



Laporan Akhir Projek Penyelidikan Jangka Pendek

**Formulating Optimization Process in
Spatial Site Selection**

By

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[Home >> Imaging Science Journal, The, Volume 58, Number 3](#)[Texture analysis of IKONOS satellite imagery for urban land use and land cover classification](#)Authors: Kabir, S¹; He, D-C²; Sanusi, M A²; Wan Hussina, W M A¹Source: [Imaging Science Journal, The, Volume 58, Number 3, June 2010](#), pp. 163-170(8)Publisher: [Maney Publishing](#)[< previous article](#) | [view table of contents](#) | [next article >](#)

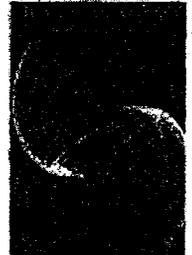
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[PDF 486.5kb](#)[Mark item](#)**Abstract:**

Traditional spectral-based methods of extracting urban land cover and land use information from remote sensing imagery have proven to be unsuitable for high spatial resolution images. Texture has been widely investigated as a supplement to spectral data for the analysis of complex urban scenes. This research evaluates the grey level co-occurrence matrix (GLCM) texture analysis technique and the maximum likelihood classification approach for the extraction of texture features to be combined with spectral data, as a method for obtaining more accurate urban land cover and land use information from high spatial resolution images. Classifications were performed on IKONOS imagery using three datasets: a spatial dataset consisting of three texture images (mean, homogeneity and dissimilarity), a spectral dataset consisting of four spectral images (red, green, blue and NIR) and a combination dataset (spatial and spectral). Results show that the combination dataset produced the highest overall classification accuracy of 86.1%, an improvement of 7.2% over the spectral dataset.

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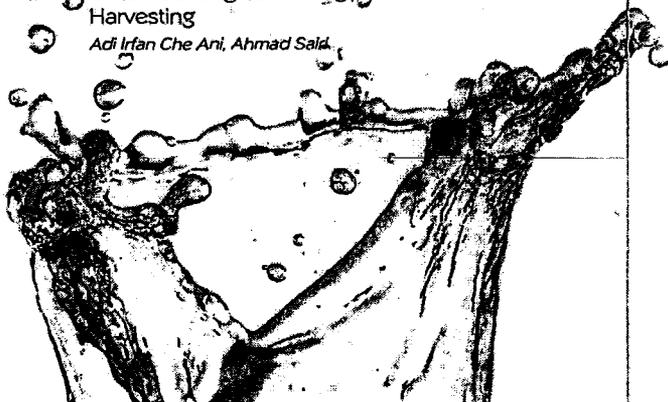
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OPTIMISATION AND MAXIMISATION OF ENERGY YIELD IN LOW WIND SPEED REGIONS

A CASE STUDY IN MALAYSIA

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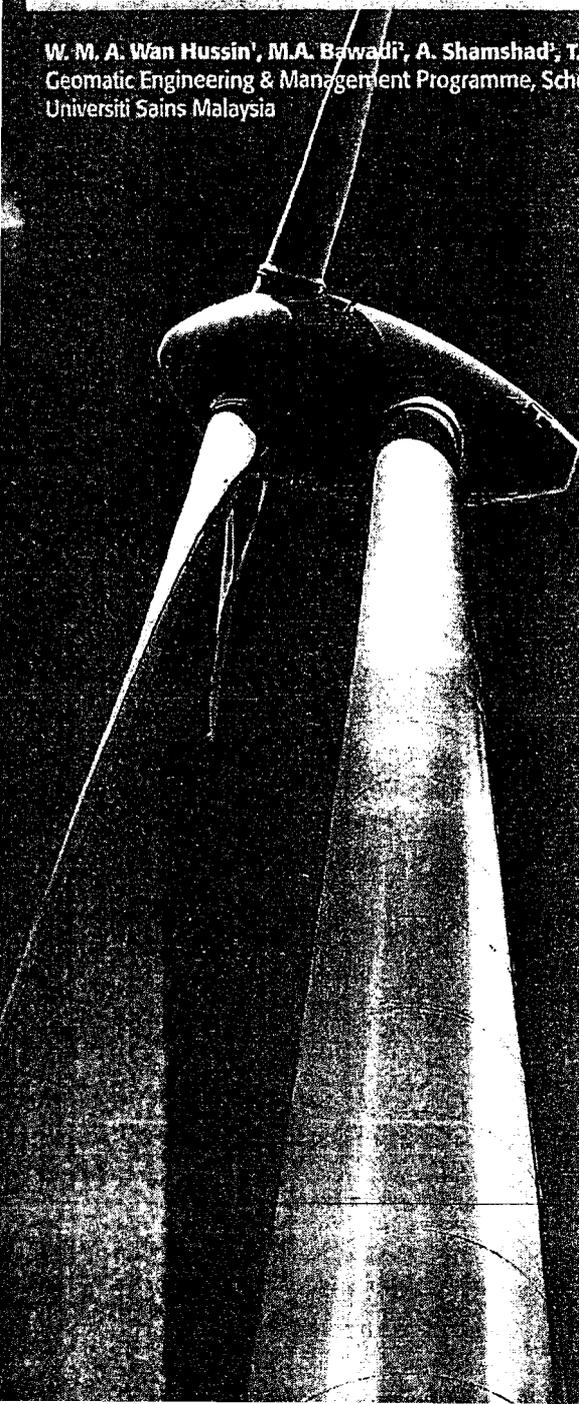
This study was carried out to optimally maximise the annual energy output by minimising the different kinds of losses in low wind locations through the design of suitable wind turbine layouts at the selected site. The site for placement of wind turbines requires detailed topography and roughness information. The method consists of positioning wind turbines to maximise the energy absorbed or equivalently minimise the loss of energy due to wake effects.

In this study, the cut-in wind speed is an important parameter in evaluating the type of wind turbine in low wind speed region is studied.

Introduction

The sea surface roughness is quite well known in open ocean condition [Hojstrup, 1994], but on land it is somewhat different if hilly areas and other land features are present. The coastal areas are the most suitable locations for turbine installation to generate energy as the mean wind speed is higher than those inland [Barthelmie, 1996]. Roughness features in the surrounding areas of wind farm also affect the wind speed in the wind farm. The wind energy production capacity depends on the total number of turbines installed in the wind farm.

The wind energy conversion system (WECS) design parameters optimisation depends on the level of the analysis. Power curve defines general analysis as cut-in, rated, cut-out wind speed and rated power. The output power is variable in only one range wind speed for pitch-controlled turbine. In this sense, the power curve can be used as a simple model of the WECS analysis. The cut-out wind should be neglected because it has a



BULETIN GIS



JAWATANKUASA PEMETAAN DAN DATA SPATIAL NEGARA

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DETECTING THE LAYOUT ERROR OF CONSTRUCTED BUILDINGS USING GIS SPATIAL ANALYTICAL TOOL

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ABSTRACT

This paper describes the development of a GIS modeling technique that can map and analyze layout error in constructed buildings. GIS system is capable of producing maps often to a standard of quality equal to any conventional mapping tools and can combine analysis with display, data input and data management. Analytical comparison between architectural drawings with the "As Built map" derived from satellite images can determine deviation of the layout buildings in reality. The development of "As Built map" and error analysis was performed in IDRISI32 software. The case study was conducted on the major buildings in the Engineering Campus Universiti Sains Malaysia. A combination of GIS map algebra technique and cross tabulation analysis was carried out to determine the extent of layout deviation of various constructed buildings within the campus. The result of the spatial cross – tabulation analysis indicates that percentage deviation of buildings ranging from 9% to 42% has occurred within the constructed campus buildings. The error analysis has also produced layout errors ranging from 9% - 65%. This gives an indication that architectural drawing specifications are generally not being followed during a certain building construction. Improper management supervision or budget factors during construction process can be identified as the cause of error. Nevertheless, this paper has proven that "As Built map" derived from satellite images is fast and accurate, and can be used for the layout error analysis. The result obtained in this study is very significant and has proven that GIS is a very important analytical tool in the study of error measurement and the modeling approach.

1. INTRODUCTION

Geographical Information System (GIS) has been generating massive interest in Malaysia and it is usually being practiced by the government sector, university educational research and in large private sector [MAS, Telekom Malaysia, and PLUS etc.], banking, development planning and

**PENCAPAIAN SKIM GERAN PENYELIDIKAN FUNDAMENTAL
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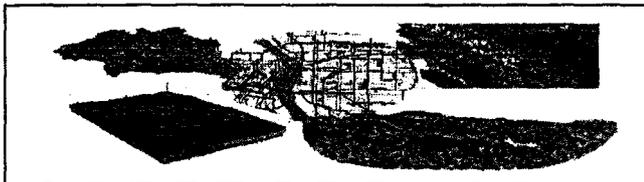
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1	Hasil Penyelidikan	Pembentangan Kertas Kerja/Penemuan Penyelidikan	3	<ol style="list-style-type: none"> 1. Mohd Sanusi S.A., Rabi'ah A. [2008]. Improved Hierarchical Criterion Weighting For GIS-Multiple Criteria Site Suitability Model. The 1st ASEAN Civil Engineering Conference: Civil Engineering Innovations for Regional Development, 3-5 December, Pataya, Thailand 2. Mohd Sanusi S.A. and Rabi'ah, A. [2009]. A. Converting Categorical Data into Quantitative Map For GIS Based Suitability Model. The National Conference on Civil Engineering, Awam' 09, USM October 27-29, Corus Hotel K.L 3. Saeed M., Mohd Sanusi S.A., & Hamidi A. [2008] Geographic Information System (GIS) Components for Deriving Sanitary Landfill Site Weighting Criteria. International Conference on Environment (ICENV 08) 15-17 December, Penang
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				<p>2. Mohd Sanusi S. A. and Rabi'ah A. [2009] Detecting The Layout Error Of Constructed Buildings Using GIS Spatial Analytical Tool. GIS Bulletin, No. 2/2009. National Spatial Data and Mapping Commission, ISSN1394-5505</p> <p>3. S. Kabir, Dong-Chen He, M.A. Sanusi and W.M.A. Wan Hussin (2009). Texture Analysis of IKONOS Satellite Imagery for Urban Land Use and Land Cover Classification, The Imaging Science Journal (In Press).</p> <p>4. M.A. Sanusi and R. Ahmad (2010). GIS based prescriptive model for solving optimal land use allocation. International Journal of Computers, Environment and Urban Systems. (Under review)</p> <p>5. M.A. Sanusi, S. Kabir, and R. Ahmad (2010). An Enhanced Analytic Hierarchy Process for Site Suitability Models Based on Multiple Criteria and GIS. International Journal of Computers and Geosciences. (Reviewed and corrected)</p>		
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FORMULATING OPTIMISATION PROCESS IN SPATIAL SITE SELECTION

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ABSTRACT (120 words)

This project has formulated an optimisation technique to spatial site selection process. The research was applied to spatial problem in searching for optimal solution in the context of optimum site location. The basic formulation was the application of linear integer programming with spatial site suitability model and tested on a hypothetical problem of defining optimal sites for optimal land use allocation in Penang Island, Malaysia. The primary sources of data was set of spatial decision variables representing the location of feasible sites and constraints represented by the attributes of feasible sites which was initially determine through GIS suitability model. The scope of work covers initial refining the spatial site suitability model as to accommodate linkage with mathematical programming and exploring the capability of several optimisation algorithms on different platforms on solving optimal solutions. This project approach has provided additional improvement in the issue of engineering site selection or facility management planning in a local scenario.

1. INTRODUCTION

We have developed a prescriptive model through mathematical approach to search for optimal solution in the context of optimum land use allocation by applying an integrated mathematical programming to spatial site suitability model. The formulation was tested on a problem of defining optimal sites for land use allocation in within Penang Island. The research covers enhancement of the spatial site suitability analysis model as to accommodate linkage with mathematical programming and exploring the capability of optimisation algorithms to solve optimal solutions.

2. RESEARCH METHODOLOGY

Description of Methodology

The methodological approach was to apply the multiple criteria land suitability method developed by Eastman (2003) and the basic optimization technique developed by Diamond and Wright (1988). We refined the model to spatially define most optimal feasible sites for the particular case study and modifications were made

to the model function in the sense that the contiguity and compactness of feasible sites from large raster data set can be determined.

Model formulation

The land use allocation problem was expressed as a binary (0-1) linear integer programming formulation:

$$\begin{aligned}
 \text{Minimise } & C_i = \sum_{i=1}^N c_i x_i \\
 \text{Subject to: } & \sum_{i=1}^N A_i x_i \geq A_{min}, \quad \sum_{i=1}^N A_i x_i \leq A_{max} \\
 & \sum_{i=1}^N S_i x_i \geq S; \quad \sum_{i=1}^N P_i x_i \leq P \\
 & \sum_{i=1}^N H_i x_i \leq H; \quad \text{and } x_i \in (0,1)
 \end{aligned} \tag{1.0}$$

where C_i is the total land development cost, N is the total number of feasible regions, x_i is 1 if allocate region i , and 0 otherwise, c_i is the land cost of feasible region i , A_i is the area of feasible region i , A_{max} is the maximum required area, A_{min} is the minimum required area, S_i is the average suitability value of feasible region i , S is the total maximum suitability value required, P is the minimum total proximity achievable, and H is the minimum total average height of selected regions. The objective of the above equation is to minimise the total land development cost of the regions allotted to residential land use. The model will identify a set of optimal feasible regions that satisfy the objective function and the various constraints.

Model implementation

The solution approach in the model is depicted by the flowchart in Figure 1. An extract summary statistics of attribute values from GIS suitability image of 42 feasible regions is included describing the total land cost per region, average suitability value, average proximity value, average heights, and area of selected regions. Optimality in the search is reached when the total suitability constraint is at maximum possible and total proximity and heights are at minimum possible. The objective function of the model presents the total minimum land cost that will occur.

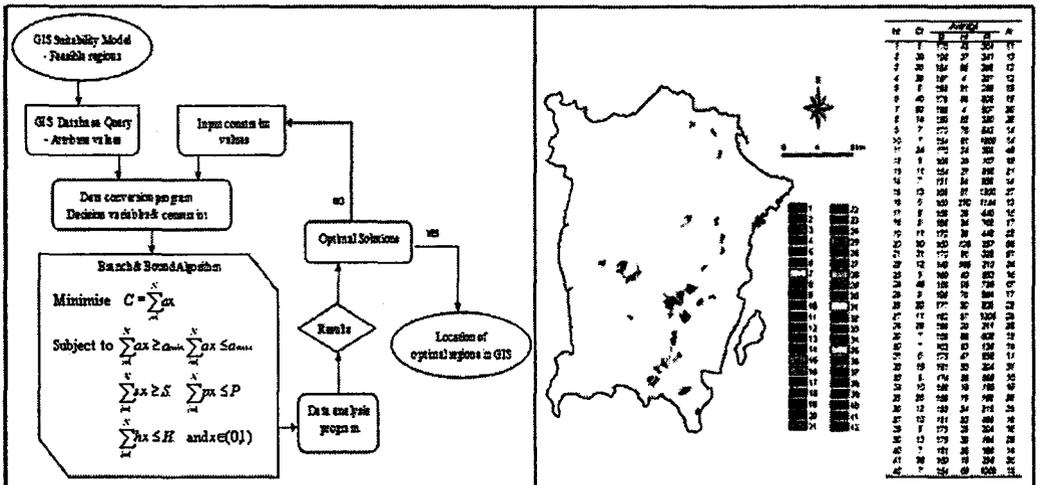


Figure 1. GIS based optimisation model for optimal land use allocation

LITERATURE REVIEW

The drawback of the GIS based suitability model is that it cannot determine the optimal sites amongst the feasible sites. Optimal site selection deals with the problem of selecting a set of feasible sites from the group of sites that best achieves a pre-specified set of goals or objectives, within specific constraints (Robert et al., 2000). In engineering terms, it involves the process of selecting a set of sites among a set of feasible locations that is normally accounted in infrastructure planning sectors, for example, in the planning of new towns, the location of a new facility, or the precise selection of a construction site. To encounter this problem, a prescriptive form of defining the most optimal location has to be addressed. Prescriptive land use modelling attempt to "prescribe or optimize land use patterns to meet desired planning goals subject to various physical, environmental, economical, and social constraints" (Sharpe et al., 1982). In other word, prescriptive models typically have objective function(s) that provides the criterion for optimizing a system and generally developed using various mathematical programming techniques namely linear or non-linear programming, and integer programming (Riveira and Maseda, 2006). Models involving allocation of spatial activities are not distinctive. It extent over areas such as urban and regional planning, forest management, reserve design, site restoration, facility location, land acquisition, or waste landfill siting (Williams 2002, Williams and ReVelle 1996, Benabdallah and Wright 1992, Gilbert et al., 1985, Tomlin and Johnston 1988, Wright et al. 1983). Eastman et al., (1995) developed a decision support module for solving land allocation problems. The tools were developed for the IDRISI geographic analysis software system and are capable of solving multiple objective land allocation problems with either complementary or conflicting objectives. Jeroen, et al., (2003) address the use of spatial optimization techniques for solving multi-site land-use allocation (MLUA) problems, where MLUA refers to the optimal allocation of multiple sites of different land uses to an area. The problem was solved using four different integer programs (IP), of which three are linear integer programs. The IPs is formulated for a raster-based GIS environment and is designed to minimize development costs and to maximize compactness of the allocated land use. Zielinska, et al., (2008) examined the applicability of spatial optimization as a generative modelling technique for sustainable land-use allocation. The test was specifically on whether spatial optimization can be used to generate number of compromise spatial alternatives that are both feasible and different from each other. The new spatial multiple objective optimization model, encourages efficient utilization of urban space through infill development, compatibility of adjacent land uses, and defensible redevelopment.

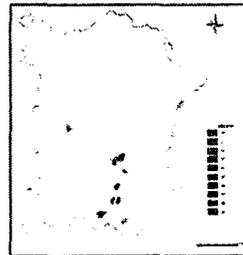
3. FINDINGS

A series of tests were made to determine most optimal solutions. The problem was set to derive 10 numbers of regions that gives total area between 350 - 400 hectares. The constraints were set to maximum total suitability value; minimum total proximity; and minimum average height of 10 regions. The optimal solution will determine 10 numbers of regions (decision variables) that minimized total land cost at maximum suitability, minimum proximity and minimum heights. The results give a value 0 or 1 for each region (decision variable). The summary of the results from the series of tests conducted is shown in Table 1. Once the optimal feasible regions have been determined, their respective locations were displayed a map form in GIS software. The most optimal regions represented by 10 decision variables from test no. 9. The model determines optimal solution for the specific condition set, namely 10 numbers of regions that produced a total area between 350 - 400 hectares. This condition refers to the development planning requirement of the Penang state local planning authority for 2005-2010. The location of the ten optimal feasible regions is shown in the map. The selected attributes of optimal regions present minimum total land cost of 2.42 million.

Table 1. The Optimal Solution of the Model

Test	Σ Suitability		Σ Height		Σ Distance		Σ Area		10 Selected Regions	Σ Cost
	Setting	Result	Setting	Result	Setting	Result	Setting	Result		
1	≤ 1885	1729	≥ 174	694	≥ 1935	5048	350-400	350	8, 15, 19, 20, 21, 24, 27, 32, 36, 39	198
2	≥ 1730	1731	≤ 693	581	≤ 5047	4363	350-400	350	11, 12, 17, 19, 20, 21, 24, 27, 32, 36	198
3	≥ 1732	1747	≤ 580	548	≤ 4362	3737	350-400	350	1, 11, 19, 20, 21, 24, 32, 36, 37, 39	199
4	≥ 1748	1752	≤ 547	534	≤ 3736	3542	350-400	353	11, 19, 20, 21, 24, 32, 36, 37, 39, 40	201
5	≥ 1753	1757	≤ 533	518	≤ 3541	3303	350-400	352	11, 20, 21, 24, 26, 32, 36, 37, 39, 40	212
6	≥ 1758	1763	≤ 517	516	≤ 3302	3263	350-400	356	11, 20, 21, 24, 32, 35, 36, 37, 39, 40	216
7	≥ 1764	1764	≤ 515	486	≤ 3262	3177	350-400	350	11, 12, 20, 21, 24, 32, 34, 36, 40, 41	223
8	≥ 1785	1782	≤ 485	483	≤ 3176	3132	350-400	350	11, 20, 21, 24, 28, 32, 34, 35, 36, 40	231
9*	≥ 1783	1785*	≤ 482	396*	≤ 3131	3117*	350-400	353*	11, 21, 24, 28, 32, 242*	242
10	≥ 1788	1788	≥ 395	487	≤ 3116	3093	350-400	351	20, 21, 24, 29, 32, 34, 35, 36, 39, 41	251
11	≤ 1786	1772	≤ 395	390	≤ 3116	3115	350-400	355	11, 12, 21, 24, 28, 32, 35, 36, 39, 41	243
12	≥ 1786	1787	≤ 395	377	≥ 3116	3182	350-400	350	11, 21, 24, 26, 28, 32, 35, 36, 40, 41	251

Region	Suitability	Height (m)	Proximity (m)	Area (hect.)	Land cost (* Ten thousand)
11	170	24	322	48	24
21	170	98	326	61	31
24	164	95	725	67	48
28	183	20	311	28	28
32	181	63	294	31	16
36	183	18	109	26	26
38	193	34	210	25	12
39	176	39	164	25	13
40	181	28	169	14	7
41	180	18	358	38	38
Total	1785	398	3117	353	242



* Optimal solution

4. CONCLUSION

The model is capable of producing optimal feasible regions based on the objectives and constraints initially set in the allocation problem. The study on the ten optimal regions through ground verification has indicated that their location characteristics are suitable for future residential land allocation. Currently, no independent evidence from experts (planners or decision makers) can suggest that the selected regions are the best or to justify the effectiveness of the proposed approach in respect to the residential land use allocation. The objective is purely to show that an optimization model can be integrated with GIS suitability analysis in solving optimal solution for land use allocation problem. It is important to acknowledge that the decision variables in the optimal problem are all the feasible regions suitable for the residential land use that was prior selected in the prior suitability analysis model.

ACHIEVEMENT

- Name of articles/ manuscripts/ books published
 - Wan Hussin W.M.A., Bawadi M.A., Majid, T.A., & Mohd Sanusi S.A. (2009). Optimisation and Maximization of Energy Yield in Low Wind Speed Regions. The Professional Journal of the Institution of Surveyors Malaysia. Vol. 44, No. 4, 7-11.
 - Mohd Sanusi S. A. and Rabi'ah A. (2009) Detecting The Layout Error Of Constructed Buildings Using GIS Spatial Analytical Tool. GIS Bulletin, No. 2/2009. National Spatial Data and Mapping Commission, ISSN1394-5505
 - S. Kabir, Dong-Chen He, M.A. Sanusi and W.M.A. Wan Hussin (2009). Texture Analysis of IKONOS Satellite Imagery for Urban Land Use and Land Cover Classification, The Imaging Science Journal (In Press).
 - M.A. Sanusi and R. Ahmad (2010). GIS based prescriptive model for solving optimal land use allocation. International Journal of Computers, Environment and Urban Systems. (Under review)
 - M.A. Sanusi, S. Kabir, and R. Ahmad (2010). An Enhanced Analytic Hierarchy Process for Site Suitability Models Based on Multiple Criteria and GIS. International Journal of Computers and Geosciences. (Reviewed and corrected)

2. Title of Paper presentations (international/ local)
 - 1) **Mohd Sanusi S.A.**, Rabiah A. [2008]. Improved Hierarchical Criterion Weighting For GIS-Multiple Criteria Site Suitability Model. The 1st ASEAN Civil Engineering Conference: Civil Engineering Innovations for Regional Development, 3-5 December, Pataya, Thailand
 - 2) **Mohd Sanusi S. A.**, and Rabi'ah, A. [2009]. A. Converting Categorical Data into Quantitative Map For GIS Based Suitability Model. The National Conference on Civil Engineering, Awam' 09, USM October 27-29, Corus Hotel K.L
 - 3) Saeed M., **Mohd Sanusi S.A.**, & Hamidi A. [2008] Geographic Information System (GIS) Components for Deriving Sanitary Landfill Site Weighting Criteria. International Conference on Environment (ICENV 08) 15-17 December, Penang
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APPENDIXES – No Appendixes