IDENTIFYING SHRINES AREA USING RADARSAT LEMBAH BUJANG, KEDAH, MALAYSIA

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ABSTRACT: Lembah Bujang was an international cultural and commercial crossroad 2000 years age. Its history, economic potential and a unique socio – cultural, art and architecture and diplomatic relationship offer fertile ground for scholar investigation. However, the issue on the pre-historic ruins as archaeological sites in Lembah Bujang were secretly demolished by modern development brings a further analysis. The aim for this research is to identify potential shrines area in two study areas consisting of Lembah Bujang and Kompleks Sungai Batu using RADARSAT images. Local Adaptive Filtering and Feature Extraction were applied to multi-temporal images of RADARSAT for years 2003 and 2014 to identify potential shrines. Two study areas were selected using ENVI 4.8. The findings show that The Local Adaptive Filtering on GAMMA Map filter is one of the best techniques in identifying potential shrines areas. This technique proves to be a reliable guide in historical sites detection in Malaysia which will also contribute to the chronological literature of the land use development planning in Lembah Bujang. Additionally, this technique will also aid in making recommendations for land use planning guidelines in preservation and conservation of heritage sites.
Keywords: remote sensing, RADARSAT, land use planning, historical sites

INTRODUCTION

Lembah Bujang, a place located in northern Malaysia (Kuala Muda, Kedah) is one of the most remarkable archaeological sites. It was an international cultural and commercial crossroad 2000 years age. Its history, economic potential and a unique socio – cultural, art and architecture and diplomatic relationship offer fertile ground for scholar investigation. Over 50 shrines and hundreds of relics are on displayed in the nearby Lembah Bujang archaeological museum. Recently, many of these prehistoric sites are being rapidly destroyed due to modern land use practices such as infrastructure development and industrialization together with development of townships are major destructive factors and require urgent conservation by the authority.

Lembah Bujang Archaeological sites are threatened by rapid development. Developers might have demolished excavation sites near Sungai Batu that contain hidden shrines during land clearing works. Simultaneously, the other perimeter areas which also have in term of significant heritage value are not protected under any policies and law which caused vulnerability upon future development. At present, most of cultural heritage legislation and management is based on old-fashioned methods of 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. (Grøn and Loska, 2002).

Renowned because of that, the capability of remote sensing techniques offer 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 paleo-geographic environment studies (Brivio et al., 2000; Parry, 1992). The used of remote sensing techniques in both historic and prehistoric site discrimination are well documented (Lyons and Hitchcock, 1977). RADARSAT-1 provides horizontal transmit and horizontal receiver (HH) data (793-821 km altitude), RADARSAT-2 launched in 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 (Shennan and Donoghue, 1991). SAR system (Synthetic Aperture Radar) is one of the recent active sensors used for archaeological investigation which can be operated from satellites to facilitate registration of small-scale topographical features (penetrating vegetation), variation in ground moisture, and the occurrence of stones.

SAR datasets, with the ability to record data beneath the earth`s surface have been applied to a number of archaeological investigations. In the central Iberian Peninsula of Spain, SAR data (with a 2.4-13.7m resolution) found potentially buried architecture (Ayuga at al., 2006). SAR data has also been used to detect archaeological site not discovered during foot survey (Sarah, 2009). In examining structural patterns at Petra, Jordan, SAR detected previously unknown linear features. The data also showed ancient pathway, open subterranean chambers, and natural landforms related to known archaeological sites. This study continued at Beidha, Jordan through a cultural sites analysis initiative, which identified the general landscape condition of the area (Comer, 2003). Airsar has been used extensively at Angkor Wat to understand more complicated human-environment interactions (Evan et al., 2007). Work done at early Bronze Age site in Israel, Leviah Enclosure (not seen in the ground or in aramid photographs) was detected with ATR and later confirmed with excavation (Ben-Dor et al., 1999). Therefore, the objective of this study is to identify potential shrines area in the two study areas consisting of Lembah Bujang and Kompleks Sungai Batu using RADARSAT to conserve the historical sites for efficient land use planning.

STUDY AREA

Lembah Bujang is located in Sungai Petani, Kedah (northern Malaysia), and specifically in Merbok, Kuala Muda district. It is one of the most significant findings of evidences 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 areas are divided into two main areas consist of Lembah Bujang and Kompleks Sungai Batu (see Figure 1).

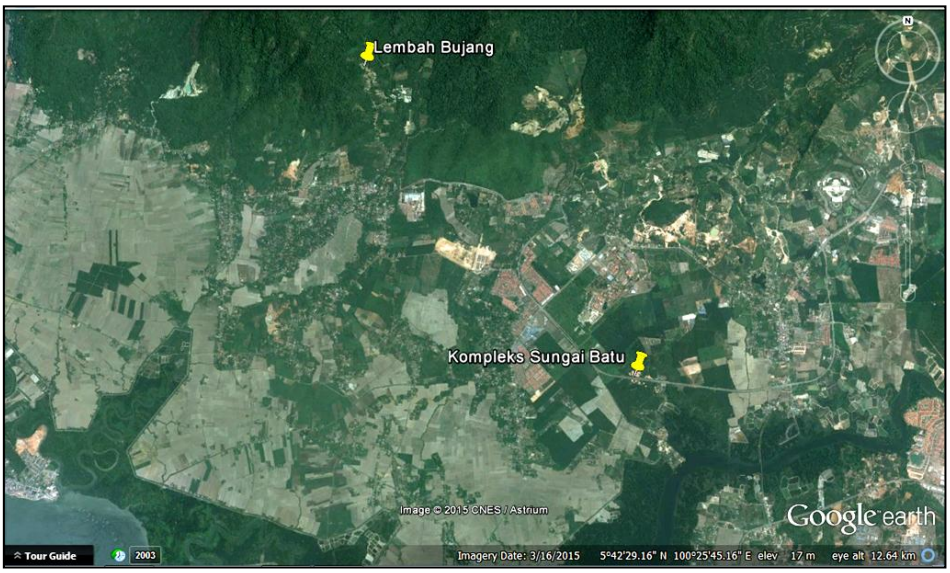


Figure 1: Location of Study Areas
Source: Google Earth, 2015

METHODOLOGY

Material and Software

The data was been collected from primary and secondary data sources. The data collected from the primary sources include topographic maps of the area, land use map, and imageries used in this study are RADARSAT for years of 2003 and 2014. Table 1 shows the detail specification for imageries used in this study.

Table 3: Detail specification of RADAR imageries used in this study

SPECIFICATIONS	IMAGE 1	IMAGE 3
Radarsat	RADARSAT1	RADARSAT2
Acquisition Date	Year 2003	Year 2014
Modes	Standard	Standard
Swath width	Standard	Standard
Band	C-Band	C-Band
Polarisation	HH	
Nominal resolution	Standard: 25m	Standard : 30m
Areas	Lembah Bujang and Sungai Batu	

Methodologies

In this study, we conducted a data collection in two different sites consist of Lembah Bujang and Kompleks Sungai Batu. The specific inventory on material of shrines was identified to be used in image processing. The complete methodology is shown in Figure 2.

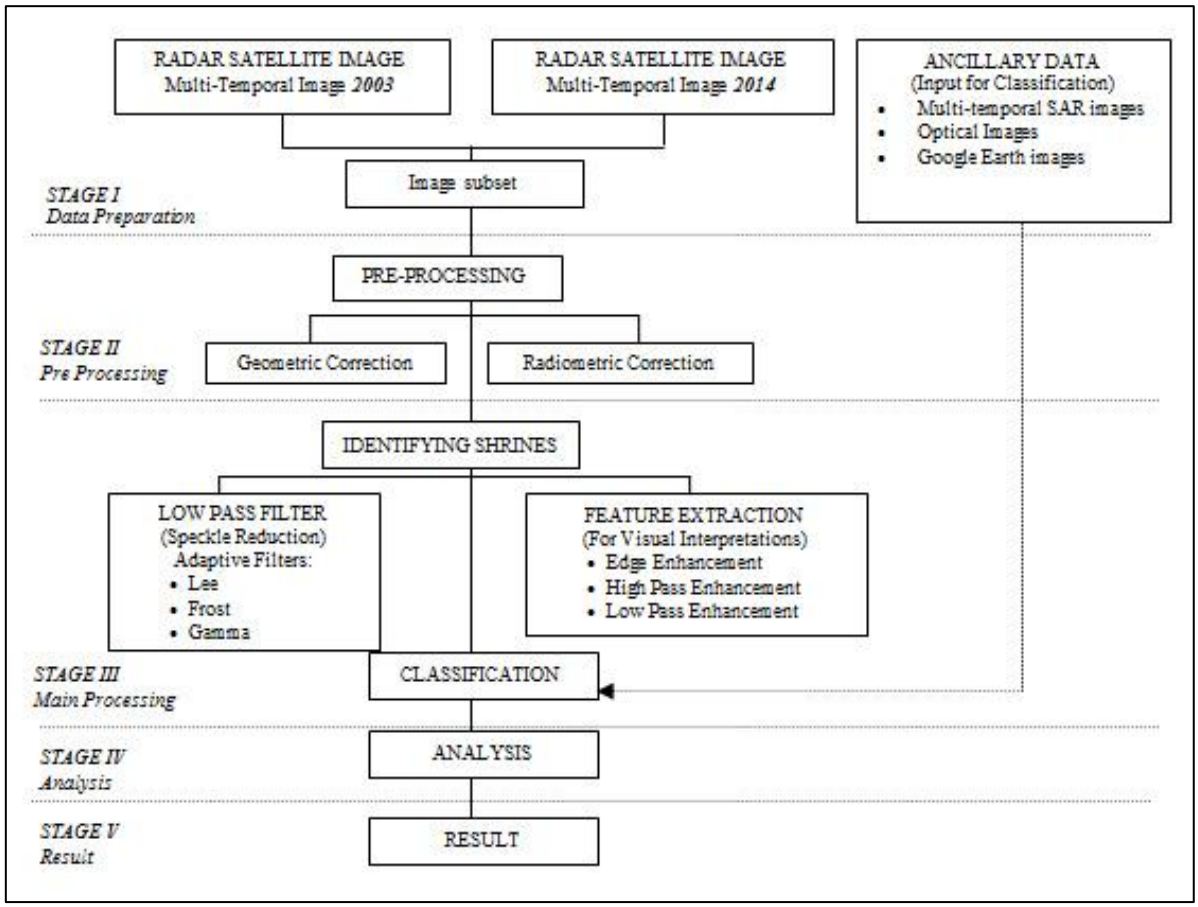
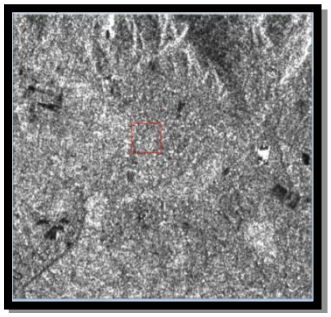


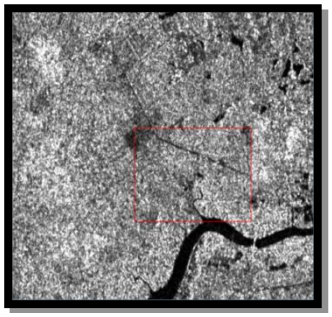
Figure 2: A Detail of RADAR Processing Images

Pre-Processing

The image pre-processing and data preparation techniques are the first to be carried out; these include image rectification and subset. The image-to-map procedures have been applied to the Radar image using a set of ground control points area appeared in the same place both in the imagery and known locations in corresponding maps and urban plans used as ancillary information in the rectification process. The rectified data sets are then subset producing the two sets of specific study areas. The Radar satellite imagery shows the subset of study area with main shrine area located at Lembah Bujang and Kompleks Sungai Batu, Malaysia in multi temporal images: 2003 and 2014. The process was carried out via ENVI 4.8. The results of subset for three areas of study are shown in Figure 3:



(a)



(b)

Figures 3: Subset of study area for three study area of (a) Lembah Bujang; and (b) Kompleks Sungai Batu

ANALYSIS OF SHRINES IDENTIFICATION

Local adaptive filter or smoothing techniques have been applied to radar imagery such as Lee, Frost and Gamma MAP filter. The advantage of adaptive filtering is its accuracy in estimating the backscattering coefficient inside homogenous (stationary) area while preserving edge and texture structure in non-stationary scenes. The performance of this proposed filter is evaluated and compared with the pixel intensity values such as enhancement of the images by using Research System tool; ENVI 4.8 as a method in RADARSAT digital images processing. Various window sizes and six of iterations 3 × 3, 5 × 5, 7 × 7 and 15 x 15 window sizes in order to fully understand the effects imposed by various window sizes and different number of iterations of each filter. Results below are the findings and details of the images after going through the filtering process.

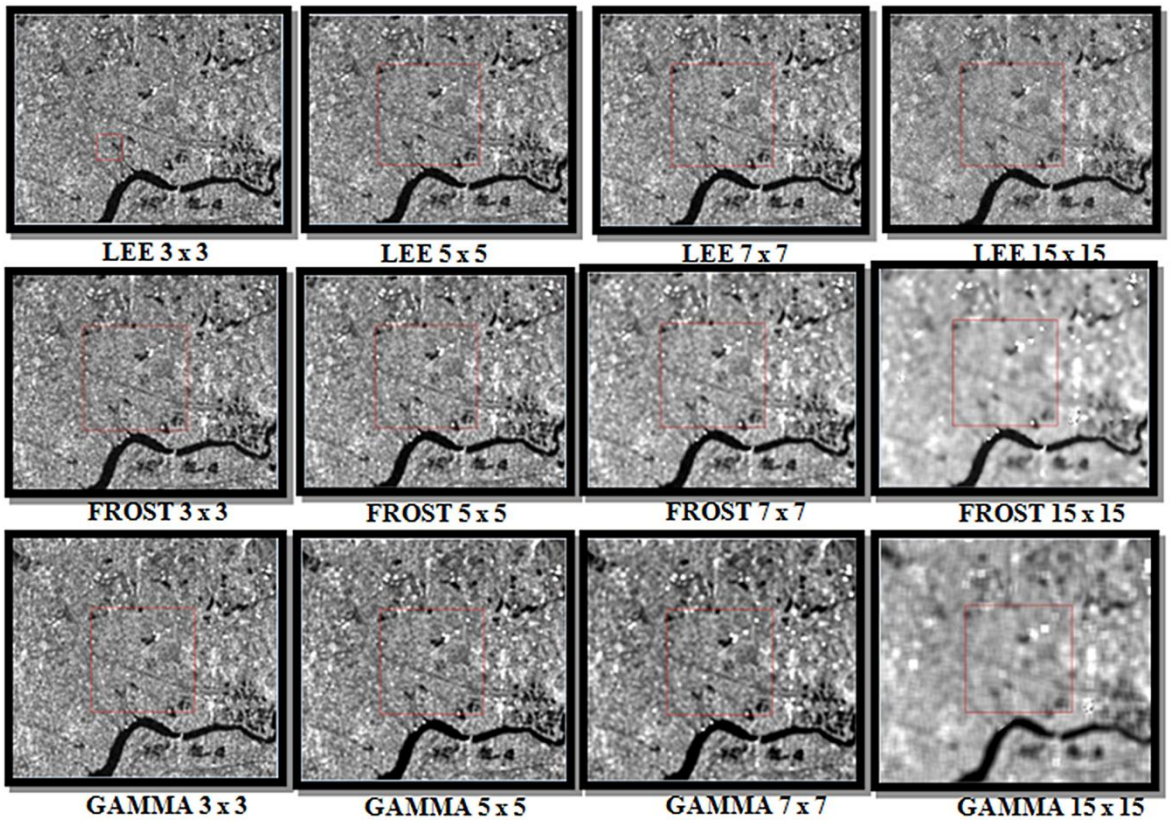


Figure 4: Result of Low pass filter image for different windows are tested for Lembah Bujang

The term 'enhancement' is used here to refer to the alteration of the appearances of an image in such a way that the information contained in the images become more readily interpretable by the viewer according of his/her needs. Four type of enhancement have been tested to compare the images appearances in the studies area. The result of Edge Enhancement in Lembah Bujang; and Sungai Batu imageries shows the equation with Kernel Size at Field to 5 and Applied Images Add Back Field to 90% per 100% with techniques Laplacian on convolution method. Same goes to high pass and low pass enhancement techniques, the value of kernel size is 5 and images add back field to 90% per 100%. This convergent study has provided refinements to the problem-solving process part of the detection of shrine area by using geospatial application technique in the heritage site. The increasing values of the window is related to the increasing brightness of the images. However, further studies in other filtering techniques can improve the radar images to minimise the speckle texture.

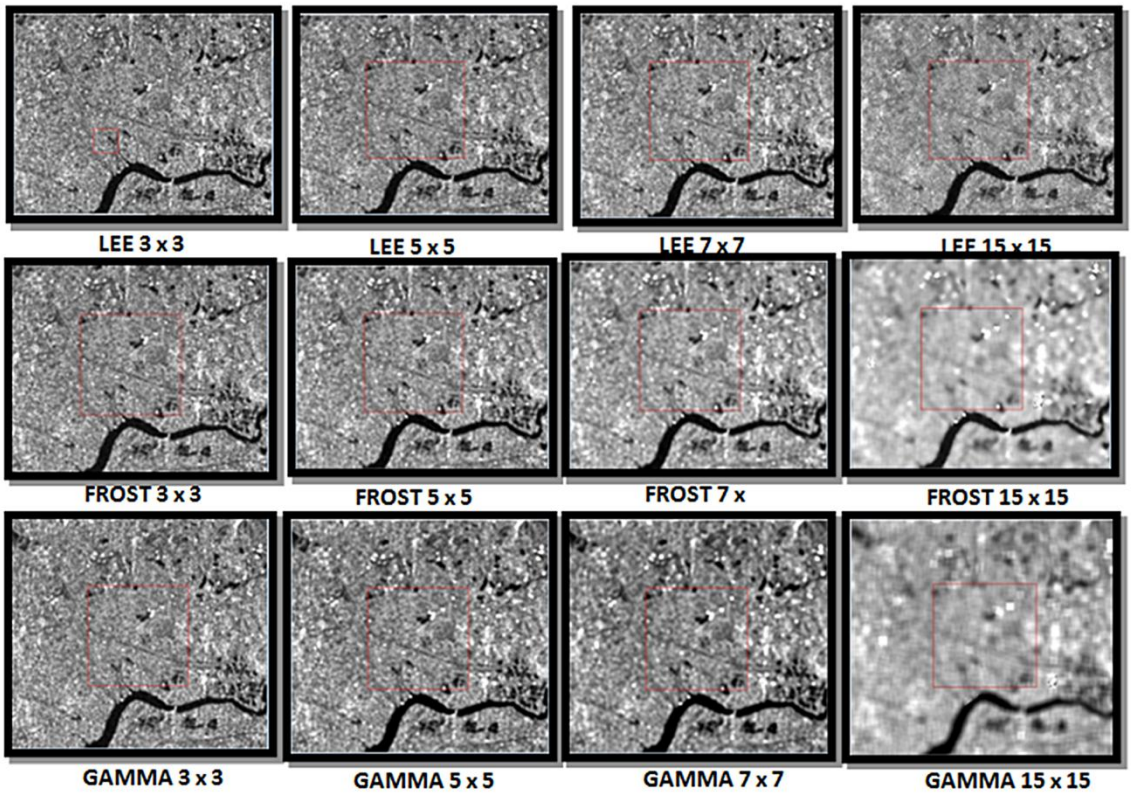


Figure 5: Result of Low pass filter image for different windows are tested for Kompleks Sungai Batu

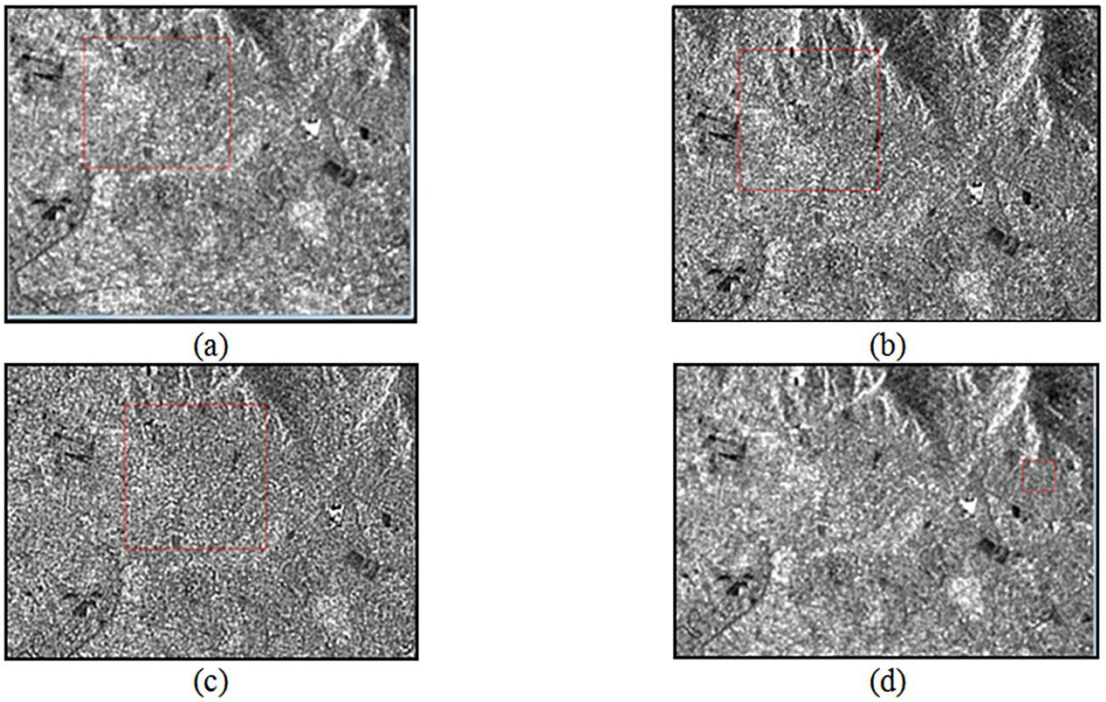


Figure 6: Result of Image Enhancement for different techniques are tested for Lembah Bujang a) Gamma Filtering 3x3, b) Edge Enhancement, c) High Pass Enhancement, d) Low Pass Enhancement

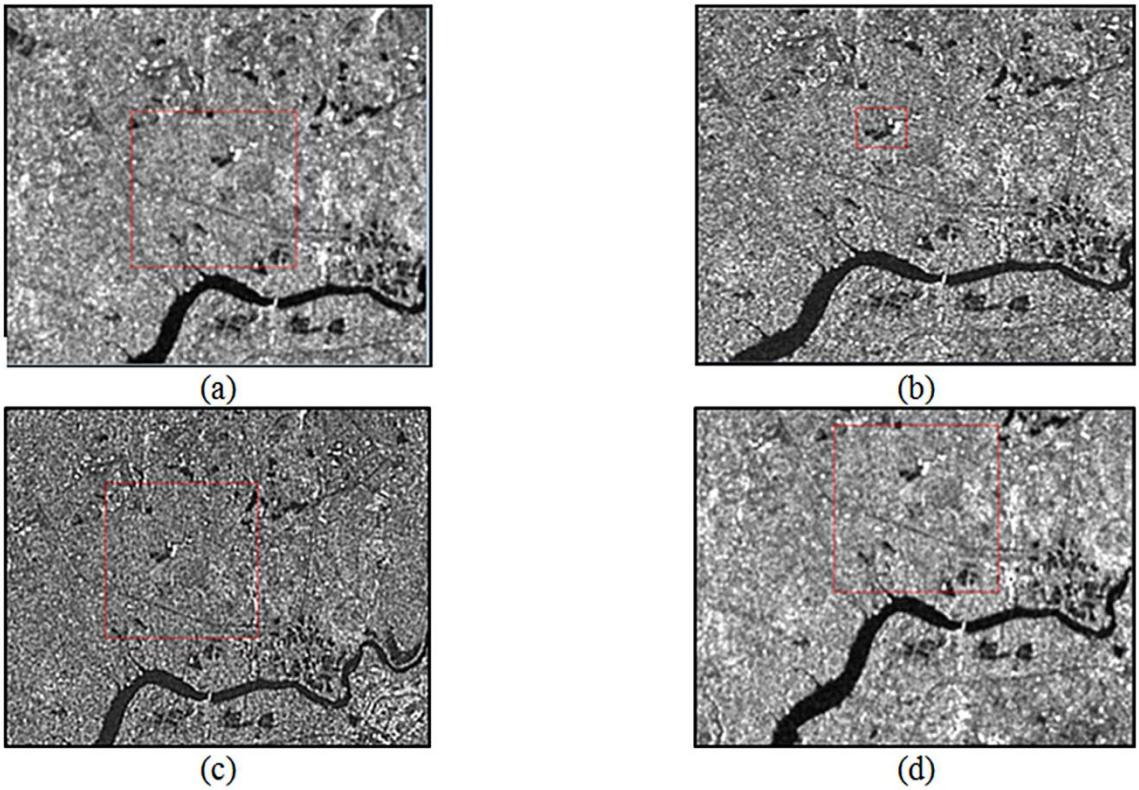


Figure 7: Result of Image Enhancement for different techniques are tested for Kompleks Sungai Batu a) Gamma Filtering 3 x 3, b) Edge Enhancement, c) High Pass Enhancement, d) Low Pass Enhancement

CONCLUSION

The goal of our research is to demonstrate the multi techniques of image processing in attempt to identify shrine areas in heritage sites at Lembah Bujang at once to improve the existing tool of urban planning in preserving the historical sites. It shows that a radar image is one of significant tools as a support system and very competent in identifying a potential shrines areas. The future studies suggested here will provide a means for land use planning development by using the remote sensing technology in the significant site area especially on historical site.

Acknowledgement

The authors greatly acknowledge the Universiti Malaya for research grant on Program Rakan Penyelidikan with International Islamic University of Malaysia, Malaysia Remote Sensing Agency and Town and Urban Planning Department, Centre for Global Archaeological Research (CGAR), Universiti Sains Malaysia, Department of National Heritage and Universiti Teknologi Malaysia for providing invaluable respective data used in this study. Authors sincerely thank all referees for their suggestions to improve the manuscript.

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