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Determination of land use and altitude of the experimental farm La María, owned by UTEQ, using aerospace technology

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Abstract

The detailed survey of the territory allows determining the different uses given to the soils of the university campuses, by including the estimation of the area dedicated to each university activity, whether educational, research, production, it is possible to establish the areas with deficit and waste in their use, errors that usually occur due to the lack of high resolution scale cartography, which is very appropriate for the good administrative management of the experimental farms (León et al., 2020). For any academic institution that manages representative extensions of surface area, destined for education, research or production, it is essential to know the structure and distribution of space and land use of their respective academic campuses (Di Leo, 2015). Nowadays, it is necessary that universities are at the forefront of technology, specifically in geographic engineering, it is evident the need for the application of aerospace technology, which allows to determine in addition to land use its relief under a high resolution and in real time, appropriate to the needs of a globalized world (Yánez-Cajo et al., 2021), this in order not to lag behind a demanding and innovative academic culture. The present project has the intention of determining the use and altitude of the soil, in high resolution and updated of the experimental farm La María to facilitate the administrative decision making processes, in a more agile and adequate way, considering the management of the university space as a fundamental axis.

Keywords: *Territory, Land use, Resolution, Aerospatial, Altitude.*

Introduction

The incorporation of cartographic products in the planning of university fields not only avoids occupying areas inappropriately, such as for infrastructure or experimental areas, but also determines the zonal treatments that must be implemented to reduce the conditions of poorly

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occupied and risky spaces, These elements constitute determinants and norms of higher hierarchy for the ordering of the uteqsino space. The development of this proposal offers a practical tool for those responsible for those involved in the ordering and management of the uteqsino space, providing criteria for the classification, use and treatments of space, without the need to understand in detail the maps and products of a technical nature. This tool aims to guide the key elements for decision-making of the UTEQ authorities, in addition to the restrictions that could be considered in the for the occupation of space, suggest actions to intervene in unused areas, prioritize actions to reduce risk in focal areas, establish areas of expansion and protection, and identify the main needs for complementary studies or information. Given the growing size and complexity of university city, characterized by its insertion in the urban fabric, universities such as the National University of Córdoba in Argentina to maintain and improve for greater harmony in the fulfillment of their functions, the relative increase of a dynamic population that inhabits it and with it the increase of mass public transport and the automotive fleet, In particular, that it circulates and remains, and, fundamentally, the sustained momentum generated by the expansion of existing activities and the appearance of many new ones, product of the university policies in progress, implemented its territorial reordering through a project of zoning of public space. The vast expanse of "La María" experimental farm not only supports the UTEQ's agricultural and livestock research but also serves as a crucial center for environmental conservation efforts. With its sustainable practices and focus on eco-friendly initiatives, the campus stands as a shining example of responsible farming and resource management. Beyond its research and educational functions, "La María" has become a community hub, regularly hosting workshops, seminars, and outreach programs to engage with local farmers and residents. This outreach not only benefits the community but also allows students to gain real-world experience and contribute positively to the region. The farm's impressive array of state-of-the-art machinery and equipment enables students to apply theoretical knowledge to practical situations, honing their skills and preparing them for the challenges of modern agriculture and production management. Moreover, the laboratories and classrooms on campus provide a conducive atmosphere for academic exploration and intellectual growth. As the heartbeat of the university's agricultural and environmental endeavors, "La María" plays a significant role in promoting research collaborations between faculties and disciplines. This interdisciplinary approach encourages innovative solutions to complex agricultural and environmental issues, contributing to the overall advancement of sustainable practices in the region and beyond. The beauty of "La María" extends beyond its academic and technical aspects. The farm's picturesque landscapes and natural surroundings offer a tranquil setting, making it an ideal place for students to find inspiration and connect with nature. It serves as a sanctuary for those seeking respite from the hustle and bustle of campus life while fostering a profound appreciation for the environment and its preservation. In conclusion, "La María" experimental farm stands as a beacon of progress, sustainability, and community engagement within UTEQ's educational landscape. Through its diverse infrastructure and unwavering commitment to excellence, it continues to nurture the next generation of skilled

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professionals and leaders in agriculture, livestock management, environmental conservation, and production. Its legacy as a transformative and influential institution remains deeply ingrained in the hearts of all who pass through its verdant fields and classrooms.

MATERIALS AND METHODS

Area of study

The present research was developed in the experimental farm "La María" belonging to the State Technical University of Quevedo, which extends between the parallels 01°05'11.3"S and the meridians 79°30'07.1"W, located in the Mocache canton of the province of Los Ríos, comprises an area of 112.44 ha (Fig. 1).

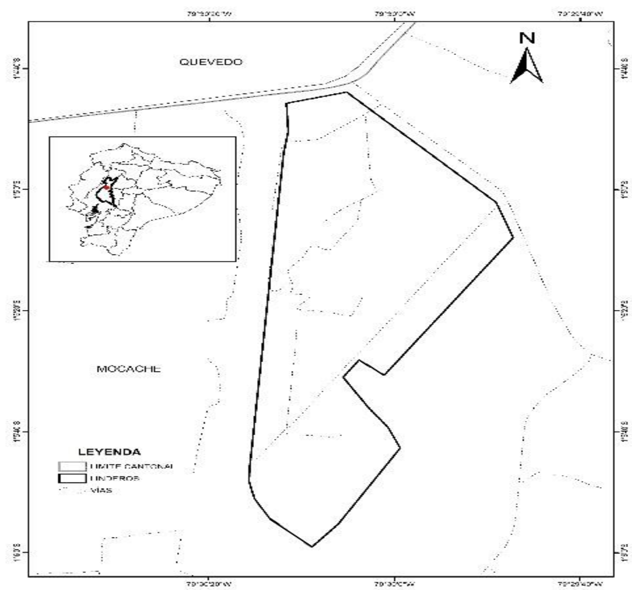

Figure 1: Finca La Maria

Source: Prepared by the author

The methodology presented in this work aims to be an indicative guide of how land use and altitude were determined from the application of aerospace technology. The methodology can be divided into field and cabinet activities.

Field Phase

In this phase the information will be collected: First, a diagnosis of the area will be made using medium precision instruments, such as GPS georeceptors (navigators), in addition to the use of some secondary instruments, such as CAD and SHP files, as a reference, performed in diagnosis Later with the diagnosis, a prospection will be carried out for the location of control points, keys to millimeter precision, both in planimetry and altimetry, in this component the GNSS station will be used. (GPS, GALILEO, BEIDOU, GLONNAS). Flight planning will be carried out, in this component the flight of the MAVIC 2 PRO rotary-wing drone will be planned, in which the environmental factors are considered: precipitation, wind speed, relative humidity, etc.

The flight plan will be made with an automated flight, considering a flight height of average of 150m in the field, to obtain a spatial resolution of 1.8 cm / px (1.8 cm per pixel), excellent for good photogrammetric processing, here the Hasselblad 20mp sensor will be used. The obtaining of the data will be plannedcough to move to image processing. Validation points of the geographical objects will be taken, making the field visit.

Cabinet

First, the information will be organized in structured folders (due to the high weight of digital files) An algorithm for photogrammetric processing will be planned, using the images, in order to obtain the orthophotomosaic (orthophoto) and Digital Elevation Models (MDE), to generate all the products derived from the images, the Agisoft Metashape software and ArcGis (ArcMap 10.8) will be used for this process. A high-performance computer will be used in all instances of the cabinet phase. Products will be validated in the field, with site visits and qualitative data collection

RESULTS

Generation of high resolution orthophoto, Once the control points in the study area were taken to establish their spatial location with an accuracy of 5 cm of error, we proceeded to carry out the survey of the aerophotogrammetric flight scenes from their respective flight plan, which involved several flight missions to complete the total surface of the study area according to what can be observed in Fig. 2

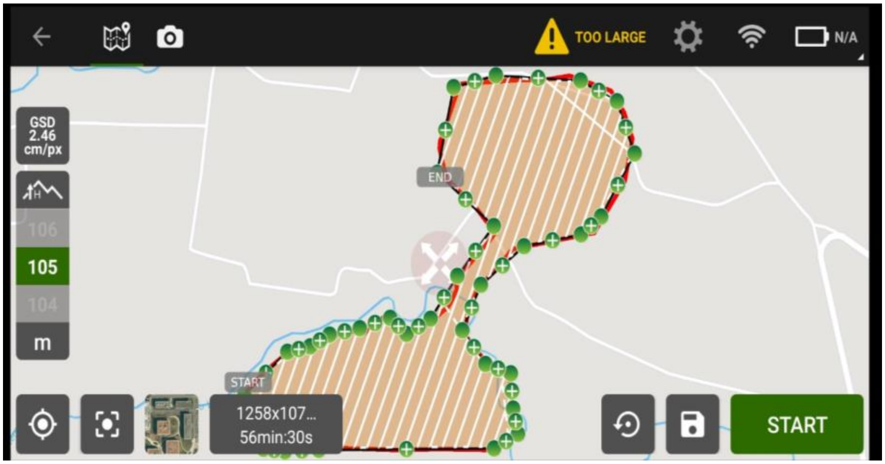

Figure 2: DJI Mavic 2 Drone Flight Plans

Source: Prepared by the author

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After carrying out the four missions with their respective flight plan, the 3932 photographic scenes were photorestored in the Agisoft Metashape Professional software, Fig. 3. With the same software, the Digital Elevation Model (DEM) of the study area was also obtained.

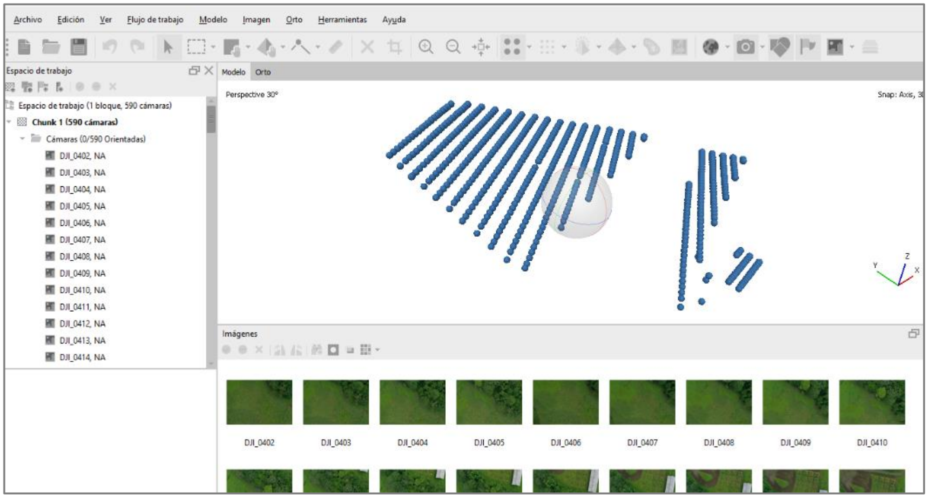

Figure 3: Photorestitution of aerospace flight scenes

Source: Prepared by the author

Figure 4 shows the high-resolution orthophoto with 1.8 cm per pixel of the La María experimental campus belonging to the State Technical University of Quevedo.

Figure 2: DJI Mavic 2 Drone Flight Plans

Source: Prepared by the author

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From the high-resolution orthophoto of the La María farm, it was digitized in order to establish the current land use of the study area. In addition, fieldwork was carried out to verify the actual land uses of the experimental farm, figure 5.

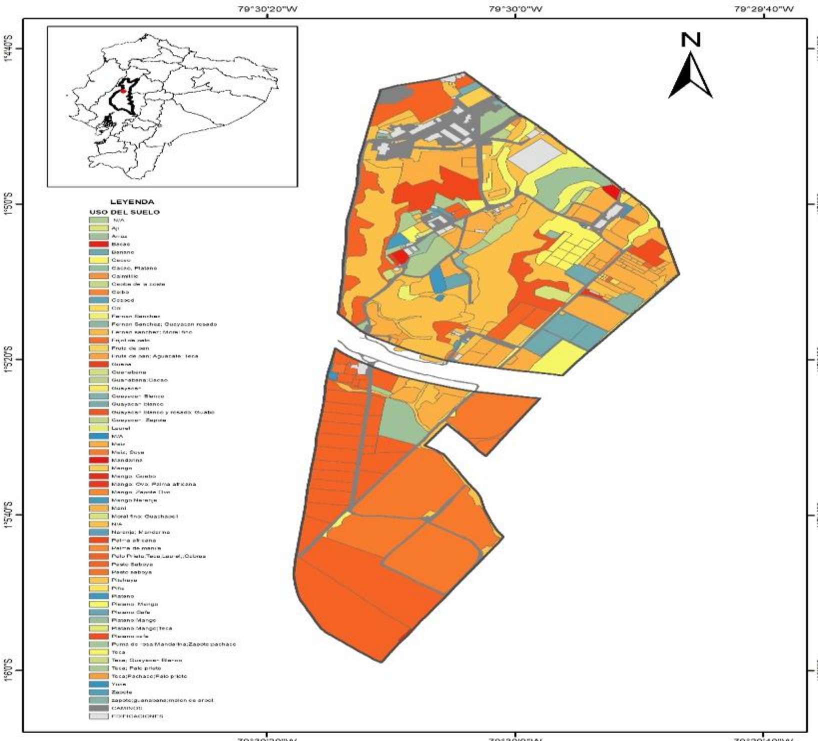

Figure 5: Land use of La María campus

Source: Prepared by the author

Table 1 provides valuable insights into the agricultural land use patterns at the expansive La María farm. The data reveals that Savoy grass cultivation dominates the agricultural area, covering a substantial 25.89 hectares, which corresponds to 33.29% of the total agricultural land. This concentration of Savoy grass cultivation constitutes a significant portion, approximately 69.17%, of the entire farm's area. On the other hand, the cultivation of peanuts occupies a comparably smaller portion of the agricultural area, with only 0.01 hectares, making up merely 0.01% of the total agricultural land. While peanuts may occupy a minor share, they can still play a role in diversifying the farm's agricultural practices and possibly contributing to niche markets. Interestingly, the table also indicates that a considerable part of the La María farm's total area, approximately 30.82%, is utilized for infrastructure and support facilities. These include roads, buildings, and other experimental constructions, which are essential for the effective functioning of the farm, enabling research activities, and providing a conducive environment for students and

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researchers. Overall, the distribution of agricultural land use showcased in Table 1 reflects the farm's strategic approach to balance research-driven cultivation, like Savoy grass, with experimental endeavors, like peanuts, while simultaneously maintaining the necessary infrastructure to support and enhance the educational and scientific aspects of the La María farm. Such a comprehensive approach underscores the farm's commitment to academic excellence and sustainability in the field of agriculture and environmental management.

Table 1: Agricultural use of the land of the farm La María

Cultivation	Area (ha)	%
Aji	0.10	0.13
Rice	2.91	3.74
Bacao	0.16	0.21
Banana	2.08	2.67
Cocoa	2.05	2.64
Cocoa, Banana	0.08	0.10
Caimitillo	0.05	0.06
Mahogany from the coast	0.42	0.54
Ceibo	0.05	0.06
Grass	0.15	0.19
Cabbage	0.09	0.12
Fernan Sanchez	0.18	0.23
Fernan Sanchez; Pink Guayacan	0.13	0.17
Fernan Sanchez; Fine morals	0.06	0.08
Stick bean	0.05	0.06
Breadfruit	0.07	0.09
Breadfruit; Avocado; Teak	0.01	0.01
Guaba	0.05	0.06
Soursop	0.09	0.12
Soursop; Cocoa	0.03	0.04
Guayacan	0.05	0.06
White Guayacan	0.15	0.19
White and pink guacan; Guabo	1.72	2.21
Guayacan, Zapote	0.14	0.18
Laurel	0.03	0.04
Corn	13.00	16.71
Corn; Soy	15.89	20.43
Tangerine	0.16	0.21
Mango	0.56	0.72
Mango; Guabo	0.05	0.06
Mango; Ovo; African palm	0.10	0.13
Mango; Zapote Ovo	0.07	0.09
Mango; Orange	0.21	0.27
Mani	0.01	0.01
Fine morals; Guachapeli	0.37	0.48
Orange; Tangerine	0.03	0.04
African palm	2.01	2.58

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Table Continues:

Manila palm	0.03	0.04
Palo Prieto; Teak; Laurel;; Goats	0.36	0.46
Savoy grass	0.11	0.14
Savoy Grass	25.89	33.29
Pineapple	0.08	0.10
Pitaya	0.10	0.13
Banana	0.49	0.63
Banana; Mango	0.18	0.23
Banana;coffee	0.56	0.72
Banana; Cafe	0.28	0.36
Banana; Mango	0.31	0.40
Banana; Mango; Teak	0.06	0.08
Rose cougar; Tangerine; Zapote;pachaco	0.52	0.67
Teak	4.67	6.00
Teak; White Guayacan	0.12	0.15
Teak; Palo prieto	0.07	0.09
Teak; Pachaco; Palo prieto	0.11	0.14
Manioc	0.02	0.03
Zapote	0.02	0.03
zapote;guanabana;melon de arbol;	0.44	0.57
TOTAL	77.78	100.00

Source: Prepared by the author

The spatial analysis of the La María farm allowed to determine a Digital Land Elevation Model with a resolution of 1 meter, as shown in figure 6.

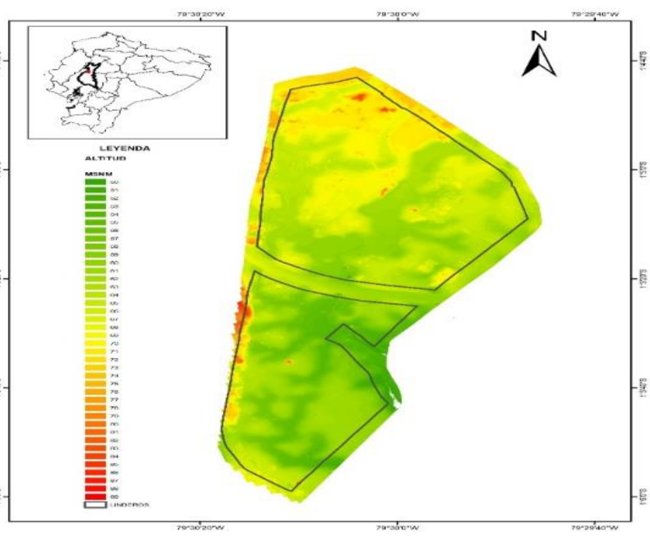

Figure 5: Land use of La María campus

Source: Prepared by the author

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Table 1 shows the surfaces by altitude levels obtained from the geostatistical analysis of the Digital Elevation Model (DEM). It can be seen that the altitude of 61 meters above sea level with 11.37 ha occupies the largest area of the farm with 10.28% while the altitude of 84 meters above sea level with 0.01 ha occupies the smallest area of the farm equivalent to 0.01%.

Table 1: Altitude of the farm La María

Altitude (masl)	Area (ha)	%
50	0.36	0.33
51	0.40	0.36
52	0.28	0.26
53	0.77	0.69
54	1.85	1.67
55	2.93	2.65
56	3.55	3.21
57	3.49	3.16
58	4.36	3.94
59	5.49	4.96
60	9.20	8.32
61	11.37	10.28
62	8.86	8.01
63	9.70	8.77
64	8.69	7.86
65	7.97	7.21
66	6.33	5.72
67	5.11	4.62
68	5.23	4.73
69	4.23	3.82
70	4.35	3.93
71	4.44	4.02
72	0.72	0.65
73	0.25	0.23
74	0.19	0.17
75	0.12	0.11
76	0.07	0.07
77	0.05	0.05
78	0.04	0.04
79	0.04	0.03
80	0.04	0.04
81	0.03	0.03
82	0.04	0.03
83	0.03	0.03
84	0.01	0.01
85	0.00	0.00
86	0.00	0.00
TOTAL	110.60	100.00

Source: Prepared by the author

DISCUSSION

Unmanned aerial vehicles (UAVs) commonly known as drones are one of the multidimensional technologies of the contemporary era (Khan et al, 2017). This technology allows photogrammetric applications in many areas of knowledge and industries such as: The prospection and exploration of mineral resources (López Jimeno & Martín Sánchez, 2015), agriculture (Montesinos Aranda, 2015), control of works and impact evaluation (Campo Molinuevo, 2015), cartography (Saez Paredes & Beltrán Noguera, 2015), and topography that is inscribed as one of the oldest professions in the world (El Meouche et al, 2016) (Peterman & Mesarič, 2012); and many others that will come in the near future, according to Hassanalian & Abdelkefi (2017). The aerophotogrammetric drone can be recommended for surveying small rural areas because the effective flight time is limited by its battery. Its navigation must be carried out at small flight heights of no more than 150 meters (Da Silva, J. E. C. F., & Botelho, M. F., 2017) The use of the drone in photogrammetry is an increasingly affordable technology, and can be used for activities such as updating, study, monitoring, inspection of the ground surface, among other more specific works. Using the appropriate methodology, it is possible to obtain orthophotos and digital elevation models (MDE) with a high spatial resolution that exceeds those offered by satellite images, (Enriquez, 2015). The technical regulations of the Military Geographic Institute (IGM) of Ecuador for the base cartography of 1:1000, establishes that the conditions of the photogrammetric flight must present the parameter Ground Sample Distance (GSD) equivalent to GSD 0.1m ± 10%, for this reason, being within this range, the orthophoto obtained with the drone can be use for the generation of a land use map at the aforementioned scale of spatial resolution.

CONCLUSIONS

Geospatial information acquisition technologies have revolutionized in recent years, complementing conventional surveying and photogrammetry techniques. The use of drones is one of the technologies for acquiring spatial data at a local scale with high resolution, significantly increasing its use in the last decade. The integration of high precision geospatial information through flights with photogrammetric drones with the accompaniment of new flight automation platforms and applying proven photorestitution algorithms, performing georeferencing with control points established with GNSS / RTK equipment has become a very efficient protocol for obtaining orthophotomosaics of a high spatial resolution of less than 2 cm per pixel. The development of this work allowed the integration of a methodological proposal to generate the land use map of the experimental farm La María. Through the methodology described, it was possible to integrate a high-precision orthophoto and MDE with the characteristics and precision that the study requires. The methodology applied in the present study can be applied in other works in other study areas, obtaining results similar to those described. This document can serve as a documentary guide to students or professionals in the area of geospatial technologies interested in deepening this area of knowledge.

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