

**METHODS ARTICLE**

# Developing a National Geo-spatial (GIS) database of Archaeological Sites in Zimbabwe

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## ABSTRACT

This paper discusses two issues: the value now accruing from the digitisation of the national record of archaeological sites in Zimbabwe and the importance of integrating Information and Communication Technologies (ICTs) in archaeological research. The record of archaeological sites in Zimbabwe, otherwise known as the Archaeological Survey Database, or the Survey Record, is a list of sites that have been reported to the National Museums and Monuments of Zimbabwe (NMMZ) and its predecessors since the 1890s. The digital spatial database that has now been developed out of the thousands of sites reported for more than a century has practical advantages over the physical and manual records available, as well as other digital databases. In the face of numerous development projects, including the recent land reform programme and other activities in Zimbabwe, the GIS database becomes handy in anticipating the magnitude of risks facing the archaeological heritage and monuments in the country. In addition, the database would be useful to researchers in spatial and settlement archaeology, or anyone interested in the whereabouts of archaeological sites. The paper uses this example of a database to demonstrate the importance of ICTs in the archaeology of Zimbabwe and southern Africa.

**KEYWORDS:** conservation, database, GIS, spatial analysis, Zimbabwe

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## Introduction

The record of archaeological sites kept by the National Museums and Monuments of Zimbabwe (NMMZ), otherwise known as the Archaeological Survey Database, is a list of sites that have been reported to that institution and its colonial predecessors over many years. Accumulation of knowledge about archaeological sites in the country, however, is much older than the NMMZ institution, as information has been accruing since the 1890s. That knowledge was eventually put into a list in 1902 and has continued to grow since then. The digital spatial database that has now been developed out of the thousands of sites reported for more than a century has practical advantages over the physical and manual records available. In addition, the digital spatial database has other merits over other digital databases in that one can relate the sites to other spatial and aspatial data forms around them. In the face of numerous development projects, including land reform, mining, agriculture, and other activities ongoing in Zimbabwe, the spatial or geographic information systems (GIS) database becomes handy in anticipating the magnitude of risks facing the archaeological heritage and monuments. Exploited with appropriate tools, including predictive modelling, the database would provide opportunities for timely response to impending or unfolding risks and disasters on archaeological sites, monuments, and other heritage places. Besides this management, conservation and preservation benefit, the GIS database would be useful to researchers in spatial and settlement archaeology, tourism development or anyone with an interest in the location of archaeological sites. In addition to the issues raised above, this paper uses this spatial database to demonstrate the importance of information and communication technologies (ICTs) in the archaeology of Zimbabwe and southern Africa and thus encourages further development of archaeological information systems.

## Growth of the Zimbabwean Archaeological Survey record: A historical background

The arrival of the British South Africa Company (BSAC) in the form of the Pioneer Column, in 1890 on the geographic area now known as Harare in Zimbabwe was followed by pegging of mineral claims, especially north of Harare (then Salisbury). After the discovery of gold in South Africa a search for a second goldfield in the north followed in the so-called Mashonaland. The presence of monumental archaeological sites that were interpreted as ancient cities in the region fuelled rumours of lost civilisations which exploited unfathomable mineral resources. The search for the 'second rand' proved unsuccessful and members of the disbanded Pioneer Column of the BSAC which had been sent north to colonise this hinterland on behalf of Cecil John Rhodes, began to search for the precious mineral at archaeological sites. There followed the ransacking of archaeological sites in search of precious objects. This unscrupulous practice was influenced by Carl Mauch, the Germany explorer who visited Great Zimbabwe and other parts of the Zimbabwe plateau in 1871, because in his speculation about the origins of the Great Zimbabwe stone-built monuments, he connected them with the wealth of the biblical King Solomon. In fact, Carl Mauch claimed to have actually recorded such evidence at other such stone structures in the midlands area of modern Zimbabwe. The possibility was confirmed by some American geologists who also reported having recovered several ounces of gold from stone-built structures in the midlands. By 1895, a company had been created to mine these structures for their precious artefacts. Several artifacts seem to have been collected at Great Zimbabwe. This alarmed the learned societies in Britain and in an effort to rescue the situation, an order was passed by the BSAC in 1902 and later in 1912 to protect the monuments.

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With this rudimentary legislation to protect cultural heritage, the record of archaeological sites, (developed initially for their exploitation) began. This early use of cultural resources laid the foundation for the establishment of the archaeological survey database. Thus, the first stage in the development of the Survey Record, 1890 to 1923, was one associated with the rule of the British South Africa Company. In terms of the Survey Record, the earlier part of this first stage saw the establishment of the Ancient Ruins Company, a private company that was formed in 1895 solely to mine ancient archaeological sites of their treasures. However, at this stage the sites were not yet organised into a formal list, although those involved in the treasure hunting must have developed their private lists meant for the 'hunt'. It is important to qualify that the Ancient Ruins Company was a private entity and therefore might not have had a formal list of the sites that were being ransacked. Following the criticisms and concerns that were raised over the destruction of archaeological heritage due to the activities of the Ancient Ruins Company, two Ordinances were passed in Southern Rhodesia to protect 'Bushmen' relics; the first one in 1902 and the next one in 1912. The Ordinances, as can be deduced from their titles<sup>1</sup>, did not deal with remnants of farming communities. However, due to the activities of the Ancient Ruins Company, several such sites, mostly stone structures, were already known to the white community. The British Society for the Advancement of Science sent Randall Maclver (1906) and later in 1929 Caton-Thompson (1931) to the then Southern Rhodesia to investigate the site of Great Zimbabwe. Thus, although there might not have been a clear formal list of sites, the whereabouts of a number of sites was known and so could be used in archaeological research. Among other sites, Randall-Maclver visited Great Zimbabwe and the Webster ruins (now Chikwanda) in Melsetter, now Chipinge (Kapumba 2018). This shows that there was sufficient knowledge on the whereabouts of several stone-built sites, thought to be important places associated with the elite of those presumed vanished civilisation.

The second stage was from 1923 to 1965, associated with formal colonial rule. The change in the administration of the colony (Rhodesia) from Company rule to a legislative body ushered in the 1936 Monuments and Relics Act and an implementing body, the Historic Monuments Commission (HMC). As has been noted above the British Society for the Advancement of Science sent Getrude Caton Thomson in 1929 to investigate the stone structures of Great Zimbabwe and other related sites. Around the same time Leo Frobenius, from Germany, visited the country and other places in Southern Africa. In 1931 a member of the first parliament of Rhodesia was asking the speaker of parliament what was being done about the material that he had collected from the ruins in Mtoko (now Mutoko) where he had conducted an excavation. Coming from Germany, Frobenius conducted an expedition to southern Africa in 1927. He visited several rock art sites including Ruchera in Mutoko. From the parliamentary report, it seems Frobenius excavated the stone structure of tere and took away a gold artefact from the site. Obviously, he was aware of the whereabouts of the sites that he wanted to visit. Locally, several rock art sites were recorded during this period, especially by Lionel Cripps who was a member of the Historic Monuments Commission (Nhamo 2007). In addition, several monuments were declared under the guidance of the Historic Monuments Commission which oversaw implementing the Monuments and Relics Act of 1936.

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<sup>1</sup> Ancient Monuments Protection Ordinance (1902) and Bushmen Relics Protection Ordinance (1912)

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Immediately after its establishment in 1936, the Commission banned illegal excavations and led campaigns throughout the country encouraging members of the farming community and everyone else to report any archaeological artefacts they came across. This was supported by the formation in 1958 of the Prehistory Society of Rhodesia whose mission included the recording of archaeological sites and organising training in archaeological excavations. In 1965, the Unilateral Declaration of Independence (UDI) by the new Prime Minister, Ian Smith, could have affected the relationship between the colony and the UK Government.

These political developments led to increased agitation amongst the African population resulting in the war of independence. This could have affected the funding that was available for monuments developments. On the other hand, however, this period, Stage 4, spanning the period 1965 to 1980, saw the increased police patrols which also led to some sites being reported from that quarter. In addition, the Prehistory Society of Rhodesia continued to conduct survey missions in the country. In the 1970s for example, they carried out a survey in the area meant for the construction of Darwendale (Hunyani) dam. Further, several survey missions were conducted between 1971 and 1973 to record archaeological sites that were going to be affected when the dam was to eventually fill up (Izzet 1974). Some expeditions were conducted by the Rhodesian Schools Exploration Society while the Ranche House School organised Field Schools on excavations and site visits.

Up until 1972 museums and the Historical Monuments Commission had existed as separate institutions. However, in 1972 they were brought under one piece of legislation, the National Museums and Monuments Act of Rhodesia (NMMR), Chap 313, of 1972. The activities of the Historical Monuments Commissions could have influenced the enactment of the 1972 legislation which made any destruction of archaeological sites illegal if this had not been authorised by the NMMR director (NMMR, Chap 313 of 1972). One would be tempted to define a new period from 1972 to 1980 due to the change that had been brought by the merger of museums and monuments. However, the merger of museums and monuments departments only had administrative effect but did not change the organisation and utility of the survey record. In addition, due to the war of independence in the country, there was little that happened during that period, especially after 1974. A number of national monuments and other sites were listed on the database in 1974. Thereafter there was not much activity.

On the research front, the general interest in archaeology in distribution maps to answer archaeological questions also influenced the recording of archaeological sites. Atlases of prehistoric places stimulated the need to organise the site record. The distribution map suddenly became an important 'object' for archaeological interpretation (see Summers 1960, 1967). Influenced by global developments in archaeology in general as well as in other disciplines such as Geography, site location has been of interest in this country since the 1960s as seen by Summers' maps that related archaeological sites with aspects of the physical environment of Rhodesia and the country's state of transport network. Summers related the distribution of sites to climate and vegetation data and concluded that pre-colonial societies exploited certain environmental corridors to penetrate much of the land between the Zambezi and the Limpopo (Summers 1960). In 1967 Summers produced yet another map, this time on tsetse fly

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distribution in relation to distributions of past populations as shown through the archaeological record (Summers 1967). From this work Summers thought that much of the lowveld of the country was not effectively occupied in the past due to the prevalence of this insect.

Following Summers' work was Garlake (1978) who became interested in the topographic location of the Zimbabwe culture sites which he thought demonstrated awareness amongst prehistoric societies of the potential of the environment in sustaining their cattle-based economy (Garlake 1978; Pwiti 1997). For him the Zimbabwe culture sites were located in areas that made it possible to exploit pastures of both the Highveld and the Lowveld. However, we now know that this thinking was based on inadequate research as it has since been debunked by later studies which showed that such sites are spread all over the Zimbabwe plateau, stretching into Mozambique, Botswana, and northern South Africa. What all this work shows however is that by the 1960s the archaeological site database was already usable for archaeological investigations.

Since the 1960s, there have always been sporadic forays into using the site record for various archaeological questions (see Sinclair and Lundmark 1984; Swan 1995; Pwiti 1996; Sinclair 2010; Sinclair *et al.*, 1992). However, after 1980, the record began to be manipulated digitally, marking a new stage, Stage 5, in the development of the Survey record. The period is also associated with the teaching of archaeology as a subject at University level. The site database has expanded significantly, especially with new discoveries by researchers from the universities now teaching archaeology and heritage management. From the 1980s members of the Archaeology Unit of the University of Zimbabwe have been conducting research in various parts of the country to try and address the bias in research coverage that was noted by Summers in the 1960s (Summers 1960). Through these projects several sites were recorded in the mid-Zambezi valley, eastern Zimbabwe, and southern Zimbabwe (especially along the Limpopo River). The rock art documentation financed by the Norwegian Agency for Development (Norad) and several impact assessment projects have also contributed to the growth in the database. Unfortunately, most of the sites from these projects, especially from impact assessments, have not been made sufficiently public, perhaps because of the contractual terms surrounding the results of these investigations. Although quite many of the newer sites are not yet appearing in the archaeological survey database, most of them can be accessed from dissertations and thesis in the universities that teach archaeology.

To conclude this section, this author notes that due to the awareness that was raised through the efforts of the Historic Monuments Commission and various bodies, several sites were reported and recorded. The site record continued to grow due to continual deposition of survey reports by both professional and amateur archaeologists, and reports made by various individuals, including farmers, policemen, and school and university researchers. In the past two decades however, there seem to have been a decline in the deposition of survey reports to the national repository despite the fact that archaeology has become a taught subject in the universities of Zimbabwe (Mahachi *pers.comm*, 2018). Ironically, this is also in spite of numerous archaeological research projects that have been conducted across the country since the 1980s.

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### **Developing the digital GIS database**

For much of its existence the Archaeological Survey database has been in the analogue format housed in the Zimbabwe Museum of Human Sciences. The organisation of the database is quite comprehensive, linking site index cards with other forms of documentation, published resources, as well as material culture recovered from the sites through excavations. The sites are plotted on a sheet fall map of Zimbabwe using the coordinates provided by the discoverer of the sites. However, it is clear from the record that some of the sites were plotted based on personal knowledge of the whereabouts of the places which the discoverer then had to determine from topographic and other geographic features recorded on the map. Basic detail about the sites is recorded on the index cards, which means the record can be used for location-based research without interaction with the actual material culture from the same sites, except when there is special need. The basic detail is what is normally captured on the standard site recording form that is used during site surveys. The detail of the form has however been evolving, influenced by research questions being pursued by the researcher. Some of the detail has been influenced by awareness to core data elements emphasised in international instruments developed for the documentation of heritage. Researchers, thus seem to be capturing data using different data standards. It is even not clear if researchers are still getting guidance from the NMMZ. To compound the problems, for one to conduct surveys, they do not necessarily have to have a permit. It is hypothesized that these differences result in delays in inputting information on the site index cards.

Although the database has been in use since the 1960s, its accessibility at that time as a digital record is not clear. It is not clear if Summers (1960, 1967) and later Garlake (1978) had any computerised database programmes to develop these distribution maps, the site record that they developed in Zimbabwe (Rhodesia then) was modelled on the Swedish format (Sinclair *et al.* 1992). The likely scenario is that they used plotters in cartography to produce the distribution maps. This means the database itself could have remained manual. In the post-colonial period, Sinclair and Lundmark (1984), Swan (1995), Pwiti (1996) and Ndoro (2005) also used the database to show distribution of various sites and ancient mines. Sinclair and Lundmark (1984) utilised this record of sites and came up with distribution maps which the two researchers used to support the argument about a northward movement of farming communities in southern Africa towards the end of the first millennium AD. Using geographic and computer techniques such as D-curves and Fuzzy set cluster analysis, the authors argued that several clusters of sites could be discerned that seemed to indicate this northward trend of sites of the Kutama Tradition (see Sinclair 1984). This is the trend that Huffman (1978) had termed the 11th century *difaqane*, borrowing from the 19th migrations of Nguni communities in southern Africa.

This researcher is, however, aware that the Department of Archaeology and Ancient History at Uppsala University has a GIS compatible record of archaeological sites from several countries in southern Africa including Zimbabwe, Botswana, and Mozambique. In fact, the Archaeological Survey site record of Zimbabwe was modelled along the Swedish national site register (Sinclair *et al.* 1992). The digital site files (developed mostly as .dbf files or ArcInfo coverages) were available to Zimbabwean scholars and other researchers who graduated from Uppsala University or were participating in African archaeology research projects and programmes that were funded by that University (Sinclair *et al.* 1992). What is clear, however, is that most of these efforts have remained private initiatives and consequently, the

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results and the digital database have remained locked in personal folios, inaccessible to the general public except in their published forms. Since the 1980s, the record has been transformed into digital formats initially using MSDOS Knowledgeman database (Sinclair et al. 1992, p. 17), and later into other formats that will be described below. At Uppsala University the list of sites could have been manipulated using GIS programmes but the same record in Zimbabwe remained not a dynamically exploitable digital record. The record has remained largely hard copy. Most people interested in this database will interface with the manual records. This, of course, limits what can be done with the record and the number of people who can access it.

From the mid-to late 1990s, archaeologists based at the University of Zimbabwe (UZ) became interested in this database as well as in GIS, influenced of course by developments that were taking place in the Urban Origins project. Various efforts were made to collect information about the sites contained in the Archaeological Survey at the Zimbabwe Museum of Human Sciences. Students manually captured the detail appearing on site index cards onto notebooks for purposes of later inputting the data into a computer programme. The whole process reflected the status with regards to data capturing technology and expertise available for that purpose. The site lists were put into Microsoft Excel workbooks, duplicating the same data fields as used in the Archaeology Survey database in the Zimbabwe Museum of Human Sciences. This was a very tedious process. By the late 1990s, the site lists were being put onto Ms Access database management programmes. This was a move towards establishing a real relational database, although the schema used was that of a flat-file which reproduced the spreadsheets in Ms Excel. Attempt was made to provide for the linking of photographic objects to the record. The challenge however was that only one photograph per record (or site) could be embedded in the database at this time. The limitation has since been rectified with the use of the attachment (@) facility in later MS Access database management programmes.

As the end of the 20<sup>th</sup> century approached, the Archaeology Unit at the University of Zimbabwe became interested in digitising the record for spatial investigations, recalling its use for such purposes in the 1960s and 1980s. In addition, a few scholars in the country had attempted their hands on Geographic Information Systems (GIS), supported by the University of Uppsala through the Urban Origins projects (Sinclair *et al.*, 1992). Examples of these scholars include Pikirayi (1993), Pwiti (1996), Swan (1995) and Walker (1995). Thus, a parallel process was also developed to input the sites in a GIS programme, specifically ArcInfo at the time. At that time in 1997 to 1998, the ArcInfo version that was available in the Archaeology Unit was still a command driven programme. The user had to know the commands by head or had to frequently consult the use manual. The sites had to be marked on a topographic map (the 1:50 000 series) and then input into the computer as points using a digitizer. This meant that the sites (or points now) lacked non-spatial attributes which had to be typed in manually in the sites record table that operated in the background of the map interface. This tedious process was only ameliorated when the Archaeology Unit acquired the menu driven ArcView programme, although sufficient basic literacy had been gained in using the ArcInfo GIS software.

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Students of archaeology were also learning to use computers for archaeological investigations and so were exposed to the spatial manipulations and database programmes, in addition to quantitative investigations using spreadsheet programmes. The teaching of heritage management courses also showed the need to use computers in developing and handling records of collections in museums, inventories of monuments records, including the archaeological survey record. In 1999, there were three third year projects that made use of GIS, involving sites from the Survey database. Another one was completed in 2001. In that year, a meeting held in Livingstone, Zambia, organised by Centre for Heritage Development in Africa (CHDA) had seen a presentation by the University of Zimbabwe archaeology students. The presentation demonstrated the potential of linking an MS Access database of sites with a GIS platform. The idea was to make the non-spatial attributes and other collections about the sites be accessed through the MS Access platform. Any investigations that would require location information would then be accessed through the GIS platform.

The interest in the database by the Archaeology Unit of UZ was related to the availability of software that could handle spatial information and could analyse the distribution in various ways. This was ESRI's ArcInfo and ArcView programmes that have continued to evolve since their appearance on the software market. Thanks to the site index which has detail about the location of the sites recorded in either geographic or projected coordinates, it was possible to develop a spatial database. Students have continued to show interest in utilising the Archaeological Survey database (see Katsamudanga 2009; Chikalipo 2017).

At about the same time in the 1990s, the NMMZ started developing their own electronic record of the sites together with artefact collections in the Zimbabwe Museum of Human Sciences. The electronic database was developed on a programme known as FoxPro. The database included links to material culture in the Zimbabwe Museum of Human Sciences. Later the organisation engaged a developer to come up with an Microsoft Access database. Upon completion however the developer seemed to have left most of the administrative functions of the database locked, including editing operations (Katsamudanga, 1998). At the end, the Microsoft Excel format of the record became the final product of this digitisation effort.

The survey record has always been a good starting point for any new research in Zimbabwe. There has been growing interest towards utilising the site database, especially amongst students of archaeology as well as amongst seasoned scholars (see Katsamudanga 1999, 2001, 2007, 2009; Kapumha 2008; Mtetwa 2007; Chuma 2001; Tafuma 2001; Chingono 2014; Chikalipo 2017; Ndoro 2001, 2006; Pwiti 1996). By using the database, it has been noted that some of what is being recorded as new sites might have been recorded already. The location of the site becomes a crucial attribute to make that determination. A GIS database thus becomes more useful in that regard.

### The Architecture of the Archaeological GIS Database

The archaeological spatial database is being developed using ArcGIS software. As shown above, significant effort was spent trying to make the data from the site index cards at the ZMHS be usable for the development of this sort of database. The Archaeology Unit at the University of Zimbabwe had to attend to the coordinate reference for each of all the sites recorded to make sure it could be used with GIS software. All the sites can now be displayed across the breadth of Zimbabwe (see Figure 1). In addition to working on the coordinates, the researchers classified the sites into cultural periods and types of sites. The sites can now be displayed as different layers based on cultural periods, cultural traditions or some other variable that was recorded. These non-spatial attributes exist on the index cards and are basically part of the core data that NMMZ expects to be recorded during site surveys. This has a bearing on metadata issues which will be discussed later in the paper.

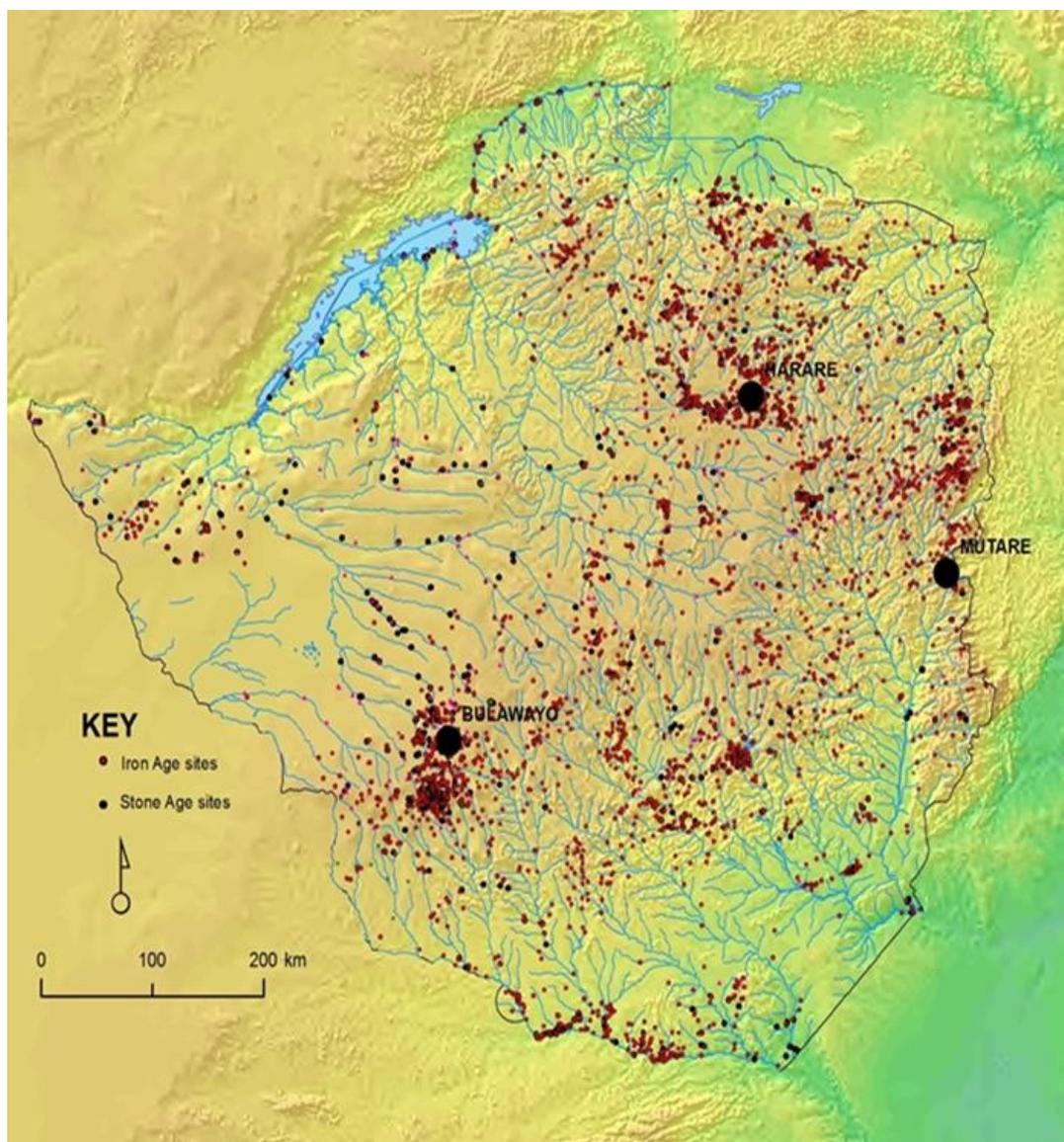


Figure 1. Distribution of Stone and Iron Age sites

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Currently, the digital spatial database is in the form of a stand-alone record on one computer; it is not yet accessible to the public. However, one can query the database layers using the appropriate tools in the ArcGIS programmes. For example, one may be interested in sites of a particular archaeological tradition. In this case, the database may be used in the same way it is being used at NMMZ with the advantage that one can search through the records by using location, spatial attributes or by graphics where one simply draws the boundary of the area of interest and the software selects sites in that area using information in the attribute tables. The next crucial step in the development of the database is to make it available online for interactive mapping and for a larger audience. In this way, the database would be truly a national database, accessed by anyone interested.

### **Challenges in developing the database**

Numerous challenges were faced in developing the spatial database. The huge hurdle was that the location detail for the sites was in varied forms. Sites had geographic coordinates (latitudes and longitudes) while others had projected grid coordinates, specifically from the Universal Transverse Mercator (UTM) system. For the latter, the coordinates had different levels of accuracy; some had four-figure grid references, others had six, demonstrating that the original recording had varied aims which influenced the different levels of accuracy in site records. While the location detail for most of the sites appeared to have been read off topographic maps of the 1:50 000 scale series, some sites lacked this locational detail altogether. The UTM coordinate system determines location to the last metre. One also has to determine the Zone from which the coordinate came. The UTM coordinate can be used to identify different levels of location accuracy, depending on how it is specified. The coordinate may be written in alphanumeric format, e.g. TS 813427, especially when it is being read off the topographic maps. The full UTM coordinate would require decoding the letters and separating the figures into Eastings (X) and Northings (Y). Thus, to deal with locational parameters of the sites the work involved decoding the reference letters and the Zone to which the coordinate belonged Zimbabwe has two zones (Zones 35 K and 36 K). To display all the sites in the two zones at once, the UTM coordinates had to be transformed to geographic coordinates. Where latitudes and longitudes had been used instead of UTM, these had to be converted to decimal degrees which made it easier to work with the GIS software. Having cleaned the database in terms of the coordinate structure, it was then possible to display the sites using the display XY data command in the software.

When a map layer of Zimbabwe's country boundary digitised with the same coordinate system specifications as used for the sites was uploaded some of the sites appeared outside the borders of the country. Verification using the site names, map references and other detail captured, showed that sometimes the grid reference letters were interchanged, resulting in the sites displaying outside the country's border. Using the example of the coordinate provided above, TS813427, the letters could have been reversed to make the coordinate ST813427. Sometimes the entire six or eight figures could have been swapped as well. This had the implication that even some of the sites within the boundaries of the country may not be at the correct locations. Those well-known sites such as national monuments like Great Zimbabwe, Khami and others were also used for this verification process. A four-figure grid reference would mean that the site is somewhere within a square kilometre. A six-figure coordinate shows the site is somewhere within an area of 100m x 100m and an eight-figure one indicates that the

site is within an area of 10m x 10m. The level of accuracy increases as the number of digits or figures in the coordinate increases to match the UTM standard. For plotting purposes, the full coordinate has to be provided which, given the properties of the UTM coordinate system, must have 7 digits for each of the X and Y coordinates. Due to its design, however, the X coordinate normally has 6 figures when in Zimbabwe because the first digit is usually a zero (0). This explains why the grid reference letters in the coordinates had to be decoded to their numerical values. Sometimes additional zeroes had to be suffixed on the listed coordinate to make it a full coordinate. For example, a coordinate such as TS4978 would then be X - 0449000; Y- 7878000. This seriously compromised the accuracy of the database. In the GIS database, the original coordinate with the grid reference letters have been retained in order that the user of the database is able to note sites where the additional zeroes were added.

In the early days sites were first plotted as points on paper maps and then manually digitised using a digitising tablet. The non-spatial data was then added manually by adding fields to the feature table and then add text manually. As students became more and more interested in the database, especially for purposes of investigating location significance and the existence of distribution patterns, a quicker way was to plot the sites using the function in the GIS software for displaying XY data. This makes it possible to import existing point data from other sources into the GIS record as long as it had coordinate information. The rest of the detail about the sites would then be input using the edit table function in the Arcview / ArcGIS software. In the manual system, the inputting of the rest of the detail was tedious, prone to mistakes and sometimes not all of the information collected was input. The method of importing the tabular data proved easier to use. With spreadsheet programmes such as Microsoft Excel, the conversion of the coordinates to full UTM was done using mathematical formulae which quickened the process and whole tables could be imported into the GIS database.

### **Discussion: The potential of the spatial database**

A spatial database has the potential to serve a variety of groups of people. As more datasets are integrated on the database innovative uses of the system will arise. For example, the database may serve traditional users such as archaeologists and heritage managers, and in the case of Zimbabwe, city planners, real estate developers, miners, tourists and village communities. In the next paragraphs, I discuss a few sectors of the Zimbabwean society that may benefit in this database.

#### *Archaeology and heritage management*

It has been mentioned above that archaeology is an inherent spatial discipline (Anselin and Getis 1992, Lloyd and Atkinson 2004). Archaeological evidence must have location for it to be deemed to have context. A geospatial database thus should extend the range of questions that can be investigated as it provides the context of the sites. Already the GIS database is proving useful to students of archaeology who almost every year have a research question concerning settlement patterning and other spatial issues in archaeology. The database is opening new research questions and demanding new datasets that might be cultural or environmental. In addition, analysis of the distributions of archaeological sites is no longer just visual. Rather, complex spatial analyses and statistical computation are being performed beyond what was possible in the yester-years (see Musindo 2013). In addition, predictive models have

been developed using this site record. What would be needed is to then confirm the results of the model by checking the situation on the ground.

A geodatabase makes it possible to integrate the sites with other datasets in the vicinities or at the same locations as the sites. That way the database becomes usable in other operations beyond traditional archaeological research. For example, the database can be used in effective pre-development impact assessments. If the area to be affected by land developers is known and is accurately specified, it can easily be spatially marked out and all sites within that area can easily be identified through various techniques such as intersection and overlay manipulations, or any other parameters in the relevant GIS software suiting the situation. The potential of the database is demonstrated below using a fictitious proposal to expand two roads; the Harare-Nyamapanda and the Harare-Masvingo Harare roads in Zimbabwe (Figures 2a and b).

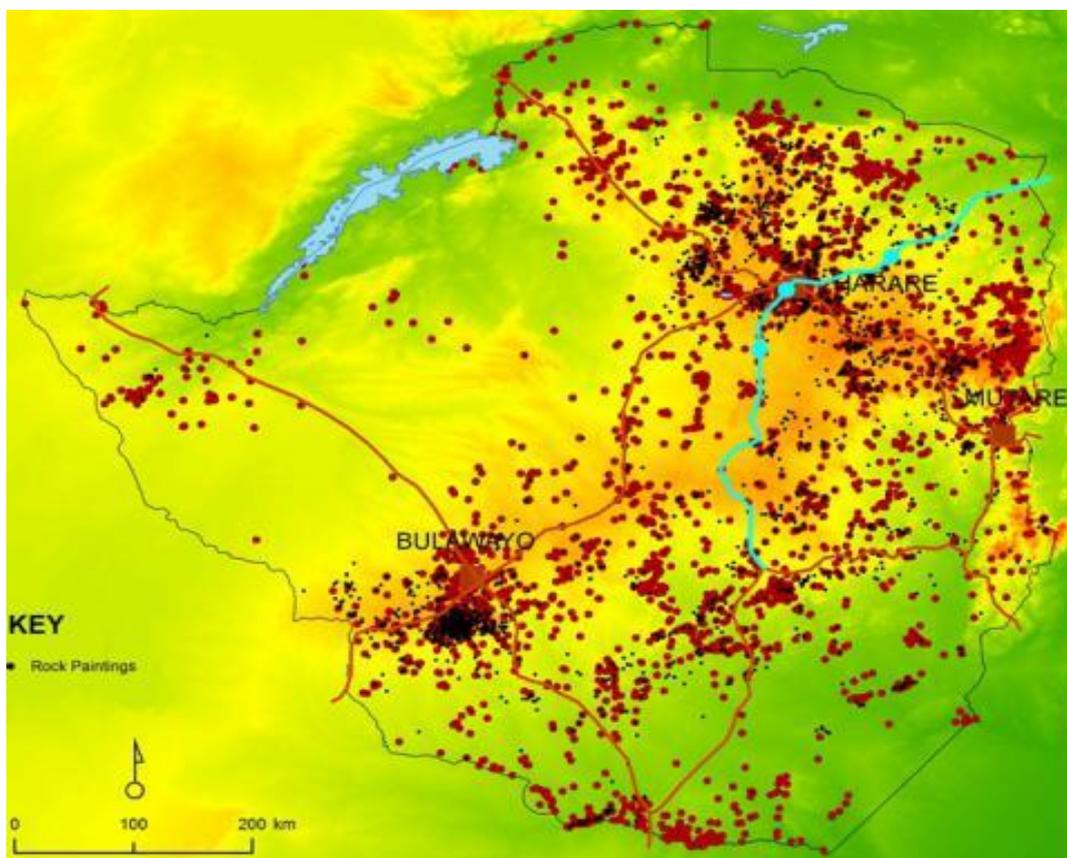


Fig. 2(a)

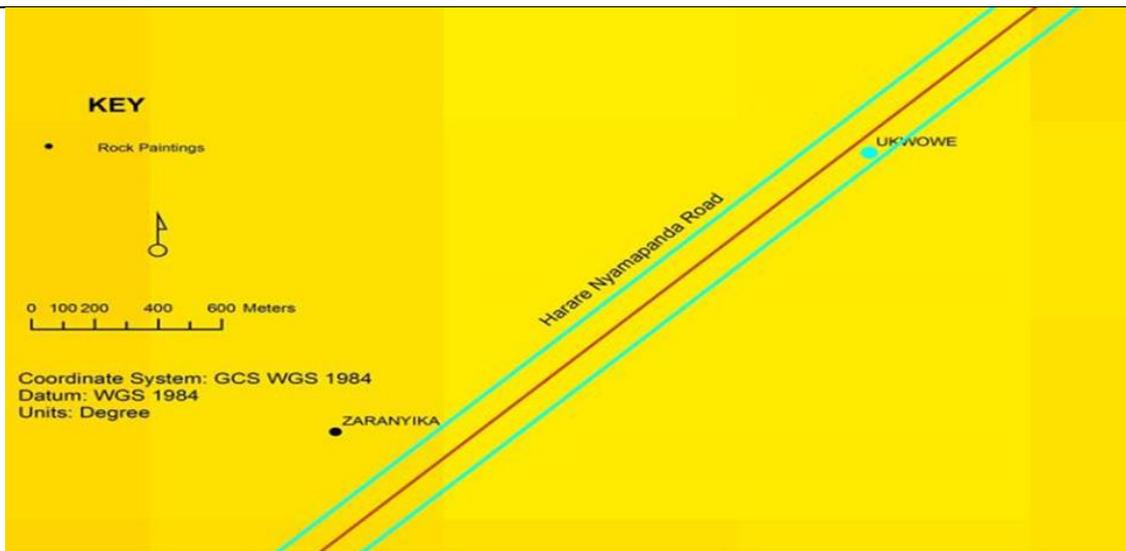


Fig. 2(b)

Figure 2. Assessing the impact of a proposed expansion of the Harare Nyamapanda Road and the Harare- Masvingo Harare Road. *This is a fictitious project only to demonstrate the potential of the spatial database under discussion. The proposed impact known from standard practice would be about 100m on either side of the current road. Image a). A map of Zimbabwe showing two roads to be expanded; Image b). a section of the Harare-Nyamapanda road showing the extent of the 100m on either side of the road (the road is the red line).*

Assuming such work has an impact within 100m on either side of the road, a developer connected to or with access to the spatial database can see for themselves the potential impact of the work. Through use of the geoprocessing functions, a rock art (Ukwowe) site is shown to be within the impact zone. Heritage management authorities with such a GIS facility can easily anticipate the risk of damage to occur and make appropriate decisions. Furthermore, they can use that as a quality control dataset to evaluate the result of an impact assessment. Future developments in the same area may rely on previous investigations whose extent should be mappable and integrated in the database as a separate layer of known surveys. South Africa has such kind of data on their South African Heritage Resource Information System (SAHRIS).

It is common knowledge that most of the sites that are in the database are not being monitored except if they are national monuments. Without adequate human resources to traverse across the country to assess the condition of all known sites, the GIS database can be monitored using remote sensing techniques, provided datasets such as aerial photographs and satellite images are available. Instead of managing by neglect, one would manage by remote sensing. Thus, the GIS database can be used in development facilitation. Numerous development projects are being commissioned. The survey record can be easily protected if the public is aware of its existence. It would be important to monitor the quality of heritage or archaeological impact assessment if the currently known record is used for cross checking.

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### *Agriculture*

The GIS database can easily be shared with other institutions that have an impact on archaeological and cultural sites or would want to make use of such sites. The land reform that began in 2000 could benefit from this service as the resettled farmers may not have had access to the cultural heritage on those farms. Land surveyors may also require this dataset and database so that as they mark land boundaries, they are aware that they are not just parcelling out land for agriculture but land with cultural resources. In some cases, such land may have sacred sites which may have to remain accessible to their owners. In addition, the integrity of the cultural heritage may have to be maintained intact.

### *Tourism*

The GIS database can be used by tourists, especially in self-guided tours. With further improvements, the database can be enhanced with additional features for interpretation. This is especially important and possible if it can be accessed through online means. Given the power of GIS to model various processes, issues of suitability of the location of some tourism facilities depends on what cultural resources might be in the area.

### *Disaster preparedness*

I have noted above the importance of the database in planning for disaster. With respect to cultural heritage, the impact of Cyclone Idai that hit Zimbabwe, Mozambique and Malawi in March 2019 is still being assessed. Had this database been in place and functional, any loss of archaeological sites could have been quickly determined. Even road constructions and other projects being implemented in the affected areas might be exacerbating the loss in archaeological sites. Decisions made on temporary holdings, opening access roads, among other activities, could have been done from a holistically informed perspective (see Lang 1998).

### **Metadata issues**

As far as application of GIS in documenting Zimbabwean archaeological sites is concerned, there is not yet much expertise. This has limited the establishment of standards that should guide application of the technology. At present, researchers use their own preferences as long as the key information required by NMMZ is provided. However, the drawbacks of manual recording systems is the weakness in enforcing completion of relevant information in the database. As a result, most of the sites record have varying degrees of completeness. Although, standards exist elsewhere across the globe, there is no pressure to conform to these standards. This is something that should be developed if the database is to continue to be useful in the future.

### **Future directions**

While there are several advantages of the GIS database, especially when several data become integrated with the site record, there are possible challenges that can be foreseen. These are however, surmountable challenges. A few of these challenges are discussed below.

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### *Site/monument security*

One of the challenges so far remains whether this database should be made public and accessed through web-based techniques. There are obvious dangers for such a move. For example, such a database might open the sites and monuments to risk of pillage and plunder as their whereabouts become common knowledge and yet with no mechanisms to secure all of them. However, the database developed out of public participation; that is the sites were a result of reports made by the public. It would therefore be unethical to deny the same public access to knowledge of this heritage.

### *Location accuracy*

The other challenge is that of accuracy of location detail which makes the database a bit unreliable for accurate risk predictions. Some of the coordinates have accuracy to the nearest kilometre which makes the data less useful where greater accuracy is required as in impact assessment or when land reforms or real estate changes demand such detail. Already attempts at relocating some of the sites during archaeological surveys has demonstrated that site locations in the database are imprecise. Changes in names of farms after which some of the names were derived makes it important to capture new site location detail with the highest accuracy possible. Where the sites are rediscovered for whatever reasons, the location detail has to be measured with greater accuracy using a suitable positioning device.

### *Public access to the database*

The current state of the GIS database requires one to know of its existence first in order to use it. Future directions in the development of the GIS database should focus on crafting a public user interface that should be accessible through online means. In its present state, the database is a stand-alone version only usable by one person. To make the online development possible, there must be a hosting institution which might be the University of Zimbabwe where the spatial database is currently located or NMMZ as the legal custodian of archaeological sites. The hosting institution must have the necessary servers and up-to-date GIS facilities. This means there are costs which the funder of such an installation might want to recoup in future unless they use public funds to do it.

An online GIS database for cultural heritage should be the way to go as it enhances heritage awareness to a larger audience than is currently possible with a static database. Digitisation of all associated documentation would lead to further conservation of this important national record. In addition, the record would become a powerful research facility.

### **Conclusion**

This paper described the current state of the digital database being developed at the Archaeology Unit of the University of Zimbabwe. From its manual state at the Zimbabwe Museum of Human Sciences in the 1990s the Archaeological Survey Record is now in a geodatabase format. Although some content such as photographs, publications and survey reports are yet to be made part of the database, the site list has become quite useful in its spatial format. The potential of this digital record has been highlighted and so should be embraced for conservation, tourism, and research purposes.

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