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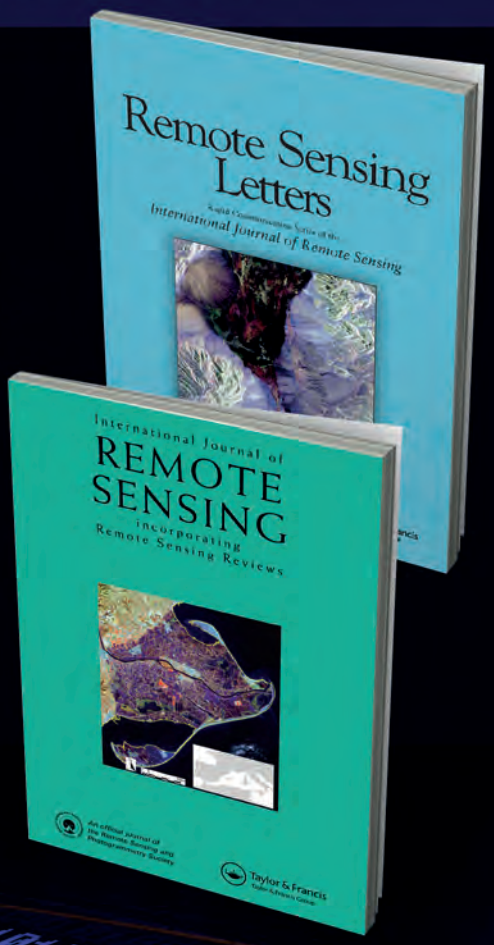

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Cover Image: Maputo Province, Mozambique, captured on the 3rd of July, 2019 by Sentinel2 - credit ESA

Editorial

Welcome readers to the SENSED summer edition!

It's a fast moving time in the Remote Sensing world, with lots of activity in both the research and commercial sectors! With this comes a plethora of news which we've boiled down into this issue, as well as the usual mix of conference reports, research articles and updates from the Council.

In terms of research articles, Oliver Baines presents a fascinating research piece on urban ecology, specifically focusing on urban forest structure in the city of London. Framing the discussion in the context of the UN sustainable development goals and noting the vast carbon emissions from London, he takes high resolution LiDAR data from the UK's national inventory, and combines this with LandSat 8 spectral data to produce maps of urban forest structure across the whole city. These types of analyses will become increasingly important in city planning as climate change becomes a bigger issue.

In another modelling exercise, Oluibukun Ajayi introduces his work in producing 3D models from UAV imagery. The work involved surveying the Federal University of Technology, Minna's campus and using modern photogrammetric methods to generate a 3D model of the area. This was then validated against surveyed GCPs which show very low error. The advent of this technology has opened photogrammetry to a wider audience than ever before, thanks to the automation of these algorithms.

Luigi Parente reports on the RSPSoc's annual student conference, Wavelength. This year it was held in Loughborough University, with, as ever, a diverse attendance from a range of Remote Sensing disciplines. He describes the conference topics ranging from geomorphology, to studies of volcanoes, to the use of UAVs in Remote Sensing research. The conference finished with election of the next shadow wavelength representative, which will see the conference travel to the University of Stirling in 2021. We're already looking forward to Emma Higgins' conference at the University of Nottingham next year!

As ever, we welcome contributions from across the Remote Sensing and Photogrammetric spectra, should you wish to contribute don't hesitate to get in touch with us. For now though, enjoy this quarter's issue, and we look forward to seeing what the next 3 months brings to the community.

James O'Connor is an Earth Observation Data Scientist working in precision agriculture, with a particular interest in using Machine Learning to assist growers optimise farming practices

George Petropoulos is a Marie Curie fellow at the Technical University of Crete, Greece - petropoulos.george@gmail.com

newsletter@rspsoc.org.uk

Chairman's Message

A warm welcome to the July edition of Sensed.

Under normal circumstances this would have been my final Chairman's message ahead of stepping down at the next AGM having completed my normal term as Chairman. However, as Philippa Mason, our Honorary General Secretary, explains in her Council News section, unfortunately Mark Jarman, the Society's Vice Chair, is no longer in a position to take on the role as the next RSPSoc Chairman. As Philippa goes on to explain on page 6, following extensive discussions during the June Council meeting, it was agreed that I remain in the role of Chairman, for one more year, allowing the new incoming Vice Chair the opportunity to settle into the Executive Committee before taking over as Chair at the 2020 AGM. I would like to take this opportunity to thank Mark for all the work he has done on behalf of the Society.

In mid-April I had the opportunity to attend the Annual Conference of the Geographical Association (GA), which handily was in Manchester. At the beginning of the year I joined the local Manchester branch of the GA as a committee member, and so was happy to contribute to the conference. I presented a practical session on how free earth observation data might be used in the A-Level curriculum, specifically looking at topics around Changing Place and Contemporary Urban Environments. From discussions in the session, and around the conference venue, it is clear that there is an opportunity for us to make contributions to this area.

Also, in terms of education, the last few months has also seen a major BBC series on aspects of our discipline, Earth from Space. This four part series made extensive use of earth observation data to examine patterns and processes across the globe.

In terms of Society business, we continue to look for members to assist with the running of the various committees of the Society. As I explained in the April Chairman's message, members getting involved with the various committees do not need to become Trustees of the Society, although we would be delighted if some did. The committees include: Publications; Technical Programme; Publicity and Communications; and Education and Training. If you are interested in finding out more about how the committees work either contact the relevant committee Chair directly via the RSPSoc Office or fell free to contact me.

The next major Society event is the Annual Conference and AGM, which as announced in the last Sensed will be hosted by the Satellite Applications Catapult. The event will take place on Friday 13th September at Harwell. I look forward to seeing many of you there.

Finally, as always, please feel free to contact me at the address below if you have any comments or suggestions regarding the Society.

Richard Armitage is Chairman of RSPSoc and Academic Lead for Geography and Environment, School of Environment and Life Sciences, University of Salford.

chairman@rspsoc.org.uk

Council News

Council met on the 12th June 2019, for its 61st meeting, in the Royal School of Mines, Imperial College London.

It was a lively meeting with the main focus points for discussion being arrangements for the Annual Conference this year, Society financial activities, publicity and awards.

The Society is now registered for VAT and Rachel and Uta in the Nottingham office have been preparing to submit the Society's first VAT return, under the guidance of Robert Killington, and in collaboration with Tina Thomson and Sam Pike. The matter is not straight forward since the Society is partially exempt from VAT and everything that the Society does now needs classifying to ensure that the correct amount of VAT is accounted for. Between them, Rachel, Uta and Tina have undertaken a enormous amount of additional work over the last year or so in getting the Society to this point; they were all sincerely thanked by Council.

Council discussed the current plans for the 2019 Annual Conference and AGM, which will be held at the Catapult, in Harwell, Oxfordshire on the 13th Sept 2019. It will be a more compact event than usual, taking place over one day, with an informal dinner the evening before, a lunchtime AGM, drinks and awards afterwards and some exciting speakers throughout the day. It promises to be an excellent meeting.

Council elected myself as Hon Gen Sec and Tina Thomson as Hon Treasurer for another year. Mark Jarman, as the current Vice-Chair, was due to take over as Chair of the Society at the AGM this September, but due to personal circumstances will now not be doing so. A new Vice-Chair has been identified and elected, but they did not feel in a position to take on the Chair role immediately but have agreed to become Chair at the 2020 AGM. This situation left the Society without a Chair for one year. In the light of this problem, Richard Armitage has agreed to remain in post as Chair for one further year until the new Vice Chair is able to take over. Council approved this plan and elected Richard to stand as Chair for one additional year. Mark was thanked for his efforts in helping to run the Society thus far, and all wished him well in his career and life beyond Council. Everyone thanked Richard for agreeing to remain in post.

Philippa Mason

Honorary General Secretary

Philippa Mason is Honorary General Secretary of RSPSoc and a Lecturer at Imperial College London.

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RSPSoc 2019
Accelerating Geospatial Intelligence through Earth Observation

Location: Satellite Applications Catapult

Date: Friday 13th September 2019

Catapult organising committee: Peter Beaumont (Convenor), Dr. Cristian Rossi, Daniel Wicks and Mark Jarman

The Remote Sensing and Photogrammetry Society and the Satellite Applications Catapult are delighted to announce that this years RSPSoc Annual Conference will be held on Friday 13th September at the Catapult in Oxfordshire. The event will be free to attend with registration to open in early July.

Conference Focus

There has never been a more exciting and productive time to be working in the geospatial sector. The ever-growing availability and access to EO data, combined with the increasing integration of geospatial analysis with artificial intelligence and machine learning is having a global impact due to the power that satellites can bring to bear on the challenges of the modern world.

The technological and scientific advances that our community are making gives us the ability to accelerate the impact that geospatial intelligence can provide to society.

Through a series of keynote speakers and a broad technical programme, this conference will provide a forum to showcase the technological and scientific advances that are being made to deliver solutions to real world challenges.

https://sa.catapult.org.uk/rspsoc-2019-accelerating-geospatial-intelligence-through-earth-observation/

A London-wide Estimate of Urban Forest Structure

Oliver Baines

Given rapid urban growth, global population is expected to surge to 10 billion people by 2050 (UN, 2017), with the proportion of urbanites growing to account for 2/3 of total population (UN, 2015). Cities pose numerous ecological challenges, be it with regard to waste management, biodiversity and water quality, among others. Carbon emissions from just the 20 largest cities in the USA for example surpass the potential land sink offered by the entire country (Luck et al., 2001). In developing nations meanwhile, sporadic and often unplanned development can generate further challenges. The scale of such impacts necessitate sustainable approaches to urbanism, with the Sustainable Development Goals (SDGs) making explicit reference to the need for 'sustainable cities' within SDG 11.

Green infrastructure is an important component of this – terms such as the 'urban forest' have emerged to describe non-negligible vegetation covers present within cities. There could be as many as 10 billion trees contained within urban environments (Endreny et al., 2018) offering several benefits to urban dwellers. Individual trees can offer shade (reducing energy requirements (Donovan and Butry, 2009), promote biodiversity through the provision of habitat islands (Olenjivzak et al., 2018), encourage physical exercise (Coombes et al., 2010) and have even been shown to be inversely related to anti-depressant usage in London (Taylor et al., 2015). Indeed, again in London, sections of the urban forest could store carbon at comparable densities to tropical rainforests (Wilkes et al., 2018). Each of these impacts is highly dependent on the structure and location of different components of the urban forest; the largest trees for example can intercept up to 70x more carbon than their smaller counterparts (Nowak et al., 2006). A comprehensive understanding of both aspects is therefore essential when quantifying the services offered.

A common approach is i-Tree Eco (iTree, 2013); standardised sampling techniques are used to record tree characteristics (height, numbers, diameter at breast height etc.) at sample plots throughout a city and then scaled up to produce city-wide estimates. Such measures are locally accurate, though are laborious and spatially coarse, producing just a single value per city (or land cover type within cities). In London, estimates of 8,421,000 trees and a canopy cover of 14% (Rogers et al., 2015) were produced, with a total value of services of £132.7m annually. Results were presented for just two areas of London, inner and outer, but to be useful for land managers, there is a need to understand the breakdown at finer spatial resolutions, or at least at the level of boroughs. Our work presented at the National Centre for Earth Observation (NCEO) conference 2018, entitled 'A London-wide estimate of urban forest structure', aimed to tackle this problem, producing spatially explicit estimates of key urban forest characteristics using Remote Sensing. Exploiting freely available datasets, we presented a method that could be adapted for uptake in cities worldwide to produce estimates of three key forest parameters – canopy cover, height and density at high spatial resolutions.

LiDAR datasets are commonly used for deriving forest characteristics, physically measuring, for example, canopy height, and can be manipulated for the delineation of individual tree crowns. Given the increasing availability of freely available LiDAR datasets (e.g. from the airborne LiDAR [ALS] from the Environment Agency in the UK), this represents a useful dataset as LiDAR can capture changes in the vertical structure of forest stands. However, coverage of airborne LiDAR datasets is limited, and resurveys can be prohibitively costly. By comparison, optical imagery, though lacking the vertical penetrative capacity of LiDAR, are much more readily available, with freely available image sources such as the Landsat and Sentinel series of

satellites offering moderate resolutions at frequent revisit intervals. By combining information from these two datasets, the limitations of each can be mitigated. Previous authors have predicted canopy height, regressing Landsat Digital Numbers against LiDAR derived heights (Wulder and Seeman, 2003), though this can fail to capture often complex relationships. Machine-learning approaches are another popular alternative therefore, with authors able to estimate canopy cover and heights over large areas using a combination of LiDAR and Landsat imagery to train a Random Forest (RF; Breiman, 2001) model (Ahmed et al., 2015). In spite of this, such an approach has not yet been applied to urban forestry, where machine-learning techniques such as RF could capture significant heterogeneity present within urban areas (in both urban forest form, and variation in spectral space).

LiDAR data were obtained from the UK environment agency as point clouds and filtered for urban/vegetated returns. Points were then clustered into increasingly homogenous groups based upon their characteristics (Wilkes et al., 2018). This generated individual tree crowns for approximately 20% of the Greater London area (Figure 1). Crowns were aggregated into regularly spaced point layers, each containing information as to the mean canopy cover, dominant canopy height, and the number of trees in the surrounding area.

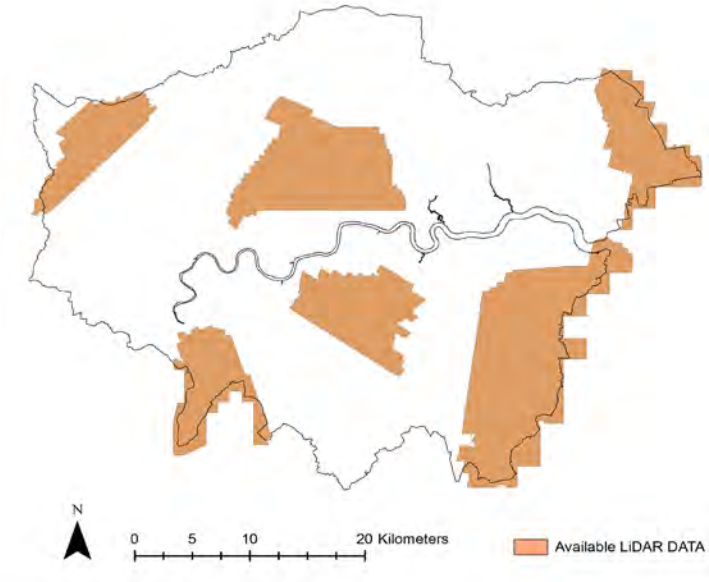

Figure 1: Availability of Environment Agency LiDAR datasets across Greater London.

Several variables were identified for outward prediction of urban forest structure, each freely available to ensure an open source approach and thus applicability to other cities. Landsat-8 bands, transformed to Surface Reflectance (SR) were chosen as a base, providing spectral information at a 30m resolution. In addition to these original bands, the Normalised Difference Vegetation Index (NDVI) was derived, under the assumption that more vegetated surfaces would, for example, have greater canopy cover and thus record a higher NDVI values. To capture spatial heterogeneity in structure, variation in each band (and the NDVI) was also captured by taking the standard deviation of each in 3*3 and 5*5 windows. In addition to just changes in geographical space, temporal variation was also accounted for to distinguish between spectrally similar surfaces. Variation in pixel values were determined across 2 years, where it was hypothesised that urban features would remain static, whilst vegetated features would exhibit phenology-based variation. Further variables related to the distributions of vegetation, temperature and precipitation, were also included. To prevent the prediction of trees within water bodies within results, these were masked out using the Modified Normalised Difference Water Index (MNDWI; Xu, 2006), filtering out water bodies of a minimum size (9 pixels) to prevent erroneous speckling.

These environmental layers were used to train a Random Forest model, producing estimates for each variable at a 30m resolution. Part of the Classification and Regression Trees family of models, RF is a machine-learning method which, in essence, generates a specified number of decision trees and takes the mean value of all trees (for regression) in order to reduce the effects of overfitting. Each decision tree takes a subset of the data and partitions it into increasingly homogenous space using a random subset of variables at each node (split) and choosing the best based upon the decrease in error. In the generation of each tree, a subset of samples are used for training and the remainder for testing, producing Root Mean

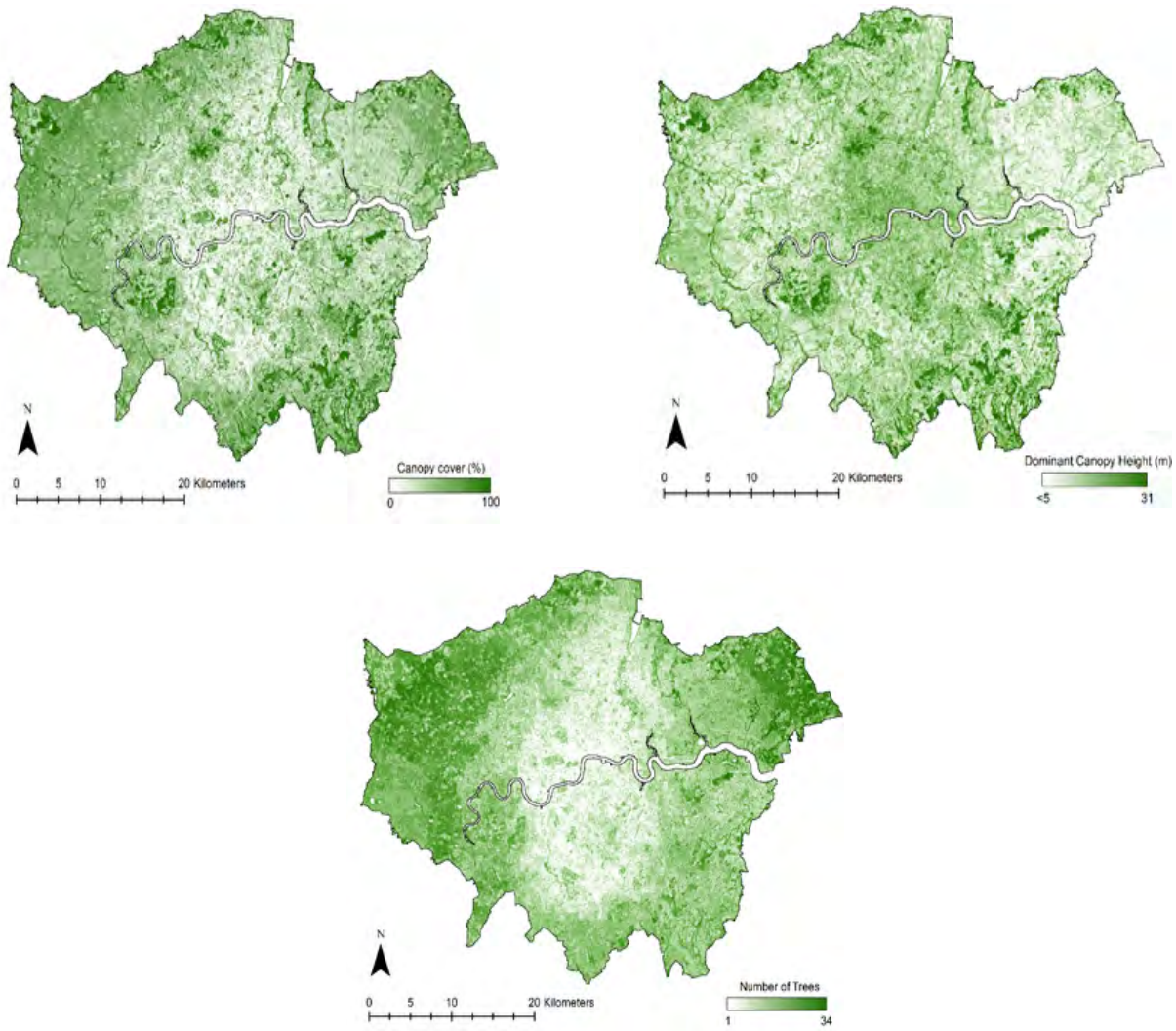

Figure 2: Random Forest outputs for each of Canopy Cover, Dominant Canopy Height, and the Number of Trees within Greater London. All values have been corrected for model bias.

Square Error (RMSE) values as a metric for model quality. The outputs for these models are shown within Figure 2.

In total, an estimate of 9m trees (58 per hectare), a canopy cover of 25% and a dominant canopy height of 11.29m was produced, with RMSE values of 3.74, 15.95 and 4.23 respectively for each variable (Figure 2). To test the applicability of LiDAR datasets from one part of the city predicting other parts, models were also cross-validated using smaller LiDAR subsets to train and partitioning one for testing. Whilst this produced significant differences, overall impacts upon model accuracy were low (<5%). Similarly, training on smaller geographic subsets (rather than the whole city) produced significant, but overall small, differences. Model accuracies were moderately lower than those produced by other studies in natural forest stands, but given urban heterogeneity, this is to be expected. Indeed, in spite of this, we find freely available image sources to be suitable for the prediction of urban forest parameters as results are significantly more spatially explicit (30m) than previous ground-based efforts. The outcomes from this study show significantly greater number of trees and canopy cover than those predicted by the i-Tree Eco, and provide a much greater insight into the distributions of trees within London. Taking the FAO definition of forest (FAO, 2018) - a contiguous area of greater than 0.5ha, with a canopy height of 5m and minimum canopy cover of 10% - over 70% of London meets the criteria for forest.

Presenting at NCEO 2018 provided an invaluable opportunity for me to disseminate my results, and was my first experience of an academic conference. The work showcased here comprises my MSc dissertation, working alongside Dr. Phil

Wilkes and Professor Mathias Disney at UCL. Since the presentation, we have been working to generate results at a higher resolution (20m, using Sentinel-2 imagery) and to produce better LiDAR point inputs. Our estimate of 9m trees above is likely a significant over-prediction as we utilised a minimum input value of 1 for the number of trees, with new estimates we are now producing suggesting the figure is likely closer to 5m, and the total London 'forest' area to be just under 50%. We hope too to generate a simple workflow that can be followed to easily produce estimates for urban forests worldwide. Understanding the nature and structure of the urban forest is essential as urban areas continue to grow – we show here that forest in urban areas is significant, and should be accounted for as such.

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Oliver is a 1st year PhD student at the University of Nottingham, working to untangle the interactions between climate change, geodiversity and plant community structure in the Arctic. The work he presented at NCEO 2018 alongside Mathias Disney and Phil Wilkes was the culmination of his MSc in Remote Sensing at UCL. Oliver has an avid interest in applying Remote Sensing to conservation issues across a range of different disciplines.

The Photogrammetric Record Metrics

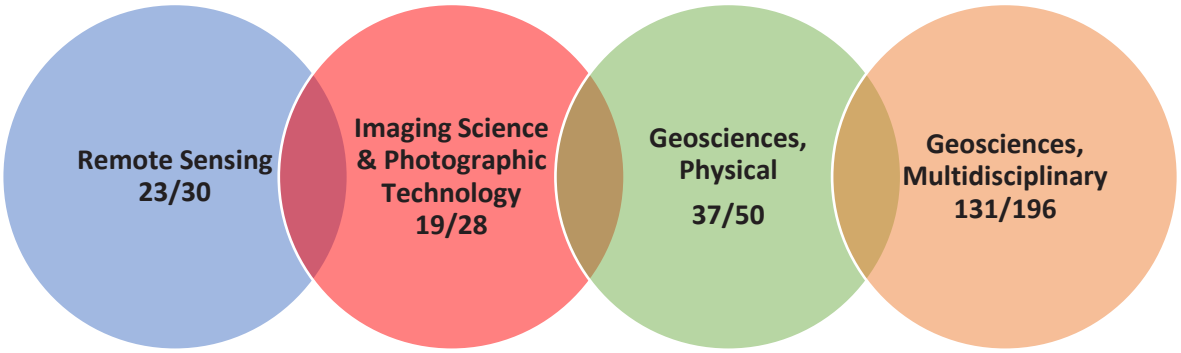
Research Metrics are a key facet of academic publishing, for judging the quality of research, worthwhile articles, and the impact of research. For *The Photogrammetric Record*, there are two key metrics; the JCR Impact Factor and the Scopus CiteScore.

Impact Factor

The Journal Citation Report (JCR) Impact Factor is one of the key metrics for *The Photogrammetric Record*, as a means of tracking the citations and impact of content as the JCR also includes category rankings for related title comparison. The most recent Impact Factor for *The Photogrammetric Record* is shown below:

Year	Impact Factor	Cites	Citable Items
2018	1.591	70	44

The Photogrammetric Record is currently ranked in four categories of the JCR, due to the multidisciplinary content in the journal. The current rankings based on the 2018 Impact Factor are:



The list below shows the top ten most cited papers in *The Photogrammetric Record* in 2018, with the top cited article in 2018 - Reshetyuk, Y and Mårtensson, S' article '*Generation of Highly Accurate Digital Elevation Models with Unmanned Aerial Vehicles*'.

All these articles will be free to access for the six weeks following the July publication of Sensed.

- *Generation of Highly Accurate Digital Elevation Models with Unmanned Aerial Vehicles*. Reshetyuk, Y; Mårtensson, S. **Vol 31:154**.
- *Documentation of heritage buildings using close-range UAV images: dense matching issues, comparison and case studies*. Murtiyoso, A; Grussenmeyer, P. **Vol 32:159.**
- *Geometric Calibration of a Hyperspectral Frame Camera*. de Oliveira, R; Tommaselli, A. M. G; Honkavaara, E. **Vol 31:155**.
- *ZY-3 Block adjustment supported by glas laser altimetry data*. Li, G et al. **Vol 31: 153.**
- *Identification of Stable Areas in Unreferenced Laser Scans for Deformation Measurement.* Wujanz, D et al. **Vol 31:155**
- *A multi-scale plane-detection method based on the Hough transform and region growing.* Leng, X et al. **Vol 31:154**.
- *Multitemporal monitoring of a coastal landslide through SfM-derived point cloud comparison.* Esposito, G et al. **Vol 32:160**.
- *Photogrammetric Terminology: Third Edition*. Granshaw, S. **Vol 31:154**.
- *Automatic Rough Georeferencing of Multiview Oblique and Vertical Aerial Image Datasets of Urban Scenes*. Verykokou, S; Ioannidis, C. **Vol 31:155**.
- *Comparison of Quality Measures for Building Outline Extraction.* Potůčková, M; Hofman. P. **Vol 31:154.**

The Photogrammetric Record Metrics

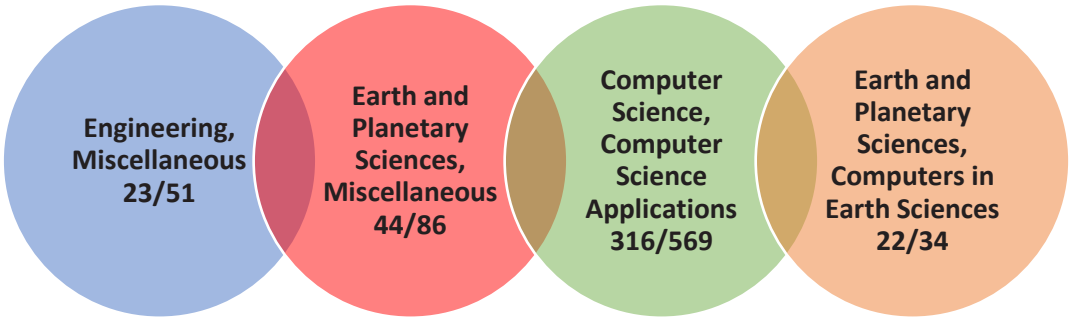
Scopus CiteScore

Scopus produces the CiteScore metric which considers the wider range of citation material over three-year citation periods across approx. 20,000 titles. This allows for greater comparative analysis across competitor journals and further information on *The Photogrammetric Record's* citation network.

CiteScore is calculated differently from the JCR Impact Factor; the CiteScore is calculated based on content published in three years and includes everything in the denominator, including other journal content such as editorials, book reviews etc. Below, you will see the calculation for the 2018 CiteScore.

Year	CiteScore	Cites	Citable Items
2018	1.26	167	133

The CiteScore also includes its own categories and rankings. In 2018, *The Photogrammetric Record* was included in four categories:



NEWS: 2019 EuroSDR Award for the best PhD thesis related to geoinformation science

Since 2016, EuroSDR has recognised contemporary PhD theses that have significantly contributed to the development of geoinformation science in the context of national mapping and cadastral agencies (NMCAs). In order to enhance collaboration between European academia and NMCAs, as well as to engage young scientists in its research endeavours, EuroSDR is pleased to announce its 2019 competition.

In order to be eligible, a PhD thesis should have been successfully defended in the period from January 2018 to August 2019. The PhD topic should be related to one or more of the research areas covered by the EuroSDR commissions (see http://www.eurosdr.net). The call is restricted to applicants that completed their PhD study in Europe.

All application material must be sent to the EuroSDR secretariat (eurosdr@kuleuven.be) to arrive no later than 30th August, 2019. The submitted application material will be evaluated by a committee approved by the EuroSDR Board of Delegates. Notification of the selected thesis will be issued by 4th October, 2019. The author of the successful PhD thesis will receive an award of 500 EUR and be invited to present his/her work at the 135th EuroSDR Board of Delegates meeting, to be held in Cyprus from 13th to 15th November, 2019. For enquiries, please, contact Dr. Markéta Potůčková, EuroSDR Commission 6 – Knowledge Transfer marketa.potuckova@natur.cuni.cz

GEO Individual Excellence Awards

The Group on Earth Observations (GEO) Programme Board is pleased to announce the launch of the GEO Individual Excellence Awards. This award will be presented to individuals who have demonstrated exceptional personal commitment to the GEO Mission and whose work has had tangible impact.

Nominations will be made using a nomination form attached to this email and available here: http://earthobservations.org/article.php?id=363

Nomination forms must be submitted electronically to awards@geosec.org

The deadline for nominations is 31 July 2019.

The winners will be recognized during GEO Week 2019 in Canberra, Australia. Visit the website for all of the details here: http://earthobservations.org/article.php?id=363

Map of Australian intertidal zone

Scientists in Australia have developed a novel National Intertidal Digital Elevation Model, which maps the intertidal zones for all of Australia. The new model harnesses 30 years of LandSat data, covering more than 15,000 square kilometres. The model has a spatial resolution of 25 m and was validated against LiDAR, RTK GPS and existing bathymetric datasets, showing error of 40 cm in sandy beach and tidal flat environments, with accuracy lower in more complex, rocky coastal areas.

Image source: NASA

PRODUCING ACCURATE 3-D MODELS FROM LOW PERCENTAGE OVERLAPPING IMAGES ACQUIRED USING UAV

Oluibukun Ajayi

INTRODUCTION

The terms Digital Surface Model (DSM), Digital Terrain Model (DTM), and Digital Elevation Model (DEM), usually refer to different types of continuous, 3-Dimensional geospatial information. DSMs are raster images in which the pixels depict the ground elevations above the sea level with all natural and human-induced features or attributes such as vegetations, buildings, hills etc. DEMs also refer to 3-D raster images of the bare-earth in which the ground elevations with reference to the mean sea level are depicted with pixel values, while a DTM which is often synonymously used as the DEM, contains regularly spaced points, characterizing the shape of the bare-earth terrain, but unlike the DEM, it also contains other geographical elements and natural features.

Various technologies have been deployed in the acquisition of elevation data for accurate generation of surface, terrain or elevation models. Land surveying technique was once the only available method of acquiring elevation data, but with the advent of remote sensing technology, such data can now be acquired quickly and rapidly, even from inaccessible and difficult terrains, thereby saving time and resources, without compromising the desired accuracy (Ajayi et al., 2018).

Recently, Unmanned Aerial Vehicles (UAVs), have been introduced for accurate 3-D mapping. They are remotely controlled or completely autonomous vehicles which can be programmed to obtain images of the surface of the earth at fixed and specified altitudes. They can fly at altitudes below cloud cover, and are easy to manoeuvre when compared to large aircraft. They have been used in different disciplines such as 3-D surveying and mapping, military, policing and surveillance patrolling, agriculture and precision farming, etc.

Photogrammetrically, to ensure stereoscopic view of a scene and to prevent gaps from occurring in the strips, and the final products due to terrain variations, crab, varied flight altitude and tilts, a minimum of 60% and 30% forward and lateral overlaps respectively are required. But, there are often instances where the resources required to ensure >60% endlap or >30% sidelap are either unavailable or unaffordable. and also, the required accuracy, size and nature of the imaging area's terrain configuration, may not justify the investment of the required resources to obtain the conventionally required overlapping percentage if an allowable result can be obtained at <60% overlap (Ajayi et al., 2017). Also, Michael et al. (2004) opined that standard conventions in photogrammetry can be challenged using digital cameras because neither film grain nor the number of images is now the major determinant driver of a photogrammetric project.

The possibility of obtaining accurate 3-D models from UAV acquired images with less than the required overlapping percentage (approximately 25%) was examined in this study since the imaging area is relatively small and gentle, and also, since a fixed flight altitude was used all through the flight mission. The study area (Figure 1) is part of the Main Campus of the Federal University of Technology, Minna, Nigeria. It is located within the boundaries of 1055093.867mN and 1054587.539mN, and 217981.805mE and 220613.904mE covering an area of about 11 hectares.

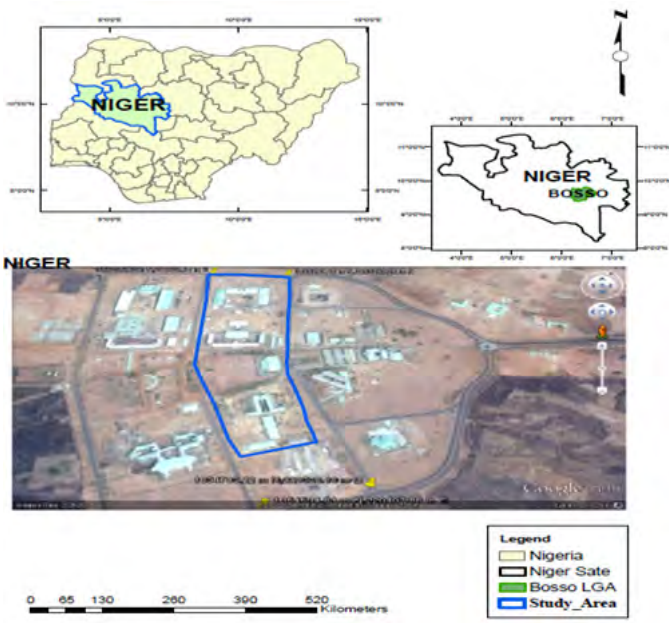


Figure 1: Study area

METHODS

An approach that integrated flight planning, image data acquisition, image processing and accuracy assessment was adopted in this study. Both office and field reconnaissance were carried out in order to design the flight plan (Figure 2), and mark preselected locations for establishing Ground Control Points (GCPs), which were used for georeferencing and optimization. Using Hi-Target DGPS receivers, 17 GCPs were established, properly densified across the study area, and marked with reflective materials for easy identification on the images. At 50 m flying height, 92 nadir images were acquired using a DJI Phantom3 UAV which was equipped with a DJI (FC300X) camera of 12 mega pixels and 2.8mm focal length.

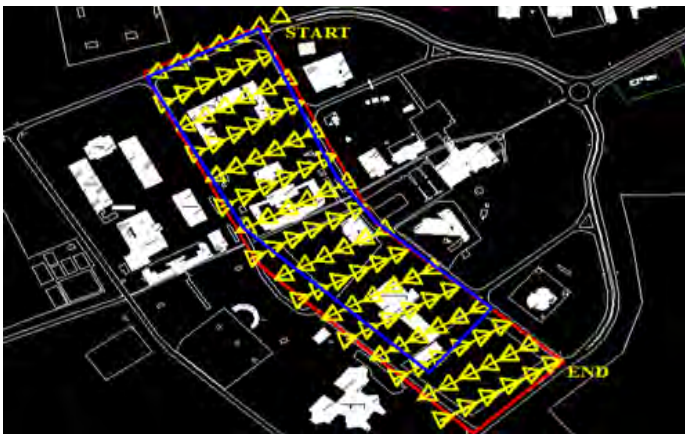


Figure 2: Mission's flight plan

The image processing phase involves absolute orientation, relative orientation, and interior orientation. The procedure (Figure 3) involves camera calibration and alignment, point cloud and dense cloud generation, and DSM, DTM and DEM generation, and was performed using the Agisoft PhotoScan software which automatically generates large number of tie points based on Structure from Motion (SfM) algorithm.

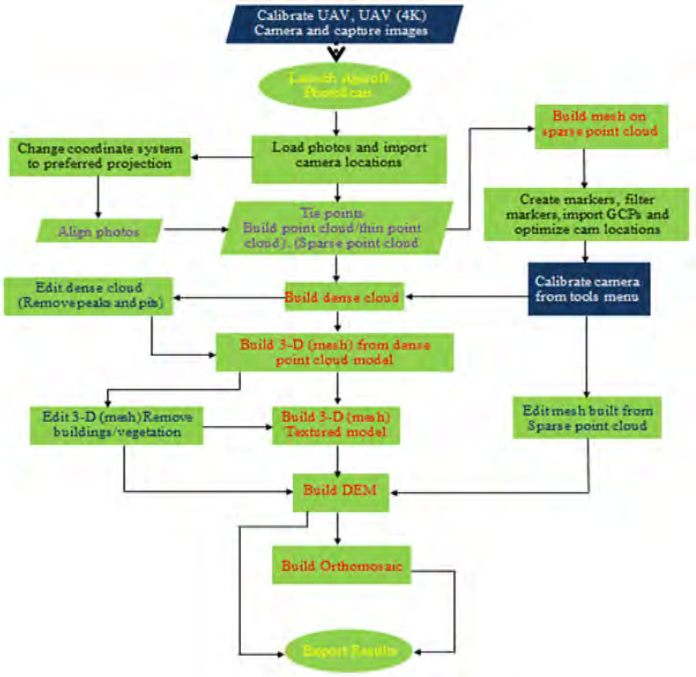


Figure 3: Process work flow

For the accuracy assessment of the generated models, the x, y, z coordinates of the GCPs were extracted from the DEM, and compared with the coordinates of the GCPs acquired by the DGPS receivers. The obtained discrepancy was used to estimate the root-mean-square-errors (RMSEr and RMSEz,) using equation (1).

$$RMSE = \sqrt{\frac{\sum(N_i - N_j)^2}{n}} \qquad (1)$$

Where *Ni* is the DEM extracted coordinates, *Nj* represents the DGPS acquired coordinates and n is the number of GCPs.

The horizontal and vertical accuracy was computed by applying 95% confidence level to the result obtained using the NSSDA method as presented in equations (2-3) respectively:

$$\text{Horizontal Accuracy} = 1.7308 \times \text{RMSE}_r \quad (2)$$

$$\text{Vertical Accuracy} = 1.96 \times \text{RMSE}_Z \quad (3)$$

RESULTS AND DISCUSSION

The DSM (Figure 3), DTM (Figure 4), and DEM (Figure 5) were obtained from interpolation of very dense 3-D point clouds of about three million, six hundred thousand. In the process of producing these models, other by-products were also generated such as the sparse point clouds, dense point clouds, 3-D mesh surfaces, and the orthomosaic. The sparse point cloud is a set of points rendered as data files that are seldomly used directly in most 3-D applications, which makes surface reconstruction very important. The 3-D wireframe was generated from the dense point clouds by surface reconstruction, and it is a detailed surface that represents the terrain in shaded mode using Delaunay triangles. The aerial triangulation process that is based on tie point measurements was used for the orthomosaic generation. The DSM with height value range of 231.18 – 257.564 m, is a model that depicts both the terrain and all natural and human-induced features. It is useful for urban planning and landscape modeling. The DTM (with height value range of 231.18 – 249.173 m) on the other hand contains the terrain features only and is required for flood modeling and geological applications. The DEM (with height value range of 231.18 – 238.772 m) depicts the bare earth's surface only and is useful for modeling topography or relief displacement (Ajayi et al, 2018). While the three models have the same lowest height value of 231.18 m, the variation in their highest height values is as a result of the terrain, surface and features depicted by each of them.

Table 1 contains the estimated RMSEr and RMSEz, and the computed horizontal and vertical accuracy. ΔN, ΔE, and ΔZ represents the difference in the northings, eastings and the height coordinates respectively.

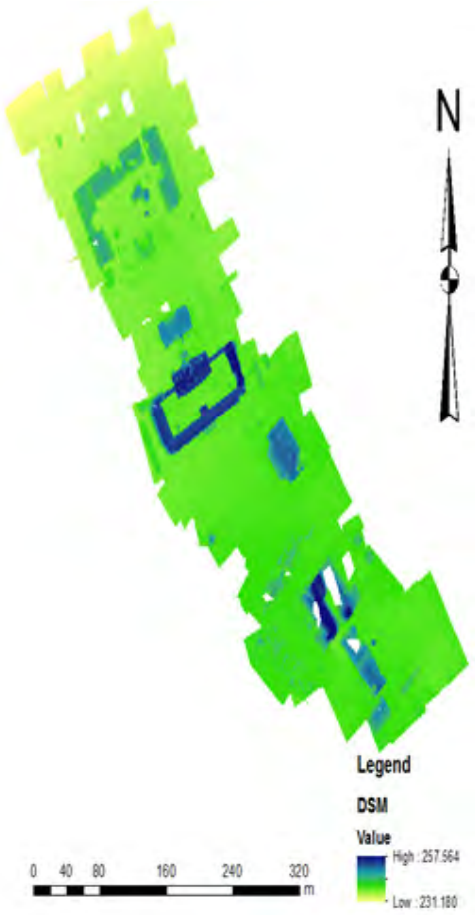


Figure 3: Generated DSM

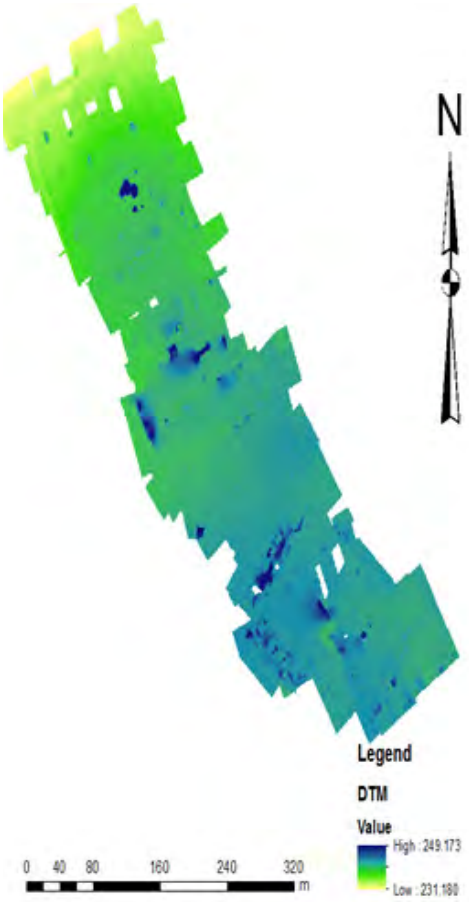


Figure 4: Generated DTM

Figure 5: Generated DEM

Station ID	Computed Discrepancies in Northings, Easting and Height coordinates of DGPS observations and UAV generated DEM		
	ΔN(m)	ΔE(m)	ΔZ(m)
GCP 01	-0.003	0.001	0.101
GCP 02	0.000	0.002	0.034
GCP 03	0.000	0.002	0.101
GCP 04	0.015	0.102	0.101
GCP 05	-0.001	0.001	-0.242
GCP 06	0.000	-0.001	0.013
GCP 07	0.002	-0.001	-0.001
GCP 08	0.000	0.000	-0.171
GCP 09	0.000	-0.001	-0.074
GCP 10	0.016	0.034	0.010
GCP 11	-0.001	0.001	-0.041
GCP 12	-0.008	0.000	0.029
GCP 13	-0.036	-0.019	0.095
GCP 14	0.002	-0.002	-0.026
GCP 15	0.000	0.001	0.093
GCP 16	0.002	-0.006	0.023
GCP 17	0.000	0.001	-0.285
SUM	**-0.012**	**0.114**	**-0.242**
RMSEr =			**0.027898**
RMSEz =			**0.058669**
Horizontal Accuracy =			**0.048286**
Vertical Accuracy =			**0.114992**

Table 1: Results of the model's accuracy assessment

RMSEr and RMSEz values of 0.027898 and 0.058669 respectively and horizontal and vertical accuracies of 0.048286m and 0.114992m respectively (Table 1) were obtained from the model's accuracy assessment which shows the measure of reliability and accurateness of the generated DEM.

CONCLUSION

This study has demonstrated the possibility of challenging the norms of conventional photogrammetry with the advent of technological advancement. Specifically, it has shown that the accurate generation of DTM, DSM and DEM from low percentage (approximately 25%) overlapping images is possible using UAVs. Though gaps are visible on the produced models, the accuracy of the obtained results (from the UAV generated 3-D models) is comparable with the results obtained using DGPS receivers.

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Michael, G., Roland, P., Martin, P. (2004). The all-digital photogrammetric workflow: Redundancy and robustness. Proceedings of ISPRS Commission I: Sensors, Platforms and Imagery. Istanbul, Turkey. XX, 232-234.

Oluibukun Ajayi is an Academic at the Department of Surveying and Geoinformatics, Federal University of Technology, Minna. He holds a BTech and MSc with a First Class Honours and Distinction respectively in Surveying and Geoinformatics and he is at the verge of completing his PhD programme also in Surveying and Geoinformatics (Remote Sensing and Photogrammetry Major). He is the recipient of the Len Curtis Award, 2018.

How to write an effective peer-review report: an editor's perspective

An interview with Tim Warner, IJRS Editor in Chief

You recently wrote an editorial for the International Journal of Remote Sensing on how to write a peer-review report for a journal. ("How to write an effective peer-review report: an editor's perspective." (2019), International Journal of Remote Sensing, 40 (13): 4871-4875. https://doi.org/10.1080/01431161.2019.1596342) What prompted you to write an editorial on this theme?

Like most students and early career professionals, I never received any mentoring in how to write peer-review reports for journals. Thus, I learned on the job, doing my best, but without really thinking about how the editor would use my reports. Now, in my role as an editor, I have come to realize that my early peer review reports were not that useful. Given how much time I put into those reports, I think that it is a pity I didn't do a better job.

What were you doing wrong?

My principal mistake was my peer-review reports were simply lists of items I noted about the paper as I read the paper. Key concerns were often buried in amongst minor issues such as spelling mistakes.

What would be a better way of structuring the report?

For most journals, a good review has four parts:

1. An evaluation of the contribution of the paper in terms of its significance and novelty.

2. A list of major concerns, which are items that will determine whether the paper should be published.

3. A separate list of minor issues that would help to improve the paper, but in general will not influence whether the paper is publishable or not.

4. A summary evaluation and recommendation regarding whether the paper is potentially publishable.

This structure helps the editor synthesize the key issues regarding the paper, and to come to a final decision on the fate of the paper. It is particularly helpful in the all-too common situation where the referees give very different evaluations regarding the potential of the paper for publication.

What to you mean by evaluating the paper's contribution terms of significance and novelty?

The contribution of a paper can be quite varied. Novelty and innovation in research is always prized. However, a paper that does not have novel insight could still potentially make a useful contribution. For example, a paper that highlights best practices and points out common errors in many current remote sensing analyses, could be every bit as valuable as something that is novel. Thus, a referee should be open-minded in approaching a paper.

Could you expand on what you mean by having an open mind in approaching a paper?

A referee's report should ideally help both the editor and author. Most referees understand the importance of providing an impartial evaluation for the editor. However, the review should also engage with the manuscript in the context of the author's aims, to provide sympathetic but critical suggestions for improving the manuscript. It is easy to give broad, sweeping criticism of a work. Constructive, thoughtful suggestions can make

a big difference to a paper, helping not just the author but even future readers.

You place special emphasis in the editorial on ethical considerations. Why is that?

In my experience, the overwhelming majority of referees are honest, thoughtful scholars, who generous give of their time to the remote sensing community in providing peer-reviews. Nevertheless, it is surprising to me to see that many referees do not adequately consider the ethical dimensions of reviewing another scholar's work.

Could you give some examples of the ethical dimensions of peer-review?

All ethical issues are important. Some issues are obvious, and are I think generally understood and honored. For example, most referees understand they should report any potential conflicts of interests that might compromise their impartiality. In addition, referees are generally very careful in honoring the confidential nature of a review. However, there are two areas where I see common ethical lapses.

First, referees often provide reviews much later than the agreed upon date. Even worse is when referees never produce a promised review, potentially delaying a decision on the paper by weeks or even months. A significant delay in the handling of a paper can have serious repercussions for an author, for example if a paper is needed as a pre-requisite for graduation or for promotion. Of course, there will always be completely legitimate reasons that a review might be delayed, for example if the referee is ill. But the key is the referee should contact the editor immediately the problem is evident, and discuss the nature and extent of the delay.

The second concern is that referees often abuse the power relations between the referee and the author by asking the author to cite the referee's own papers.

Is it always unethical for a referee to suggest to an author to cite the referee's papers?

There are many situations where it is perfectly appropriate, in fact desirable, to bring the referee's own work to the attention of the author. I think the way to understand the ethical dimensions of this issue is to consider who benefits if the referee's papers are cited in the paper. To illustrate this idea, consider two hypothetical scenarios. In the first scenario, the referee writes, "If the authors consult the procedures in [my] paper on atmospheric correction they may be able reduce the noise in their results." In the second scenario, the referee simply writes, "Please cite the following three key papers [of mine]." The key is that in the first scenario, consulting the new paper can potentially strengthen the paper. In the second case, there is no substantive improvement to the paper and the referee is unethically exploiting the author's desire for the paper to be published.

It seems this issue of writing peer-review reports is quite a complex subject. What other resources are available on the topic?

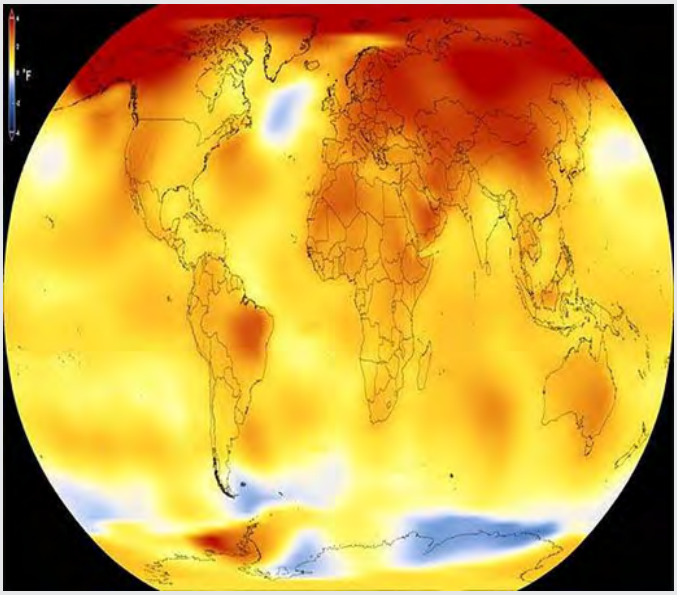
The editorial gives a lot more detail on these and related issues. Readers may also wish to consult a website on this topic created by Taylor and Francis, the publishers of the International Journal of Remote Sensing (IJRS)and Remote Sensing Letters website on writing peer review reports. https://editorresources.taylorandfrancis.com/reviewer-guidelines/ IJRS has also teamed with Publons, a social media website that tracks peer-review efforts. Publons offers the Publons Academy, in which scholars can learn about, and even receive individual mentoring in peer-review. Finally, IJRS is a member of the Committee for Publishing Ethics (COPE). COPE has many useful resources on publishing ethics on its website, www.publicationethics.org

PRISMA satellite launched

Italy's PRISMA satellite has begun its mission orbiting Earth on March 22nd. Its hyperspectral eyes will soon observe and acquire new images of Earth giving insight into its natural resources. PRISMA is an Italian Space Agency's satellite demonstrator. Using the VEGA launcher, it took off from the European base of Kourou in French Guyana at 2.50 am GMT+1. Now the satellite will face three months of verifications; its operational activity will start in June 2019. PRISMA's full program cost 126 million Eur. It will produce significant industrial and scientific benefits for the national community and around the planet.

NASA temperature reevaluation

A new assessment has revealed that NASA's estimation of the Earth's long-term temperature rise is accurate to within 0.05 degrees Celsius for recent decades. The study of statistical uncertainty within the existing GISS surface temperature analysis data product, built on readings from 6,300 weather stations, confirms that the global temperature of the earth has increased by slightly more than 1 degree celsius since 1880 cannot be explained by uncertainty or error within the analysis. These robust new statistical methods will provide a firmer base for ongoing monitoring of global warming, as well as forecasting global changes as a result of it.



Source: NASA

DigitalGlobe, the ubiquitous brand which lead the development and distribution of the WorldView series of satellites/data, is no more. The brand, along with SSL technologies and Radiant Solutions, are now under the umbrella of Maxar, in a move intended to simplify the solutions and partnerships which Maxar operate.

MAXAR TECHNOLOGIES

Wavelength 2019

Luigi Parente

The School of Architecture, Building and Civil Engineering (ABCE) based on the Loughborough University 440 acre single-site campus was chose as location for the 7th edition of the Wavelength conference (25 – 27 March, 2019). The conference has hosted a rich mix of post-graduate students, academics and representatives from sponsors. A total of 17 oral presentations and 6 posters were exhibited during the 3 days long event.

Registration opened on Monday at noon and an ice-breaker lunch was served in the area adjacent to the conference room at the School of ABCE. After lunch, Luigi Parente (Wavelength Rep) welcomed all attendees and opened the first session which started with a range of presentations based around the use of space-born data including: use of InSAR technology to track surface deformation over permafrost regions (Zhenming Wu, University of Reading), for modelling the dynamics of dune movement (Ahmed Mutasim Abdalla Mahmoud, University of Nottingham) and to assess landslide susceptibility in combination with optical data (Udeme Nkanga, University of Nottingham), application of LiDAR datasets for hydrogeologic investigations on a karstic island in the Phillippine Archipelago (Robert M. DiFilippo, Loughborough University) and modelling of hourly global horizontal irradiance from satellite-derived datasets and climate variables as new inputs with artificial neural networks (Bikhtiyar Ameen, University of Leicester).

The first session was followed by an eloquent keynote talk delivered by Dr. Richard Armitage (University of Salford and Chair of the RSPSoc). Dr. Armitage's presentation ranged from an inspirational career-orientated talk and benefits for members of the RSPSoc to issues related to the routine measurement of phenology in the UK. The successive session included two talks delivered by Chun-Hsing Ho (Northern Arizona University, USA) who illustrated the use of cost-effective sensors mounted on cars or bikes to predict road surface conditions and described a GIS-based mapping solution used for recording and displaying detected road conditions. The first day was closed by a '2 minute poster introduction' before participants walked together to the centre of Loughborough for a meal at 'The Fenways' (local pub with great variety of craft beers).

keynote speaker, Dr. Richard Armitage

Day 2 kicked off with a rousing speech by the second keynote speaker, Prof. Jim Chandler (Loughborough University). Prof. Chandler shared his experiences as photogrammetrist delivering a talk titled "From analytical to SfM photogrammetry – how to exploit change". His tips on how to become 'successful researchers' were well received by all delegates attending the conference which approached him for further questions during the break.

After a short coffee/tea break, five talks on photogrammetric studies completed the second day of presentations. The works presented included the application of SfM photogrammetry to historical imagery (William Jay, Plymouth Marine Laboratory), a bathymetric assessment of rivers based on a UAV-SfM approach (Amy Woodget, Loughborough University), optimisation of the use of UAVs and SfM to characterise river bed sediments (Leo Camelo, Loughborough University), volumetric measurement combining

low cost photogrammetry and a robotic platform (Ben Sargeant, University College London) and the use of convolutional neural networks for delineating agricultural masks (Alex M. Hamer, Cranfield University).

Amy Woodget presentation

On day 3 the last session was focussed on the use of UAV. After a stimulating review of UAV platforms, sensors and potential applications by Federica Frontera (University of Nottingham), the audience 'flew' to the beautiful Utile island in the Caribbean, where Emma Higgins (University of Nottingham), is employing airborne remote sensing to study the abundance, distribution and microhabitat use of Anolis lizards. Aleksandra Zaforemska (Newcastle University) talked about several segmentation algorithms for individual tree detection from UAV LiDAR point clouds and following, Olumese Efeovbokhan from the University of Nottingham explained how he is using data collected with unmanned aerial vehicles to generate high resolution data required for hydrological modelling.

After a short break, Emily Winter and Nicole Anderson from Geospatial Insight (one of the conference sponsors) engaged the attendees presenting Hexagon Geospatial products. Proceeding finished with the announcing of the best oral and poster presentation.

Emily Winter and Nicole Anderson

Wavelength 2020 will take place at University of Nottingham organized by Emma Higgins and supported by the next Wavelength Rep (Mortimer Werther, University of Stirling).

I strongly encourage any interested parties to get involved!

Luigi Parente is a third year PhD student at the School of Architecture, Building and Civil Engineering, Loughborough University, UK. He is a geoscientist with interest in slope instabilities and monitoring techniques including photogrammetry and remote sensing. Currently his research is orientated at developing a low-cost monitoring system for geomorphic change based on the use of SfM photogrammetry

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Non RSPSoc or RSPSoc affiliated conferences:

ISPRS WG IV/1, WG V/5, "Student Consortium Summer School "Geospatial technologies for natural environment management and monitoring"

- Date: August, 26-30, 2019
- Abstract submission:
- Venue: Wroclaw , Poland
- More information: http://isprs.pwr.edu.pl/

ISPRS ICWG III/Iva GI4DM "GeoInformation for Disaster Management"

- Date: September 3-6th, 2019
- Abstract submission: Closed
- Venue: Prague, Czech Republic
- More information: http://www.gi4dm2019.org/

ISPRS TC I & WG I/10 Workshop and Summer School on the Evaluation and Benchmarking Sensors, Systems and Geospatial Data in Photogrammetry and Remote Sensing

- Date: September 16-20th, 2019
- Abstract submission: July 31st, 2019
- Venue: Warsaw, Poland
- More information: http://ptfit.sgp.geodezja.org.pl/workshop2019/

Nordic Remote Sensing Conference 2019

- Date: September, 17-19th, 2019
- Abstract submission: Closed
- Venue: Aarhus Institute of Advanced Studies (AIAS), Aarhus University, Denmark
- More information: http://aias.au.dk/events/aias-conference-nordic-remote-sensing-2019-norsc19/

MRSS19 - Munich Remote Sensing Symposium 2019

- Date: September, 18-20th, 2019
- Abstract submission: April 15th, 2019
- Venue: Munich, Germany
- More information: http://www.mrss.tum.de

ISPRS ICWG II/III PIA19 "Photogrammetric Image Analysis 2019"

- Date: September, 18-20, 2019
- Abstract submission: Closed
- Venue: Munich, Germany
- More information: http://www.pf.bgu.tum.de/isprs/pia19/

10th Workshop on Hyperspectral Image and Signal Processing: Evolution in Remote Sensing

- Date: September, 24-26th, 2019
- Abstract submission: Closed
- Venue: Amsterdam, The Netherlands
- More information: http://www.ieee-whispers.com/conference-info/

ISPRS WG V/7 International Workshop "Measurement, Visualisation and Processing in BIM for Design and Construction Management"

- Date: September, 24-25, 2019
- Abstract submission: Closed
- Venue: Prague, Czech Republic
- More information: http://mvpbim2019.org/

International Conference on Geo-Information Technology and Its Applications (ICGITA 2019) in Nanchang, China

- Date: October, 11-13th, 2019
- Abstract submission: July 20th, 2019
- Venue: Jiangxi, China
- More information: www.icgta2019.net

Joint SMPR and GIResearch 2019: "Sensors and Models in Photogrammetry and Remote Sensing"

- Date: October, 12-14, 2019
- Abstract submission: Closed
- Venue: Tehran, Iran
- More information: https://geospatialconf2019.ut.ac.ir/

Conference calendar:

RSPSoc is proud to announce the following meetings organised by the Society and our affiliated Special Interest Groups

Date	Meeting	Venue	Contact
13th September 2019	RSPSoc Annual Conference	Satellite Applications Catapult	RSPSoc@nottingham.ac.uk

We are also pleased to promote the following events from RSPSoc's affiliated organisations

Date	Meeting	Venue	Contact
October, 25-27th, 2019	ISPRS Workshop on Remote Sensing and Synergic Analysis on Atmospheric Environment	Nanjing, China	http://isprs-2019.csp.escience.cn/dct/page/1
December, 2-3rd, 2019	ISPRS TC II: "LowCost 3D 2019"	Sousse, Tunisia	https://www.cajg.org/
December, 9-13th, 2019	GRSG Annual Conference and AGM 'Exploring New Frontiers'	Frascati, Italy	http://www.grsg.org.uk/agm30th/

For further information on the RSPSoc Technical Programme please access the Events tab on: www.rspsoc.org.uk

The Society encourages members to organise meetings. Anyone interested in organising a meeting should contact the Technical Programme Chairman, Kay Smith, in the first instance. These enquiries should be directed through the RSPSoc Office (rspsoc@nottingham.ac.uk).

Become a corporate member of RSPSoc

The RSPSoc is the UK's leading Society for remote sensing and photogrammetry. We engage with a wide range of stakeholders in education, science, research, industry, commerce and public services. As a charity, our remit is to inform and educate our members and the public, and as an international Society, RSPSoc is active both nationally, and internationally. We organise regular meetings and hold a prestigious and highly attended Annual Conference. We would love to have your company on-board as part of our membership. Why not join our growing society at: www.rspsoc.org.uk enjoy from a range of excellent benefits:

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- **Postings to the RSPSoc website eg your Company Profile, announcing new products and services, advertise jobs etc. Items can also be included in SENSED (at Editor's discretion) and email listserver. Contact RSPSoc office for further details**
- **Entitlement for staff to apply for RSPSoc New Professional Membership which has other associated benefits**

Join now!

The RSPSoc Newsletter and mailings go to all members of The Remote Sensing and Photogrammetry Society and currently we have more than 1000 international members (of whom approximately 65% are UK, 20% are European and 15% are international).

By joining our society through corporate membership you can reach out to all of our members through a range of communication media (website, email and newsletter). Making use of this huge knowledge and skills pool is easy once you're a member of the Society.

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Commercial members interested in advertising in the Newsletter should email copy to the Editor at newsletter@rspsoc.org.uk; most formats can be accommodated. For inserts in the Society mailing please contact us for information on postage deadlines and exact numbers of copies required. All orders should be accompanied by remittance.

Type	Corporate member	Non-member	Special rate for next two issues
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Half page colour advertisement in one newsletter	£300	£400	£150 member / £300 non-member
Advertiser-supplied, loose-leaf inserts posted to all society members in newsletter mailing	£600	£1000	not available

Please contact newsletter@rspsoc.org.uk for a copy of the conditions attached to advertising contracts.

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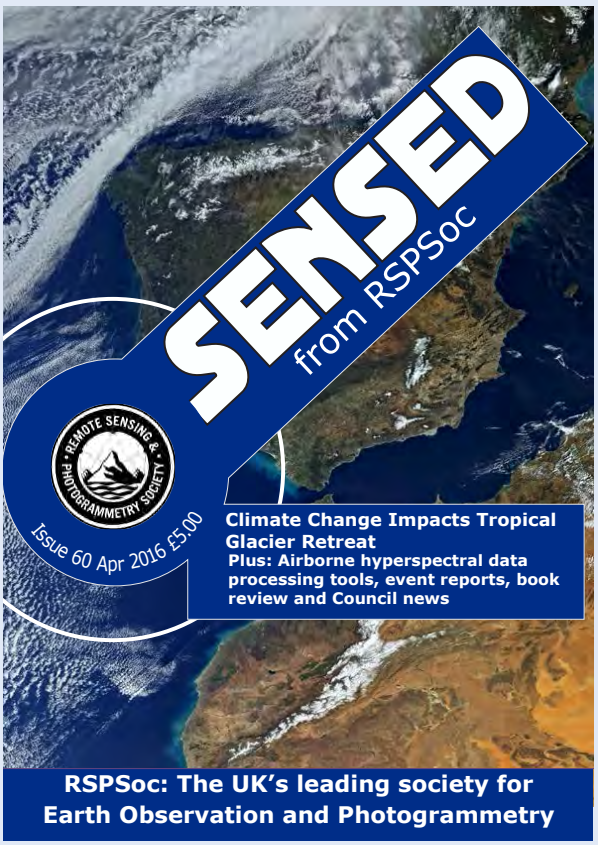
SENSED - Guidelines for authors

We are seeking **science-focused** articles for *SENSED*, the magazine of the Remote Sensing and Photogrammetry Society. *These guidelines also apply to authors submitting meeting reports.*



Your article will get exposure to around 1,500 international readers which will raise the profile of your research and can lead to increased citations of your papers.

We are looking for articles which:

- Summarise a new development within the fields of remote sensing and/or photogrammetry
- Raise thought-provoking questions to develop a discussion within the community
- Review a scientific meeting of relevance to the fields
- Provide an overview of an exciting new product or sensor in the commercial sector

Articles should be 500-1000 words long, can be submitted to the Editor at any time, and will be carefully reviewed before publication. If you are aiming for a particular issue then please discuss this with the Editor beforehand, and respect the deadlines below.

To submit an article, please email the following to newsletter@rspsoc.org.uk

- The raw text of your article *with no extra formatting (including embedded images, citations or footnotes)* as a Word document or a plain text file
- Some appropriate graphics (photographs, diagrams or graphs) *as separate files in JPEG, TIFF or PNG format*. All articles must be accompanied by at least one graphic, if in doubt then include more graphics and let the Editor decide. Please provide a caption for each submitted graphic.
- A short (approximately fifty word) biography of the author, written in the third person (for example, [*Name]/[surname] is a X and he did his PhD at Y...*), and a head-and-shoulders photograph (in one of the formats above)
- If relevant, up to three references to relevant publications can be included (formatted in the International Journal of Remote Sensing style, with author-date citations in the text)

We look forward to receiving your submissions!

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Deadlines

April issue: 1st March
July issue: 1st June
October issue: 1st September
January issue: 1st December

Frascati 19

30th Anniversary Event

GRSG ANNUAL CONFERENCE & AGM

9TH TO 13TH DECEMBER 2019

EXPLORING NEW FRONTIERS

THE GRSG IS DELIGHTED TO ANNOUNCE THAT OUR 30TH ANNIVERSARY ANNUAL CONFERENCE AND AGM WILL BOTH TAKE PLACE AT THE OFFICES OF THE EUROPEAN SPACE AGENCY IN FRASCATI, ITALY.

THIS VERY SPECIAL CONFERENCE WILL BRING TOGETHER THE GRSG MEMBERSHIP TO EXPLORE HOW THE LAST THIRTY YEARS HAVE SHAPED OUR INDUSTRY AND, MORE IMPORTANTLY TO DISCOVER WHAT THE NEXT THREE DECADES OF GEOLOGIC REMOTE SENSING WILL BRING.

IMPORTANT DATES

CALL FOR ABSTRACTS OPEN:	01 MAY 2019
CALL FOR ABSTRACTS CLOSES:	01 SEP 2019
CONFERENCE TICKETS ON SALE:	01 JUL 2019

SPECIAL GEOLOGICAL SOCIETY PUBLICATION

THIS YEAR, AS A CELEBRATION, WE ALSO PLAN TO PREPARE A SPECIAL GEOLOGICAL SOCIETY PUBLICATION FROM OUR TECHNICAL PROGRAMME. WE WOULD LOVE TO INCLUDE A WIDE DIVERSITY OF PRESENTATIONS, AS ALWAYS, IN OUR TECHNICAL PROGRAMME AND WITHIN THIS VERY SPECIAL CELEBRATION PUBLICATION AND ENCOURAGE SUBMISSIONS WITH THIS IN MIND.

GRSG
GEOLOGICAL REMOTE SENSING GROUP

WWW.GRSG.ORG.UK/AGM30TH