

# Evaluating QField as a Mobile GIS Solution for Archaeological Survey

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## Abstract

The recent developments in the field of geospatial ‘free and open source software’ (F/OSS) are reflected in its more widespread use among archaeologists. The article presents practical application of one of these F/OSS programs, namely QField, for archaeologists. QField is mobile version of desktop GIS program QGIS, customized for Android platform. The salvage survey in the northern Israel at the site of Khirbet es-Swade/Ma’agar Snir and survey of Hellenistic and Roman fortifications in the southern Golan Heights provide case-studies for the utilization of the program. The program’s performance is evaluated with regard to 1) preparation and pre-processing of the data; 2) data collection and fieldwork; and 3) data export and post-processing.

**Keywords:** Archaeological survey; Archaeological methods; Mobile GIS; Open source software; Israel

## Introduction

The use of various computer applications in archaeology for recording, storage and analysis of the data is common occurrence in the contemporary research which encompasses survey, excavations and post-fieldwork analysis (Tripcevich – Wernke 2010; Orenco 2015; Averett – Gordon – Counts eds. 2016 which contains overview of recent developments). While in past many archaeologists, as other professionals, depended on proprietary (also ‘closed source’) software, nowadays more scholars are turning to ‘free and open source software’ (F/OSS). Only F/OSS, is claimed (Ducke 2012; 2015), can provide researchers with control over data processing and allows reproducibility of the research, due to its open source code. Moreover, since most F/OSS programs are free of charge under liberal open source licenses (such as GNU General Public License) they can be easily incorporated even into long-term research project or used for education purposes with little to no cost.

Therefore, it was decided to use F/OSS program

in order to evaluate its possibilities and potential for archaeological survey and its performance during the fieldwork on two case studies. The first to be presented is initial salvage survey of the site Khirbet es-Swade/ Ma’agar Snir in northern Israel and the second one is the survey of Hellenistic and Roman fortifications in the southern Golan Heights (Fig. 1). The program in question is QField and it was chosen for three reasons: 1) it is F/OSS and free of charge; 2) it works offline and 3) it is built on QGIS which is another F/OSS desktop GIS (Geographic Information System) program that is already used by number of professionals, including archaeologists. The basic functions of the program and the workflow, from the survey design through project setup to post-survey work will be described. The program’s performance will be evaluated with regard to 1) preparation and pre-processing of the data; 2) data collection and fieldwork; and 3) data export and post-processing (Wagtendonk – De Jeu 2007). This paper should serve as a brief guide through one out of several existing programs for scholars interested in (or who are already using) digital solutions in the fieldwork.



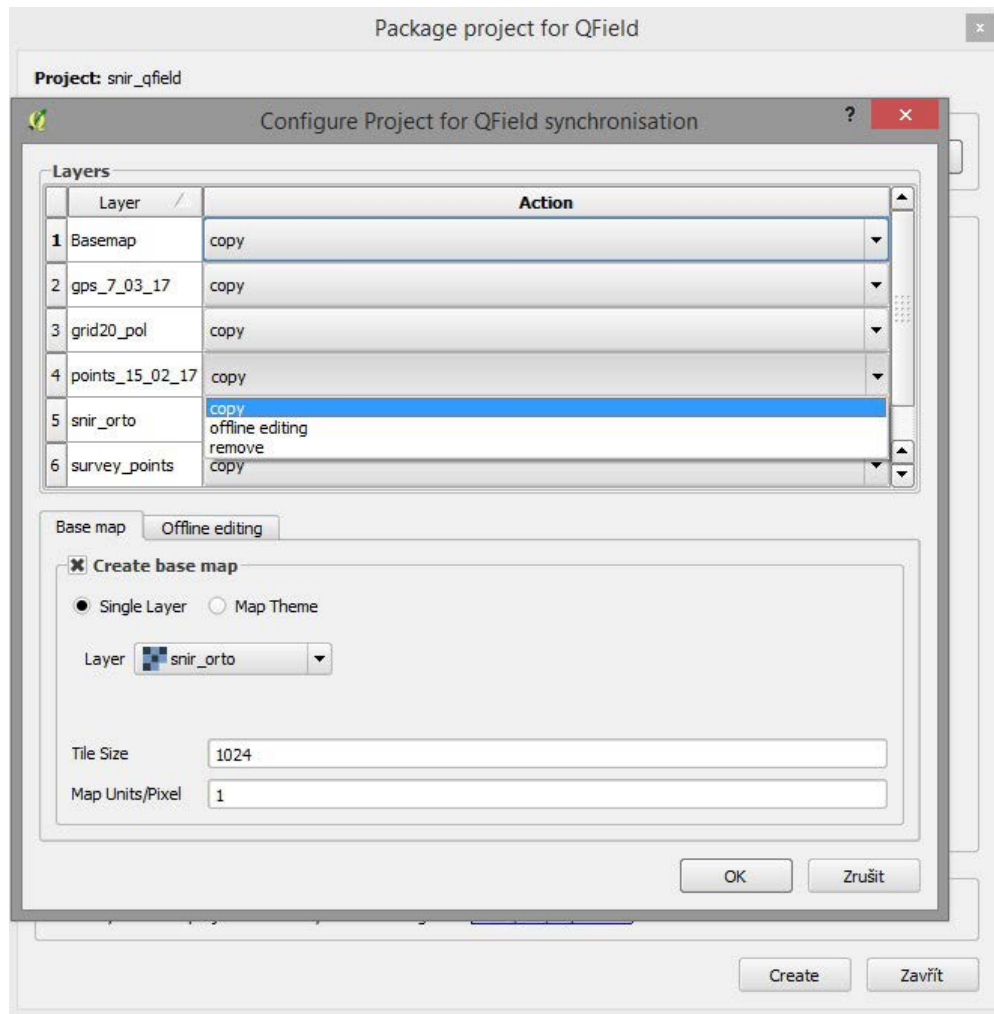
**Figure 1.** Study region of the two case studies..

## Software and Hardware

QField is in fact light version of desktop program QGIS (formerly QuantumGIS) customized for Android platform (version 4.3 and later) so that it can be used off-line on portable devices in the field. The developers emphasize QField is the QGIS since it is based on same source code. The program was built around three ideas: be compatible with QGIS, keep it as simple as possible and that it is mode-based.

The workflow begins with creation of portable project on desktop QGIS which will be uploaded onto the Android device. That means that in the first step

user prepares all data he/she will need in the field in QGIS, including setting coordinate system and project and layer properties (such as display, read-only and identify behaviour etc.). The compatibility of the two programs allows for all settings made in QGIS to work also in QField. The project is saved in QGIS project format (.qgs), which is stored together with the rest of the project data (layers etc.) in a single directory that is uploaded into the portable device. The configuration of the portable project itself into the project directory can be made either manually or using QFieldSync plugin for QGIS which can also serve for synchronizing collected data from portable



**Figure 2.** Configuration of the portable project using QFieldSync plugin.

device to computer (Fig. 2). The options are either to overwrite working copies or to update files on computer using changelog that keeps track of all the changes in the data done on the portable device.

Among supported data formats belong ESRI Shapefile, SpatiaLite and PostGIS (both SQL – Structured Query Language – databases supporting vector geometry), GeoPackage (geodatabase supporting raster data), WMS and MBTiles (web mapping services) and raster data (.tiff). In order to avoid working with huge raster data on portable devices with limited storage and memory space, raster layers can be converted to compact GeoPackage basemap.

The work in QField itself is based around two modes – browsing and digitizing. User can either browse the data put into the project earlier on desktop while in the field or he/she can digitize (create) new data. Since QField was designed from the start to be used as a field tool, the user interface is simplified to maximum extent and includes only essentials for fieldwork (Fig. 3). Everything – including layer

selection, editing and digitizing new data is possible on regular touch screen.

In the first case study QField v0.8 was employed, which was upgraded to v0.10 before the start of the second case study. In both case studies choice was made to employ ESRI shapefiles for data storage and acquisition, despite some of its limitations, since the format is widely used and supported on all platforms.

During both case studies same mobile device was used: Lenovo tablet TAB 2 A10-70 (4 core CPU 1.7 GHz, 2 GB RAM, Android 5.01). In general, the GPS module in most recent cell phones and tablets is on par with common GPS handheld devices (Odolinski – Teunissen 2018), i.e. the deviation of measurements is on average around 2 m, which was deemed enough for extensive survey in the first case study.

The portable projects were built according to specific needs of each case study. They will be described in following sections in connection with research design.

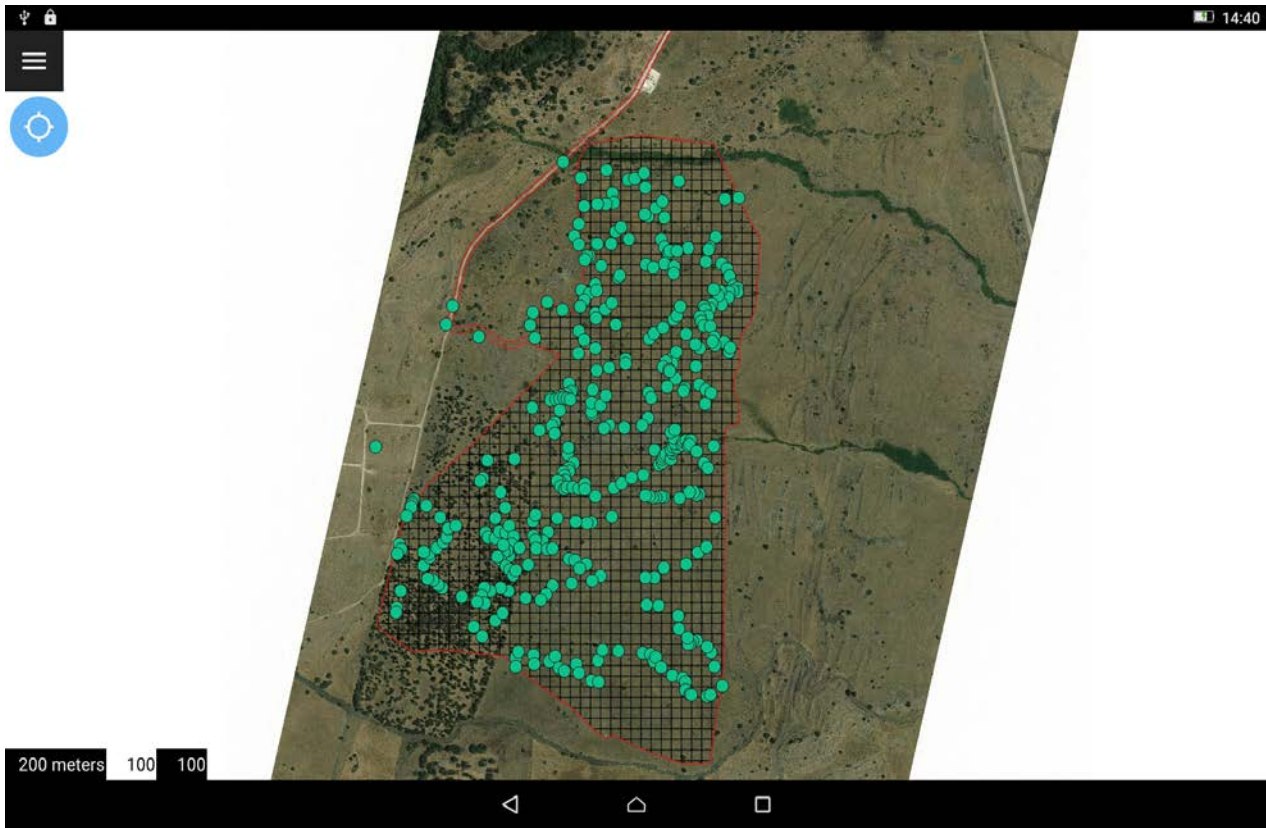


Figure 3. User interface (v0.8).

✕
Add feature on survey\_points
📁

**id**

**type**

**note**

**photo**

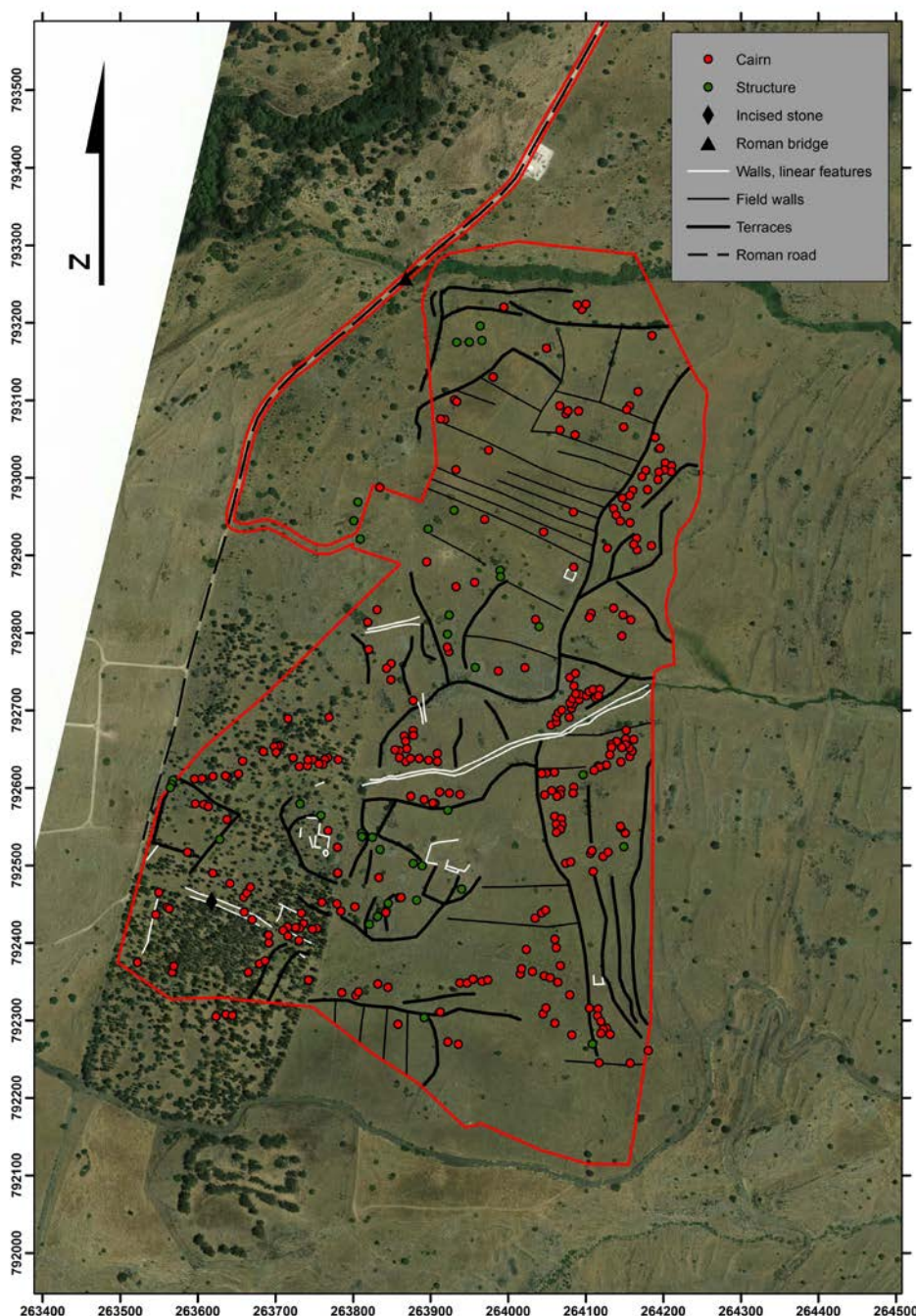
Figure 4. Digitize form of Khirbet es-Swade/Ma'agar Snir survey.

### Case Study 1: Survey of Khirbet es-Swade/ Ma'agar Snir

The survey area covers some 52 ha and is located ca. 2 km south of ancient sanctuary and city of Caesarea Philippi-Paneas at the foot of Hermon Mountain in the northern Golan Heights (Fig. 3). The previous surveys recorded a site named Khirbet es-Swade with several ruined structures and pottery finds from Hellenistic, Roman, Byzantine, Mameluke and Ottoman periods, together with remains of Roman road leading from Paneas southwards including standing Ro-

man bridge across Pera' stream (Epstein – Gutman 1972: 259, site no. 15; Hartal 2017, sites no. 66 and 70). However, Khirbet es-Swade overlaps with the survey area only in its south-eastern margins. The data at our disposal included georeferenced orthophoto of the area, kindly supplied by the construction company, and the polygon shapefile of proposed water reservoir to be built. The principal aim of the survey was to provide assessment of the archaeological potential of the area before its development.

From the orthophoto it was possible to identify linear features, probably representing agricultur-



**Figure 5.** Visualisation of the results of the survey (Khirbet es-Swade/ Ma'agar Snir).

al terraces or field boundaries, several rectangular structures and dozens of small circular features apparently built of stones. Therefore, another goal of the survey was to verify these features, identify new ones and to carefully survey the forest in the southwestern part of the survey area, where no features could have been identified from the orthophoto.

The survey was designed as extensive, where all anthropogenic site and off-site features visible above ground are recorded. All of the area was covered by walking with a team of three to four people. The pot-

tery and other small finds were not systematically collected although their presence was noted in the field.

The portable project for QField contains polygon shapefile defining the area of the survey, a 20 m grid for better orientation in the field, a blank survey point shapefile and the orthophoto of the area. Both approaches of working with raster data were tested – with original raster and with converted GeoPackage basemap. Survey point layer (Fig. 4) includes fields: id (number ), type, note and photo



Figure 6. Drop-down list with pre-defined values.

(indicating if the feature was photographed). I.e. single features (such as cairns, ovens) are represented by one point whereas structures and linear features are represented by multiple points providing outline of the structures. Linear features could have been drawn in separate layer, but this was deemed to be too time consuming for the project, as the features were visible on the orthophoto and they only needed to be verified. The tick-box on the right of the fields (Fig. 4) can be crossed, so when creating new feature in the layer the last input values are automatically filled in.

After concluding the field work the survey shapefile was downloaded to desktop computer and opened in QGIS. The attributes in the type field were used for extraction of points pertaining to different structures (cairns, installations) and linear features (field walls, remains of buildings etc.) which were then drawn accordingly in separate shapefile. The data stored in the survey shapefile basically served as simple geodatabase for visualisation and post-survey analysis of the area (Fig. 5).

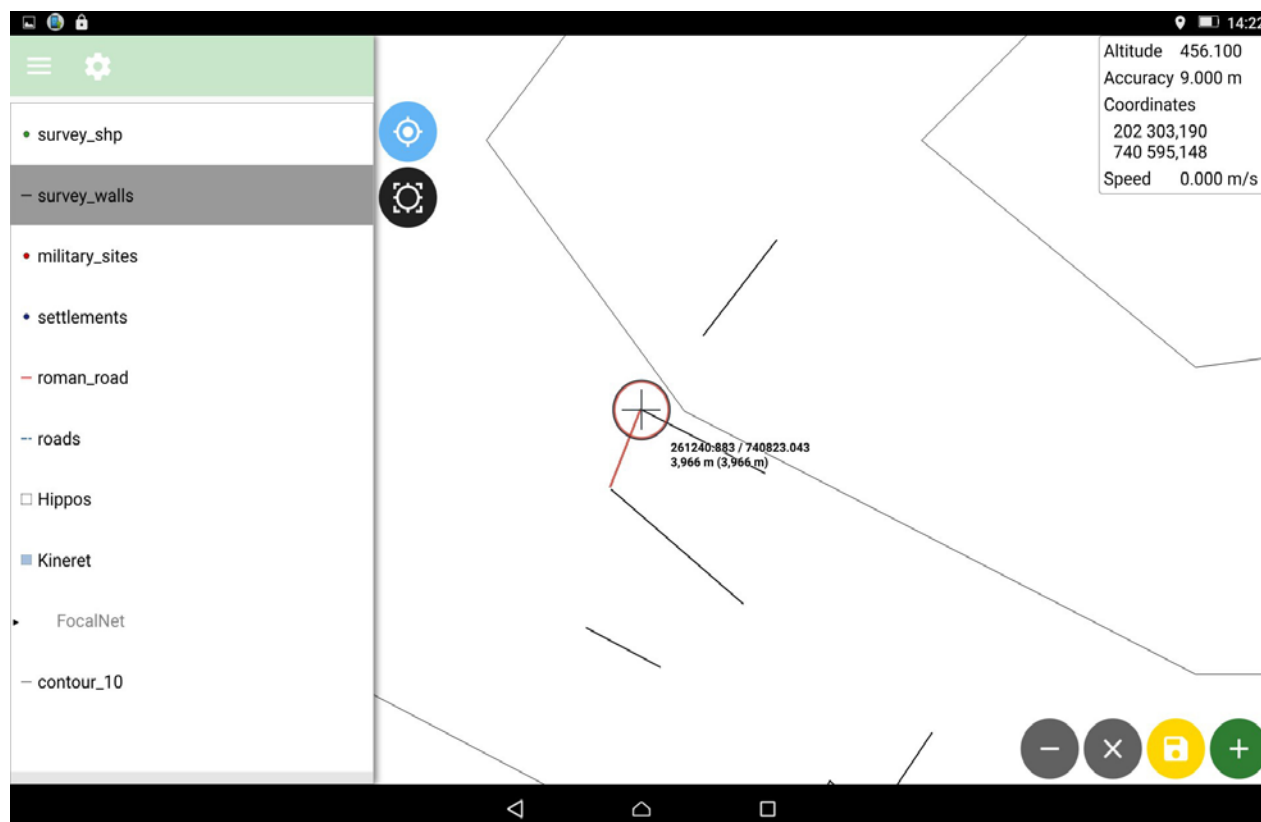
The area was surveyed in course of two days in February and March 2017. In total, 520 points

were collected during the survey (Fig. 3). Among the surveyed features are agricultural terraces; field boundaries; a Roman/Byzantine tower; ruins of possibly two farmhouses, probably from medieval period; tentative agricultural installations in the fields, among those most prominent are shallow, partly dug out oval features, possibly kilns/ovens. Category of finds that stands out in the survey is presence of 283 stone cairns, varying in dimensions from 0.4–2.5 m in diameter to 0.4–1.7 m in height. However, their purpose and date are obscure.

Fast conclusion of the project was enabled mainly thanks to quick point acquisition and data input into the survey layer. This was achieved through the design of the survey shapefile and ergonomics of the program, minimising user's workload.

### Case study 2: The Hellenistic and Roman Fortifications in the Territory of Hippo

The second survey is part of ongoing PhD research of the author, which is focused on Hellenistic and Roman period fortifications in the region of the city



**Figure 7.** Line drawing, including distance measure (v0.10).SOLIDAR, IGN)

of Antiochia-Hippos in the southern Golan Heights. The goal of the survey is to record position of the sites, provide detailed plan of the structures, recording the masonry, building techniques and methods and survey of their environment, which may provide material for the dating of the sites.

Since the survey is still ongoing, only one example of the surveyed sites will be discussed below.

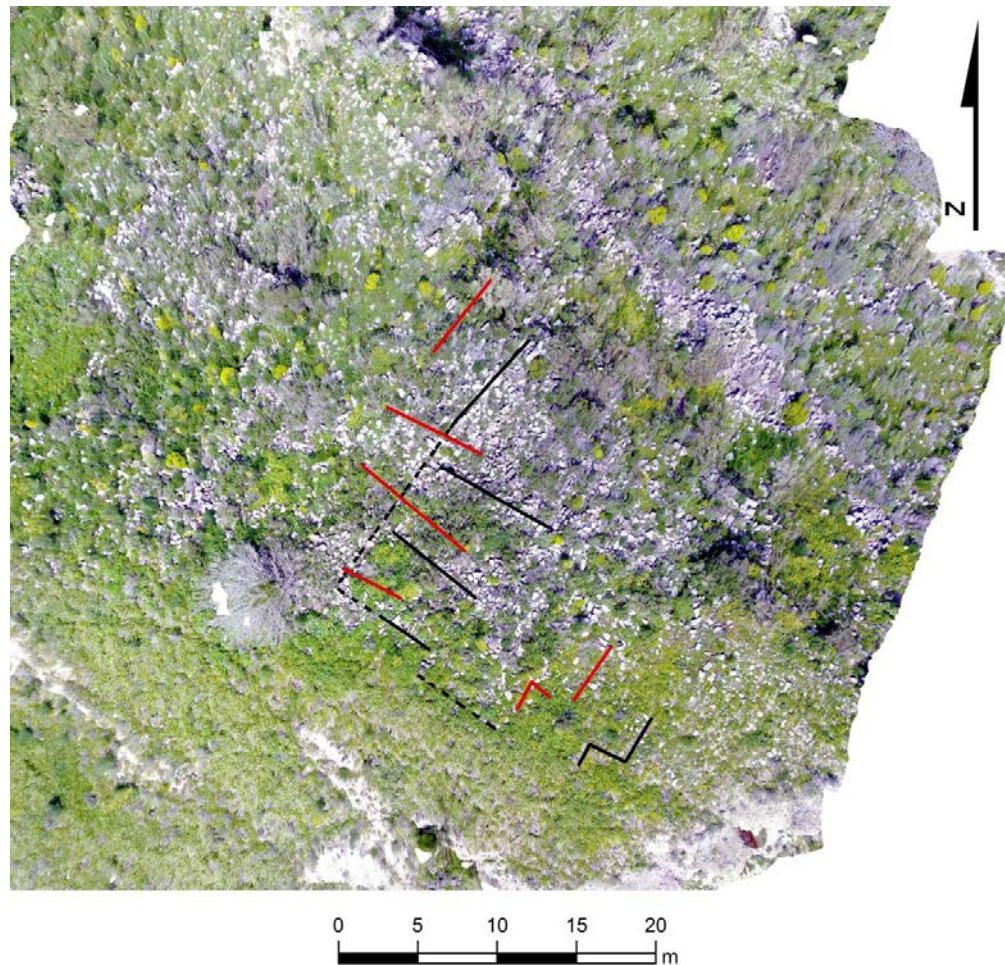
The portable project includes 1) contour map of the region 2) polygon delimiting the Sea of Galilee 3) line vector layer representing paths and tracks digitized from 1940s topographical maps with extant remains of the Roman roads and 4) two point vector layers representing sites from the database of the Archaeological Survey of Israel (one for settlement sites and one for fortified sites). For the data collection two vector layers were prepared: point vector layer for digitizing data on the surveyed sites together with on-site and off-site features whose type can be selected from drop-down list (prepared beforehand in QGIS; Fig. 6) and a line vector layer for drafting the walls of the structures. The point vector contained automatically filled FID and fields type, note and photo. Photo field allows for storing pictures taken

by the Android device to be paired with given vector feature stored in a layer.

The surveyed site, called Zukey Kawarot, is located on prominent conical hill in the western piedmont of the Golan Heights. The site is composed of a large heap of ruined masonry on top of the hill (covering ca. 600 m<sup>2</sup>) and several installations on the northern slope. Thus, both point layer (data of single features) and polyline layer (walls) were used.

The survey of the site and its surroundings was again carried out very efficiently thanks to input of data through pre-defined values. The site drawing using line vector layer proved to be effective and, considerably precise (for the purpose of survey). Moreover, it can be used to measure distances as well (Fig. 7).

Major issue occurred during post-processing of the data. After exporting the survey data to desktop, it was attempted to pair site drawing with an orthophoto of the same structure generated from drone imagery (Fig. 8). The deviation of measurements of both GPS devices (tablet and drone) multiplies and creates large discrepancies which are not easily corrected without precise measurements.



**Figure 8.** Discrepancy between walls drafted during survey (in red) and walls drafted on the orthophoto (in black), site of Zukey Kawarot.

## Conclusions

The choice of QField as a F/OSS solution for archaeological survey was made in light of recent debate revolving around proper scientific conduct in research. The program was used for data collection in course of two extensive field surveys of in the Golan Heights in order to evaluate its potential for archaeological fieldwork focusing on three areas: 1) preparation and pre-processing; 2) data collection and field performance; and 3) data export and post-processing. In all three areas QField proved to be efficient and fast tool.

The filling out of attribute table for each survey point taken proved to be fast and straightforward mainly thanks to the possibility to use pre-filled values or drop-down lists. This shows that the careful preparation of the portable project improves performance of the surveyor in the field and could enhance the uniformity of data collected. The possibility to draw plans of surveyed structures and

distance measurements directly in the field greatly contributed to the effectivity of the workflow and enhanced the precision of the drawings, as plan drafting is usually very time-consuming process and prone to inaccuracies caused by the drafters.

Even loading and displaying raster data (1.2 GB file representing orthophoto of the survey area in the first study case) was fast. Occasionally the program (v0.8) “froze” and tablet needed to be restarted. However, even if the program crashed, no data was lost; since each measured point must be stored before it is possible to continue, therefore only last point not yet stored might be lost. This problem seemed to improve greatly in later version (0.10) used in course of the second case study, which did not experience any crashes.

The major issue in post-processing appears to be incorporation with additional data obtained by different methods, such as combination of site drawing with an orthophoto generated from drone imagery in the second case study.



The compatibility and connection with desktop QGIS program made preparation of the portable project and (post-)processing of the collected data simple and straightforward especially for user already acquainted with GIS. The compatibility with widespread data formats (covering vector, raster and geodatabase formats), allows for transfer and work on the data across platforms when needed. All in all, QField is suitable tool for storing and recording archaeological data in the field in digital format without need to recourse to tedious paperwork.

## Discussion

To summarize the performance of the QField solution it can be said:

1. Preparation and pre-processing: Workflow is fast, completely digital and can be done on one computer. The users acquainted with GIS will find no problems in configuring the portable project.
2. Data collection and fieldwork: Rightly configured portable project allows for fast and uniform input of data. The GPS provided appropriate spatial accuracy for extensive field survey and also good basic orientation in the field. The combination of outputs from various GPS devices, however, causes discrepancies. These could be overcome using ground control points (GCP) measured with the mobile device to rectify drone images. Occasional instability of the program (previous version) did not result in loss of data.
3. Data export and post-processing: Migration of data between portable device and computer is done typically through cable or wireless connection. Once opened on desktop in QGIS the data needs little to none editing as they are already stored in pre-defined GIS-compatible files. Therefore, errors and inaccuracies stemming from conversion are eliminated. This leaves more time for actual post-survey analysis.

QField proved to be useful and efficient tool for field survey. Generally, program's performance during fieldwork is smooth and fast. Preparation of portable project may not seem as straightforward for unskilled users, but extensive user guide is available online. The support of common data formats (such as shapefile) makes it easy for collected data to be transferred and used on variety of platforms and software (both proprietary and F/OSS) with practically no editing necessary. Moreover, support for SpatiaLite and PostGIS – SQL databases – means these could be used, theoretically, not only for extensive or intensive survey, such as pottery collecting in pre-defined squares, but also for paperless documentation of excavations. The issue that needs to be addressed is how it would be possible to connect/synchronize several devices, so that more than one person can work on the project in course of the fieldwork. In that way, an extensive survey consisting of several teams could work in fast and efficient way; while at the same time team members could control and check on the job of the others.

The main advantages of QField are a) low cost; b) offline operation; c) ergonomics of touch-screen operation; d) customization of portable project; e) support of wide range of GIS compatible formats; f) interoperability with desktop applications without need to convert data.

Especially the user customization of the portable project is crucial for archaeological fieldwork as each project can be tailored to suit specific research design.

Among the disadvantages of the program can be counted poorer support of raster formats (apart from web mapping services it supports only .tif and GeoPackage). Another weakness is not connected with the program. It is the hardware limitation of the GPS receiver which often creates large inaccuracies where more precision would be needed (e.g. site drawing). And, as it was shown in the second case study, it makes combination of data collected through multiple GPS devices problematic. This might be alleviated by using GCP measured with one device only (or with introduction of better technologies in the future perhaps). Further, as of now, there is no support for iOS devices.

I am confident that the future of 'free and open source software' and mobile GIS in archaeology is bright.

## Acknowledgments

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