SPEED OF OCCURRENCE OF THE OIL SPILL INCIDENT IN THE NIGER DELTA: A STOCHASTIC MARKOV PATTERN ANALYSIS

BY

MBA, IFEOMA CHRISTY [(1)], AMEH, CHIKA[(2*)] MBA, EMMANUEL IKECHUKWU[3], NNAMDI S. UGWU

DEPARTMENT OF ECONOMICS [(CORRESPONDING AUTHOR) 2*] , DEPARTMENT OF STATISTICS [3] , DEPARTMENT OF POLITICAL SCIENCE[3] DEPARTMENT OF ECONOMICS [1]

Abstract

Oil spillage in Niger Delta region of Nigeria has been on an increase and almost on a regular basis but the thrust of this study is the speed of occurrence of the oil spill incidence with respect to the reported date of the incident. The objective of this study is on the speed of occurrence of the oil spill incident in the Niger Delta: a stochastic markov pattern analysis with emphasis on how fast a particular state of occurrence switches to the other and on an average how long it takes for another report of oil spill incident to be announced and investigated. The stochastic markov pattern analysis was employed and also the summed differences of dates of spillages were also considered, the monthly occurrences and their respectively averages were also examined and it was discovered that its speed of occurrence is on an average approximately less than one week i.e. 6.7 or one week, i.e. 7 days before another incident is reported. It was also discovered that the transition probabilities of the switching from a state of earlier occurrence to a state of later occurrence is high, that is, 80%. The study concluded that to reduce or manage oil spillage in Nigeria, the Federal government and Federal environmental management agency should enforce the laws governing oil spill incident in Nigeria.

Keywords: occurrence, oil spill, Niger Delta

Jel Codes: P28, Q53, Q56

Introduction

Nigeria is a country that is blessed with a lot of natural resources, natural resources such as crude oil, rubber, lime stone are amongst the numerous gifts from God Almighty. Amidst these precious gifts, Nigeria is yet to be called "a developed country" irrespective of the name, 'the giant of Africa'. Nigeria has all she needs to make her great in all ramifications. One of the blessings given to Nigeria has turned to be her greatest nightmare and that is Crude oil. the major issue is that instead of the natural resources to bring about the needed gains or say blessings to both the country and her citizens, the feedback is a 'resource curse'. The discovery of Oil in 1956 on a commercial basis at Olobiri (CAB, 2005) and subsequent discoveries in other parts of the country gave rise to diverse problems that are harmful to man and development. Problems such as pipe line vandalization, oil bunkering and siphoning, oil theft are some of the problems facing the country and depriving her of the necessary and supposed growth. When it comes to oil in the Niger Delta, oil spillage or oil spill incident has become a household name. It is rather imperative to think that it is a recent issue.

Oil spill incidence has been a re-occurring phenomena in Nigeria and with the incessant spillages, wildlife and humans are in trouble as regards health. Man and his environment are no longer safe. Oil spill according to (UNDP, 2006) is a common outcome of oil exploitation and exploration in the Niger Delta . it is the activities of men that give rise to oil spillages. For example, operational activities of the oil workers can cause oil spillages, oil bunkering and siphoning can bring about spillages and sabotages can also give rise to oil spillages. The major concern of this study is to view the oil spill incident data

with respect the date of occurrences thereby using the stochastic Markov recognition pattern analysis to estimate the speed of occurrence of the oil spill incident. In order to find a lasting solution to the problem of oil spill, it is important to see how fast or the speed at which the incidence occurs in a given time period, this would make the joint investigators to have an idea of more likely occurrences of oil spills in the future thereby serving as a form of checkmate to more oil spillages ahead.

Literature Review

There are basically no literature(s) presently on the speed of occurrence of oil spill with respect to date, current literature reviewed were basically on markov regime switching for oil returns, speed of convergence of the canonical markov approximation with full connections with respect to summable decays. Researchers such as (Bressaud, Fernandez, & Galves, 1999; Günay, 2015; Yeh, 1995) were amongst the studies reviewed; Gunay (2015) looked at volatility modelling for oil returns using the markov regime switching generalised autoregressive (MRS-GARCH), GARCH and the exponential GARCH and they were able to do a comparison of the GARCH methods applied and thus discovered that the MRS-GARCH outperformed all the other methods applied. Bressaud et al (1999) examined the speed of d bar convergence with respect to summable decays, they applied the canonical markov approximation and saw that the speed of convergence converges at a rate proportional to the decay while Yeh (1998) used markov analysis for calculating the rate of occurrence of failures. Other literatures reviewed were om wind turbine; studies like that of (Legesse, Saha, & Carpanen, 2017; Selwyn & Kesaran, 2012) were basically on wind turbines. Legesse et al (2017) used the markov model in predicting the wind turbine behaviour and thus, they concluded that Durban and its environs need greater wind to bring about efficiency while that of Selwyn et al (2012) modelled wind turbine with markov though trying to estimate its reliability level, it was thus discovered from their study that their results will aid in planning and maintenance of wind turbine.

Methodology

The data on oil spill incident ranging from January 2015 to September 2018 from shell Nigeria. The data includes reported date of the oil spill incident, the site of the oil incident, the joint investigation date, the estimated oil spill volume (bbl) and so on but our interest is on the date of the oil spill incident.

The Markov Chain Model

The monthly observed reported oil spill incident will follow three states, where $S_t = 0$, if the state, which would otherwise be referred to as occurrence of oil spill in an earlier date (OCED)

$S_t = 1$; if the state, which would otherwise be referred to as occurrence of oil spill in a later date (OCLD)

$S_t = 2$; if the state, which would otherwise be referred to as occurrence of oil spill maintained on same date (OCMD)

Thus, whether states $S_t = 0,1,2$; the process respectively would be regime 0, 1, 2; so that there would be an observed change between the period with respect to date at an initial start date t and t + 1. Thus, the observed change Y_t is a random draw which follows a normal distribution. That is;

$Y_t \sim N(\mu_0, \sigma_0^2)$ distribution for the 'OCED' state (i)

$Y_t \sim N(\mu_1, \sigma_1^2)$ distribution for the 'OCLD' state (ii)

$Y_t \sim N(\mu_2, \sigma_2^2)$ distribution for the 'OCMD' state (iii)

Therefore the probabilities of the switching strategies amongst the three different states and regimes are defined by the P_{ij} which is the transition probability. Hence the transition probability state can be switched amongst the states or that a particular state (i) be followed by another state (j). The current date of oil spill depends on the preceding date of oil spill and not the past.

The Markov Chain (MC) is given as;

$MC = P(X_{t+1} = x/X_1 = x_1, X_2 = x_2, \ldots, X_t = x_t)$ (iv)

Thus;

$MC = P(X_{t+1} = x_{t+1}/ X_t = x_t)$ (v)

Where $t \in N$

X is the reported date of oil spill incident in the Niger Delta at different time period. Therefore, the P_{ij} is given as;

$(P_{ij}) = P(_{ji})$ where i and j $\in S$. The matrix of the transition probability P_{ij} becomes;

$$P_{ij} = \begin{bmatrix} P_{00} & P_{01} & P_{02} \\ P_{10} & P_{11} & P_{12} \\ P_{20} & P_{21} & P_{22} \end{bmatrix}$$

Which can thus be represented in a tabular form by just maintaining its switches row wise

Mathematically; the transition probability matrix can be written as:

$$P = P_{ij} = \begin{bmatrix} P_{00} & P_{01} & 1 - P_{00} - P_{01} \\ 1 - P_{11-}P_{12} & P_{11} & P_{12} \\ P_{20} & 1 - P_{20} - P_{22} & P_{22} \end{bmatrix}$$

Where i, j ∈ S and

$P_{00} = P(\varphi_k = 0 / \varphi_{k-1} = 0) = \alpha$ (vi)

$P_{01} = P(\varphi_k = 1 / \varphi_{k-1} = 0) = \beta$ (vii)

$P_{02} = P(\varphi_k = 2/\varphi_{k-1} = 0) = 1 - \alpha - \beta$ etc (viii)

Such that $0 \leq \alpha, \beta, \gamma, \delta, \varepsilon, \zeta \leq 1$ and their sum, that is row wise cannot exceed 1.

$P_{00} + P_{01} + P_{02} = 1$ (ix)

The Date Identification Algorithm

Given an initial start date of January 07, 2015, thus the identification can be viewed as follows:

- Take the difference between the initial start date t and the next preceding date t+1
- Identify consecutive date of oil spill that are same as no because the difference would read zero
- A new month starts an initial start date again as the end of the previous month marks the terminal of that month's identification process
- The differences are summed per month and thus the switching to the respective states OCED, OCLD an d OCMD are done with respect to the differences that exist between them.

Analysis and Interpretation of Results

TABLE (I) SUMMED DIFFERENCES OF OIL SPILL REPORTED DATES ACCORDING TO MONTHS

MONTHS	JAN	FEB	MAR.	APR	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
2015*	23	21	12	25	18	37	27	26	29	20	20	16
MONTHLY OCCURRENCES OF OIL SPILL	8	10	7	11	15	11	15	12	19	7	9	7
AVERAGE MONTHLY OCCURRENCES OF OIL SPILL	2.8	2.1	1.7	2.3	1.2	3.4	1.8	2.2	1.5	2.9	2.2	2.3
2016*	22	17	26	1	27	26	29	19	18	21	29	20
MONTHLY OCCURRENCES OF OIL SPILL	8	8	9	1	7	6	10	4	6	6	6	3
AVERAGE MONTHLY OCCURRENCES OF OIL SPILL	2.8	2.1	2.9	1	3.9	4.3	2.9	4.8	3	3.5	4.8	6.7
2017*	18	20	26	24	12	27	27	30	17	20	16	7
MONTHLY OCCURRENCES OF OIL SPILL	6	6	11	8	4	9	11	7	5	4	5	7
AVERAGE MONTHLY OCCURRENCES OF OIL SPILL	3	3.3	2.4	3	3	3	2.5	4.3	3.4	5	3.2	1
2018*	25	24	28	26	29	20	27	30	12			
MONTHLY OCCURRENCES OF OIL SPILL	10	9	9	12	14	18	14	10	8			
AVERAGE MONTHLY OCCURRENCES OF OIL SPILL	2.5	2.7	3.1		2.2	1.1	1.9	3	1.5			

*** represents the summed monthly differences**

The table above represents the summed differences of oil spill date according to months, the second row represents the monthly occurrences of oil spill and the third row is for the average monthly occurrences of oil spill. From the table (i) above, one can see that in the year 2016 precisely in April, there was just one incident of oil spill reported, thus, the differences remain as one. On an average, it can also be seen that on the maximum that oil spill incident can occur just approximately 6.7 which to the nearest whole number is 7, i.e. weekly. This implies that in a month, on an average, oil spill incident in the Niger Delta occurs approximately one week or less before the next occurrence.

TABLE (II) THE FREQUENCY TABLE OF TRANSITION STATES OF REPORTED DATES OF OIL SPILLAGES

YR	OCED/ OCED	OCED/ OCLD	OCED/O CMD	OCLD/ OCED	OCLD/ OCLD	OCLD/O CMD	OCMD/ OCED	OCMD/ OCLD	OCMD/ OCMD
2015	2	3	1	4	0	0	1	0	1
2016	1	4	0	5	2	0	0	0	0
2017	2	3	0	4	1	0	0	1	1
2018	0	4	0	4	1	0	0	0	0

From the table (ii) above, one can see the switching of states with respect to the different years. The zeros signify that there are no switches from a particular state, say in 2015, occurrence of oil spill in a later date (OCLD) to occurrence in a maintained date (OCMD). This implies that in the year 2015, oil spill incident left a later date it entered initially and switched to another state but this particular state is a maintained date, still in the same year 2015, the maintained date remained still in that state and didn't

switch but just once. See also the occurrence in an earlier date to still an earlier date. For instance, if the spill happened on 1/8/18 and again on 3/8/18, the difference is 2, and on 10/8/18, the difference from 3/8/18 to 10/8/18, the difference is 7, one would discover that from 2 to 7, it is from an earlier occurrence to later occurrence but if the difference, say 2 to 7 to 7 then from 7 to 7 is maintained.

TABLE (III) TRANSITION PROBABILITIES OF REPORTED DATES OF SPILLAGES IN THE NIGER DELTA

YR	OCED/ OCED	OCED/ OCLD	OCED/O CMD	OCLD/ OCED	OCLD/ OCLD	OCLD/O CMD	OCMD/ OCED	OCMD/ OCLD	OCMD/ OCMD
2015	0.33	0.5	0.17	1	0	0	0.5	0	0.5
2016	0.2	0.8	0	0.71	0.29	0	0	0	0
2017	0.4	0.6	0	0.8	0.2	0	0	0.5	0.5
2018	0	1	0	0.8	0.2	0	0	0	0

From table (iii) above, the transition probabilities show that the switches from one state to the other though varies but one can see that in the year 2018, with probability 0.8, that is 80% switch of oil occurrence in a later date to a state of occurrence in an earlier date, thus, the switching rate is high. From OCLD to OCLD is 20%, that is 0.2, though low but not maintained long in that state so it switches fast and hardly remains in a particular state for long. In the year 2017, 71% switches from OCLD to OCED is also high. This implies that the differences in the dates moves faster from an earlier date or say a date of lower difference to a new date of higher difference and this assertion supports the earlier table on average monthly occurrences.

Conclusion and Recommendation

Nigeria, is a country blessed with natural resources but major issues like oil spillage shouldn't be left unattended to. From this study, it can be seen that the health and environs of the residents and indigenes of the Niger Delta region are not in good shape. The frequent and steady occurrences of oil spill incident in that region is very high and thus the switches are also high. It takes approximately less than or one week on an average for a reported oil spill incident to be announced and in a month, the occurrences on a maximum is 19 times (see 2015, September) and as low as a day before another report of oil spill is been announced. The Federal government should work hand in hand with the environmental agencies to enforce the already existing laws as regards oil spill management and thus bring to book all the perpetrators of these criminal act except this is done and some persons are used as scape goats for others to learn. The federal government should also liaise with the joint investigation personnel to ensure that the issue of oil spillage is a thing of the past.

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