Climate Change and Fish Farmers Adaptation A Case Study of New Bussa Fishing Population

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Abstract
This research work takes a look into the importance of some commercial inland fish species, how they are affected by climate change and how fish farmers in the study area are adjusting to the variation in climate, as there is strong evidence that the fisheries sub-sector of agriculture is experiencing major challenges as a result of climate change. Respondents in the study area are majorly fish farmer and perceived climate change factors to include variability of temperature, air humidity and total rainfall.

INTRODUCTION

According to the fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC) 2014, climate change is defined as a change in the state of the climate that can be identified (e.g. by using statistical tests) by changes in the mean and the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be caused due to natural internal processes or external forces such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in landuse. Climate change is a change in climate that is attributable directly or indirectly to human activities. It affects the atmospheric conditions of the earth thereby leading to global warming. According to Raymond and Victoria (2008), climate change has the potential to affect all natural systems thereby becoming a threat to human development and survival socially, politically and economically. A comprehensive

summary by the IPCC in 2007 stated that human actions are very likely the cause of global warming; meaning a 90% or greater probability is attributable to man, and many of this human activities are carried out dally thereby forcing the change in climate, some of these activities carried out by man have varying contributions to the changes in the climatic systems. The burning of coal, oil and natural gas (gas flaring), as well as deforestation and various agricultural and industrial practices, are altering the composition of the atmospheric and are contributing to climate change (www.gerio.org). These human activities lead to increased atmospheric concentration of a number of greenhouse gases, which in turn produce greenhouse effects (www.undp.org).

Climate change among other things is a major challenge on agricultural practises and development in the World, Africa and Nigeria. Ziervogel *et al* (2006) noted that climate change, which is attributable to natural climate cycle and human activities, has adversely affected agricultural productivity in Africa. This is particularly because African agriculture is predominantly rain-fed and hence fundamentally dependent on the vagaries of weather (Watson *et al,* 1987). Zoellick (2009) stated that, as the planet warms, rain fall patterns shift, and extreme events such as droughts, floods, and forest fires become more frequent. This results in poor and unpredictable yields, thereby making farmers more vulnerable, particularly in Africa (UNFCCC, 2007). Climate change affects agriculture in several ways, one of which is its direct impact on food production. Besides, almost all sectors in agriculture (crop, livestock, pastoralism, fishery, etc) depend on weather and climate whose variability have meant that rural farmers who implement their regular annual farm business plans risk total failure due to climate change effects (Ozor *et al*, 2010). The risk from climate in Africa, and the rest of the world, includes, rising temperatures and heat waves, shortfalls in water supply/increasing floods arising from shortage/excessive rainfalls, sea level rise, increasing likelihood of conflict and induced environmental and vector borne diseases. These conditions emanating from climate change are bound to compromise agricultural productions (crop, livestock, forest and fishery resources), nutritional and health statuses, trading in agricultural commodities, human settlements (especially of agricultural communities), tourism and recreation among others (Tologbonse *et al,* 2010). Apart from the physical and financial implication of climate change, climate change also has serious impact on fisheries and aquaculture as climate is a major driver that enhances the growth and sustainability of aquaculture sector. The recent variation in temperature, air humidity and total rainfall has not been favourable to aquaculture production in ponds system. These problems have contributed to major loss of production and increase in socio-economic and income vulnerability among farmers. The small scale or individual farmers are among the highest vulnerable to climate change (Tan, 1998). According to F.A.O (2009), global fish production came to about 144 million metric tones (mmt) comprising 92mmt from capture and over 51mmt from aquaculture. Production of 92mmt from capture represents a decrease of 2.2mmt compared to figures for 2005. Considering Nigeria's enormous water resources, human capital and other natural endowments, the Federal Department of Fisheries estimated fish production of over 1.7mmt comprising 201,300mt (offshore fisheries), 288,200mt (inland fisheries) and 1,180,215mt (aquaculture) (George,2010). Climate change requires the development of natural resources management strategies that ensures the sustainable use of soil and water, halt biodiversity decline and deal with emerging issues such as demand for renewable energy (A. Aphunu et al, 2012), so therefore, efforts must be put into reducing human activities enhancing climate change and also improving on ways to adapt to the consequences of the change. Adaptation is understood to include efforts to adjust to ongoing and potential effects of climate change (Mani et al, 2008).Within the context of climate change, adaptation include the actions people take in response to, or in anticipation of changing climate conditions in order to reduce adverse impacts or take advantage of any opportunities that may arise.

This paper discusses the perception of fish farmers on the impact of climate change on fish production as well as strategies adopted to cope with the impacts in New Bussa. The specific objectives were to

(i) Determine fish farmers' level of climate change awareness;
(ii) Examine sources of information on climate change;
(iii) Determine fish farmers' perception of impact of climate change on fish production;
(iv) Ascertain fish farmers' coping strategies of reducing/alleviating the effect of climate change, and

LIST OF COMMERCIAL FISHES IN KANJI

FAMILY NAME / SPECIES			
Schilbeidae cont. *Eutroplus niloticus*			
Physaillia pellucida			
CENTROPMIDAE *Lates niloticus*			
GYMNARCHIDAE *Gymnarchus niloticus*			
OSTEOGLOSSIDAE *Heterotis niloticus*			

FAMILY NAME / SPECIES	SL. AT AGE	LENGTH INC. PER YR.	
Schilbeidae cont. *Eutroplus niloticus*			
Physaillia pellucida			
CENTROPMIDAE *Lates niloticus*			
GYMNARCHIDAE *Gymnarchus niloticus*			
OSTEOGLOSSIDAE *Heterotis niloticus*			

FAMILY NAME / SPECIES	SL.IN MM. MESH SIZE				LENGTH/WEIGHT REL.	SL. AT AGE
Schilbeidae cont. *Eutroplus niloticus*	89	102	127	178		1 2 3
Physaillia pellucida						
CENTROPMIDAE *Lates niloticus*						
GYMNARCHIDAE *Gymnarchus niloticus*						
OSTEOGLOSSIDAE *Heterotis niloticus*						

FAMILY NAME / SPECIES	BREEDING AREA	NATURAL MORTALITY	GN MESH SELECTION			
			38	51	64	78
Schilbeidae cont. *Eutroplus niloticus*						
Physaillia pellucida						
CENTROPMIDAE *Lates niloticus*	PELAGIC SPAWNER					
GYMNARCHIDAE *Gymnarchus niloticus*						
OSTEOGLOSSIDAE *Heterotis niloticus*						

FAMILY NAME / SPECIES	MIN LEN/AGE MATURITY	FECUNDITY	BREEDING PATTERN
Schilbeidae cont. *Eutroplus niloticus*	MALE : 132 /2 FEMALE : 147 /2 (Olatunde, 1977)	13 900 - 25 500 (Olatunde, 1977)	BREEDS DURING RAINS ONE SPAWN JUNE - OCT
Physaillia pellucida	MALE : 52 /1 FEMALE : 53 /1 (Olatunde, 1977)	1 150 - 3 900 (Olatunde, 1977)	BREEDS DURING JUNE TO MARCH MULTISPAWNING
CENTROPMIDAE *Lates niloticus*	MALE : 420 /2 FEMALE : 530 /2 (Balogun, 1988)	0.15 - 35 M. (Balogun, 1988)	NOV- MARCH JAN - APRIL
GYMNARCHIDAE *Gymnarchus niloticus*			BUILDS 1m. LARGE NESTS, GUARDS EGGS, JUNE-SEPT
OSTEOGLOSSIDAE *Heterotis niloticus*			

FAMILY NAME / SPECIES	FISHING GEAR USED	FACTORS AIDING CAP	MAXIMUM LENGTH
Schilbeidae cont. *Eutroplus niloticus*	CAST NET, GILL NET BEACH SEINE (Lelek, 1973)		MALE: 187 FEMALE: 252 (P)
Physaillia pellucida	BEACH SEINE		131
CENTROPMIDAE *Lates niloticus*	GILL NET BAITED LL BEACH SEINE		1626 1520 1743
GYMNARCHIDAE *Gymnarchus niloticus*	GILL NET CAST NET	FISH OFTEN CAUGHT AS THEY GUARD NESTS	
OSTEOGLOSSIDAE *Heterotis niloticus*	TRAPS GILL NET BEACH SEINE		

FAMILY NAME / SPECIES	MIGRATION	WHERE FISH CAUGHT	WHEN FISH CAUGHT
Schilbeidae cont. *Eutroplus niloticus*		MAINLY OPEN WATER (Lewis, 1974)	OCT - NOV (Olatunde, 1977)
Physaillia pellucida	MIGRATE TO SHALLOWS TO BREED	OPEN WATER (Olatunde, 1977)	FEB - MARCH (Olatunde, 1977)
CENTROPMIDAE *Lates niloticus*	MIGRATE TO SHALLOW AREAS DURING LOW WATER	OPEN WATER (Reed et al. 1967	JAN - APRIL
GYMNARCHIDAE *Gymnarchus niloticus*			OCT - DEC
OSTEOGLOSSIDAE *Heterotis niloticus*			AUG - DEC

FAMILY NAME / SPECIES	TROPHIC LEVEL	DIET	DISTRIBUTION
Schilbeidae cont. *Eutroplus niloticus*	OMNIVORE	INSECTS FISH - CLUPEIDS	PELAGIC WIDE DISTRIBUTION WITH CLUPEIDS
Physaillia pellucida	OMNIVORE	PLANKTON CRUSTACEA	DEEP WATER BENTHIC
CENTROPMIDAE *Lates niloticus*	PREDATOR	FISH - CLUPEIDS - ALESTES ETC	OPEN WATER JUVENILES- SHALLOW ADULTS - DEEP
GYMNARCHIDAE *Gymnarchus niloticus*	PREDATOR	INSECTS PRAWNS FISH	
OSTEOGLOSSIDAE *Heterotis niloticus*	OMNIVORE	INVERTEBRATES COPEOPODS CHIRONOMIDS	SHALLOW AREAS

FAMILY NAME / SPECIES	SL AT AGE mm.				LENGTH INC PER YEAR							
BAGRIDAE cont. *Bagrus bayad*	4	5	6	7	1	2	3	4	5	6	7	8
Chrysichthys nigroditatus					13.2 (Ajayi, 1972)	5.9	4.1	5.8	2.8			
Chrysichthys auratus					8.5 (Ajayi, 1972)	4.9	3.0	2.8				
Clarotes laticeps					13.0 (Ajayi, 1972)	8.2	5.1	3.8	3.0			
CLARIDAE *Heterobranchus bidorsalis*												
Clarius anguillaris												
Clarius gariepinus												
MORMYRIDAE *Mormyrus rume*												
SCHILBEIDAE *Schilbe mystus*												

Journal of Natural Sciences Research
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.6, No.11, 2016

FAMILY NAME / SPECIES	SL IN mm. MESH SIZE				LENGTH/WEIGHT REL.	SL AT AGE		
BAGRIDAE cont. *Bagrus bayad*	89	102	127	178		1	2	3
Chrysichthys nigroditatus								
Chrysichthys auratus								
Clarotes laticeps								
CLARIDAE *Heterobranchus bidorsalis*								
Clarius anguillaris								
Clarius gariepinus								
MORMYRIDAE *Mormyrus rume*					LOGW = 2.59 LOGL -3.79 (P)			
SCHILBEIDAE *Schilbe mystus*					LOGW = -1.83 +2.93LOGL LOGW = -2.20 +3.24LOGL LOGW = 3.05LOGL -4.97(P)	89 105	133 142	(m) 171 (f)

FAMILY NAME / SPECIES	BREEDING AREA	NATURAL MORTALITY	GN MESH SELECTION			
BAGRIDAE cont. *Bagrus bayad*			38	51	64 227	76 248 (P)
Chrysichthys nigroditatus			127	154	168	(P)
Chrysichthys auratus						
Clarotes laticeps						
CLARIDAE *Heterobranchus bidorsalis*	SHALLOW AREAS WITH VEGETATION					
Clarius anguillaris	SHALLOW AREAS WITH VEGETATION					
Clarius gariepinus						
MORMYRIDAE *Mormyrus rume*						
SCHILBEIDAE *Schilbe mystus*	SMALL RIVERS ENTERING THE LAKE		140	105 89 184	142 133 218	171 (P)

Journal of Natural Sciences Research
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.6, No.11, 2016

FAMILY NAME / SPECIES	MIN LEN/AGE MATURITY	FECUNDITY	BREEDING PATTERN
BAGRIDAE cont. *Bagrus bayad*	MALE : 171 FEMALE : 293 (Ajayo, 1972)		OCT- NOV
Chrysichthys nigroditatus	MALE : 180 FEMALE : 140	18 740 (Imevbore, 1970)	JULY - SEPTEMBER
Chrysichthys auratus		2 250 (Ajayi, 1972)	ALL YEAR, MAINLY JUNE- OCT
Clarotes laticeps	MALE: 300 FEMALE: 280 (Ita, 1982)	11 690 - 19 310 (Imevbore, 1970)	OCT - NOV
CLARIDAE *Heterobranchus bidorsalis*			
Clarius anguillaris			
Clarius gariepinus	260		
MORMYRIDAE *Mormyrus rume*	MALE: 325 FEMALE: 330 (Imevbore, 1970)		POSSIBLY NEEDS FLOWING WATER TO INDUCE SPAWNING
SCHILBEIDAE *Schilbe mystus*	MALE : 93 FEMALE :150 (Olatunde, 1972)	9 000 (Olatunde, 1977)	BREEDS ONCE DURING RAINS MAY TO AUGUST

FAMILY NAME / SPECIES	FISHING GEAR USED	FACTORS AIDING CAP	MAXIMUM LENGTH
BAGRIDAE cont. *Bagrus bayad*	FOUL HOOKING LL GILL NETS		512
Chrysichthys nigroditatus	GILL NET TRAP		MALE: 297 FEMALE: 302 (P)
Chrysichthys auratus	GILL NET TRAP		570
Clarotes laticeps	LONG LINES		
CLARIDAE *Heterobranchus bidorsalis*	GILL NET TRAP CAST NET		
Clarius anguillaris	GILL NET TRAP		
Clarius gariepinus	FOUL HOOK LL (Reed et al. 1967)		
MORMYRIDAE *Mormyrus rume*			
SCHILBEIDAE *Schilbe mystus*	CAST NET TRAPS, GILL NET	DORSAL FIN PECTORIAL SPINE	MALE: 311 FEMALE: 321

FAMILY NAME / SPECIES	MIGRATION	WHERE FISH CAUGHT	WHEN FISH CAUGHT
BAGRIDAE cont. *Bagrus bayad*		DEEP WATER	DURING LOW WATER
Chrysichthys nigroditatus		DEEP WATER	ALL YEAR BUT MAINLY JUNE - OCT
Chrysichthys auratus		SHALLOW WATER NOT DEEPER 4m.	
Clarotes laticeps		FLOWING SHALLOW WATER (Motwani,1970)	
CLARIDAE *Heterobranchus bidorsalis*			JULY - OCTOBER
Clarius anguillaris			JULY - OCTOBER
Clarius gariepinus			
MORMYRIDAE *Mormyrus rume*	MIGRATES TO SURFACE AT NIGHT (Motwani,1970)		
SCHILBEIDAE *Schilbe mystus*		SMALL RIVERS ENTERING THE LAKE	AUG - NOV

FAMILY NAME / SPECIES	TROPHIC LEVEL	DIET	DISTRIBUTION
BAGRIDAE cont. *Bagrus bayad*	PREDATOR	SMALL FISH - ALESTES	LIMITED DISTRIBUTION WATER > 12 m.
Chrysichthys nigroditatus	OMNIVORE	SEEDS INSECTS, BIVALVES DETRITUS	SHALLOW INSHORE WATER > 4M MUD/FINE SAND
Chrysichthys auratus	OMNIVORE	FISH INSECT NYMPHS	
Clarotes laticeps			
CLARIDAE *Heterobranchus bidorsalis*			
Clarius anguillaris			
Clarius gariepinus			
MORMYRIDAE *Mormyrus rume*	PREDATOR	LARVAE BENTHIS INSECTS	
SCHILBEIDAE *Schilbe mystus*	PREDATOR	LARVAE INSECTS SMALL FISH	MAINLY OPEN WATER

FAMILY NAME / SPECIES	SL AT AG				LENGTH INC PER YEAR
MOCHOKIDAE cont. *Synodontis ocellifer*	4 144	5	6	7	
Synodontis clarius					
Synodontis batensoda	133	148	164		FOR 0+ 1+ 2+ 3+ 680
Synodontis schall	160 (Willoughby, 1974)	186	210	231	
Synodontis membranaceus	195	232	258	284	
Synodontis resupinatus	165	194	221	245	
Synodontis gambiensis	166 (Willoughby, 1974)	194	216	224	
BAGRIDAE *Auchenoglanis occidentalis*					
Bagrus domac					

FAMILY NAME / SPECIES	SL IN mm MESH SIZE				LENGTH WEIGHT REL.	SL AT AGE		
MOCHOKIDAE cont. *Synodontis ocellifer*	89	102	127	178	LOGW = 3.12 LOG L -4.84 (P)	1 64	2 94	3 124
Synodontis clarius								
Synodontis batensoda					LOGW = 3.29 LOG L -5.11 (P)	50	81	107
Synodontis schall	194	203				64	98	132
Synodontis membranaceus	240 282	244 276	259 290	(P)	LOGW = 2.98 LOG L -4.46 (P)	73	113	155
Synodontis resupinatus	199	209	(P)		LOGW = 3.17 LOG L -4.88 (P)	67	102	135
Synodontis gambiensis					LOGW = 3.29 LOG L -5.22 (P)	54	93	134
BAGRIDAE *Auchenoglanis occidentalis*								
Bagrus domac								

FAMILY NAME / SPECIES	BREEDING AREA	NATURAL MORTALITY	GN ESH ELECTION			
MOCHOKIDAE cont. *Synodontis ocellifer*	HEADWATERS OF RIVERS		38	51	64	76
Synodontis clarius				121	135	(P)
Synodontis batensoda						
Synodontis schall	CENTRAL LAKE PARTICULARLY OLD RIVER BASIN		143	155	162	179 (P)
Synodontis membranaceus				210	246	237 (P)
Synodontis resupinatus				290		186
Synodontis gambiensis						
BAGRIDAE *Auchenoglanis occidentalis*						
Bagrus domac						

FAMILY NAME / SPECIES	MIN LEN/AGE MATURITY	FECUNDITY	BREEDING PATTERN
MOCHOKIDAE cont. *Synodontis ocellifer*	MALE : 111 /2,3 FEMALE : 120 /3 (Willoughby,1974)	3 500 - 72 000	MIGRATED TO HEADWATERS JULY - NOVEMBER
Synodontis clarius			BREEDS DURING OCTOBER
Synodontis batensoda	MALE : 139 /4 FEMALE : 126 /4	6 850 - 20 400	BREEDS DURING SEPT TO OCT
Synodontis schall	MALE : 104 /2 FEMALE : 118 /2	7 130 - 73 000	BREEDS DURING MAY - NOVEMBER
Synodontis membranaceus	MALE : 237 /5 FEMALE : 245 /5	33 700 - 180 000	BREEDS DURING JULY TO NOVEMBER
Synodontis resupinatus	165 /4		BREEDS DURING AUGUST - NOVEMBER
Synodontis gambiensis	MALE : 160 /4 FEMALE : 171 /4 (Willoughby, 1974)	1 390 - 84 500	BREEDS DURING JULY - OCTOBER (Willougby, (1974)
BAGRIDAE *Auchenoglanis occidentalis*	MALE : 330 FEMALE : 388 /5 (AJAYI,1972)	5 300 - 16 000 (Ajayi, 1972)	
Bagrus domac	MALE : 412 FEMALE : 293		OCT- NOV

FAMILY NAME / SPECIES	FISHING GEAR USED	FACTORS AIDING CAP	MAXIMUM LENGTH
MOCHOKIDAE cont. *Synodontis ocellifer*	GILL NET		275 (P)
Synodontis clarius	GILL NET		
Synodontis batensoda	GILL NET		300 (Willougby, 1974)
Synodontis schall	GILL NET		327 (P)
Synodontis membranaceus	GILL NET BEACH SEINE	LARGE DORSAL AND PECTORAL FIN SPINES	500 (Willoughby, 1974)
Synodontis resupinatus	GILL NET		400 (Willoughby, 1974)
Synodontis gambiensis	GILL NET	LARGE DORSAL SPINE	267
BAGRIDAE *Auchenoglanis occidentalis*	CAST NET GILL NET FOUL HOOK LL.		
Bagrus domac	GILL NET FOUL HOOKING LL		

FAMILY NAME / SPECIES	TROPHIC LEVEL	DIET	DISTRIBUTION
MOCHOKIDAE cont. *Synodontis ocellifer*	OMNIVORE	PLANKTON INSECT LARVAE DETRITUS	EVENLY DISTRIBUTED
Synodontis clarius	OMNIVORE	INSECT LARVAE MOLLUSC DETRITUS	
Synodontis batensoda	OMNOVORE	PLANKTON ALGAE DETRITUS	EVENLY DISTRIBUTED
Synodontis schall	OMNIVORE	INSECT NYMPH LARVAE, EGGS DETRITUS	EVENLY DISTRIBUTED BUT HIGHER IN WEST CENTRAL BASIN
Synodontis membranaceus	OMNIVORE	PLANKTON DETRITUS	DEEP WATER CLOSE TO THE SHORE
Synodontis resupinatus	OMNIVORE	PLANKTON DETRITUS	AROUND FOGE AREAS OF UNCLEARED VEG.
Synodontis gambiensis	OMNIVORE	ALGAE NYMPHS, ARTHROPODS MOLLUSCS, DETRITUS	SHALLOW SHELTERED AREAS
BAGRIDAE *Auchenoglanis occidentalis*	OMNIVORE	PLANKTON MOLLUSCS, SEEDS DETRITUS	SHALLOW WATER WITH MUDDY BOTTOM
Bagrus domac			

FAMILY NAME/ SPECIES	SL AT AGE				LENGTH INC PER YEAR
CITHARINIDAE cont. *Distichodus rostratus*	4	5	6	7	
Distiichodus auratus					
CYPRINIDAE *Labeo pseudocoubie*					
Labeo coubie					
Labeo sengalensis					
CICHLIDAE *Sarotherodon galilaeus*	419 390 404	455 420 438	475		FOR 1+ 2+ 3+ 680
Oreochromis niloticus	428	456			
Tilapia zillii	256	(AKITUNDE,1976)			
MOCHOKIDAE *Synodontis budgetti*	162	187	204		

FAMILY NAME / SPECIES	SL IN mm. MES SIZE				LENGTH/WEIGHT REL.	SL AT AG mm.		
CITHARINIDAE cont. *Distichodus rostratus*	89	102	127	178	LOGW=LOG1.71+3.015LOGL LOGW=3.06LOGL-4.82 (P)	1 195	2 326	3 425
Distiichodus auratus					LOGW=2.96LOGL-4.57			
CYPRINIDAE *Labeo pseudocoubie*					LOGW=3.06LOGL-4.7			
Labeo coubie					LOGW=3.11LOGL-4.82 (P)			
Labeo sengalensis	261	282	(P)					
CICHLIDAE *Sarotherodon galilaeus*					W=-1.81+3.02(LOGL) LOGW=3.03 LOG L -4.38 LOGW=2.87 LOG L -4.11(P)			
Oreochromis niloticus					W=-1.68+2.93 (LOGL) LOGW=3.11LOGL - 4.64 (P)	159 140 146	290 259 294	368 349 359
Tilapia zillii					W=-2.08+3.35 (LOGL) LOGW=3.11 LOGL - 4.61(P)	165	295	383
MOCHOKIDAE *Synodontis budgetti*						146	209	235 (AKITUNDE,1976

Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.6, No.11, 2016

FAMILY NAME/ SPECIES	BREEDING AREA	NATURAL MORTALITY	GILL NET SELECTION			
CITHARINIDAE cont. *Distichodus rostratus*	SHALLOW AREAS		38 117	51 165	64 191	76 (P)
Distiichodus auratus	SHALLOW AREAS					
CYPRINIDAE *Labeo pseudocoubie*						
Labeo coubie						
Labeo sengalensis			122	186	226	261
CICHLIDAE *Sarotherodon galilaeus*	SHALLOW , CLEAR AREAS		87	107	(P)	
Oreochromis niloticus	SHALLOW AREAS WITHIN VEGETATION					
Tilapia zillii	SHALLOW AREAS SANDY BOTTOM (Ita, 1978)					
MOCHOKIDAE *Synodontis budgetti*						

FAMILY NAME / SPECIES	MIN LEN AT MATURITY	FECUNDITY	BREEDING PATTERN
CITHARINIDAE cont. *Distichodus rostratus*	300	0.2 - 0.7 M. (Imevbore,1970)	BREEDS NOV - DEC IN SHALLOW WATER
Distiichodus auratus			BREEDS NOV - DEC IN SHALLOW WATER
CYPRINIDAE *Labeo pseudocoubie*	546 (Ita, 1982)		BREEDS SEPT-NOV
Labeo coubie	MALE: 285 FEMALE: 220 (Imevbore, 1970)		
Labeo sengalensis	MALE: 335 FEMLAE: 390 (Imevbore, 1970)		
CICHLIDAE *Sarotherodon galilaeus*	MALE : 168 FEMALE : 155	1120 - 7110 MEAN : 3400	BREEDS ALL YEAR BUT MAINLY OCT-FEB MOUTH BROODER
Oreochromis niloticus		250 - 5020 MEAN : 3300	BREEDS OCT - FEB MOUTH BROODER
Tilapia zillii		1300 - 8050 MEAN : 3800	BREEDS OCT - FEB NEST BUILDER GUARDS YOUNG
MOCHOKIDAE *Synodontis budgetti*	MALE : 224 FEMALE : 201	6900 - 41200	BREEDS SEPT - OCT

Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.6, No.11, 2016

FAMILY NAME/ SPECIES	BREEDING AREA	NATURAL MORTALITY	GN MESH SELECTIVITY 38mm	51	64	76
CLUPEIDAE *Sierrathrissa Leonensis*	OPEN WATER		N/A	-	-	-
Pellonula afzeliusi	OPEN WATER		N/A	-	-	-
CHARACIDAE *Alestes baremose*	FLOOD PLAINS EAST SIDE		170	214		
Alestes dentex	AS ABOVE		147	216	258	271
Alestes nurse	AS ABOVE		119	159		
Alestes macrolepidotus	AS ABOVE			199	246	293
Hydrocynus forskahlii			184	246	311	357
CITHARINIDAE *Citharinus citharus*	EAST SIDE NORTH OF WARRA. NORTH OF YAURI SHALLOW AREAS WITH VEGETATION (Arawomo,1988)			222	230 209 142	247 207 199
Citharinus distichoides				120 127	159 158	185 196

FAMILY NAME/ SPECIES	FISHING GEAR USED	FACTORS AIDING CAPT.	MAXIMUM LENGTH
CLUPEIDAE *Sierrathrissa Leonensis*	BEACH SEINES ATTALA NET BELOW DAM	MIGRATES TO SHALLOW WATER AT NIGHT ATTRACTED TO LIGHT SHOALING	28 mm (SL)
Pellonula afzeliusi	BEACH SEINES ATTALA NET BELOW DAM		67 mm (Otobo, 1978)
CHARACIDAE *Alestes baremose*	GILL NET CAST NET BEACH SEINE		M: 239 F: 300 (P)
Alestes dentex	AS ABOVE (Reed, 1967)		M: 278 F: 331 (P)
Alestes nurse	AS ABOVE		M: 177 F: 224 (P)
Alestes macrolepidotus	AS ABOVE		M: 395 F: 405 (P)
Hydrocynus forskahlii	GILL NET LONG LINE CAST NET	TEETH EASILY TANGLED IN GILL NET	M: 416 F: 526 (P)
CITHARINIDAE *Citharinus citharus*	GILL NET CAST NET	MIGRATES INTO SHALLOWS TO BREED WHERE IT CAUGHT EASILY BY CAST NET AND GILL NET.JUVENILES MOVE TO DEEP WATER	M: 378 F: 464 (P)
Citharinus distichoides	GILL NET CAST NET		442

METHODOLOGY

New Bussa is a town in Niger State, Nigeria. It is the new site of Bussa after the K ainji Lake dam set the previous location underwater. As of 2007 New Bussa is the headquater of Borgu Emirate and Borgu Local Government. New Bussa is located at about 40km North at 10°1351''N 4°28'31''E (Altitude 561 ft or 170 meters)

DATA COLLECTION AND SAMPLING PROCESS

The fish farmers in this area constitute the population of this study, so therefore a random sampling technique is used to select respondents from fishing communities like Kainji (Lake), Monai, Nassarawa, e.t.c.

Data for the study were collected through a semi-structured interview schedule. In order to characterize the respondents on their socio-economic status, educational level, fish farm experience, number of ponds owned, membership of social groups, household size and average annual income, were ascertained. In ascertaining perceived impact of climate change on fish production, a four-point Likert-type scale with options of strongly agree, agree, disagree and strongly disagree with nominal values of 4,3,2 and 1 respectively was used to obtain responses from fish farmers. Also, to determine strategies adopted by fish farmers to reduce the effects of climate change, farmers were agreed to tick options from a list of various mitigation and adaptation options obtained from literature, expert opinions and observations. Data were analyzed using both descriptive and influential statistics. Objectives one, two and four were analyzed using frequency and mean scores. While objectives three was analyzed using mean scores.

RESULT AND DISCUSSION

Table 1

RESPONDENT	FREQUENCY	PERCENTAGE
MALE	81	79.4%
FEMALE	21	20.6%
TOTAL	102	100%

Source: field survey

This implies that majority of fish farmers in the study area are male (79.4%), while female fish farmers population is about 20.6% of the total. This agrees with findings of scholars like Ogunlade (2007), George (2010), Aphunu (2012), Olokor (2013), who found out that fish farmers in this area is dominated by the male gender, this may be as a result of tedious and laborious activities involved in aquaculture

DEMOGRAPHY

Table 2

AGE	NUMBER	PERCENTAGE
10-20	10	9.8%
21-30	21	20.5%
31-40	42	41.2%
41-50	15	14.7%
51-60	8	7.8%
61-70	5	4.9%
71-80	1	0.9%
80 ABOVE	NIL	NIL
TOTAL	102	100%

Source: field survey

The age demographic result above shows that 41.2% of the respondent are between age 31-40, which simply implies that majority of those involve in fish farming in the study area are young, energetic and well within the productive age, which can handle the variation in climate.

MARITAL STATUS

Table 3

MARITAL STATUS	NUMBER	PERCENTAGE
SINGLE	25	24.5%
MARRIED	77	75.4%
TOTAL	102	100%

Source: field survey

The above result indicate that majority of the respondents in the study area are married and has help from their immediate family.

EDUCATIONAL BACKGROUND

Table 4

EDUCATIONAL BACKGROUND	NUMBER	PERCENTAGE
TERTIARY	48	47.1%
SECONDARY	45	44.1%
PRIMARY	7	6.8%
NONE	2	2%
TOTAL	102	100

Source: field survey

Table 4 above shows the educational background of the respondent within the study area and indicates that majority of respondents have tertiary educational background and closely followed by those with secondary educational background. The implication of this is that majority of the fish farmers are showing considerable progress in education and enlightened, which in turn can influence their perception and adoption of latest technologies in aqua cultural practises.

EXPERIENCE

Table 5

YEARS OF EXPERIENCE	FREQUENCY	PERCENTAGE
1-5	45	44.1%
6-10	24	23.5%
11-15	18	17.6%
16-20	15	14.7%
21-25	NIL	NIL
26/ABOVE	NIL	NIL
TOTAL	102	100

Source: field survey

The above result shows that majority of the respondents have between 1-5 years experience as fish farmers which indirectly means that they are new entrants, and that their knowledge about fish farming and how climate change can affect the practise may not be full, this will definitely tell on their knowledge of mitigating and adaptation to the effect of climate change as well.

NUMBER OF POND OWNED

POND	FREQUENCY	PERCENTAGE
1-5	71	69.6%
6-10	20	19.6%
11-15	11	10.8%
16 ABOVE	NIL	NIL
TOTAL	102	100%

Source: field survey

Table 6 above shows that majority of the respondents owned between 1-5 (69.6 %) ponds, which invariably implies that majority of the respondents are small scale fish farmers, which means their relative income is low and are most times used to support or augmenting household issues.

CLIMATE CHANGE AWARENESS

Table 7

AWARENESS	FREQUENCY	PERCENTAGE
YES	75	73.5%
NO	27	26.5
TOTAL	102	100%

Source: field survey

EXTENT OF KNOWLEDGE

Table 8

KNOWLEDGE	FREQUENCY	PERCENTAGE
NO KNOWLEDGE	37	36.3%
LITTLE KNOWLEDGE	45	44.1%
REASONABLE KNOWLEDGE	11	10.8%
GREAT KNWOLEDGE	9	8.8%
TOTAL	102	100%

Source: field survey

Table 7 and 8 above shows the awareness and extent of knowledge of respondent to the issue of climate change, whereby 73.5% of the respondents agrees to be aware of climate change while a majority of 44.1%of the same total respondent says they have little knowledge of climate change. Although there is a little improvement in the level of awaereness (relating it this to the findings by Aphunu, 2012), this implies a high level of awareness, yet a low level of access to information about climate change.

SOURCES OF INFORMATION ON CLIMATE CHANGE TO FISH FARMERS

Table 9

SOURCE OF INFORMATION	FREQUENCY	PERCENTAGE
EXTENSION WORKERS	2	1.9%
FRIENDS/ NEIGBOURS	25	24.5%
INTERNET	12	11.8%
PERSONAL EXPERIENCE	35	34.3%
NEWSPAPER	3	2.9%
RADIO/ TELEVISION	15	14.7%
NONE	10	9.9%
TOTAL	102	100%

Source: field survey

Table 9 above shows different ways with which fish farmers can get information on climate change. This result shows that majority of the respondent got their information about climate change majorly through personal experience (34.3%), followed by friends or neighbours (24.5%), and radio or television (14.7%). The finding is in line with that of George (2010) where personal contacts, family and friends were the main sources of information on climate change. Similarly, Tologbonse *et al* (2010) found out that the most important information source on climate change was personal experience followed by radio and television. Farmers' knowledge on climate change through personal experience was probably due to the fact that their livelihood seems to be seriously threatened. Result in table 9 shows that extension workers are the least source of information which has negative implication on extension administration and policy making since the knowledge of climate change impact is related to the availability of information on the phenomenon.

PERCEPTION OF IMPACT OF CLIMATE CHANGE

VARIABLES	Mean	Std. Deviation
Drastic change in weather condition	3.04	0.906
Intensive sunshine	2.56	0.809
Increased incidence of drought	2.29	0.860
Increased incidence of flooding	2.86	1.847
Increase temperature and heat waves	2.64	0.767
Increased production of a specific kind of fish specie	2.45	0.727
Food insecurity	2.50	0.857
Increased cost of fish production	2.34	0.728

Source: field survey

Data above shows the responses of fish farmers on the various impact or effect of climate change that they have notice, whereby 85.3% of the total respondents agreed that climate change has drastically change the weather, 66.7% also agreed that change in climate has cased intensive sunshine, while 50.8%, 69%, 28%, 78%, 49%, and 58% agreed that climate change has cased increased drought, increased flooding, increased temperature, increased production of specific kind of fish specie, food insecurity and increased cost of fish production respectively.

ADAPTATIVE MEASURES WITH THE IMPACT OF CLIMATE CHANGE

These are some ways in which fish farmers have been perceived to adjust to the various impact of climate change. Below is a statistic of these modes of adjustments.

Strategies	Percentages Yes	No
Building ponds close to water sources	56.5	43.5
Digging wells or boreholes to supply water during dry period	38.8	61.2
Building shades to cover ponds during dry period	52.3	47.7
Building embankment to prevent flood water	61.5	38.5
Rearing of quick maturing fish species	52.6	47.4
Stocking fishes that are more favoured by climate change	80.0	20.0
Use of indoor fish production facilities e.g. circulatory system	15.2	84.8
Procurement of weather and water monitoring kits	85.0	15.0
Acquiring more information about climate change	60.0	40.0

Other strategies adopted e.g. building concrete/tarpaulin ponds, preventive treatment of fish e.t.c.

Source: field survey

The above result indicates the various adaptative measures used by fish farmers, while some agreed that a particular methods is suitable, others disagree. More so, the great number of farmers (80.0%) agreed that stocking fishes that are favoured by climate change is one of the best methods of adapting to the impact of climate change, so also 85.0% and 61.5% respondents agreed that acquiring weather and water monitoring kits as well as building embankment to prevent flood water respectively are other good methods of adaptation.

CONCLUSION AND RECOMMENDATION

Climate change has been the most serious threat to aquaculture and fish production in new bussa, Niger state, Nigeria. Although farmers in the study area have knowledge of climate change, but this knowledge is not adequate enough as they (farmers) rely more on their personal experience rather than agriculture extension officer or the mass media as their main source of information about climate change. Furthermore, findings makes it clear that as a result of the change in climate, farmers have source for other means of coping with this change in weather to sustain their fish production e.g. erecting shade or cover over fish pond, digging boreholes or wells to provide water throughout dry period .e.g. So therefore, more indigenous adaptative strategies should be encouraged, more so more mass media enlightenment campaign should be made on the climate change, impact of climate change, and the effect and possible adaptation strategies of climate change

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