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Preface

We would like to present, with great pleasure, the inaugural volume-7, Issue-12, December 2021, of a scholarly journal, *International Journal of Engineering Research & Science*. This journal is part of the AD Publications series *in the field of Engineering, Mathematics, Physics, Chemistry and science Research Development*, and is devoted to the gamut of Engineering and Science issues, from theoretical aspects to application-dependent studies and the validation of emerging technologies.

This journal was envisioned and founded to represent the growing needs of Engineering and Science as an emerging and increasingly vital field, now widely recognized as an integral part of scientific and technical investigations. Its mission is to become a voice of the Engineering and Science community, addressing researchers and practitioners in below areas

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Algorithm and Computational Complexity	Artificial Intelligence
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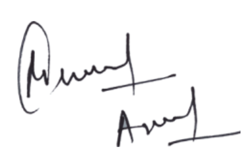
Neural Networks	Plastic Engineering

Each article in this issue provides an example of a concrete industrial application or a case study of the presented methodology to amplify the impact of the contribution. We are very thankful to everybody within that community who supported the idea of creating a new Research with IJOER. We are certain that this issue will be followed by many others, reporting new developments in the Engineering and Science field. This issue would not have been possible without the great support of the Reviewer, Editorial Board members and also with our Advisory Board Members, and we would like to express our sincere thanks to all of them. We would also like to express our gratitude to the editorial staff of AD Publications, who supported us at every stage of the project. It is our hope that this fine collection of articles will be a valuable resource for *IJOER* readers and will stimulate further research into the vibrant area of Engineering and Science Research.



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Adaptation of New Technologies by Fish Farmers in South East, Nigeria

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Abstract— *Adaptation of new technologies like intensive system of fish culture, processing of fish using modified drum ovum as well as other new technologies were studied in the South East Nigeria. Data collection for this study came from primary and secondary data. The primary data was generated through field survey using well-structured questionnaires as a major research instrument. The secondary data on the other hand were obtained through relevant literature ranging from textbooks, journals, articles, periodicals, seminar papers and proceedings. The result evinced that fish farmers in the entire south east used mainly intensive system of farming and less of extensive system of farming. Modified drum ovum is the most popular processing method preferred by all the fish farmers in the entire five south east states of Nigeria while choker kiln is the least. This can be attributed to its availability and affordability. The study recommends government support towards fish farming activities in the entire five South Eastern States of Nigeria. The farmers are encouraged to form cooperative societies or groups to gain easy access to credit facilities, they should also as a matter of urgency reorganize their various state Agricultural Development Programmes and recruit young fishery graduate that can be deployed in their state local government areas as well as providing financial assistance to these fish farmers through loans, subsidies in the form of feed, fish fingerlings, processing units etc. and organized special trainings in on-farm feed formulation, hatchery, fish processing, marketing, fish pond management and maintenance.*

Keywords— Adaptation, New Technology, primary and secondary data, fish farmers and south east.

I. INTRODUCTION

The government research institutions and the universities have made effort in developing improved strategies and technologies so as to increase production to meet the demand of the country and even export. These technologies are new improved ideas, methods, practices, innovations and inputs which supersede the ones previously in use. It also provides the means of achieving a sustainable increase in fish farm productivity and consequently leading to an improved living standard of the people as stated by Ifejika and Ayanda (2014). But according to Bolorundu (2016) the level of adoption of these technologies by the fish farmers is very low. This is due to the combination of various constraints among which are faulty aquaculture policies, institutional framework and unfavourable socio-economic environment.

The adoption of new strategies and technologies by fish farmers is very important for aquaculture. For quite sometimes, a lot of fishery technologies had been introduced by research institutes, state and federal Ministries of Agriculture and other related organizations concerned with fishery innovations, but the response of the farmers had been negligible. It has been noted that people do not just adopt a technology because it is available to them. In their submission, Berdgue and Eswbar (2017) stated that even when the technologies are available and appropriate, some constraints tends to exert influence on their decision to adopt or not. For instance, agricultural development project and farming skill acquisition centres in the state has for long been assisting fish farmers on how to develop fish farming and to increase production so as to meet the increasing demand of animal protein using the modern recommended fish farming technologies. To this effect, various training programmes were conducted toward achieving these objectives but less attention is given to assessing their level of adoption and problems faced in production. Thus it becomes necessary to study the effect of socio-economic and new technologies on fish farmers in South Eastern, Nigeria.

In achieving this, the study intends to answer the following questions:

1. What is the effect of socio-economic characteristics of fish farmers on aquaculture productivity within the five South Eastern states of Nigeria?
2. In what ways do the use of new technologies influence sustainability of fish farmers within the five States of South Eastern, Nigeria?
3. In what ways can aquaculture be improved and promoted within the five States of South Eastern, Nigeria?
4. What are those major constraints faced by fish farmers in improving aquaculture productivity within the five States of South Eastern, Nigeria?
5. What are the potential of governmental support towards aquaculture improvement and productivity within the five States of South Eastern, Nigeria?

Technologies are increasingly being developed in a global market, for farm level application with an impact on the sustainability beyond the farm. Adoption and use of technology for sustainable fish farming systems is a multi-disciplinary approach taking into account a wide range of objective geared towards sustainable aquaculture.

According to FAO (2017) over the last five years the system and technology used in aquaculture has developed rapidly. Similarly, research by (El-Gayar, 2011) showed that recent advances in information technology have had profound impact on all walks of life and aquaculture is no exception. He continues to state that the growing importance of aquaculture as an alternative source for food protein has further emphasised the need to adapt and develop advanced IT for the better management of aquaculture facilities as well as the regional planning for aquaculture development. According to Wetengere, (2010) improving farm production through integrated modern technologies into the existing farming systems is essential for the enhancement of household food and income security. His study recommended that technology developers should strive to improve the profitability of fish farming through the reduction of the risk of losing fish, shortening culture cycle to target market size fish, use of low cost inputs and/or integrating fish farming with the existing farming systems and access to urban market. According to Olatunji and Ogunremi (2016) findings on awareness of fish farming technologies by fish farmers they found out that lack of awareness, lack of knowledge of effects of recommended technology or negative attitude to the innovation may be responsible for non-adoption among farmers.

A research by Jacobi (2013) indicates that one of the reasons for slow aquaculture development in developing countries has been; use of traditional fish and water husbandry, political, social and economic constrains that restrict investment and delay expansion and lack of information on fish farming technology (FAO, 2017). In his study Henri *et al.* (2011) contend that adopt ion of fish farming technology is more likely to be adopted by the younger farmers. However, Jacobi (2013) case study shows that it is difficult for some countries to obtain knowledge on pond design and construction, hatchery equipment and other farm inputs such as aerators, cages and hatching incubators.

In regards to the use of technology Rajan (2013) research found out that feed management, selection and management of seed are some of the important technological components in fish farming. In his study, Onzere (2013) found that communities still used traditional methods of fish farming, harvesting and preservation. In her research Kagiri (2016) stated that lack of technology is among constrains fish farmers face in developing countries, it has led to reduced output as well losses since the fish harvested cannot be stored for long period that would enable fish farmers market their produce at a later date or even transport to a different location for sale. Wetenegere (2010) states that fish farming have very high potential which can be fully utilized if only technology was adopted. According to Singas and Manus (2014) farmers adopt fish farming technologies if they are assured that fish farming is a profitable venture. In his study Wetenegere (2010) implies that importance of the recommended technology related to existing practices must be clearly demonstrated to farmers. To ensure that the small scale farmers get the desired benefit, low cost technologies appropriate to the farmers needs to be extended widely.

In conclusion technology adoption and use is quite broad and is affected by development, dissemination and application of the technologies at farm level especially farm capital and other inputs. It's also affected by extension, advice and information which form the basis of farmer knowledge as well as technologies and practices in the overall agro-food sector that have an impact at the farm level. Fish farmers have always looked at new aquaculture technology as a way of reducing cost of production a clear indication that demand driven adoption and use of technology. Fish farmers invest in sustainable technology and farm practice if they expect the investment to be profitable, have the right education, information and motivation.

The study therefore sort to establish the influence on the use of new technologies on sustainability of fish farmers in these study areas.

II. MATERIALS AND METHODS

2.1 Study Area

South-East of Nigeria is one of the six geopolitical zones in Nigeria. The region consists of the following states: Abia, Anambra, Ebonyi, Enugu and Imo. South East geopolitical zone is 99.9% of population of Igbo people.

2.2 Experimental Design

General survey of the five states that make up South East of Nigeria namely; Abia, Anambra, Ebonyi, Enugu and Imo states were visited through the assistance of the staffs of the various ministries of Agriculture and National Resources. Also, those from Agricultural Development Program in these five states. During this period that lasted for over one month, identification, location and visitation of all known existing fish farmers were traced and counted in the order to ascertain the exert number of fish farmers that were interviewed and issued with questionnaire. It was also from these trips that these following agricultural zones were identified and mapped out. It was also during this period that the five states were divided according to their agricultural zones where the fish farmers' circles and blocks were identified and mapped out and subsequently visited.

Subsequently identified fish farmers were counted according to their circles, blocks, agricultural zones as well as their respective States from where they were interviewed and issued with questionnaire. This general survey carried out laid to identification of the following circles, blocks and agricultural zones

2.3 Sampling Size and Technique

The population sample comprise of three hundred and twenty(320) fish farmers that were randomly selected within the following circles, blocks and the agricultural zones of the five states. The Lists of Circles, Blocks and Agricultural Zones among the Five States of South East are presented in Table 1.

TABLE 1
LISTS OF CIRCLES, BLOCKS AND AGRICULTURAL ZONES AMONG THE FIVE STATES OF SOUTH EAST

Sr. No.	State	Agricultural zone	Fish block	Fish circle
1	Abia	Aba	15	30
		Ohafia	9	20
		Umuahia	10	21
		Total	**34**	**71**
2	Anambra	Aguta	13	25
		Anambra	12	25
		Awka	9	18
		Onitsha	15	39
		Total	**49**	**102**
3	**Ebonyi**	Ebonyi central	7	20
		Ebonyi North	8	20
		Ebonyi South	12	29
		Total	**27**	**69**
4	**Enugu**	Enugu East	15	31
		Enugu North	11	21
		Enugu West	8	18
		Total	**34**	**70**
5	**Imo**	Okaigwe	7	12
		Orlu	17	38
		Owerri	13	22
		Total	**37**	**72**

Source: Field survey (2019)

Using Taro Yamani formula, Yamani Taro (1967) the following number of respondents were identified.

$$n = \frac{N}{1+N(e)^2}$$

Where n = Sample size

N = population size

e = 0.05 based on research condition

2.4 Method of Data Collection

In this study, questionnaires, interviews, field observation, visits to fish farms where photographs were taken which was used during data collection. However, questionnaire was the major tool used for gathering necessary data from fish farmers (respondents). The questionnaire was structured in such a way that it provided answers to the research questions.

2.5 Questionnaire

A self-administered questionnaire was adopted to collect primary data for the study. The questionnaire was divided into five sections namely, Section A: which looked at bio-data and socio-economic factors affecting fish farmers, Section B: Considered those new technologies that tend to influence the sustainability of fish farm business, Section C: Considered some constraints that tend to affect fish farm productivity while Section D: looked at the potential of government support towards fish farm improvement and profitability. Section E: Tried to proffer solutions and suggestions towards the fish farm improvements and promotion.

2.6 Oral Interview

Interview is a systematic way of talking and listening to people. It is a conversation between a respondent (fish farmer) and the researcher based o he topic in question in order to gather facts, opinions, ideas and knowledge. The purpose of oral interview in the study was to get adequate information that may be vital for the success of this study through verbal interview between researcher and respondent fish farmers within the selected sample area.

2.7 Field Observations

The Field observation involved in the visitation of these zones of the five states that make up the South East as well as take some photographs on the type of fish pond they use in rearing their fish and other aquatic organisms.

2.8 Source of Data Collection

Data collection for this study came from primary and secondary data. The primary data was generated through field survey using well-structured questionnaires as a major research instrument. The secondary data on the other hand were obtained through relevant literature ranging from textbooks, journals, articles, periodicals, seminar papers, proceeding, and internet etc.

2.9 Viability of the instrument

Copies of the questionnaires were given to experts in Agricultural Economics, Fisheries Economics and Statistics and Computer Science in Nnamdi Azikiwe University for Validation.

2.10 Data Analysis

Analytical tools that was adopted in this study were descriptive statistics (frequency, percentage, mean), inferential statistics and SPSS version 2020 was used to analyse research questions, research hypothesis and objectives of the study. Multiple Regression and Z statistics was adopted to test the hypothesis of the study. The computation was done using SPSS 22 package).

III. RESULTS

The rate at which various farming systems and processing technology are used in Abia state is presented in Table 2.

TABLE 2
TYPE OF FARMING SYSTEMS AND PROCESSING TECHNOLOGY USED IN ABIA STATE.

		Frequency	Percent	Valid Percent	Cumulative Percent
	Intensive	41	67.2	68.3	68.3
	Semi intensive	17	27.9	28.3	96.7
	Extensive	2	3.3	3.3	100
	Total	60	98.4	100	
Missing	System	1	1.6		
Total		61	100		

The result revealed that farmers in Abia state used mostly intensive system of fish farming (67.2%), semi intensive (27.9%) with extensive system having the least (3.3%). Fish farmer's in Abia state processed their fish using more of modified drum ovum (36.1%), Altona (29.5%), solar tent (16.7%) ad chokor kiln having the least (13.3%).

The rate at which various farming systems and processing technology are used in Anambra state is presented in Table 3.

TABLE 3
TYPES OF FARMING SYSTEMS AND PROCESSING TECHNOLOGY USED IN ANAMBRA STATE.

	Frequency	Percent	Valid Percent	Cumulative Percent
Intensive	59	73.8	73.8	73.8
Semi intensive	17	21.3	21.3	95
Extensive	4	5	5	100
Total	80	100	100	

Fish farmers in Anambra state used more of intensive system of fish farming (73.8%) than semi intensive (21.3%) with extensive system having (5.0%). They also prefer to process their fish using modified drum ovum (33.8%) followed by Altona (33.8%), while choker kiln and solar tent had (16.3%) respectively.

The frequency at which various farming systems and processing technology are used in Ebonyi state is presented in Table 4.

TABLE 4
TYPES OF FARMING SYSTEMS AND PROCESSING TECHNOLOGY USED IN EBONYI STATE.

	Frequency	Percent	Valid Percent	Cumulative Percent
Intensive	40	66.7	66.7	66.7
Semi intensive	17	28.3	28.3	95
Extensive	3	5	5	100
Total	60	100	100	

Fish farmers from Ebonyi state used intensive system of farming more (66.7%) that semi-intensive system of farming (28.3%) and extensive (5.0%). They also process their fish using modified drum ovum (35.0%), altona (31.7%), solar tent (18.3%) and chokor Kiln (15.0%).

The percentage at which various farming systems and processing technology are used in Abia state is presented in Table 5.

TABLE 5
TYPES OF FARMING SYSTEMS AND PROCESSING TECHNOLOGY USED IN ENUGU STATE.

	Frequency	Percent	Valid Percent	Cumulative Percent
Intensive	39	65	65	65
Semi intensive	18	30	30	95
Extensive	3	5	5	100
Total	60	100	100	

Fish farmers from Enugu state used intensive system of farming more than semi intensive (30.0%) and extensive (5.0%). They also prefer to process their fish using modified drum ovum (36.7%) and altona (35.0%), choker kiln (15.0%) and solar tent (13.3%).

The rate at which various farming systems and processing technology are used in Imo state is presented in Table 6.

TABLE 6
TYPES OF FARMING SYSTEMS AND PROCESSING TECHNOLOGY USED IN IMO STATE.

	Frequency	Valid Percent	Valid Percent	Cumulative Percent
Intensive	39	65	65	65
Semi intensive	19	31.7	31.7	96.7
Extensive	2	3.3	3.3	100
Total	60	100	100	

The table showed that majority of fish farmers in Imo state used intensive system of farming (65.5%) more than semi-intensive (31.7%) and extensive (3.3%). They also process their fish using modified drum ovum and altona (36.7%) respectively choker kiln and solar tent (13.3%) respectively.

The summary of farming system and processing methods in all the states is given in Table 7 and Table 8, respectively.

TABLE 7
SUMMARY OF FARMING SYSTEM IN ALL THE STATES

Current technology	Abia state	Anambra state	Ebonyi state	Enugu state	Imo state
Intensive	41	40	40	39	39
Semi intensive	17	17	17	18	19
Extensive	2	3	3	3	2
Total	60	60	60	60	60

Fish farmers in the entire south east used mainly intensive system of farming and less of extensive system of farming.

TABLE 8
SUMMARY OF PROCESSING TECHNOLOGY IN ALL THE STATES.

Processing technology	Abia state	Anambra state	Ebonyi state	Enugu state	Imo state
Modified drum ovum	22	27	21	22	22
Choker kiln	8	13	9	9	8
Altona	18	27	19	21	22
Solar tent	12	13	11	8	8
Total	60	80	60	60	60

Modified drum ovum as the most popular processing method preferred by all the fish farmers in the entire five south east states of Nigeria while choker kiln is the least.

Results of the multiple comparisons among farming systems and among processing methods in south east, Nigeria are shown in Tables 9 and 10.

TABLE 9
MULTIPLE COMPARISONS AMONG FARMING SYSTEMS IN SOUTH EAST, NIGERIA

(I) Current technology	(J) Current technology	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intensive	Semi intensive	22.20000*	0.4899	0	21.1326	23.2674
	Extensive	37.20000*	0.4899	0	36.1326	38.2674
Semi intensive	Intensive	-22.20000*	0.4899	0	-23.267	-21.133
	Extensive	15.00000*	0.4899	0	13.9326	16.0674
Extensive	Intensive	-37.20000*	0.4899	0	-38.267	-36.133
	Semi intensive	-15.00000*	0.4899	0	-16.067	-13.933

TABLE 10
MULTIPLE COMPARISONS AMONG PROCESSING TECHNOLOGIES IN SOUTH EAST, NIGERIA

(I) Processing technology	(J) Processing technology	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Modified drum ovum	Choker kiln	13.4000*	1.00664	0	11.2067	15.5933
	Altona	1.4	1.00664	0.19	-0.7933	3.5933
	Solar tent	12.4000*	1.00664	0	10.2067	14.5933
Choker kiln	Modified drum ovum	-13.4000*	1.00664	0	-15.593	-11.207
	Altona	-12.0000*	1.00664	0	-14.193	-9.8067
	Solar tent	-1	1.00664	0.34	-3.1933	1.1933
Altona	Modified drum ovum	-1.4	1.00664	0.19	-3.5933	0.7933
	Choker kiln	12.0000*	1.00664	0	9.8067	14.1933
	Solar tent	11.0000*	1.00664	0	8.8067	13.1933
Solar tent	Modified drum ovum	-12.4000*	1.00664	0	-14.593	-10.207
	Choker kiln	1	1.00664	0.34	-1.1933	3.1933
	Altona	-11.0000*	1.00664	0	-13.193	-8.8067

Multiple comparisons among farming systems revealed no significant differences between intensive systems of fish farming ($P < 0.05$) when compared with semi-intensive and extensive systems. There was also no significant difference when extensive systems were compared with intensive and semi intensive.

Multiple comparisons among processing technologies showed that there were significant difference between modified drum ovum and altona ($P < 0.05$) while there were no significant difference ($p < 0.05$) between modified drum ovum and choker kiln and solar tent. There were no significant difference ($P > 0.05$) between and choker kiln and solar tent. There was also no significant difference ($p > 0.05$) kiln while there were no significant difference ($P > 0.05$) when compared with modified drum ovum and atona.

The influence on the use of new technologies on the sustainability of fish farmers in south east Nigeria was also examined during the study period. Most fish farmers in South East Nigeria used intensive system of farming and less extensive system. The difference in the culture systems are that the input fingerlings and out (harvest) are high in intensive system as their higher number of input and output when tend to improve upon the result from the farm (Chioma and Adebayo, 2012; Abioma *et al* 2012). It was also observed that majority of the fish farmers in south east used modified drum ovum as the most popular fish processing method. This can be attributed to its availability and affordability. When intensive system of fish farming were compared with other systems, there was no significant different ($p<0.05$) among them. However, when modified drum was compared with other types of processing there were significant difference ($p>0.05$).

Result of respondents on ways fish farming can be improved and promoted within the south east showed that fish farmers in south eastern Nigeria have not received adequate extension services 96.0 percent while only a weaker 1.4 percent received.

Salau *et al.* (2014) also reported below level of extension services to fish farmers in Nasarawa State Nigeria.

There were no significant constraints faced by fish farmers in south east, Nigeria.

Data from respondents showed that fish farmers in south east were faced with numerous constraints that tend to reject the smooth running of fisheries enterprises in south east, Nigeria. Among the major constraints were marketing constraints was noticed to be among their major challenge as most fish farmers after struggling to produce their fish the market where they can sell at a competitive price.

There were closely followed by environmental, production, infrastructural, financial, production as well as institutional respectively.

IV. CONCLUSION

Result from respondents showed that the entire government of southeast do not support towards aquaculture improvement as there is no government support noticed during this study. There were no extension services from government, no loan facilities, no training, etc. Most of the fish farmers are just car but their fish farming activities through self-help and family support.

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Suitability of Crushed Sandcrete Block (Csb) as Fine Aggregate for Masonry Works

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***Abstract*— *This paper focuses on the prospects of recycled broken sand Crete hollow blocks as fine aggregate for masonry works. Sandcrete hollow blocks were taken from dealers in Zaria and tested for density, water absorption, dimension tolerances, drying shrinkage, wetting expansion and compressive strength as compared to hand moulded blocks which were moulded in the laboratory to NIS 87(2004) specification. Density ranges from 1797.37Kg/m^3 – 1974.00Kg/m^3, water absorption ranges from 5.38% - 10.38%, drying shrinkage ranges from 0.028% - 0.044%, wetting expansion ranges from 0.042% - 0.059% and the 28th day compressive strength ranges from 0.45N/mm^2 - 0.85N/mm^2. Results showed that density, water absorption, drying shrinkage, wetting expansion and 28th-day compressive strength of block samples manufactured from quarry fine collected from one of the industries was 2070.11Kg/m^3, 9.54%, 0.034%, 0.05%, and 1.38N/mm^2 respectively. The study confirmed that the quality of sand Crete blocks manufactured in Zaria does not meet the specified standard in respect of strength.*

***Keywords*— Aggregate, Crushed Sandcrete Block, River sand, waste materials.**

I. INTRODUCTION

In most construction sites today, broken Sandcrete blocks are being disposed of as waste materials**.** The application of recycled aggregates from construction and demolition wastes is viewing the potential presentation in construction as another to primary (natural) aggregates. It saves usual resources and decreases the space essential for landfill removal (Buchner and Scholten, 1992). In Nigeria and many other developing countries, the building construction industry is exploring and still combining materials within its immediate surroundings in search of suitable materials that can combine to facilitate the building of civil engineering structures.

It is a recognised detail that the non-stop generation of solid waste materials gives a serious environmental challenge. For this motive, it is very significant to study and develop any technology, procedure or method that may help to exploit their use efficiently (Bolden, 2013). Due to the high cost of building materials in Nigeria, the average citizen finds it difficult to afford good housing in the country. This trouble has led to the use of local wastes as alternatives to conventional materials in the construction industry**.** One of the main challenges of our current society is to safeguard the environment. The significant features in this respect are the decrease in the consumption of energy and natural raw materials and the consumption of waste materials.

The two main potential markets to utilize recycled waste materials successfully are the transportation and construction industries (Bolden, 2013).

Crushed Sandcrete block (CSB) is a cohesion-less sandy material developed artificially by the mechanical disturbance of Sandcrete block, which is composed largely of particles with a diameter range of 0.05mm to 5mm depending on the mode of crushing (Afolayan et. al. 2008). A research carried out by Seeley (1993), stated that Sandcrete blocks are walling materials that consist of coarse sand or crushed rock dust mixed in proportion with cement and water and compacted to various shapes. Abdullahi, (2005) defined Sandcrete hollow blocks as structural walling units which are dimensionally larger than bricks and have one or more large holes or cavities passing through them. The solid materials range between 50% to 75% of the total volume of the block calculated from the overall dimension.

This makes it attain acceptable strength to be used as walling material. Hollow Sandcrete blocks have featured for a very long time in building construction works in Nigeria. Seeley, (1993) grouped Sandcrete blocks into two key categories:

1. Lightweight block: These are Sandcrete blocks made from lightweight aggregates. These types of blocks are non-load bearing and are not appropriate to be used below ground floor damp proof course. There are intended for use in non-load bearing walls and partitions.
2. Dense Sandcrete: These are Sandcrete blocks made from dense weight aggregates. These types of blocks are load-bearing and are appropriate to be used beneath ground floor damp proof course (DPC) and are resilient even when exposed to extreme climate.

This research aims to find out the suitability of using these crushed Sandcrete blocks as fine aggregate for masonry works, an endeavour is made to link some of the engineering properties of recycled crushed Sandcrete block (CSB) with the natural fine aggregate. Although an enormous quantity of broken Sandcrete block is available for recycling from construction sites and block industries, Sandcrete blocks collected from the four (4) manufacturers in Zaria and tested in the laboratory were used in the present study to produce the recycled aggregates. The broken Sandcrete blocks were crushed into fine aggregates with the use of a hammer.

II. MATERIALS AND METHODS

2.1 Study area

This research started with a general survey of Zaria town locating the block manufacturing sites. The majority of the block manufacturers in Zaria have located along Kwangila - Shika road because of the easy access to the highway. A total of nine hollow Sandcrete block manufacturing industries were visited. Field trips were made to these sites supported by interviews with key individuals within the industry, who were asked to respond to a structured questionnaire. The general questions included:

- Mix ratio
- Type and source of material
- W/C ratio
- Cement type
- Mode of production
- Sizes of blocks produced
- Type of machine used
- Number of workers
- Curing period

The information gathered was analysed to select four (4) block manufacturers based on random sampling and even distribution within Zaria. 15 samples of Sandcrete hollow blocks were randomly collected and paid for from each of the selected block manufacturers. Blocks made from quarry fine was collected from industry A and tested. In addition, hand moulded samples of hollow Sandcrete blocks were manufactured in the laboratory to NIS 87(2004) specification using a cement-aggregate ratio of 1:8 and water-cement ratio of 0.6. Dangote brand of ordinary Portland cement was used. The information got is shown in Table 1.

Industry A: Rahusa Blocks (Zango junction)

Industry B: Aliyu Kwari Blocks (College of Aviation Technology main gate)

Industry C: Hand Moulded Laboratory Samples to NIS 87(2004) specifications

Industry D: Nasara Blocks (opposite ABU North gate)

Industry E: Alheri Blocks (Samaru village, along Basawa road)

TABLE 1
SUMMARY OF THE INFORMATION OBTAINED ON THE FOUR (4) SELECTED BLOCK MANUFACTURERS IN ZARIA.

Industry	Mix ratio	Mode of production	W/C Ratio	Type of material	Size of blocks produced
A	1:10	Machine mould	Not defined	River sand & quarry fine	460x230x230 460x230x150
B	1:12	Machine mould	Not defined	River sand	460x230x230 460x230x150
C	1:8	Hand moulded lab samples	0.6	River sand	460x230x230
D	1:12	Machine mould	Not defined	River sand	460x230x230 460x230x150
E	1:14	Machine mould	Not defined	River sand	460x230x230 460x230x150

III. RESULTS AND DISCUSSION

3.1 Dry compressive strength test

The compressive strength test was determined on the Sandcrete blocks between two Celotex boards of thickness 10mm using the Universal testing machine in the Department of Civil Engineering laboratory, Ahmadu Bello University, Zaria. The entire test was carried out at the same rate of loading. Each block was weighed and positioned in the testing machine is flanked by the two Celotex boards. Load is applied until failure occurred and the load at failure is verified against each sample. The compressive strength of the blocks is calculated by dividing load at failure and the effective area of the block in square millimetres.

The Sandcrete hollow blocks were tested at the following ages: 7, 14, and 28 days respectively. The average mean value of the compressive strength of five samples is presented in Table. 2. The test was conducted by Appendix C.4.1 of BS 2028 (1985). The results for the selected industries A, B, D and E are presented in Fig. 1 which shows the compressive strength and the age days of the block.

TABLE 2
COMPRESSIVE STRENGTH TEST RESULTS

Industry	A	B	C	D	E
Age(days)	(N/mm^2)	(N/mm^2)	(N/mm^2)	(N/mm^2)	(N/mm^2)
7	0.61	0.40	1.21	0.42	0.33
14	0.70	0.45	1.79	0.52	0.40
28	0.85	0.65	2.01	0.56	0.45

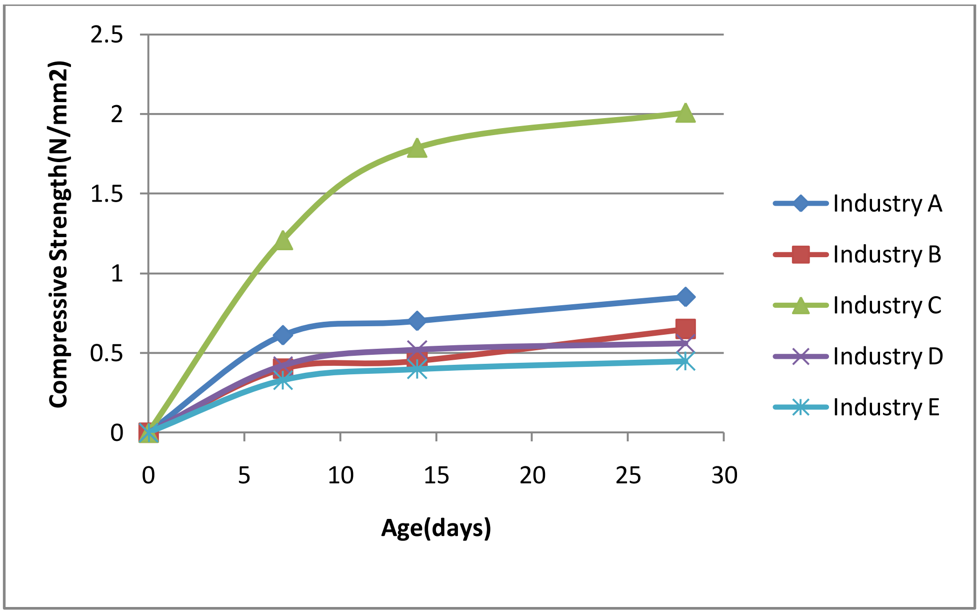

FIGURE 1: Compressive Strength versus age curve

Test results show that the average 28th-day compressive strength of manufacturers A, B, D and E is 0.85, 0.65, 0.56 and 0.45 N/mm^2 respectively. The 28th-day compressive strength of blocks made from quarry fine aggregates collected from RAHUSA block manufacturer was 1.38 N/mm^2.

The Nigerian Industrial Standard (NIS 87: 2004) stated that the compressive strength of individual load-bearing machine vibrated blocks shall not be less than 2.5 N/mm^2 and also, the average compressive strength of five blocks shall not be less than 3.45 N/mm^2. Furthermore, the Nigerian Industrial Standard (NIS 87: 2004) indicated that the lowest compressive strength of individual load-bearing hand compacted blocks shall not be less than 2.0 N/mm^2 and the average compressive strength of five blocks shall not be less than 2.5 N/mm^2. It is perceived that manufacturer A has the highest 28th-day compressive strength of 0.85 N/mm^2 while manufacturer E has the lowest 28th-day compressive strength of 0.45 N/mm^2. The high strength of manufacturer A can be documented to the higher cement aggregate ratio related to the other manufacturers.

From Fig.1 it can be observed that the 28th-day compressive strength of blocks collected from the four selected producers ranges from 0.45N/mm^2 - 0.85N/mm^2.

This confirmed earlier work done by Omopariola, (2014) and Satyanarayanaet et.al, (2013) on the standard of Sandcrete hollow blocks manufactured in Kaduna state does not meet the specified standard in respect to strength.

This low strength value can be ascribed to the absence of adequate knowledge, non-adherence to the established standard and poor quality control measures on the part of Sandcrete block manufacturers in Zaria. The cement-sand mix ratio used by the manufacturers is one-part cement to ten or fourteen parts of sand (1:10 to 1:14) compared to one-part cement to six or eight parts of sand (1:6 to 1:8) and is below codes requirements. Mixing water is not measured and is based on eye judgement.

3.2 Density determination

This experiment was carried out following the BS 2028 (1985). The test was aimed at determining the density of the Sandcrete hollow blocks at 28days. Results are presented in Table 3 with an average of five readings for each industry.

The British standard BS 2028(1985) described three types of blocks: Types A, B, and C.

1. Type A: These have a density of not less than 1500Kg/m^3; they are strong even when exposed to adverse climate.
2. Type B: These are made of lightweight aggregates and are load-bearing. They may be used below ground floor damp proof course. Density is less than 1500Kg/m^3 but more than 625Kg/m^3
3. Type C: they are similar to type B blocks except they are non-load bearing and are not appropriate to be used below ground floor damp proof course. They are envisioned for use in non-load bearing walls and partitions.

The mean density of blocks made from quarry fine aggregate collected from manufacturer A is 1909.09 kg/m^3. These values are greater than 1500kg/m^3 therefore they could be classified as type A blocks. They are load-bearing and may be used below damp proof course even when exposed to adverse climate. Sandcrete blocks are obtainable for the construction of load-bearing and non-load-bearing structures. Load bearing blocks must follow building code regard to their crushing and the amount of solid mineral contained in section example the total width of the block. Sandcrete blocks also contribute most to the task of transforming the actual load from the overlaying structural element to the foundation. In this case, the load-bearing wall is those walls acting as supports for the whole structure to transmit the weight to the ground surface underneath it for stability (NIS 87:2004).

TABLE 3
DENSITY TEST RESULTS

Industry	A	B	C	D	E
Mean Density(Kg/m^3)	1909.09	1881.28	1874.00	1863.58	1797.37

3.3 Water absorption test

The test was conducted by BS 2028 (1985). Based on the code requires the water absorption for blocks shall not exceed 12% of the dry weight (BS 2028, 1985). The results of the mean water absorption of five different readings are shown in Table 4.

TABLE 4
WATER ABSORPTION TEST RESULTS

Industry	A	B	C	D	E
Mean water absorption (%)	5.38	9.07	5.05	9.45	10.38

The average water absorption for blocks made from quarry fine was 9.54%. This satisfies the 12% value recommended by BS 2028(1985).

3.4 Drying shrinkage and wetting expansion

The test was carried out as specified by BS 2028 (1985). Measurements were done with a micrometre screw gauge. Table 5 is the mean of five readings from each industry.

TABLE 5
AVERAGE DRYING SHRINKAGE AND WETTING EXPANSION TEST RESULTS

Industry	A	B	C	D	E
Mean Drying shrinkage (%)	0.028	0.036	0.023	0.039	0.044
Mean Wetting expansion (%)	0.042	0.047	0.035	0.051	0.059

BS 2028 (1985) limits the drying shrinkage and wetting expansion of Sandcrete blocks to 0.05%. These values satisfy the requirements of BS 2028 (1985). This indicates that the Sandcrete hollow blocks manufactured in Zaria are of low cement content and as such will exhibit a normal change in dimensional properties when exposed to moisture condition change.

3.5 Dimension tolerance

Length, breadth and height of four (4) Sandcrete hollow block specimen were measured up to 1mm accuracy for manufacturers A, B, D and E. Each dimension was measured at three different sections and the mean of the three was taken as the value of the parameter for that specimen. Measurements were done with a micrometre screw gauge. The summary of results of the dimension tolerance measured for the four selected block industries is presented in Table 6.

TABLE 6
DIMENSION TOLERANCE TEST RESULTS

Industry	A	B	C	D	E
Dimension	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**
Length (L)	0	0	0	0.2	0.4
Breath (B)	0	0	0	0.4	0.4
Height (H)	0	0.4	0	0.4	0.4

From Table 6 The British Standard BS 2028(1985) gave the work size of 450x225x225mm for type A and B blocks with a tolerance of ±3.0mm for length and height and ±1.5mm tolerance in width. This represents a tolerance of 0.67%. The actual/normal size of the blocks produced in Nigeria is 460x230x230mm. Therefore, the normal size will be used as the size for tolerance. From Tables 7 and 8, it was observed that all of the dimensions of the sampled Sandcrete hollow blocks from any of the five industries fall within the permissible deviations specified by the BS 2028 (1985).

TABLE 7
DIMENSION TOLERANCE TEST RESULT

Industry / Sample Number	A			B			C			D			E		
	L	B	H	L	B	H	L	B	H	L	B	H	L	B	H
1	461	230	230	461	231	230	460	230	231	461	230	229	461	231	230
2	460	230	231	460	230	231	459	230	230	461	230	230	462	231	229
3	460	231	230	460	230	231	460	230	229	460	231	229	461	230	231
4	461	230	231	460	231	230	460	230	230	460	231	230	462	230	230
5	460	231	230	461	230	231	460	229	230	461	231	229	462	231	229
Average(mm)	460	230	230	460	230	231	460	230	230	461	231	229	462	231	229
Difference(mm)	0	0	0	0	0	1	0	0	0	1	1	-1	2	1	-1
Tolerance (%)	0	0	0	0	0	0.4	0	0	0	0.2	0.4	0.4	0.4	0.4	0.4

TABLE 8
DIMENSION TOLERANCE TEST RESULT (QUARRY FINE)

Industry / Sample Number	A		
	LENGTH	BREATH	HEIGHT
A1	460	230	230
A2	461	229	230
A3	460	230	230
A4	460	231	231
A5	460	230	230
Average(mm)	460	230	230
Difference(mm)	0	0	0
Tolerance (%)	0	0	0

IV. CONCLUSION

The suitability of crushed Sandcrete block as fine aggregate for masonry work has been carried out, based on the findings the resulting conclusions can be noted:

1. The lack of adequate knowledge, non-adherence to established standard and poor quality control measures on the part of Sandcrete block manufacturers in Zaria is responsible for the considerable variations and low compressive strength.
2. The cement-sand mix ratio used by the manufacturers in Zaria is one-part cement to ten or fourteen parts of sand (1:10 to 1:14) compared to one-part cement to six or eight parts of sand (1:6 to 1:8) and is below codes requirements.
3. A curing period of 1 to 3 days has been adopted by Sandcrete hollow blocks manufacturers in Zaria instead of a minimum of seven (7) days.
4. The water absorption of Sandcrete hollow blocks in Zaria satisfies the code requirements.
5. The densities of Sandcrete blocks manufactured in Zaria are greater than $1500Kg/m^3$ which makes them be classified as Type A blocks.
6. The density, water absorption, drying shrinkage, wetting expansion and 28^{th}-day compressive strength of block samples manufactured from quarry fine collected from a manufacturer in Zaria is $2070.11Kg/m^3$, 9.54%, 0.034%, 0.05%, and $1.38N/mm^2$ respectively.

RECOMMENDATIONS

From the foregoing, this suggests that crushed Sandcrete blocks (CSB) are a good substitute for river sand in ordinary construction works particularly in dwellings where river sand is in low supply and waste Sandcrete blocks are freely obtainable. This will help in decreasing the danger these broken Sandcrete blocks as to our environment. Because of the above, there is a vital need to take the following measures:

1. An evaluation of a comparative cost-benefit analysis should be measured.
2. Creation of awareness on capacity building towards the use of construction and demolition waste.
3. Execution of techno-legal regime with legislations, guidance, penalties etc. for the dumping of building and construction waste.
4. Designing dumping sites for pre-selection, treatment, and recycling of CSB for construction purposes.

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Towards a Computational Framework to Streamline the Global Digital Transformation Process in the Post-COVID Era

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Abstract— *In this paper, we first introduce and define "Digital Divide 2.0", and show that, unlike the "traditional" Digital Divide, this is about the survival of countries and their ability to cope with a global environment that is more and more instable and uncertain! We build an argumenta supporting our assumption and, from there, we present the foundations of a computational framework to guide and streamline the Digital Transformation Process.*

Keywords— Computational Framework, COVID19, Development, Digital Divide 2.0, Digital Transformation.

I. INTRODUCTION

A notable fact that popped-up with the COVID Pandemic, all around the world, is the predominance of Technology tools and digital environments to cope with the situation and minimize the impacts following the restriction on F2F activities/meetings. A kind of "virtual/digital" life emerged where individuals work, shop, do business, meet, etc. remotely.

All countries suffered serious impacts following this pandemic, at all levels (social, business, psychological, etc.). Countries with weaker ICT penetration (infrastructure, platforms, e-Services, etc.) were indeed more impacted since they could not take benefit of the new emerging virtual/digital life, which means no school, no commerce, no services, etc. This situation strangely recalls the concept of digital divide [7] raised by the Scientific Community in the field of ICT4D [3] to point out the gap between 2 Worlds: The world of Countries that are using technology (especially ICTs) to streamline their development at all levels, and the others that are lagging behind.

More importantly, the longer the pandemic lasts the complex/difficult the situation gets, and the higher the chances advanced (technology wise!) countries will shift to a "new-normal", leaving behind the rest of the world that will "really" struggle, and leading to an explicit manifestation of Digital Divide 2.0, which is the Covid19 release of the Digital Divide! "Fighting" against Digital Divide 2.0 requires for a Country to be advanced in the Digital Transformation Process, which globally means the ability of Citizens to dispose of / and be familiar with the effective usage of Technology Tools, at a daily basis, in the New-Normal Configuration of life.

Today more than even, World Leaders are aware of the importance of ICTs, not only from a theoretical perspective but, more importantly, from a real need on the ground, following concrete and palpable distress of the population, in all sectors, and on a daily base. Has this been possible, many of these Leaders would have not hesitated to acquire Plug-&-Play Solutions and Systems to immediately deploy and "fix" the situation! So what an extraordinary opportunity, for Academics and Researchers, to seize and try to elaborate a roadmap for the Digital Transformation Process, mainly for Developing and Less Developed Countries (DLDC) which, in the majority, have not yet launched this Process!

II. DIGITAL DIVIDE 2.0

The Digital Divide refers to the gap between countries with an effective access to / usage of digital and information technology and those with very limited or no access/usage at all [4] [8]. It includes the imbalances in physical access to technology as well as in resources and skills needed to effectively participate as a digital society.

Interest in linking ICT to Development started in 1984 when the Independent Commission of the International Telecommunication Union (ITU) delivered its final report entitled "The Missing Link" and known as "The Maitland Report" [5]. The report noted the need to pursue telecommunication reforms to extend the coverage of telephony and its effects and thereby, address the "Telecom Divide". The digital divide is closely related to the knowledge divide since the lack of access to technology creates a challenge to obtaining useful information and knowledge. Several studies found out also that digital divide is interlinked with other human development divides [2]. They pointed out two contradictory facets of Technology: a "positive" facet enabling the boosting of economy, business and public administration, and a "negative" facet consolidating the digital divide, the isolation of regions/populations and degradation of their life conditions. Because of their ubiquitous nature, Information and Communication Technologies (ICTs) are being used everywhere, in developed countries, to do almost everything quickly and accurately [1]. All important domains of our modern society have experienced a boost in progress due to the introduction and use of ICT, including: better service delivery to citizens and businesses, better access to information for decision makers, better management of administrative and business structures, better citizens/client records, and better information for the community [1].

Indeed, since the 90's, significant efforts have been deployed by many DLDCs around the world to address the digital divide especially through the enhancement of the physical infrastructure including Hardware, Telecom, Connectivity, etc. [5] and the legal framework and business environment. Unfortunately, considerable pitfalls persisted [2] and did not allow for a real take-off in terms of ICTs penetration, appropriation and usage in the daily needs of citizens. In Other words, the Digital Transformation Process did not take place, in many DLDCs and the Digital Divide grew up and grew up, until the CoviD-19 hit, living these countries with no serious means to battle against the COVID and try to survive. The COVID-19 Pandemic announced the beginning of a New-Normal, worldwide, and we can reasonably expect that similar phenomenon, of different natures/types, will pop-up soon or late. Digital Transformation, at national/global level, is in our view the only way for DLCS to be Resilient and cope with the "hazardities" of New-Normal, and ensure the Survival and of the country.

Hence, "Digital Divide 2.0" refers to the striking lack/dysfunctions of ICTs (Infrastructure, Services, Acceptance, Appropriation, Actual Usage, etc.), coupled with sudden occurrence(s) of exceptional phenomenon, worldwide, requiring from Countries an advanced level of Digital Transformation to try and cope with the situation, and survive.

Digital Divide 2.0 is different from Digital Divide 1.0 simply because the world has considerably changed since then, and the stakes are quite different: staying alive or quitting! Digital Divide 2.0 is more than a valid argument for decision makers in DLDC to launch the process of Digital Transformation in their respective countries. It clearly means that Digital Transformation is not anymore an option for any country that hopes to exist/survive/prosper in the New-Normal era!

III. ON THE DIGITAL TRANSFORMATION PROCESS

Digital Transformation (DX) is often defined as the Process of integration of digital technologies into all areas of a business resulting in fundamental changes to how businesses operate and how they deliver value to customers". Successful DX is indeed far more than about adopting new Technologies. The 2016 World Bank report "Digital Dividends" [11] strongly emphasized that technical solutions alone do not secure development. Other decisive factors include favorable framework conditions and an education system that prepares people for modern working life and for universal participation in the global digital economy.

DX is a vector of/for renewal, simplification and improvement that is incorporated into international development policy approaches. New technologies and digital solutions help developing countries to achieve economic growth and improve welfare, and to skip some developmental stages (Leapfrogging process). DX makes it easier to achieve the United-Nations Sustainable Development Goals and promote quicker, more inclusive growth and development in many countries.

It is interesting to notice that, despite the ubiquity and omnipresence of the digital transformation manifestations and impacts at all levels, the Academic Literature has paid a little attention to these developments.

Efforts to properly addressing the DX related conceptual and modeling issues have only emerged very recently, mainly in the Business/Management Discipline. For instance, marketing researchers have focused on digital advertising and social media effects including attribution model developments [12] [13] and multi-channel and Omni-channel developments [14]. The strategic management literature has mostly focused on the conceptualization, operationalization and renewal of (digital) business models (e.g. [15]. In Software Engineering / Computing Literature, researchers have traditionally paid more attention to technical developments regarding adoption and use of digital technologies and resulting business value (e.g. [16]).

Curiously, we don't find in the open literature, any model that specifically addresses the digital transformation, as a global societal shift/change, from a conceptual level along to the design and implementation stages, with clear transformation steps, challenges, opportunities, risks, etc. We don't find neither any academic research that addresses the Digital Transformation from a Development Perspective, which means the creation (including the conceptualization and modeling phases) of a direct relation between any country's Development Process and its general level in terms of ICTs penetration and usages among the population in their various daily needs [9]. Individuals need to be explicitly and structurally exposed to Technology, on a daily basis, for long a period, from different perspectives (discovery, learning, interacting, using for leisure, using for job, etc.) to progressively develop an ownership/appropriation feeling that allows individuals to be proactive in terms of usage, dissemination, development and Creation/Co-Creation of Technology. These are exactly the elements around which is built the DX Concept, at the conceptual, organizational and societal/human levels.

Indeed, there is no magic potion for instantly transforming a country/society digital, and that is basically why a whole DX is needed. This is by nature a long term process that is complex, delicate and somehow costly [10]. However, we can consolidate and speed-up this Process through a generic method/roadmap that will guide the various stakeholders during the whole Transformation Process. Such a method hall not only provide practical guidelines to system DX Concept, analysts and developers during the different phases of the project, but it should also provide means to raise the awareness of the various stakeholders involved in the project with respect to the impacts of their decisions on the whole DX Process.

IV. A COMPUTATIONAL MODEL TO STREAMLINE THE DIGITAL TRANSFORMATION PROCESS IN DLDCS

The framework we are presenting in this paper is adapted from the eFez Project [6].

Let us first tart by stating the main principles on which our Framework relies (and which explicitly show the its "extra" ICTs Dimension):

- All stakeholders must be involved as early as possible in the process of developing any e-Service, and their involvement and motivation must be sustained during the whole Project. A special care must be given to sustain favorable conditions for the Project from its onset until its completion. In our current circumstances, Fighting against COVID-19 and staying alive during and after the Pandemic is a major motivation no stakeholder can deny. That is why we think the immediate upcoming 2 or 3 years are just prosperous to launch the DX process in DLDCs with as many ICT Projects as possible, with a clear focus on not only providing s-Services a such but also, and more importantly, contributing the whole Process of DX. Boosting and sustaining the motivation of stakeholders and keeping on the favorable conditions surrounding any ICT Project will both be possible through the two major arguments we already stated : a New-Normal way of living (business, leisure, work, personal relations and interactions, etc.) is being established AND exceptional phenomenon can pop-up any time from now on, requiring a high level of resilience and adaptability if one wants to survive, and assumes indeed a high level of DX at a country level;
- A special care must be devoted to the creation and update of a project vision to which all stakeholders shall adhere to. A Selection of projects to be developed in order to contribute and consolidate the DX Process is indicated in Section III.B.2 of this paper;
- Outcomes and outputs of the project must be identified as early as possible and refined during the project with a special concern for Digital Transformation Improvement. Clear indications and indicators shall be elaborated to allow for measuring the actual improvement as indicated in Section III.B.3 of this paper;
- The Framework/Roadmap that is proposed shall mandatory cover at least all the traditional steps of information system development, delivery and deployment, with an emphasis on the actual indicators to be measured as indicated in section III.B.4 of this paper.

Figure-1 that follows depicts the Phases, Actors information flows and Interactions of our Framework:

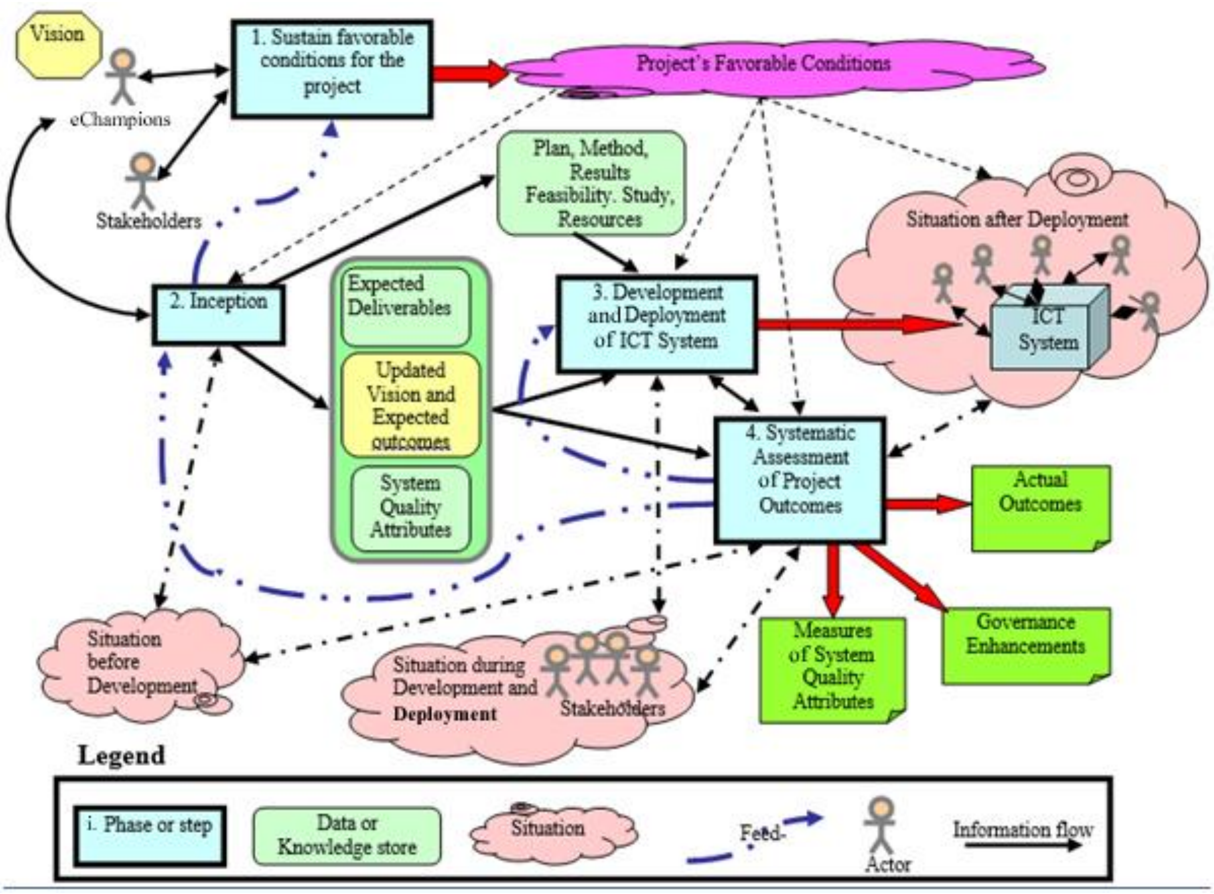

FIGURE 1: Phases, Actors information flows and Interactions of the proposer framework Approach [6]

In the following Sections we provide an overview of our Framework/Roadmap as a directed walk through the elements contained in Figure 1:

4.1 Sustaining the Favorable Conditions for the Project

This is a phase that shall "stay" active during the whole duration of any automation project. It consists in creating, enhancing and maintaining the conditions that favor the project's progress and push it forward. It involves the various stakeholders among whom we particularly point out the project's champions (called eChampions) that promotes and supports the project at all the critical levels of the organization's hierarchy.

The project's management team must be aware that certain stakeholders and the eChampions may change from one phase to the other and act accordingly in order to maintain favorable conditions for the project, given the changes taking place in the organization. The thin dashed arrows in Figure 1 show that these favorable conditions influence every phase of the project.

4.2 The Inception Phase

This is a critical phase of any automation Project and can only start when favorable conditions are met, among which the strong will and influence of high-ranked eChampions that support the project. These favorable conditions should build up during the phase.

The e-Champion and the development team must develop a clear and structured vision of the future ICT System and of the outcomes it must provide to the whole Country and its Citizens. Clearly the priority of developing ICT Projects shall be related to their potential of creating/generating global changes in the society, Country wide. For instance, Projects in the following areas would have the highest priority:

- **Datafication**: The digitization of all back office data in strategic areas including education, health, public administration, etc., along with the elaboration of national standards for Electronic data exchange and applications interoperability;

- **Localization:** Consists of developing Localized Applications, Data and Tools, needed by citizens in their daily life, both for work and leisure. These shall be in the native language of the citizens and shall focus, value and capitalize on the common social and cultural traits of the Country and its population;
- **Education:** This obviously a key success factor in the integration in the knowledge society and one of the main channels to build and consolidate the ICT awareness and readiness in any country. It should rather focus on the contents, the pedagogy, the trainers and the messages to be conveyed to apprentices in relation to the Digital Transformation, rather than on equipment, devices and technical manipulations and issues;
- **Governance:** This is a very important aspect for citizens to benefit from the advantages of ICTs, and, at the same time, to raise their level of usage, appropriation, readiness and awareness. The impact of e-Government on good governance has been demonstrated in different studies [6] and the debate is no more at this level but rather on how to take full benefit of ICTs and what the highest priority fields for a specific country are.

The Inception Phase is paramount in helping eChampions shaping their vision and refining their expectations with respect to the project's output (project's deliverables) and its outcomes. It is during this important phase that the most critical stakeholders are led to share the project's vision and reach a consensus on its main targets (output and outcomes). This increases the favorable conditions for the project as represented by the large dashed arrow linking rectangle 2 to rectangle 1 in Figure 1.

4.3 The Development and Deployment Phase

This step starts whenever the GO decision has been made after the completion of the Inception phase. A critical success factor is that favorable conditions are maintained all along this phase. All the Inception phase's outputs are available during the development of the ICTs system. It mainly consists of sub-phases similar to those found in traditional analysis and design methods applied to the creation of information systems, mainly: requirement analysis, development of a strong system architecture, business analysis, refinements and development of new workflows taking into account the introduction of the ICTs system in the organization, usability analysis, interfaces' and system's design, implementation and tests, deployment and adjustments). Again in this phase both organizational issues (procedures, workflows, business rules etc.) and software development issues are addressed. The technical norms and goals based on quality criteria fostering improved governance and set up during the inception phase are refined during the development phase and give strong directions to the development and deployment of the ICTs system. As in all the method's phases, a special emphasis is put on respecting the project's vision, which has a strong influence on the system's architecture and on making decisions with the aim of achieving the best outcomes set up during the previous phase. Hence, there is a guarantee that the project will provide the best outcomes and achieve the best results that can be achieved, given the situations that prevailed before and during the development and deployment of the system. This emphasis on working towards a significant improvement of governance should be adopted by all the development team members as well as by the majority of stakeholders.

4.4 Outcomes Assessment and Contribution to National DX Process

This a very important phase of the method that is carried out in parallel with the other phases. Its goal is to systematically assess and monitor the evolving situation during the course of the project with respect to the achievement of the expected project outcomes and to the respect of system quality attributes toward consolidated DX. Again during this phase, favorable conditions should be maintained and they may be different/complementary to those that prevail during the other phases, since the right setting must be set up in order to conduct the various investigations needed to carry out the various assessments pertaining to measuring the project success but also in measuring the impact of this project on the whole Digital Transformation Process nationwide.

So far, and to the best of our knowledge, there is no ongoing research that targets the elaboration of a formal framework that measures the Maturity level of Country/Society with respect to their level of DX. Such a framework would first require a conceptualization (through a formal Model that we call "The Digital Transformation Maturity Model: DTMM") of the structures and linkages between the ICT Systems/Applications and the "State/level" of Digital Transformation in a particular Country, Region or Population.

Once the DTMM is ready, the next important step would be elaborate a Computational Model that transforms the conceptual relations between ICT Systems/Applications and the "State/level" of Digital Transformation as stated in the DTMM into a set of Aggregates/Attributes/metrics that are measurable and that will be measures while the system is running and serving citizens and Populations.

V. CONCLUSION

This paper reflects and describes the progress of our thoughts in relation to the role of ICTs in helping people in coping with the new-normal way of life imposed by COVID-19. We believe this is urgent more than ever in the past to launch the process of digital transformation in all countries that have not started it yet to avoid further damages and distresses to their populations. Clearly, without a solid digital “Capital”, no country will be able to face the “hazards” of the future.

Our main contribution in this paper is to announce the idea of a Computational framework to justify and streamline the Digital Transformation Process in Developing and Developed Countries. Indeed we still need serious work to formalize the structure and all the constituting elements of this framework, both at the conceptual and computational levels, but the first brick is there, and others will quickly follow as we progress in our Research.

PROJECT INFORMATION

The eFez Project intended to implement the first e-Government system, at the municipal level, in Morocco and, in parallel, to develop a road map of “e-Government for good governance” to be used in future projects to ease and speed up the process of generalization of such systems in Morocco and comparable developing countries. The targeted e-Government system was related to the automation of the back and front offices’ operations of the Register Office, known in Morocco as the “Bureau d’Etat Civil”. Additionally, the project aimed at assessing the results, outcomes and effects of the deployment of an e-government system on governance and, overall, the transformation of a completely manual municipal service delivery process. The eFez project was funded by the International Development Research Center (IDRC) of Canada, and took place in the city of Fez/Morocco, between 2004 and 2012. For more details, see [6].

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The Effects of Three Furrow Shapes on Water Advance Characteristics, Application Efficiency, Deep Percolation and Tail Water Run-off

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Abstract— *Furrow irrigation is considered to be inefficient when compared to most pressurized irrigation systems. The objective of this research was to determine if different furrow shapes have different impacts on water management practices such as application efficiency, deep percolation ratio and tail water runoff. Three furrow shapes, a triangular (V-shaped), rectangular (R) and trapezoidal (T_p) shaped were evaluated and the results were compared with output from SIRMOD II. The parameters calculated from field data were not very different from those determined by the model. This indicated that the model predicted the volume balance of the field data with reasonable accuracy. It was observed that the time of advance was shorter for the triangular shaped furrow and much longer for the rectangular shaped furrow. Performance efficiency parameters were good for the trapezoidal and triangular shaped furrows and very poor for the rectangular furrow. Tail water ratio (TWR) was much higher in the triangular furrow and lower in the rectangular furrow. Where there was no deep percolation ratio, the model failed to return a reasonable value.*

Keywords— ***Advance, recession, SIRMOD II, infiltration, application efficiency, deep percolation, run-off.***

I. INTRODUCTION

Furrow irrigation is probably the oldest and most widely used method for applying irrigation water to many field crops and vegetables worldwide (Childs et al., 1993; Walker and Skogerboe, 1989; Nie et al., 2018, Dlamini, 2020). Lima et al. (2014) observed that surface irrigation systems still remain the most used irrigation system worldwide mainly due to their energy saving capacity and ease of operation but they show low performance level as a consequence to the general design and inadequate management. This observation was also made by Lamaddalena et al. (2021). According to Spencer et al. (2019) the two primary factors causing inefficiencies in furrow irrigation are deep percolation losses and tail water runoff and are the two major constraints in furrow irrigation practices. Eldeiry et al. (2005) although measured various parameters including furrow geometry, in their study they concluded that the length of the furrow and its inlet inflow are the main factors affecting application efficiency. They observed that when using longer furrow lengths the irrigation system was less sensitive to variations in furrow inflow, furrow shape, field slope, and roughness. However, where longer furrow lengths are not possible, the application of water should be carefully controlled to maintain high efficiencies. In free ending furrow irrigation, the recession phase was very fast in the entire field compared to the advance. Thus, the time of advance becomes the main contributor to the water application in the furrow. Haddad and Bouhadef (2012) studied the impact of geometric shape of farming grooves on sediment transport and found that there were variations among the shapes.

The results of Schwankl et al. (2000) indicated that variability of furrow physical characteristics, in decreasing order of their relative impact on furrow irrigation performance was: furrow inflow rate, infiltration, geometry, and roughness. The infiltration characteristics (Dlamini, 2021) also plays an important role in understanding the movement of water along the furrow, with furrow shape (Eldeiry et al. 2005) being a critical parameter for determining the advance time. The application efficiency (AE) and distribution uniformity (DU) are the main indicators to evaluate the overall performance of any surface irrigation event (Lamaddalena et al. 2021). Holzapfel et al. (2010) noted that efficient irrigation practices that minimize deep percolation will therefore minimize leaching of contaminants. A good correlation was obtained among performance irrigation parameters; application efficiency (AE), requirement efficiency (RE), requirement distribution efficiency (RDE), and total distribution efficiency (TDE) and the design or management variables for furrow irrigation.

The analysis of performance indices by Assefa et al, (2017), on furrow irrigation in sugarcane indicated that the effect of slope was not statistically significant except distribution uniformity and uniformity coefficient; furrow length and flow rate were highly significant on all performance indicators. All indices except deep percolation ratio and storage efficiency had shown an increasing trend as flow rate increases. In furrow irrigation in clayey soil, Eldeiry *et al*. (2004) found that furrow length and application discharge are the main management and design parameters affecting application efficiency. Alazba (1999) noted that furrow performance relies on many irrigation parameters that include furrow geometry (shape, size, length, and slope); soil characteristics (infiltration and roughness); and management parameters (flow rate, application time, and required depth).

Generally, reduced application efficiency with furrow irrigation occurs because of runoff or deep percolation (Hsiao et al., 2007). Although hard to eliminate, runoff can be controlled by tail water reuse systems, changing furrow stream size, or changing irrigation set time (Eduardo et al., 2010). Deep percolation reduces irrigation efficiency and increases pumping costs. In addition, chemicals applied to the soil surface to control pests and improve production can leach below the root zone and into the groundwater.

Uniform application of water using furrow irrigation is difficult to achieve. As water advances down a field, the opportunity time, or the time water has to infiltrate the soil, is greater at the upper end of the field than the lower end (Dlamini, 2001). Non-uniform furrow irrigation, a primary cause of deep percolation, is usually more pronounced during the first irrigation of the season. Early in the season, soil conditions are loose because the soil has not yet consolidated due to irrigation or rainfall. Cultivation and furrow construction loosen the soil further and encourage surface soil water evaporation. In addition, root activity early in the growing season depletes soil water in the top layers of the soil. All of these conditions can result in dry, loose soil making irrigation difficult. If moving water down the field is difficult, non-uniform irrigation will result, causing deep percolation of water below the root zone, particularly at the head end of the field.

Any process allowing water to advance in a furrow and reach the end of the field faster will help improve water distribution and obtain more uniform irrigation. Fornstrom et al. (1985) used a technique called furrow firming to improve the advance rate of water in a furrow study. Many models have been developed that simulates surface irrigation, but most on isolated irrigation events assuming that there is no spatial variation in field parameters (e.g. infiltration, roughness, slope and cross section). The objective of this study was to evaluate the effect of three furrow shapes (a rectangular (R), trapezoidal (Tp) and triangular (V)) on furrow performances; application efficiency, deep percolation and tail water runoff.

II. MATERIALS AND METHODS

Advance and recession measurements were carried out on three different furrows shapes, each 180 m long and spaced 1.4 m apart. There were two guard furrows for each measured furrow, one on either side bordering the furrow of interest. Three furrow shapes (a rectangular (R), trapezoidal (Tp) and triangular (V)) were evaluated for furrow performances; application efficiency, deep percolation and tail water runoff (Dlamini, 2001). It was essential to ensure that inflow did not vary with time.

The advance – recession set up consisted of two Washington State flumes (WSC), one placed five metres from the inlet used for measuring inflow and the other placed at the end of the furrow, used for measuring runoff (outflow). The first stake position, 00, was placed 3 m down the upper flume and the last stake placed at 180 m down the furrow, 3 m before the tail-water measuring flume. In the case of the first flume, this was done to ensure that the water was set to the desired flow rate before it reaches the 00 measuring position, and for the last flume, so that the backwater effect from the flume did not interfere with the last stake reading. During each irrigation event, a constant inflow (Issaka et al., 2015; Walker, 2003) of about 60 liters per minute was maintained. The water was supplied from a sprinkler hydrant and controlled to the desired flow rate using a 25 mm globe valve.

Wooden stakes were placed 30 m apart along the entire furrow. The time water was allowed into the furrow was noted. The movement of the advance was noted by recording the time water arrive at each wooden stake (station). This was done until the water had reached the last stake at 180 m of the furrow length. After the water had reached the end of each furrow, it was allowed to runoff for a fixed interval (a period of 15 minutes), the same for all the furrows. Recession (time) was taken as the time when the tail of water passed a wooden stake. A degree of subjective judgment is required for recession, but errors are small in magnitude when compared to the contact time.

A furrow profilometer instrument (Walker and Skoggerboe, 1987; Dlamini, 2001) was used to measure the furrow profile before the first irrigation and after each irrigation event to determine any changes in furrow geometry. This device uses vertical rods to indicate relative soil surface elevations across a section of the furrow. Changes within the furrow were assumed to be due to the effect of irrigation and determined by calculating the cross sectional changes of the furrow.

Equations that relate the measured top width of each furrow shape were used to calculate the wetted perimeter, cross-sectional and applied water depth as functions of the distance along the furrow length.

Other measurements included the time water reached the furrow end T_L, the time to the middle of the furrow $T_{1/2L}$, the wetted perimeter at each point (w_p), the depth of flow (y) and the top width of the water level (T) at each station along the furrow. These measurements were required for the calculation of the Kostiakov-Lewis equation exponent "a" and the coefficient *"k"* as described by Baustista and Wallender (1985); Walker and Skoggerboe (1987). The equation was then used to determine the volume balance relationship of each furrow shape based on the time of advance and the top width of the water surface at each station (Izadi et al., 1977).

The steady or basic infiltration rates (f_o) were measured on another set of furrows by using the inflow –outflow method (Dlamini, 2001).

III. RESULTS AND DISCUSSION

The actual shapes of the furrows as measured in the field situation are shown in Fig. 1 for the triangular, Fig. 2 for the trapezoidal, and Fig. 3 for the rectangular shape. It is noted that it was not possible to get a perfect triangular (V shape), trapezoidal and a rectangular shape because during furrow forming the soil was dry and tended to fall back after the implement has passed, meaning that the furrows did not maintain a constant shape for the entire furrow length.

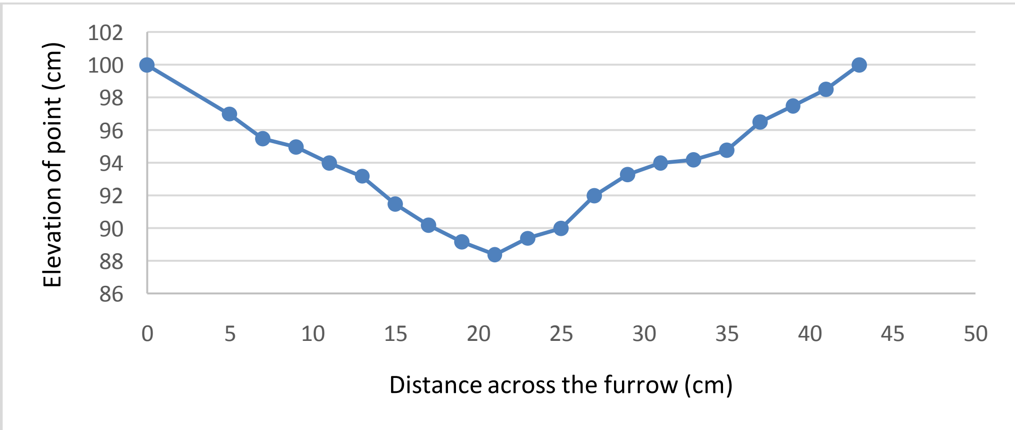

FIGURE 1: Average Geometry of the Triangular (V shape) Furrow (Measured Using the Profilometer Instrument) Before Irrigation at USU Greenville Farm, Logan during Summer

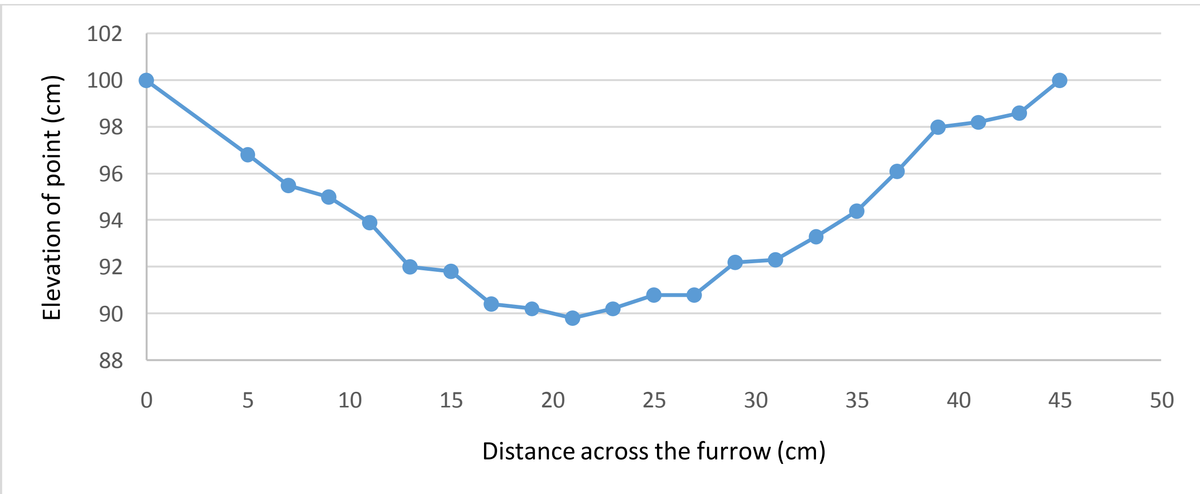

FIGURE 2: Average Geometry of the Trapezoidal Furrow (Measured Using the Profilometer Instrument) Before Irrigation at USU Greenville Farm, Logan during Summer

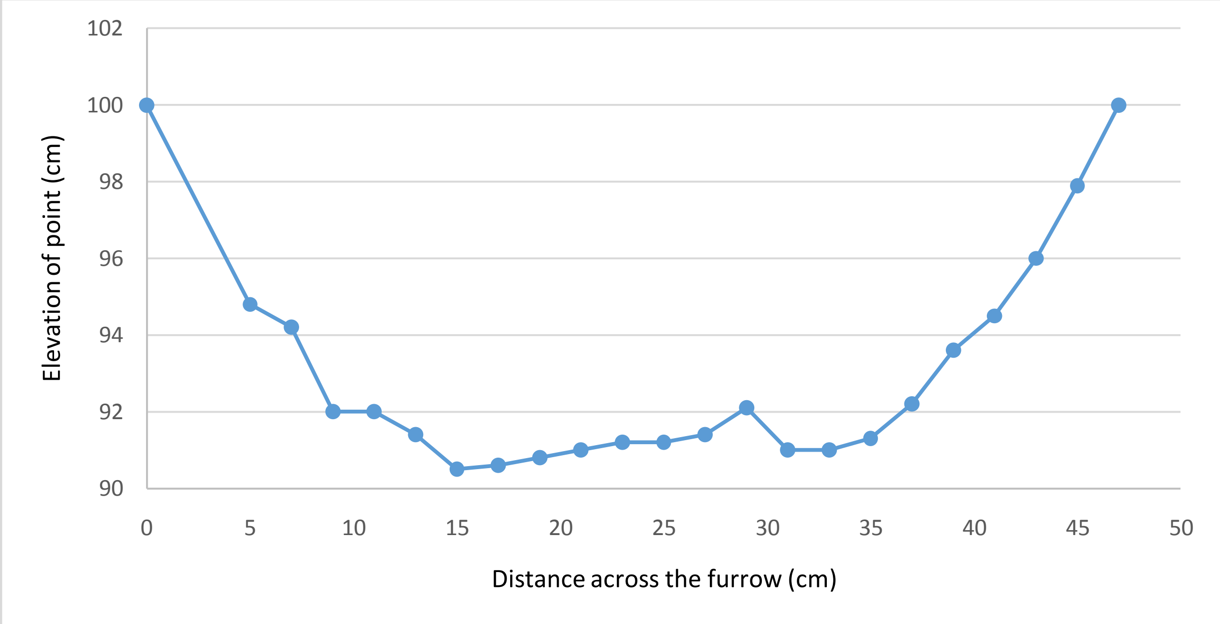

FIGURE 3: Average Geometry of the Rectangular Furrow (Measured Using the Profilometer Instrument) Before Irrigation at USU Greenville Farm, Logan during Summer

The design top width was 45 cm and a depth of 15 cm for all the furrow shapes. In an examination of the measured geometry of the furrows, it was observed that for the triangular and trapezoidal shapes about 3 cm of depth was lost due to soil refill, and about 4 cm for the rectangular shape even through the setting in the tractor implement was controlled and set at one position for all the shapes.

Table 1 gives the summary of the hydraulic properties of the three furrow shapes taken before the first irrigation event.

TABLE 1
SUMMARY OF THE HYDRAULIC PROPERTIES OF THE THREE FURROW SHAPES BEFORE IRRIGATION AT USU GREENVILLE FARM, LOGAN DURING SUMMER.

Hydraulic Property	Triangular (V)	Trapezoidal (Tp)	Rectangular (R)
Topwidth (T)	0.43	0.45	0.47
Depth (y)	0.12	0.11	0.10
Bottom Width (b)	0	0.16	0.20
Side Slope (m)	1.79	1.32	1.35
Calculated Properties			
Wetted perimeter (Wp)	0.49	0.52	0.47
Cross-sectional Area (A)	0.026	0.0336	0.0335
Hydraulic Radius (Rh)	0.052	0.064	0.071

The trapezoidal furrow had the largest wetted perimeter which was similar for both the rectangular and triangular. The triangular furrow shape had the smallest cross sectional area and hydraulic radius compared to the other two shapes.

Values of the basic intake rate for the first and second irrigation events obtained for each furrow shape within the measurement period are shown in Table 2. Since the experiment was done on a field with the same soil type, the basic intake rate was expected to be the same for all the furrow shapes. However, one observation to be made from the data is that the approach to the basic intake rate was faster for the triangular (V) shaped furrow and much slower for the rectangular (R) shaped furrow.

TABLE 2
DERIVED VALUES OF THE BASIC INTAKE RATE (cm/min) FOR THE FIRST AND SECOND IRRIGATION EVENTS FOR THE THREE FURROW SHAPES AT USU GREENVILLE FARM, LOGAN DURING SUMMER

Irrigation Event	Triangular (V)	Trapezoidal (Tp)	Rectangular (R)
1st Irrigation	0.00798	0.00826	0.0120
2nd Irrigation	0.00395	0.00446	0.0051

To solve the Kostiakov-Lewis equation (Dlamini, 2001; 2021), requires knowledge of the parameters "a" and "k". These values were calculated from the log-log transformation of the infiltration rate data by solving for the slope and intercept. Table 3 shows the values of "a" and "k" for each furrow shape for the first and second irrigation event. The data was analyzed based on three replicates to test if there were differences between irrigations events and within furrow shapes.

TABLE 3
KOSTIAKOV-LEWIS INFILTRATION PARAMETERS "a" AND "k" FOR THE THREE FURROW SHAPES AT USU GREENVILLE FARM, LOGAN DURING SUMMER.

Furrow shape/Irrig Event	Kostiakov-Lewis Infiltration Parameters			
	a		K (m^3/min^a)	
	1	2	1	2
Triangular (V)	0.307	0.281	0.00796	0.00493
Trapezoidal (T_p)	0.302	0.310	0.00916	0.00507
Rectangular (R)	0.376	0.295	0.00887	0.00658
Mean	0.328	0.295	0.00866**	0.00553**

***** Indicates that the values of the F statistic were significant at 1% level***

The results shows that differences between furrow shapes were not significant for values of "a", meaning that the values of "a" are independent of the furrow shape. The values did not significantly change from one irrigation event to another, though smaller for the second irrigation event. This might mean that the values of the parameter "a" are a function of the soil type rather than the furrow characteristics.

Values for the parameter "k" were smaller for the triangular shape furrow and larger for the rectangular. The values were also smaller for the second irrigation event.

The "a" and "k" values for each furrow were then applied in SIRMOD II model (Walker and Skogerboe, 1987; Walker, 2003) to simulate the performance of each irrigation, and then compare the measured and simulated characteristics.

To characterize the performance of each irrigation, the following measures of performance (equation 1-3) were calculated; application efficiency (E_a), deep percolation ratio (DPR) and tail water ratio (TWR)

$$E_a = \frac{Z_{req}\, X_d + V_{zi}}{Q_o\, t_{co}} * 100\% \tag{1}$$

$$DPR = \frac{V_{za} - Z_{req}\, X_d}{Q_o\, t_{co}} * 100\% \tag{2}$$

$$TWR = 100\% - E_a - DPR \tag{3}$$

where Z_{req} is the target depth of application, m; X_d is the distance of the advance, m; V_{zi} is the area inadequately irrigated, m^2; Q_o is the inflow into the furrow, m^3/min; t_{co} is the cut-off time, minutes; and V_{za} is the area adequately irrigated, m^2.

The outputs for the first and second irrigation events are summarized in table 4-6 for the triangular, trapezoidal and rectangular shape respectively.

TABLE 4
INFILTRATION PARAMETERS FOR THE TRIANGULAR (V) SHAPED FURROW FROM THE ADVANCE AND RECESSION MEASUREMENTS AT USU GREENVILLE FARM, DURING SUMMER

Parameter	Irrigation Event			
	1		2	
	Measured	SIRMOD II	Measured	SIRMOD II
Q_o (1/s)	1.0		1.0	
T_{co} (min)	51.3		36	
k (m^3/min^a)	0.00796		0.00493	
A	0.307		0.281	
T_L (min)	34.9	38.1	17.5	19.9
$T_{0.5L}$ (min)	12.5	14.3	8.1	9.3
Performance Measures				
Ea	76.8	79.9	37.1	40.3
DPR	0	-0.7	0	-0.9
TWR	23.2	20.8	62.9	60.6

TABLE 5
INFILTRATION PARAMETERS FOR THE TRAPEZOIDAL (T_p) SHAPED FURROW FROM THE ADVANCE AND RECESSION MEASUREMENTS AT USU GREENVILLE FARM, DURING SUMMER.

Parameter	Irrigation Event			
	1		2	
	Measured	SIRMOD II	Measured	SIRMOD II
Q_o (1/s)	1.0		1.0	
T_{co} (min)	86		56.3	
k (m^3/min^a)	0.00916		0.00507	
A	0.302		0.31	
T_L (min)	67.7	70.1	39.8	41.4
$T_{0.5L}$ (min)	19.9	20.6	14.5	15.5
Performance Measures				
Ea	70.8	72.5	75.5	78.8
DPR	15.9	21	0	-0.5
TWR	13.3	6.5	24.5	21.7

TABLE 6
INFILTRATION PARAMETERS FOR THE RECTANGULAR (R) SHAPED FURROW FROM THE ADVANCE AND RECESSION MEASUREMENTS AT USU GREENVILLE FARM, DURING SUMMER.

Parameter	Irrigation Event			
	1		2	
	Measured	SIRMOD II	Measured	SIRMOD II
Q_o (1/s)	1.0		1.0	
T_{co} (min)	184.0		75.0	
k (m^3/min^a)	0.00887		0.00658	
A	0.376		0.295	
T_L (min)	161.0	164.0	56.0	64.0
$T_{0.5L}$ (min)	50.6	51.1	20.5	24.7
Performance Measures				
Ea	34.2	34.1	77.3	81
DPR	57.4	62.3	1.8	2.8
TWR	8.4	3.6	20.9	16.2

The parameters calculated from field data were not very different from those determined by the model. This indicated that the model predicted the volume balance of the field data with reasonable accuracy. It was observed that the time of advance was shorter for the triangular shaped furrow and much longer for the rectangular shaped furrow. Performance efficiency parameters were good for the trapezoidal and triangular shaped furrows and very poor for the rectangular furrow. Tail water ratio (TWR) was much higher in the triangular furrow and lower in the rectangular furrow. Where there was no deep percolation ratio, the model failed to return a reasonable value.

IV. CONCLUSION

From the results of the study, it could be concluded that the parameters calculated from field data were not very different from those determined by the SIRMOD II model. This indicated that the model predicted the volume balance of the field data with reasonable accuracy. It was also observed that the time of advance was shorter for the triangular shaped furrow and much longer for the rectangular shaped furrow. Performance efficiency parameters were good for the trapezoidal and triangular shaped furrows and very poor for the rectangular furrow. The tail water ratio (TWR) was much higher in the triangular furrow and lower in the rectangular furrow. Where there was no deep percolation ratio, the model failed to return a reasonable value.

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American Continent Lithospheric Earthquakes after Nuclear Tests of France in November 1990

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Abstract— *The correlation between lithospheric earthquakes on the American continent and tropical cyclones that arose after the French nuclear tests is considered. The transfer of the local impact of TC on the lithospheric plates of the other hemisphere is proposed to be assessed by the effect of "Fantom" TC symmetric with respect to the center of the Earth. It is shown that the localization of earthquakes shifts in accordance with the movement of the "Fantom" TC and its intensity. This indicates that TCs are a trigger for earthquakes in the most intense seismic areas.*

Keywords— nuclear test, typhoon, earthquake, american continent.

I. INTRODUCTION

Earlier it was shown that in separate seismically active areas earthquakes correlate with the energy of TCs and their localization [1-6]. Moreover, the energy of lithospheric earthquakes released at all major faults during the day has maxima at the phases of a sharp increase and decrease in TC intensity, which was shown for the strongest typhoon Gay-92 in 35 years [4].

Several mechanisms have been proposed for the TC effect on earthquakes:

1. The first one is associated with oscillations of long waves excited by TC in the coastal zone. This mechanism has been studied using special seismic sensors at ~ 2800 US stations for more than 10 years [1].
2. The second one is associated with the lithospheric mechanism of the transfer of the moment of forces from the rarefaction area under the TC when it is located near the edge of the large lithospheric plate adjacent to the small one. This mechanism was considered in the analysis of small lithospheric plate earthquakes with magnitude M> 4.5 without foreshocks of [2-3].
3. The third one is that vertical displacements of the Earth's surface in the zones of action of a cyclone and anticyclone can cause a stress release in seismically active regions, as shown by the example of Kamchatka in [5].
4. Fourthly, it is shown that the impact of the Harry-89 TC during the passage of the New Caledonia Island can be considered as a lever that "lifted" the northeastern edge of the Australian plate, which caused a series of earthquakes [6]. By the example of the Vanuatu fault closest to the Harry TC, the change in the depth of earthquakes from deep focus h ~ 100 km to the upper boundary of the lithosphere h ~ 30 km is explained.

It seems important to return to the observations of the transfer of the Pacific Plate influence to the area of the Mid-American Trench and Peru-Chile Trench due to the French nuclear tests in November 90 [3], to explain the mechanism of the release of lithospheric stresses in areas far from the source of impact.

II. CORRELATION BETWEEN LITHOSPHERIC EARTHQUAKES AND TC INTENSITY

We consider lithospheric earthquakes h> 20 km near the American continent after the Nuclear Test on 14-Nov-90 before the dissipation of super typhoons Page and Owen on December 4. Earthquake data were taken from the United States Geological Survey (USGS) [7], and tropical cyclone data were taken from the Joint Typhoon Warning Center (JTWC). JTWC results for 1990 are presented in the report [8].

During the selected period, 24 earthquakes with magnitude M> 4.5 were recorded, which are presented in Table 1. When constructing a correlation between the energy of earthquakes and the intensity of TC (Fig. 1), earthquakes with M> 4.0 were taken into account, that is, 14 weaker earthquakes were additionally included.

TABLE 1
EARTHQUAKES M_W >4.5 NEAR THE AMERICAN CONTINENT

No.	Date 1990	Area	UT h:m	Epicenter N/W	Mw	Depth km
1	11-15	Coixtlahuaca, Mexico	04:27	17.91 / 97.33	4.7	70.4
2	11-16	South Sandwich Islands region	07:20	-59.71 / 26.24	5.7	33.0
3	11-17	Santiago de Cao, Peru	10:24	-8.68 / 79.88	4.7	35.0
4	11-18	coast of Central America	14:15	2.29 / 84.41	5.0	33.0
5	11-18	Cayarani, Peru	19:46	-14.62 / 71.9	4.8	136.3
6	11-18	Bonaire, Saint Eustatius and Saba	20:28	17.8 / 63.04	5.4	91.8
7	11-20	Tocopilla, Chile	16:28	-22.69 / 69.88	4.7	58.3
8	11-20	Diego de Almagro, Chile	22:33	-26.38 / 70.82	4.6	56.0
9	11-21	Iquique, Chile	07:56	-20.5 / 68.92	4.6	126.0
10	11-21	Las Vegas, Honduras	12:58	14.89 / 87.55	4.5	33.0
11	11-21	Curahuara de Carangas, Bolivia	16:45	-17.53 / 69.1	4.5	169.2
12	11-21	San Pedro de Atacama, Chile	23:23	-22.9 / 68.71	4.6	81.4
13	11-22	Los Andes, Chile	01:17	-32.19 / 69.99	4.6	119.7
14	11-22	Huarmey, Peru	14:25	-10.13 / 78.62	5.1	47.5
15	11-23	Zorritos, Peru	07:27	-3.62 / 80.82	4.9	33.0
16	11-23	Palora, Ecuador	22:15	-1.8 / 78.08	4.7	155.7
17	11-23	Salento, Colombia	22:35	4.71 / 75.57	6.1	144.6
18	11-24	Coro, Venezuela	07:53	10.76 / 69.42	5.1	41.9
19	11-25	Caucasia, Colombia	01:52	8.09 / 75.06	4.7	73.8
20	11-25	Sucúa, Ecuador	12:32	-2.69 / 77.77	5.4	25.4
21	11-26	Calama, Chile	18:50	-21.35 / 68.72	4.5	124.2
22	12-02	Calama, Chile	14:37	-21.82 / 68.33	5.3	120.7
23	12-03	Cepitá, Colombia	00:38	6.77 / 72.97	5.3	159.0
24	12-04	Upala, Costa Rica	08:02	10.91 / 84.85	4.8	159.0

The earthquake energy ***E*** in joules will be estimated by the formula (1) which connects it with the magnitude ***M*** [9].

$$M = 2/3(\lg E - 4.8) \quad (1)$$

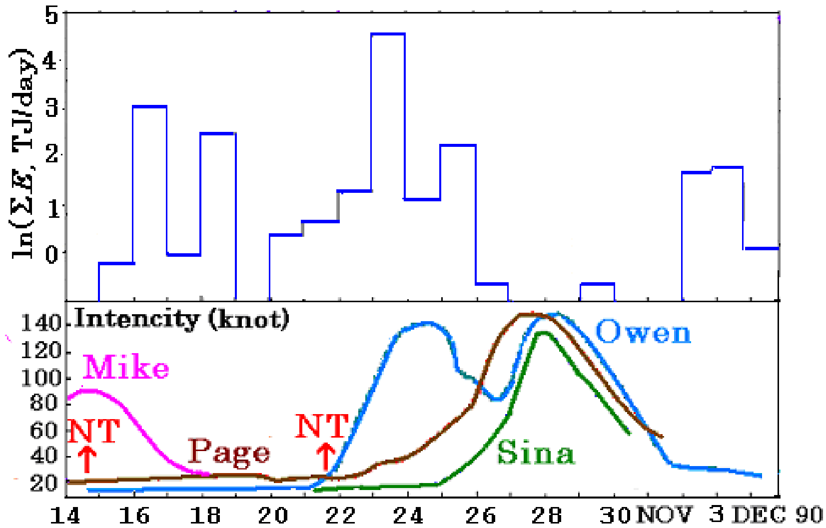

FIGURE 1: TC intensity and energy of lithospheric earthquakes per day

Intensity – the maximum sustained 1- minute mean surface wind speed, typically within one degree of the center of a tropical cyclone (1 knot = 0.51444 m/s).

The histogram values are given in natural logarithms of the sum of earthquake energies per day in terajoules.

In Fig. 1, four time intervals of seismic stress relief are distinguished. The picture becomes clearer if the earthquake sources and the centers of the "Fantom" TC are superimposed on the map of lithospheric faults, i.e. diametrical projections of TC centers to the other hemisphere (Fig.2).

III. LOCALIZATION OF EARTHQUAKES RELATING TO SEISMIC FAULTS AND "FANTOM" TC DISPLACEMENT

The transfer of the impact of typhoons Mike, Page, Owen and TC Sina on the lithospheric plates of the other hemisphere can be explained from the law of conservation of angular momentum. For a rotating closed system of interacting lithospheric plates, the change in angular momentum due to the uplift of the plate in the area of pressure drop in the center of the TC should be compensated by the corresponding movement of other plates. This impact will be considered as the impact of the "Fantom" TC. Fig. 2 shows their dates and the centers of the corresponding TC, enclosed in quotation marks.

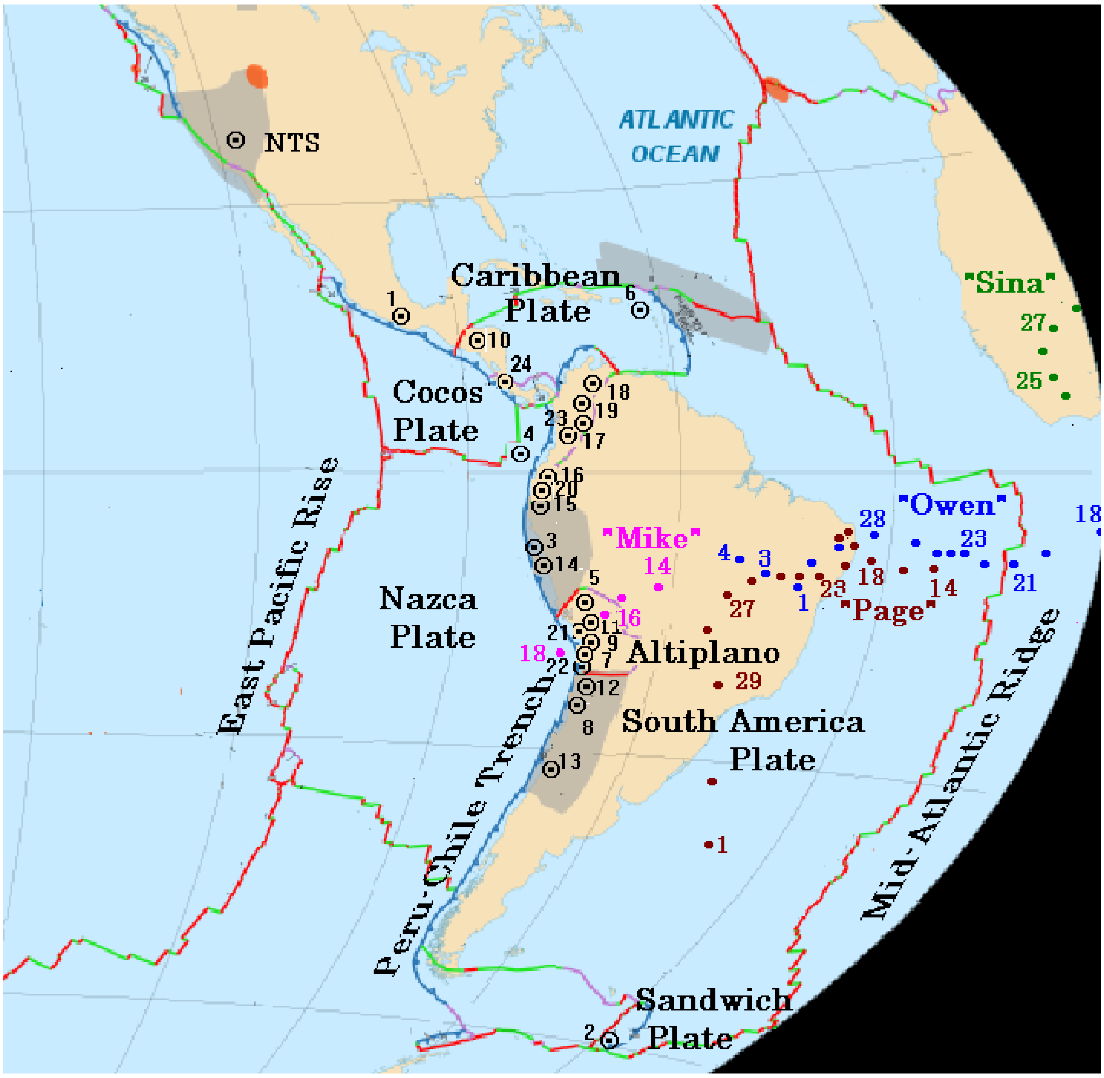

FIGURE 2: Location of earthquakes (Table 1) and diametrical projections of TCs on the map of lithospheric faults

Most of the considered earthquakes have occurred along the Peru-Chile Trench.

IV. THE DISCUSSION OF THE RESULTS

1. Earthquakes No 1-6 (Table 1) occurred on November 15-18 during the phase of falling intensity of Typhoon Mike (Fig. 1). During this time, Mike left the Philippine Islands and approached China. On November 17, it passed through the Hainan Island 270 km long. In a diametrically opposite area, "Fantom" Mike crossed the Altiplano high plateau and crossed the Peru-Chile Trench (Fig. 2). Earthquakes No 1, 5, 6 were deep focus with h ~ 100 km, which

corresponds to the pulling out of the "roots" of lithospheric plates from magma and their rupture in the weakest point [6]. Earthquakes No 2-4 were at a depth of h ~ 30 km, which corresponds to the pattern of uplift in the center of impact and downward movement at the edges of oceanic plates [6].

2. Earthquakes No 7-20 (Table 1) occurred on November 20-25 with the development of the first maximum of Typhoon Owen and an increase in Page intensity (Fig. 1). During this time, Owen approached Mariana Trench. On November 19-21 Page almost stopped, and on 22nd its center shifted to Challenger Deep. In the diametrically opposite area, the "Fantom" Owen crossed the Mid-Atlatic Ridge on 22-Nov (Fig. 2). After that, on 22-24-Nov at the stage of increasing intensity of Owen and Page, the foci of earthquakes No 13-18 began to systematically move to the north. At the phase of decrease in Owen intensity and increase in Page intensity, the foci of earthquakes No 18-20 began to move systematically to the south.
3. From 26 to 30 November, Owen, Page and Sina developed synchronously to the fifth category. Seismic activity on the American continent has dropped sharply. At the stage of their intensity growth, only one earthquake No 21 occurred. At the stage of decreasing intensity on 29-Nov, there are two earthquakes with M = 4.4. One thing happened in Mexico (5:30 UT, 18.3 N 100.6 W) when Owen's "Fantom" entered the mainland. Another happened in Peru (13:28 UT, 18.2 S 69.3 W) when the "Fantom" Page left the mainland. These earthquakes are not included in Table 1, but were taken into account when constructing the histogram.
4. Earthquakes No 22-24 (Table 1) occurred on December 2-4, when only Owen remained. All earthquakes were deep focus and strong enough, which indicates that, apparently, there was a relaxation of the displacements of lithospheric plates, which arose due to the impact of three super typhoons.

The forecast of the occurrence of earthquakes, at present, can be given probabilistically [10], which is shown in other articles of this collection. Satellite methods for monitoring the displacement of lithospheric plates are now widely implemented; see, for example, [11], which can confirm the main conclusions of this work. The development of crustal earthquakes, accompanied by the release of radon, can also be predicted by changes in a number of geophysical parameters [12].

V. CONCLUSION

1. The TC impact on lithospheric plates is one of the triggers for the release of seismic stresses.
2. Lithospheric earthquakes occur at the phases of a sharp increase and decrease in the TC intensity.
3. Critical moments in areas diametrically distant from the TC can be determined by the peculiarities of the movement of the "Fantom" TC relative to seismic faults.

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