



Cartography M.Sc.

Improvement of Decision Making and Communication in Disaster Risk Management through Cartographic Dashboards

By Rosalie Stefanie Kremser

- **Background, Problem Statement and Motivation**
- **Research Identification & Hypothesis**
- **Methodology**
- **Results**
- **Conclusion and Outlook**

Background, Problem Statement and Motivation

- Disasters are becoming increasingly present in our everyday lives [1]
- Risk management and assessment of disasters has gained in importance
- Crisis management makes strong use of **cartographic visualization** techniques (COVID-19 dashboards [2]) and they are in demand
- The field of Cartography is constantly evolving [3]
- State of the art: disaster risk management is still frequently conducted with static maps and reports [3]



Research Identification and Hypothesis

Aim:

Analyze the potential and the added value of dashboards (as innovative and interactive cartographic tool) in disaster risk management compared to currently used media like static maps and reports.

Hypothesis:

Interactive cartographic visualization tools like dashboards will be an upgrade for risk and vulnerability assessment for natural and human-induced disasters and geopolitical risks.

- I. Identify whether decision making and communication flow could be improved by the interactive character of a dashboard compared to static maps.**
- II. Identify whether dashboards as interactive cartographic visualizations are a useful tool for risk and vulnerability assessment for disaster risk management purposes.**
 - i. Identification of a core user and his or her needs within the disaster risk industry for a user centered dashboard design. Furthermore, identify whether the dashboard will be accepted by the core user as an alternative to static maps.**
- III. Investigate whether the concept of a dashboard as an interactive cartographic visualization is applicable to other potential user groups, working in the disaster risk industry in different sectors.**

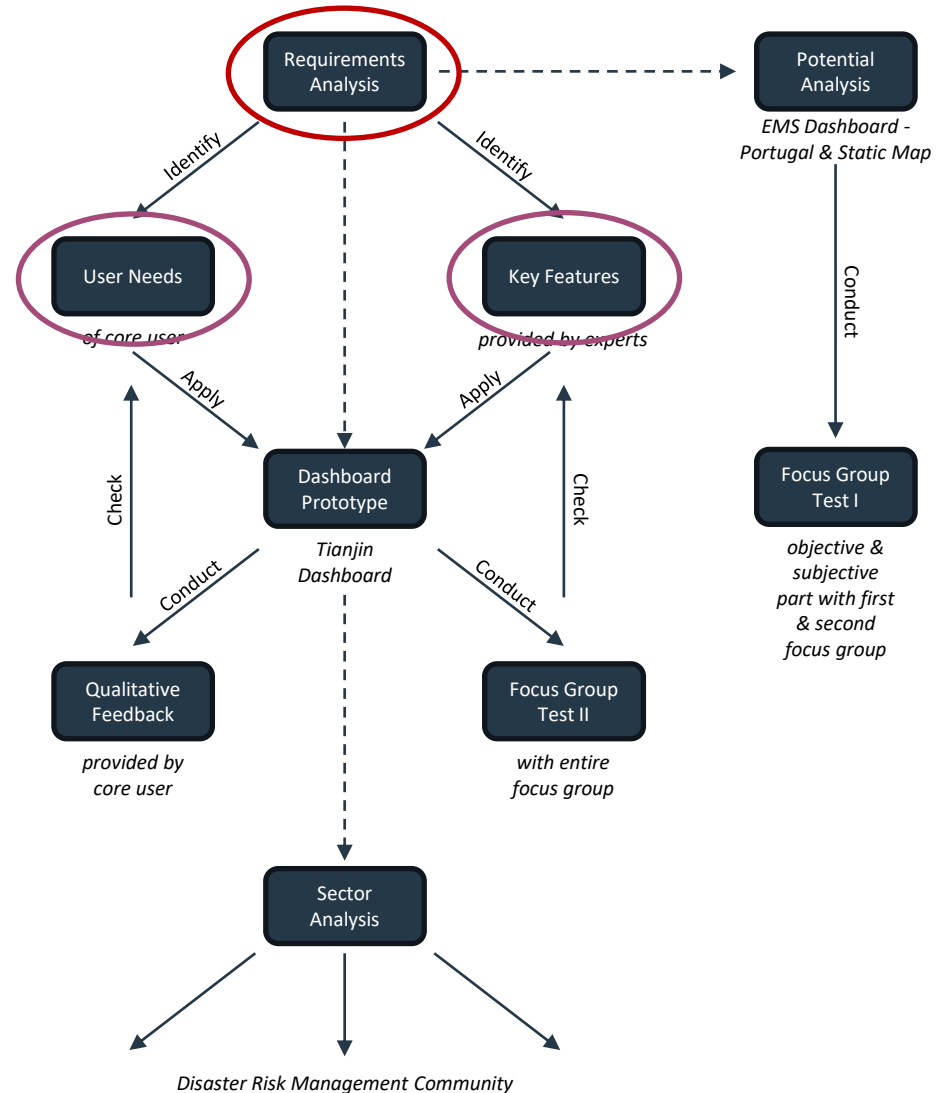
To answer all research objectives methodology is divided into four main parts:

- **Requirements analysis**
- **Potential analysis**
- **Dashboard prototype**
- **Sector analysis**

Methodology – Requirements Analysis

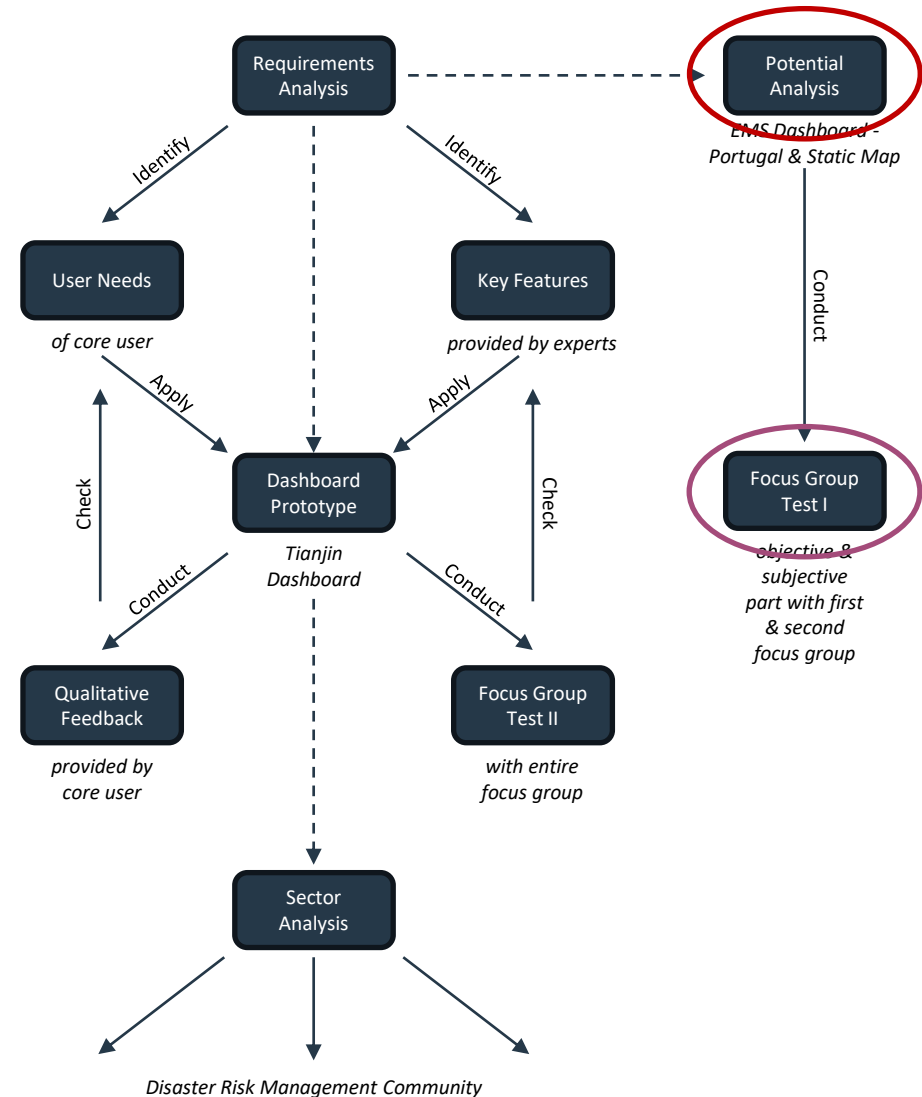
Aim:

- Identify **key features** necessary for a successful dashboard concept and design
 - Method: two qualitative interviews with independent experts who have longstanding experience in the field and in conceptualizing dashboards
- Identify the **user needs** of core user GAF AG to meet their standards and to achieve a high core user satisfaction
 - Method: a qualitative expert interview with core user GAF AG



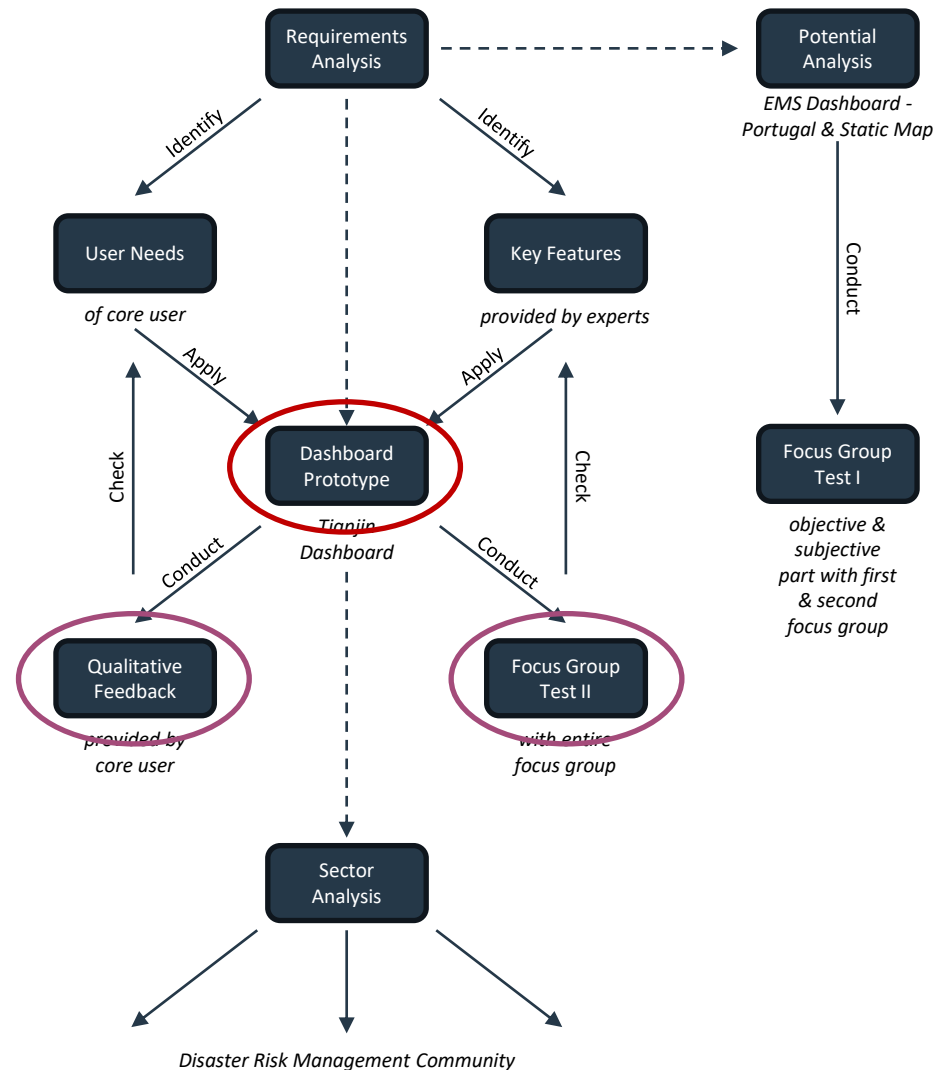
Aim:

- Investigate the applicability of **dashboards** for vulnerability and risk assessment in a direct comparison to a conventional **static map** used in disaster risk management from the Copernicus Emergency Management Service
- Method: Dashboard developed with QGIS, ArcGIS Pro, ArcOnline and ArcGIS Dashboards
- Method: Focus group test I with objective part (**efficiency and error rate**) and subjective part (**user satisfaction and effectiveness**) with two focus group test groups à 17 participants [4]



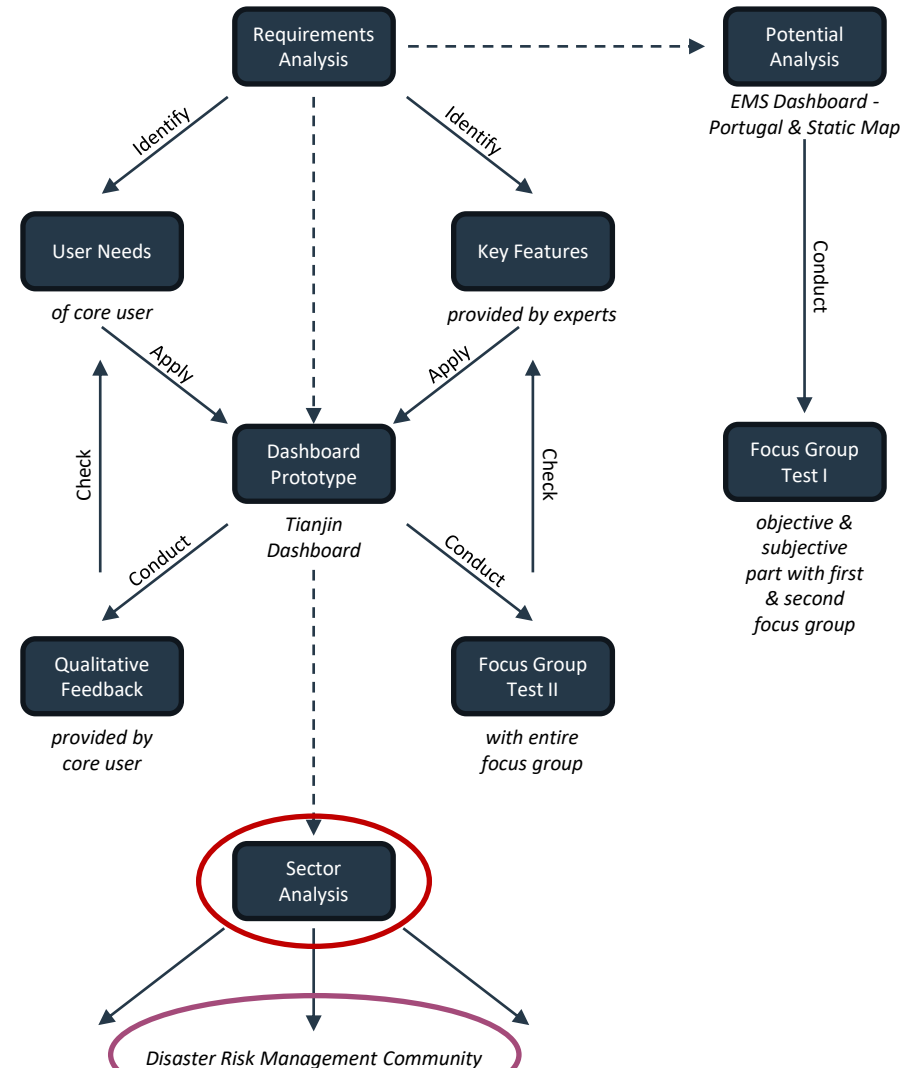
Aim:

- Explore the potentially added value and usability of dashboards in disaster risk management through their interactive nature as an alternative to conventional methods like static maps and reports
 - Method: Dashboard developed with, ArcGIS Pro, ArcOnline and ArcGIS Dashboards, ArcGIS Web App Builder
 - Method: Focus group test II à 34 participants independently revalidating the key features implemented in prototype
 - Method: Qualitative feedback of core user GAF AG by questionnaire



Aim:

- **Test whether the concept of a dashboard is applicable and scalable to other potential user groups and stakeholder, working in the field of disaster risk management**
 - **Method: Contacting stakeholders working in disaster risk management but in different sectors**
 - **Method: Online questionnaire via SoSci-Survey (46 participants)**



Results

- **Requirements analysis**
- **Potential analysis**
- **Dashboard prototype**
- **Sector analysis**

Results – Requirements Analysis

Key Features

- **Qualitative expert interviews**
 - **Little effort in the use**
 - **High intuition**
 - **Efficient bundling of information**
 - **Exploring the complexity of the database**
 - **No overloading of information**
 - **Enabling the identification of trends, correlations and coherences**
 - **Central arrangement of the maps**
 - **Graphs and indicators to support comprehension of topic**
 - **Easy to use, regardless of expertise and knowledge of topic**
 - **Fun to operate**

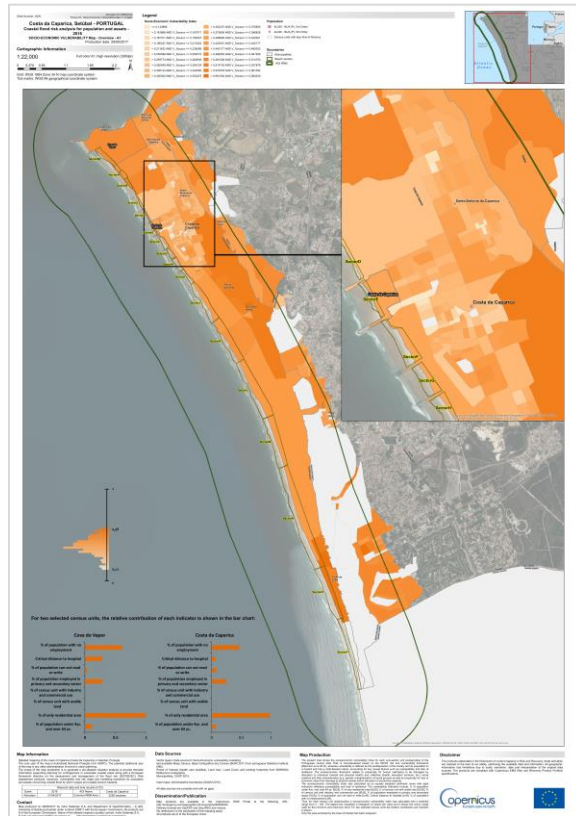
Results – Requirements Analysis

Core Aspects

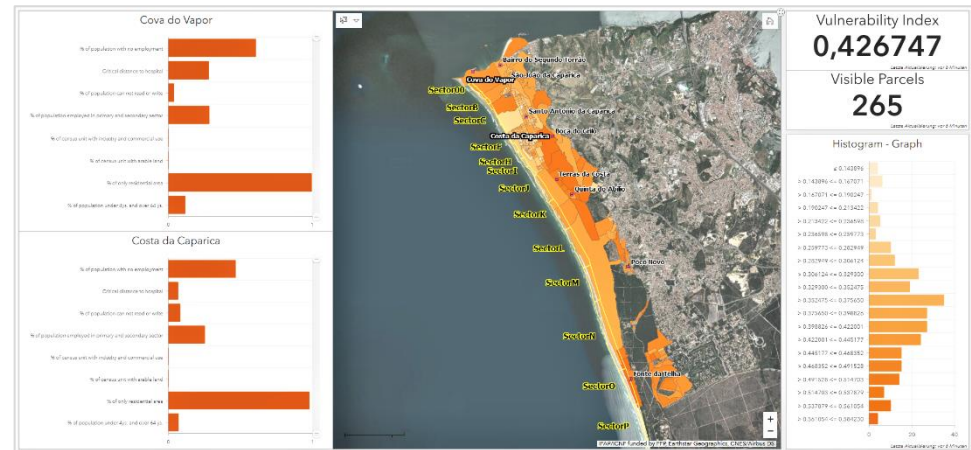
- Qualitative interview with core user GAF AG:
 - **Fast and intuitive** data and information capture provided by the medium dashboard
 - **Appropriate interconnection and efficient consolidation of information and data through interactive maps, graphs and indicators**
 - **Profound and clear comprehensibility of the additional information content provided by the graphs and indicators**
 - **Meaningful visualization of information providing, at best, support in the decision making process in the case of a catastrophic event**
 - **Exploratory data analysis with the incorporation of the user of the dashboard**
 - **Increase of potential client satisfaction through dashboards as a potentially presentation medium for business orders**
 - **Appealing design and visualization of data in the interactive maps and graphs included in the dashboard**
 - **Provided benefit compared to currently products such as static maps in disaster risk management**

Results – Potential Analysis

EMS034 Dashboard



Static Map EMS034

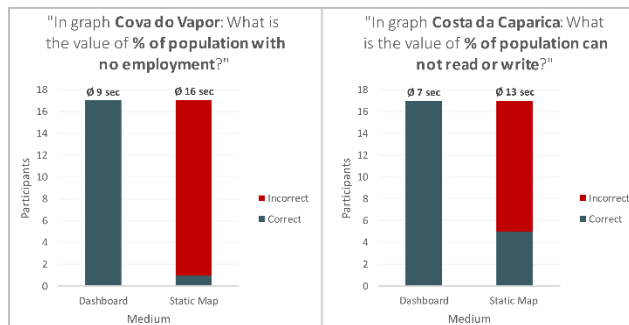
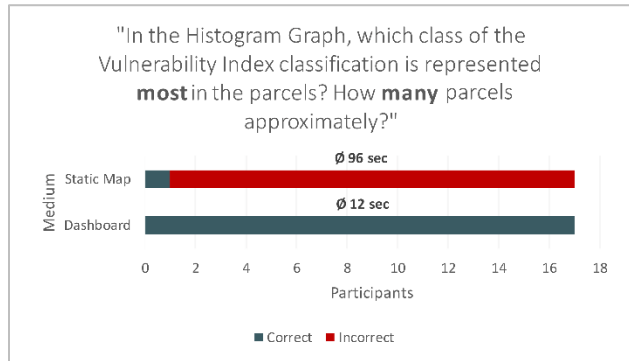
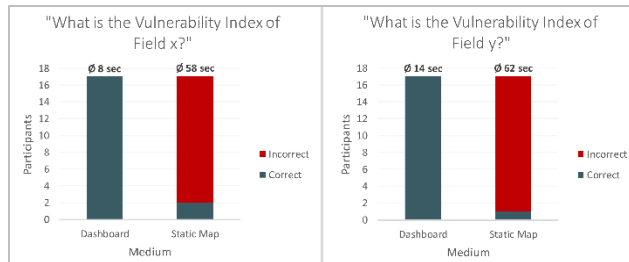


Dashboard EMS034

Cartographic media **static map** and **dashboard** for direct comparison in the frame of the focus group test I

Results – Potential Analysis

Focus Group Test I – Objective Part



Objective part of the focus group test was performed to evaluate correctness (error rate) and efficiency based on the answers of the provided medium and if **interactivity** (provided by dashboard) influences both parameters

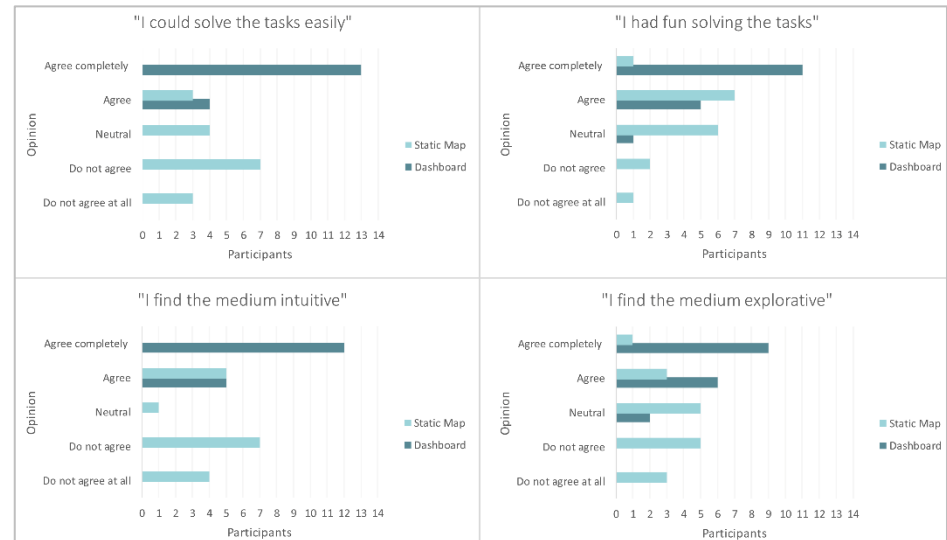
- **Correctness:**
Dashboard outperformed the static map in terms of **granularity** and **accuracy** of answers
- **Efficiency:**
Testing revealed that the medium dashboard was more efficient, by being able to solve tasks **faster**

Results – Potential Analysis

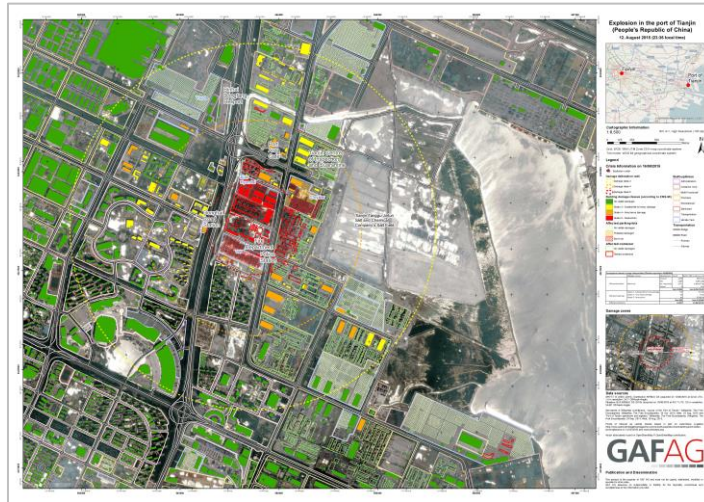
Focus Group Test I – Subjective Part

Subjective part aimed to investigate how the participants assessed the effectiveness of the medium and the degree of user satisfaction linked to the used medium

- **Effectiveness:**
Dashboards are perceived **highly effective** in terms of intuition and exploration
- **User Satisfaction:**
Dashboards reflect a **high level** of user satisfaction while interacting with the medium



Results – Dashboard Prototype



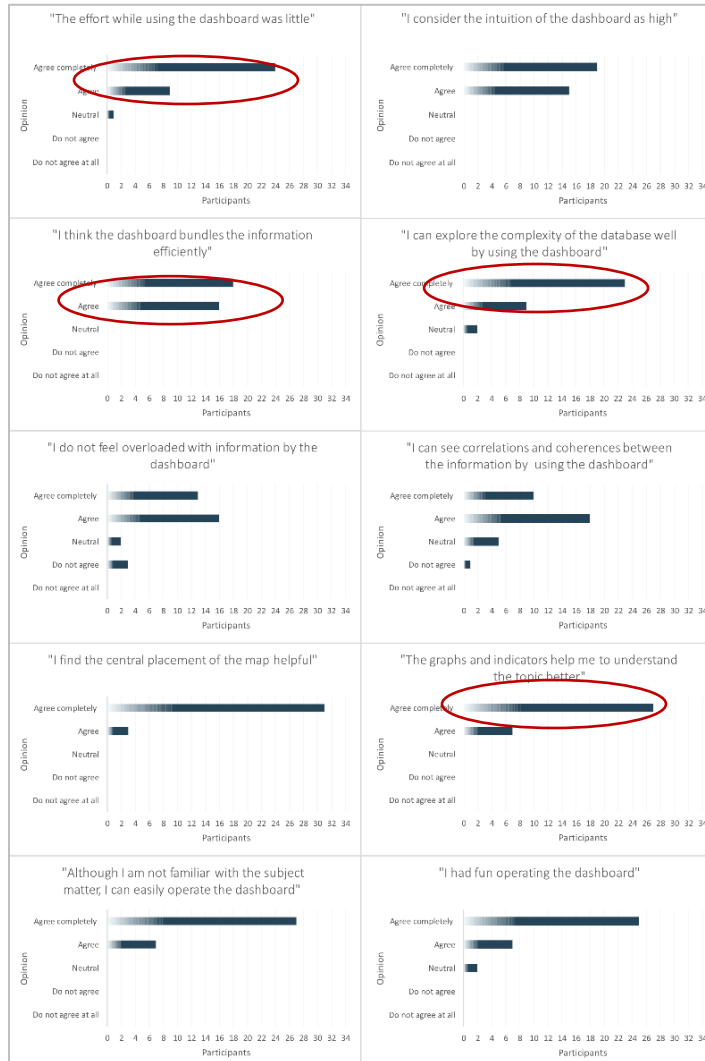
Initial **static map** of core user GAF AG for damage assessment of the Tianjin explosion 2015



Tianjin **Dashboard** depicting the same and additional information as an interactive dashboard

Results – Dashboard Prototype

Focus Group Test II



- Summarized, the Tianjin Dashboard has been perceived as **very positive** by the 34 participants
- Participants thought the effort was **little**, information was presented in **bundled** and **coherent** manner and they could **easily operate** the dashboard
- Some participants encountered their limitations because they were either **over- or under-demanded** by the software

Results – Dashboard Prototype

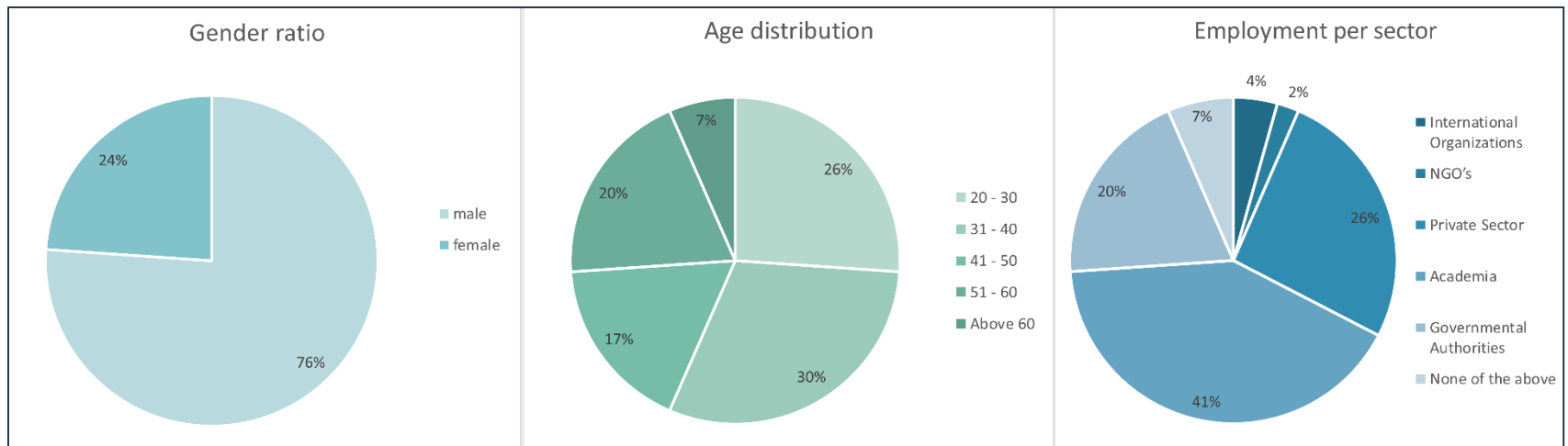
Qualitative Feedback

- *"due to the different layers and their attributes the capture of the information and data was very easy"*
- *"information and data are suitably linked and **efficiently bundled**"*
- *"the information was presented in an **easily understandable way** and was sufficiently detailed"*
- *"since the focus can be placed on damaged and destroyed objects, the presentation can **contribute to decision making**"*
- *"due to the large amount of information displayed, the user can be directed towards the topic and gain a comprehensibility on a deep level"*
- *"for a large number of customers, the descriptive presentation of data, could **increase customer satisfaction** through the use of a dashboard (easier grasp of the information and focus on the essentials)"*
- *"the color scheme and combination of colors are selected intuitively. Discreet presentation of the base map is **ideally** chosen in order to **visualize the damage appropriate.**"*
- *"in my opinion, a dashboard represents a **clear added value compared to a static map**. The user can decide for himself or herself which information can be depicted, with simultaneous quantitative evaluation of the displayed elements."*

→ *Very positive feedback on the dashboard prototype*

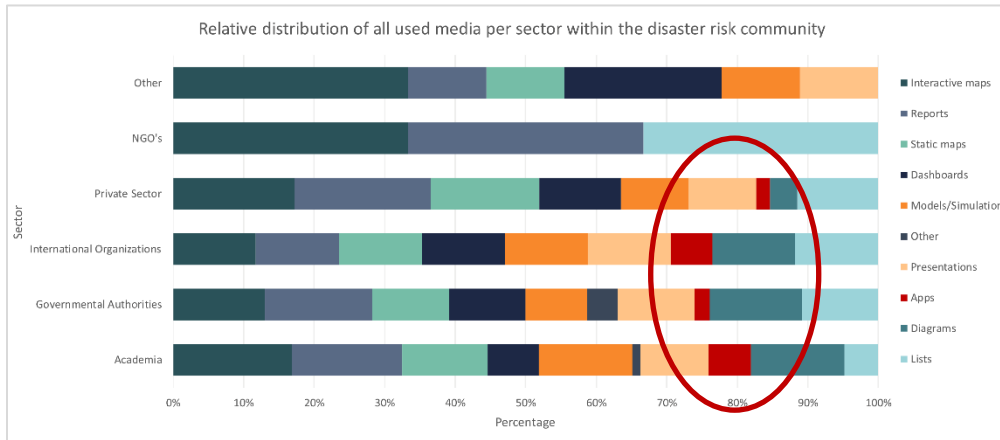
Results – Sector Analysis

Disaster Risk Community Profile

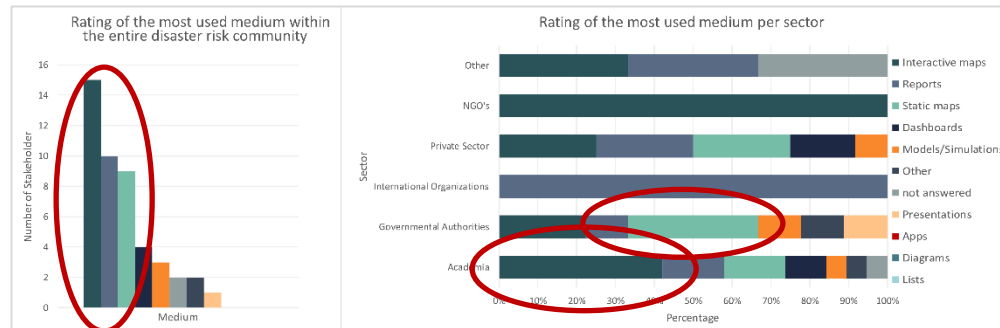


- **46 participants of contacted stakeholder successfully completed survey**
- **76% male participants; 24% female participants**
- **Evenly age distribution**
- **Mostly Academia and Private Sector - NGO's and International Organizations are underrepresented**

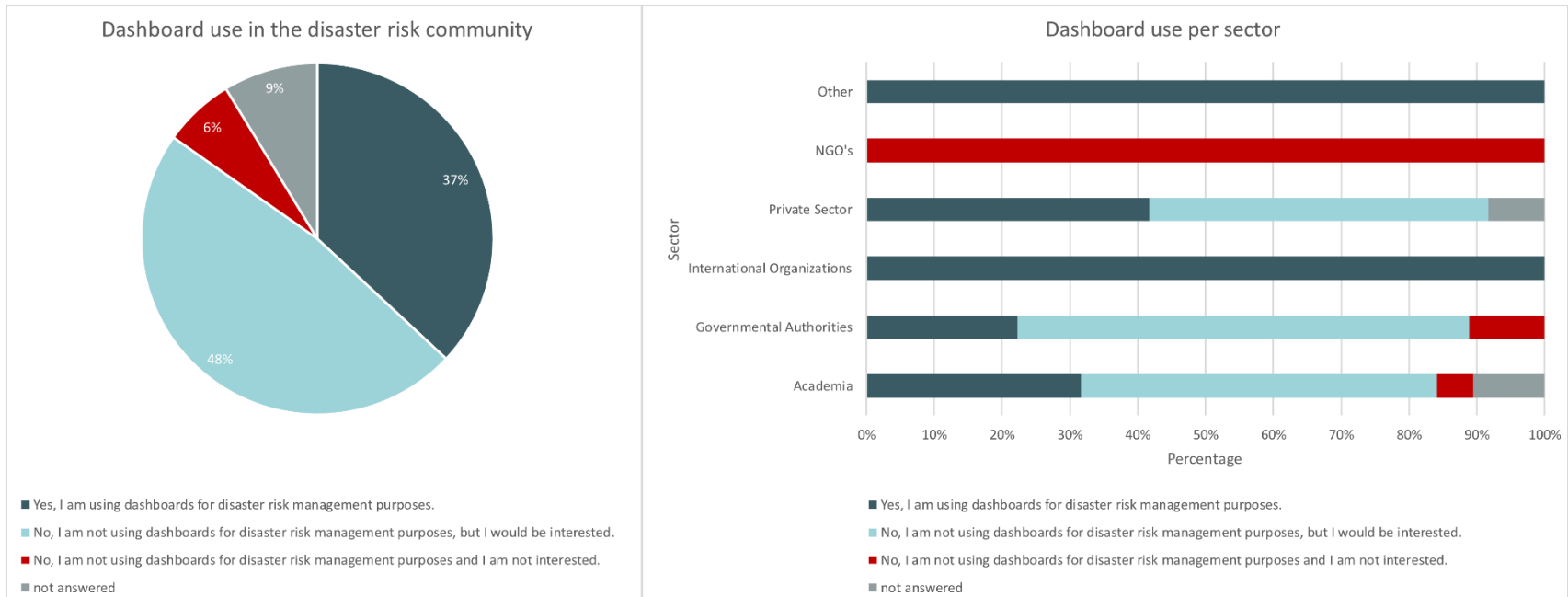
Results – Sector Analysis



- **Interactive maps, reports and static maps account mostly for largest shares in all sectors.**
- **Discovering new trends like app use**



Results – Sector Analysis



- **A rough third of the participants responded that they already use dashboards for disaster risk management purposes**
- **Half of the stakeholder (48%) do not so but would be interested in using dashboards**
- **= over 80 % expressed interested in using dashboards for disaster risk management – variations sector wise occur**


- I. **Identify whether decision making and communication flow could be improved by the interactive character of a dashboard compared to static maps.**
- II. **Identify whether dashboards as interactive cartographic visualizations are a useful tool for risk and vulnerability assessment for disaster risk management purposes.**
 - i. **Identification of a core user and his or her needs within the disaster risk industry for a user centered dashboard design. Furthermore, identify whether the dashboard will be accepted by the core user as an alternative to static maps.**
- III. **Investigate whether the concept of a dashboard as an interactive cartographic visualization is applicable to other potential user groups, working in the disaster risk industry in different sectors.**

→ What is the answer to those Research Objectives?

Identify whether decision making and communication flow could be improved by the interactive character of a dashboard compared to static maps.

- **Potential Analysis (focus group test I - objective part)**
 - **Results proved that dashboards enable faster and more accurate transfer of risk-related data and information, which effectively can contribute to facilitating decision-making as well as communication flows**
- **Expert Interviews (single statements)**
 - **Findings are also reflected in parts of the content of expert interviews**

Identify whether dashboards as interactive cartographic visualizations are a useful tool for risk and vulnerability assessment for disaster risk management purposes.

- 
- Requirements Analysis → pre-condition
 - Potential Analysis (focus group test I - subjective part)
 - Dashboard Prototype (focus group test II)
 - Dashboard Prototype (qualitative feedback)
 - Expert Interviews (single statements)

→ Combination of findings allow the conclusion that dashboards **do** constitute a useful tool for risk and vulnerability assessment

Identification of a core user and his or her needs within the disaster risk industry for a user centered dashboard design. Furthermore, identify whether the dashboard will be accepted by the core user as an alternative to static maps.

- Requirements Analysis – Core Aspects
 - User needs were identified through qualitative interview with core user GAF AG
- Dashboard Prototype – Qualitative Feedback
 - User needs were **successfully** applied which is validated through the **positive qualitative feedback**

Investigate whether the concept of a dashboard as an interactive cartographic visualization is applicable to other potential user groups, working in the disaster risk industry in different sectors.

▪ Sector Analysis

- **A big YES!**
- **85% of the questioned stakeholder expressed an interest in dashboards**
- **High willingness** to use dashboards for disaster risk management purposes

- I. **Identify whether decision making and communication flow could be improved by the interactive character of a dashboard compared to static maps.** ✓
- II. **Identify whether dashboards as interactive cartographic visualizations are a useful tool for risk and vulnerability assessment for disaster risk management purposes.** ✓
 - i. **Identification of a core user and his or her needs within the disaster risk industry for a user centered dashboard~ design. Furthermore, identify whether the dashboard will be accepted by the core user as an alternative to static maps.** ✓
- III. **Investigate whether the concept of a dashboard as an interactive cartographic visualization is applicable to other potential user groups, working in the disaster risk industry in different sectors.** ✓

Hypothesis:

Interactive cartographic visualization tools like dashboards will be an upgrade for risk and vulnerability assessment for natural and human-induced disasters and geopolitical risks.

- **Numbers and intensity of natural and anthropogenic disasters continues to rise → accelerated by climate change [5]**
- **Field of disaster risk management is constantly evolving, and its increasing importance has turned a small community into an entire industry**
- **Structuring more and more information technically into one application while degree of automation can be expected to continue to rise in the future**
- **Beirut explosion in Lebanon 2020**

THANK YOU FOR YOUR ATTENTION



This is a koala
(Source, 2018)

- [1] Munich Re. (2020b). *Risks posed by natural disasters: Economic losses caused by natural catastrophes are trending upwards*. Retrieved April 26th, 2020, from <https://www.munichre.com/en/risks/natural-disasters-losses-are-trending-upwards.html>
- [2] Robert Koch-Institute. (2020). *Rki covid-19 germany*. Retrieved August 07th, 2020, from <https://experience.arcgis.com/experience/478220a4c454480e823b17327b2bf1d4>
- [3] Tomaszewski, B. (2014). *Geographic information systems (gis) for disaster management* (1st ed.). Boca Raton: CRC Press.
- [4] Roth, R., Ross, K., & MacEachren, A. (2015). User-centered design for interactive maps: A case study in crime analysis. *ISPRS International Journal of Geo-Information*, 4(1), 262–301.
- [5] UNDRR. (2015b). *Global assessment report on disaster risk reduction (gar) 2015: Making development sustainable : the future of disaster risk management*. New York: United Nations.



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