Digitized Road Information

Capacity Development Project for Operationalization of PNG Forest Resource Information Management System (PNG-FRIMS) for Addressing Climate Change

1. Introduction

Road information is useful for estimating area affected by human activities. People move via roads quickly and enter into areas adjacent to the roads for various purposes, such as logging, subsistence agriculture, wood collection, mining, and plantations. As these activities continue to increase, so too does the need for more roads to cater for the logistics of these activities.

Road network is growing year by year, as a result, continuous updating of the information is necessary to grasp current status of the land. Satellite imagery is a strong tool for capturing up-to-date national scale road network information. This is made possible with the rising number of free mid-resolution satellite imagery such as LANDSAT and Sentinel-2 which are helpful in covering a nationwide network. While high resolution satellite imagery can detect more small and obscure ground features, the downside is that it is expensive and difficult to acquire.

With mid-resolution satellite imagery, it is simple to spot new constructed roads as the forest features and cleared areas for the new roads have dissimilar spectral reflectance, i.e., telling apart forests and new cleared areas for roads is easy due to their different colours on the satellite image. On the other hand, old cleared areas in forests which have already been covered by grass over time, are not as clear. This is due to the fact that the old cleared areas (covered in grass) have a similar spectral reflectance (same color) to forests, and thus, it is difficult to distinguish both features from each other on the satellite image. Timely updating of the road network after construction of new roads is necessary to keep the quality of the information.

Roads in cities, grasslands, agricultural fields are difficult to find because roads and the surrounding area shows similar color in mid-resolution satellite imagery. It is recommended to update road network information using road GIS information generated by institutions such as National Economic and Fiscal Commission, Department of Works & Implementation, and other government department or independent organizations that have up-to-date GIS Road data. This can also be done by acquiring high-resolution satellite imagery every decade.

As of August 2017, national road network, including all kinds of roads such as roads in forest, cities, agricultural field, etc. have been developed for the whole country in the years 2000, 2005, 2011 and 2015. In this Fact Sheet, the procedures followed to update this information is described.

2. Methods

Data Acquisition

The data acquired for the use of digitizing roads were sourced from various government departments, donor agencies, and datasets that were developed by the Project.

Table 1: The datasets used for digitizing road GIS information

Layer (Dataset)	Source	Remarks
Road GIS information	GeoBook	Derived from NEFC[1] 2005 Cost of Services surveys, satellite imagery and RAMS[2] data
River GIS information	GeoBook	Derived from 1:250 000 topographic maps
Census Unit Information	GeoBook	Derived from PNG 2008 Census
Provincial Boundaries	Developed by the Project[3]	
LANDSAT AGP[4] 2000	Developed by the Project	
LANDSAT AGP 2005	Developed by the Project	
LANDSAT AGP 2011	Developed by the Project	
LANDSAT AGP 2015	Developed by the Project	
RapidEye 2011	Procured by Grant Aid Program[5]	

Types of Roads to be Digitized

1. National Roads – Roads that are recognized as under the care and management of the National Government. These roads are the major highways and roads that connect the main centres and regions throughout the country.
2. Provincial Level Roads – Roads that are recognized as under the care and management of the Provincial Government. These roads are mainly found within the borders of a province.
3. Logging Roads – There are 4 main types of logging roads; 1) Main roads, 2) Secondary roads, 3) Feeder Roads and 4) Spur Roads. The main roads are connected to the provincial roads. The Spur roads are roads that have a specific use of connecting a particular location to the road network. The Feeder roads enable traffic coming from the Spur Roads to the Secondary roads, which then lead to the Main Roads.

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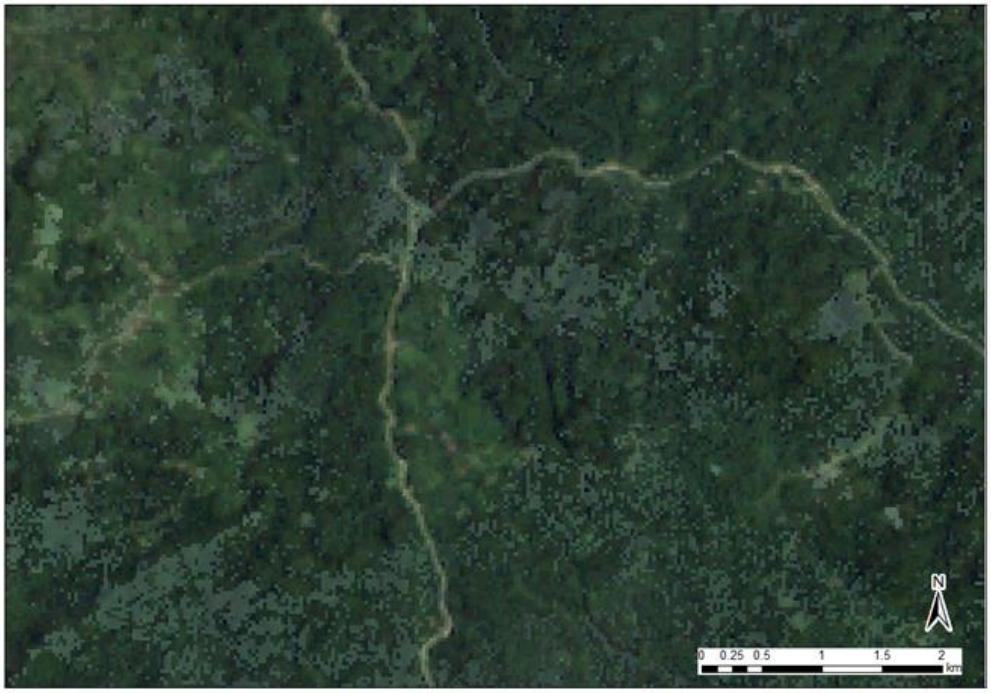
[1] National Economic and Fiscal Commission
[2] Road Asset Management System
[3] Capacity Development Project for Operationalization of PNG Forest Resource Information Management System (PNG-FRIMS) for Addressing Climate Change
[4] Annual Greenest Pixel
[5] "The Forest Preservation Programme in the Independent State of Papua New Guinea" funded by the Government of Japan (2012 – 2013)

Procedure

1. Road network of year 2000 was developed as the basis of the information.

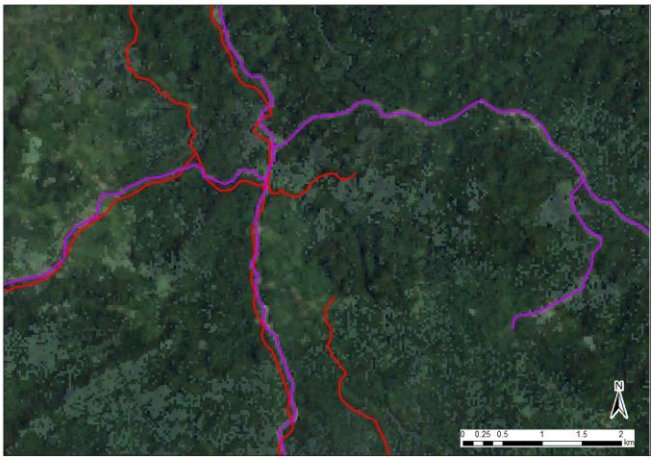
   A. Digitize road directly based on the LANDSAT AGP (Year 2000) satellite image.

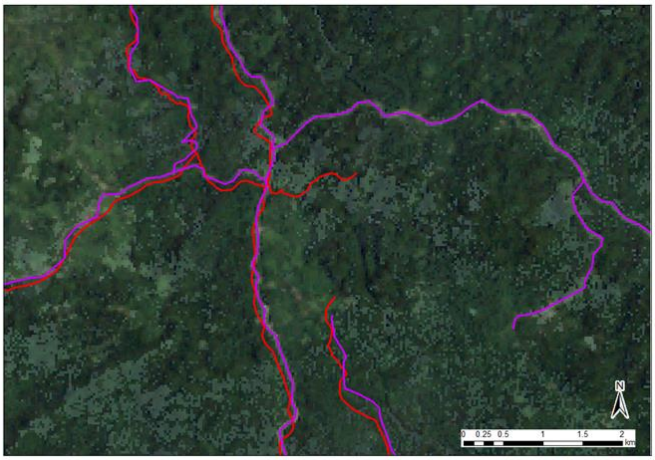


Note: Annual Greenest Pixel (AGP) refers to the mosaicked imagery including all the scenes in each year beginning from the first day of the year and continuing to the last day of the year obtained by specified satellite(s) with the greenest pixel on top, where the greenest pixel means the pixel with the greatest value of the Normalized Difference Vegetation Index (NDVI).

Use "Snapping" tool to connect line features.

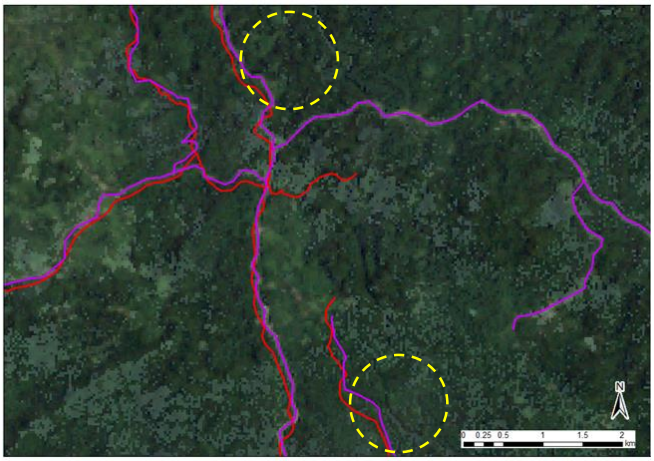
B. Road information of Geobook is a good reference to digitize unclear roads on LANDSAT AGP.

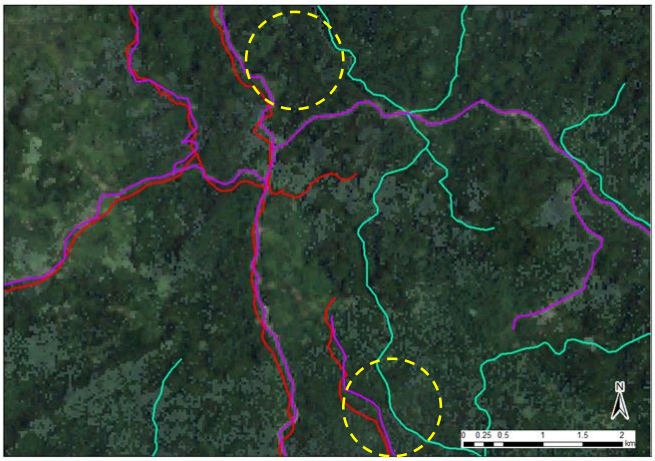




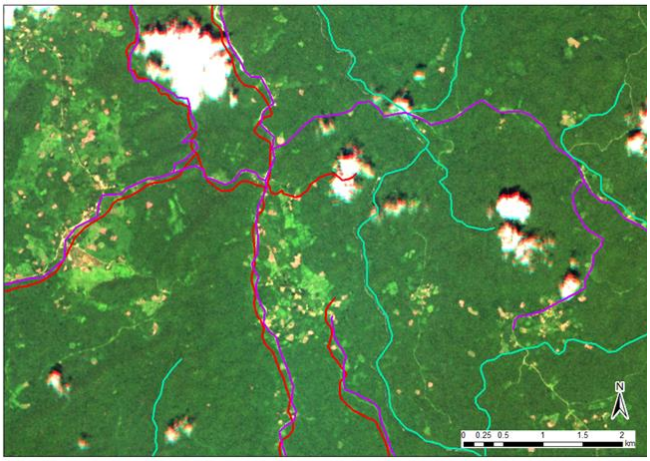
Note: Some roads may not be clear from the satellite images. This issue can be fixed by overlaying GeoBook information (red line) and using it as reference to digitize the roads (purple line).

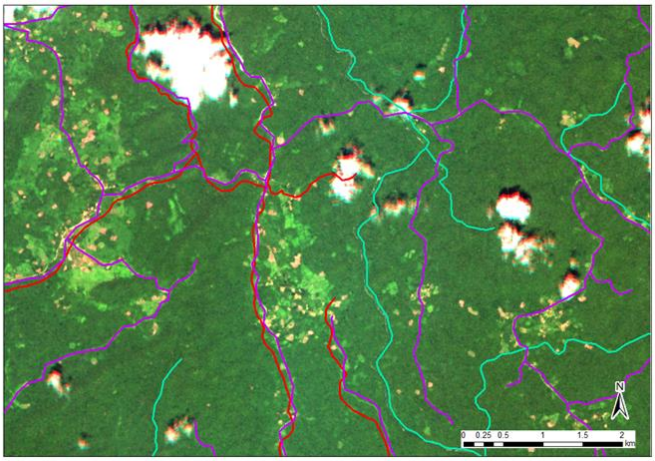
C. To avoid digitizing rivers as roads, refer to the river GIS information (light green line).



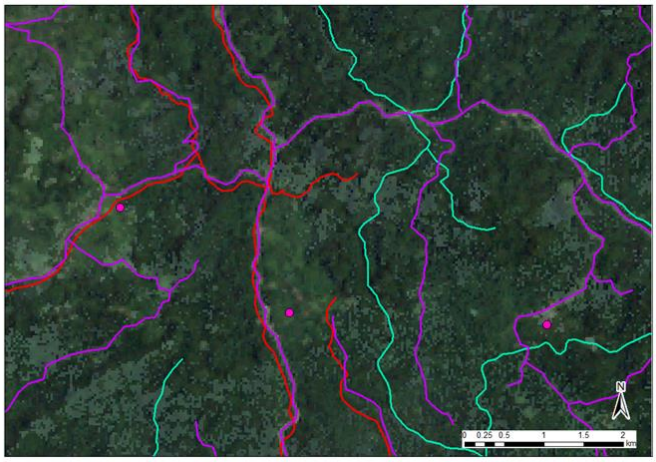


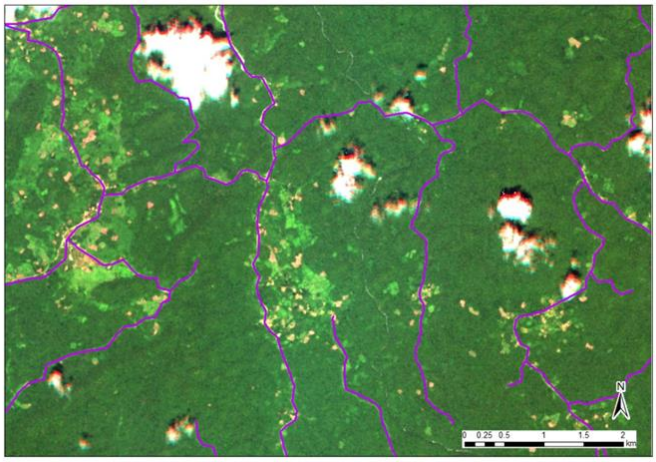
D. Comparing LANDSAT imagery (above) and RapidEye imagery (below), digitize unclear roads.



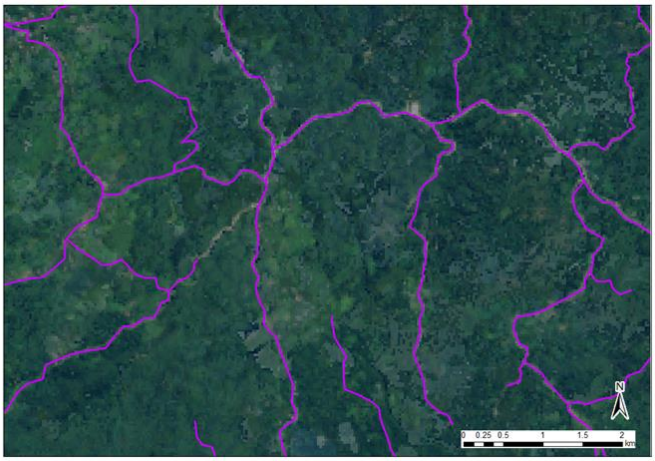


E. Census Unit information is also useful to estimate intensity of human activities. In the following images (below), the pink circles are Census Unit information. The color spotting around the points indicate existing of agricultural fields there.



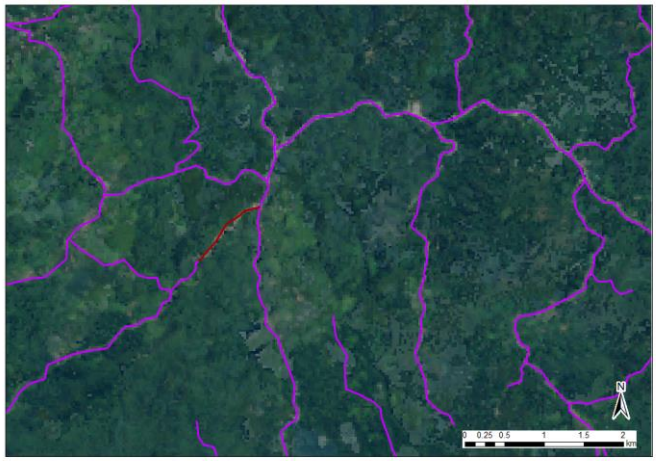


2. Road network of year 2005, 2011 and 2015 were digitized in order from the oldest year adding line features on the road network feature on the older year.



LANDSAT AGP 2005 with the digitized road data (purple line) from the Year 2000 overlayed.

The road data is then digitized for the year 2005 (red line) by adding features from LANDSAT AGP 2005 to the road data from Year 2000.



3. Results

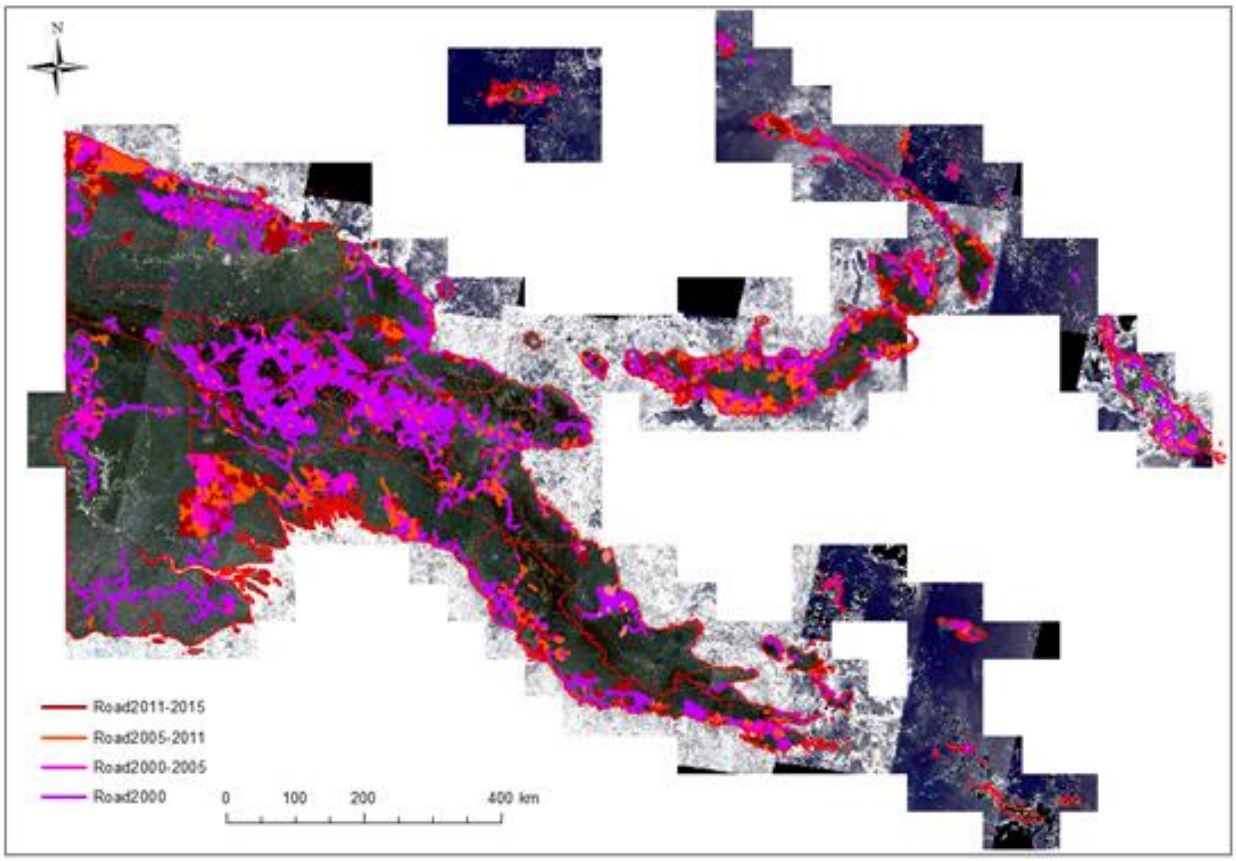


Fig.1: Map of completed road GIS information

4. Discussion

Issues

The main issues faced during this exercise included:

1. Difficulty in identifying some of the minor road features (Feeder and Spur) from the mid-resolution satellite imagery. Although the satellite images were satisfactory in recognizing main roads, it lacked the clarity to display smaller logging roads as these roads are usually 40 meters wide. The spur, feeder, main, secondary roads are all logging roads as long as logging is active in setups and coupes until the roads are decommissioned. If decommissioned roads are maintained/used frequently they are visible and data can be captured by satellite imageries whereas if roads are not maintained over a certain period, they become invisible due to regrowth/secondary vegetation so data could be sourced from (previous) logging plans, existing/available data or from other relevant government agencies.

1. The presence of heavy cloud cover over most parts of the country, which made it difficult to identify road network from the satellite images.

Recommendations

To fix these problems, high resolution satellite imagery would be much better to use in this exercise. But this again poses the question of cost and availability. Thus, as a compromise, supplementary data from donor agencies and other government departments were acquired. This included the data from the GeoBook and the RapidEye satellite imagery that were used to check and confirm the features identified in the LANDSAT AGP satellite imagery.

With regard to the smaller logging roads (Feeder and Spurs), as they cannot be captured with satellite imagery, the main supplementary source of data is the Annual Logging Plans (ALPs) and Forest Working Plans (FWPs). This being the case because the logging companies have up-to-date information on the status of the roads. Combining the data from the ALP's and the satellite images allows us to better identify these less clear road features for digitization.

5. Conclusion

Digitizing of road network in all of PNG was arduous and tedious work but the resulting data will be very useful in the future. The main complications faced were handled with the help of the reference data like the GeoBook and the Census data. This data was instrumental in the identification and digitization of the roads.

It would be wiser to update vital information on the road network in PNG from 2015 upward, and this can be done by utilizing LANDSAT AGP satellite images which are free to acquire. This data will greatly improve the ease of which digitizing can be performed with the use of already digitized data as a reference for subsequent years in the future.