# A STOCHASTIC MODEL FOR PREDICTING NUMBER OF FIRE ACCIDENT OCCURRENCE IN NIGER STATE

**BY**


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**MTech/SPS/2018/8942**

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**A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF TECHNOLOGY (MTech) IN APPLIED MATHEMATICS**

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## ABSTRACT

Fires are one of the most complex issues that many communities face, as they can cause serious environmental hazards and havoc.Fire outbreaks could be very complicated to quench, yet we cannot totally avoid fire accidents as they (fire) can be ignited from different sources, thereby exposing lives and properties to destruction. The thrust of this research is to provide the government with reliable models to curb the number of fire accidents that occur in order to reduce the loss of lives and property. A stochastic model that predicts the number of fire accident occurrences in Niger State is presented in this thesis. A three-state stochastic model was formulated using the principle of Markov. Each state of the model has four possible observations. The parameters of the model were estimated using the fire accident data collected from the archive of the Niger State Fire Service, after which the model was trained using the Baum-Welch Algorithm to achieve maximum likelihood. The validity test for the model showed 75% accuracy for short-time prediction and 50% accuracy for long-time prediction. This result indicates that the model is more reliable and dependable for short-time prediction. Information for this model could serve as a guide to the government in policy formulation that might assist in curbing the number of fire accident occurrences in the State.

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## LIST OF ABBREVIATION/ GLOSSARIES

| | |
|---|---|
| NECOM | New England Conservatorium of Music |
| NITEL | Nigeria Telecommunication Limited |
| NEMA | National Emergency Management Agency |
| LGA | Local Government Area |
| PHCN | Power Holding Company of Nigeria |
| GWR | Geographically Weighted Regression |
| FSI | Fire Simulation Interface |
| FSM | Fire Simulation Module |
| CFD | Computational Fluid Dynamics |
| LNG | Liquefied Natural Gas |
| LES | Large Eddy Simulations |
| FDS | Fire Dynamics Simulations |
| N | Number of States in the Model |
| M | Number of Distinct Observation Symbols per State |
| $Q = q_1, q_2, q_3, \ldots q_T$ | State Sequence of Length $T$ Taking Values from $S$, |
| $O = o_1, o_2, o_3, \ldots o_T$ | An Observation Sequence Consisting of $T$ |
| $A = \{a_{ij}\}$ | A Transition Probability Matrix $A$, |
| $B = \{b_j(o_t)\}$ | A Sequence of Observation Probability Matrix |
| $\pi = \{\pi_1, \pi_2, \cdots \pi_N\}$ | The Initial Probability Distribution |
| HMM | Hidden Markov Model |
| $\lambda = \{A, B, \pi\}$ | The Complete Paramteter Set of the HMM |
| $\delta t(i)$ | The Highest Joint Probability of a State Sequence Ending |

| | |
|---|---|
| | in qt = $si$ and a Partial Observation Sequence Ending in $o_t$ given $\lambda$ |
| $\psi_t(j)$ | The State $s_i$ at time t which gives us $\delta t(j)$,used for Backtracking |
| $\gamma_t(i, j)$ | The Joint Probability of $q_t = s_i$ and $q_{t+1} = s_j$ given O and $\lambda$ |
| $\alpha_t(i)$ | The Joint Probability of $\{o1, o2, ..., ot\}$ and $qt = s_i$ Given $\lambda$, |
| $\beta_t(i)$ | The Joint Probability of $\{ot+1, ot+2, ..., oT\}$and $q_t = s_i$ given |
| $\gamma_t(i)$ | The Probability of $q_t = s_i$ given O and $\lambda$ |

# CHAPTER ONE

# 1.0 INTRODUCTION

## 1.1 Background to the Study

Fire is the rapid oxidation of a material in the exothermic chemical process of combustion, releasing heat, light, and various reaction products (Charles, 2000). Fires start when a flammable and/or a combustible material, in combination with a sufficient quantity of an oxidizer such as oxygen gas or another oxygen-rich compound is exposed to a source of heat or ambient temperature above the flash point for the fuel and is able to sustain a rate of rapid oxidation that produces a chain reaction (Yusuf, 2012).

Fires are both natural and social phenomena that cause extensive harm to societies in terms of human lives, economic losses, and operational costs (Corcoran *et al*., 2011; Corcoran and Higgs, 2013; Jennings, 2013; Spatenkova and Virrantaus 2013). Fires also affect communities, their livelihoods and productivity, and can create serious damage and havoc to urban infrastructure, reserved or unreserved (Jennings, 2013 and Corcoran *et al*., 2007). All types of fire that are residential fires pose the greatest risk to human lives and the surrounding environment because of their high likelihood to lead to fatal consequences (Ceyhan *et al*., 2013).

The complexity of people's behaviour at an individual and collective level in cities has made fire risk extremely complicated to model and theorize (Corcoran *et al.* 2011; Jennings, 2013; Spatenkova and Virrantaus, 2013). While the number of studies have been increasing in recent years, the current knowledge about the spatial aspects of fire risk is still limited to a few studies mostly from developed countries, such as the United Kingdom (UK), Australia, Canada, Sweden and Finland (Corcoran *et al.* 2007; Chhetri *et al.*, 2010; Asgary *et al.* 2010; Corcoran *et al.*, 2011; Spatenkova and Virrantaus 2013; Wuschke *et al.* 2013; Guldaker *et al.* 2018; Ardianto and Chhetri 2019).

Cases of fire outbreaks in Nigeria have become a perennial problem. This is, indeed, worrisome. Generally, fires are initiated with a single fuel object. The smoke produced from the burning object is transported by a smoke plume and collects the upper portion of the space as a layer. The smoke plume also transports the heat produced by the fire into the smoke layer, causing the smoke layer to increase in depth and also temperature (Charles, 2000). This smoke layer radiates energy back to unburned fuels in the space, causing them to increase in temperature. Fire spreads to other objects either by radiation from flames attached to the originally burning item or from the smoke layer. As other objects ignite, the temperature of the smoke layer increases further, radiating more heat to other objects (Charles, 2000). In small compartments, the unburned objects may ignite nearly simultaneously. This situation is called flashover. In large compartments, it is more likely that objects will ignite sequentially. The sequence of the ignition depends on the fuel arrangement and composition and ventilation available to support combustion of available fuels (Charles, 2000). Dry weather has been identified as the major cause of the recent spate of incidents while storing of petrol in living houses and markets, careless disposal of cigarette stubs, adulterated fuel, power surge, electric sparks and illegal connection of electricity are all sources of fire outbreaks. Many people have faulted the responsiveness of fire services and emergency first responders in the country, who have been reputed to always arrive late and without sufficient equipment to the scene of fire incidents. There have also been renewed calls for the federal and state governments to adequately fund the fire department and emergency agencies, while the culture of insuring properties is not imbibed by Lagos residents to mitigate the damage and misery of the misfortune (Yusuf, 2012).

In 1983 the fire outbreak in New England Conservatorium of Music (NECOM) house, a 37 storey structure housing, the then Nigerian Telecommunication Limited (NITEL) in Lagos. The fire started mysteriously and the havoc was tremendous. The loss was mostly on the property as it was learnt fire started in one of the nights of the year. It cost the Federal government colossal amount of money to renovate the building, not to talk of the vital document lost in the inferno. The Pipe line explosion in Jesse, Delta State occurs according to National Emergency Management, Agency (NEMA) in October 18, 1998 which accounted for the highest number of casualties with 1082 person's dead and hundreds injured. Also there was a multiple bomb explosion at the Nigerian military cantonment, Lagos: This occurred on January 27, 2002, which left up to 800 persons dead and thousands homeless. Pipe line explosion, Abule Egba (Lagos): This occurred in December 26, 2006. Up to 700 persons lost their lives and several undefined persons injured. Frequent fire accidents in the year 2012, in Abuja, the Federal capital: Not fewer than 69 persons were killed in the fire incidents and property worth 765 million naira was also destroyed during the period (extract from the Federal fire service magazine). Various fire accidents in Rivers State have also been recorded in 2012, and no fewer than 230 persons died while 73 others received various degrees of injuries in 222 recorded fire incidents that occurred in Port Harcourt and other parts of the state. Numerous fire accidents in Osun and Gombe States: in Osun State fire incidents claimed 31 lives and destroyed property worth 227 million naira in 2012. Also the same year in Gombe State, fire killed about 60 persons and damaged property worth 790 million naira.

In 2016, fire disaster accident occurred in Lapai Local Government Area (LGA) of Niger State. It was reported that the fire was caused by Power Holding Company of Nigeria (PHCN) when they restored power with a powerful output (current) that led to fire outbreak incident that destroy properties worth millions of naira despite no life was lost. It was not long ago that a similar sad incident happened in Maitumbi area of Bosso LGA, lives and properties worth millions of naira were also lost.

### 1.2 Statement of the Research Problem

The outbreak of fire in Niger State and some other parts of the country is one of the challenging situation faced by inhabitants of this geographical location as in most cases lives and properties worth millions of naira are lost. Fire accident could be very difficult to combat as it can emanate from diverse source . Prediction of fire accident has been a challenging task to researchers for several decades,because its occurrance is Stochastic in nature. It is based on this note, that Hidden Markov Model is been adopted to predict the number of fire accident occurence in Niger State with the view of providing the government with information to mitigate the impact of fire accident occurrence in the State.

### 1.3 Aim and Objectives of Study

The aim of this research is to develop a Stochastic model for the prediction of number of fire accident occurrence in Niger State, with a view of providing necessary model to the policy makers in mitigatig the impact of fire accident occurrences.

The Objectives are to:

i. develop Hidden Markov Model for the prediction of fire accident occurrence.

ii. train the developed Hidden Markov Model using Baum-Welch Algorithm.

iii. make prediction with the trained Hidden Markov Model using Viterbi Algorithm.

## 1.4 Significance of the Study

Fire accident is one of the most complex issues faced by lots of communities,as it could lead to serious environment hazard and havoc. Fire outbreak could be very complicated to quench, yet we cannot totally avoid fire accident as it (fire) can be ignited through different sources and thereby exposing lives and properties to destruction. However, in recent times, fire occurrence has gained more attention in combating.Hence, the results from this model will provide more understanding in fire accident occurrence within the years.

## 1.5 Scope and Limitation of the Study

This thesis focuses on the application of Hidden Markov Model via Viterbi Algorithm to predict fire accident occurences in Niger State. However, the model can be valid with data application of other States as well.

## 1.6 Definition of terms

### 1.6.1 Mathematical model

A mathematical model can be defined as a description of a system using mathematical concepts and language to facilitate proper explaination of a system and the process of developing a methematical model is termed mathematical modelling. It can also be view usually to describes a system by a set of variables and a set of equation that establish relationships between the variable. It can also be viewed as a way of capturing or representing reality within the frame work of mathematical apparatus that helps in understanding the reality better.

### 1.6.2 Markov chain

A Markov chain is a discrete-time stochastic model describing a sequence of possible events in which the probability of each event depends only on the state attained in the previous event.

### 1.6.3 Markov process

A Markov process is the continuous-time version of a Markov Chain. A Markov process is a random process in which the future is independent of the past, give the present.

### 1.6.4 State space

The state space of a dynamical system is a set of all possible state of the system each coordinate is state variable and the value of all the state variable completely describe the state of the system. In other word, each point in the state space corresponds to different state of the system. The State space is a collection of all possible values of random variable.These state may be continuous or discrete comprise of finite or countable numbers or numerical values. A set of data is said to be continuous if it can conceivaably assume any numerical value within any two point on a continuum (Lawal, 2017).

### 1.6.5 Hidden markov model

A Hidden Markov Model consists of two(double) stochastic processes. The first stochastic process is a Markov chain that is characterized by states and transition probabilities. The states of the chain are externally not visible, therefore “hidden”. The second stochastic process produces emissions observable at each moment, depending on a state-dependent probability distribution. It is important to notice that the denomination “hidden” while defining a Hidden Markov Model is referred to the states of the Markov chain, not to the parameters of the model.

### 1.6.6 Stochastic model

A Stochastic model is a tool for estimating probability distributions of potential outcomes by allowing for random variation in one or more inputs over time.

### 1.6.7 Stochastic process

A stochastic process is a collection of random variables X $\{X_t : t \in T\}$ defined on a common probability space,taking value in a common set S, ( the state space) and indexed by a set T, often either N or$(0,\infty)$ and thought of as time (discrete or continuous respectively) (Oh, 2015).

### 1.6.8 Transient state

A State $i$ is said be transient if given that in state $i$, there is a non-zero probability that we will never return to $i$. Formally, let the random variable $T_i$ be the first return time to state. A state $i$, is said to be transient if and only if, starting from state $i$, is a positive probability that the process may not eventually return this state (Lawal, 2017).

### 1.6.9 Prediction

Prediction is the process of making forecast of the future based on the past and present data and most commonly by analysis of trends. A common place example maybe estimated of some variable of interest at some specified future data (Murali and Vijayalakshmi, 2014).

### 1.6.10 Dynamic programming

Dynamic Programming is way of solving a complex problem by first breaking down the problem into a collection of simpler subproblems, after which those subproblems are solved just once and the results are stored in a memory based data struture. The next time the subproblem is met, instead of recomputing its solution, the previously computed solution is used, thereby saving computational time.

### 1.6.11 Deterministic model

Deterministic means that, random phenomena are not involved. Deterministic model is a mathematical model in which outcomes are precisely determine through known relationships among states and events, without any room for random variation. In these models, the parameter values and the initial conditions determined the output. In comparison, stochastic models use ranges of values for variables in the form of probability distribution.

# CHAPTER TWO

## 2.0 LITERATURE REVIEW

### 2.1 Fire Initiation

Fires start when a flammable or a combustible material, in combination with a sufficient quantity of an oxidizer such as oxygen gas or another oxygen-rich compound, is exposed to a source of heat or ambient temperature above the blaze point for the fuel/oxidizer mix, and is able to sustain a rate of rapid oxidation that produces a chain reaction (Murali and Vijayalakshmi, 2014). This is commonly called the fire tetrahedron. Fire cannot exist without all of these elements in place and in the right proportions. Some fuel oxygen mixes may require a catalyst, a substance that is not directly involved in any chemical reaction during combustion, but which enables the reactants to combust more readily. Once ignited, a chain reaction takes place whereby fires can sustain its own heat by the further release of heat energy in the process of combustion and may propagate, provided there is a continuous supply of an oxidizer and fuel. If the oxidizer is oxygen from the surrounding air, the presence of a force of gravity, caused by acceleration, is necessary to produce convection, which removes combustion products and brings a supply of oxygen to the fire. Without gravity, a fire rapidly surrounds itself with its own combustion products and non-oxidizing gases from the air, which exclude oxygen and extinguish it (Nnabuko, 2015).

Fire is one of the most common production safety accidents. The trend of fire can be mastered by analyzing the historical data**.** Prominent among the methods of predicting are based on models which employ regression, time series or stochastic approaches. The prediction of fire accidents is an important component of fire management decision-making process. However, fire accidents are influenced by many complex factors, such as environment, climate, fire investment, public's fire safety consciousness and so on, the statistic data of fire accidents always take on the characteristic of both randomicity and fluctuation, so it is quite important to select an appropriate forecasting method, Many researches around the world, had proposed several methods in atttempt to provide information that could enable humanity to prevent or reduce fire accident occurance. Some of the researchers are reported as follows.

## 2.2 Review of Related Materials

Keane *et al.* (2013) conducted a research on Fire Severity Mapping System for Real-Time Fire Management Applications and Long-Term Planning. Accurate, consistent, and timely fire severity maps are needed in all phases of fire management including planning, managing, and rehabilitating wildfires.The problem is that fire severity maps developed from satellite imagery are difficult to use for planning wildfire responses before a fire has actually happened and can't be used for real-time wildfire management because of the timing of the imagery delivery. The objective of the research was to blend many fire severity mapping approaches that will help meet demands from fire and other natural resource managers for accurate and rapid assessment of spatial fire severity given time, funding, and resource constraints. Also, China fire services in 2012 modelled Fire Risk Assessment of Residential Buildings Based on Fire Statistics from China by considering incidence of fire from 1991 to 2001. From their analysis , it was noted that the spatial temporal and causal fire incident data for the last six years have been analysed to gain an understanding of fire characteristics and the elements affecting fire risks. It was found that the number of fires was observed to be higher during cold winter months, and fires were more frequent during the weekend. The number of fires was lower during night time, whereas the number of fire deaths between midnight and 4a.m. was much higher than at other times of the day. Most fire incidents occurred in residential buildings. In economically developed East China, the fire situation is much more serious. Electrical failures and improper use of fire in daily life were major causes of fire incidents. Based on the statistical data from China's fire services and the China Statistical Year book, the risk of occupant deaths and the risk of direct property loss are calculated to express the risk level in residential buildings. It was found that the risk of occupant deaths had a declining trend over the years. Statistics is considered a useful tool for learning from the actual events , and it helps decision makers develop proactive fire protection measures to reduce fatalities and financial losses caused by fires.

Also Shin (2015) studied how design fires can be used in Fire Hazard Analysis. Many countries have introduced, or are planning to introduce in the near future, performance and aim based codes by the use of engineering analysis of fire development and occupant evacuation of the performance and aim based code were considered and the level of safety provided to the occupants in a building by a particular fire safety design were assessed Central to this performance based on the approach that was used for a suitable design fires that can characterize typical fire growth in a fire compartment. The research gave description of what features of design fires needed and how they can help analyse fire hazards to the occupants in a building as a result of smoke movement, untenable state in the stairs , and occupant response and evacuation.

Asante (2012) used regression analysis to study Fire Outbreaks in Assin North Municipality. The analysis sought to identify the five main causes of fire outbreaks (electrical, commercial, domestic, bush fire and institutional) and determine its effect on quarterly total number of fire outbreaks and develop implementation control and precaution system. The study was based on cases in Assin North Municipality Fire Outbreaks and covered ten years quarterly period from 2001 to 2010.During the analytical stages of the project, it was realized that the data obtained defined the assumption of the normal distribution. From the analysis, it was concluded that, the five variables( electrical, commercial, domestic, bush fire and institutional) were the best predictors of the quarterly total number of fire outbreaks and the researcher recommended that there should be intense education on fire outbreak in the country at large and also urge people that call the fire service helpline to fake fire outbreaks to stop in order for Ghana Fire Service to embark on their duties professionally and efficiently.

Ardianto (2018) used the Geographically Weighted Regression (GWR) in his doctoral dissertation to study local spatial drivers of residential fires in Melbourne, Australia. Ardianto (2018) found, for example, that owning an apartment increased fire risk more in the eastern Melbourne and decreased it in the central business district. Results indicate that the explanatory variables show great variability not only in their predictive outcome, but also in their intensity and direction across the study area. Overall, these studies prove that residential fires are nonstationary, and the GWR is able to address this problem and to find spatial variations in the study area (Spatenkova and Virrantaus 2013; Ardianto 2018).

Shin *et al*. (2014) selected the priority of fire and explosion danger of chemical material, and presented guidance, supervision and safety education method for disaster prevention of middle and small scale site after analyze the prevention data of the fire and explosion disaster. Shin (2015) presented that cause of welding, heater and electric power as current situation each principle factor of fire explosion is 78%, and suggested transmission and distribution, machine facility and chemical products as cause material. Oh (2015) has studied fire disaster factors of 7 major industries and to establish a preventive measure with special reference to apartment building project. For this purpose, countermeasure was planned by analyzing disaster cases and preventive measure was suggested by figuring out progression of work, risk factors of fire by industrial type and inflammable and combustible materials. As mentioned above, research about fire accident cause analysis have studies that have only analyzed fire cause material and each work process. However, there has not been a study that analyzed a variety cause of fire accident (as time, season and official management and so on.). Therefore, this study aims to analyze the cause of fire accident based on the collected data of news accrued in construction site using big data analysis method.

Pantousa (2017), developed a Fire-Structure Interface (FSI) simplified dual-layer model. The model calculates the temporal evolution of the gas-temperature in the fire compartment in every virtual zone which is divided in two layers (hot and cold layer).

Sakurahara *et al.* (2018), developed an integrated probabilistic risk assessment methodological framework for Fire PRA. The Fire Simulation Module (FSM), includes state-of-the-art models of fire initiation, fire progression, post-fire failure damage propagation, fire brigade response, and scenario-based damage is used in simulation using a computational fluid dynamics (CFD) code, fire dynamics simulator.

Nilson *et al.* (2015) conducted some computational simulations and experiments. The comparisons showed that the fire diameter and geometry of the enclosure influence the grid size. Fire dynamic simulator were reliable for far field temperature predictions when grid sizes of up to half the fire diameter were used. For near field predictions, the models require a finer grid size to meet more accurate predictions.

Jujuly *et al.* (2015), conducted a three-dimensional Computational Fluid Dynamics (CFD) simulation of Liquefied Natural Gas (LNG) pool fire using ANSYS CFX-14. The CFD model solves the fundamental governing equations of fluid dynamics, namely, the continuity, momentum and energy equations. Several built-in sub-models are used to capture the characteristics of pool fire.

Maragkos *et al.* (2017), compared Large Eddy Simulations (LES) using advanced modelling approaches related to thermophysical, turbulence and combustion modelling, with some of the standard models used in the fire community. A comparison between the predictions of the new and the standard models available in the code against experimental data, it is identified that the predictions with the advanced modelling approaches are qualitatively and quantitatively better when compare to the standard models in the code.

According to Kacem *et al*. (2016), developed an in-depth pyrolysis model of a semi-transparent solid fuel (PMMA) with in-depth radiation and a moving gas/solid interface which was coupled with a CFD code including turbulence, combustion and radiation for the gas phase.

However, only a few studies adopted numerical simulation of fire in the fire accident investigation. A representative example in this regard is the National Institute of Standards and Technology of the US, which has used FDS in assisting the investigation on some typical fire cases. For instance, it simulated the fire taking place in a single-story timber-structured night club in Rhode Island in February, 2003, demonstrating the consistency between the results of Fire Dynamics Simulator (FDS) numerical simulation and the results of full-scale fire experiment and exhibiting the role of firefighting facilities in fire control under equal conditions.

# CHAPTER THREE

## 3.0 MATERIALS AND METHOD

### 3.1 Study Area and Data Source

The data used in this research work were collected from the archive of Niger State Fire service for the period of 8 years (2013 – 2020). Niger state with a population of 5,556,247 million people (National population commission, 2020) is located in the North central zone along the Middle Belt region of Nigeria. It is classified as one of the largest states in the country (in terms of landmarks), spanning over 86,000 $km^2$ in land area.

### 3.2 Hidden Markov Model

A Hidden Markov Model consists of two(double) stochastic processes. The first stochastic process is a Markov chain that is characterized by states and transition probabilities. The states of the chain are externally not visible, therefore "hidden". The second stochastic process produces emissions observable at each moment, depending on a state-dependent probability distribution. It is important to notice that the denomination "hidden" while defining a Hidden Markov Model is referred to the states of the Markov chain, not to the parameters of the model.

#### 3.2.1 Characteristics of hidden markov model

Hidden Markov Model is characterized by the following

N= number of states in the model

M= number of distinct observation symbols per state

Q = a state sequence of length $T$ taking values from $S$,

$$Q = q_1, q_2, q_3, \ldots q_T \tag{3.1}$$

$$O = o_1, o_2, o_3, \ldots o_T \tag{3.2}$$

$O$ = an observation sequence consisting of $T$ observations, taking values from the discrete

$A = \{a_{ij}\}$, a transition probability matrix $A$, where each $a_{ij}$ represents the probability of moving from state $s_i$ to state $s_j$, with $\sum_{J=1}^{N} a_{ij} = 1$

$B = \{b_j(o_t)\}$, observation probability matrix

where

$b_j(o_t) = p(o_t \mid q_t = s_j)$ is the probability that the symbol $O_t$ is emitted when the system is in state $s_j$

If the observation is continuous a probability density function is used as follows:

$$\int_{-\infty}^{+\infty} b_j(x)dx = 1 \tag{3.3}$$

$\pi = \{\pi_j\}$ is the initial probability distribution, where $\pi_i$ indicates the probability of starting in state $s_i$ .

Also,

$$\sum_{i=1}^{N} \pi_i = 1$$

The Hidden Markov Model (HMM) is denoted by

$$\lambda = (\mathrm{A}, \mathrm{B}, \pi) \tag{3.4}$$

### 3.2.2 Three fundamental problems of hidden markov model

According to Rabiner, 1989 and Lawal, 2017, three fundamental problems of HMM are as follows:

**Problem 1-Evaluation:** Given the complete parameter set $\lambda$ and an observation sequence $O = \{o_1, o_2, ..., o_T\}$, determine the likelihood $P(O \mid \lambda)$.

**Problem 2 – Decoding:** Given the complete parameter set $\lambda$ and an observation Sequence $O = \{o_1, o_2, ..., o_T\}$, determine the best hidden states sequence

$Q = \{q_1, q_2, ...q_T\}$.

**Problem 3 – Training:** Given the observation sequence

$O = \{o_1, o_2 ...o_T\}$,

How to estimate the parameters $\lambda = (A_r, B_r, \pi_r)$ of the HMM?

This is the model $\lambda^* = (\hat{A}, \hat{B}, \hat{\pi})$ that maximizes the probability of

$O = \{o_1, o_2, ..., o_T\}$.

#### *3.2.2.1 Solution to problem 1 (evaluation)*

This is an evaluation problem, which means that given a model and a sequence of observations, what is the probability that the observations was generated by the model.

This information can be very valuable when choosing between different models wanting to know which one that best matches the observations.

To find a solution to problem 1, the probability of a given observation sequence, $O=\left(o_1,o_2,....o_T\right)$ given the model $\lambda=(\mathrm{A},\mathrm{B},\pi)$ was calculated. In other words, $P(O \mid \lambda)$ was obtained. The most intuitive way of doing this, is to enumerate every possible state sequence of length T. then, the state sequence is given as

$$Q=\{q_1,q_2,..q_T\} \tag{3.5}$$

Where $q_1$ is the initial state the probability of observation sequence $O$ given a state sequence in equation (3.6)

$$P(O/Q,\lambda)=\prod_{t=1}^{T} p(o_t/q_{t,}\lambda) \tag{3.6}$$

By definition of B we obtain

$$P(O \mid Q,\lambda)=P(o_T \mid o_1,...o_{T-1},Q,\lambda)P(o_1,...,o_{T-1} \mid Q,\lambda) \tag{3.7}$$

$$P(O \mid Q,\lambda)=P(o_T \mid q_T,\lambda)P(o_1,...,o_{T-1} \mid Q,\lambda)$$

$$\prod_{t=1}^{T} P(o_t \mid q_t,\lambda)=b_{q_1}(o_1)b_{q_2}(o_2)........b_{q_T}(o_T) \tag{3.8}$$

And by the definition of $\Pi$ and $A$ it follows as:

$$P(Q \mid \lambda)=P(q_1)\prod_{t=2}^{T} P(q_t \mid q_{t-1})=\pi_{q_1}a_{q_1q_2}a_{q_2q_3}.....a_{q_{T-1}q_T} \tag{3.9}$$

The joint probability of O and Q, the probability that O and Q occurs simultaneously, is simply the product of equation (3.8) and (3.9) as

$$P(O \mid Q,\lambda)P(Q \mid \lambda) = \frac{P(O \cap Q \cap \lambda)}{P(O \cap \lambda)} . \frac{P(Q \cap \lambda)}{P(\lambda)} = \frac{P(Q \cap Q \cap \lambda)}{P(\lambda)} \tag{3.10}$$

$$P(O,Q \mid \lambda) = P(O \mid Q,\lambda)P(Q \mid \lambda) \tag{3.11}$$

$$P(O,Q \mid \lambda) = P(q_1)\prod_{t=2}^{T} P(q_t \mid q_{t-1})\prod_{t=1}^{T} P(o_t \mid q_t)$$

$$= \pi_{q_1} b_{q_1}(o_1) a_{q_1 q_2} b_{q_1}(o_2) .... a_{q_{T-1} q_T} b_{q_T}(o_T) \tag{3.12}$$

Equation (3.12) says that at the initial time $t = 1$ are in state $q_1$ with probability $\pi_{q_1}$, and generate the observation $o_1$ with probability $b_{q_1}(o)$. As time ticks from $t$ *to* $t + 1$( $t = 2$) the transform from state $q_1$ to $q_2$ with probability of $a_{q1q2}$, and generate observation $o_2$ with probability $b_{q_2}(o_2)$ and so on until $t = T$.

Equation (3.12) is the joint probability of equation (3.8) and equation (3.9).

Hence, we obtain this

$$P(O \mid \lambda) = \sum_{all} P(O,Q \mid \lambda) = \sum_{Q} P(O \mid Q,\lambda)P(Q \mid \lambda) \tag{3.13}$$

This procedure involves a total of $2TN^T$ calculations, which makes it infeasible, even for small values of N and T. Therefor it is needed to find a more efficient way of calculating $P(O|\lambda)$. Such a procedure exists and is called the Forward-Backward Procedure. For initiation the forward variable is defined as:

$$\alpha_t(i) = P(o_1, o_2, .., o_t, q_t = s_i \mid \lambda) \tag{3.14}$$

In other words, the probability of the partial observation sequence, $o_1, o_2, \ldots, o_t$ until time $t$ and given state $s_i$ at time $t$. $\alpha_t(i)$ can be inductively solved as follows: Initialization.

$$\alpha_1(i) = P(o_1, q_1 = s_i \mid \lambda) \tag{3.15}$$

$$\alpha_1(i) = \pi_i b_{ri}(o_1) \tag{3.16}$$

$$\alpha_{t+1}(j) = P(o_1, o_2, ..., o_{t+1}, q_{t+1} = s_j \mid \lambda) \tag{3.17}$$

$$= P(o_1, o_2, ..., o_{t+1}, q_{t+1} = s_j \mid \lambda) P(q_{t+1} = s_j \mid \lambda)$$

$$= P(o_1, o_2, ..., o_t \mid q_{t+1} = s_j, \lambda) P(o_{t+1} \mid q_{t+1} = s_j, \lambda) P(q_{t+1} = s_j \mid \lambda)$$

$$= P(o_1, o_2, ..., o_t, q_{t+1} = s_j \mid \lambda) b_{rj}(o_{t+1})$$

$$= b_j(o_{t+1}) \sum_i P(o_1, o_2, ...., o_t, q_t = s_i, q_{t+1} = s_j \mid \lambda)$$

$$= b_j(o_{t+1}) \sum_i P(o_1, o_2, ...., o_t, q_{t+1} = s_j \mid q_t = s_i, \lambda) P(q_t = s_i \mid \lambda)$$

$$= b_j(o_{t+1}) \sum_i P(o_1, o_2, ...., o_t, \mid q_t = s_i, \lambda) P(q_{t+1} = s_j \mid q_t = s_i, \lambda) P(q_t = s_i, \lambda)$$

$$= b_j(o_{t+1}) \sum_i P(o_1, o_2, ...., o_t, \mid q_t = s_i, \lambda) q_{ij} P(q_t = s_i, \lambda)$$

$$= b_j(o_{t+1}) \sum_i P(o_1, o_2, ...., o_t, \mid q_t = s_i, \lambda) q_{ij}$$

$$\alpha_{t+1}(j) = \sum_i \alpha_t(i) q_{ij} b_j(o_{t+1}) \quad \text{(Lawal, 2017)} \tag{3.18}$$

From equation (3.18) it can be observed that the probability of the observation sequence can be calculated as:

$$P(O \mid \lambda) = \sum_{i=1}^{N} P(O, q_T = s_i \mid \lambda) \tag{3.19}$$

Termination:

$$P(O \mid \lambda) = \sum_{i=1}^{N} \alpha_T(i) \tag{3.20}$$

Step 1 sets the forward probability to the joint probability of state $s_j$ and initial observation $o_1$. The second step, which is the heart of the forward calculation is illustrated in figure 3.1.

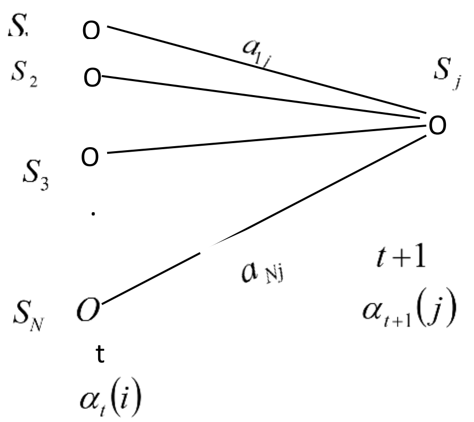


**Figure 3.1:** Diagram of forward probability
(Rabiner, 1989)

Figure 3.1 Illustration of the sequence of operations required for the computation of the forward variable $\alpha_t(i)$.

It can be see that state $s_j$ at time $t+1$ can be reached from $N$ different states at time $t$.

By summing the product over all possible states $s_i, 1 \leq i \leq N$ at time t results in the probability of $s_j$ at time $t+1$ with all previous observations in consideration. Once it is calculated for $s_j$, it is easy to see that $\alpha_{t+1}(j)$ is obtained by accounting for observation $o_{t+1}$ in state $s_j$, in other words by multiplying the summed value by the probability $b_j(o_{t+1})$ .The computation of (3.18) is performed for all states $s_j, 1 \leq j \leq N$, for a given time $t$ and iterated for all $t = 1, 2, ., t-1$. Step 3 then gives $P(O|\lambda)$ by summing the terminal forward variables $\alpha_T(i)$ . This is the case because, by definition

$$\alpha_t(i) = P(o_1, o_2, .., o_t, q_t = s_i \mid \lambda)$$

And therefore, $P(O|\lambda)$ is just the sum of the $\alpha_T(i)$ 's.

$$P(O \mid \lambda) = \sum_{i=1}^{N} \alpha_T(i)$$

In a similar manner, it can be consider a backward variable, $\beta_t(i)$ defined as follows

$$\beta_t(i) = P(o_{t+1}, ...o_T \mid q_t = s_i, \lambda) \tag{3.21}$$

$\beta_t(i)$ Is the probability of the partial observation sequence from t +1 to the last time, T, given the state $s_i$ at time $t$ and the HMM $\lambda$. By using induction, $\beta_t(i)$ is found as follows:

Initialization:

$$\beta_T(i) = 1 \tag{3.22}$$

Induction:

$$\beta_t(i) = P(o_{t+1}, ...o_T \mid q_t = s_i, \lambda)$$

$$\beta_t(i) = \sum_j P(o_{t+1}, ...., o_T, q_{t+1} = s_j \mid q_t = s_i, \lambda) \tag{3.22}$$

$$\beta_t(i) = \sum_j P(o_{t+1},..,o_T \mid q_{t+1} = s_j, \lambda) P(q_{t+1} = s_j \mid q_t = s_i, \lambda)$$

$$\beta_t(i) = \sum_j P(o_{t+1} \mid q_{t+1} = s_j, q_t = s_i, \lambda) P(q_{t+2},..., o_T \mid q_{t+1} = s_j, q_t = s_i, \lambda) a_{ij}$$

$$\beta_t(i) = \sum_j P(o_{t+1} \mid q_{t+1} = s_j, \lambda) P(q_{t+2},..., o_T \mid q_{t+1} = s_j, \lambda) a_{ij}$$

$$\beta_t(i) = \sum_j P(o_{t+1} \mid q_{t+1} = s_j, q_t = s_i, \lambda) P(q_{t+2},..., o_T \mid q_{t+1} = s_j, q_t = s_i, \lambda) a_{ij}$$

$$\beta_t(i) = \sum_j a_{r\,ij} b_{r\,j}(o_{t+1}) \beta_{t+1}(j) \tag{3.23}$$

Step 1 defines $\beta_T(i)$ to be for all $s_i$. Step 2, which is illustrated in figure 3.2, shows that in order to have been in state $s_i$ at time $t$, and to account for the observation sequence from time $t+1$ and on, it can consider all possible states $s_j$ at time $t+1$, accounting for the transition from $s_i$ to $s_j$ as well as the observation $o_{t+1}$ in state $s_j$, and then account for the remaining partial observation sequence from state $s_j$ (Lawal, 2017).

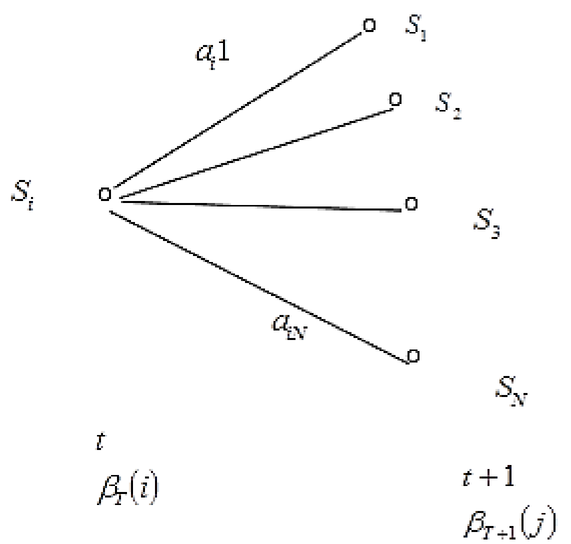


**Figure 3.2:** Diagram of backward probability
(Rabinar,1989)

The Figure 3.2 Illustration of the sequence of operations required for the computation of the backward variable $\beta_t(i)$. As mentioned before the backward variable is not used to find the probability $P(O|\lambda)$. Later on it will be shown how the backward as well as the forward calculation are used extensively to help to solve the second as well as the third fundamental problem of HMMs.

#### *3.2.2.2 Solution to problem 2 (decoding)*

In this second problem, attempt to find the 'correct' hidden path that is, trying to uncover the hidden path. This is often used when we want to learn about the structure of the model or to get highest state sequences.

There are several ways of finding the "highest" state sequence according to a given observation sequence. The difficulty lies in the definition of an highest state sequence. One possible way is to find the states $q_t$ which are individually most likely. This criteria maximizes the total number of correct states. To be able to implement this as a solution to the second problem we start by defining the variable

$$\gamma_t(i) = P(q_t = s_i \mid o, \lambda) \tag{3.24}$$

Which gives the probability of being in state $s_i$ at time $t$ given the observation sequence, O, and the model $\lambda$. Equation (3.24) can be expressed using the forward and backward variables, $\alpha_t(i)$ and $\beta_t(i)$ as follows:

$$\gamma_t(i) = \frac{P(O \mid q_t = s_i, \lambda)P(q_t = s_i)}{P(O \mid \lambda)}$$

$$= \frac{P(o_1,..., o_t \mid q_t = s_i, \lambda) P(o_{t+1},..., o_T \mid q_t = s_i, \lambda)}{\sum_j P(o, q_t = s_i \mid \lambda)}$$

$$= \frac{P(o_1,..o_t, q_t = s_i \mid \lambda) P(o_{t+1}....o_T \mid q_t = s_i)}{\sum_j P(o \mid q_t = s_j, \lambda) P(q_t = s_j \mid \lambda)}$$

$$\therefore \gamma_t(i) = \frac{\alpha_t(i)\beta_t(i)}{\sum_j \alpha_t(j)\beta_t(j)}$$

(Lawal, 2017) (3.25)

It is simple to see that $\gamma_t(i)$ is a true probability measure. Since $\alpha_t(i)$ accounts for the partial observation sequence $o_1, o_2, ...o_T$ and the state $s_i$ at time $t$, while $\beta_t(i)$ accounts for the remainder of the observation sequence $o_{t+1}, o_{t+2},.., o_T$ given state $s_i$ at time $t$. The normalization factor $P(O|\lambda)$ = $\sum_{i=1}^{N} \alpha_t(i)\beta_t(i)$ makes $\gamma_t(i)$ a probability measure, which means that

$$\sum_{i=1}^{N} \gamma_t(i) = 1. \tag{3.26}$$

We can now find the individually most likely state $q_t$ at time $t$ by using $\gamma_t(i)$ as follows:

$$q_t = \arg\max \ 1 \le i \le N[\gamma_t(i)], 1 \le t \le T. \tag{3.27}$$

Although equation (3.27) maximizes the expected number of correct states there could be some problems with the resulting state sequence. For example, when the HMM has state transitions which has zero probability the highest state sequence may, in fact, not even be a valid state sequence. This is due to the fact that the solution of equation (3.27) simply determines the most likely state at every instant, without regard to the probability of occurrence of sequences of states.

To solve this problem we could modify the optimality criterion. For example, by solving for the state sequence that maximizes the number of correct pairs of states $(q_t, q_{t+1})$ or triples of states $(q_t, q_{t+1}, q_{t+2})$.

The most widely used criterion however, is to find the single best state sequence, in other words to maximize $P(Q|O,\lambda)$ which is equivalent to maximizing $P(Q,O|\lambda)$. To find the highest state sequence use a method, based on dynamic programming, called the 'VITERBI ALGORITHM' which is often used.

To find the best state sequence $Q = \{q_1, q_2, ..., q_T\}$ for a given observation sequence $O = \{o_1, o_2, ...., o_T\}$, we need to define the variable.

$$\delta_t(i) = \max P[q_1, q_2, ...., q_{t-1},, q_t = i, o_1, o_2, ...., o_t \mid \lambda] \tag{3.28}$$

Which means the highest probability along a single path, at time $t$, which accounts for the first $t$ observation and ends in state $s_i$. By induction we have:

$$\delta_{t+1}(j) = [\max i\delta_t(i)a_{ij}]b_j(o_{t+1}) \tag{3.29}$$

To be able to retrieve the state sequence, we need to keep track of the argument which maximized equation (3.29) for each $t$ and $j$. This is done via the array $\psi_t(j)$. The complete procedure for finding the best state sequence can now be stated as follows:

Initialization:

$$\delta_t(i) = \pi_{ri} b_{ri}(o_1),$$
$$\psi_1(i) = 0 \forall_i$$

Recursion $(t = 2..........T)$

$$\delta_t(j) = \max_i \delta_{t-1}(i) a_{rij} b_{rj}(o_t),$$

$$\psi_t(j) = \arg\max_i \delta_{t-1}(i) a_{rij} \tag{3.30}$$

Termination:

$$P* = max\ 1 \le i \le N[\delta T(i)]$$

$$q_T^{*} = \arg\max_i \delta_T(i)$$

Path (state sequence) backtracking

$$q_T^{*} = \psi_{t+1}(q^{*}_{t+1}), t = T-1, T-2, ....1 \tag{3.31}$$

The variable $\psi_t(j)$ keeps track of the optimal state at time $t-1$ if the state at time $t$ is $j$. Once the best state at time $T$ is known (which is $q^{*}_T$), the optimal path can be retrieved by backtracking the variable $\psi$ (Lawal, 2017)

#### ***3.2.2.3 Solution to problem 3 (training)***

This is training process and it involves the adjustment of the model parameter to best fit the observations. In general, the goal of learning is to calculate $\lambda^*$ that maximizes the likelihood $P(O \mid \lambda)$ of the sample of training sequence, using the Baum-Welch Algorithm, we define $\gamma_t(i, j)$ as the probability of being $s_i$ at time t and $s_j$ at time $t+1$, given the whole observation $O$ and the model $\lambda$, that is

$$\gamma_t(i, j) = P(q_t = s_i, q_{t+1} = s_j \mid O, \lambda) \tag{3.32}$$

The needed information for the variable $\gamma_t(i, j)$ is shown in figure 3.3.

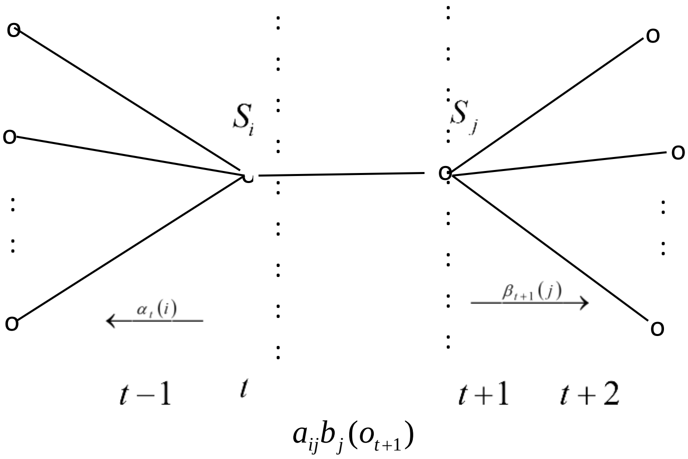


**Figure 3.3:** Diagram of forward and backward variables (Rabinar,1989)

The Figure 3.3 Illustration of the sequence of operations required for the computation of the joint event that the system is in state $s_i$ at time $t$ and state $s_j$ at time $t+1$. From this figure one should be able to understand that $\gamma_t(i, j)$ can be written using the forward and backward variables as follows:

$$\gamma_t(i, j) = \frac{P(O \mid q_t = s_i, q_{t+1} = s_j, \lambda)P(q_t = s_i, q_{t+1} = s_j, \lambda)}{P(O \mid \lambda)} \tag{3.33}$$

$$= \frac{P(O \mid q_t = s_i, q_{t+1} = s_j, \lambda)P(q_{t+1} = s_j \mid q_t = s_i, \lambda)P(q_t = s_i \mid \lambda)}{P(O \mid \lambda)}$$

$$= \frac{P(o_1,...,o_t \mid q_t = s_i, \lambda)P(o_{t+1} \mid q_{t+1} = s_j, \lambda)P(o_{t+1},..,o_T \mid q_{t+1} = s_j, \lambda)a_{ij}P(q_t = s_j \mid \lambda)}{P(O \mid \lambda)} \tag{3.34}$$

$$= \frac{P(o_1, o_2,.., o_t q_t = s_i \mid \lambda)P(o_{t+1} \mid q_{t+1} = s_j, \lambda)P(o_{t+1},.., o_T \mid q_{t+1} = s_j, \lambda)a_{rij}}{\sum_{i=1}^{N}\sum_{j=1}^{N}\alpha_t(i)a_{rij}b_{rj}(o_{t+1})\beta_{t+1}(j)} \tag{3.35}$$

$$\therefore \gamma_t(i,j) = \frac{\alpha_t(i) a_{rij} b_{rj}(o_{t+1}) \beta_{t+1}(j)}{\sum_{i=1}^{N}\sum_{j=1}^{N} \alpha_t(i) a_{rij} b_{rj}(o_{t+1}) \beta_{t+1}(j)} \qquad (3.36)$$

(Lawal ,2017)

Also the probability measure since the numerator is simply $P(q_t = s_i, q_{t+1} = s_j, O/\lambda)$ and denominator is $P(O|\lambda)$, as described in equation (3.25), $\gamma_t(i)$ is the probability of being in state $s_i$ at time t, given the observation sequence and the model. Therefore, there is a close relationship between $\gamma_t(i)$ and $\gamma_t(i,j)$. We can express $\gamma_t(i)$ as the sum of all $\gamma_t(i,j)$ over all existing states as follows:

$$\gamma_t(i) = \sum_{j=1}^{N} \gamma_t(i,j) \qquad (3.37)$$

By summing $\gamma_t(i)$ is the expected number of visits to state $S_i$ at a time$t$, and $\gamma_t(i,j)$ is the expected number of transition from $S_i$ at time $t$ to $s_j$ at time $t+1$.

Using equation (3.4), (3.14), (3.21), (3.24) and (3.32), the Baum-Welch Algorithm follow as:

The Baum-Welch Algorithm

1. Initialize $\lambda = (A, B, \pi)$
2. Calculate $\alpha_t(i)\, and\ \beta_t(i)\ for\ all\ t, i$
3. Calculate $\gamma_t(i,j)\, and\ \gamma_t(i)\, for\ all\ t$
4. Estimation of the model parameters $A, B, \pi$ for the HMM is as follows:

$$\hat{\pi}_i = \gamma_i(i) \qquad (3.38)$$

$$\hat{a}_{ij} = \frac{\sum_{t=i}^{T-1} \gamma_t(i, j)}{\sum_{t=1}^{T-1} \gamma_t(i)} \qquad (3.39)$$

$$\hat{b}_j(m) = \frac{\sum_{t=1}^{T} \gamma_t(j)\{o_t = v_m\}}{\sum_{t=1}^{T} \gamma_t(j)} \qquad (3.40)$$

Repeat Step 2 until convergence

where

$\sum_{t=1}^{T-1} \gamma_t(i) =$ Expected number of transition from state $i$

$\sum_{t=1}^{T-1} \gamma_t(i, j) =$ Expected number of transitions from state $i$ to state $j$

$$\hat{a}_{ij} = \frac{\sum_{t=1}^{T-1} \gamma_t(i, j)}{\sum_{t=1}^{T-1} \gamma_t(i)}$$

With the above definition, one can then outline the Baum-Welch Re-estimation formula as follows.

$\hat{\pi}_i =$ Expected frequency in state $i$ at time $t = 1$

$$= \gamma_t(i) \qquad (3.41)$$

$$\hat{a}_{ij} = \frac{expected\ number\ of\ transition\ from\ state\ i\ to\ state\ j}{expected\ number\ of\ transitions\ from\ state\ i} \qquad (3.42)$$

$$\hat{b}_j(m) = \frac{expected\ number\ of\ times\ in\ state\ j\ and\ observing\ m_v}{expected\ number\ of\ times\ in\ state\ j} \quad (3.43)$$

$$\hat{b}_j(m) = \frac{\sum_{t=1}^{T} \gamma_t(j)\{o_t = v_{m_v}\}}{\sum_{t=1}^{T} \gamma_t(j)}$$ (Lawal, 2017) and (Rabiner, 1989).

We should see that, from equation (3.38) can be interpreted as the frequency in state $s_i$ at time $t+1$, also from Equation (3.39) should be interpreted as the expected number of transitions from state $s_i$ to $s_j$ divided by the number of transitions from state $s_i$. And finally, equation (3.40) can be seen as the expected number of times in state $s_j$ and observing the symbol $m$, divided by the expected number of times in state $s_j$. If the current HMM is defined as $\lambda = \{A, B, \pi\}$ and used to compute the right hand side of equation (3.38) to equation (3.40), and at the same time re-estimation HMM can be defined as $\hat{\lambda} = \{\hat{A}, \hat{B}, \hat{\pi}\}$ determined from the left hand side of equation (3.38) to equation (3.40) it has been proven that either

1. The initial model $\lambda$ defines a critical point of the likelihood function, in which case $\hat{\lambda} = \lambda$ or 2. Model $\hat{\lambda}$ is more likely than model $\lambda$ in the sense that $P(O \mid \hat{\lambda}) > P(O \mid \lambda)$, which means that one have found a new model $\hat{\lambda}$ from which the observation sequence is more likely to have been produced.

An iterative re-estimation process, replacing λ with $\hat{\lambda}$ can be done to a certain extent, until some limiting point is reached. The final result of this re-estimation procedure is called a maximum likelihood estimation of the HMM. The problem, earlier discussed is that the forward-backward algorithm only leads to a local maximum. For most applications the optimization surface is very complex and has many local maxima. The re-estimation formulas of equation (3.38) to equation (3.40) can be derived directly from Baum´s auxiliary function (Rabinar,1989).

$$Q(\lambda,\hat{\lambda}) = \sum_{Q} P(Q/O,\lambda)\log[P(O,Q/\lambda)] \tag{3.44}$$

By maximizing over $\hat{\lambda}$. It has been proven that maximization of $Q(\lambda,\hat{\lambda})$ leads to an increasing likelihood as follows:

$$\lambda[Q(\lambda,\hat{\lambda})] \Rightarrow P(O/\lambda) \geq P(O/\hat{\lambda}) \tag{3.45}$$

An important aspect of the re-estimation procedure is that the stochastic constraints of the HMM parameters, namely

$$\sum_{i=1}^{N} \hat{\pi}_I = 1 \tag{3.46}$$

$$\sum_{J=1}^{N} \hat{a}_{ij} = 1 \tag{3.47}$$

$$\sum_{k=1}^{N} \hat{b}_j(v_k) = 1 \tag{3.48}$$

Are automatically satisfied at each iteration (Rabinar,1989).

## 3.3 Hidden Markov Model for Prediction of Fire Accident Occurrence

### 3.3.1 Model formulation

Fire accidents are influence by many complex factors such as environment, climate, Fire investment, public fire safety consciousness and so on, the statistic data of fire accidents always take on the characteristic of both randomicity and fluctuations (Sun and Mao, 2011). Since the fire accident occurrence depends on these factors and these factors are not static both varies along the quarters of the year this means that, the number of occurrence of fire accident also varies along the quarters of the year. This situation is stochastic in nature and of the double type. This means that the number of occurrence of fire accident in each quarter of the years varies and the factor influencing the occurrence of the fire accident also varies among the quarters of the year. In general, fire accident occurrence among quarters of the year is a double stochastic process. It is based on this that HMM is being adopted to model the number of fire accident occurrence in Niger State.

Now, Let the number of fire accident occurrence within the quarters of the year be taking as the state of the model and the factors influencing fire accident occurrence within the quarters be taking as emission of the Hidden Markov Model, hence we have the following model assumptions

(i) The transition between the states is governed by first order Markov dependency as represented in equation (3.49)

$$P\{X_{n+1} = j \mid X_0 = i_0, ..., X_{n-2} = i_{n-2}, X_{n-1} = i_{n-1}, X_n = i\} = P_{ij} \tag{3.49}$$

(ii) The probability of generating current observation symbol depends on current state, as represented by equation (3.50)

$$P(O \mid Q, \lambda) = \prod_{t=1}^{T} P(o_t \mid q_t, \lambda) \tag{3.50}$$

(iii) The number of fire accident occurrence in a year is considered to be low, if it is less than 83

(iv) The number of fire accident occurrence in a year is considered to be moderate, if it is within the range (83 - 159)

(v) The number of fire accident occurrence in a year is considered to be high, if it is above 159

Hence, we have the following states and observations for the Hidden Markov Model of fire accident occurrence prediction in Niger state

State 1: Low Fire accident occurrence

State 2: Moderate Fire accident occurrence

State 3: High Fire accident occurrence

Observations:

$Q_1 = O_1$ = First Quarter (January to March)

$Q_2 = O_2$ = Second Quarter (April to June)

$Q_3 = O_3$ = Third Quarter (July to September)

$Q_4 = O_4$ =Fourth Quarter (October to December)

The classification of states and the observations, and the assumption made in this work are based on the study area and the data obtained.

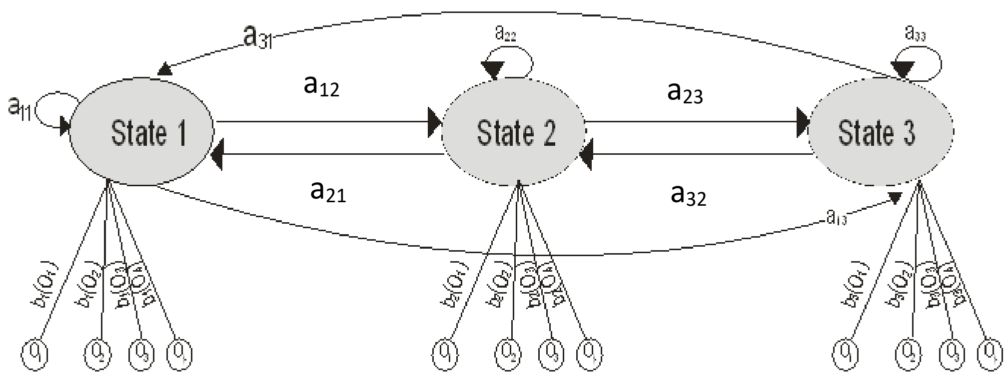


**Figure 3.4:** Transition diagram of the fire accident occurrence model

The following are the possible emission from figure 3.4

**State 1: Emissions**

$b_1(o_1) = p(o_1 \text{ at } t|q_1 \text{ at } t)$ $b_1(o_2) = P(o_2 \text{ at } t|q_1 \text{ at } t)$

$b_1(o_3) = P(o_3 \text{ at } t|q_1 \text{ at } t)$ $b_1(o_4) = p(o_4 \text{ at } t|q_1 \text{ at } t)$

**State 2: Emissions**

$b_2(o_1) = P(o_1 \text{ at } t|q_2 \text{ at } t)$ $b_2(o_2) = P(o_2 \text{ at } t|q_2 \text{ at } t)$

$b_2(o_3) = p(o_3 \text{ at } t|q_2 \text{ at } t)$ $b_2(o_4) = p(o_4 \text{ at } t|q_2 \text{ at } t)$

**State 3: emissions**

$b_3(o_1) = P(o_1 \text{ at } t|q_3 \text{ at } t)$ $b_3(o_3) = p(o_3 \text{ at } t|q_3 \text{ at } t)$

$b_3(o_2) = P(o_2 \text{ at } t|q_3 \text{ at } t)$ $b_3(o_4) = p(o_4 \text{ at } t|q_3 \text{ at } t)$

### 3.3.2 Transition probability matrix

The transition between the states are represented by equation (3.51)

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \tag{3.51}$$

### 3.3.3 Observation probability matrix

The matrix below represents observation emitted from the model

$$B = \begin{bmatrix} b_1(O_1) & b_1(O_2) & b_1(O_3) & b_1(O_4) \\ b_2(O_1) & b_2(O_2) & b_2(O_3) & b_2(O_4) \\ b_3(O_1) & b_3(O_2) & b_3(O_3) & b_3(O_4) \end{bmatrix} \tag{3.52}$$

### 3.3.4 Initial probability distribution

The initial probability distribution for the model is given below

$$\pi = [\pi_1, \pi_2, \pi_3] \tag{3.53}$$

### 3.3.5 The hidden markov model for fire accident occurrence

The general Hidden Markov Model for the number of fire accident occurrence prediction is given by the compact notation in equation (3.54)

$$\lambda = (\mathrm{A}, \mathrm{B}, \pi) \tag{3.54}$$

### 3.3.6 Hidden markov model training

The Hidden Markov Model for fire Accident Occurrence developed will be trained using Baum Welch Algorithm introduced in section 3.2.2.3. This will enable the model to better understand the previous recorded information. At the end of the training, the new hidden Markov model $\lambda^*$ will best fit the observed data. The Viterbi algorithm will then make predictions with better accuracy.

## CHAPTER FOUR

## 4.0 RESULTS AND DISCUSSION

### 4.1 Application of the Hidden Markov Model for Prediction of Number of Fire accident Occurrence

The formulation of the model is presented in section 3.3. The data used in this illustration was collected from the archive of Niger State Fire Service for the period of 8 years (2013-2020). The raw data is shown in appendix A - H and the summary is presented in Table 4.1 below.

**Table 4.1: Summary of State and Observation of Fire Occurrence for a Period of Eight Years**

| Years | States | Observations |
|---|---|---|
| 2013 | 1 (L) | ($Q_1$) |
| | 1(L) | ($Q_2$) |
| | 1(L) | ($Q_3$) |
| | 1(L) | ($Q_4$) |
| 2014 | 1(L) | ($Q_1$) |
| | 1(L) | ($Q_2$) |
| | 1(L) | ($Q_3$) |
| | 1(L) | ($Q_4$) |
| 2015 | 1(L) | ($Q_1$) |
| | 1(L) | ($Q_2$) |
| | 1(L) | ($Q_3$) |
| | 1(L) | ($Q_4$) |
| 2016 | 1(L) | ($Q_1$) |
| | 1(L) | ($Q_2$) |

| | | |
|---|---|---|
| | 1(L) | $(Q_3)$ |
| | 1(L) | $(O_4)$ |
| 2017 | 2(M) | $(Q_1)$ |
| | 1 (L) | $(Q_2)$ |
| | 1(L) | $(Q_3)$ |
| | 1(L) | $(Q_4)$ |
| 2018 | 2(M) | $(Q_1)$ |
| | 1(L) | $(Q_2)$ |
| | 1(L) | $(Q_3)$ |
| | 1(L) | $(Q_4)$ |
| 2019 | 2(M) | $(O_1)$ |
| | 2(M) | $(Q_2)$ |
| | 1(L) | $(Q_3)$ |
| | 2(M) | $(Q_4)$ |
| 2020 | 3(H) | $(Q_1)$ |
| | 2(M) | $(Q_2)$ |
| | 1(L) | $(Q_3)$ |
| | 2(M) | $(Q_4)$ |

**4.2 Validity Test for the Model**

To test for the validity of the model, the parameters of the HMM1 were estimated using the fire accident occurrence data from 2013 to 2017, then make prediction for 2018, 2019 and 2020.

The Transition Count Matrix (C), Pseudo count Transition Matrix (S) and Transition Probability Matrix (A) are given in Equations (4.1), (4.2) and (4.3) respectively.

$$C = \begin{bmatrix} 17 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \tag{4.1}$$

$$S = \begin{bmatrix} 18 & 2 & 1 \\ 2 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} \tag{4.2}$$

$$A = \begin{bmatrix} 0.8571 & 0.0952 & 0.0476 \\ 0.5000 & 0.2500 & 0.2500 \\ 0.3333 & 0.3333 & 0.3333 \end{bmatrix} \tag{4.3}$$

While Observation count matrix (E), Pseudo count Observation matrix (D) and Observation probability matrix (B) are given in equations (4.4), (4.5) and (4.6), respectively.

$$E = \begin{bmatrix} 4 & 5 & 5 & 5 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \tag{4.4}$$

$$D = \begin{bmatrix} 5 & 6 & 6 & 6 \\ 2 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix} \tag{4.5}$$

$$B = \begin{bmatrix} 0.625 & 0.750 & 0.750 & 0.750 \\ 0.250 & 0.125 & 0.125 & 0.125 \\ 0.125 & 0.125 & 0.125 & 0.125 \end{bmatrix} \tag{4.6}$$

The initial state probability distribution is given below

$$\pi = [0.95, 0.05, 0] \tag{4.7}$$

The general HMM1 is represented by equation (4.8)

$$\lambda_1 = (A, B, \pi) \tag{4.8}$$

After 1000 iteration of the Baum Welch Algorithm, The equation (4.8) stabilised to equation(4.9), the equation (4.8) was trained using a built-in Baum algorithm Algorithm function in the Matlab 2015.

$$\lambda_1^* = \left( \hat{A}, \hat{B}, \hat{\pi} \right) \tag{4.9}$$

where

$$\hat{A} = \begin{bmatrix} 0.5556 & 0.4444 & 0.0000 \\ 0.0000 & 0.0000 & 1.0000 \\ 1.0000 & 0.0000 & 0.0000 \end{bmatrix} \tag{4.10}$$

$$\hat{B} = \begin{bmatrix} 0.000 & 0.000 & 0.500 & 0.500 \\ 1.000 & 0.000 & 0.000 & 0.000 \\ 0.000 & 1.000 & 0.000 & 0.000 \end{bmatrix} \tag{4.11}$$

And $\pi =$ [0.95, 0.05, 0] (4.12)

## 4.3 Making Prediction with the Model

From the summary of fire accident data presented in table 4.1, the process is in State 1 at the last Quarter of 2017 (that is with Observation $Q_4$). Now, to obtain the likely state sequence of the process in 2018 given the observation sequence of the year 2018 that is $Q_1$, $Q_2$, $Q_3$ and $Q_4$, we use Viterbi algorithm presented in section(3.2.2.2) as shown in figure 4.1.

To avoid underflow of the Viterbi algorithm, each of the obtained node in the computation process was normalised using the following equations:

$$c_t = \frac{1}{\sum_{t=1}^{N} \alpha_t(i)} \tag{4.13}$$

$$\hat{\alpha}_t(i) = c_t \times \alpha_t(i) = \frac{\alpha_t(i)}{\sum_{t=1}^{N} \alpha_t(i)} \tag{4.14}$$

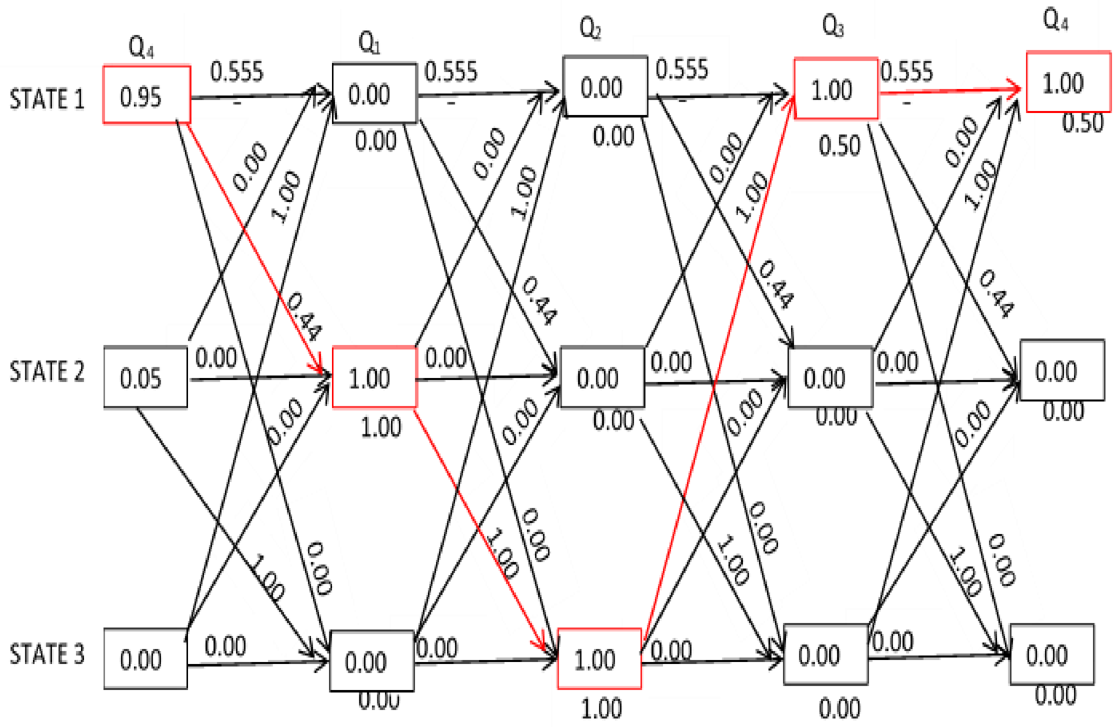


**Figure 4.1:** Viterbi Algorithm for Observation Sequence $Q_4$,$Q_1$,$Q_2$,$Q_3Q_4$

State 1 to state 2, has the highest probability value under $Q_1$ that is, (0.95 x 0.44)1.00=0.4222, normalising this value using equation (4.13) and (4.14) the value 1 was obtained, then move to the next path of computation.

State 2 to state 3, has the highest probability value under $Q_2$ that is (0.05 x 1.00)1.00=0.0500, normalising this value using equation (4.13) and (4.14) the value 1 was obtained , then move to the next path of the computation.

State 3 to state 1, has the highest probability value under $Q_3$ that is (0.95 x 0.55)0.50=0.2639, normalising this value using equation (4.13) and (4.14) the value 1 was obtained, then move to the next path of the computation.

State 1 to state 1, has the highest probability value under $Q_4$ that is, (0.95 x 0.55)0.50=0.2636, normalising this value using equation (4.13) and (4.14) the value 1 was obtained, The results of the computation of figure 4.1 are represented in Table 4.2 below.

**Table 4.2: The Result for 2018 Number of Fire Accident Occurrence Based on Viterbi Algorithm Prediction**

| Year/Months | 2017 | | 2018 | | |
|---|---|---|---|---|---|
| States: | 1 | 2 | 3 | 1 | 1 |
| Observation: | $Q_4$ | $Q_1$ | $Q_2$ | $Q_3$ | $Q_4$ |

Similarly from the calculation of Table 4.2, the process is in State 1 at the last Quarter of 2018 (that is with Observation $Q_4$). Now, to obtain the likely state sequence of the process in 2019 given the observation sequence of the year 2019 that is $Q_1$, $Q_2$, $Q_3$ and $Q_4$, hence the use viterbi algorithm presented in section (3.2.2.2) as shown in figure 4.2.

To avoid underflow of the viterbi algorithm each of the obtained node was normalised in the computation process using the following equations (4.13) and (4.14)

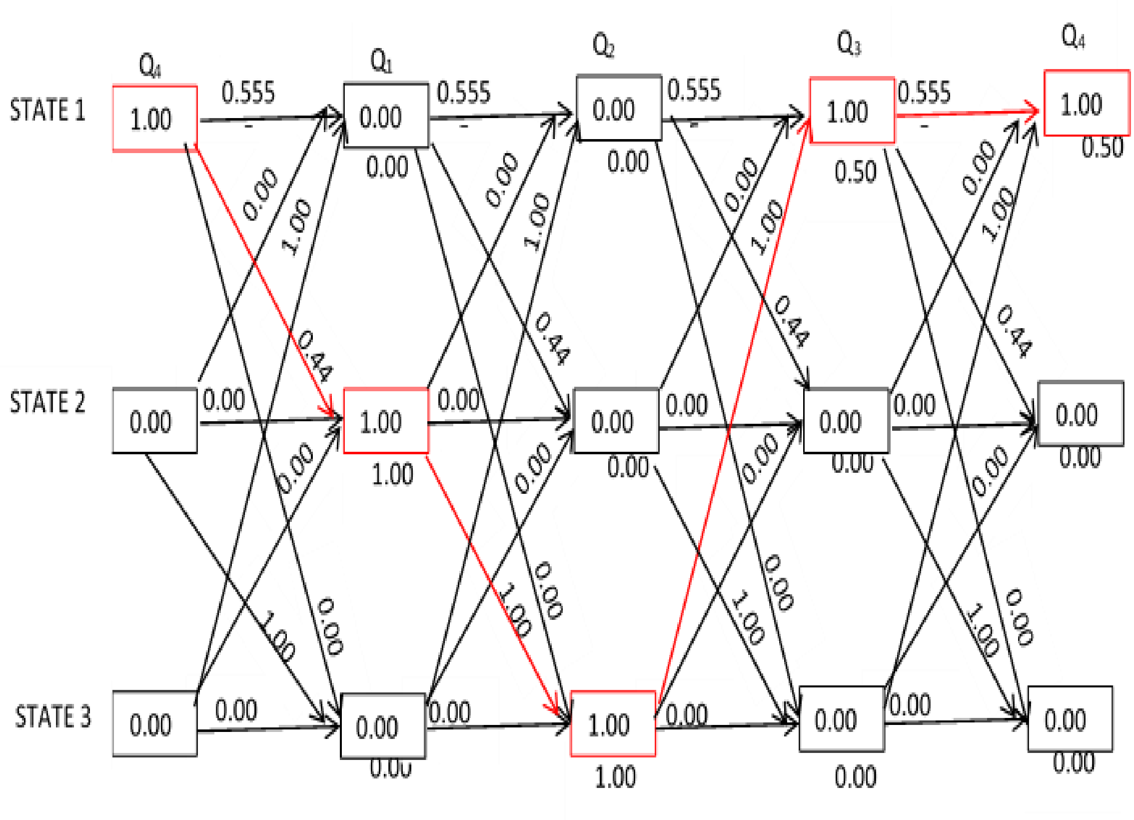


**Figure 4.2:** Viterbi Algorithm for Observation Sequence $Q_4$,$Q_1$,$Q_2$,$Q_3$,$Q_4$

State 1 to State 2, has the highest probability value under $Q_1$ that is (0.444 x 1.00)1.00=0.444, normalising this value using equation (4.13) and (4.14) we obtain the value 1, State 2 to State 3, has the highest probability value under $Q_2$ that is, (1.000x1.000)1.00=1.000, State 3 to state 1, has the highest probability value under $Q_3$ that is, (1.000x1.000)0.50= 0.50, normalising this value using equation (4.13) and (4.14) we obtain the value 1.

State 1 to state 1, has the highest probability value under $Q_4$ that is, (1.000x0.55)0.50 = 0.2775, normalising this value using equation (4.13) and (4.14) we obtain the value 1. The results of the computation of figure 4.2 are represented in Table 4.3.

**Table 4.3: The Result for 2019 Number of Fire Accident Occurrence Based On Viterbi Algorithm Prediction**

| Years | 2019 | | | |
|---|---|---|---|---|
| States | 2 | 3 | 1 | 1 |
| Observation | $Q_1$ | $Q_2$ | $Q_3$ | $Q_4$ |

Similarly, the process is in State 1 at last Quarter of 2019 (that is with Observation $Q_4$). Now, to obtain the next likely state sequence of the process in 2020 given the observation sequence of the year 2020 that is $Q_1$, $Q_2$, $Q_3$ and $Q_4$, we use viterbi algorithm presented in section(3.2.2.2) as shown in figure 4.3.

To avoid underunderflow of the Viterbi algorithm we normalised each of the obtained node in the computation process using the following equations(4.13) and (4.14)

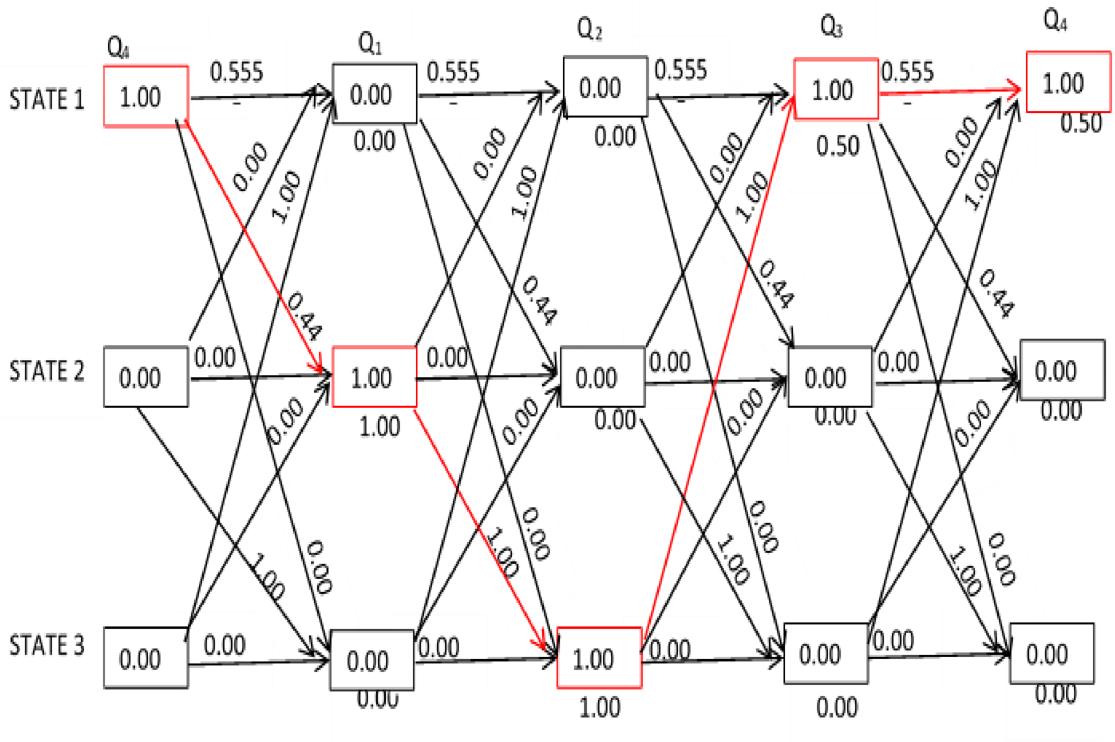


**Figure 4.3:** Viterbi Algorithm from $Q_4Q_1Q_2,Q_3,Q_4$

State 1 to state 2, has the highest probability value under $Q_1$ that is(0.444 x 1.00)1.00=0.444, normalising this value using equation (4.13) and (4.14) we obtain the value 1, State 2 to state 3, has the highest probability value under $Q_2$ that is, (1.000x1.000)1.00=1.000.

State 3 to state 1, has the highest probability value under $Q_3$ that is, (1.000x1.000)0.50= 0.50, normalising this value using equation (4.13) and (4.14) we obtain the value 1, State 1 to state 1, has the highest probability value under $Q_4$ that is, (1.000x0.55)0.50 = 0.2775, normalising this value using equation (4.13) and (4.14) we obtain the value 1,

The results of the computation of figure 4.3 are represented in Table 4.4 below.

**Table 4.4: The Result for 2020 Number of Fire Accident Occurrence Based On Viterbi Algorithm Prediction**

| Year | 2020 | | | |
|---|---|---|---|---|
| States | 2 | 3 | 1 | 1 |
| Observation | $Q_1$ | $Q_2$ | $Q_3$ | $Q_4$ |

In general, the summary of the fire accident occurence is shown in table 4.5

**Table 4.5: Summary of the Fire Accident Occurence**

| Year | 2018 | | | | 2019 | | | | 2020 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| States | 2 | 3 | 1 | 1 | 2 | 3 | 1 | 1 | 2 | 3 | 1 | 1 |
| Observatio | $Q_1$ | $Q_2$ | $Q_3$ | $Q_4$ | $Q_1$ | $Q_2$ | $Q_3$ | $Q_4$ | $Q_1$ | $Q_2$ | $Q_3$ | $Q_4$ |

**Table 4.6: Comparison of the Predicted States and Observations, and the Actual States and Observations from Table 4.1.**

| Year | 2018 | | | | 2019 | | | | 2020 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Actual States | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 2 | 1 | 2 |
| Predicted States | 2 | 3 | 1 | 1 | 2 | 3 | 1 | 1 | 2 | 3 | 1 | 1 |
| Observation | $Q_1$ | $Q_2$ | $Q_3$ | $Q_4$ | $Q_1$ | $Q_2$ | $Q_3$ | $Q_4$ | $Q_1$ | $Q_2$ | $Q_3$ | $Q_4$ |

From the table 4.6, it can be observed that the prediction for 2018 Quarters has 75% accuracy, then 2018 and 2019 Quarter has 62.5% accuracy and lastly for 2018 to 2020 has 50% accuracy. The result of the model clearly showed that, the model performed excellently for short time prediction and performed fairly for long time prediction.

### 4.4 Hidden Markov Model (HMM2) for Future Forecast

HMM2 was developed to predict number of Fire Accident Occurrance for future years, the parameters of the model were determined using Fire Accident Occurrance data from 2013 to 2020 after which the prediction for 2021 and 2022 was done.

Transition Count Matrix

$$C = \begin{bmatrix} 19 & 5 & 0 \\ 4 & 1 & 1 \\ 0 & 1 & 0 \end{bmatrix} \tag{4.13}$$

Pseudo count Transition Matrix

$$S = \begin{bmatrix} 20 & 6 & 1 \\ 5 & 2 & 2 \\ 1 & 2 & 1 \end{bmatrix} \tag{4.14}$$

Transition Probability Matrix

$$A = \begin{bmatrix} 0.7407 & 0.2222 & 0.0370 \\ 0.5555 & 0.2222 & 0.2222 \\ 0.2500 & 0.5000 & 0.2500 \end{bmatrix} \tag{4.15}$$

Observation Count Matrix

$$C = \begin{bmatrix} 4 & 6 & 8 & 6 \\ 3 & 2 & 0 & 2 \\ 1 & 0 & 0 & 0 \end{bmatrix} \tag{4.16}$$

Pseudo count Observation Matrix

$$S = \begin{bmatrix} 5 & 7 & 9 & 7 \\ 4 & 3 & 1 & 3 \\ 2 & 1 & 1 & 1 \end{bmatrix} \tag{4.17}$$

Observation Probability Matrix

$$\mathrm{B} = \begin{bmatrix} 0.4545 & 0.6363 & 0.8181 & 0.6363 \\ 0.3636 & 0.2727 & 0.0909 & 0.2727 \\ 0.1818 & 0.0909 & 0.0909 & 0.0909 \end{bmatrix} \tag{4.18}$$

Initial State Probability

$$\pi = \begin{bmatrix} 0.75 & 0.2187 & 0.0312 \end{bmatrix} \tag{4.19}$$

$$\lambda_2 = (A, \quad B, \quad \pi) \tag{4.20}$$

After 1000 iteration of Baum Welch Algorithm, equation (4.20) stabilized to (4.21)

$$\lambda^* = \left( \hat{A}, \quad \hat{B}, \quad \hat{\pi} \right) \tag{4.21}$$

where

$$\hat{A} = \begin{bmatrix} 0.5333 & 0.4667 & 0.0000 \\ 0.0000 & 0.0000 & 1.0000 \\ 1.0000 & 0.0000 & 0.000 \end{bmatrix} \quad (4.22)$$

$$\hat{B} = \begin{bmatrix} 0.0000 & 0.0000 & 0.6000 & 0.4000 \\ 1.0000 & 0.0000 & 0.0000 & 0.0000 \\ 0.0000 & 1.0000 & 0.0000 & 0.0000 \end{bmatrix} \quad (4.23)$$

$$\hat{\pi} = \begin{bmatrix} 0.75 & 0.2187 & 0.0312 \end{bmatrix} \quad (4.24)$$

The training was done using built-in Baum algorithm Algorithm function in the Matlab 2015.

### 4.4.1 Making prediction for 2021

From the fire accident data presented in table 4.1, the process is in State 2 at the last Quarter of 2020 (that is with Observation $Q_4$). Now, to obtain the likely state sequence of the process in 2021 given the observation sequence of the year 2021 that is $Q_1$, $Q_2$, $Q_3$ and $Q_4$, the viterbi algorithm was used, as presented in section (3.2.2.2) and shown in figure 4.4.

To avoid underflow of the viterbi algorithm each of the obtained node was normalised in the computation process using equations (4.13) and (4.14).

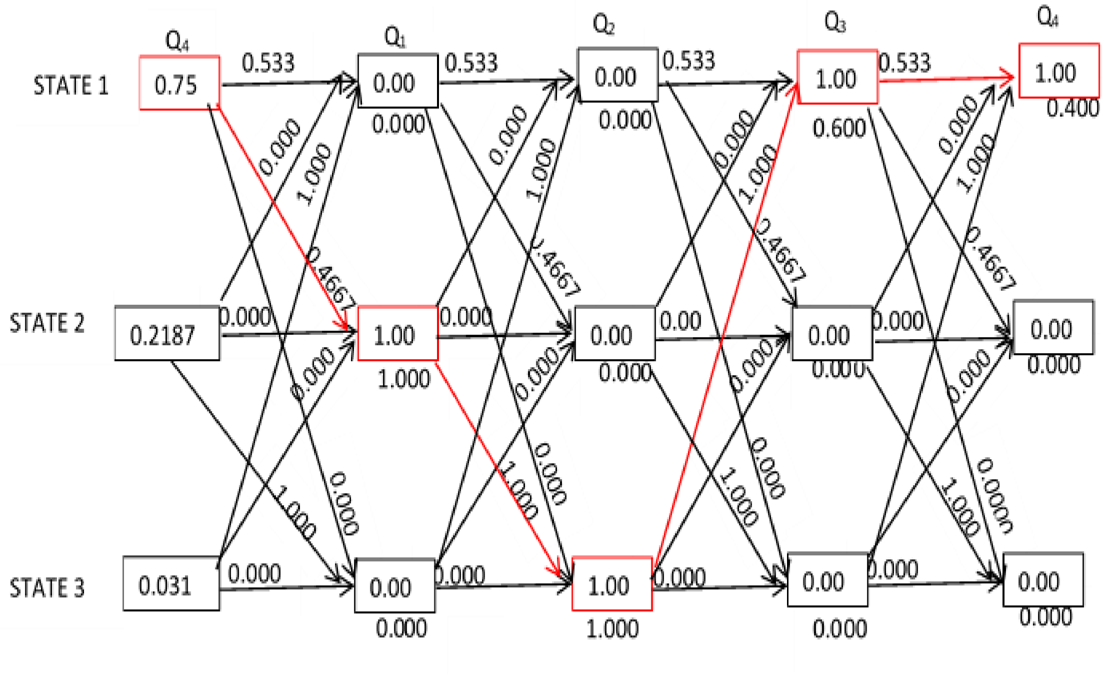


**Figure 4.4:** Viterbi Algorithm for Observation Sequence $Q_4$,$Q_1$,$Q_2$,$Q_3$,$Q_4$

State 1 to state 2, has the highest probability value under $Q_1$ that is, (0.75x0.4667)1.0000 = 0.3500 , normalising this value using equation (4.13) and (4.14) we obtain 1, then we move to the next path of the computation. State 1 to state 3, has the highest probability value under $Q_2$ that is (0.0312x1.0000) 1.0000= 0.0312, normalising this value using equation (4.13) and (4.14) we obtain 1, then we move to the next path of the computation.

State 3 to state 1, has the highest probability value under $Q_1$ that is (0.0312x1.0000)0.6000 = 0.01872, normalising this value using equation (4.13) and (4.14) we obtain 1, then we move to the next path of the computation. State 1 to state 1, has the highest probability value under $Q_4$ that is (0.75x0.5333)0.4000 = 0.1599, normalising this value using equation (4.13) and (4.14) we obtain 1, The results of the computation of figure 4.4 are represented in Table 4.7 below.

**Table 4.7: The Result for 2021 Number of Fire Accident Occurrence Based on Viterbi Algorithm Prediction**

| Year | 2020 | 2021 | | | |
|---|---|---|---|---|---|
| States: | 1 | 2 | 3 | 1 | 1 |
| Observation: | $Q_4$ | $Q_1$ | $Q_2$ | $Q_3$ | $Q_4$ |

### 4.4.2 Making prediction for 2022

Similarly, from the calculation of Table 4.7, the process is in State 1 at the last Quarter of 2021 (that is with Observation $Q_4$). Now, to obtain the likely state sequence of the process in 2022 given the observation sequence of the year 2022 that is $Q_1$, $Q_2$, $Q_3$ and $Q_4$, we use Viterbi algorithm presented in section(3.2.2.2) as shown in figure 4.6.

To avoid underflow of the Viterbi algorithm, we normalised each of the obtained node in the computation process using the following equations (4.13) and (4.14).

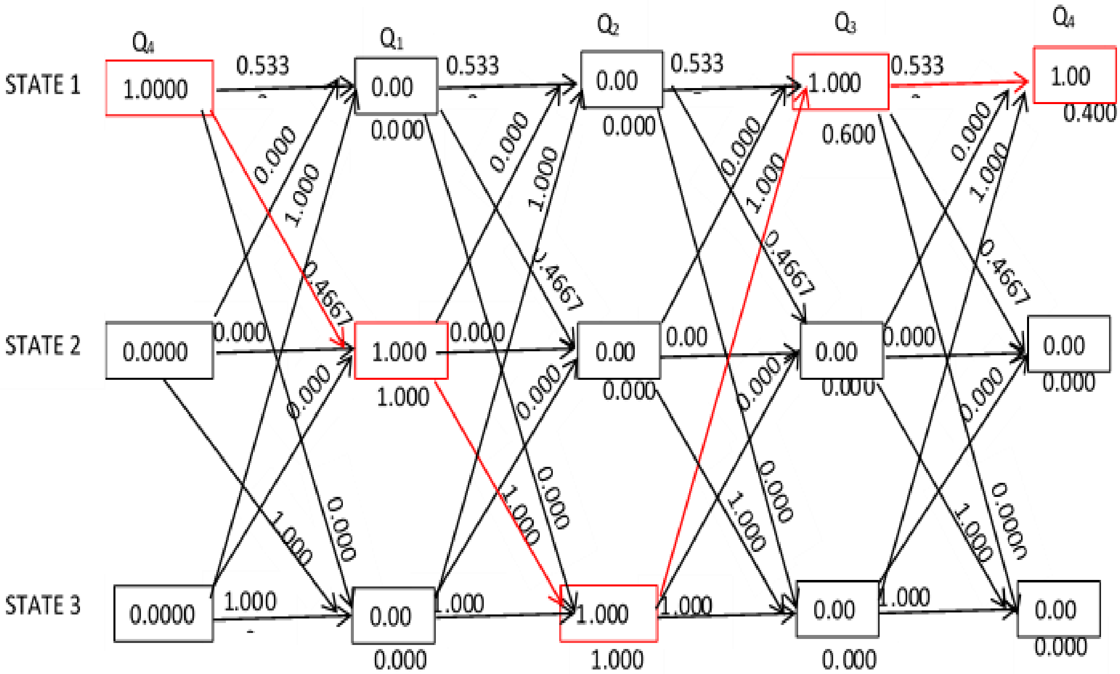


**Figure 4.5:** Viterbi algorithm for Observation Sequence $Q_4$,$Q_1$,$Q_2$,$Q_3$ and $Q_4$

State 1 to state 2, has the highest probability value under $Q_1$ that is, (1.00x0.4667) 1.0000 = 0.4667 , normalising this value using equation (4.13) and (4.14) we obtain 1, then we move to the next path of the computation. State 2 to state 3, has the highest probability value under $Q_2$ that is (1.000x1.0000) 1.0000= 1.0000.

State 3 to state 1 , has the highest probability value under $Q_3$ that is (1.0000x1.0000) 0.6000 = 0.6000, normalising this value using equation (4.13) and (4.14) we obtain 1, then we move to the next path of the computation. State 1 to state 1, has the highest probability value under $Q_4$ that is (1.0000x0.5333) 0.4000 = 0.21332, normalising this value using equation (4.13) and (4.14) we obtain 1, The results of the computation of figure 4.6 are represented in Table 4.8 below.

**Table 4.8: The Result for 2022 Number of Fire Accident Occurrence Based on Viterbi Algorithm Prediction**

| Years | 2022 | | | |
|---|---|---|---|---|
| States | 2 | 3 | 1 | 1 |
| Observation | $Q_1$ | $Q_2$ | $Q_3$ | $Q_4$ |

## 4.5 Discussion of Results

The parameter of the HMM1 were determined using fire Accident Occurrance data from 2013 to 2017. After 1000 iterations of the Baum Welch Algorithm, $\lambda_1$ stabilised to a new model $\lambda_1^{\bullet}$, Viterbi Algorithm was then used to make a prediction for Fire Accident Occurrance for 2018, 2019, and 2020. From the table 4.1, the HMM1 was in state 1 at 2017 last Quarter($Q_4$), It make transition to state 2 in 2018 emitting observation ($Q_1$), then it make move to state 3 emitting observation ($Q_2$), at that point, it also make move to state 1 emitting observation ($Q_3$), it then make move to state 1 emitting observation ($Q_4$). The Validity test for the Quarters of 2018 show 75% Accuracy.

Similary in 2019 the process is in state 2 first Quarter ($Q_1$), then make move to state 3 emitting observation ($Q_2$) , at that point, it also make move to state 1 emitting observation ($Q_3$), it also make move to state 1 emitting observation ($Q_4$). The validity test for 2018 and 2019 Quarters showed 62.5% Accuracy.

Similar interpretation is given in 2020, the process is in state 2 at first Quarter of 2020 ($Q_1$). then it make move to state 3 emitting observation ($Q_2$), at that point, it also make move to state 1 emitting observation ($Q_3$), it also make move to state 1 emitting observation at ($Q_4$), The validity test for 2018, 2019 and 2020 shows 50% Accuracy.

Generally, the result for the validity test showed that the model perform excellently for short time prediction and perform fairly for long time prediction.

For the Future Forcast the parameter of the HMM2 were estimated using Fire Accident Occurrance data from 2013 to 2020. After 1000 iteration of the Baum Welch algorithm $\lambda_2$, stabilised to another model $\lambda_2^{\bullet}$, the Viterbi Algorithm was then used to make prediction for future Quarters. From the table 4.1, the HMM2 was in state 2 last Quarter of 2020, then it make move to state 2 emitting observation ($Q_1$) in 2021 , at that point, it also make move to state 3 emitting observation($Q_2$), it also make move to state 1 emitting observation($Q_3$) it also make move to state 1 emitting observation ($Q_4$) 2021.

Similar interpretation is given to movement in state 2 emitting observation ($Q_1$), at 2022 at that point, it also make move to state 3 emitting observation ($Q_2$), it also make move to state 1 emitting observation ($Q_3$) it also make move to state 1 emitting observation at ($Q_4$) year 2022.

# CHAPTER FIVE

## 5.0 CONCLUSION AND RECOMMENDATIONS

### 5.1 Conclusion

A stochastic model that forcast the number of fire accidents occurrence in Niger State has been developed and implemented in the State. A validity test was conducted on the model for both short and long time prediction. It was observed that, the accuracy of the model decreases as the period of the prediction increases. The short time prediction gave 75% accuracy while the long time prediction gave 50% accuracy. The results indicate that, the model is more reliable for short time prediction. Results from this model could serve as important information to the government for policy formulation that might assist in curbing the number of Fire accident occurrence in the State.

### 5.2 Contribution to Knowledge

In this study, the following contributions were made to knowledge;

(i) A stochastic model was developed and implemented in Niger State for predicting the number of fire accidents occurrence.

(ii) A validity test was established and it was used to conduct both short and long time predictions.

(iii) The thesis established that short time prediction gave 75% accuracy whereas long time prediction gave 50% accuracy.

### 5.3 Recommendations

Based on our findings, we make the following recommendations:

1. The model should be used for short time prediction of maximum of four Quarters (a year). This is because it performs excellently for short time prediction and fairly for long time prediction.
2. The government should routinely enlighten the general public on the prevention of fire accident occurrence especially when high number of fire accident occurrence is predicted in the State.
3. The model developed should be extended by future researchers to capture the emission in a form of continuous observation; this will improve the accuracy of the model in prediction.

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## APPENDIX A

## DATA ON FIRE ACCIDENT OCCURRENCES IN NIGER STATE YEAR, 2013

**FIRST QUARTER**

NIGER STATE FIRE/RESCUE INCIDENT FOR THE MONTH OF JANUARY – MARCH, 2013

| S/NO | | H/Qtrs Bosso Road | Bida | K/gora | Kutigi | Kagara | Lapai | Suleja | Agaie | Kuta | Rijau | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Number of calls | 32 | 2 | - | - | - | - | 5 | - | - | - | 39 |
| 2. | Fire call | 30 | 2 | - | - | - | - | 5 | - | - | - | 37 |
| 3. | Rescue | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 4. | False alarm | 1 | - | - | - | - | - | - | - | - | - | 1 |
| | **Supposed cause** | | | | | | | | | | | |
| 1. | Electric fault | 23 | - | - | - | - | - | 4 | - | - | - | 27 |
| 2. | Bush burning | 3 | - | | | | | 1 | | | | 4 |
| 3. | Candle stick | 1 | 1 | - | - | - | - | - | - | - | - | 2 |
| 4. | Generator | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 5. | Still under investigation | 2 | 1 | - | - | - | - | - | - | - | - | 3 |
| | **Type of Fire** | | | | | | | | | | | |
| 1. | Domestic | 21 | 2 | - | - | - | - | 3 | - | - | - | 26 |
| 2. | Vehicle | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 3. | Bank | 1 | - | | | | | | | | | 1 |
| 4. | Public Schools | 3 | - | - | - | - | - | - | - | - | - | 3 |
| 5. | Public building | 3 | - | - | - | - | - | - | - | - | - | 3 |
| 6. | Shops | 1 | - | - | - | - | - | 2 | - | - | - | 3 |
| | **Casualty** | | | | | | | | | | | |
| 1. | No of live saved | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 2. | Fatally injured | - | - | - | - | - | - | - | - | - | - | - |
| 3. | No of animals saved | - | - | - | - | - | - | - | - | - | - | - |

The estimated lost: **Five Hundred and Six Million, Ninety Eight Thousand Naira Only (N506,098,000.00).**

The estimated saved: **Three Billion, Seven Hundred and Eighty One Million, Seven Hundred Thousand Naira only (N3,781,700,000.00)**

PFS I ISAH M. IBRAHIM
*Senior Fire Prevention Officer*
For: *Director*

SECOND QUARTER

# NIGER STATE FIRE/RESCUE INCIDENT FOR THE MONTH OF APRIL – JUNE, 2013.

| | | HEADQUARTERS BOSSO ROAD | BIDA | KONTAGORA | KUTIGI | KAGARA | LAPAI | SULEJA | AGAIE | KUTA | RIJAU | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Number of calls | 27 | - | - | 2 | - | - | 4 | - | - | - | 53 |
| 2. | Fire calls | 25 | - | - | 2 | - | - | 4 | - | - | - | 31 |
| 3. | Rescue | - | - | - | - | - | - | - | - | - | - | - |
| 4. | False Alarm | 2 | - | - | - | - | - | - | - | - | - | 2 |
| | SUPPOSED CAUSE | | | | | - | - | | - | - | - | - |
| 1. | Electric fault | 18 | - | - | 1 | - | - | 3 | - | - | - | 22 |
| 2. | Bush Burning | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 3. | Candle stick | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 4. | Road traffic accident | - | - | - | 1 | - | - | - | - | - | - | 1 |
| 5 | Still under investigation | 5 | - | - | - | - | | 1 | - | - | - | 6 |
| | TYPES OF FIRE | | | | | | | | | | | |
| 1. | Domestic | 10 | - | - | - | - | - | 3 | - | - | - | 13 |
| 2. | Vehicle | 3 | - | - | - | - | - | - | - | - | - | 3 |
| 3. | Public schools | 3 | - | - | - | - | - | - | - | - | - | 3 |
| 4. | Public Building | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 5. | Electric pole | 3 | - | - | - | - | - | - | - | - | - | 3 |
| 6. | Shop | 3 | - | - | - | - | - | - | - | - | - | 3 |
| 7. | Petrol tanker | - | | - | 2 | - | - | 1 | - | - | - | 3 |
| 8. | Church | 1 | - | - | - | - | - | - | - | - | - | 1 |
| | CASUALTY | | | | | | | | | | | |
| 1. | No. of lives saved | - | - | - | 10 | - | - | - | - | - | - | 10 |
| 2. | Fatally injured | - | - | - | 5 | - | - | - | - | - | - | 5 |
| 3. | No. of animals saved | - | - | - | - | - | - | - | - | - | - | - |

**THE ESTIMATED LOST:** twenty five million, five hundred and thirty five thousand naira only (₦ 25, 535, 000. 00)

**THE ESTIMATED SAVED:** six hundred and eighty million, one hundred and fifty thousand naira only (₦ 680, 150, 000.00)

PFS I ISAH M. IBRAHIM
Senior Fire Prevention officer
For: Director

THIRD QUARTER

# NIGER STATE FIRE/RESCUE INCIDENT FOR THE MONTH OF JULY – SEPTEMBER, 2013.

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| | | HEADQUARTERS BOSSO ROAD | BIDA | KONTAGORA | KUTIGI | KAGARA | LAPAI | SULEJA | AGAIE | KUTA | RIJAU | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Number of calls | 13 | 1 | - | - | 1 | - | 2 | - | - | - | 19 |
| 2. | Fire calls | 13 | 1 | - | - | 1 | - | 2 | - | - | - | 17 |
| 3. | Rescue | - | - | - | - | - | - | - | - | - | - | - |
| 4. | False Alarm | 2 | - | - | - | - | - | - | - | - | - | 2 |
| | SUPPOSED CAUSE | | | | | - | - | | - | - | - | - |
| 1. | Electric fault | 7 | 1 | - | - | 1 | - | 2 | - | - | - | 11 |
| 2. | Bush Burning | - | - | - | - | - | - | - | - | - | - | - |
| 3. | Candle stick | - | - | - | - | - | - | - | - | - | - | - |
| 4. | Road traffic accident | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 5 | Still under investigation | 5 | - | - | - | - | | - | - | - | - | 5 |
| | TYPES OF FIRE | | | | | | | | | | | |
| 1. | Domestic | 12 | 1 | - | - | 1 | - | 2 | - | - | - | 16 |
| 2. | Vehicle | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 3. | Public schools | - | - | - | - | - | - | - | - | - | - | - |
| 4. | Public Building | - | - | - | - | - | - | - | - | - | - | - |
| 5. | Electric pole | - | - | - | - | - | - | - | - | - | - | - |
| 6. | Shop | - | - | - | - | - | - | - | - | - | - | - |
| 7. | Petrol tanker | - | | - | - | - | - | - | - | - | - | - |
| 8. | Church | - | - | - | - | - | | | | | | - |
| | CASUALTY | | | | | | | | | | | - |
| 1. | No. of lives saved | - | - | - | - | - | - | - | - | - | - | - |
| 2. | Fatally injured | - | - | - | - | - | - | - | - | - | - | - |
| 3. | No. of animals saved | - | - | - | - | - | - | - | - | - | - | - |

**THE ESTIMATED LOST:** Fifty eight million, nine hundred and fifty six thousand nine hundred naira only (₦ 58, 956, 900. 00)

**THE ESTIMATED SAVED:** Seventy four billion, two hundred million naira only (₦ 74, 200, 000, 000.00)

**ACFS I ISAH M. IBRAHIM**
Senior Fire Prevention officer
**For:** Director

NIGER STATE FIRE/RESCUE INCIDENT REPORT FOR THE MONTH OF OCTOBER – DECEMBER 2013
FORTH QUARTER

| No | | BOSSO ROAD/TUNGA | BIDA | KONTAGORA | KUTIGI | KAGARA | LAPAI | SULEJA | AGAIE | KUTA | RIJAU | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of calls | 41 | 4 | - | 1 | - | - | 4 | - | - | - | 50 |
| 2. | Fire Calls | 37 | 4 | - | 1 | - | - | 4 | - | - | - | 46 |
| 3. | Rescue | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 4. | False Alarm | 2 | - | - | - | - | - | - | - | - | - | 2 |
| SUPPOSED CAUSE | | | | | | | | | | | | |
| 1. | Electric Fault | 25 | 3 | - | - | - | - | 4 | - | - | - | 32 |
| 2. | Candle Stick | 1 | 1 | - | - | - | - | - | - | - | - | 2 |
| 3. | Road traffic Accident | 1 | - | - | 1 | - | - | - | - | - | - | 2 |
| 4. | Still under investigation | 10 | - | - | - | - | - | - | - | - | - | 10 |
| TYPES OF FIRE | | | | | | | | | | | | |
| 1 | Domestic | 34 | 4 | - | - | - | - | 4 | - | - | - | 42 |
| 2. | Vehicle | 1 | - | - | 1 | - | - | - | - | - | - | 2 |
| 3. | Shops | 2 | - | - | - | - | - | - | - | - | - | 2 |
| CASUALTY | | | | | | | | | | | | |
| 1. | Number of lives saved | - | - | - | - | - | - | - | - | - | - | - |
| 2. | Fatally injured | - | - | - | - | - | - | - | - | - | - | - |
| 3. | Number Of Animal Saved | - | - | - | - | - | - | - | - | - | - | - |

ESTIMATED LOST: - One Billion Four Hundred Nineteen Million, Seven Hundred and Thirty Thousand Naira Only (₦1, 419,730,000.00) .

ESTIMATED SAVED: Two Billion Two Hundred and Eleven Million, and Two Hundred Thousand Naira Only. (₦2, 211, 200, 000.00).

Isah M. Ibrahim
For: Director

**APPENDIX B**

**DATA ON FIRE ACCIDENT OCCURRENCES IN NIGER STATE YEAR, 2014**

FIRST QUARTER

NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH JANUARY – MARCH 20

| S/NO. | | H/QUARTER BOSSO ROAD | BIDA | K/GORA | KUTIGI | KAGARA | LAPAI | SULEJA | AGAIE | KUTA | RIJAU | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Number of calls | 45 | - | - | - | - | - | 3 | - | - | - | 48 |
| 2. | Fire calls | 42 | - | - | - | - | - | 3 | - | - | - | 45 |
| 3. | Rescue | - | - | - | - | - | - | - | - | - | - | - |
| 4. | False Alarm | 3 | - | - | - | - | - | - | - | - | - | 3 |
| | SUPPOSED CAUSE | | | | | | | | | | | |
| 1. | Electric Fault | 19 | - | - | - | - | - | 3 | - | - | - | 22 |
| 2. | Bush Burning | 7 | - | - | - | - | - | - | - | - | - | 7 |
| 3. | Petrol Tanker | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 4. | Generator | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 5. | Firewood | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 6. | Still under Investigation | 11 | - | - | - | - | - | - | - | - | - | 11 |
| | TYPES OF FIRE | | | | | | | | | | | |
| 1. | Domestic | 32 | - | - | - | - | - | 1 | - | - | - | 33 |
| 2. | Vehicle | 3 | - | - | - | - | - | - | - | - | - | 3 |
| 3. | Bank | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 4. | Public Building | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 5. | Shop | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 6. | Industry | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 7. | Public School | - | - | - | - | - | - | 2 | - | - | - | 2 |
| | CASUALITY | | | | | | | | | | | |
| 1. | Nos. of Live saved | - | - | - | - | - | - | - | - | - | - | - |
| 2. | Fatally Injured | - | - | - | - | - | - | - | - | - | - | - |
| 3. | Nos. of Animal Saved | - | - | - | - | - | - | - | - | - | - | - |

1. THE ESTIMATED SAVED: Five Billion, Six Hundred and One Million, Six Hundred Thousand Naira. Only.

   (₦ 5, 601, 600, 000.00)

2. THE ESTIMATED LOST: Ninety Five Million, Four Hundred Thousand Naira. Only.

   (₦ 95, 400, 000.00)

ACFS ISAH M. IBRAHIM
Senior Fire Prevention Officer
*For: Director*

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# SECOND QUARTER

## NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH APRIL – JUNE 2014

| S/NO. | | H/QUARTER BOSSO ROAD | BIDA | K/GORA | KUTIGI | KAGARA | LAPAI | SULEJA | AGAIE | KUTA | RIJAU | TOATAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Number of calls | 8 | - | - | - | - | - | 2 | - | - | - | 10 |
| 2. | Fire calls | 8 | - | - | - | - | - | 2 | - | - | - | 10 |
| 3. | Rescue | - | - | - | - | - | - | - | - | - | - | |
| 4. | False Alarm | - | - | - | - | - | - | - | - | - | - | |
| | **SUPPOSED CAUSE** | | | | | | | | | | | |
| 1. | Electric Fault | 7 | - | - | - | - | - | 2 | - | - | - | 9 |
| 2. | Bush Burning | - | - | - | - | - | - | - | - | - | - | |
| 3. | Petrol Tanker | - | - | - | - | - | - | - | - | - | - | |
| 4. | Generator | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 5. | Firewood | - | - | - | - | - | - | - | - | - | - | |
| 6. | Still under Investigation | - | - | - | - | - | - | - | - | - | - | |
| | **TYPES OF FIRE** | | | | | | | | | | | |
| 1. | Domestic | 4 | - | - | - | - | - | 1 | - | - | - | 5 |
| 2. | Vehicle | - | - | - | - | - | - | - | - | - | - | |
| 3. | Bank | - | - | - | - | - | - | - | - | - | - | |
| 4. | Public Building | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 5. | Shop | - | - | - | - | - | - | 1 | - | - | - | 1 |
| 6. | Filling Station | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 7. | Electric Pole | 2 | - | - | - | - | - | - | - | - | - | 2 |
| | **CASUALITY** | | | | | | | | | | | |
| 1. | Nos. of Live saved | - | - | - | - | - | - | - | - | - | - | - |
| 2. | Fatally Injured | - | - | - | - | - | - | - | - | - | - | - |
| 3. | Nos. of Animal Saved | - | - | - | - | - | - | - | - | - | - | - |

1. **THE ESTIMATED** LOST: **Seventeen Million, five hundred thousand Naira only. (₦17,500,000.00)**
2. **THE ESTIMATED** SAVED **Five hundred and fifty four Million, seven hundred thousand Naira Only.**

**(₦554,700,000.00)**

**ACFS ISAH M. IBRAHIM**
Senior Fire Prevention Officer
*For: Director*

## THIRD QUARTER

## NIGER STATE FIRE/RESCUE INCIDENT REPORT FOR THE MONTH OF JULY –SEPTEMBER 2014

| s/no | | Bosso road Headquarter | Bida | Kutigi | Kontagora | Suleja | Kuta | Agaie | Lapai | Rijau | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of calls | 4 | - | - | - | 3 | - | - | - | - | 7 |
| 2 | Fire calls | 1 | - | - | - | 3 | - | - | - | - | 4 |
| 3 | False Alarm | 2 | - | - | - | - | - | - | - | - | 2 |
| 4 | Special services | 1 | - | - | - | - | - | - | - | - | 1 |
| | SUPPOSE CAUSE OF FIRE | | | | | | | | | | |
| 1 | Electric Fault | - | - | - | - | 1 | - | - | - | - | 1 |
| 2 | Yet to be known | 1 | - | - | - | - | - | - | - | - | 1 |
| 3 | Children playing with matches | - | - | - | - | - | - | - | - | - | - |
| 4 | Road traffic accident | 1 | - | - | - | 1 | - | - | - | - | 2 |
| 5 | Electric cooker | - | - | - | - | 1 | - | - | - | - | 1 |
| | TYPES OF FIRE | | | | | | | | | | |
| 1 | Domestic | 1 | - | - | - | 2 | - | - | - | - | 3 |
| 2 | Vehicle | 1 | - | - | - | 1 | - | - | - | - | 2 |
| 3 | Shops | | | | | | | | | | |
| | CASUALITY | | | | | | | | | | |
| 1 | Nos. of live saved | | | | | | | | | | |
| 2 | Fatally injured | | | | | | | | | | |
| 3 | Nos. of animals saved | | | | | | | | | | |
| | | | | | | | | | | | |

The estimated lost :- Fourteen million, four hundred and fifty thousand, five hundred naira only(#14,450,500.00)

The estimated saved:- Three hundred and thirty six million, seven hundred thousand naira only (#336,700,000.00)

ACFS Isah M. Ibrahim
For:Director

# FOURTH QUARTER

## NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OCTOBER – DECEMBER 2014

| S/NO. | | H/QUARTER BOSSO ROAD | BIDA | K/GORA | KUTIGI | KAGARA | LAPAI | SULEJA | AGAIE | KUTA | RIJAU | TOATAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Number of calls | 26 | 5 | 2 | - | - | - | 3 | - | - | - | 36 |
| 2. | Fire calls | 25 | 4 | 2 | - | - | - | 3 | - | - | - | 34 |
| 3. | Rescue | - | 1 | - | - | - | - | - | - | - | - | 1 |
| 4. | False Alarm | 1 | - | - | - | - | - | - | - | - | - | 1 |
| | SUPPOSED CAUSE | | | | | | | | | | | |
| 1. | Electric Fault | 11 | 3 | 2 | - | - | - | 2 | - | - | - | 18 |
| 2. | Bush Burning | 3 | 1 | - | - | - | - | - | - | - | - | 4 |
| 3. | Road Traffic Accident | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 4. | Stove | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 5. | Mosquitoes coil | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 6. | Still under Investigation | 7 | - | - | - | - | - | - | - | - | - | 7 |
| 7. | Arson | - | - | - | - | - | - | 1 | - | - | - | 1 |
| | TYPES OF FIRE | | | | | | | | | | | |
| 1. | Domestic | 17 | 3 | 1 | - | - | - | 2 | - | - | - | 23 |
| 2. | Vehicle | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 3. | Public School | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 4. | Public Building | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 5. | Shop | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 6. | Filling Station | | - | - | - | - | - | 1 | - | - | - | 1 |
| 7. | Hospital | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 8. | Market | - | 1 | - | - | - | - | - | - | - | - | 1 |
| 9. | Bank | - | - | 1 | - | - | - | - | - | - | - | |
| | CASUALITY | | | | | | | | | | | |
| 1. | Nos. of Live saved | - | - | - | - | - | - | - | - | - | - | - |
| 2. | Fatally Injured | - | - | - | - | - | - | - | - | - | - | - |
| 3. | Nos. of Animal Saved | - | - | - | - | - | - | - | - | - | - | - |

THE ESTIMATED LOST: Sixty four Million and fifty one thousand naira only. (₦64,051,000.00)

THE ESTIMATED SAVED: Two Billion, and forty Million naira only. (₦2,040,000,000.00)

**ACFS ISAH M. IBRAHIM**
Senior Fire Prevention Officer
*For: Director*

## APPENDIX C

## DATA ON FIRE ACCIDENT OCCURRENCES IN NIGER STATE YEAR, 2015

**FIRST QUARTER**

**NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF JANUARY – MARCH 2015**

| S/No | | Bosso Road Headquarters | Bida | Kontagora | Kutigi | Kagara | Lapai | Agaie | Kuta | Suleja | Rijau | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of calls | 43 | 3 | - | - | - | - | - | - | 2 | - | 48 |
| 2 | Fire calls | 41 | 3 | - | - | - | - | - | - | 2 | - | 46 |
| 3 | Rescue | - | - | - | - | - | - | - | - | - | - | - |
| 4 | False Alarm | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 5 | Special Service | - | - | - | - | - | - | - | - | - | - | - |
| | SUPPOSED CAUSE | | | | | | | | | | | |
| 1 | Bush Burning | 7 | - | - | - | - | - | - | - | 1 | - | 8 |
| 2 | Children Playing Matches | - | 1 | - | - | - | - | - | - | - | - | 1 |
| 3 | Electric Fault | 19 | - | - | - | - | - | - | - | 1 | - | 20 |
| 4 | Road Traffic Accident | - | - | - | - | - | - | - | - | - | - | - |
| 5 | Hot Ashes in Refuse Dumping Site | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 6 | Still Under Investigation | 11 | 2 | - | - | - | - | - | - | - | - | 13 |
| 7 | Fuel Leakage from Motorcycle | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 8 | Gas Cooker | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 9 | Over Heating of Engine | 1 | - | - | - | - | - | - | - | - | - | 1 |
| | TYPES OF FIRE | | | | | | | | | | | |
| 1 | Domestic | 32 | 2 | - | - | - | - | - | - | - | - | 34 |
| 2 | School | 1 | - | - | - | - | - | - | - | 1 | - | 2 |
| 3 | Vehicle | 3 | - | - | - | - | - | - | - | - | - | 3 |
| 4 | Shop | 3 | 1 | - | - | - | - | - | - | 1 | - | 5 |
| 5 | Filling Station | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 6 | Electric pole | 1 | - | - | - | - | - | - | - | - | - | 1 |
| | CASSUALTY | | | | | | | | | | | |
| 1 | Nos. of the Saved | - | - | - | - | - | - | - | - | - | - | - |
| 2 | Fatally injured | - | - | - | - | - | - | - | - | - | - | - |
| 3 | Nos. of Animal Saved | - | | - | - | - | - | - | - | - | - | - |

**ESTIMATED LOST:** Eighty one million, six hundred and thirty thousand, naira only(# 81,630,000.00)

**ESTIMATED SAVED:** Five hundred and forty one million, five hundred thousand naira only(541,500,000.00)

ACFS Isah M. Ibrahim
Senior Fire Prevention Officer
For: Director

## SECOND QUARTER

## NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF APRIL-JUNE,2015

| S/NO | | Bosso Road Headquarters | BIDA | KUTIGI | LAPAI | SULEJA | AGAIE | KONTAGORA | KAGARA | KUTA | RIJAU | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of Calls | 22 | 1 | - | 1 | 1 | 1 | - | - | 1 | - | 27 |
| 2 | Fire Calls | 20 | 1 | - | 1 | 1 | 1 | - | - | 1 | - | 25 |
| 3 | Rescue | - | - | - | - | - | - | - | - | - | - | - |
| 4 | False Alarm | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 5 | Special Service | - | - | - | - | - | - | - | - | - | - | |
| | **SUPPOSED CAUSE** | | | | | | | | | | | |
| 1 | Electric Fault | 10 | - | - | - | - | - | - | - | 1 | - | 11 |
| 2 | Bush Burnings | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 3 | Stove | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 4 | Gas Cooker | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 5 | Over Heating of Batteries | - | - | - | - | - | 1 | - | - | - | - | 1 |
| 6 | Still under Investigation | 3 | 1 | - | 1 | 1 | - | - | - | - | - | 6 |
| 7 | Generator | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 8 | Holder Bulb | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 9 | Air Condition | 1 | - | - | - | - | - | - | - | - | - | 1 |
| | **TYPE OF FIRE** | | | | | | | | | | | |
| 1 | Domestic | 13 | - | - | - | - | - | - | - | - | - | 13 |
| 2 | Public School | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 3 | Petrol Tanker | - | - | - | 1 | - | - | - | - | - | - | 1 |
| 4 | Shops | 3 | 1 | - | - | 1 | - | - | - | - | - | 5 |
| 5 | Computer Centre | - | - | - | - | - | - | - | - | 1 | - | 1 |
| 6 | Transformer | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 7 | Bank | - | - | - | - | - | 1 | - | - | - | - | 1 |
| 8 | Bush Burning | 1 | - | - | - | - | - | - | - | - | - | 1 |
| | **CASSUALTY** | | | | | | | | | | | |
| 1 | Nos. of live saved | - | - | - | - | - | - | - | - | - | - | - |
| 2 | Fatally Injured | - | - | - | - | - | - | - | - | - | - | - |
| 3 | Nos. of Animal Saved | - | - | - | - | - | - | - | - | - | - | - |

ESTIMATED LOST: Five Hundred and Sixty Three Million, One Hundred and Fifty Thousand Naira Only (# 563,150,000.00)

ESTIMATED SAVED: Five Hundred and Three Billion, Five Hundred and Nine Million Five Hundred Thousand Naira Only (503,509,500,000.00).

Isah M. Ibrahim
ACFS Fire Prevention Officer
For: Director.

## THIRD QUARTER

## NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF JULY – SEPT. 2015

| S/No | | Bosso Road/Hqrt. | Bida | Kutigi | Kontagora | Suleja | Agaie | Kagara | Kuta | Lapai | Rijau | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Number of calls | 17 | 2 | - | 3 | 4 | - | 1 | | - | - | 27 |
| 2. | Fire calls | 14 | 2 | - | 3 | 3 | - | 1 | | - | - | 23 |
| 3. | Rescue | 1 | - | - | - | 1 | - | - | | - | - | 2 |
| 4. | False Alarm | 2 | - | - | - | - | - | - | | - | - | 2 |
| 5. | Special service | - | - | - | - | - | - | - | | - | - | |
| | **SUPPOSED CAUSE** | | | | | | | | | | | |
| 1. | Electric Fault | 9 | 2 | - | 2 | 2 | - | - | | - | - | 15 |
| 2. | Road traffic Accident | - | - | - | - | - | - | 1 | | - | - | 1 |
| 3. | Bush Burning | - | - | - | - | - | - | - | | - | - | |
| 4. | Stove | 1 | - | - | - | - | - | - | | - | - | 1 |
| 5. | Arson | 1 | - | - | - | - | - | - | | - | - | 1 |
| 6. | Leakage of Petrol | 1 | - | - | - | - | - | - | | - | - | 1 |
| 7. | Still under investigation | 2 | - | - | 1 | - | - | - | | - | - | 3 |
| 8. | Gas Explosion | - | - | - | - | 1 | - | - | | - | - | 1 |
| | **TYPE OF FIRE** | | | | | | | | | | | |
| 1. | Domestic | 9 | 2 | | 2 | 2 | - | - | | - | - | 15 |
| 2. | Vehicle | - | - | - | - | - | - | 1 | | - | - | 1 |
| 3. | Gas | - | - | - | - | 1 | - | - | | - | - | 1 |
| 4. | Market | - | - | - | 1 | - | - | - | | - | - | 1 |
| 5. | Shops | 1 | - | - | - | - | - | - | | - | - | 1 |
| 6. | Public school | 4 | - | - | - | - | - | - | | - | - | 4 |
| | **CASUALITY** | | | | | | | | | | | |
| 1. | No. of live saved | - | - | - | - | - | - | - | | - | - | |
| 2. | Fatally injured | - | - | - | - | 8 | - | 2 | | - | - | 10 |
| 3. | No. of animal saved | - | - | - | - | - | - | - | | - | - | |

**ESTIMATED LOST:** Two Hundred and One Million, Four Hundred and Fifty Thousand, Six Hundred and Fifty Naira Only (₦201,450,650.00)

**ESTIMATED SAVED:** Five Hundred and Six Million Five Hundred Thousand Naira Only (₦506,500,000.00)

**ACFS Isah M. Ibrahim**
*Senior Fire Prevention Officer*
*For:* Director

Fouth Quarter

## NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF OCTOBER- DECEMBER,2015

| S/No | | Bosso Road Headquarters | Bida | Kutigi | K/gora | Suleja | Agaie | Kagara | Kuta | Lapai | Rijau | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of calls | 28 | 2 | • | • | 8 | • | • | • | | • | 38 |
| 2 | Fire calls | 27 | 2 | • | • | 6 | • | • | • | • | • | 35 |
| 3 | Rescue Calls | • | • | • | • | • | • | • | • | • | • | • |
| 4 | False Alarm | 1 | • | • | • | • | • | • | • | • | • | 1 |
| 5 | Special Service | • | • | • | • | • | • | • | • | • | • | • |
| | SUPPOSED CAUSE | | | | | | | | | | | |
| 1 | Bush Burning | 5 | • | • | • | • | • | • | • | • | • | 5 |
| 2 | Electric Fault | 8 | 1 | • | • | 5 | • | • | • | • | • | 14 |
| 3 | Skill Under Investigation | 8 | 1 | • | • | • | • | • | • | • | • | 9 |
| 4 | Heater | 1 | • | • | • | • | • | • | • | • | • | 1 |
| 5 | Gas cooker | 2 | • | • | • | • | • | • | • | • | • | 2 |
| 6 | Accident | 1 | • | • | • | 1 | • | • | • | • | • | 2 |
| 7 | Dust Been | 1 | • | • | • | • | • | • | • | • | • | 1 |
| 8 | Over Heating | 1 | • | • | • | • | • | • | • | • | • | 1 |
| | TYPES OF FIRE | | | | | | | | | | | |
| 1 | Domestic | 12 | • | • | • | 4 | • | • | • | • | • | 16 |
| 2 | Public School | 2 | • | • | • | • | • | • | • | • | • | 2 |
| 3 | Vehicle | 1 | • | • | • | 1 | • | • | • | • | • | 2 |
| 4 | Shop | 4 | 2 | • | • | • | • | • | • | • | • | 6 |
| 5 | Church | 1 | • | • | • | • | • | • | • | • | • | 1 |
| 6 | Preservator with fish | 1 | • | • | • | • | • | • | • | • | • | 1 |
| 7 | Factory | • | • | • | • | 1 | • | • | • | • | • | 1 |
| 8 | Bush Burning | 2 | • | • | • | • | • | • | • | • | • | 2 |
| 9 | Transformer | 1 | • | • | • | • | • | • | • | • | • | 1 |
| 10 | Petroleum Filling Station | 1 | • | • | • | • | • | • | • | • | • | 1 |
| 11 | Market | 2 | • | • | • | • | • | • | • | • | • | 2 |
| | CASSUALTY | | | | | | | | | | | |
| 1 | Nos. of the Saved | • | • | • | • | • | • | • | • | • | • | • |
| 2 | Fatally Injured | 1 | • | • | • | • | • | • | • | • | • | 1 |
| 3 | Nos. of Animal Saved | • | | • | • | • | • | • | • | • | • | • |

**ESTIMATED LOST:** Ninety one million naira only (#91,000,000.00)

**ESTIMATED SAVED:** Two Billion, Twenty nine million, five hundred thousand naira only (#2,029,500,000.00)

ACFS Isah M. Ibrahim
Senior Fire Prevention Officer
For: Director

# APPENDIX D

## DATA ON FIRE ACCIDENT OCCURRENCES IN NIGER STATE YEAR, 2016

FIRST QUARTER

NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF JUNUARY-MARCH,2016

| S/NO | | Bosso Road Tunga | BIDA | KUTIGI | LAPAI | SULEJA | AGAIE | K/gor | KAGARA | KUTA | RIJAU | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of Calls | 50 | 2 | 1 | . | 10 | . | . | . | . | . | 63 |
| 2 | Fire Calls | 47 | 2 | 1 | . | 10 | . | . | . | . | . | 60 |
| 3 | Rescue | . | . | . | . | . | . | . | . | . | . | . |
| 4 | False Alarm | 3 | . | . | . | . | . | . | . | . | . | 3 |
| | SUPPOSED CAUSE | | | | | | | | | | | |
| 1 | Electric Fault | 25 | | 1 | . | 4 | . | . | . | . | . | 33 |
| 2 | Bush Burnings | 3 | 1 | . | . | 1 | . | . | . | . | . | 5 |
| 3 | Road Traffic Accident | . | . | . | . | . | . | . | . | . | . | 1 |
| 4 | Sparking at discharging during off loading of fuel | . | . | . | . | 1 | . | . | . | . | . | 2 |
| 5 | Wiring Problem | . | . | . | . | . | . | . | . | . | . | 1 |
| 6 | Disposal of Charcoal | 1 | . | . | . | 2 | . | . | . | . | . | 2 |
| 7 | Children Playing with matches | . | . | . | . | . | . | . | . | . | . | 1 |
| 8 | Gas Cooker | 11 | 1 | . | . | 1 | . | . | . | . | . | 1 |
| 9 | Spot Under Investigation | . | . | . | . | . | . | . | . | . | . | 12 |
| 10 | Generator | | | | | 1 | . | . | . | . | . | 2 |
| | TYPE OF FIRE | 37 | 1 | . | . | 5 | . | . | . | . | . | 43 |
| 1 | Domestic | 1 | . | . | . | . | . | . | . | . | . | 1 |
| 2 | Vehicle | 4 | . | . | . | 2 | . | . | . | . | . | 6 |
| 3 | Bush Burning | 1 | . | . | . | . | . | . | . | . | . | 1 |
| 4 | Filling Station | 1 | 1 | 1 | . | . | . | . | . | . | . | 3 |
| 5 | Shops | 1 | . | . | . | 1 | . | . | . | . | . | 1 |
| 6 | Petrol Tanker | . | . | . | . | . | . | . | . | . | . | 1 |
| 7 | Timber Shade | 1 | . | . | . | 1 | . | . | . | . | . | 1 |
| 8 | Market | . | . | . | . | . | . | . | . | . | . | 1 |
| 9 | Generator | 1 | . | . | . | 1 | . | . | . | . | . | 1 |
| 10 | School | | . | . | . | | | | | | | 1 |
| 11 | Super Market | | | | | | | | | | | 1 |
| 12 | Post Office | | | | | | | | . | . | . | . |
| 13 | Tree | | | | . | . | . | . | . | . | . | . |
| | CASSUALTY | . | . | . | . | . | . | . | . | . | . | . |
| 1 | Nos. of live saved | . | . | . | . | . | . | . | . | | | |
| 2 | Fatally Injured | . | . | . | | | | | | | | |
| 3 | Nos. of Animal Saved | | | | | | | | | | | |

ESTIMATED LOST: One Billion ,Four hundred and Nine Million, four hundred and fifteen thousand Naira only. (#1,409,415,000.00)

ESTIMATED SAVED: Ten Billion, four hundred and Ninety one Million, one hundred thousand Naira only. (#10,491,100,000.00)

ACFS Isah M. Ibrahim
Fire Prevention Officer
For Director

## SECOND QUARTER

## NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF APRIL-JUNE,2016

| S/NO | | Bosso Road Tunga | BIDA | KUTIGI | LAPAI | SULEJA | AGAIE | KONTAGORA | KAGARA | KUTA | RIJAU | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of Calls | 16 | . | . | . | . | . | . | 2 | 1 | . | 19 |
| 2 | Fire Calls | 16 | . | . | . | . | . | . | 2 | 1 | . | 19 |
| 3 | Rescue | . | . | . | . | . | . | . | . | . | . | . |
| 4 | False Alarm | . | . | . | . | . | . | . | . | . | . | . |
| 5 | Special Service | . | . | . | . | . | . | . | . | . | . | |
| | SUPPOSED CAUSE | | | | | | | | | | | |
| 1 | Electric Fault | 9 | . | . | . | . | . | . | 2 | 1 | . | 12 |
| 2 | Bush Burnings | . | . | . | . | . | . | . | . | . | . | . |
| 3 | Burning Tree | 1 | . | . | . | . | . | . | . | . | . | 1 |
| 4 | Linkage from Gas Cooker | 1 | . | . | . | . | . | . | . | . | . | 1 |
| 5 | Cigarette ashes | 1 | . | . | . | . | . | . | . | . | . | 1 |
| 6 | Sull under Investigation | 4 | . | . | . | . | . | . | . | . | . | 4 |
| | TYPE OF FIRE | | | | | | | | | | | |
| 1 | Domestic | 10 | . | . | . | . | . | . | 2 | . | . | 12 |
| 2 | Public School | 2 | . | . | . | . | . | . | . | . | . | 2 |
| 3 | Tree | 1 | . | . | . | . | . | . | . | . | . | 1 |
| 4 | Shops | 1 | . | . | . | . | . | . | . | . | . | 1 |
| 5 | School | 1 | . | . | . | . | . | . | . | . | . | 1 |
| 6 | Hospital | 1 | . | . | . | . | . | . | . | . | . | 1 |
| | CASSUALTY | | | | | | | | | | | |
| 1 | Nos of live saved | . | . | . | . | . | . | . | . | . | . | . |
| 2 | Fatally injured | . | . | . | . | . | . | . | . | | . | 5 |
| 3 | Nos of Animal Saved | . | . | . | . | . | . | . | . | . | . | . |

**ESTIMATED LOST: TEN MILLION, FIVE HUNRED THOUSAND NAIRA ONLY (# 10,500,000.00)**

**ESTIMATED SAVED: ONE HUNRED AND FIFTY SEVEN MILLION NAIRA ONLY (#157,000,000.00)**

Isah M. Ibrahim
ACFS Fire Prevention Officer
For Director.

6

## NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF OCTOBER – DECEMBER, 2016.

### FORTH QUARTER

| NO | | BOSSO ROAD TUNGA | BIDA | KONTAGORA | KUTIGI | SULEJA | AGAIE | LAPAI | KAGARA | KUTA | MOKWA | RIJAU | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Number of calls | 27 | 3 | - | - | 5 | - | - | 1 | - | 1 | - | 37 |
| 2. | Fire calls | 25 | 3 | - | - | 5 | - | - | 1 | - | 1 | - | 35 |
| 3. | Rescue | - | - | - | - | | - | - | - | - | - | - | |
| 4. | False Alarm | 2 | - | - | - | | - | - | - | - | - | - | 2 |
| 5. | Special service | - | - | - | - | | - | - | - | - | - | - | |
| | **SUPPOSED CAUSE** | | | | | | | | | | | | |
| 1. | Electric fault | 9 | 2 | - | - | 4 | - | - | - | - | 1 | - | 16 |
| 2. | Bush burning | 9 | | - | - | | - | - | - | - | - | - | 9 |
| 3. | Cigarette end | 1 | 1 | - | - | | - | - | - | - | - | - | 2 |
| 4. | Fire wood from kitchen | 1 | - | - | - | | - | - | - | - | - | - | 1 |
| 5. | Still under investigation | 3 | - | - | - | | - | - | - | - | - | - | 3 |
| 6. | Wiring problem | 1 | - | - | - | | - | - | - | - | - | - | 1 |
| 7. | Generator | - | - | - | - | 1 | - | - | - | - | - | - | 1 |
| 8. | Road traffic accident | - | - | - | - | | - | - | 1 | - | - | - | 1 |
| 9. | Over heating of gas cooker | 1 | - | - | - | | - | - | - | - | - | - | 1 |
| | **TYPE OF FIRE** | | | | | | | | | | | | |
| 1. | Domestic | 17 | 3 | - | - | 3 | - | - | - | - | - | - | 23 |
| 2. | Vehicle | 1 | - | - | - | | - | - | 1 | - | - | - | 2 |
| 3. | Electric pole | 1 | - | - | - | | - | - | - | - | - | - | 1 |
| 4. | Public office | 1 | - | - | - | | - | - | - | - | - | - | 1 |
| 5. | Market | 4 | - | - | - | 1 | - | - | - | - | - | - | 5 |
| 6. | Generator | 1 | - | - | - | | - | - | - | - | - | - | 1 |
| 7. | Motor park | - | - | - | - | | - | - | - | - | 1 | - | 1 |
| 8. | Church | - | - | - | - | 1 | - | - | - | - | - | - | 1 |
| | **CASUALTY** | | | | | | | | | | | | |
| 1. | Nos. of live saved | - | - | - | - | - | - | - | - | - | - | - | |
| 2. | Nos. of animal saved | - | - | - | - | - | - | - | - | - | - | - | |
| 3. | Fatally injured | - | - | - | - | - | - | - | 18 | - | - | - | 18 |

**ESTIMATED LOST:** One Hundred and Twenty Nine Million, Nine Hundred and Twenty Thousand Naira Only (N129,920,000.00)

**ESTIMATED SAVED:** Two Billion, Five Hundred and Seventy Seven Million, Seven Hundred thousand Naira Only (N2,577,700,000.00)

**ACFS Isah M. Ibrahim**
*Senior Fire Prevention Officer*
*For: Director*

## APPENDIX E

## DATA ON FIRE ACCIDENT OCCURRENCES IN NIGER STATE YEAR, 2017

FIRST QUARTER

NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF JANUARY – MARCH 2017

| S/No | | Bosso Road Headquarters | Bida | Kutigi | K/gora | Suleja | Agaie | Kagara | Kuta | Lapai | Rijau | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of calls | 81 | 14 | - | 8 | 14 | - | 1 | - | - | - | 118 |
| 2 | Fire calls | 76 | 14 | - | 8 | 13 | - | 1 | - | - | - | 112 |
| 3 | Rescue Calls | - | - | - | - | 1 | - | - | - | - | - | 1 |
| 4 | False Alarm | 5 | - | - | - | - | - | - | - | - | - | 5 |
| 5 | Special Service | - | - | - | - | - | - | - | - | - | - | - |
| | SUPPOSED CAUSE | | | | | | | | | | | |
| 1 | Bush Burning | 22 | 5 | - | 2 | 2 | - | - | - | - | - | 31 |
| 2 | Children Playing Matches | 1 | 1 | - | - | - | - | - | - | - | - | 2 |
| 3 | Electric Fault | 25 | 6 | - | 6 | 5 | - | 1 | - | - | - | 43 |
| 4 | Horse Grasses | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 5 | Dumping of Ashes | - | - | - | - | 1 | - | - | - | - | - | 1 |
| 6 | Still Under Investigation | 19 | - | - | - | - | - | - | - | - | - | 19 |
| 7 | Leakage of gas from Pipe | - | - | - | - | 1 | - | - | - | - | - | 1 |
| 8 | Heater | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 9 | fire wood | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 10 | Stove | - | - | - | - | 1 | - | - | - | - | - | 1 |
| 11 | Generator | - | - | - | - | 1 | - | - | - | - | - | 1 |
| 12 | Gas cooker | 1 | - | - | - | 1 | - | - | - | - | - | 2 |
| 13 | Student riot | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 14 | Kick starter | - | - | - | - | 1 | - | - | - | - | - | 1 |
| 15 | Candle stick | 3 | - | - | - | - | - | - | - | - | - | 3 |
| 16 | High voltage | - | 2 | - | - | - | - | - | - | - | - | 2 |
| 17 | Petrol from kitchen | 1 | - | - | - | - | - | - | - | - | - | 1 |
| | TYPES OF FIRE | | | | | | | | | | | |
| 1 | Domestic | 47 | 13 | - | 8 | 10 | - | 1 | - | - | - | 79 |
| 2 | Container | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 3 | Vehicle | - | - | - | - | 1 | - | - | - | - | - | 1 |
| 4 | Shops | 4 | - | - | - | - | - | - | - | - | - | 4 |
| 5 | Horse grasses | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 6 | Farm | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 7 | Public building | 4 | - | - | - | - | - | - | - | - | - | 4 |
| 8 | Company | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 9 | Tree | 2 | 1 | - | - | 1 | - | - | - | - | - | 4 |
| 10 | Bush Burning | 5 | - | - | - | 1 | - | - | - | - | - | 6 |
| 11 | Tires | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 12 | Generator | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 13 | Schools | 3 | - | - | - | - | - | - | - | - | - | 3 |
| 14 | Market | 3 | - | - | - | - | - | - | - | - | - | 3 |
| 15 | University | 1 | - | - | - | - | - | - | - | - | - | 1 |
| | CASSUALTY | | | | | | | | | | | |
| 1 | Nos. of Lives Saved | - | - | - | - | - | - | - | - | - | - | - |
| 2 | Fatally injured | - | - | - | - | - | - | - | - | - | - | - |
| 3 | Nos. of Animal Saved | - | - | - | - | - | - | - | - | - | - | - |

**ESTIMATED LOST:** Five hundred and fourteen million, Three hundred and Sixty eight thousand naira only (#514,368,000.00)

**ESTIMATED SAVED:** Four Billion, two hundred and six million, six hundred thousand naira only(#4,206,600,000.00)

CFS Isah M. Ibrahim
Senior Fire Prevention Officer
For Director

SECOND-QUARTER

NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF APRIL – JUNE 2017

| S/No | | Bosso Road Headquarters | Bida | Kutigi | K/gora | Suleja | Agaie | Kagara | Kuta | Lapai | Rijau | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of calls | 21 | 3 | . | 12 | 5 | . | . | . | . | . | 41 |
| 2 | Fire calls | 21 | 2 | . | 12 | 5 | . | . | . | . | . | 40 |
| 3 | Rescue Calls | . | 1 | . | . | . | . | . | . | . | . | 1 |
| 4 | False Alarm | . | . | . | . | . | . | . | . | . | . | |
| 5 | Special Service | . | . | . | . | . | . | . | . | . | . | |
| | SUPPOSED CAUSE | | | | | | | | | | | |
| 1 | Bush Burning | 2 | . | . | . | . | . | . | . | . | . | 2 |
| 2 | Children Playing Matches | . | . | . | . | . | . | . | . | . | . | |
| 3 | Electric Fault | 14 | 1 | . | 11 | 2 | . | . | . | . | . | 28 |
| 4 | Still Under Investigation | 4 | 1 | . | . | 2 | . | . | . | . | . | 7 |
| 5 | fire wood | . | . | . | . | 1 | . | . | . | . | . | 1 |
| 6 | Gas cooker | 1 | . | . | . | . | . | . | . | . | . | 1 |
| 7 | Fuel Leakage | . | . | . | 1 | . | . | . | . | . | . | 1 |
| | TYPES OF FIRE | | | | | | | | | | | |
| 1 | Domestic | 15 | 1 | . | 11 | 12 | . | 1 | . | . | . | 29 |
| 2 | Vehicle | 2 | . | . | 1 | . | . | . | . | . | . | 3 |
| 3 | Shops | . | . | . | . | 2 | . | . | . | . | . | 2 |
| 4 | Public building | 1 | . | . | . | . | . | . | . | . | . | 1 |
| 5 | Bush Burning | . | . | . | . | . | . | . | . | . | . | |
| 6 | Public Schools | 1 | . | . | . | . | . | . | . | . | . | 1 |
| 7 | Public Office(High Court) | 1 | . | . | . | . | . | . | . | . | . | 1 |
| 8 | Bakery | . | . | . | . | 1 | . | . | . | . | . | 1 |
| 9 | Electric Pole | 1 | . | . | . | . | . | . | . | . | . | 1 |
| 10 | Shear butter machines | . | 1 | . | . | . | . | . | . | . | . | 1 |
| | CASSUALTY | | | | | | | | | | | |
| 1 | Nos of Lives Saved | . | . | . | . | . | . | . | . | . | . | . |
| 2 | Fatally injured | . | . | . | . | . | . | . | . | . | . | . |
| 3 | Nos of Animal Saved | . | | . | . | . | . | . | . | . | . | . |

ESTIMATED LOST: Thirty One Million, One Hundred and One Thousand, Six Hundred Naira only (#31,101,600.00)

ESTIMATED SAVED: One Hundred and Eighty Five Million, Seven Hundred Thousand Naira only(#185,700,000.00)

CFS Isah M. Ibrahim
Senior Fire Prevention Officer
For. Director

## THIRD QUARTER

### NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF JULY-SEPTMBER, 2017

| S/N | | Minna BossoRoad HQs/Tunga | Bida | Kutigi | K/Gora | Suleja | Agaie | Kagara | Kuta | Lapai | Rijau | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of calls | 18 | 5 | - | 7 | 4 | - | - | - | - | - | 34 |
| 2 | Fire calls | 16 | 5 | - | 7 | 4 | - | - | - | - | - | 32 |
| 3 | Rescue | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 4 | False alarm | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 5 | Special Service | - | - | - | - | - | - | - | - | - | - | - |
| | **SUPPOSED CAUSE** | | | | | | | | | | | |
| 1 | Electric Fault | 12 | 4 | - | 6 | 4 | - | - | - | - | - | 26 |
| 2 | Bush burning | 1 | - | - | 1 | - | - | - | - | - | - | 2 |
| 3 | Ashes | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 4 | Still Under investigation | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 5 | Road traffic accident | - | 1 | - | - | - | - | - | - | - | - | 1 |
| 6 | Electric cooker | 1 | - | - | - | - | - | - | - | - | - | 1 |
| | **TYPES OF FIRE** | | | | | | | | | | | |
| 1 | Domestic | 14 | 4 | - | 4 | 4 | - | - | - | - | - | 26 |
| 2 | Vehicle | - | 1 | - | - | - | - | - | - | - | - | 1 |
| 3 | Shops | - | - | - | 3 | - | - | - | - | - | - | 3 |
| 4 | Bush burning | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 5 | Refuse dumping site | 1 | - | - | - | - | - | - | - | - | - | 1 |
| | **CASUALTY** | | | | | | | | | | | |
| 1 | No. of live saved | - | - | - | - | - | - | - | - | - | - | - |
| 2 | No. of animal saved | - | - | - | - | - | - | - | - | - | - | - |
| 3 | Fatally injured | - | - | - | - | - | - | - | - | - | - | - |

**ESTIMATED LOST:**-Thirty Three Million, One Hundred and Twenty Four Thousand, Seven Hundred and Forty Naira(#33,124,740.00)

**ESTIMATED SAVED:**- Eighteen Billion, One Hundred and Sixty Nine Million Naira(#18,169,000,000.00) Only.

CFS Isah M. Ibrahim
Senior Fire prevention Offic
For: Director

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | Church | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 6 | Transformer | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 7 | Tree | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 8 | Clinic | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 9 | Public office | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 10 | Bank | - | 1 | - | - | - | - | - | - | - | - | 1 |
| 11 | Petrol tanker | - | 1 | - | - | 1 | - | - | - | - | - | 2 |
| 12 | Generator plant | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 13 | Refuse dumping site | 1 | - | - | - | - | - | - | - | - | - | 1 |
| | **CASUALTY** | | | | | | | | | | | |
| 1 | Nos. of live saved | - | - | - | - | - | - | - | - | - | - | 4 |
| 2 | Nos. of animal saved | - | - | - | - | - | - | - | - | - | - | |
| 3 | Fatally injured | - | - | - | - | - | - | - | - | - | - | 3 |

**ESTIMATED LOST:-Six Hundred Five Million, Four Hundred and Five Thousand Naira(#605,405,000.00)**

**ESTIMATED SAVED:- Five Billion, Five Hundred and Thirty Million, Six Hundred and Seventy Thousand, Four Hundred and Fifty Naira(#5,530,670,450.00) Only.**

CFS Isah M. Ibrahim
Senior Fire Prevention Officer
For: Director

# APPENDIX F

## DATA ON FIRE ACCIDENT OCCURRENCES IN NIGER STATE YEAR, 2018

### FIRST QUARTER

NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF JANUARY - MARCH, 2018

| S/N | | Minna Bosso Road HQs/Tunga | Bida | Kutigi | K/Gora | Suleja | Agaie | Kagara | Kuta | Lapai | Rijau | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of calls | 48 | 9 | 1 | 12 | 16 | 1 | - | - | - | - | 87 |
| 2 | Fire calls | 44 | 8 | 1 | 12 | 16 | 1 | - | - | - | - | 82 |
| 3 | Rescue | - | 1 | - | - | - | - | - | - | - | - | 1 |
| 4 | False alarm | 4 | - | - | - | - | - | - | - | - | - | 4 |
| 5 | Special Service | - | - | - | - | - | - | - | - | - | - | - |
| | **SUPPOSED CAUSE** | | | | | | | | | | | |
| 1 | Electric Fault | 34 | 2 | - | 9 | 10 | - | - | - | - | - | 55 |
| 2 | Bush burning | 7 | - | - | 3 | - | 1 | - | - | - | - | 11 |
| 3 | Children playing with matches | 1 | 1 | - | - | - | - | - | - | - | - | 2 |
| 4 | Explosion from a defective kerosene Stove | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 5 | Spark from Car Battery | - | 1 | - | - | 1 | - | - | - | - | - | 2 |
| 6 | Use of defective generator | - | 1 | - | - | 1 | - | - | - | - | - | 2 |
| 7 | Still Under investigation | 1 | 1 | - | - | - | - | - | - | - | - | 2 |
| 8 | Over Flowing of petrol from petrol Tanker | - | 1 | 1 | - | - | - | - | - | - | - | 2 |
| 9 | Road traffic accident | - | - | - | - | 1 | - | - | - | - | - | 1 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 | Explosion of Handset | - | - | - | - | 1 | - | - | - | - | - | 1 |
| 12 | Glowing embers of Left over hot Charcoal | - | 1 | - | - | - | - | - | - | - | - | 1 |
| | **TYPES OF FIRE** | | | | | | | | | | | |
| 1 | Domestic | 39 | 2 | - | 9 | 12 | - | - | - | - | - | 62 |
| 2 | Vehicle | - | 1 | - | - | 1 | - | - | - | - | - | 2 |
| 3 | Shops | - | 2 | - | - | - | - | - | - | - | - | 2 |
| 4 | Bush burning | 4 | - | - | 3 | - | 1 | - | - | - | - | 8 |
| 5 | Petrol tanker | - | 1 | 1 | - | 2 | - | - | - | - | - | 4 |
| 6 | School | 1 | 1 | - | - | - | - | - | - | - | - | 2 |
| 7 | Market | - | 1 | - | - | 1 | - | - | - | - | - | 2 |
| | **CASUALTY** | | | | | | | | | | | |
| 1 | Nos. of live saved | - | - | - | - | - | - | - | - | - | - | 4 |
| 2 | Nos. of animal saved | - | - | - | - | - | - | - | - | - | - | |
| 3 | Fatally injured | - | - | - | - | - | - | - | - | - | - | 3 |

**ESTIMATED LOST:-One Billion, Six Hundred and Thirty Four Million, Four Hundred and Five Thousand, Five Hundred and Sixty Six Naira(₦1,634,405,566.00) Only**

**ESTIMATED SAVED:- Five Billion, Six Hundred and Fifty Eight Million, Eight Hundred and Seventy Five Thousand, Four Hundred and Twenty Eight Naira(₦5,658,875,428.00) Only.**

**CFS Isah M. Ibrahim**
**Senior Fire Prevention Officer**
***For: Director***

## SECOND QUARTER

## NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF APRIL-JUNE, 2018

| S/NO | | Minna Bosso Road, Tunga & Headquarters | BIDA | KONTA GORA | KUTIGI | LAPAI | SULEJA | AGAIE | KAGARA | KUTA | RIJAU | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of Calls | 24 | 8 | 8 | - | - | 8 | - | - | - | - | 48 |
| 2 | Fire Calls | 21 | 7 | 8 | - | - | 8 | - | - | - | - | 44 |
| 3 | Rescue | - | 1 | - | - | - | - | - | - | - | - | 1 |
| 4 | False Alarm | 3 | - | - | - | - | - | - | - | - | - | 3 |
| 5 | Special Service | - | - | - | - | - | - | - | - | - | - | |
| | **SUPPOSED CAUSE** | | | | | | | | | | | |
| 1 | Electric Fault | 16 | 6 | 6 | - | - | 5 | - | - | - | - | 33 |
| 2 | Bush Burnings | - | - | 2 | - | - | - | - | - | - | - | 2 |
| 3 | Gas Explosion | - | - | - | - | - | 1 | - | - | - | - | 1 |
| 4 | Spark from car Battery | - | - | - | - | - | 1 | - | - | - | - | 1 |
| 5 | Still under investigation | 5 | 1 | - | - | - | - | - | - | - | - | 6 |
| 6 | Road traffic Accident | - | - | - | - | - | 1 | - | - | - | - | 1 |
| | **TYPE OF FIRE** | | | | | | | | | | | |
| 1 | Domestic | 16 | 7 | 8 | - | - | 6 | - | - | - | - | 37 |
| 2 | Petrol Tanker | - | - | - | - | - | 2 | - | - | - | - | 2 |
| 3 | Shops | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 4 | Market | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 5 | Bank | 1 | - | - | - | - | - | - | - | - | - | 1 |
| | **CASSUALTY** | | | | | | | | | | | |
| 1 | Nos. of live saved | - | - | - | - | - | - | - | - | - | - | |
| 2 | Nos. of Animal Saved | - | - | - | - | - | - | - | - | - | - | |
| 3 | Fatally Injured | - | - | - | - | - | 3 | - | - | - | - | 3 |

**ESTIMATED LOST:** One Billion, Two Hundred and Twenty Three Million, Nine Hundred and Ninety Thousand Naira (N1,223,990,000.00) Only

**ESTIMATED SAVED:** Two Billion, Six Hundred and Ninety Seven Million, Eight Hundred Thousand Naira (₦2,697,800,000.00) Only

CFS Isah M. Ibrahim
*Senior Fire Prevention Officer*

## THIRD QUARTER

## NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF JUNE - SEPTEMBER, 2018

| S/NO | | Minna Bosso Road, Tunga & Headquarters | BIDA | KUTIGI | KONTAGORA | SULEJA | AGAIE | KAGARA | KUTA | LAPAI | RIJAU | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of Calls | 29 | 7 | - | 6 | 4 | - | - | - | - | - | 46 |
| 2 | Fire Calls | 28 | 6 | - | 6 | 4 | - | - | - | - | - | 44 |
| 3 | Rescue | - | 1 | - | - | - | - | - | - | - | - | 1 |
| 4 | False Alarm | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 5 | Special Service | - | - | - | - | - | - | - | - | - | - | |
| | **SUPPOSED CAUSE** | | | | | | | | | | | |
| 1 | Electric Fault | 16 | 4 | - | 6 | 1 | - | - | - | - | - | 27 |
| 2 | Road Traffic Accident | - | 2 | - | - | 3 | - | - | - | - | - | 5 |
| 3 | Wiring Problem from Vehicle | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 4 | Abacha Stove (Charcoal Stove) | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 5 | Defective Generator | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 6 | Still under investigation | 3 | - | - | - | - | - | - | - | - | - | 3 |
| 7 | Over Heating from car battery | 2 | - | - | - | - | - | - | - | - | - | 2 |
| 8 | Gas Cooker | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 9 | Oil Spillage | 3 | - | - | - | - | - | - | - | - | - | 3 |
| | **TYPE OF FIRE** | | | | | | | | | | | |
| 1 | Domestic | 18 | 4 | - | 6 | - | - | - | - | - | - | 28 |
| 2 | Vehicle | 2 | 2 | - | - | - | - | - | - | - | - | 4 |
| 3 | Shops | 1 | - | - | - | 1 | - | - | - | - | - | 2 |
| 4 | Hospital | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 5 | Leakage of Fuel from Petrol Tanker | 1 | - | - | 3 | - | - | - | - | - | - | 4 |
| 6 | School | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 7 | Bank | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 8 | NNPC Depot Pago | 3 | - | - | - | - | - | - | - | - | - | 3 |
| | **CASSUALTY** | | | | | | | | | | | |
| 1 | Nos. of live saved | - | - | - | - | - | - | - | - | - | - | |
| 2 | Nos. of Animal Saved | - | - | - | - | - | - | - | - | - | - | |
| 3 | Fatally Injured | - | 1 | - | - | - | 3 | - | - | - | - | 4 |

**ESTIMATED LOST:** Six Hundred and Thirty Seven Million, Nine Hundred Thousand Naira (₦637,900,000.00) Only

**ESTIMATED SAVED:** One Billion, Two Hundred and Eight Four Million, Five Hundred Thousand Naira (₦1,284,500,000.00) Only

**CFS Isah M. Ibrahim**
*Senior Fire Prevention Officer*
*For: Director.*

FORTH QUARTER

NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF OCTOBER - DECEMBER, 2018

| S/NO | | Minna Bosso Road, Tunga & Headquarters | BIDA | KONTA GORA | KUTIGI | SULEJA | LAPAI | AGAIE | KUTA | KAGARA | RIJAU | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of Calls | 43 | 10 | 11 | - | 9 | - | - | - | - | - | 73 |
| 2 | Fire Calls | 39 | 10 | 11 | - | 8 | - | - | - | - | - | 68 |
| 3 | Rescue | - | - | - | - | 1 | - | - | - | - | - | 1 |
| 4 | False Alarm | 4 | - | - | - | - | - | - | - | - | - | 4 |
| 5 | Special Service | - | - | - | - | - | - | - | - | - | - | - |
| | **SUPPOSED CAUSE** | | | | | | | | | | | |
| 1 | Electric Fault | 18 | 10 | 11 | - | 5 | - | - | - | - | - | 44 |
| 2 | Bush Burning | 8 | - | - | - | - | - | - | - | - | - | 8 |
| 3 | Gas Cooker | 2 | - | - | - | 1 | - | - | - | - | - | 3 |
| 4 | Children Playing with Matches | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 5 | Generator | 2 | - | - | - | 1 | - | - | - | - | - | 3 |
| 6 | Arson/Political Violence | - | - | - | - | 1 | - | - | - | - | - | 1 |
| 7 | Still under investigation | 8 | - | - | - | - | - | - | - | - | - | 8 |
| | **TYPE OF FIRE** | | | | | | | | | | | |
| 1 | Domestic | 34 | 6 | 11 | - | 5 | - | - | - | - | - | 56 |
| 2 | Transformer | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 3 | Bush Burning | - | - | - | - | 1 | - | - | - | - | - | 1 |
| 4 | Horses Cave | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 5 | Vehicle | 2 | 2 | - | - | 1 | - | - | - | - | - | 5 |
| 6 | Tricycle | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 7 | Shops | - | 1 | - | - | 1 | - | - | - | - | - | 2 |
| 8 | Generator | - | 1 | - | - | - | - | - | - | - | - | 1 |
| | **CASSUALTY** | | | | | | | | | | | |
| 1 | Nos. of live saved | - | - | - | - | - | - | - | - | - | - | - |
| 2 | Nos. of Animal Saved | - | - | - | - | - | - | - | - | - | - | - |
| 3 | Fatally Injured | - | - | - | - | - | - | - | - | - | - | - |

**ESTIMATED LOST:** Three Hundred and Forty Seven Million, Twenty Thousand Naira (₦347,020,000.00) Only

**ESTIMATED SAVED:** One Billion, Three Hundred and Fifty Eight Million, four Hundred Thousand Naira (₦1,358,400,000.00) Only

**CFS Isah M. Ibrahim**
*Senior Fire Prevention Officer*
*For: Director.*

## APPENDIX G

## DATA ON FIRE ACCIDENT OCCURRENCES IN NIGER STATE YEAR, 2019

FIRST QUARTER

NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF JANUARY – MATCH 2019

| S/NO | | Minna | BIDA | KONTA GORA | SULEJA | KAGARA | KUTIGI | KUTA | LAPAI | AGAIE | MOKWA | NEW BUSSA | RIJAU | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of Calls | 87 | 16 | 15 | 20 | 4 | 1 | 1 | | | 1 | 1 | 1 | 147 |
| 2 | Fire Calls | 77 | 15 | 15 | 20 | 4 | 1 | 1 | | | 1 | 1 | 1 | 136 |
| 3 | Rescue | 1 | 1 | | | | | | | | | | | 2 |
| 4 | False Alarm | 9 | | | | | | | | | | | | 9 |
| 5 | Special Service | | | | | | | | | | | | | |
| | **SUPPOSED CAUSE** | | | | | | | | | | | | | |
| 1 | Electric Fault | 29 | 14 | 13 | 11 | 3 | | | | | 1 | 1 | 1 | 73 |
| 2 | Bush Burning | 11 | 1 | 1 | | | | | | | | | | 13 |
| 3 | Children Playing with Matches | 4 | | | 2 | | | | | | | | | 6 |
| 4 | Wiring Problem | | | | 1 | | | 1 | | | | | | 2 |
| 5 | Gas Cooker | 3 | | | | | | | | | | | | 3 |
| 6 | Charcoal From Kitchen | 4 | | | | | | | | | | | | 4 |
| 7 | Defective Kerosene Stove | 1 | | | | | | | | | | | | 1 |
| 8 | Spark from car Battery | 1 | | | 1 | | | | | | | | | 2 |
| 9 | Still under investigation | 16 | | | 1 | | | | | | | | | 17 |
| 10 | Road Traffic accident | 2 | | 1 | 2 | | | | | | | | | 5 |
| 11 | Defective Generator | 3 | | | 1 | | | | | | | | | 4 |
| 12 | Refuse Dump | 3 | | | | | | | | | | | | 3 |
| 13 | Candle Stick | | | | 1 | | | | | | | | | 1 |
| 14 | Arson | | | | | 1 | | | | | | | | 1 |
| | **TYPE OF FIRE** | | | | | | | | | | | | | |
| 1 | Domestic | 54 | 12 | 11 | 12 | 3 | | | | | 1 | | 1 | 94 |
| 2 | Vehicle | 5 | | | 4 | | | 1 | | | | | | 10 |
| 3 | Shops | 5 | 2 | 2 | 4 | 1 | 1 | | | | | | | 15 |
| 4 | Bush Burning | 3 | 1 | | | | | | | | | | | 4 |
| 5 | Power House | 1 | | | | | | | | | | | | 1 |
| 6 | School | 4 | | 1 | | | | | | | | | | 5 |
| 7 | Market | 1 | | | | | | | | | | | | 1 |
| 8 | Petrol Tanker | | | 1 | | | | | | | | | | 1 |
| 9 | Public Office | 1 | | | | | | | | | | | | 1 |
| 10 | Transformer | | | | | | | | | | | 1 | | 1 |
| 11 | Church | 1 | | | | | | | | | | | | 1 |
| 12 | Filling Station | | | | | | | | | | | | | |
| 13 | Generator | 1 | | | | | | | | | | | | 1 |
| 14 | Yam Bam | 1 | | | | | | | | | | | | 1 |
| | **CASSUALTY** | | | | | | | | | | | | | |
| 1 | Nos. of live saved | | | | | | | | | | | | | |
| 2 | Nos. of Animal Saved | | | | | | | | | | | | | |

ESTIMATED LOST: Four Hundred and Sixty Five Million, Two hundred and Ninety Thousand Naira (N465,290,000.00) Only

ESTIMATED SAVED: Five Billion, Six Hundred and Fifteen Million, Six Hundred and Fifty Thousand Naira (N5,615,650,000.00) Only

CFS Isah M. Ibrahim
*Senior Fire Prevention Officer*
*For: Director.*

## NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF APRIL 2019

| S/NO | | Minna | BIDA | KONTA GORA | KUTIGI | SULEJA | AGAIE | KAGARA | KUTA | LAPAI | RIJAU | NEW BUSSA | MOKWA | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of Calls | 33 | 4 | 8 | | 3 | | 1 | | | 1 | 1 | | 51 |
| 2 | Fire Calls | 31 | 2 | 8 | | 3 | | 1 | | | | | | 45 |
| 3 | Rescue | | | | | | | | | | 1 | 1 | | 2 |
| 4 | False Alarm | 2 | 2 | | | | | | | | | | | 4 |
| 5 | Special Service | | | | | | | | | | | | | |
| | **SUPPOSED CAUSE** | | | | | | | | | | | | | |
| 1 | Electric Fault | 16 | 1 | 7 | | | | 1 | | | | | | 25 |
| 2 | Bush Burning | 1 | | | | | | | | | | | | 1 |
| 3 | Wiring Problem | 1 | | | | | | | | | | | | 1 |
| 4 | Spark from car Battery | 1 | | | | | | | | | | | | 1 |
| 5 | Still under investigation | 3 | | | | | | | | | | | | 3 |
| 6 | Defective Generator | 1 | | | | 1 | | | | | | | | 2 |
| 7 | Candle Stick | 1 | | | | | | | | | | | | 1 |
| 8 | Air Freshener Stick | 1 | | | | | | | | | | | | 1 |
| 9 | Arson | 1 | | | | | | | | | | | | 1 |
| 10 | Charcoal Stove | 1 | | | | | | | | | | | | 1 |
| 11 | Children Playing with Matches | 2 | | | | | | | | | | | | 2 |
| 12 | Road Traffic accident | 1 | 1 | | | | | | | | | | | 2 |
| 13 | Defective Car Radiator | | | | | | | | | | | | | |
| 14 | Pressing Iron | | | | | 1 | | | | | | | | 1 |
| 15 | Leakage of Gas Cylinder | | | | | 1 | | | | | | | | 1 |
| 16 | Refilling of Tricycle in a filling Station | 1 | | | | | | | | | | | | 1 |
| 17 | Fire Wood | | | 1 | | | | | | | | | | 1 |
| | **TYPE OF FIRE** | | | | | | | | | | | | | |
| 1 | Domestic | 20 | | 8 | | 2 | | 1 | | | | | | 31 |
| 2 | Vehicle | 4 | 1 | | | 1 | | | | | | | | 6 |
| 3 | Shops | 1 | 1 | | | | | | | | | | | 2 |
| 4 | Bush Burning | 1 | | | | | | | | | | | | 1 |
| 5 | Public Office | 1 | | | | | | | | | | | | 1 |
| 6 | Bank | 1 | | | | | | | | | | | | 1 |
| 7 | Transformer | 1 | | | | | | | | | | | | 1 |
| 8 | Restaurant | 1 | | | | | | | | | | | | 1 |
| 9 | Generator | 1 | | | | | | | | | | | | |
| | **CASSUALTY** | | | | | | | | | | | | | |
| 1 | Nos. of live saved | | | | | | | | | | | | | |
| 2 | Nos. of Animal Saved | | | | | | | | | | | | | |
| 3 | Fatally Injured | | | | | | | | | | | | | |

## NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF MAY 2019

| S/NO | | Minna | BIDA | KONTA GORA | KUTIGI | SULEJA | AGAIE | KAGARA | KUTA | LAPAI | RIJAU | NEW BUSSA | MOKWA | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of Calls | 17 | | 4 | | 1 | | 2 | 2 | | | | 1 | 27 |
| 2 | Fire Calls | 14 | | 4 | | 1 | | | 2 | | | | 1 | 22 |
| 3 | Rescue | | | | | | | | | | | | | |
| 4 | False Alarm | 3 | | | | | | 2 | | | | | | 5 |
| 5 | Special Service | | | | | | | | | | | | | |
| | **SUPPOSED CAUSE** | | | | | | | | | | | | | |
| 1 | Electric Spark | 9 | | 3 | | | | | | | | | 1 | 13 |
| 2 | Cigarette end | 1 | | | | | | | | | | | | 1 |
| 3 | Reckless driving | 1 | | | | | | | | | | | | 1 |
| 4 | Over Heating | 1 | | | | | | | | | | | | 1 |
| 5 | Wiring Problem | 2 | | | | | | | | | | | | 1 |
| 6 | Electric high Tension Cut off | | | | | | | | 1 | | | | | 1 |
| 7 | Defective Stove | | | | | 1 | | | | | | | | 1 |
| 8 | Under Investigation | | | | | | | | 1 | | | | | 1 |
| 9 | Children Playing with naked fire | | | 1 | | | | | | | | | | 1 |
| | **TYPE OF FIRE** | | | | | | | | | | | | | |
| 1 | Domestic | 8 | | 3 | | 1 | | | 1 | | | | | 13 |
| 2 | Vehicle | 4 | | | | | | | | | | | | 4 |
| 3 | Market | 1 | | | | | | | | | | | | 1 |
| 4 | Meter | 1 | | | | | | | | | | | | 1 |
| 5 | Bush Burning | | | | | | | | 1 | | | | | 1 |
| 6 | Public School | | | 1 | | | | | | | | | 1 | 2 |
| | **CASSUALTY** | | | | | | | | | | | | | |
| 1 | Nos. of live saved | | | | | | | | | | | | | |
| 2 | Nos. of Animal Saved | | | | | | | | | | | | | |
| 3 | Fatally Injured | | | | | | | | | | | | | |

**Estimated Lost:** Eighty Million, Eight hundred and One Thousand Naira (₦80,801,000.00) Only
**Estimated Saved**: Two Hundred and Ninety Six Million, Five Hundred and Seventy Two Thousand, Six Hundred Naira (₦296,572,600.00) Only

**CFS Isah M. Ibrahim**
*Senior Fire Prevention Officer*
*For: Ag. Director.*

## NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF JUNE 2019

| S/NO | | Minna | BIDA | KONTA GORA | KUTIGI | SULEJA | AGAIE | KAGARA | KUTA | LAPAI | RIJAU | NEW BUSSA | MOKWA | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of Calls | 8 | 3 | 5 | 2 | 6 | | | 4 | 1 | | | 3 | 32 |
| 2 | Fire Calls | 7 | 3 | 5 | | 6 | | | 3 | 1 | | | 3 | 28 |
| 3 | Rescue | | | | 1 | | | | | | | | | 1 |
| 4 | False Alarm | 1 | | | 1 | | | | 1 | | | | | 3 |
| 5 | Special Service | | | | | | | | | | | | | |
| | **SUPPOSED CAUSE** | | | | | | | | | | | | | |
| 1 | Electric Spark | 6 | 2 | 4 | | 5 | | | 2 | 1 | | | | 20 |
| 2 | Road Traffic Accident | 1 | | | | | | | | | | | 1 | 2 |
| 3 | Glowing ember of left over hot Charcoal | | 1 | 1 | | | | | | | | | | 2 |
| 4 | Yet to be Known | | | | | 1 | | | | | | | | 1 |
| 5 | Mechanical Fault | | | | | | | | 1 | | | | | 1 |
| 6 | Defective Grinding Engine | | | | | | | | | | | | 1 | 1 |
| 7 | Explosion of petrol from Jerry can | | | | | | | | | | | | 1 | 1 |
| | **TYPE OF FIRE** | | | | | | | | | | | | | |
| 1 | Domestic | 6 | | 4 | | 4 | | | 2 | | | | | 16 |
| 2 | Vehicle | 1 | | | | | | | 1 | | | | 1 | 3 |
| 3 | Shop | | 2 | 1 | | | | | | | | | 1 | 4 |
| 4 | Restaurant | | 1 | | | | | | | | | | | 1 |
| 5 | Transform | | | | | 1 | | | | | | | | 1 |
| 6 | Electric Pole | | | | | 1 | | | | 1 | | | | 2 |
| 7 | Market | | | | | | | | | | | | 1 | 1 |
| | **CASSUALTY** | | | | | | | | | | | | | |
| 1 | Nos. of live saved | | | | | | | | | | | | | |
| 2 | Nos. of Animal Saved | | | | | | | | | | | | | |
| 3 | Fatally Injured | | | | | | | | | | | | 3 | 3 |

**Estimated Lost:** Eleven Million, Two hundred and Fifty Thousand Naira (₦11,215,000.00) Only

**Estimated Saved**: One Hundred and Thirty Four Million, Five Hundred Naira (₦134,500,000.00) Only

**CFS Isah M. Ibrahim**
*Senior Fire Prevention Officer*
*For: Ag. Director.*

## NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF JULY, 2019

| S/NO | | Minna | BIDA | KONTA GORA | KUTIGI | SULEJA | AGAIE | KAGARA | KUTA | LAPAI | RIJAU | NEW BUSSA | MOKWA | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of Calls | 10 | 4 | 6 | | 14 | | | | | | | 3 | 37 |
| 2 | Fire Calls | 10 | 2 | 5 | | 14 | | | | | | | 3 | 34 |
| 3 | Rescue | | 2 | 1 | | | | | | | | | | 3 |
| 4 | False Alarm | | | | | | | | | | | | | |
| 5 | Special Service | | | | | | | | | | | | | |
| | **SUPPOSED CAUSE** | | | | | | | | | | | | | |
| 1 | Electric Spark | 6 | 2 | 4 | | 6 | | | | | | | 1 | 19 |
| 2 | Gas explosion | 1 | | | | 1 | | | | | | | | 2 |
| 3 | Inverter | 1 | | | | | | | | | | | | 1 |
| 4 | Children playing with matches | 1 | | | | | | | | | | | | 1 |
| 5 | Wiring problem | 1 | | 1 | | | | | | | | | | 2 |
| 6 | Road Traffic Accident | | | | | 7 | | | | | | | 2 | 9 |
| | **TYPE OF FIRE** | | | | | | | | | | | | | |
| 1 | Domestic | 7 | | 4 | | 7 | | | | | | | 1 | 19 |
| 2 | Vehicle | 1 | | 1 | | 7 | | | | | | | 2 | 11 |
| 3 | Office | | | | | | | | | | | | | |
| 4 | Police Station | 1 | | | | | | | | | | | | 1 |
| 5 | Transformer | | 1 | | | | | | | | | | | 1 |
| 6 | High Tension cut off | 1 | | | | | | | | | | | | 1 |
| 7 | Shop | | 1 | | | | | | | | | | | 1 |
| | **CASSUALTY** | | | | | | | | | | | | | |
| 1 | Nos. of live saved | | 1 | 1 | | | | | | | | | | 2 |
| 2 | Nos. of Animal Saved | | 1 | | | | | | | | | | | 1 |
| 3 | Fatally Injured | | | | | | | | | | | | | |

**Estimated Lost:** One Hundred and Ten Million, Six hundred Thousand Naira (₦110,600,000.00) Only

**Estimated Saved**: Six Hundred and Eighty Seven Million, Nine Hundred and Fifty Thousand Naira (₦687,950,000.00) Only

**CFS Isah M. Ibrahim**
*Senior Fire Prevention Officer*
*For: Controller.*

# NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF AUGUST, 2019

| S/NO | | Minna | BIDA | KONTA GORA | KUTIGI | SULEJA | AGAIE | KAGARA | KUTA | LAPAI | RIJAU | NEW BUSSA | MOKWA | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of Calls | 7 | | 2 | 1 | 3 | | 1 | | | | | 2 | 16 |
| 2 | Fire Calls | 6 | | 2 | 1 | 3 | | 1 | | | | | 2 | 15 |
| 3 | Rescue | | | | | | | | | | | | | |
| 4 | False Alarm | 1 | | | | | | | | | | | | 1 |
| 5 | Special Service | | | | | | | | | | | | | |
| | **SUPPOSED CAUSE** | | | | | | | | | | | | | |
| 1 | Electric Spark | 4 | | 2 | 1 | 1 | | 1 | | | | | 1 | 10 |
| 2 | Battery Spark | 1 | | | | | | | | | | | 1 | 2 |
| 3 | Still under Investigation | 1 | | | | | | | | | | | | 1 |
| 4 | Road traffic accident | | | | | 1 | | | | | | | | 1 |
| 5 | Off leading | | | | | 1 | | | | | | | | 1 |
| | **TYPE OF FIRE** | | | | | | | | | | | | | |
| 1 | Domestic | 4 | | 2 | 1 | | | 1 | | | | | | 8 |
| 2 | Vehicle | 1 | | | | | | | | | | | 1 | 1 |
| 3 | Shop | | | | | 1 | | | | | | | 1 | 2 |
| 4 | Tanker | | | | | 2 | | | | | | | | 3 |
| 5 | Office | 1 | | | | | | | | | | | | 1 |
| | **CASSUALTY** | | | | | | | | | | | | | |
| 1 | Nos. of live saved | | | | | 7 | | | | | | | | 7 |
| 2 | Nos. of Animal Saved | | | | | | | | | | | | | |
| 3 | Fatally Injured | | | | | 1 | | | | | | | | 1 |

**Estimated Lost:** One Hundred and One Million, Two hundred Thousand Naira (₦101,200,000.00) Only

**Estimated Saved:** Six Hundred and Twenty Million, Eight Hundred and Fifty Thousand Naira (₦620,850,000.00) Only

**CFS Isah M. Ibrahim**
*Senior Fire Prevention Officer*
*For: Controller.*

## NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF SEPTEMBER, 2019

| S/NO | | Minna | BIDA | KONTA GORA | KUTIGI | SULEJA | AGAIE | KAGARA | KUTA | LAPAI | RIJAU | NEW BUSSA | MOKWA | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of Calls | 15 | | | | 4 | | 1 | | | | | 1 | 21 |
| 2 | Fire Calls | 15 | | | | 13 | | | | | | | 1 | 19 |
| 3 | Rescue | | | | | 1 | | 1 | | | | | | 2 |
| 4 | False Alarm | | | | | | | | | | | | | |
| 5 | Special Service | | | | | | | | | | | | | |
| | **SUPPOSED CAUSE** | | | | | | | | | | | | | |
| 1 | Electric Spark | 10 | | | | 1 | | | | | | | | 11 |
| 2 | Gas Cooker | | | | | 1 | | | | | | | | 1 |
| 3 | Inverter Battery | | | | | 1 | | | | | | | | 1 |
| 4 | Road traffic accident | 1 | | | | | | | | | | | 1 | 2 |
| 5 | Still under investigation | 3 | | | | | | | | | | | | 3 |
| 6 | Defective Generator | | | | | | | | | | | | | |
| 7 | Mosquito Coil | 1 | | | | | | | | | | | | 1 |
| | **TYPE OF FIRE** | | | | | | | | | | | | | |
| 1 | Domestic | 7 | | | | 2 | | | | | | | | 9 |
| 2 | Vehicle | 1 | | | | 1 | | | | | | | | 1 |
| 3 | Shop | 1 | | | | | | | | | | | | 2 |
| 4 | Petrol Tanker | 1 | | | | | | | | | | | 1 | 2 |
| 5 | Office | 2 | | | | | | | | | | | | 2 |
| 6 | Market | 1 | | | | | | | | | | | | 1 |
| 7 | Motor Cycle | 1 | | | | | | | | | | | | 1 |
| 8 | Generator | 1 | | | | | | | | | | | | 1 |
| | **CASSUALTY** | | | | | | | | | | | | | |
| 1 | Nos. of live saved | | | | | | | | | | | | 1 | 1 |
| 2 | Nos. of Animal Saved | | | | | | | | | | | | | |
| 3 | Fatally Injured | | | | | | | | | | | | | |

**Estimated Lost:** Two Hundred and Sixty Four Million, Three Hundred Thousand Naira (₦264,300,000.00) only.

**Estimated Saved**: Eight Hundred and One million, One Hundred and Ninety Eight thousand, Two Hundred and Ten Naira (₦801,198,210.00) only.

**CFS Isah M. Ibrahim**
*Senior Fire Prevention Officer*
*For: Controller.*

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# NIGER STATE FIRE/RESCUE REPORT FOR THE MONTH OF OCTOBER-DECEMBER, 2019

| S/N | | Minna | BIDA | KONTA-GORA | KUTIGI | SULEJA | KAGARA | KUTA | LAPAI | RIJAU | NEW BUSSA | AGAIE | MOK-WA | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of Calls | 48 | 11 | 13 | | 18 | 4 | | | | 11 | | 5 | 110 |
| 2 | Fire Calls | 42 | 10 | 11 | | 16 | 2 | | | | 10 | | 5 | 96 |
| 3 | Rescue | | | 2 | | 1 | 1 | | | | | | | 4 |
| 4 | False Alarm | 3 | 1 | | | 1 | | | | | 1 | | | 6 |
| 5 | Special Service | 3 | | | | | 1 | | | | | | | 4 |
| | **SUPPOSED CAUSE** | | | | | | | | | | | | | |
| 1 | Electric spark | 20 | 6 | 10 | | 7 | | | | | 8 | | | 51 |
| 2 | Bush Burning | | 4 | | | | | | | | 2 | | 1 | 7 |
| 3 | Children Playing with Matches | 2 | | | | 1 | | | | | | | | 3 |
| 4 | Wiring Problem | 3 | | 1 | | | | | | | | | 1 | 5 |
| 5 | Defective Gas Cooker | 1 | | | | 3 | | | | | | | | 4 |
| 6 | Glowing ember of left over hot charcoal | | | | | | | | | | | | 1 | 1 |
| 7 | Defective Kerosene Stove | 1 | | | | | | | | | | | | 1 |
| 8 | Spark from Car Battery | | | | | 1 | | | | | | | | 1 |
| 9 | Still Under investigation | 1 | | | | | | | | | | | | 1 |
| 10 | Road Traffic accident | 5 | | | | 4 | | | | | | | | 9 |
| 11 | Defective Generator | 2 | | | | 1 | | | | | | | | 3 |
| 12 | Refuse Dump | 4 | | | | | 1 | | | | | | | 5 |
| 13 | Electric pole cable | 1 | | | | | | | | | | | | 1 |
| 14 | Over heating from car radiator | | | | | | 1 | | | | | | | 1 |
| 15 | Welding works | | | | | | | | | | | | 1 | 1 |
| 16 | Explosion of petrol from Jeri can | | | | | | | | | | | | 1 | 1 |
| 17 | Arson | | | | | 1 | | | | | | | | 1 |
| | **TYPES OF FIRE** | | | | | | | | | | | | | |
| 1 | Domestic | 20 | 6 | 10 | | 7 | | | | | 7 | | | 50 |
| 2 | Vehicle | 3 | | 1 | | 1 | 1 | | | | | | 1 | 7 |
| 3 | Shop | 5 | | | | 5 | | | | | 1 | | 1 | 12 |
| 4 | Bush Burning | 2 | 4 | | | | | | | | 2 | | 1 | 9 |
| 5 | School | 1 | | | | | | | | | | | | 1 |
| 6 | Petrol Tanker | | | | | 6 | | | | | | | 1 | 7 |
| 7 | Church | 1 | | | | | | | | | | | | 1 |
| 8 | Electric Pole | 1 | | | | | | | | | | | | 1 |
| 9 | Timber Shade | | | | | | | | | | | | 1 | 1 |
| 10 | Mobile Mast | 1 | | | | | | | | | | | | 1 |
| 11 | Tree Burning | 2 | | | | | 1 | | | | | | | 3 |
| 12 | Public Office | 1 | | | | | | | | | 2 | | | 3 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | Vehicle | 18 | 1 | 1 | | 13 | | 2 | | | | | 61 | |
| 3 | Shop | 7 | 6 | 3 | 1 | 5 | 1 | | | | | | .4 | 39 |
| 4 | Bush Burning | 4 | 1 | | | | | | | | | | .2 | 25 |
| 5 | Power House | 1 | | | | | | | | | | | | 6 |
| 6 | School | 4 | | 2 | | | | | | | | | | 1 |
| 7 | Market | 2 | | | | | | | | | | | 1 | 5 |
| 8 | Petrol Tanker | | | 1. | | 2 | | | | | | | 1. | 3 |
| 9 | Public Office | 3 | | | | | | | | | | | | 3 |
| 10 | Transformer | 1 | | | | 1 | | | | | | | | 3 |
| 11 | Church | 2 | | | | | | | | 1 | | | | 3 |
| 12 | Generator | 2 | | | | | | | | | | | | 2 |
| 13 | Yam Bam | 1 | | | | | | | | | | | | 2 |
| 14 | Restaurant | 1 | 1 | | | | | | | | | | | 1 |
| 15 | Bank | 1 | | | | | | | | | | | | 2 |
| 16 | Electric Pole | | | | | 1 | | | 1 | | | | | 1 |
| 17 | Meter | 1 | | | | | | | | | | | | 2 |
| 18 | Motor Cycle | 1 | | | | | | | | | | | | 1 |
| 19 | High Tension Cut off | 1 | | | | | | | | | | | | 1 |
| | CASSUALTY | | | | | | | | | | | | | 1 |
| 1 | Nos. of live saved | | 1 | 1 | | 7 | | | | | | | | |
| 2 | Nos. of Animal Saved | | 1 | | | | | | | | | | 1 | 10 |
| 3 | Fatally Injured | 6 | | | | 1 | | | | | | | | 1 |
| | | | | | | | | | | | | | 3 | 10 |

**Estimated Lost:** Nine Hundred and Thirty Million, Nine Hundred and Twenty Three Thousand Naira (₦930,923,000.00) only.

**Estimated Saved**: Four Billion, One Hundred and Seventy Four Million, Nine Hundred and Seven thousand, Six Hundred Naira (₦4,174,907,600.00) only.

**CFS Isah M. Ibrahim**
*Senior Fire Prevention Officer*
*For: Controller.*

## APPENDIX H

## DATA ON FIRE ACCIDENT OCCURRENCES IN NIGER STATE YEAR, 2020

### NIGER STATE FIRE/RESCUE REPORT FOR FIRST QUARTER JANUARY - MARCH, 2020

| S/N 0 | | Minna | BIDA | KONTA GORA | KUTIGI | SULEJA | KAGARA | KUTA | LAPAI | RIJAU | NEW BUSSA | AGAIE | MOKWA | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of Calls | 102 | 10 | 47 | 2 | 50 | 4 | | 1 | 10 | 2 | | 8 | 236 |
| 2 | Fire Calls | 95 | 10 | 47 | 2 | 49 | 4 | - | 1 | 9 | 2 | - | 6 | 225 |
| 3 | Rescue | | | | | | | | | 1 | | | | 1 |
| 4 | False Alarm | 7 | | | | 1 | | | | | | | | 8 |
| 5 | Special Service | | | | | | | | | | | | 2 | 2 |
| | **SUPPOSED CAUSE** | | | | | | | | | | | | | |
| 1 | Electric Spark | 37 | 9 | 23 | | 26 | 4 | | | 5 | | | 2 | 106 |
| 2 | Bush Burning | 24 | | 9 | | | | | 1 | 2 | 1 | | | 37 |
| 3 | Children Playing with Matches | 3 | | 1 | | 5 | | | | | 1 | | | 10 |
| 4 | Wiring Problem | 4 | | 1 | | 1 | | | | | | | | 6 |
| 5 | Gas Cooker | 4 | | | | 3 | | | | | | | | 7 |
| 6 | Glowing ember of left over hot charcoal | | | 4 | | 5 | | | | 1 | | | | 10 |
| 7 | Defective Kerosene Stove | 2 | | 1 | | | | | | | | | | 3 |
| 8 | Spark from Car Battery | | | | | 2 | | | | | | | | 2 |
| 9 | Still Under investigation | 9 | | 1 | | 3 | | | | | | | | 13 |
| 10 | Road Traffic accident | 1 | | | 2 | | | | | | | | 3 | 6 |
| 11 | Defective Generator | 4 | | | | 2 | | | | | | | | 6 |
| 12 | Refuse Dump | 3 | | 4 | | 1 | | | | | | | | 8 |
| 13 | Air Conditioner | 1 | | | | | | | | | | | | 1 |
| 14 | Welding Works | 1 | | | | | | | | | | | | 1 |
| 15 | Pressing Iron | 1 | | | | | | | | | | | | 1 |
| 16 | Leakage of Gas Cylinder | | | | | 1 | | | | | | | | 1 |
| 17 | Refilling of tricycle in a filling station | | | 1 | | | | | | | | | | 1 |
| 18 | Fire wood | 1 | | 2 | | | | | | 1 | | | | 4 |
| 19 | Defective Car radiator | | | | | | | | | | | | 1 | 1 |
| 20 | Suspected Arson | | 1 | | | | | | | | | | | 1 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **TYPE OF FIRE** | | | | | | | | | | | | | |
| | Domestic | 61 | 9 | 29 | | 29 | 4 | | | 7 | 1 | | 2 | 142 |
| 2 | Vehicle | 6 | | 2 | 2 | 10 | | | | | | | 3 | 23 |
| 3 | Shop | 6 | | 6 | | 6 | | | 1 | | | | | 19 |
| 4 | Bush Burning | 11 | | 5 | | 3 | | | | 1 | | | | 20 |
| 5 | Power House | 4 | | 1 | | | | | | | | | | 5 |
| 6 | Market | | | | | | | | | 1 | | | | 1 |
| 7 | Petrol Tanker | | | 1 | | | | | | | | | | 1 |
| 8 | Public Office | 3 | 1 | | | | | | | | | | | 4 |
| 9 | Church | | | | | | | | | | | | 1 | 1 |
| 10 | Generator | 2 | | | | | | | | | | | | 2 |
| 11 | Yam Barn | 1 | | | | | | | | | | | | 1 |
| 12 | Donkey House | | | 1 | | | | | | | | | | 1 |
| 13 | Gas Cooker | | | 1 | | | | | | | | | | 1 |
| 14 | Hotel | 1 | | | | | | | | | | | | 1 |
| 15 | Farm | | | 1 | | | | | | | | | | 1 |
| 16 | Refuse Dump | | | | | 1 | | | | | 1 | | | 2 |
| | **CASUALTY** | | | | | | | | | | | | | |
| 1 | No. of lives saved | | | | | | | | | | | | | |
| 2 | No. of Animals Saved | | | | | | | | | | | | | |
| 3 | Fatally Injured | | | | | | | | | | | | | |

**Estimated Lost:** Two Billion, Seven Hundred and Sixty Eight Million, Two Hundred and Fifty Nine Thousand, One Hundred and Fifty Five Naira (₦2,768,259,155.00) only.

**Estimated Saved**: Twelve Billion, Three Hundred and Eight Million, One Hundred and THREE thousand, Two Hundred Naira (₦12,308,103,200.00) only.

**ACF Isah M. Ibrahim**
*Senior Fire Prevention Officer*
*For: Controller.*

# NIGER STATE FIRE / RESCUE REPORT FOR SECOND QUARTER, APRIL-JUNE 2020.

| S/N. | | Minna | BIDA | KONTA GORA | KUTIGI | SULEJA | KAGARA | KUTA | LAPAI | RIJAU | NEW BUSSA | AGAIE | MOK WA | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of Calls | 51 | 7 | 11 | - | 21 | 4 | - | - | - | 2 | - | 4 | 100 |
| 2 | Fire Calls | 49 | 7 | 9 | - | 17 | 4 | - | - | - | 2 | - | 4 | 92 |
| 3 | Rescue | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 |
| 4 | False Alarm | 2 | - | 2 | - | 3 | - | - | - | - | - | - | - | 7 |
| 5 | Special Service | | | | | | | | | | | | | |
| | SUPPOSED CAUSE | | | | | | | | | | | | | |
| 1 | Electric spark | 31 | 5 | 8 | - | 4 | 2 | - | - | - | 2 | - | 2 | 54 |
| 2 | Bush Burning | 2 | 2 | - | - | 3 | 1 | - | - | - | - | - | - | 8 |
| 3 | Children Playing with Matches | 1 | - | - | - | 1 | - | - | - | - | - | - | - | 2 |
| 4 | Wiring Problem | 2 | - | - | - | - | - | - | - | - | - | - | - | 2 |
| 5 | Defective Generator | 2 | - | 1 | - | 1 | - | - | - | - | - | - | - | 4 |
| 6 | Glowing ember of left over hot charcoal | 2 | - | - | - | - | - | - | - | - | - | - | - | 2 |
| 7 | Bull Eye | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 |
| 8 | Defective Kerosene Stove | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 |
| 9 | Spark from Car Battery | - | - | - | - | 1 | - | - | - | - | - | - | 1 | 2 |
| 10 | Still Under investigation | 2 | - | - | - | 2 | - | - | - | - | - | - | - | 4 |
| 11 | Road Traffic accident | 2 | - | - | - | 2 | - | - | - | - | - | - | 1 | 5 |
| 12 | Defective Gas Cylinder | - | - | - | - | 2 | - | - | - | - | - | - | - | 2 |
| 13 | Defective Inverter Battery | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 |
| 14 | Candle Stick | 2 | - | - | - | - | - | - | - | - | - | - | - | 2 |
| 15 | Armor Cable | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 |
| 16 | Burning Refuse Dump | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 |
| | TYPES OF FIRE | | | | | | | | | | | | | |
| 1 | Domestic | 30 | 2 | 8 | - | 7 | 1 | - | - | - | - | - | 2 | 50 |
| 2 | Vehicle | 5 | 1 | - | - | 2 | - | - | - | - | - | - | 1 | 9 |
| 3 | Shop | 6 | 1 | - | - | 1 | - | - | - | - | - | - | - | 8 |
| 4 | Bush Burning | 1 | - | - | - | 1 | 1 | - | - | - | - | - | - | 3 |
| 5 | School | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 |
| 6 | Mosque | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 |
| 7 | Petrol Tanker | - | - | - | - | 1 | - | - | - | - | - | - | 1 | 2 |
| 8 | Church | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 |
| 9 | Electric Pole | 4 | - | - | - | - | - | - | - | - | - | - | - | 4 |
| 10 | Market | 1 | 1 | - | - | - | - | - | - | - | - | - | - | 2 |
| 11 | Sport complex | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 |
| 12 | Tree Burning | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 |
| 13 | Public Office | 1 | 1 | - | - | - | - | - | - | - | - | - | - | 2 |
| 14 | Transformer | | | | | 1 | 1 | | | | 2 | | | 4 |

86

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | Defective Gas Cooker | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 |
| 16 | Refuse Dump | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 |
| 1[illegible] | Generator | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 |
| | **CASUALTY** | | | | | | | | | | | | | |
| 1 | No.of lives saved | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 2 | No.of animal saved | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 3 | Fatally injured | 4 | - | - | - | 3 | - | - | - | - | - | - | - | 7 |

**Estimated Lost:** One Billion, Two Hundred and Forty One Million, One Hundred and Seventy Six Thousand, Four Hundred Naira (**₦1,241,176,400.00**) Only.

**Estimated Saved:** Four Billion, Eight Hundred and Seventy Six Million, Four Hundred and Ninety Eight Thousand, Four Hundred Naira (**₦4,876,498,400.00**) Only.

**ACF Isah M. Ibrahim**
*Senior Fire Prevention Officer*
*For: Controller.*

# NIGER STATE FIRE / RESCUE REPORT FOR THIRD QUARTER, JULY-SEPTEMBER 2020.

| S/. | | Minna | BIDA | KONTA GORA | KUTIGI | SULEJA | KAGARA | KUTA | LAPAI | RIJAU | NEW BUSSA | AGAIE | MOK WA | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of Calls | 21 | 3 | 13 | - | 23 | 1 | - | 1 | - | 4 | - | 6 | 72 |
| 2 | Fire Calls | 15 | 2 | 11 | - | 20 | 1 | - | 1 | - | 4 | - | 6 | 60 |
| 3 | Rescue | - | 1 | 1 | - | 2 | - | - | - | - | - | - | - | 4 |
| 4 | False Alarm | 6 | - | 1 | - | 1 | - | - | - | - | - | - | - | 8 |
| 5 | Special Service | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | SUPPOSED CAUSE | | | | | | | | | | | | | |
| 1 | Electric spark | 12 | 2 | 6 | - | 1 | 1 | - | 1 | - | 3 | - | 2 | 28 |
| 2 | Defective Inverter Battery | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 3 | Children Playing with Matches | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 |
| 4 | Armor Cable | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 5 | Gas Cylinder Explosion | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 |
| 6 | Welding Works | - | - | 1 | - | 1 | - | - | - | - | - | - | - | 2 |
| 7 | Refueling Generator While Working | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 |
| 8 | Defective Kerosene Stove | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 9 | Spark from Car Battery | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 |
| 10 | Still Under investigation | - | - | - | - | 2 | - | - | - | - | - | - | - | 2 |
| 11 | Road Traffic accident | 2 | - | 1 | - | 9 | - | - | - | - | 1 | - | 4 | 17 |
| 12 | Electric Fault | - | - | - | - | 4 | - | - | - | - | - | - | - | 4 |
| | TYPES OF FIRE | | | | | | | | | | | | | |
| 1 | Domestic | 9 | - | 6 | - | 6 | - | - | 1 | - | 3 | - | 2 | 27 |
| 2 | Vehicle | - | 2 | 1 | - | 1 | - | - | - | - | - | - | 1 | 5 |
| 3 | Shop | 3 | - | 2 | - | 1 | - | - | - | - | - | - | - | 6 |
| 4 | Transformer | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 |
| 5 | Office | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 |
| 6 | Supermarket | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 |
| 7 | Petrol Tanker | 2 | - | 1 | - | 10 | - | - | - | - | - | - | 3 | 16 |
| 8 | Hospital | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 9 | Electric Pole | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 |
| 10 | Generator | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 |
| | CASUALTY | | | | | | | | | | | | | |
| 1 | No.of lives saved | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 2 | No.of animal saved | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 3 | Fatally injured | - | 1 | 1 | - | 1 | - | - | - | - | - | - | 5 | 8 |

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**Estimated Lost:** One Billion, Six Hundred and Eighty Million, Five Hundred and Twenty Seven Thousand, Three Hundred Naira **(N1,680,527,300.00)** Only.

**Estimated Saved:** Three Billion, Eight Hundred and Fourteen Million, Three Hundred and Forty Four Thousand, Two Hundred Naira **(N3,814,344,200.00)** Only.

**ACF Isah M. Ibrahim**
*Senior Fire Prevention Officer*
*For: Controller.*

# NIGER STATE FIRE/RESCUE REPORT FOR THE MONTHS OF JANUARY - DECEMBER, 2020

| S/N | | Minna | BIDA | KONTA GORA | KUTIGI | SULEJA | KAGARA | KUTA | LAPAI | RIJAU | NEW BUSSA | AGAIE | MOKWA | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of Calls | 225 | 28 | 81 | 2 | 113 | 13 | - | 6 | 11 | 14 | - | 20 | 513 |
| 2 | Fire Calls | 200 | 26 | 77 | 2 | 100 | 13 | - | 6 | 10 | 13 | - | 18 | 465 |
| 3 | Rescue | - | 2 | 1 | - | 5 | - | - | - | 1 | 1 | - | - | 10 |
| 4 | False Alarm | 25 | - | 3 | - | 8 | - | - | - | - | - | - | - | 36 |
| 5 | Special Service | - | - | - | - | - | - | - | - | - | - | - | 2 | 2 |
| | **SUPPOSED CAUSE** | | | | | | | | | | | | | |
| 1 | Electric Spark | 117 | 22 | 47 | - | 36 | 10 | - | 1 | 5 | 6 | - | 6 | 250 |
| 2 | Bush Burning | 26 | 2 | 9 | - | 3 | 2 | - | 1 | 2 | 4 | - | - | 49 |
| 3 | Children Playing with Matches | 4 | - | 1 | 7 | - | - | - | - | - | 1 | - | 1 | 14 |
| 4 | Wiring Problem | 6 | - | 1 | - | 1 | - | - | - | - | - | - | - | 8 |
| 5 | Defective Gas Cooker | 6 | 1 | - | - | 5 | - | - | - | - | - | - | - | 12 |
| 6 | Glowing ember of left over hot charcoal | 3 | - | 4 | - | 5 | - | - | - | 1 | - | - | - | 13 |
| 7 | Defective Kerosene Stove | 3 | - | 2 | - | - | - | - | - | 1 | - | - | - | 6 |
| 8 | Spark from Car Battery | - | - | - | - | 4 | - | - | - | - | - | - | 1 | 5 |
| 9 | Still Under investigation | 10 | - | 1 | - | 10 | - | - | - | - | - | - | - | 21 |
| 10 | Road Traffic accident | 7 | - | 1 | 2 | 15 | - | - | 4 | - | 2 | - | 9 | 40 |
| 11 | Defective Generator | 7 | - | 1 | - | 5 | - | - | - | - | - | - | - | 13 |
| 12 | Refuse Dump | 3 | - | 4 | - | 2 | 1 | - | - | - | - | - | - | 10 |
| 13 | Defective Car radiator | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 |
| 14 | Welding Works | 1 | - | 1 | - | 1 | - | - | - | - | - | - | - | 3 |
| 15 | Candle Stick | 2 | - | - | - | - | - | - | - | - | - | - | - | 2 |
| 16 | Defective Inverter Battery | 2 | - | 1 | - | - | - | - | - | - | - | - | - | 3 |
| 17 | Pressing Iron | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 |
| 18 | Fire wood | 1 | - | 2 | - | - | - | - | - | 1 | - | - | - | 4 |
| 19 | Armored Cable | - | - | 1 | - | 1 | - | - | - | - | - | - | - | 2 |
| 20 | Refilling Tricycle | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 21 | Electric fault | - | - | - | - | 4 | - | - | - | - | - | - | - | 4 |
| 22 | Transformer | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 |
| 23 | Suspected Arson | - | 1 | - | - | 1 | - | - | - | - | - | - | - | 2 |

| | TYPE OF FIRE | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Domestic | 129 | 18 | 51 | - | 51 | 6 | - | 1 | 6 | 8 | - | 7 | 277 |
| 2 | Vehicle | 12 | 3 | 3 | 2 | 16 | - | - | - | - | 1 | - | 5 | 42 |
| 3 | Shop | 23 | 2 | 10 | - | 8 | 1 | - | 1 | - | - | - | - | 45 |
| 4 | Bush Burning | 12 | - | 5 | - | 4 | 1 | - | - | 3 | 3 | - | - | 28 |
| 5 | School | - | - | - | - | - | 1 | - | - | - | 1 | - | - | 2 |
| 6 | Market | 3 | 1 | - | - | - | 1 | - | - | 1 | - | - | - | 6 |
| 7 | Petrol Tanker | 3 | - | 2 | - | 13 | - | - | 4 | - | - | - | 5 | 27 |
| 8 | Public Office | 4 | 2 | - | - | - | 1 | - | - | - | - | - | - | 7 |
| 9 | Church | - | 1 | - | - | - | - | - | - | - | - | - | 1 | 2 |
| 10 | Donkey house | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 11 | Electric Pole | 4 | - | - | - | 2 | - | - | - | - | - | - | - | 6 |
| 12 | Tree Burning | - | - | - | - | 3 | - | - | - | - | - | - | - | 3 |
| 13 | Gas Cooker | - | - | 1 | - | 1 | - | - | - | - | - | - | - | 2 |
| 14 | Defective Generator | 2 | - | - | - | - | - | - | - | - | - | - | - | 2 |
| 15 | Power House | 4 | - | 1 | - | - | - | - | - | - | - | - | - | 5 |
| 16 | Yam Ban | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 |
| 17 | Hotel | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 |
| 18 | Refuse Dump | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 19 | Sport Complex | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 |
| 20 | Transformer | 1 | - | - | - | 1 | - | - | - | - | - | - | - | 2 |
| 21 | Mosque | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 |
| 22 | Farm | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 23 | Hospital | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 24 | Super Market | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 |
| | CASUALTY | | | | | | | | | | | | | |
| 1 | No. of lives saved | | | | | | | | | | | | | |
| 2 | No. of Animals Saved | | | | | | | | | | | | | |
| 3 | Fatally Injured | 4 | 2 | 1 | - | 6 | - | - | - | - | - | - | 5 | 18 |

**Estimated Lost:** Nine Billion, Seven Hundred and Eight Thousand, Six Hundred and Ninety Five Thousand, Eight Hundred and Fifty Five Thousand Naira (₦9,708,695,855.00) only.

**Estimated Saved:** Twenty Five Billion, Three Hundred and Eight Million, One Hundred and Three thousand, Two Hundred Naira (₦25,308,103,200.00) only.

**ACF Isah M. Ibrahim**
*Senior Fire Prevention Officer*
*For: Controller.*