Cartography M.Sc.

Communicating Disaster Risk Information – Cartographic Dashboards and Mixed Reality

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Outline

- Background and Motivation
- Research Identification, Hypothesis, and Research Objectives
- Methodology
- Results
- Conclusion and Outlook

Introduction and Motivation

- Disasters are an ever-increasing threat in the modern world, both natural and anthropogenic.
- Disaster risk management already makes strong use of cartographic visualizations.
- New technologies within the field of cartography need to be explored such as dashboards and mixed/augmented reality. [1][2]
- State-of-the-art: Digital dashboards are currently being used, but AR + dashboard combination has only minimally been explored and none involving the map itself being an AR element.[3]

Research Identification and Hypothesis

Aim:

To understand how it is possible to integrate augmented reality technology into a cartographic dashboard and if it is useful in communicating disaster risk information.

Hypothesis:

- There are multiple ways to integrate AR into a cartographic dashboard.
- An AR cartographic dashboard can improve the communication of information to a user within the context of disaster risk management.
- A well-designed and intuitive dashboard layout is necessary for user comprehension.

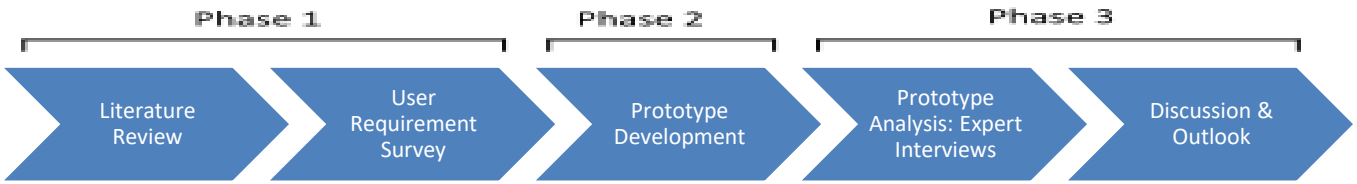
Research Objectives

1. Discover needs of a disaster risk management professional for cartographic technologies.
   a) Identify how an AR cartographic element can support disaster management
2. Identify how to integrate AR technologies into a cartographic dashboard.
3. Understand if a dashboard with an AR element can improve the communication of information to a user about disaster risk and how
   a) Analyze how dashboard layout impacts user

Methodology

To meet all research objectives, the methodology was divided into three phases:

- User requirement survey
- Proof-of-concept prototype
- Expert interviews



Methodology – User Requirement Survey

Research Objective 1: Discover needs of a disaster risk management professional for cartographic technologies. (a) Identify how an AR cartographic element can support disaster management

The aim of the survey was to understand:

- what devices disaster risk professionals are already using
- how important maps are for them and what type of information is on them
- if they have already worked with AR products
- what their biggest problems and needs currently are
- what they see for the future of the technology they use to address disasters

Methodology – Proof-of-concept

Research Objective 2: Identify how to integrate AR technologies into a cartographic dashboard.

- A proof-of-concept prototype instead of a case study was chosen based on previous research that suggests that tasks tested should be derived from real situations at the time of disaster [4]
- Dashboard layout: comparative methodology employed
- AR element chosen to function within the desktop dashboard setting

Methodology – Expert Interviews

Research Objective 3: Understand if a dashboard with an AR element can improve the communication of information to a user about disaster risk and how. (a) Analyze how dashboard layout impacts user

- Expert interviews were chosen as the best method to analyze a proof-of-concept prototype.
- Since a proof-of-concept prototype is not fully functional, testing behavior is not possible.
- Instead, having a deeper conversation about the pros and cons and possible uses is important and provides attitudinal feedback. [5]
- An expert from an office location and a field expert were interviewed to understand different possible applications.

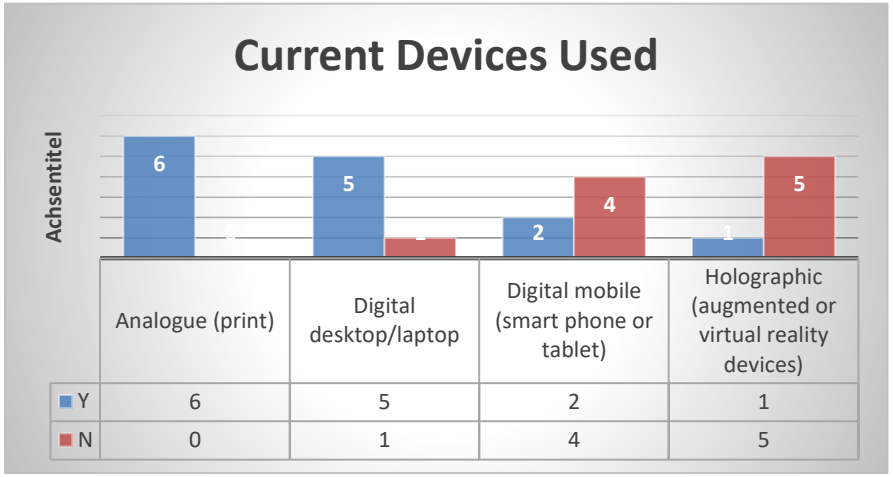
Results

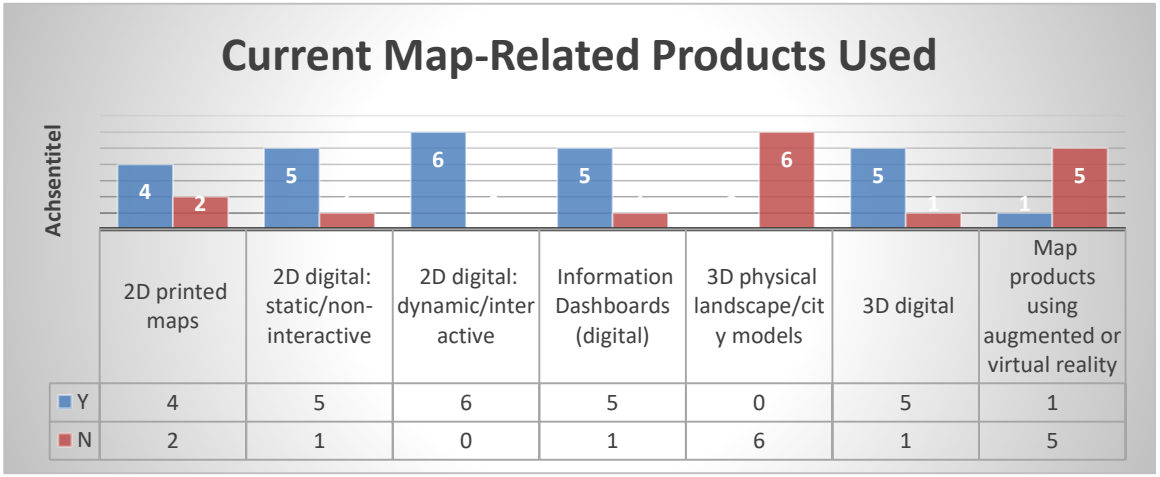
- User Requirement Survey
- Proof-of-Concept
- Expert Interviews

Results – User Requirement Survey

Participants:

- Six experts
- Four from German Federal Office of Civil Protection and Disaster Assistance, one each from Munich and Berlin Fire Departments





Results – User Requirement Survey

Results – User Requirement Survey

Problems:

- Data availability
  - Specifically getting real-time data
- Modifiable are unit problem
- Data quality
- Complicated operation

Needs:

- Ease of use/user-friendly
- Convey the information without room for misinterpretation/simple, meaningful representations
- Data quality/official information
- Real-time data

Results – User Requirement Survey

Information needs:

- Understanding spatial context and relationships
- Data exploration
- Geo-referenced information
- A broad overview
- Quickly identify trends
- Comprehensive information on urban development data
  - Populations figures
  - Infrastructure and settlement structures
  - 3D overview of deployment site

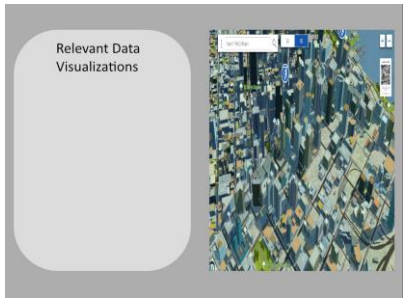
Results – User Requirement Survey

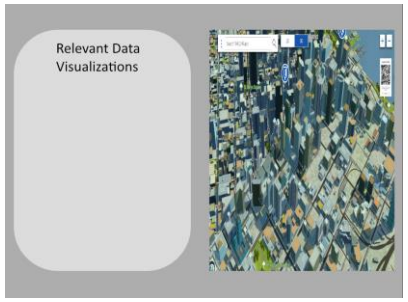
Benefit of new technology:

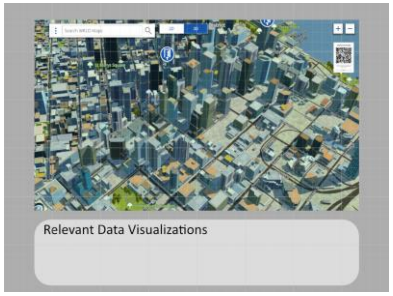
- "…the benefits can be very great. However, it must also be guaranteed that these technologies can also be operated by absolute laymen and, if necessary, still function after a power failure."
- "In the context of disaster risk management cycle, the most direct potential would be in the response or recovery phase. However, scenario-based preparation tasks might also be supported."
- "Allows a better understanding of the situation, possibly integration of real-time information (task forces, situation picture)."
- "A challenge might be the complexity of such an application, e.g., user-friendliness, design, and experience."

Results – Proof-of-Concept

Dashboard Layout:





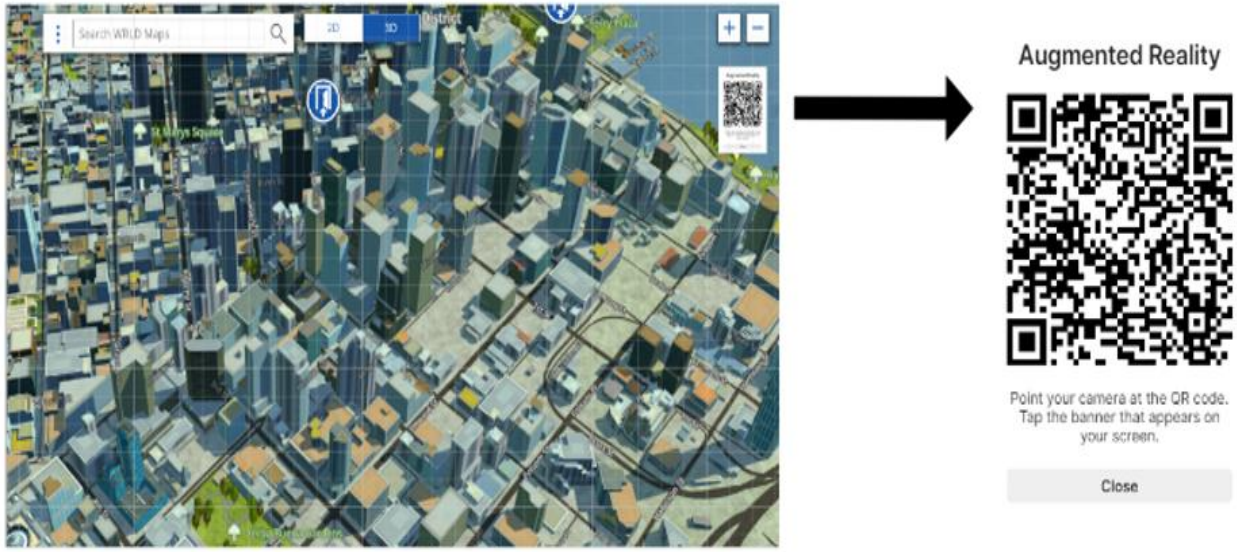


Results – Proof-of-Concept

Dashboard Layout:

Results – Proof-of-Concept

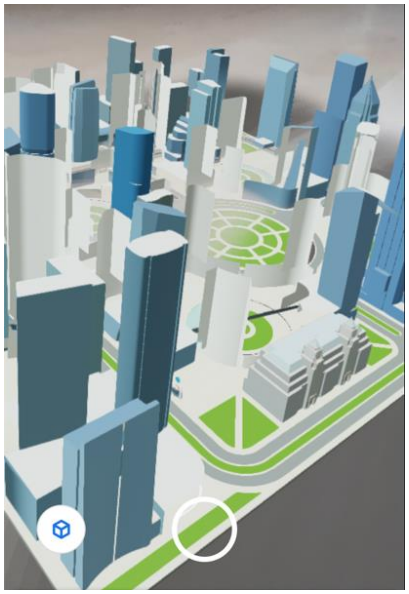
AR element:

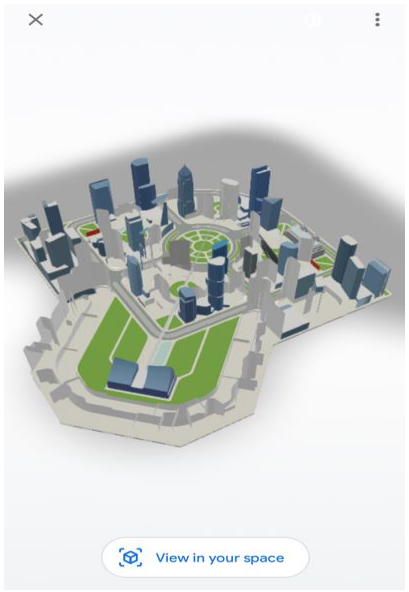


Base map: WRLD3D

Results – Proof-of-Concept

AR element:





Technical Specifications:

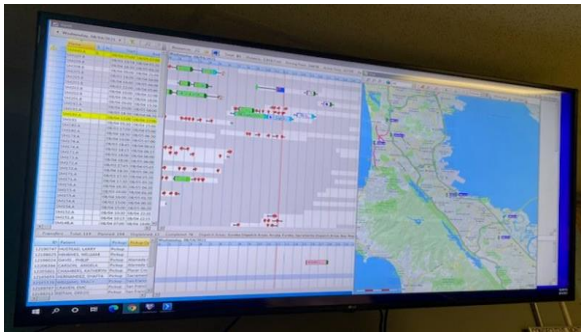
- Markerless AR
- 12,994 polygons
- 24MB
- 137 materials
- Visualized using Vectary web software
- Created by Yoshi Productions 2018

Results – Expert Interviews

Office Expert: State of California – Deputy Director of COVID-19 Response & Paramedic Supervisor for San Mateo County EMS 911 System

Current products:

- Pros:
  - Software automatically identifies which ambulance is closest and sends info for recommended travel directions
  - Country-wide 911 coverage map shows likelihood of an ambulance making it to the site on time
- Cons:
  - Uses 4 different tools/softwares that don't "talk" to each other
  - Sometimes software doesn't work and has to use radio to inform driver
  - Lack of legend and key means a lot of trial and error
  - Bad delay when updating real time (around 2 minutes)
  - Too many layers



Results – Expert Interviews

Office Expert: State of California – Deputy Director of COVID-19 Response & Paramedic Supervisor for San Mateo County EMS 911 System

Prototype:

- First impression:
  - 3D looks good
  - Zoom function was useful
  - "This would be extremely useful for a tactical EMS (TEMS) operator or a SWAT medic."
- For law and fire services, the benefits are:
  - Indoor navigation
  - Ingress/egress points
- For EMS, the benefits are:
  - Ability to establish a triage treatment and transport zone for a large-scale event.
  - Ingress/egress information on mobile devices for those at the scene
- Concluding thoughts:
  - With 3D and the ability to spin/turn it around, it would help understand how big a space or building is, which is difficult to do with the technology available
  - If this data could be gathered by private locations such as an airport and offered to emergency services, it would extremely beneficial because they currently use publicly available information such as Google maps, which doesn't have detailed information about gates and entrances, for example.
- Dashboard layout:
  - Map and data visualizations:
    - Found anything up to four panes to be fine
    - Location of panes didn't bother him
    - Five panes is too many
    - Showed some hesitancy with 4 panes, but said if it's designed clearly, then it would be okay

Results – Expert Interviews

Field Expert: American Medical Response

Current products:

- Pros:
  - GPS is reliable and easy to use
  - Print maps work without internet or wifi.
- Cons:
  - Provides only the most basic information
  - Not tailored to his specific work

Results – Expert Interviews

Field Expert: American Medical Response

Prototype:

- First impression:
  - Looks a map of a baseball field
  - Seems glitchy
  - Nothing too shocking
- For his role:
  - Useful for zooming in on
  - Doesn't think it would be useful for navigation
  - "Would be great for buildings to have QR codes so you could scan it and get an AR model."
- Concluding thoughts:
  - Considers AR technologies to have possible use if implemented correctly
  - Saving any number of seconds is valuable in emergency services, so if it can take time off of decision making then it's important.
- Dashboard layout:
  - Map and data visualizations:
    - "Simpler the better."
    - Like the 2 pane layouts the most
    - Said increasing number of panes adds increasing complexity

Conclusion: Research Objective 1 and 1a

What is important to disaster risk professionals when designing a cartographic product? What part of disaster risk management can AR support?

- Data quality and ease-of-use are paramount in designing a product
- Overview of situation and also specific details. Being able to see the whole picture of disaster is vital to good decision-making, and thus a map should be able to provide both.
- AR can support many different parts of disaster risk management. For example, for response, AR can be used for human evacuation and rescuing people from (mass) casualty incidents. And for recovery, AR can support damage detection and building reconstruction.

Conclusion: Research Objective 2

Within the context of a dashboard, how can an AR element be integrated?

- While there are different ways to integrate AR into a dashboard setting, the prototype in the thesis showed how you can integrate markerless AR technology into a digital dashboard setting so that a disaster risk professional can continue to use the dashboard on their computer, while also having the ability to add an AR element if desired.
- In this context, the map itself is the AR element as opposed to the symbolization.

Conclusion: Research Objective 3 and 3a

Does an AR element within a dashboard improve the communication of information to a user about a disaster, and if yes, how? How does the dashboard layout impact the user?

- Yes, an AR element within a dashboard improves the communication of information to a user.
- By increasing the amount of information a disaster risk professional has about a disaster area, the better decisions can be made.
- AR provides that additional information by giving an additional way to view the map.
- However, the AR element needs to work seamlessly enough in order to not interrupt workflows or cause technological problems.
- Dashboard layout needs to be simple enough for users to easily navigate the program.

Conclusion: Hypothesis

- There are multiple ways to integrate AR into a cartographic dashboard.
  - This hypothesis was proven to be true. Cartographic dashboards have the ability to integrate AR in different ways.
- An AR cartographic dashboard can improve the communication of information to a user within the context of disaster risk management.
  - This hypothesis was also proven to be true. AR can improve the communication of disaster risk information to a user and improve decision-making.
- A well-designed and intuitive dashboard layout is necessary for user comprehension.
  - This hypothesis was also proven to be true. Dashboard design is imperative for user comprehension.

Outlook

- With increased focus on developing software specifically for the field of disaster management, more research and development should go into creating advanced solutions that are specifically built to meet a group's needs.
- Creating a custom AR cartographic dashboard requires a lot of technology and manpower, and there is therefore still a lot of limitations associated with the technology. For example, having a real-time, updating, 3D, AR map is extremely technologically demanding.
- There is a bright future for AR to be embedded into dashboards since dashboards are already being used. Integrating AR could be a next step to providing more overall information, which is important for disaster risk professionals to make decisions.

Thank you for your time!

References

[1] Helzel, K. (2019). Supporting enhanced disaster management with interactive 3D and Mixed Reality Maps [Master Thesis]. Technical University of Munich.

[2] Kremser, R. (2020). Improvement of Decision Making and Communication in Disaster Risk Management through Cartographic Dashboards [Master Thesis]. Technical University of Munich.

[3] Luchetti, G., Mancini, A., Sturari, M., Frontoni, E., & Zingaretti, P. (2017). Whistland: An Augmented Reality Crowd-Mapping System for Civil Protection and Emergency Management. ISPRS International Journal of Geo-Information, 6(2), 41

[4] Vassell, M., Apperson, O., Calyam, P., Gillis, J., & Ahmad, S. (2016). Intelligent Dashboard for augmented reality based incident command response co-ordination. *2016 13th IEEE Annual Consumer Communications Networking Conference (CCNC)*, 976–979.

[5] Rohrer, Christopher. (2014). When to Use Which User-Experience Research Methods. Nielsen Norman Group.