Using small unmanned aircraft to assess harmful algal blooms in ponds and lakes

Water quality in ponds and lakes is of the utmost importance, it affects drinking water quality, recreational use of lakes, and agricultural production. Excess nutrients entering ponds and lakes, from agricultural, urban and industrial activities, may cause cyanobacteria (also known as blue-green algae) to multiply and degrade water quality, and they have the potential to generate dangerous toxins that can sicken or even kill people and animals. High densities of cyanobacteria are referred to as harmful algal blooms (HABs). One of the challenges associated with traditional assessments of HABs is that they are temporally and geographically dynamic, and local conditions can change more rapidly than the time between the taking of water samples and the availability of results from a laboratory. Rapid, accurate assessments of local HAB characteristics can therefore play a role in making the assessment of risk more appropriate for the decisions needed to manage risk.

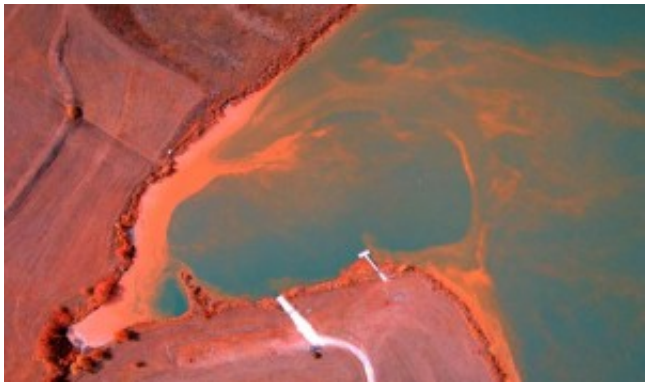

Fig. 1. Using small unmanned aircraft to assess harmful algal blooms in ponds and lakes.

Modified digital cameras placed on small unmanned aircraft systems (sUAS) can be used to determine the distribution patterns of HABs, at the local level, very rapidly (Fig. 1.). The operational altitude of sUAS is restricted to altitudes of 400 ft (122 m) or less above the surface in most countries that regulate sUAS operations. At a flight altitude of 122 m typical fixed wing sUAS currently available can cover about 600 acres in 25 to 50 minutes, at a spatial resolution of less than 5 cm. This allows for assessment of ponds and lakes in situations where the area of interest is within the coverage capacity of the sUAS, and the initial data can be reviewed directly following the flight. The sensor technology is based on the light reflectance characteristics of cyanobacteria. Cyanobacteria contain pigments that strongly reflect near infrared light, while absorbing blue light. Cyanobacteria density at the water surface can therefore be estimated by using the difference in the levels of reflection of near infrared (NIR) and blue light, using an algorithm known as a blue normalized difference vegetation index (BNDVI):

BNDVI = (NIR - blue)/(NIR + blue)

Experiments were performed over ponds and lakes to test the efficiency of the technique. Cyanobacteria densities in water samples were compared to data derived from sUAS. Multiple images were combined using scale-invariant feature transform software to produce reflectance maps. Each point in the resulting map was derived from the averaged reflectance values of multiple images covering each point on the surface.

Algal densities were correlated with BNDVI values, indicating that algal density could be derived from the sUAS-based imagery. The imagery could also be used to rapidly map and visualize the distribution patterns of HABs at the local level. Due to the short time interval between sUAS flights and the availability of high resolution HAB distribution data, the method was particularly well suited to tracking changes in HAB distribution over time, and the detection of small areas of algal accumulation along shorelines (a particularly hazardous situation for pets and other animals). A limitation of the method is that it does not provide direct evidence of toxin production. It should, therefore, be viewed as a complimentary source of data for local risk assessment, and not as a replacement of traditional methods.

sUAS-based remote sensing is a rapidly growing segment of aviation, and regulations for their use within national airspace systems are in place or being developed in multiple parts of the world. Used appropriately, it can be an invaluable tool in the local characterization of HABs, and play a role in the enhancement of public health, animal health, and environmental health.

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