The Practice of Coastal Management Initiatives in Using Geographical Information System in Selangor, Malaysia

Tuminah Paiman[1] and M. Zainora Asmawi[2]

***Abstract*—**Globally, coastlines are undergoing rapid development and firm management policies have to be established. However, for any shore management to be effective, the policies need to be based on informed decision-making. GIS encourages the development and use of standards for coastal data definition, collection and storage, which promotes compatibility of data and processing techniques between projects and departments, as well as ensuring consistency of approach at any one site over time. Purpose of this research to gather a perception from government agencies that has used GIS in managing coastal area in Selangor. Two main divisions of coastal change analysis may be recognized: monitoring and simulation modelling. GIS modelling and simulation of coastal phenomena are extremely valuable techniques for assessing the effectiveness and likely impacts of such intervention. Thus, a well-designed coastal area information system could be a significant decision support tool to aid the development of integrated and sustainable coastal resource management strategies.

***Keywords*—**Coastal Management Planning, GIS and Government Implementation.

I. Introduction

COASTAL area is considered as one of the most complex areas to be handled by traditional planning system. In managing the coastal area, there must be an integrated coastal management between various related agencies, technically and physically [8].

Nowadays, Geographic Information System (GIS) is becoming a tool of utility for analysing the dynamic of the coastal areas. Among frequent user of GIS whose, works relating to the coastal areas are engineers and land managers. Both are concerned with the spatial and time distribution of coastal changes like landslides and sediment drift whereas identifying the possible causes and consequences. In order to record coastal behaviour, assessing the time frame is very important. It must be gathered by doing a multi-temporal study where large quantities of data from various types and sources are collected for a better description of the coastal behaviour. Therefore, a reliable inventory describing the type, activity and definition of landslides are needed before any analysis takes place [7].

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What needs to be noted is that, management of the coastal area depending on coastal manager's ability to acknowledge and comprehend the complexity of natural coastal processes. Modelling coastal processes needs the ability to combine both spatial and non-spatial information from multiple datasets. GIS has the ability to integrate physical, ecological, socio-economic, and hazards information makes it be among the best assessment tool to support management efforts in the coastal area. Through GIS' practises, coastal managers are capable to model vulnerability to coastal erosion, sea-level rise and other threats so that decision makers have the necessary tools to protect local communities and effectively manage coastal natural resources [3].

II. Coastal Management In Selangor

Malaysia has indirectly introduced coastal management in the year 1957 through the Federal system which consist of three levels of Government: federal, state and local. The coastal management in Malaysia was established in managing the coastal areas from various threats such as coastal pollution coastal erosion, over exploitation of fishery resources, deforestation of mangrove forest, etc. [14]. Malaysia was rapidly developing the Integrated Coastal Zone Management (ICZM) in between 1980 and 1996. The ICZM implementation was introduced in 1996 in Peninsular Malaysia and Sabah. The project was funded by with the Danish Cooperation for Environment and Development (DANCED) and the Sabah State Government. It was designed to prepare an ICZM system for Sabah, Sarawak and Pulau Pinang [13].

Furthermore, in line with the efforts towards improving the quality of the global environment and the implementation of Agenda 21 in the Declaration of Rio de Janeiro in 2001, The International Maritime Organization (IMO) has established a Regional Office in Manila, Philippines under the Partnership in Environmental Management for the Seas of East Asia (PEMSEA) to plan, develop and implement the Integrated Coastal Management (ICM) in line with the needs and capabilities of local, national and regional. The program was implemented through The United Nations Development Program (UNDP) with funding and support from The Global Environment Facility (GEF). In the context of Malaysia, Port Klang and its coastal waters have been chosen as 'National Demonstration Site' under PEMSEA program. This plan has been adopted by the Selangor State Government since 8th August 2007 and was gazetted on 10th September 2009. This

project has been run by the Lembaga Urus Air Selangor (LUAS).

In short, there is coastal management initiative in Selangor that initiate by LUAS. Suitable for Port Klang Declaration mission which is to integrate the planning, management and implementation efforts for the development of coastal and contingent watershed areas with the participation of all parties, this research is trying to find any relationship between LUAS coastal management and various technical departments who related with the coastal area.

III. Geographical Information System (GIS) In Selangor

In 1997, Selangor state government developed Darul Ehsan Geographical Information System (DEGIS) [2]. It was using 'top down' approach since Selangor state government did not have experience with GIS application yet. During that time also, Selangor state government in the midst of digitizing the data on land lots, boundaries, transportation system, topography and other for the whole Selangor. At the same time, government agencies and local authorities in Selangor had developed GIS applications but it was not integrated and high cost. DEGIS was designed for land management system by incorporates the GIS real time distribution information and the real-time distribution capability of Internet-based workflow technology management capability. It assists a planner's decision-making by improving access to real time data information [2].

The programme called Darul Ehsan Geographical Information System (DEGIS), is part of the State's electronic government (e-government) initiative to facilitate citizen and Government interaction via electronic means. The objective of DEGIS is to provide a platform for co-ordination of datasets and GIS application systems that are being developed in various Government agencies within the Selangor State.

The Strategic Planning GIS involves manipulation of district level data while the Land Management and Operation GIS handle the daily business processes of the land offices. The ultimate objective is to convert all land-related information within the State administrative council into a more efficient and integrated digital format, in line with the national objective of realising e-government. Furthermore, as land plays a major role in the state revenue, priority is given to implementing a GIS system to manage these crucial resources. In addition, the system will be linked online to all the relevant authorities responsible for the approval of land-related matters. With the Internet concept in place, the usage online casino reviews of the system are unlimited and will eventually greatly benefit the public [1].

In addition, the projects are also geared towards improving the information support for decision-making and problem solving to user organisation and to increase the productivity of the staff engaged in the information support, planning and evaluation activities [1]. However, GIS in Selangor did not include the elements of coastal management. To condense, on the initial stages of DEGIS, coastal area management is not part of the GIS implementation concerned. Therefore, this research is trying to find out the usage of GIS application can benefit and facilitate various parties such as LUAS, Local Authorities and Technical Departments on coastal management in Selangor.

IV. Matters Of Coastal Management In Selangor

A. The Coastal Area is a Difficult Geographical Area to Manage

Reference [12] and [10] have identified that the coastal area is an important geographical area that need to be managed. It is due to several related issued occurs in the coastal areas such as temporal issues (tides and seasons) and the overlapping of physical characteristics and geography (offshore, near shore, shoreline, inshore), jurisdictions, legal mandates and remits of government agencies and the often competing needs of stakeholders. Furthermore, many different local, national and regional government agencies are responsible for different aspects of the same physical areas and uses of the coastal zone, for examples, fisheries, environment, agriculture, transport (inland and marine), urban planning and more.

In Selangor cases, in term of jurisdictions and legal mandates, JPBD Selangor was appointed by the Selangor State Planning Committee to appoint any consultant to produce a local plan for Selangor's district referred to the policy that has been made by the government. However, enforcement power towards the coastal area is not fall under Local Planning Authority; it is handled by Lembaga Urus Air Selangor (LUAS) since they are the authority for coastal management in Selangor. On the other hand, contractor in civil works for coastal development is monitored by the LUAS and Department of Irrigation and Drainage (DID) which it is involved with engineering and construction phases which handled by both agencies.

B. The Complexity of Coastal Physical Characteristics Challenge the Application of GIS Methods

Reference [10], [15] and [4] have recognised that the dynamic nature of the coastal area and the inherent complexity of coastal physical characteristics challenge the application of GIS methods. For example, the shoreline is described as a line of connection between land and water body but it is difficult to capture because of the natural variability of water level [10].

The Malaysian coastline varies from scenic bays flanked by rocky headlands to shallow mud flats lined with mangrove forests. Selangor is situated on the west coast of Peninsular Malaysia, it has mild wave climate of the Straits of Malacca make for wide mud shores and coastal forests rich in biodiversity [6]. Moreover, coastline areas receive continuous problems such as coastal erosions and sea level rise. Including Selangor, coastal area issues became national threats where government have to keep eyes on it. Therefore, the government assigned bodies that can control and solve the issues accordingly.

C. Disintegration between Coastal Area Management Related Authority

Coastal area management is also facing challenge in the need to widen public consultation and strengthen public participation during the selection of management options, and

the requirement to improve the information dissemination process once decisions have been made [11]. Likewise, [4] has ascertained that users of coastal GIS are faced with both uncertainties in the information derived from spatial data, and uncertainty that inherently exists in the models.

There are no relevant overall guidelines, policies or legislation as yet. There is not a single body or act which is given the responsibility and which has a comprehensive mechanism for the effective coordination of all the various law and jurisdiction pertaining to development in the coastal zone. However, there are a few acts and subsidiary legislations which have relevance to coastal zone development as stated above. Besides this, it has to be emphasized that there are no other legislation in Malaysia that promise to preserve, protect, develop, and where possible enhance the resources of the coastal zone [16].

D. Lacking of GIS Application in Coastal Management

Finally, GIS is not an immediate solution to coastal management problems. It is due to lack of research concerning the methods that can be used, and the effect on each problem concerns [15]. Even though GIS has a good tools that can run different task, but it lack of integrating measured and modelled data [17].

This research has identified the gaps in their findings, whereby, limitation has been made as to the potential influencing latent factors such as suitability in choosing the right GIS applications for different coastal area or coastal physical characteristics, data availability for current coastal management practices', and historical or past experiences in managing the coastal area either conventional or modern systems.

V. Studies On GIS As Decision Making In Coastal Management

GIS can be used for any number of coastal management applications, like improving the administration and enforcement of zoning ordinances. It can measure straight-line distances and areas, and thus determine a minimum lot width of 100 ft. and minimum lot size of 20,000 sq. ft. as often mandated in subdivision regulations. Or, GIS can also be used to generate buffers around lines or designated areas. Reference [9] says GIS can be used as an aid to decision making in coastal management, by identifying conflict areas and bring together a broad user community interested in similar problems. The benefits of taking a GIS approach to coastal management, might include:

1. The ability to model, test, and compare alternative scenarios - before the proposed strategy is imposed on the real world;
2. The ability to handle much larger data bases and to integrate and synthesize data. It's leading to a more holistic and coordinated management strategies;
3. Enhanced capacity for data exchange.

There are few successful GIS tools that have been used in managing the coastal area that can be taken into account, which lists in Table I:

Table I
Example Of GIS Application Used In Coastal Management

Component of coastal management	Application/Tools	Country
Huge databases and models	Geographical Information Infrastructure (GII) • Monitoring the Netherlands' coastal zone • Risk management 'Eagle Suite.'	Rijkswaterstaat (RWS) / Ministry of Transport, Public Works and Water Management, Netherland
Management strategies	The COSMO (Coastal zone Simulation Model) • Coastal Zone Management Centre, the Netherlands	(SAMPAK – Thailand) (COMA – West Africa) (CORAL – Maldives) (DSMOZ – Mozambique)
Policy alternatives	RamCo (Rapid Assessment Module for Coastal Zones) Policymakers: climate change, demographic growth or changing economic demand	Research Institute for Knowledge Systems (RIKS), the Netherlands
Coastline Management	SHO-MAN (the SHOreline MANagement tool): assessing the impact of management actions on the development of the coastline	National Institute for Coastal and Marine Management, The Netherlands

Table II is a list of several GIS studies related to coastal management that can be taken into account in implementing GIS application in coastal management in Selangor. Apart from that, it can be taken into account the do and don'ts of GIS application usage and coastal management.

TABLE II
GIS STUDIES IN THE FIELD OF COASTAL MANAGEMENT

Authors	Remarks
Roger A. Longhorn (Coastal Spatial Data Infrastructure)	Spatial data is only one facet of an SDI implementation. Important institutional, jurisdictional, data policy and standards/ interoperability issues also Figure high on the agenda. These appear to be the principal focal points for most regional and global SDI initiatives, rather than detailed basic reference data specifications.
Simon Gomm (Bridging the Land-Sea Divide Through Digital Technologies)	There may be limited availability of single datasets covering the land-sea divide, digital technologies offer the capabilities to combine and resolve available adjacent datasets to satisfy diverse applications for the coastal zone.
Paul S.Y. Pan (Monitoring Coastal Environments Using Remote Sensing and GIS)	The availability of good quality data sets is essential to the success of the development of the system.
Eleanor Bruce (Spatial Uncertainty in Marine and Coastal GIS)	Fragmentation of the landscape into manageable spatial data models is required in many applications of coastal and marine GIS. During this process of abstracting reality the loss of detail potentially introduces levels of uncertainty that may have significant consequence in analysis and modelling results.
Françoise Gourmelon and Iwan Le Berre (Towards an Institutional GIS for the Iroise Sea (France))	The experience acquired after ten years of coastal GIS development shows that even if the databases are useful in much scientific and management applications, their prospects depend on a better standardisation of geographical reference data and their metadata, and on a better integration of the GIS into environmental coastal zone management systems.
Darius Bartlett and R. Sudarshana (Cultural Intermixing, the Diffusion of GIS and its Application to Coastal Management in Developing Countries)	Integrated coastal zone management should be informed coastal zone management. This evidently requires access to appropriate, timely and reliable data and information which, in turn, suggests an important role for GIS and other suitable information technologies.
David R. Green and Stephen D. King (Applying the Geospatial Technologies to Estuary Environments)	The capability to gather higher resolution data from remote sensing, to process, integrate and visualise environmental data within a GIS, and the use of GIS as a data handling tool for spatial analysis and modelling has provided the basis for studying the environmental processes operating in an estuary. Online GIS and decision support tools are also empowering the policy and decision-maker, as well as the coastal manager and practitioner.

VI. RESULT AND FINDINGS ON CURRENT CONDITION FOR COASTAL MANAGEMENT IN SELANGOR

A. Usage of GIS in Coastal Management

In determining whether GIS application in coastal management has been impacted agencies' variation in benefiting GIS, the means difference between the benefits reaped by agencies have been tested for One-Way ANOVA Kruskal Wallis analysis measurement. Based on the Table 5.10 above, at 9 degree of freedom, with calculated $\chi 2$ (9) = 16.919, p = 0. 006 < 0.05, mean rank of 31.523 (integrated management and sustainable development of coastal and marine areas) and 23.234 (addressing critical uncertainties for the management of the coastal area) has led to the rejection of difference in means for agencies in areas of GIS application is useful in coastal management. This is supported by the significant value 0.000 which is less than 0.05. Hence, both results confirmed the rejection of null hypothesis that means difference is dependent on usage of GIS in managing coastal management.

TABLE III
KRUSKAL WALLIS DESCRIPTIVE FOR MEAN DIFFERENCES OF RESOLVING COASTAL MANAGEMENT ISSUES BY USING GIS APPLICATION

Department	Integrated management and sustainable development of coastal and marine areas	Marine environment	Sustainable use and conservation of marine living resources	Addressing critical uncertainties for the management of the coastal area
LUAS	51.50	37.00	37.61	63.71
DID	39.14	44.55	48.95	35.41
MaCGDI	39.14	44.55	48.95	31.05
JPBD	32.38	47.38	41.88	37.25
Forestry	31.50	45.30	36.70	33.60
MDKL	77.00	37.00	16.00	55.50
MPSp	38.50	41.15	48.80	35.90
MPK	19.25	37.00	31.13	46.38
MDKS	28.00	37.00	50.50	37.25
MDSB	77.00	37.00	16.00	55.50
Test Statistics[a,b]				
Chi-Square	31.523	6.397	15.884	23.234
df	9	9	9	9
Asymp. Sig.	.000	.700	0.69	.006

a. Kruskal Wallis Test
b. Grouping Variable: Department/Agencies

Human activities involving various land use activities sometimes demands on coastal ecosystems which often result in resource-use conflicts. Hence, a proper balance between the different demands must be achieved and resolved by informed decision making. Integrated management and sustainable development of coastal and marine areas ensembles these decisions to be made, implemented and monitored using GIS in order to promote sustainable coastal development. Department of Irrigation and Drainage has addressed the issue on maintenance of coastal physical development especially on erosion beach at Pantai Remis has worsen due to human activities such as tourist and recreational activity.

Addressing critical uncertainties for the management of the coastal area has been point out since there are various legislation and policy related to coastal area. Non-Government Organisation, Malaysian Nature Society has pointed out local authorities normally controlling coastal area using any local plans or special area plan. However, respondents concerned on the effectiveness of the implementation of local plan and special area plan in managing the coastal area and its surrounding eco system. Respondent' hope that with the usage of GIS can increased the effectiveness of local plan implementation in Selangor.

B. Expectation on usage of GIS in coastal management

An "H" score assumed as a Chi-Square value is calculated

using the sums of the ranks of each group. The test statistic for a Kruskal-Wallis test is given by: Where N is the total amount of participants so N = 83 and n is the amount of participants in each group so n1 = n2 = n3 = n4 = n5 = 83. Therefore the test statistic, H, is calculated as follows:

$$H = \frac{12}{83\,(83+1)}\left(\frac{44.101^2}{24} + \frac{51.908^2}{28} + \frac{8.375^2}{5} + \frac{14.345^2}{7} + \frac{35.868^2}{19}\right) - 3\,(83+1) = 244.054$$

The H value of 244.054 is higher compared to the critical value of 16.919 found in Appendix III. This critical value is calculated by selecting the appropriate size of group's value and p value. In this case there are 83 participants in each group and the appropriate p value is 0.05 as a 5% significance level is required. It can be concluded that, each departments have a different expectation on the usage of GIS application in coastal management in Selangor.

TABLE IV
KRUSKAL WALLIS DESCRIPTIVE FOR MEAN DIFFERENCES OF EXPECTATION OFFERED FROM GIS APPLICATION

Dept.	More spatial integration and commitment from all levels of	Clear division of scope of work at all levels of management	Greater public awareness and participation	Improvement in institutional arrangements	Improvement in decision making processes
LUAS	60.07	29.89	36.11	32.00	42.04
DID	35.00	40.50	36.77	50.86	46.00
MaCGDI	29.18	40.50	40.32	47.09	46.00
JPBD	39.88	40.50	49.63	37.19	46.00
Forestry	36.40	40.50	46.70	40.30	46.00
MDKL	74.00	79.50	54.50	32.00	6.50
MPSp	35.00	40.50	46.70	40.30	46.00
MPK	28.75	40.50	44.75	42.38	46.00
MDKS	35.00	40.50	35.00	52.75	46.00
MDSB	74.00	79.50	54.50	32.00	6.50
Test Statistics[a,b]					
Chi-Square	44.101	51.908	8.375	14.345	35.868
df	9	9	9	9	9
Asymp. Sig.	.000	.000	.497	.111	.000

a. Kruskal Wallis Test
b. Grouping Variable: Department/Agencies

Table IV above show what are the expectation respondents needed from GIS application in managing the coastal area in Selangor. Most of the respondents agreed that:

i. Clear division of scope of work at all levels of management:

With the help of GIS application, coastal management implementation can be sorted out especially on development control and development plan. With the GIS application is accessible for everyone, each development applicant should confirmed their application land status beforehand. MyGDI is the great tools that can make a good division on this issue. Each different development proposal should be submitted into one channel but the approval process will be done by local authority. However, each management and expertise should help during the process.

ii. More spatial integration and commitment from all levels of management:

Officer McGDI also shared that not all data is accessible and some of the data are sensitive and need approval before it released by MaCGDI. This can be name as the major setback in MyGDI. Applicant may request a data from MaCGDI but if the data falls under sensitive data, the applicant should personally request the data from the proprietor of the data.

iii. Improvement in decision-making processes:

As mentioned before, development plan and development control are the main tools in coastal management for decision making processes. Selangor State Structure Plan, 5 Selangor coastal district plans, RFZPPN and other relevant documents by LUAS. Each of the relevant documents was producing maps whereby GIS was the main tools in the production. Therefore, by acknowledge and make full use any GIS application may reduce the hiccups during decision making processes.

VII. CONCLUSION

The successfulness of managing the coastal area in Selangor coastal districts depends on the coastal management and GIS practices from all bodies. Since different bodies handled the same issue which is the coastal area, it is significance to see how the management of coastal works out without giving any difficulties and overlapped power above the coastal area in Selangor. In line with that, this study tries to assist by identifying how the government agencies applying the GIS as contribute best to coastal management or vice versa in the Selangor coastal district context. As recommendation, this study suggesting in elevating the usage of coastal management and GIS application. RFZPPN concentrated in managing the coastal area in Selangor while MyGDI becoming the connector between data catalogue and users of GIS application. The usage of coastal management and GIS can be increased by accelerating the execution of electronic government and knowledge economy especially in local authority's level. The usage of coastal management and GIS application should be increased by spreading the existence and awareness of local geospatial data industry in Selangor. Other GIS associated application such as Remote Sensing and other imaginary resources can be used in order to increase the quality and usage of coastal management and GIS application.

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