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ACCURACY OF MOBILE GNSS APPLICATIONS FOR CADASTRAL SURVEYING: COMPARISON WITH RTK

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Abstract. *This paper evaluates the accuracy of mobile GNSS-based applications for cadastral area measurements, compared to professional GNSS RTK determinations using a Trimble R10 receiver with ROMPOS corrections. Three Android applications – GPS Fields Area Measure, Maps Area and Distance Calculator, and Mapulator – were tested on a Motorola Edge 40 Neo smartphone under typical field conditions. The study aimed to assess whether such mobile solutions can provide sufficiently reliable results for practical surveying tasks. Comparison with RTK reference measurements revealed deviations between -0.2% and +2.4%, with the most accurate results obtained using Maps Area and Distance Calculator due to its digitization workflow based on an orthophoto map. The applications relying solely on the internal GNSS chip showed slightly larger fluctuations, reflecting the influence of satellite geometry, signal quality, and device positioning. From a geodetic perspective, mobile applications are suitable for preliminary survey stages, quick estimates, land parcel approximations, and general field orientation. However, they cannot replace classical cadastral or engineering methods because of inherent limitations such as the lack of differential corrections, sensitivity to multipath effects, satellite coverage dependency, and operator-related errors during digitization. Mobile GNSS apps offer practical and accessible solutions for non-specialists, yet their use in technical, professional, or legal contexts requires caution and proper validation. Future research could focus on testing performance in dense urban environments, agricultural parcels with irregular shapes, and exploring possibilities for integrating mobile measurements with professional GIS and cloud-based mapping platforms to enhance data consistency and usability.*

Keywords*: cadastral surveying, mobile GNSS applications, positioning accuracy*

INTRODUCTION

The Global Navigation Satellite System (GNSS) has undergone rapid development during the last decades, becoming a fundamental tool for positioning, navigation, and timing applications worldwide (KAPLAN, 2006; MISRA, 2011) (figure 1).

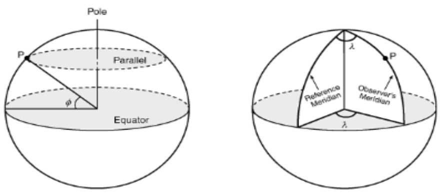

Figure 1. Geocentric latitude and longitude (MISRA, 2011)

The integration of GNSS technology into smartphones has opened new research perspectives, allowing the development of mobile applications capable of determining distances, perimeters, and areas with acceptable accuracy for non-technical purposes (figure 2). While professional GNSS receivers using differential techniques such as RTK (Real Time Kinematic) can achieve centimeter-level accuracy (RIZOS, 2002), smartphones are usually limited to single-frequency L1 observations, resulting in positioning errors of several meters.

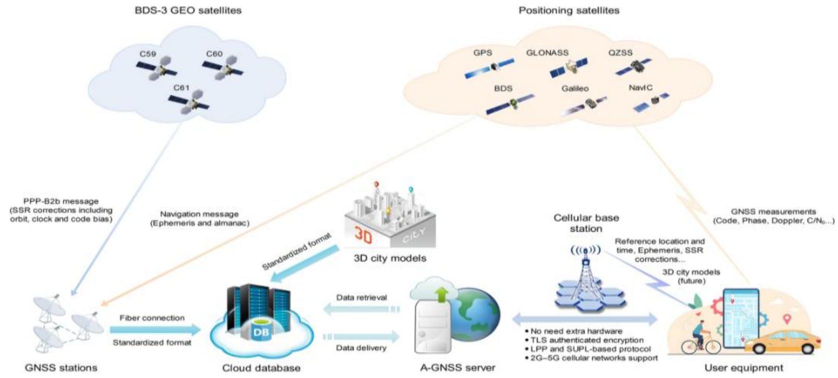

Figure 2. Multi-frequency smartphone positioning performance evaluation
(Wang et al., 2024)

Recent advances in multi-constellation systems (GPS, GLONASS, Galileo, BeiDou) and the availability of dual-frequency signals in modern devices have significantly improved the reliability and convergence time of mobile positioning (TEUNISSEN, 2017). Nevertheless, the accuracy remains strongly dependent on satellite visibility, multipath effects, and the absence of correction services.

The use of mobile GNSS applications for cadastral purposes is particularly relevant in the context of developing countries, where cost-effective alternatives to professional surveying equipment are required. Although they cannot replace official cadastral surveys, mobile apps may provide useful preliminary data for land management, agricultural monitoring, and urban planning (figure 3). This study investigates the accuracy of three GNSS-based mobile applications when compared with professional RTK measurements, aiming to assess their potential role in cadastral surveying workflows.

Figure 3. Maps Area and Distance Calculator app (Source: https://play.google.com/store/apps/details?id=com.lketech.android.maps.distance.calculator)

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The aim of this paper is to evaluate the potential of mobile GNSS-based applications for cadastral area determination by comparing results with those obtained from a professional GNSS RTK receiver (Trimble R10).

MATERIAL AND METHODS

For testing, a green area located near the Faculty of Civil Engineering (UPT) was selected, characterized by regular shape, physical delimitations, and favorable GNSS reception conditions (figure 4).

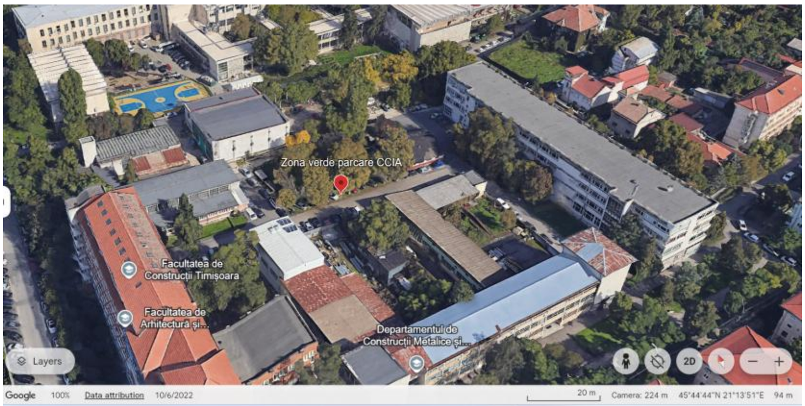

Figure 4. View the area on Google Earth

It is physically delimited (curbs, alleys), has a regular shape, and offers favorable conditions for GNSS reception (partially open sky). The chosen area corresponds to a green space located on the side of the institution's parking lot, clearly delimited by physical elements (curbs, alleys), which makes it suitable for tracing contours both on the ground and digitally on the orthophoto map.

This choice was motivated by several considerations:

- easy accessibility for repeating measurements;
- good satellite visibility (partially open sky, no tall buildings or trees above);
- relatively regular shape, favorable for evaluating differences between methods;
- direct practical interest, given the university context and the educational nature of the work.

Measurements were performed with a Motorola Edge 40 Neo smartphone, equipped with a multi-constellation GNSS L1 receiver, and three mobile applications were tested: GPS Fields Area Measure, Maps Area and Distance Calculator, and Mapulator (table 1 and table 2).

Table 1

Main characteristics of Motorola Edge 40 Neo smartphone

Component / Characteristic	Description / Relevance
GNSS Receiver	Supports GPS, GLONASS, Galileo, BeiDou (L1), multi-constellation positioning
Sensors	Accelerometer, gyroscope, compass – assist GNSS positioning
Connectivity	Mobile + Wi-Fi (A-GPS assisted positioning)
Operating System	Android 14, supports advanced GNSS APIs

Table 2

Comparative characteristics of GNSS mobile applications

Application	Developer	Operation Mode	Export Options	Estimated Accuracy
GPS Fields Area Measure	Farmis (Lithuania)	Walking in field / point placement	KML, CSV, PNG	3–10 m
Maps Area and Distance Calculator	Studio Noframe (Ukraine)	Manual point placement on map	KML, CSV	3–10 m
Mapulator	Cluain Mobile Solutions (Ireland)	GPS live + manual map editing	KML, GeoJSON, CSV	2–10 m

RESULTS AND DISCUSSIONS

For reference, RTK measurements were performed using a Trimble R10 dual-frequency receiver connected to the ROMPOS national network, providing a relevant basis for comparison (figure 5).

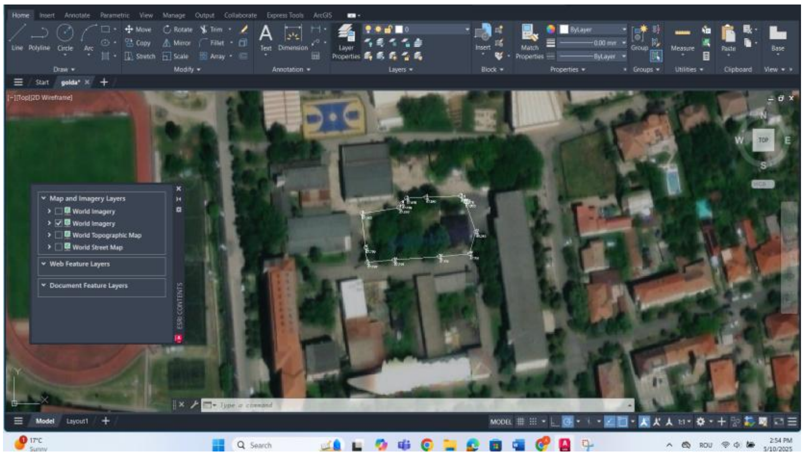

Figure 5. Reporting RTK measurements in Autocad

Data were exported in KML format and compared visually and numerically in Google Earth Pro, enabling the evaluation of accuracy for each mobile application (figure 6 and figure 7).

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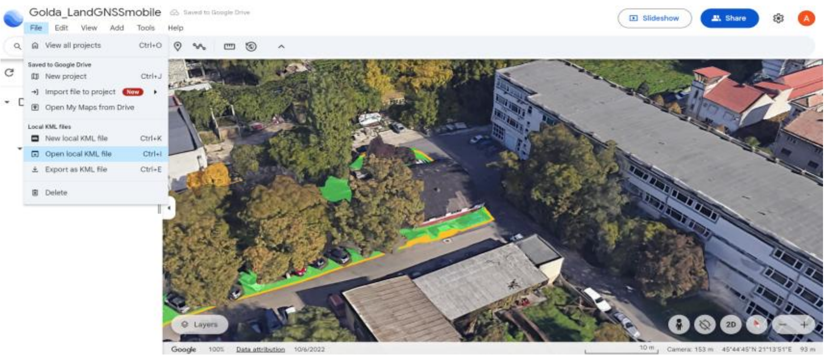

Figure 6. Importing KML files into Google Earth

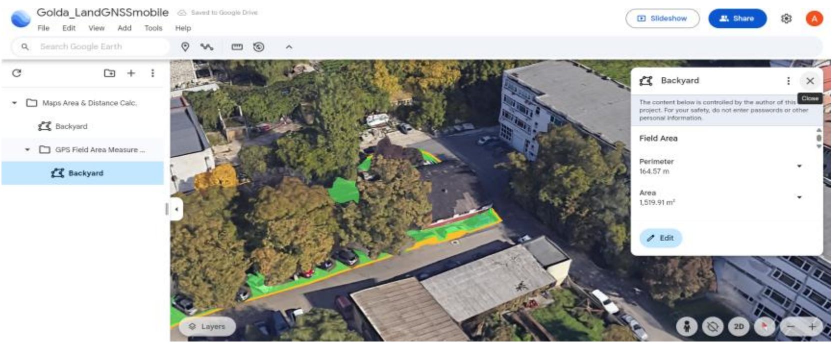

Figure 7. Example: Viewing the measured area in Google Earth GPS Fields Area Measure app

The numerical results show that GPS Fields Area Measure and Mapulator both measured 1,520 m², representing a +2.4% deviation from the RTK reference (1,680 m²). Maps Area and Distance Calculator produced 1,682 m², with only -0.2% deviation, showing the best performance (table 3).

Table 3

Results of area measurements compared to RTK reference

Method	Measured Area (m²)	Deviation from RTK (%)
GPS Fields Area Measure	1,520	+2.4%
Maps Area & Distance Calculator	1,682	-0.2%
Mapulator	1,520	+2.4%

The main sources of error include the lack of differential corrections, L1-only GNSS positioning, and human errors in contour tracing. Still, the applications provide rapid and acceptable results for non-legal cadastral tasks.

CONCLUSIONS

The study confirms that mobile GNSS applications can provide approximate cadastral surface estimations with errors ranging between -0.2% and +2.4% compared to RTK reference. Among the tested applications, Maps Area and Distance Calculator showed the highest accuracy. Mobile apps are suitable for preliminary surveying tasks, offering quick and accessible solutions, but should not be used in official cadastral works requiring centimeter-level accuracy (figure 8).

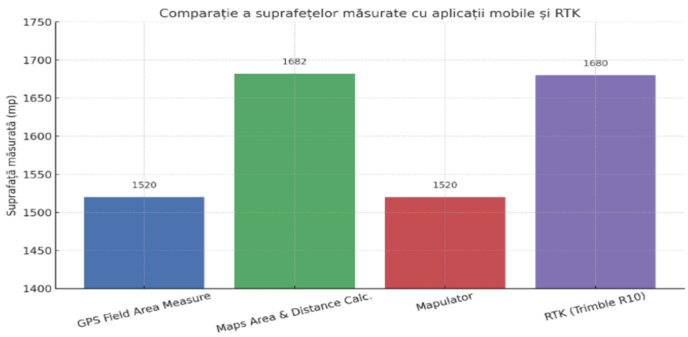

Figure 8. Comparison of measured areas

Further studies are recommended in complex urban environments and with newer dual-frequency smartphones. Future research may include expanding testing in dense urban environments or on uneven surfaces, as well as evaluating the integration of these applications with professional GIS platforms.

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