



Institute of Archaeology

ARCL0143  
Geophysical survey in Archaeology  
MSc, 15 credit module

2022–2023

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Room 204c

Deadline: 28th April 2023



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This document and other resources are available from the Moodle.



# 1 Overview

## Module description

This course provides a working knowledge of the theory, method, equipment and software associated with geophysical survey in archaeology. Students develop practical familiarity with basic GIS for the production of reports, and geophysical survey packages such as TerraSurveyor, and a variety of equipment for field capture of geophysical data.

The structure of the course provides students with opportunities for both field- and lab-based learning and is taught using a combination of lectures and practical lab sessions in the Institute's AGIS laboratory, as well as a short fieldwork component. It is assessed via a project report.

## Module aims

- To introduce the main geophysical survey techniques used in archaeology.
- To demonstrate how to interpret geophysical survey data.
- To show how basic Earth Resistance and magnetometry data can be processed.
- To show the various ways in which geophysical surveys may be reported.
- To provide hands-on experience of undertaking surveys in the field.

## Learning outcomes

By the end of the course the students should:

- have a basic understanding of the advantages and disadvantages of the various survey methods;
- have a basic understanding of field procedure;
- be able to process magnetometry and Earth Resistance data;
- have an understanding of the processing and interpretation of survey data;
- be able to write a survey report.

## Methods of assessment

This course is assessed by means of a project report based on the data collected during fieldwork. The report should be a maximum of 3,000 words (excluding captions, citations and bibliography). During the course, students are encouraged to seek feedback on the outcome of their practical exercises as a means of formative assessment.

## Communications

- Moodle is the hub for this course.
- Important information will be emailed to you via the QuickMail feature of Moodle. Please check your UCL email regularly. If you mainly use a different email address, consider forwarding your UCL emails to it.
- If you have any queries, please email Kris.

## Week-by-week summary

Week	Date	Subject
1	13th January 2023	Introduction to the course. Surveying, grids and GPS. Practical: getting images into Google Earth and QGIS.
2	20th January 2023	Earth Resistance survey (1). Practical: basic data processing in TerraSurveyor.
3	27th January 2023	Earth Resistance survey (2). Practical: further data processing in TerraSurveyor.
4	3rd February 2023	Magnetometry (1). Practical mag data processing using grids.
5	10th February 2023	Magnetometry (2). Practical mag data processing using GPS.
6	13th–17th February 2023	<i>Reading week</i> Practical course at St Albans / Sopwell
7	24th February 2023	Ground Penetrating Radar (1). Practical: demonstration of GPR data processing.
8	3rd March 2023	Ground Penetrating Radar (2). Practical: creating interpretation maps.
9	10th March 2023	EM and magnetic susceptibility surveying. Practical: mag sus data processing.
10	17th March 2023	Data fusion. Practical: data fusion data processing.
11	24th March 2023	Report writing and archiving. Practical: creating layouts in QGIS.

## Weekly module plan

Teaching will be by a mixture of lectures and supervised practical exercises. Each approximately one hour lecture will be followed by a one hour computing practical.

N.B. Participation in practical exercises is limited by the availability of suitably equipped computers, and is *guaranteed only for those who are taking this course as an examined module for a Masters degree*.

The course also includes a two-day field course held in reading week.

## Workload

There will be 10 hours of seminars/lectures for this course and 10 hours of supervised practicals, as well as 10 hours on the field course. You will be expected to undertake around 70 hours of reading and independent project work for the course, plus 50 hours producing the assessed work. This adds up to a total workload of 150 hours for the course.

## Basic texts

The key texts for this course are:

CONYERS, L. B. 2012. *Interpreting Ground-Penetrating Radar for Archaeology*. Left Coast Press, Walnut Creek. INST ARCH AL 12 QTO CON.

CONYERS, L. B. 2013. *Ground-penetrating Radar for Archaeology*. AltaMira Press, Lanham, third edition. INST ARCH AL 12 CON.

- GAFFNEY, C. F., J. GATER & S. OVENDEN 2002. *The Use of Geophysical Techniques in Archaeological Evaluations*. CIfA, Reading, second edition. INST ARCH GAF; INST ARCH AL QTO. GAF.
- GAFFNEY, C. F. & J. GATOR 2002. *Revealing the Buried Past. Geophysics for Archaeologists*. Tempus, Stroud. ISSUE DESK IOA GAF 2.
- JOHNSON, J. K. (ed.) 2006. *Remote Sensing in Archaeology: An Explicitly North American Perspective*. University of Alabama Press, Tuscaloosa. INST ARCH AL 13 JOH.
- JONES, R. E. & L. SHARPE (eds.) 2006. *Going over old ground. Perspectives on archaeological geophysical and geochemical survey in Scotland, Proceedings of a conference held at the Department of Archaeology, University of Glasgow, Scotland, August 2003*. British Archaeological Report 416, Oxford. INST ARCH DAA QTO SERIES BRI 416.
- SCHMIDT, A., P. LINFORD, N. LINFORD, A. DAVID, C. GAFFNEY, A. SARRIS & J. FASSBINDER 2015. *EAC Guidelines for the use of Geophysics in Archaeology: Questions to Ask and Points to Consider*. Europae Archaeologia Consilium and the Association Internationale sans But Lucratif, Namur. Also available from <https://www.europae-archaeologiae-consilium.org/eac-guidlines>. INST ARCH AK 40 SCH.

## 2 Assessment

The assessment consists of a single project report based on the fieldwork undertaken in reading week. Data will be provided for the magnetometry and earth resistance surveys, and processed images provided for the GPR survey. More detailed information and advice will be given after reading week when we know what data we have managed to collect.

## 3 Schedule and syllabus

### 3.1 Teaching schedule

The course will be taught in Term 2. Classes will be held on Fridays, with lectures and practicals in the AGIS lab from 13:00–15:00. In addition, a mandatory two-day field course will also take place in Reading Week about which further details will be made available when confirmed.

### 3.2 Detailed week-by-week syllabus

The following is an outline for the course as a whole, and identifies essential and supplementary readings relevant to each session. Information is provided as to where in the UCL library system individual readings are available. For journals, if no specific location is given they are available over the internet either via the library catalogue or the online reading list which can be accessed via Moodle. Often, however, the images are poor and you might like to look at the printed versions in the library.

#### Session 1: Introduction to Geophysical survey

Aims and methods in geophysical survey; survey basics (grids, GPS).

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## Reading

The best general book in archaeological geophysics remains that by Gaffney & Gator (2002) and should be seen as essential reading for most of the course. The paper by Millett (2013) has many sensible comments on geophysical survey from the perspective of an archaeological ‘consumer’.

There is surprisingly little on issues to do with gridding-out surveys. The guide by Historic England (2015a) discusses GPS surveying in general.

ENGLISH HERITAGE 2008. *Geophysical Survey in Archaeological Field Evaluation*. English Heritage, second edition. <https://content.historicengland.org.uk/images-books/publications/geophysical-survey-in-archaeological-field-evaluation/geophysics-guidelines.pdf/>.

GAFFNEY, C. F., J. GATOR & S. OVENDEN 2002. *The Use of Geophysical Techniques in Archaeological Evaluations*. CIfA, Reading, second edition. INST ARCH GAF; INST ARCH AL QTO. GAF.

GAFFNEY, C. F. & J. GATOR 2002. *Revealing the Buried Past. Geophysics for Archaeologists*. Tempus, Stroud. ISSUE DESK IOA GAF 2.

HISTORIC ENGLAND 2015a. *Where on Earth Are We? The Role of Global Navigation Satellite Systems (GNSS) in Archaeological Field Survey*. Historic England, London, second edition. Available from <https://historicengland.org.uk/images-books/publications/where-on-earth-gnss-archaeological-field-survey/>.

HISTORIC ENGLAND 2015b. *Where on Earth Are We? The Role of Global Navigation Satellite Systems (GNSS) in Archaeological Field Survey*. Historic England, London, revised edition. <https://historicengland.org.uk/images-books/publications/where-on-earth-gnss-archaeological-field-survey/>.

HISTORIC ENGLAND 2018. *Using Airborne Lidar in Archaeological Survey: The Light Fantastic*. Historic England, Swindon. <https://historicengland.org.uk/images-books/publications/using-airborne-lidar-in-archaeological-survey/>.

MEYER, C. 2013. ‘Interpretation and guidelines for reporting.’ In C. Corsi, B. Slapšak & F. Vermeulen (eds.), *Good Practice in Archaeological Diagnostics*, pp. 177–90. Springer, Cham, Heidelberg, New York, Dordrecht and London. Ebook available via library. INST ARCH AL12 COR.

MILLETT, M. J. 2013. ‘Understanding Roman Towns in Italy: Reflections on the role of geophysical survey.’ In P. Johnson & M. J. Millett (eds.), *Archaeological Survey and the City*, pp. 24–44. Oxbow, Oxford. ISSUE DESK IOA JOH 6.

SCHMIDT, A., P. LINFORD, N. LINFORD, A. DAVID, C. GAFFNEY, A. SARRIS & J. FASSBINDER 2015. *EAC Guidelines for the use of Geophysics in Archaeology: Questions to Ask and Points to Consider*. Europae Archaeologia Consilium and the Association Internationale sans But Lucratif, Namur. Also available from <https://www.europae-archaeologiae-consilium.org/eac-guidlines>. INST ARCH AK 40 SCH.



## Practical

Today's practical will look at getting geophysics data plots into Google Earth and QGIS as images.

## Session 2: Earth Resistance survey (1)

This lecture will introduce you Earth Resistance survey. The basic techniques will be introduced and then some of the issues and choices discussed.

## Reading

See the relevant sections in Gaffney & Gator (2002).

ASTIN, T., H. ECKARDT & S. HAY 2007. 'Resistivity Imaging Survey of the Roman barrows at Bartlow, Cambridgeshire, UK.' *Archaeological Prospection* 14: 24–37. INST ARCH PERS.

CAMPANA, S. & S. PIRO (eds.) 2009. *Seeing the Unseen. Geophysics and landscape archaeology*. CRC Press, Boca Raton, London, New York and Leiden. INST ARCH AL 12 CAM.

CARRERAS MONFORT, C. 2013. 'Earth resistance survey: a mature archaeological geophysics method for archaeology.' In C. Corsi, B. Slapšak & F. Vermeulen (eds.), *Good Practice in Archaeological Diagnostics*, pp. 153–63. Springer, Cham, Heidelberg, New York, Dordrecht and London. Ebook available via library. INST ARCH AL12 COR.

DABAS, M. 2009. 'Theory and practice of the new fast electrical imaging system ARP©.' In Campana & Piro (2009), pp. 105–26. See the case studies towards the end of the paper. INST ARCH AL 12 CAM.

DABAS, M., A. HESSE & J. TABBAGH 2000. 'Experimental resistivity survey at Wroxeter archaeological site with a fast and light recording device.' *Archaeological Prospection* 7: 107–18.

GAFFNEY, C. F. & J. GATOR 2002. *Revealing the Buried Past. Geophysics for Archaeologists*. Tempus, Stroud. ISSUE DESK IOA GAF 2.

SCHMIDT, A. 2009. 'Electrical and magnetic methods in archaeological prospection.' In Campana & Piro (2009), pp. 67–81. INST ARCH AL 12 CAM.

SCHMIDT, A. 2013. *Earth Resistance in Archaeology*. Altamira, Plymouth. INST ARCH AL 12 SCH.

SOMERS, L. 2006. 'Resistivity survey.' In J. K. Johnson (ed.), *Remote Sensing in Archaeology: An Explicitly North American Perspective*, pp. 109–29. University of Alabama Press, Tuscaloosa. INST ARCH AL 13 JOH.

WALKER, A. R. 2000. 'Multiplexed resistivity survey at the Roman town of Wroxeter.' *Archaeological Prospection* 7: 119–32.

WALLIS, N. J. & V. D. THOMPSON 2019. 'Early platform mound communalism and co-option in the American Southeast: Implications of shallow geophysics at Garden Patch Mound 2, Florida, USA.' *Journal of Archaeological Science: Reports* 24: 276–89.

## Practical

Basic Earth Resistance survey in TerraSurveyor.

### Session 3: Earth Resistance survey (2)

This lecture will discuss further Earth Resistance survey methods including multiplexed survey, resistivity tomography, square arrays and using a cart system.

## Reading

As for last week.

## Practical

Further Earth Resistance survey in TerraSurveyor. ERT processing in Res2DInv.

### Session 4: Magnetometry (1)

This session will examine the principals and practicalities of magnetometry survey.

## Reading

See the relevant sections of Gaffney & Gator (2002).

ASPINALL, A., C. GAFFNEY & A. SCHMIDT 2008. *Magnetometry for Archaeologists*. Altamira, Lanham, New York, Toronto and Plymouth. INST ARCH AL 13 ASP.

BURKS, J. & R. A. COOK 2011. 'Beyond Squier and Davis: rediscovering Ohio's earthworks using geophysical remote sensing.' *American Antiquity* 76(4): 667–89. INST ARCH PERS.

CAMPANA, S. & S. PIRO (eds.) 2009. *Seeing the Unseen. Geophysics and landscape archaeology*. CRC Press, Boca Raton, London, New York and Leiden. INST ARCH AL 12 CAM.

CREIGHTON, J. & R. FRY 2016. *Silchester: Changing Visions of a Roman Town*. Britannia Monograph Series 28. Society for the Promotion of Roman Studies, London. INST ARCH DAA 410 QTO CRE; ISSUE DESK IOA CRE 2.

GAFFNEY, C. F., J. A. GATER, P. LINFORD, V. L. GAFFNEY & R. WHITE 2000. 'Large-scale systematic Fluxgate Gradiometry at the Roman city of Wroxeter.' *Archaeological Prospection* 7: 81–99.

GAFFNEY, C. F. & J. GATOR 2002. *Revealing the Buried Past. Geophysics for Archaeologists*. Tempus, Stroud. ISSUE DESK IOA GAF 2.

JORDAN, D. 2000. 'Magnetic techniques applied to archaeological survey.' In M. Pasquinucci & F. Trémont (eds.), *Non-Destructive techniques applied to Landscape Archaeology*, pp. 114–24. Oxbow, Oxford. IOA DAG 100 QTO BAR.

KVAMME, K. 2006. 'Magnetometry: Nature's gift to archaeology.' In J. K. Johnson (ed.), *Remote Sensing in Archaeology: An Explicitly North American Perspective*, pp. 205–33. University of Alabama Press, Tuscaloosa. INST ARCH AL 13 JOH.

- LOCKYEAR, K. & E. SHLASKO 2017. ‘Under the Park. recent geophysical surveys at Verulamium (St Albans, Hertfordshire, UK).’ *Archaeological Prospection* 24(1): 17–36.
- POWLESLAND, D. 2009. ‘Why bother? large scale geomagnetic survey and the quest for “real archaeology”.’ *In* Campana & Piro (2009), pp. 167–82. INST ARCH AL 12 CAM.
- SCHMIDT, A. 2009. ‘Electrical and magnetic methods in archaeological prospection.’ *In* Campana & Piro (2009), pp. 67–81. INST ARCH AL 12 CAM.
- WHITE, R. H., C. GAFFNEY & V. L. GAFFNEY 2013. *Wroxeter, the Cornovii and the Urban Process. Final report of the Wroxeter Hinterland Project, 1994–1997. Volume 2, Characterizing the city.* Archaeopress, Oxford. INST ARCH DAA 410 QTO GAF.

## Practical

Basic magnetometry processing in TS with gridded data.

## Session 5: Magnetometry (2)

Further discussion of magnetometry survey.

## Reading

As for last week.

There are a series of large scale magnetometry surveys which are worth looking at. There is my work at Verulamium (Lockyear & Shlasko 2017, also see the project blog), surveys at Silchester (Creighton & Fry 2016), Wroxeter (White *et al.* 2013), hillforts in Dorset (Stewart & Russell 2017) and Orkney (Brend *et al.* 2020). It is worth browsing some of these to see how the results have been presented.

- BREND, A., N. CARD, J. DOWNES, M. EDMONDS & J. MOORE 2020. *Landscapes Revealed: geophysical survey in the heart of the Neolithic Orkney World Heritage Area 2002–2011.* Oxbow, Oxbow. AVAILABLE ONLINE VIA THE LIBRARY.
- CREIGHTON, J. & R. FRY 2016. *Silchester: Changing Visions of a Roman Town.* Britannia Monograph Series 28. Society for the Promotion of Roman Studies, London. INST ARCH DAA 410 QTO CRE; ISSUE DESK IOA CRE 2.
- LOCKYEAR, K. & E. SHLASKO 2017. ‘Under the Park. recent geophysical surveys at Verulamium (St Albans, Hertfordshire, UK).’ *Archaeological Prospection* 24(1): 17–36.
- STEWART, D. & M. RUSSELL 2017. *Hillforts and the Durotriges: a geophysical survey of Iron Age Dorset.* Archaeopress, Oxford. ONLINE VIA LIBRARY.
- WHITE, R. H., C. GAFFNEY & V. L. GAFFNEY 2013. *Wroxeter, the Cornovii and the Urban Process. Final report of the Wroxeter Hinterland Project, 1994–1997. Volume 2, Characterizing the city.* Archaeopress, Oxford. INST ARCH DAA 410 QTO GAF.

## Practical

Processing magnetic data collected using a GPS.

## Session 6: Ground Penetrating Radar (1)

This session will introduce at the third main geophysical technique: Ground Penetrating Radar.

### Reading

The best general introduction to GPR is that by Conyers (2013, 2004). His other books (Conyers 2012, 2017, 2016) are also worth consulting.

CONYERS, L. B. 2004. *Ground-Penetrating Radar for Archaeology*. Altamira, Walnut Creek, second edition. IOA AL 12 CON.

CONYERS, L. B. 2006. 'Ground-penetrating radar.' In J. K. Johnson (ed.), *Remote Sensing in Archaeology: An Explicitly North American Perspective*, pp. 131–59. University of Alabama Press, Tuscaloosa. INST ARCH AL 13 JOH.

CONYERS, L. B. 2012. *Interpreting Ground-Penetrating Radar for Archaeology*. Left Coast Press, Walnut Creek. INST ARCH AL 12 QTO CON.

CONYERS, L. B. 2013. *Ground-Penetrating Radar for Archaeology*. Altamira, Walnut Creek, third edition. IOA AL 12 CON.

CONYERS, L. B. 2016. *Ground-Penetrating Radar for Geoarchaeology*. Wiley Blackwell, Chichester. Online access via UCL library.

CONYERS, L. B. 2017. *Ground-Penetrating Radar and Magnetometry for Buried Landscape Analysis*. Springer, Cham. INST ARCH AL 12 CON; ISSUE DESK IOA CON 4.

CONYERS, L. B. & J. LECKEBUSCH 2010. 'Geophysical archaeology research agendas for the future: Some ground-penetrating radar examples.' *Archaeological Prospection* 17: 117–23.

FINZI, E. & S. PIRO 2000. 'Radar (G.P.R.) methods for historical and archaeological surveys.' In M. Pasquinucci & F. Trémont (eds.), *Non-Destructive techniques applied to Landscape Archaeology*, pp. 125–35. Oxbow, Oxford. IOA DAG 100 QTO BAR.

GAFFNEY, C. F. & J. GATOR 2002. *Revealing the Buried Past. Geophysics for Archaeologists*. Tempus, Stroud. ISSUE DESK IOA GAF 2.

GOODMAN, D. 2009. 'GPR methods for archaeology.' In S. Campana & S. Piro (eds.), *Seeing the unseen. Geophysics and landscape archaeology*, pp. 229–44. CRC Press, Boca Raton, London, New York and Leiden. INST ARCH AL 12 CAM.

NOVO, A. 2013. 'Ground-Penetrating Radar (GPR).' In C. Corsi, B. Slapšak & F. Vermeulen (eds.), *Good Practice in Archaeological Diagnostics*, pp. 165–76. Springer, Cham, Heidelberg, New York, Dordrecht and London. Ebook available via library. INST ARCH AL12 COR.

### Practical

Demonstration of GPR-Slice.

## Session 7: Ground Penetrating Radar (2)

Further discussion of GPR survey including multichannel surveys.

## Reading

See last week.

## Practical

Creating interpretation maps.

## Session 8: Magnetic susceptibility survey, EM survey, multi-methods and ground truthing

### Reading

There are a variety of papers which should be consulted depending on your interests. That by Dalan (2008) should be considered essential. There are a few multiple instrument papers published, including a useful selection in the new book edited by McKinnon & Haley (2017).

CLAY, R. B. 2006. 'Conductivity survey: a survival manual.' *In* Johnson (2006), pp. 79–107. INST ARCH AL 13 JOH.

DALAN, R. 2006a. 'A geophysical approach to buried site detection using down-hole susceptibility and soil magnetic techniques.' *Archaeological Prospection* 13: 182–206.

DALAN, R. 2006b. 'Magnetic susceptibility.' *In* Johnson (2006), pp. 161–203. INST ARCH AL 13 JOH.

DALAN, R. 2008. 'A review of the role of magnetic susceptibility in archaeogeophysical studies in the USA: Recent developments and prospects.' *Archaeological Prospection* 15: 1–31.

HARGRAVE, M. 2006. 'Ground truthing the results of geophysical surveys.' *In* Johnson (2006), pp. 269–304. INST ARCH AL 13 JOH.

JOHNSON, J. K. (ed.) 2006. *Remote Sensing in Archaeology: An Explicitly North American Perspective*. University of Alabama Press, Tuscaloosa. INST ARCH AL 13 JOH.

KEAY, S., G. EARL, S. HAY, S. KAY, J. OGDEN & K. D. STRUTT 2009. 'The role of integrated geophysical survey methods in the assessment of archaeological landscapes: the case of Portus.' *Archaeological Prospection* 16: 154–66.

KVAMME, K. 2003. 'Geophysical surveys as landscape archaeology.' *American Antiquity* 68(3): 435–57.

KVAMME, K., E. ERNENWEIN, M. HARGRAVE, T. SEVER, D. HARMON & F. LIMP 2006a. 'New approaches to the use and integration of multi-sensor remote sensing for historic resource identification and evaluation.' Technical report, University of Arkansas. Final Report of SERDP Project SI-1263. <https://wayback.archive-it.org/6471/20110809194829/http://cast.uark.edu/home/research/geophysics/multi-sensor-data-fusion-for-historic-resource-identification/data-fusion-final-report.html>.

KVAMME, K., J. K. JOHNSON & B. S. HALEY 2006b. 'Multiple methods surveys: case studies.' *In* Johnson (2006), pp. 251–67. INST ARCH AL 13 JOH.

MCKINNON, D. P. & B. S. HALEY (eds.) 2017. *Archaeological remote sensing in North America: innovative techniques for anthropological applications*. University of Alabama Press, Tuscaloosa. INST ARCH AL 12 MCK.

## Practical

Mag sus data processing.

## Session 9: Data fusion

This week looks at merging or fusing data from different types of sensors and data sets. The intent is to demonstrate how disparate remotely sensed data can be brought together to create more informative data outputs than having only one type of data set.

## Reading

CONYERS, L. B. 2017. *Ground-Penetrating Radar and Magnetometry for Buried Landscape Analysis*. Springer, Cham. INST ARCH AL 12 CON; ISSUE DESK IOA CON 4.

KEAY, S., G. EARL, S. HAY, S. KAY, J. OGDEN & K. D. STRUTT 2009. ‘The role of integrated geophysical survey methods in the assessment of archaeological landscapes: the case of Portus.’ *Archaeological Prospection* 16: 154–66.

KVAMME, K. 2006. ‘Integrating multidimensional geophysical data.’ *Archaeological Prospection* 13(1): 57–72.

KVAMME, K., E. ERNENWEIN, M. HARGRAVE, T. SEVER, D. HARMON & F. LIMP 2006. ‘New approaches to the use and integration of multi-sensor remote sensing for historic resource identification and evaluation.’ Technical report, University of Arkansas. Final Report of SERDP Project SI-1263. <https://wayback.archive-it.org/6471/20110809194829/http://cast.uark.edu/home/research/geophysics/multi-sensor-data-fusion-for-historic-resource-identification/data-fusion-final-report.html>.

## Practical

Some basic data fusion.

## Session 10: Report writing and archiving

This week we will look at issues around writing reports and archiving the data. We will contrast the ‘typical’ commercial survey type report with publication in academic reports and excavation reports.

## Reading

Principally, look at any of the readings we have examined so far and contrast the those with some of the grey literature reports available on the ADS.

For archiving, see Schmidt (2013).

SCHMIDT, A. 2013. *Geophysical data in archaeology: a guide to good practice*. Oxbow Books, second edition.

## Practical

Creating layouts in QGIS.