Living labs at the TU Delft campus

”playing safely with fire”

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Delft University of Technology and TU Delft Safety and Security Institute

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Outline

- The setting and vision
- A living lab to learn from evacuation experiences from buildings and to experiment with innovations in monitoring and steering of people's behaviour
- A living lab to learn from good and safe practices and occupational hygiene in laboratories
- Concluding remarks

The setting

- A world of new technology; robotics, internet of things, 3D printing, wireless data via wearables, social media and citizen participation for massive data collection, autonomous vehicles, new inspection techniques with remote sensing, new sniff machines, powerful microscopy, AI and nanotechnology, etc.

- At the same time we are being threatened by natural hazards, climate change, changing land use, security threats, cascading effects, budget cuts, ageing, etc.

- And at TUD in particular: fire, traffic accidents, explosions / emissions from laboratories, theft, vandalism, cyber crime, bomb threats, undesired intimacies, failures in climate control / ventilation, water damage, panic in crowded class rooms, staircase / slip accidents, food/water pollution, asbestos, incapacitation.

Vision

- Collecting big-data from living labs will allow researchers to calibrate and validate their models, in particular the human- and organisational factors, with the aim to develop innovations with an impact on safety and security for individuals, organisations and society as a whole.

Evacuation exercises as living lab

- HSE department and local emergency responders with operational experience
- The faculties Architecture, Civil-, Electrical-, Aerospace Engineering, Computing Sciences, Policy Management with knowledge in sensors, actuators and in integral-(human/organisation/technology), normative- and ethical modelling

Rinze Benedictus **Structural integrity**	Richard Curran / Henk Blom **Air traffic safety**	Guido de Croon **UAV**	Marileen Dogterom **Safety in Bionano-technology**	Eelco Visser **Programming Language-based Security**	Dick Epema **Trust and Reputation Systems**
Bas Jonkman / Matthijs Kok **Flood risk**	Serge Hoogendoorn / Hans van Lint **Traffic & evacuation safety**	Bert Wolterbeek **Nuclear Security**	Andreas Schmidt-Ott **Nano-safety/ Aerosol spectrometry**	Frank Redig /Geurt Jongbloed **Applied Probability, Risk and Statistics**	Inald Lagendijk **Privacy preserving data processing**
Bart van Arem **Transport safety**	Nick van de Giesen **Hydrology**	Machiel van Dorst **Spatial safety**	Peter Luscuere / Philo Bluyssen **Indoor climate and safety**	Rob Kooij **Network Robustness**	Arie van Deursen **Software Engineering**
Jan Rots / Klaas van Breugel **Structural Safety**	Ramon Hanssen **Remote sensing**	Sisi Zlatanova **Geo-information for Crisis Management**	Pieter van Gelder **Safety Science**	Alexander Yarovoy **Sensors for safety & security**	Jan van den Berg **Cyber Security** (TBM + EWI)
Jeroen van den Hoven / Sabine Roeser **Risk ethics**	Alexander Verbraeck **Virtual reality**	Yao-hua Tan **Supply chain security**	Genserik Reniers **Chemical plant safety**	Cees van Beers **Economic consequences of failures**	Michel van Eeten **Governance of Cyber security**

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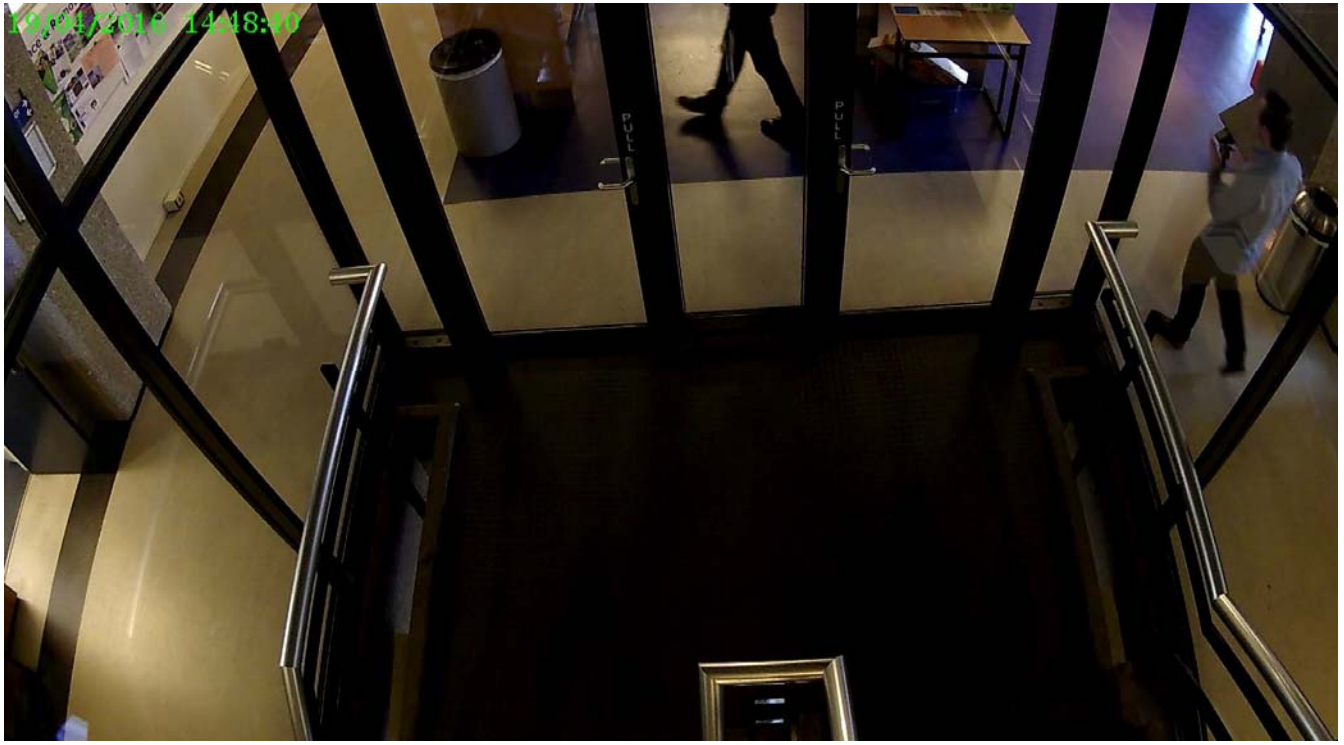
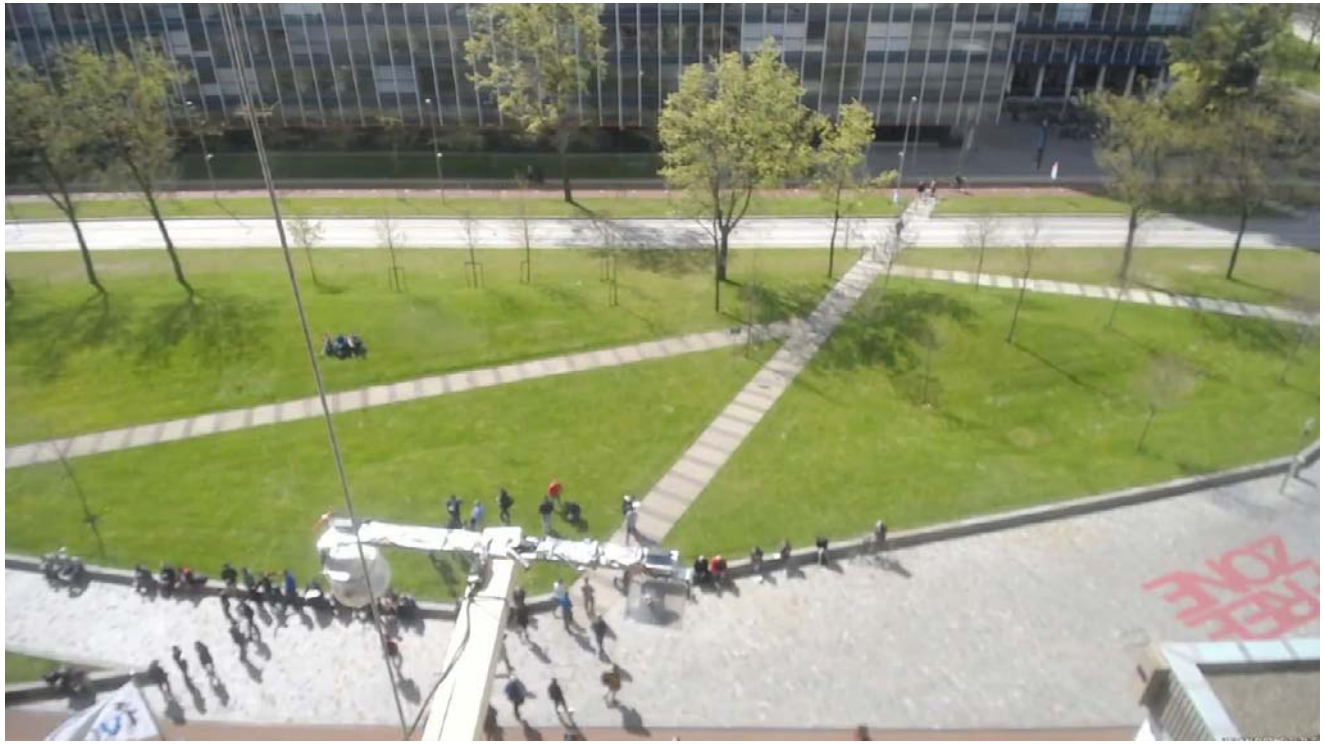
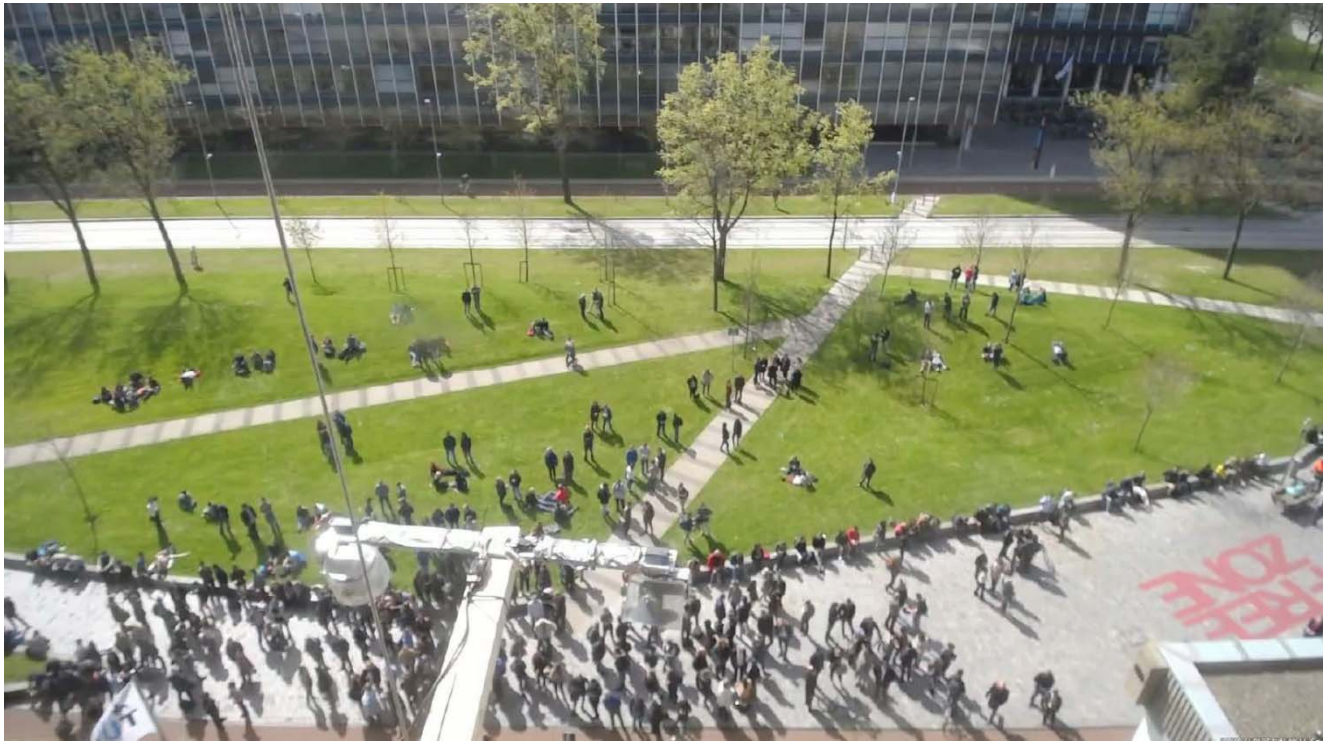
A selection of innovative sensors and actuators, tested at the TU Delft living lab

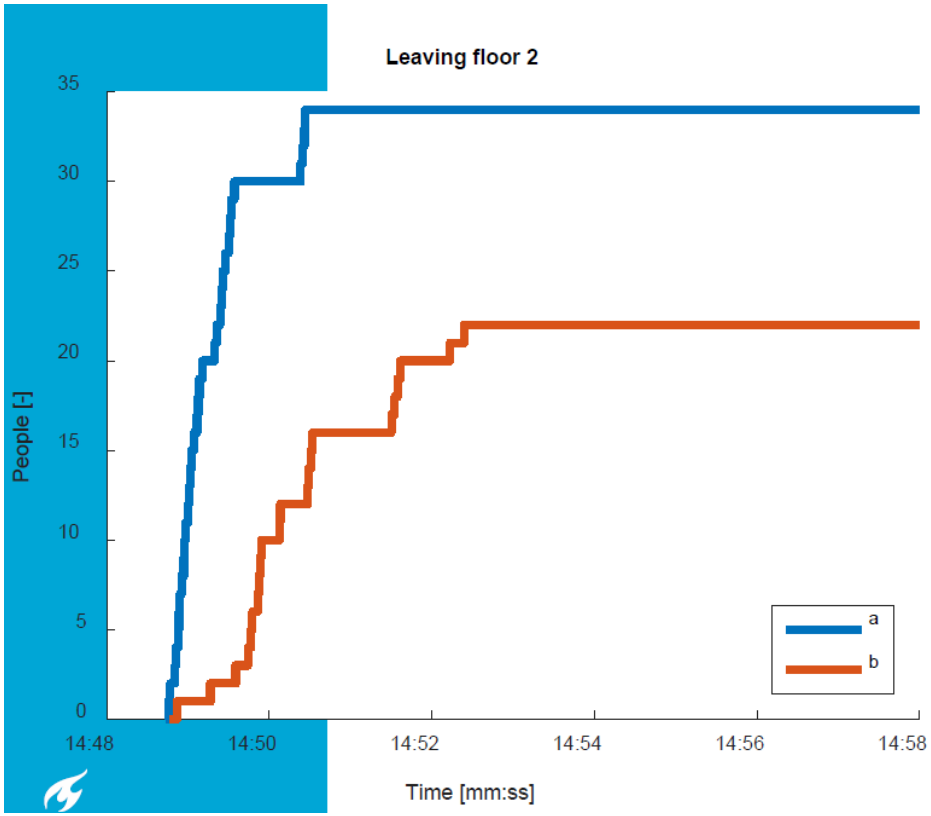
CCTV data inside/outside buildings (Daamen et al.)

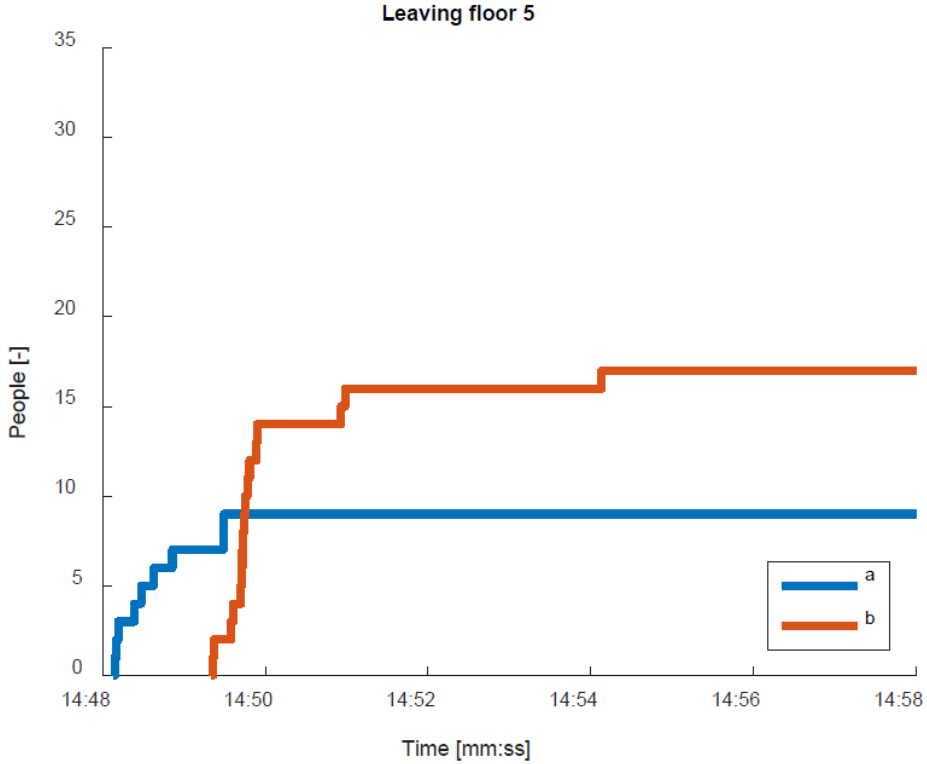




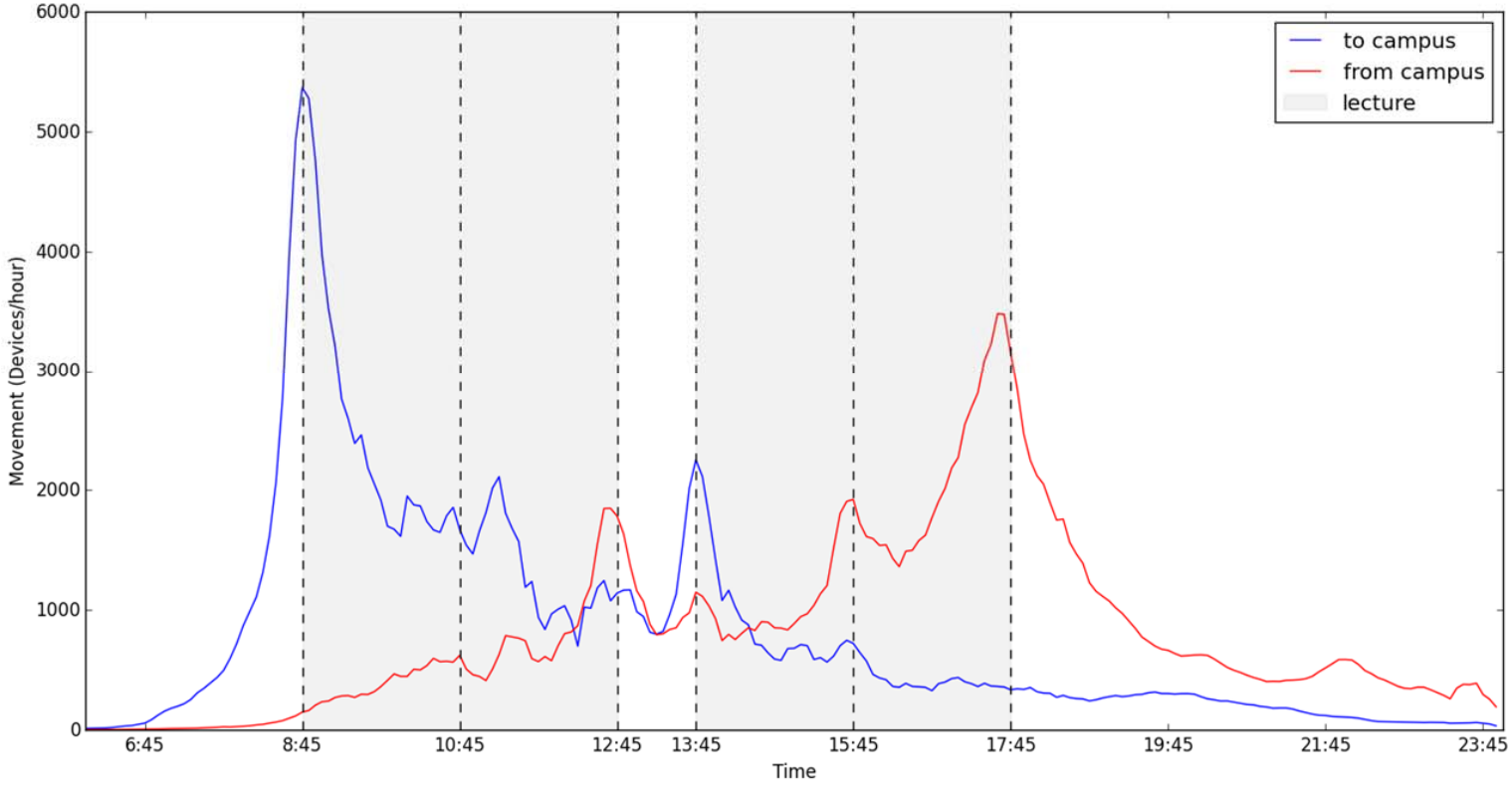


Evacuation pattern per floor at CiTG building

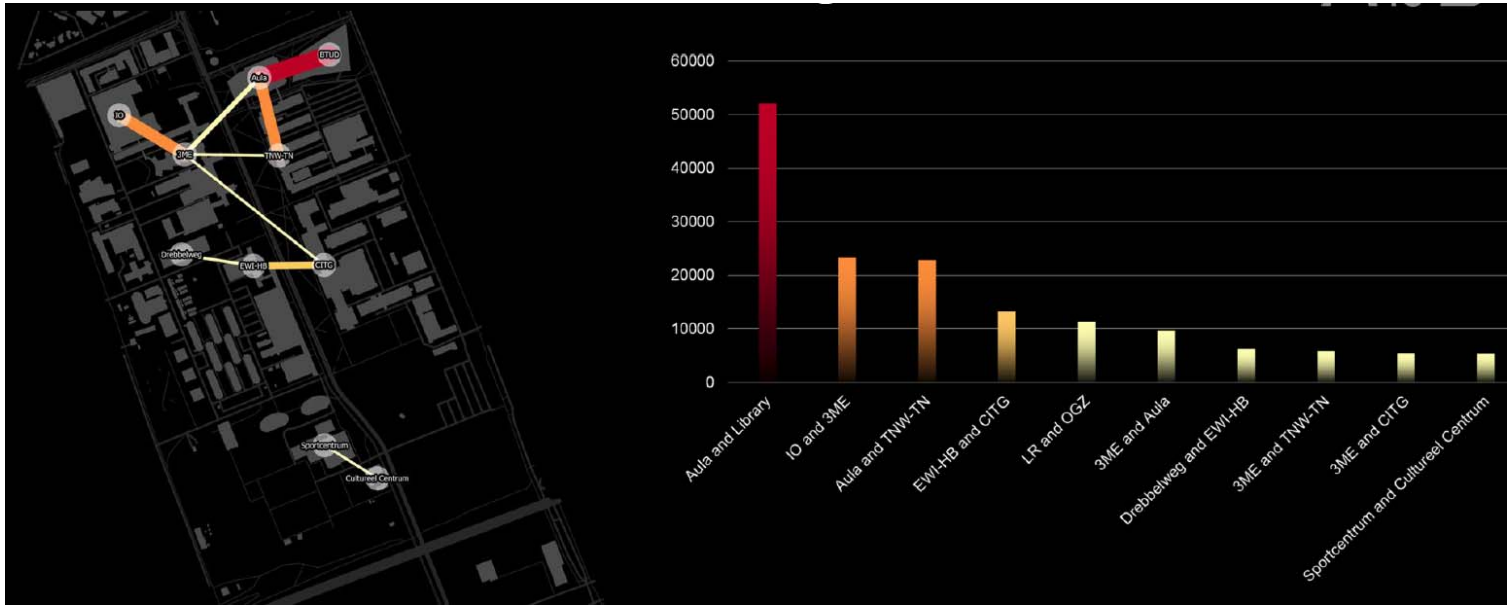




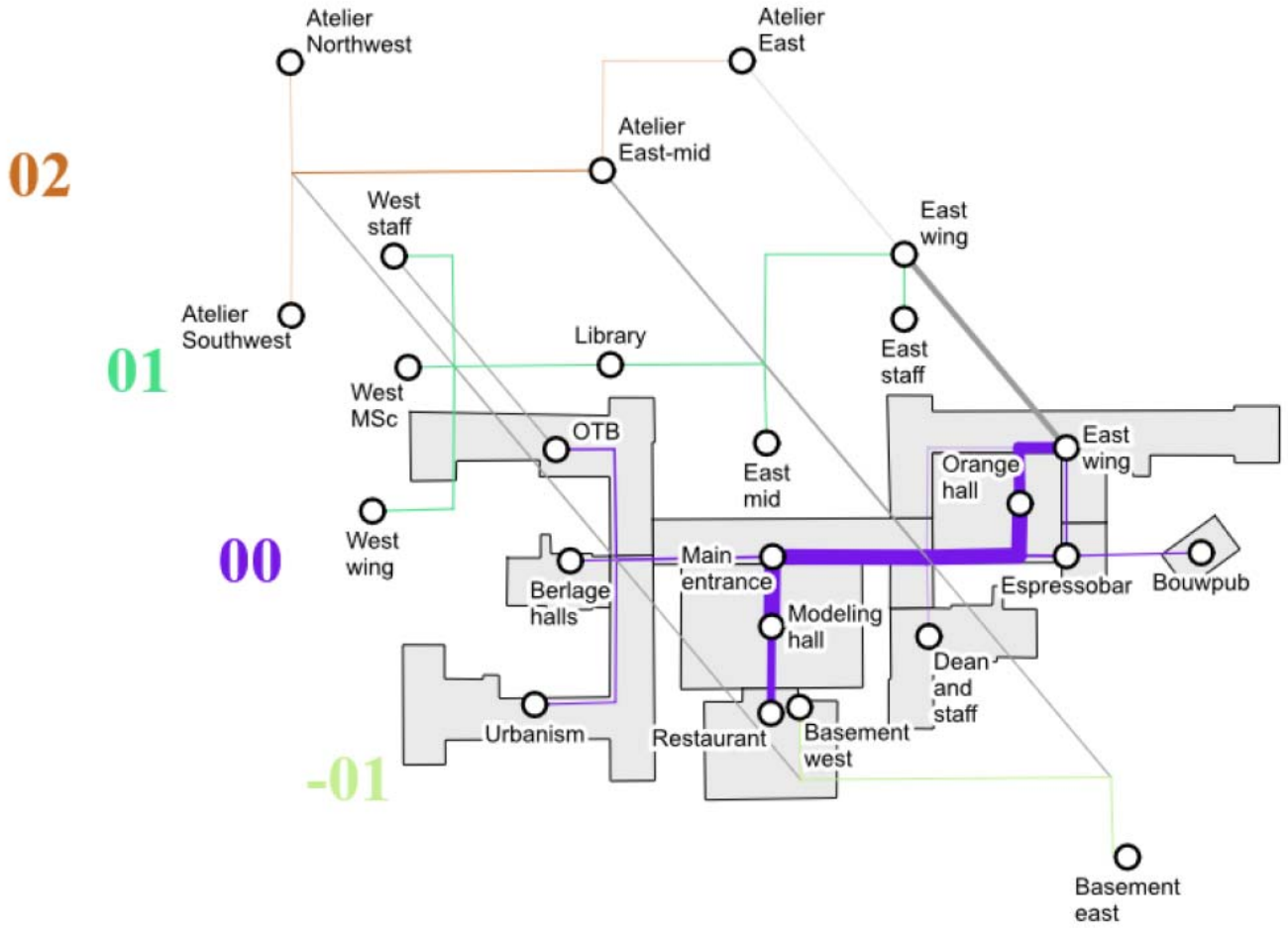
Identifying movement patterns from large scale WiFi -based location data of the Eduroam network, (work by Verbree et al.)



Movements between buildings

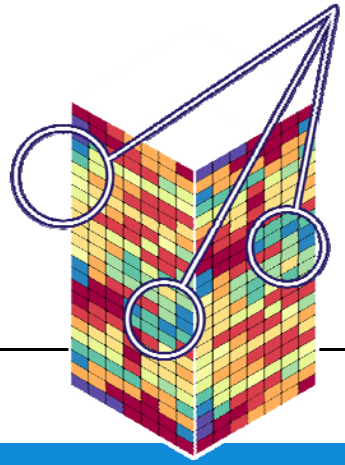


Movement inside one building, during BK event



Lone Rooftop

- ‘Lone Rooftop’ integrates all types of sensor data, whether these are beacons, workspace sensors, motion detectors or access control systems.
- Smart algorithms translate the number of devices into the number people and their respective positions
- Occupancy rates in buildings can be presented in real-time and as forecasted based on historical data
- Efficiency in evacuations but also no-shows or inefficient use of classrooms are instantly visible



Sentiment analysis of Twitter messages during evacuation (work by Houben et al.)

- An algorithm has been developed which takes a Twitter ID as input, filters out retweets and determines for each tweet the conveyed emotion (positive, neutral, negative).
- An aggregate score (between -1 and 1) is computed, which is an estimate of the overall emotion: a value close to 1 is heavily positive, close to 0 means mostly neutral and -1 indicates very negative sentiments.
- Algorithm has been used in the scope of 'Culture-aware User Modeling study' and showed that Chinese users have a stronger tendency to publish and propagate messages that express positive sentiments than American users. Furthermore, people talk more positively about organizations than about persons or locations.

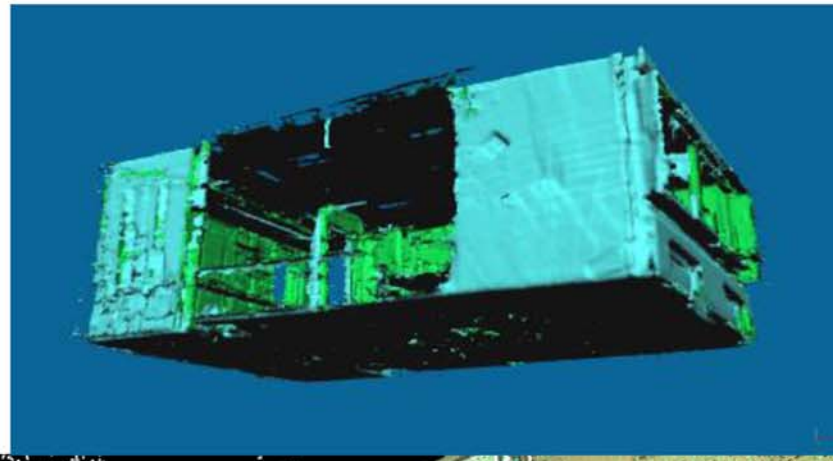
GPS trackers (work by Hoogendoorn et al.)

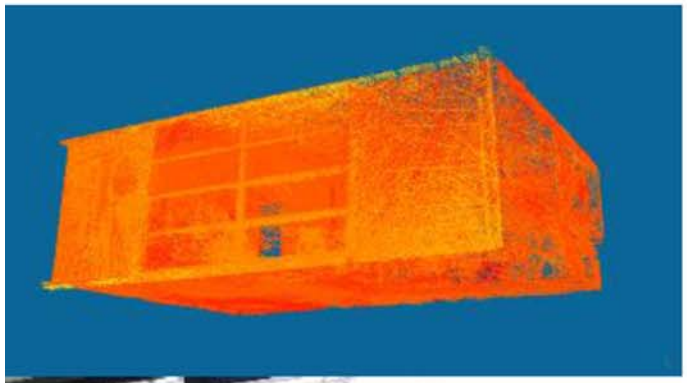
- Monitoring of speeds and routes by individuals using GPS trackers

3D indoor modelling of geometries (work by Zlatanova et al.)

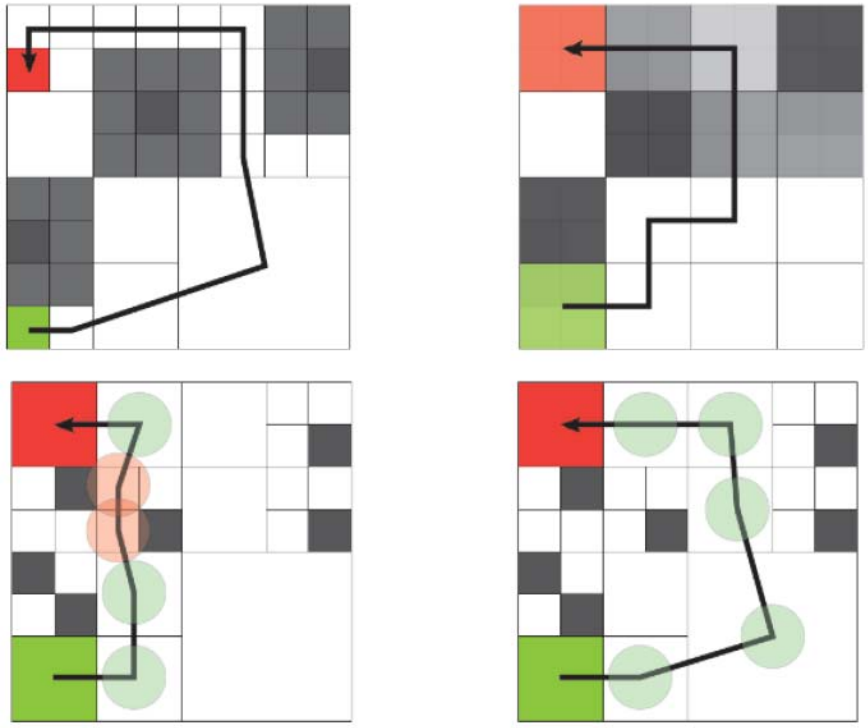
To provide information to first responders for navigation / optimized evacuation routes

- Fire brigade station
- ZEB1, Google Tango, Leica





Pathfinding / optimized evacuation routing



Geo-targeted text messaging (work by Sillem et al.)

- Allows for sending sms-like messages to all cell phones within reach of a number of specified antennas
- A typical message could read: 'Alarm mayor. Risk explosion Delft centre. Go inside, close doors + windows. More info: TVWest'.
- Testing with messages urging people to go to a certain place or to get information elsewhere and then text back
- Text messages decreased the percentage of people that remained ignorant of the alarm

Some exotic ways to monitor and steer evacuees

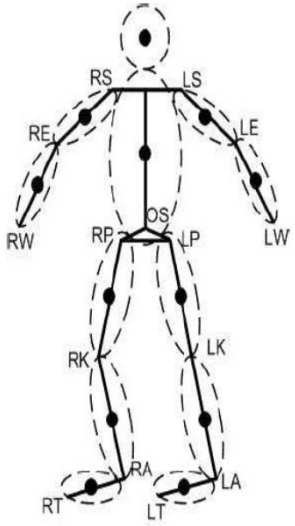
Self-deploying networks with drones (work by Chris Verhoeven)

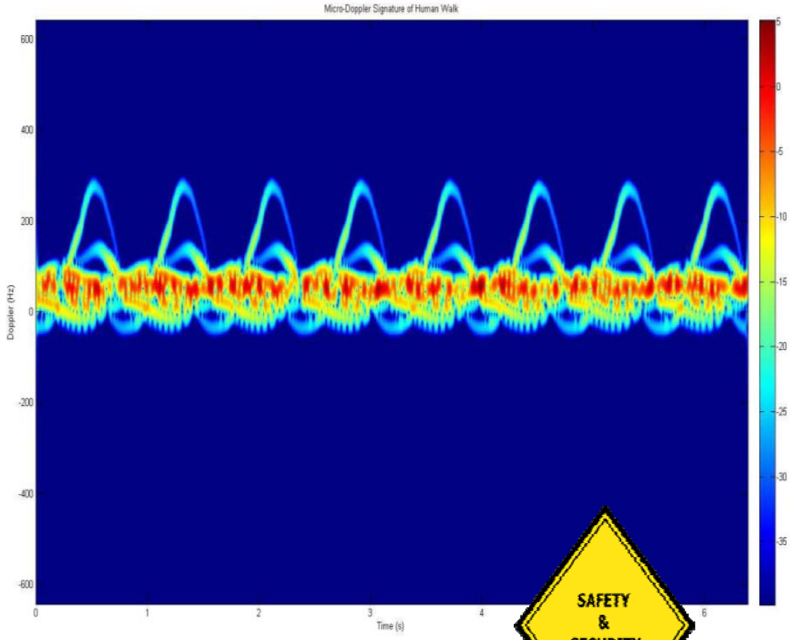
For guiding evacuees to exits by light signals

Micro-wave sensing (work by Alexander Yarovoy)

Micro-Doppler analysis of human movements for classification:

- Cardio- and breathing spectrum analysis
- Human behaviour analysis

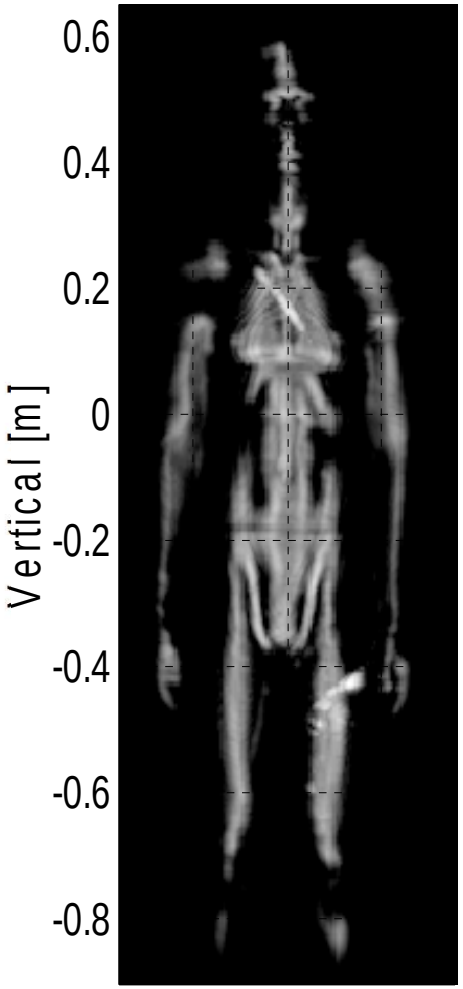


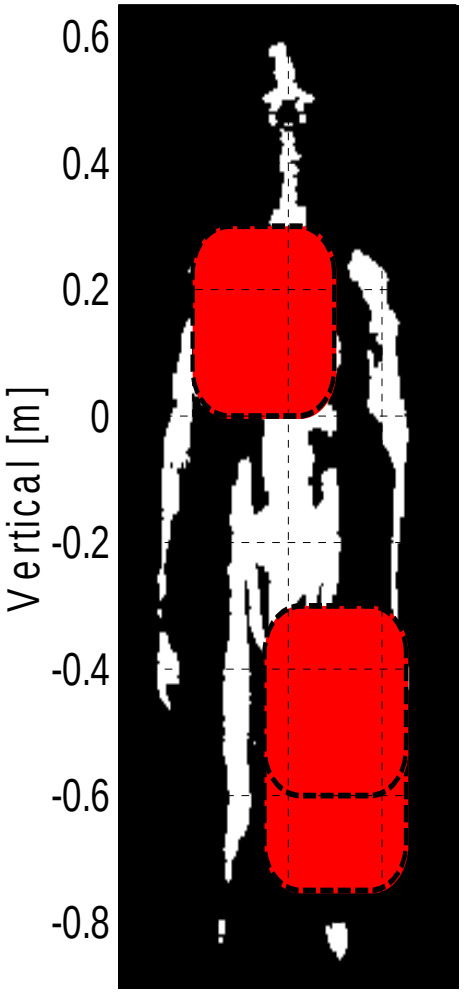


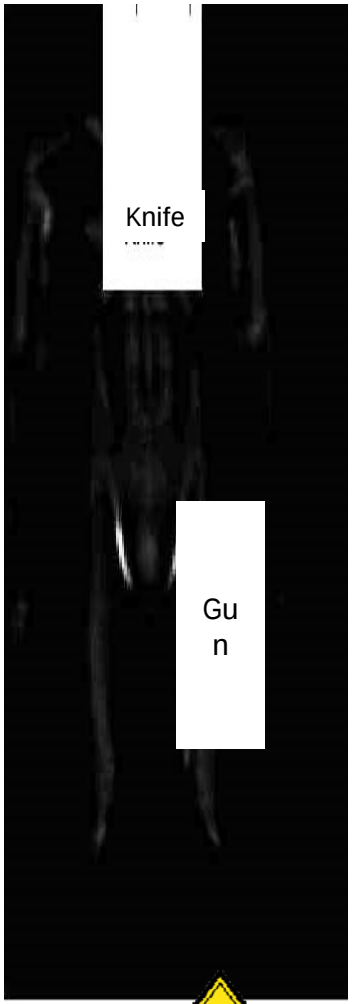
Microwave Image

Spectrum-based Neural-network

SIFT Detection







May 18, 2017

SAFETY & SECURITY

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Courtesy of
Prof. Yarovoy, EWI, TU Delft

Monitoring by facial recognition

- What are the benefits of this new technology? (Improved safety, fewer incidents, Better Service?)
- How to deal with false positives (make algorithms more robust, with loss of performance, What level of false/positives is acceptable?)
- Differences between the use of this technology in the public and private space (Only by police authorities or also by private parties?)
- Legal issues (options for people outside the legal system to punish?)
- Perception of privacy degradation in relation to gender / age differences?
- Communication issues (facial recognition takes place for your and our security?)
- Possibility of whitelisting (use the technology only for desired persons?)

Systematic storage of all measurements of evacuation exercises

EVALUATIEVERSLAG BHV OEFENING & INZET

ALGEMENE INFORMATIE OEFENING/INZET			
Faculteit/Dienst			
Datum oefening/inzet	[DAG] [DD-MM-YYYY]		
Locatie oefening/inzet			
Aangekondigd? (*Wisten BHV-ers de dag/week van te voren? Wisten de bewoners van de oefening?)*	☐ Aangekondigd	☐ Onaangekondigd	
Type oefening/inzet? *(ontruiming, brand, bom, studenten, brandweer enz.)*			
Tijdstip eerste melding?			
PRESTATIE-INDICATOREN			
Duur na eerste melding en binnenkomen ploegleider bij inzetpost	[MM:SS]		
Hoe zijn de BHV-ers gewaarschuwd?	☐ Ontruimingssignaal	☐ Pager	☐ Anders:
Duur na eerste melding en binnenkomen eerste BHV-ers bij inzetpost	[MM:SS]		
Duur beslissing (gedeeltelijke) ontruiming *(kan direct zijn)*	[MM:SS]		
Duur opdracht ontruimingssignaal in werking te stellen *(kan direct zijn)*	[MM:SS]		
Duur aanzetten slow whoop *(kan direct zijn)*	[MM:SS]		

Living lab of TU Delft Laboratories

- We have 1000 labs at TU Delft
- About 100 labs with hazardous materials, high pressures, electrical-, mechanical-, bio -, laser risks
- An average high-risk lab is being used by about 5 people per day, incl. researchers, supporting staff, BSc/MSc students, with an average stay of about 2 hours in the lab
- Number of incidents in high-risk labs is about 20 – 30 per year, but only minor incidents. Serious incidents in high-risk labs have not been observed so far

Living lab of TU Delft Laboratories

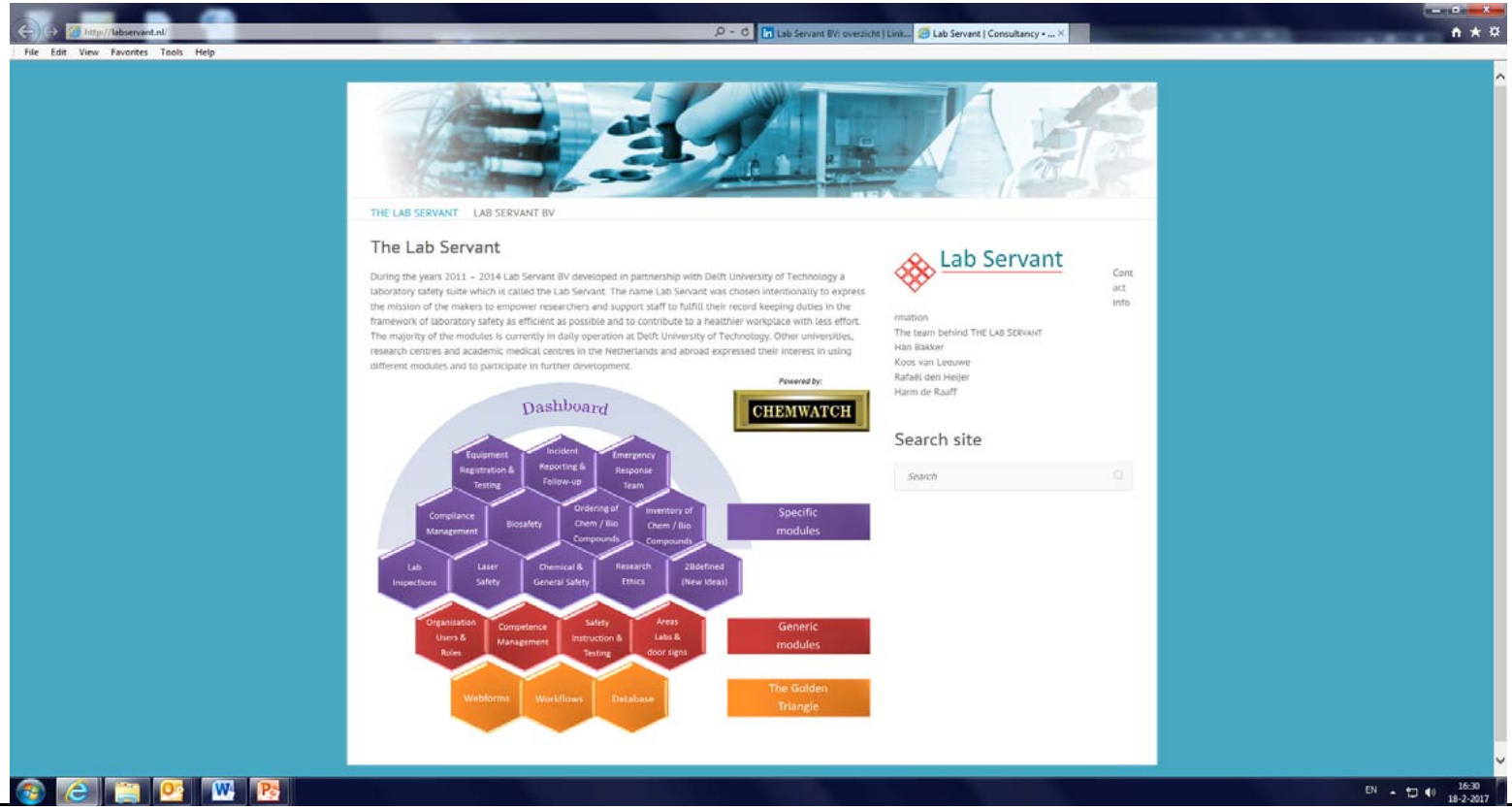
- Number of serious incidents outside high-risk labs is about 2-3 per year. One fatal road accident with bicycle and truck on campus road. Most of the time, incidents related to people feeling unwell.
- Evacuation exercises in high-risk labs take place once per year.
- High-risk experiments have to be approved by supervisor prior to execution, in which preventive and repressive measures have to be reported.

Living lab of TU Delft Laboratories

- The aim is that all applications for conducting high-risk experiments are submitted by a TUD-wide standardized tool, called Lab Servant
- At this moment, the usage rate at Applied Sciences is close to 100%. Other faculties lagging behind.
- A PhD student submits on average 1 application per year
- At this moment about 1500 applications are registered over a period of 8 years and downloadable from the tool
- This database allows for measuring cross correlations with observed incidents, and eventually for learning how to conduct safe experiments.

Lab Servant

We hypothesize that the Lab Servant improves the processes in the laboratories, and leads to higher safety levels



Concluding remarks

- A living lab allows researchers to test their innovations in practice and to investigate the 'unpredictable' human behaviour
- A living lab is able to systematically record and store the experiments in big-databases, from which we can retrieve success stories, and causes for failure
- A living lab is an excellent mechanism to stimulate collaboration across disciplines / TU wide coverage
- Evacuation exercises can and should be used to further improve the decision making around evacuations
- The question which performance level an evacuation exercise should achieve, can be answered if sufficiently large datasets are available

Thank you