Geographical Research

Using an 'Interpretative Model' for Contextual Design of Heritage Landscape Databases: The Case of St Helena Island National Park in Queensland, Australia

CHEN YANG
Landscape Architecture, Queensland University of Technology, 2 George Street, Brisbane, Qld 4001, Australia. Email: tjyangchen@126.com

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Abstract
Due to the increasing speed of landscape changes and the massive development of computer technologies, the methods of representing heritage landscapes using digital tools have become a worldwide concern in conservation research. The aim of this paper is to demonstrate how an 'interpretative model' can be used for contextual design of heritage landscape information systems. This approach is explored through building a geographic information system database for St Helena Island national park in Moreton Bay, South East Queensland, Australia. Stakeholders' interpretations of this landscape were collected through interviews, and then used as a framework for designing the database. The designed database is a digital inventory providing contextual descriptions of the historic infrastructure remnants on St Helena Island. It also reveals the priorities of different sites in terms of historic research, landscape restoration, and tourism development. Additionally, this database produces thematic maps of the intangible heritage values, which could be used for landscape interpretation. This approach is different from the existing methods because building a heritage information system is deemed as an interpretative activity, rather than a value-free replication of the physical environment. This approach also shows how a cultural landscape methodology can be used to create a flexible information system for heritage conservation. The conclusion is that an 'interpretative model' of database design facilitates a more explicit focus on information support, and is a potentially effective approach to user-centred design of geographic information systems.

KEY WORDS *heritage landscape; interpretative model; cultural landscape; GIS; St Helena Island*

Introduction

The term heritage landscape refers to landscapes that are recognised as places of historical and cultural significance. A heritage landscape could be an ancient city, a designed garden, or a historic village. For example, Port Arthur Historic Site, one of the most famous heritage landscapes in Australia, features the surviving examples of large-scale convict transportation and the colonial expansion of European powers throughout the 19th century (United Nations Educational, Scientific and Cultural Organization (UNESCO),

2010). Heritage landscapes are the result of the gradual accumulation of cultural values and attributes within natural systems, in both their tangible and intangible dimensions. The tangible environments provide a physical setting for our daily lives. The intangible aspects – such as traditions, values, and ongoing interactions between people and place – represent cultural identity.

The socio-economic transformations, environmental changes, and urban development pressures in the world today mean that landscapes are changing with increasing speed, and new landscapes are gradually or abruptly replacing traditional ones (Eetvelde and Antrop, 2004). Important historical information is being lost through destructive changes, and as a result, the cultural continuity of the past is challenged. Therefore, the conservation of heritage landscapes has become a worldwide concern over the past two decades. The number of World Heritage cultural landscapes increased from 30 to 85 between 2002 and 2013. In 2012, the *UNESCO Recommendation of the Historic Urban Landscape* was released as a result of six years of intensive global discussion (O'Donnell and Turner, 2012).

Documentation of heritage landscapes is essential in conservation, because firstly, heritage documents are significant references in conservation research and practice. Secondly, documents are used to record the alterations within heritage landscapes, which is important information for maintaining the authenticity of heritage places and their management. Thirdly, documents, as a kind of landscape representation, can greatly impact people's understanding of places (Hamylton, 2013). Past events make low or less impact on the present unless they are memorised in history books, monuments, and jovial festivities that are recognised as part of an ongoing tradition (Tuan, 1977, 174). Therefore, innovative and research-focused documentation of heritage landscapes has become an important issue in the global heritage discipline.

Significant progress has been made in developing and implementing digital tools that acquire, store, analyse, and share geographic information describing the physical characteristics of specified locations on the Earth's surface (Goodchild, 2009). Since UNESCO first used a computer-assisted information management system in 1992 to help the Cambodian government to protect Angkor Wat, the rapid rise in geospatial technologies has revolutionised the documentation of cultural heritage. Geospatial technologies have slowly superseded traditional cartography, supported by recent developments in Geographic Information System (GIS), Global Positioning System, and remote sensing (Hamylton, 2013). For example, applications for World Heritage nominations today must be in electronic format to create a uniform heritage archive for periodic monitoring (UNESCO, 2009). It is therefore necessary to develop innovative applications of digital tools to assist the documentation of heritage landscapes.

In Australia, while many heritage information systems have been built at the national or state level, the conservation of individual heritage landscapes is still based on hard copy paper documentation and local managers' memories. Many national or regional heritage information systems cannot be used for the conservation of individual heritage landscapes due to their spatial and temporal generality that is problematic (Veland *et al*., 2014). From the perspective of individual landscapes, different types of information for a site are held by a number of organisations. This fragmentation of information is a major obstacle for efficient conservation. Small, locally based conservation organisations typically lack the data, expertise, and technological resources to benefit from the advanced developments of digital technologies (Freeman *et al*., 2010).

Only a small number of projects have developed information management systems for locally based landscape conservation in Australia, such as the Uluru-Kata Tjuta Cultural Site Management System (CSMS) (Australian Government, Department of Environment, 2012), the Indigenous GIS Database for the Barmah-Millewa area in south-eastern Australia (Griggs *et al*., 2013), and the geographic bibliographic database for the Goulburn Broken Catchment in Victoria (Wallis *et al*., 2011). However, the research and practice of GIS are still largely concerned with the environmental values of landscape (Veland *et al*., 2014). It is necessary to explore the approach for mapping and databasing heritage landscapes containing both natural and cultural values.

This paper aims to present an alternative perspective on the user-centred design of GIS that takes into account the conservation context of heritage landscapes. It uses an 'interpretative model' to design GIS databases for conservation practice. The intention of this paper is to explore a new approach, rather than to focus entirely on the design of GIS database.

The specific objectives are to:

1. explore the contemporary information requirements in the conservation practice of heritage landscapes in Australia;
2. design a sample GIS database for a heritage landscape, which could be used to assist local conservation practice; and
3. identify the potential applications of this database.

In the following sections of this paper, I firstly establish a theoretical framework for building heritage landscape databases. Then the Methods section presents the process of data collection and analysis in detail. Thirdly, the Results section demonstrates the GIS database designed for an Australian heritage landscape, which is followed by a discussion of new concepts of database design. Finally, the last section is a short conclusion that summarises the main contributions of this paper.

An interpretative model for the design of heritage landscape databases

This research applies a cultural landscape methodology to heritage conservation and an 'interpretative model' of landscape representation in the design of a GIS database. The cultural landscape methodology has provided a revolutionary guide for heritage research and conservation since the 1990s (Yang and Sim, 2013). This methodology was adopted because it covers aspects that are not covered by the 'conventional' concepts of cultural heritage. Before the 1990s, the UNESCO World Heritage Convention (WHC), as a leading authority of heritage conservation, was criticised for legitimising a particular Western perception of heritage in terms of both policy and practice (Byrne, 1991; Pocock, 1997; Cleere, 2001; Sullivan, 2004). The WHC was dominated by monumentally grand and aesthetic sites (Arizpe, 2000; Cleere, 2001; Yoshida, 2004), which led to a museum-like approach that excluded dynamic processes and contexts (Lennon, 2012). There was no mechanism for recognising places that had evolved from the interaction of cultural values and natural processes. Accordingly, the term 'cultural landscape' offered a revolutionary methodology of heritage conservation through its innovative perspective of heritage place:

> Cultural landscapes represent the combined works of nature and man (UNESCO, 2008, 85). They are illustrative of the evolution of human society and settlement over time, under the influence of physical constrains and/or opportunities presented by their natural environment and of successive social, economic and cultural forces, both external and internal (UNESCO, 2008, 85).

Within a cultural landscape methodology, heritage sites are not seen as static relics, but are seen as dynamic entities that are interdependent on people, social structures, and associated ecological systems (Taylor and Lennon, 2011). Accordingly, the aim of conservation is to establish an agreement about the heritage place among key stakeholders (UNESCO, 2009). Furthermore, it is difficult to apply the universal methods or tools for the conservation of different landscapes. *The Nara Document on Authenticity (1994)*, an international document that addresses the understanding of authenticity of cultural heritage, recommends that each heritage site should develop its own conservation approaches appropriate for its specific culture (Logan, 2001, quoted in Lennon, 2007).

However, while the cultural landscape methodology has been accepted in the conservation domain, the documentation of heritage landscapes is still based on the 'conventional' concepts of cultural heritage. In Australia, the Queensland Heritage Register database is still focused on the built form, and its history; neither landscape nor wider national historical contexts are included. By way of contrast, ParkInfo, a GIS for national park management in Queensland, is mainly about fire, pests, and vegetation (Kington, 2006). Conservation of heritage landscapes containing both natural and cultural values is therefore problematic in these divided administrative systems. However, the rapid development of digital tools means that it is possible to integrate different values into a comprehensive information system. Unfortunately, this issue has not yet been systematically investigated in Australia.

This paper introduces an 'interpretative model' in the design of information systems. As a type of landscape representation, designing and building information systems are seen as interpretative activities. In the work labelled 'critical cartography' (Crampton and Krygier, 2005), landscape representation is considered a form of cultural and social construction (Harvey, 1989; Wood, 1992; Pickles, 2004). Therefore, rather than setting up a model of a universal, value-neutral researcher, cartographers acknowledge and value the role of active interpreters. This

approach recognises that interpretation is a dialogue between the researcher's data – other place and other people – and the researcher (Duncan and Ley, 1993). Accordingly, this paper tries to build an information system derived from people's interpretations of the place. Rather than just conducting a field survey of the physical environment, information system design should begin with exploring local stakeholders' cognitive maps of the place in question. This 'interpretative model' is consistent with the cultural landscape methodology that believes landscapes are culturally and socially constructed entities. Thus, only the landscape elements 'interpreted' by stakeholders as heritage can be integrated into the system.

In terms of technology, this research uses GIS, one of the most powerful tools in cultural resource management, to build an information system for a heritage landscape. GIS is designed to capture, store, manipulate, analyse, manage, and present all types of geographically referenced data (Foote and Lynch, 1995). Computer-based GIS integrates data from diverse disciplines and various formats to generate useful information about an area of the earth on an appropriated scale (Easa and Chan, 2000). Over the past two decades, GIS has been broadly applied to support heritage research related to archaeology, anthropology, history, and other interdisciplinary studies, to deal with spatial issues. Indeed, the improvement to cultural resource management might not have been achieved by any other technologies (Wheatley and Gillings, 2002; Chapman, 2006).

The basis of a GIS is the geographic database (geodatabase). Geodatabases contain geographic data for a particular area and subject. Similarly, virtually all-large GIS implementations manage data within a database management system (DBMS), a specialist piece of software designed to handle multiuser access to an integrated set of data (Longley *et al*., 2011). This research used an object database management system (ODBMS) that can store geographic objects and provide object-oriented query tools (Longley *et al*., 2011).

Methods

Study area – St Helena Island National Park

St Helena Island National Park is located in Moreton Bay five kilometres east of the mouth of the Brisbane River (Figure 1). It covers 0.751 km^2 of land.

St Helena Island was used in this study for three reasons. Firstly, St Helena Island is a heritage landscape containing both natural and cultural values. Geologically, St Helena Island provides important evidence of the evolution of the east coast of South East Queensland (SEQ). The environmental significance of this island is recognised through its role as part of Queensland's internationally significant Moreton Bay Ramsar site and part of the Moreton Bay Aggregation wetlands. In terms of human settlement, two middens on St Helena Island today are the evidence of the Aboriginal occupation for over 2000 years (Alfredson, 1983). St Helena Island is also significant in demonstrating the cultural evolution of Queensland. It was used as a prison for more than 60 years between 1866 and 1932. The remnants of the prison and associated buildings and gardens can still be seen today (Figure 2). Therefore, these natural and cultural values of St Helena Island offered valuable material for building a heritage landscape database. Secondly, St Helena Island is a protected landscape representing the contemporary social and cultural construction of 'heritage landscapes' in Queensland. It is a typical heritage landscape in Queensland demonstrating the conflicted values held by different legislative frameworks (Table 1). In Queensland, national parks are mainly protected for natural and aesthetic values, but the cultural heritage council mainly looks after cultural relics and monuments. St Helena Island was the first national park declared in Queensland for its combined historical and cultural values (Department of National Parks, Recreation, Sport and Racing, 2013). As a result, the conflicts between cultural and natural values have become an obstacle for efficient conservation. These issues need to be considered in the design of heritage landscape database.

Thirdly, local management authorities have already used some information systems in the conservation of St Helena Island, which provided good references for this study. Currently, two information systems are used, but none of them is proven to be very effective. Strategic Asset Maintenance System (SAMS) is a GIS-based system used by Queensland Parks and Wildlife Service (QPWS) for the maintenance of built assets in National Parks. However, only some infrastructure remnants used for current management are recognised as 'assets' and are represented in this system. Other historic remnants are not recorded, even though they are historically important. Thus, it is difficult to apply funding or programmes for those 'erased' elements not

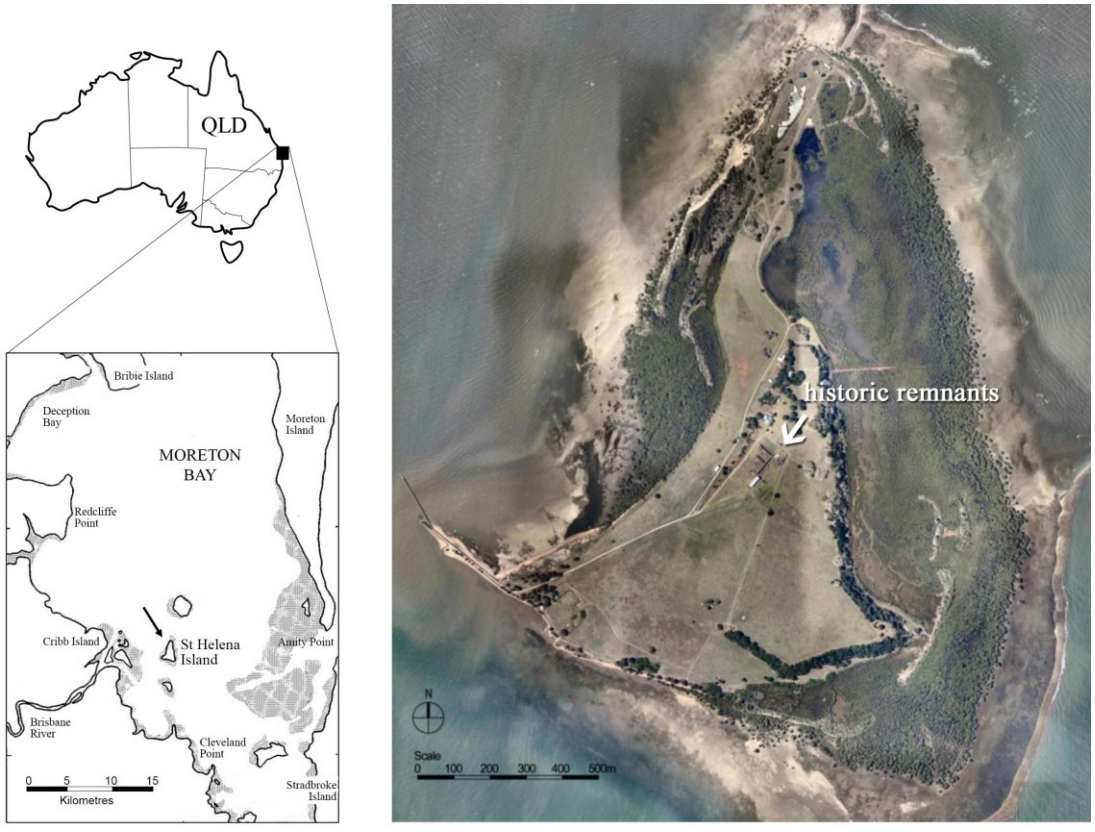

Figure 1 Location of St Helena Island National Park.

included within SAMS. The other information system containing St Helena Island data is the Cultural Heritage Information Management System (CHIMS) held by the Department of Cultural Heritage in Queensland State Government. This system is a collection of site files providing references for research and publication. Thus, CHIMS cannot be used for on-site conservation of St Helena Island. Therefore, St Helena Island needs a contextual database that can be used by QPWS for on-site conservation.

Data collection and analysis

The conceptual framework of the database was established based on local stakeholders' interpretations of St Helena Island. Accordingly, data collection started from semi-structured interviews. Five stakeholders were interviewed between August 2013 and February 2014. These included a park ranger, a heritage expert, a teacher of environmental education, a historian, and an academic landscape researcher. These stakeholders have worked on St Helena Island for more than 15 years. Thus, the interpretations were collected from a community whose understanding have influenced and will continue to influence the conservation of St Helena Island.

Each interviewee was asked to answer two open-ended questions:

> Question 1: In your view, what information should managers be collecting and using to guide the conservation of St Helena Island?
> Question 2: Imagine you will bring a visitor group to St Helena Island tomorrow morning. The group will stay on the island for about two hours. You are now at home and planning for tomorrow's trip. Could you mark out the route and sites on the island you want to show them tomorrow? What are you going to explain to these visitors when they access these sites? And why?

The first question was used to identify the information stakeholders most required in conservation practice. Qualitative research methods – including open and axial coding, categorising,

Figure 2 Historic remnants on St Helena Island.

Table 1 Protection programmes related to St Helena Island (Department of National Parks, Recreation, Sport and Racing, 2013).

	Natural Heritage	Cultural Heritage
Legislative framework	Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth) Marine Parks Act 2004 Nature Conservation Act 1992	Aboriginal Cultural Heritage Act 2003 Queensland Heritage Act 1992
Plans and agreements	Ramsar Convention on Wetlands Boon Convention China-Australia Migratory Bird Agreement Japan-Australia Migratory Bird Agreement Republic of Korea – Australia Migratory Bird Agreement	
Registration and Database	Australian Wetlands Database	Register of National Estate Queensland Heritage Register

connecting, and developing themes (Tesch, 1990) – were used to analyse the interview transcriptions.

The second question was asked to identify the stakeholders' cognitive maps of St Helena Island. Stakeholders' recognitions were then used as the conceptual framework of the database. With this question, each interviewee was asked to provide an interpretation of St Helena Island for a group of tourists. The interviewees were shown a poster-size (29.7 × 42 cm) aerial photograph of St Helena Island, and were asked to mark out the sites or landscape elements at which they wished to stop.

As well as these two open-ended questions, some typical phenomenographical questions, such as 'what do you mean by that?', 'why is this important?' and 'what are you going to say to your guests?' were asked to generate more responses. Each interview took approximately 40 minutes, which provided rich data to explore stakeholders' understandings of St Helena Island.

The second interview question revealed the way stakeholders divided the landscape and the

language they used to describe the landscape. Heritage elements were derived from the nouns of their descriptions. All elements have attributes, which are the adjectives or the descriptive properties of the description. Verbs in the description revealed the relationships between elements. For example, Table 2 demonstrates the method used to analyse a park ranger's interpretation of the Stockade on St Helena Island. The sample transcription contains eight nouns indicating heritage elements within the Stockade and boundaries of them. Verbs, such as 'come down' and 'come through', indicate the spatial relationships of these elements. Adjectives in the interpretation indicate the size and condition of these elements (Table 2).

Apart from the interview data, documentary evidence was collected to expand the conceptual framework of the database. Conservation documents of St Helena Island were collected from QPWS. Additionally, some public resources, such as the State Library of Queensland (SLQ), Queensland Museum and Queensland University of Technology (QUT), were accessed as supplementary sources. Eight main documents were selected based on their themes and time periods (Table 3). The statements of St Helena Island in these documents were examined to complement the 'conceptual framework' identified from interviews. The same qualitative research methods were used to analyse these documents.

Maps were derived from documentary evidence as a special dataset for this study as they are important materials for geodatabase construction (Table 3). These maps were manually digitalised using AutoCAD software (Autodesk, Inc., San Rafael, CA, USA). Through a georeferencing process, these maps were synthesised together to form a base-map for the database. Stakeholders' cognitive maps were

Table 2 Analysis of a park ranger's plan for a tour in the Stockade on St Helena Island.

Transcription (sample)	
'Yes, I probably, the next point probably will be the underground cell block, and talk about the discipline and what happens to the prison. I would probably then, come down to the stores building, and talk about that use, and talk about a little bit about the prisoner's lives, the visiting boxes people could come. I talk about the big yard, come around the corner, to the kitchen area, (and) then I probably come through to the remained cell block, so that's a good place to actually talk about the life of the prisoners. So I tend to take people around here before I go to the museum.'	Nouns Underground cell block, the stores building, the visiting boxes, yard, corner, kitchen area, cell block, museum Adjectives Big, remained Verbs Talk, come down, come around, come through, take

Table 3 Conservation documents and maps of St Helena Island.

Documents	Maps
Site files: 1. Historical Document Collection of St Helena Island 2. Survey Report of St Helena Island Conservation plans: 1. Management Policies and Guidelines (1982) 2. Record of Components of Cultural Significance 1983) 3. St Helena Island Interim Strategic Plan (1983) Heritage register documents: 1. Register of the National Estate (1978) 2. Historic Park Register 3. Cultural Heritage Information Management System (1992)	Historic maps: 1. Plan of St Helena Island (1865) 2. Plan of St Helena Island (1884) 3. Plan of St Helena Island (1887) Survey maps: 1. Topographic Map of St Helena Island 1:2500, the Department of Mapping and Surveying (1981) 2. Components of Cultural Significance (1983), QPWS Management plans: 1. Management guideline map (1983), QPWS

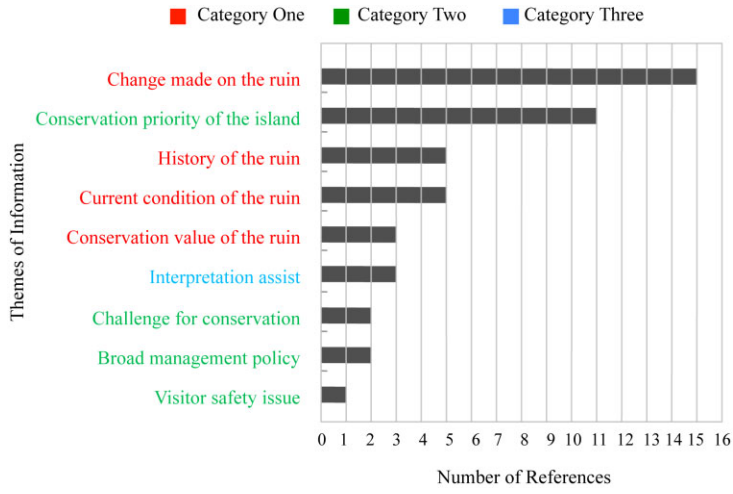

Figure 3 Stakeholders' information requirements for historic landscape databases.

projected on the base-map. As complementary data, site observations were conducted on St Helena Island to improve understanding of the physical environment and stakeholders' interpretations.

Design of the GIS database for St Helena Island

A sample geodatabase was constructed using ESRI ArcGIS 10.1 software (Environmental System Research Institute, Redlands, CA, USA) running with a Microsoft Windows 7 platform (Microsoft Corporation, Redmond, WA, USA) on a PC. A vector-based representation, rather than raster based, was selected as the major digital representation as most elements on St Helena Island are discrete landscape elements. This sample database was only built as an experimental system, rather than to be actually used in conservation practice. In the design process, however, the outcome was periodically demonstrated to stakeholders to get feedback. Some thematic maps were generated from the database to address the information requirements of conservation practice.

Results

Conservation requirements of St Helena Island

Nine themes of information requirements were generated from the interviews (Figure 3). These themes were categorised into three requirements. Firstly, all stakeholders mentioned that the database needed to contain systematic statements of historic infrastructure remnants (ruin) on St Helena Island. Under this topic, four themes were revealed from the 28 references in stakeholders' responses (Figure 3). These themes included the ruin's history, conservation value, current condition, and changes made on them.

Secondly, three of the five stakeholders mentioned that St Helena Island needs synthesised information for decision-making. This requirement includes four themes and 16 references (Figure 3). The park ranger explained this requirement from the management perspective: Within the national park management system, limited resources are available for the conservation of cultural remnants. Therefore, local managers require synthesised information to decide which area or component gets priority in conservation practice. Under this theme, the teacher of environmental education and the historian mentioned that historic research and guide tour design are urgent issues.

Thirdly, two of the five stakeholders mentioned that the interpretation on St Helena Island needs the assistance of visual representation. This category includes one theme and three references. The park ranger and the heritage expert said that only about 10% of the built structures of the prison are left on the island today, making it difficult for visitors to imagine the historic layout of the landscape. These two stakeholders mentioned that the database should be able to assist the visualisation of the historic condition of St Helena Island to enhance tourist experience.

Stakeholders' cognitive maps of St Helena Island

Five cognitive maps were derived from stakeholders' interpretations of St Helena Island. It was found that this island was recognised by stakeholders as having three layers. The first layer was the whole site, which was mainly called 'the island' or 'St Helena' by stakeholders. Certain attributes, such as history, conservation significance, and management instructions, were attached to this layer in stakeholders' interpretations.

Secondly, St Helena Island was recognised as containing different landscape compartments. The term compartment means an area comprised of different landscape components. A compartment has specific historic function and conservation significance. For example, in the interviews, all stakeholders described the Stockade as an area with clear boundaries and certain historic values. Based on the interview, five cognitive maps indicated five different ways of dividing the island into compartments (Figure 4). These cognitive maps were manually digitalised and overlayed together to reveal a shared understanding of St Helena Island (Figure 4). As a result, some 18 compartments were finally identified and used in the database (Figure 5: Bookmark 1).

The third layer contained different types of landscape components. In the interviews, five stakeholders described 71 stops in total (Figure 4), indicating six types of landscape components (Table 4).

The sample GIS database for St Helena Island National Park

Three feature classes were designed in the database to represent the three layers in the cognitive maps (Figure 4). Polygons were used to represent the whole island and landscape compartments. Landscape components were represented using different features: Buildings were represented by polylines drawn on their footprints; points were used to represent plants, Aboriginal

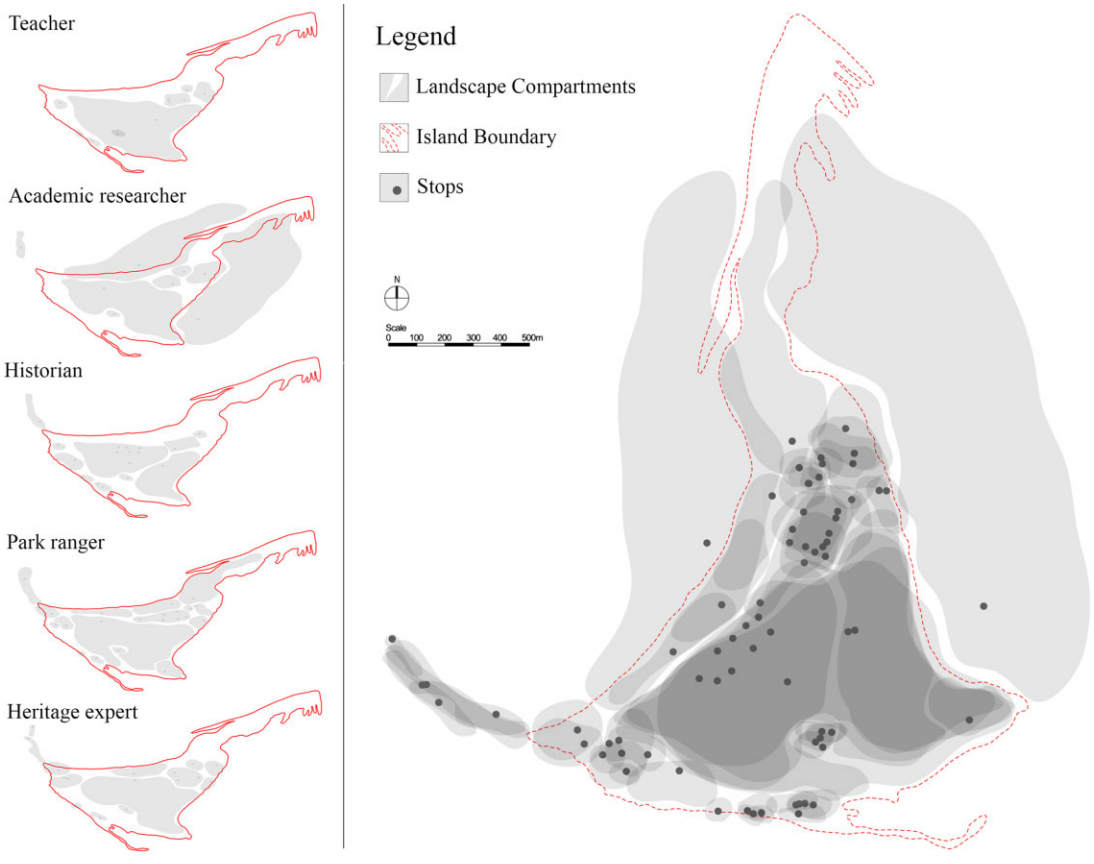

Figure 4 Stakeholders' cognitive maps of St Helena Island.

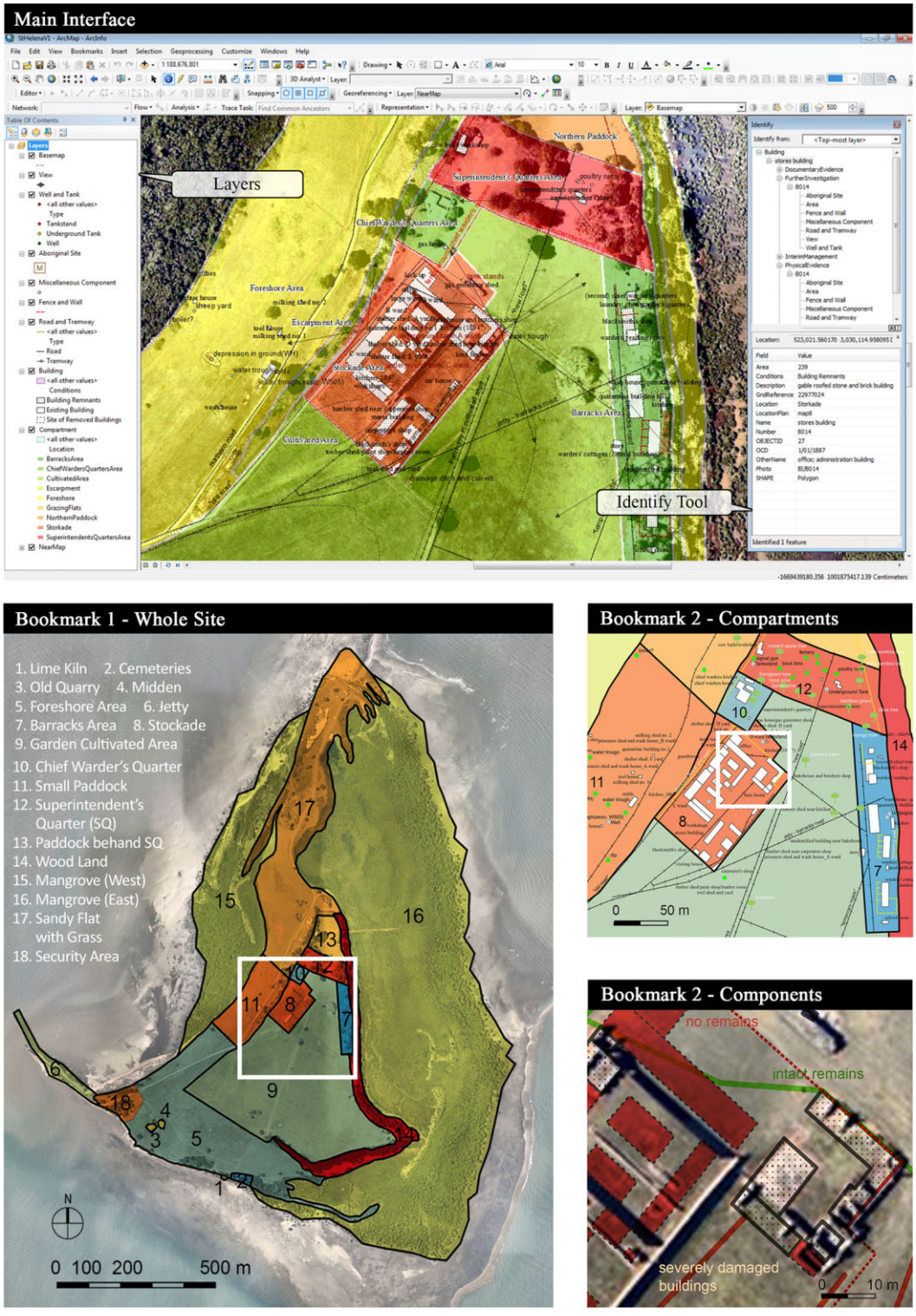

Figure 5 The user interface of the GIS database for St Helena Island.

Table 4 Features and attributes of the geographic database for St Helena Island.

	Features		
	The whole island	Compartments	Landscape components: buildings/structures; roads/tramways; plants; Aboriginal sites; wells/tanks; small-scale components
Attributes	Knowledge of physical environments: names; date of construction; measurements; historical documents; photographs Intangible cultural heritage: agricultural practice; traditional craftsmanship; oral history Conservation guides: current condition; acceptable change; conservation significance; management instructions; intervention records		

sites, wells and small-scale components; and polylines were selected to represent roads and tramways.

In terms of feature attributes, the names used by stakeholders were used as feature names in the database. The content analysis of interview data identified three categories of attributes: knowledge about the physical components, intangible cultural heritage, and conservation guides (Table 4). It has to be noticed under the theme of intangible cultural heritage, oral history was designed as a category to integrate indigenous cultural history into the database. Additionally, 'acceptable change' is a field under the theme of 'conservation guide'. It contains the acceptable parameters of compartments and components, which could be used as conservation references. For example, the cultivated land and the historic trees on the island need to be periodically trimmed so that the historic skyline of the landscape will not change.

The initial user interface of the sample GIS database is a map of St Helena Island (Figure 5). This map and the layers available through it allow access to the spatial layers and the ability to perform queries on these layers. This graphic user interface (GUI) is similar to the typical GUIs used for Internet mapping, such as a Google map. Users are able to zoom in and out at different scales by using spatial bookmarks. Three bookmarks were set for the three main layers of St Helena Island: The whole island is the primary home of the ArcMap documents. Other two bookmarks display compartments and components (Figure 5). These bookmarks, demonstrating St Helena Island at three different scales, cover all the objects in conservation and management.

The database addressed the three information requirements in the conservation of St Helena Island. Firstly, it is a digital inventory containing contextual descriptions of historic remnants on St Helena Island, including both natural and cultural elements. Even very small components such as wells or tanks are represented and addressed with detailed statements. The ArcMap Identify tool allows users to choose a specific feature and retrieve attribute data regarding it. Attribute tables were joined together to create an integrated view of the database. For example, a dialog box containing a comprehensive statement of the Store Building on St Helena Island appears when the feature is clicked with the identify tool (Figure 5: Main Interface).

Secondly, decisions in terms of historic research, landscape restoration and potential development could be assisted by the new knowledge from the sample GIS database. Taking historic research as an example, the sample GIS database provided new knowledge to identify the compartment needing historic research. Figure 6 is a holistic picture of the available historical artefacts representing St Helena Island. It indicates that two compartments of very high significance only have a moderate amount of historic representation. These are the Chief Warder's Quarters and the Superintendent's Quarters, and they should get the highest priority in terms of historic research.

Thirdly, the sample database produced visual representations of the historic condition of St Helena Island. For instance, the Garden Cultivated Area is very significant in demonstrating the agricultural history of the Island. Currently, however, there is not enough documentary evidence or research being undertaken about the transformation of this agricultural land in the early history of the prison. Thus, the vulnerable pattern of this farming land has quickly faded away in the past 30 years (Figure 7). A thematic map overlaying the cultivated land in 1887 on the current satellite image revealed the extent of agricultural practice and the types of crops at that time

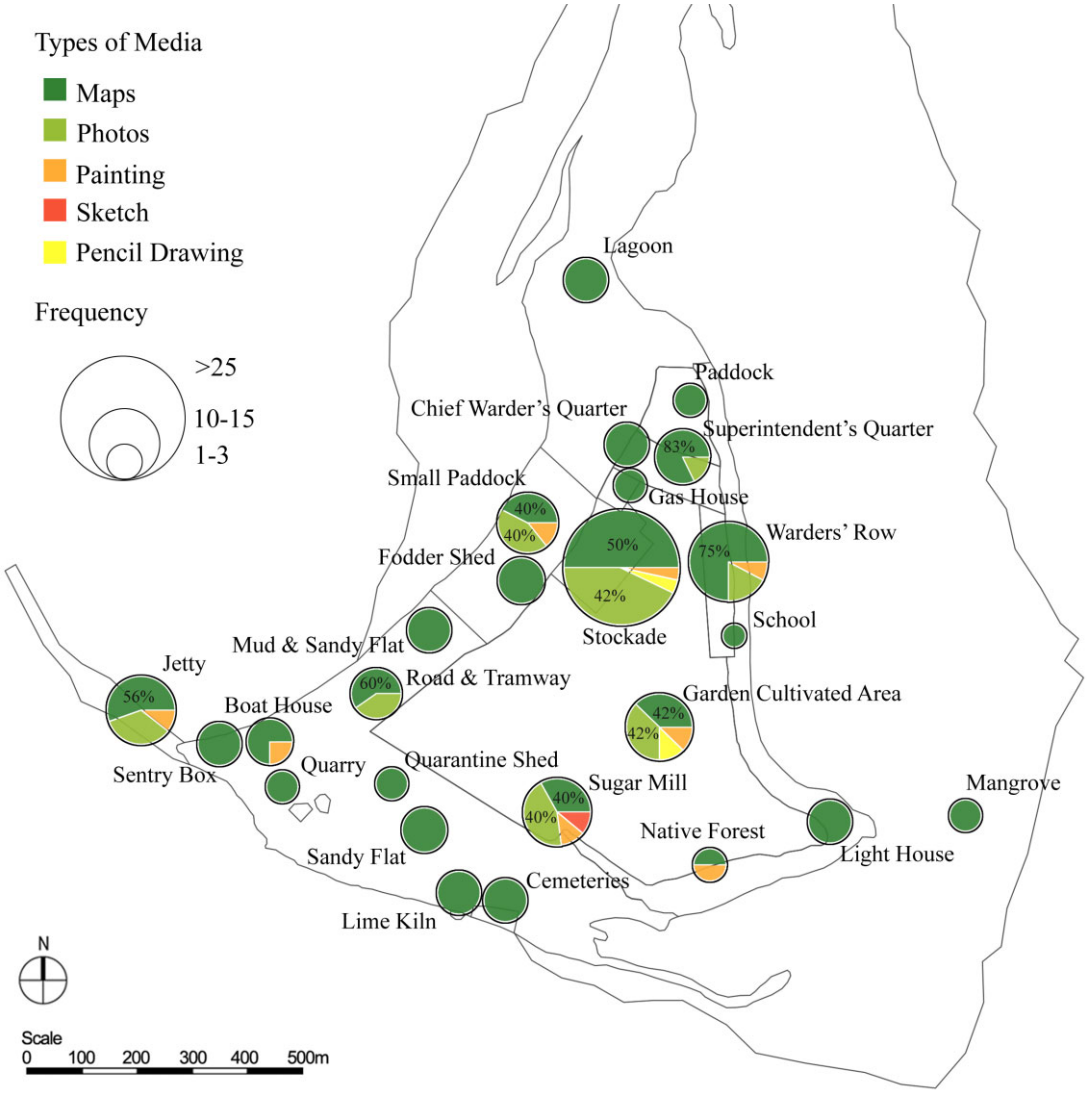

Figure 6 Representations of St Helena Island between 1866 and 1920.

(Figure 8). The knowledge of agricultural practice on the Island is thus demonstrated, and this map can be used today to assist interpretation. Maps of other themes, such as the development of the tramway system on the island, building material production, and water supply, could be easily created within the sample database.

Discussion

An alternative approach using an 'interpretive model' of representation and advanced tools to document heritage landscapes in Australia is offered at both the theoretical and pragmatic levels:

Differing from the conventional view of landscape representation, this approach is based on an 'interpretative model' that acknowledges and values the role of the interpreter. Rather than establishing a model based on a generic, objective author (Duncan and Ley, 1993), it recognises that interpretation is a dialogue between one's data – other places and other people – and the researcher who is embedded within a particular intellectual and institutional context (Duncan and Ley, 1993). This 'interpretative model' built the connection between the society and heritage landscapes, which avoided the inapplicability of

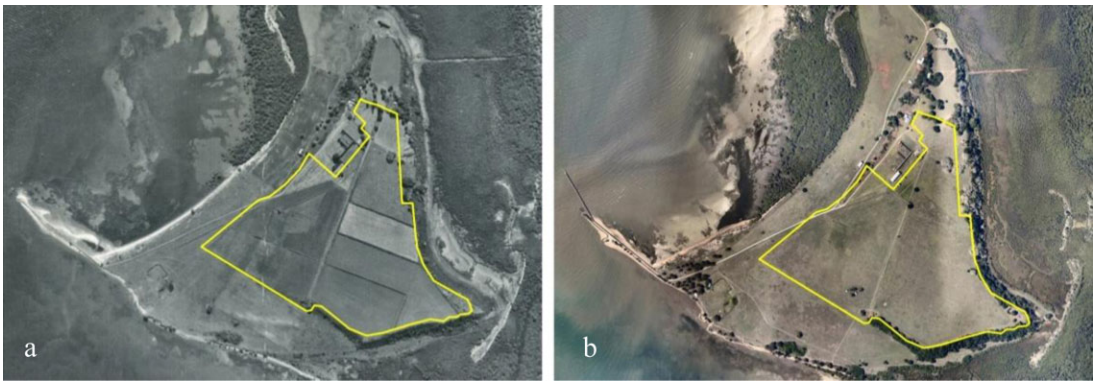

Figure 7 Cultivated areas on St Helena Island in (a) 1972 and (b) 2011.

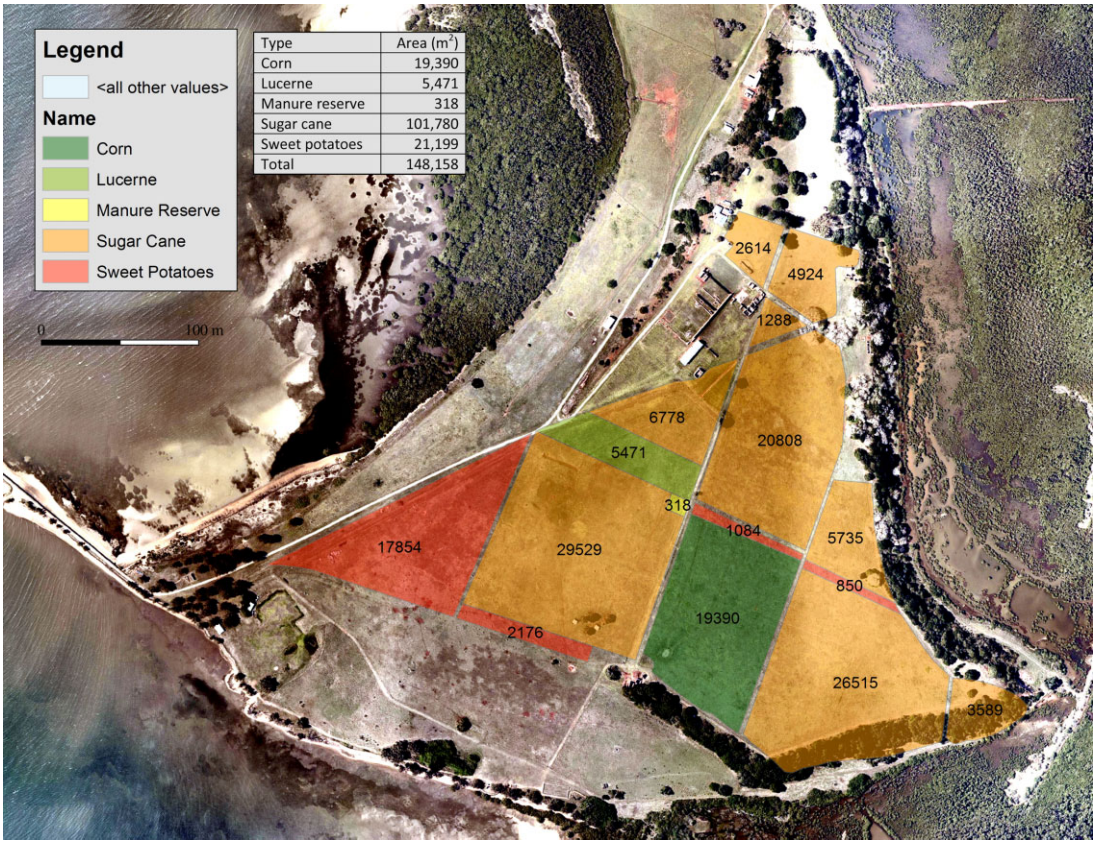

Figure 8 Historic locations of cultivated areas on St Helena Island.

many new databases. The designed database could be easily accepted and used by the conservation managers of St Helena Island since its structure and language were derived from stakeholders' interpretations of the island. Rather than focusing primarily on GIS technologies, the focus of this paper was on improving the database designer's understanding of the place.

The design of GIS database uses a cultural landscape perspective. This paper explores St

Helena Island as a whole landscape, rather than separated natural and cultural elements. The concept of 'landscape compartment' is introduced to integrate both cultural and natural heritage elements. Each compartment has its own value and conservation instructions. This approach to some extent can moderate the conflicts between cultural and natural values. The design process also highlights the interaction between local communities and the landscape, which is reflected by the concepts of 'flexibility' of the database and 'acceptable change' of heritage parameters. The designed database assists a virtual dialogue among key stakeholders, which contributes to the agreement of landscape development.

In Australia, the representation of indigenous culture is an important conservation issue. Based on the cultural landscape methodology, this paper establishes an approach to represent the intangible dimensions of heritage landscape. In the case study of St Helena Island, oral history, as the most important indigenous heritage, has been collected and represented in the database. Thus, this paper offers an effective method to representing indigenous cultures related to heritage landscapes.

Digital documentation of heritage landscapes has become an unavoidable trend in the conservation domain. This paper presents a theoretical framework for mapping and databasing heritage landscapes. In this paper, some concepts, including an interpretative model, landscape compartments, and flexible information system, were introduced and tested within the context of heritage landscape documentation. This new framework is open and flexible, so that the designed database is a living archive of heritage landscape.

At the practical level, this paper presents a pragmatic guide for building heritage landscape databases in Australia. The paper reveals the contemporary information requirements from a small, locally based conservation organisation. The sample database is designed within the local conservation context, which mainly focused on the historic infrastructure remnants. This method could be used for other heritage landscapes containing both natural and cultural heritage elements. It is a bottom-up strategy that explores local stakeholder's understandings of heritage landscapes and uses them as indicators for database design. The sample database can be easily transferred into an applicable system to be used by QPWS in conservation planning. This method of database design facilitates a more explicit focus on information support, and is a potentially effective approach to user-centred designs of geographic information systems.

Conclusions

The fragmentation of information has become a major obstacle for efficient conservation and management of individual heritage landscapes. In Australia, locally based conservation organisations lack comprehensive information platforms assisting their conservation and management of heritage landscapes. This paper explores an innovative approach for building such information platforms. Firstly, an 'interpretative model' of database design facilitates a more explicit focus on information support, and is a potentially effective approach to user-centred design of GIS. Secondly, the cultural landscape perspective provides a holistic tool for heritage documentation, which integrates natural and cultural, tangible and intangible heritage, into conservation and management. Thirdly, this paper offers a pragmatic guide for building GIS, which can be used as references for other landscape documentation projects in Australia and other countries.

Sound documentation is essential for heritage landscape conservation. The rapid development of digital technologies not only brings opportunities, but also challenges for the documentation of heritage landscapes. Digital tools have to be used in a contextual framework so that in the future heritage landscapes can be meaningfully conserved.

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