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PLANIALTIMETRICAL MAPPING AND SURVEY FOR AREAS REGULARIZATION WITH THE USE OF DRONES

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Abstract: Reducing water losses is a daily challenge for sanitation companies. In order to mitigate this problem and improve the loss indicators monitored by these companies, various practices are carried out on several fronts, one of the main ones being the reduction of losses through regularization of vulnerable areas due to the great positive impact on volumes, control of pressure on the network, billing, and above all, social responsibility. This work aims at quickly mapping irregular areas that will undergo the process of regularization and/or monitoring of already regularized areas, using drones. The planialtimetric data, obtained from the aerial photogrammetric survey, may be used by the maintenance, operation and engineering areas for the development of studies and projects for water supply and sewage collection, as well as in optimizing the Company's registration base. Regarding the aerial images, these will subsidize the previously mentioned areas, plus the commercial area for carrying out studies and monitoring the territorial and demographic expansion of the occupations.
Keywords: *Drones*, reduction of losses, regularization of areas.

INTRODUCTION

The operation of water supply systems and the reduction of losses are part of the routine of sanitation companies worldwide and are directly impacted by the irregular supply in low-income communities.

In the city of São Paulo, part of the percentage is concentrated in communities that have irregular connections, due to unrestrained consumption not accounted for and a high number of leaks due to the low quality of the materials used and construction methods.

According to the Municipal Housing Secretariat (SEHAB), the city of São Paulo has the largest number of favelas in Brazil and through technology it is possible to act in the regularization of areas with the use of *drones* to provide basic sanitation and quality of life for these needy people, as well as promoting greater control of the supply systems for the Company, expressive gains in the reduction of water losses and an increase in billing with greater speed and reduced cost.

OBJECTIVE

The objective of these surveys using drones is to offer an economical option with greater agility in mapping the areas to be regularized, also subsidizing the basic projects of the water supply and sewage collection networks.

The use of this equipment for the planialtimetric survey of the area and collection of aerial images streamlines the collection of data that, after treatment in the office, will be used for the counting and classification of existing buildings, registration of the road system/access to houses, as well as the identification of irregular releases of sewage into water bodies. From these data it is possible to carry out planning studies, elaboration of basic projects for the implantation of water and sewage networks, as well as to improve the access logistics during the works of implantation of the networks.

METHODOLOGY

Initially, a pilot was carried out in the Demo Guidelli community, located in an area adjacent to Rua Professor Demo Guidelli in the Cidade Tiradentes Supply Sector, east zone of São Paulo, where an area of approximately 7,000 m² was mapped and which made it possible to learn about the technology and methodology for later application in the Paiolzinho community, which is made up of the junction of the Japequino, Vaquejada, Vista Alegre and CDHU communities.

The Paiolzinho community is located adjacent to the street: Inácio Monteiro (east area of the city of São Paulo), in the same region as the Demo Guidelli community and has an area of approximately 780,000 m².

The traditional method for regularizing areas consists of choosing the area to be regularized, negotiation with the granting authority, meetings with local leadership, manual counting of buildings, manual collection of measurements and topographical survey with equipment on the ground. For all these stages to happen, it takes an average of three months until all the material is ready.

Figure 1: Used Mavic Pro 2 drones. Source: Sabesp (2022).

In order to optimize this process, an opportunity arose for a partnership between an engineering company and Sabesp, through the Regional Management Unit (UGR) where some steps were defined, namely:

- **Selection of the area to be regularized** - consists of choosing consolidated areas subject to regularization with the consent of the granting authority.
- **Negotiation with the granting authority** - phase in which consent is provided for the implementation of water supply and sewage collection networks.
- **Meeting with local leadership** – occasion when information is passed on to the community and support from local leadership is requested to facilitate access to areas.
- **Scheduling of the date** - weather conditions must be taken into account and the appropriate notices made to local residents.
- **Flight plan** - In this phase, the flight request must be made at the National Civil Aviation Agency (Anac), strategic support points on the ground for the images must be provided, interferences such as electrical networks, buildings, trees, communication towers and poles must be studied, in addition to choosing the right equipment.
- **Survey and mapping** – stage in which specific drones are used, stationary GPS GNSS and GPS receiver of the "Rover" type connected via radio with the stationary GPS.
- **Image processing** - it is the final phase of the survey and mapping. At this moment, the images are processed in specific software for the fine adjustment of the geographic coordinates, creation of the Orthomosaic and the digital terrain model.
- **Restitution** – consists of the graphic restitution (vectorization) of the orthophoto, from standard "CAD" software, of the main graphic elements: buildings and road system using the SIRGAS 2000 Coordinate System as a base, allowing the subsequent loading and updating in the "GIS" system of the company.

Below are some photos obtained during the survey activities and data collection in the field:

Figure 2: MRTech Engenharia team collecting a support point with a "Rover" type GPS receiver. Source: Sabesp (2022).

Figure 3: Clandestine connections hoses. Source: Sabesp (2022)

Figure 4: Drone synchronization for flight start. Source: Sabesp (2022).

RESULTS

On March 26, 2022, the MRTech Engenharia and Sabesp teams carried out an aerial photogrammetric survey and vectorial restitution of the Paiolzinho community area (Japequino, Vaquejada, Vista Alegre and CDHU communities), obtaining the following results:

- Orthophoto / Restitution

Figure 5: Base in CAD format, returned. Source: Sabesp (2022)

After obtaining the 1295 photos from the aerial photogrammetric survey, the images were processed using specific software, including the post-processing of the control points, processing the 3D point cloud and obtaining the rectified orthophoto using the SIRGAS 2000 Coordinate System as standard. The files were provided in the formats: .TIF and .ECW, allowing the loading of images in the main CAD and GIS software available on the market.

Figure 6: Restitution of roads with axles and buildings (consolidated x construction). Source: Sabesp (2022).

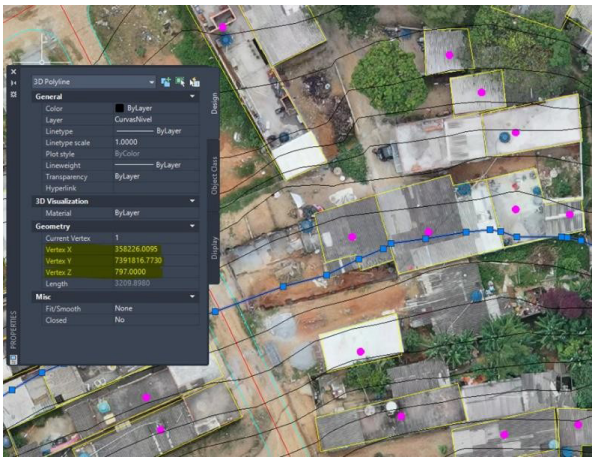

Figure 7: Planialtimetry – Level curves. Source: Sabesp (2022).

- Terrain Model

The Digital Terrain Model (MDT) is a product that represents a part of the Earth's surface considering its information. This way, it considers altitudes showing the elevations of the terrain, the ground, without considering buildings, trees and other objects above the terrain level.

MDTs can be applied to carry out studies of relief, slope, hydrographic calculations, activities in which terrain information is required.

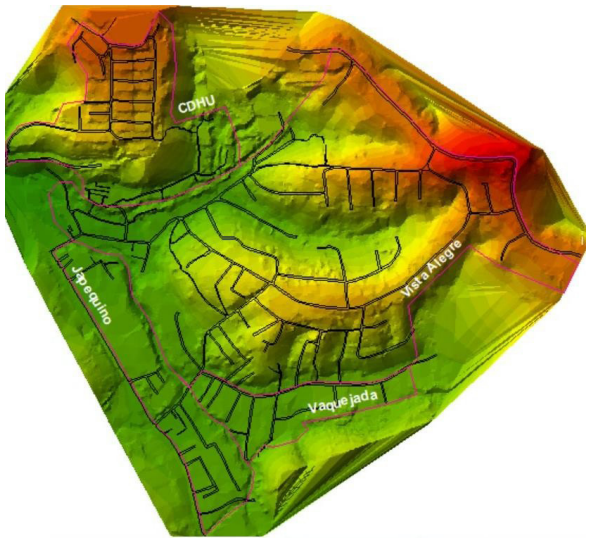

Figure 8: Digital terrain model. Source: Sabesp (2022).

Name	Area (m^2)	Hectare (ha)
CDHU	137.314,00	13,73
Japequino	90.149,40	9,01
Vaquejada	52.837,20	5,28
Vista Alegre	501.797,00	50,18
Total	782.097,60	78,21

Table 1: Table of areas. Source: Sabesp (2022)

Figure 9: Delimitations of constructions. Source: Sabesp (2022)

Name	Constructions (un)
CDHU	416
Japequino	479
Vaquejada	272
Vista Alegre	1.612
Total	2.779

Table 2: Quantitative table of mapped constructions. Source: Sabesp (2022)

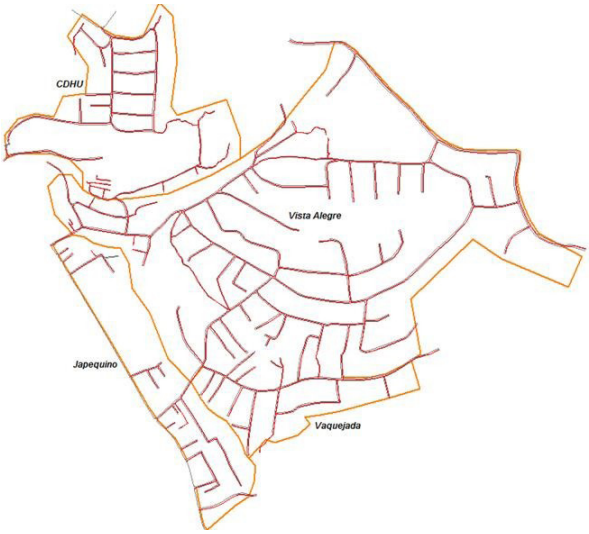

Figure 10: Extension of existing pathways. Source: Sabesp (2022).

Name	Road Length (km)
CDHU	3,01
Japequino	1,46
Vaquejada	1,31
Vista Alegre	9,49
Total	15,27

Table 3: Existing road quantitative framework. Source: Sabesp (2022).

Name	Area (m^2)	Cost per m^2 (BRL)	Total Cost (R$)
CDHU	137.314,00	0,10	14.299,18
Japequino	90.149,40	0,16	14.229,60
Vaquejada	52.837,20	0,22	11.858,00
Vista Alegre	501.797,00	0,05	25.240,60
Total	782.097,60	0,08	65.627,38

Table 4: Table of costs with the survey. Source: Sabesp (2022).

Figure 11: Technical visit (Sabesp, MRTech Engenharia and community leadership) . Source: Sabesp (2022).

CONCLUSIONS

The mapping, registration and planialtimetric survey carried out in the area object of this work proved to be effective for the Company, as it optimized the time in relation to the traditional survey carried out in the areas of communities and the quality of the products supplied. At this stage, it was possible to measure a 90% reduction in the time to obtain the products in relation to the traditional method.

Given the accuracy of this survey, it was sent to carry out basic projects for the water supply and sewage collection networks by the Business Unit's engineering teams, who are currently carrying out technical inspections in the area together with the management company's technical team to enable the development of projects for subsequent regularization of the area with international investments.

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