DIDRO

An innovative multi-sensor UAV solution for routine and emergency monitoring of levees

PARTNERS

GEOMATYS

RÉPUBLIQUE FRANÇAISE
Liberté Égalité Fraternité

INRAE

IGN
INSTITUT NATIONAL DE L'INFORMATION GÉOGRAPHIQUE ET FORESTIÈRE

Cerema

ENTENTE Valabre
CEREN

SURVEY copter

ATECHSYS ENGINEERING
DRONES POWERED SOLUTIONS

Why DIDRO ?

2010 – Storm Xynthia
Failure and major damages to flood defenses along a coastline of 200 km; 47 people died

2011 – 40% of levees reported as in « bad condition »

Since 2011 – Strengthening of the French regulation for levee management
- High frequency of routine inspections
- Continuous monitoring during hydrometeorological events

La Faute-sur-Mer, Feb. 2010
© Sciences et Vies, 2014

Guérande, Feb. 2010
© DREAL Pays de la Loire, 2010

USUAL METHOD

© France Digues, 2018

Visual inspection Foot patrols

+ Low cost
+ No specific instruments
+ Rather exhaustive

- - Low efficiency
- Security issues
- Difficult to access vegetated areas

ALTERNATIVE METHODS

© CEREMA, 2018

« Infrared Light Vehicle »

+ High efficiency
+ Reasonable cost

- Limited and skewed coverage
- Requires road on the crest
- Not deployable during emergency

© SafeCluster, 2018

Helicopters or airplanes

+ High efficiency
+ Flexible
+ Deployable during emergency

- - Costly
- Highly qualified pilot

What is DIDRO ?

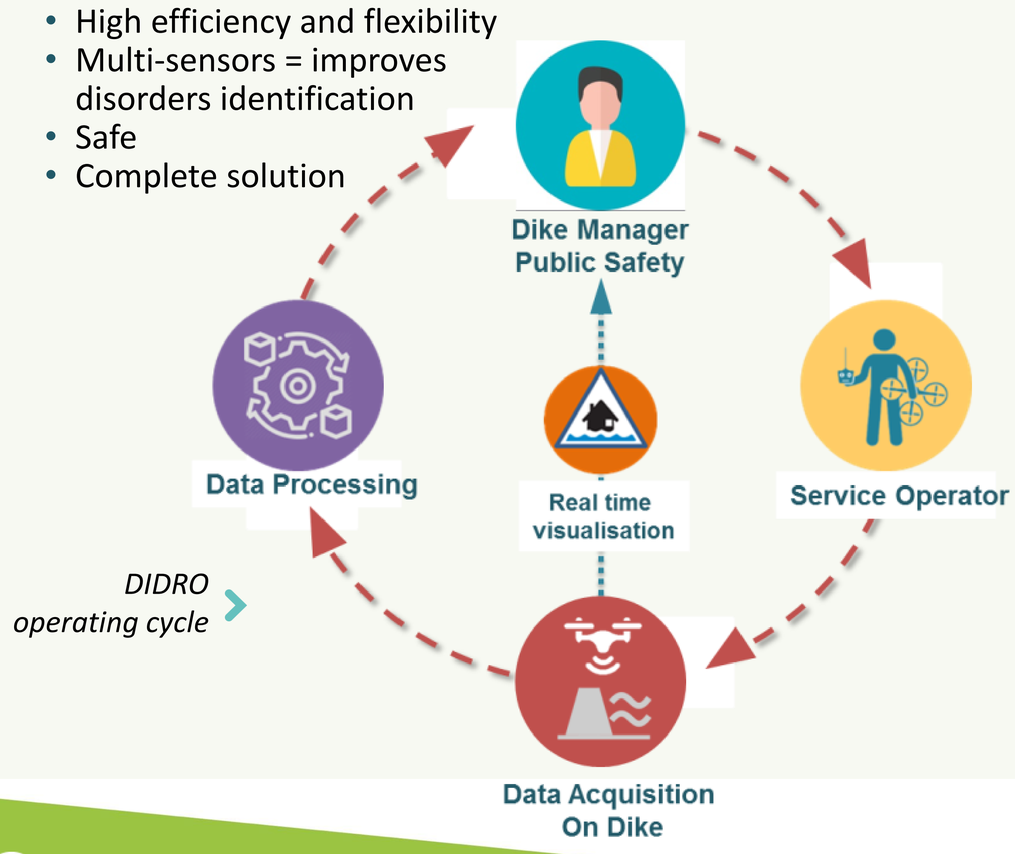
DIDRO = DIke (levee) monitoring by DROnes

Operationnal solution for **both routine and hydro-meteorological emergency monitoring** of all types of levees

Detection of **disorders** on levees and in their immediate surroundings

Dedicated to levee managers and to public safety services

Benefits:
- High efficiency and flexibility
- Multi-sensors = improves disorders identification
- Safe
- Complete solution



DIDRO operating cycle

Routine monitoring

Centimetric to metric indicators of disorders:
- Seepage
- Animal burrows
- Settlement
- Erosion/scouring
- etc.

Data available on **3D web platform** after pre-processing

3 operational modes

emergency monitoring

During a flood / high waters

Metric indicators of disorders:
- Breach initiation
- Crest or slope collapse
- Erosion on the water-side
- Risk of overtopping
- etc.

Real time visualisation of data

Support to public safety

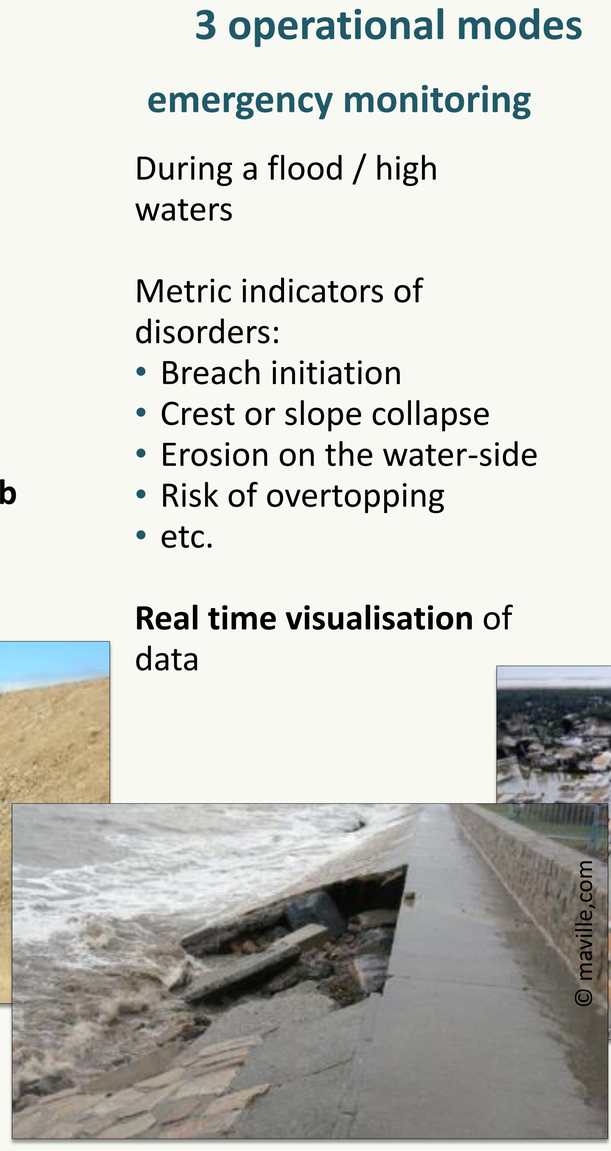
Imminent levee failure/ Levee has already failed

- Flooded buildings and roads
- Water height estimations
- People in flooded areas
- etc.

Real time visualisation of data

© Rémy Tourment

Seepage through a levee



© maville,com

Damaged masonry seawall

© Bertrand Gay/AFP

Flooded residential area

Centre
Provence-Alpes-Côte d'Azur

Contact:
Vincent Heurteaux (Geomatys): vincent.heurteaux@geomatys.com
Rémy Tourment (INRAE): remy.tourment@inrae.fr
Sérgio Palma-Lopes (Université Gustave Eiffel): sergio.palma-lopes@univ-eiffel.fr
Marion Tanguy (IFSTTAR): marion.tanguy@ifsttar.fr
Raphaël Antoine (CEREMA): raphael.antoine@cerema.fr

INRAE
3275 route de Cézanne
CS 40061
13182 Aix-en-Provence Cedex 5
(France)
Tél. +33 (0)4 42 66 99 10
www6.paca.inrae.fr/recover/

DIDRO

An innovative multi-sensor UAV solution for routine and emergency monitoring of levees

PARTNERS

GEOMATYS

RÉPUBLIQUE FRANÇAISE
Liberté Égalité Fraternité

INRAE

IGN
INSTITUT NATIONAL DE L'INFORMATION GÉOGRAPHIQUE ET FORESTIÈRE

Cerema

ENTENTE Valabre
CEREN

SURVEY copter

ATECHSYS ENGINEERING
DRONES POWERED SOLUTIONS

Payloads and UAVS

Routine and emergency monitoring

COPTER 4

Manufactured by *Survey Copter*
40 km range
Max. autonomy: 2.5 h
Max. payload: 8.5 kg
Max. wind speed on ground: 10m/s
Max. take-off weight: 30 kg
Propulsion: petrol engine

How to easily and quickly mount the payloads on the UAV?

Specific modular structure
« clic-clac »

<u>Adaptable to other types of UAVs</u>

Routine monitoring mode : full payload configuration

Thermal infrared (TIR) camera
Infratec Variocam HD Research 900
1.6 kg
→ **Thermal anomalies** due to seepage + surface mapping

LIDAR
YellowScan Surveyor
1.6 kg
→ DSM
Topographical anomalies due to settlement, initiation of slope failure, etc.

Visible (VIS)
+ Near Infrared (NIR) cameras
IGN Camlights
700 g
→ Photogrammetry (VIS)
Visual detection of disorders
+ Helps to interpret TIR and LIDAR data
NIR: Vegetation state (hydric state of the levee)

© DIDRO

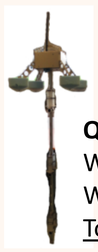
emergency monitoring mode : configuration n°1

LIDAR
YellowScan Surveyor
1.6 kg
→ Dense point cloud
Major topographical anomalies
Breaches, slope or crest collapses, etc.

Visible (VIS) and Thermal Infrared (TIR)
T120 SurveyCopter
360° rotation
x 12 optical zoom
1.0 kg
→ Analog video
Signs of **levee failure** or **overtopping**

emergency monitoring: 4 other configurations

Self-Potential electrodes
Electric potential measu-rements
Location of inner seepage or leakage
Only if hydraulic head
<u>Towed</u> by the UAV



Geophones + GPS
Passive Seismic monitoring
Inner state of the levee
Sea levee only
<u>Data collection</u> using UAV

QUADRO sensor
Water sampling
Water quality measurements
<u>Towed</u> by the UAV

Drifting target + GPS
Direction and speed of river flow
<u>Dropped</u> by the UAV

Support to public safety

Visible (VIS) and Thermal Infrared (TIR)
T120 SurveyCopter
360° rotation
x 12 optical zoom
1.0 kg

© Survey Copter

→ Analog video
Night/Day view of the situation in flooded area

© Survey Copter

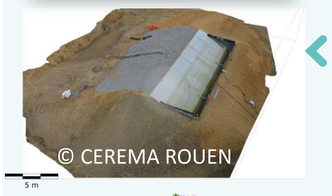
ALIACA
Manufactured by *Survey Copter*
50 km range
Max. autonomy: 3 h
Max. payload: 1.1 kg
Max. wind speed on ground: 12m/s
Max. take-off weight: 12 kg
Propulsion: electrical engine

First tests

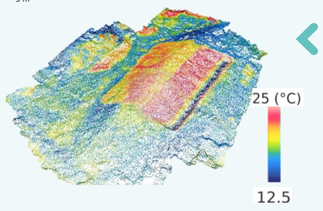
Data acquisition on an experi-mental levee (CEREMA Rouen/EDF, France)

R. Antoine and C. Fauchard (ENDSUM team, CEREMA)

Variocam HD Research 900 and Camlights mounted on a DJI M600 Pro



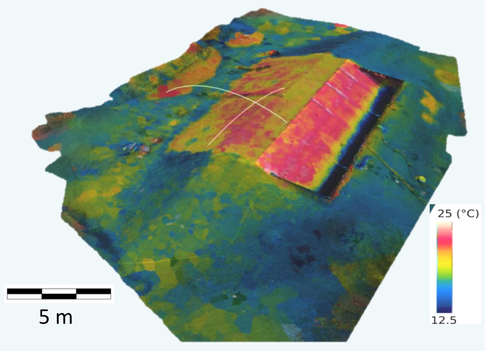
Photogrammetry 3D model from VIS imagery

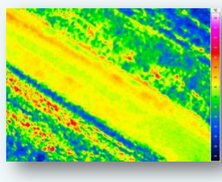


Dense point cloud extracted from TIR imagery

Combination of 3D TIR and visible models

Advanced data analysis and interpretation





TIR image before photogrammetric processing

Data acquisition on an levee along the Loire river (Bou, France)

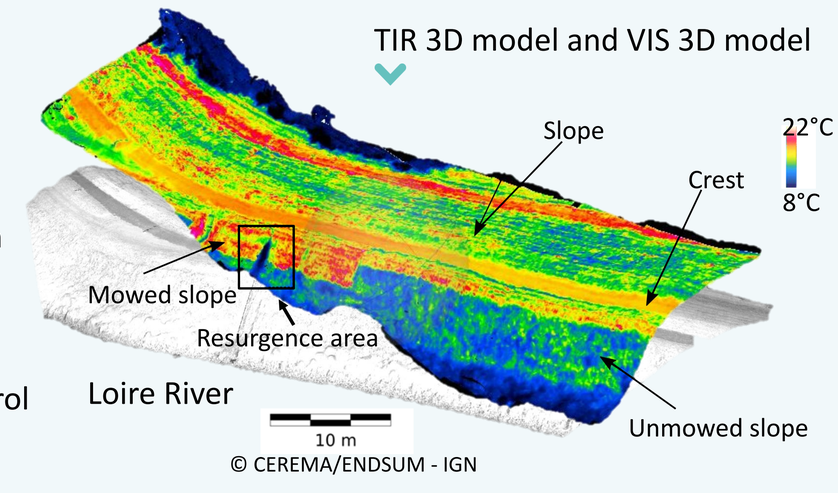
Artificial resurgence area

Copter 4 with Variocam HD head 900 and Camlights

Artificial resurgence on the river side slope

Ground countrol station and screen for real time data display

TIR 3D model and VIS 3D model

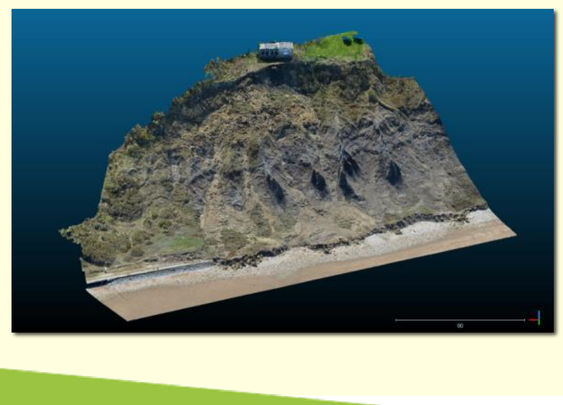


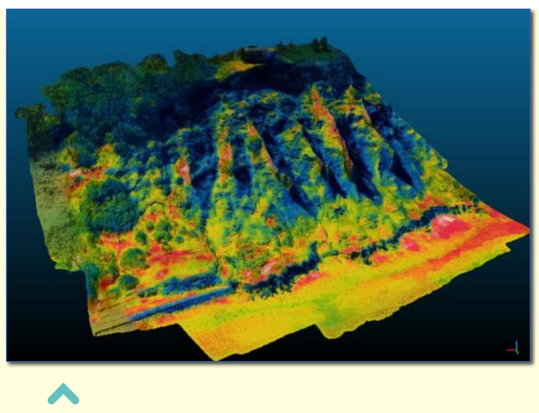
© CEREMA/ENDSUM - IGN

Prospects

- Several tests during spring and summer 2019

→ Final demonstrator in September





The Vaches Noires cliffs (France) (R. Antoine and C. Fauchard, Cerema/Endsum)

Other applications:

Evolution of the coastline (CEREMA Rouen)
Monitoring of cliff erosion using VIS photogrammetry + Combined with TIR photogrammetry for hydrological monitoring using surface temperature

Torrential floods in Alpine environments
Analysis of forest stands and instable areas + deposition areas, type and size of deposits, etc.

Centre
Provence-Alpes-Côte d'Azur

Contact:
Vincent Heurteaux (Geomatys): vincent.heurteaux@geomatys.com
Rémy Tourment (INRAE): remy.tourment@inrae.fr
Sérgio Palma-Lopes (Université Gustave Eiffel): sergio.palma-lopes@univ-eiffel.fr
Marion Tanguy (IFSTTAR): marion.tanguy@ifsttar.fr
Raphaël Antoine (CEREMA): raphael.antoine@cerema.fr

INRAE
3275 route de Cézanne
CS 40061
13182 Aix-en-Provence Cedex 5 (France)
Tél. +33 (0)4 42 66 99 10
www6.paca.inrae.fr/recover/