

LAUREL Flying Sensor Training Part I: Lavaka Monitoring

Training report

Antananarivo, 14-16 February 2018

Authors:

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Client:

World Bank

Location training:

World Bank Office, Antananarivo, Madagascar
Antananarivo lavaka test site

Location flight operations:

Antananarivo lavaka test site



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1 Introduction

1.1 Background and objectives

Flying Sensors (FSs) are bound to create a revolution in temporal and spatial remote sensing of agriculture and ecophysiology at a close range. Within the PADAP program it is foreseen that stakeholders will purchase FSs for information collection to support sustainable land management activities. Based on this, it was decided that a demonstration of the use of Flying Sensors and training on their use will be included in LAUREL activities.

The objective of the first training (Part I) was to offer an introduction on the use of Flying Sensors (FSs) with the focus on applications for land degradation and sustainable land management. The complete training course (Part I and II) consists of capacity building in the following areas:

- FS piloting skills
- Image processing skills
- Detecting land degradation with FSs
- Monitoring effects of sustainable land management interventions
- Correlating FS outputs to other land degradation monitoring tools and mapping methods

1.2 Practical details

In the framework of the LAUREL program (supported by World Bank) a training on Flying Sensors took place in Antananarivo from 14 to 16 February 2018. The training was conducted by Jan van Til (FutureWater) with support of Tojo Rasolozaka (WWF aerial surveillance and drone specialist). A group of 11 persons was trained. The participants were mostly all engineers and active in land and water management in Madagascar (see list of participants in Appendix II). The training focused especially on FS piloting skills and image processing skills.

Field visits were organized on 14 and 16 February during which RGB and NIR images of a lavaka test area near Antananarivo were captured. The images were taken on an automated flight with the Sensy-M Flying Sensor. Impressions of the field visit are provided in Figures 1 and 2. Appendix I contains the full training program.

After the training was concluded, Jan van Til handed over one Sensy-M kit to Tojo Rasolozaka.

- The Sensy-M kit comprises:
- Mavic Pro quadcopter
- Batteries (3x)
- NIR camera
- Tablet (Samsung Tab A 2016)

This material will remain at the disposal of the LAUREL project for usage in Part II of the training.

Two training manuals were prepared in French and shared with all participants (Figure 3):

1. Manual Sensy-M
2. Manual Image Processing



Figure 1. Training at the lavaka test site near Antananarivo



Figure 2. Lavaka test site near Antananarivo



Figure 3. Manuals prepared for the training.



Figure 4. The training took place in the World Bank office

1.3 Location of lavaka test site

As recommended by WWF Madagascar, the field demonstration was organized at a location to the south east of Antananarivo, where land degradation has resulted in the occurrence of a lavaka.

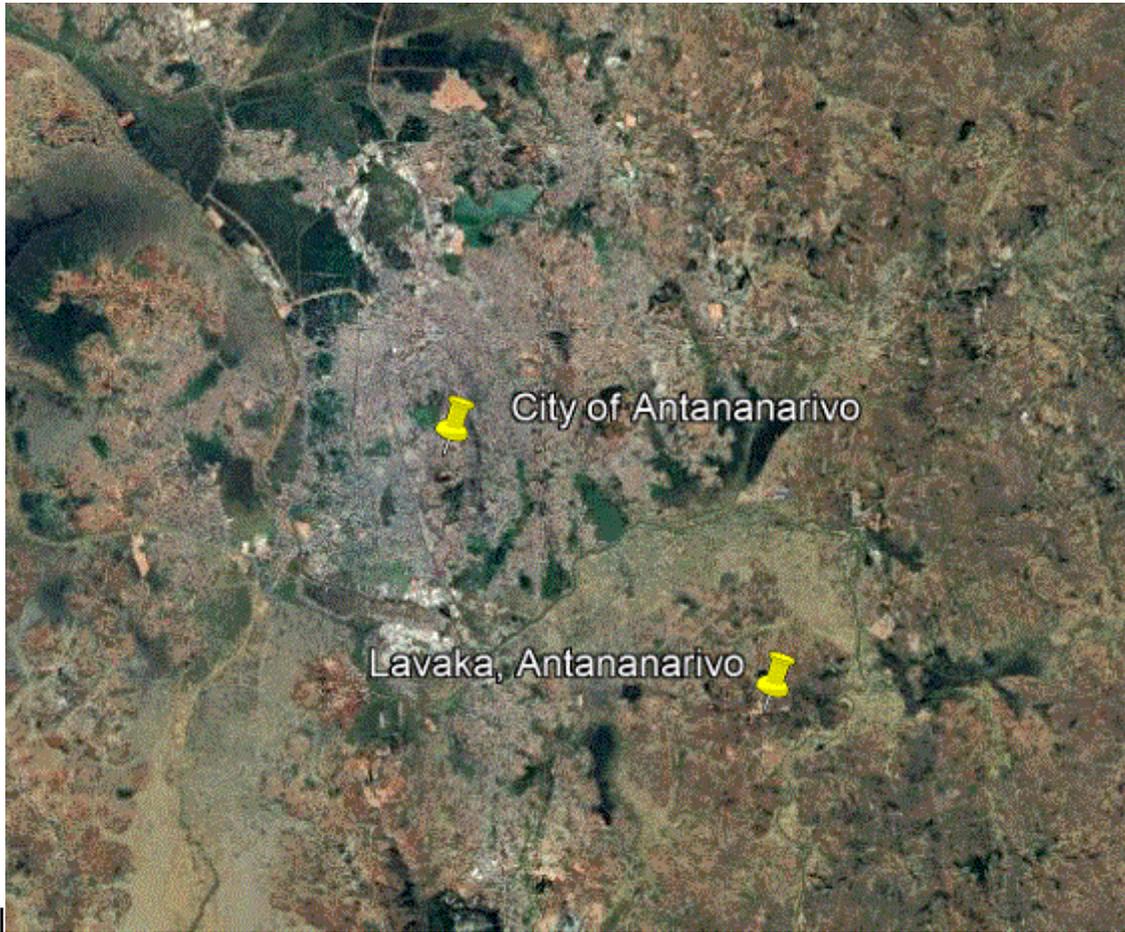


Figure 5. Location of the lavaka test site

5 km



Figure 6. Lavaka test site

100 m

2.1 Single images

This paragraph demonstrates some of the images captured during the field visits.

Flight operations details

Flying Sensor: Sensy-M

Area: lavaka test site near Antananarivo (490x 290m)

Sensors: RGB & NIR cameras

Flight number: 20180214_F01

Flight date: 14 February 2018

Sensor details

At F01 (flight 1) both RGB (Red Blue Green) and NIR (Near InfraRed) images were taken.

Number of RGB images: 118

Number of NIR images: 90

Resolution: 12 MP, 4000x3000. GSR: 3,5 cm

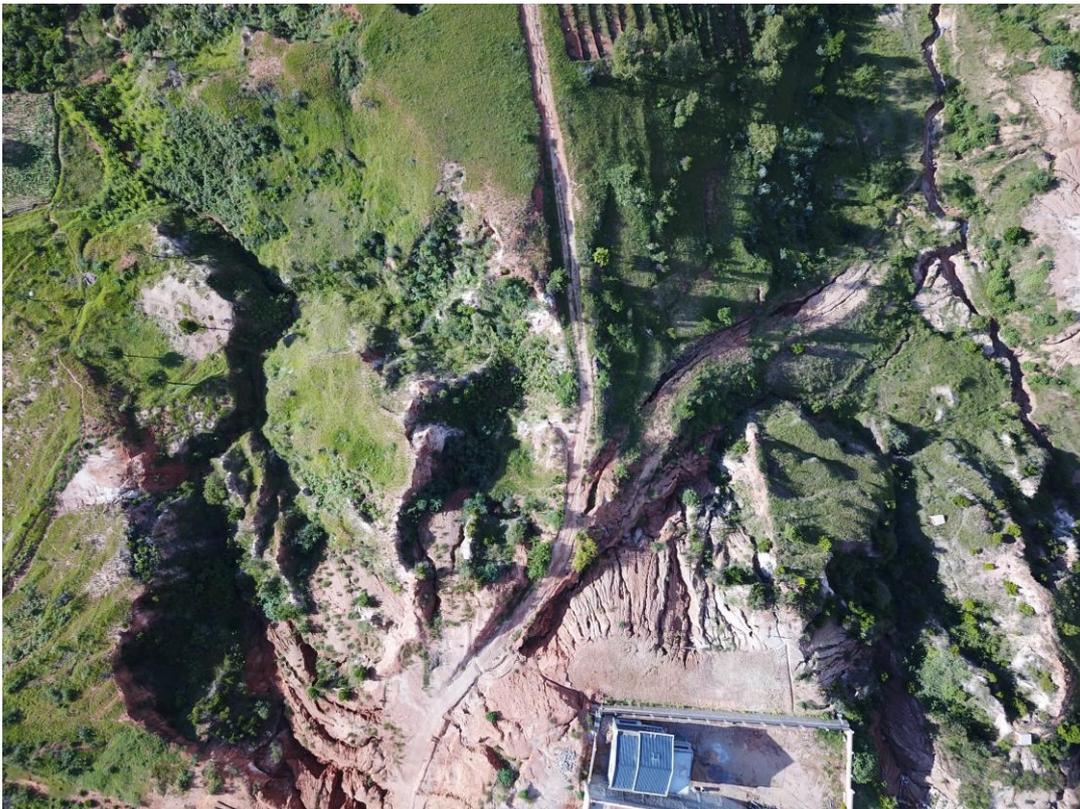


Figure 7. Single RGB image, lavaka test site





Figure 8. Single NIR image, lavaka test site

20 m 

2.2 Processed images

The “raw” images can be processed into different derived products, which can subsequently be applied for different purposes related to land degradation and sustainable land management. Examples of processed images are given below.

- 1 Orthomosaic RGB, below referred to as Ortho RGB
- 2 Orthomosaic NIR, below referred to as Ortho NIR
- 3 Rough DEM/DSM, below referred to as DEM
- 4 3D model, below referred to as 3D Model
- 5 KMZ/KML, below referred to as KML
- 6 Normalized Difference Vegetation Index map, below referred to as NDVI map
- 7 Land cover classification map, below referred to as land cover map



Figure 9. Ortho RGB, lavaka test site

100 m

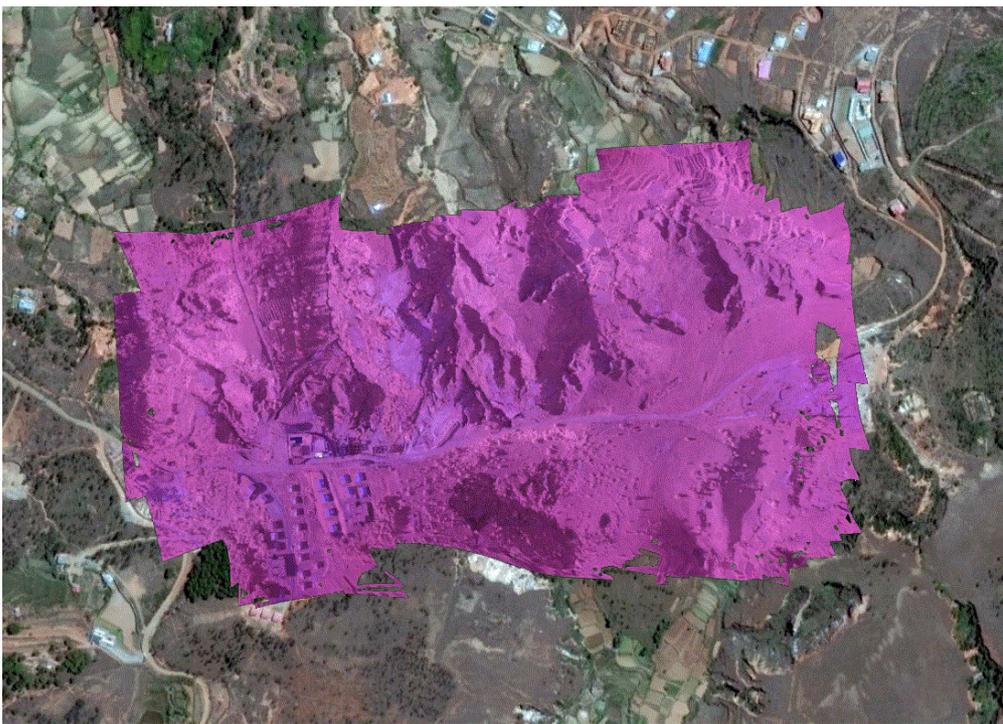


Figure 10. Ortho NIR, lavaka test site projected in Google Earth

200 m

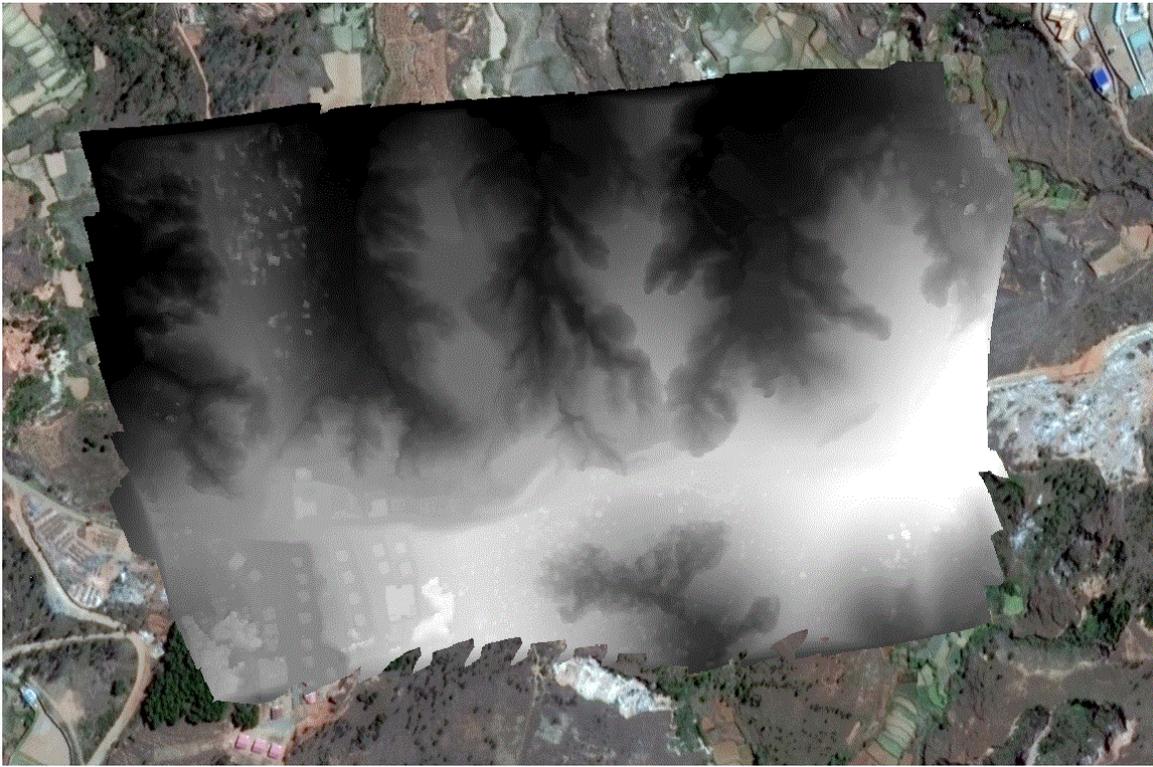


Figure 11. Rough DEM, lavaka test site projected in Google Earth

100 m 

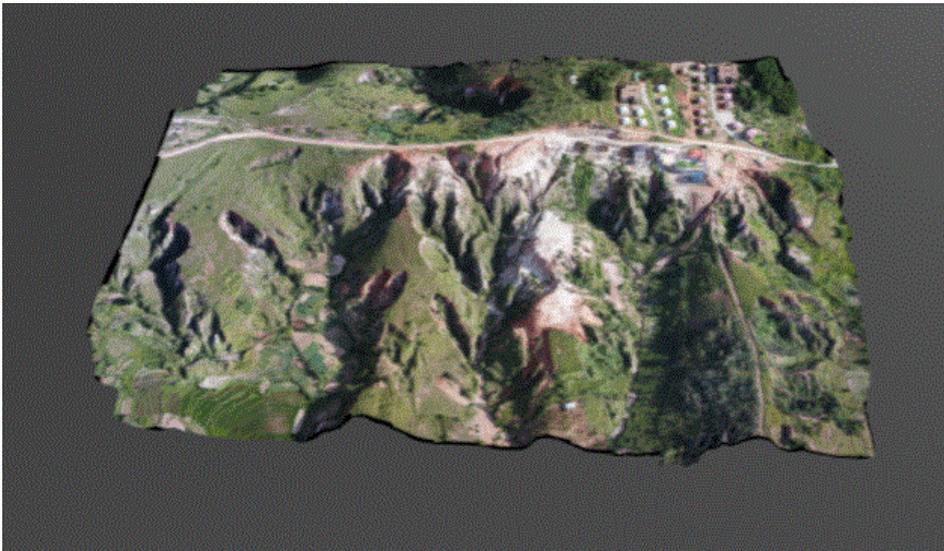
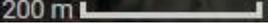


Figure 12. 3D model, lavaka test site

200 m 

For an interactive high-resolution 3D model view of the lavaka, see online:

<https://sketchfab.com/models/daac1275b064475a9a5273b0e672e4a3>



Figure 13. KMZ/KML, lavaka test site projected in Google Earth

100 m

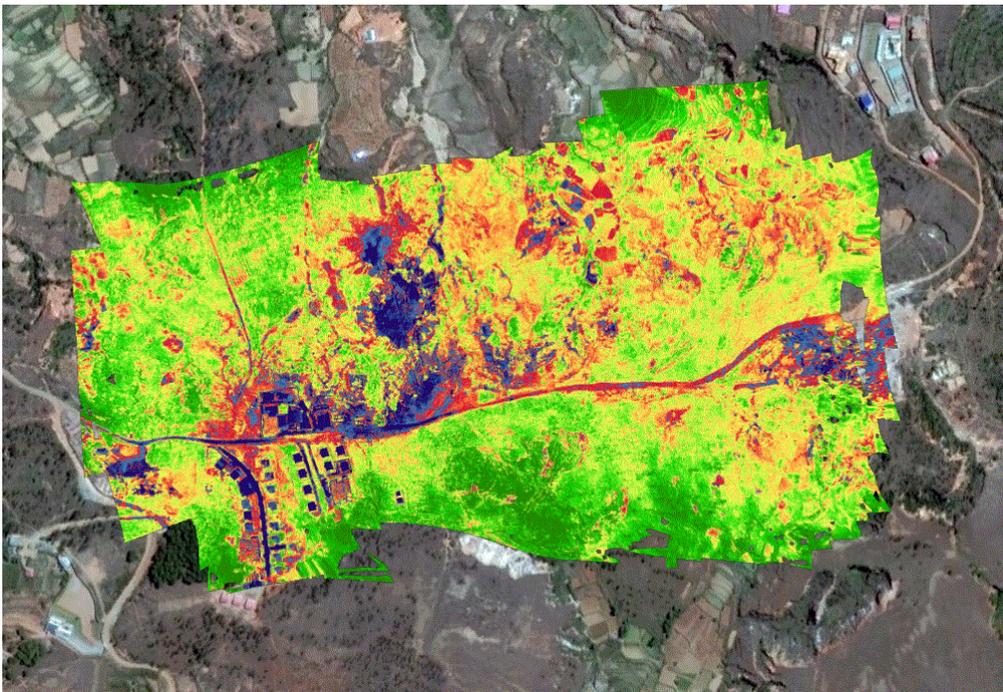


Figure 14. NDVI map, lavaka test site projected in Google Earth

200 m

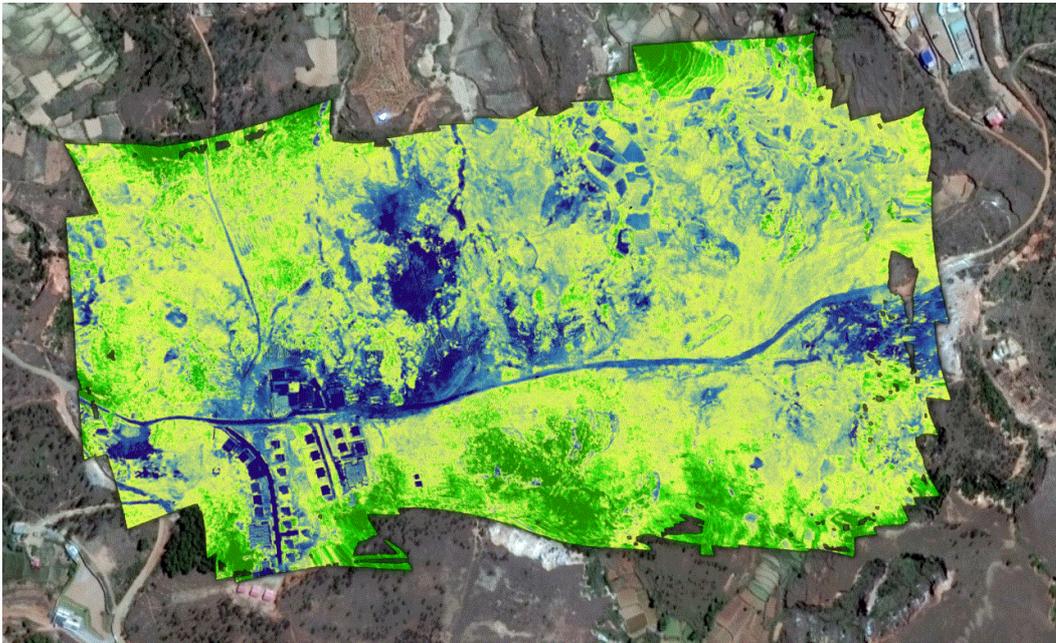


Figure 15. Vegetation cover map, lavaka test site projected in Google Earth. Supervised classification based on NDVI image. 200 m

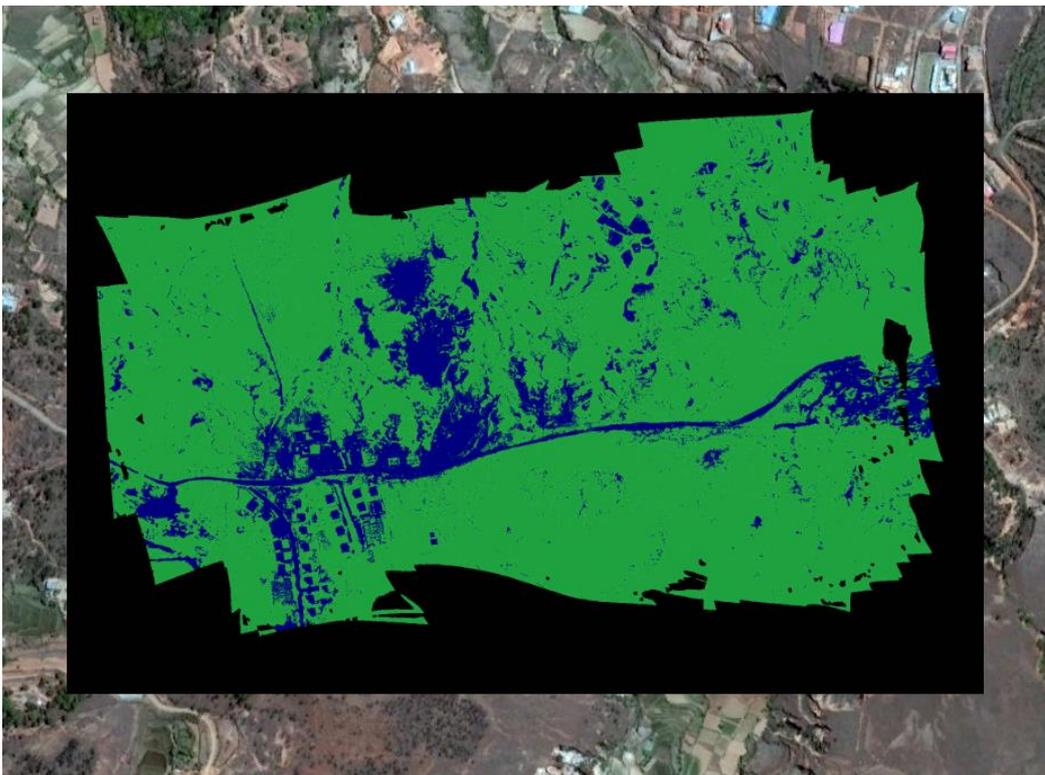


Figure 16. Vegetation map (blue = bare, green = vegetation cover), projected in Google Earth. Supervised classification based on NIR image. 200 m

3 Applications and benefits of processed images

The previous chapter demonstrates a number of derived products from FS imagery, all having very high resolution due to observation of the land surface from a relatively short distance. Each processed mosaic, map or model has its own features and potential applications. Different parameters can be determined, such as volume, vegetation conditions, soil conditions and land cover type. Within the context of land and water management in Madagascar, relevant applications include especially:

- inspection of forestry (e.g. illicit deforestation)
- inspection land degradation
- inspection of coastline degradation
- inspection of vegetation

Table 1 shows an overview of FS-derived products, their resolution and example applications.

Table 1. Derived products of FS images and their relevant applications

<i>Description</i>	<i>Example applications</i>	<i>Resolution</i>
Ortho RGB	Overview image Visual inspection Deriving inputs for biophysical model	Max GSR: 2 cm Common GSR: 10 cm
Ortho NIR	Input for NDVI	Max GSR: 2 cm Common GSR: 10 cm
NDVI map	Vegetation stress diagnosis Assessment lavaka maintenance Assessment bare soil Input for biophysical model	Max GSR: 2 cm Common GSR: 10 cm
Land cover map	Vegetation classification Forestry Land use / land cover change assessment Input for biophysical model	Max GSR: 2 cm Common GSR: 10 cm
DEM	Damage inspection Lavaka volume assessment Evaluating SLM practices / terracing Input for biophysical model	Max x-y res. 5 cm; z res. 5-10 cm Common x-y res. 10 cm; z res. 10-20 cm
3D model	Visualization / dissemination Inspection tool for decision makers	Max x-y res. 5 cm; z res. 5-10 cm Common x-y res. 10 cm; z res. 10-20 cm
KMZ /KML	Localization in Google Earth Visualization / dissemination	Max x-y res. 5 cm; z res. 5-10 cm Common x-y res. 10 cm; z res. 10-20 cm

Within LAUREL, FSs do not only hold potential for monitoring and mapping land degradation, but they also yield valuable data that can be put to use in LANDSIM-P, the modeling component of the project. Notable biophysical model inputs that can be derived from FS imagery include stone cover of the land surface, plant diameter, and vegetation density. A location- and land cover type-specific assessment of these parameters will improve the dynamic modelling of erosion processes by LANDSIM-P, which would otherwise rely on generic literature values.

4 Evaluation and recommendations

At the end of the training, the experiences of the participants were discussed and evaluated. The following points list the most notable feedback from the group:

- The training participants are enthusiastic about the new technology and its great potential. They think it might be very useful to deploy Flying Sensors (FSs) in their professions, for tasks like surveillance, monitoring hotspots of LD, monitoring status of forestry. The participants have experienced the use of FSs and the processing of ortho-mosaics as user-friendly. They were interested to learn more. They were planning to do home studies on processing with the help of the supplied manuals.
- The group came up with the idea to mount other sensors on the FS. That would be a good idea, as long as the sensor is not too heavy. The payload of FS Sensy-M is max. 300 grams.
- Members of the PADAP team suggested that it will be necessary to perform flights at one of the PADAP hotspots. For this purpose a multi-day trip should be organized. This is according to the intentions of the LAUREL team for the second part of the training.
- The presently used FSs are good for medium-sized tasks, but fall short for large-scale monitoring operations. This can partly be solved by establishing the connection with RS. In the long term, it may be an interesting option to explore an upgrade to bigger FSs that can carry out flights with larger range.
- Everybody is looking forward to the continuation of the training (part II) in which we will focus on:
 - Continuation with piloting skills
 - Advanced image processing
 - Exploring further applications based on processed maps and models

Based on discussions with the participants and observations during the training, we further recommend the following:

- Consider other sensors like thermal or lidar. Preferably user-friendly and low budget;
- Consider using a train-the-trainers approach in the next training;
- Organize a multi-day field trip to PADAP hotspots for flight operations to collect the first specific data for the PADAP sites. Preferably in accordance with other LAUREL activities on land degradation during the next mission;
- The needs for the FS training part II should be established in close consultation with the other LAUREL land degradation experts;
- More powerful FS for larger-scale operations may provide added value for the PADAP land degradation monitoring requirements. This will be further explored during the next training session at one of the PADAP sites;
- The following training objectives will need to receive further attention during Part II of the training:
 - Detecting land degradation
 - Monitoring effects of SLM interventions
 - Relating FS outputs to existent land degradation monitoring tools and mapping methods

Appendix I: Training program

Day 1, Wednesday 14 February

Morning

- Preparatory discussions with training supervision team
- Technical preparations: mounting NIR Cam

Afternoon

- Technical preparations: mounting NIR Cam
- Preparatory field visit (FutureWater and WWF) to land degradation hotspot, 8 km SE from downtown Antananarivo
 - Exploration of the area for field visit of Friday 16 February
 - Conducting flights in order to collect images from LD hotspot

Day 2, Thursday 15 February, 8.00-17.00h. Location: office WB

(in French, as shared with participants)

- | | |
|--------------|---|
| 8.00-10.00h | Introduction sur FSs <ul style="list-style-type: none">• Introductions de l'équipe de formateur' et des participants• Historique et vue d'ensemble et présentation des activités de FutureWater et HiView• FSs: plateformes volantes & capteurs; applications diverses |
| 10.00-10.30h | Pause |
| 10.30-12.00h | Introduction au Flying Sensor SENSY-M, à l'aide d'un manuel
Le SENSY-M est un quadcopter équipé de deux capteurs : visuel et NIR (NearInfraRed, autrement dit capteur en proche rouge) |
| 12.00-13.00h | Déjeuner |
| 13.00-15.00h | Suite de l'introduction au Flying Sensor SENSY-M : vols automatiques
Suivi par un court discours sur les activités opérationnelles <ul style="list-style-type: none">• Pre-site (préparations, réglementation, listes de vérification)• On-site (sécurité, préparations, activité de voler)• Post-site (stockage data, rapportage, postcure) |
| 15.00-15.30h | Pause |
| 15.30-17.00h | Introduction à quelques traitements d'images <ul style="list-style-type: none">• Orthophotographies• Cartes de l'indice NDVI (Normalized Difference Vegetation Index)• Modèles numériques d'élévation (Digital Elevation Models, DEMs) |

Day 2, Friday 16 February, 8.00-17.00h. Location: lavaka test site (morning), office WB (afternoon)

- | | |
|-------------|---|
| 8.00-13.00h | Visite du site de démonstration.
Localisation : Alasora, sur la route des lotissement IMV
En première partie les participants prendront part aux exercices fonciers du pilotage manuel du FS. |
|-------------|---|

Ensuite, des vols automatiques (à l'aide d'une tablette ou d'un smartphone) seront démontrés ayant pour objectif l'acquisition d'images aériennes en relation avec la dégradation des sols.

- 13.00-14.00h Déjeuner et retour au bureau de la Banque Mondiale WB
- 14.00-16.00h Traitement des images captées durant le vol de démonstration.
- 16.00-16.30h Pause
- 16.00-17.00h Evaluation de l'entraînement. Prévision sur la session suivante.

Appendix II: List of participants

	Nom	Profil	Poste occupé/Organisation
01	Herinarivo Razafindralambo	Ingénieur agronome	Assistant technique des opérations/PADAP ; herinarivo@yahoo.fr
02	Andraina Rajemison	Ingénieur forestier	Responsable environnement/foresterie/PADAP ; andrainarajemison@gmail.com
03	Mamy Rasolofoarivony	Ingénieur forestier	Assistant en sauvegarde environnementale et sociale/PADAP ; rasolofoarivonymamy85@gmail.com
04	Fabienne Randrianarisoa	Géographe	Responsable SIG/PADAP ; fabi.msis@gmail.com
05	Tojo Rafidimanantsoa	Ingénieur hydraulicien	Responsable Eau et irrigation/PADAP ; rafidimanantsoa@yahoo.fr
06	Ollier Duranton Andrianambinina	Ingénieur informaticien	Administrateur du système d'information/MNP ; adsi@madagascar.national.parks.mg;
07	Jean Michel Ravoninjatovo	Ingénieur forestier	Collaborateur technique/BNCREDD ; ravoninjatovoj@yahoo.fr
08	Fameno Tahiana Ranaivoson	Géographe	Direction de l'Intégration de la Dimension Environnementale/MEEH ; famenotahiana@gmail.com
09	Noelson Laingo Herizo Randriamasinoro	Ingénieur géomètre topographe	Observatoire de l'aménagement du territoire/M2PATE ; nixonnoelson@gmail.com
10	Rakotondranivo Mihary Nantenaina	Ingénieur forestier	Collaborateur auprès de la Direction Contrôle Forestier/MEEF ; miharynantenaina@yahoo.fr
11	Haja Rabeharisoa	Ingénieur hydraulicien	Chef de service irrigation/MPAE ; hazjah@yahoo.fr