



ANALYSIS OF SHRINES DETECTION USING
GEOSPATIAL TECHNIQUES; CASE STUDY OF
LEMBAH BUJANG, KEDAH, MALAYSIA.

BY

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ABSTRACT

Lembah Bujang is an oldest historical site dated back 2 million years ago and become a starting point to understand the origins and history of civilization in Malaysia. The aim for this research is to identify the potential shrines area in three study areas consist of Lembah Bujang, Sungai Batu, and Kg. Pengkalan Bujang which is using RADARSAT and GIS techniques in conserving the historical site. Satellite Remote Sensing application has been proved efficiently used in various archaeological studies. The multi-temporal images of RADARSAT-1 and RADARSAT-2 are used to identify and spot the shrines area surrounding of sites. The images of multi-temporal in 2003 and 2014 with single microwave frequency 5.3 GHz, in the C-Band; the wavelength of 5.6 cm were interpreted through a specific site to address the research questions. Two techniques in identifying potential shrines consist of Local Adaptive Filtering and Feature Extraction have been used and tested to the RADARSAT images of three selected study areas by using processing software of ENVI and ArcGIS. The finding shows that the Local Adaptive Filtering on GAMMA Map filter is one of the best techniques in identifying potential shrines area due to it's preserving the pixel values of the images after processing. While edge enhancement improves the appearances of the shrines images to more readily interpret by the researcher. This research also will contribute possible remote sensing techniques in monitoring any expansions of land use developments surrounding the shrines area simultaneously assist in making recommendations in land use planning guidelines for preservation and conservation in the heritage site.

ملخص البحث

إن لمبه بوجانج هو أقدم موقع تاريخي يعود إلى 2 مليون سنة وأصبح نقطة بداية لفهم أصول وتاريخ الحضارة في ماليزيا. إن هدف هذا البحث هو تحديد منطقة الأضرحة المحتملة في ثلاثة مجالات دراسية تحتوي على لمبه بوجانج، وسونجاي باتو، وكامبونج بنكالان بوجانج والتي تستخدم تقنية رادارسات (RADARSAT) ونظام المعلومات الجغرافية (GIS) في الحفاظ على الموقع التاريخي. وقد أثبت بشكل فعال استخدام تطبيق الاستشعار عن بعد بالأقمار الصناعية لمختلف دراسات الآثار. تم استخدام صور الاستشعار عن بعد الرقمية لرادارسات 1 (RADARSAT-1) ورادارسات 2 (RADARSAT-2) لتحديد وتعيين أماكن الأضرحة حوالي المواقع. تم تفسير صور الاستشعار عن بعد الرقمية في 2003م و 2014م مع تردد ميكرويف أحادي 5.3 جيجا هرت، في الحزمة سي باند (Band-C)؛ طول الموجة ل 5.6 سم من خلال موقع مخصص للإجابة عن أسئلة البحث. لقد تم استخدام واختبار تقنيتين لتحديد الأضرحة المحتملة وذلك يتضمن تصفية تكيف محلية (Local Adaptive Filtering) واستخلاص الخصائص (Feature Extraction) على صور رادارسات (RADARSAT) لثلاثة مناطق دراسية مختارة وذلك باستخدام برنامج معالجة انفي (ENVI) وآرسيجس (ArcGIS). تظهر النتائج أن تصفية تكيف محلية (Local Adaptive Filtering) على مصفاة خريطة جاما (GAMMA Map) هي واحدة من أفضل التقنيات في تحديد منطقة الأضرحة المحتملة نظرا لحفظها قيم البكسل للصور بعد المعالجة. وبينما يتحسن تعزيز الحافة فإن ظهور صور الأضرحة تكون أكثر جاهزية للتفسير بواسطة الباحث. سيسهم هذا البحث بتقنيات استشعار عن بعد ممكنة لمراقبة أي توسعات في تطوير استخدام الأرض حوالي منطقة الأضرحة كما أنها تساعد في إعطاء توصيات في توجيهات استخدام تخطيط الأرض لحفظ وصون الموقع الأثري.

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of Urban and Regional Planning.

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DECLARATION

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This thesis is dedicated to my beloved parent, my family and my SV for their endless love, support and encouragement. Thank you very much!

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Abbreviations

AD	After Decade
CCRS	Canada Centre for <i>Remote Sensing</i>
CE	Common Era
CGAR	Centre of Global Archaeology Research
EIA	Environment Impact Assessment
ENVI	<i>Exelis</i> Visual Information Solutions
GC	Geometric Correction
GIS	Geographic Information System
LIDAR	Light Detection and Ranging
RC	Radiometric Correction
RS	Remote Sensing
SAR	Synthetic Aperture Radar
SB1A	Sungai Batu 1A
SB1B	Sungai Batu 1B
SB2	Sungai Batu 2
SB2E	Sungai Batu 2E

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF STUDY

Lembah Bujang is located in Merbok, Kedah, is between Gunung Jerai (1,300 meters high) in the north and Muda River in the south of Kedah, Malaysia. It became a starting point of the civilization of the Kedah Tua Kingdom and a strategic area for settlement and a centre for a trade and industry (Jacq-Hergoualc'h, 1992, Bellwood 1997). The issues raised by The Centre for Global Archeological Research (CGAR), University Sains Malaysia are pertaining the evidence which indicates that the civilization of the valley dates to the 4th century CE, whereas historically the valley was used as a trade route much earlier (Mokhtar, 2009-2010). It's history, its tangible and intangible heritage culture, economic and socio administrator and significance, and its diplomatic relationship offer fertile ground for scholar investigation. Approximately, over hundred shrines and hundreds of relics and artifact are founded around the Lembah Bujang. Unfortunately; these prehistoric sites are being rapidly destroyed due to modern land use practices such as infrastructure development and industrialization together with the development of townships are major destructive factors and require urgent conservation by the authority. The issues on these pre-historic ruins at archaeological sites in Lembah Bujang some 1200 years old were secretly demolished by a land developer. (Article can refer in Appendix C) Some site has been dug up from its spot near Sg.Batu (Site 11) with particular shrines hidden from sight because it location is in the private old palm land and the developer have probably demolished it first before clearing the site for development purposed. At

present, most of the cultural heritage legislation and management is based old-fashioned methods and prefer a high cost to handle services and field survey which underpin regional and national registers of cultural heritage sites. This old method had been influenced realistic forecasting and lack of reliable data and causes costly and time-consuming due to their application over large areas and introduces unnecessary conflicts.

Therefore, the availability of remote sensing technologies and its capability offers the advantage of providing a synoptic view, covering large areas, and demonstrating the capability to detect features not easily visible on the ground that may be important for archaeological applications (Brivio et al., 2000). Nevertheless, the availability of multi-spectral data proved to be an effective data source for paleogeographic environment studies (Brivio et al., 2000; Parry, 1992). The use of remote sensing techniques in both historic and prehistoric site discrimination is well documented (Lyons, 1977, Lyons and Hitchcock, 1977 and Kruckman, 1972). Radarsat 1 provides horizontal transmit and horizontal receiver (HH) data (793-821 km altitude), Radarsat 2 was launched 2008, provides VV polarization, cross polarization (HV or VH), dual polarization (HH+HV@VV+VH) and quad-polarization (HH+VV+HV+VH). This makes RADARSAT an incredibly versatile imagery type (798km altitude). The application of radar to a later phase of development because the multispectral technique seems to be the most promising in terms of cultural heritage site localization and monitoring, and has already shown its usefulness (Grøn et al. 1999; Holm-Olsen et al. 1999; Shennan & Donoghue D. 1991). SAR system (synthetic aperture radar) is one of the active sensors used for archaeological investigation. Its highest resolution is 1 m in Spotlight mode (3 m in Ultra Fine mode) requirement capable in penetrating solid features including

vegetative cover and soil surface. In the central Iberian Peninsula of Spain, SAR data (with a 2.4-13.7m resolution) found potentially buried architecture (Ayuga et al, 2006). The expected output of this study is images of shrines area consist of Lembah Bujang, Sungai Batu and Kg.Pengkalan Bujang by using RADARSAT and GIS processing techniques in conserving the historical site in the context of efficient land use planning.

1.2 PROFILE OF STUDY AREA

Lembah Bujang is located in Sungai Petani, Kedah (northern Malaysia), and specifically in Merbok district of Kuala Muda. It is one of the most significant findings of evidence proving the earliest civilizations of Malay Peninsula. Lembah Bujang holds a significant value as a physical prove of the earliest civilization in the Southeast Asia region. The specific study area is divided into three main areas consist of Lembah Bujang, Kompleks Sungai Batu and Kg.Pengkalan Bujang (Figure 1).

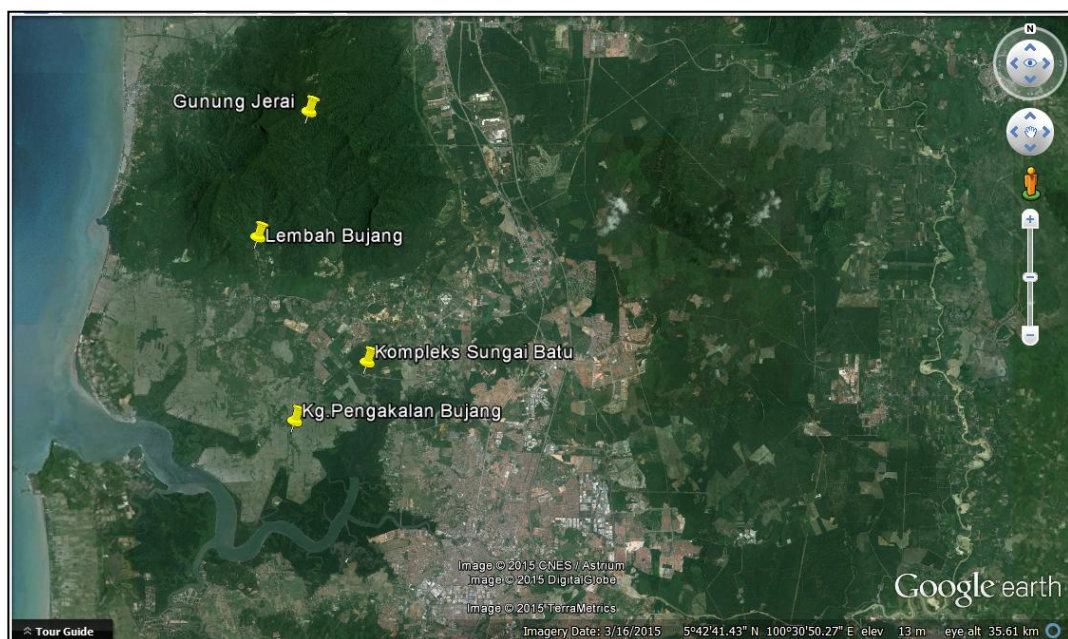


Figure 1.1: Location of the study areas

1.2.1 Lembah Bujang.

Three specific study areas have been chosen due to their remarkable of historical in Malaysian civilizations. Lembah Bujang was an international cultural and commercial crossroad 2000 years age. It is history, its potential, economic and socio – cultural administrator and significance, its art and architecture and its diplomatic relationship offer fertile ground for scholar investigation. The chronology of the study areas will be discussed in chapter two.

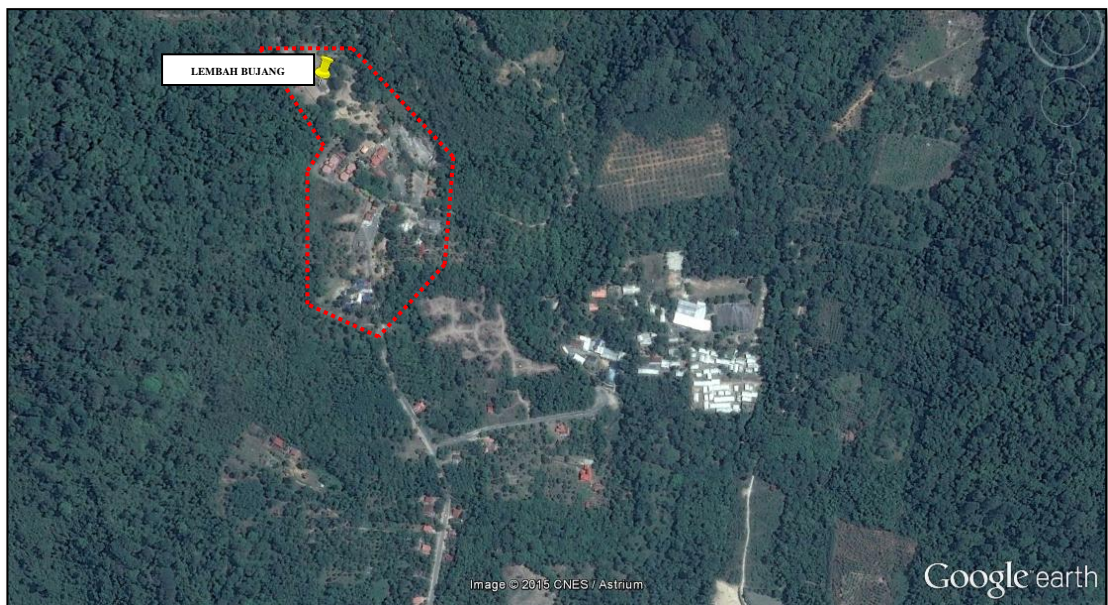


Figure 1.2: Location Map of Lembah Bujang

1.2.2 Sungai Batu.



Figure 1.3: Location Map of Sungai Batu.

1.2.3 Kg.Pengkalan Bujang.



Figure 1.4: Location Map of Kg.Pengkalan Bujang

1.3 PROBLEM STATEMENTS

In this research, there is some problems and issue that will be addressed;

- i. Distribution of shrine complex and no clear boundary separating the site and the surrounding area.

The shrines complex are scattered around not only in Sungai Petani but spreading to down south to the boundary of Kepala Batas, Pulau Pinang and to the north up to Yan. Currently, there are two areas that have been gazette in Kuala Muda Local Plan 2020; Archaeological site of Lembah Bujang and archaeological site of Sungai Batu, but, there are more shrines in other places. It is difficult to include every shrine under a gazette reserve. The owners of the land do not recognize their land as part of heritage site leads to the land transaction to the private developer (Yeoh, 2013). Upon site clearance, the process will damage the archaeological evidence that is uncovered by the research centre. Certain criteria need to be fulfilled to ensure no heritage area will be destroyed for development in the future.

- ii. Lack of tools and techniques in determining the boundary of heritage sites.

Currently, the site is still under the on-going study of Universiti Sains Malaysia. The overall distribution of shrines area is quite huge and scattered around the district of Sungai Petani, Kedah. But the actual area that covers the shrine site is not clearly determined, thus, the sites that are gazette in Kuala Muda Local Plan 2020 are only Heritage Zone Sungai Batu and Heritage Zone Lembah Bujang. According to Heritage Act (2005), buffer zones only gazette for the sites with physical archaeological evident, not including the area which is under examination. Therefore, the integration of remote sensing and GIS techniques is one of the mechanisms that authorities can

apply in monitoring and observing the shrines area in Lembah Bujang from the uncontrolled development.

- iii. Lack of protection and development control surrounding the heritage sites that is not yet gazetted under Heritage Act 2005.

The archaeological activities and research of heritage area are under research grant of Universiti Sains Malaysia while the development plan of Lembah Bujang district is under the jurisdiction of Sungai Petani Municipal Council. In order to be gazette under Heritage Act 2005, National Heritage Department and local authority need to identify the area and the vicinity, also conducting activity of preserving the physical structure of the shrine complex. The procedure to acquire the buffer zones of 200 meters parameter as mentioned in Heritage Act 2005 only after physical preservation and conservation of the heritage sites have been done. It does not provide buffer zones to the surrounding area to prevent the development encroaching the heritage area where the probability of unearthed shrines is positive.

1.4 RESEARCH QUESTION

Based on the problem statement, the relevant research questions can be developed as below;

1. Does the combination of remote sensing and GIS techniques can be apply in detecting a potential shrine area for the historical site?
2. What is the specific technique for RADARSAT in detecting potential shrine area for the historical site?

3. How geospatial techniques can be applied to urban planning policies through preserving an archaeology site?

1.5 STUDY AIM AND OBJECTIVES

The aim of this study is to integrate remote sensing and GIS techniques in identifying potential shrines area in preserving and protecting historical area through the efficient use of land planning policies. Therefore, three objectives are formulated as follow;

1. To analyze the combination of remote sensing imagery and GIS processing techniques in determines shrines areas in Lembah Bujang, Sungai Batu and Kg.Pengkalan Bujang.
2. To detect potential shrine areas using RADARSAT through filtering techniques.
3. To recommend the advancement of the geospatial technologies that possibly can be applied to preserve historical site.

1.6 SCOPE OF STUDY

1. RADARSAT-1 and RADARSAT-2 imagery database were obtained from Agency Remote Sensing Malaysia (ARSM). Datasets consist of satellite Radar images from the year 2003 and 2014 are acquired in order to determine the shrine area in the specific study area; i) Lembah Bujang ii) Kompleks Sungai Batu and iii) Kg.Pengkalan Bujang.The radar satellite images later will be analyzed using remote sensing application, ENVI 4.8.