

DRONES

Drones for monitoring water quality

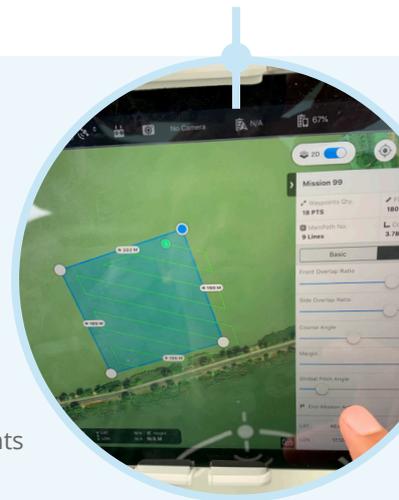
Drones are excellent for monitoring water quality from the colour of water. They can be deployed in all but the worst weather conditions, flying just tens of metres above the water surface, and are able to look at features as small as one square metre. In just one flight a single drone can cover several thousands of square metres.

Drones can complement traditional water sampling and satellite remote sensing because they have much higher spatial resolution than satellites, are not hindered by cloud cover and can provide multiple surveys per day.

How are we using drones in MONOCLE?

In MONOCLE we are developing solutions to make it easier to use drones to monitor water quality. Using low cost RGB sensors we can assess the concentration of total suspended matter or turbidity of the water. Adding multispectral sensors (including near-infrared channels) improves the accuracy of these measurements and gives information on chlorophyll-a pigment concentration - an indication of phytoplankton (algae) presence. Some highlights of our work so far include:

- A new pilot app, making it possible to fly and map your sites easily using a mobile device.
- An online platform to receive drone data and automatically turn them into valuable products.
- Adapted the iCOR atmospheric correction software to work with drone imagery.
- Operational protocols to execute flights and process data.



Flying the right camera

There are many types of cameras, and many ways to use them. Before you start a project, it is important to consider which camera suits your purpose best.

Think about spatial resolution: which is the smallest detail that you want to see? This will then determine the camera lens focal length.

Think about spectral resolution: how many colours do you need to see? A standard RGB (Red-Green-Blue) camera will suffice to produce a natural colour image. However, more colours can be recorded using multispectral cameras, or even hundreds of colours channels using hyperspectral cameras. Sometimes, gathering temperature information using a thermal camera is useful as warm water discharge affects water quality.

Think about contrast: how well do you need to see intensity differences in an image?

Think about timing: when do you want to take the images? Some phenomenon might only be visible briefly, so you then need to plan for just that moment.

Be prepared to make compromises: cameras that give the best spatial resolution together with hundreds of colour channels and high contrast are very expensive. The position and attitude determination also have limits, so it does not make sense to take centimetre-resolution images if you can only determine location with decimetre precision. Think about what you really need and the product you want to obtain.

Once you have been through this process, you will be able to select the right camera for your purpose. Then, you wait for the circumstances to be just right. For instance, strong or variable wind makes it difficult to capture good quality data, as the camera will be moving around during exposure. But soon enough, you'll have the flight completed.



How to collect good observations

Starting off with good quality data is key to obtain qualitative information about the water. Continue reading to see how we conduct our drone flights.

Here are some challenges that we face:

- To create a mosaic of images that covers a large area it essential to know the location and orientation of the camera for every single image. This is achieved using a combined system that measures location (using GNSS satellites like GPS or Galileo) and orientation (using accelerometers and gyroscopes).
- Water absorbs most of the sunlight, so we need very sensitive cameras to image the water. By looking at the water in many wavebands (UV, visible and infrared), we can model the behaviour of the water better, and so obtain better quality measurements.
- Sometimes, the camera looks in the direction of the sun, and sees sun glint, which is very bright and makes that part of the image unusable. Careful flight planning (so that the sun is always on the same side in every image) and mounting the camera just right can help minimise this problem.
- Light can also be scattered in the atmosphere, reflected at the water surface and captured by the camera. This is 'sky glint', and it cannot be avoided during the flight itself. But we can correct for it in post-processing.

Products derived from drone images

When all the images have been collected, processing the data can begin and there are a number of steps that can improve the images:

- *Coregistration*: putting all images in a single reference frame, so that you can create a larger mosaic
- *Atmospheric correction*: removing the influence on colour and intensity that comes from the atmosphere. After this, you'll see the real colour of the water.

We can also derive information on indicators and other quantitative information on water quality by further interporating the observed colour of water.

Examples include:

- *Chlorophyll-a concentration*: this is usually a good indicator of algal blooms.
- *Turbidity*: this is a measure of the haziness of water. If it is high, underwater vegetation will be affected because sunlight is limited.
- *Oils spills* can be detected.
- *Marine litter* shows up in high resolution images, and it follows the currents.
- *Water temperature*, e.g. *mapping discharge from rivers or industry*.



Combining drone imagery with other observations of water quality

To make the use of drones most effective, they should be integrated in to the whole water quality monitoring chain. For example:

- Real time turbidity measurements using buoys is standard practise. What if we could use the values measured there to trigger autonomous drones to fly? Imagine a sudden increase in turbidity measured by a buoy, and then being able to capture the bigger picture with a drone flight. We could then delineate the affected area and perhaps even find the source of the increased turbidity.
- Satellites cover much larger areas in just a few minutes than a drone could in a year, but at significantly lower spatial resolution. Drone flights that coincide with the satellite overpass can provide data to improve the products derived from the satellite imagery.

Visit www.monocle-h2020.eu for more information



MONOCLE is an EU-funded research project developing water quality observation solutions using satellites, buoys, ships, and hand-held devices. These range from highly accurate automated systems to low-cost sensor solutions that can be built and operated by citizens.

www.monocle-h2020.eu

@monocle_h2020

monocle@pml.ac.uk

This factsheet was produced by PML, VITO and Sitemark.

Check out the work they and other organisations are doing in MONOCLE at www.monocle-h2020.eu.