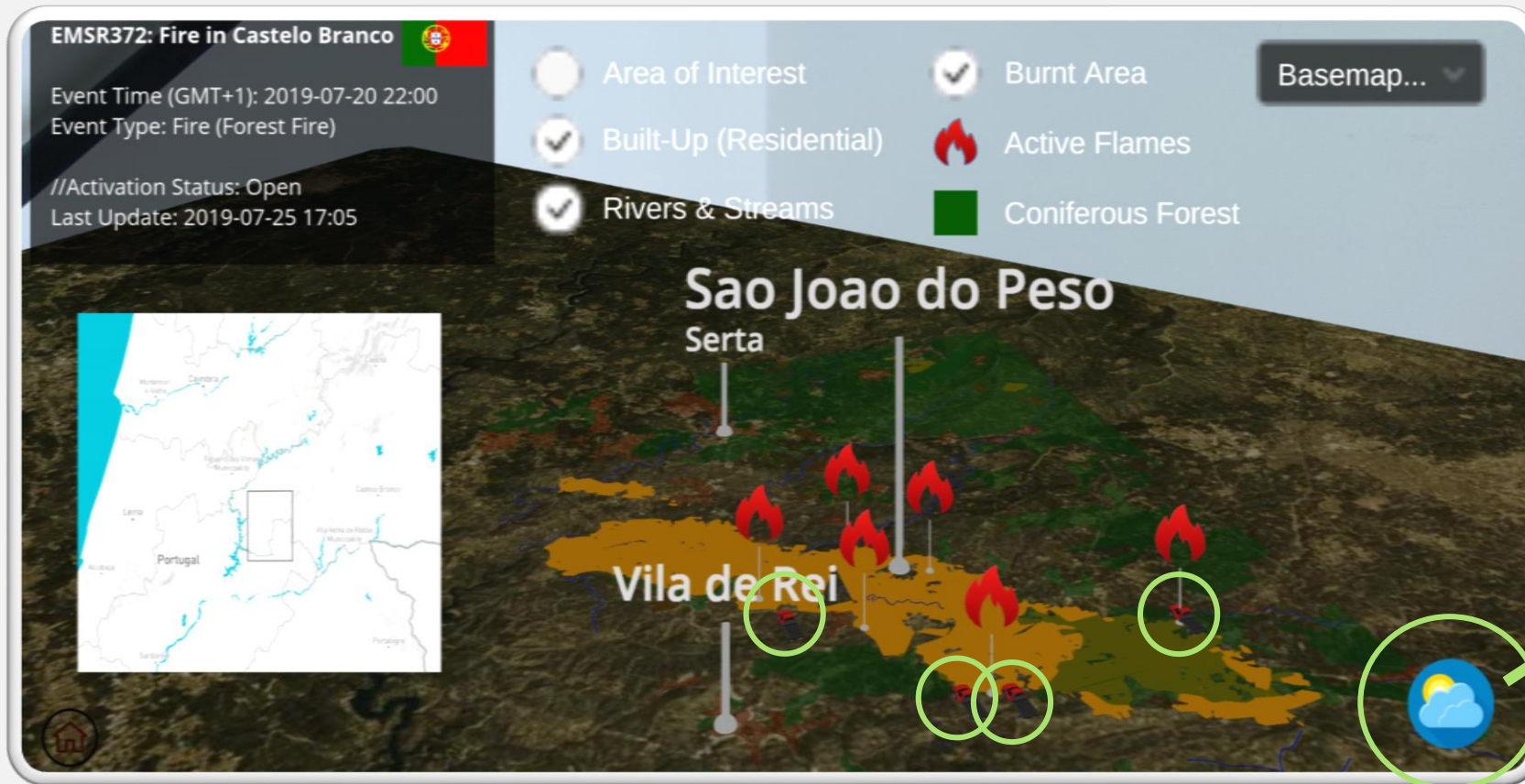
★ Layers can be set active or inactive



Prototype feature 5

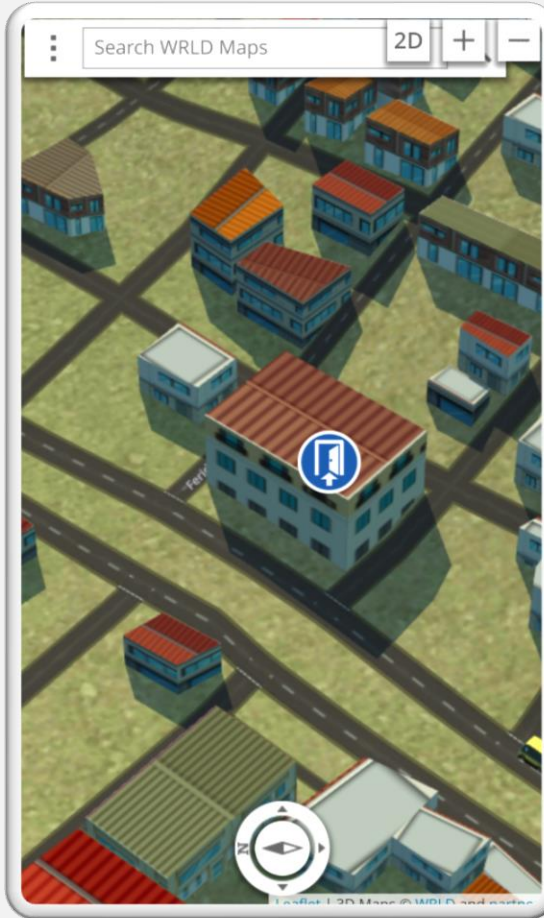
★ Real-time data implementation possible

- GPS positions of vehicles/first responders (at the moment only working in Unity)
- Current wind/weather prognosis & forecast (at the moment only via webservice)



Prototype feature 6

★ 3D Indoor Map Implementation via WRLD 3D Platform



RESULTS III: Expert Interviews



Fig.12: Fire department control room
SOURCE: Own photograph

Core statements

BBK

- Used map types: *2D static digital maps*
- DiMAN *evaluation positive*, assumed benefits on all management levels
- Tabletop-MR approach declared as *science fiction* (not yet deployable at the BBK)

FWM

- Used map types mostly *analogue* and *on paper*
- Biggest problem area of used maps: *topicality*
- DiMAN *evaluation positive*, two main application areas were defined: for the *education of firefighters* and in *crisis rooms*

THW

- Used map types: *mixed (incl. 3D)*
- Biggest problem area of used maps: *homogeneity*
- DiMAN *evaluation positive*, 3D perception of space enhances perception and situational awareness

CONCLUSION

Main Results

- ❖ Disaster Management is a *complex, interdisciplinary* and *multi-actor process*
- ❖ Slow **innovation lifecycle** in EM
- ❖ Very **negative assessment** of *used maps* and *displayed information* by practitioners
- ❖ Clear *demand* of more **real-time data integration** into maps
- ❖ **Benefits/Potential** of cartographic 3D/MR visualizations were *indicated* in the survey and *confirmed* by experts from the field
- ❖ Developed **Tabletop-MR application** considered useful in *crisis rooms* and for *EM situation training* of practitioners
- ❖ **Limitations** exist in the form of *model sensitivity* to environmental influences, *data availability* and *hardware dependency*
- ❖ **Future research** should be pointed at *specific disaster types*


References

- Copernicus EMS (Cartographer). (2019). [EMSR352] Ahvaz detail: Grading Product, version 2, release 1, RTP Map #01. URL: <https://emergency.copernicus.eu/mapping/list-of-components/EMSR352>
- Onslow County NY (2019). Emergency Management. URL: <https://www.onslowcountync.gov/581/Emergency-Management>
- Oxstrand, Johanna & Ohara, John & Blanc, Katya & Whaley, April & Joe, Jeffrey & Medema, Heather. (2013). Development of an Initial Model of Human- Automation Collaboration – Results From a Needs Analysis.
- Valendu (2018). What is the difference between virtual reality, augmented reality and mixed reality? URL: <https://medium.com/@valendu/what-is-the-difference-between-virtual-reality-augmented-reality-and-mixed-reality-67dfec904c64>



Thank You!

 Kevin Helzel

 +49 160 7709727

 kevin.helzel@tum.de

TECHNISCHE UNIVERSITÄT MÜNCHEN