



UNIVERSITI PUTRA MALAYSIA

**APPLICATION OF ANALYTIC NETWORK PROCESS AND GIS FOR EVALUATING
INTEGRATED COASTAL LAND USE IN KUALA LANGAT DISTRICT, SELANGOR,
MALAYSIA**

SHARAREH POUREBRAHIM ABADI

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**APPLICATION OF ANALYTIC NETWORK PROCESS AND GIS FOR
EVALUATING INTEGRATED COASTAL LAND USE IN KUALA LANGAT
DISTRICT, SELANGOR, MALAYSIA**

By

SHARAREH POUREBRAHIM ABADI

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfilment of the Requirements for the Degree of Doctor of Philosophy**

May 2008



This Thesis is dedicated to

Mr and Mrs Irvash

My Husband, Mehrdad

My Son, Parsa, My parents and my sister

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

**APPLICATION OF ANALYTIC NETWORK PROCESS AND GIS FOR
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May 2008

Chair: Professor Mohd Ibrahim Hj Mohamed, PhD

Faculty: Environmental Studies

Coastal lands are increasingly threatened by short-sighted planning policies that have focused on human activities rather than the systems sustaining them. Evaluation of coastal land uses for sustainable development involves the identification of the most important criteria and indicators. Analytic Network Process (ANP) is a new method that has potential application in the field of coastal land use development. The purpose of this research was to develop an integrated approach for evaluating the suitability of different kinds of land uses in the coastal area for sustainable development. The coastal area of Kuala Langat District, Selangor, Malaysia, was selected as the study area. There were two main objectives in this research. The first was to identify the most important criteria for coastal land use development and the second was to find the optimal land utilization suitability based on different planning scenarios. Two different approaches were applied to achieve these objectives. For the first objective, the approach employed was multi criteria evaluation using Analytic Network Process by expert opinion. For the second objective, the spatial scenario

evaluation using ARCGIS software was adopted. Three scenarios residing on economic and social development, environmental conservation and sustainable development were defined and evaluated. Four land uses, namely, residential, conservation, tourism and industry were considered. Through evaluation of the scenarios, existing plans and guidelines, land availability and investigation of current land uses and the optimum suitability for sustainable coastal land use development were proposed.

The research has demonstrated an innovative reliable method for identification of the best criteria using ANP and expert opinion. This is the first time ANP has been used for criteria development in coastal land use planning. A new software with the capability of choosing the best criteria for ANP was also developed. The current and future project patterns of growth till the year 2020 were analyzed. The GIS database for the study area was developed for scenario analysis. This analysis has resulted in a series of suitability maps for conservation, tourism, residential and industrial development. However, considering the sustainable development scenario, only one optimal land suitability map was recommended, based on criteria obtained from ANP and expert knowledge. The spatial scenario planning framework developed in this research is an example of an effective integrated decision-making framework. This research has successfully managed to identify and develop a scientifically based method to find the optimal land suitability for sustainable development in coastal land uses. The integration of social, economic and environmental criteria within the planning framework has provided an efficient spatial approach for coastal land use development. It is hoped that this ANP based approach can be employed in land use suitability assessments at both the local plan and structure plan level.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Kedoktoran Falsafah

**APLIKASI PROSES RANGKAIAN ANALISA DAN SISTEM
MAKLUMAT GEOGRAFI UNTUK MENILAI GUNATANAH
PERSISIRAN PANTAI YANG BESEPADU DI DAERAH KUALA
LANGAT, SELANGOR , MALAYSIA**

Oleh

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Tanah persisiran pantai semakin diancam oleh polisi perancangan yang tidak begitu mendalam, yang telah menfokuskan pada aktiviti manusia berbanding dengan system yang menyokongnya. Penilaian gunatanah persisiran pantai untuk pembangunan lestari melibatkan pengenalpastian kriteria-kriteria dan penunjuk-penunjuk yang paling mustahak. Proses Rangkaian Analisa (Analytical Network Process -ANP) ialah satu kaedah yang mempunyai aplikasi berpotensi dalam bidang pembangunan gunatanah persisiran pantai. Tujuan penyelidikan ini ialah untuk membangunkan satu pendekatan bersepadu untuk menilaikan kesesuaian pelbagai jenis gunatanah dalam kawasan persisiran pantai bagi tujuan pembangunan lestari. Tanah persisiran pantai daerah Kuala Langat, Selangor, Malaysia telah dipilih sebagai kawasan kajian. Penyelidikan ini terdiri daripada dua objektif utama. Yang pertama ialah untuk mengenalpasti kriteria-kriteria yang paling penting untuk pembangunan gunatanah persisiran tanah pantai; dan yang kedua ialah untuk mencari kesesuaian gunatanah yang optima berasaskan senario-senario perancangan yang berbeza. Dua pendekatan

yang berlainan telah diguna untuk mencapai objektif-objektif tersebut. Untuk objektif pertama, pendekatan yang diguna ialah penilaian pelbagai kriteria dengan penggunaan ANP melalui pendapat-pendapat pakar. Bagi objektif kedua, penilaian scenario ruang dengan perisian ARCGIS telah digunakan. Tiga scenario berasaskan pembangunan socio-ekonomi, pemeliharaan alam sekitar dan pembangunan lestari telah didefinisikan dan dinilai. Untuk tujuan ini empat jenis gunatanah telah dipertimbangkan, ialah penempatan, pemeliharaan, pelancongan dan industri. Melalui penilaian senario-senario, pelan-pelan dan garis panduan-garis panduan yang sediaada, tanah yang sediaada dan penyiasatan gunatanah sekarang, kesesuaian optima gunatanah persisiran pantai yang lestari telah kemukakan. Penyelidikan telah menunjukkan satu kaedah yang inovatif untuk pengenalpastian kriteria-kriteria dengan penggunaan ANP dan pendapat-pendapat pakar. Ini adalah kali pertama ANP digunakan untuk pembangunan kriteria-kriteria dalam perancangan gunatanah persisiran pantai. Satu perisian baru dengan kebolehan memilih kriteria-kriteria yang terbaik untuk ANP telah juga dibangunkan. Berasaskan analisa corak-corak pertumbuhan gunatanah yang lalu, corak pertumbuhan masa depan sehingga tahun 2020 dapat di ramalkan. Pengkalan data GIS telah di bangunkan untuk analisa senario. Analisa ini telah menghasilkan siri peta-peta kesesuaian bagi tujuan pemeliharaan, pelancongan, penempatan dan pembangunan industri. Walaubagaimanapun dari segi senario pembangunan lestari hanya satu peta kesesuaian tanah yang optima telah dicadangkan berasaskan ANP dan pendapat-pendapat pakar. Rekabentuk perancangan ruang yang dibangunkan dalam penyelidikan ini merupakan satu contoh rekabentuk pembuatan keputusan yang berkesan dan bersepadu. Penyelidikan ini telah mengenalpasti dan membangunkan satu kaedah berasaskan sains untuk mencadangkan kesesuaian tanah yang optima

bagi pembangunan lestari gunatanh persisiran pantai dengan jayanya. Intergrasi kriteria-kriteria sosial, ekonomi dan alam sekitar dalam rekabentuk perancangan telah memberikan satu pendekatan ruang yang cekap bagi tujuan pembangunan gunatanah persisiran pantai. Adalah diharapkan bahawa pendekatan berasaskan ANP ini dapat digunakan dalam penilaian kesesuaian gunatanah pada tahap pelan tempatan dan pelan struktur.

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I certify that an Examination Committee has met on **26 May 2008** to conduct the final examination of **Sharareh Pourebrahim Abadi** on her **Doctor of Philosophy** thesis entitled "**Integrated coastal land use development using Analytic Network Process and GIS: Case of Kuala Langat District, Selangor, Malaysia**" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the student be awarded the Doctor of Philosophy degree.

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

SHARAREH POUREBRAHIM ABADI

Date: 26 May 2008

TABLE OF CONTENTS

	Page
ABSTRACT	iii
ABSTRAK	v
ACKNOWLEDGEMENTS	viii
APPROVAL	ix
DECLARATION	xi
LIST OF TABLES	xv
LIST OF FIGURES	xvii
LIST OF ABBREVIATIONS	xix
CHAPTER	
1 INTRODUCTION	1
1.1 Background	1
1.2 Problem Statement	2
1.3 Significance of the Study	3
1.4 Research Objectives	6
1.5 Scope of the Study	7
1.6 Research Design	8
1.7 Structure of the Thesis	11
2 CONTEXTUAL OVERVIEW AND THEORETICAL TECHNIQUES IN SUSTAINABLE COASTAL LAND USE PLANNING	 13
2.1 Introduction	13
2.2 The Concept of Sustainable Coastal Land use Planning	13
2.3 Planning Process in Malaysia	14
2.4 Previous Studies on Coastal Land use Planning in Malaysia	16
2.5 Characteristics, Definitions and Applications of Criteria and Indicators	17
2.6 An Overview of Criteria Development Techniques	20
2.7 Multi Criteria Evaluation Techniques, Definition and Application	23
2.7.1 The Analytic Network Process as a Multi Criteria Evaluation Method	28
2.7.2 Comparisons between Different Techniques in Multi Criteria Evaluation Methods	30
2.8 Spatial Multi Criteria Evaluation Technique	32
2.9 Some Relevant Studies in Spatial Multi Criteria Evaluation	33
2.10 Summary	37
3 SPATIAL MULTI CRITERIA EVALUATION METHOD FOR INTEGRATED COASTAL LAND USE PLANNING	 38
3.1 Introduction	38
3.2 Framework of Method for Integrated Coastal Land use Planning	38
3.3 Study Area	41
3.4 Data Collection	44



3.5	Multi Criteria Evaluation Method to Find the Most Important Criteria	47
3.5.1	Identification of Policies and Strategies	47
3.5.2	Present Criteria Applicable for Coastal Land Use Planning	50
3.5.3	The Method of Expert Opinion Surveying in Integrated Coastal Land Use Planning	51
3.5.4	Using Analytic Network Process to Find the Most Important Criteria	54
3.5.5	The Method of Indicators Selection in Integrated Coastal Land Use Planning	63
3.6	Spatial Analysis Phase	64
3.6.1	Land use Change Detection Analyses Method	64
3.6.2	The Method of Preparation the Main Layers in GIS Database	65
3.7	Suitability Analysis and Evaluation based on Spatial Multi Criteria Method	71
3.7.1	Scenario Definition	71
3.7.2	Suitability Analysis	72
3.7.3	Scenario Evaluation and Sensitivity Analysis	75
3.8	Summary	76
4	RESULTS OF AN INTEGRATED COASTAL LAND USE PLANNING BASED ON SPATIAL MULTI CRITERIA ANALYSIS	77
4.1	Introduction	77
4.2	Results of First Phase: A New perspective on Analytic Network Based Planning	78
4.2.1	Results of an Integrated Approach to Find the Most Important Criteria Using ANP and Expert Opinion	78
4.2.2	Results of Survey Sensitivity Analysis	88
4.2.3	Results of Development of ICLUDEC as a Planning Support System	94
4.2.4	Evaluation of Indicators by Modified Smart Filter	98
4.3	Phase II: Spatial Analysis	101
4.3.1	Results of Land-use Change Analysis over Last 30 Years	102
4.3.2	Prediction of Land use Changes for Future Growth Continuity	105
4.3.3	Database Design and Spatial Analysis	109
4.4	Results of Phase III: Scenario Assessment and Suitability Analysis	113
4.4.1	Scenario definition	113
4.4.2	Results of Suitability analysis	114
4.4.3	Results of Sensitivity Analysis	139
4.4.4	Planning Process to Achieve Optimum Suitability Map for Sustainable Coastal Land uses	143
4.5	Discussion	155

4.5.1	Planning Support Method for Integrated Coastal Land Use Planning	156
4.5.2	Multi Criteria Planning Approach using Land Use Pattern Analysis and Suitability Assessment	157
4.5.3	Limitations of the Research	159
5	CONCLUSIONS AND RECOMMENDATIONS	161
5.1	Introduction	161
5.2	Research Findings	162
5.2.1	Identification of the Most Important Criteria for Coastal Land Use Development using ANP and Experts Knowledge	162
5.2.2	Development of the New Planning Support System	163
5.2.3	Sensitivity Analysis to Explore the Number of Experts Need for Surveying	163
5.2.4	GIS Database Development for Multi Criteria Evaluation	164
5.2.5	Exploring the Land Use Change Pattern	164
5.2.6	Scenario Assessment and Suitability Analysis	165
5.3	Contributions of the Research toward Knowledge	165
5.3.1	Planning Support Method for Integrated Coastal Land Use Planning	165
5.3.2	Survey Sensitivity Criteria	166
5.3.3	Spatial Planning Based on Suitability Analysis	166
5.4	Recommendations	167
5.5	Conclusion	170
	REFERENCES	171
	APPENDICES	182
	BIODATA OF STUDENT	191
	LIST OF PUBLICATIONS	192

LIST OF TABLES

Table		Page
2.1	Summary of methods for assessing criterion weights	26
3-1	Data collected during study and their sources	45
3-2	Detail of data and information obtained from different sources	46
3-3	Strategies for sustainable coastal land use development in Kuala Langat	49
3-4	The fundamental scale of evaluation	52
3-5	One part of priority questionnaire with respect to accessibility	53
3-6	Initial matrix for comparison between criteria	57
3-7	Modified SMART filter indicators	63
3-8	Buffers and set backs for development of different land uses	67
3-9	Traveling time by type of destination	69
4-1	Results of averaged priority matrix with respect to accessibility	79
4-2	Matrix after normalization	80
4-3	The super matrix	81
4-4	The results of weighted matrix	83
4-5	The results of Limited matrix to get priority by range limit of 0.005	84
4-6	The final rank of the most important criteria by range limit of 0.005, N=28	85
4-7	The cumulative results of ranking of the most important criteria	86
4-8	The results of limited matrix to get priority (range limit =0.01, N=15	90
4-9	The ranking of the criteria by range limit of 0.01, N=15	91
4-10	The ranking of the criteria by range limit of 0.05, N=6	92
4-11	The results of limited matrix to get priority by range limit of 0.05, N=6	93
4-12	The results of indicators evaluation by modified smart filter	99
4-13	The list of criteria and indicators for integrated coastal land use development in Kuala Langat	101
4-14	Land use changes analysis over 30 years	104
4-15	The objectives, criteria and indicators of coastal land use development	111

4-16	The detail characteristics of spatial information in GIS database	112
4-17	The list of generated scenarios	114
4-18	Indicator weighting for socio-economic scenario	115
4-19	Indicator type rating for socio-economic scenario	116
4-20	Suitability comparisons for different land uses in the first scenario	121
4-21	Legal and rules for second scenario	123
4-22	Indicator weighting for the environmental protection scenario	125
4-23	Indicator type rating for the environmental protection scenario	126
4-24	Comparisons of suitability for different land uses in the second scenario	131
4-25	Indicator weighting for sustainable development scenario	132
4-26	Indicator type rating for sustainable development scenario	133
4-27	Comparisons of suitability for different land uses in the third scenario	138
4-28	Comparisons of suitability analysis for scenarios and land uses	139
4-29	Sensitivity analysis results based on small changes in life support systems and high value area categories	141
4-30	Sensitivity analysis results based on changes in criteria weights	143

LIST OF FIGURES

Figure		Page
1-1	Link of the Study Output in the Planning Process	5
1-2	Logical Research Framework	10
2-1	Hierarchical Framework of Development Plan System	16
3-1	Framework of the Research Study	39
3-2	Location of Study Area in Peninsular Malaysia	41
3-3	Definition of Coastal Zone in This Study	42
3-4	Map of the Study Area by Mukims	43
3-5	The Model of Structuring Criteria for the Research Study	55
3-6	Structuring the Model for Artificial Example	56
3-7	Some Functions in <i>ICLUDEC</i> Software	62
3-8	Suitability Analysis using Model Builder, Arc GIS	74
4-1	The Cumulative Results of Criteria Ranking	87
4-2	Programming of Limited Matrix in MAT LAB Software	89
4-3	Process of Criteria Selection in <i>ICLUDEC</i> Software	95
4-4	Process of Comparisons in <i>ICLUDEC</i> Software	95
4-5	Super Matrix Results in <i>ICLUDEC</i> Software	96
4-6	Weighted Matrix Results in <i>ICLUDEC</i>	96
4-7	Limited Matrix Results in <i>ICLUDEC</i>	97
4-8	Ranking of Results in <i>ICLUDEC</i>	97
4-9	Land use Changes Analysis over 30 Years in the Study Area	102
4-10	Forest Change Pattern	105
4-11	Mangrove Forest Change Pattern	106
4-12	Peat Swamp Forest Change Pattern	107
4-13	Developed Area Change Pattern	107
4-14	Agricultural Area Change Pattern	108
4-15	Hierarchical Model of Spatial Information in GIS Database	110
4-16	Conservation Suitability Map for the First Scenario	117
4-17	Tourism Suitability Map for the First Scenario	118
4-18	Residential Suitability Map for the First Scenario	119
4-19	Industrial Suitability Map for the First Scenario	120
4-20	Legal map for Environmental Protection Scenario	124

4-21	Conservation Suitability map for Second Scenario	127
4-22	Suitability Map for Tourism Development based on Second Scenario	128
4-23	Suitability Map for Residential Development based on Second Scenario	129
4-24	Suitability Map for Industrial Development based on Second Scenario	130
4-25	Conservation Suitability Map for the Third Scenario	134
4-26	Suitability Map for Tourism Development based on Third Scenario	135
4-27	Suitability Map for Residential Development based on Third Scenario	136
4-28	Industrial Suitability Map for the Third Scenario	137
4-29	Sensitivity Analysis based on Small Changes in Classes for Tourism Development for the Second Scenario	140
4-30	Sensitivity Analysis based on Changes in Weighting for Tourism Development for the Second Scenario	142
4-31	Evaluation of Current and Suitable Industries Land Use	145
4-32	Evaluation of Current and Suitable Residential Land Use	146
4-33	Land Availability for Development	148
4-34	Suitable Land Available for Tourism Development	149
4-35	Suitable Land Available for Residential Development	150
4-36	Suitable Land Available for Industrial Development	151
4-37	Optimum Suitability Map for Sustainable Development of Coastal Land uses	153

LIST OF ABBREVIATION

9MP	9 th Malaysia Plan 2006-2010
DID/JPS	Department of Irrigation and Drainage/ Jabatan Peparitan dan Saliran, Malaysia
DOE	Department of Environment, Malaysia
DOS	Department of Statistics, Malaysia
DANCED	Danish Cooperation for Environment and Development
EPU	The Economic Planning Unit, Malaysia
ICZM	Integrated Coastal Zone Management
JPBD	Jabatan Perancangan Bandar dan Desa / Town and Country Planning Department, Malaysia
LESTARI	Institute Alam Sekitar dan Pembangunan/ Institute for Environment and Development, Malaysia
LUAS/ SWMA	Lembaga Urus Air Selangor/ Selangor Waters Management Authority, Malaysia
NAP 3	Third National Agriculture Policy, Malaysia
NEP	Malaysia's National Environment Policy
NOD	Objectives National Oceanography Directorate, Malaysia
NOSCP	Malaysian National Oil Spill Contingency Plan
NPBD	Malaysia's National Policy on Biological Diversity
OECD	Organisation for Economic Co-operation and Development
OPP	Outline Perspective Plan 2001 – 2010, Malaysia
PAGE	Pilot Analysis of Global Coastal Ecosystems
PEMSEA	GEF/UNDP/IMO Regional Program on Building Partnerships in Environmental Management for the Seas of East Asia
UKM	Universiti Kebangsaan Malaysia
UNEP	United Nations Environment Programme



CHAPTER 1

INTRODUCTION

1.1 Background

The coastal zones are important boundaries in the natural system as they form the transition areas between terrestrial and marine environments (Douven *et al.*, 2003). Malaysia has about 48,000 km of coastline and about 70% of the Malaysian population live in the coastal zone. The coastal areas of Peninsular and East Malaysia are historically the locations for early human settlements and trading activities (EPU and DANCED, 1999). With rapid population growth and economic activities, town planning in those days were arbitrary with rather unhealthy with unsanitary conditions (Mazlin *et al.*, 2003). The competition between coastal ecosystems and human activities along the coastal zones has resulted in some environmental degradation having a negative impact on the economic and social value of the coast (Tang *et al.*, 2005). There are also institutional issues such as lack of trained human resource, insufficient legal provisions for the coastal land planning, inadequate implementation of existing policies, legislation and guidelines, poor link between science and policy making and the lack of financial resources for coastal zone management (EPU and DANCED, 1999).

It needs some integrated approaches designed for the unique requirement of sustainable coastal land use development (Vollenweider, 1992; Turner, 2000; Sarda, 2005). Some new techniques such as development of decision-support systems for evaluating the current state and predicting future trends in coastal areas (Ballinger

and Smith, 1994; Fabbri, 2006; Fedra, K., 2003; 2007) and some new methods such as Analytic Network Process (ANP) (Saaty, 2004) and computer based planning tools like GIS can assist to the integration, analysis and interpretation of information (Boorquez *et al.*, 2001; Ayad, 2004).

1.2 Problem Statement

Coastal lands are increasingly threatened by short-sighted planning policies that have focused on human activities rather than the systems sustaining those (Shi *et al.*, 2004). Malaysia has envisioned becoming a developed country by the year 2020. So lands are being developed very fast through establishments of residential, industrial and commercial centers. Kuala Langat district as the case study is located in the strategic area, because this area is identified as a Klang Vally II. The district has been experiencing rapid development, influence by some fast growing new centers like Kuala Lumpur International Airport, Klang Valley, Cyberjaya and Putrajaya. These have caused degradations of the natural habitats located in this area such as forests, peat swamp, mangroves and wetlands and land use changes from forest and agriculture to development areas. Also some sensitive area such as reclaimed lands, geo-disaster area, flash flood prone areas, dumping grounds and high erosion area need urgent sustainable plan for future development.

On the other hand, an important goal in geo-environmental evaluation is to provide assistance to policy makers, planners and developers in planning the optimal development of an area while simultaneously preserving the environment. The draft district local plan for this area are being prepared by on going projects under the

auspices of the Department of Town and Country Planning and the results of this study could surely enhance this planning process of the study area. The evaluation results can assist planners in making decisions on land use alternatives for specific land parcels (Dai *et al.*, 2001). Evaluation of the sustainability in coastal land use needs to identify specific criteria and indicators. It is quite difficult to interpret criteria for sustainable land use development in the local level without any adaptation and translation of issues.

There is a need to design integrated approaches for sustainable coastal land use development, applying techniques such as multi-criteria analysis and supporting tools like GIS to help bridge the gap between town and country planning process and coastal zone planning (Brody *et al.*, 2004).

1.3 Significance of the Study

In the Ninth Malaysia Plan, one of the strategic thrust for addressing environmental and natural resources issues will focus on developing suitable sustainable development criteria. Also the Town and Country Planning Act, 1976 (Act 172) with its latest amendment in year 2001, has manifested the concern of adopting the Geographical Information System (GIS) in the development planning process, especially in the preparation of development plans.

It becomes necessary to suggest a complete methodology to develop and identify criteria for evaluation of coastal land use development. The planning framework developed in this research is referred to as spatial scenario planning framework.

Comprehensive criteria in the fields of economic, environmental and social were considered and the most important criteria were selected to be used practically in the process of spatial planning. This study uses appropriate tools like GIS and Multi Criteria Evaluation with experts' knowledge in the fields of environment, social and economy to propose a suitable plan for integrated coastal land use development. This framework is useful for efficient planning of future coastal land uses. In addition it is also useful to analyze change patterns in the past to project suitable land uses for the future and essentially this approach has been employed in the study area.

Based on the Malaysian Town and Country Planning Act 1976 (Act 172) last amended in 2001, the development plans provide the development framework and guidelines which need to be continually updated according to the present statuses of development. [Figure 1.1](#) shows the link of the study input in overall planning process. The outputs of this study can assist in making judicious decisions for future development of the study area.

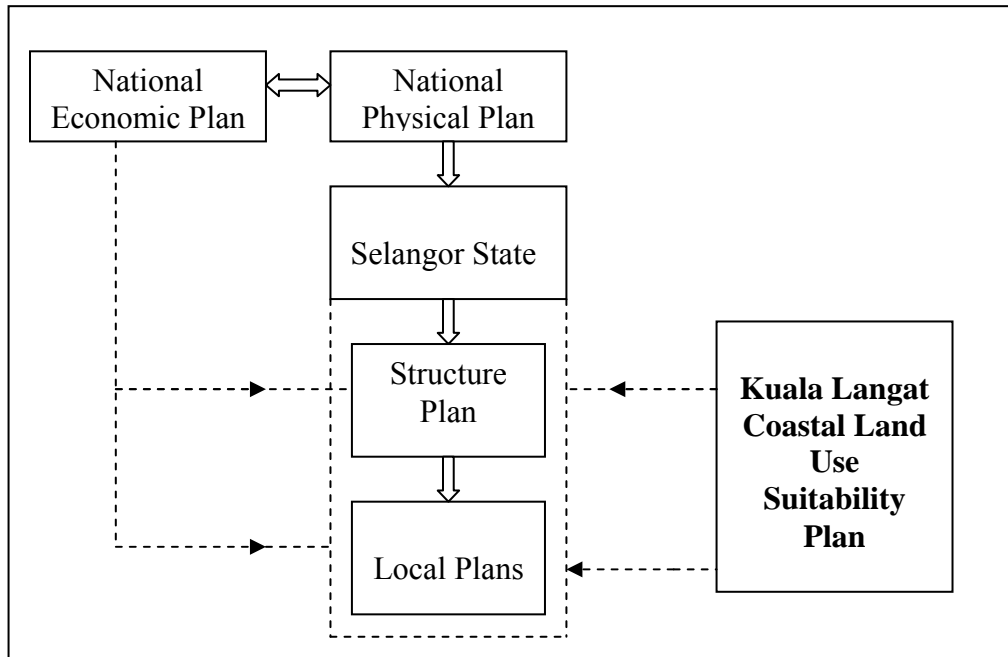


Figure 1.1. Link of the Study Output in the Planning Process

This research formulates an integrated approach for finding the optimum land use suitability for future sustainable development in the coastal area. In the process of identifying socio-economic and environmental criteria, involving the expert opinion from beginning with the analytical capabilities of the Analytic Network Process (ANP) has become a useful tool box. The use of GIS-based decision making, definition and evaluation of different scenarios for future development of land uses in coastal areas has strengthen further this research approach compared to other researches. The methodology is expected to be brief with a set of guidelines and recommendations for organizing and expressing the complexities found in coastal fringes. To-date there is no published applications of ANP in spatial planning of coastal land uses and related fields.