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CHAPTER 9

A NEW WEB-BASED APPROACH FOR THE ACQUISITION, COLLATION AND COMMUNICATION OF COMPLEX INLAND ACID SULFATE SOILS DATA

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INTRODUCTION

Soil-landscape systems are inherently complex and the product of a unique integrative history of ancient and modern hydro-pedological processes, making it difficult for scientists and resource managers to quantify the sustainability of environmental systems (i.e. to make balanced and integrated judgements on natural resource and environmental conditions in specific regions). To assess soil-landscapes involves selecting key attributes and methods to describe, quantify and integrate pedological, hydrological, geological, biogeochemical, isotope and mineralogical information in order to seek answers to important environmental questions across a variety of temporal and spatial scales (i.e. from the molecular scale up to the macroscopic environmental systems scale in paddocks, catchments or regions). To incorporate these factors, Fitzpatrick et al. (2003) developed a systematic approach, which incorporated a sequence of steps to construct easy-to-follow pictorial manuals for identifying critical soil indicators, land use options and best management practices. These manuals contain sketches of typical landscape cross-sections (i.e. idealised descriptive, explanatory or predictive mechanistic toposequence models) with colour photographs of soils to enable farmers to readily compare these features with their own soil-landscape. This approach has been successfully applied and adopted in three regions (Mt Lofty Ranges in SA, Glenelg catchment management authority in Victoria and Iraq marshlands). However, apart from these areas the approach has not been adapted to other regions around the world, probably because: (i) there is no interactive, systematic framework to help integrate the large quantities of variable data often used to construct soil-regolith models and (ii) it is expensive to print colour documents and manuals, which may need to be altered as subsequent research causes the conceptual models to evolve.

Scientific researchers are often faced with the task of summarizing, condensing and effectively communicating large amounts of complex data (Benda, Poff et al 2002). Poor planning and a lack effective communication can produce vast quantities of complex and confusing information that is difficult to digest. Universities and research organisations produce countless remarkable discoveries, insights and advances. However, their ability to share this knowledge with the community, government and industry rarely matches their research capability (Cribb and Hartomo 2002). Consequently, in earth science, a structured approach is needed to ensure suitable soil-regolith indicators are selected and used efficiently.

The new approach described in this paper was originally inspired by: (i) the difficult task of collating large amounts of geological, soil, hydrological, geochemical and mineralogical data to construct mechanistic toposequence models and (ii) effectively communicating this information as part of a PhD thesis. To achieve these goals, a high level of data organisation was achieved through a web-based data site, which allowed large quantities of information to be rapidly reviewed and discussed in a logical manner. Subsequently, it was deemed advantageous to adopt and expand on this approach to develop a framework to cope with vast quantities of data generated by: (i) a large multidisciplinary, acid drainage project in the wheat belt of Western Australia (Baker and Fitzpatrick 2005; Fitzpatrick, Baker et al. 2005; Rogers and George 2005) and (ii) an environmental consultancy, which examined inland acid sulfate soils in the River Land of South Australia (Fitzpatrick, Hicks et al. 2006).

Hence, the objective of this paper is to describe a systematic web-based approach for improved acquisition, collation and communication of diverse soil-regolith data. A significant problem with large multi-disciplinary and multi-organisational research and consulting efforts is uniformity in data acquisition, collation and communication (ACC). This can be overcome, independent of project size, by implementing a series of minimum, basic requirements that must be adhered to during ACC. This systematic approach incorporates any or all of the highly effective techniques for soil-regolith field description protocols, such as the USDA Field book for describing and sampling soils, (terminology from: Schoeneberger et al. 2002) Australian Soil and Land Survey Field Handbook, (McDonald et al. 1990) as well as the commonly used project management tools (e.g. Gantt Charts etc.) to create a flexible and dynamic template for ACC. The steps outlined in this paper will assist in:

- Planning environmental and mineral exploration soil-regolith projects of any size
- Maintaining uniformity of field protocols and hence quality of data acquisition
- Rapid and effective communication within a multidisciplinary project team
- Dynamic progress reporting to clients and other interested parties
- Production of final report
- Providing a cost effective alternative to colour filled pamphlets and booklets
- Reporting findings to the general public via the internet

METHODOLOGY

The methodology described here outlines ways of structuring large data sets to provide a tool for rigorously planning data acquisition, coupled with rapid and effective communication. Web display and delivery was chosen due to its almost universal availability. While Microsoft FrontPage 2003 was used to construct the web-based data site, any web authoring software is appropriate. The builder (author) of the data web site requires a basic to advanced knowledge of the web authoring program (depending on the desired sophistication of the data site) and a good scientific grasp of the content, relevance and impact of the data being displayed. The sequential steps outlined in Box 1 and Figure 1 summarise the procedures necessary for developing a generic soil-regolith, web-based data site.

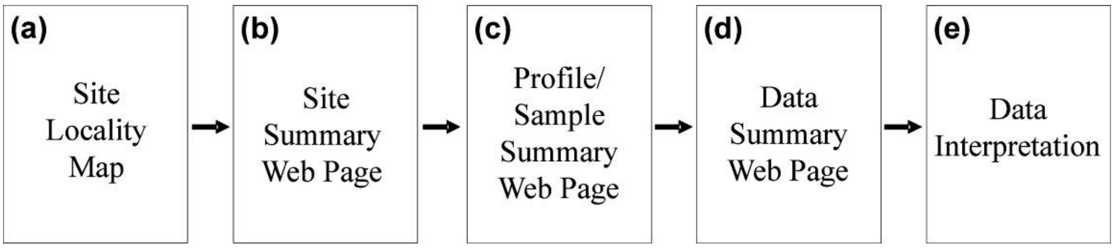

Figure 1. Flow diagram outlining the main components of a web-based data site.

BOX 1. Steps for constructing a web-based data site

Stage 1. ***Prior to field work***

a. Define the project objectives.
b. Identify the spatial coverage of the area to be studied.
c. Break the area down into sites where observations and samples will be taken (new sites can be added at any time during field work).
d. Identify methodologies and laboratory techniques required, available and budgeted for to achieve project objectives.
e. Ensure field equipment required for sample collection is appropriately matched to chosen methodologies and laboratory techniques.

Stage 2. ***In the field (at each site)***

a. Reconfirm site location with GPS.
b. Photograph site from a number of perspectives including any defining features (e.g. large trees) in fields of view.
c. Sample and describe soil, rocks, vegetation according to established conventions (e.g. McDonald et al 1990; Schoeneberger et al 2002) and appropriate to the techniques that will be applied in the laboratory.
d. Collect representative sub-samples to be stored in chip trays.
e. Photograph each sample, with scale, from a minimum of two perspectives and zoom settings.
f. Draw a brief schematic diagram highlighting important landscape features, photograph locations and sample locations.

Stage 3. ***Data collation and communication***

a. Construct a site locality map using appropriate software (e.g. Arc GIS) to begin to highlight any spatial relationships between sites (Figure 1a).
b. Import map into web authoring program.
c. Use site photos, schematic diagram and field notes to construct a summary web page of each site, providing some general information and links to more detailed data (Figure 1b).
d. Use HyperText Markup Language (HTML) to link each site locality on the map (Figure 1a) to the corresponding site summary web page (Figure 1b).
e. Use sample photos and field notes to construct a summary page for each sample, group of samples or profile as appropriate (Figure 1c) and use HTML to link back to site summary web pages (Figure 1b).
f. Create data summary pages for each sample, group of samples or profile that contains or has links to all detailed field observations and laboratory results (Figure 1d).
g. As more data is returned from the laboratory it can easily be added to the data site via the data summary pages (Figure 1d).
h. Once all the data has been uploaded to the web site HTML links can be incorporated to highlight relationships between samples from different locations that share physical and chemical characteristics.
i. Further data interpretation facilitates the addition of graphs, statistical analysis, diagrams and conceptual models to the web site. This provides a convenient storage location that keeps the interpretation within the bounds of the project.
j. Each product of interpretation (e.g. graphs, conceptual models etc.) is HTML linked to the sample, sample site and data that produced it (Figure 1e).

DISCUSSION

The steps listed in stages 1.a-e (Box 1) seem obvious but are vitally important for the efficient and cost effective implementation of a field based soil-regolith project. Careful planning can shorten time spent in the field and decrease the likelihood of unnecessary follow up data collection. Identifying all possible methodologies and laboratory techniques that may be used during the project will mean that any specialised equipment required for data collection will be on hand.

Stage 2.a-2.f (box 1) outlines the steps that should be taken to maintain the value of data collected in the field. Irrespective of the money spent on laboratory techniques and sample analysis, data becomes useless if it is not known where the sample comes from or its context in the regolith environment. A "mud map" or schematic diagram recording sample and photo locations aids in accurately documenting data collection. Chip trays provide a simple yet vital method of communicating regolith characteristics to: (i) members of a project team, (ii) the client and (iii) the scientists conducting subsequent laboratory investigations. Chip trays are photographed and digitally incorporated into the web-based data site to facilitate rapid communication. Digital photos are an effective method of documenting site and sample characteristics. They are an aid to memory and provide relative locations at sample sites. Photographs are an excellent method of communication and hence a vital component of a web-based data site.

The points raised in stage 2 (Box 1) do not replace good quality, thorough field observations. These steps simply ensure that field work maintains its value whilst providing the means to construct a tool for highly effective and rapid communication.

Stage 3.a-j (box 1) concerns the collation and subsequent communication of soil-regolith data collected in the field. The aim of the web-based data site is to provide HTML links in every location where a user requires further information. This can only be achieved if the person constructing the data site has a firm grasp of the science being displayed and the requirements of the end user. The first stage is to group data according to where it was collected. This is most easily achieved by constructing a map of the study area delineating site locations (Figure 2 - (i)). The locality map, when linked to the site summary pages allows rapid and simple navigation between sites and provides links to more detailed information. The location of each sample or group of samples taken at each site is displayed on photos in the site summary pages (Figure 2 - (ii)). This provides an accurate record of each sample's locality relative to that of others and their spatial distribution in the regolith environment. For this reason it is vital to obtain good quality site photographs in the field. Each sample, group of samples or profile can then be investigated in more detail via a HTML link to a sample summary page (Figure 2 - (v)). These pages give more detailed information on each sample and their relative location within a profile or group of samples. Good quality photographs, with a scale, of each sample can be invaluable in later data interpretation. Data summary pages (Figure 2 - (vi)) contain or have direct HTML links to all the observations and data recorded in the field (e.g. pH, Eh etc.), subsequent laboratory observations and results from laboratory techniques (XRD, XRF, ICP-MS etc.). Once the basic structure of the data site (described above) has been constructed any additional data can be added quickly and easily. Data, such as SEM photos, can be made available as soon as they have been acquired (Figure 2 - (vii)). Photographs of soil materials in the chip trays can be added to the data site to save the need to retrieve samples from storage (Figure 2 - (viii)). Often multi-organisational and multi-disciplinary research efforts involve team members spread over vast distances making it impractical for all to have access to samples. Spreadsheets containing geochemical data (e.g. XRD (Figure 2 - (ix)) and XRF (Figure 2 - (x)) can be made available for download, via the data site, without risking the original data. There is no practical limit to the amount and type of data that can be stored and displayed in this fashion (Figure 2 - (iii)).

Interpretation can commence contemporaneous with or following data upload to the web-based data site. Data can be grouped via HTML links according to shared physical and chemical characteristics. Interpretive models (Figure 2 - (iv)), graphs, statistical analysis and other forms of interpretation can be included in the site. The advantage of this is that interpretation does not exist independent of the data that created it, which is instantly accessible via HTML link.

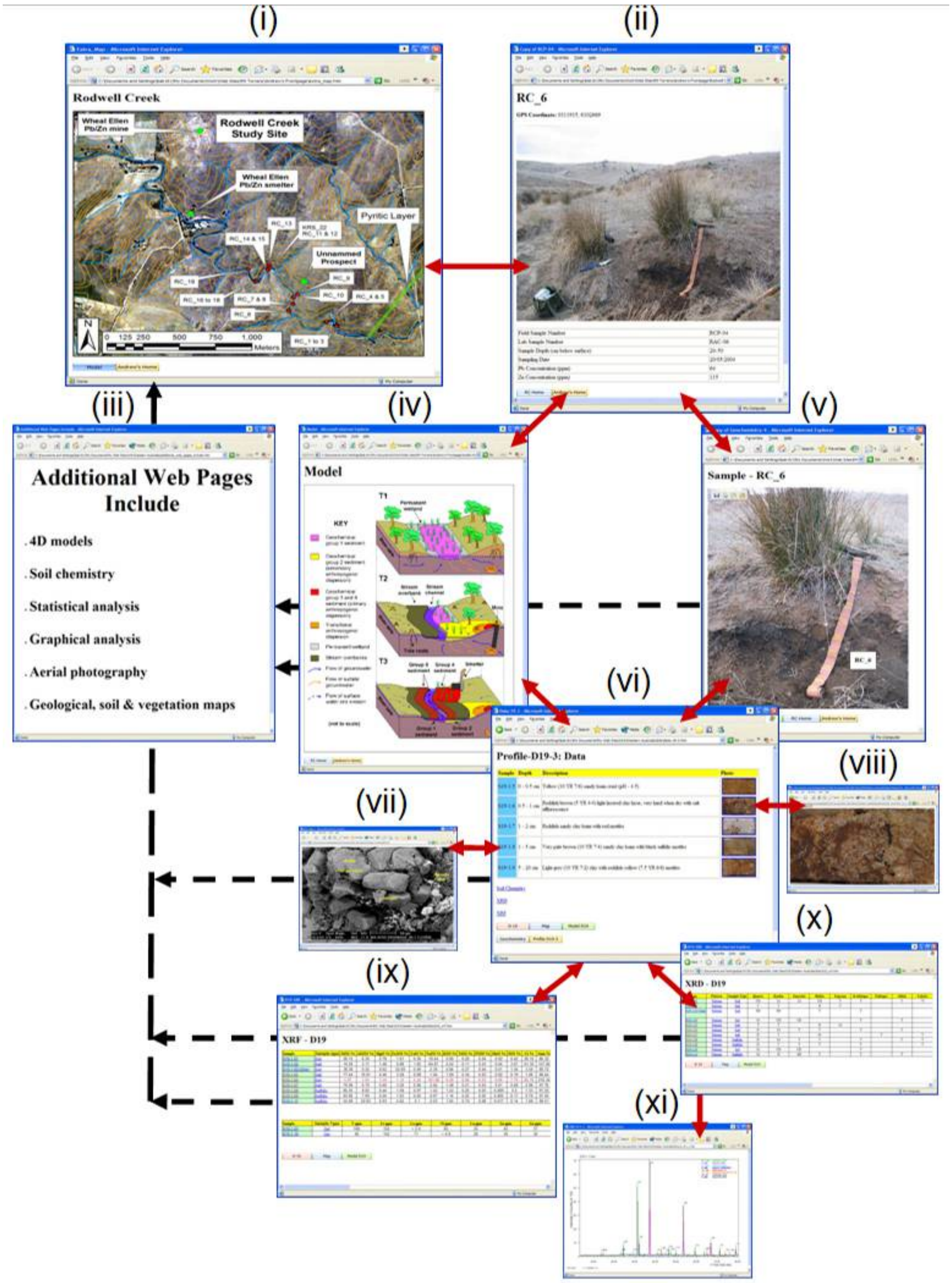

Figure 2. Flow diagram constructed of web views from one project's web-based data site. Views represent; (i) Site locality map, (ii) site summary web page, (iii) additional web pages that were included in the data site, (iv) 4-dimensional, interpretive model, (v) profile/sample summary page, (vi) data summary page, (vii) SEM photograph, (viii) chip tray photograph, (ix) XRF data, (x) XRD data, (xi) XRD spectra.

The web-based data site provides a dynamic framework to manage large, complex projects (Figure 3). A project team often includes numerous scientists from many different fields (Figure 3a). A huge range of complex information is often gathered during the life of a multidisciplinary project (e.g. geochemical data, soil data, water chemistry and spatial information). This data is passed on to the data web site manager (Figure 3b) who collates it (described above) to produce a web-based data site (Figure 3c). The data site can then be used by the different members of the project team to communicate internally. Information is easier to interpret (Figure 3e) because it can be viewed within the context of the whole project rather than in discipline defined subsections. Throughout the project the client has access to the collated data and the subsequent interpretation via the web-based data site (Figure 3d). This improves communication between the client and project team thus increasing the likelihood of a satisfactory outcome for all parties.

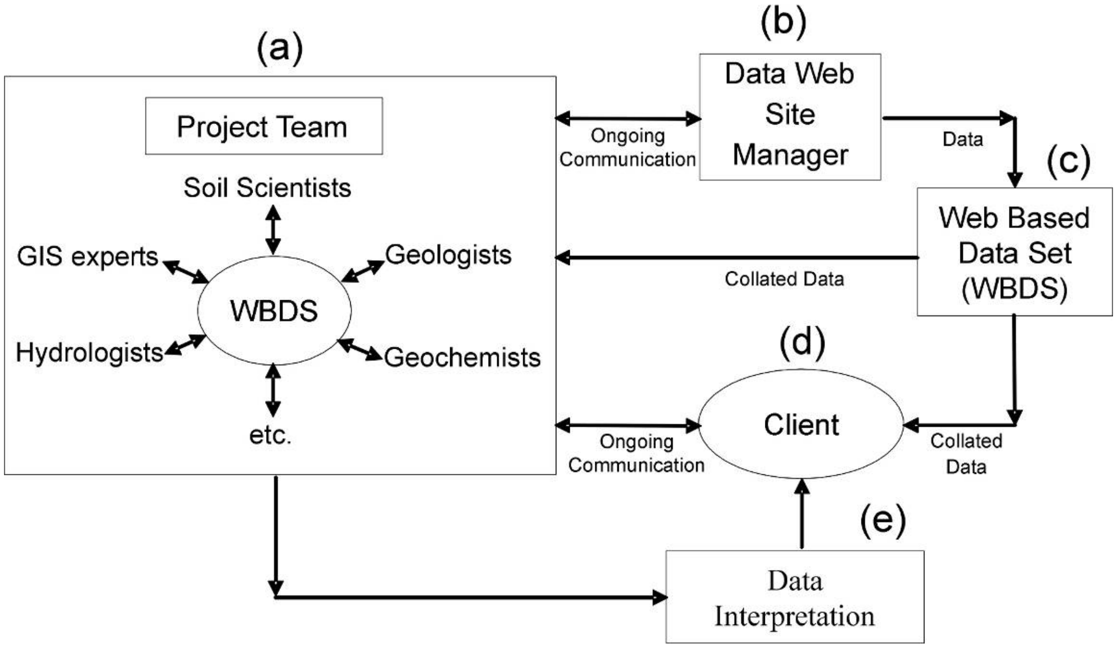

Figure 3. How a web-based data site should be used as part of a dynamic framework to manage large, complex projects.

An extension of the web-based data site is to use a SharePoint web site. This allows any member of a project team to add and alter information on the site. Any additions or updates to a SharePoint web site occur immediately. The site is always live and reflects changes as they are made. This can however create confusion as team members use the SharePoint site as a dumping ground for data. The site can rapidly lose cohesion unless all team members have excellent communication skills and a firm grasp of the authoring program and the data being entered. Hence it is recommended that SharePoint sites be avoided for the authoring of this type of data site.

An available alternative in most web authoring software is for team members to create data site sections that can be screened and uploaded by the data site author. In this circumstance a SharePoint web site is very useful for exchanging data between team members and conveying data and/or data site sections to the data site author.

This approach has been adopted to develop a framework to cope with vast quantities of data generated by: (i) a large multidisciplinary, acid drainage project in the wheat belt of Western Australia (Baker and Fitzpatrick 2005; Fitzpatrick et al. 2005; Rogers and George 2005) and (ii) an environmental consultancy, which examined inland acid sulfate soils in the River Land of South Australia (Fitzpatrick, Hicks et al. 2006).

Future projects that will utilise aspects this approach include:

- A major consulting project in Brunei
- National coastal acid sulfate soil atlas.
- National inland acid sulfate atlas.
- Acid drainage project in the wheat belt of Western Australia.

CONCLUSIONS

An interactive, web-based data site was devised to store and interrogate the large quantities of complex and varied data collected as part large multi-disciplinary and multi-organisational research and consulting efforts – involving inland ASS projects. Web display and delivery was chosen due to its almost universal availability. This approach can be used to plan environmental and mineral exploration soil-regolith projects of any size. It allows rapid and effective communication between members of multidisciplinary project teams and clients.

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