Adoption of open source GIS in South Africa: some case studies

by Gavin Fleming, Kartoza and OSGeo

Abstract

A number of companies and government departments in South Africa have adopted or migrated to open source GIS in the recent past and the trend is on the increase. This paper showcases some of these success stories and delves into the rationales behind the moves and the practical considerations needed to make them work.

Keywords

FOSS, open source, case studies

Introduction

At the 2012 Ukubuzana, I reported on a survey of free and open source software (FOSS) GIS implementations in South Africa [1]. It demonstrated that FOSS GIS was being used in diverse applications in the private and public sectors. I conducted the survey to get a sense of the uptake of FOSS GIS in general and especially after the South African cabinet’s statement on open source in February 2007 [2]. I was expecting FOSS uptake to be strong in the government sector, but it emerged that private sector uptake was arguably stronger. Private companies are adopting FOSS for a variety of reasons, including: lower total cost of ownership; functionality that meets their needs; full control of application development; and non-cost-constrained scaling.

After having worked with FOSS in the GIS industry for over ten years, at CSIR, Mintek, SAEON, AfriSpatial and now Kartoza, I have gained personal experience and insight which others might find useful. Here I report on three private companies which have made full or partial migrations to FOSS GIS over the past few years. These are Tracks4Africa, i@ Consulting and Kirchhoff Surveyors.

The qualitative study of each company is broken into these sections: previous status; objectives and management rationale; current status; migration details; management response; and staff response.

I have attempted to be objective and balanced. Views expressed are my own based on hands-on experience and communication with management and staff.

Tracks4Africa

Tracks4Africa1 produces compiled map products for navigation devices, geospatial web and mobile applications, and books and hardcopy maps for the tourism industry. Tracks4Africa crowdsources its data from the travel community, mainly in the form of GPS tracks and waypoints. It uses the crowdsourced data to build and maintain its own routable road network and point of interest (POI) database covering the whole of Africa.

Fig. 1: Example of Tracks4Africa website.

1 http://tracks4africa.co.za
Previous status

As Tracks4Africa grew from a community that started by sharing GPS tracks on CD ROMs, a diverse ecosystem of tools and techniques grew around geospatial data management. Some aspects of this ecosystem are shown in Table 1.

<table>
<thead>
<tr>
<th>Data</th>
<th>Tools</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Dbase files</td>
<td>*FoxPro</td>
<td>*Compiled IMG files for Garmin navigation devices</td>
</tr>
<tr>
<td>*ESRI shape files</td>
<td>*ArcGIS</td>
<td>*Ad hoc digital and paper maps</td>
</tr>
<tr>
<td>*GPX files</td>
<td>*GlobalMapper</td>
<td>*High quality country-level travel maps</td>
</tr>
<tr>
<td></td>
<td>*Garmin Mapsource</td>
<td>*The Padkos website of travel-related POIs</td>
</tr>
</tbody>
</table>

Table 1: Tracks4Africa GIS ecosystem prior to FOSS migration.

Objectives and management rationale

In 2010, Tracks4Africa wished to build a bespoke web presence which integrated its various offerings and would include interactive web maps. While doing so the company wanted to minimise costs and pro-actively investigate development using FOSS.

Coupled with FOSS application development, Tracks4Africa also wished to reduce its dependence on old technology, legacy code and dependence on specific individuals, as well as reduce its dependence on proprietary software for data processing and management.

Table 2 outlines the current status.

<table>
<thead>
<tr>
<th>Data</th>
<th>Tools</th>
<th>Additional, new outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>*PostGIS database (OGC compliant)</td>
<td>*QGIS(^2) (FOSS)</td>
<td>*Integrated website including dynamic content, web maps, data submission and e-commerce</td>
</tr>
<tr>
<td>*GPX files (open standard)</td>
<td>*Django(^3) (FOSS)</td>
<td>*REST API supporting local and third-party applications</td>
</tr>
<tr>
<td></td>
<td>*PostGIS(^4) (FOSS)</td>
<td>*iGo/TopMap compiled navigation products</td>
</tr>
<tr>
<td></td>
<td>*ArcGIS</td>
<td>*iOS mobile app</td>
</tr>
<tr>
<td></td>
<td>*GlobalMapper</td>
<td>*Android app</td>
</tr>
<tr>
<td></td>
<td>*Garmin Mapsource</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Tracks4Africa GIS ecosystem after FOSS migration.

Migration details

PostgreSQL\(^5\)/PostGIS was chosen as the enterprise database.

The new web application was built with Django, with the first core set of online data being the Padkos POIs, now called “Listings”.

Web mapping was implemented with PostGIS as a data source. Mapnik\(^6\) was used to render the new base map. Styling was done in Mapnik XML. MapServer\(^7\) was used to render the POIs and to render road layers when public base maps were drawing instead of the Tracks4Africa base map. Tilecache\(^8\) was used to seed and serve

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2 [http://qgis.org](http://qgis.org)
3 [http://djangoproject.com](http://djangoproject.com)
4 [http://postgis.net](http://postgis.net)
5 [http://postgresql.org](http://postgresql.org)
6 [http://mapnik.org/](http://mapnik.org/)
7 [http://mapserver.org/](http://mapserver.org/)
8 [http://tilecache.org/](http://tilecache.org/)
pre-seeded map tiles. Finally, Tracks4Africa webmapping is migrating to CartoCSS9 styling and Tilemill10 and now Mapbox with Mapbox Studio11.

For a long time while PostGIS supported the website, data management was still done in ArcGIS on shapefiles and in FoxPro on Dbase (dbf) files. Tracks4Africa had a geographically distributed data management team and were using ftp to synchronise shapefiles across sites. This practice was fraught with issues. Shapefile management was made more reliable by zipping them and committing them to a Subversion12 version control repository. Coordination among distributed office staff were also improved. Subversion (and code versioning systems in general) was not designed with such a use in mind, but it worked well for many years. Although diffs can not be made on binary files, previous versions could be recovered.

During this time, shapefiles were loaded into the PostGIS database on a “release” basis so that the web map could be updated based on recent work on the shapefiles.

Ultimately, all shapefiles were loaded for the last time into PostGIS and data management was switched almost completely to a combination of QGIS and PostGIS:

- In-database SQL functions have replaced the FoxPro dbf routines that play a significant role in cleaning data, generating statistics and maintaining integrity.
- Spatial (geometry) and attribute management is done almost exclusively in QGIS and through SQL in the database.

All database, web and map servers run Ubuntu Linux. Desktop users still run Windows. All code, styles and other documentation is maintained in a self-hosted Git13 repository, and ArcGIS, GlobalMapper and other legacy tools are used occasionally for some tasks.

For training purposes key staff attended an “Enterprise GIS with FOSS course” presented by Kartoza where they were exposed to PostGIS, SQL and web mapping (through Geoserver and OpenLayers). Indirect training occurred through general consultation.

A significant amount of self-learning took place. This speaks to the availability and quality of documentation and free community resources available online. Notably: no staff ever attended a QGIS course, yet it is their core day-to-day tool, while a key staff member has completely “grokked”14 SQL and “GIS in a database” and is really flying, pretty much on her own.

Custom development Tracks4Africa funded improvements in the simplification tool in core QGIS15. This is a typical argument for and advantage of adopting FOSS: If there is something a FOSS tool does not do, fund its development instead of, in the proprietary case, waiting and hoping for the functionality to be included in a future release. All other users benefit from the improvements you fund. Conversely, you benefit from the many improvements others in a similar position fund.

Management response

The management objectives mentioned above have been achieved.

Additionally, great freedom has been achieved to generate multiple and unforeseen products off a well-managed ORDBMS (object-relational database management system).

There is flexibility in office systems to accommodate diverse tools and workflows and no vendor lock-in.

Staff response

Staff enjoy working with QGIS and PostGIS. They trust these tools and find them intuitive to use.

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9 https://github.com/mapbox/carto
10 www.mapbox.com/tilemill
11 www.mapbox.com/design/#mapbox-studio
12 https://subversion.apache.org/
13 https://git-scm.com/
14 https://en.wikipedia.org/wiki/Grok
15 http://changelog.qgis.org/qgis/version/2.8/#246
i@ Consulting

i@ Consulting is a firm specialising in town and regional planning and land use management consulting and systems. A key product relevant to this discussion is CitySolve, which is a hosted land use management platform, of which a municipality and its staff are typically users.

Fig. 2: A CitySolve view showing one of the web mapping components.

Previous status

Spatial data management was done using shapefiles and ArcGIS in the GIS department. Engineers and town planners typically used CAD. In a common scenario, these two user groups have to frequently share data — indeed many workflows go back and forth between these departments.

Objectives and management rationale

There was a requirement to bring spatial functionality and web mapping into the recently developed CitySolve product. i@ chose to do this with FOSS tools. i@ also wished to migrate internal data management operations to better practice methodologies, specifically those built around a database and to do this using FOSS.

The long term vision for all spatial data management at i@ is for it to be database driven and for all workflow, CAD and GIS, to be centred around a common database platform, using FOSS tools wherever possible.

Current status

CitySolve web mapping components run on the OpenGeo Suite, which consists of this FOSS stack:

- PostGIS database
- Geoserver web map server
- GeoWebcache tile caching server
- GeoExt and PHP-based custom application

The CitySolve database is maintained in a PostGIS instance on the office local area network (LAN), through QGIS and SQL. It is replicated to a PostGIS slave instance at the internet service provider (ISP), so changes appear instantly online. The web application is also configured by editing the database in the office.

Other office GIS management tasks are gradually being migrated to PostGIS and QGIS.

16 http://iatconsulting.co.za
17 http://boundlessgeo.com/opengeo-suite/
18 http://geoserver.org/
19 http://geowebcache.org/
20 http://geoext.org/
A particularly convenient FOSS tool is the OpenGeo Suite plugin\textsuperscript{21} for QGIS, which facilitates direct control and management of PostGIS and Geoserver from within QGIS.

All database, web and map servers run Ubuntu Linux. Desktop users still run Windows.

\textit{Migration details}

The CitySolve web mapping application was a turnkey development, so did not entail much migration other than training and documentation. Most of the spatial data consists of static layers loaded from shapefiles into PostGIS as they are received from municipalities. Non-spatial and more dynamic components of CitySolve are based on PHP\textsuperscript{22} and MySQL\textsuperscript{23}. Integration between spatial and non-spatial components is achieved through web-services and MySQL foreign data wrappers in PostgreSQL. CitySolve implementation did entail the introduction of PostGIS and QGIS into the office environment. On-the-job training was done with key staff members.

More general migration of internal data management and workflows to PostGIS and QGIS is occurring gradually as staff acquire new skills and on a per-project basis.

\textit{Management response}

The originally stated objectives have been achieved. Migration is occurring at a managed and manageable pace.

\textit{Staff response}

Staff find QGIS and PostGIS intuitive and productive to work with. A recently hired GIS manager had PostGIS training from Afrispatial five years ago and so is primed for the position.

\textbf{Kirchhoff Surveyors}

Kirchhoff Surveyors\textsuperscript{24} is a firm of professional land surveyors. Survey firms are increasingly venturing beyond the bounds of strict land surveying and into GIS, for data management, map making and other ancillary services that can expand their offerings and improve their internal data management practices. Until recently this firm had not done much GIS. That changed when it landed a contract that required land surveying expertise and professional oversight, but was in fact a GIS project at its core.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{fig3.png}
\caption{A QGIS screenshot of a remote work environment for Kirchhoff Surveyors, where live data capture takes place through WFS services provided by Geoserver running on the office LAN.}
\end{figure}

\textit{Previous status}

Land surveyors traditionally use CAD and specialised survey tools, most of which are proprietary (such as Revit) and this practice was no different.

\textsuperscript{21} [Link to OpenGeo Suite plugin]
\textsuperscript{22} [Link to PHP]
\textsuperscript{23} [Link to MySQL]
\textsuperscript{24} [Link to Kirchhoff Surveyors website]
Objectives and management rationale

Kirchhoff Surveyors won a substantial contract which was really a GIS project requiring professional land surveyor oversight. The firm had the foresight to invest in a dedicated GIS server and establish in-house GIS capacity based on FOSS GIS.

Current status

The survey firm maintains a dedicated GIS server running Ubuntu Linux on the office LAN. The server runs OpenGeo Suite, consisting of PostGIS, Geoserver and Geowebcache, and QGIS.

A team of GIS data capturers work on Windows workstations running QGIS. They simultaneously edit data in the central PostGIS database and use forms in QGIS to improve data capture efficiency and quality.

Layers and tables which need to be edited or styled dynamically come into QGIS via direct PostGIS connections. The rest of the layers which are used for orientation and would otherwise consume unnecessary resources and waste users' time to style, are served from Geoserver as web map services (WMS) and used in QGIS as a base map.

A GIS specialist works on the GIS server in QGIS and PostGIS, managing data and doing analyses, and reporting and quality control not only for this project, but for new business that the firm can now take on because it has GIS capacity.

Kirchhoff Surveyors funded the development by Kartoza of the Surveyor General (SG) Diagram Downloader plugin for QGIS. This is another example of the power of FOSS. Many people need survey diagrams and it is a laborious task to find and download them from the SG website, especially when you have to download thousands, as was the case in this project. Developing a FOSS tool in the form of a QGIS plugin solved the immediate problem by automating downloads, but has also benefitted hundreds of other users in South Africa.

Migration details

This was a turnkey development in the sense that GIS capacity at Kirchhoff Surveyors started out as a FOSS solution. Consulting, documentation and training helped establish in-house capacity, which is now almost independent.

Management response

The project is ongoing at this time of writing, but objectives are being met and the proprietor of Kirchhoff Surveyors is very happy with his firm's new-found GIS capacity. The fact that it is FOSS has meant that it has come at a very low cost.

Furthermore, highly skilled and motivated GIS staff have been hired, who come with academic and practical experience and training in FOSS GIS, specifically QGIS and PostGIS, in this case from the University of Pretoria.

Staff response

Staff enjoy working with QGIS and PostGIS. For many of the data capturers, this was their first experience with GIS and it has proven easy to learn and to teach.

Conclusion

This paper highlights three use cases among many private companies, government departments and educational institutions in South Africa where FOSS GIS is being applied successfully. Awareness of FOSS GIS in the market is growing and the service provider ecosystem is growing accordingly, offering consulting, training and support services. Transitioning to FOSS is certainly a viable proposition.

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References


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https://plugins.qgis.org/plugins/SGDiagramDownloader