SoilMapp – mobilising Australian soil data

Mark Thomas[1], Neal Dalgliesh[2], Peter Wilson[3], Kavinga Hubert[4], David Jacquier[3], Garry Swan[3], Dean Holzworth[2], Matthew Birks[5], Linda Brunker[6] and Paul Davis[7]

[1]CSIRO Land and Water, PMB 2, Glen Osmond, South Australia 5064 Email mark.thomas@csiro.au
[2]CSIRO Ecosystem Sciences, PO Box 102, Toowoomba, Queensland 4350
[3]CSIRO Land and Water, GPO Box 1666, Acton, ACT 2601
[4]CSIRO Information Management and Technology, Private Bag 33, Clayton, Victoria 3169
[5]CSIRO Information Management and Technology, 1 Wilf Crane Crescent, Yarralumla, ACT 2600
[6]CSIRO Information Management and Technology, PMB 2, Glen Osmond, South Australia 5064
[7]CSIRO Information Management and Technology, PMB 24, Geelong, Victoria 3220

Abstract
CSIRO is developing a mobile application – or *app* - called "*SoilMapp*" to deliver location-specific soil information. SoilMapp couples the fast-evolving and widespread public adoption of mobile data delivery technologies (i.e. wireless broadband with mobile tablets) with national soil and soil water characterisations for crop simulation modelling, and is tailored for soil and agricultural scientists and consultants. The app is intuitive to use and provides the user with soil data and information for specific locations by spatially intersecting the databases at the user's or pre-defined locations. The resulting data will be converted to records for site specific applications (e.g. crop simulations). SoilMapp is expected to be available to the public once completed by mid 2012.

Key Words
Mobile soil data delivery, ASRIS, APSoil, crop simulation modelling

Introduction

The rapid growth in "apps" via smart phones and other mobile devices is revolutionising wireless delivery of services via the internet. Although evolving at a pace, the convergence of technologies (i.e. hardware with geographic positioning, operating software and communications) is now robust and reliable. This is exemplified by the fact that, at time of writing (April 2012), there are >1,100,000 apps available for Apple™ and Android™ platforms (source: www.wikipedia.com). Users have come to expect apps to be freely available (or at low cost), highly intuitive to use following a certain user-feel genre, and with a narrow scope of purpose.

At the heart of the CSIRO's Grains Research and Development Corporation (GRDC) project: *Doing it better, doing it smarter-managing soil water in Australian agriculture* is the development of tools and know-how targeting the Australian rain fed farming industry. The overall objective of the project is to increase effective use of soil water to deliver greater grain yields. One part of the project involves growth, maintenance and public access of the APSoil database (Dalgliesh *et al.*, 2012). This database supplies soil water characteristics as input for the farming systems simulator, the Agricultural Production Systems Simulator (APSIM, Keating *et al.*, 2003). Another component of the project targets the principal stakeholder group of agricultural consultants, which sees the development of soil knowledge being of paramount importance to the continuing development of their community of practice. CSIRO is also responsible for delivery of the Australian Collaborative Land Evaluation Program (ACLEP). ACLEP's primary role is to underpin cooperation and collaboration between federal and state soil agencies to promote sustainable land use by stakeholders, typically from soil science, agriculture, land use policy and government more broadly. Part of this role is to make available consistent soil mapping and soil data to interested parties, which is the function of the Australian Soil Resource Information System (ASRIS, http://www.asris.csiro.au/index_ie.html). ASRIS is a web-enabled facility that offers interactive access to a rich content of standardised national soil mapping and information (e.g. reference soil profiles).

The GDRC and ACLEP projects share common objectives, including: (i) the supply of location-specific soil data and information, and (ii) education of stakeholders. Given the common project objectives, an idea developed of using app technology to facilitate easy data and information sharing, and increasing stakeholder knowledge in the soils that they manage. With support from CSIRO information technology (IT) scientists, a six month project was initiated for completion on 30 June 2012, to develop the initial version of "*SoilMapp*".

This paper outlines the development and functionality of SoilMapp to deliver location-specific soil information. (Unless specified, here *soil information* includes soil content in a number of formats, including maps, records, tables and descriptions). With the objectives of GRDC and ACLEP projects at the forefront, the target user community includes Australian agricultural consultants and soil scientists – although it is envisaged that this will be increased over time to include policy planning, education and general users. Development progress to date (i.e. April 2012) is presented, as is the planned functionality of the final product in July 2012.

Methods

Defining SoilMapp functionality and basic design

SoilMapp will deliver the best available soil information for a specific location from ASRIS, APSoil and other available databases (such as the CSIRO National Soil Archive). To satisfy these needs, the basic design requirements for SoilMapp include the ability to:

- identify a location, whether *in situ* (e.g. in a paddock using iPad geographic position system) or at a pre-defined bookmarked location;
- display soil type candidates for that location though a suite of "*discovery screens*";
- view and export details for generic soil type information, landscape setting and local soil name, ASRIS reference profiles for the soil type, and a summary of typical physical and chemical properties for the soil type;
- view APSoil soil water and constraining property data typical of the soil type; and finally,
- allow modification of the soil water and constraining property data for the soil at the user-location (or elsewhere) for bespoke input to crop simulation modelling (e.g. APSIM).

The flow of key database/user interactive services includes interfacing with the ASRIS and APSoil databases to supply the user with location-specific information in the specifications in user-defined specifications (e.g. in the right mapping extent and mapping content). Furthermore, the user will be able to manipulate data tables from APSoil to create bespoke soil data tables fitting the soil water characteristics of their soils, and save and send these modified tables for crop simulation modelling (e.g. APSIM).

Platform choice and system architecture

SoilMapp has been developed using the Apple™ operating systems (iOS) for the iPad mobile platform. This decision is based on the rationale that the iOS/Apple™ combination commands a very significant proportion of the app market, and that the iPad option offers a screen size and resolution suitable for interaction with practical mapping extents, and visualisation of quality documents. The preferred design was for a so-called "thin app layer" for remote processing before transmission of results back to the device. Much of the development effort has involved configuring web services, which are the core of the app's functionality. Web services allow SoilMapp to send user-requests and preferences to the soil information systems (i.e. ASRIS and APSoil databases), and retrieve, then display the results as location-specific mapping. Some of the web services are achieved using standard applications (e.g. ESRI's ArcSDE™ web server to draw on ASRIS data content), whereas others have been specifically customised (e.g. drawing XML items from the APSoil database).

Focus area and reference group

A South Australian (SA) region comprising the Midnorth and Yorke Peninsula (M&YP) agricultural areas was selected as a focus area during the pilot development of SoilMapp. The area was selected for a number of reasons: (i) the legacy of a successful SA soil survey and mapping program, (ii) the area features a concentration of APSoil sites, and (iii) strong support by an active hub of local agricultural consultants. However, SoilMapp now functions everywhere in Australia, serving up soil data according to local availability and quality. A reference panel (RP) was created comprising members of the development team, M&YP agricultural consultants, SA government, Australian Soil Science Society Inc., and the National Committee on Soil and Terrain. The RP is tasked to ensure that the SoilMapp maintains a strong user focus in terms of the functionality that it offers. For this reason, the contributions of the non-development team members are particularly valuable. The RP was inaugurated in person in late March 2012 and convenes periodically.

Results and discussion

App design and user interface

Much of the planned functionality of SoilMapp has been implemented at time of writing. This means that

most of the web services are now in place and operate reliably, and allow full interaction between the user, and the ASRIS and APSoil databases. The look-and-feel of the app complies with the "app genre" (i.e. parsimonious in display content and a high standard of graphics).

Currently deployed functionality

The key functionality at present includes:

- A front screen comprising a base map of Australia with user controlled overlay of (<*soil layer*>) an Australian Soil Classification soil map, ASRIS reference profiles (red dots) and APSoil reference profiles (green dots) (Figure 1). Activation of <*GPS location*> will zoom into the user's location.
- Zooming to a selected area, and a touch on desired location reveals a location box containing geographic coordinates, address, and (i) *ASRIS soil discovery*, (ii) *reference profile*, and (iii) *APSOIL profile* menus (Figure 2).
- On activation of *ASRIS Soil Discovery*, users are presented with a list of candidate soils identified according to Australian Soil Classification (Isbell and CSIRO, 2002) (Figure 3). Candidate soils are listed in decreasing probability (green, yellow or red) within the intersected ASRIS soil mapping unit. Selecting a candidate and <*Soil type*> tab invokes a type-profiles summary for the candidate soil. Other tabs show the local soil name based on a morphology (e.g. "sandy loam over heavy clay") (<*Local soil names*>), the landform context of the selected location (<*Landscape*>), full soil survey description, and physical and chemical characteristics of the reference profile for the soil candidate (<*Reference profile*>), and a table presenting key physical and chemical characteristic of the candidate soil on a layer-by-layer basis (<*Summary data*>). A panel shows the regional context of the candidate soil location.
- On activation of the *APSoil Discovery* users are presented with the candidate soil types and the regional context for the location (Figure 4). The candidates offered are profiles from the APSoil database within a 30 km radius of the selected site. On selecting a candidate soil and the *Water* tab, users are presented with a table of key soil water characteristics on a layer-by-layer basis and water retention curves for the soil and selected crops. The selection wheel allows specification of crop-specific soil water retention characteristics for that soil, and the corresponding data is updated to the data table (highlighted in yellow). The soil shown in Figure 4 has soil water characteristics for wheat, barley and oats.

Figure 1. First map screen showing soil layer, and the ASRIS and APSoil reference profiles.

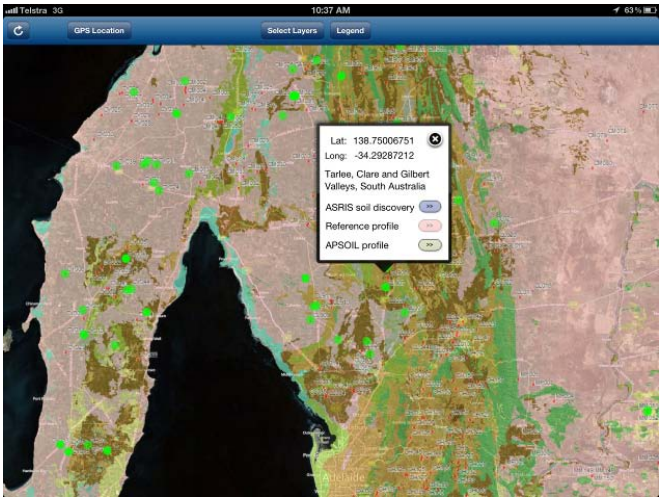

Figure 2. A zoom into the Midnorth and Yorke Peninsula regions of South Australia.

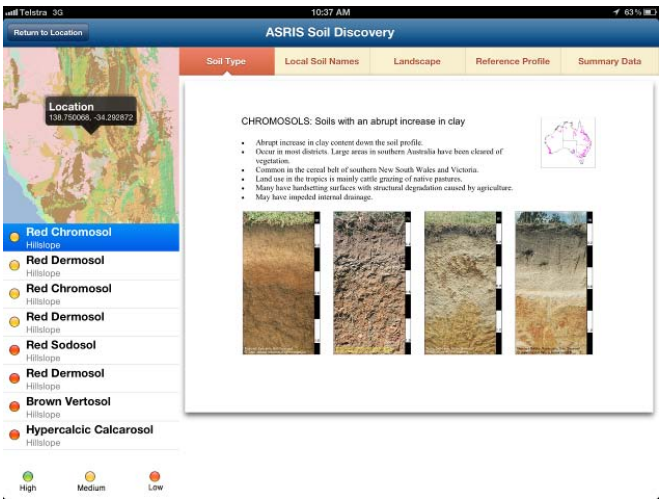

Figure 3. ASRIS Soil Discovery screen.

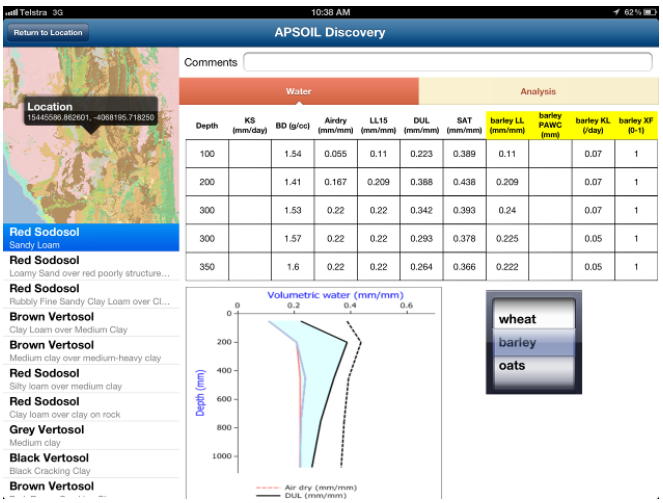

Figure 4. APSoil discovery screen.

Pending functionality and future development

In terms of the key operational functionality, the ability to work offline by allowing caching of information at pre-defined locations will be made, as will the ability to email data records that SoilMapp generates, e.g. for integrating soil-specific APSoil modifications for APSIM crop simulations. Though clearly complementary, it can be envisaged that SoilMapp may split into two discrete apps: one that would provide a singular focus on delivering the mobile needs of soil and land managers through concentrating on delivering soil mapping and general soil data (i.e. an ASRIS-type focus), whereas the other would have sole focus on rain fed agricultural needs and supporting more effective crop simulation (i.e. an APSoil/APSIM focus).

Conclusions

CSIRO soil, agricultural and IT scientists are collaborating to deliver a mobile app called "SoilMapp" for iPad tablets. This app exploits recent, substantial advances in mobile information delivery. SoilMapp provides a user-friendly method for agricultural and other users to interrogate available soil mapping (ASRIS) and soil water characterisation data (APSoil) to support land use decisions and crop simulation modelling (e.g. APSIM). Examples of the as-yet completed development have been presented. Suggestions are offered regarding the strategic pathway for SoilMapp future, which could involve splitting the app into two: one with a focus on delivering national soil mapping information, and the other, a focus on delivering soil water data for crop simulations and associated farming education.

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