Development of a custom weed mapping application for annual weed surveys by a mining company in the Northern Territory of Australia

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Summary   Energy Resources of Australia Ltd (ERA) is a mining company operating in the Alligator Rivers Region of Northern Australia. Weeds are one of the most important environmental issues affecting ERA mining leases and surrounding Kakadu National Park. Since 2003, ERA has been conducting annual weed surveys. The surveys form an important part of the weed management cycle, providing a valuable long-term record of changes in weed distribution, density, and number of species which assists with direct control and forward planning. This paper presents a custom ArcPad application that was developed in order to reduce time and error during data entry. The application was based on the ArcPad integrated development environment 'Studio'. The paper first describes the background to the weed surveys and the methodology, followed by a description of the development and testing of the application. The paper concludes by highlighting the success of the application, and a brief discussion of the future of mobile mapping applications for weeds (e.g. improvements in PDA devices).

Keywords   ArcPad, Geographic Information System, mapping.

INTRODUCTION

Energy Resources of Australia Ltd. (ERA) is a uranium mining company that operates in the Alligator Rivers Region of the Northern Territory of Australia. Weeds are one of the most important environmental issues affecting ERA mining leases and surrounding Kakadu National Park. Annual fine scale weed surveys have been conducted on ERAs two leases—the Ranger Project Area (RPA) and Jabiluka since 2003. These surveys have provided a valuable long-term record of changes in weed distribution, density, and number of species. Since the first weed survey, the Esri mobile mapping software ArcPad has been used with a field Personal Data Assistant (PDA). Although there are some quality free mobile mapping software programs currently available (e.g. Cybertracker), they lack the ability to capture polygon data, which are essential for recording large weed infestations. ArcPad is in essence a 'miniature' Geographic Information System (GIS), which captures, stores, edits and displays geographic data. Previous versions of ArcPad (e.g. v.6) were

prone to screen clutter from the toolbar palettes, which reduced the screen space for displaying background images and GIS shape-files. Another problem was that the ArcPad software was not efficient in using the hardware resources of the PDA. As a result, data layers were often slow to re-draw—particularly for large shape-files and background imagery. The main issue with ArcPad during the weed surveys was that the data entry was unnecessarily time consuming. This increased the risk of data entry errors, especially when working in the hot and humid conditions typical during the survey. Given that a large number of weed records were collected during the surveys (e.g. >11 000 points in 2010) the extra time for entering a single record represented a large amount of cumulative time over the entire weed survey. The objective of this project was to develop a custom ArcPad application to reduce data entry time and error in the field during the annual weed surveys.

MATERIALS AND METHODS

The application was developed in three stages: planning, building, and testing, which are described in detail below.

Planning   The form designs were initially drafted on paper; with the objective of making the forms as simple and functional as possible. All the essential input information was placed on one page, with secondary information on other pages. The form design reflected a desire to limit the amount of time spent in the field at each sample location by reducing the amount of 'taps' required by the user to enter the details. The application was designed to contain three main data entry pages: Priority, Description, and Other, as well as a default Picture tab where photos could be captured. The Priority page contained 14 priority species that were mapped during the 2011 weed survey. That page was the primary data entry page. The Description and Other pages were optional data entry pages, allowing general details about a particular site to be entered, as well as the occurrence of non-priority weed species.

Building   The customisation and development environment from ArcPad version 8 onwards is Studio

(ESRI 2010). Within the Studio environment there are several different types of customisation options, including applets, extensions, and layer definitions. The layer definition was the most basic of all the possible ArcPad customisations available, and was used for the current application. A custom applet or extension would not have added much in terms of time savings or ease of use, given that there is minimal user input for ArcPad required outside of the data entry phase. A layer definition file (.apl) was associated with the point, line, and polygon shape-files, and contained the accompanying customised data form(s).
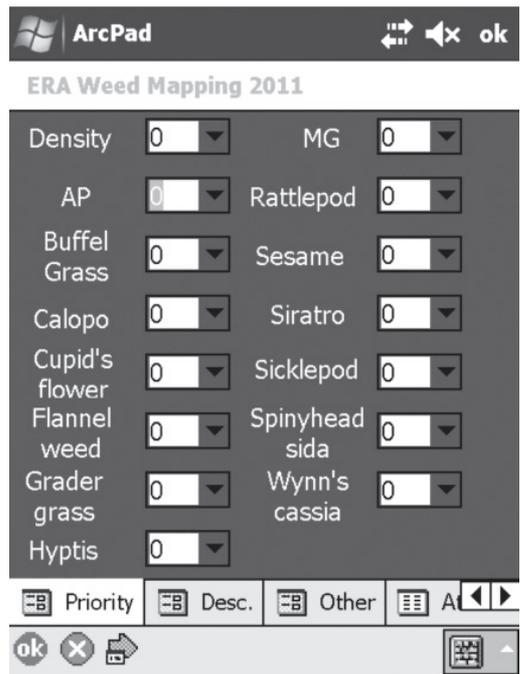
Testing This is arguably the most important stage during the development of software or related applications. All aspects of an application must be deemed 'foolproof' before it is used in an actual field setting. For the current application, a series of tests were carried out: 1) indoors without the GPS activated. The full range of input options were tested, to make sure that the form parameters were all correctly set; 2) outdoors- with GPS activated; and 3) a limited field test at Ranger Uranium Mine, with background imagery and other GIS data included to test the performance of the PDA and ArcPad using the same datasets as the actual weed survey.

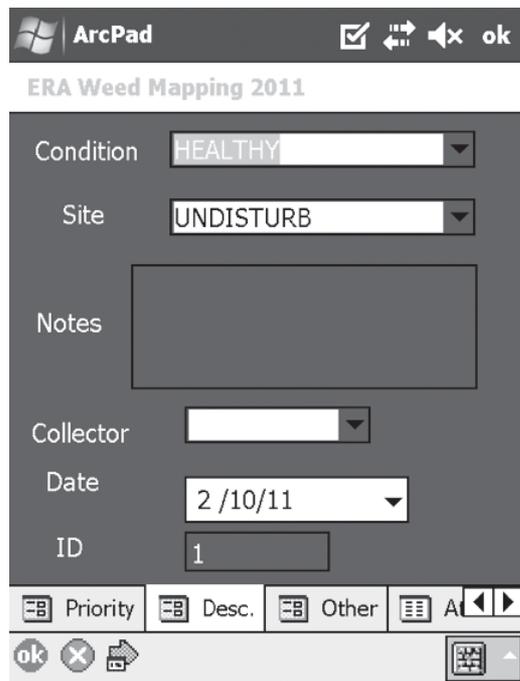**Figure 1.** Priority species page.

RESULTS

Building Dropdown lists with density values were used for the priority weed species (Figure 1). The densities of the 14 priority weed species, as well as Overall Density were included on the same page, which eliminated the need to scroll down a list. The dropdown list gave a choice of density values 1–4, with 0 being the default. The Overall Density field was rendered in bold, to make it more visible to users and reduce the chance of a null (0) entry.

The Description page (Figure 2) contained fields called Condition and Site. The Site field represented the status of the immediate region where a sample is being taken: a) Slashed; b) Burnt; c) Cleared/graded/excavated; d) Undisturbed e) Feral animal damage; f) Inundated. The Condition field represented the status of the weed infestation that is being mapped: a) Sprayed; b) Pulled; c) Dead; d) Healthy; e) Fire damage; f) Insect damage. These fields were set with Undisturbed and Healthy fields respectively as defaults, as these were the most common conditions encountered during weed surveys.

The 'Collector' field was left blank by default. If the user selects their name at the start of a survey session, the field does not have to be populated again until another person uses the PDA, or at the start of the next survey session. The 'Date' field automatically

Figure 2. Description page.

used the date from the Windows Mobile software settings. The 'ID' field was set to auto-increment for every successive record.

The 'Other' page for non-priority species is shown in Figure 3. The 19 species were selected based on the 2010 weed survey report (Gellert and McIntyre 2010). New species recorded in subsequent surveys can be added to the page. In previous weed surveys, these species have been listed for each WMA, but the spatial location was not been recorded, except in the case of candle bush (*Senna alata*), guinea grass (*Panicum maximum*), and gamba grass (*Andropogon gayanus*). Although it may not be essential to record the location of the non-priority weed species sighted during the survey, the convenience of the data entry form does provide an incentive to do so. Given that the priority status of these species may change in the future, a record of the location may be useful.

The final two pages in the form were the Attribute page and the Picture page. The Attribute page was retained to allow the user to make manual edits to a record if desired. This page represents the original method of entering weed data in the field, in the absence of the custom application. The Picture page allows digital photographs to be captured concurrently with the spatial location of weed point, line or polygon features. The name of the photograph for a particular record is stored in the 'PHOTO' field of the attribute table.

Testing   During early testing of the application, the keyboard from the Windows Mobile software appeared automatically whenever page features were selected. The keyboard was not required during data entry, except for the 'Notes' box on the Description page. However the keyboard is 'hard wired' in the Windows Mobile software to pop-up, and there were no options to disable it. To address this issue, a freeware applet called Null Keyboard was sourced from the internet and installed on the Nautiz® PDA. The 'NullKB' option disables the keyboard during data entry.

The application performed satisfactorily during the field testing phase, and during the entire 2011 weed survey (Gellert and McIntyre 2011). The application itself was well received by the staff involved in the weed survey. One user who had not previously used a field PDA or the ArcPad software commented favourably on the ease and simplicity of data entry. There were a small amount of data points that were corrupted and had to be discarded. Out of 8600 points collected, only 250 (~3%) of the points were corrupted. The loss of these survey points was very likely due to a temporary malfunction of the Nautiz X7® caused by the hot conditions, rather than a problem with the software application.

DISCUSSION

The two most recent versions of ArcPad (v.8 and v.10) represent a substantial improvement over earlier versions (e.g. v.6). These software improvements, along with the additional processing power of the Nautiz X7® and the custom field data entry application contributed towards time savings in the field and increased ease of use. Given the demonstrated success of the custom application during the 2011 weed survey, there is great potential to apply modified versions of the application to other field activities done by ERA, especially where large numbers of data records are collected. Some examples include surface water sampling, bore monitoring, vegetation surveys, fire scar mapping, and recording fauna sightings. The application has serious time-saving benefits compared to recording data on paper and converting it to digital form (e.g. MS Excel®). While mobile mapping technology may never completely replace traditional equipment such as field notebooks and SLR cameras, the reliability, convenience, and ever-improving technology means it may eventually become the standard for field data collection.
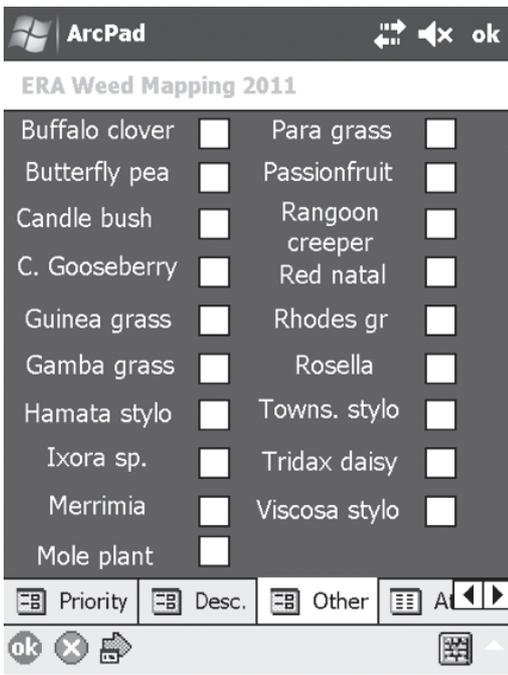
Figure 3.   Non-priority species page.

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