Monitoring of simulated clandestine graves of dismembered homicide victims using remote piloted aircraft, electrical tomography, and ground penetrating radar to optimize searches in Colombia, South America

Carlos Martín Molina, Kristopher Wisniewski, Vivienne Heaton, Jamie Pringle, Edier F. Ávila, Luis Herrera, Jorge Guerrero, Miguel Saumett, Mario Duarte, Raúl Echeverri, Alejandra Baena

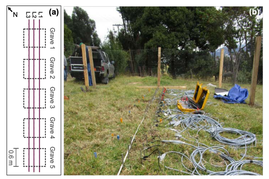
Abstract

In most Latin American countries there are significant numbers of missing people and forced disappearances, over 120,000 in Colombia alone. Successful detection of shallow buried human remains by forensic search teams is difficult in varying terrain and climates. Previous research has created controlled simulated clandestine graves of murder victims to optimize search techniques and methodologies. This poster reports on a study on controlled test site results over four simulated dismembered victims' clandestine graves as this is sadly a common scenario encountered in Latin America.

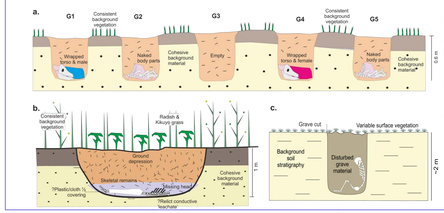
Multispectral images were, electrical resistivity tomography (ERT), and ground penetrating radar (GPR), collected once post-burial. Study implications suggest that, whilst clandestine graves of dismembered homicide victims would likely result in smaller-sized graves when compared to graves containing intact bodies, these graves can still potentially be detected using air-based and geophysical methods.

Experimental Lab

Experimental Lab Location
Aerial photograph of the study area at the Forensic laboratory at the Antonio Nariño University, Colombia, South America.



Experimental Lab View.
a) Plan-view map of control test site showing positions of the five simulated clandestine graves at the Forensic laboratory at the Antonio Nariño University, Colombia, South America. b) Site photograph showing grave locations (orange and blue stakes) and electrical resistivity data being collected.

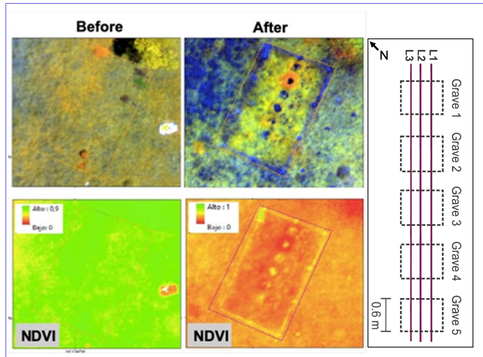


Schematic figures of typical clandestine graves of homicide victims found in Colombia, South America.
a. This study simulating dismembered homicide male (G1-2) and female (G3-G4) individual victims. b. Study of a decapitated victim in tropical environment and c. A schematic of unusual vertically oriented clandestine grave.

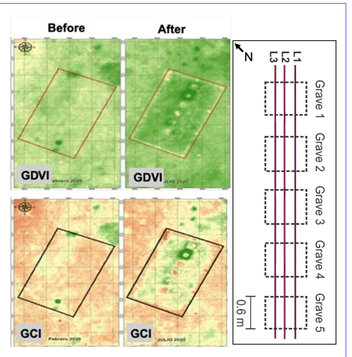
Figure 1. Experimental Lab

Remote Sensing

RPA results were very positive and were able to detect all graves, although it was only possible to collect Day 178 survey data.



Comparative RPA-taken images of multispectral (top row) and (bottom row) NDVI radiometric index data (see text) five days before and 128 days after controlled graves were created with the test site boundaries (5 m x 10 m) shown (dotted rectangles).

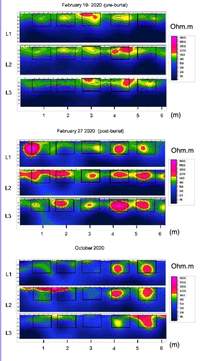


Comparative RPA-taken images of GDVI (top row) and (bottom row) GCI radiometric index data, acquired five days before and 128 days after controlled graves were created with the test site boundaries shown (rectangles).

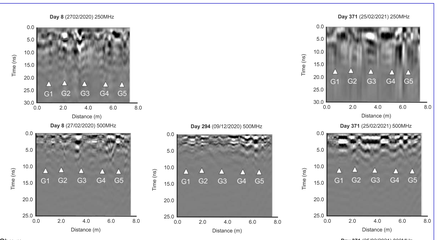
Figure 2. RPAs Images.

Geophysical Techniques

Electrical Resistivity Tomography ERT



Sequential ERT 2D processed profiles acquired over the controlled test site over one year. Simulated clandestine graves (G1,G2,G4,G5) and controlled grave position (G3) are shown as black squares.



Ground Penetrating Radar GPR

Sequential GPR 2D profiles taken over the simulated clandestine grave sites post-burial. Top row are 250 MHz, middle row are 500 MHz and bottom row are 800 MHz datasets for Day 8 (27/02/2020), Day 294 (09/12/2020) and Day 371 (25/02/2021) days post-burial respectively. Buried simulated grave positions are marked.

Figure 3. Geophysical Techniques Profiles

Survey	Post-burial date	Graves 1	2	3	4	5
		Half male clothed	Half male naked	Empty (Control)	Half female clothed	Half female naked
Resistivity (ERT)	Control	○	○	○	○	○
	Day8	●	●	●	●	●
	October 15 - 2020	◍	◍	○	●	●
	Day294	●	●	○	◍	◍
	Day371	●	●	○	●	●
GPR 250 MHz	Day8	◍	◍	●	●	●
	Day371	◍	◍	●	●	◍
GPR 500 MHz	Day8	○	◍	◍	◍	◍
	Day294	○	◍	○	◍	◍
	Day371	◍	◍	○	◍	◍
GPR 800 MHz	Day371	◍	◍	○	●	●

Table 1. Geophysical response of ERT and GPR to graves, where The detection is good ⬢, middle ⬣ and poor ⬡

ERT data was also successful at resolving all the graves. GPR data were more mixed, the early surveys (Day 8) resolving all graves but subsequent surveys only producing medium or poor anomalies.

Conclusions

Simulated clandestine graves of dismembered homicide victims, a common burial scenario in Latin America, were created on a controlled test site near to Bogotá City in Colombia. Study implications suggest that, despite their small size in plan-view, dismembered homicide victim graves can be imaged using RPA and geophysical methods if data is carefully collected, processed and imaged.

Acknowledgments

The authors would like to thank the American Academy of Forensic Sciences (AAFS) Humanitarian and Human Rights Resource Center (HHRRC) for funding this project. The Universidad Antonio Nariño and Universidad de Cundinamarca are thanked for funding the authors and given the time to undertake the study. GEOSENSE Colombia is also thanked for its constant support with the GPR technique and Keele University for advice and contributions to this work.

Reference

Molina, C. M., Wisniewski, K., Heaton, V., Pringle, J. K., Avila, E. F., Herrera, L. A., Guerrero, J., Saumett, M., Echeverry, R., Duarte, M., & Baena, A. (2021). Monitoring of simulated clandestine graves of dismembered victims using uavs, electrical tomography, and GPR over one year to aid investigations of human rights violations in Colombia, South America. Journal of Forensic Sciences. https://doi.org/10.1111/1556-4029.14962