Applications of Remote Sensing in Remediation of Contaminated Water and Soil

Butu M.[1], Rodino S.[1,*]

[1]National Institute of Research and Development for Biological Sciences

*corresponding author: e-mail: steliana.rodino@yahoo.com

Abstract
This paper reviews the use of remote sensing for practical applications in remediation of contaminated water and soil. Due to their flexibility of use, the Unmanned Aerial Vehicles open interesting new prospects in the management of remediation of contaminated water and soil regarding various aspects such as sources of contamination, spatial dimension of contamination, level of contamination. However, the specificity of this kind of vehicles and of the sensors that they are capable to transport still requires detailed research work before making it fully operational for most of the unspecialized human resource existing in remediation of contaminated water and soil sectors.
Keywords: remote sensing, Unmanned Aerial Vehicles, remediation

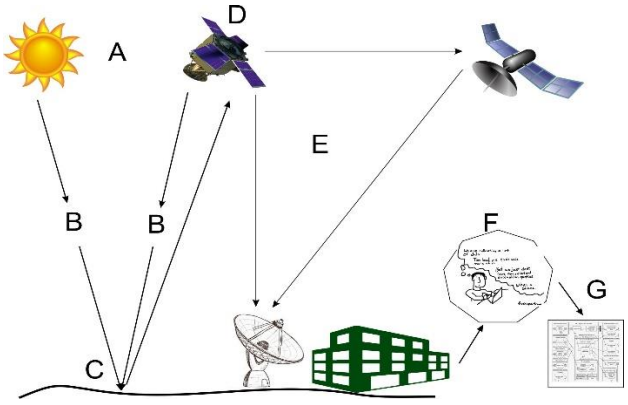
1. Introduction

Aerial imagery applied to remediation of contaminated water and soil has grown significantly during the last years to identify the levels of contamination on an intra-plot scale [Ong, C., 2019]. Remediation of contaminated water and soil can be improved by two approaches: proactive (contamination control) or reactive (treatment or remediation of contaminated water and soil). Scientific advances made possible by the use of satellites in water and soil monitoring are being nowadays adapted to the uses with Unmanned Aerial Vehicles (UAV) [Gholizadeh, A., 2018]. The aims of research are: identification of investigation methods with practical applicability, common to various sectors of remediation and optimization of these methods for obtaining relevant results in water and soil remediation field [Koptsik, G.N., 2014; Gholizadeh, A., 2018].

2. Remote Sensing

Applications of remote sensing process are based on acquisition of spectral reflectance information [fig 1]. Current limitations and challenges of the remote sensing techniques are identified. Future solutions are synthesized and evaluated aiming that remote sending (RS) to be integrated into water and soil remediation research services. RS is used to collect data on inaccessible or dangerous sites without physical contact with the area, object or phenomenon under investigation.

Figure 1. Remote sensing process



A - Light source; B - Radiation and atmosphere; C - Interaction with target; D - Recording of energy by the sensors; E - Transmissions. reception and processing; F - Interpretations and analysis; G - Applications

The remote sensing systems are passive (human eye, camera, radiometer) and active (radar, sonar, laser).
The advantages of remote sensıng are:
- provides a view for the large region;
- offers geo-referenced information and digital information;
- most of the remote sensors operate in every season, every day, every time and even in real tough weather.

The remote sensıng is a costly method and needs highly specialised human resources for data interpretation.
The satellite imagery consists of photographs collected by satellites and can give information on land cover, habitats, landscape and infrastructure, multiple engagements by time series or mapping and monitoring changes and predict future (fig 2).

3. Ecological Modelling

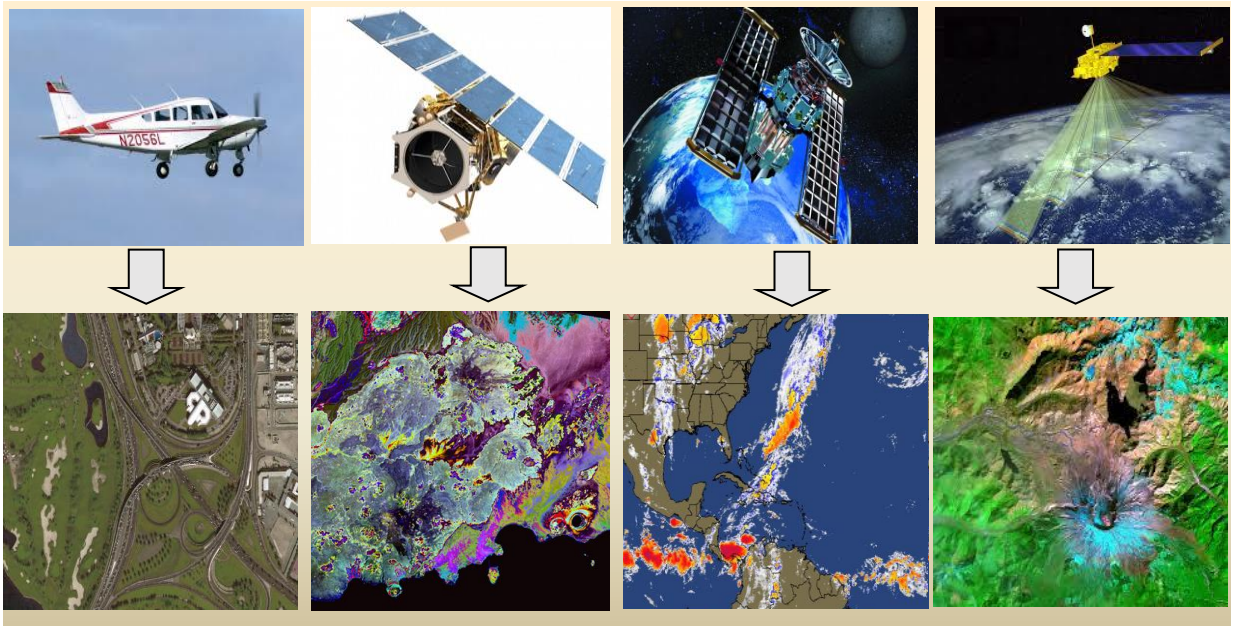


Figure 2. Satellite imagery: Landsat/Ikonos/Quickbird/Aster

The main applications of remote sensing for ecological modelling are relating with development of new methods for the calculation of vegetation attributes by using remote sensing systems [Lassalle, G., 2019].
A UAV with 4 sensors: 24-megapixel RGB camera, multispectral camera, a thermal camera, a LiDAR (Light Detection and Ranging) can be used for 3D-laserscanning of vegetation. With these sensors, the drone can be used for: acquiring high-resolution images of vegetation; measuring vegetation heights based on LiDAR; extracting the NDVI index for the canopy

4. Current Status of Research

The state-of-the-art on development of the tools and technologies of remote sensing and the potential practical benefits of their application on the remediation of contaminated water and soil research are under investigation [Ramadas, M., 2018].

The main result raising the efficiency of field sampling missions (costs vs benefits), by implementation of remote sensing techniques in all remediation sectors.

Although high resolution images can be obtained, the precision that remote sensing by UAV brings, demand complex image processing and the use of ground calibration measurements. Their use necessitates a good control of the optimal flight conditions (time and position of the sun, inclination of the vehicle, altitude and mode of flight, illumination and constant conditions throughout the measurement acquisition phase).

Acknowledgements

This work was supported by grants of the Ministry of Research and Innovation through Program 1 - Development of the National R & D System, Subprogram 1.2 - Institutional Performance - Projects for Excellence Financing in RDI, Contract no. 22PFE / 2018

References

Connor, D.T., Martin, P.G., Smith, N.T., Payne, L., Hutton, C., Payton, O.D., Yamashiki, Y. & Scott, T.B. (2018), "Application of airborne photogrammetry for the visualisation and assessment of contamination migration arising from a Fukushima waste storage facility", *Environmental Pollution*, vol. **234,** pp. 610-619.

Gholizadeh, A., Saberioon, M., Ben-Dor, E. & Borůvka, L. (2018), "Monitoring of selected soil contaminants using proximal and remote sensing techniques: Background, state-of-the-art and future perspectives", *Critical Reviews in Environmental Science and Technology*, vol. **48**, no. 3, pp. 243-278.

Koptsik, G.N., (2014). Modern approaches to remediation of heavy metal polluted soils: A review. *Eurasian Soil Sci*. 47, 707–722.

Lassalle, G., Fabre, S., Credoz, A., Hédacq, R., Borderies, P., Bertoni, G., Erudel, T., Buffan-Dubau, E., Dubucq, D. & Elger, A. (2019), "Detection and discrimination of various oil-contaminated soils using vegetation reflectance", *Science of the Total Environment*, vol. **655**, pp. 1113-1124.

Ong, C., Carrère, V., Chabrillat, S., Clark, R., Hoefen, T., Kokaly, R., Marion, R., Souza Filho, C. R., Swayze, G., Thompson, D. R., (2019). Imaging Spectroscopy for the Detection, Assessment and Monitoring of Natural and Anthropogenic Hazards. *Surv. Geophys.*, **40**(3), 431–470.

Ramadas, M., Samantaray, A.K., (2018). Applications of Remote Sensing and GIS in Water Quality Monitoring and Remediation: A State-of-the-Art Review BT - *Water Remediation*, in: Bhattacharya, S., Gupta, A.B., Gupta, A., Pandey, A. (Eds.). *Springer Singapore*, Singapore, pp. 225–246.