Using drones for characterization of areas degraded by gold mining in the Peruvian Amazon.

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INTRODUCTION

Characterization of deforested and degraded areas in preparation for reforestation is both time consuming and labor intensive. Drones, or Unmanned Aerial Vehicles (UAVs), can provide new ways for planning and monitoring forest restoration projects in the tropics, with savings in time and money, as well as improving data collection (Messinger et al. 2016).

Drones provide high-resolution and real-time imagery, allowing for detailed characterization and study of a wide variety of previously unexplored degradation scenarios (Miller et al. 2017).

In this study, we sought to develop an effective method for characterizing and classifying areas degraded by gold mining, and for planning field forest restoration experiments across the landscape in Madre de Dios, southeastern Peruvian Amazon (Fig. 1).

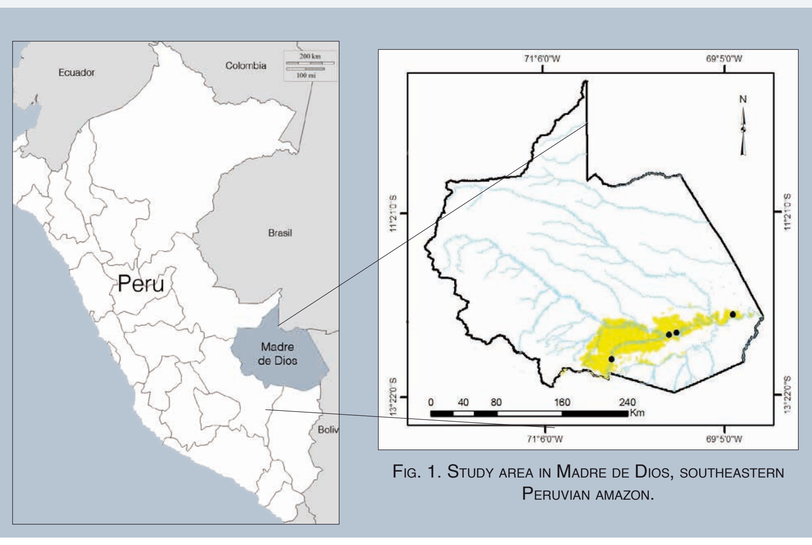

Fig. 1. Study area in Madre de Dios, southeastern Peruvian amazon.

Fig. 2. Aerial view of the degradation of the tropical forest by gold mining operations. Photo : Thomas Munita

METHODS

Using small UAVs, we collected imagery from 10 different sites comprising a total of 40 ha of areas degraded by suction pumps based small-scale gold mining, in the districts of Laberinto, Tambopata and Inambari, in the department of Madre de Dios, Peru (Fig. 2).

Imagery was taken using a DJI-Phantom 4 drone with a 12 MP camera imaging at a frame rate of 2/s. The flight mission was planned using DroneDeploy automated flight software to fly a grid pattern over the site at a height of 75 m, and resulting in a series of photos with 80% overlap among adjacent images. (Fig. 3).

Orthomosaics and 3D reconstructions of the sites with 2 cm GSD were created using Agisoft Photoscan 1.2.6., and exported as Geo-TIFFs (Fig. 3).

Classification of the orthmosaics was performed using Ecognition Developer 9.1 software, in a process that involved: (1) the use of a multiresolution segmentation algorithm, (2) collection of training samples, in four categories (bare soil, mounds of gravel, flood zones, and natural regeneration areas); (3) classification of images; (4) post-processing of classification and reforestation planning using ArcGIS 10.5.1.

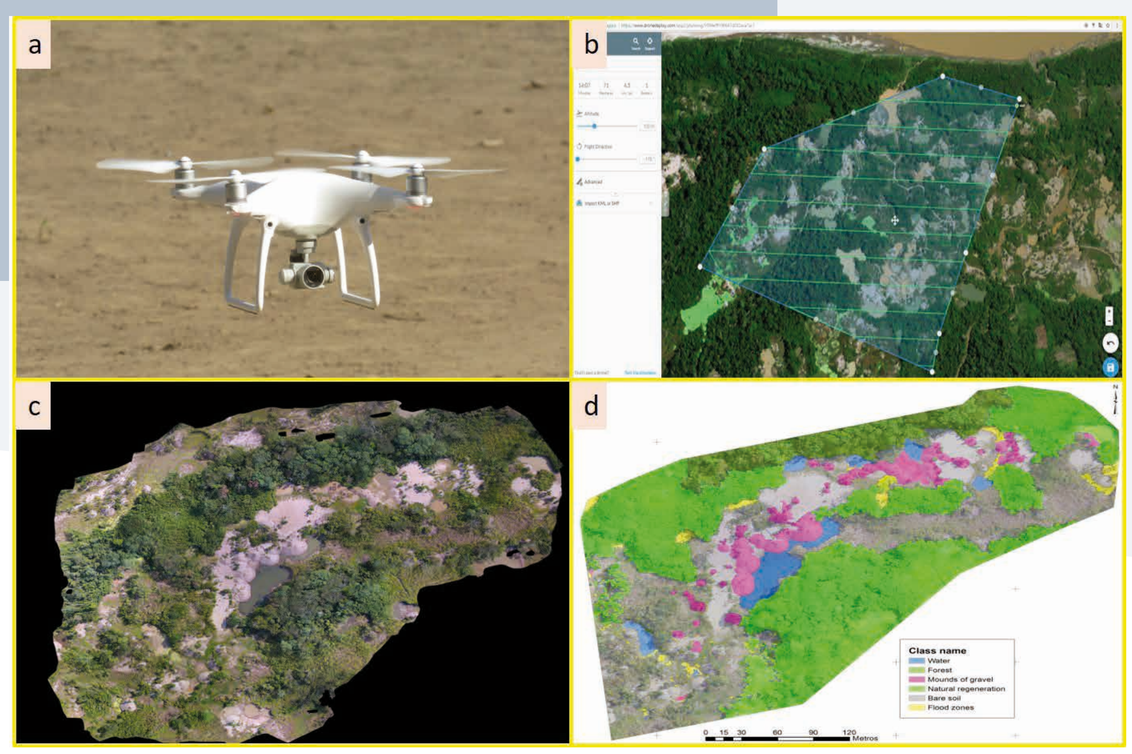

Fig. 3. Methodology used: a) DJI Phantom 4, b) flight plan using DroneDeploy, c) orthmosaic in Geo-Tiff format, and d) classified orthomosaic using ecognition and ArcGIS.

RESULTS

We have generated high resolution mosaics (3.2 cm /pixel) and other products such as digital elevation models (5 cm / pixel) and dense point clouds, from a total of 40 ha of mined areas.

Four major classes of substrate were identified in suction-mined areas: a) bare soil; b) mounds of gravel; c) natural regeneration; and d) flood zones. These classes were consistent in all sites where mining operations occured with suction pumps (Fig. 4).

To plan reforestation, a 3 x 3 m spacing grid was overlapped to the classified orthomosaic, representing the seedlings to be planted on each class (Fig. 4). This procedure allows planning effective reforestation or restoration by matching the species and individuals to particular degradation and substrate conditions to maximize plant performance and also to minimize field costs and time.

Drone flight in an area degraded by gold mining.
Photo : CINCIA - Jesus Alferez

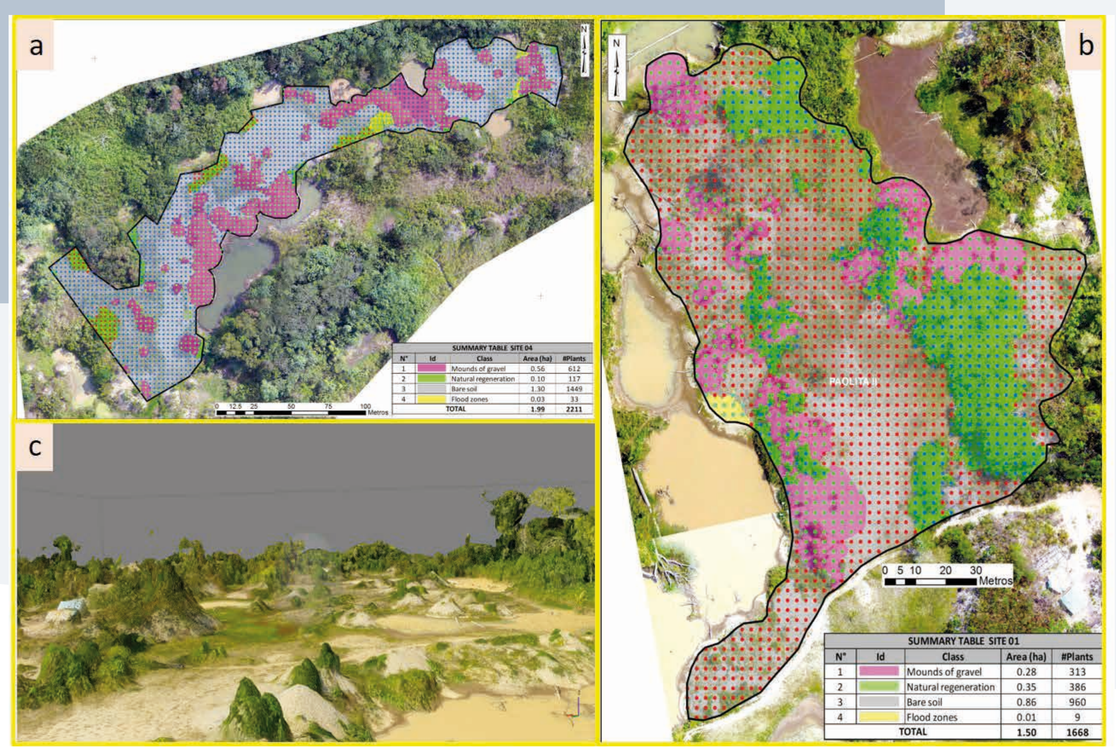

Fig. 4. Results: a) and b) site maps for reforestation, and c) 3D recreation using Agisoft Photoscan for identifying mounds of gravel.

CONCLUSION

The use of drones in restoration is a powerful tool that provides high resolution, real time imagery, central to planning restoration by high precision planting, accurate stratification of restoration efforts across complex landscapes, accurate matching of species to substrates and growth conditions, and also can radically decrease labor costs through subsequent monitoring of seedling performance.

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LITERATURE CITED

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