COLLARIS

COLLaborative network on unmanned AeRIal Systems (UAS) and their applications in the field of disaster response

Funded by the European Union

D4.3A – Overview of currently used auxiliary systems and available capabilities, including common practices: assessment and recommendations for future use

WP4 – Solutions for data analysis and data sharing and auxiliary support systems

Initial Deliverable Report Preview

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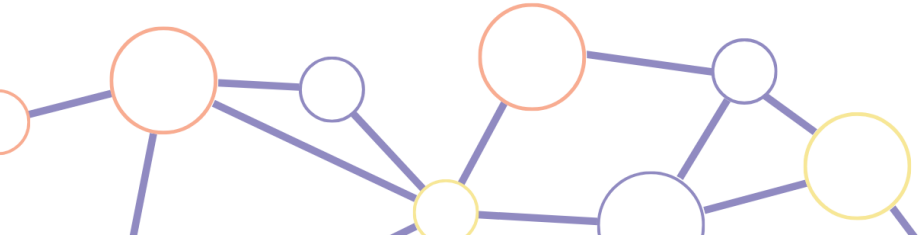
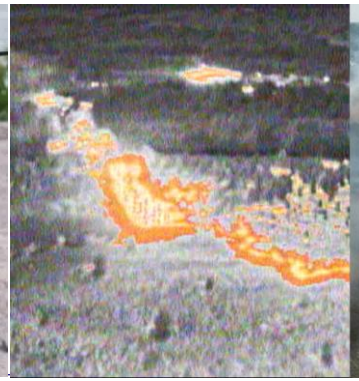


Scope of the Deliverable 4.3

- Description of the most commonly used auxiliary support systems for unmanned aerial systems (UAS) in disaster management and their available capabilities
- Consists of the results from desk research and a quick poll
- First version of a report, will be finalized in an updated version in June 2024 and include results from workshops and trials


Auxilliary support systems

- Report focusses mainly on different sensors as well as delivery platforms that are of use in disaster management:

Visual RGB-Cameras,
Thermal Imaging Sensors (Infrared),
Multispectral Cameras,
Laser Scanners / Lidar,
Radars,
Chemical Sensors,
Searchlights,
Microphones,
Loudspeakers,
Delivery Platforms, and
RTK Base Stations

Methods

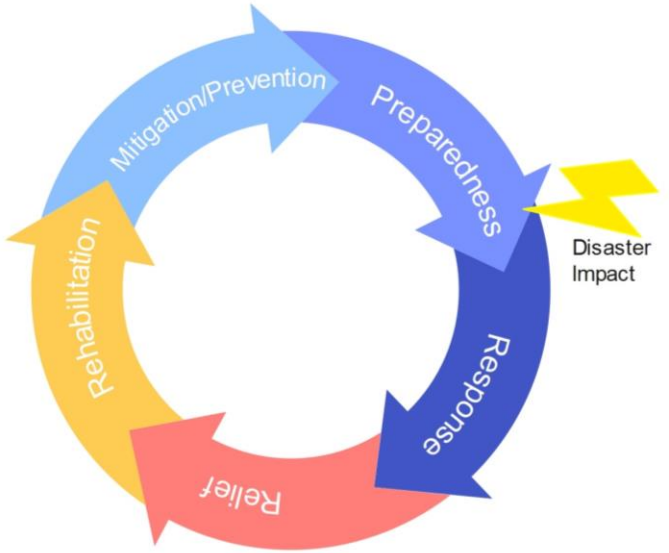
- Desk top research by identifying relevant literature with the search terms ’drone’ OR ‘UAS’ OR ’UAV’ AND ’disaster management’
- Auxiliary support systems most frequently mentioned in literature served as a starting point, complemented by information on the websites of the most prominent suppliers about the currently available capabilities on the market
- Quick poll with COLLARIS stakeholders provided further input to the content of the report

Visual RGB-Cameras

- Most widely used auxiliary support system in disaster management
- Systematic literature study analysed 635 relevant articles published between 2006 and 2021: 87% used RGB-cameras
- Possibility of „eye in the sky“ is oftentimes the reason to acquire a UAS, commonly available, affordable and simple to use
- After processing, point clouds, orthophoto maps, numerical terrain models (NMT), numerical land cover models (NMPT), and 3D models can be obtained

Visual RGB-Cameras

- Used for:
  - Reconnaissance flights during disaster events to help with situational awareness → assists in planning response strategies, resource allocation, and identifying potential risks or hazards
  - Post-disaster damage assessment for an overview of the situation from above, e.g., structural damage, infrastructure failures, or other impacts caused by disasters
  - Locating and identifying people in search and rescue missions

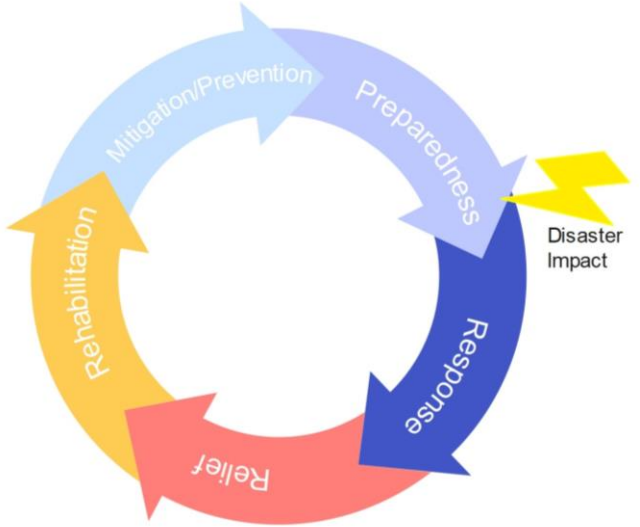


Thermal imaging sensors (infrared)

- Ability to detect heat (e.g., warm bodies) and reproduce this information via different colouring in video feed
- Prices vary depending on their features:
  (1) Thermal sensitivity: the camera's ability to detect and display small differences in temperature accurately. Higher thermal sensitivity allows for better detection of heat signatures and more precise temperature distinctions
  (2) Resolution: The higher the resolution, the more detailed the thermal images are
  (3) Image and video capture: Thermal imaging cameras can capture both still images and video footage. Further features could be digital zoom, image enhancement, ability to record and stream a thermal video, multiple colour palettes, image blending (overlaying thermal and visual images), GPS tagging, and integration with mapping or analysis software

Thermal imaging sensors (infrared)

- Used for:
  - Firefighting purposes, e.g., to locate the source of structural fires and embers of wildfires, see through thick smoke and enable the detection of hotspots during the mop-up phase of a wildfire
  - Post-disaster: assessing structural integrity of buildings, identify potential hazards, and evaluate the extent of damage caused by disasters like earthquakes, floods, or hurricanes
  - Potential use of infrared sensors in the detection of embankment wear during floods (early symptoms of embankment failure - hydraulic punctures, piping, soaking, fresh underflows and cold water pools near the embankment)

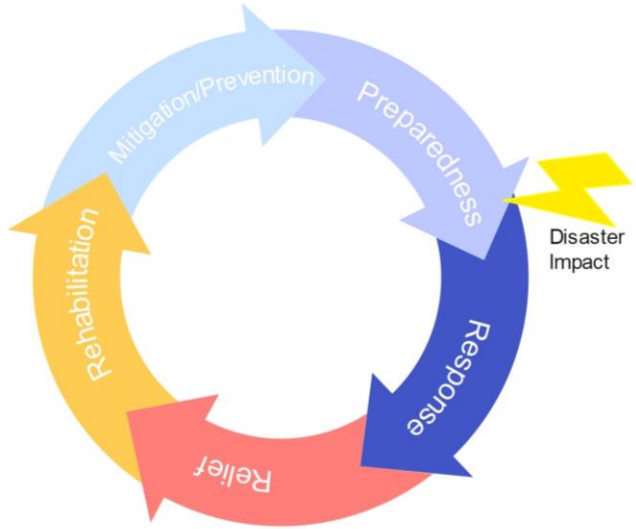


Multispectral Cameras

- Able to capture imagery across multiple spectral bands
- Can detect changes in vegetation health, land cover, and water bodies, enabling a comprehensive assessment of the impacted areas
- By capturing data across different spectral bands, multispectral cameras can detect stress levels, vegetation recovery, or changes in plant physiology
- For water bodies, it is possible to analyse and monitor environmental factors such as water quality, pollution levels, or sedimentation
- Aid in the assessment and monitoring of critical infrastructure, such as bridges, roads, or buildings, affected by disasters. They can detect structural changes, identify potential vulnerabilities, and provide valuable data for evaluating the safety and integrity of infrastructure post-disaster.

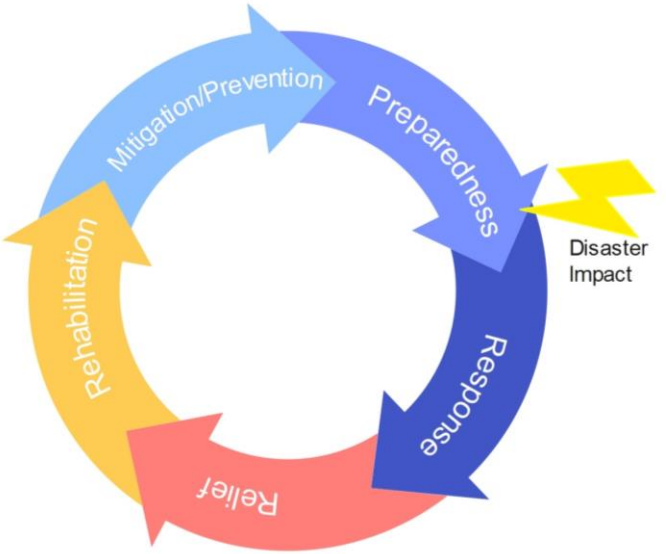
Multispectral Cameras

- Used for:
  - Index calculation of burned forests after a wildfire to assess damage
  - Searching for natural firebreaks such as deciduous treelines which aids decision-making and firefighting strategies



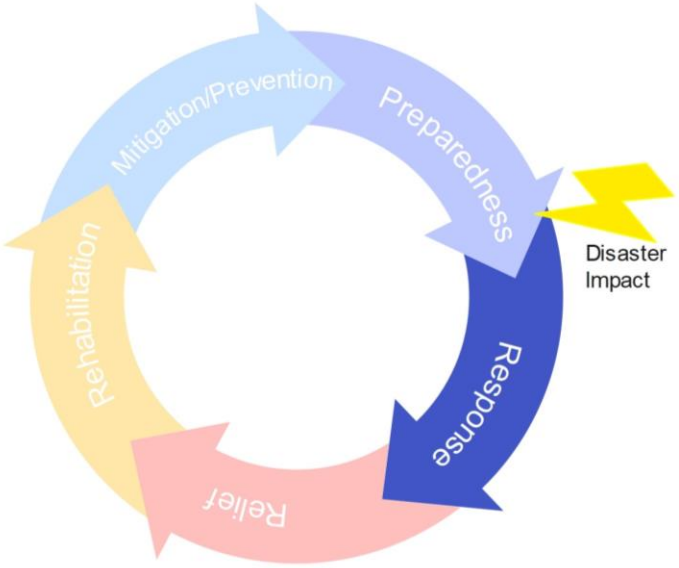
Laser Scanners / Lidar

- Remote sensing method which uses light in the form of a pulsed laser to measure ranges (variable distances) to the surface → results in point cloud that is used in 3D models
- Used in:
  - Response phase to earthquakes for post-event imagery to assess the damage
  - Identification and mapping of landslides
  - Mapping the canopy fuel attributes needed for wildfire predictions
  - Analysis of smoke clouds resulting from large forest fires



Radars

- Devices that measure the reflection of electromagnetic waves and used for locating, tracking, and recognizing various objects at large distances
- Used in:
  - SAR operations when debris and other substances cover an area where people are buried

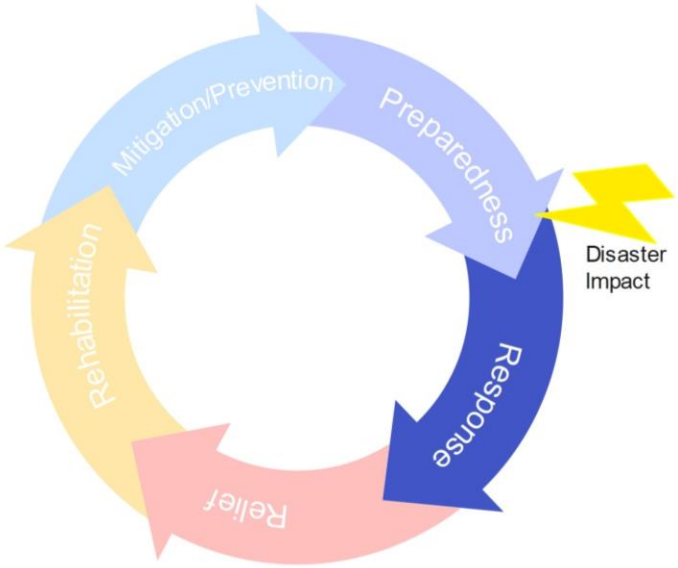


Chemical Sensors

- Wide variety for many purposes to detect different gases and chemical components
- Gas-specific sensors:
  - Designed to detect and measure specific gases or volatile organic compounds
  - Often used in applications such as detecting toxic gases or hazardous substances
  - Cheapest option of chemical sensors while their cost depends on factors like sensitivity and accuracy
- Multispectral sensors:
  - Can detect and measure multiple types of gases simultaneously
  - Offer broader capabilities in terms of detecting various chemical compounds and provide more comprehensive data for analysis
- Hyperspectral sensors:
  - Even higher spectral resolution and can detect a wide range of chemical compounds or pollutants with greater precision
  - Often used for detailed environmental monitoring and analysis

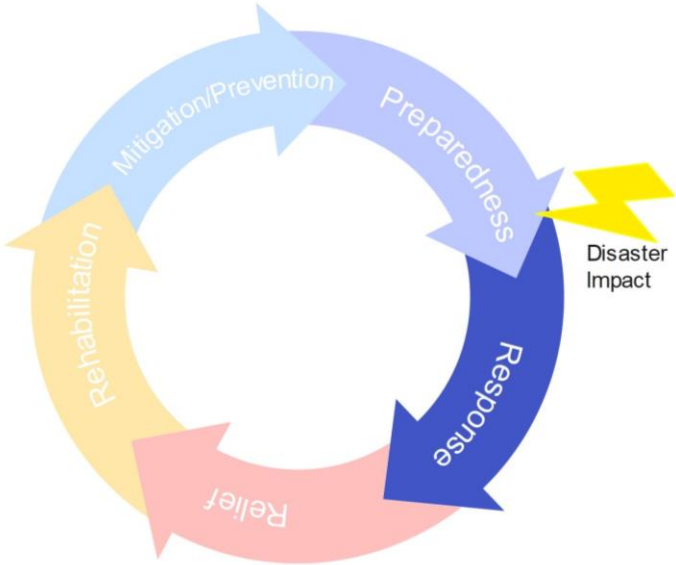
Chemical Sensors

- Used in:
  - Detecting hazardous materials, toxic gases, or chemical leaks in disaster areas
  - Monitoring critical infrastructure such as pipelines, storage tanks, or chemical plants during and after disasters
  - Forest fires to monitor air quality and smoke components (such as permanent gases, volatile organic compounds, semi-volatile organic compounds, and particles)



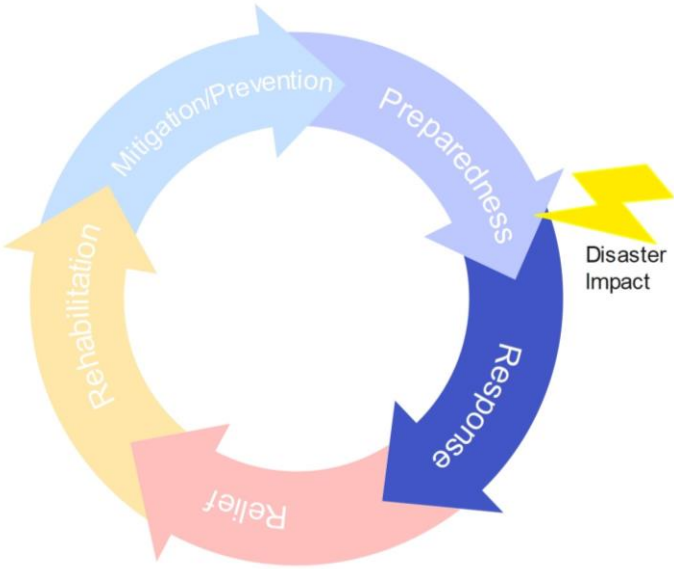
Searchlights

- Powerful and focused illumination during low-light conditions or at night
- Particularly interesting for organizations that predominantly use UAS with RBG-cameras in SAR operations
- Used in:
  - Night and in low-light conditions to use UAS as “the eye in the sky”
  - Indication of a point of interest (e.g., in a casualty) without other localization aids
  - Rescue activities as a temporary floodlight



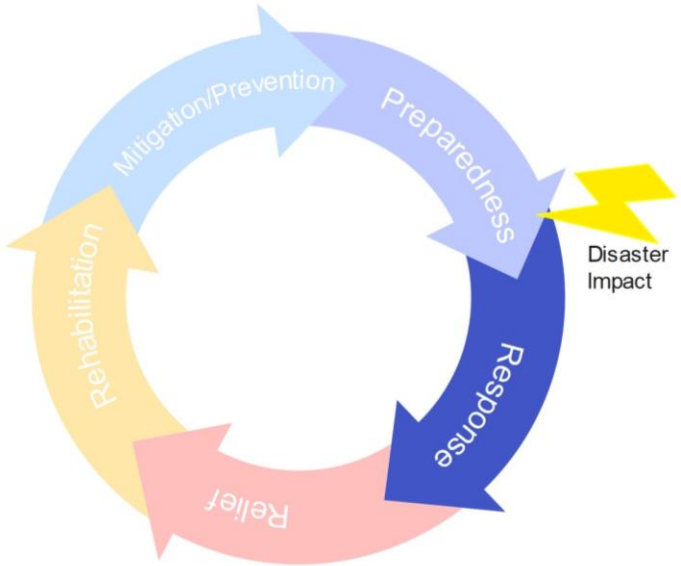
Microphones

- In research phase to detect cries for help and signals from survivors with the help of AI
- Could complement vision in situations where visual feedbacks are limited due to bad lighting conditions (darkness, fog) or obstacles limiting the field of view



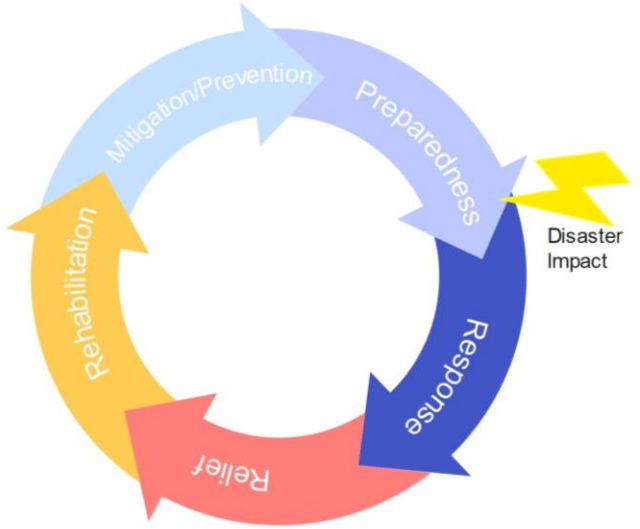
Loudspeakers

- Produce acoustic signals → mostly used for conveying messages to people
- Used in:
  - Communicating rules and government mandated precautions to residents during Covid19
  - Complementing traditional warning communication channels (e.g., sirens, media, emergency vehicles), especially in hard-to-reach locations
  - Early communication in SAR to reassure victims that help is under way



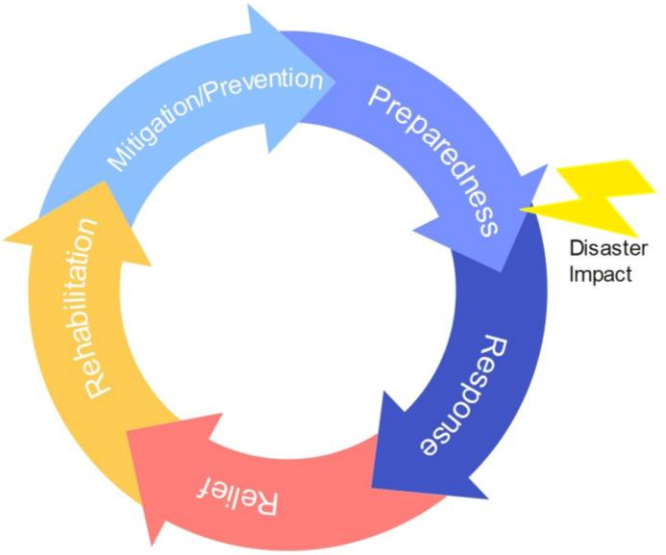
Delivery Platforms

- Designed to carry payloads of various sizes and weights to transport supplies and equipment → capacity depends on the specific drone model and delivery platform configuration
- Used in:
  - transportation of essential medical supplies to hard-to-reach disaster-affected areas (first aid kits, medications, vaccines, blood units, or diagnostic equipment)
  - Backing-up of conventional delivery methods to supply basic necessities, emergency kits, or communication equipment



Real Time Kinematics (RTK) Base Stations

- Capability to correct GPS position data in real time accurate to a centimetre → provides highly accurate geolocation data for drones
- Used in:
  - Cases when the accuracy of positioning is crucial for the practices in disaster management
  - Confined spaces and flying close to objects which in turn facilitates the capturing of clearer, more precise photos



Advantages and Disadvantages I

Auxiliary Support System	Advantages	Disadvantages
Visual RGB-Cameras	Easily accessible and attainable, reason to acquire a UAS	Low quality in high-contrast or low-light conditions
Thermal Imaging Sensors (Infrared)	„see through“ smoke, fog, dust, and darkness	Expensive, accuracy can be impacted by environmental factors, leading to misinterpretation Vulnerable to weather conditions
Multispectral Cameras	Facilitate advanced mapping and analysis techniques, enable detailed analysis of various environmental factors	Expensive, need additional processing or analysis software → specific expertise needed
Laser Scanner / Lidar	Facilitate rapid identification of instabilities after landslides, can be deployed during night, does not necessitate line-of-sight observation	Not feasible for large areas, additional software and expertise necessary

Advantages and Disadvantages II

Auxiliary Support System	Advantages	Disadvantages
Radar	Ability to detect and track objects and terrain features in low-visibility conditions, can cover large areas	High costs, weight, specialized expertise, lower resolution than other optical sensors
Chemical and Electrochemical Sensors	Immediate data collection and analysis, can cover large and difficult to access areas	Limitations in detectation range and sensitivity, regular calibration and maintenance, specialized expertise
Searchlights	Increasing operational time for optical sensors during low-light conditions, cheap, easily integratable	Better options for for night operation available (depending on deployment scenario)
Microphones	Complementing vision	No system feasible yet, still in research phase

Advantages and Disadvantages III

Auxiliary Support System	Advantages	Disadvantages
Loudspeakers	Enables emergency management authorities to provide real-time updates, evacuation notices, safety instructions, or other critical information to a large number of people quickly	Can be affected by environmental factors (wind, background noise)
Delivery Platforms	Rapid delivery of critical resources, aid, or equipment; customizable, allowing for the transport of various types of payloads	payload limitations based on the drone model (size, weight, volume), limited flight ranges, not able to fly in adverse weather conditions
RTK Base Stations	Accuracy in determining the position of the UAS for data collection and monitoring	External device, disrupted signal can lead to a loss of calibration data

General Considerations

- Every auxiliary support system adds weight to the UAS, limits its batter run time and hence, flight time → In what circumstances should the UAS and its auxiliary support systems be used?
- Certain systems require specialized knowledge (operating the system, analyzing the collected data) → How to obtain and keep knowledge in the organization? Is specialized personnel available at short notice?
- What are the established practices in the organization? Does the use of the desired system fit within them? New practices require constant training and embeddedness in operations to be retrievable in high-pressure situations

Stay in touch!

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