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Bayesian Expected Opportunity Loss of Bori-Ogoni Reclaimed Diesel Spill Multipurpose Multi-Objective Farmland Project

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ABSTRACT
Bori-Ogoni is an environmental sensitive region as declared by United Nation Environmental Protection Agency (UNEP). Clean up of all impacted aspects of it environment has failed due to poor management of allocated resources. This research focuses on applying Bayesian expected opportunity loss (EOL) model to optimally implement allocated resources in reclaimed diesel spill multi-purpose/multi-objective farm land project at Bori-Ogoni in Rivers State of Nigeria. The specific objectives are to develop payoff matrix from secondary data in reclaimed diesel spill farmland projects and analyze the expected opportunity loss from the payoff matrix for reliability and sustainability of the farm projects. Bayesian decision theory was used to determine the EOL of the projects. Result showed that the EOL of the maize, cassava, yam, oil palm and fish farming are 0.80, 0.78, 0.72, 0.72 and 0.00 billion naira respectively. The result showed that investors should invest more in fish farming because it will yield maximum profit at zero EOL The Bayesian expected opportunity loss provides adequate information that will enable investors to take informed decision in investing resources for sustained productivity and development of organizations. It is recommended that federal ministry of Environment, Agriculture, and National Oil Spill Detection Regulation Agency (NOSDRA) should subscribe to useful tools like EOL in executing environmental and agricultural projects for sustainability and development of the Nation's GDP.

KEYWORD: Bayesian theory, Expected opportunity loss, Reclaimed farmland projects, Multipurpose/multi-objective projects

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I. INTRODUCTION

Diesel oil spill in Niger Delta has caused so much damages to aquatic lives, humans, plants, and animals (Amie-Ogan, Petaba, Leyira, Nwikina, Philip-Kpae, and Akpan,2022). The UNEP report, 2016 recommend immediate reclamation of impacted environmental aspects. Implementation of UNEP reports has practically failed due to improper allocation of resources. A reclaimed farmland multipurpose/multiobjective project was proposed to help generate profit maximization model for sustainability of oil spill reclamation projects in Bor-Ogoni, Rivers State Nigeria (Gbinu, Mahmud, Akpan, Badom, Nwiyor. and Letam, 2022). The works of Mahmud, Gbinu, Amie-Ogan, Ndam, Letam, and Akpan, (2022) discussed on cost minimization model that be used to reduce the investment cost of multipurpose / multi-objective reclaimed diesel spill farm land projects. The works of Mahmud et al.,(2022) and Gbinu et al., (2022) showed how profit of seventy five billion, eight hundred and twenty six thousand naira (₦75,826,000,000) was maximized per year and cost of five billion, eight hundred and thirty five thousand, seven hundred and fifty naira (₦5,835,750,000) was minimized in investing in multipurpose/multiobjective reclaimed diesel spill farmland projects.

Much more profit can be obtained from the pay off matrix developed by Gbinu et al.,(2022) and Mahmud et al.,(2022). Bayesian decision theory can be used to take optimal market decision that can optimally yield much more profit to further develop and sustain the farmland project (Ramalakshmi and Sharathchandra,2015). Xiang and Landschoot, (2019) developed a modal-based Bayesian interference to accomplish estimation of the directions of arrivals (DoAs) of sound sources. The thought Angelini, (2019) showed that, prior analysis, preposterous analysis, posterior analysis provides managers the best framework or models to take informed decision. Valdés , Cheng ,Comendador and Nieto (2018) combined Bayesian Network and information theory to forecast mid air accident reoccurrence in aviation industry. Bayesian models can be used to detect hidden cause of losses in complex multipurpose/ multi-objective farmland project to minimize unexpected futuristic losses (Yamazaki and Motomura, 2019). Bayesian decision models can be used to rank the impact of multipurpose/multi-objective farmland project structure to suggest possible future modifications of the system for improvement and sustainability (Schneps, Overill, and Lagnado ,2018). According to Martel-Escobar, Vázquez-Polo and Hernández-Bastida (2018); David, Fabrizio, and Refik (2019), and Mihali, Van Opheusden , and Ma (2017), Bayesian inference is used to audit prior information using complex entropy priors. This makes it possible to audit errors in complex multipurpose/multi-objective farmland project structures proposed by Gbinu et al., (2022) and Amie-Ogan et al.,(2022). In the view of Stengård and van den Berg (2019); Rigoli , Mathys , Friston and Dolan (2019); Wei (2019); Lee,Wang, Vlahov , Brar and Theodorou (2018),and Shen and Ma (2016), Bayesian decision theory is useful in scaling workers performances based on perceptual decision-making task and to suggest how incentive value of an option is affected by other options available during choice and by options presented in the past. This will help increase returns of investment of the project and the model can be replicated in other multipurpose multi-objective projects (Hardwicke, Tessler, Peloquin, and Frank ,2018; Cook and Puri, 2017 and Davis ,Kisiel and Duckstein, 2018)

Scholars have not explored the Bayesian expected opportunity loss in multipurpose/multi-objective projects. Hence, this research is geared towards determining the Bayesian expected opportunity loss of the farmland project. Gupta (2014) considered an alternative approach to minimizing EMV approach. He postulated that the EOL approach is geared towards minimizing possible investment strategies that results in expected opportunity loss. Expected opportunity loss or expected value of regrets represents the amount by which maximum possible profit will be reduced under various possible stock actions. The course of action that minimizes these losses or reductions is the optimal decision alternative.

II. MATERIALS AND METHODS

The method used in this research is based on the thoughts of Taha (2013); Gupta and Hira (2014); Gbinu et al., (2022), and Mahmud et al.(2022). Pay off matrix of Bori-Ogoni multipurpose multi-objective reclaimed diesel spill farmland project was used to analyse and determine the expected opportunity loss of the projects using Bayesian decision theory.

To determine the EOL of the farmland projects, prepare the conditional profit table for each decision - event combination and write the associated probabilities. For each event, determine the conditional opportunity loss (COL) by subtracting the payoff from the maximum payoff for that event. Calculate the expected opportunity loss (EOL) for each decision alternative by multiplying the COL'S by the associated probabilities and then adding the values. Finally, select the alternative that yields the lowest EOL. (Gupta and Hira, 2014).

III. EXPECTED OPPORTUNITY LOSS (EOL) ANALYSIS

Preparation of conditional profit table for each decision - event combination and writing of the associated probabilities.

Table 3.1 Conditional profit table (Billion naira)

State of nature (Lands)	Probability	Expected profits from different Farm types (Billion Naira)				
		Maize	Cassava	Yam	Oil Palm	Fishery
Hectre A	0.10	0.010	0.020	0.050	0.050	0.440
Hectre B	0.32	0.040	0.070	0.160	0.160	1.320
Hectre C	0.10	0.010	0.020	0.050	0.050	0.440
Hectre D	0.23	0.030	0.050	0.110	0.110	0.880
Hectre E	0.25	0.010	0.020	0.050	0.050	0.440

Determination of conditional opportunity loss (COL) by subtracting the payoff from the maximum payoff for each event

Table 3.2 Conditional profit determination table (Billion naira)

State of nature (Lands)	Probability	Expected profits from different Farm types (Billion Naira)				
		Maize	Cassava	Yam	Oil Palm	Fishery
Hectre A	0.10	0.430	0.420	0.390	0.390	0.000
Hectre B	0.32	1.280	1.250	1.160	1.160	0.000
Hectre C	0.10	0.430	0.420	0.390	0.390	0.000
Hectre D	0.23	0.850	0.830	0.770	0.770	0.000
Hectre E	0.25	0.430	0.420	0.390	0.390	0.000

Calculation of the expected opportunity loss (EOL) for each decision alternative by multiplying the COL'S by the associated probabilities and adding the values

Table 3.3.Expected loss table (naira)

State of nature (Lands)	Probability	Expected profits from different Farm types (Billion Naira)				
		Maize	Cassava	Yam	Oil Palm	Fishery
Hectre A	0.10	0.043	0.042	0.039	0.039	0.000
Hectre B	0.32	0.410	0.400	0.371	0.371	0.000
Hectre C	0.10	0.043	0.042	0.039	0.039	0.000
Hectre D	0.23	0.196	0.191	0.177	0.177	0.000
Hectre E	0.25	0.108	0.105	0.098	0.098	0.000
EOL (Naira)		0.799	0.780	0.724	0.724	0.000

Selection of the alternative that yields the lowest EOL.The minimum expected loss is 0.00 naira. The action call for investors to invest more in fishery as the expected loss is zero naira. Maize and cassava farming is expected to have a maximum expected opportunity loss of 0.80 and 0.78 billion naira respectively. Lesser profit is expected here because more losses are anticipated. Yam and oil palm farming are much more lucrative to invest in sequel to the fact that their EOL are 0.72 billion naira respectively compared to maize and cassava farming with the highest EOL"S of 0.80 and 0.78 billion naira respectively. Investors may consider to also invest in oil palm and yam since their EOL's are lesser compared to maize and cassava.

IV. RESULTS AND DISCUSSION

Table 4.1. Payoff matrix of accrued benefit from farm produce on five hectares of reclaimed diesel spill cultivated on five hectares of land in Bori per billion naira

		Player A				
		Maize	Cassava	Yam	Oil Palm	Fishery
Player B	Hectares A 10%	0.01	0.02	0.05	0.05	0.44
	Hectares B 32%	0.04	0.07	0.16	0.16	1.32
	Hectares C 10%	0.01	0.02	0.05	0.05	0.44
	Hectares D 23%	0.03	0.05	0.11	0.11	0.88
	Hectares E 25%	0.01	0.02	0.05	0.05	0.44

Discussion of the result in table 4.1

i. Table 4.1 showed the payoff matrix of diesel spill that affected 10%, 32%, 10%, 23% and 25% of land in Hectre A,B,C,D,E and F of Bori respectively.

ii. Player A plays his strategy to minimize cost of cultivating maize, cassava, yam oil palm and fishery while player B plays his strategy to maximize profit on hectare A,B,C,D and E

iii. The value in the payoff matrix is the accrued benefit per billion naira of a multipurpose multi objective project.

Table 4.2 Results of expected loss table (Billion naira)

State of nature (Lands)	Probability	Expected profits from different Farm types (Billion Naira) Maize	Cassava	Yam	Oil Palm	Fishery
Hectre A	0.10	0.043	0.042	0.039	0.039	0.000
Hectre B	0.32	0.410	0.400	0.371	0.371	0.000
Hectre C	0.10	0.043	0.042	0.039	0.039	0.000
Hectre D	0.23	0.196	0.191	0.177	0.177	0.000
Hectre E	0.25	0.108	0.105	0.098	0.098	0.000
EOL (Naira)		0.799	0.780	0.724	0.724	0.000

Discussion of the result in table 4.2

i The minimum expected loss is 0.00 billion naira. The action call for investors to invest more into fishery as the expected loss is zero naira.

ii Maize and cassava farming is expected to have a maximum expected opportunity loss of 0.80 and 0.78 billion naira respectively .

iii Yam and oil palm farming are expected to have EOL of 0.72 billion naira respectively compared to maize and cassava farming with EOL"S of 0.80 and 0.78 billion naira respectively. It is expected that investors may also consider to cultivate yam and palm oil as much more profit can be maximized compared to maize and cassava.

V. CONCLUSION

The value in the payoff matrix is the accrued benefit per billions of naira for a multipurpose multi objective project reclaimed diesel spill farmland projects. This action calls for managers and investors to invest more in fishing because it has minimum expected loss of 0.00 naira and highest maximum anticipated profit. Yam and palm oil farming will maximize much more profit compared to maize and cassava farming because they have the least EOL of 0.72 billion naira respectively compared to maize and cassava with the highest EOL of 0.80 and 0.78 billion naira respectively. However, if investors invest more in research to know the possible cause of incurred expected opportunity loss in the project, and put appropriate measures in place to prevent such reoccurrence, then their EOL will reduce and profits can be optimally maximized.

VI. RECOMMENDATION

Federal ministry of environment, agriculture and national oil spill detection regulation agency (NOSDRA) in alliance with the legislative arm of government should sponsor bill for the adoption and implementation of the developed EOL optimization model of reclaimed diesel spilled soil since it will help fulfill the requirements of ISO 14001:2015 standards.

VII. CONTRIBUTION TO KNOWLEDGE

The Bayesian expected opportunity loss model developed will help manager of multipurpose/multi-objective reclaimed oil spill farmland projects and other lucrative projects to take informed decision in investment that will optimally develop and sustain the projects.

This research work implements Bayesian decision theory in solving the oil spill challenge in Niger Delta and agrees with environmental management system as per ISO 14001:2015.

REFERENCES

[1]. Amie-Ogan T. G., Petaba L. D., Leyira F. G., Nwikina B. B., Philip-Kpae F. O., and Akpan P. P. (2022). Diesel Spill Retention Modeling Of Niger Delta Soil", *International Journal of Engineering Research and Applications (IJERA)* , 12 (1):50-55, ISSN: 2248-9622 , www.ijera.com.

[2]. Angelini P., (2019). An Original and Additional Mathematical Model Characterizing a Bayesian Approach to Decision Theory, *Journal of Mathematics Research, Canadian Center of Science and Education,*. 11(3), 1-13. https://ideas.repec.org/a/ibn/jmrjnl/v11y2019i3p1.html

[3]. Cook M. J. and Puri B. K (2017). Application of Bayesian decision-making to laboratory testing for Lime disease and comparison with testing for HIV, *International journal of general medicine*

[4]. David R.I., Fabrizio R., and Refik S. (2019). Advances in Bayesian decision making in reliability, *European Journal of Operational Research*, Received 23 December 2017, Revised 9 March 2019, Accepted 13 March 2019, Available online 16 March 2019.doi.org/10.1016/j.ejor. 2019.03.018

[5]. https://www.sciencedirect.com/science/article/abs/pii/S0377221719302577

[6]. Davis D. R.,Kisiel C.C. and Duckstein L. (2018). Bayesian decision theory applied to design in hydrology, *Journal of Water Resources Research*, doi.org/10.1029/WR008i001p00033 https://agupubs.onlinelibrary.wiley.com/doi/10.1029/WR008i001p00033

[7]. Gbinu K. S., Mahmud H., Akpan P. P., Badom F. Z., Nwiyor P. S. and Letam L. P. (2022). Profit Maximization Modeling Of Bori-Ogoni Multipupose Multi Objective Diesel Spill Land Reclamation Project, *International Journal of Engineering Research and Applications (IJERA)* , 12 (1),37-41, ISSN: 2248-9622 , www.ijera.com.

[8]. Gupta P. K and Hira D. S. (2014). Operations Research,S Chand & Company Pvt. Ltd, New Deli, India,*S. Chand publishing*, 7th Edition,1498.

[9]. Hardwicke, T., Tessler, M., Peloquin, B., & Frank, M. (2018). A Bayesian decision-making framework for replication. *Behavioral and Brain Sciences*, 41, E132. doi:10.1017/S0140525X18000675

[10]. Lee K., Wang Z., Vlahov B. I., Brar H. K., Theodorou E. A.(2018). Ensemble Bayesian Decision Making with Redundant Deep Perceptual Control Policies, Submitted on 30 Nov 2018, last revised 19 Feb 2019.

[11]. Mahmud H., Gbinu K. S., Amie-Ogan T. G., Ndam E., Letam L. P., and Akpan P. P. (2022). Cost Minimization Modelling Of Niger Delta Multi-Pupose/Multi-Objective Diesel Spill Land Reclamation Project, *International Journal of Engineering Research and Applications (IJERA*) , 12 (1),31-36, ISSN: 2248-9622 , www.ijera.com.

[12]. Martel-Escobar M., Vázquez-Polo F.-J. and Hernández-Bastida A. (2018).Bayesian Inference in Auditing with Partial Prior Information Using Maximum Entropy Priors. Entropy,doi.org/10.3390/e20120919, https://www.mdpi.com/1099-4300/20/12/919

[13]. Mihali A., Van Opheusden B., and Ma, W. J. (2017). Bayesian microsaccade detection. *Journal of Vision*, 17(1):13, 1–23,doi:10.1167/17.1.13.

[14]. Petaba L. D., Badom F. Z., Pepple M. S., Amie-Ogan, T. G. , Nwikina B. B., and Akpan P. P. (2022). Diesel Spill Transportation Modeling Of Niger Delta Soil, *International Journal of Engineering Research and Applications (IJERA)* , 12 (1).42-49, ISSN: 2248-9622 , www.ijera.com.

[15]. Ramalakshmi N. and Sharathchandra K. K,(2015). "Bayesian Decision Theory in Marketing Research"-An Analysis of Bayes Theorem in Marketing Decision Making, *International Journal in Management and Social Science*, (10)3,pp 151 http://www.ijmr.net.in email id-irjmss@gmail.com

[16]. Rigoli F, Mathys C, Friston KJ and Dolan RJ (2019). Correction: A unifying Bayesian account of contextual effects in value-based choice. *PLOS Computational Biology* 15(10): e1007366. https://doi.org/10.1371/journal.pcbi.1007366 View correction https://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1005769

[17]. Schneps L., Overill, R., and Lagnado D. (2018). Ranking the Impact of Different Tests on a Hypothesis in a Bayesian Network. *Entropy*, 20, 856. doi.org/10.3390/e20110856 https://www.mdpi.com/1099-4300/20/11/856

[18]. Shen S. and Ma W.J., (2016).A detailed comparison of optimality and simplicity in perceptual decision-making, *Psychological Review*, 123 (4), 452-480. DOI: 10.1037/rev0000028 https://www.cns.nyu.edu/malab/static/files/publications/2016%20Shen%20Ma.pdf

[19]. Stengård E, van den Berg R (2019). Imperfect Bayesian inference in visual perception. *PLoS Comput Biol* 15(4): e1006465. https://doi.org/10.1371/journal.pcbi.1006465 https://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1006465

[20]. Taha A. T. (2013) Operations Research, *Manipal Technologies Ltd*, Pearson Education, 9th Edition, New Dehli, India

[21]. UNEP (2016). UNEP Ogoni land oil assessment reveals extent of environmental contamination and threat to human lives. https://www.unenvironment.org/news-andstories/ story/unep-ogoniland-oil-assessmentreveals- extent-environmental-contamination

[22]. Valdés R.M. A., Cheng S.Z. L., Comendador, V.F G. and Nieto F.J. S. (2018) Application of Bayesian Networks and Information Theory to Estimate the Occurrence of Mid-Air Collisions Based on Accident Precursors. *Entropy*, 20, 969. doi.org/10.3390/e20120969 https://www.mdpi.com/1099-4300/20/12/969

[23]. Wei J. M. (2019). Bayesian Decision Models: *A Primer Neuron Journal* (1) 104 P164-175, DOI:https://doi.org/10.1016/j.neuron.2019.09.037

[24]. Xiang N. and Landschoot C. (2019)Bayesian Inference for Acoustic Direction of Arrival Analysis Using Spherical Harmonics. *Entropy*, 21, 579. doi.org/10.3390/e21060579 https://www.mdpi.com/1099-4300/21/6/579

[25]. Yamazaki K. and Motomura Y. (2019).Hidden Node Detection between Observable Nodes Based on Bayesian Clustering. Entropy, 21, 32. doi.org/10.3390/e21010032 https://www.mdpi.com/1099-4300/21/1/32