Applying Integrated Ecological Planning and Adaptive Landscape Evaluation Tool for Developing Countries in the Framework of Sustainable Spatial Planning and Development, Study Case Bintan Island, Indonesia

Written by:

[1] Tanuwidjaja, Gunawan. & [2]Malone-Lee, Lai Choo.

[1] MSc. Environmental Management (NUS), S.T. (ITB)
Urban Planner & Researcher, Green Impact Indonesia,
Integrated Urban, Drainage and Environmental Planning and Design Consultant
Address: Jl. Taman Siswa 75, Bandung 40262, West Java, Indonesia
Mobile: +62 812 212 20842
Email: gunteitb@yahoo.com

[2] Ph.D. (Tokyo), Masters Urban Planning (Sydney), B.Sc Real Estate (NUS)
Director of Centre for Sustainable Asian Cities
School of Design and Environment, National University of Singapore
Address: 4 Architecture Drive, Singapore 117566
Email: sdemalon@nus.edu.sg

Abstract. Developing countries, like Indonesia, face great development pressure due to economic development for great number of populations. Various environmental problems later emerge due to unplanned, uncontrolled and unsustainable land use development as well as severe environmental destructions. The need for integrated ecological planning actually emerges from this concern.

The integrated ecological planning could be defined as "Planning process that consider the ecological condition, environmental carrying capacity, and other social economy that affect the location. Later on, integration of infrastructure planning such as water management, mass transportation, waste management, energy conservation, etc. Involvement of stakeholders would be integrated in the process application. "

The real ecological planning application face constraints such as the lack of political will, lack of expertise, tools, research, and funding in government as well as consultants. But still the integrated ecological planning should be applied to achieve the more sustainable development as well as to conserve of strategic or important ecological areas.

One of the important steps of ecological planning is the landscape evaluation methodology. The evaluation method research was started in 2005, for National University of Singapore, MSc Environmental Management program. Later through real application, we redefine the method with real application in other planning projects in other countries.

Our research involves identifying the key elements of all evaluation methods, which were later distilled and refined to build on **A**daptive **L**andscape Evaluat**i**on **T**ool or "**ALiT**". The strengths of system lie mainly in establishing evaluation methods, adaptive list of data, and scoring thresholds that embraces sustainable land development principles. The method was validated in Bintan Buyu, Bintan Island, Indonesia and proven to be applicable for local government. While the criteria and other scoring system would need to be adjusted to each different cases.

The proposed system is comprehensive yet manageable and practicable. It encompasses four important elements as part of the development and evaluation process, namely, initial secondary data collection, rapid survey to verify critical data, multi-disciplinary analysis with Geographic Information System (GIS), and lastly, stakeholders' inputs. The authors believe that **ALiT** can be a very useful tool for reducing environmental destruction while accommodating economic development in developing countries.

We understands that there are constrains in method application due to lack of political will as well as limited funding to gather all environmental, social and economical aspects. Because of that, the vision for developing Sustainable Spatial Planning must be made first between stakeholders of the region comprising Public, People and Private (Government, the People and the Private sector). And Integrated Spatial Planning with Focus on Ecological Approach would be the near-future trend for the World.

Keywords: *Integrated Ecological Planning, Landscape Evaluation, Land Evaluation, Sustainable Planning, Sustainable Land Development.*

1 Introduction

In the present year, the world faces extreme environmental problems that threaten its livelihood. The problems are resource depletion, global climate change, extinction of plants and animals, loss of wildlife habitats, increasing pollution, and poverty (Miller, 2003). We believe that these environmental issues were caused by 2 main factors, which were exponential population growth and the rise of anthropocentrism and liberalism.

First, the world's population has increased exponentially from 2.521 billion in 1950 to 6.782 billion in 2009. With the current population growth, it was predicted to reach 9 billion by 2040 and to put more pressure to the Earth. Further, the world's population was not distributed equally according to availability of resources. This also stressed to certain areas on Earth. [1]

Secondly, we also believe that anthropocentrism and liberalism justify human conduct to the unsustainable development. The anthropocentrism suggested that "human beings are the central of the universe and the nature is created only to serve human interest." This was parallel to Liberalism which upheld "the autonomy of the individual and political liberties". Unfortunately, these principals were used to justify the extreme exploitation of the earth. [2]

The current economic system was also found unsustainable because of speculative and inefficient production; over-utilisation of non-renewable resources and excessive pollution. Therefore, severe resource depletion, biodiversity loss and increasing pollution happened. Similarly to that, environmentalists believed that if the impact of great population, unsustainable consumption pattern and technological advancement in the world were combined, enormous environmental impact would occur. And finally, it

[1] http://www.census.gov/ipc/www/popclockworld.html, estimated by United States Census Bureau on 5th September 2009;
http://au.encarta.msn.com/encyclopedia_1461501471/Population_Explosion.html;
http://en.wikipedia.org/wiki/File:Population-milestones.jpg

[2] http://dictionary.reference.com/;
http://en.wikipedia.org/wiki/;
http://www.merriam-webster.com/

would increase Earth's environmental vulnerability index (Miller, 2003, Kaly et all, 2004; Kaly et all, 2005).

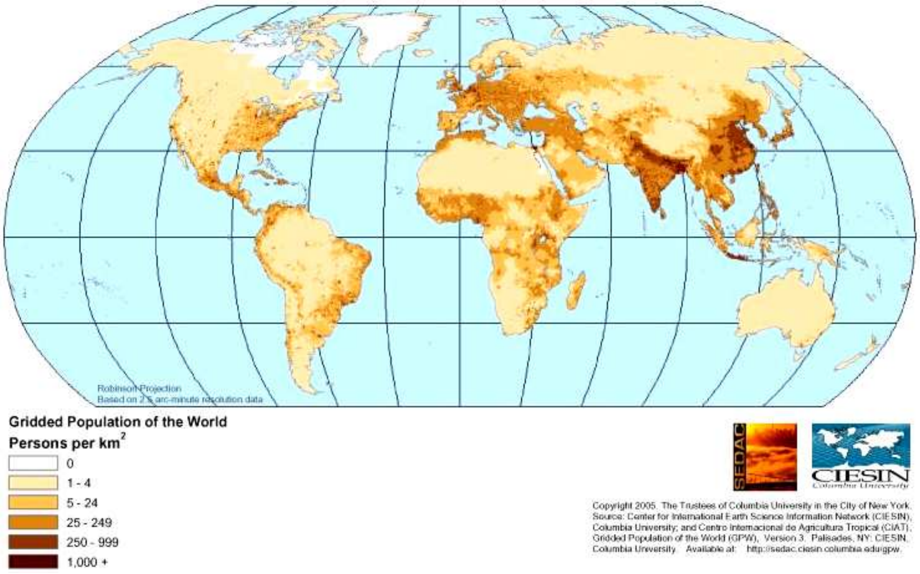

Figure 1 Population Density Map of the World. (Source: http://sedac.ciesin.org/wdc/map_gallery.jsp; Center for International Earth Science Information Network (CIESIN) Columbia University, and Centro Internacional de Agriculture Tropical (CIAT), Gridded Population of The World (GPW) Version).

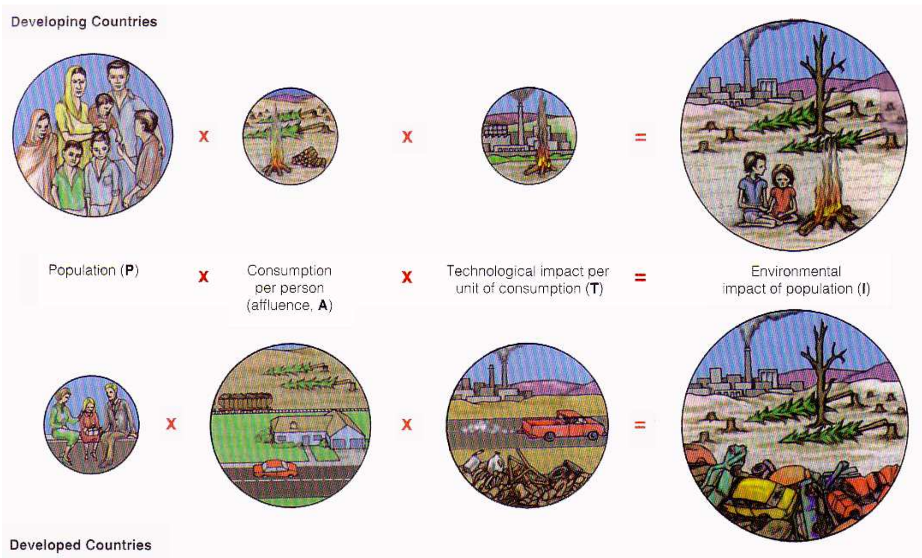

Figure 2 The Combined Environmental Impact of Population, Consumption Pattern and Technological Advancement to the World. (Sources: Miller, 2003)

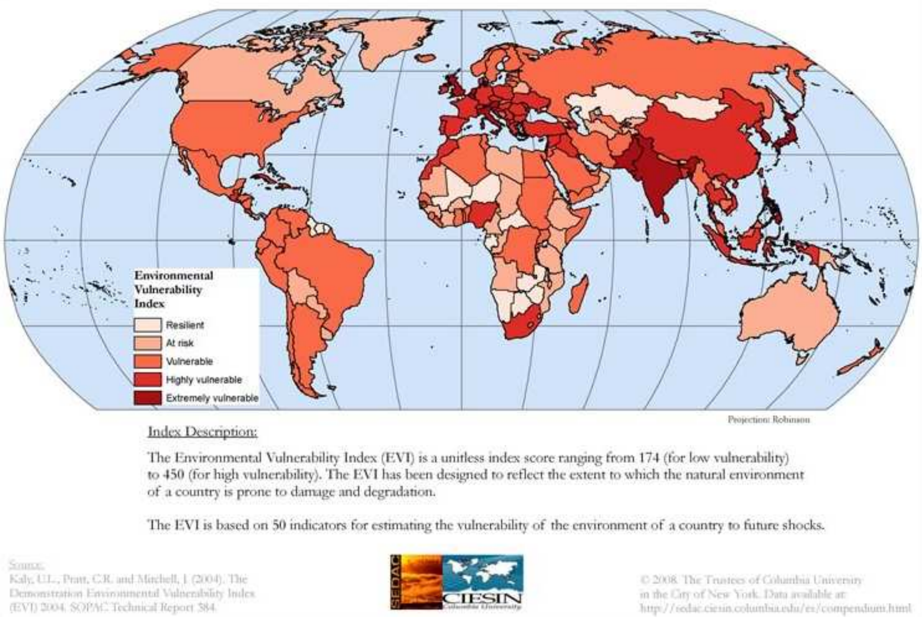

Figure 3 Environmental Vulnerability Index Map of the World. (Source: http://sedac.ciesin.org/wdc/map_gallery.jsp; Kaly et all, 2004).

Land, as one earth's resources, also faces development pressure. Due to its limited supply and speculation activities, many important natural areas were sacrificed for land development. Eventually, this increased rates of deforestation and desertification worldwide (Millennium Ecosystem Assessment, 2005)

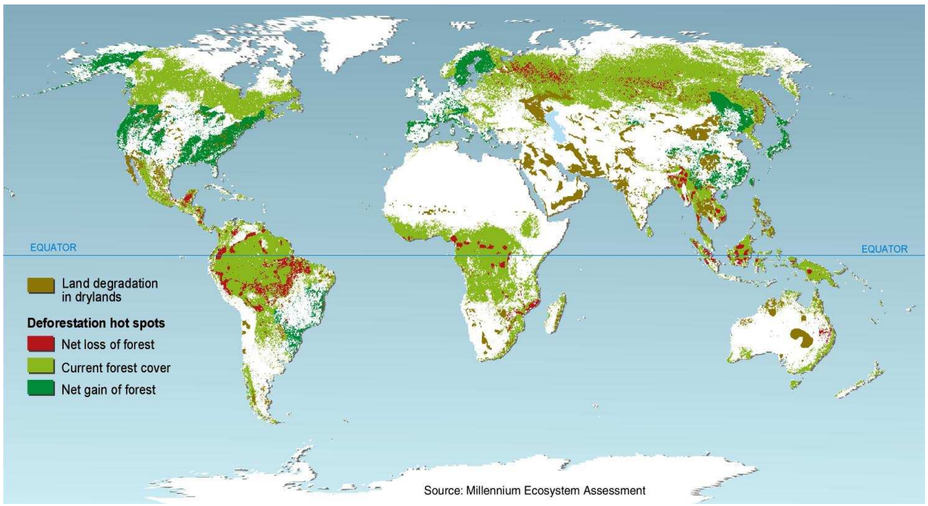

Figure 4 The World's Deforestation in 2000. (Source: Millennium Ecosystem Assessment, 2005; http://images.wri.org).

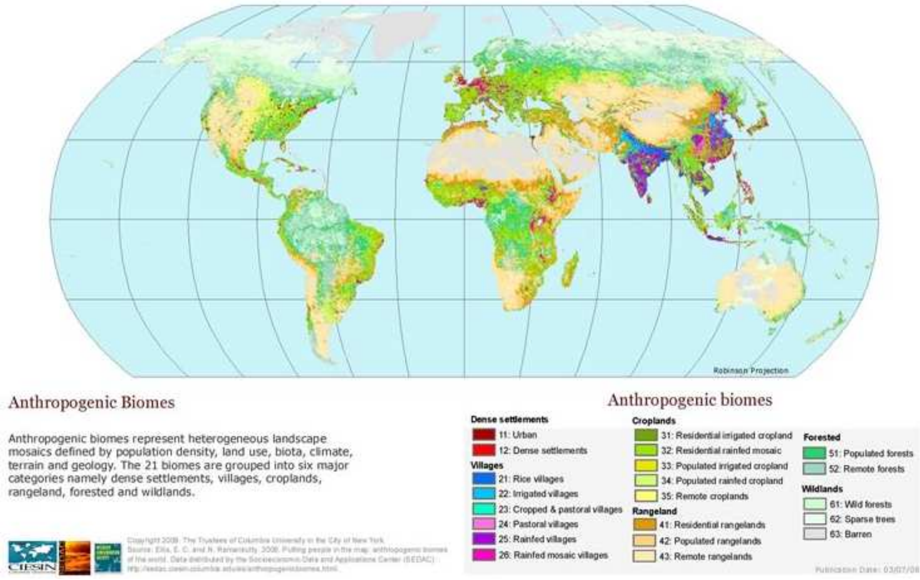

Figure 5 The World's Anthropogenic Biomes (Land Development) in 2000. (Source: http://sedac.ciesin.org/wdc/map_gallery.jsp; Ellis, E.C. and N. Ramankutty, 2008).

Understanding the complexity of the developing countries context, we decided to evaluate the environmental issues in the countries further in this paper. Beside those factors mentioned above, poverty also created great land and natural area conversion in the developing countries. Unfortunately, these developing countries are mostly located in the "biodiversity hotspot" and affected by greater biodiversity loss. (Mulongoy K.J. & Chape S., 2004; UNEP-WCMC, 2002 - World Atlas of Biodiversity; UNDP 2004 - Human Development Report 2004)

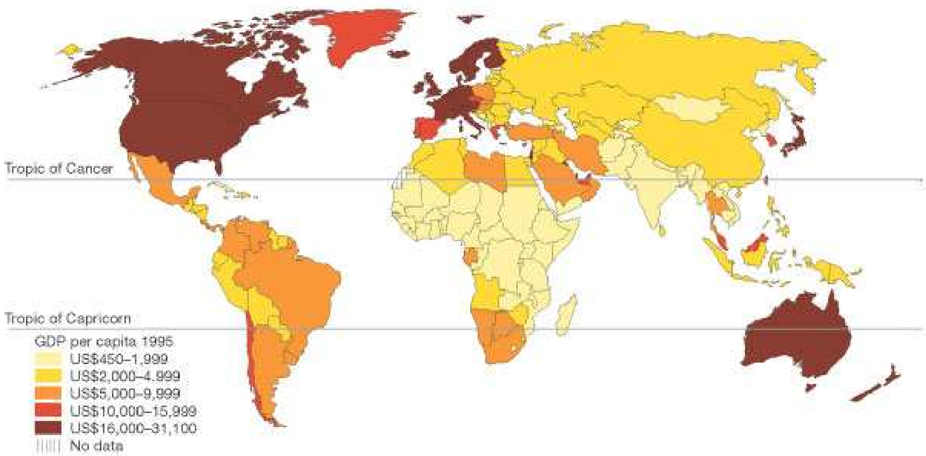

Figure 6 Distribution of GDP per capita in 1995. (Source: Sachs & Malaney,

2002).

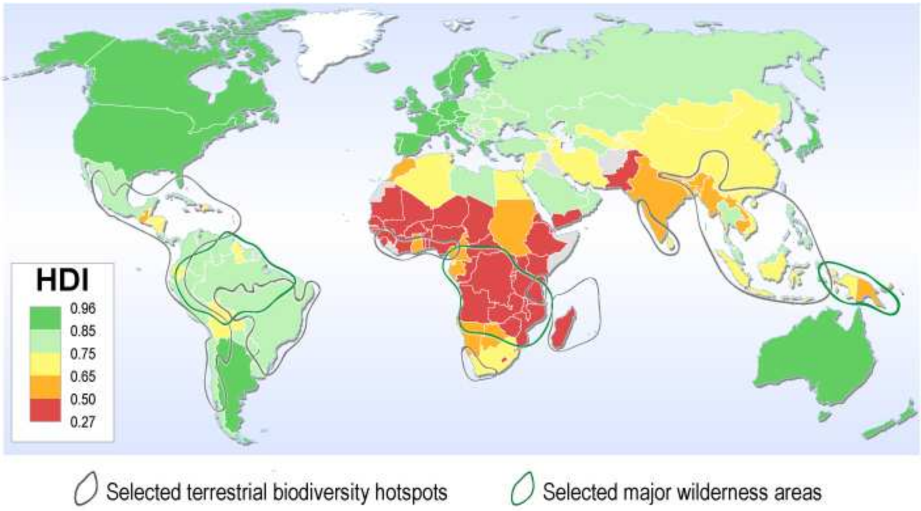

Figure 7 Relationship between Biodiversity Hotspot Location and Developing Countries. Legend: Developing Countries HDI = 0.27 – 0.75. (Sources: http://maps.grida.no; Mulongoy K.J. & Chape S., 2004; UNEP-WCMC, 2002 - World Atlas of Biodiversity; UNDP 2004 - Human Development Report 2004)

One of real example of extensive deforestation and biodiversity loss is Indonesia. Extensive deforestation has happened since 1950s. In 1998, it was reported that forty percent of the forests, which was reported in 1950, had been cleared. From 162 million ha forest, only 98 million ha forest was left (FAO - Global Forest Resources Assessment, 2005).

Further, other reports showed that 1,708,750 to 1,871,500 ha of forests were deforested annually. While 147 species of mammals (including orangutan, tiger, rhinoceros, and elephant), 114 birds, 28 reptiles, 91 fishes and 28 invertebrates had become extinct in the process. (WRI et all. (2002) - State of the Forest Indonesia; WRI et all. (2000) - Trial by Fire; FAO - Global Forest Resources Assessment 2005)

The extensive deforestation also reduced of biodiversity richness in Indonesia. There are 3 main centres of species richness in Indonesia, which are Irian Jaya (with high species richness and endemism), Kalimantan (with high species richness but moderate endemism), and Sulawesi (with moderate species richness and high endemism). So Indonesia’s biodiversity was affected tremendously by unsustainable land development (WRI et all., 2002 - State of the Forest Indonesia; WRI et all., 2000 - Trial by Fire).

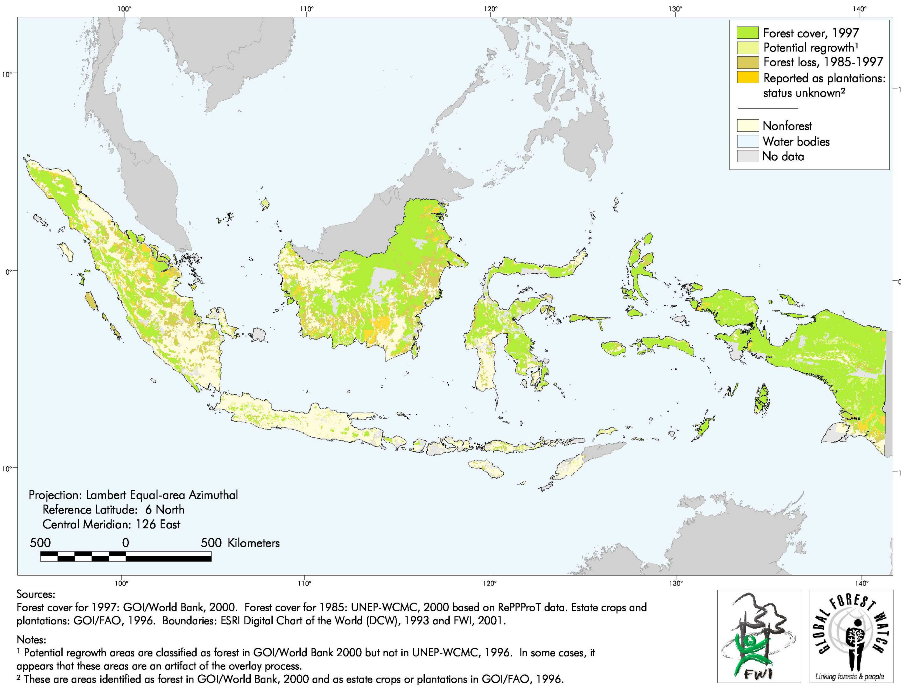

Figure 8 Natural Forest Cover Change in Indonesia, 1985 – 1997. (Sources: WRI et all., 2002 - State of the Forest Indonesia)

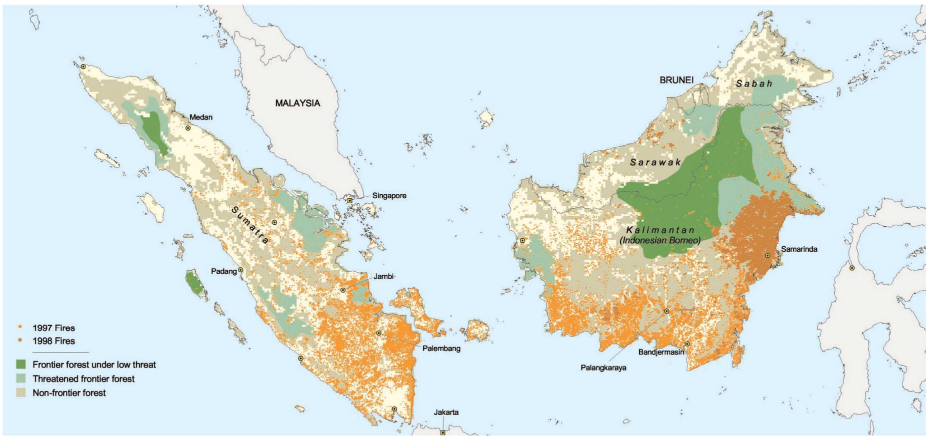

Figure 9 Forest Cover and 1997-1998 Forest Fires in Western Indonesia. (Sources: WRI et all., 2000 - Trial by Fire, Forest)

Table Forest Area and Deforestation, 1985–1997 (GOI/World Bank Estimates)

	1985			1997				
Island	**Land Area** (Ha)	**Forest Cover** (Ha)	**Forest as % Land Area**	**Land Area** (Ha)	**Forest Cover** (Ha)	**Forest as % Land Area**	**Forest Change 1985–1997** (Ha)	**Forest Change** (%)
Sumatra	47,530,900	23,323,500	49	47,059,414	16,632,143	35	6,691,357	-29
Java and Bali	13,820,400	1,345,900	10	nd	nd	nd	nd	nd
Nusa Tenggara	8,074,000	2,469,400	31	nd	nd		nd	nd
Kalimantan	53,583,400	39,986,000	75	53,004,002	31,512,208	60	8,473,792	-21
Sulawesi	18,614,500	11,269,400	61	18,462,352	9,000,000	49	2,269,400	-20
Maluku	7,801,900	6,348,000	81	nd	*5,543,506*	nd	*804,494*	*-13*
Irian Jaya	41,480,000	34,958,300	84	40,871,146	33,160,231	81	1,798,069	-5
Total	**190,905,100**	**119,700,500**	**63**	**189,702,068**	***100,000,000***	***50***	***20,504,994***	***-17***

Sources: 1985 Land Area and Forest Cover from RePPProT (Regional Physical Planning Programme for Transmigration), "The Land Resources of Indonesia: A National Overview." (Jakarta, Indonesia: Land Resources Department of the Overseas Development Administration, Government of UK, and Ministry of Transmigration, Government of Indonesia, 1990). 1997 Land Area and Forest Cover from D. Holmes, "Deforestation in Indonesia: A Review of the Situation in 1999." (Jakarta, Indonesia: World Bank, 2000).
Notes: nd = no data. Holmes did not live to complete his analysis and did not make estimates of forest cover for the islands of Java, Bali, or Nusa Tenggara. Numbers in italics are Holmes's estimates based on assumptions about areas not mapped in 1997. The total forest area of 100 million ha is Holmes's preliminary estimate based on assumptions about forest loss rates over the study period. It appears to overestimate by about 2 million ha.

Tabel 1 Forest Area and Deforestation, 1985 – 1997 (Government of Indonesia and World Bank Estimates).(Sources: WRI et all., 2002 - State of the Forest Indonesia)

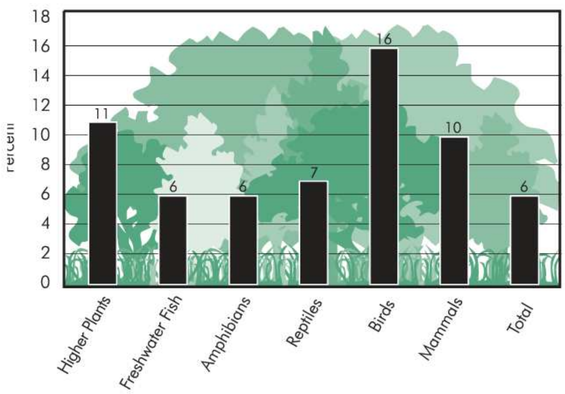

Figure 10 Biotic Richness: Percent of World's Species Found in Indonesia. (Sources: WRI et all., 2002 - State of the Forest Indonesia)

It can be concluded, that major problems such as resource depletion, great population, high population density and poverty are very often faced by developing countries. Because of that sustainable development approach becomes very crucial. And it has to be implemented starting with the adoption of sustainable spatial planning practice.

On the contrary, the implementation of sustainable spatial planning faced a lot of obstacles in developing countries. Lack of political wills, limited government budget, limited timeframe for project execution, corruption and poverty were the major hindrances. On the other hand, sustainable spatial planning and development control is the only solution for sustainable development. One successful practice is Singapore. (Wong T-C. et all, 2008).

The Singapore planning was done with meticulous effort of the Government and achieving Singapore's model of sustainability (Wong T-C. et all, 2008). Enhancing the city condition, the government further prepared several sustainable strategies such as Singapore's Green Plan, and Singapore's Sustainable Development Blueprint. [3]

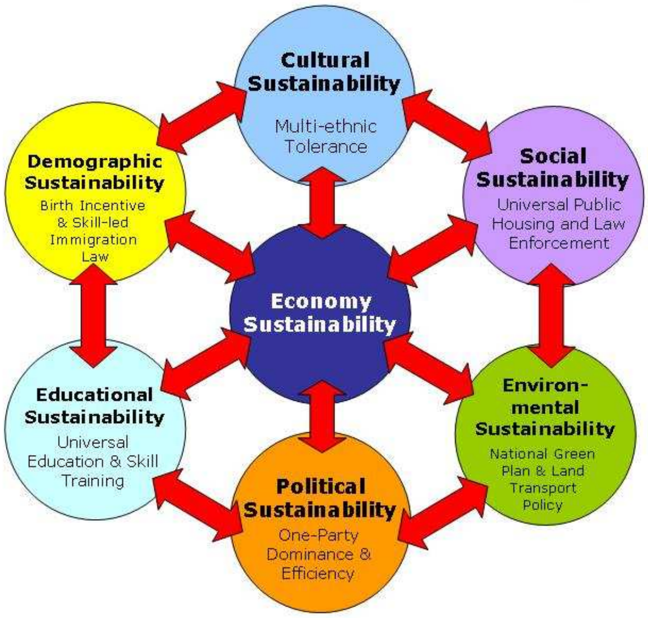

Figure 11 The Singapore Sustainable City Model. (Source: Wong T-C. et all, 2008, redrawn by Tanuwidjaja G.).

Historically, the sustainable spatial planning was invented in by Ian McHarg. He invented Ecological Planning, which defined as, "Comprehensive land use planning which consider the social, legal, economy, the need, aspiration and perception of the future user," (McHarg, 1992; McHarg, 1998).

Based on the previous works, we developed the "Integrated Spatial Planning with Focus on Ecological Approach", which could be defined as "Planning process which consider the ecological condition (biodiversity), environmental capacity, and social -economic context that influence the site. Further, in the planning process, integration of infrastructure planning such as water resource management, etc must be evaluated and implemented. Lastly, but not least the stakeholders' participation must be facilitated in all decision making process." And this concept could be described in the following figure.

[3] http://app.mewr.gov.sg/web/Contents/Contents.aspx?ContId=1342
http://app.mewr.gov.sg/data/ImgCont/1292/sustainbleblueprint_forweb.pdf

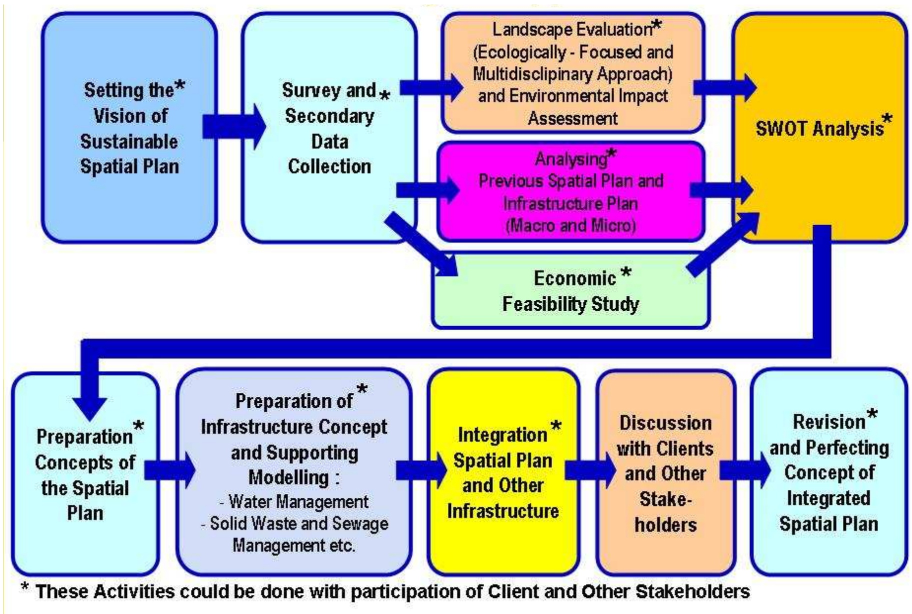

Figure 12 The Integrated Spatial Planning with Ecological Approach.

And there are the critical points in the approach, which are:

Conducting multidisciplinary landscape evaluation to determine the conservation area and mitigate major environmental impact to the site.
Conserving of critical ecological area that are important for ecology and other environmental services
Evaluating of local natural resources, such as water resources, infrastructure provisions etc.
Lastly but not least, determining the carrying capacity of potential area for development.

Therefore, a simple landscape evaluation tool is needed to support the concept above which suitable for developing countries. The tool must be simple enough for the users without compromising its validity. Further, it should prescribe the sustainable recommendation and cater stake-holders participation.

1.1 Description

This research was conducted to develop integrated landscape evaluation method for planners and government authorities of developing countries. Meanwhile, to validate the tool's applicability, the authors chose the case in Bintan Island, Indonesia. It was undertaken to understand its limitations and further refinement. And it was conducted following these steps:

To develop integrated method of landscape evaluation, the authors tried to identify the key elements of several past evaluation methods. And we evaluated their strength, weaknesses and possible area for development with the current technology.

These previous researches in landscape evaluation or site evaluation are:

1. Approaches for General Areas : McHarg (1992); Anderson (2000); Aylward (2000)
2. Approaches for Rural and Natural Areas: Coventry-Solihull-Warwick (1971); A.O.N.B.(Penning – Roswell, 1975); Blacksell and Gild (1975); Ratcliffe (1977); Li, Wang, Liang & Zhou (2006)
3. Approaches for Urban Areas: Weiss, Donnelly and Kaiser (1966); White (1985); Freeman (1999); Briffet (2001); Balmori & Benoit (2003)

Distilling the relevant methods and criteria, the authors prescribed the landscape evaluation tools named **ALiT**, the acronym for **A**daptive **L**andscape Evaluat**i**on **T**ool. "*Alit*" in Sundanese language (native language of West Java, Indonesia) means "small or simple". This was parallel to our intention to deliver a simple evaluation method for developing countries.

We further refined and validated the methods during application. And later we also integrated inputs from stakeholders in Bintan and experiences with Singapore's Urban Planning Consultant in various developing countries. [4]

1.1.1 Landscape Evaluation Method

Broadly, there are eight stages of ALiT (Adaptive Landscape Evaluation Tool), which are:

1. Defining the Purpose, Scope & Context of the Evaluation
Criteria Selection
Secondary Data Collection
GIS Database Processing
Rapid Survey of Critical Areas (Reconnaissance Survey especially for Biological Aspect)
Expert Consultation (Semi-Delphi Consultation)
GIS Analysis (including Ecological Factors, Other Natural Factors and Socio - Economic Factors)
Stakeholders Evaluation (Stakeholders Participation)

[4] http://www.jurong.com/; Gunawan has practiced as Urban Planner with Jurong Consultant Pte Ltd , Planning Division for 2 years

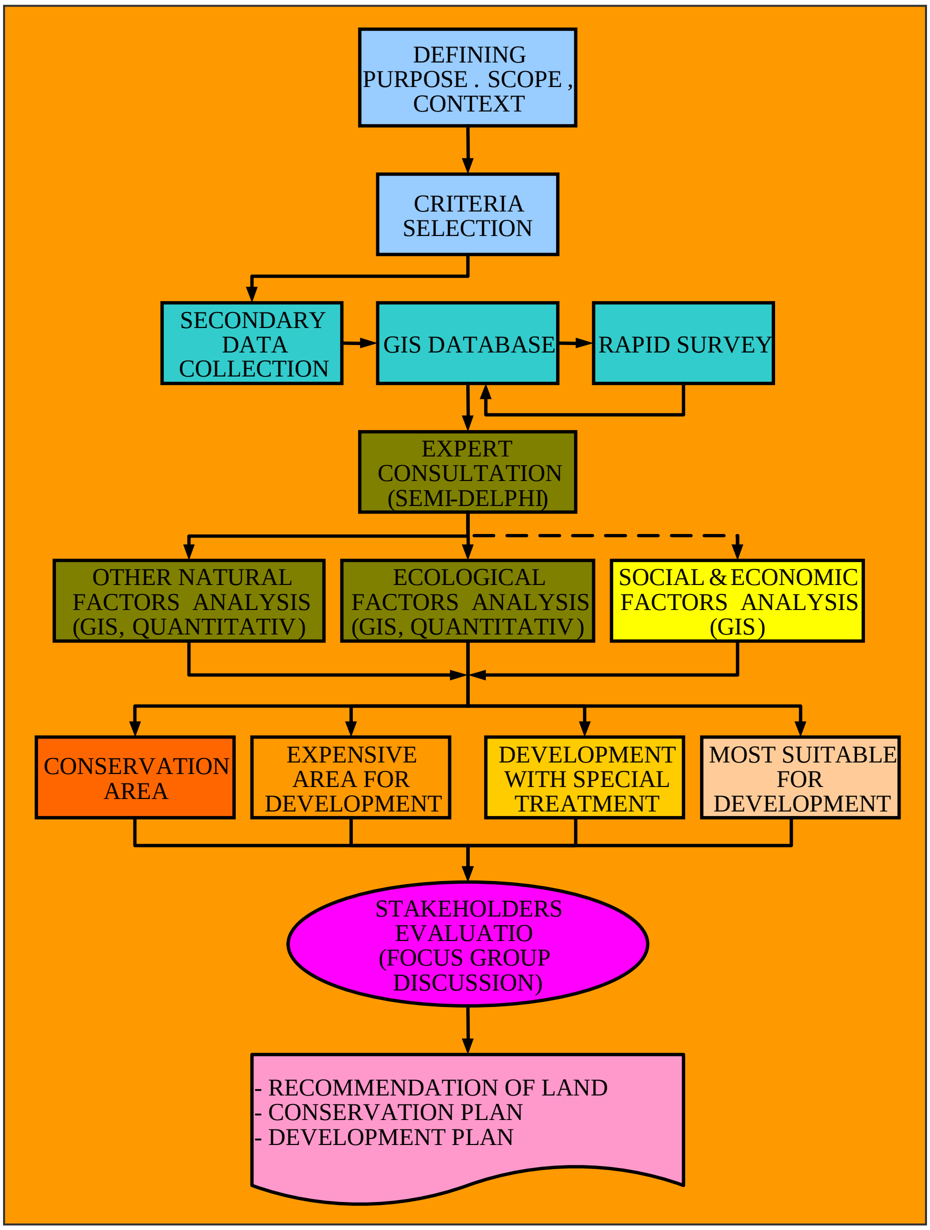

Figure 13 ALiT's (Adaptive Landscape Evaluation Tool) Methodology.

And we would describe the methodology of ALiT in detail below.

1.1.1.1 Defining the Purpose, Scope & Context of the Evaluation

Determining the purpose and the scope of evaluation is a crucial step for ALiT application. Because it would help determining the suitable method, resource allocation as well as evaluation time frame.

We suggest compulsory purpose, which are:

- evaluating and protecting area for conservation
- predicting and reducing environmental impacts from adjacent and future development
-

Two additional alternative purposes are suggested, such as:

- determining the suitability of certain development to certain location
- selecting the most suitable location for certain development (site selection)

Originally, we adopted the possible land use of ALiT from Anderson (2000), McHarg (1992) and Singapore's Environmental Pollution Control Act (Code of Practices on Pollution Control, 2000). But consequently, we simplified them into categories of residential, industrial and commercial & institutional facilities for simpler application. While other spatial uses were still under thorough and further research.

1.1.1.2 Criteria Selection & Secondary Data Collection

Originally, sixteen general criteria were selected to represent the environmental functions and socio-economic considerations. These criteria were adapted from previous work of McHarg (1992,1998), White (1985), Ratcliffe (1977), Anderson (2000), Balmori and Benoit (2003).

These criteria were later divided into three groups representing ecological factors, other natural factors and socio-economic factors. The strategy was conducted to reduce the possible bias of the evaluation result. This strategy was adopted by Freeman (1999) but with simpler criteria.

Group 1 Data Set was prepared to measure the ecological value and conserve natural areas. The ecological value is mainly represented by ecosystem type which is not similar in every location. Other factors if available such as patch size, rarity of plant and animal species, ecological connectivity and water bodies' buffer would reinforce the accurate results.

Group 2A Data Set was prepared to measure the suitability for development relating to construction and cataclysm costs. Those criteria are the existing land use, topography (especially slope), geology, soil types, hydrology, climate, and resources. They are also considered as important criteria because of consideration of hazardous potential such as flooding, hurricane, typhoon, landslide, erosion, etc.

Later on, Group 2B was added to the criteria. This group include criteria related to physical factors, such as accessibility and existing infrastructure, which require major investments if needed. The authors realise that additional parameter can be included, for example access to rail, ports airports and logistic warehouses for industrial area suitability for other application, such as new industrial area.

Following on, Group 3 Data Set was prepared to measure social and economic aspects. They are political-legal factors, economic factors, and social factors. Some of the factors can record social-economic condition such as high crime rate, or are endemic for certain diseases, etc. that needed by the policy makers.

Finally, the human sensory aspect, comprising visual quality and other pollution were included in Group 3. These criteria are useful in finding locations for tourism areas, hotels, resorts or high-end residential developments that require better visual quality.

Ideally, we believe that all data described above should be collected. But learning that only limited data are often available in developing countries context, we suggested the evaluators collecting critical data, such as: ecological, topographical, geology, soil types, hydrology and other potential natural catastrophes. These data must be available whether as secondary data or the rapid primary assessment result. Additionally, further detailed studies are still needed to produce more accurate analysis.

1.1.1.3 GIS Database Processing

After data collection, the data have to be processed directly. We suggest the evaluators to reconsider the processing method based on the purpose; availability of skill sets, tools or software and time.

We believe that GIS (Geographic Information System) software should be used to produce more accurate data. On the other hand considering the limitation in developing countries, we provided two major methods for ALiT such as: GIS database and manual database.

Under the GIS flow, there are several alternative steps identified:

2. Selecting and using GIS Software (such as Arc View GIS 3.1) for database management and analysis
3. Purchasing a baseline vector map from remote sensing service providers
4. If the vector map unavailable, other topographical map could be digitised with GIS software (Autocad, Mapinfo etc)
5. Digitising other factors into GIS data set (grid or shapefiles)
6. Continuing to analysis phase

Under the manual flow, we find that McHarg's transparent layer map could be used to produce conservation and development suitability maps (McHarg, 1998). We also note improvement of this method with assistance of the latest computer graphic software application (such as Photoshop and Power point).

1.1.1.4 Rapid Survey

Considering budget and time constraints, the rapid survey is suggested to be focused in the critical areas. These areas could be areas with high biodiversity & high scenic values; and areas to be developed in the near future. And these locations are better to be identified first from aerial image or secondary data (GIS or land use map).

Further, other important possible access or mode of transport also should be surveyed. These areas are ports, major roads (according to the roads classifications), railways, light rails, airports, as well as major commercial – institutional facilities.

Other potential hazards also must be identified, such as: wetlands, flood prone areas, slopes with potential landslide, polluting industries, hazardous material storage, etc. This information is important especially for residential and commercial – institutional facilities.

Having tried several survey methods in ALiT application, we recommend combination of McHarg transparent maps (McHarg, 1992), photographs, video documentation, GPS set, and survey tables. These methods are found to be effective, well-documented and shorter in time wise.

1.1.1.5 Expert Consultation (Semi Delphi)

Interpretation of the secondary data should be conducted involving a team of experts. A team, comprising of a Planner, Landscape Ecologist, Conservationist, Hydrologist, Civil Engineer, Geologist, and Socio-Economic Scientist, should be recruited.

Later on, all data need to be interpreted and translated into ranking criteria following the sustainable principals by the team. The principals were already prescribed in the previous work of McHarg (1992), White (1985), Ratcliffe (1977), Anderson (2000), Balmori and Benoit (2003). And sample of ranking criteria is presented in the following table.

Tabel 2 Sample of Ranking Criteria for ALiT

No	Criteria	Highest Conservation Value	Most Suitable for Development
	Group 1		
A	**Vegetation**		
A1	Ecosystem Type	Highest Conservation Value	Lowest Conservation Value
A2	Patch Size	More than 10 ha	Less than 0.4 ha
A3	Rarity of Plant Species	Threatened and Endangered Species	No Species Found
A4	Ecological Connectivity	Good	Fragmented
A5	Riparian & Beaches Buffer	Less than 15 m	More than 165 m
B	**Animal**		
B1	Rarity of Animal Species	Threatened and Endangered Species	No Species Found

This approach was originally prescribed by McHarg (1998). Later, we adopted different approach of scoring method similar to Freeman (1999). Lastly, we redefine the scoring interpretation validity with more assistance of Semi-Delphi discussion.

Adopting Environmental Impact Assessment, we differentiate the important criteria with major environmental impact from other normal criteria (Morris and Therivel, 1995). This concept is translated into two types of scoring scales. The first scale (0 to 30) is dedicated for criteria with major impact (major-weighting). The second scale (0 to 3) is prescribed for the ones with minor impact (minor-weighting).

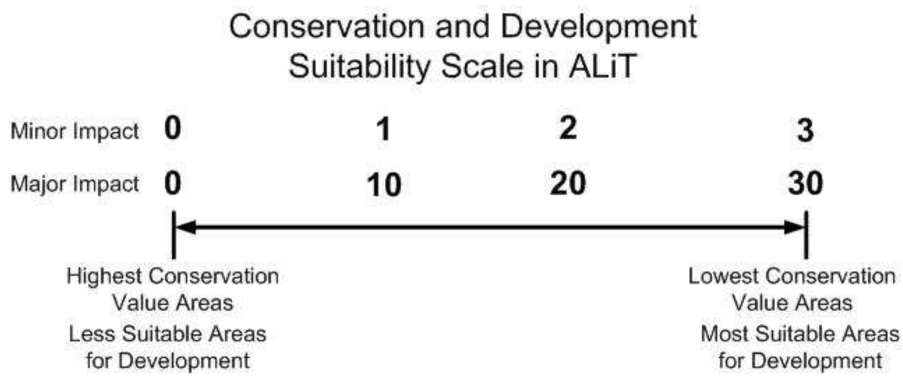

Figure 14 Conservation and Development Suitability Scale in ALiT.

We also produce new approach in scoring technique, which described 0 or zero representing the high conservation areas or totally unsuitable area for development. On the contrary we prescribed 30 or 3 representing the most suitable area for development.

Tabel 3 Criteria Interpretation for ALiT

No	Criteria Interpretation		Major Weighting	Minor Weighting
	Conservation	Development Suitability		
1	High Conservation Value	Not Suitable for Development	0 – 9	0
2	Medium Conservation Value	Expensive for Development	10 -19	1
3	Low Conservation Value, Partial Human Intervention	Suitable for Development with Special Treatment	20 – 29	2
4	No Conservation Value, Massive Human Intervention	Most Suitable for Development	30	3

Tabel 4 Table 4. Sample ALiT Scoring for Bintan Ecological Data

(Legend: Italic text showed Indonesian translation)

No	Category *(Kategori)*	Criteria Score *(Nilai Kriteria)*
A	Vegetation *(Flora)*	
A1	Ecosystem Type (*Tipe Ekosistem)*	
	Which specific to Bintan *(Spesifik untuk Bintan)*	
	Bare Earth *(Tanah Terbuka)*	30
	Mining *(Pertambangan)*	30
	Human Settlement (Permukiman)	25
	Agriculture *(Pertanian)*	20
	Scrub *(Padang)*	20
	Marsh *(Rawa)*	15
	Plantation (Kebun)	15
	Abandoned Plantation *(Kebun yang Ditinggalkan)*	12
	Secondary Forest *(Hutan Sekunder)*	10
	Mangrove	5
	Coral Reef *(Terumbu Karang)*	0
	Fresh Water Swamp Forest *(Hutan Rawa Air Tawar)*	0
	Primary Forest *(Hutan Primer)*	0
A2	Patch Size *(Luas Ekosistem)*	
	0-0.4 ha	2
	0.4 -1 ha	1
	1 -10 ha	0
	> 10 ha	0

Tabel 5 Sample ALiT Scoring for Bintan Ecological Data continued

Legend: Italic text showed Indonesian translation

No	Category *(Kategori)*	Criteria Score *(Nilai Kriteria)*
A3	**Rarity of Plant Species *(Kelangkaan Flora)***	
	No Data (Tidak ada Data)	2
	Common Species *(Spesies Biasa)*	2
	Endemic Species to Large Area *(Spesies Endemik pada Daerah yang Luas)*	2
	Endemic Species to Small Area *(Spesies Endemik pada Daerah yang Sempit)*	1
	Threatened and Endangered Species *(Spesies Langka dan Terancam Langka)*	0
A4	**Ecological Connectivity *(Konektivitas Ekologi)***	
	Good *(Baik)*	0
	Fragmented *(Tidak baik)*	2
A5	**Riparian & Beaches Buffer *(Buffer untuk Sungai, Danau, Rawa dan Pantai)***	
	0 - 15 m	0
	15 - 50 m	0
	50 - 165 m	1
	> 165 m	2
B	**Animal *(Fauna)***	
B1	**Rarity of Animal Species *(Kelangkaan Fauna)***	
	No Data (Tidak ada Data)	2
	Common Species *(Spesies Biasa)*	2
	Endemic Species to Large Area *(Spesies Endemik pada Daerah yang Luas)*	2
	Endemic Species to Small Area *(Spesies Endemik pada Daerah yang Sempit)*	1
	Threatened and Endangered Species *(Spesies Langka dan Terancam Langka)*	0

We decide to bring Bintan's case to explain the rationale of selecting 0 score for the high conservation areas. Further, to measure a total conservation score or development suitability for one area, all the critical criteria or factors of the location should be calculated following these calculations.

Tabel 6 Score Calculation for ALiT

Conservation suitability score (Group 1 score)	= factor A score * factor B score, etc

Development suitability score	= factor C score * factor D score * factor E score, etc

(Group 2 or 3 score)

So for example, if the area is a primary forest in Bintan; with patch size of 0.4 ha; possesses certain endemic species of plants to small; not connected with ecological corridor (fragmented); located at 165 m distance from the beach; and possesses one endemic species of animals to large area. The individual factor score would follow this table.

Tabel 7 Sample of Score Calculation for ALiT for Ecological Score

No	Category *(Kategori)*	Criteria Score *(Nilai Kriteria)*
A	**Vegetation *(Flora)***	
A1	**Ecosystem Type (*Tipe Ekosistem)***	
	Primary Forest *(Hutan Primer)*	0
A2	**Patch Size *(Luas Ekosistem)***	
	0-0.4 ha	2
A3	Rarity of Plant Species (Kelangkaan Flora)	
	Endemic Species to Small Area (Spesies Endemik pada Daerah yang Sempit)	1
A4	Ecological Connectivity (Konektivitas Ekologi)	
	Fragmented (Tidak baik)	2
A5	Riparian & Beaches Buffer (Buffer untuk Sungai, Danau, Rawa dan Pantai)	
	50 - 165 m	1
B	Animal (Fauna)	
B1	Rarity of Animal Species (Kelangkaan Fauna)	
	Endemic Species to Large Area (Spesies Endemik pada Daerah yang Luas)	2

The conservation score of the area would be able to calculated as follow

Conservation score (Group 1 score)	= A1 score	* A2 score	* A3 score	* A4 score	* A5 score	* B1 score
	= 0	*2	*1	*2	*1	*2
	= 0					

So, it can be concluded that the primary forest patch is not suitable for any development. Further, similar principal also would be able to be applied in development suitability. Flood prone areas, high potential areas for landslide and earthquake are not suitable for development according to ALiT.

1.1.1.6 GIS Analysis

GIS analysis is started with conversion of attributes above into scores by database software or GIS scripting. Later on all GIS data should be compiled and calculated in three groups. Similar classification of data sets, we also proposed categorising scoring into 3, which are Group 1 score for the ecological value; group 2 score for suitability in other natural aspect and group 3 score for suitability in socio–economic aspect.

The conservation threshold needs to be redefined again in the expert panel. The threshold is not fixed, but from conventions of the experts, producing balance conservation and development recommendation.

For example, the threshold in Bintan was adjusted to 47%. It was selected in the view of conserving important area and recommending less ecological important area for development, such as scrubland, agriculture, mining, barren earth. For comparison, Freeman (1999) recommended score 14 of total 30 for conservation threshold in Leeds case or 46%. After setting the threshold, we could find areas with low ecological score which could be suitable for development.

Potential suitable areas for development need to be evaluated for other factor suitability. And thresholds would need to be set for each score (score 2 and score 3). Finally the analysis would produce 3 recommendation of area, such as: very suitable area for development, suitable area with certain treatment, area that expensive to develop and area not suitable for the development.

Tabel 8 Sample of Threshold of Conservation and Development Suitability

No	Criteria Interpretation	Criteria Score
	Group 1 Score (Conservation) for Bintan Case	
1	Proposed for conservation	0 - 47%
2	Recommended for development, need further Group 2 and 3 assessment	47.1 - 100%
	Group 2 and Group 3 Scores (Development Suitability)	

1	Not Suitable for Development	0 – 33.3%
2	Expensive for Development	33.3 – 66.6%
3	Suitable for Development with Special Treatment	66.6 – 99.9%
4	Most Suitable for Development	100%

Further, sustainable planning and design concept must be prepared for area that are expensive for development and suitable but need certain treatment. For example, barren land in Bintan could be developed, but with the careful soil erosion prevention. Another example, proper structural system with adaptation to the earthquake is needed for development in the earthquake prone areas.

1.1.1.7 Stakeholder Evaluation

Stakeholder evaluation of the interim landscape evaluation results is needed. It was proposed to ensure the acceptance of the local communities, government as well as private sectors and reduce the social impacts from the plan.

Participatory approach was originally developed in UK and USA. This process was later introduced to the developing countries by the non-government organisation, such as ADB, GTZ, USAID and JICA, to post-disaster areas such as Aceh (Nanggroe Aceh Darussalam Province, Indonesia). Although still facing difficulty, these processes were generally accepted in Indonesia and quite successful. [5]

The difficulties of implementing participatory planning are the limitation of project time (especially government-funded and international-funded) and possible conflict of interests. Further, we also found that the future spatial development information could create land speculation in the countries with liberal land market, such as India, Indonesia, Vietnam, etc.

But we still believe that the stakeholders' participation still would bring positive impacts to the communities and sustainable spatial planning. Finally, we would like emphasise that after ALiT implementation, an Integrated Spatial Plan should be prepared by professional consultants. Further to validate ALiT applicability, we will describe its application in Bintan Island, Indonesia.

1.1.2 Application of ALiT (Adaptive Landscape Evaluation Tool) in Bintan Buyu

ALiT was applied to review the ecological condition as well as the feasibility of Bintan Buyu Development, Bintan Island, Indonesia. The area was originally designated by Bintan Regency Government as the new District Centre (named as Bandar Seri Bintan) in

[5] http://www.reliefweb.int/library/documents/2005/brr-idn-22sep.pdf
http://www.adb.org/Documents/Reports/39127-INO/FactSheets/village-plans.pdf
http://www.scribd.com/doc/13103851/Participatory-Planning-in-Aceh-URDIGTZ-Seminar-2526-July-2008
http://indonesia.usaid.gov/en/Article.361.aspx
http://www.jica.go.jp/indonesia/english/activities/pdf/JICAinAceh.pdf

2004. Facing resistance from Central Government because of conservation status of the area, the Local Government conducted feasibility re-evaluation with our team assistance.

Although the development was rejected by the Central Government, we are glad to participate because our ability to mitigate the impacts and to produce sustainable spatial development scenario. And we focused our evaluation in measuring the conservation value and residential suitability of the location which described accordingly.

First, a general survey and interviews for collecting secondary data were conducted. The process involved Bintan Planning Agency (*BAPPEDA*); Statistics Agency (*BPS*); Forestry Agency (*Dinas Kehutanan*; Public Works Agency (*Dinas PU*); and Investment Coordination and Regional Promotion Board (*BKPMD*) of Bintan.

The most-updated critical GIS data sets were collected from the Public Works Department (1993). Other maps were also collected from Indonesian National Geological Research Centre and National Water Resources Centre in Bandung, West Java, Indonesia. And this allowed the application of GIS software (Arc View GIS 3.1). The data later were scanned, geo-referenced and converted to shape-files (SHP).

A comprehensive site survey was conducted with team of four persons, comprising 1 Urban Planner, 2 Biologists and 1 Civil Engineer (Government Officer), in June 2006. It was executed using ALiT's recommended tools. And we found it very effective and accurate because of adequate expertise and tools.

In the survey, some points for biological assessment were selected representing each ecotype. Many important ecotypes had been converted to agriculture land or human settlement based on 1993's eco-types. This finding actually highlighted the importance of latest remote sensing image data in evaluation process. Unfortunately, because of funding limitation, the data was not collected.

GIS database analysis was later conducted focusing only on Ecological score and Residential Development Suitability for other natural factor score. The analysis was conducted involving of multidisciplinary team consisting of Principal Urban Planner and Researcher, Landscape Ecologist, Conservationist, Hydrologist cum Drainage Engineer, and Civil Engineer cum Geologist. During the analysis process, we were also assisted by 2 Senior GIS experts for GIS database processing and analysis from National University of Singapore.

All data later were collected and processed following the criteria priority and significance in the evaluation process.

Tabel 9 Data Processed in Bintan Buyu Evaluation.

(Legend : Y = Yes, N = No)

No	Criteria	Availa-bility	Consi-dered in the Gene-ral Analysis	Calcu-lated in ALiT Scoring	Reason
	Group 1				
A	**Vegetation**				

No	Criteria	Availa-bility	Consi-dered in the Gene-ral Analysis	Calcu-lated in ALiT Scoring	Reason
A1	Ecosystem Type	Y	Y	Y	
A2	Patch Size	N			
A3	Rarity of Plant Species	N			
A4	Ecological Connectivity	Y	Y	Y	
A5	Riparian & Beaches Buffer	Y	Y	Y	
B	**Animal**				
B1	Rarity of Animal Species	Y	Y	Y	Partial data available

Tabel 10 Data Processed in Bintan Buyu Evaluation.

(Legend : Y = Yes, N = No)

No	Criteria	Availa-bility	Consi-dered in the Gene-ral Analysis	Calcu-lated in ALiT Scoring	Reason
	Group 2A				
C	**Existing Land Use**				
C1	Compatibility with Existing Land Use	N			
C2	Existing Facility Adequacy	Y	Y	Y	
D	**Topography**				
D1	Elevation	Y	Y	Y	
D2	Slope	Y	Y	Y	
E	**Geology**				
E1	Foundation Strength	Y	Y	Y	
E2	Earthquake and Volcanic Zone	Y	Y	N	Because similar factor affecting the site
E3	Anticline, Syncline, and Fault	Y	Y	N	
F	**Soils**				
F1	Foundation Strength	Y	Y	Y	
F2	Erosion by Soil Type	Y	Y	Y	
G	**Inland Hydrology**				
G1	Recharge Areas	Y	Y	Y	
G2	Aquifer Productivity	Y	Y	Y	
G3	Surface Waters and Flood Zone	Y	Y	Y	
G4	Catchments Areas	Y	Y	Y	
H	**Marine Hydrology**				
H1	Marine Features	N			
I	**Climate**				
I1	Hurricane, Typhoon	Y	Y	N	Because almost similar factor affecting the site
I2	Annual Rainfall	Y	Y	N	
I3	Rainy Days in 1 year, Dampness, Average Temperature, Monthly Temperature, Wind Pattern, Sun Angle and Trajectory	Y	Y	N	
J	**Resources**				
J1	Mining Resources	Y	N		Because not evaluated for Mining

Tabel 11 Data Processed in Bintan Buyu Evaluation.

(Legend : Y = Yes, N = No)

No	Criteria	Availa-bility	Consi-dered in the Gene-ral Analysis	Calcu-lated in ALiT Scoring	Reason
	Group 2B				
N	**Location**				
N1	Distance from the Main Road	Y	Y	Y	
N2	Average Distance from Other City within Area	Y	Y	N	Because similar factor affecting the site
N3	Average Distance from Regional and International Centre	Y	Y	N	
O	**Circulation**				
O1	Inland Transport	Y	Y	Y	
O2	Water Transport	Y	Y	Y	
P	**Utilities**				
P1	Availability of Utilities Facility	Y	Y	Y	

Tabel 12 Data Processed in Bintan Buyu Evaluation.
(Legend : Y = Yes, N = No)

No	Criteria	Availa-bility	Consi-dered in the Gene-ral Analysis	Calcu-lated in ALiT Scoring	Reason
	Group 3				
K	**Politics and Legal Factors**				
K1	Municipal Government Economic and Human Resources Capacity	Y	Y	N	Because similar factor affecting the site
K2	Future Government Plan	Y	N		Because the Master Plan was cancelled
L	**Economic Factors**				
L1	Land Market Pricing	N			
L2	Land Ownership	N			
L3	Regional Gross Domestic Product Trend	Y	Y	N	Because similar factor affecting the site
M	**Social Factors**				
M1	Higher Education Level	Y	Y	N	Because data only available in general and similar factor affecting the site
M2	Middle Education Level	Y	Y	N	
M3	Criminalities Level	N			
M4	Population Density	Y	Y	N	Because data only available in general and similar factor affecting the site
M5	Number of Patients and Deaths by Diarrhoea	Y	Y	N	
M6	Number of Patients and Deaths by Dengue/Malaria	Y	Y	N	
Q	**Human Sensory**				
Q1	Visual Quality	N			
Q2	Other Pollution	N			

Because we found that only limited numbers of data were available for Bintan Buyu, we decided to focus the evaluation to available data and completing some critical data with primary survey.

From the application, we also found that some data were only available in regional scale, not in the local scale. Therefore, we decided including the data in general evaluation, but not including them in the total scoring calculation. This was implemented for simpler ALiT application. Further, only the most significant data were discussed in this paper.

The ecological condition of the Bintan Buyu was originally adopted from 1993's Natural Resources Inventory (by Bintan Planning Agency, cited in BKPMD 2005) and validated by primary rapid biological assessment.

Bintan Buyu was historically occupied by the agriculture communities in 1950's. In 1991 by Presidential Decree No. 32 (Keputusan Presiden No 32, 1991), the area was designated as protected catchments area, but it was implemented without land acquisition and community participation. This later caused the conservation plan fail, leaving agriculture activities and creating rural - natural area patchwork (cited in Riau Islands Planning Agency and CV Geometric Tehnik, 2005).

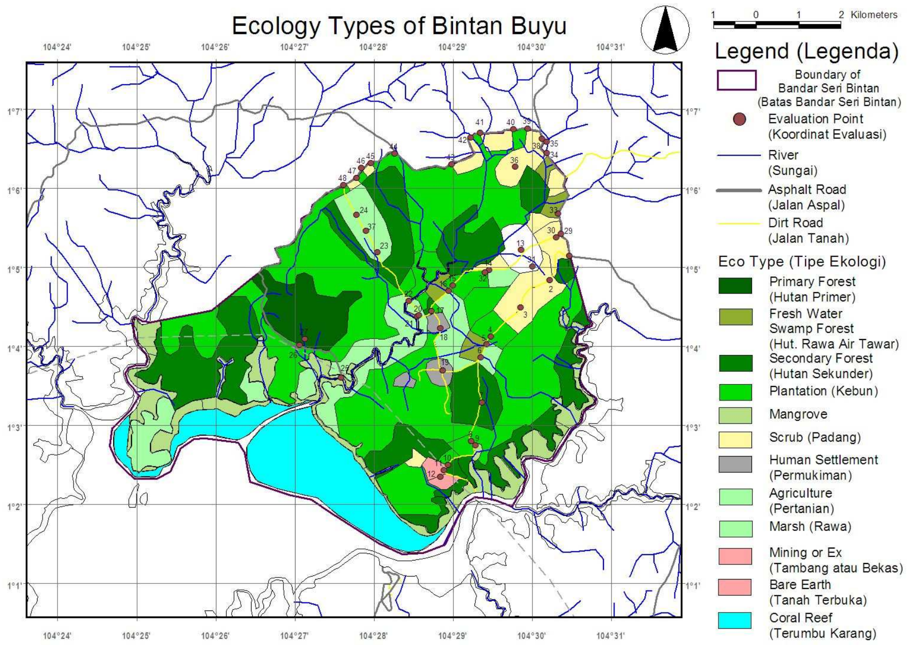

Figure 15 Ecosystem Type of Bintan Buyu. (Sources: Riau Islands Planning Agency, 2004; corrected in the Rapid Biological Assessment, 2006)

Bintan Buyu's ecological condition was composed of several eco-types. First, the highest ecological areas found were coral reef, mangrove, primary forest, and fresh water swamp forest. We suggested these to be conserved because of important functions, such as habitat for plant and animal, coastline protection, waste assimilator, water purification, and nursery ground for marine life and birds (Whitten et al., 2000).

Further, areas with the second highest ecological value were the secondary forests, marshes and abandoned plantations. They held certain functions of habitat for biodiversity but they were still in the recovery process after human interventions. For example, the team found Banded Leaf Monkeys in the abandoned plantations which could be considered a good habitat.

The third ecotypes, with the second lowest ecological values, were agricultural land and scrubland in the area. These areas could be considered as a man-made environment and possessed low biodiversity, which were the dragonflies and birds. Therefore, these areas were possible for development. On the contrary some patches of scrub should be preserved for local species habitat.

Finally, the team found some very low ecological value areas, which were could be developed, if the development was permitted. They were the mining or ex-mining areas and barren earth.

Meanwhile, two important endemic species were also found in the area. The Banded Kingfisher (*Lacedo pulchella)* and Banded Langur (*Presbytis siamensis rhionis*) are two examples of the endemic species.

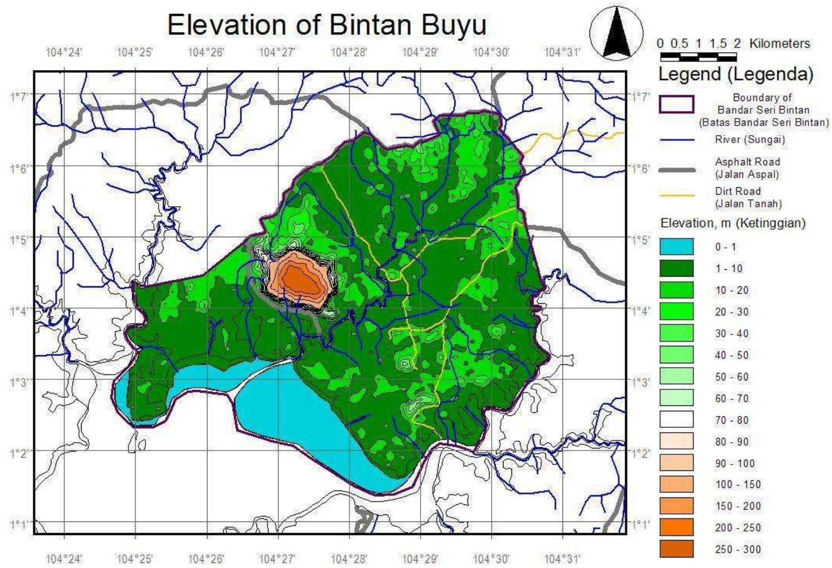

Figure 16 Elevation of Bintan Buyu. (Source: Bintan Regency Public Works Department, 1993)

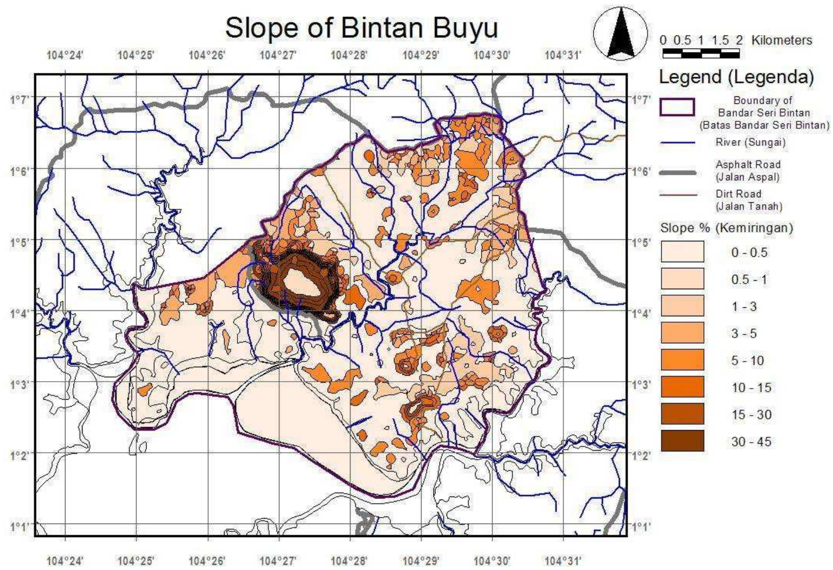

Figure 17 Slope of Bintan Buyu. (Source: Bintan Regency Public Works Department,

1993)

Topographically, Bintan Buyu area was located on the altitude of 0 to 255 m from sea level. Bintan Mountain (*Gunung Bintan*) the highest point of the area and with 15-45 percent slope. It held important functions of water catchments and wildlife habitat. Therefore, this area was not suitable for development (Bintan Regency Public Works Department, 1993).

Meanwhile, extensive the lowland areas, with 0-1 percent slope, were identified in the location. These areas were often vegetated by mangrove, fresh water swamp forest and marshes. And they were not definitely suitable for development because of poor soil strength, extreme land subsidence, and very high cost of infrastructures especially for landfill and flood protection.

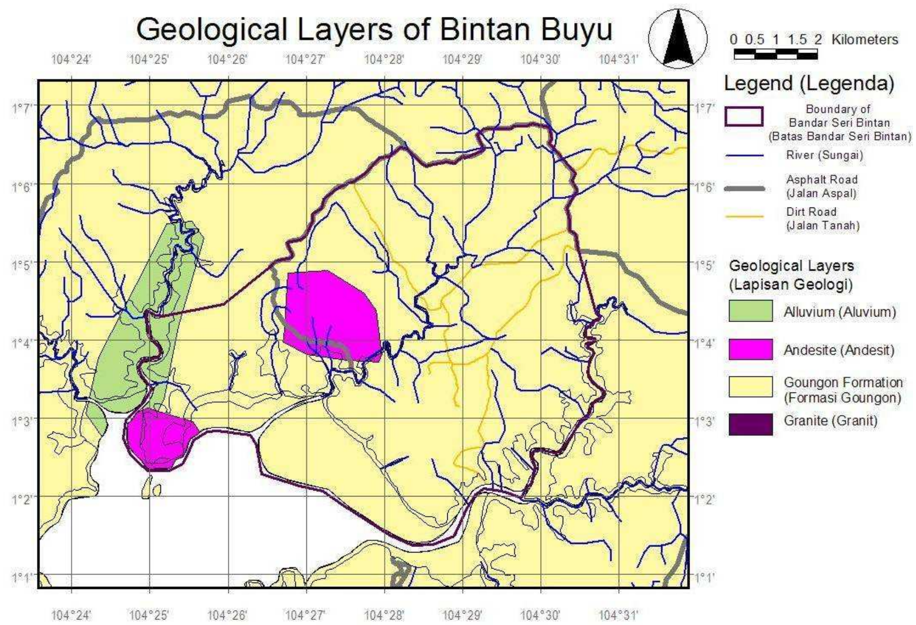

Figure 18 Geological Layers of Bintan Buyu. (Source: Kusnama et.al., 1994)

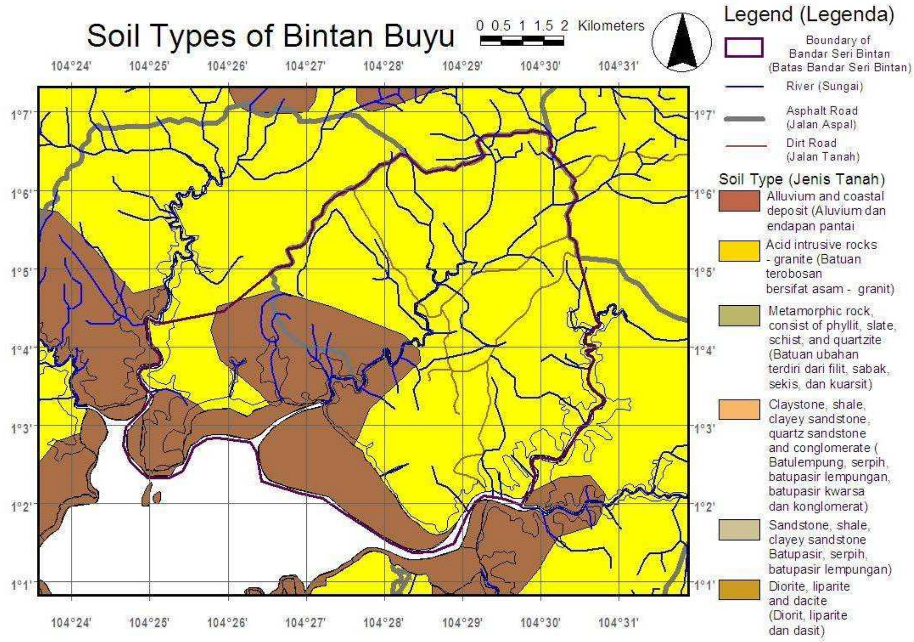

Figure 19 Soil Types of Bintan Buyu. (Source: Akus et.al., 1994)

The Geological layer found in Bintan Buyu area was Andesite, Goungon Formation, and Alluvium (Kusnama, et al., 1994). Areas with Andesite layer were not suitable for development due to the rock layer hardness and expensive excavation cost. Meanwhile, areas with the Alluvium layer were not suitable for development due to poor strength and possible soil erosion. So, only areas with Goungon Formation were found feasible for development.

Bintan Buyu, were categorised as the Zone VI earthquake hazard. Or it was considered safe from earthquakes or tsunamis. And no anticline, syncline, strike slip fault, or normal fault were found affecting the area (Kusnama, et al., 1994). And it means that the area possessed higher development suitability, but the score was excluded from calculation because similar attribute in the area.

Bintan Buyu's soil was composed of 2 types, which were Alluvium and coastal deposit, (consisting of gravel, sand, clay and mud deposit); and Acid intrusive rocks - granite (Akus et al., 1994). The Alluvium soil was found to be more vulnerable for erosion and weakest for foundation strength.

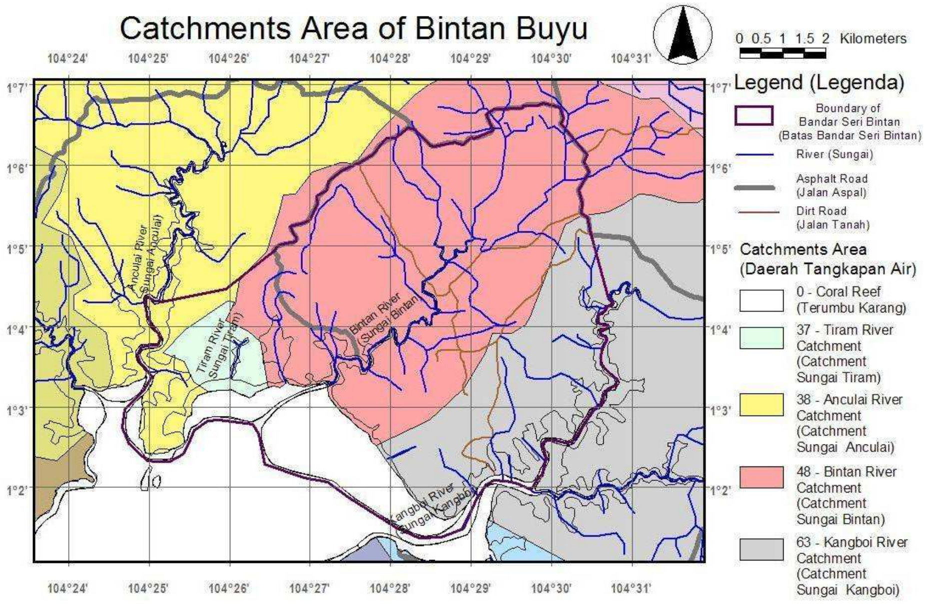

Figure 20 Catchments Area of Bintan Buyu. (Source: Akus et.al., 1994).

There were three main rivers in the area, of Bintan River, Kangboi River, and Anculai River. 3 major catchments and 1 minor catchments were also identified. In 1991, these catchments were designated as protected catchments area, but apparently this strategy was not effectively implemented (Riau Islands Planning Agency and CV Geometric Tehnik, 2005). And the plan was not compatible anymore because of the present of polluting activities, such as mining in Lomesa, Bintan Buyu. The polluting developments were also not compatible with residential development.

Bintan’s economy depends heavily on industry, mining, trade and tourism sectors with total Regional Domestic Product 1,053.84 Billion Rupiah (BKPMD, 2005). So the development of new district centre should be adapted to the real economic condition and environmental capacity.

Tabel 13 Table 10. Bintan's Regional Domestic Product in 2003 – 2004. (Source: BPS, 2004)

No	Sectors	2003		2004		Annual Increase
		Billion Rupiah	% to Regional Domestic Product	Billion Rupiah	% to Regional Domestic Product	%
1	Agriculture	54.11	5.65	61.68	5.85	13.14
2	Mining	259.28	27.08	290.48	27.56	11.51
3	Industry	383.17	40.02	412.81	39.17	6.94
4	Energy	1.78	0.19	2.08	0.20	17.48
5	Construction	43.71	4.57	49.83	4.73	13.78
6	Trade and Tourism	122.96	12.84	135.20	12.83	9.23
7	Transportation and Communication	48.03	5.02	54.24	5.15	12.47
8	Finance	19.63	2.05	21.51	2.04	8.81
9	Services	24.72	2.58	26.01	2.47	4.53
	Total	957.39		1,053.84		9.24

Legend: [yellow] The highest contributor to Regional Domestic Product [pink] The lowest contributor to Regional Domestic Product

We also noted the population of Bintan Buyu increased 0.88% annually. In April 2006, local population was recorded reaching 2,065 persons (Teluk Bintan District Office, 2006). Most of local population worked in agriculture and fishers sectors. On the other hand, no detailed local social data was available causing evaluation difficulty. It can be concluded that the Bintan Buyu community depended heavily in agriculture and fisheries. Meanwhile, if the location was developed, new economic activities must be introduced with investments to support the new district centre.

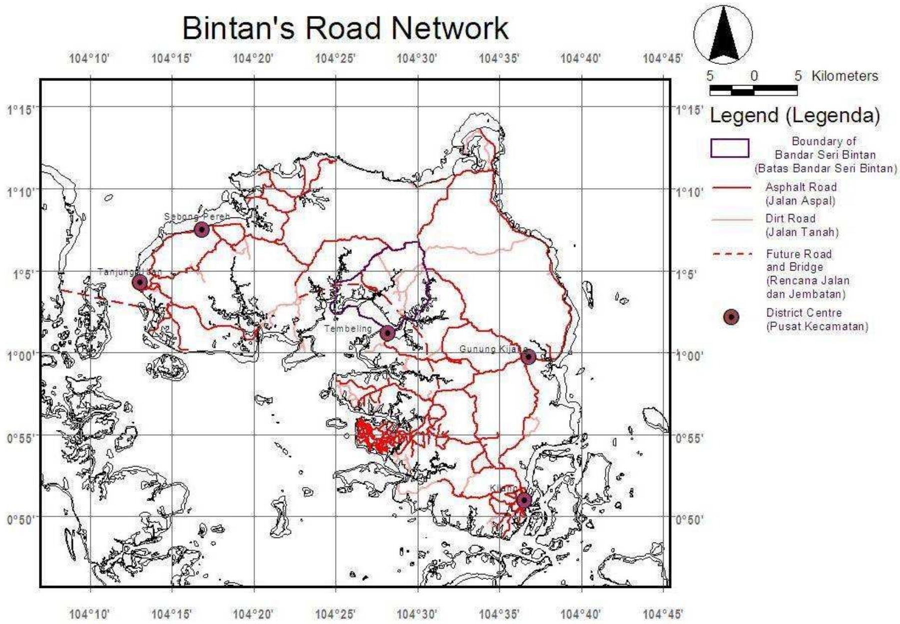

Figure 21 Bintan's Road Network. (Source: Bintan Regency Public Works Agency and Riau Islands Planning Agency, 2004)

Bintan Buyu was located centrally in the island but poorly connected (by dual-lane asphalt road) with other area in 2006. In the future, a coastal ring road along would be constructed connecting the area. Unfortunately, the road was not planned considering the ecological condition and affected the important forests in the area (Riau Islands Planning Agency, 2004). Further, Bintan Buyu was not served by proper public transportation and infrastructures. These eventually would require heavy investments if the city was developed.

Other description of the area, such as Inland Hydrology, atmospheric condition, potential resources, Location, Circulation, Utilities, Politics and Legal Factors, Economic Factors, Social Factors, Human Sensory, etc; were described in our complete research report (Tanuwidjaja G., 2006).

1.1.3 Discussion

The research concluded that Bintan Buyu was a fragmented natural area with some important biological areas. The remaining ecological areas needed a serious conservation and enhancement strategy. Further, this strategy could be combined with sustainable eco-tourism. This had been implemented successfully by Banyan Tree Resorts and Hotels in northern area of Bintan Island.

We also recommended preserving and improving several areas of scrubland, forest, riparian area to improve ecological connectivity of the area. Several areas in the Northern of Bintan Buyu were recommended for development due to low ecological values.

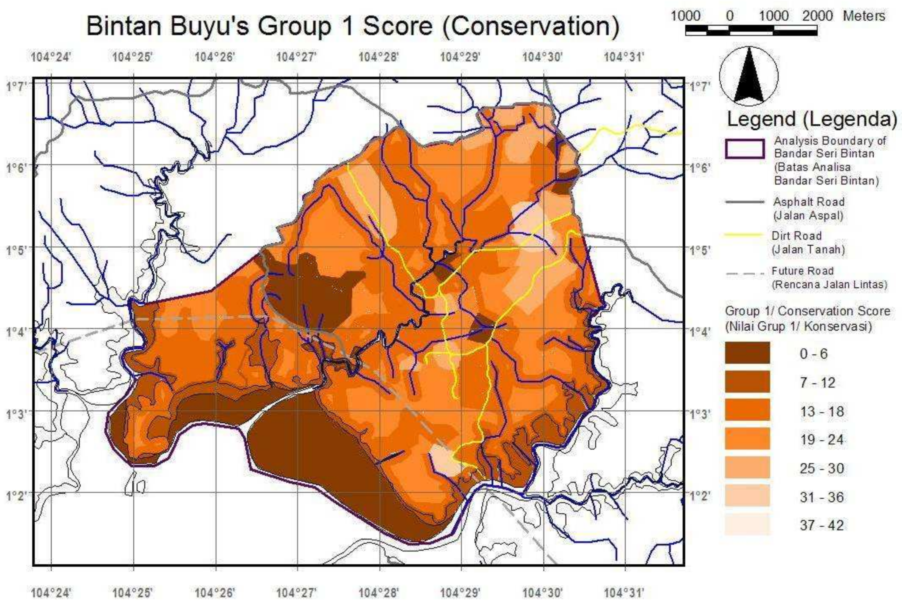

Figure 22 Bintan Buyu's Group 1 Score (Conservation Score).

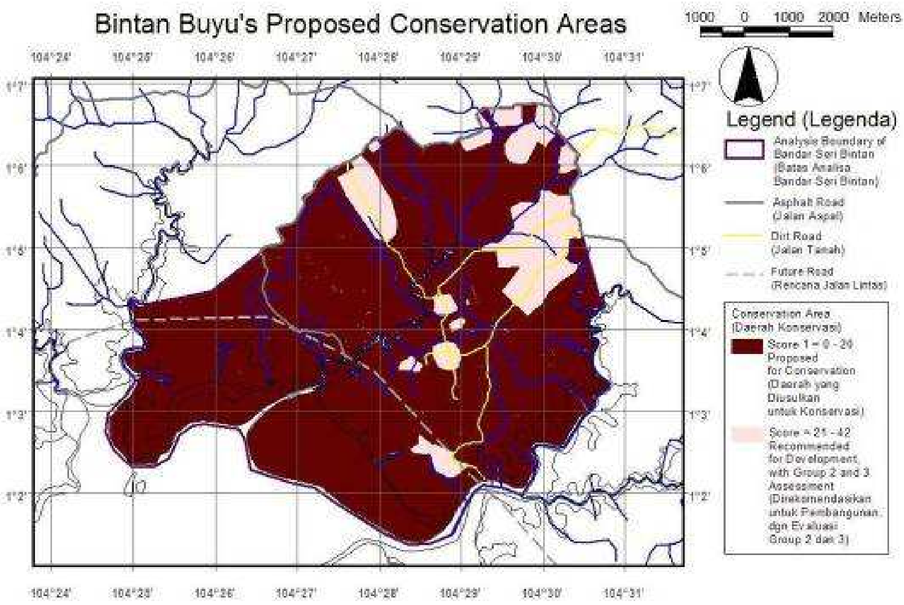

Figure 23 Bintan Buyu's Conservation Area.

The evaluation of other natural factors was further recommended for possible areas of development in the North. However, critical threats, such as landslide potential, flooding potential and land subsidence, must receive proper attention. Finally, the spatial plan must be prepared carefully with integration with other infrastructures.

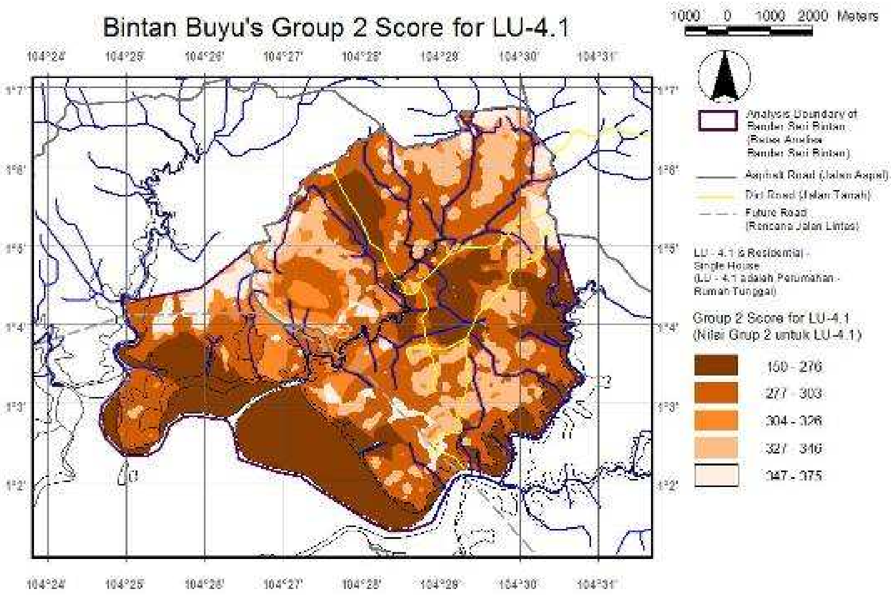

Figure 24 Bintan Buyu's Group 2 (Other Natural Factors) Score for Residential.

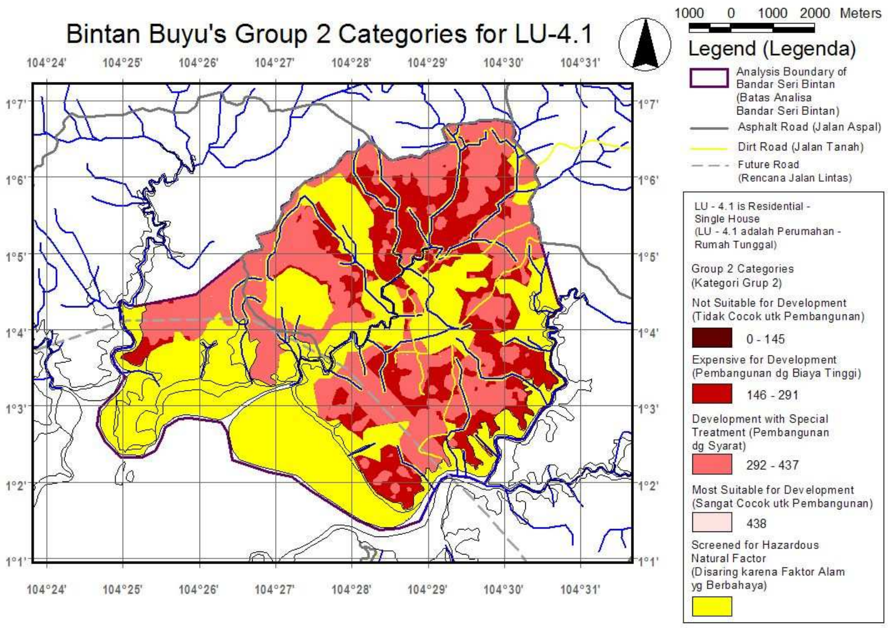

Figure 25 Bintan Buyu's Group 2 Suitable Area for Residential.

To be able to achieve a sustainable township in Bintan Buyu, it is important to set the population according sustainable principal. There were two possible recommendations identified.

The first method was suggested by McHarg's with limiting development to less ecological important areas (McHarg 1998). The scrub, agriculture and some of plantation areas, approximately 10.5 sq km in the northern of Bintan Buyu, were suggested for development. Later with multiplying the area with sustainable population density, we could produce population number.

McHarg recommended another way to sustainable population setting. He suggested limiting the city population following the city ecological carrying capacity. This was prescribed for Wilmington and Dover, considering sewage disposal capacity, ground water supply and reservoir water supply. Respectively, he suggested a population of 33,100 people for the respective city (McHarg 1998).

First, we decided to follow the second recommendation using local rain-water supply capacity. With calculating the lowest monthly rainfall in Bintan, area of Bintan River catchments, runoff coefficient, we could produce minimum amount of possible available rain-water. Assuming 30% of the flow was utilised by the municipal water supply, we could prescribe sustainable township's population of Bandar Seri Bintan of 57,000 persons.

But combining both methods, the authors recommended 57,000 populations (19,000 housing units) to be settled in the less ecological important areas in the Northern area of Bintan Buyu. Further assuming only 50% of the areas were designated as residential, the average residential density could reach 109 persons/ ha, with a low to medium rise development.

Later, proposed development type could be elaborated following mixed-used neighbourhood unit concept with 400 - 600 m radius adapted from Perry's Neighbourhood (Urban Planning Guide, 1986). This option was recommended because of limited economic capacity of the developing countries. Further public utilities and integrated waste management should be provided for the area.

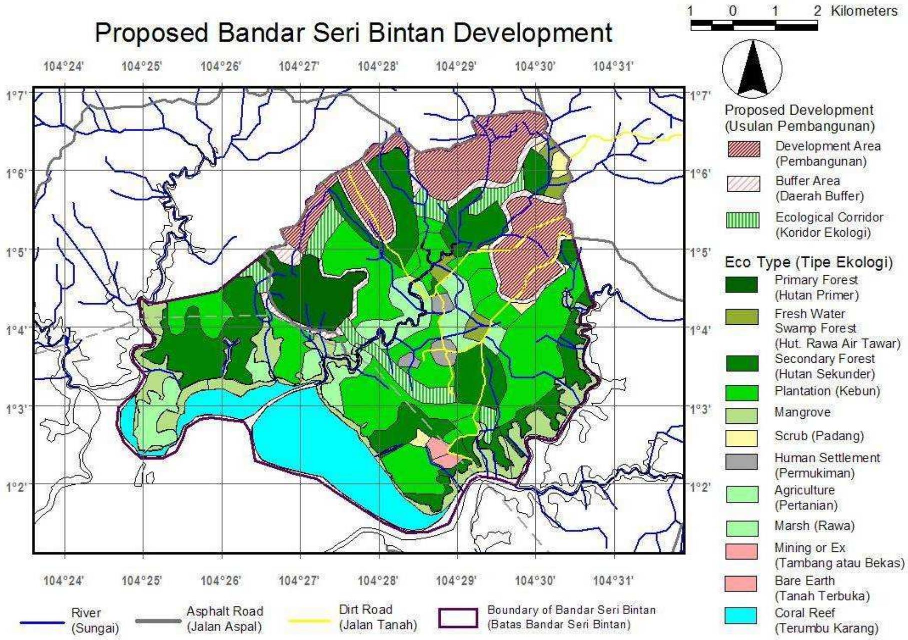

Figure 26 Proposed Fiction Scenario of Development of Bandar Seri Bintan.

Lastly, stakeholders' evaluation was conducted in 2006. It involved of Bintan Planning Agency and private sector, Banyan Tree Resorts Bintan. The positive as well as negative response was received. First, the positive response came from the private sector who agreed to support the recommendation and help disseminate this concept to the local Government.

On the other hand, the Bintan Government disagreed with our recommendation and pursued other development or original alternative. But consequently, the Central Government cancelled the development of Bandar Seri Bintan because of the catchments conservation regulation.

1.1.4 Evaluation of ALiT approach.

ALiT implementation in Bintan was considered successful. The evaluation method was found feasible by Officer of Bintan Planning Agency, because of simple ALiT application and improving capacity of local planning agency.

On the other hand, several obstacles were found in implementing the process, including expensive GIS software and remote sensing data. For example, Arc View GIS 3.1 software would cost around US$ 7,500, while SPOT (remote sensing) images would cost US$ 3,000. These were the main challenges for its application.

The important factor of landscape evaluation is evaluator. The authors suggest including a team comprising at least of a civil engineer, planner and ecologist for comprehensive application. It is suggested to prescribe an ecologically balanced recommendation. The team must work integrally and each of the experts must possess skill set. The skill set needed are comprehension the local ecology; knowledge of existing land use and its potential, geological condition, soil types and hydrology regimes; understanding of social and economic potentials and other constraints in the location.

The authors believed the importance of screening process for hazardous potential. The rationale is to reduce the environmental destructions and costs from natural disasters. The cases of the hurricane in New Orleans, tsunami and earthquake in Aceh signify this need.

1.2 Conclusion

Landscape evaluation process is an important step to the sustainable land development. The evaluation of the previous methods revealed the importance of selecting the evaluation criteria, proper weighting, rapid survey, multi-disciplinary and stakeholders approach in solving the problem.

ALiT (**A**daptive **L**andscape Evaluat**i**on **T**ool) has been made specifically for such contexts. The tool's strengths could be found at five distinguishing stages. The first is the criteria (factors) selection. This is important to achieve effective comprehensive evaluation. The second is the expert consultation for setting scores and weights for the factors. This step actually validates the biases from subjective analysis.

The third is rapid survey to complete the absent of data, with multidisciplinary team. The fourth is the stakeholders' evaluation. The authors believed that participation of the people, public and private sectors would guarantee better realisation of the development. Lastly, the method also reduces result bias by using three data sets for evaluation, which are ecological, natural and socio-economic factors.

1.3 Reference

1.3.1 Books

a. "A strategy for the sub-region", Coventry-Solihull-Warwickshire Sub-Regional Planning Study Group, Suppl. Rep. No. 5 Countryside (1971).
b. Akus U.T., Sunarya Y., Setiadi H., and Sukrisna (1994), Hydro-geological Map and Report, Tanjung Pinang, 1016, 1017, Scale 1:250.000, Geological Research and Development Centre.
c. Anderson L.T. (2000), Planning the Built Environment, Planner Press, Chicago, USA.
d. Aylward B. (August 2000), Land Use, Hydrological Function and Economic Valuation, UNESCO Symposium/ Workshop Forest-Water-People in the Humid Tropics, Kuala Lumpur, Malaysia, edited by Bonell M. and Bruijnzel L.A., published by Cambridge University Press.
e. Balmori D. and Benoit G. (eds.) (2003), The LAND Code: Guidelines for Environmentally Sustainable Land Development, Yale School of Forestry and Environmental Studies, USA.
f. Bintan Regency Public Works Department, 1993, GIS Map

g. BKPMD Kab. Kepulauan Riau (Riau Islands Regency Investment Coordination and Regional Promotion Board). (2005), Potential Investment Research Report (Pengkajian Peluang Investasi Potensi/ Unggulan Daerah)
h. Blacksell M. and Gilg A.W. (Nov 1975), “Landscape Evaluation in Practice – the Case of South-East Devon”, Transactions of Institute of British Geographers, number 66.
i. BPS Kab. Kepulauan Riau (Statistic Bureau Riau Island) (2004), Riau Islands Statistics, 2004
j. Briffet C. (2001), “Is Managed Recreational Use Compatible with Effective Habitat and Wildlife Occurrence in Urban Open Space Corridor Systems?” in Landscape Research 26 (2) pp. 137-163.
k. Code of Practice on Pollution Control (2000 Edition) (with amendments in Feb 2001, Jun 2002 and Feb 2004).
l. Conley, D. (2008), You may ask yourself: An introduction to thinking like a sociologist, W.W. Norton and Company. New York p392
m. Economic and Social Commission for Asia & the Pacific (2004), "Official Statistics and its Development in Indonesia", Sub Committee on Statistics: First Session 18–20 February 2004. p19.
n. Ellis, E.C. and N. Ramankutty (2008), Putting People in the Map: Anthropogenic Biomes of the World.
o. Freeman C. (1999), “Development of A Simple Method for Site Survey and Assessment in Urban Areas”, Landscape and Urban Planning: 44, pp.1-11.
p. International Monetary Fund (2007), Report for Selected Countries and Subjects (GDP), World Economic Outlook Database, April 2007..
q. Kaly U.L, Pratt C.R..& Mitchell J. (2004), Manual: How to Use the Environmental Vulnerability Index (EVI). SOPAC Technical Report 383.
r. Kaly U.L., Pratt C. & Mitchell, J. (2005), The Environmental Vulnerability Index (EVI) 2004. SOPAC Technical Report 384.
s. Kusnama, K. Sutisna, T.C. Amin, S. Koesoemadinata, Sukardi, B. Hermanto (1994), Systematic Geological Map, Indonesia Sheet Tanjung Pinang, 1016, 1017, Scale 1:250.000, Geological Research and Development Centre, Bandung Indonesia.
t. Li A., Wang A., Liang S. and Zhou W. (2006), “Eco-environmental Vulnerability Evaluation in Mountainous Region Using Remote Sensing and GIS – A Case Study in the Upper Reaches of Minjiang River, China”, Ecological Modelling: 192 (1), pp. 175-187.
u. McHarg I. (1992), Design With Nature, John Wileys & Sons, Inc, New York.
v. McHarg I. (1998), Steiner Frederick R. (ed) To Heal the Earth, Selected Writings of Ian L. McHarg, Island Press, Washington D.C.
w. Millennium Ecosystem Assessment (2005), Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute, Washington, DC.
x. Miller G.T. (2003), Environmental Science, Working With Earth, 10th edition, Brooks/Cole Thomson Learning USA.
y. Morris P. & Therivel R. (1995), Methods of Environmental Impact Assessment, The Natural and Built Environment Series 2, London
z. Mulongoy K.J. & Chape S. (2004), Protected Areas and Biodiversity: An Overview of Key Issues
CBD Secretariat and UNEP-WCMC, February 2004. Biodiversity Series No 21.

aa. Penning – Roswell E.C. (1975), “Constraints of The Application of Landscape Evaluations”, Transactions of the Institute of British Geographers: 66 (November), pp. 149 - 155.
bb. Ratcliffe D.A. (1977), A Nature Conservation Reviews, vols. 1 and 2, Cambridge University Press, Cambridge.
cc. Riau Islands Planning Agency (2004), Revision of 2006-2015 General Regional Plan Riau Islands Regency (Rancangan Umum Tata Ruang Wilayah Kab. Kepulauan Riau)
dd. Riau Islands Planning Agency and CV Geometric Tehnik (2005), Research and Mapping of Water Recharge and Catchments Potentials in Riau Island Regency (Kajian dan Pemetaan Potensi Daerah Resapan dan Tangkapan Air Hujan di Kab. Kepulauan Riau).
ee. Sachs J. & Malaney P. (2002), “The economic and social burden of malaria” in Nature 680-685, p 415,
ff. Saragedin, I. (2002), “World Poverty and Hunger: A Challenge for Science”, Science, 296 pp. 54-58
gg. Tanuwidjaja G. (2006), Developing a Landscape Evaluation Tool in Developing Countries, Case Studies Bintan Island, Indonesia, Dissertation of Master of Science in Environmental Management, National University of Singapore.
hh. Teluk Bintan District Office (2006), District Statistics Data 2005
ii. UNDP (2004), Human Development Report 2004: Cultural liberty in today’s diverse world
jj. UNEP-WCMC (2002) World Atlas of Biodiversity,
kk. Urban Planning Guide (1986) (ASCE Manuals and Reports on Engineering Practice; no 49), American Society of Civil Engineers, New York.
ll. Weiss S.F., Donnelly T.G. and Kaiser E.J. (1966), “Land Value and Land Development Influence Factors: An Analytical Approach for Explaining Policy Alternatives” in Land Economics: 42 (2), pp 230-33.
mm. White E.T. (1985), Site Analysis: Diagramming Information for Architectural Design, Architectural Media, USA.
nn. Whitten T., Damanik S.J., Anwar J., and Hisyam N. (2000), Ecology of Sumatra, Periplus, Singapore.
oo. Wong T-C., Yuen B., and Goldblum C. (Eds.) (2008), Spatial Planning for a Sustainable Singapore, Springer in Association with the Singapore Institute of Planners. Singapore;
pp. World Bank (2006), "Indonesia at a Glance,.Indonesia Development Indicators and Data.”
qq. World Bank (2006), "Making the New Indonesia Work for the Poor - Overview" (PDF). Press release.
rr. World Commission on Environment and Development (1987), Our Common Future, Report of the World Commission on Environment and Development, Published as Annex to General Assembly document A/42/427, Development and International Co-operation: Environment August 2, 1987.
ss. World Resources Institute (2001), World Resources 2000–2001.Washington DC: p.246–248.
tt. World Resources Institute, Forest Frontiers Initiative, WWF-Indonesia & Telapak Indonesia Foundation (2000), Trial by Fire, Forest Fires and Forestry Policy in Indonesia’s Era of Crisis and Reform.
uu. World Resources Institute, Forest Watch Indonesia, Global Forest Watch (2002), State of the Forest Indonesia.

vv. World Resources Institute, United Nations Environment Programme, United Nations Development Programme, and the World Bank, (1996), World Resources: A Guide to the Global Environment: 1996-97, New York: Oxford University Press, 1996, p. xi.

ww. Wright R. & Nebel B. (2007) Environmental Science, Toward A Sustainable Future: International Edition, 10th Edition, Pearson Education, Inc, publishing as Benjamin Cummings

1.3.2 Website

a. http://app.mewr.gov.sg/data/ImgCont/1292/sustainbleblueprint_forweb.pdf
b. http://app.mewr.gov.sg/web/Contents/Contents.aspx?ContId=1342
c. http://au.encarta.msn.com/encyclopedia_1461501471/Population_Explosion.html;
d. http://dictionary.reference.com/;
e. http://en.wikipedia.org/wiki/;
f. http://en.wikipedia.org/wiki/File:Population-milestones.jpg
g. http://indonesia.usaid.gov/en/Article.361.aspx
h. http://www.adb.org/Documents/Reports/39127-INO/FactSheets/village-plans.pdf
i. http://www.census.gov/ipc/www/popclockworld.html, estimated by United States Census Bureau on 5th September 2009;
j. http://www.jica.go.jp/indonesia/english/activities/pdf/JICAinAceh.pdf
k. http://www.jurong.com/
l. http://www.merriam-webster.com/
m. http://www.reliefweb.int/library/documents/2005/brr-idn-22sep.pdf
n. http://www.scribd.com/doc/13103851/Participatory-Planning-in-Aceh-URDIGTZ-Seminar-2526-July-2008

1.4 Acknowledgments

We express our highest appreciation for:

- Team of experts: Prof Han Sun Sheng, Dr. Ho Hua Chew, Dr Simon Yanuar Putra, Mr Benjamin Lee, Mrs Joyce Martha Widjaya, Mr Alfrendo Satyanaga and Ms Anbarasi Boopal.
- Bintan’s Government Agencies’ staffs: Ms Yanti, Mr Ahmad and Mr Buyung.
- Bintan People: Mr Udin, Mr Bun Seng
- Banyan Tree Hotels and Resort: Mr Michael Kwee, Mr. Mirza Pedju.
- Jurong Consultants Pte Ltd: Mr Yuen Heng Mun, Mr Allister Yong Winston, Mr Loh Kwok Pheng, Mrs Noorliza and Ms Amanda Ong.
- Research Assistants: Mr Deny St, Mr Septian Hornas and Mr Agus Sudarman.