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Comparison of Established Water-Obstacle Reconnaissance Methods with Emerging Technical Capabilities of Sensor Suites and Their Unmanned Carrier Platforms

Ota ROLENEC [1]*, Natálie HANÁKOVÁ [1], Radek PROCHÁZKA [1], Ľubomír POROČÁK [1], Radek MOJŽÍŠEK [1]

[1] *Department of Engineer Support, Faculty of Military Leadership, University of Defence, Address: Kounicova 65, 602 00 Brno, Czech Republic*

*Correspondence:*ota.rolenec@unob.cz*

Abstract

This paper examines how uncrewed platforms and contemporary sensor suites may extend engineer reconnaissance of water obstacles in support of river-crossing planning. The paper combines a structured review of Czech doctrinal practice and candidate sensor-platform combinations with a field experiment carried out on a selected section of the River Svratka, using unmanned aerial vehicle (UAV)-borne Light Detection and Ranging (LiDAR), UAV-borne ground-penetrating radar (GPR) and Global Navigation Satellite System (GNSS) control points. The combined evaluation indicates that LiDAR is highly effective for bank geometry and approach assessment, whereas GPR can complement it by indicating the longitudinal bed profile and sediment interfaces, albeit with greater interpretative uncertainty.

KEY WORDS: *engineer reconnaissance, GIS, GPR, LiDAR, sonar, unmanned aerial systems, water obstacles.*

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1. Introduction

The success of military operations is closely conditioned by timely and accurate terrain intelligence. In the field of engineer mobility support, this requirement is especially acute during the preparation of river crossing, ferrying, rafting, bridging or fording tasks, where incomplete or obsolete information may delay tempo, misallocate specialised assets, or increase exposure of personnel and equipment [1–2]. In practical terms, the commander requires a reliable description of the water obstacle itself and of the adjacent terrain: width, depth, current, bank geometry, bed bearing capacity, vegetation, approaches and likely trafficability constraints.

Within Czech engineer practice, reconnaissance of water obstacles is still rooted in direct in-situ measurement, supported where necessary by diver-based underwater inspection and by standard engineer reconnaissance kits [2–3]. These procedures remain operationally valuable because they provide physical confirmation of the bed and banks; however, they are also time-consuming, personnel-intensive and difficult to execute under hostile observation, poor visibility or compressed decision cycles. The challenge is therefore not to replace conventional methods outright, but to determine which parts of the reconnaissance problem may be shifted forward to uncrewed platforms and remote sensors without degrading decision quality.

This paper addresses that problem through a structured review of doctrinal requirements, present reconnaissance procedures and the technical characteristics of candidate sensor-platform combinations. In addition, it reports a field experiment carried out on a selected reach of the River Svratka in order to test the practical utility of unmanned aerial vehicle (UAV)-borne Light Detection and Ranging (LiDAR) and ground-penetrating radar (GPR) in the same spatial framework. The paper also places this topic within a broader trend in military-engineering research, where modelling, optimisation and data-supported decision-making are increasingly used to improve engineer tasks, including wet-gap

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planning and adjacent support functions [4–6]. That wider research environment also reflects growing interest in digitally enabled engineer capabilities and uncrewed methods [7–9].

2. Baseline Engineer Reconnaissance Requirements and Current Practice

Engineer reconnaissance of a water obstacle is conducted in order to identify, evaluate and designate a section suitable for crossing. From the doctrinal point of view, this requires both general information applicable to all crossing types and specific information tied to the intended means of crossing [1, 3]. The critical variables include obstacle width, depth distribution, current velocity and direction, bank slope and condition, bottom composition and bearing capacity, vegetative cover, and the accessibility of approaches and exits. In river-crossing planning, these parameters are not merely descriptive; they directly govern the choice of crossing site, the suitability of available engineer assets and the expected preparation time.

In the organisational setting of the Czech Armed Forces, engineer reconnaissance of water obstacles is performed by dedicated engineer reconnaissance groups drawn from organic engineer units, including specialised elements equipped for diver-supported underwater inspection [2–3]. One engineer reconnaissance element may survey a site for a floating, ferry or bridge crossing on a water obstacle within about 1–2 hours, while reconnaissance and marking of a ford may take roughly 1.5 hours under favourable conditions [2]. These timings, however, are contingent on hydrometeorological stability, site accessibility, visibility and the degree to which underwater verification is required.

The practical strengths of the established approach are obvious. Direct measurement provides high confidence in depth, bank geometry and the physical character of the riverbed, especially when divers can inspect problematic sectors. The principal weaknesses are equally clear. Reconnaissance teams must approach the obstacle, remain in the area for a significant period, and in some cases enter the water. Under modern battlefield conditions marked by wide-area surveillance, precision fires and electronic contestation, such exposure may be unacceptable during the initial information-gathering phase [3–4]. This creates a strong rationale for examining remote and stand-off means of reconnaissance.

3. Method, Field Experiment and Analytical Framework

The paper adopts a structured review and capability-oriented analytical approach complemented by a field experiment. First, doctrinal and educational sources were used to describe the information requirements and established procedures of engineer reconnaissance of water obstacles in the Czech context [1–3]. Secondly, relevant literature on unmanned systems and sensing technologies was synthesised in two groups: platform and LiDAR-related sources [10–12], and sources focused on bathymetry, GPR, sonar and GIS-supported planning [5, 13–14].

The comparison was organised around six practical criteria: (i) the part of the reconnaissance problem addressed by the method, (ii) achievable measurement quality, (iii) environmental sensitivity, (iv) likely carrier-platform compatibility, (v) operational footprint and detectability, and (vi) post-processing burden before usable engineer outputs can be generated. This framework was selected because it mirrors the actual decision problem faced by commanders and military engineers: a sensor is only operationally useful if its output can be acquired, interpreted and integrated into crossing decisions in time.

The review was further informed by the wider body of defence-engineering publications provided in the supplementary literature file. Although several of these studies are not directly focused on water obstacles, they are relevant because they show how contemporary defence research increasingly combines optimisation, modelling and digitally enabled methods across adjacent engineer domains [15,18,19]. They also indicate a broader organisational interest in uncrewed support capabilities and engineer support functions beyond the immediate wet-gap context [9, 16–17].

3.1. Experimental Site and Measured Variables

The practical part of the study was conducted on a short reach of the River Svratka at Veverská Bítýška. Two candidate localities were considered during planning, and the final site was selected one day before the measurement on the basis of hydrometeorological conditions, terrain state and safe access for the equipment. The principal variables assessed in the experiment were obstacle width, bank geometry, depth distribution, and the qualitative character of the bed and sediments. In order to keep the outputs comparable, the main LiDAR and GPR measurements were collected over the same river section and later evaluated in a common spatial framework.

3.2. Equipment and Field Procedure

Two unmanned platforms carrying different sensor systems were employed in the field trial. Georadar measurement was conducted with a DJI Matrice 600 carrying a Zond-12e sensor, while LiDAR acquisition was performed with a DJI Matrice 350 RTK equipped with a Zenmuse L1 sensor (see Figure 1). Global Navigation Satellite System (GNSS) control points were surveyed with an Emlid RS2+ receiver in order to verify the georeferencing and vertical consistency of the LiDAR outputs. The LiDAR flight lines were planned with sufficient overlap to produce a continuous point cloud of the river, both banks and the adjoining access space, whereas the GPR sortie was intended to capture the water surface, the water–bed interface and major changes in subsurface structure along the measured profile.

Fig. 1. Unmanned platforms used in the measurements – (A) LiDAR system; (B) ground-penetrating radar system

3.3. Data Processing and Experimental Evaluation

The experimental data were processed so that mutually comparable engineer outputs could be generated. LiDAR data were prepared in DJI Terra and evaluated in CloudCompare, where profile cuts across the obstacle were derived. GNSS points were imported into the Geographic Information System (GIS) environment and used to verify the spatial accuracy of the point cloud. GPR data were processed in Prism2, including adjustment of the time window, zero-line correction and low-frequency filtering, in order to improve the readability of radargrams. DMR 5G was used as a supporting background source during pre-planning.

4. Assessment of Uncrewed Carrier Platforms and Sensor Suites

4.1. Carrier Platforms

From the standpoint of water-obstacle reconnaissance, the distinction between fixed-wing and rotary unmanned aerial systems is fundamental. Fixed-wing platforms offer superior endurance and greater area coverage, which is advantageous for theatre-level scanning or route reconnaissance over extended sectors. Their limitations lie in their need for launch and recovery arrangements and in their inability to hover over a specific segment of bank, approach or shallow channel. For the detailed inspection of a candidate crossing site, rotary platforms are generally more suitable because they can maintain a stable hover, manoeuvre precisely at low altitude and operate from restricted launch positions [7].

A second distinction concerns commercial off-the-shelf systems versus purpose-built military platforms. Commercial systems are attractive due to availability, low cost and ease of operator training, but their use in operational environments is constrained by endurance, payload capacity, cybersecurity concerns and vulnerability to electromagnetic interference or geofencing restrictions. Military systems typically offer improved resilience and integration potential, but at higher logistical and financial cost. For engineer reconnaissance, the decisive variable is not the label attached to the platform, but whether the platform can safely carry the required sensor and return interpretable data under field conditions.

4.2. Candidate Sensing Technologies

Electro-optical (EO) and thermal payloads remain the simplest and most immediately useful reconnaissance tools carried by small rotary UAVs. They are well suited to rapid inspection of bank geometry, vegetation, approach routes, local obstacles and possible concealment. They can also assist in documenting seasonal or recent changes in the crossing area. Their weakness is obvious: they do not measure the submerged bed directly, nor do they provide a reliable physical estimate of bearing capacity. They are therefore necessary but insufficient for a complete water-obstacle assessment.

Conventional LiDAR offers major advantages for the geometric description of banks, approaches and the wider crossing zone. It can rapidly generate a high-resolution point cloud, especially when integrated with accurate navigation and inertial measurement [12]. In practical terms, this improves the description of micro-relief, breaklines, embankments and access corridors, and it supports the production of terrain products that are more precise than standard visual imagery alone. The field experiment confirmed this value clearly: the LiDAR point cloud provided reliable cross-sections for the measured river reach, but it did not resolve the submerged bed because the near-infrared beam reflected from the water surface. Sensor analysis shows that conventional LiDAR provides high-resolution topographic mapping of banks and approaches but is generally limited at the water surface (see Figure 2).

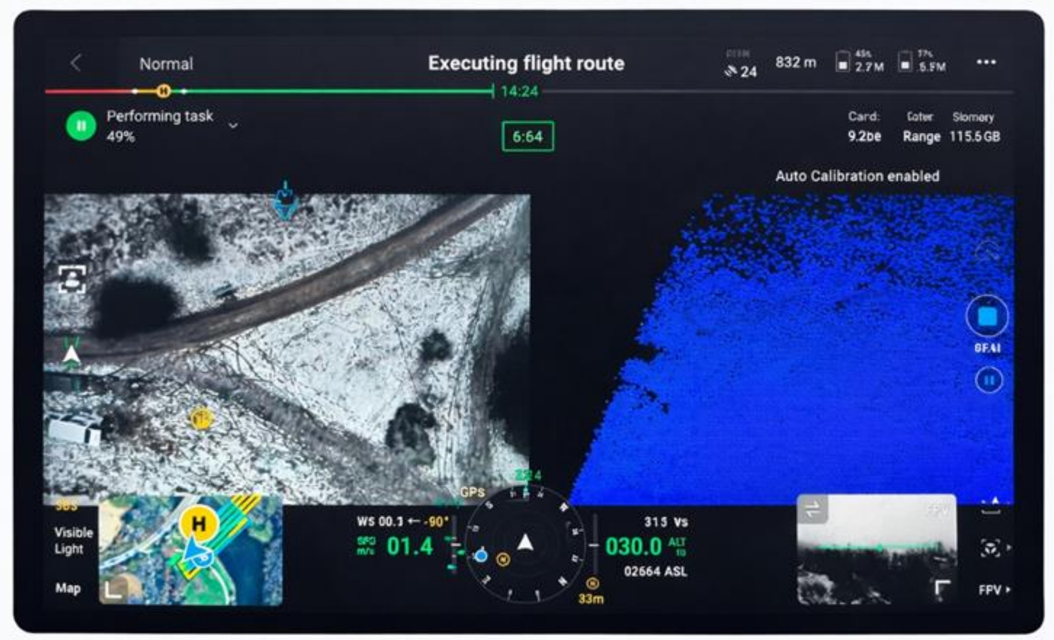

Fig. 2. Simultaneous in-flight acquisition of LiDAR and imaging data

Bathymetric LiDAR partially addresses that limitation by using green wavelengths capable of penetrating clear and relatively calm water [13]. In favourable conditions it can support shallow-bed mapping and near-shore bathymetry, which is directly relevant to fording analysis and to the characterisation of likely bridge and ferry approaches. Nevertheless, its performance is highly sensitive to turbidity, suspended matter, surface disturbance and lighting conditions. This means that its operational promise is real but conditional, and it should not be treated as a universally available substitute for direct depth measurement.

Ground-penetrating radar (GPR) is particularly interesting because recent work shows that it may support bathymetric profiling and sediment-layer interpretation, including in UAS-enabled configurations [11,14]. For engineer reconnaissance, this raises the prospect not only of measuring depth in selected sectors, but also of improving understanding of bottom composition and sediment structure. The field trial showed that the method can indeed indicate the water surface, the bed profile and local changes in the subsurface structure; however, it also confirmed that the output requires cautious interpretation and careful signal processing.

Sonar remains one of the most robust tools for underwater mapping and depth determination. Its chief limitation is not measurement principle but carrier-platform compatibility. In most realistic cases, sonar is better suited to a boat or uncrewed surface vehicle than to a small aerial carrier. For engineer reconnaissance, the operational implication is straightforward: if the submerged portion of the problem is decisive, aerial systems may identify the sector and reduce search time, but sonar or direct underwater inspection may still be required to complete the picture. An indicative comparison of candidate sensor-platform combinations for water-obstacle reconnaissance is presented in Table 1.

Table 1. Indicative comparison of candidate sensor-platform combinations for water-obstacle reconnaissance

Method	**Primary contribution**	**Likely carrier**	**Operational strengths**	**Main constraints**
EO/thermal imaging	Bank inspection, approaches, vegetation, obstacles	Small rotary UAV	Fast, low burden, immediately interpretable	No direct submerged-bed measurement
Conventional LiDAR	Detailed topography of banks and access corridors	Rotary UAV / larger UAS	High-resolution terrain model	Weak performance below water surface
Bathymetric LiDAR	Shallow-bed and near-shore bathymetry	Larger rotary UAV / specialised UAS	Rapid stand-off measurement in clear water	Highly sensitive to turbidity and surface state
GPR	Bathymetry and sediment-layer indication	Specialised UAS / ground platform	Potential subsurface insight	Complex integration; degraded performance in conductive media
Sonar	Depth profile and underwater mapping	Boat / USV	Mature underwater sensing	Normally requires surface platform or direct deployment

5. GIS-Supported Pre-Planning and Integration into Engineer Workflow

A key conclusion of the review is that the greatest immediate gain does not arise from any single sensor in isolation, but from combining pre-existing geospatial datasets with focused uncrewed reconnaissance and selective follow-on verification. In the Czech environment, this is especially relevant because ZABAGED and the DMR 5G (see Figure 3) digital terrain model already support initial identification of potentially suitable crossing sectors [5]. Such datasets cannot replace reconnaissance, but they can significantly reduce the search space by highlighting bank morphology, access corridors and terrain discontinuities before teams move forward.

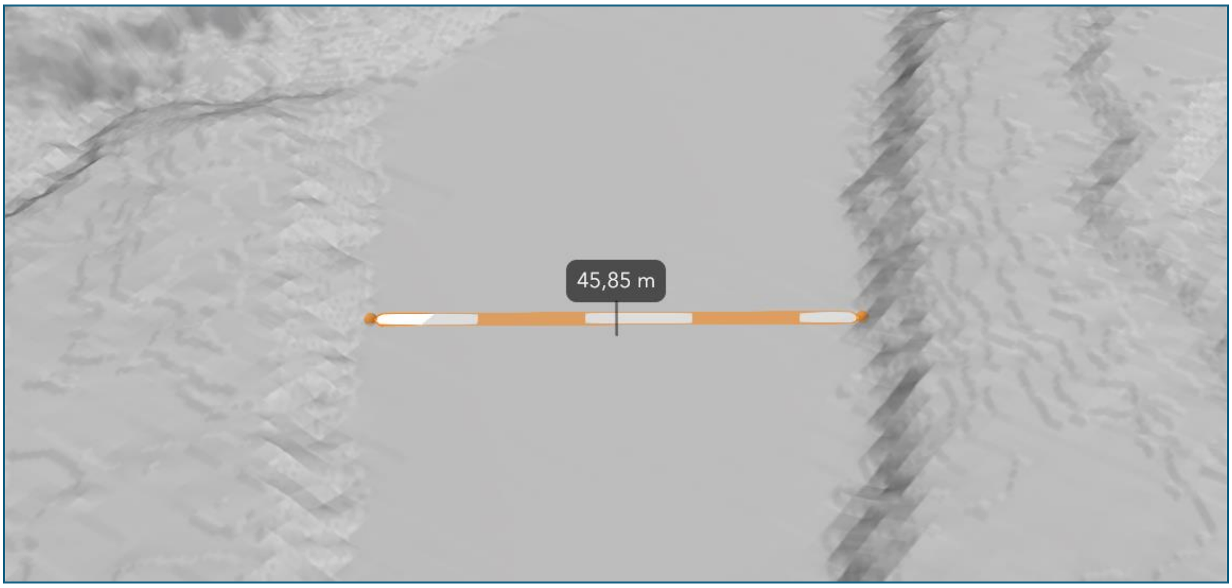

Fig. 3. DMR 5G digital terrain model with an indicative determination of the watercourse width

A practical integration concept therefore comprises four stages. First, the engineer staff conducts GIS-supported pre-screening and shortlists candidate sectors. Secondly, a rotary UAV performs initial stand-off inspection, focusing on banks, approaches, obstacles, vegetation and local geometry. Thirdly, if the site remains promising, a specialised sensor or follow-on method is used to examine the submerged portion of the problem, whether through bathymetric LiDAR, GPR in suitable conditions, sonar or direct underwater confirmation. Fourthly, the outputs are fused into an engineer product usable for crossing selection and task organisation.

This workflow has clear organisational implications. It requires operator training not only in flight procedures but also in sensor employment, data processing and interpretation for engineer decision support. It also requires disciplined definition of what information must be confirmed physically before a commander commits assets. In that sense, digitalisation does not eliminate engineer judgement; rather, it shifts judgement earlier and gives it a broader evidential basis.

6. Experimental Evaluation and Discussion

6.1. Findings of the Field Experiment

The field trial produced a georeferenced LiDAR point cloud covering the measured reach of the Svratka, both banks and the adjoining access areas (33UXQ05945912). Accuracy verification against GNSS control points indicated a root mean square deviation of 0.019 m, a mean vertical deviation of −0.007 m, and observed deviations from −0.024 m to 0.017 m. These values showed that the LiDAR outputs were accurate enough for cross-section generation, slope evaluation and other spatial analyses relevant to engineer reconnaissance. The resulting point cloud made it possible to generate a continuous model of the area without significant gaps in coverage across the main surveyed section of the water obstacle. The acquired data therefore provided a sufficient basis for producing cross-sectional profiles (see Figure 4) and for evaluating the channel shape, watercourse width, and bank slopes.

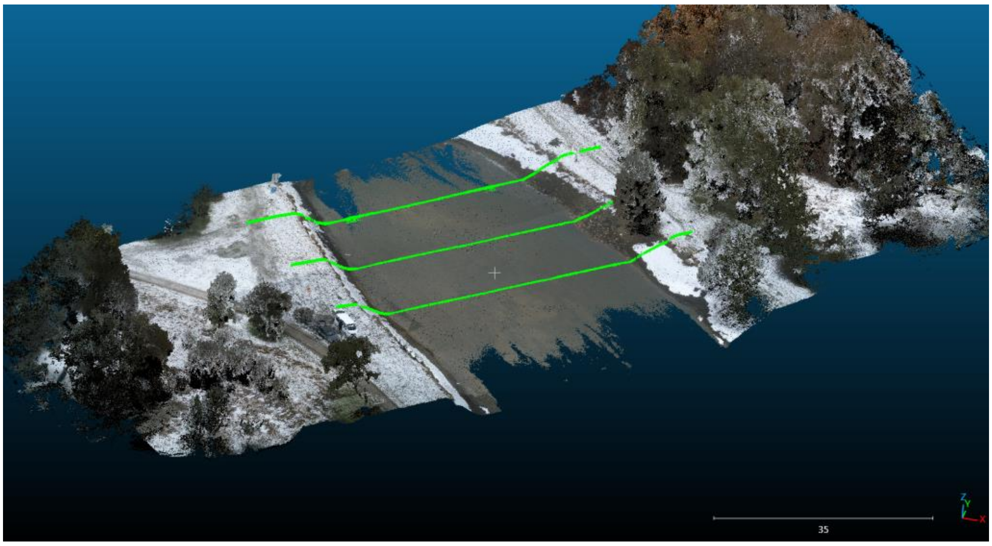

Fig. 4. DMR 5G digital terrain model with an indicative determination of the watercourse width

For a more detailed evaluation of the water-obstacle geometry, three cross-sectional profiles were generated from the LiDAR point cloud across the watercourse at selected locations within the surveyed reach (see Figure 5).

Fig. 5. DMR 5G digital terrain model with an indicative determination of the watercourse width

The generated profiles captured different sections of the watercourse and made it possible to assess the width of the water obstacle, the bank slopes, and the character of the adjacent terrain. The basic spatial parameters of the selected cross-sectional profiles are presented in Table 2.

Table 2. Selected LiDAR-derived cross-section parameters from the measured river reach

Profile	**Width [m]**	**Left-bank slope [°]**	**Right-bank slope [°]**	**Position in reach**
P1	36.39	28.2	20.9	Upper
P2	40.22	25.8	17.9	Middle
P3	44.86	26.5	19.0	Lower

The cross-sections show that the water-surface width increased progressively from the upper to the lower profile and that the measured reach was not morphologically symmetrical. In all three profiles, the left bank was steeper and shorter, whereas the right bank was longer and more gradual. For engineer assessment this is important because bank gradient and elevation arrangement directly influence access, vehicle movement and the selection of a suitable crossing point.

The GPR measurements yielded radargrams in which, after basic processing, two principal interfaces could be distinguished: the water surface and the bed, or the water–sediment boundary. A representative radargram (see Figure 6) showed that the bed profile was not constant along the measured section. The bed deepened progressively to approximately 0.42 m at a distance of about 12–14 m along the profile, remained relatively even around 0.38 m in the central part, and then rose again towards the bank. The radargrams also indicated local changes in subsurface structure; however, interpretation remained sensitive to system response in the upper part of the record and to the approximate nature of converting time to depth.

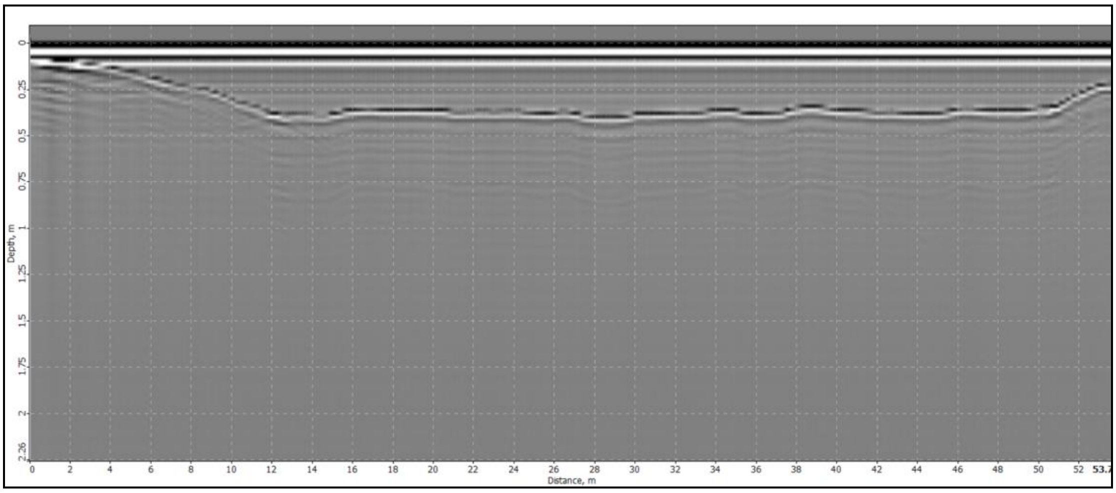

Fig. 6. DMR 5G digital terrain model with an indicative determination of the watercourse width

6.2. Discussion

Taken together, the experimental findings support the view that uncrewed systems are best understood as a capability extension to conventional reconnaissance rather than a universal replacement. Their strongest contribution lies in the early phase of information acquisition: reducing search time, improving situational understanding of the banks and approaches, documenting local morphology, and narrowing the sectors in which costly or risky direct inspection must occur. Their weakest contribution remains the reliable characterisation of the submerged bed under all conditions.

A possible representative of such a concept is the DJI Matrice 350 RTK platform. This multirotor platform has a payload capacity of up to 2.7 kg, a declared flight endurance of up to 55 minutes without payload, and the ability to operate in wind speeds of up to 12 $m \cdot s^{-1}$, which corresponds to the requirements for the stable and accurate execution of reconnaissance flights. For the acquisition of spatial data on the surface portion of the obstacle, the Zenmuse L2 system may be considered a suitable LiDAR module, as it is compatible with this platform and provides high measurement accuracy. To supplement the reconnaissance with data from below the water surface, the Zond Aero LF system may be considered; this is a lightweight ground-penetrating radar suitable for medium-sized platforms and operating in the 50–300 MHz frequency range. A diagram of the proposed configuration is shown in Figure 7.

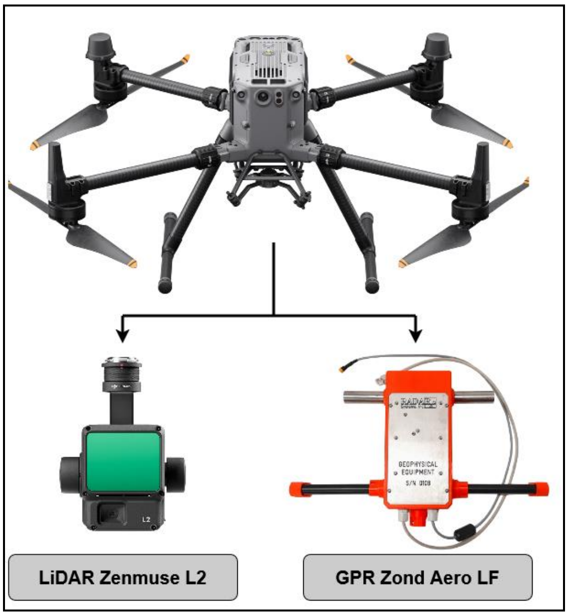

Fig. 7. Conceptual design of a modular unmanned aerial vehicle for engineer reconnaissance of a water obstacle

Several constraints deserve explicit emphasis. The first is endurance. Small rotary systems are tactically convenient but often offer only a limited dwell time once a meaningful sensor payload is added. The second is environmental sensitivity: rain, wind, foliage, snow, turbidity and seasonal hydrological variation all affect measurement quality. The third is the operational environment itself. Electromagnetic contestation, line-of-sight limitations, emissions control, camouflage requirements and the threat of hostile observation may sharply reduce the practical availability of some otherwise attractive systems. The fourth is the data chain: a point cloud or radargram has no operational value until it is converted into a concise engineer judgement. An overview of the principal qualitative differences between traditional reconnaissance and reconnaissance employing unmanned systems, according to selected evaluation criteria, is presented in Table 3.

Table 3. Qualitative comparison of traditional reconnaissance and reconnaissance employing UAVs

Criterion	**Traditional reconnaissance**	**Reconnaissance employing UAVs**
Safety of unit personnel	Higher level of risk due to the direct presence of personnel within the obstacle area.	Lower level of risk owing to the reduced direct presence of personnel within the obstacle area.
Extent of personnel coordination required	Typically requires the coordination of several personnel both for measurement and for data recording.	Requires fewer personnel during data acquisition, but places greater demands on specialist operation and evaluation.
Nature of the data obtained	Predominantly point-based or partial data obtained through direct measurement.	More spatially comprehensive outputs in the form of models, profiles, or radargrams.
Completeness of the data obtained	Enables direct verification of selected parameters but captures the broader spatial context less effectively.	Captures spatial relationships more effectively but does not allow bearing capacity to be assessed reliably without contact verification.
Accuracy of outputs	Direct measurements at individual points.	Dependent on the sensor, measurement settings, and data processing.
Verifiability of data in the field	High potential for immediate verification directly at the measurement site.	Lower potential for direct verification, as part of the data is acquired indirectly.
Data-processing requirements	Lower requirements for subsequent processing and conversion into a report.	Higher requirements for data processing, interpretation, and expert evaluation.

The broader supplementary literature reinforces this interpretation. Work on uncrewed engineer capabilities, modelling and wet-gap optimisation points in the same direction as the present experiment: engineer capability development is increasingly shaped by the integration of digital tools, quantitative analysis and multi-domain data [6, 8, 15]. At the same time, publications dealing with minefield design, water support and environmental support illustrate how similar methods are being extended across adjacent engineer functions [9, 16–17].

The field trials were restricted to one section of a water obstacle, the tactical environment was not fully modelled, and the evaluation concentrated chiefly on technical performance parameters rather than on a complete operational experiment. These limitations do not invalidate the findings, but they do indicate that the next step should be controlled field validation comparing traditional and uncrewed reconnaissance on the same river section under repeatable conditions.

Conclusions

Established engineer reconnaissance methods remain indispensable because they provide physical confirmation of the decisive variables governing river crossing. At the same time, the field experiment confirmed that emerging uncrewed platforms and sensor suites can move part of the reconnaissance effort forward in time and away from direct personnel exposure. In the tested configuration, UAV-borne LiDAR proved highly effective for bank geometry, obstacle width and access assessment, while GPR complemented it by indicating the longitudinal bed profile and qualitative changes in subsurface structure.

The most promising approach is therefore a layered one: GIS-supported pre-planning, rapid stand-off aerial inspection, selective specialist sensing, and targeted direct verification where risk and uncertainty remain. For the Czech Armed Forces, the central task is not merely the purchase of sensors, but the creation of procedures, training and data workflows that allow remotely gathered information to be translated into timely engineer decisions. On that basis, unmanned reconnaissance should be regarded as an operational amplifier of engineer capability rather than as a substitute for engineer expertise.

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References

1. **Kyjovský J.** Bojová ženijní podpora: vojenské mosty, cesty a přepravy: studijní text [Combat Engineer Support: Military Bridges, Roads and Crossings: Study Text]. Brno: University of Defence, 2016. ISBN 978-80-7231-463-8.
2. **Zelený J., Poročák Ľ.** Organizace a použití jednotek ženijního vojska Armády České republiky [Organisation and Employment of Engineer Units of the Army of the Czech Republic]. Brno: University of Defence, 2020.
3. **Sedláček M., Zelený J.** Requirements for engineer information in water crossing. Vojenské rozhledy, 2019, 28(4), p. 44–62. DOI: 10.3849/2336-2995.28.2019.04.044-062.
4. **Hrnčiar M., Kompan J., Nohel J.** The future of the battlefield: Technology-driven predictions in the land domain. Revista Científica General José María Córdova, 2025, 23(49), p. 277–296. DOI: 10.21830/19006586.1323.
5. **Dohnal F., Straka Š., Duchan D.** Design of Web GIS Application for Planning of Military River Crossing. In Proceedings of the Challenges to National Defence in Contemporary Geopolitical Situation. Brno: University of Defence, 2024. DOI: 10.3849/cndcgs.2024.489.
6. **Sedláček M., Dohnal F.** Proposal of Optimization of Depth Values in Wet Gap Crossing Military Operations. Advances in Military Technology, 2021, 16(1), p. 35–47. DOI: 10.3849/aimt.01421.
7. **Klíma M., Bureš M., Blaha M.** Ant Colony Optimization Based Algorithm for Test Path Generation Problem with Negative Constraints. In Proceedings of the IEEE International Conference on Software Quality, Reliability and Security. Los Alamitos: IEEE Computer Society Press, 2024, p. 701–712. DOI: 10.1109/QRS62785.2024.00075.
8. **Bilina M., Bilinová I., Palaśiewicz T., Žižka P., Grufík M.** Developments in Establishment of Minefields by UAVs: A Response to Conflict in Ukraine. In 2025 International Conference on Military Technologies (ICMT). IEEE, 2025, p. 1–8. DOI: 10.1109/ICMT65201.2025.11061279.
9. **Hanáková N., Malachová H., Davidová P.** Potable Water Supply in the Czech Armed Forces: Roles of Military Engineering and Logistics. In 2025 International Conference on Military Technologies (ICMT). IEEE, 2025, p. 1–8. DOI: 10.1109/ICMT65201.2025.11061309.
10. **Munasinghe I., Perera A.G., Deo R.C.** A Comprehensive Review of UAV-UGV Collaboration: Advancements and Challenges. Journal of Sensor and Actuator Networks, 2024, 13(6), p. 81. DOI: 10.3390/jsan13060081.
11. **Ludeno G., Capozzoli L., Rizzo E., Soldovieri F., Catapano I.** A microwave tomography strategy for underwater imaging via ground penetrating radar. Remote Sensing, 2018, 10(9), p. 1410. DOI: 10.3390/rs10091410.
12. **Elamin A., Abdelaziz N., El-Rabbany A.** A GNSS/INS/LiDAR Integration Scheme for UAV-Based Navigation in GNSS-Challenging Environments. Sensors, 2022, 22(24), p. 9908. DOI: 10.3390/s22249908.
13. **Szafarczyk A., Toś C.** The Use of Green Laser in LiDAR Bathymetry: State of the Art and Recent Advancements. Sensors, 2023, 23(1), p. 292. DOI: 10.3390/s23010292.
14. **Bandini F., Kooij L., Mortensen B.K., Caspersen M.B., Thomsen L.G., Olesen D., Bauer-Gottwein P.** Mapping Inland Water Bathymetry with Ground Penetrating Radar (GPR) on Board Unmanned Aerial Systems (UASs). Journal of Hydrology, 2023, 618, p. 128789. DOI: 10.1016/j.jhydrol.2022.128789.
15. **Švehlík M., Sedláček M., Hasilová K., Drábek J., Šlouf V.** Applications in Engineer and Artillery Support: Mathematical Modeling of Symphatetic Detonation. In Proceedings of the Challenges to National Defence in Contemporary Geopolitical Situation. Brno: University of Defence, 2024. DOI: 10.3849/cndcgs.2024.634.
16. **Bilina M., Hasilová K., Žižka P.** Impact of Minefield Rows Spacing on Vehicle Hit Probability in a Simulated Minefield. In 2025 International Conference on Military Technologies (ICMT). IEEE, 2025, p. 1–6. DOI: 10.1109/ICMT65201.2025.11061330.
17. **Hanáková N., Maňas P.** Czech Military Engineer Support of Environmental Protection during Peace Support Operations. In 2023 International Conference on Military Technologies (ICMT). IEEE, 2023, p. 150–153. DOI: 10.1109/ICMT58149.2023.10171316.
18. **Korec D., Blaha M., Barta J., Varecha J.** Innovative Approaches to the Use of Artillery in Wildfire Suppression. Fire, 2025, 8(6), p. 232. DOI: 10.3390/fire8060232.
19. **Bilina M., Vítek M., Dražan T., Žižka P.** Effectiveness of 3D Printed Shaped Charge Liners in Demolitions. In 2025 International Conference on Military Technologies (ICMT). IEEE, 2025, p. 1–7. DOI: 10.1109/ICMT65201.2025.11061306.