

# PPP Used For Surveying - Experiences From Uganda.

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## Introduction:

For a Ground Control Point (GPC) Survey in Uganda COWI has done some preliminary surveys in order to verify that PPP surveying method will fulfil the demands for GCPs in two categories A and B:

	A	B
X,Y	7 cm	15 cm
Height(ellip)	20 cm	20 cm

As logistics is a very large challenge for ordinary static GPS, the PPP method could be of great advantage.

The Canadian service CSRS-PPP is a free online service provided by Natural Resources, Canada was chosen as a easy to use and very reliable service.

The result from CSRS must be transformed to local coordinates by a transformation from ITRF08(epoch April 2016) to ITRF05(epoch July 2010). Here the largest contributor is the plate tectonic movement.

The first comparison is between existing coordinates from the zero order networks stations Lira1 and Fort Portal1, establish by IGN France in July 2010. The results looks very promising, only the East coordinate of Fort Portal is a small 'outlier' which might be explained by the low observation time of 2 hours.

Station	North (m)	East (m)	Ellip, Ht (m)	Obs time(hrs)
FPT1	0,019	-0,002	0,021	5
FPT1	0,019	0,048!	-0,007	2 !
FPT1	0,010	0,017	0,004	5
LRA1	0,031	0,021	0,015	6
LRA1	0,015	0,018	0,022	6
LRA1	0,025	0,027	-0,014	6
<b>MEAN</b>	<b>0,020</b>	<b>0,022</b>	<b>0,007</b>	

The next comparisons are between PPP and a traditional static GPS network of 10 stations around Lira1 and 12 stations around Fort Portal1. Distances are between 5 and 60 km and observation times between 2 and 12 hours.

For the Lira1 survey the largest difference between the PPP method and the ordinary adjustment computed in Graf/Nav were found to be:

**Northing 0.034 m Easting: 0.022 m Ellipsoid height: -0.050 m**

(3 hrs obs. time) and for the Fort Portal survey:

**Northing 0.035 m Easting: 0.043 m Ellipsoid height: -0.056 m**

(4½ hrs. obs time).  
In average

**Northing 0.017 m Easting: 0.007 m Ellipsoid height: -0.004 m**

All the differences comply very well within the specifications of the Ground Control Points and no significant bias is seen in the results.

## Conclusions and further work:

**By comparing the adjustment methods from Lira and Fort Portal observations, it can be concluded and justified that the 'PPP method' is well within the accuracies specified in the Technical Specifications.**

**The observation time for each point shall be above three hours as performed in all observations.**

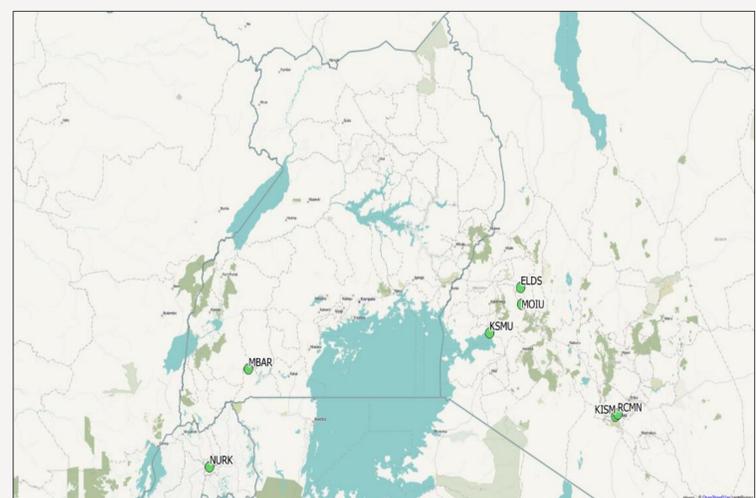
**The accuracy of the 'PPP method' is very reliable, however the result of a single station PPP observation is very difficult to judge and further the relationship between observation time and accuracy is a challenge.**

## Acknowledgements:

This study has been carried out as a part of the joint venture project with Pasco and COWI: "Production of Base Maps for Land Administration in Uganda." From Pasco has Roland Saftenberger been in charge of the field work

## Plate movements in Uganda:

Fortunately all of Uganda is situated on the Somali tectonic plate, which has been investigated in the paper "Re-evaluation of the kinematics of Victoria Block using continuous GNSS data" by R.M.S. Fernandes et al. published in Geophysical Journal International in July 2012.



Average movement of the stations above to the right is 25.3 mm/year east and 17.67 mm/year north. The final date for monitoring was in 2011. The IGS station MBAR is included in the analysis carried out by Jet Propulsion Laboratory and published on the web page <http://sideshow.jpl.nasa.gov/post/series.html>. Observations are included until the beginning of 2016.

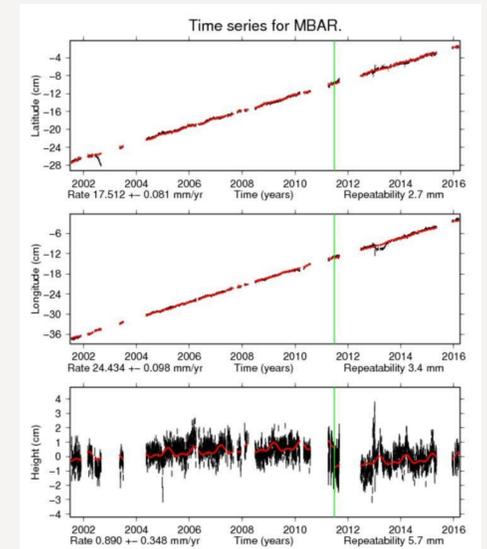
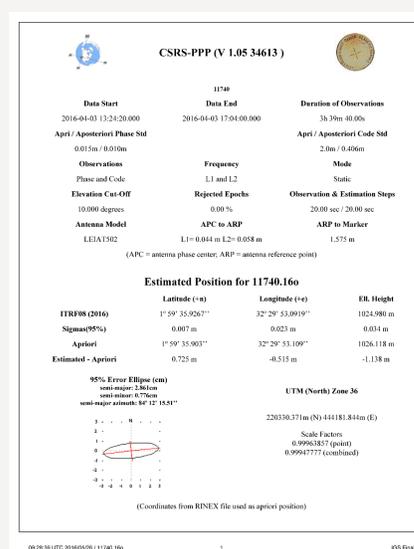
The uncertainty is based on the GNSS data only. Movements analysed by the Jet Propulsion Laboratory correspond closely with values published by Fernandes et al.

The values from the Jet Propulsion Laboratory are more recent and will therefore be used for further calculation of the GNSS observations.

East: 24.434 mm/year, uncertainty: 0.081 mm/year

North: 17.512 mm/year, uncertainty: 0.098 mm/year

Height: 0.890 mm/year, uncertainty: 0.348 mm/year



## References:

Fernandes, R.M.S. et al.: "Re-evaluation of the kinematics of Victoria Block using continuous GNSS data" published in Geophysical Journal International in July 2012, (Fernandes et al. 2012)  
IGN, France: Geodetic report – Zero Order network 2011 (IGN, 2011)

