SIMPLE TOOLS, SMART RESULTS – SPATIAL DATA IN A DIGITAL AGE

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Abstract

Access to geospatial data has traditionally been a limiting factor in terms of project planning. This is due to three main constraints: limits of the spatial and temporal coverage of available data, cost of acquiring data, and the time required for acquiring new data. Using a the case of a Strategic Environmental Assessment (SEA) of a hydropower development in Namibia and Angola as a case study, this paper examines how the instant availability of data can influence impact assessment and facilitate better decision-making. The paper connects GIS, remote sensing, local specialist knowledge, and basic computer software and then explores the possibilities they present for impact assessors and project developers. This is all is framed using an SEA case study to illustrate how practical, timely, cost effective and flexible decision making tools can be generated.

Introduction

Environmental Assessment Practitioners (EAPs) are now more than ever better positioned to perform fast, flexible and cost-effective strategic environmental assessments (O'Riordan, 2014). One of the major contributing factors to this has been the increase in availability of spatial data over the last 40 years. During this time three main factors have limited the usefulness of data: 1) cost of data; 2) data acquisition time; and 3) data coverage or lack thereof (which has a direct effect on points 1 and 2) (Pettorelli, Laurance, O'Brien, Wegmann, Nagendra, & Turner, 2014).

The existence of remotely sensed data has vastly improved an EAPs ability to conduct site-specific environmental assessments. However the use of remote sensing data by EAPs has been generally limited to the immediate project location and seldom applied to a regional scale. This has begun to change.

Spatial data and the digital age

Over the last 40 years a body of geospatial data has been accumulating on a global scale, to the point where now the entire earth’s surface has been captured by either aerial photograph or satellite image. Prior to the mid-2000’s this data was difficult to come by as most satellites were owned by governments or research organisations. It was also costly at a project level, where selected data could be purchased, but at a premium.

From around 2005 this began to change (Blaschke, et al., 2014). Events such as the launch of Google Earth in June 2005 (Google, 2014), the free release of NASA’s Landsat data via the internet from 2008 onwards (USGS, 2008), and a marked increase in the number of commercial satellite imaging companies have fundamentally altered the playing field. For example, since its launch Google Earth has been downloaded well over 1 billion times (Sandeep, 2011). The exposure Google Earth has generated for geospatial data has helped transform the fields of remote sensing and Geographical Information Systems from the niche technology sectors they previously occupied (amongst others: mapping, surveying and earth science research) into a globally available mainstream technology.

What Google Earth did was enable anyone with a computer and an internet connection to view a satellite image of any location on the planet. Initially this was at a low resolution. These data were mostly captured by geostationary earth observing satellites at small scales, and by satellites such as SPOT, Landsat, at medium scales and QuickBird at large scales (Lillesand, Kiefer, & Chipman, 2004; LANDinfo, 2014; Jones, 2013).

There has also been exponential growth in data processing power, software capability and interconnectivity, and a torrent of analysis - most of which is available online. We now have more data, in more formats, that is easier to work with than ever before. However, it is often difficult to navigate this maze of information and possibilities to find the approach that is *fit-for-purpose* (George, Haas, & Pentland, 2014).

Focussing on study design can avoid the problems of complicated tasks such as image processing and the need to spend large sums of money on data. Three key actions can enable the production of a study that is fit-for-purpose, cost effective, and flexible to project changes, i.e. using simple tools to produce a smart result. These key actions are:

1) Study Resolution: Determine the level of detail required in terms of study outputs in order to suffice for the purposes of the study itself - make the study 'fit-for-purpose'.
2) Study design: In terms the final deliverable, spend understanding the level of detail required, application of the results, and potential users.
3) Data integration: Deciding which data to use and how to integrate the data is key to making the sum of the simple tools equal a smart result.

Case Study: Baynes Hydropower Plant, Namibia and Angola

Background

The Governments of Angola and Namibia have for some time contemplated the development of a hydropower scheme along the lower Cunene River. The techno-economic study of the Baynes Hydropower Plant has been completed and accepted by the Project Joint Technical Committee (PJTC) (Cunene Consortium, 2011). The ESIA for the development is nearing completion.

Angola and Namibia have begun considering options for ancillary infrastructure required for construction and operational phases of the project. This includes the power lines, access roads, port facilities, an airfield and construction camp. A Strategic Environmental Assessment (SEA) was commissioned to assess the potential impacts of the ancillary infrastructure (Walmsley, Pallet, & Tarr, 2013). The SEA would provide sufficient information to facilitate informed decision-making with regards to the environmental and social impacts of the overall project.

Study resolution

This was done by assessing: a) the level of confidence in terms of the description of the ancillary infrastructure (i.e. the likelihood that it would change in later stages of design); and b) the objectives and desired outcomes of the SEA. Considering these factors it was determined that what the SEA needed to produce was:

- High level understanding of what environmental and social features are potentially occurring and where they are in relation to the ancillary infrastructure (e.g. habitats or settlement types); and
- Assessment of the potential sensitivity of the identified features to the proposed activities associated with the ancillary infrastructure.

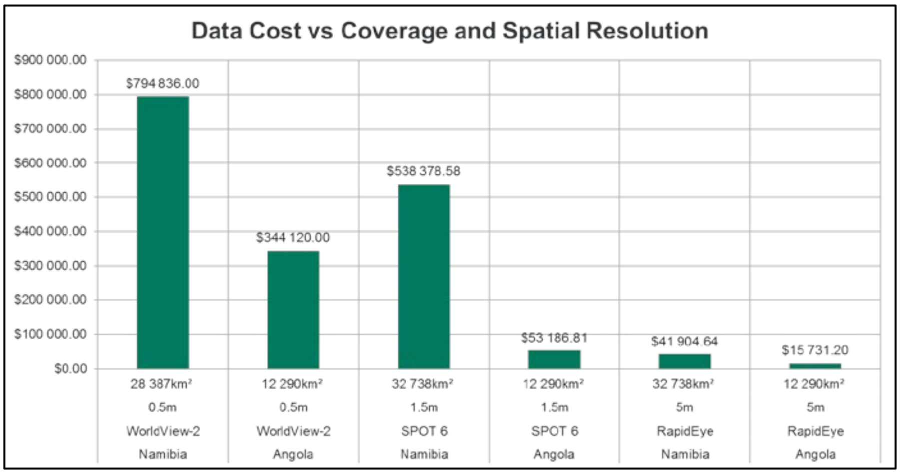
Study design

Step 1: Understand the location and nature of the ancillary infrastructure. This involved answering the following questions: a) What will the proposed ancillary infrastructure consist of? b) Where will this ancillary infrastructure be located? and c) What activities will be associated with the construction, operation and decommissioning of this infrastructure? Possible routes for road access and power lines, and possible locations for an airstrip and a zone of influence for the construction camp were considered in a workshop setting. The project engineers then provided descriptions of the activities typically associated with the construction, operation and decommissioning of such ancillary infrastructure. This was then defined in spatial terms by mapping each of the components of the ancillary infrastructure.

Step 2: Identification and characterisation of environmental and social sensitive features. Having established what ancillary infrastructure would be needed, where it would likely be located, and the nature of the activities associated with it, the environmental and social assessment stage of the process could then begin. This involved firstly identifying biophysical and social features associated with the proposed ancillary infrastructure. Secondly it involved assigning a sensitivity rating to each of the identified features. However, before the biophysical and social features could be identified, the resolution of the study needed to be defined.

The study needed to cover over 3000 km of road and 1500 km of power lines across two countries, much of which is in inaccessible areas. It was thus assessed that investigating the routes and sites in the field was too costly and time consuming and not flexible to changes in the alignments. Thus a desktop-based mapping exercise was decided upon. Various data sources were considered, such as, commercial satellite data and pre-produced data sets. Figure 1 shows a comparison of the cost of purchasing satellite data at varying spatial resolutions for the AoI.

Figure 1 Cost of satellite data for the AoI (Geo Data Design, 2014)



While the cost of the RapidEye imagery may have been acceptable to the project, the spatial resolution of the image was not high enough for the purpose of the SEA. Then on the other end of the scale, the high resolution imagery (WorldView-2) was not acceptable from a cost perspective. Bearing in mind that the satellite imagery would be used only for visually identifying and recording the possible presence of high level environmental and social features, an assessment of the imagery provided in Google Earth was undertaken. This revealed that the Google Earth had the project AoI well covered with good quality high resolution imagery that would suffice for the purposes of the project. Additionally, two pre-produced commercial data sets were purchased: TomTom topographical data, and a selection of Namibian environmental / social data from a local data supplier. These data sets were converted to Google Earth formats and used to augment the satellite imagery. The roads, power lines, construction camp and airstrip were first mapped in ArcGIS. Buffer zones were applied based on the activities and potential zone of impact. This was then converted from ArcGIS shapefiles into Google Earth kml format (1). In each country a biophysical and social specialist was selected to undertake the identification and mapping of environmental and social features. The value of local knowledge for a strategic assessment project such as this was high particularly as specialists would be visually interpreting what they would be seeing in the imagery. The specialists mapped all features within the buffer zones using the *"Placemark"*, *"Path"*, and *"Polygon"* functions. For each identified feature the feature type, sensitivity, brief description of the feature, and a reference for the feature was recorded. The data was then converted into ArcGIS shapefiles for analysis and display.

A data capture procedure was then developed which utilised a combination of Google Earth for the spatial component and Microsoft Excel for the descriptive component. So for every feature identified and mapped, this would require the data fields to be entered in Microsoft Excel. Once the mapping was complete the Google Earth data was converted into ArcGIS shapefiles. For the lines and the areas a centroid point was generated to represent its general location.

The entire dataset was unified into a single point shapefile. Using the "join" function in ArcMap the information specific to each point in the MS Excel file was then incorporated into the attribute tables of the unified shapefile. The key to the join function working is that the two datasets have an attribute that is exactly the same. A detailed naming process was followed by the specialists when mapping the features in Google Earth. The name was recorded in the MSExcel file acting as a unique identifier. Data was then integrated in ArcMap and analysed (Figure 2).

Results

Due to proper study design the specialists we able to map and assess a study area of 3300 km^2. Over 7000 features were identified, mapped and assessed (Figure 3). Good data structure facilitated queries to provide strategic answers related to route selection. The technique was able to adapt to route and alignment changes quickly and easily. Data was presented as much as possible in visual format to aid in rapid understanding and improved planning. Data provided a planning tool for the next phases of the project.

(1) Google Earth *Keyhole Markup Language*

Figure 2 Study sequences

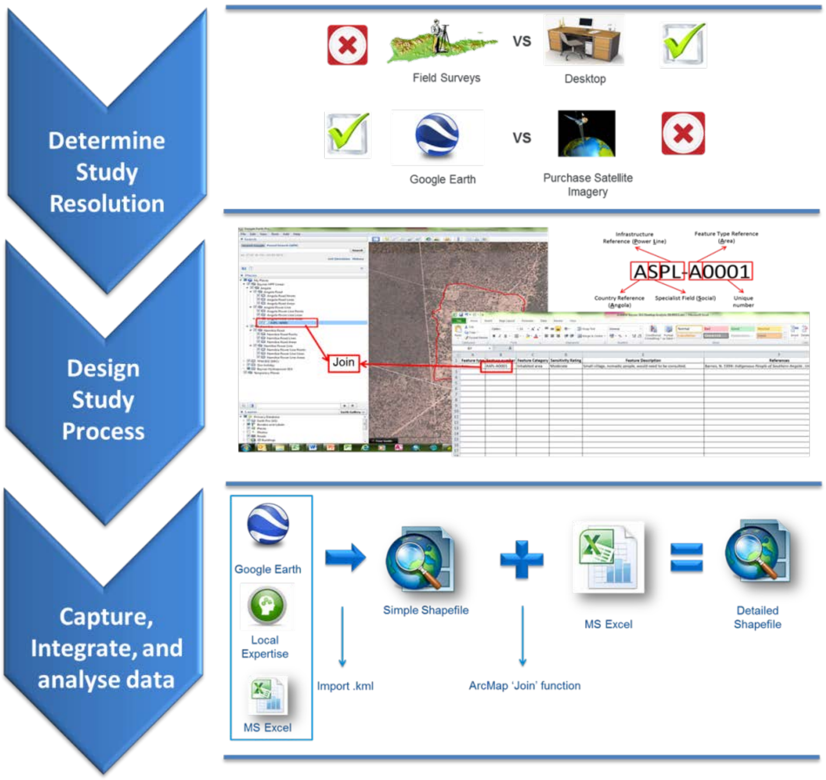
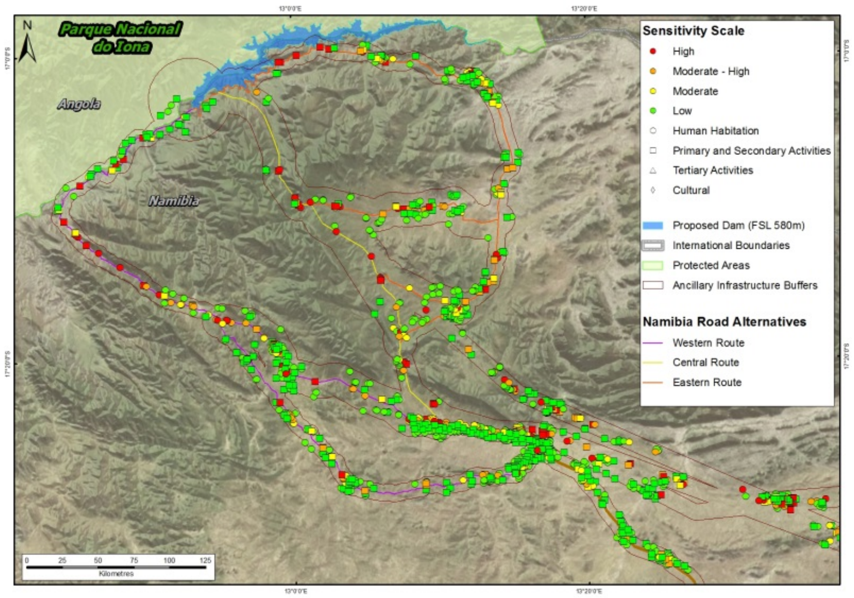


Figure 3 Project output example



Conclusions

In the digital age the traditional data constraints of cost, time, and coverage have diminished substantially. In comparison to data generation techniques such as in-field surveys or the purchase and processing of satellite imagery, the methodology described here was far more cost effective and flexible to change. This was enabled by the availability of spatial data such as that provided in Google Earth. Transforming this data into valuable environmental and social information required local knowledge and the combination of a number of simple tools to produce a smart result. As such this paper presents an approach to strategic assessments that will assist EAPs in the impact assessment process.

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