



FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

Presented at the FIG Working Week 2024,
19-24 May 2024 in Accra, Ghana

Methodological cadastral baseline for the multipurpose physical survey of real estate using SFM-CRP photogrammetric techniques for 3D reconstruction.



Esp. Yosef Harvey Cortes Millan (Speaker) yosef.cortes@igac.gov.co

Cadastral Engineer and Geodesist of the Universidad Distrital Francisco José de Caldas (UDFJC), Specialist in Geographic information systems, and candidate for the Master's degree in geomatics and geoinformation. . Official Researcher at the Institute of Geography Agustín Codazzi (IGAC).

Ms. Kellith Melixa Gómez Urrego kellith.gomez@igac.gov.co

Environmental Engineer, Master's degree in Information Management and Geospatial Technologies. Official researcher at the Institute of Geography Agustín Codazzi (IGAC). **Ph.D.**

Johan Andrés Avendaño Arias Johan.avendano@igac.gov.co

Geographer of the Universidad Nacional de Colombia (UNAL), Cadastral Engineer and Geodesist of the Universidad Distrital Francisco José de Caldas (UDFJC), Specialist in Public Policy Analysis. Master's degree in Territory, Space, and Society, and Ph.D. in Geography, Development, Territory, and Society from the École des Hautes Études en Sciences Sociales (EHES) of France. University lecturer and researcher, with extensive experience as a consultant and analyst in areas such as public policy, cadaster, planning, poverty, and territorial management. Current Director of the Directorate of Research and Perspective of the IGAC.





FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

1. INTRODUCTION

The adoption of Colombia's Multipurpose Cadaster Public Policy aims to enhance property information with greater legal certainty and efficiency in the real estate market. To overcome technological limitations in inventorying property dimensions, we propose low-cost tools like the Structure from Motion technique that are utilized for three-dimensional reconstructions of facades, proving feasible for high-rise cadastral consolidation.



ORGANISED BY



PLATINUM SPONSORS





FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

2. MATERIALS AND METHODS:

2.1. Study Area:

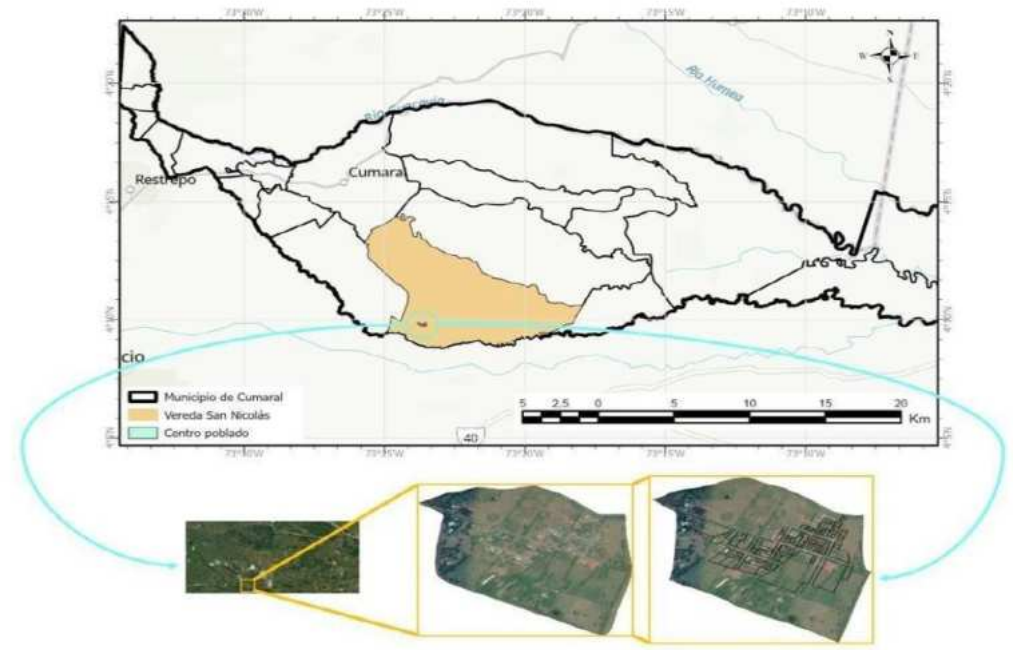


Figure 1. Pilot Area: Vereda San Nicolás (Municipality of Cumaral).

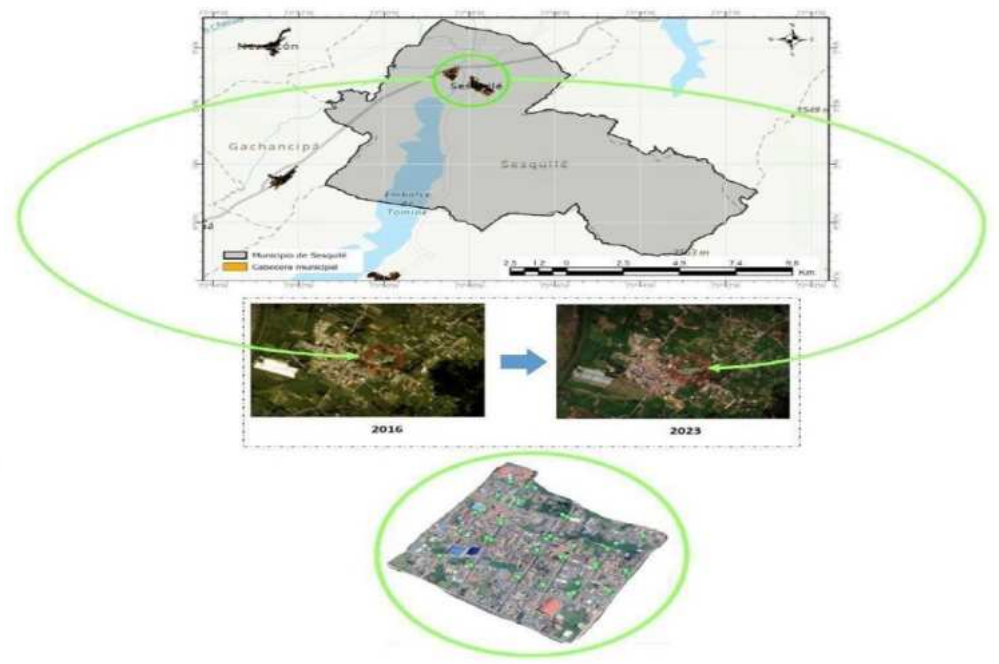


Figure 2. Study Area: Municipality of Sesquillé.



FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

2. MATERIALS AND METHODS:

2.2 Application of the SfM-CRP technique:

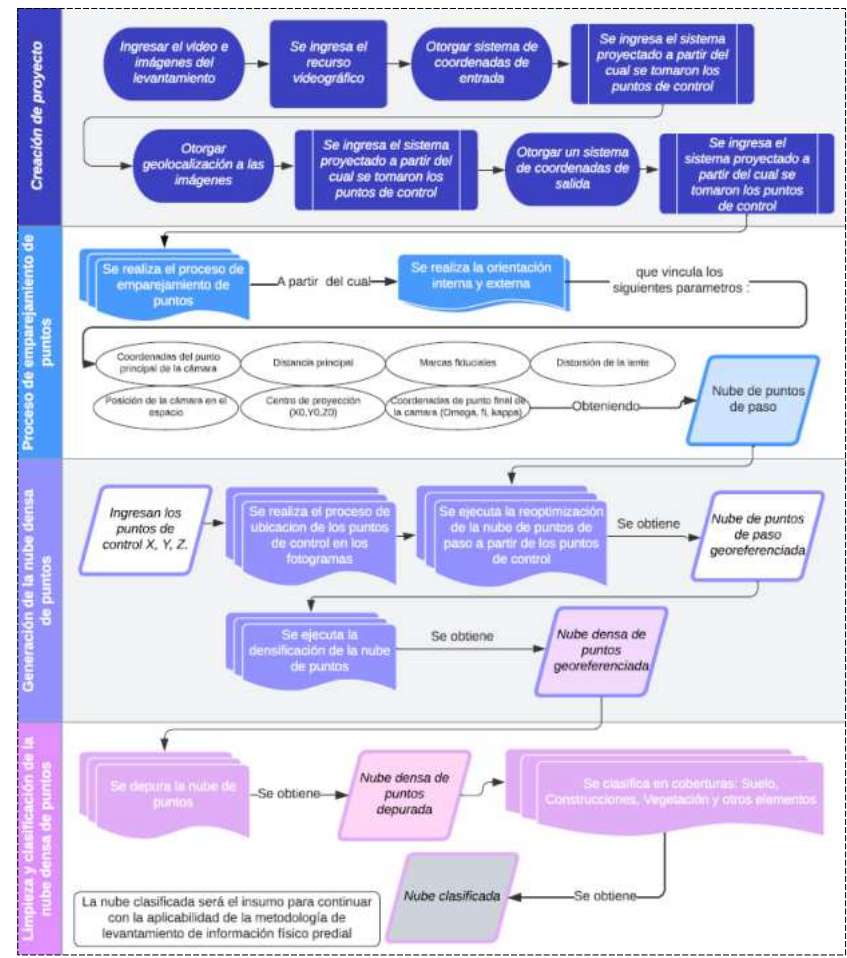


Figure 3. Methodology for 3D reconstruction of facades for cadastral purposes using the SfM-CRP technique.



FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

3. RESULTS:

3.1. Implementation of the SFM-CRP technique in San Nicolás (Cumara):

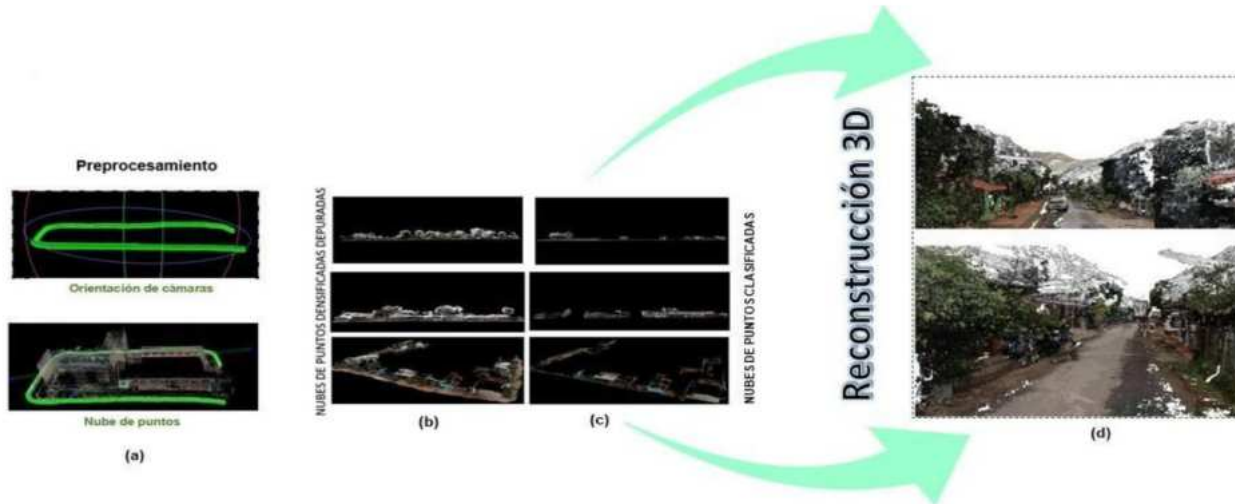


Figure 4. Point clouds of the San Nicolás village: (a) georectified point clouds, (b) densified point clouds, (c) classified point clouds and (d) result of the three-dimensional reconstruction.

Table 1. GSD and RMS values of the densified point clouds - San Nicolás village.

# Cloud	GSD (cm)	RMS Error X*	RMS Error Y*	RMS Error Z*
1	1.21	0.003146	0.005241	0.000976
2	1.28	0.197585	0.269953	0.085804
3	0.79	0.006373	0.007185	0.001445
4	0.85	0.030572	0.019747	0.000940
5	0.70	0.013030	0.013737	0.000426
6	3.11	0.000037	0.000029	0.000008

* The units of measurement for X, Y and Z are in meters.



FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

3. RESULTS:

3.2 Implementation of the SfM-CRP technique in the municipality of Sesquilé:

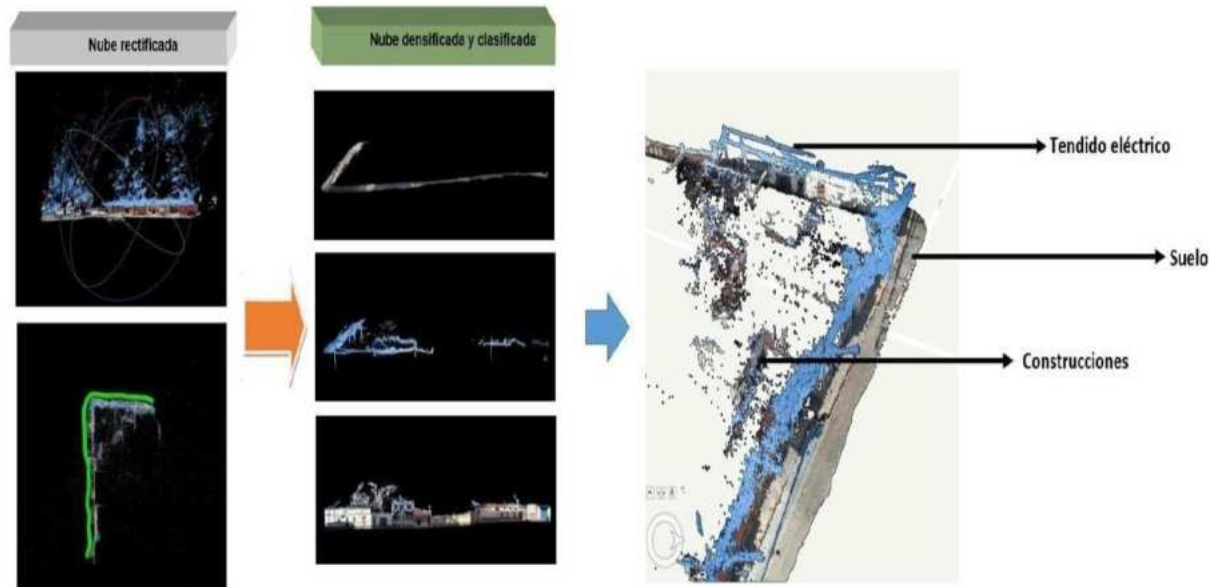


Figure 5. Densified georectified and classified point clouds - Sesquilé.



Figure 6. Unified Densified Point Clouds – Sesquilé.



FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

3. RESULTS:

3.2 Implementation of the SfM-CRP technique in the municipality of Sesquilé:

Table 2. GSD and RMS values of the densified point clouds - Sesquilé municipal seat.

# Cloud	GSD (cm)	RMS Error X*	RMS Error Y*	RMS Error Z*
1	0.56	0.011005	0.006805	0.013039
2	0.70	0.002557	0.004645	0.000099
3	0.62	0.001519	0.003076	0.000161
4	0.62	0.002276	0.001721	0.000148
5	0.81	0.018958	0.004078	0.000787
6	0.71	0.001000	0.001200	0.000200
7	0.67	0.007263	0.004065	0.0028468
8	0.67	0.007263	0.004065	0.0028468
9	0.59	0.0012595	0.0014605	0.0001235

*The units of measurement for X, Y and Z are in meters.



FIG Working Week 2024

19-24 May

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

3. RESULTS:

3.3 Validation of metrics in vertical and horizontal component



Figure 7. Validation of metrics for the San Nicolás trail.



FIG Working Week 2024

19-24 May

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

3. RESULTS:

3.3 Validation of metrics in vertical and horizontal component

Measurement	Value
Measurement (m)	0.00
Measurement (m)	0.00
Measurement (m)	0.00
Measurement (m)	0.00
Measurement (m)	0.00
Measurement (m)	0.00

PREDIO 2



Figure 8. Validation of metrics at the Sesquilé municipal seat.



FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

3. RESULTS:

3.4 Identification of cadastral management processes for the San Nicolás district:

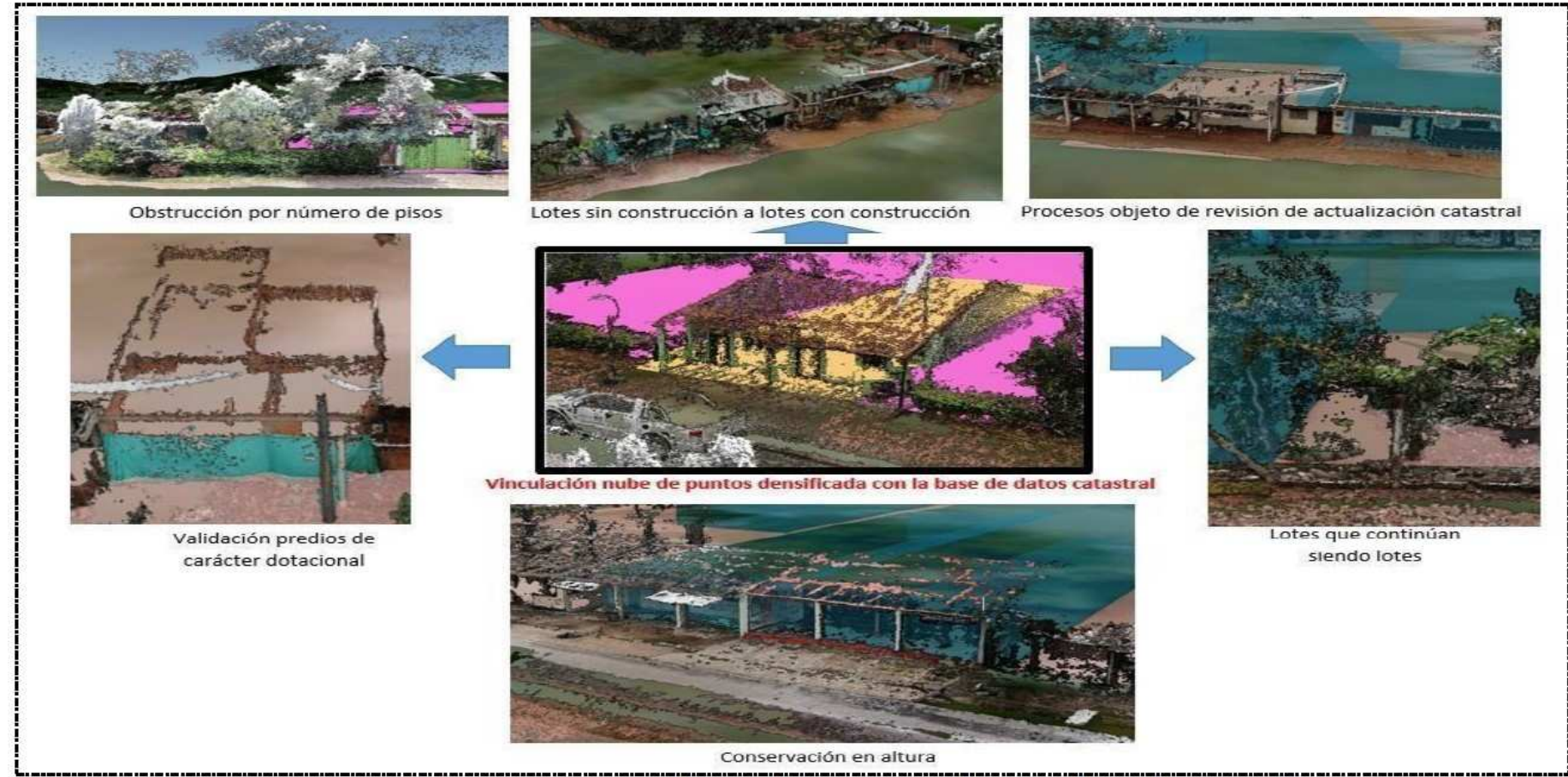


Figure 9. Identification of physical changes in the San Nicolás rural district.



FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

3. RESULTS:

3.4 Identification of cadastral management processes for the San Nicolás district:

Table 3. Cadastral management processes identified in the San Nicolás district

Identified cases subject to cadastral review: 42 pre-God	Identified cases subject to cadastral conservation
Registered with 0 apartments that with cadastral update. The number of properties would be 1 floor: 26 properties, of which 2 are presumed to be for use by the public.	10 plots
Registered as 1-story properties, which are currently lots without construction: 2 lots.	
Registered with 0 apartments that with cadastral update pa-2 floors: 1 property	
Possible disengagements: 3 properties	
Possible encompasses: 1 property	

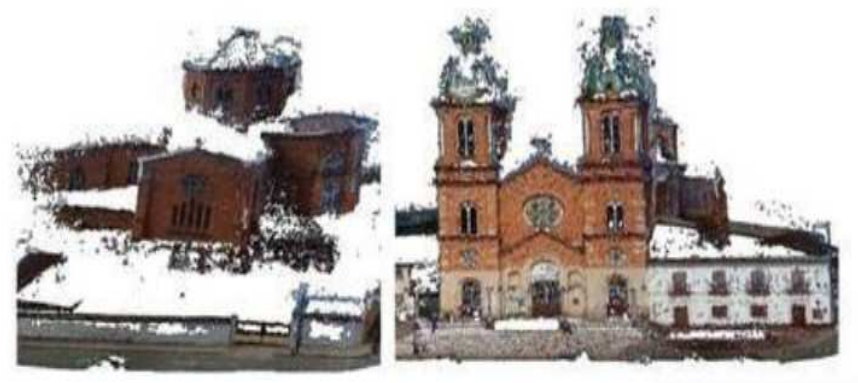


FIG Working Week 2024

19-24 May

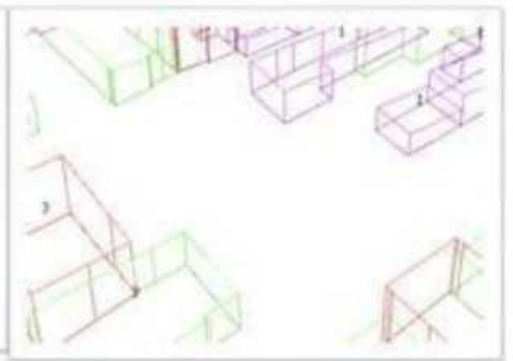
Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All



validation of properties
of an endowment nature

lots that remain lots



ORGANISED BY



PLATINUM SPONSORS





FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All



conservation at height

validation by number of floors or
cadastral units

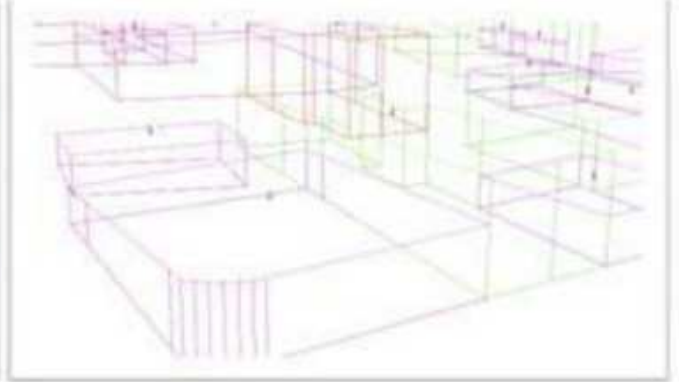


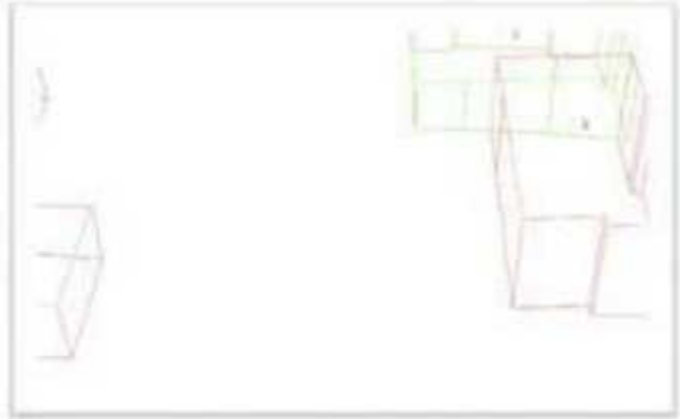


FIG Working Week 2024

19-24 May

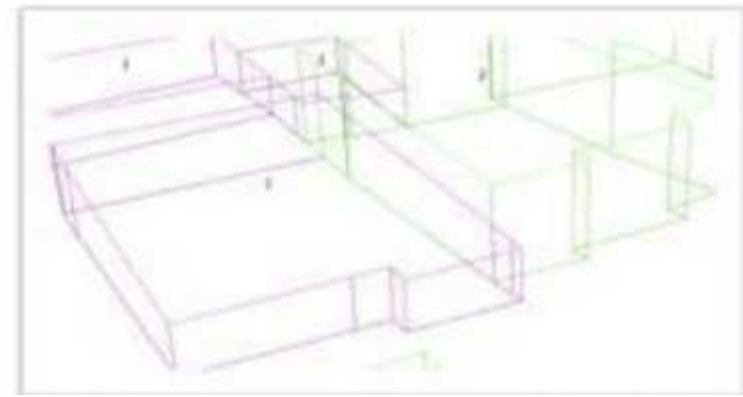
Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All



lots without construction
to lots with construction

cadastral revision object
processes



ORGANISED BY



PLATINUM SPONSORS



GEOSA
General Authority for Survey
and Geospatial Information





FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

3. RESULTS:

3.5 Identification of cadastral management processes at Sesquilé.

Table 4. Cadastral management processes identified in Sesquilé

CADASTRAL MANAGEMENT PROCESSES		
Cases identified and subject to cadastral review: 24properties	Cases identified for training cadastral	Cases identified for preservation cadastral information
Registered with 0 floors than with update would be upgraded to 1 floor: 2 Properties	3 plots	47 plots
Registered as 1-story properties that are recurrently- The lots are not built-up lots: 0 properties.		
Registered with 0 floors than with update would be upgraded to 2 stories: 5 properties		
Registered with 1 floor than with upgrade would be upgraded to 2 stories: 7 properties		
Registered with 2 floors than with upgrade cadastral would go to 3 floors: 9 properties		
Possible disengagements: 1 Disengagement of the property (257360100000000210042000000000) from 1 to 3 2-story houses each		
Possible encompasses: 0		



FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

4. DISCUSSION:

Resolution 471 of 2020 and its amendment, Resolution 529 of 2020, set forth minimum technical specifications for the basic official cartography in Colombia, including orthoimages, digital terrain models (DTM), and vector cartographic databases. However, these standards do not address the requirements for a three-dimensional cadastre. Resolution 529 of 2020 defines the root mean square error (RMS) as the method for evaluating positional accuracy, particularly in the vertical component for DTMs. Despite three-dimensional reconstructions not being explicitly considered as DTMs, their key attribute is the height component. Comparing the results at the village and municipal levels with regulated RMS values for vertical accuracy, software-generated mean square error values ranged from 0.000008 to 0.09 meters in the San Nicolás district of Cumaral municipality and from 0.000099 to 0.013 meters in Sesquilé, Cundinamarca. These fall within the margin established by the standard, suggesting the validity of the SFM-CRP technique for 3D facade reconstruction. These reconstructions are significant for high-altitude cadastral bases due to their minimal accuracy errors and interoperability with various geographic information systems. The technique's ability to fragment images adequately and associate 3D reconstructions with alphanumeric data in cadastral bases enhances property identification for cadastral management processes, aligning with the implementation of the multipurpose cadastre.

ORGANISED BY



PLATINUM SPONSORS





FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

5. CONCLUSIONS:

With the development of this research project, it is concluded that 3D reconstruction provides valuable information for the multipurpose cadastre, by providing an approximation of the exterior aspects of the buildings, specifically the facade and finishes. This, when associated with alphanumeric data from the cadastral database, made it possible to identify the properties that are the object of cadastral management processes in the San Nicolás (Cumaral) district and in the municipal capital of Sesquilé. Likewise, the accuracies obtained in the vertical and horizontal components provided assurance of the veracity of the applied technique. The RMS values are within the range established in the current regulations for cartographic products that include the height variable.

However, with the generation of the 3D reconstruction, the absence of regulations for a three-dimensional cadastre became evident. Finally, the methodological proposal was implemented at different scales (village and municipality) and topographic terrain conditions, demonstrating its versatility, flexibility and low cost of application. Therefore, it can be considered as a potential indirect method to move from a two-dimensional cadastre to a three-dimensional one.

ORGANISED BY



PLATINUM SPONSORS





FIG Working Week 2024

19-24 May

Accra, Ghana

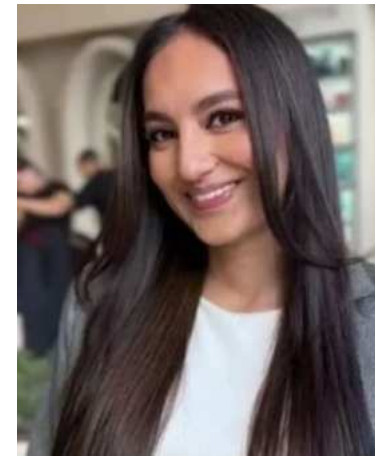
Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All



**Ph.D. Johan Andrés
Avendaño Arias**
Johan.avendano@igac.gov.co



**Esp. Yosef Harvey
Cortes Millan (Speaker)**
yosef.cortes@igac.gov.co



**Ms. Kellith Melixa
Gómez Urrego**
kellith.gomez@igac.gov.co

ORGANISED BY



PLATINUM SPONSORS





FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

SUSTAINABLE DEVELOPMENT GOALS

International Federation of Surveyors supports the Sustainable Development Goals

Commission 3

3D Land administration and digital twins

Serving Society for the Benefit of People and Planet



ORGANISED BY



PLATINUM SPONSORS

