GPS Data Integration into GIS for Offshore Facilities Management – Chevron Nigeria Experience

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Keywords: geo-information, geodetic services, GPS data integration, GIS technology adoption.

SUMMARY

The revolution of Geodetic information for operational and facilities management, and change in paradigm motivates GIS technology adoption by Chevron Nigeria. The production and management of geo-information, to cope with the increased demand for geodetic services within chevron naturally informed the need for modern methods of data capture.

When Chevron Nigeria was faced with problems of having different types of survey information, which were based on different reference datum. The Company decided to use GPS technology (LEICA GPS System 500 with SKI-Pro software) in 2002 to capture both spatial and attribute information of all offshore facilities (oil wells, jacket orientation, helicopter landing, etc.) in the Niger Delta area of Nigeria and exported data captured for use in ArcGIS.

Chevron Nigeria has found GPS to be a powerful, cost-effective data gathering tool. It is easily integrated into GIS and significantly improves the quality of information used in decision making. With update maps resulting from the integration of GPS and GIS, the company has benefited immensely from the combination of technologies which offer the potential of more and better spatial information for pipeline planning, decision making, and data management.

This presentation hereby highlighted the experience, the tasks, and moreover the challenges faced by Chevron Nigeria on the acquisition of GPS datasets for offshore facilities.

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INTRODUCTION

Good management of an oil field and compliance with ever-increasing stringent environmental regulations is enhanced by technologies that improve a company's understanding of field/production facilities and environmental conditions that have occurred to both through time. In Nigeria, Kazakhstan, Indonesia, and offshore Cabinda, computer-aided drafting (CAD) and Global Positioning System (GPS) technologies have effectively been used by Chevron to provide accurate maps of facilities and to better understand environmental conditions. Together these proven technologies have provided a solid and cost-effective base for planning field operation, verifying well and seismic locations, and locating sampling sites. Chevron has been evaluating the capability of Geographical Information System (GIS) technology to integrate images, maps, and tabular data into a useful database that can help managers and workers better evaluate conditions in an oil field, plan new facilities, and monitor/predict trends (for example, of air emissions, groundwater, soil chemistry, subsidence, etc.). Chevron routinely uses GIS for oil spill modeling and is now using GIS in the field for integrating GPS data with field observations and programs.

This paper outlines some developments in GPS and GIS with reference to oil and gas mapping activities; it attempts an integration of these geospatial technologies within the digital mapping process. It suggests some future actions to undertake in order to help kick-start the development of this field in Chevron Nigeria limited.

OBJECTIVES

- To resolve spatial errors suspected to result from the use of different but unknown set of datum shift parameters in Chevron Nigeria in the past.
- Conduct GPS field surveys to map all Chevron facilities in offshore area of company's operations
- To validate and integrate existing analogue and CAD drawings within the core GIS environment
- Design a data dictionary schema (code list) for tracking all feature

PROJECT STUDY AREA

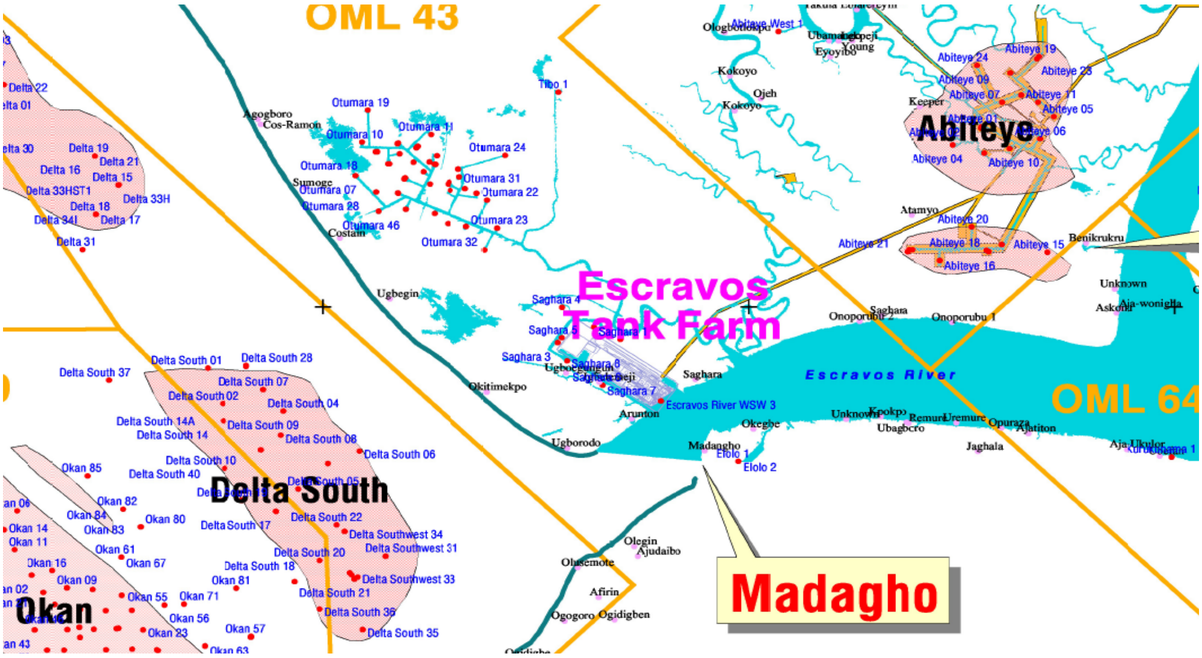

Fig. 1: Map showing the Study Area

An Offshore Jacket

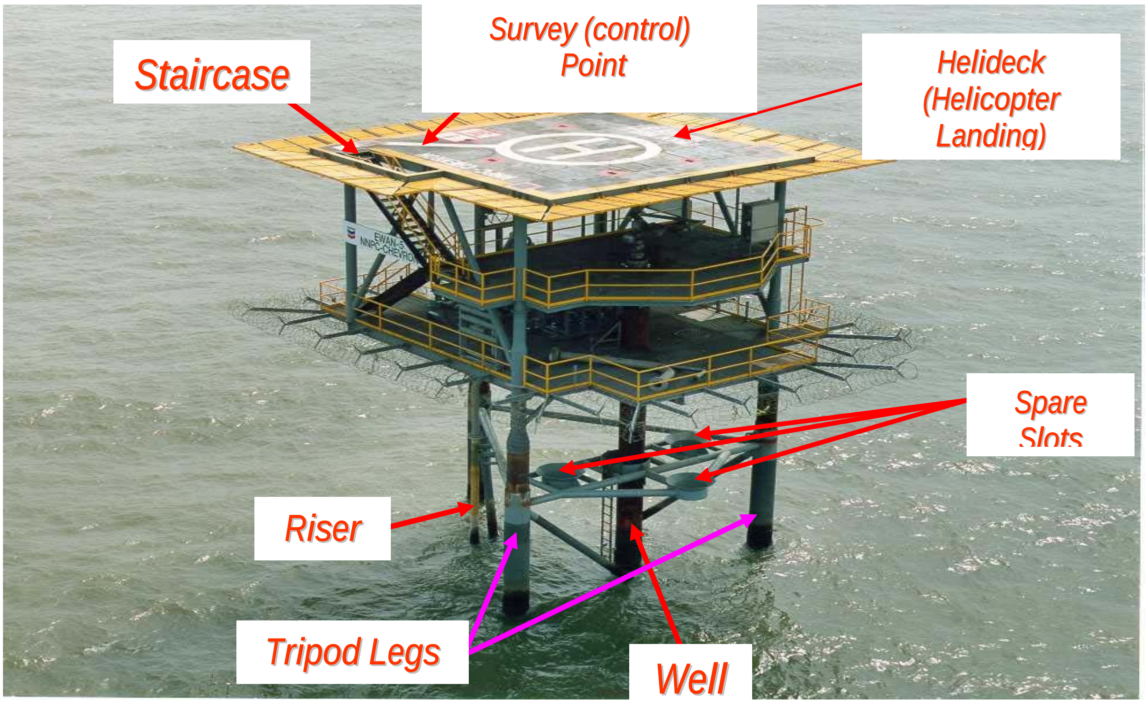

Fig. 2: Typical well jacket

FIELD OBSERVATION

Methodology

- Personnel – a team of our GPS crew (1 surveyor, 2 assistance)
- Operations
  - ~ *setting up of base station & rover station*
  - ~ *simultaneous observation at both base & rover stations using RTK mode*
  - ~ *error broadcast for rover station correction*
  - ~ *point & polygon features captured as points (polygon corner points)*
  - ~ *Positional quality (for quality assurance)*
    - * *GPS algorithm check before coordinate fixes to confirm centimeter accuracy*

DATA PROCESSING

Pre-processing (densification network/captured features)

- The GPS system is capable of real time processing of ambiguity resolution & latitude/longitude coordinates for immediate display.
- Data downloading
  - ~ *GPS interfaced with window based laptop*

Post-processing

- Ski-Pro software was used for office processing of the GPS observations. Of particular interest is the adjustment module, which was used for refining the network extension by setting a 3D statistical constrain.
- All captured feature latitude/longitude coordinates (in WGS-84) were batch processed by transforming them to NNO (X,Y) system using iaproj software.

RESULTS AND DISCUSSION

- **Features**
  - ~ total number of points captured =651
    point features = 550 (risers, survey points, well-head)
    polygon feature = 138 (helideck, staircase**)**
- **GPS data & existing conventional data sets**
  - ~ A comparison of the two data sets shows linear difference ranging from 2-6 meters, increasing further offshore in same direction in most locations.

SAMPLE GPS & EXISTING DATA SETS

						GPS_RESULT_LAT/LONG		GPS_RESULT_GRID		EXISTING_GRID RECORD		DIFFERENCES_IN CO-ORD (ΔE) (ΔN)	
Sr	Fac_ID	Point_ID	Well Name	Content	Status	Latitude (DMS)	Longitude (DMS)	Easting(M)	Northing(M)	MINNA_EAST	MINNA_NORTH	MINNA_EAST	MINNA_NORTH
1	DES	[illegible]	Well1	Oil	Shut-In	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.046	1.522
2	DES	10-WEL10	Well10	Gas	Shut-In	5 35 26.210782 N	5 6 13.038448 E	297683.898	175810.038	297682.303	175808.676	1.595	1.363
3	DES	[illegible]	Well11	Oil	Shut-In	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	DES	04-WEL12	Well12	Oil	Shut-In	5 35 13.332181 N	5 6 56.574557 E	299020.452	177258.617	299019.484	177256.437	0.968	2.180
5	DES	[illegible]	Well13	Oil	Shut-In	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	DES	09-WEL14	Well14	Oil	In Use	5 36 4.091764 N	5 6 12.143644 E	297651.624	176973.396	297650.907	176971.161	2.717	2.235
7	DES	[illegible]	Well15	Oil	Shut-In	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8	DES	15-WEL16	Well16	Oil	Shut-In	5 34 49.496493 N	5 6 52.338082 E	298891.789	174683.715	298890.257	174681.954	2.532	1.761
9	DES	[illegible]	Well17	Oil	Shut-In	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	DES	13-WEL18	Well18	Oil	Shut-In	5 34 8.135087 N	5 7 25.419998 E	299911.077	173414.486	299910.279	173411.850	1.798	2.636

Table 1: Comparing GPS results with existing data to determine the accuracy and harmonization of all coordinates captured

EXAGGERATED VIEW

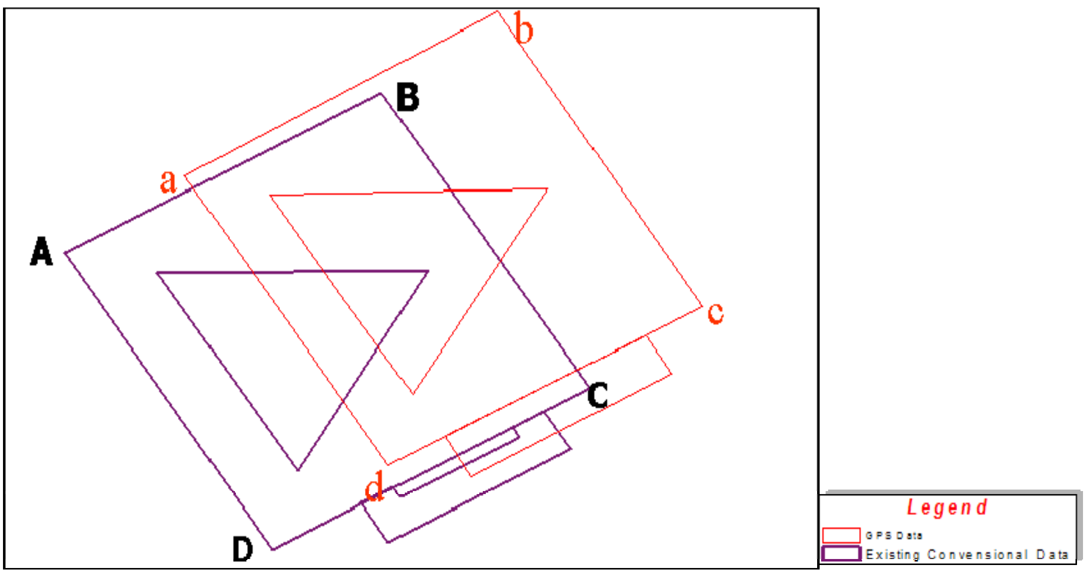

Fig 3: Comparing GPS results with Existing Datasets

SCANNED ANALOGUE MAP BEFORE DATA INTEGRATION INTO GIS

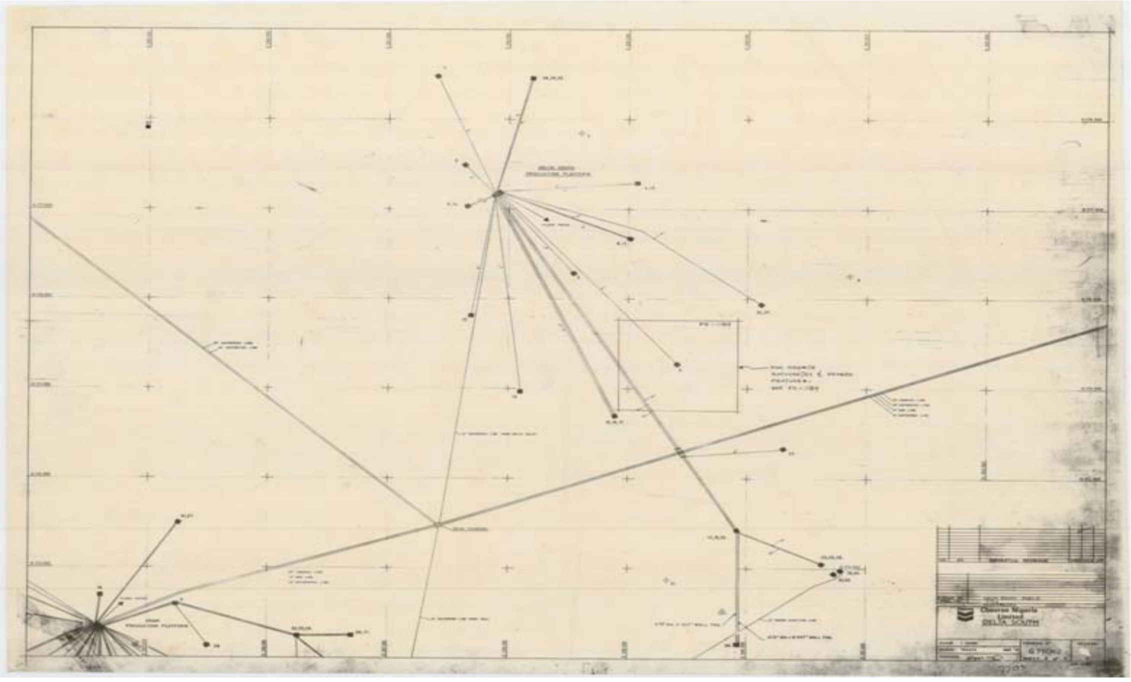

Fig 4: Scanned Analogue map before data integration into GIS

GPS DATA INTEGRATED INTO GIS

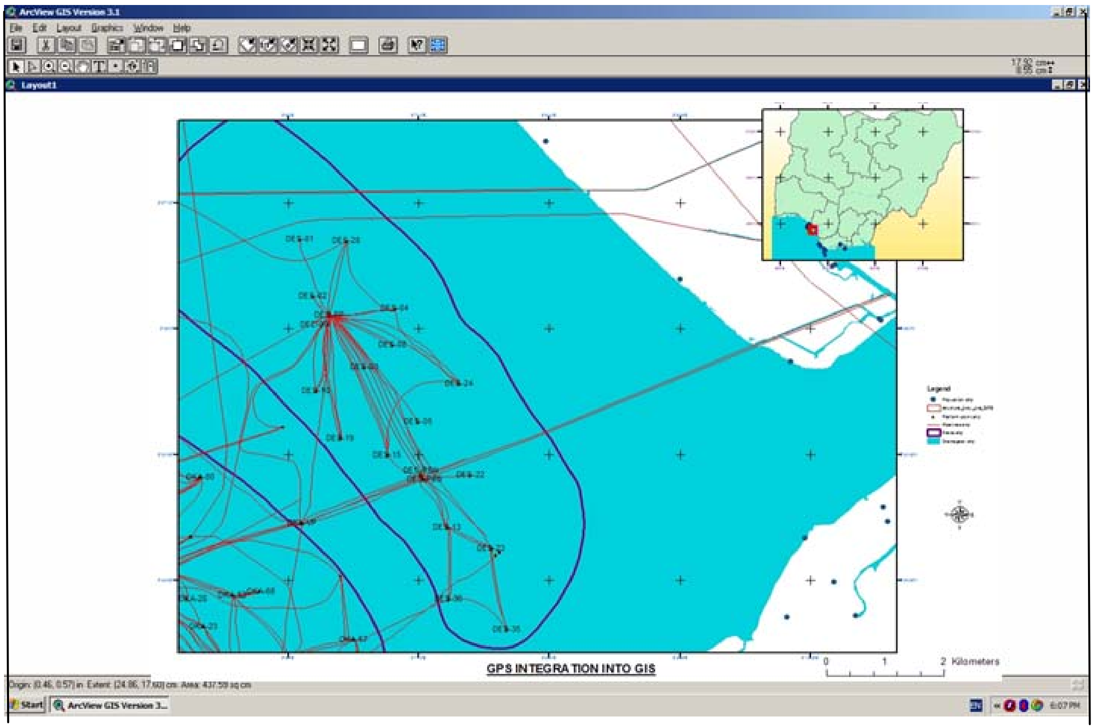

Fig 5: GPS results integrated into GIS environment

CONCLUSION

- Sensitizing our customers toward adoption of new coordinate set for planning and design.
- Synchronization of all SDE layer to the new coordinate set.
- Adoption of GPS in swamp and land locations (view blockage-mangrove forest)
- Control extension to land locations
- Tracking and documenting changes resulting from data dynamics

PROSPECTS

- More economic and efficient data updating approach
- Opportunity for deformation studies of Chevron facilities
- Survey-aware features position updating in GIS (survey analyst Ext)
- Provision of consistent data with known reliability in ArcIMS deployment

RECOMMENDATIONS

- Geospatial data should be saved and stored so that it may be retrieved later.
- GPS positional data should be used to upgrade a less accurate GIS base map.
- All digital maps should have their associated metadata tagged to them.
- By using accurate GPS points from a variety of projects can result in a digital base map that possesses a higher level of spatial accuracy in GIS environment.
- GPS data, combined with the field application of the conceptual work as presented in the study will generate more and better spatial information for offshore facilities planning, engineering, and research.

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BIOGRAPHICAL NOTES

Surv. Emmanuel Olayinka Ajayi, born in 1957 is a fellow of the Nigeria Institution of Surveyors. Graduated in 1982 with a B.Sc in Surveying from University of Civil Engineering, Bucharest, Romania. Obtained M.Sc degree in Surveying (with bias to Geodesy) from University of Lagos, Nigeria in 1988 and MBA degree in Project Management from Obafemi Awolowo University, Ile-Ife, Nigeria in 2001. He was registered to practice as a Surveyor in Nigeria in 1989. He joined Chevron Nigeria Limited in 1994 as a Survey Engineer in the Facility Engineering Department and rose to the position of Chief Surveyor, GIS-Survey Unit, Chevron Nigeria Limited since May 1998.

Surv. Sylvester Efe Owhojeta, born in 1967 is a member of the Nigerian Institution of Surveyors. Graduated in 1991 with a B.Sc in Surveying,
Geodesy and Photogrammetry from University of Nigeria, Nsukka, Nigeria. Obtained a Masters degree in Petroleum Economics from Ambrose Alli University, Ekpoma, Nigeria in 2005. He was registered to practice as a Surveyor in Nigeria in 2001. Up to date he has been practicing as a Registered Surveyor. Since July 2005 on contract engagement with the GIS-Survey Unit of Chevron Nigeria Limited, Escravos – Nigeria

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