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A MULTI-CRITERIA DECISION ANALYSIS (MCDA) APPROACH TO CONFLICT MANAGEMENT USING STAKEHOLDER PARTICIPATION AND MILLENNIUM DEVELOPMENT GOALS (MDGS) AGENDA

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ABSTRACT

Conflicts arise due to competing interests for limited resources which has resulted social conflicts and environmental degradation. The coastal regions of the world are particularly affected, as 60% of the world's population inhabits this region. There is, therefore, the need to develop an appropriate multi-criteria decision analysis tool that can ensure the sustainable utilization of this unique environment. An outline of a multi-criteria decision analysis (MCDA) framework to conflict management that incorporates multiple objectives is presented. Criteria based on Millennium Development Goals (MDGs) were identified for the determination of the social adaptive capacity of rural dwellers. Various stakeholders' interest (operators, developers, regulators, community members, and other major experts) were directly incorporated into the approach to improve decision-making processes. MCDA method was applied to conflict management using Delta State of Nigeria as a case study. Results obtained indicated that the Ukwuani local government area (LGA) had the lowest adaptive capacity (AC) index of 1.29, while Warri South had the highest AC index of 2.29. The implication of the study is that Ukwuani will be the least able to cope with disturbances and to attain the MDGs agenda. Hence the LGA would require more socio-economic assistance. The method developed in this study has been found to be effective in enhancing stakeholder involvement in decision-making and useful in developing a consensus-based approach to conflict management.

Keywords: Multi-Criteria Decision Analysis (MCDA); Adaptive Capacity; Conflict Management; Millennium Development Goals (MDGs); Stakeholder Participation; Niger Delta

INTRODUCTION

The causes of a major crisis in some regions can oftentimes be traced to natural resource control, environmental degradation, activities from outside the region, and marginalization of relevant stakeholders. Zeng, Zhou, Cowell and Huang (2001) noted that there are numerous interest groups in the coastal zone, each of which has its own focus on particular aspects of coastal environment. The degradation of Niger Delta environment and the resulting crisis has led to socio-economic strangulation of the Nigerian economy. Thus, there is need to address the current problem in order to inform policy makers with the appropriate approach to conflict management.

In order provide a framework to assist in improving the quality of life and secure sustainable development of the local populace, an integrated approach that takes into consideration the Millennium Development Goals (MDGs) was applied. At the United Nations Millennium Summit held on September 2000, 147 Heads of States adopted eight MDGs, which set targets

to reduce poverty, hunger, disease, illiteracy, environmental degradation, and discrimination against women by 2015 (United Nations Development Programme 2005).

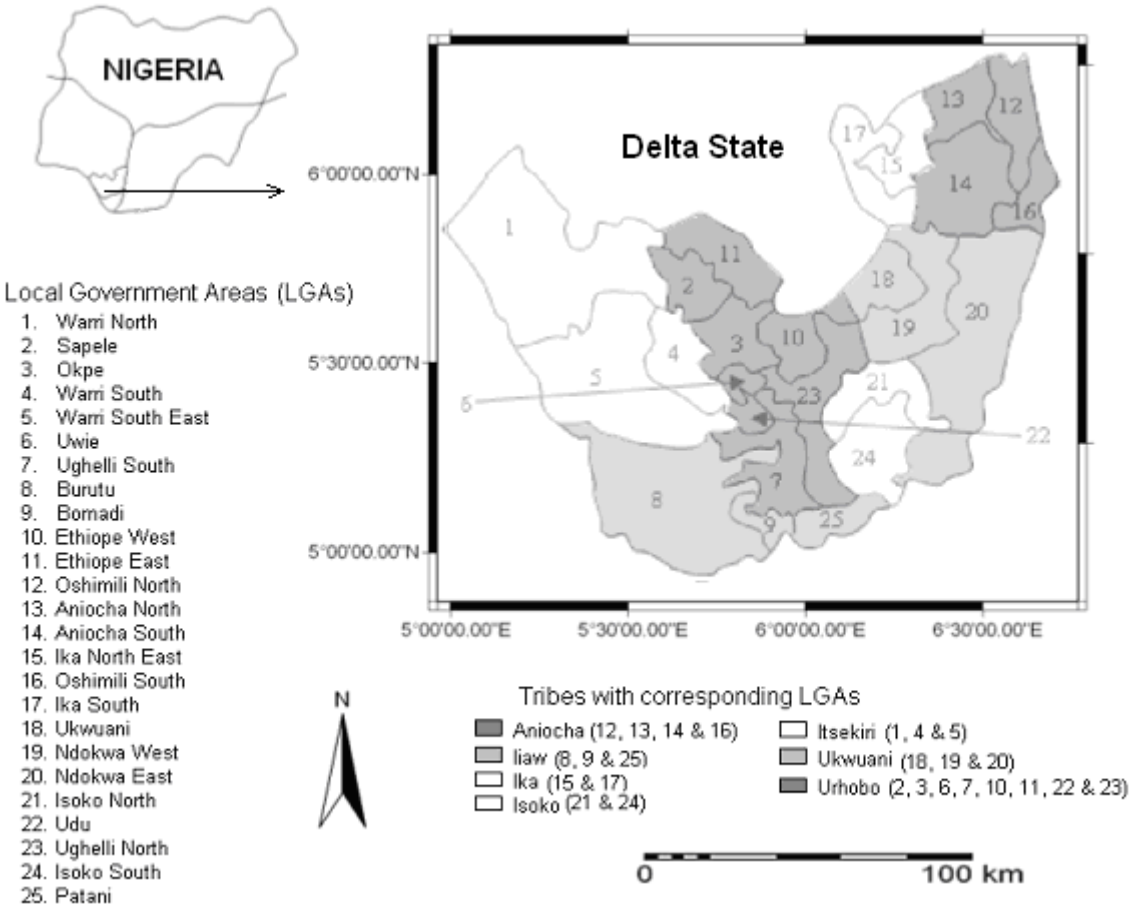
One approach to incorporating preferences of interest groups into formal decision analysis procedures is to use a multi-criteria decision analysis (MCDA). Multi-criteria decision analysis has been widely applied to mapping risks of agricultural pollution (Giupponi, Eiselt, & Ghetti, 1999), land use planning and management (Malczewski, Moreno-Sanchez, Bojorquez-Tapia, & Ongay-Delhumeau, 1997; Joerin & Musy, 2000), environmental decision making (Kiker, Bridges, Varghese, Seager, & Linkov, 2005), flood vulnerability assessment (Yalcın & Akyurek 2004), potential degree of conflict associated with oil and gas production activities (Brody, Grover, Bernhardt, Tang , Whitaker, & Spence, 2006).

STUDY AREA

The Delta State, which was selected for this study, is located in Niger Delta region of Nigeria (Figure 1). The State was created on August, 27 1991 from the defunct Bendel State. Presently, the State is made up of 25 Local Government Areas and 149 communities. Its population was estimated to be 4,098,391 in 2007 (Federal Republic of Nigeria 2007). The major tribes in the State are Urhobo, Ijaw, Isoko, Ibo, and Itsekiri.

The study area lies in the wet equatorial climatic region with a mean daily temperature of 26°C. It is also characterized by high cloud cover and relative humidity of 78.5% for Warri (SPDC, 2006). The average rainfall is 3,000 mm. The pristine vegetation has been reduced considerably in the area and replaced by mosaic of secondary re-growth such as arable farmlands (cassava, maize, and yams) and tree crops (oil palm, rubber, cocoa, and plantain) (Osuji and Onojake 2006). The remaining natural vegetation still occurs as fresh water swamp forest, mangrove swamp forest, and evergreen lowland rainforest.

Figure 1: Map of Delta State and Local Government Areas



CONFLICT MANAGEMENT AND ADAPTIVE CAPACITY

Conflict management refers to the long term management of intractable conflicts. Conflict in the Niger Delta arose in the early 1990s due to tension between oil companies and host communities. Specific factors have contributed to the prolonged conflict in the Niger Delta. Among them are the neglect by the government and oil companies, unemployment, military rule, the minority question, and a badly structured Nigerian federalism, especially as it concerns finances (Ibeanu 2000).

Adaptive capacity is the ability of households to anticipate and respond to changes in the coastal ecosystems and to minimize, cope with, and recover from the consequences. The concept of adaptive capacity was introduced in the Intergovernmental Panel on Climate Change (IPCC TAR) (IPCC, 2001), according to which the factors that determined adaptive capacity to climate change included economic wealth, technology and infrastructure, information, knowledge and skills, institutions, equity, and social capital (Metzger, Rounsevell, Acosta-Michlik, Leemans, & Schroter, 2006). In particular, adaptive capacity indicates a community's potential to cope with disturbances and take advantage of new opportunities, whether due to climate impacts (IPCC 2001) or conservation interventions.

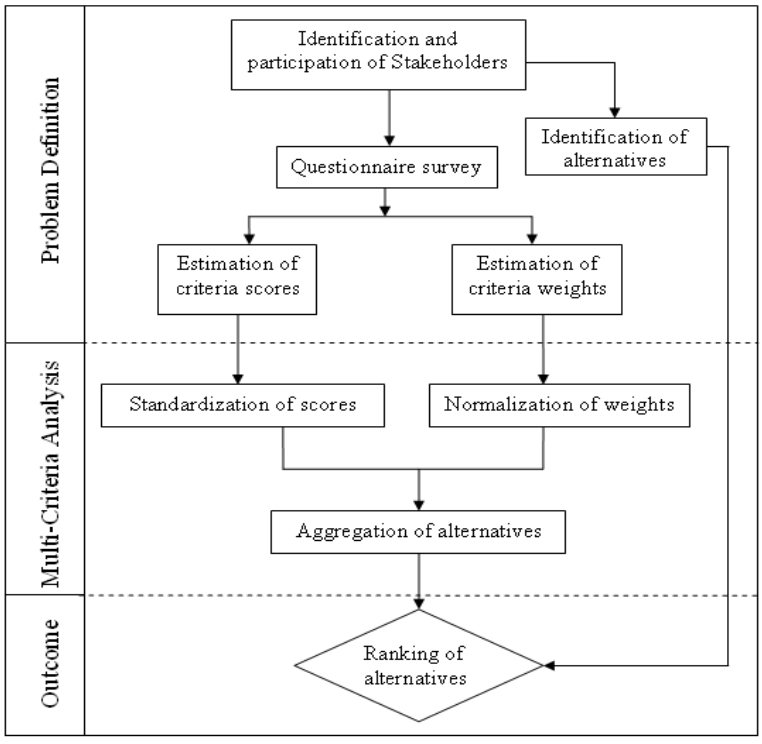
MULTI-CRITERIA DECISION ANALYSIS

Almost all decision analysis methodologies share similar steps of organization in the construction of the decision matrix (Kiker, Bridges, Varghese, Seager, & Linkov, 2005). Decision processes have been defined as having three separate stages: problem identification, developing possible courses of action, and selecting a course of action from the choices available (Janssen, 1996). Multi-criteria decision analysis (MCDA) tools can be applied to assess value judgments of individual decision makers or multiple stakeholders (Kiker, Bridges, Varghese, Seager, & Linkov, 2005). One of the advantages of an MCDA approach in group decisions is the capacity for calling attention to similarities or potential areas of conflict between stakeholders with different views, which results in a more complete understanding of the values held by others (Kiker, Bridges, Varghese, Seager, & Linkov, 2005).

The methodology utilized follows a three step approach. According to (Triantaphyllou, Kovalerchuk, Mann, & Knapp, 1997), there are three main steps in utilizing any decision-making technique involving numerical analysis of alternatives (Figure 2):

- Problem definition for determining the relevant criteria and alternatives.
- Multi-Criteria Analysis (MCA) for attaching numerical measures to the relative importance (i.e. weights) of the criteria and to the impacts (i.e. the relative performance) of the alternatives on these criteria.
- Processing the numerical values to determine a ranking of each alternative.

Figure 2: Flowchart of methodology for Multi-criteria decision analysis (MCDA)



Problem Definition

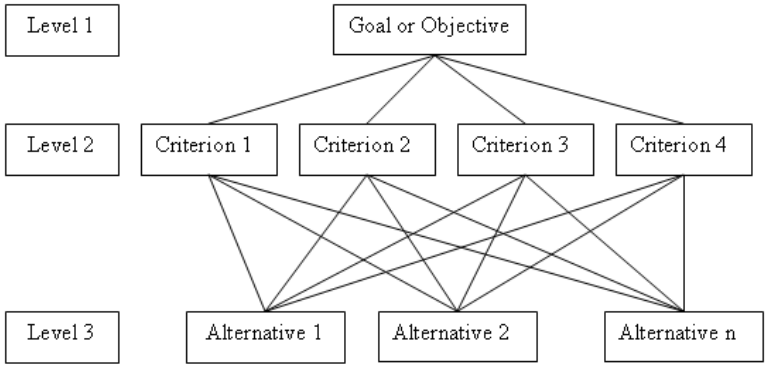
The problem definition step involves

1. Definition of alternatives: Identify the policy alternatives which are to be compared with each other;
2. Selection and definition of criteria: Identify the effects or indicators relevant for the decision;
3. Identification and participation of Stakeholders: Identify relevant stakeholder for the assignment of criteria scores and weights
4. Stakeholder questionnaire survey: Solicit scores and weights among stakeholders
5. Estimation of scores and weights for each alternative: Assign values for each effect or indicator for all alternatives

Definition of Alternatives

The hierarchical structure of consists of three levels, as shown in Figure 3. Criteria or objectives can be divided into sub- or sub-sub-criteria (objectives) for additional information and for clarification and refinement (Qureshi & Harrison 2003). The first level represents the ultimate goal of the decision hierarchy (areas vulnerable to pollution), the second level represents the criteria and sub-criteria utilized in this work, and the third level represents the options or alternatives. These alternatives should be described by some index (e.g. vulnerability index, risk index, adaptive capacity index, etc.) and should be evaluated by means of some specific criteria, which constitute the decision rules (Critto, Giove, Nadal, Samiolo, Carlon, Silvoni, Foramiti, & Marcomini, 2002).

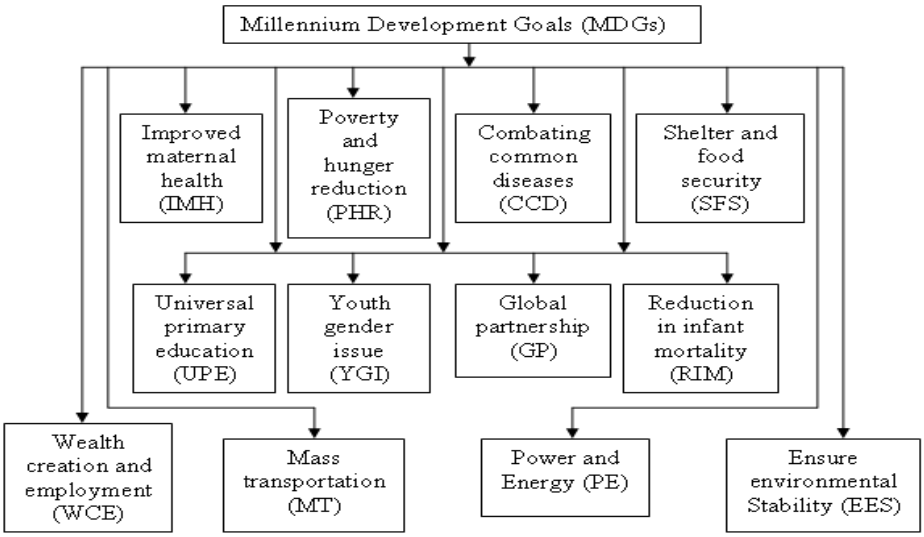
Figure 3: Problem definition with three different hierarchy levels



Selection and Definition of Evaluation Criteria for Adaptive Capacity Index

The Millennium Development Goals (MDGs) evaluation criteria were used for estimating the adaptive capacity index (Figure 4). MDGs were selected because they take into consideration the socio-economic conditions that are vital to the existence of inhabitants of a place.

Figure 4: Millennium development goals for determining adaptive capacity



Identification and Participation of Stakeholders

No matter the context, stakeholder involvement is increasingly recognized as being an essential element of successful environmental decision making (Linkov, Kiker, Bridges, Gardner, Rogers, Belluck, & Meyer, 2006). A stakeholder can be defined as a person or group who can affect or is affected by the outcomes of the decision at hand (Proctor & Qureshi 2005). Participation of stakeholders in this study was divided along these two main groups. The institutional/academic members (experts) provided expert opinion for assigning weights to the different criteria, while the local residents (host community members) were solely for the purpose of obtaining information on adaptive capacity. This approach was adopted due to the lack of socio-economic data. Sensitivity analysis was applied to test the robustness of the overall results.

Stakeholder Questionnaire Survey

Usually surveys are conducted using a questionnaire containing a number of queries and requesting the stakeholders' response (Munier, 2004). It is usually impossible and not economically feasible to physically interview hundreds or thousands of people, unless a full, formal census is taken. Therefore it is necessary to operate with samples, which allow one to work with a small, representative number of people, and from them, infer results about the whole population. A questionnaire survey has the advantage of minimizing facilitator and participant bias, as participants are expected to complete their questionnaires on individual basis. Since the survey was not exploratory in nature and only elicited numerical responses, no information was lost through a self-completion questionnaire survey.

The questionnaire was prepared carefully, taking into consideration input from different stakeholders. The initial questionnaire was sampled by these groups to ensure that the questions were well understood and the meaningful within the context of the research. Two different sets of questionnaires were disseminated: the first questionnaire was used to obtain scores from community members for analysis of the quality of life through adaptive capacity; and the second questionnaire

was used to elicit relative importance of selected criteria. The socio-economic survey provided a household-level adaptive capacity index in 20 out of the 25 Local Government Areas of Delta State.

Estimation of Scores and Weights (Relative Importance) of Criteria

SPSS Statistical package version 15.0 for Windows was used to calculate the central tendency values (for example, the median, grouped median, and mean) of scores and weights of the criteria. Scores for all criteria were obtained on a similar scale of 1 - 3. A value of 1 indicated the worst outcome (i.e. the area has the highest negative impact) for each criterion, while 3 indicated the best outcome. The weights were obtained on a 5 point scale, where 1 indicated least important and 5 indicated the most important criteria.

Multi-Criteria Analysis

Multi-criteria analysis involved a three-step approach: standardization of scores, normalization of weights, and the ranking of alternatives.

Standardization of Criteria Scores

Standardization is essential when the unit of measure of the different criteria differ. Since all criteria were on a 1-3 scale, it was not necessary to carry out any further standardization procedure.

Normalization of Criteria Weights

In order for the weight values to be combined, the process of normalization was carried out by dividing each weight by the sum of the weights such that their total sum equals unity. A normalization of weights for the Adaptive Capacity was accomplished using the formula:

$$z = y_i \Big/ \sum_{i=1}^{n} y_i \qquad (1)$$

Where z is the normalized weight value for the ith class and y_i is the raw weight.

Ranking of Alternatives

After the completion of standardization and normalization procedures for the criteria, they were evaluated using the Weighted Summation method. It was chosen due to its simplicity and it also provides a complete ranking of alternatives (Balasubramaniam, Boyle and Voulvoulis 2007). Equation 2 was used in the calculation of the Adaptive Capacity Index (ACI).

$$ACI = \sum (w_j x_{ji}) \qquad (2)$$

The weighted summation is based on the concept of a weighted average and involves the simple process of multiplying a score against a criterion x_{ji} by the weight of that criterion w_j, before finding the sum of the weighted scores.

Sensitivity Analysis

The sensitivity analysis was carried out to establish the influence of different weightings assigned to the selected criteria. The weightings of the criteria were tested according to the range of weightings identified by the experts using three different

scenarios. Scenario 1 presented the assignment of actual weighting obtained for all criteria. Scenario 2 was based on the application of equal weighting to all criteria and scenario 3 had the assignment of 50% of the total scores to poverty and hunger reduction (PHR) criterion.

RESULTS

Criteria scores

A total of 190 respondents participated in the questionnaire survey. Results of the multi-criteria analysis for the derivation of scores for the adaptive capacity criteria from stakeholders (host community members) are displayed in Table 1.

Table 1: Summary of score (grouped median) for Millennium development goals criteria from stakeholders (community members from local government areas in Delta State)

AC / LGAs	N	WCE	IMH	UPE	PHR	YGI	GP	RIM	CCD	SFS	PE	MT	EES
Aniocha North	7	1.65	1.95	2.00	1.83	1.83	1.29	2.43	1.71	1.80	1.33	1.43	1.57
Aniocha South	13	1.61	2.31	2.00	2.00	2.33	1.33	1.67	2.67	2.00	1.00	1.67	2.10
Burutu	3	1.10	1.50	1.33	1.33	2.00	1.67	2.00	1.67	1.33	1.00	1.67	2.00
Ethiope East	21	1.45	1.93	1.88	1.53	1.59	1.52	2.21	2.15	1.76	1.10	1.82	1.76
Ethiope West	4	1.54	1.50	2.00	1.67	1.75	1.75	2.25	2.00	2.00	2.25	2.25	1.75
Ika North-East	7	1.57	2.14	1.50	1.57	2.00	1.33	2.00	2.29	2.29	1.67	1.43	1.90
Ika South	4	1.50	1.75	2.00	1.67	2.00	1.50	2.25	2.33	2.00	1.00	1.50	2.00
Isoko North	5	1.80	2.00	2.20	1.80	1.20	2.00	2.60	2.40	2.25	1.50	2.00	1.60
Isoko South	12	2.00	1.00	1.00	2.00	2.00	2.00	1.50	1.00	1.50	1.50	1.50	1.50
Ndokwa East	11	2.00	2.00	1.67	2.00	1.00	1.00	2.00	2.00	1.00	1.00	2.00	2.00
Ndokwa West	3	1.33	1.67	2.00	2.00	1.67	1.67	2.67	2.33	2.00	1.33	1.67	2.00
Okpe	5	2.00	1.40	1.60	1.50	1.60	1.50	1.75	1.80	2.00	1.40	2.00	2.00
Oshimili North	4	1.75	1.50	2.00	1.25	1.50	1.50	1.75	1.75	2.00	1.00	2.25	2.00
Udu	14	1.67	2.00	1.67	1.50	2.00	1.67	2.00	2.00	1.50	1.50	1.25	1.25
Ughelli North	4	1.50	2.00	2.50	1.75	1.75	2.00	2.25	2.00	2.25	1.50	1.75	1.75
Ughelli South	6	2.00	2.00	2.17	1.40	1.90	1.40	2.00	1.67	1.83	1.50	1.83	1.50
Ukwani	12	1.00	2.00	1.00	1.00	1.50	1.00	2.00	1.00	1.50	1.00	1.00	1.50
Uvwie	22	1.00	2.25	1.50	1.50	1.00	1.50	2.00	2.00	1.50	1.75	1.50	1.00
Warri South-West	12	2.00	3.00	1.50	1.50	1.50	2.50	2.00	2.50	2.00	2.00	2.00	1.50
Warri South	21	2.00	3.00	3.00	2.25	2.00	2.00	3.00	2.00	3.00	1.00	2.00	2.00

Note: Abbreviations for Table 1- WCE-Wealth creation and employment, IMH-Improved maternal health, UPE-Universal primary education, PHR-Poverty and hunger reduction, YGI-Youth/gender issue, GP-Global partnership for development, RIM-Reduction in infant mortality, CCD-Combating common diseases, SFS-Shelter and food security, PE-Power and energy, MT-Mass transportation, EES-Ensure environmental sustainability.

Ukwani LGA recorded the lowest criteria score of 1.00 in 7 out of the 12 selected criteria (WCE, UPE, PHR, GP, CCD, PE, and MT), while Warri South presented the highest score of 3.00 in 4 out of 12 measured criteria.

Criteria Weights

Actual weights extracted from the two groups of experts are presented in Table 2. The first group of experts was made up of 18 staff in oil-related organizations, namely oil exploration and production companies, Department of Petroleum Resources

(DPR), and Federal Ministry of Environment (FMEn). The second group of experts comprised of 15 lecturers from Tertiary institutions, specializing in environmental, social, and economic fields.

Table 2: Summary of weights (grouped median, mean and standard deviation) from experts for millennium development goals criteria

	Group 1 (GP1)			Group 2 (GP2)			Total Median (GP1)	Total median (GP2)	Mean	SD
Experts N	Oil Comp 8	DPR 7	FMEn 4	Geo 5	Eco 4	Soc 6				
MDGs										
WCE	4.57	3.83	4.25	4.57	4.20	4.67	4.22	4.48	4.35	0.32
IMH	3.67	4.00	4.00	3.67	3.75	4.50	3.89	3.97	3.93	0.32
UPE	4.00	4.00	4.50	4.25	4.12	4.00	4.17	4.12	4.15	0.20
PHR	4.83	4.00	4.33	4.90	4.33	4.50	4.39	4.58	4.48	0.34
YGI	3.50	3.00	3.67	4.33	3.67	3.00	3.39	3.67	3.53	0.50
GP	3.67	3.60	4.00	4.33	2.90	3.50	3.76	3.58	3.67	0.48
RIM	4.00	4.00	3.67	4.20	3.40	4.15	3.89	3.92	3.90	0.31
CCD	4.67	3.50	3.25	4.33	3.00	4.50	3.81	3.94	3.88	0.71
SFS	4.20	3.50	4.00	4.33	4.00	4.50	3.90	4.28	4.09	0.35
PE	3.80	4.00	5.00	3.50	3.50	4.20	4.27	3.73	4.00	0.56
MT	2.60	2.80	3.00	3.00	3.17	3.50	2.80	3.22	3.01	0.31
EES	4.40	3.17	4.50	4.20	3.20	3.75	4.02	3.72	3.87	0.59

From the analysis of the criteria weights, the two groups of experts, namely GP1 and GP2, rated poverty and hunger reduction (PHR) as the criterion having the highest importance, with median values of 4.39 and 4.58, respectively. The least important criterion, as deduced from the two groups, was mass transportation (MT), with values of 2.80 and 3.22. Combating common diseases (CCD) had the highest standard deviation (SD = 0.71), indicating the varied views the experts had on its importance. Experts were more consistent in assigning weights to universal primary education (UPE) with SD = 0.20, indicating their knowledge on the importance of the criterion. The normalized weights of criteria for adaptive capacity for three different scenarios are shown in Table 3.

Table 3: Normalized weights for adaptive capacity for three different scenarios

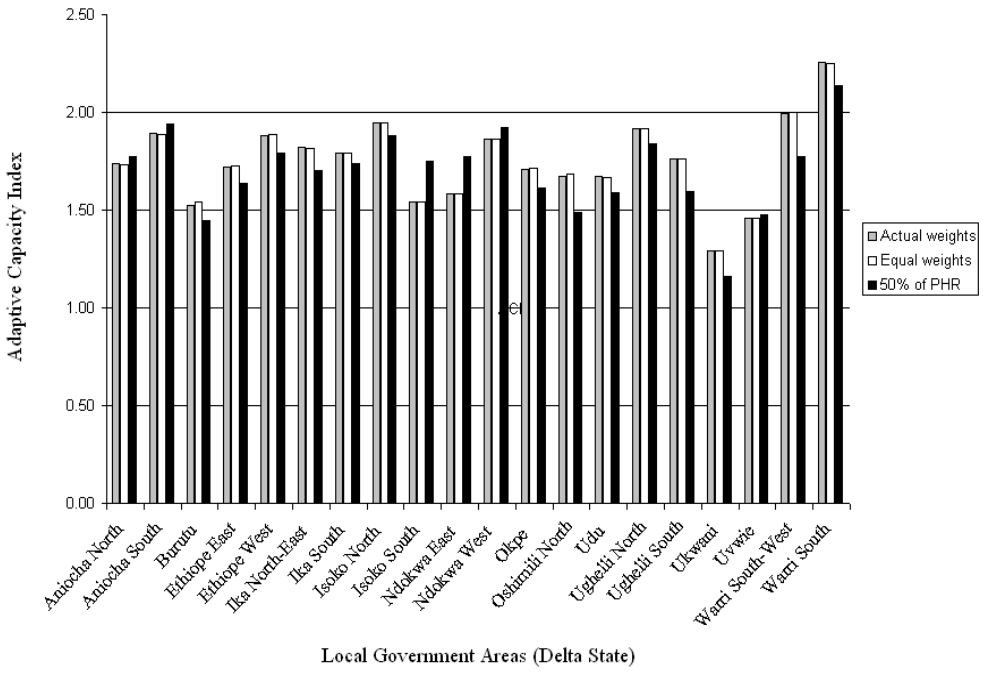
Criteria	Code	Actual weights Scenario 1	Equal weights Scenario 2	50% for PHR Scenario 3
Wealth creation and Employment	WCE	0.093	0.083	0.045
Improved maternal health	IMH	0.083	0.083	0.045
Universal primary education	UPE	0.089	0.083	0.045
Poverty and hunger reduction	PHR	0.096	0.083	0.500
Youth/gender issue	YGI	0.076	0.083	0.045
Global partnership for development	GPD	0.078	0.083	0.045
Reduction in infant mortality	RIM	0.083	0.083	0.045
Combating common diseases	CCD	0.083	0.083	0.045
Shelter and food security	SFS	0.088	0.083	0.045
Power and energy	PE	0.086	0.083	0.045
Mass transportation	MT	0.063	0.083	0.045
Ensure environmental sustainability	EES	0.082	0.083	0.045

To test the robustness of the weights obtained in the study, two alternative scenarios were tested in addition to the actual weights. In the first scenario, the weights that were used were comprised of the actual measured weights. Scenario 2 had equal weights being assigned to all the criteria, while in scenario 3, the PHR was rated 0.5 and the other weights were given a value of 0.045.

Ranking for Alternatives

The weighted summation method using Equation 2 was applied for the combination of weights and scores. This produced the ranking values for the LGAs. Figure 5 represents the calculated adaptive capacity index for the different local government areas.

Figure 5: Adaptive Capacity Indices from Three Scenario Analyses



The actual and equal weights scenarios produced similar results, with Ukwani having the lowest adaptive capacity index of 1.29 and Warri South having a ACI of 2.29. Analysis using the three scenarios showed that the weights are less sensitivity to a slight weight increment, as in the case of scenarios 1 and 2, but become more sensitive when the criterion PHR is given 0.5 value. The ranking order of the local government areas also changed slightly for scenarios 1 and 2. A significant change was observed in the ranking order of scenario 3 (Figure 6).

Rank	**Actual Weights Scenario 1**	**Equal Weights Scenario 2**	**50% for PHR Scenario 3**
1	Ukwani	Ukwani	Ukwani
2	Uvwie	Uvwie	Burutu
3	Burutu	Burutu	Uvwie
4	Isoko South	Isoko South	Oshimili North
5	Ndokwa East	Ndokwa East	Udu
6	Udu	Udu	Ughelli South
7	Oshimili North	Oshimili North	Okpe
8	Okpe	Okpe	Ethiope East
9	Ethiope East	Ethiope East	Ika North-East
10	Aniocha North	Aniocha North	Ika South
11	Ughelli South	Ughelli South	Isoko South
12	Ika South	Ika South	Ndokwa East
13	Ika North-East	Ika North-East	Warri South-West
14	Ndokwa West	Ndokwa West	Aniocha North
15	Ethiope West	Aniocha South	Ethiope West
16	Aniocha South	Ethiope West	Ughelli North
17	Ughelli North	Ughelli North	Isoko North
18	Isoko North	Isoko North	Ndokwa West
19	Warri South-West	Warri South-West	Aniocha South
20	Warri South	Warri South	Warri South

DISCUSSION

Two groups of experts, comprising staff of oil related organizations and lecturers from tertiary institutions were involved in the assignment of weights (relative importance). Coincidentally, mass transportation (MT) with a mean value of 3.01 was rated as the least important by the two groups of experts, as presented in Table 2. Poverty and hunger reduction (PHR), on the other hand, was regarded as the most important, with a mean weight of 4.48. This, to a large extent, generally depicts the economic situation in the region.

The calculated AC indices using actual weights ranked Ukwuani as having the lowest index (1.29) and Warri South was ranked the highest (2.26). Sensitivity analysis using equal weights and 50% of the weights assigned to PHR were also applied. These produced a similar ranking order as the actual weights, as presented in Figure 4. Sensitivity analysis helped to substantiate the ranking order obtained using the actual weights and also added robustness in the weights obtained.

CONCLUSION

The purpose of using MCDA is to assist decision makers, planners, developers, and the public in selecting the best alternative from a number of possible options. The important features of this methodology is that it provides different stakeholders the ability to participate in the decision making process. It has been observed that conflicts arise from different interests because of scarcity or depleted quality of resources (Torell, 1997). Making decisions are especially troublesome when intuition, alone, cannot help us determine which of several outcomes is the most desirable, or the least objectionable. Hence, the necessity for the application of MCDA that addresses the problem through stakeholder involvement and the selection of criteria that are also responsive to the issues being addressed.

Multi-criteria decision analysis and the millennium development goals were applied for the ranking of LGAs in terms of their adaptive capacity (AC). In order to achieve this, criteria scores and weights were derived with the aid of the questionnaire survey. Scores were elicited from stakeholders (members of host oil communities) of 20 LGAs in Delta State. Scores varied from 1.00 to 3.00 as shown in Table 1. Power and energy (PE) criterion recorded the lowest score (1.00) in eight LGAs, indicating the dismal performance of this criterion and the prevailing condition of the power sector in the study area and in the nation at large. Improved maternal health (IMH) was rated the highest in two LGAs. This could be attributed to government assisted programs in the LGAs involved.

The MCDA approach effectively integrates a number of criteria in a credible and transparent manner. The process shows that stakeholder views and values can be used in a rigorous framework which can be well understood by policy makers, regulators, and planners. The approach has engaged a wide range of stakeholders and shows that participatory approaches can be used in conjunction with decision support tools, such as the MCDA. The methodology developed was useful when multiple options and conflicting evaluation were involved in the decision making process

REFERENCES

Balasubramaniam, A., Boyle, A.R., & Voulvoulis, N. (2007). Improving petroleum contaminated land remediation decision-making through the MCA weighting process. *Chemosphere*, 66(5), 791-798.

Brody, S. D., Grover, H., Bernhardt, S., Tang, Z., Whitaker, B., & Spence, C. (2006). Identifying Potential Conflict Associated with Oil and Gas Exploration in Texas State Coastal Waters: A Multicriteria Spatial Analysis. *Environmental Management*, 38, 597-617.

Critto, A., Giove, S., Nadal, N., Samiolo, M., Carlon, C., Silvoni, S., Foramiti, S., & Marcomini, A. (2002). DESYRE – DEcision Support sYstem for REhabilitation of contaminated sites: objectives and structure. In: Rizzoli, A. E. and

Jakeman, A. J. eds.*Proceedings of the Integrated Assessment and Decision Support. Proceedings of the 1st Biennial Meeting of the iEMSs*: The International Environmental Modelling and Software Society (iEMSs), 211-216, Manno.

Federal Republic of Nigeria. (2007). Official Gazette *Federal Government, Lagos*. 94(24).

Giupponi, C., Eiselt, B., & Ghetti, P.F. (1999). A multicriteria approach for mapping risks of agricultural pollution for water resources: The Venice Lagoon watershed case study. *Journal of Environmental Management*, 56, 259–269.

Ibeanu, O. (2000). Oiling the Friction: Environmental Conflict Management in the Niger Delta, Nigeria. *Environmental Change and Security Project Report*, (6).

Intergovernmental Panel on Climate Change. (2001). Technical summary: climate change 2001: impacts, adaptation, and vulnerability. A Report of Working Group II of the Intergovernmental Panel on Climate Change.

Intergovernmental Panel on Climate Change. (2001). Technical summary: climate change 2001: impacts, adaptation, and vulnerability. A Report of Working Group II of the Intergovernmental Panel on Climate Change.

Janssen, R. (1996). *Multiobjective Decision Support for Environmental Management*. 2nd ed. Dordrecht: Kluwer Academic Publishers.

Joerin, F. & Musy, A. (2000). Land management with GIS and multicriteria analysis. *International Transactions in Operational Research*, 7(1), 67-78.

Kiker, G.A., Bridges, T.S., Varghese, A., Seager, T.P. & Linkov, I. (2005). Application of multicriteria decision analysis in environmental decision making. *Integrated Environmental Assessment and Management*. 1, 95-108.

Linkov,, I., F.K., S., Kiker, G., T.P., S., Bridges, T., Gardner, K.H., Rogers, S.H., Belluck, D.A., & Meyer, A. 2006. Multicriteria Decision Analysis: A Comprehensive Decision Approach for Management of Contaminated Sediments. *Risk Analysis*, 26(1), 61-78.

Malczewski, J., Moreno-Sanchez, R., Bojorquez-Tapia, L.A., & Ongay-Delhumeau, E. (1997). Multicriteria Group Decision-making Model for Environmental Conflict Analysis in the Cape Region, Mexico. *Journal of Environmental Planning and Management*, 40(349-374).

Metzger, M.J., Rounsevell, M.D.A., Acosta-Michlik, L., Leemans, R., & Schroter, D. (2006). The vulnerability of ecosystem services to land use change. *Agriculture, Ecosystems & Environment*, 114(1), 69-85.

Munier, N. (2004). *Multicriteria Environmental Assessment: A Practical Guide*. London: Kluwer Academic.

Osuji, L.C. & Onojake, C.M. (2006). Field reconnaissance and estimation of petroleum hydrocarbon and heavy metal contents of soils affected by the Ebocha-8 oil spillage in Niger Delta, Nigeria. *Journal of Environmental Management*, 79(2), 133-139.

Proctor, W. & Qureshi, E. (2005) *ANZSEE conference on Ecological Economics in Action* Massey University, Palmerston North, New Zealand.

Qureshi, M. E. & Harrison, S.R. (2003). Application of the Analytic Hierarchy Process to riparian revegetation policy options. *Small-scale Forest Economics, Management and Policy*, 2(3), 441-458.

Shell Petroleum & Development Company. (2006). *Environmental Evaluation Report (EER) for Jeddo Composting Plant: Final report*. SPDC.

Torell, E. (1997). *Conflicts Regarding Natural Resources Utilization in Coastal Zones of Developing Countries. The Sida Marine and Coastal Initiative*. Stockholm.

Triantaphyllou, E., Kovalerchuk, B., Mann, L., & Knapp, G.M. (1997). Determining the most important criteria in maintenance decision making. *Journal of Quality in Maintenance Engineering*, 3(1), 16-28.

United Nations Development Programme. (2005). Annual Report. United Nations Development Programme.

Yalcın, G. & Akyurek, Z. (2004) In *XXth International Society for Photogrammetry and Remote Sensing Congress.* Istanbul.

Zeng, T.Q., Zhou, Q., Cowell, P., & Huang, H. (2001). Coastal GIS: Functionality Versus Applications. *Journal of Geospatial Engineering*, 3(2), 109-126.

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