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Bio-indicators for Impact Assessment of Radionuclides Contamination

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Abstract: *The activity of important radionuclides ^{232}Th, ^{226}Ra and ^{40}K were analysed in twelve medicinal plants collected from Mangalore and surrounding region by gamma spectrometry. The activity in the representative soil sample is also measured in order to study the transfer of radionuclides from soil to plant. In plant the average values of ^{232}Th, ^{226}Ra and ^{40}K activity were found to be 0.8 $Bqkg^{-1}$, 5.0 $Bqkg^{-1}$ and 37.1 $Bqkg^{-1}$ respectively. In soil the average values of ^{232}Th, ^{226}Ra and ^{40}K activity were found to be 54.7 $Bqkg^{-1}$, 64.2 $Bqkg^{-1}$ and 384.3 $Bqkg^{-1}$ respectively. The average values of transfer coefficient for ^{232}Th, ^{226}Ra and ^{40}K were found to be 0.02, 0.08 and 0.10 respectively. The ^{232}Th activity was below detection level for most of the plant samples, though the activity was significant in soils associated to these plants. The significant activity of ^{226}Ra in both plant and associated soil shows the higher root uptake of this radionuclide from soil. All the plants and associated soils showed significant ^{40}K activity. The plant Mamia suregia showed higher transfer coefficient for all the three radionuclides. The plant can be used as bioindicator for the future monitoring of these radionuclides. The absorbed gamma dose rates prevailing in the study area were also measured using portable scintillometer. The results of these systematic investigations are presented and discussed in this paper.*

Key Words: *Radionuclide, ^{232}Th, 226Ra, 40K, Soil, Scintillometer, Transfer Coefficient.*

Introduction

Mangalore city and the nearby areas of the coastal Karnataka are heading to become a region of major industrial activity centre. In view of this detailed studies on the radioactivity and trace element concentration in terrestrial, aquatic and atmospheric environs of the region has been carried out. As part of the program the activities of important radionuclides ^{232}Th, ^{226}Ra and ^{40}K in twelve medicinal plants which are commonly found in the region were analysed by gamma spectrometry. Medicinal plants are important for pharmacological research and drug development, not only when plant constituents are used directly as therapeutic agents, but also when they are used as basic materials for the synthesis of drugs.

To study the transfer of radionuclides from soil to plant, the activity in the representative soil sample was measured. The uptake of radionuclides within the soil to plant is a part of the biochemical cycling. The mobility and availability of radionuclides depend on several factors such as geochemical, biological and climatic conditions. The transfer factor, defined as the ratio of the concentration of the radionuclide in plant to the concentration of the radionuclide in soil was calculated. This factor is also known as the plant root uptake factor. From the concentration of radionuclides in soil the radium equivalent activity Ra_{eq} (single quantity which represents the specific activities of ^{232}Th, ^{226}Ra and ^{40}K) was estimated. Detailed gamma radiation survey was also been carried out in the environment using portable plastic scintillometer. The results of these systematic investigations are presented and discussed in this paper.

Materials and Methods

1. Sampling

In the present study, 12 ayurvedic medicinal plants and associated soils collected from Moodabidri, near Mangalore, were analyzed for the concentration of natural radionuclides ^{232}Th, ^{226}Ra and ^{40}K. About 1 kg of soil sample was collected from the plant sampling site and brought to the laboratory. All the samples were carefully processed following standard procedure (EML procedure manual, 1983). The soil samples were oven dried, ground, sieved and filled in air tight plastic containers and stored for about one month to ensure secular equilibrium between ^{226}Ra and its short lived daughters. The containers were sealed carefully to avoid the escape of gaseous ^{222}Rn and ^{220}Rn (Narayana et al., 2001). These samples were subjected to gamma spectrometry analysis.

Approximately 5 kg of each plant (leaf, stem, root and fruits if any) were collected in a big polythene bag, brought to the laboratory, washed with running water to free from pollutants and cut into pieces. The samples were then ashed at 500^0C in a muffle furnace. The ashed vegetation samples were filled in air tight plastic vials and stored for about one month to ensure secular equilibrium between ^{226}Ra and its short lived daughters. These samples were subjected to gamma spectrometric analysis.

2. Experimental Set-up

Gamma spectra from the samples are recorded using a high efficiency 5" x 5" NaI (Tl) detector coupled to a 4K Multi-channel analyzer. The gamma ray spectrometer was calibrated using different standards and the efficiency of the detector was determined experimentally (Narayana et al., 2001). The standards for uranium and thorium were prepared using known weight of analyzed ore samples that are in radioactive equilibrium and mixing them with silica powder simulating the sample matrix. ^{40}K standard was prepared by taking oven dried analar potassium chloride. The spectrum obtained from NaI(Tl) is more complex to analyze. The Compton continuum of higher energy peak contributes to the count rate observed in the lower energy peak. Therefore Compton contribution from the higher energy peak to the lower energy peak should be evaluated to determine the activity. In the present work simultaneous equation method (Abani, 1994) was employed for the analysis of the spectrum and to determine the concentration of various radionuclides. The activity of ^{232}Th was evaluated from 2614 keV gamma line of ^{208}Tl, the activity of ^{226}Ra from 1764 keV gamma line of ^{214}Bi and that of ^{40}K from its 1461 keV photopeak.

From the concentrations of naturally occurring radionuclides in the soil, the total absorbed gamma dose rates in air were estimated. The conversion factors (dose coefficients) used to compute the total dose rate in air per unit specific activity concentration in soil (1 Bq kg^{-1}) were 0.623 nGy h^{-1} for ^{232}Th, 0.461 nGy h^{-1} for ^{226}Ra and 0.0414 nGy h^{-1} for ^{40}K (UNSCEAR, 2000). Inorder to compare the specific activities of materials containing different concentrations of radium, thorium and potassium, the radium equivalent activity concentration index Ra_{eq} was calculated (Beretka and Mathew, 1985). The radium equivalent activity is the single quantity which represents the specific activities of ^{232}Th, ^{226}Ra and ^{40}K. The equation used to find out the radium equivalent activity is based on the estimate that 1 Bq kg^{-1} of ^{226}Ra, 0.7 Bq kg^{-1} of ^{232}Th or 13 Bq kg^{-1} of ^{40}K generate the same gamma ray dose rate.

The Minimum Detectable Activity (Narayana et al, 2001) at 95 % confidence level for 36,000 seconds of counting time and 275g sample weight was found to be 0.4 Bq kg^{-1} for ^{232}Th, 1.8 Bq kg^{-1} for ^{226}Ra and 5.4 Bq kg^{-1} for ^{40}K. Each sample weighing about 275g were counted for sufficiently long time (36,000 seconds) to reduce the counting error. The activity reported corresponds to dry weight of the sample.

Results and Discussion

The results of activity of ^{232}Th, ^{226}Ra and ^{40}K in plant and associated soil samples are given in Table 1. From the table it is clear that the level of activity of these radionuclides in plant is much lower when compared to soil. In plant the activity of ^{232}Th varies in the range BDL – 3.3 Bq kg^{-1} with an average value of 0.8 Bq kg^{-1}, the activity of ^{226}Ra varies in the range 3.3 - 7.8 Bq kg^{-1} with an average value of 5.0 Bq kg^{-1} and that of ^{40}K varies in the range 26.1 - 58.3 Bq kg^{-1} with an average value of 37.1 Bq kg^{-1}. In soil the activity of ^{232}Th varies in the range 41.6 – 68.9 Bq kg^{-1} with an average value of 54.7 Bq kg^{-1}, the activity of ^{226}Ra varies in the range 58.2 - 72.5 Bq kg^{-1} with an average value of 64.2 Bq kg^{-1} and that of ^{40}K varies in the range 335.3 – 448.8 Bq kg^{-1} with an average value of 384.3 Bq kg^{-1}.

The ^{232}Th activity was below detection level in most of the plant samples analyzed, though the activity was significant in soils associated to these plants. This shows that the uptake of this radionuclide by plant is negligible even though the soil on which the plant grows has significant amount of ^{232}Th activity. The variation of activity of ^{226}Ra shows near uniform trend in almost all plant samples. The observed ^{226}Ra activity was higher compared to ^{232}Th activity in all plants. The significant activity of ^{226}Ra in both plant and associated soil shows the higher root uptake of this radionuclide from soil. It is clear from the table that all the plants and associated soils show significant ^{40}K activity. The higher activity of ^{40}K in plants may be due to the continuous accumulation of ^{40}K through root uptake over a period of time. It is known that as an essential element of metabolism, plants take up potassium from soil in varied amounts depending upon the metabolism.

The activities of ^{232}Th, ^{226}Ra and ^{40}K in soil samples are compared with the reported values of other environs in Table 2. The average values obtained for ^{232}Th (54.7 Bq kg^{-1}) is higher in comparison with the population weighted world average value of 45 Bq kg^{-1}, the average value obtained for ^{226}Ra (64.2 Bq kg^{-1}) is approximately double the population weighted world average of 32 Bq kg^{-1}. The higher ^{232}Th and ^{226}Ra activity observed in the soil samples may be traced to the laterite type of soil prevailing in the region (Narayana et al, 2001). The average activity of ^{40}K (384.3 Bq kg^{-1}) in the present study is less in comparison with the population weighted world average of 420 Bq kg^{-1} (UNSCEAR, 2000).

From the activity of naturally occurring radionuclides the radium equivalent activity was calculated. The results of radium equivalent activity are given in Table 3. The radium equivalent activity varies in the range 143.5 Bq kg^{-1} to 189.1 Bq kg^{-1} with an average value of 172.1Bq kg^{-1}. The average radium equivalent activity in the soil samples lies much below the recommended limit of 370 Bq kg^{-1} (UNSCEAR, 2000).

Table 3 also gives the results of gamma absorbed dose rate measured at 1m above the ground level using portable plastic scintillometer. The absorbed gamma dose rate measured in the study area varies 34.8 nGy h^{-1} to 52.2 nGy h^{-1} with an average value of 43.5 nGy h^{-1}. The radiation level follows almost a uniform pattern with dose rates close to the mean value except in some sampling stations. The present value lies between the dose rate ranges of 18 - 93 nGy h^{-1} given for the world (UNSCEAR, 2000). The measured dose rates were less in comparison with the all India average value of 88.5 nGy h^{-1} projected by Nambi et al. (1987). The absorbed dose rates in air due to naturally occurring radionuclides in coastal Karnataka are related to the local geology of the region (Narayana et al., 2001).

The soil-to-plant transfer coefficients (Table 3) vary in the range 0.03 - 0.06, 0.05 - 0.13 and 0.06 - 0.15 for ^{232}Th, ^{226}Ra and ^{40}K, respectively with corresponding average values of 0.02, 0.08 and 0.10. It is clear from table that, the transfer coefficient for ^{40}K is significantly higher compared to ^{232}Th and ^{226}Ra, suggesting higher levels of uptake of ^{40}K. Similar findings were reported by Avadhani (2002) for Goa environs. According to ANL (1993), the transfer coefficient values for Th, Ra and K are 0.001, 0.04 and 0.3 respectively.

The soil to plant or soil to vegetation transfer factor, for a given type of plant and for a given radionuclide can vary considerably from site to site with season and time after contamination. These variations depend on such factors as the physical and chemical properties of the soil, environmental conditions and chemical form of the radionuclide in the soil. Furthermore, soil management practices such as ploughing, liming, fertilizing and irrigation can also effect the uptake of radionuclide by the vegetation. It is interesting to note that the plant *Mamia suregia* showed higher transfer coefficient for all the three radionuclides though the soil associated with *Mamia suregia* showed low activity when compared to the soil activity associated with other plants. This indicates that the uptake of radionuclides by the plant is moderately high compared to other plants. Therefore the plant can be used as bioindicator for the future monitoring of these radionuclides contamination and for impact assessment.

Table 1. The Activity of ^{232}Th, ^{226}Ra and ^{40}K in Plants and Associated Soils

Sample ID	Name	Activity in plant (Bq kg^{-1})			Activity in soil (Bq kg^{-1})		
		^{232}Th	^{226}Ra	^{40}K	^{232}Th	^{226}Ra	^{40}K
MP1	*Putranjeeva roxburghii*	2.6 ± 0.6	5.3 ± 1.1	37.8 ± 2.9	58 ± 0.7	62.2 ± 1.2	358.2 ± 3.1
MP2	*Mamia suregia*	2.1 ± 0.9	7.8 ± 1.6	50.4 ± 4.1	41.6 ± 0.7	58.2 ± 1.2	335.3 ± 3.1
MP3	*Mesua nagassarium*	BDL	4.8 ± 1.1	35.7 ± 2.9	68.9 ± 0.8	61.4 ± 1.2	358.8 ± 3.1
MP4	*Saraca indica*	BDL	3.3 ± 0.7	26.4 ± 2.1	52.2 ± 0.7	58.3 ± 1.2	369.1 ± 3.2
MP5	*Syzygium jambolanum*	BDL	4.8 ± 1.1	39.5 ± 3.1	55.8 ± 0.8	63.7 ± 1.3	366.0 ± 3.2
MP6	*Garcinia indica*	BDL	3.7 ± 0.8	27.3 ± 2.2	48 ± 0.7	61.2 ± 1.3	356.7 ± 3.2
MP7	*Ficus benghalensis*	BDL	4.6 ± 1.1	41.2 ± 3.1	62.4 ± 0.8	64.8 ± 1.3	362.6 ± 3.2
MP8	*Flacartia montana*	BDL	3.7 ± 0.9	31.0 ± 2.4	59.9 ± 0.8	58.3 ± 1.2	361.5 ± 3.2
MP9	*Nyctanthes arbor-tristis*	BDL	7.6 ± 1.7	58.3 ± 4.7	48 ± 0.9	72.5 ± 1.5	431.0 ± 3.8
MP10	*Morinda citrifolia*	BDL	3.3 ± 0.7	26.1 ± 2.0	47.2 ± 0.9	70.5 ± 1.5	428.6 ± 3.8
MP11	*Ficus recemosa*	1.9 ± 0.7	5.4 ± 1.1	39.5 ± 3.1	60.4 ± 0.9	69.3 ± 1.5	435.3 ± 3.8
MP12	*Barringtonia acutangula*	3.3 ± 0.6	5.4 ± 1.0	32.3 ± 2.6	54.4 ± 0.9	70.3 ± 1.5	448.8 ± 3.8
Mean		**0.8**	**5.0**	**37.1**	**54.7**	**64.2**	**384.3**
Median		**2.4**	**4.8**	**36.7**	**55.1**	**63.0**	**364.3**
Range		**BDL-3.3**	**3.3-7.8**	**26.1-58.3**	**41.6-68.9**	**58.2-72.5**	**335.3- 448.8**

BDL-Below Detection Limit

Table 2. Comparison of ^{232}Th, ^{226}Ra and ^{40}K Activity in Soil with Other Environs.

Activity (Bq kg^{-1})			Region	Reference
^{232}Th	^{226}Ra	^{40}K		
41.6 - 68.9 (54.7)	58.2 - 72.5 (64.2)	335.3 - 448.8 (384.3)	Moodubidiri, Coastal Karnataka	Present work
14 - 160 (64)	7 - 81(29)	38 - 760 (400)	India	UNSCEAR (2000)
10 - 200(60)	3 - 60 (26)	40 - 800 (350)	Irland	McAulay& Moran (1988)
18 - 135 (50)	35 -228 (90)	281 - 711 (524)	Chaina	Ziqiang et al., (1988)
29.8	20.1- 62.3	61 - 316.7	Karnataka	Narayana et al., (2001)
45	32	420	Popln. Wtd. world avg.	UNSCEAR (2000)

Table 3. Radium Equivalent Activity, Absorbed Dose and Transfer Coefficient

Sample ID	Ra_{eq} (Bq kg^{-1})	Dose rate (nGy h^{-1})	Transfer Coefficient		
			^{232}Th	^{226}Ra	^{40}K
MP1	172.7	34.8	0.04	0.09	0.11
MP2	143.5	43.5	0.05	0.13	0.15
MP3	187.5	52.2	-	0.08	0.10
MP4	161.3	34.8	-	0.06	0.07
MP5	171.7	43.5	-	0.07	0.11
MP6	157.3	43.5	-	0.06	0.08
MP7	182.0	34.8	-	0.07	0.11
MP8	171.8	52.2	-	0.06	0.09
MP9	174.3	52.2	-	0.11	0.14
MP10	171.0	34.8	-	0.05	0.06
MP11	189.1	52.2	0.03	0.08	0.09
MP12	182.6	43.5	0.06	0.08	0.07
Mean	**172.1**	**43.5**	**0.02**	**0.08**	**0.10**
Median	**172.3**	**43.5**	**0.05**	**0.08**	**0.10**
Range	**143.5 – 189.1**	**34.8 – 52.2**	**0.03 - 0.06**	**0.05 - 0.13**	**0.06 - 0.15**

Conclusion

The ^{232}Th uptake by plant is negligible when compared to the uptake of ^{226}Ra and ^{40}K by medicinal plants. The average activity concentrations for ^{232}Th and ^{226}Ra in soil in the environment of Moodabidri are higher than the population weighted world average value. The radium equivalent activity in the soil samples lie below the recommended limit. The radiation level follows almost a uniform pattern in the study area. The transfer coefficient for ^{40}K is significantly higher compared to ^{232}Th and ^{226}Ra. The transfer coefficient for a given plant and for a given radionuclide can vary considerably from site to site with season and time after contamination. The plant *Mamia suregia* can be used as bioindicator for the future monitoring of radionuclide contamination and for impact assessment.

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Competitive Status of Africa's Cocoa Products in the World Market

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Abstract: *To formulate efficient and articulated future cocoa policy prescriptions, and ensure the continuous contribution of the subsector to poverty reduction, income generation and growth of Africa's agricultural sector, the present research empirically examined the global competitiveness of Africa's cocoa export during the spanning period of 2000-2013. The used dated data were sourced from FAO and UNCTAD databases. Export trends and indices of the revealed comparative advantage, as well as Trade Mapping (TM), were examined for cocoa beans, cocoa butter, cocoa paste and cocoa powder/cake. Empirical findings showed that Africa has only revealed comparative and competitive advantages in the exportation of cocoa primary product and disadvantage in the comparative and competitive status in the exportation of its secondary cocoa products. Furthermore, Africa is among the winner group with it controlling a large chunk of the market despite the decline in the export market of cocoa during the studied period. Hence, in order to enhance Africa's relative comparative and competitive advantages in the exportation of cocoa products and its continuing presence in the world markets, Africa should improve on the quality of its cocoa products keeping in-view the best marketing grade and standardization for cocoa products in the global market. Also, Africa should invest more in post-harvest technologies to have a breakthrough in the secondary sub-sectors of cocoa via value addition, thus increasing its global share in the market which in turn would enhance its foreign exchange earnings from the exportation of cocoa.*

Key Words: *Competitiveness; Comparative; Cocoa products; Export; Africa*

Introduction

The export sector is considered as a medium for accelerating the economic development as it supports the flow of resources from low productive sectors to high productive sectors, leading to an overall increase in output (Dhiman and Sharma, 2017). According to Feder (1983), as reported by Dhiman and Sharma (2017), exports growth can affect total productivity growth through dynamic spillover effects on the rest of the economy. Some countries were able to witness high economic growth due to the significant pace in the global trade.

Holding firmly to development and sustainability of subsectors on which nation's agriculture strongly depends have been the actions reflected by various regimes in most of the developing countries worldwide. Such actions are reflected in their pursuit of enhancing food security, foreign exchange earnings and poverty minimization through exports as against income draining through imports.

With the global increase in cocoa exports in recent years from 3.133 million MT in the year 2007 to 3.768 million MT in 2011, the role of Africa in global exports of cocoa cannot be overstated. Africa cocoa exports accounted for approximately 77% of world cocoa exports between the aforementioned periods, with Asia-Oceania and America's shares being 16.3 percent and 6.3 percent respectively.

Africa's trade policy should be based on comparative advantage according to the World Trade Organization (WTO)'s Agreement on Agriculture (AoA), under which member countries are required to utilize the benefits of comparative and competitive advantage in the international economy, increasing competition and forcing resources to be allocated more efficiently. From the trade theory point of view, competitive advantage is a more useful concept than comparative advantage. Competitiveness includes market distortions while comparative advantage assumes undistorted markets (Vollrath 1985, Vollrath and Huu 1988). With the gradual reduction in trade barriers led by the process of globalization, more emphasis is now being placed on promoting export competitiveness (Prasad 2004). As a founding member of GATT and signatory to WTO, Africa has accepted both the opportunity for and challenge of trade liberalization. Sequel to this, this paper attempts to measure Africa's cocoa products export competitiveness in the global markets. Therefore, the objectives of this research were to determine Africa's cocoa export growth and competitiveness in the global markets; compared Africa's cocoa export growth to global demand; and, determine the market structure and extent of diversification of the cocoa sector.

Research Methodology

The study used annual dated time series data sourced from the FAO and UNCTAD databases, spanning from 2000 to 2013. The data covered export value of Africa's cocoa products *viz.* cocoa beans, cocoa butter, cocoa paste and cocoa powder/cake. The first objective was achieved using revealed comparative advantage (RCA) index, revealed symmetric comparative advantage (RSCA), revealed export advantage (RXA) and revealed trade advantage (RTA). The second objective was achieved using Trade mapping analysis (TMA): and, the last objective was achieved using Herfindahl-Hirschman Index (HHI) and Berry's index of diversification (BID). The empirical models are given below:

Empirical model

Indexes of Export's Revealed Comparative Advantage

Following Balassa (1965) as cited by Navghan *et al.* (2017); Gupta and Khan (2017); Astaneh *et al.*(2014) the revealed comparative advantage (RCA) is given below:

$$RCA_{ij} = \frac{X_{ij} \ / \sum X_{ij}}{X_{iw} \ / \sum X_{iw}} \qquad \text{(1)}$$

Where;

RCA_{ij} = revealed comparative advantage of ith commodity by country j

X_{ij} = Export of ith commodity by country j

$\sum X_{ij}$ = Total export of ith commodity class by country j

X_{iw} = Export of ith commodity by the world

$\sum X_{iw}$ = Total export of ith commodity class by the world

The numerator represents the commodity structure of the exports from i[th] country and the denominator represents the product structure of the global market. The range of *RCA* is between 0 to ∞. *RCA* > 1 shows sectors in which a country is relatively more specialized and vice versa (the more the value of the index, the greater reliability and the better the given position). In other words, if RCA >1, then the state has a revealed comparative advantage in the commodity; if RCA <, then the state has a revealed comparative disadvantage in the commodity; and, RCA=1, implies comparative neutrality.

The benefit of comparative advantage index is that it takes into consideration the intrinsic advantage of a particular export commodity as well as the consistency with changes (Batra and Khan, 2009). However, one of the main disadvantages of *RCA* index is its wide range such that it is too wide to determine the degree of comparative advantage properly (Astaneh *et al.,* 2014). To solve the above problem, Laursen (1998) introduced another form of *RCA* index using a symmetric or normalized index by a homogeneous transformation called revealed symmetric comparative advantage (RSCA):

$$RSCA_{ij} = \left(RCA_{ij} - 1\right)/\left(RCA_{ij} + 1\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

These changes range between -1 and +1 so that negative values indicate no advantage and positive values indicate that there is an advantage.
Vollrath (1989; 1991) criticized additional counting of export and, instead introduced an improved constructed version called relative export advantage (RXA) index. This index has been used by many researchers in their studies on export comparative status such as Bentler and Li (2002); Akhtar *et al*.(2009) and Astaneh *et al.*(2014).

$$RXA_{ij} = \frac{X_{ij} \;/\sum_{1,1\neq j} X_{i1j}}{X_{iw} \;/\sum_{1,1\neq w} X_{i1w}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

Where;

RXA_{ij} = revealed export advantage of i[th] commodity of country j

X_{ij} = Export of i[th] commodity of country j

$\sum_{1,1\neq j} X_{i1j}$ = Total export of i[th] commodity class of country j minus the product considered

X_{iw} = Export of i[th] commodity of the world

$\sum_{1,1\neq w} X_{i1w}$ = Total export of i[th] commodity class of the world minus the product considered.

$$RCA_{ij}\# = lnRXA_{ij} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

$RCA_{ij}\#$ is simply the logarithm of the relative export advantage index. A positive value indicates a comparative/competitive advantage, whereas a negative value indicates a comparative/competitive disadvantage.

The mentioned indexes are static. New indexes are expanded which have more consistency with the new conception of competitive advantages. One of them is Trade Map (TM) introduced by International Trade Centre (ITC) and United Nations Conference on Trade and Development (UNCAD) and compares export growth to global demand growth. The groups of export commodities are classified into winners and losers based on *TM* and defined in Table 1. Based on the information in Table 1, if the global growth rate of import of commodity *i* (r_i) is bigger (less) than the growth rate of aggregated imports, the market of this commodity is identified as emerging (declining) market. If the export growth rate of country *j* for commodity i^{th} (d_{ij}) is bigger (less) that the import growth rate of this commodity (r_i), the country is a winner (looser) on that commodity.

Table 1: Trade Mapping Coordinates

Coordinate	Property	Decision Rule
First Quarter	$d_{ij} > r_i > r$	Winners in emerging markets
Second Quarter	$d_{ij} < r_i > r$	Losers in emerging markets
Third Quarter	$d_{ij} > r_i < r$	Winners in declining markets
Fourth Quarter	$d_{ij} < r_i < r$	Losers in declining markets

Relative Trade Advantage (RTA): Besides using the exports as a factor, as in Balassa index, this index has also taken into consideration imports. Following Navghan *et al.* (2017) the RTA index is given below:

$$RTA = RXA - RMA \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

$$RTA = \frac{X_{ij} \;/\sum X_{ij}}{X_{iw} \;/\sum X_{iw}} - \frac{M_{ij} \;/\sum M_{ij}}{M_{iw} \;/\sum M_{iw}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

Where; RTA is relative trade advantage; RXA is RCA or Balassa index; and RMA is the relative import advantage.

M_{ij} = Import of i^{th} commodity by country j

$\sum M_{ij}$ = Total Import of i^{th} commodity class by country j

= Import of i^{th} commodity by the world

M_{iw} = Total Import of i^{th} commodity class by the world

Herfindahl–Hirschman Index (HHI)

Herfindahl-Hirschman index is the sum of the squares of market shares of all active firms in the industry. This index is very similar to Hirschman index except for the square root (Hirschman, 1964), and it is shown below:

$$HHI = \sum_{i=1}^{n} S_i^2 \quad \text{...} \quad (7)$$

Where; S_i is the market share of i^{th} subsector in the sector; n is the number of sub-sectors. Types of market structure and characteristics as reported by Williams and Rosen (1999) are presented in Table 2.

Table 2: Market Structure

Market type	HHI	Feature
Perfect Competition	$HHI \rightarrow 0$	None of the subsectors have considerable share in the sector
Monopolistic Competition	$HHI \rightarrow 10)$	None of the sub-sectors had more than 10% share in the sector
Opened Oligopoly	$6 < (1/HHI) \leq 10$	Few subsectors account for maximally 40% share in the sector
Closed Oligopoly	$1 < (1/HHI) \leq 6$	Few subsectors account for maximally 60% share in the sector
Monopoly	$HHI \rightarrow 10$	One subsector account for whole share of a sector

Source: Williams and Rosen (1999)

Diversification Index

However, literature has shown various methods used to measure level and degree of diversification but for the present empirical examination, Berry's index and Theil's Entropy index were used.

Berry's Index of Diversification (BID) $= 1 - \sum_{i=1}^{n} P_{it}^{2}$ .... (8)

$$P_{it} = \frac{A_{it}}{\sum_{i=1}^{n} A_{it}} \quad \text{.. (9)}$$

Where;

$P_{it} =$ Share contribution of i^{th} sub-sector to the main sector at time *'t'*

$A_{it} = i^{th}$ Export value of i^{th} sub-sector at time *'t'*

$\sum_{i=1}^{n} A_{it} =$ Export value of cotton sector at time '*t*'

The value of Berry's index varies between zero and one. It is one (1) in case of perfect diversification and zero in case of perfect specialization.

Entropy Index of Diversification (EID) $= \sum_{i=1}^{n} P_{it} \log\left(\frac{1}{P_{it}}\right)$ .... (10)

The value of Entropy index (E) varies from zero to *log n*. *'EID'* takes the value of zero in case of perfect specialization and *log n* when there is perfect diversification.

The actual degree of diversification to maximum diversification for a given sector can be measured through Berry's index as given below:

Degree of diversification by Berry's Index $= Berry's\ Index \Big/ \left(1 - \frac{1}{n}\right)$ ... (11)

Degree of diversification by Entropy Measure $= Entropy\ Index/logn$ .... (12)

Where;

$n =$ number of sub-sectors in the agriculture sector

Rule of Thumb:

0	=	specialization
0.01-0.19	=	Very low diversification
0.20- 0.39	=	Low diversification
0.40-0.59	=	Moderate diversification
0.60-0.79	=	High diversification
0.80-0.99	=	Very high diversification
1.00	=	Perfect diversification

Results and Discussion

Africa's Cocoa Export Status during the Period of 2000-2013

A perusal of Table 3 showed that of the total value of Africa's cocoa products, cocoa beans accounted for 81.95%, distantly followed by cocoa paste which contributed 8.68%, then cocoa butter with share contribution of 7.15% and cocoa powder/cake with marginal share contribution of 2.23% during the studied period. Therefore, it can be inferred that the main share of Africa's cocoa export has been accounted by cocoa bean which is not surprising as the continent's export concentration on cocoa products is beamed towards cocoa beans. Also, the continent is faced with challenges of post-harvest technologies needed for value addition of cocoa raw material, thus, the reason for exporting most of its cocoa as a primary product i.e. in its raw form rather than as secondary products i.e. the processed form which will yield varieties of cocoa products.

The total export value of Africa's cocoa beans during the studied period was \$51.9 billion with the export growth been marked by fluctuation. Furthermore, the average annual growth rate of cocoa beans was observed to be 10.34% and showed positive growth over the time. The export value of cocoa paste, cocoa butter and cake were \$5.4 billion, \$4.5 billion and \$1.4 billion respectively, and all had positive average annual growth over the studied period. In total, Africa's cocoa export value stood at \$63.3 billion with an annual average growth value of 10.76% during the studied period. Furthermore, the cocoa product with the highest average annual export growth is cocoa powder, followed by cocoa butter, then cocoa paste and lastly cocoa beans. The high annual average growth rate for cocoa powder

Table 3: Growth and Export Value ('000 dollars) of Africa's Cocoa Export

Years	Beans		Butter		Paste		Powder/Cake		Total cocoa		World
	Value	Growth	Value	Growth	Value	Growth	Value	Growth	Value	Growth	share %
2000	1568765	-	100386	-	129767	-	25848	-	1824766	-	42.43
2001	1761084	12.26	117483	17.03	198533	52.99	27007	4.483	2104107	15.31	45.37
2002	2721446	54.53	205242	74.69	311694	56.99	71559	164.97	3309941	57.31	46.63
2003	3070139	12.81	264964	29.09	327185	4.96	111694	56.09	3773982	14.02	44.68
2004	3080101	0.32	260470	-1.69	287969	-11.99	88472	-20.79	3717012	-1.51	40.69
2005	3002683	-2.51	292779	12.40	297558	3.33	58956	-33.36	3651976	-1.75	39.37
2006	3184218	6.05	302285	3.25	344868	15.89	62996	6.85	3894367	6.64	41.36
2007	3073924	-3.46	349641	15.67	396070	14.85	77491	23.01	3897126	0.07	36.96
2008	3768998	22.61	403958	15.54	456631	15.29	81864	5.64	4711451	20.89	36.07
2009	5223464	38.59	461636	14.28	503314	10.22	124488	52.07	6312902	33.99	41.62
2010	4917432	-5.86	479713	3.92	622816	23.74	188618	51.52	6208579	-1.65	35.56
2011	6832623	38.95	487685	1.66	584756	-6.11	183174	-2.89	8088238	30.28	41.24
2012	5366600	-21.45	340004	-30.28	469397	-19.73	145983	-20.30	6321984	-21.4	39.32
2013	4375316	-18.47	462536	36.04	569391	21.30	164335	12.57	5571578	-11.87	36.45
Mean		**10.34**		**14.72**		**13.98**		**23.07**		**10.76**	**40.41**

is attributed to wide fluctuation in the export volume of this product due to intensive post-harvest technologies requirement which is highly limited in Africa, thus reflecting its effect in the export value of cocoa powder. The marginally higher annual average growth rate than the cocoa beans observed for cocoa butter and paste is attributed to stability in the export volume which is reflected in the export value as post-harvest technologies required for their value addition is not highly intensive, while the stable average annual growth rate for cocoa bean is attributed to stability in the export volume of the product given that exportation of the commodity is done in its raw form. Furthermore, the average share of Africa in the world export of cocoa products is 40.41%, indicating the moderate share of Africa in the global market due to low quality in the international market and moderate domestic consumption.

Comparative Advantage of Africa's Cocoa Products

Presented in Table 4 are the export's revealed comparative advantage of Africa's cocoa products calculated by RCA, RSCA, RXA and RTA during the studied period. The results showed that Africa has revealed comparative

Table 4a: Comparative Advantage Indices of Africa's Cocoa Export During 2000-2013

Product	Index	2000	2001	2002	2003	2004	2005	2006	2007
Beans	RCA	1.667449	1.570805	1.474658	1.573768	1.715637	1.728238	1.632292	1.675653
	RSCA	0.25022	0.222033	0.191807	0.222929	0.263525	0.266926	0.240206	0.252519
	RCA#	1.750513	1.504371	1.300102	1.405245	1.644121	1.628457	1.496809	1.434754
	RTA	1.457226	1.205358	0.839965	0.831528	1.190401	1.304924	1.175431	1.227995
Butter	RCA	0.20925	0.240974	0.306374	0.336551	0.288617	0.26286	0.261729	0.288242
	RSCA	-0.65392	-0.61164	-0.53095	-0.49639	-0.55205	-0.58371	-0.58513	-0.5525
	RCA#	-1.81268	-1.62919	-1.34507	-1.25018	-1.44813	-1.6164	-1.61144	-1.52284
	RTA	-3.00616	-2.9618	-1.99238	-1.8981	-2.37269	-2.99734	-2.80898	-3.2581
Paste	RCA	0.784707	0.892092	0.916333	0.829983	0.810683	0.893229	0.887795	0.939391
	RSCA	-0.12063	-0.05703	-0.04366	-0.09291	-0.10456	-0.0564	-0.05944	-0.03125
	RCA#	-0.26367	-0.12687	-0.09691	-0.20599	-0.22968	-0.12357	-0.13137	-0.06985
	RTA	-1.37613	-1.59011	-1.3709	-1.08072	-1.30119	-1.28309	-1.46312	-1.61914

Product	Index	2008	2009	2010	2011	2012	2013	Mean
Beans	RCA	1.742265	1.573929	1.695765	1.722181	1.767098	1.751727	1.663676
	RSCA	0.270676	0.222978	0.258096	0.265295	0.277221	0.273184	0.248401
	RCA#	1.549833	1.464577	1.469173	1.732017	1.804356	1.504335	1.54919
	RTA	1.221789	1.240868	1.316241	1.574858	1.634825	1.295815	
Butter	RCA	0.261528	0.283259	0.331883	0.328752	0.323512	0.369938	0.292391
	RSCA	-0.58538	-0.55853	-0.50163	-0.50517	-0.51113	-0.45992	-0.54915
	RCA#	-1.64884	-1.48408	-1.28758	-1.25288	-1.25505	-1.16188	-1.45187
	RTA	-2.5358	-2.47077	-2.36279	-2.0623	-2.04733	-1.79465	
Paste	RCA	0.90156	0.747863	0.829926	0.619913	0.626746	0.761185	0.817243
	RSCA	-0.05177	-0.14425	-0.09294	-0.23463	-0.22945	-0.1356	-0.10389
	RCA#	-0.11542	-0.32018	-0.20953	-0.52714	-0.51616	-0.30924	-0.23183
	RTA	-1.71137	-2.13636	-1.40944	-1.78746	-1.45126	-1.26759	

Table 4b: Comparative Advantage Indices of Africa's Cocoa Export During 2000-2013

Product	Index	2000	2001	2002	2003	2004	2005	2006	2007
Powder/Cake	RCA	0.108225	0.098966	0.157479	0.17407	0.133239	0.126081	0.157415	0.181042
	RSCA	-0.80469	-0.81989	-0.72789	-0.70348	-0.76485	-0.77607	-0.72799	-0.69342
	RCA#	-2.34956	-2.43897	-1.97428	-1.90461	-2.18831	-2.19157	-1.941	-1.80529
	RTA	-6.23842	-5.44351	-5.37864	-4.88724	-5.06186	-5.21012	-5.56014	-4.9184
Total Cocoa	RCA	12.91713	14.00559	14.14667	12.97224	12.0484	12.12989	12.87444	12.70168
	RSCA	0.856292	0.866716	0.867958	0.856859	0.846725	0.847676	0.85585	0.854033
	RCA#	2.693232	2.798694	2.890539	2.780523	2.673708	2.67031	2.726081	2.696092
	RTA	2.497604	2.597559	2.698269	2.582458	2.471259	2.488774	2.564367	2.535509

Product	Index	2008	2009	2010	2011	2012	2013	Mean
Powder/Cake	RCA	0.164691	0.180045	0.169488	0.108126	0.098298	0.152795	0.143569
	RSCA	-0.71719	-0.69485	-0.71015	-0.80485	-0.821	-0.73491	-0.75009
	RCA#	-1.89765	-1.81063	-1.94166	-2.43658	-2.56415	-2.0632	-2.10768
	RTA	-6.48564	-6.69106	-7.00562	-7.64636	-7.82025	-7.59205	
Total Cocoa	RCA	12.43042	11.64385	10.79432	12.09694	12.16716	10.24945	12.36987
	RSCA	0.851084	0.84182	0.830427	0.847293	0.848107	0.822213	0.849504
	RCA#	2.672834	2.644143	2.553658	2.676099	2.644774	2.435223	2.682565
	RTA	2.513945	2.480257	2.366236	2.501355	2.428323	2.233866	

and positive competitive advantage in the exportation of cocoa beans and revealed comparative and competitive disadvantage in the exportation of the rest of the cocoa products which are in secondary form during the studied period as indicated by RCA greater than unity, positive RSCA and RXA values for the former and vice versa for the latter. These results are not surprising as the continent specialized more in the exportation of the raw product or primary product (cocoa beans) due inadequacy of post-harvest technologies in most of the exporting countries in the country due to capital paucity. Furthermore, the results of the overall cocoa sector for the continent showed that Africa had revealed comparative and competitive advantage in the exportation of cocoa during the studied periods as indicated by the positive values for RSCA and RXA. However, the reason for the comparative and competitive advantages of the sector may be attributed to specialization in the exportation of the primary product which triggered Africa's share in the world export volume to be almost 50%. ICCO (2012) reported that out of the five major cocoa export countries in the world, four (Ivory Coast, Ghana, Nigeria and Cameroon) are from Africa with an approximate net export of cocoa beans plus net exports of cocoa products converted to bean equivalent to be 72.3%.

The cursory review of Africa's share of global cocoa exports showed changes in the export values of cocoa products to be related to changes in RCA, RSCA and RXA's. Consequently, Africa's share of global exports is such that whenever its share of global exports increases (or decreases), the mentioned indices increase (decrease) as well. Thus, Africa can increase its revealed comparative advantage by enhancing its share export in the global market. Investigating comparative advantage index in the export of Africa's cocoa products showed that Africa has the potential to achieve higher comparative and competitive advantages in the exportation of cocoa, as evidenced by its advantage in cocoa beans export over the studied periods. Perhaps, the moderate comparative and competitive advantages are due to low-quality standard of its cocoa and some specific trade policies.

The result of the relative trade advantage (RTA) showed that Africa had relative trade advantage in the exportation of cocoa beans subsector and the cocoa sector as a whole as indicated by the RTA index which showed a positive balance of trade for the cocoa beans subsector and the overall cocoa sector during the studied period. However, the trade balances for the other sub-sectors of the cocoa sector were not favourable as evidenced by the negative values of the RTA index during the studied period. Therefore, the reason for favourable trade balance for cocoa beans is due to specialization of the continent in the exportation of cocoa as a raw material or in its primary form while the unfavourable balance of trade for the other sub-sectors is due inadequate post-harvest technologies which will add value to these products, thus, the reason for Africa to resort to importation of these products to bridge the wide gap between the domestic demand and supply for processed or secondary cocoa products. In addition, Africa’s GDP has been affected as the importation of secondary cocoa products is a drain on its foreign exchange earnings.

Competitive Situation of Africa’s Cocoa Products in the Global Markets

Presented in Table 5 are the Trade Mapping and competitive situation of Africa’s cocoa products in the global markets. The external factors that may cause the reduction in the comparative advantage of Africa’s cocoa exports include the increase in the production of other countries, trade agreements of other countries with the applicant countries for reducing trade barriers thereby increasing the export share, and the problems due to the entry of these goods in the importing countries.

The results of the trade mapping analysis for Africa’s total cocoa products' export markets revealed that despite that the export market for these products have declined during the studied period, Africa had taken greater share of the market and is among the winner group. Product-wise analysis showed that the export market for cocoa beans has emerged during the studied period with Africa taken a greater share of the market and is among the winner group. For the cocoa butter, inspite of the fact that Africa controlled a greater share in the market and has been among the winner group, the export market for cocoa butter has declined during the studied period. Unfortunately, results showed Africa to have poor share in the cocoa paste and powder markets which declined during the studied period and is among the loser groups in the export markets of these products. The good trade situations for cocoa beans and cocoa butter in the global markets are not surprising as specialization in the exportation of the primary product or raw material of cocoa triggered the performance of the former and requirement of less intensive technologies enhanced the export performance of the latter. The poor trade situation of Africa in the global markets for cocoa paste and powder/cake is not surprising as the continent paid low attention to secondary products of cocoa due to capital paucity to procure intensive technologies required for value addition for these products.

Table 5a: Trade Mapping Index (TMI) for Africa's Cocoa Export

Product	Growth %	2000	2001	2002	2003	2004	2005	2006	2007
Beans	**WIG**	-	4.257045	42.91366	40.32286	-2.56036	5.623671	2.238169	19.50024
	WCIG	-	6.771803	41.5827	41.43135	-7.6101	4.397586	4.79461	19.34734
	ACEG	-	12.25926	54.53244	12.81278	0.32448	-2.51349	6.04576	-3.46377
	Assessment	-	**LDM**	**WDM**	**LEM**	**WDM**	**WEM**	**LDM**	**WEM**
Butter	**WIG**	-	4.257045	42.91366	40.32286	-2.56036	5.623671	2.238169	19.50024
	WCIG	-	-8.25199	28.21195	32.00514	14.52415	29.79489	0.777786	17.45317
	ACEG	-	17.03126	74.69932	29.09833	-1.69608	12.40412	3.246818	15.66601
	Assessment	-	**WDM**	**WDM**	**WEM**	**LEM**	**LEM**	**WDM**	**WEM**
Paste	**WIG**	-	4.257045	42.91366	40.32286	-2.56036	5.623671	2.238169	19.50024
	WCIG	-	18.88054	62.20167	26.5309	-3.29305	1.069652	9.668105	28.25162
	ACEG	-	52.9919	56.99858	4.969938	-11.9859	3.329872	15.89942	14.84684
	Assessment	-	**LDM**	**LEM**	**WEM**	**WEM**	**WDM**	**LDM**	**LEM**

Product	Growth %	2008	2009	2010	2011	2012	2013	Mean
Beans	**WIG**	26.02151	4.809182	18.50053	11.98267	-19.5698	-3.03472	10.78605
	WCIG	25.8908	10.44511	11.15253	12.94809	-22.436	-9.2834	9.959458
	ACEG	22.61194	38.59026	-5.85879	38.94697	-21.4562	-18.4714	9.597161
	Assessment	WEM	**LDM**	**WEM**	**LDM**	**WEM**	**WEM**	**WDM**
Butter	**WIG**	26.02151	4.809182	18.50053	11.98267	-19.5698	-3.03472	10.78605
	WCIG	31.46222	-9.96614	-0.66434	-11.7651	-28.6454	35.12481	9.290082
	ACEG	15.53508	14.27822	3.915856	1.661827	-30.282	36.0384	13.68551
	Assessment	**LEM**	**WDM**	**WDM**	**WDM**	**WEM**	**LEM**	**WDM**
Paste	**WIG**	26.02151	4.809182	18.50053	11.98267	-19.5698	-3.03472	10.78605
	WCIG	24.29229	3.912545	35.11701	13.35683	-17.5703	9.77351	15.15652
	ACEG	15.29048	10.22335	23.74303	-6.11095	-19.7277	21.30265	12.98368
	Assessment	**WEM**	**WDM**	**LEM**	**LEM**	**LEM**	**LDM**	**LEM**

Table 5b: Trade Mapping Index (TMI) for Africa's Cocoa Export

Product	Growth %	2000	2001	2002	2003	2004	2005	2006	2007
Powder/Cake	**WIG**	-	4.257045	42.91366	40.32286	-2.56036	5.623671	2.238169	19.50024
	WCIG	-	10.71979	60.17555	58.2627	-6.45637	-22.6688	-10.75	17.34841
	ACEG	-	4.483906	164.9646	56.08659	-20.7907	-33.362	6.852568	23.0094
	Assessment	-	**LEM**	**LDM**	**LEM**	**WEM**	**WEM**	**WDM**	**WDM**
Total Cocoa	**WIG**	-	2.0052	5.316572	18.56897	15.71268	6.493625	10.89519	21.12736
	WCIG	-	4.257045	42.91366	40.32286	-2.56036	5.623671	2.238169	19.50024
	ACEG	-	15.30832	57.30859	14.01962	-1.50955	-1.74968	6.637256	0.070846
	Assessment	-	**LDM**	**LDM**	**LEM**	**WDM**	**WDM**	**WDM**	**WEM**

Product	Growth %	2008	2009	2010	2011	2012	2013	Mean
Powder/Cake	**WIG**	26.02151	4.809182	18.50053	11.98267	-19.5698	-3.03472	10.78605
	WCIG	13.63459	21.49646	83.75427	38.13547	-6.31789	-20.4723	16.9187
	ACEG	5.643236	52.06684	51.51501	-2.88626	-20.3036	12.57133	21.41792
	Assessment	**WEM**	**LDM**	**LEM**	**LEM**	**LEM**	**WDM**	**LDM**
Total Cocoa	**WIG**	22.48036	-11.6676	12.07585	22.54284	0.947175	4.342763	9.345781
	WCIG	26.02151	4.809182	18.50053	11.98267	-19.5698	-3.03472	10.78605
	ACEG	20.89553	33.99061	-1.65254	30.27519	-21.8373	-11.8698	9.991934
	Assessment	**LEM**	**LDM**	**LEM**	**WDM**	**WEM**	**WDM**	**LEM**

Note: WIG (World import growth %); WCIG (World cocoa import growth %); and, ACEG (Africa's cocoa export growth %)

Market Structure of Africa's Cocoa Products

A perusal of the Table showed the export market structure of Africa's cocoa to be monopolistic over the studied period (Table 6). This outcome is not surprising as Africa adopts different marketing strategies ranging from grading to standardization for their cocoa products especially cocoa beans so that they can have a good cut in the global market of cocoa. The results showed that the cocoa sector of Africa has low diversification owing largely to concentration on the exportation of the product in its primary form due to inadequate post-harvest technologies required for enhanced value addition. Therefore, the study suggested the need for more investment in post-harvest technologies in order to have comparative and competitive advantages in the exportation of the secondary cocoa products thereby increasing its global share in the cotton markets and maximization of foreign exchange earnings from the exportation of its cocoa products.

Table 6: Export Trade Structure of Africa's Cocoa

Year	Market structure	1/HHI	BID	EID	DBID	DEID
2000	Monopolistic Competition	1.338005	0.252619	0.336825	0.23356	0.168478
2001	Monopolistic Competition	1.403092	0.287288	0.383051	0.25567	0.184427
2002	Monopolistic Competition	1.450959	0.310801	0.414401	0.277408	0.200107
2003	Monopolistic Competition	1.48125	0.324895	0.433193	0.291232	0.21008
2004	Monopolistic Competition	1.432378	0.30186	0.402481	0.27324	0.197101
2005	Monopolistic Competition	1.450637	0.310648	0.414197	0.275424	0.198677
2006	Monopolistic Competition	1.464825	0.317324	0.423099	0.279855	0.201872
2007	Monopolistic Competition	1.560241	0.359073	0.478764	0.309979	0.223602
2008	Monopolistic Competition	1.52209	0.343009	0.457345	0.297827	0.214837
2009	Monopolistic competition	1.435281	0.303272	0.404363	0.272335	0.196448
2010	Monopolistic Competition	1.552118	0.355719	0.474292	0.312395	0.225345
2011	Monopolistic Competition	1.383135	0.277005	0.369339	0.255172	0.184068
2012	Monopolistic Competition	1.370738	0.270466	0.360621	0.250309	0.18056
2013	Monopolistic Competition	1.575078	0.365111	0.486814	0.318525	0.229768

Conclusion and Recommendations

Empirical evidence showed that Africa has revealed comparative and competitive advantages in the exportation of cocoa if considered from the sector point of view with the primary product has been the principal sub-sector that gave the continent trade edge advantage in the global cocoa markets. However, from the sub-sector point of view, it was observed that Africa had only revealed comparative and competitive advantage in the exportation of cocoa beans due to specialization owing to less use of intensive technology as the product is virtually in its raw or primary form. While for the secondary products which required intensive technologies for conversion, evidence showed Africa to be comparative and competitive disadvantaged in the exportation of these products due to capital paucity which is a barrier to the availability of adequate post-harvest technologies required for value addition to the primary cocoa product.

Furthermore, it can be inferred that the competitive situation of Africa's cocoa in the global market is good as it controlled a large share of the market and is among the winner group despite a decline in the export market for cocoa products during the studied period. Therefore, the following recommendations were made:

1. There is a need for special attention on productivity enhancement and cost minimization through the adoption of improved varieties, proper mechanization, enhanced quality and production methods as the appropriate solutions to improve the position of Africa's exporting cocoa products amongst commercial competitors.
2. Africa should adopt regulating guarantee prices and tariffs in such a way that their effect on relative prices is taken into account, in order to guarantee efficient production.
3. The commercial production status and behavior of competing countries should be properly monitored by Africa's manufacturers, exporters, and domestic decision-makers to deal with the effects of externalities. Furthermore, timely and appropriate responses should be done to improve the competitive position of these products in the potential target markets.
4. Africa cocoa exporting countries should observe and adhere to the health standards of the targeting importing countries especially European

countries in order to enhance its global share in the world market. This can be achieved by promotional plans and educating farmers according to the international markets, food hygiene legislation for agricultural products, increased investment in the health control laboratories and use of appropriate product packaging materials and product trademarks for the foreign markets.

5. Africa should adopt accurate systematic plan coupled with increased competition and competitiveness, in order to penetrate potential cocoa importing target markets. For this purpose, Africa cocoa exporters should target potential markets and infiltrate them with the awareness of the competitors, rules and regulations of marketing and coherent marketing plan.

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Water Literacy among Rural Households in Kerala: A Study from Kannur District

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Abstract: *Water as a basic human need is a limited natural resource and is very precious in nature. It is estimated that among 1360 million cubic kilometres available, only 0.2 million cubic kilometres is fresh water. In Kerala, 85 percent of drinking water needs are met from ground water. In recent decades human demand and misuse of water continuously increased and shortage of water is a global issue. The careless usage and less availability of water indicate the need for water literacy among people. The study revealed that rural households in Kerala are highly water literate and they ensured environmental sustainability as their responsibility.*

Key Words: *Water Literacy, Rural Households, Kerala.*

Introduction

Water is a limited natural resource, basic human need and a precious national asset. Three fourth of the surface of earth is covered with it. Recently, the demand and misuse of water resource has increased considerably. Water is very essential for the survival of living beings and several problems related to the quality and availability of water like, water pollution and water scarcity is also severe. In the case of Kerala, plenty of water resources including forty four rivers, fresh water lakes, streams and many other water bodies, still safe and pure drinking water are some important features (Niranjan Mandal, 2011). Several projects, schemes and methods were introduced for ensuring the availability of drinking water, water sustainability and water conservation in Kerala. On the other hand, waste water management from bathing, washing and cleaning is also important.

Sustainability of water availability is a major component of environmental sustainability. Kerala, a water rich region, suffers scarcity of water during February to May every year. To face the problem of scarcity of water several water conservation methods were introduced and practiced; various water supply projects are also implemented in districts and selected panchayaths (Jha and Jain, 2010). In this context, the present paper studied: (i) the use of water and management of water sustainability among rural households, (ii) the efficiency of water supply schemes and (iii) the waste water management in the rural areas of Kerala.

Review of Literature

Srinivasula and Haripriya (2006) examined the factors affecting child health due to drinking water quality and sanitation in Chrornepet and Pallavararn township of Tamilnadu. Verma Manisha (2009) observed the provision of safe drinking water to promote good health and welfare of the people. Umesh Narayan Panjiar (2010) examined the need to ensure sustainable development of water resources and its efficient management. Gautham and Bharadwaj (2010) evaluated the nature and extent of pollution control and effectiveness of it in existence. Singh, et.al (2010), Naleenkumar (2010) and Archana Gupta and Akanksha Shakla (2010) observed that, among many other causes for poverty, scarcity of water is a major one. Karunakaran (2012) analysed the diversification of crops and groundwater depletion in the Kasaragod district in Kerala. Brij Pal (2012) analysed the policies and programmes of rural water supply and sanitation. Rajanbabu (2013) also expressed the variations in climate characteristics responsible for uneven distribution among the availability of water resources. Smitha and Mani (2015) observed the model and procedure followed for implementation of Jalanidhi programme.

Methodology and Materials

The study used primary and secondary data. Secondary data were collected from the official sources of Govt. of Kerala and records of panchayaths. Primary data were collected from households of Kannur district in Kerala. Sixty households from the Kuttiyattoor Grama panchayath in Kannur district was taken for data collection. The data were analysed using statistical techniques and the opinion of respondents was collected to analyse the effectiveness of Jalanidhi project. The respondents are categorised as effective, moderately effective, low effective and the efficiency is determined by analysing the quality of water and accuracy of water availability.

Results, Analysis and Discussion

1. Water Literacy: The term water literacy means water related knowledge. It includes basic knowledge of water source and other aspects that interconnected with it consisting management and related issues. Water literate has basic understanding of use and management, water sustainability and understanding of the importance and role of water in life (Ramaswamy Iyer, 2010). In Kerala, 85 percent of drinking water needs are met from ground water. About 5 percent of ground water extracted is used for domestic drinking; 85 percent for irrigation and the remaining 10 percent for other sectors including industries (Government of Kerala, 2017).

Table 1: Water Resources Used by People

Water resources used by people	Number of people	Percent
Open well	52	87
Tube well	22	37
Pipe water	36	60
Neighbour's water resources	4	7
Pond	3	5

2. Water Conservation Methods: Water is the most critical input for agriculture and sixty percent of the farms are rain fed in Kerala. Management of water promotes conservation and harvesting of rain water for augmenting surface and ground water resources (Shrikrishnan, 2011). In Kerala major technical methods to conserve water are rain water harvesting, historical water bodies, ponds, these are good opportunities for rain water harvesting in Kerala.

Table 2: Consumption of Water by Households Per Day in the Study Area

Quantity of water (in liters)	Number of households	Percent
Below 250	3	5
250-500	14	23
501-750	18	30
751-1000	16	27
Above 1000	9	15
Total	**60**	**100**

3. Rural Water Supply Schemes in Kerala: The important water supply schemes followed in Kerala are Sector Reform Project, Swajaldhara, Giridhara, Jeevadhara and Jalanidhi.

4. Water Resources Used by People in the Study Area: Table 1 shows the different water resources used by people in the study area and most of the people are using more than one or two water resources.

Table 3: Average Consumption of Water Per Day

Purpose	Quantity of water (in litters)	Percent
Drinking	35	5
Cooking	42	6
Washing	259	37
Bathing/toilet	252	36
Life stock	56	8
Other	56	8
Total	**700**	**100**

5. Water Consumption of People in the Study Area: Table 2 reveals the daily water consumption of family and most of them consume in between 500 to 1000 litters of water every day and the average water required per day for a family is 700 litters (table 3).

Table 4: Edification of Children about the Importance and Methods of Saving Water

Edification of Children	Percent
Families which inform their children about the importance of water	63
Families which do not inform their children about the importance of water	37
Families which shows interest in their children about how to save water	55
Families which do not show interest in their children about how to save water	45

Table 4 analyses the data of families which informed their children about the importance of water for saving water; and families which do not inform their children about the importance of water. The table shows that 63 percent of households informed their children to save water. It also shows the details of families which show interest in their children to save water or minimize the amount of water required for different activities. 55 percent of households edify their children about how to save water and 45 percent of households do not give importance to such things.

Table 5: Efficiency of Water Supply Schemes in the Study Area

Schemes	More efficient (in %)	Efficient (in %)	Less efficient (in %)
Jalanidhi	8	33	59
Pazhassi scheme	7	57	36

6. Efficiency of Water Supply Schemes in the Study Area: Safe and pure drinking water is the most urgent requirement of the people. In the study area there are Jalanidhi and Pazhassi irrigation schemes. The efficiency of these projects are analysed from the response of the households (table 6).

Table 6: Response on Assistance Received from the Govt for Water Conservation

Assistance	Percent
Rain Water Harvesting Scheme	**9**
MGNREGP	**9**
No Assistance	**82**

7. Water Conservation Methods in the Study Area: The exploitation of earth's natural resources posed a threat to sustainability. The management of valuable resources of soil, water and biomass through various conservation programmes is very essential. This also promotes conservation and harvesting of rain water for augmenting surface and ground water resources. The conservation methods are both traditional and modern. The government introduced various schemes for water conservation and provide assistance to the people (table 6).

Table 7: Distances between Well and Septic Tank in the Study Area

Distances between Well and Septic Tank (in Meters)	Number of Households	Percent
Below 4	6	10
4-7	12	20
More than 7	42	70
Total	**60**	**100**

8. Water Related Pollution in the Study Area: The distance between well and septic tank creates a chance for the presence of coli form bacteria in the water, leads to spread of various diseases. Table 7 indicates that in 70 percent of the family, the distance between well and septic tank is more than 7 meters while the requirement is 7 meters; among the remaining 30 percent, it is less than 7 meters.

In urban areas there are so many reasons for pollution, but in the case of rural sector it is comparatively less. In each family, wastes are created by daily activities and are disposed using many methods (table 8).

Table 8: Waste Disposal in the Study Area

	Organic waste	Plastic waste	Cloth waste	Paper waste
Waste pit	20 (33)	6 (10)	8 (13)	4 (7)
Compost	26 (43)	-	-	-
Biogas	6 (10)	-	-	-
Collection by panchayath	-	42 (70)	-	-
Throwing away	8 (14)	8 (13)	4 (7)	6 (10)
Burn out		4 (7)	48 (80)	50 (83)
Total	**60 (100)**	**60 (100)**	**60 (100)**	**60 (100)**

Figures in bracket shows percentage to total

The major types of waste generated from domestic activities are organic waste, plastic waste, paper waste and cloth waste. The disposal of organic waste is 33 percent, and 43 percent are disposing it in compost and 10 percent in biogas. Majority of plastic waste (70 percent) is collected by panchayaths; 14 percent households thrown away and remaining 7 percent burn out plastics. Majority of cloth waste (80 percent) and paper waste (83 percent) is burnt out.

9. Waste Water Re-Use in the Study Area: In the case of domestic usage of water, waste water is mainly generated from bathing and washing. This is reused for watering the plants, trees and garden and for cleaning purposes. Table 9 depicts the details of reuse of waste water by households.

Table 9: Waste Water Reuse in the Study Area

	Households which Reuse Waste Water	Households which do not Reuse Waste Water	Total
No. of households	32	28	60
Percent	53	47	100

In the study area, the main source of waste water generation is domestic activities, such as bathing and washing. In most houses it is reused for watering plants, kitchen garden and trees and is also used for cleaning bathroom, toilet and outside areas of house. Another way of managing is converting waste water from kitchen to biogas plants.

Table 10: Waste Water Management in the Study Area

Methods of Waste Water Management	Percent
Reuse for Watering Plants	**55**
Reuse for Cleaning	**25**
Convert to Biogas Plants	**20**

Table 10 depicts the methods of waste water management in rural areas. In the study area, 55 percent of households reuse water for watering plants, 25 percent for the purpose of cleaning and 20 percent for biogas plants.

Conclusion

In the present century, water is a global issue, particularly in the consumption, saving and management; but the present generation is not so serious about these facts. Kerala is a water rich region with two rainy seasons and 44 rivers; but the state suffers scarcity of it. To face these problems, several water conservation methods are in practice. The careless usage and less availability of water indicate the need for water literacy among people. Among the rural households in Kerala, attitude towards the consumption and conservation of water varied on the basis of availability of it. In water scarce areas, the households are very careful in the usage and protection of water and they also teach their children for the careful usage. In joint family system, the elders have control over the activities of youngsters, but in nuclear families the households do not give importance for controlled consumption.

Most of the families are efficient in waste disposal and waste water management and reusing it for watering trees, plants and cleaning purposes. In conclusion the rural people are very conscious about the importance of water sustainability and treats conservation of environmental resources as their responsibility. So, most of the rural households can considered as water literate; but still importance of effective use and management of water sustainability is essential.

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A Study on the Effectiveness of Incentive Programmes at Aditya Birla Retail Pvt. Ltd Mangaluru

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Abstract : *Workforce today articulates more about their needs. Employees desire the best of everything – competitive salaries, comfortable and inspirational lifestyles, job security, career enhancement options, work-life balance, and so on. Competition for talent is ever increasing and organizations need to have well-defined philosophies and strategies to help them develop innovative ways of tapping intrinsic motivation of employees by engaging their hearts and minds. While many organisations are struggling to make sufficient progress in this direction, there are organizations that have institutionalized robust practices and effective processes in different people practice areas that go a long way in positively impacting employee perception. In this regard, two types of rewards are identified, and they are intrinsic reward and extrinsic reward. Extant research showed that reward can affect job satisfaction and thereby employee performance, so this study proposes a new framework based on mediating role of job satisfaction. India's Best Companies for Rewards and Recognition was conceptualized to recognize companies who are leading the way in the area of Rewards and Recognition for us learns from. Human resources are the most important among all the resources an organization owns. To retain efficient and experienced workforce in an organization is very crucial in overall performance of an organization. Motivated employees can help make an organization competitively more value added and profitable. The present study would be an attempt to find out the major factors that motivate employees and to show relationship among reward, recognition and motivation while working within an organization. The data were collected from employees of diverse type of organizations to gain wide representation of sectoral composition. The participation in survey was voluntary and confidentiality of responses was ensured. The statistical analysis showed that different dimensions of work motivation and satisfaction are significantly correlated and reward and recognition have great impact on motivation of the employees. Implications of* *the study for managers and policy makers in the context of human resource practices have been discussed. Limitations and guidelines for future research are also provided. A meta-analytic review of all adequately designed field and laboratory research on the use of incentives to motivate performance is reported. Team-directed incentives had a markedly superior effect on performance compared to individually- directed incentives.*

Key Words : *Job Satisfaction, Employee Performance, Reward, Recognition, Motivation, Incentives.*

Introduction

Incentives are monetary or non monetary benefits paid to workers in recognition of their outstanding performance. The purpose of Incentive Program is to help the employee perform better, accomplish more and be motivated to work towards making an organization more effective. The Incentive Program is the evaluation of on employee job performance in order to determine the degree to which the employee is performing effectively. Incentive Program should be designed to show more precisely how well workers are doing their jobs and to evaluate the work performance of the team with a view to identifying weaknesses and strengths as well as opportunities for improvement and skills development.

Incentive Programs are designed to provide adequate measures to put-in-place the right practices that would increase the commitment of the employees towards the organization and increase the customer base by providing world class services. The main aim of the incentive system is to inform the employee about the quality of his or her performance. The Incentive System needs to be very transparent and helpful both to the employees and to the organization. The only after analyzing the current state of Incentive Program, the human resource managers can go to the next step of improvements.

The use of financial incentives – financial rewards paid to workers whose production exceeds some predetermined standard was first popularized by F.W.Taylor in the late 1800s. Financial incentive refers to performance linked compensation paid to improve motivation and productivity of employees. It implies monetary inducement offered to employees to perform beyond acceptance standards. The use of incentives assumes that people's actions are related to their skills and ability to achieve important long run goals. Unlike wages and salaries which are relatively fixed, incentives generally vary from individual to individual and from period to period for the same individual.

Definition of Incentive

According to The National Commission on Labor, "Wage incentives are extra financial motivation. They are designed to stimulate human effort by rewarding the person, over and above the time rated remuneration for improvements in the present or targeted results."

According to Dale Yoder (1986) "Incentive wages relate earnings and productivity and may use premiums, bonuses or a variety of rates to compensate for superior performance."

Wage incentive scheme is essentially a managerial device of increasing a worker's productivity. Simultaneously it is a method of sharing gains in productivity with workers by rewarding them financially for their increased rate of output. An incentive scheme is a plan or programmes to motivate individual or group performance. An incentive programme is most frequently built on monetary rewards, but may also include a variety of non monetary rewards or prizes. Incentive system of payment is the imparting of incentives to workers for higher production and productivity.
The International Law Office refers to incentives as "Payment by results".

Characteristics of Incentive Plans

1. Minimum wages are guaranteed to all workers.
2. An Incentive plan may consist of both monetary and non monetary elements.
3. For a successful Incentive plan, the essentials are timing, accuracy and frequency of incentives.
4. The Incentive plan requires that it should be properly communicated to the workers to encourage individual performance, provide feedback and encourage redirection.

Company Profile

Aditya Birla Retail Limited, a company registered under the companies Act 1965. And the ADITYA has built and maintained goodwill in the minds of public at large in the world in general and in Karnataka with 121 stores. Their business is running across the country. The company has 891 Supermarkets and 11 Hypermarkets and their product offerings include a wide range of fresh fruits and vegetables, groceries, personal care, home care, general merchandise and a basic range of apparels. Currently, there are over 600 more Supermarkets across the country.

Aditya Birla Retail Limited is the retail arm of **Aditya Birla Group**, India's first truly multinational corporation with revenues of USD 28 Billion Corporation. The Group's foray into the Retail sector began in 2006 with the acquisition of Trinethra, the south India based chain of stores, The Company ventured into food and grocery retail sector in May 2007 were Aditya Birla Retail launched its own brand of stores "more".

Over 50 per cent revenues flow from operations outside India Anchored by a workforce of 100,000 employees belonging to over 25 different nationalities. Subsequently **Aditya Birla Retail Ltd.** expanded its presence across the country under the brand "more" with 2 formats **Supermarket and Hypermarket**.

Beyond business - The Aditya Birla Group is working in 3,700 villages, reaching out to 7 million people annually through the Aditya Birla Centre for Community Initiatives and Rural Development, spearheaded by Mrs. Rajashree Birla. It focuses on: health care, education, sustainable livelihood, infrastructure and espousing social causes. It also runs 41 schools and 18 hospitals, transcending the conventional barriers of business to send out a message that "We Care".

Review of Literature

According to Merchant and van der Steede (2008), there are a couple of critical factors for a successful incentive system. The rewards must be valued, rewards without value for the individual do not provide motivation. Size of rewards must be large enough to affect employees' behaviour, too little a valued reward will also fail to give motivation. Employees should also understand why a reward is given and the intrinsic value. Rewards given short after performance have a stronger effect than those given a long time after. Therefore they should be given as soon as possible. A reward should be reversible so that mistakes can be corrected.

According to Anthony and Govindarajan (2003), individuals are more motivated by the chance of a reward than the fear of punishment. This suggests that incentive systems should be reward-oriented.

A longitudinal study shows that workers paid by piece rate earn higher pay due in part to higher effort, and in part to a risk premium (Mercy,1984). Another article mainly focuses on the employee and employer relationship, understanding employees' positive reactions to organization and what influences their individual behaviors. Group of people in the organization taken as sample group which will also forecast the employee obligation, work stress and its effect on behavior and which type of incentives plan should be given to them in the Context of California (Michel, 2007).

Methodology

The objective of the paper was to study the "The Effectiveness of Incentive Programs" at Aditya Birla Retail Private Limited, Mangalore. D.K. It was a descriptive study conducted among 40 employees of the given company who were in different stores of **more** Supermarkets.

Analysis and Interpretation

This chapter deals with the analysis and interpretation of the data collected. The most important step in an effective research is analyzing and interpreting the data collected and presenting it in a logical sequential manner. This will make its user easier to understand. Analysis basically means to calculate the total number of response to study it and further classify it. Interpretation means to find out what the analysis says or what one understands out of the analysis.

Table 1: The Level of Satisfaction of Respondents with the Working Culture of the Organization

Level	No. of respondents	Percentage
Highly Satisfied	5	12.5
Satisfied	12	30
Average	20	50
Dissatisfied	3	7.5
Highly Dissatisfied	0	0
TOTAL	**40**	**100**

The above table shows that 12.5% of respondents are Highly satisfied with the working culture of the organization, 30% of respondents are Satisfied with the working culture of the organization, 50% of respondents are Average satisfaction with the working culture of the organization, 7.5% of respondents are Dissatisfied with the working culture of the organization and there are no respondents who are Highly Dissatisfied with the working culture of the organization. It shows that majority of the employees are satisfied with the working culture.

Table 2: The Type of Incentive that Motivates Respondents

Types of Incentives	No. of Respondents	Percentage
Incentive Award	18	45
Promotion	20	50
Appreciation Letter	2	5
TOTAL	**40**	**100**

The above table shows that 45% of respondents are motivated by incentive awards, 50% of respondents are motivated by Promotion schemes, 5% of respondents are motivated by Appreciation letter.

Table 3: The Level of Satisfaction of Employees with the Incentives of the Organization

Level	No. of Respondents	Percentage
Highly Satisfied	7	17.5
Satisfied	25	62.5
Dissatisfied	8	20
Highly Dissatisfied	0	0
TOTAL	**40**	**100**

The above table shows that 17.5% of respondents are highly satisfied with the incentives provided by the organization, 62.50% of respondents are satisfied with the incentives provided by the organization, 20% of respondents are dissatisfied with the incentives provided by the organization and no respondents are highly dissatisfied with the incentives provided by the organization.

Table 4: The Opinion of Employees Regarding the Reasonable Periodical Increase in Salary

Level	No. of Respondents	Percentage
Highly Satisfied	1	2.5
Satisfied	21	52.5
Average	16	40
Dissatisfied	2	5
Highly Dissatisfied	0	0
TOTAL	**40**	**100**

The above table shows that 2.5% of the employees Highly Satisfied with the reasonable periodical increase in salary, 52.5% of the employees Satisfied with the reasonable periodical increase in salary, average 40% of the employees satisfied with the reasonable periodical increase in salary, 5% of the employees are dissatisfied with the reasonable periodical increase in salary and no respondents are highly dissatisfied with the reasonable periodical increase in salary.

Table 5: The Level of Job Security for the Employees of ABRL.

Level	No. of Respondents	Percentage
Highly Satisfied	0	0
Satisfied	11	27.5
Average	25	62.5
Dissatisfied	4	10
Highly Dissatisfied	0	0
TOTAL	**40**	**100**

The above table shows that there are no employees who are highly satisfied with the job security provided by ABRL, 27.5% of employees satisfied with the job security provided by ABRL, 62.5% of employees average satisfied with the job security provided by ABRL, 10% of employees highly dissatisfied with the job security provided by ABRL and there are no employees who are highly dissatisfied with the job security provided by ABRL.

Table 6: The Opinion of Employees Regarding Effective Performance Appraisal System

Level	No. of Respondents	Percentage
Highly Satisfied	5	12.5
Satisfied	20	50
Average	14	35
Dissatisfied	1	2.5
Highly Dissatisfied	0	0
TOTAL	**40**	**100**

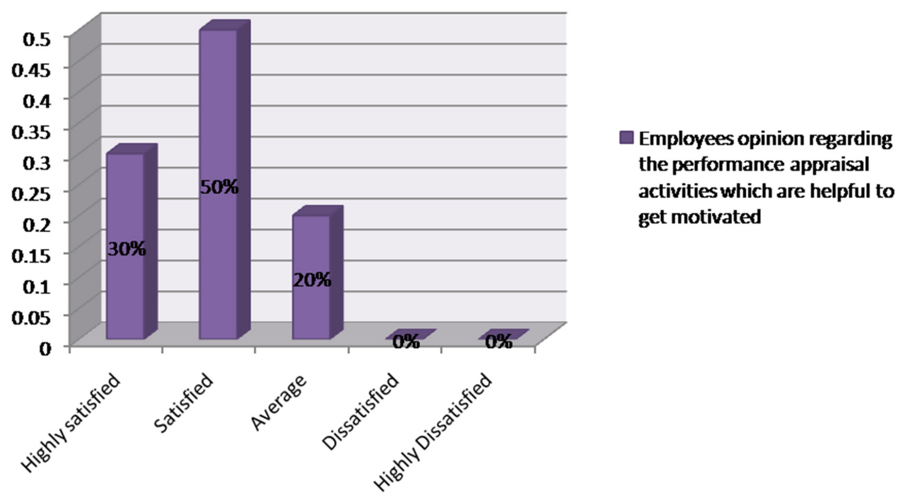
From the above table we can find that 12.5% of employees are Highly Satisfied, 50% of employees are Satisfied, 35% of employees show Average satisfaction, 2.5% of employees are Dissatisfied with the performance appraisal system of ABRL and there is no employee who is highly dissatisfied with the performance appraisal system of ABRL.

Table 7: The Employees Opinion Regarding the Effective Promotional Opportunities

Level	No of respondents	Percentage
Highly Satisfied	4	10
Satisfied	13	32.5
Average	15	37.5
Dissatisfied	8	20
Highly Dissatisfied	0	0
TOTAL	**40**	**100**

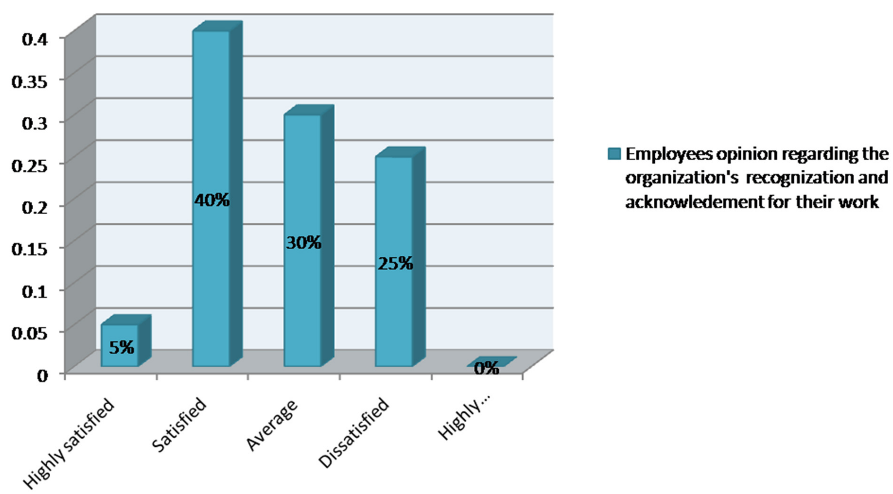
The above table shows that 10% of employees are Highly satisfied, 32.5% of employees are Satisfied, 37.5% of employees show Average satisfaction, 20% of employees are Dissatisfied with the promotional opportunities in ABRL and there is no employee who is highly dissatisfied with the promotional opportunities in ABRL.

Chart 1: The Employees Opinion Regarding the Performance Appraisal Activities Which are Helpful to Get Motivated



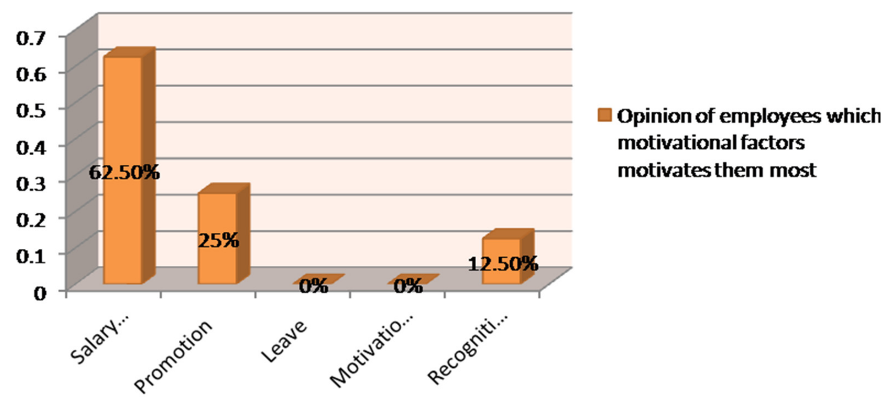
From the above figure shows that 30% of employees are Highly satisfied, 50% of employees are Satisfied, 20% of employees show Average Satisfaction with the performance appraisal activities of ABRL which is helpful to get motivated and there is no employee Dissatisfied and Highly dissatisfied with the performance appraisal activities of ABRL which is helpful to get motivated.

Chart 2: The Opinion of the Employees about the Organization's Recognition and Acknowledgment of their Work



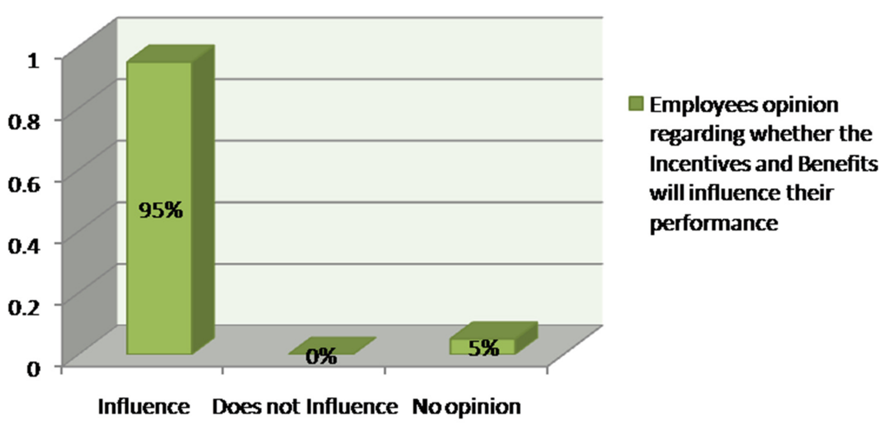
The figure 2 explains that 5% of employees are Highly Satisfied, 40% of employees are Satisfied, 30% of employees show Average Satisfaction, 25% of employees are Dissatisfied with the organization's recognition and acknowledgement for their work and there are no employees who are Highly Dissatisfied with the organization's recognition and acknowledgement for their work.

Chart 3: The Opinion of the Employees that Which Motivational Factors Motivate Them the Most



The above figure illustrates that 62.5% of employees have an opinion that they get motivated by Salary increase, 25% of employees have an opinion that they get motivated by Promotion, 12.5% of employees have an opinion that they get motivated by Recognition and there are no employees who are motivated by Leave and Promotional Talk.

Chart 4: Employee's Opinion Regarding whether the Incentives and Benefits will Influence their Performance.



The above table shows that 95% of employees are agreed that Incentives and Benefits will influence their performance, no employees say that Incentives and Benefits does not influence their performance and 5% of employees had No Opinion regarding the influence of Incentives and Benefits on the performance.

Findings

It is with the various Incentive Programs ABRL had been able to achieve employees effectiveness to a great extent and there by contributing to the success of the organization.

From the study it had been found that 50% employees are average satisfied with the working culture of the organization. 50% of the respondents have an opinion that promotion motivates them more and 45% of respondents have an opinion that incentive awards motivate them more. More than 62% of respondents were satisfied with the incentives provided by the organization. 62.5% of employees agreed with the job security provided by the organization. Half of the respondents were satisfied with the effective performance appraisal system of the organization. From the survey it was found that 70% of respondents were satisfied with the promotional opportunities provided by the organization. More than 80% of the respondents were satisfied and they had an opinion that performance appraisal activities were helpful to get motivated. 25% of respondents had the opinion that they were dissatisfied with the organization because organization did not recognize and acknowledge their work. 62.5% of respondents believed that salary increase would motivate them. It was also found out that 95% of respondents were of the opinion that the incentives and benefits would influence their performance.

Recommendations

Monthly payout could be introduced taking into consideration of the employees' common opinion. Organization should make sure that they provide update information regarding its various Incentive schemes to the employees. Organization could motivate their employees by providing increase in payout and include non-monetary benefits also in the Incentive scheme. Achieving the incentive program should also be included as a parameter in giving promotion to the employees so that the employees would get motivated to perform better. Individual performance should also be included as a criterion for calculating the incentive rather than group performance.

Conclusion

The research study shows that most of the employees were new to the company because 50% of them had only less than 1 year experience, and very less number of employees had 4-6 years of experience in the organization. The opinions collected from the respondents reveal that the major drawback of the present system was that the employees were confused with the Incentive Program and other benefits like Attendance bonus, Annual Bonus etc. Majority of the respondents expect salary increase and promotion as a factor which motivated them more. The employees were not completely satisfied because organization did not recognize and acknowledge their work. They get motivated to perform more because of the monetary benefits they receive as incentive. The Incentive system helped the employees in increasing their performance. It also indicated the present Incentive system practiced in ABRL would be fairly good and the employees were happy with the criteria in which their Incentive was calculated.

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Kerala Deluge 2018: Ecological, Economic and Psychosocial Impacts and Management

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Abstract: *The great deluge in Kerala occurred in August 2018 with death toll of 483 and 10 lakh people in rescue camps affected the entire state of Kerala in Indian subcontinent had devastating impact and was the most severe disaster of the century. Although floods are generally considered as natural disasters the deluge in Kerala had significant causative factors that it could be defined as both natural and manmade. This paper is an attempt to analyse quantitatively and qualitatively the economic, psychological and social impacts of the tragic event so as to identify the criterion and indicators of precautionary measures to be adapted for future mitigation. Methodologically narrative and phenomenological approaches were adopted screening the secondary data sources from online and offline materials. The article depicted the causative factors and physical hazards that took place leading to indicators of the very nature of the mishap that club both natural and nurturing features contributed to the deluge. The analysis focused on the ecological and economic aftermath of the deadly flood leaving heavy economic burden on the affected individuals, families, properties, business activities, agriculture, environment and service sectors of government and nongovernment as well. The Psychological impact defined innovative avenues of resilience in individual, familial and social realms. It weaved a social effect through the network of dedication, hard work and coordination in rescue and relief operations spread over in the entire state of Kerala. The involvement of the 3000 fishermen with their boats in rescue operations and the coordination of the military, paramilitary, police and other forces with disaster management operations of the government and the commitment of numerous NGOs created a new saga in the history of disaster management and mitigation. The article also highlighted the role of social work professionals in the entire rescue, relief and rehabilitation activities in disaster management.*

Key Words: G*reat Deluge, Causative Factors, Ecological and Economic Burden, Psychological Impact, Social Effect, Management Strategies*

Introduction

Kerala one of the south Indian states was affected by severe floods from 9 August 2018, due to unusually high rainfall during the monsoon season. It was the worst flood in Kerala in nearly a century. Over 483 people died, and 14 were missing. About a million people were evacuated, mainly from Chengannur, Pandanad, Edanad, Aranmula, Kozhencherry, Ayiroor, Ranni, Pandalam, Kuttanad, Malappuram, Aluva, Chalakudy, Thiruvalla, Eraviperoor, Vallamkulam, N.Paravur, Chendamangalam, Eloor and few places in Vypin Island and Palakkad. All 14 districts of the state were placed on red alert. According to the Kerala government, one-sixth of the total population of Kerala had been directly affected by the floods and related incidents. The Indian government had declared it a Level 3 Calamity, or "calamity of a severe nature". It is the worst flood in Kerala after the great flood of 1099 (Malayalam year) that took place in 1924.

Thirty-five out of the fifty-four dams within the state were opened, for the first time in history. All five overflow gates of the Idukki Dam were opened at the same time, and for the first time in 26 years 5 gates of the Malampuzha dam of Palakkad were opened. Heavy rains in Wayanad and Idukki have caused severe landslides and have left the hilly districts isolated. The situation was regularly monitored by the Prime Minister, and the National Crisis Management Committee coordinated the rescue and relief operations.

The Damage Data as per Government Records (www.donation.cmdrf.Kerala.gov.in/assets)

1. More than 370 lives lost (Later updated on 30-8-2018 as 483);
2. More than 1 million people displaced (A total of 10, 28, 000 people have been sheltered in the flood-hit districts),
3. 3,274 Relief Camps opened,
4. Lost crops in 54000 hectares,
5. 537 landslides,
6. 221 bridges damaged,
7. Preliminary estimates count a loss of more than 3 billion USD (20, 000 plus crores in INR),
8. 10000 km of roads damaged,
9. 300000 farmers affected.

Local and National Response

The Central Government of India had released EUR 10 million under the State Disaster Response Fund (SDRF), as well as immediate relief funding of EUR 12.6 million from the National Disaster Response Fund (NDRF) in order to respond to the emergency. (DG ECHO 13/08/2018, Government of India 14/08/2018)

The Indian Army (ten columns of the Army, a unit of Madras Regiment, the Navy, the Air Force and NDRF) had been mobilised for rescue and evacuation in all districts affected by flooding and landslides. The State Government had provided food and shelter assistance, and offering approximately EUR 5,000 to families of deceased victims, and over EUR 24,000 to families having lost their home and land. (DG ECHO 13/08/2018) The State Government was planning on providing additional teams if needed. (DD News 13/08/2018, Government of India 14/08/2018).

National NGO CASA was operating in some of the flood affected areas, and was supporting the civil society group CARD in assisting people affected by the floods. (Act Alliance 11/08/2018).

International Response

A Unified Response Strategy (URS) and coordination mechanism between various organisations had been put in place by SPHERE India. Needs assessments were being conducted in affected districts by various humanitarian organisations including Caritas India, Oxfam India, CARE, Save the Children, World Vision India, Habitat for Humanity. (SPHERE India 11/08/2018, SPHERE India 12/08/2018)

All the international organisations on the ground had already implemented wash, shelter, food, livelihoods, and health response. (SPHERE India 12/08/2018)

There were several natural and manmade causes contributed to the severe flood situation in Kerala. The government departments and media reported those causes which could be analysed to know the severity of the impact of the deluge.

Literature

The Causes of Deluge in Kerala

Kerala received heavy monsoon rainfall, which was about 75% more than the usual rain fall in Kerala, on the mid-evening of August 8, resulting in dams filling to capacity; in the first 24 hours of rainfall the State received 310 mm of rain. Almost all dams had been opened since the water level had risen close to overflow level due to heavy rainfall, flooding local low-lying areas. For the first time in the State's history, 35 of its 54 dams had been opened. The deluge has been considered an impact of the global warming. The Government of Kerala argued in the Supreme Court that the very sudden release of water from the Mullaperiyar Dam by the Tamil Nadu government was one of the reasons for the devastating flood in Kerala. The Tamil Nadu government rejected the argument, saying that Kerala suffered the deluge due to the discharge of excess water from 54 reservoirs across Kerala, spurred by heavy rains from within the state; It also argued that the flood surplus from the Idukki dam is mainly due to the flows generated from its own independent catchment due to unprecedented heavy rainfall, while the discharge from Mullaperiyar dam was significantly less. Though it is difficult to attribute any single event to climate change, it's possible role in causing the heavy rainfall event over Kerala cannot be ruled out.

Table 1. District wise Data of Increased Rainfall in Kerala

(1 June 2018 – 17 August 2018)

District	Rainfall (mm)	Normal (mm)	% increase
Alappuzha	1648.1	1309.5	29%
Ernakulam	2305.9	1606.0	48%
Idukki	3211.1	1749.1	94%
Kannur	2450.9	2234.9	10%
Kasaragod	2549.94	2489.1	12%
Kollam	1427.3	985.4	56%
Kottayam	2137.6	1452.6	50%

Kozhikode	2796.4	2156.5	30%
Malappuram	2529.8	1687.3	52%
Palakkad	2135.0	1254.2	75%
Pathanamthitta	1762.7	1287.5	44%
Thiruvananthapuram	920.8	643.0	45%
Thrissur	1894.5	1738.2	16%
Wayanad	2676.8	2167.2	26%
Kerala	2226.4	1620.0	41%

Natural Causes

The great depression due to low pressure in the atmosphere led to heavy rainfall in the State. The amount of rain water in a short span of time was massive that created huge amount of water leading to flood. There was 237.87 cm rain fall in Kerala from the month of June to August.

Table 2. Data of Rainfall during Major Floods in Two Centuries

Year	June	July	August	September	Total rainfall
1878	93.6cm	54.8cm	85.5cm	58.6cm	292.54cm
1924	101.5cm	125.3cm	58.4cm	26.4cm	311.53cm
1961	96.1cm	95.2cm	63.7cm	39.2cm	294.34cm
2018	75.2cm	85.8cm	76cm (till 20th)	——-	237.87cm

(Meteorological survey, Indian Institute of Tropical Meteorology, Malayala Manorama, P.7, 21-08-2018)

The phenomenon in the sea; the higher level of the sea and the ocean was 25cm high during the flood days. The difference between high tide and low tide was less and it was only 5cm during flood days. The amount of water flowing to sea got reduced as a result of such phenomenon. There was wave and wind set up phenomenon on the shore leading to pushing back the rain water to the shore that was flowing towards the sea. (Balakrishnan Nair, 2018).

Manmade Causes

1. **The Sudden Opening of the Shutters in Major Dams**: If the Dams were opened gradually well in advance the effect of the mishap could have been lighter compared to what actually happened.
2. **Poor Waste Management and Drainage System:** The drainages were filled with effluents and it prevented free flow of rain water leading to flood.
3. **Deforestation:** Due to massive deforestation the rain water that falls on Western Ghats rush to the low lane area within short span of time. Afforestration is the solution to prevent such mishaps.
4. **Unscientific Disposal of Plastic Waste**: The plastic carry bags and pet bottles prevented free flow of water and preventing water to be absorbed underground
5. **Major Dams**: Construction of major Dams carry large amount of water and when released create a flood. Minor dams will be a solution to prevent such disaster.
6. **Unscientific Construction and Mining:** The unscientific construction of buildings in Western Ghats, mining of rocks in the same geographical area leaving the terrain into major disasters.
7. **Filling of Estuaries and Marshy Lands:** Land filling for development activities causes disappearance of marshy lands which were functioning as sponges to absorb excess water. The Chennai flood in 2017 was similar incident due to lack of sufficient estuaries. **Paddy fields** which acted as **water reservoir** and the **low lying flood plains** of many rivers made their way out in the name of development like airports, bungalows, villas and Malls.

As Kerala struggles to recover from its worst floods in a century, ecologist Madhav Gadgil's report that had warned against damage to the environment would be back in focus. A committee headed by Gadgil submitted a 500-page report in 2011 recommending a slew of measures to protect the fragile ecosystem of the Western Ghats—a mountain range that runs parallel to the coast across six Indian states, including Kerala. Zones marked out as ecologically sensitive in Gadgil's report were among the regions worst hit by the floods that took over 400 lives in the southern state. Gadgil had no doubt that if his report had been implemented, there would have been "substantially less" loss of human life and damage to property. Unscientific management of water in reservoirs by the Kerala government was one of the key reasons for the scale of devastation by the heaviest rainfall in a century, Gadgil said in an interview with Bloomberg Quint.

This year, the reservoirs were almost full halfway through the monsoon. When the last rainfall came, they suddenly released the water. Illegal stone quarrying was another reason that led to greater devastation in Kerala. Gadgil said rampant quarrying led to more landslides and rubble deposits, blocking streams and rivers. Kerala has this huge criminal economic enterprise. It's flourishing in Kerala and that has led to landslides especially in Idukki. The Gadgil report was rejected in the past over concerns that its implementation would hurt local economies. It recommended that 90% of the Western Ghats should be a "no-go area".

Gadgil said the only threat of implementing measures to protect the environment will be to "extensive profits, often through criminal means". Citing examples of illegal mining in Goa and polluting industries in coastal Maharashtra, the ecologist warned that ignoring or subverting existing laws and recommendations will only put the environment at a greater risk and pave the way for more disasters like what was seen in Kerala.

"I do not agree that economy and ecology are at loggerheads. What is at loggerheads is this greed for extensive profits and often through criminal means" (Madhav Gadgil, Ecologist, *Bloomberg Quint)*.

Were There Early Signs?

One of the most severely affected areas is Ernakulum in Kochi, along the Periyar River, into which excess water from the Idamalayar dam was drained. Dam-safety expert N Sasidharan claimed that authorities waited till the water level in the Idamalayar reservoir reached its capacity of 169 feet, and had it been opened sooner, would likely have spared the massive evacuation efforts in the vicinity.

MC Joseph of Kuttikkatt village near Eloor said that the authorities made a mistake by opening all four gates of the dam at once, flooding the underlying regions at a much faster rate than expected. "This is the result of poor planning by the disaster management authority," Sasidharan added.

"Sitting at Geneva, I had on 14 June cautioned that the reservoirs will be filled by July. I had made the prediction based on the experience in Thailand and Pakistan," Murali Thummarukudy, Chief of Disaster Risk Reduction in the United Nations Environment Programme (UNEP) said to *Malayala Manorama,* a Kerala daily. "Unfortunately, our engineers did not foresee this," he added.

Time for Retrospection

Commenting on the impact of the rains and ensuing damage, advocate Susheela Bhatt, former Government Pleader said, "It is the time for us to reflect". "I fought for preserving mother nature when I was overseeing Munnar officially. But nobody took it seriously. After seeing this rain havoc, I think it's high time to be retrospective," she said. Following the heavy rains and landslides, Munnar is cut off from other areas. Just last month, the government had disbanded the Munnar Special Tribunal, set up in 2011 by the then chief minister VS Achuthanandan to settle the controversial land disputes and encroachments in Munnar. Socialist Unity Centre of India leader M Shajir Khan said that the havoc was caused only because we ignored the Gadgil and a watered-down Kasturirangan report. "We allowed encroachments. We allowed deforestation. We allowed excessive quarrying. We kneeled and crawled in front of the land grabbing mafia. And eventually, we are suffering now. They built resorts on ecologically fragile land. They mined tones of rocks from ecologically fragile lands. They built skyscrapers on wetlands. And now the entire state is sinking. We are paying the price for our ineffectiveness in stopping the greedy land grabbers," Shajir said. "People-inclusive nature protection is not happening here. The public must utilise their democratic rights," he added.

Amendments and Uncontrolled Quarrying

Meanwhile, Dr M Kamarudeen, a Biodiversity Management expert, said that this government has given a free run to quarry lobbies for construction on wetlands. "Recently, the government had amended the Conservation of Paddy Land and Wetland Act, 2008, diluting its original intention. As per the new version, if anybody wants to build a house on a paddy land, then there are a lot of hiccups. But if it is a corporate project, then there are no issues," Kamarudeen said. "The amendment is encouraging large-scale land reclamation, causing environmental degradation and groundwater depletion. Though the bill states that paddy fields and wetlands will be reclaimed only for 'projects that benefit the public', it does not provide a clear definition of such a project," he said, adding that such amendments have worsened the situation in the state following the rains. "According to a study, Kerala has about 6,000 quarries. The use of explosives to blast rock in quarries causes rapid landscape changes leading to landsides. Quarrying and construction should not be allowed in landslide-prone areas. Not only should the Western Ghats, but also the estuarine mangroves be preserved to minimise natural calamities," the expert added.

These were the causative factors leading to great deluge in Kerala. This paper would be focusing on the socio-economic and psychosocial impact of the deluge. It also would highlight the rescue, relief, rehabilitation and reconstruction attempts made in massive scale with government and NGO collaborations creating a model in disaster management and mitigation.

Methodology

Methodologically narrative and phenomenological approaches were adopted screening the secondary data sources from online and offline materials. The article depicted the causative factors and physical hazards that took place leading to indicators of the very nature of the mishap that club both natural and nurturing features contributed to the deluge. The analysis focused on the ecological and economic aftermath of the deadly flood leaving heavy economic burden on the affected individuals, families, properties, business activities, agriculture, environment and service sectors of government and nongovernment as well.

Rescue, Relief, Rehabilitation and Reconstruction in Kerala Deluge

The official machinery worked, with Armed Forces units and the National Disaster Response Force working in tandem with, and as coordinated by, the local administration for rescue and relief operations. Helicopters and naval and coastguard boats rescued people stranded atop homes and other elevations.

But the biggest rescue work was done by Kerala's fisher folk, who arrived with their boats, strong bodies and generosity of spirit and spent tireless hours moving people to safety.

A million or so people made it to schools, churches, community halls and other large buildings that turned into functional relief camps. Ordinary people ran the camps. Volunteers turned up in droves food and other essentials materials. The information technology-savvy had set up networks to register calls for help and guide rescue workers, supplementing the official call centre and help lines. No great leader had to order such work to be organised. Relief came into being, organised spontaneously, some under the auspices of some agency or the other, the rest with the unbidden ease with which seeds below the parched soil start sprouting once the rains arrive.

Why was Kerala's proactive response to the floods so sharply different from the passive victimhood that mostly characterises the flood-affected in the rest of India? The answer lies not in the State's superior level of literacy, but in the political empowerment of the people over generations. People united beyond class, cast and creed and save lives of their brethren.

The Details of the Rescue and Relief Operations

Table 3. District wise Rescue Camps during Flood (Malayala Manorama Daily P. 9, 08-20-2018).

Districts	Number of Camps Operated	Number of People in Camps
Kasargod	01	168
Kannur	06	1227
Wayanad	202	28,861
Kozhikode	150	23,060
Malappuram	155	32,743
Palakkad	80	7647
Trichur	721	2,04,181
Ernakulam	733	2,61,634
Kottayam	411	98,175

Idukki	211	33,636
Alappuzha	601	2,77,706
Pathanamthitta	528	69,505
Kollam	89	16,811
Thiruvananthapuram	42	3,285
Total	**3,930**	**10,58,639**

Rescue Operations

Fishermen Community: With the request of the Department of Fisheries, State of Kerala and the Liberal Federation of Kerala Fishermen, 2, 927 fishermen rescued 65,000 people using 667 boats.

Table 4. The Number of Boats and Fishermen Operated in Rescue Mission.

Districts	Number of boats operated	Number of fishermen
Kannur	42	72
Kozhikode	25	145
Malappuram	25	392
Palakkad	6	25
Trichur	31	114
Ernakulam	127	343
Kottayam	15	18
Alappuzha	118	706
Kollam	165	752
Thiruvananthapuram	113	360
Total	**667**	**2,927**

(Source. Malayala Manorama Daily, p.6, 08-23-2018)

The Government Forces

Chief Minister's Office

The Chief Minister cancelled his medical treatment trip to USA and stayed back to give leadership for Disaster Management operations. Full time observation cell was started and the representatives of various central and state forces, different government departments cooperated with the cell to organise and coordinate rescue operations. Every day morning and evening high power committee meeting was held under the chairmanship of the chief minister to assess the ongoing rescue and relief operations.

Army - about 1500 personnel in 70 teams rescued 31,000 people.

Air Force - about 2000 personnel in 92 teams using 26 Helicopters (Mi17 V5 type) rescued 16,005 persons and involved in distribution of food, clothes and other essential materials. They rescued several people through airlifting. Later the number of helicopters increased to 96.

Navy: Prepared food for 5000 affected people.

Coast Guard: About 575 experts involved in rescue operations in 36 teams with 21 boats and 36 Jiminy boats.

State Police force: 40,000 policemen using 2476 vehicles rescued 53,000 people.

The Fire force: 4100 firemen rescued 34,527 persons and helped 85,000 people.

Table 5. The Materials and Food Provided by Central Government

Materials			Food items		
548	–	Machine boats	Milk	-	6,00,000 tons
6,900	–	Life jackets	Food packet	-	3,00,000
3000	–	Lifebuoy	Drinking water	-	14,00,000 liters
167	–	Tower light	Water purifiers	-	150 - capacity to purify 1,00,000 liters of water
548	–	Machine boats			
6,900	–	Life jackets			
2100	–	Rain coats			
1300	–	Gumboot			
153	–	Chainsaw			

(Source: Malayala Manorama Daily p. 13, 08-20-2018)

Ordinary People

Private Torus Trucks: 400 numbers. **Prisoners**: distributed food for Rs. 4,00,000/-

Social Media

Step 1 : Call for help through social media such as Whatsapp, facebook, twitter, missed calls etc from those caught in houses flooded and transit the information to rescue team in operation

Step 2 : Sorting the emergency request using hash tags

Step 3 : Online control room; available information fed to excel sheets

Step 4 : Call centres; online call centres of volunteers to confirm the request for help and to coordinate with disaster management team for rescue operations

Step 5 : Local centres provided locations needed help and rescue operations and handover to rescue team

Step 6 : Rescue Operations: The helicopters and boats as they receive request for help reached on spot and rescued people to safe camps.

The Role of the Media in General

Both print, visual and electronic media played an active role in providing adequate information to the public particularly the disaster affected people in rescuing their lives and to coordinate relief activities in camps in which more than 10,00,000 people took shelter. The impressive role of the media is well appreciated nationally and internationally with higher end of social responsibility for the welfare of the affected people.

The televisions, radio and newspapers informed the instructions of the authorities about the cautions to be taken in the process of resettlement. The houses which were flooded with muddy water had to be carefully cleaned as there would be threats of snake bites, electro locution, health hazards and so on.

National and International Resource Mobilization

The state governments in India, various foreign governments, NGOs like world vision, Caritas India, Catholic Diocesan Social Services, Mata

Amritanandamai Matt and volunteers from different institutes mobilized manpower, materials and money for relief operations of deluge affected Kerala. Interestingly the students of JNU, Delhi conducted a strike against the poor fund given by central government were taken into custody by the Delhi police and the students collected Rs 4,00,000/- from the police towards flood relief activities. Various companies and corporate donated money and materials from their CSR fund.

Ecological, Economic and Psycho Social Impacts

Ecological Impacts

During the rains, water drains off to the rivers and lakes, and they in turn flow to the sea. Almost all the rivers in Kerala are choked with sand deposits, which reduce the capacity of the rivers to hold more water. The net result is, with the slightest increase in water level, there would be flood. The same thing applies to lakes also. Protecting the river bed is an urgent need. The most affected area is Kuttanad which is the agricultural part of Kerala. The Kuttanad area is fully inundated and all the crops are destroyed. Kuttanad is situated below the sea level; naturally we have to plan very carefully. It is an ecologically sensitive area and the government has to stop construction of buildings in this agricultural area. This area is a trigger factor for all the floods in the nearby areas. It is high time we have a master plan for Kuttanad and implement it aggressively in a time bound manner.

Floods cause extraordinarily large number of fatalities due to high population density and regularly un-enforced development requirements which keep on increasing day by day. It causes massive amounts of damage to humans' lives, property and critical infrastructure which are lifeline to a state.

After a flood, situation gets grimmer leaving behind a lot of development works to do and rebuilding. It reversed the current development gains and degrading the quality of life, and severely affected the future growth of the state. Floods not only affected life of humans but animals too as it destroyed their habitat thus bringing close encounter with man and animal. Agricultural lands are destroyed, crops gets submerged in water. Huge economic loss to farmers is seen in Kerala floods.

By September, the floodwaters had receded, but relief programs continued. Officials estimated that the cost of rebuilding would go over \$3.7 billion.

Millions of jobs were impacted, while the tourism and agriculture sectors were severely hit. Over 57,000 hectares of farmland were ruined. That is equivalent to over 100,000 football fields. Infrastructure and healthcare facilities were damaged as well. Many people remained homeless and fears of contracting water-borne diseases increased. According to the NGO, People for Animals, at least 40,000 animals such as dogs, rats, and cows died in the floods. Their bodies then contaminate the water, increasing the risk of leptospirosis ("rat fever"), cholera, typhoid, diarrhea, and hepatitis among others. Cases of leptospirosis have been reported in at least five of the thirteen flood-hit districts.

To combat the spread, antibiotics were distributed at relief camps. According to the central government, Kerala has the best performing public health system among India's states. This infrastructure combined with education has helped to maintain the outbreak.

Since the disaster, many have commented on why the floods became so deadly. Although some praised the government for their fast response time, other experts criticized authorities for lack of preparation and for not releasing water from the dams earlier and gradually. Although Kerala's progress is high in many areas, in the month before the flooding the government ranked the state as one of the lowest performers in water resource management. In addition, the government has been criticized for refusing offers of foreign aid from Qatar and the United Arab Emirates. Authorities cite the desire to rely on domestic resources, which has been a traditional policy. But with a projected rebuilding cost of over $3.7 billion, they may have to reassess. A rethinking of preventative measures, of rebuilding plans, and of how land use affects the environment are needed for the population's health and future.

Flooding of areas used for socio-economic activities produces a variety of negative impacts. The magnitude of adverse impacts depends on the vulnerability of the activities and population and the frequency, intensity and extent of flooding. Some of these factors are shown below;

Loss of Lives and Property: Immediate impacts of flooding include loss of human life, damage to property, destruction of crops, loss of livestock, non-functioning of infrastructure facilities and deterioration of health condition owing to waterborne diseases. Flash floods, with little or no warning time, cause more deaths than slow-rising riverine floods.

Loss of Livelihoods: As communication links and infrastructure such as power plants, roads and bridges are damaged and disrupted, economic activities come to a standstill, resulting in dislocation and dysfunction of normal life for a period much beyond the duration of the flooding. Similarly, the direct effect on production assets, be it in agriculture or industry, can inhibit regular activity and lead to loss of livelihoods. The spillover effects of the loss of livelihoods can be felt in business and commercial activities even in adjacent non-flooded areas.

Decreased Purchasing and Production Power: Damage to infrastructure also causes long-term impacts, such as disruptions to clean water and electricity, transport, communication, education and health care. Loss of livelihoods, reduction in purchasing power and loss of land value in the flood plains lead to increased vulnerabilities of communities living in the area. The additional cost of rehabilitation, relocation of people and removal of property from flood-affected areas can divert the capital required for maintaining production.

Mass Migration: Frequent flooding, resulting in loss of livelihoods, production and other prolonged economic impacts and types of suffering can trigger mass migration or population displacement. Migration to developed urban areas contributes to the overcrowding in the cities. These migrants swell the ranks of the urban poor and end up living in marginal lands in cities that are prone to floods or other risks. Selective out-migration of the workforce sometimes creates complex social problems.

Hindering Economic Growth and Development: Preliminary estimates cite a loss of more than 3 billion US dollars (about 20,000 crores in Indian Rupees). Rough surveys reckon over 10,000 km of roads are damaged. The states farmers, around 2.6 lakhs of them, have lost crops, cattle, goats and other livestock. The high cost of relief and recovery may adversely impact investment in infrastructure and other development activities in the area and in certain cases may cripple the frail economy of the region. Recurrent flooding in a region may discourage long-term investments by the government and private sector alike. Lack of livelihoods, combined with migration of skilled labour and inflation may have a negative impact on a region's economic growth. Loss of resources can lead to high costs of goods and services, delaying its development programmes.

An assessment of the destruction, the economic costs and impact of reconstruction would be a challenge given the scale and extent of the damages. The rebuilding and reconstruction of the 5 most affected districts and of the infrastructure destroyed is likely to be a long drawn out process, one which is likely to have a sizeable economic and financial costs attached to it. CARE Ratings Limited attempted to analyse the likely impact of the disaster on the economy and the industries that are likely to be impacted.

Immediate Impact on Employment

The five worst-affected districts of the state's 14 districts i.e. Idduki, Ernakulam, Kollam, Kottayam and Pathanamthitta have an estimated population of 11.09 million which accounts for nearly 30% of the state's total population.

They estimated that the employment of nearly 4.13 million individuals of these districts had been affected on account of the deluge and the resultant disruptions.

Political Implications: Ineffective response to relief operations during major flood events may lead to public discontent or loss of trust in the authorities or the state and national governments. Lack of development in flood-prone areas may cause social inequity and even social unrest posing threat to peace and stability in the region.

Drought after Flood

A few days after receiving one of the highest rainfalls in a century, Kerala came under the threat of severe drought. Water level in wells, ponds and rivers had recorded lowest levels and some wells even collapsed. The water level in wells, especially in high ranges of Idukki district has come down by 20 feet in just a matter of 15 days. Chief minister Pinarayi Vijayan had directed the State council for Science, Technology and Environment to carry out studies on the phenomenon after floods across the state and suggest possible solutions to the problem.

A.B. Anita, Executive Director, Centre for Water Resources Development Management (CWRDM), an autonomous research institution under the State government, said heavy run-off of the top soil in the upland areas and the siltation in the rivers were the reasons for the falling water level. The top soil in the hills and upland areas had been removed in the flash floods to a depth of up to two metres in many places. As the top soil was shaved off, it ruined the hills' capacity to sponge in rainwater, she said. Ms. Anita cited ecological destruction caused by deforestation, harmful land use in the upland areas and sand mining in the streams and rivers as having contributed to the top soil run-off and siltation. This was exacerbated by the impact of climate change at the macro level.

Echoing her views, experts at the National Institute of Technology, Calicut, (NIT-C) said it was usual for the water level in the rivers and domestic wells to fall after fluvial floods. However, this time the discharge had been full, taking the sand and the rocks in the youth-stage along with the floods. "So the water level in the rivers came down. And when the river water level got reduced, the groundwater table also did not get replenished since the rivers and groundwater table were connected," said K. Saseendran, geologist and professor at the NIT-C.

Psycho-social Effects

The huge psycho-social effects on flood victims and their families could traumatize them for long periods of time. The loss of loved ones can generate deep impacts, especially on children. Displacement from one's home, loss of property and livelihoods and disruption to business and social affairs could cause continuing stress. The stress of overcoming these losses could be overwhelming and produce lasting psychological impacts.

Psycho-social Management

The psycho-social management team of NIMHANS, Bangalore got involved in the process of psycho social care of the survivors by training and sending nearly 1000 volunteers across the state. Various social work colleges in Kerala and outside Kerala along with NGOs contributed for the same. Kerala Social Service Forum with the help of CARITAS India was also engaged in providing psycho-social care and rehabilitation to the victims through its Catholic Diocesan Social Service Departments.

Those who fall into grief reaction needs grief counselling by trained counsellors and if they were not diagnosed properly that they could be falsely diagnosed as depressive, or Bipolar or psychotic illness and false treatment could be administered. Hence adequate caution should be taken handling the mental health issues of the survivors in any disaster situation.

Deluge Mitigation

We all know what are the causes of floods, still we are not acting on a serious planned note to mitigate its effect. It's high time that we understand this underlying problem and act at the earliest.

Unplanned construction ignoring nature in the name of development should be avoided and seriously dealt with as it comes out to be the biggest villain in the scene.

Changing the course of river in the name of development should be avoided strictly because it will only a damage stored for the future.

Deforestation should be stopped and planting of trees should be encouraged. Cutting of Trees in such a large number affects the Pattern of monsoon and it becomes irregular. Climate change and reduced capacity of soil in storing water are the ill effects of Deforestation.

Participatory planning at every stage should be practiced towards **flood mitigation** where Centre and State works in coherence.

Sustainable development is the need of the hour where human development shouldn't disturb the nature's ability to provide natural resources and ecosystem services on which the society depends.

Early warning System should be strengthened. Help of **Indian Space Research Organisation (ISRO)** is of paramount importance in this, as it is happening now as their satellites are sending important pictures and data in detecting and monitoring of situations over large regions of Kerala floods.

National Disaster Management Plan (NDMP), 2016 which was the first of its kind of national plan prepared in the country for disaster management to mitigate any disaster related loss.

NDMP was along the lines of globally set standard of **Sendai framework for disaster risk reduction** of which **India is a signatory.** The objectives of National Disaster Management Plan (NDMP), 2016 had to be followed in letter and spirit.

Conclusion

The deluge in Kerala leaves behind massive responsibility for the Government, NGOs, and the society for rehabilitation and reconstruction. Huge financial commitment would be required in rectifying the economic damages of houses, agriculture, cattle, roads, bridges, plantations, tourism and other business areas. The psycho social issues of survivors would be another major concern both health workers and social workers need to undertake. Every disaster would be a sign to reflect over the socio economic development plans to make it socially and economically sustainable. Although flood is a natural disaster in the contest of Kerala deluge the manmade reasons were highly attributed. Hence a long term development plan preserving the ecological concerns of the State would be a major fact in the process of mitigation. The role of the local resources particularly the fishermen was appreciated from all quarters. They should be rewarded for their commitment and should professionally train them for future. Further research studies should be done to analyse the micro, meso and macro impacts of the deluge to develop better disaster preparedness and management.

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