AHP Modeling for Multicriteria Decision-Making and to Optimise Strategies for Protecting Coastal Landscape Resources

S. Baby

***Abstract*—The objective of the study is to optimize the strategies built by SWOT (Strength, Weakness, Opportunity, and Threat) - QSPM (Quantitative Strategic Planning Matrix) that would help the policy maker and to rationalize the dilemma in decision making to fabricate environmental protection policies, laws and standards .These laws for coastal resources against the anthropogenic activities will help curb deteriorating impacts on environmental components that was identified from the RIAM (Rapid Impact Assessment Matrix) process in the State of Kuwait. Optimizing and rationalizing of the strategies are performed with the concept of AHP (Analytic Hierarchy Process) /ANP (Analytical Network Process) utilizing multi-criteria decision (MCD) making software – SuperDecision.AHP/ANP with SuperDecision has often helped as an effective means of dealing with complex decision-making for the strategies to be prioritized, optimized and rationalized. AHP/ANP helps capture both subjective and objective evaluation measures, providing a useful mechanism for checking their consistency relative to considered alternatives, thus reducing bias in decision making particularly during the SWOT-QSPM process. The new priorities generated by optimizing and rationalized by AHP/ANP Model was the best fit strategies for effective policy construction to tackle the coastal deterioration.**

***Index Terms*—SuperDecision, judgment scale, sanity check, consistency, sensitivity, morphology, coastal deterioration.**

I. Introduction

The State of Kuwait has an area of 17,800 km^2 which is bounded by 500 km of coastline including the nine islands. The urban and industrial area constitutes of approximately 845.22 km^2 which is polarized towards a coastline of 158.880 km in the north east end of Kuwait bay and the south eastern shore of Arabian Sea. The limited coastal resources have been deteriorating rapidly during the last three decades due to human interventions and sprawling activities. The urban sprawl is predicted to encroach the untouched coastal resources of ecological importance. In order to combat the negative impact on coastal areas, AHP model study was undertaken to raise building blocks for appropriate strategy development which will further aid law makers to establish policies which would in turn help curb the activities that accelerate the diminishing of coastal lines.

Baby [1] in his study with RIAM has investigated the anthropogenic activities in the State of Kuwait that are responsible for changing the coastal morphology (impacts). The study was conducted for 15 sub-categories of activities under 5 major categories (Table I) impacting 27 coastal environmental components under 4 major components (Table II) and was listed with scores from highest to lowest with negative and positive values.

In another study, Baby and Nathawat [2] used SWOT (Strength, Weakness, Opportunity, and Threat) to build coastal management strategies which came up with 24 strategies listed (Table III).The strategies were given weightage signifying the highest valued to the lowest to mitigate the impacts and preserve the coastal environment. 24 coastal management strategies were prioritized with QSPM (Quantitative Strategic Planning Matrix) that would help in policy makers to protect the coastal environment form human interference.

Even though, the strategies were prioritized by SWOT-QSPM, these were not prioritized based on interrelating with the scores obtained from RIAM for coastal activities and environmental components. Strategies prioritized associating with the coastal anthropogenic activities and coastal environmental components, would be more affirmative, in giving prominence to the strategies, which could bring effective policies, to preserve the natural coastal resources. Baby and Nathawat [2] have recommended extended application of AHP (Analytical Hierarchical Process) to SWOT-QSPM results to optimize the results. By reducing complex decisions to a series of one-on-one comparisons, then synthesizing the results, AHP not only helps decision makers arrive at the best decision, but also provides a clear rationale that it is the best [3]. Schmoldt *et al.* [4] have demonstrated the use of the AHP with other analytical tools (e.g., mathematical programming), for group and participatory decision making, as part of other decision methods e.g., SWOT, and with extensions e.g., fuzzy sets, GIS.

II. Objectives

Main aim of the study is to reach ultimate prioritized strategies (i.e. optimize) built by SWOT-QSPM that would help the authorities (policy makers). Other than that it would rationalize the dilemma in decision making to fabricate environmental protection policies, laws and standards for coastal landscape resources against the anthropogenic activities causing deteriorating impacts that was identified from the RIAM process. In order to achieve this, following objectives are covered i.e.:

Manuscript received December 12, 2012; revised February 19, 2013.

S. Baby is with Birla Institute of Technology, Department of Remote Sensing & Geoinformatics, Mesra, India and GEO Environmental Consultation, Hawally, P. O. Box: 677, Al-Surra 4507, Kuwait (e-mail: sajimathewvk@hotmail.com).

1) To link the management strategies with anthropogenic activities and coastal components affected.
2) To synthesize factual data, qualitative judgments and intangible factors
3) To produce efficient, rational decisions that tolerates uncertainty and minimizes bias.
4) To decide and adopt the strategies on the basis of their significance of controlling activities in order to protect coastal environmental components and implement them

III. Literature Review

A. The Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP)

The foundation of the Analytic Hierarchy Process (AHP) is a set of axioms that carefully delimits the scope of the problem environment [5]. It is based on the well-defined mathematical structure of consistent matrices and their associated right eigenvector's ability to generate true or approximate weights [6]-[10]. The mathematics of the AHP and the calculation techniques are briefly explained by Coyle [11], [12] but its essence is to construct a matrix expressing the relative values of a set of attributes.

The Analytic Hierarchy Process (AHP) is a powerful and flexible decision making process [7], [8] and [13] to help people set priorities and make the best decision when both qualitative and quantitative aspects of a decision need to be considered. Both qualitative and quantitative information can be compared using informed judgments to derive weights and priorities. AHP is a general problem-solving method that is useful in making complex decision (e.g. multi-criteria decisions) based on variables that do not have exact numerical consequences.

Designed to reflect the way people actually think, AHP is a mathematical method developed in the 1970's by Dr. Thomas Saaty, while he was a professor at the Wharton School of Business, and continues to be the most highly regarded and widely used decision-making theory.

The Analytic Network Process (ANP) is the most comprehensive framework for the analysis of societal, governmental and corporate decisions that is available today to the decision-maker. It is a process that allows one to include all the factors and criteria, tangible and intangible that has bearing on making a best decision. The Analytic Network Process allows both interaction and feedback within clusters of elements (inner dependence) and between clusters (outer dependence). Such feedback best captures the complex effects of interplay in human society, especially when risk and uncertainty are involved [14].

One of the major advantages of the AHP is that the analysis does not always require statistically significant sample size. The simplicity of AHP approach is that, unlike other 'conjoint' methods, the qualities (or levels) of different attributes are not directly compared. The AHP approach thus removes the need for complex survey designs and can even be applied (in an extreme case) with only a single respondent [15]. The Analytic Hierarchical Process (AHP) is one of the methodological approaches that may be applied to resolve highly complex decision making problems involving multiple scenarios, criteria and actors [7].

The techniques including AHP and Fuzzy AHP have been selected to obtain preference weights of land suitability criteria in a case study area located in south-east Queensland [16]. According to them, these techniques have proved useful to handle the problems which involve the design of alternatives which optimize the objectives. On the other hand it enables researchers to put more expert knowledge together to make more precise decision and moderate personal.

Kurttila *et al*. [17], Stewart *et al.* [18], Usman and Murakami [19] have pooled AHP with SWOT to provide a new hybrid method for improving the usability of SWOT analysis. However, instead of SWOT the AHP uses the ideas of Benefit – Opportunity – Cost – Risk (BOCR) from which SWOT was adopted. BOCR modeling using AHP/ANP receives large popularity in a decision making society in last few decades [20].

B. AHP Application

Analytical Hierarchy Process (AHP), has been extensively used in almost all the applications related to MCDM or MCDA are known acronyms for 'multiple criteria decision making' and 'multiple criteria decision analysis' in the last 20 years [21], used in scientific studies [22-26], adopted in many applications including resource allocation, business performance evaluation, project selection, and auditing and additional application areas include problems in public policy, marketing, procurement, health care, corporate planning and transportation planning [27].

AHP and its broad application across a variety of natural resource and environmental problems have been mentioned by Schmoldt *et al.* [4]. AHP application can be noticed in the studies related to coastal management and resources. AHP application can be seen in Abad [28] work as a part of environmental impact assessment and integrated coastal zone management studies. Ni *et al.* [29] and Qin *et al.* [30] describe their use of AHP in determining the optimal length and location for a coastline reclamation project considering both developmental and environmental factors.

C. SuperDecision Software for AHP and ANP

The Super Decisions software implements the Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP) for decision making with dependence and feedback, a mathematical theory for decision making developed by Thomas L. Saaty. The software for the decision making with dependence and feedback was developed by William Adams in 1999-2003. He and his team have developed software which can undergo AHP and ANP and is known as SuperDecision from Creative Decisions Foundation, 4922 Ellsworth Avenue, Pittsburgh, PA 15213, USA .

Adams and Saaty [31] mentions that ANP is an extension of his Analytic Hierarchy Process (AHP) for decision making which involves breaking down a problem into its decision elements, arranging them in a hierarchical structure, making judgments on the relative importance of pairs of elements and synthesizing the results. With the AHP the process is top-down. With the ANP it is recognized that there is feedback between the elements in different levels of the hierarchy and also between elements in the same level,

so the decision elements are organized into networks of clusters and nodes. The ANP was briefly introduced in Saaty's first book on decision making, The Analytic Hierarchy Process.

The Super Decisions software is a simple easy-to-use package for constructing decision models with dependence and feedback and computing results using the supermatrices of the Analytic Network Process. This software was designed to run in many different computing environments from Windows 3.1/95/98/NT to Macintosh to Unix systems such as Linux, SGI's, Sun Systems, etc. There is also a Web version.

Other than SuperDecision there are various other similar type and known commercial software for MCDM or MCDA that can implement such studies are Expert Choice, PROMETHEE, Smart Picker, VISA, HIPRE, Criterium Decision Plus, OnBalance, Hiview, ERGO. Some other decision support software are Analytica, DATA, DecisionPro, DPL and Precision Tree [32].

IV. Materials and Methodology

A. Steps

Decision modeling using multi-criteria decision software called SuperDecision, based on the analytic hierarchy process (AHP) methodology, developed by Thomas L. Saaty using the weighting-ranking approach in evaluation and choice mode, typically consists of five steps:

1) Structuring the decision model: building a hierarchy of objectives/criteria and alternatives.
2) Entering alternatives: establishing priorities among elements of the hierarchy.
3) Comparing – relatively – the problem where necessary levels of uncertainty exists.
4) Synthesizing the results using a common scale.
5) Conducting sensitivity analysis.

The software supporting AHP helps in organizing the various elements of a problem into a hierarchy. Software guides in judging, via pair-wise comparisons, the relative importance of the objectives and the preference for the alternatives that have been defined. Software derives priorities for management by combining intangible information from our experience and intuition, and tangible information such as data.

B. Input Information

The input information to create the model is the following:

S. N.	Information	Description	Location	Source
01	Coastal Activities	5 Major Categories = 15 sub-categories	Table 1	Baby, (2011)
02	Coastal Environmental Components	4 Major Components = 27 sub-components	Table 2	Baby, (2011)
03	Coastal Management Strategies	24 (51% important strategies + 26% average strategies + 23% weak strategies)	Table 3	Baby and Nathawat, (2011)

C. Modeling: Creation of Structure

The study requires very large models involving 15 sub-categories of activities under 5 major categories impacting 27 environmental components of Kuwait and 24 coastal management strategies. Even larger models can be accommodated by a technique of clustering and linking between nodes. Udo [27] mentions in his literature that very large AHP models can be created using AHP software. Very large AHP model allows number of children nodes for each parent node or build a model with unlimited number of criteria as well as an unlimited number of alternatives.

TABLE I: Coastal Developmental Projects in 5 Major Categories in Kuwait

	Major Categories	S. No.	Sub-categories	Activities with values which are positive and negative effect on coast
A.	Industrial Infrastructures and Activities (-2519/6 = -406) -406	01	Oil refinery complexes, oil terminals, petrochemical industries, power stations, desalination plants	-509
		02	Sewage treatment plants and other establishments	-372
		03	Coastal oil exploration	- 0.1 (0 value replaced by -0.1 for pairwise comparison study)
		04	Pipeline, outfalls and intake	-676
		05	Dredging, dumping, reclamation, shore and beach nourishment, beach repair and construction	-524
		06	Beach sand mining	-438
B	Commercial and Residential Structures and Activities (-328/3= -109) -109	07	Cities and residential township, shopping malls	-44
		08	Hotels, resorts and restaurants.	-110
		09	Beach houses	-174
C	Aesthetic and Recreational Infrastructure and Activities (-192/2 = -96) -96	10	Artificial beaches, artificial islands, reefs,	-107
		11	Waterfronts, aqua parks, artificial lagoons	-85
D	Transport structures and activities (-15/2 = -7.5) -7.5	12	Shipyard, port, harbors, marina, jetties, bridges, embankments, runaway.	-30
		13	Highways and minor roads	+15
E	Coastal Protection Structures and Activities (-193/2 = -96.5) -96.5	14	Groins, sea walls, riprap, revetments, break waters	-99
		15	Sea and coastal defense projects	-94

TABLE II: Environmental Component for Kuwait Coast

S. No.	Categories	Description	S. No.	Coastal Environmental components	Value of impacts on environmental components
01	Physical/ Chemical Components (PC)	Covering all physical and chemical aspects of the environment, including finite (non-biological) natural resources, and degradation of the physical environment by pollution.	PC1	Coastline and shore	-345
			PC2	Erosion and accretion	-245
			PC 3	Subsidence	-104
			PC 4	Pollution (Chemical and Thermal)	-285
			PC 5	Natural beaches	-210
			PC 6	Coastal land degradation	-298
			PC 7	Coastal conflicts of human activities	-260
			PC 8	Geomorphology landforms (Rocky, coastal sand dunes, estuaries, deltas, sabkhas, khor, reef coast, sand, muddy, gravely, oolitic)	-276
02	Biological/ Ecological Component (BE)	Covering all biological aspects of the environment, including renewable natural resources, conservation of biodiversity, species interactions, and pollution of the biosphere.	BE1	Vegetation	-258
			BE2	Mangrove, sea grass, etc.	-310
			BE3	Salt marsh, swamp, tidal flats, intertidal flats, etc.	-234
			BE4	Coral, oyster, mudskipper	-229
			BE5	Terrestrial ecosystem	-230
03	Sociological/ Cultural Component (SC)	Covering all human aspects of the environment, including social issues affecting individuals and communities; together with cultural aspects, including conservation of heritage, and human development.	SC1	Human habitat and Urban Sprawl	-306
			SC2	Aquaculture and fisheries	-253
			SC3	Coastal land cover	-310
			SC4	Cultural heritage	-69
			SC5	Existing utilities	+40
			SC6	Surfing, diving, swimming, boat racing,	-258
			SC7	Site view	-342
			SC8	Occupation and employment	+306
04	Economic/ Operational Component (EO)	To qualitatively identify the economic consequences of environmental change, both temporary and permanent, as well as the complexities of project management within the context of the project activities.	EO1	Trade	+ 210
			EO2	Commercial	+246
			EO3	Real Estates	+324
			EO4	Hospitality and tourism	+184
			EO5	Navigation	+203
			EO6	Existing utilities	+62
Note:- negative impact and + positive impact					

Very large models, however, impose significant effort in eliciting pair wise comparison assessments, as for instance what faced for this study for comparison of numerous criteria and alternatives. The software provides ratings capability in which alternatives are not compared against each other but are compared against standards or norms which was done in the case of 24 strategies against the 27 environmental components.

AHP algorithm is basically composed of two steps:

- Determine the relative weights of the decision criteria
- Determine the relative rankings (priority) of alternatives

The process starts with:

1) Breaking down a complex decision problem into hierarchical structure into the following elements:
   a) Overall goals (sub-goals) to be attained,
   b) Criteria and sub-criteria,
   c) Scenarios, and
   d) Alternatives.
2) The models was constructed by defining the goal and structuring a non-linear criteria/alternatives
3) The decision was de-composed into objectives and sub-objectives
4) Each level of the model reflected a redefinition of problem elements with increasing specificity
5) Decisions were reduced to component elements that were readily organized and analyzed
6) The models lead through a series of judgments on the objectives and sub-objectives
7) The judgment process was generally based on the relative importance or preference ascribed to objectives and sub-objectives
8) Judgments was made utilizing the pair wise comparison method whereby individual decision factors are compared as isolated elements related to a common parent
9) Judgments was made verbally, numerically or graphically
10) 'The software', derived Ratio Scale Priorities by calculating the principle right eigenvector of the reciprocal matrix of pair wise judgments
11) From multiple pair wise rating and comparisons, the researcher's experience and intuition are synthesized with objective data to yield effective strategic decisions
12) *Graphical Sensitivity Analysis* enables the researcher to adjust priorities to see the effect of changes in judgments on the overall ranking of decision alternatives
13) *Inconsistency Ratio Analysis* enables the researcher to test the mathematical accuracy of judgments within the model to identify and correct:
   a) Errors in entering judgments
   b) Lack of concentration
   c) Inappropriate use of extremes

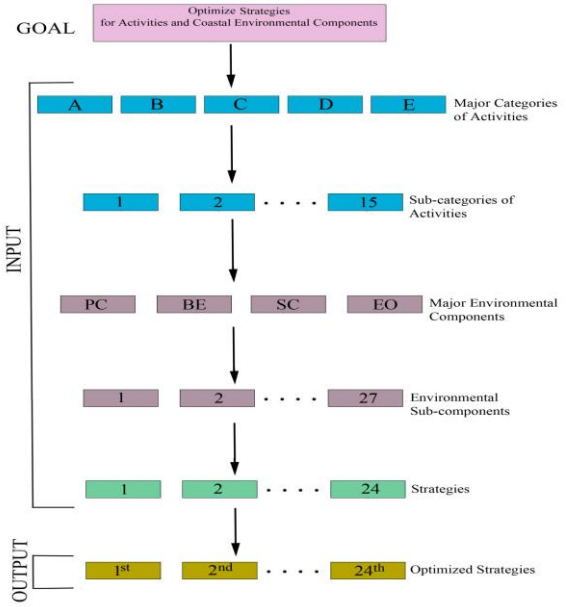

Fig.1. AHP/ANP Articulate (network) diagram.

TABLE III: PRIORITIES OF THE STRATEGIES FOR MANAGING AND PROTECTING THE COASTAL MORPHOLOGY

SN		Strategy	Rate (importance value)	Type of Strategies and Share in % (Rounded)
Str 01	SO_1	Foreseeing the trend in human attraction towards coast, interest in having real estate on coastal areas, urge for luxury, increase in coastal urban encroachment; build coastal and marine management programs, rules, regulations and standards and based on obligatory EIA reports declare the sensitive coastal geomorphology as protected and restricted areas.	7.50	51% (Important Strategies)
Str 02	SO_2	Meeting the demand of more land for urbanization and developmental activities, create buffer distance or set back from the coastal edge to protect coastal land cover and focus development away from the coast.	7.25	
Str 03	ST_1	Endanger to marsh land, wetland, coastal sand dunes, coastal vegetation and wildlife habitat and threat of extinction should be tackled with involvement of KEPA, Municipality, environmental rules, regulations, standards and obligatory reports (EIA).	7.00	
Str 04	WO_3	"Visioning" process to identify options to improve CZM and development of 'indigenous standards' for 'The State of Kuwait' to protect endangered coastal morphology landscape areas.	6.50	
Str 05	WT_1	Take proper steps to combat improper knowledge on long term impacts, undermining impacts, unavailability of long-term plans for coastal and marine abatement for deterioration, non availability of sufficient environmental rule that would lead to congested coastal population, housing, beach houses, visual intrusion, and disappearance of natural morphologic view, concentration of industries, establishments, and human activities per each square km of coast.	6.15	
Str 06	SO_7	Environmental auditing, re-evaluation; amendments and revision of laws and policies; indigenous standards for the State of Kuwait; and developing different volumes of handbook for environmental laws, standards and regulations for each environmental components including a separate volume for coastal morphology, and coastal edge.	5.80	
Str 07	WO_6	Solve conflict in the land cover and human interference through visioning process of environmental sustainable development and long-term programs.	5.35	
Str 08	SO_6	Government and Ministries should take initiative in establishing Ecological Police, handed with sufficient power and guidelines to safeguard Kuwait's ecology & environment, protect coastal area and coastline, monitor, and implement stringent penalties to violators of environmental rules and regulations.	5.00	
Str 09	WO_2	Recognize and identify the expertise, skill, experiences, good research work towards sustainable development	4.85	26% (Average Strategies)
Str 10	ST_2	Involving standard environmental laboratories, research centers, KISR, ROPME, KU and environmental consultancies to understand and evaluate the carrying capacity of coastal areas	4.15	
Str 11	WO_4	Auditing of research work and reports to access the accuracy , authenticity, reliability, accuracy and genuineness	3.80	
Str 12	WT_2	Avoid lack of proper understanding and interpretation of the environmental influence of the projects on coast that can dominate short-term economic interests over long-term sustainability gains	3.75	
Str 13	SO_3	Take advantage of the existing standard environmental laboratories, research centers, KISR, ROPME, KU and environmental consultancies in opening the door for doctorate studies in Kuwait with research topics related to sustainable development in Kuwait.	3.50	
Str 14	WO_5	Develop coastal management plans with identification of needs and gaps of integrated coastal zone management.	3.20	
Str 15	ST_3	Involving EIA and its mandate, as supporting resource to create awareness methods and convince the importance of preserving the coastal morphologic landscape	3.00	
Str 16	WT_4	Systematic approach can avoid non organized organization structure, and lack of clear future plan would prolong in the law making, declaring protected zone, natural heritage and widening of the 'implementation gap' for laws and strategies	2.95	23% (Weak Strategies)
Str 17	ST_4	A good practical tool for management of coastal areas (should have /with) strategies to exploit sustainable alternatives and options	2.85	
Str 18	WO_8	Spread awareness of the condition of the coastal resources and their collective responsibility to manage the environment at a sustainable level by involving locals, different communities, stakeholders and expats	2.8	
Str 19	ST_5	Pressure from renovating, upgrading and new - Petrochemical Industries, Oil Companies, Energy, Desalination plants, various other coastal projects, real estate, business giants, dweller, stakeholders and politicians in encroaching the coastal morphology should be controlled by environmental rules, regulations, standards and obligatory reports (EIA) and concrete Master Plan	2.75	
Str 20	SO_4	Kuwait having its own 'Marine Environmental Ship' with onboard laboratories; own satellite data receiving station; and own satellite in space would help a lot in environmental research, monitoring, and development.	2.70	
Str 21	SO_5	Utilize Governments resources, efficient media and other resources to increase awareness of the condition of their heritage, the coastal resources and their collective responsibility to manage the environment at a sustainable level.	2.55	
Str 22	WT_3	Develop methods to eradicate lack of scientific temper and leadership training that would slow proper awareness and convincing the importance of preserving the coastal morphologic landscape.	2.35	
Str 23	ST_6	Proper strategies to neutralize, counter or offset the hallo, decibel and vanity effect within KEPA, Municipality, and other organization that would affect the process of development of laws to protect coastal morphology in future	2.25	
Str 24	WO_7	Deteriorating and increased stress on natural coastal morphology and landscape can be combated by encouraging eco-tourism and through ecotourism regulations.	2.00	
Total			100%	100%

S= Strength; W = Weakness; T = Threat and O = Opportunities. The coupling represent the combination of SWOT

D. Information Flow Diagram (IFD)

Information Flow Diagram (Fig. 1) clearly illustrates the input to AHP SuperDecision software to decide and compile the optimized strategies. The information which constitutes

the ingredients for the software is the 15 sub-categories of coastal anthropogenic activities (Table I) under 5 major categories (A-E) that are responsible for the alteration of 27 environmental sub-components (Table II) within 4 major components (PC, BE, SC & EO). This information would decide better coastal strategies (Fig. 1) out of 24 coastal management strategies (Table III) that would be pathway towards policies significant for controlling the anthropogenic activities and would protect the coastal resources of Kuwait.

E. Creation of Model

An interesting AHP/ANP model was created (Fig. 2). Every node in a level is the parent of every node in the next level down. The model starts with the goal and move systematically down. "Covering criteria" in the next to last level was connected only to those elements for which pairwise comparing made sense in the bottom level i.e. only connecting a parent node in the next to last level to children nodes in the bottom level that can be logically pairwise compared with respect to it. In this study, there are too many pairwise comparisons. For bottom level of alternative strategies rating model was used.

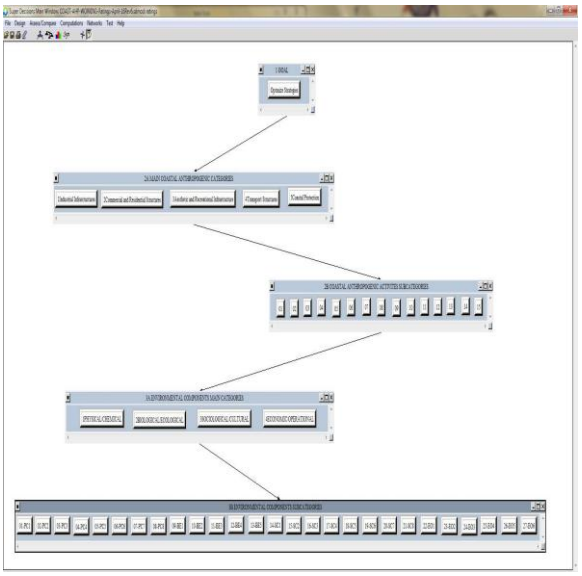

Fig. 2. Screen shot for AHP model created.

F. Rating Model

Ratings model (Fig. 3a-Fig. 3c) was started first covering criteria that are across the top and the alternative strategies are in the left column. 'Verbal statement of preferences' was created and 'rating values' were assigned as 8,6,4,2 and 0.1 (Table IV) as for using in rating and comparison mode. A verbal statement of preferences was filled out in rating model as shown in Fig. 3a-Fig. 3c and the rating values were used in Pairwise Questionnaire comparisons.

TABLE IV: RATING SCALE

Verbal Statement of Preference	# Rating Values
Sufficiently Adequate	8
More Adequate	6
Appreciably Adequate	4
Less Adequate	2
Inadequate	0.1

Dr. Rozann W. Saaty, from Creative Decisions Foundation says that anything compared against inadequate is infinitely better – so using the value zero would create problem of taking the ratios. The software does not allow a zero for direct data because when forming the ratios (which replace the judgments) in the pairwise comparison matrix there would be some infinite entries. For calculating and overcoming the problem - zero was replaced with '0.1' for the inadequate comparison. Same priorities were used for every column. If a project is inadequate with respect to a criterion and deserves a zero, the cell was left blank in the 'Rating Model Window' as shown in the Fig. 3a- Fig. 3c.

The assigning of categories from Sufficiently Adequate, More Adequate, Appreciably Adequate, Less Adequate and Inadequate (Fig. 3a-Fig. 3c) for the 'Strategies (1 to 24)' with respect to the 'Environmental Components (1to 27) were performed with help of expert opinion.

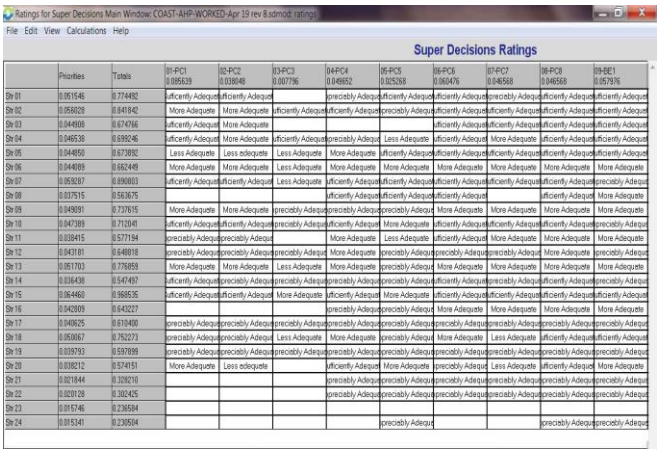

Fig. 3a. Screen shot for Rating Model from 01PC1-09BE1.

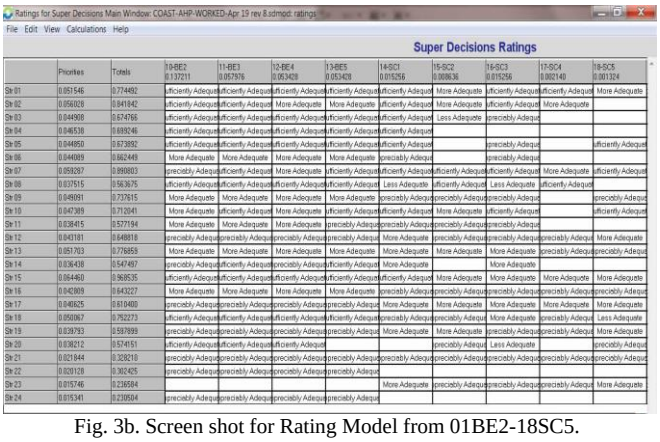

Fig. 3b. Screen shot for Rating Model from 01BE2-18SC5.

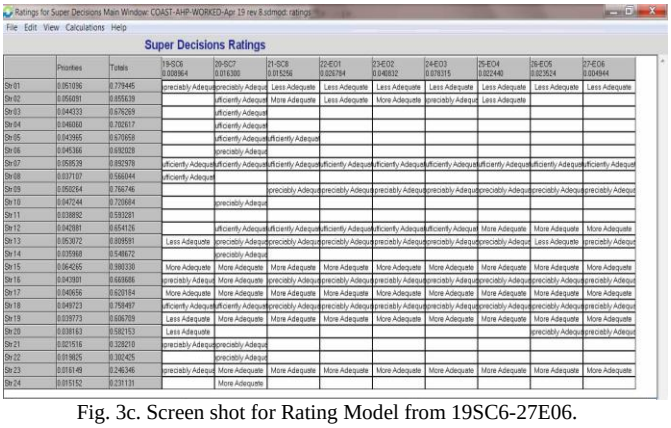

Fig. 3c. Screen shot for Rating Model from 19SC6-27E06.

G. Pairwise Comparisons Model

Pairwise comparisons in the main model were performed. Pairwise comparisons give meaningful priorities for columns in Ratings. Strength of AHP is its use of pair-wise comparisons of criteria to derive accurate ratio-scale priorities, as opposed to the traditional approach of assigning single weights [33].

In this respect simple formula was framed to do carry out comparison using the grading values of (Table I-Table III). Irrespective of sign if both are negative or positive the highest number is taken into consideration because negative and positive shows the type of impacts.

In the row:

1) (Higher one - Lesser one) / (Higher one) $\times 100 = x$
2) $x/10 = y$.
3) 'y' was rounded off whenever the value is in decimal
4) Locate and select on the scale towards the direction of higher number.

The above steps were performed for all the pairwise comparisons in the main screen. Starting with the goal and pairwise comparison for the elements in the cluster beneath the goal for importance. While performing the process always "View Totals" in rating was turned on. It was noticed that the 'Totals' are much more informative, than the priorities. Once the action is finished for the each window, the box was checked at the right hand bottom corner of the comparison mode to indicate when the comparisons are finished so it intimates the software about the completion.

Judgment Scales

Workout for the Comparison in the 'Judgment Scale' for '02-PC2' (Fig. 4) is explained as such - in the second row the ratio of 'Sufficiently Adequate' to 'Appreciably Adequate is 8/4 (From Table IV), so when rounded off to the nearest integer we get 2. In the same way all the other comparison was worked out.

TABLE V: THE SAATY RATING SCALE

Intensity of importance	Definition	Explanation
1	Equal importance	Two factors contribute equally to the objective
3	Somewhat more important	Experience and judgment slightly favor one over the other.
5	Much more important	Experience and judgment strongly favor one over the other
7	Very much more important	Experience and judgment very strongly favor one over the other. Its importance is demonstrated inpractice.
9	Absolutely more important.	The evidence favoring one over the other is of the Highest possible validity.
2,4,6,8	Intermediate values	When compromise is needed

Judgment scale mean the Fundamental 1-9 scale known as 'The Saaty Rating Scale' (as seen in Table V & Fig. 4) of the AHP/ANP model, These are absolute numbers. Judgment is made in pair. For a pair (Sufficiently Adequate and Appreciably Adequate), when you assign a 2, for example, it means the dominant element is 2 times as important, preferred or likely than the other one. In other word, the judgment is tilted to the side 'Sufficiently Adequate' at 2. It can also be stated as such: [2 x Appreciably Adequate= Sufficiently Adequate] or [Appreciably Adequate = 1/2 Sufficiently Adequate].

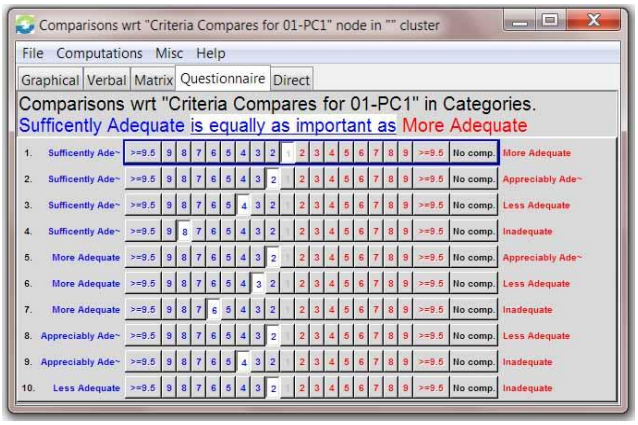

Fig. 4. Pairwise Questionnaire comparisons Model.

The inconsistency index (0.0781) is desirable to be less than 0.1 (Fig. 5). This was kept in mind while performing the pairwise comparison for all the items.

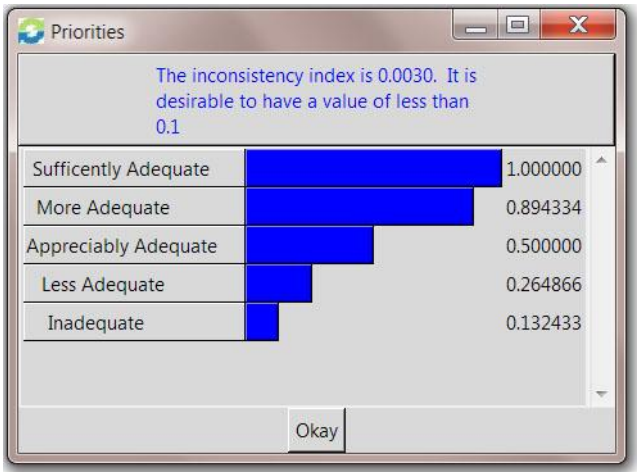

Fig. 5. Priorities showing inconsistency.

H. Sanity Check and Consistency

Sanity Check

'Sanity Check' was selected which indicated the comparison was complete without any missing items. Sanity Check reveals incomplete comparisons and duplicated goals, among other things. Unintentionally skipped comparison will also be caught by the Sanity Check.

Inconsistency / Consistency Ratio (Analysis)

The final stage is to calculate a Consistency Ratio (CR) to measure how consistent the judgments have been relative to large samples of purely random judgments. If the CR is much in excess of 0.1 the judgments are untrustworthy because they are too close for comfort to randomness and the exercise is valueless or must be repeated

Consistency applies only to the pairwise comparison matrices. The consistency is desirable to be less than 0.10. Each one was looked at, and the consistency was tried to

improve if it was above 0.10. But that too has limitations while doing it and should be convincing. In this study there were one instance when the consistency have showed abnormally higher values than 0.10 for example the value of 0.30180 (industrial infrastructure), one case of 0.16649 (Commercial and Residential Structures), and all for all the environmental sub-categories showed the value of 0.17130. However, it is more important to be valid – that is, link with reality, than it is to be consistent. If one, as a judge, compare people of different heights, but give them a judgment of 1 for each pair meaning they are the same height, you will be totally consistent – but very far off from reality. There should be a tolerable level of consistency, but it does not count as much as whether the priority vector for a set of pairwise comparisons matches our "gut" understanding.

V. Results and Discussions

The task of prioritization and optimization of strategies were completed with AHP/ANP Model through SuperDecision software. AHP follows the hierarchical structure with pairwise comparison for the levels shown in the main window where as ANP undergoes at the last part not shown in the main window but in separate window (Fig. 3a-Fig. 3c). ANP criteria was completed with prioritization by asking how important they are in the alternatives being considered among the 'Strategies' for the 'Environmental Sub-Components'.

Graphical Sensitivity Analysis

Sensitivity was performed using any element in the model. In a hierarchical model one investigates sensitivity on the alternative rankings by changing the priority of the criteria (one after the other). The priorities of the alternatives (Strategies) are read from the projection on the y-axis of the point at which the alternative line intersects the vertical dotted line. The priority ranges from 0.0 to 1.0 on the x-axis. The vertical line is always shown initially at 0.5 on the x-axis, or at 50% priority (Fig. 6. Moving the dotted line and dragging can give different scenarios of projection changes for the alternatives (Strategies).

While analyzing for the numerical values, it was seen there are changes in the priorities among so many alternatives but the change in priorities are not remarkable with great differences that can be seen in the graphic while moving the vertical dotted line which is initially set at 0.5 on the x-axis for the priority no. 1 (Fig. 6). 'Sensitivity Analysis' was done for other criteria and alternatives but no visible changes were seen on the graph. The fact is, the difference of highest priority strategy (Str.15 = 0.06446) and lowest priority strategy (Str. 24 =0.015341) is 0.049119, distributed over a range of 24 strategies. For such scenarios the 'Graphical Sensitivity Analysis' was not seen much effective in deciding the strategies or understanding the best criteria or alternatives by changing priority by dragging the dotted line.

Accessing 'View Totals' and 'Priorities'

The totals are obtained by multiplying each column priority by the priority of the rating in the cell and summing across the row. If an alternative is perfect, i.e. gets the top ranking for every column, the total will be 1.000. The priorities are obtained by normalizing the totals. The totals are very useful in allocating resources using an optimization approach (say "Solver" in Excel that does linear programming).

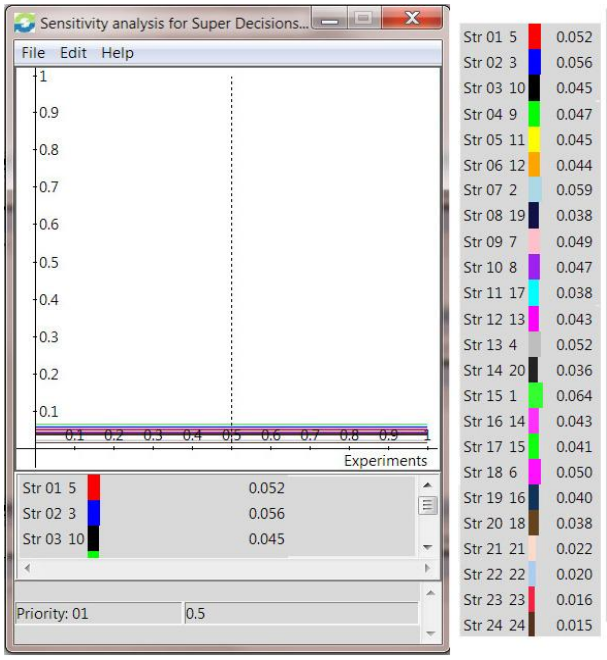

Fig. 6. Sensitivity graph and bar for Priority No. 01 for value 0.5.

'View Totals' and 'Priorities' in Ratings (Fig. 3a- Fig. 3c) were accessed. But, the Totals are much more meaningful when scanned down in the list of alternatives in Ratings. In fact, a nice diversity of priorities (totals) for the strategies can be noticed. It was noticed some high-valued strategies above 90% and that the low valued ones are really not very effective against controlling any of the major anthropogenic activities that changed the environmental components that would affect directly or indirectly the coastal morphological landscape (CML). In this study 'Totals' and 'Priorities' showed similar trend. 'Priorities' are values that are 'Normalized' values that are obtained from summing the column / row and dividing each one with the sum.

The ratings spreadsheet i.e. 'Rating Priorities Matrix' was exported to Excel and was sorted for the alternatives on the totals, or on one of the columns and did it for all the columns. Similarly the totals were done for each row each alternative. From this process I could find the high valued alternatives for each of them. To get priorities from rating spreadsheet in Excel it was normalized: summed the results and divided the total for each alternative by the sum. These are analogous to priorities derived by pairwise comparing in AHP/ANP. The results from Excel sheet were less fine-tuned and accurate. So it was thought to consider the results of pairwise comparing as better than other one.

The 'Priorities and 'Totals' were plotted on graph for the strategies. It can viewed from the graph (Fig. 8) that the 'Priorties' are very less prominent among them than 'Total' to identify the remarkable differences between the strategies. All the strategies demonstrated less difference in values among the fellow strategies. The strategies had the benchmark value above 0.2. Graph shows no strategies below 0.2; 4 between 0.2 to 0.4; 5 between 0.4 to 0.6; 12

between 0.6 to 0.8 and; 3 between 0.8 to 1.0.

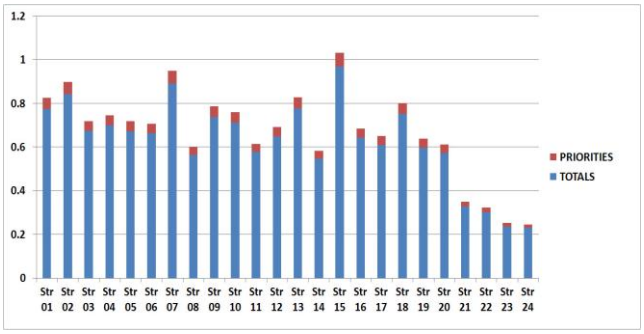

Fig. 7. 'Priorities' and 'Total' values for Strategies obtained from AHP/ANP modeling.

The 'Totals' and 'Priorities' obtained from AHP/ANP studies, were sorted in decreasing order (Fig. 7). It is remarkable to observe that AHP/ANP modeling using SuperDecision software have reshuffled all the strategies priority level developed by SWOT-QSPM (Quantitative Strategic Planning matrix) (Table III) to new level of optimized priorities except for the last 4 strategies (20 to 24) (Fig. 7) and they are separately listed in Table VI and Table VII.

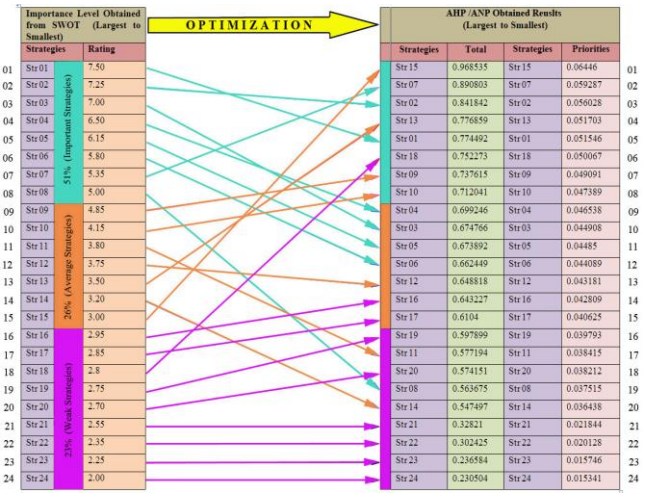

Fig. 8. Strategies prioritized by SWOT to AHP/ANP optimized-normalized strategies.

The arrow in Fig. 8 indicates the level to which the strategies are shifted from SWOT-QSPM to ANP/AHP. Amazing reshuffling and shift in strategies can be understood because of integrating RIAM for multicriteria decision, refining and redefining the SWOT-QSPM strategies. The new priorities generated by optimizing and rationalized by AHP/ANP Model was cross verified for its importance level and found that the shift is the best fit irrespective of the shift in strategies for effective policy construction. The 'Optimized and Rationalized Strategies' (ORStr.) is listed below (Table VI and Table VII) in decreasing priority level.

The main advantage of the AHP/ANP is its ability to rank choices of 'Strategies' in the order of their effectiveness in meeting conflicting objectives of preserving the environmental components and controlling the anthropogenic activities causing it. The judgments made about the relative importance of, as for this study, shows ability to satisfy those objectives, have been made in good faith, and then the AHP/ANP calculations lead inexorably to the logical consequence of those judgments. It is quite hard – but not impossible – to 'Fiddle' the judgments to get some predetermined result. The further strength of the AHP is it shows the ability to detect inconsistent judgments.

TABLE VI: OPTIMIZED AND RATIONALIZED STRATEGY PART 1

Decreasing Order of Priorities (Importance)	Optimized and Rationalized Strategy
ORStr.01	Involving EIA and its mandate, as supporting resource to create awareness methods and convince the importance of preserving the coastal morphologic landscape
ORStr.02	Solve conflict in the land cover and human interference through visioning process of environmental sustainable development and long-term programs.
ORStr.03	Meeting the demand of more land for urbanization and developmental activities, create buffer distance or set back from the coastal edge to protect coastal land cover and focus development away from the coast.
ORStr.04	Take advantage of the existing standard environmental laboratories, research centers, KISR, ROPME, KU and environmental consultancies in opening the door for doctorate studies in Kuwait with research topics related to sustainable development in Kuwait.
ORStr.05	Foreseeing the trend in human attraction towards coast, interest in having real estate on coastal areas, urge for luxury, increase in coastal urban encroachment; build coastal and marine management programs, rules, regulations and standards and based on obligatory EIA reports declare the sensitive coastal geomorphology as protected and restricted areas.
ORStr.06	Spread awareness of the condition of the coastal resources and their collective responsibility to manage the environment at a sustainable level by involving locals, different communities, stakeholders and expats
ORStr.07	Recognize and identify the expertise, skill, experiences, good research work towards sustainable development
ORStr.08	Involving standard environmental laboratories, research centers, KISR, ROPME, KU and environmental consultancies to understand and evaluate the carrying capacity of coastal areas
ORStr.09	"Visioning" process to identify options to improve CZM and development of 'indigenous standards' for 'The State of Kuwait' to protect endangered coastal morphology landscape areas.
ORStr.10	Endanger to marsh land, wetland, coastal sand dunes, coastal vegetation and wildlife habitat and threat of extinction should be tackled with involvement of KEPA, Municipality, environmental rules, regulations, standards and obligatory reports (EIA).
ORStr.11	Take proper steps to combat improper knowledge on long term impacts, undermining impacts, unavailability of long-term plans for coastal and marine abatement for deterioration, non-availability of sufficient environmental rule that would lead to congested coastal population, housing, beach houses, visual intrusion, and disappearance of natural morphologic view, concentration of industries, establishments, and human activities per each square km of coast.
ORStr.12	Environmental auditing, re-evaluation; amendments and revision of laws and policies; indigenous standards for the State of Kuwait; and developing different volumes of handbook for environmental laws, standards and regulations for each environmental components including a separate volume for coastal morphology, and coastal edge.
ORStr.13	Avoid lack of proper understanding and interpretation of the environmental influence of the projects on coast that can dominate short-term economic interests over long-term sustainability gains
ORStr.14	Systematic approach can avoid non organized organization structure, and lack of clear

In short, the AHP/ANP is a useful technique for discriminating between competing options in the light of a range of objectives to be met. The calculations are not complex and, while the AHP/ANP relies on what might be seen as a mathematical trick, you don't need to understand the mathematics to use the technique. Do, though, be aware that it only shows relative value.

The SWOT-QSPM technique has proved to be of great help in the understanding of the environment for organizations and, consequently, in the strategic planning of their growth and development. However, Osuna and Aranda [34] says, their experience has shown that often its usefulness has been sub valued by limiting it to the stage of strategies design. Its value could be increased substantially by complementing it with techniques for the evaluation of these strategies, and for the selection of the most convenient one for the organization. This can be done with the application of AHP/ANP techniques.

SWOT-QSPM analysis, is a widely applied tool in strategic decision planning, offers one way to systematically approach a decision situation. However, through the studies of Baby and Nathawat (2011) from SWOT provides no means to analytically determine the importance of factors or to assess the match between SWOT factors and decision alternatives. In this study to overcome the decision uncertainty, the AHP/ANP and its eigenvalue calculation framework are supplemented with SWOT-QSPM developed

'Coastal Strategies' and RIAM identified 'anthropogenic activities and impacts on coastal areas' of Kuwait.

TABLE VII: OPTIMIZED AND RATIONALIZED STRATEGY PART 2

Decreasing Order of Priorities (Importance)	Optimized and Rationalized Strategy
	Kuwait; and developing different volumes of handbook for environmental laws, standards and regulations for each environmental components including a separate volume for coastal morphology, and coastal edge.
ORStr.13	Avoid lack of proper understanding and interpretation of the environmental influence of the projects on coast that can dominate short-term economic interests over long-term sustainability gains
ORStr.14	Systematic approach can avoid non organized organization structure, and lack of clear future plan would prolong in the law making, declaring protected zone, natural heritage and widening of the 'implementation gap' for laws and strategies
ORStr.15	A good practical tool for management of coastal areas (should have /with)strategies to exploit sustainable alternatives and options
ORStr.16	Pressure from renovating, upgrading and new - Petrochemical Industries, Oil Companies, Energy, Desalination plants, various other coastal projects, real estate, business giants, dweller, stakeholders and politicians in encroaching the coastal morphology should be controlled by environmental rules, regulations, standards and obligatory reports (EIA) and concrete Master Plan
ORStr.17	Auditing of research work and reports to access the accuracy , authenticity, reliability, accuracy and genuineness
ORStr.18	Kuwait having its own 'Marine Environmental Ship' with onboard laboratories; own satellite data receiving station; and own satellite in space would help a lot in environmental research, monitoring, and development.
ORStr.19	Government and Ministries should take initiative in establishing Ecological Police, handed with sufficient power and guidelines to safeguard Kuwait's ecology & environment, protect coastal area and coastline, monitor, and implement stringent penalties to violators of environmental rules and regulations.
ORStr.20	Develop coastal management plans with identification of needs and gaps of integrated coastal zone management.
ORStr.21	Utilize Governments resources, efficient media and other resources to increase awareness of the condition of their heritage, the coastal resources and their collective responsibility to manage the environment at a sustainable level.
ORStr.22	Develop methods to eradicate lack of scientific temper and leadership training that would slow proper awareness and convincing the importance of preserving the coastal morphologic landscape.
ORStr.23	Proper strategies to neutralize, counter or offset the hallo, decibel and vanity effect within KEPA, Municipality, and other organization that would affect the process of development of laws to protect coastal morphology in future
ORStr.24	Deteriorating and increased stress on natural coastal morphology

The AHP/ANP succeeded after RIAM and SWOT-QSPM studies, yielded analytically determined priorities for the factors included in the analysis and make them commensurable. In addition, it demonstrates that decision alternatives can be evaluated with respect to each SWOT-QSPM and RIAM by applying the AHP/ANP. It should be noted that the importance value (Table III) determined by SWOT-QSPM study was not used in AHP/ANP Modeling to avoid unnecessary conflict, bias and dominance.

VI. CONCLUSIONS

The challenge of the study was complex, optimizing and rationalizing of the strategies. The purpose is to optimize the strategies built by SWOT-QSPM that would help the policy maker and to rationalize the decision confusion to fabricate environmental protection policies, laws and standards for coastal resources against the anthropogenic activities causing deteriorating impacts on environmental components that was identified from the RIAM process in the State of Kuwait. The optimizing and rationalizing of the strategies were performed with the concept of AHP (Analytic Hierarchy Process) /ANP (Analytical Network Process) utilizing multi-criteria decision (MCD) making software - SuperDecision

AHP/ANP with SuperDecision helped as an effective means of dealing with complex decision-making for the strategies to be prioritized and optimized. AHP/ANP helps capture both subjective and objective evaluation measures, providing a useful mechanism for checking their consistency relative to considered alternatives, thus reducing bias in decision making particularly during the SWOT-QSPM process.

Literature review have indicated that no remarkable work have been come across in the literature research about utilizing AHP software for prioritizing and optimizing the coastal protection strategies i.e. generated from the SWOT-QSPM to reduce the bias and increase the effectiveness to draw attentions of the policy makers to develop National dedicated coastal policies for the State of Kuwait.

The 'Totals' and 'Priorities' obtained from AHP/ANP studies, were sorted in decreasing order of importance known as 'Optimized and Rationalized Strategies' (ORStr.) and is listed in (Table VI and Table VII). Table VI and Table VII detail each of the strategies from 1 to 24. The new priorities generated by optimizing and rationalized by AHP/ANP Model was the best fit strategies for effective policy construction to tackle the coastal deterioration.

ACKNOWLEDGEMENT

I am grateful to Prof. Tom Saaty, Distinguished University Professor, University of Pittsburgh who created the AHP and ANP beginning when he was a professor at the Wharton School of Business in the 1970s, for his willingness to help me and for accepting my request to review the paper once it is finished. I really appreciated his down to earth attitude and his prompt responses to my earnest requests for help.

My sincere gratitude also goes to Rozann W. Saaty, Vice-President of Creative Decisions Foundation, 4922 Ellsworth Avenue, Pittsburgh, PA 15213, USA for her entire support for this study, including providing me with the SuperDecisions software developed by her and her team, based on the AHP and ANP theory created by Prof. Tom Saaty. I thank her for her responsiveness in giving lessons about the basics of applying the SuperDecisions software to AHP and ANP modeling for my studies. We worked together using Skype and she patiently listened to my queries and reviewed my daily progress through email. She helped me move from scratch, starting as a learner, to what I have achieved in this study.

REFERENCES

[1] S. Baby, "Assessing and Evaluating Anthropogenic Activities Causing Rapid Evolution in the Coastal Morphological Landscape Changes (CMLC) of Kuwait Using RIAM," *Environment and Natural Resources Research*, vol. 1, no. 1, pp.152-170, 2011.

[2] S. Baby and M. S. Nathawat, "Formulating Coastal Management Strategies (CMS) for preserving the Endangered Coastal Morphological Landscape (CML) in 'The State of Kuwait', from Anthropogenic Activities using SWOT," *International Journal of Oceans and Oceanography*, vol. 5, no. 1, pp. 85-109, 2011.

[3] Expert Choice. (2012). We call it the A, B, C's of decision making: Alignment, Buy-in and Confidence. [Online]. Available: http://www.expertchoice.com/about-us/our-approach

[4] D. L. Schmoldt, G. A. Mendoza, and J. Kangas, "Past Developments and Future Directions for the AHP in Natural Resources", in *The Analytic Hierarchy Process in Natural Resource and Environmental*

Decision Making, D. L. Schmoldt *et al.* Eds., Netherlands: Kluwer Academic Publishers, 2001, pp. 289–305.
[5] T. L. Saaty, "Axiomatic Foundation of the Analytic Hierarchy Process, *Management Science*, vol. 32, pp. 841-855, 1986.
[6] B. G. Merkin, "Group Choice", NY: John Wiley & Sons, 1979.
[7] T. L. Saaty, "The Analytic Hierarchy Process," New York: McGraw-Hill, pp. 20-25, 1980.
[8] T. L. Saaty, "Decision Making for Leaders: The Analytic Hierarchy Process for Decisions in a Complex World," Pittsburgh, PA: RWS Publications, 1990.
[9] T. L. Saaty, "How to Make a Decision: The Analytic Hierarchy Process," *Interfaces*, vol. 24, pp. 19-43, 1994.
[10] T. L. Saaty, "Fundamentals of Decision Making," Pittsburgh, PA: RWS Publications, 1994.
[11] R. G. Coyle, "A Mission-orientated Approach to Defense Planning," *Defense Planning*, vol. 5, no. 4, pp. 353-367, 1989.
[12] R. G. Coyle, "Practical Strategy," *Open Access Material*, AHP, Pearson Education Limited, 2004.
[13] T. L. Saaty, "Fundamentals of Decision Making and Priority Theory with the Analytic Hierarchy Process," Pittsburgh: RWS Publications, 1994.
[14] Creative Decision Foundation. (2012). Super Decision Software for decision making. [Online]. Available: http://www.superdecisions.com
[15] D. Dutta, "Climate Perturbation and Coastal Zone Systems in Asia Pacific Region: Holistic Approaches and Tools for Vulnerability Assessment and Sustainable Management Strategy," *Final Report submitted to Asia-Pacific Network for Global Change Research*, pp. 52, 2007.
[16] R. Mosadeghi, R. Tomlinson, H. Mirfenderesk, and J. Warnken, "Coastal Management Issues in Queensland and Application of the Multi-Criteria Decision making Techniques," *Journal of Coastal Research*, vol. SI 56, pp. 1252-1256, 2009.
[17] M. Kurttila, M. Pesonen, J. Kangas, and M. Kajanus, "Utilizing the analytic hierarchy process (AHP) in SWOT analysis - a hybrid method and its application to a forest-certification case," *Forest Policy and Economics*, vol. 1, pp. 41–52, 2000.
[18] R. A. Stewart, S. Mohamed, and R. Daet, "Strategic implementation of IT/IS projects in construction: a case study," *Automation in Construction*, vol. 11, pp. 681–694, 2002.
[19] F. Usman and K. Murakami, "Preliminary Evaluation for Strategy on Coastal Vegetation Belts against Tsunami Hazard in Pacitan, Indonesia," *European Journal of Scientific Research*, vol. 63, no. 4, pp. 530-542, 2011.
[20] T. Feglar, J. K. Levy, T. Feglar, T. Jr. Feglar, "The BOCR and Business Rules Motivation Model," *ISAHP 2005*, Honolulu, Hawaii, 2005.
[21] W. Ho, "Integrated analytic hierarchy process and its applications - a literature review," *European Journal of Operational Research*, vol. 186, no. 1, pp. 211–228, 2008.
[22] M. H. Abed, M. Monavari, A. Karbasi, P. Farshchi, and Z. Abedi, *International Conference on Environmental and Agriculture Engineering IPCBEE*, vol. 15, pp. 120-124, 2011
[23] I. Linkov, F. K. Satterstrom, G. Kiker, C. Batchelor, T. Bridges, and E. Ferguson, "From comparative risk assessment to multi-criteria decision analysis and adaptive management: Recent developments and applications," *Environment International*, vol. 32, pp.1072–1093, 2003.
[24] Ç. Comert, O. Bahar, and N. Şahin, "Integrated Coastal Zone Management and Cage Siting for Marine Aquaculture. Fresenius Environmental Bulletin," presented at the 14th International Symposium on Environmental Pollution and its Impact on Life in the Mediterranean Region (MESAEP), Seville, Spain, PSP, vol. 17, no 12b, 2008, pp. 2217- 2218.
[25] L. Xing, Z. Yunxuan, S. Fang, K. Runyuan, W. Wen, and Z. Zongsheng, "A Decision Support Framework for the Risk Assessment of Coastal Erosion in the Yangtze Delta," *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, vol. 38, no. II, pp. 502-507, 2010.
[26] A. Sadeghi-Niaraki, K. Kim, and M. Varshosaz, "Multi-Criteria Decision-based Model for Road Network Process," *Int. J. Environ. Res*., vol. 4, no. 4, pp. 573-582, 2010.
[27] G. G. Udo, "Using analytic hierarchy process to analyze the information technology outsourcing decision Industrial Management & Data Systems," MCB University Press, vol. 100, no. 9, pp. 421-429, 2000.
[28] D. T. Abad, "Improving Environmental Impact Assessment for better Integrated Coastal Zone Management," PhD Dissertation Submitted to the Academic Board of Wageningen University and the Academic Board of the UNESCO-IHE Institute for Water Education. Published by A. A. Balkema Publishers, a member of Swets & Zeitlinger Publishers, pp. 234, 2004.
[29] J. R. Ni, A. G. L. Borthwick, and H. P. Qin, Integrated approach to determining post-reclamation coastlines, *Journal of Environmental Engineering*, vol. 128, no. 6, pp. 543-551, 2002.
[30] H. P. Qin, J. R. Ni, and A. G. L. Borthwick, "Harmonized optimal post-reclamation coastline for Deep Bay, China," *Journal of Environmental Engineering*, vol. 128, no. 6, pp. 552-561, 2002.
[31] W. J. L. Adams and R. Saaty, "Taken from GuideSuper Decisions Software Guide," *Creative Decisions Foundation*, pp. 43, 2003.
[32] M. Kuhn, "Introduction to Decision Support Software," *Adelphi Research gGmbH, 14aD – 14193 Berlin*, pp. 22, 2002.
[33] N. Roura-Pascual, D. M. Richardson, R. M. Krug, A. Brown, R. A. Chapman, G. G. Forsyth, D. C. Le Maitre, M. P. Robertson, L. Stafford, B. W. V. Wilgen, A. Wannenburgh, and N. Wessels, "Ecology and management of alien plant invasions in South African fynbos: Accommodating key complexities in objective decision making," *Biological Conservation*, vol. 142, no. 8, pp. 1595–1604, 2009.
[34] E. E. Osuna and A. Aranda, "Combining SWOT and AHP Techniques for Strategic Planning," *ISAHP 2007*, Viña del Mar, Chile, August 2-6, 2007.

Saji Baby was born in Kerala (India) in 1964. He is completing his PhD on topic- "Coastal Landscape Morphological Evolution of Kuwait" studying changes and environmental constraints from 1960s. He possess Master of Technology in Remote Sensing from Birla Institute of Technology, Ranchi, Master of Philosophy in Environmental Science & Engineering from Pondicherry Central University, Post Graduate Diploma in Ecology and Environment from IIEE, Patna, and Master of Science in Life Sciences from Ranchi University, Bachelor of Science Honors and has acquired Graduate of the Institution of Engineers (Grad.IE). He has successfully completed advanced training in Remote Sensing and Sensors from National Remote Sensing Agency, Department of Space, Hyderabad, India. He is currently working as Principal Scientist Manager (Research and Development) with GEO International Environmental Consultation Co., Kuwait. He has significant international experience of 18 plus years in Scientific Research, Sustainable Development and Management. He has been key resource person and expert in more than 80 plus environmental studies on projects in the State of Kuwait. His experience includes in Pollution Identification, Pollution Control and Mitigation, Petroleum Contamination, Planning and Management of Environmental Projects, Environmental Impact Assessment, Environmental Risk Assessment, Coastal zone Management, Remote Sensing, course tutor and instructor.