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Catch per unit effort (CPUE) and water level variations in the lower reaches of the White Volta River (Yapei), Ghana

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Catch per unit effort (CPUE) and water level variations in the lower reaches of the White Volta River were studied at three landing sites namely, Pataplapei (upstream), Porturto (midstream), and Aglassipei (downstream) from October 2011 to March 2012 to provide relevant information for further and future studies. The water depths were measured monthly with speedtech hand eco sounder. Fishing effort was measured as the number of fishermen per day whereas catch per unit effort (CPUE) was defined in this study as kilogram of fish per canoe per day (kg/canoe/day). Post flood season (October to December) had increasing CPUE associated with decreasing water levels. The dry season (January to March) however, had both fluctuating CPUE against the decreasing waters and decreasing CPUE associated with the decreasing water levels particularly in Pataplapei (upstream). Overall, the mean CPUE during the dry season was slightly higher (1.03 kg/canoe/day higher) than the post flood season whereas the fishing effort was higher in the post flood season than the dry season. Aglassipei (downstream) had mostly the highest mean CPUEs, followed by Pataplapei (upstream). Porturto (midstream) had mostly the lowest mean CPUEs due to the high fishing pressure at that site. Moreover, total catches declined as the water levels drew down. The post flood season (October-December) had more catches than the dry season (January-March).

Key words: White Volta River, fishing effort, catch per unit effort, water level, eco sounder, post flood season, dry season.

INTRODUCTION

Inland capture fisheries contributed 27% of total Ghanaian fish production in 2009 (FAO, 2009). It is estimated that the Lake Volta and its tributary rivers provides 90% of the national freshwater fish production (Abban, 1999). Water is increasingly becoming scarce because of extensive desertification and increasing demands by growing and developing human populations (Quarcoopome et al., 2008). In the northern part of

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Ghana where long dry seasons and a single unreliable rainy season prevail, fishing and other agricultural activities are influenced by water levels. The Lake Volta and Volta Rivers in the last four decades have undergone great changes in their ecology, limno-chemistry and socio-economy (Ofori-Danson et al., 2001). Increased pressure on land along the banks has led to high rates of deforestation. This has resulted in increased soil erosion leading to the transportation of high loads of silt and nutrients through rivers into the lake, thereby contributing to eutrophication of lake and its tributary rivers as reported by Ofori-Danson et al. (2001).

Furthermore, wetlands bordering the lake are being converted into agricultural land or land for grazing cattle, and therefore may not be able to act as natural filters for nutrients and silt, and now do not provide breeding grounds for many fish species (Ofori-Danson et al., 2001). As a result of these problems, the Lake Volta research and development project (VLR and DP) was undertaken under the food and agricultural organization and United Nations development programme during the first decade of the lake's existence (FAO and UNDP, 1971, 1979). These studies came to an end in 1978. Since then, systematic data collection from the Lake Volta and Volta Rivers natural resources has been lacking. There have been calls for renewed studies to facilitate their management due to declining catches. According to Braimah (2003) some 300,000 fisher folk depend on the Volta reservoir for their livelihood. The Volta reservoir is endowed with a wide variety of fisheries resources. Dankwa et al. (1999) identified 121 species in the Volta basin in Ghana.

The importance of fishing activities at Yapei cannot be underestimated. Yapei is 52 km southwest of the Northern regional capital Tamale. Tamale is one of the five most populous cities in Ghana with a population of 371,351 (Ghana Statistical Service, 2012). Yapei is easily accessible as it is on the Accra-Kumasi-Tamale trunk road. Yapei is one of the nine main sources of smoked fish to the Tamale central market (Obodaiet al., 2009). The Tamale central market is the largest market center in the metropolis and majority of the inhabitants buy their food stuffs from this market. It thus makes Yapei an important supplier of fish, especially smoked fish. Fishermen at the Yapei stretch of the White Volta River practice unregulated and unselective harvesting of fish with fishermen harvesting all sizes of fish without regard to the sustenance of the fishery. These practices are targeted at more catches for more income. Fish can only be harvested at the maximum sustainable yield (MSY) when all the biological parameters are known (Ezenwaji and Ezenwaji, 2009).

Knowing that the relationship between catch per unit effort and water level variations are of great importance to the fishing industry as they help to predict the best fishing effort, time and water level for maximized catch per unit effort, the study focused on providing information on the relationship between CPUE and water level variations of three landing sites from the lower reaches of the White Volta River, Ghana.

MATERIALS AND METHODS

Study area

The samples were collected at the Yapei stretch of the White Volta River, which is a major landing site in the Northern region of Ghana. Three non-overlapping landing sites namely Pataplapei, Porturto and Aglassipei were selected (Figure 1) to provide a representative overview of the fisheries in the area. Pataplapei lies within latitudes N 09° 08. 555', W 001° 12.166'. Porturto within N 09.08.427', W 001° 09.547' whilst Aglassipei lies within N 09° 06.724', W 001° 07.710'.

Fishing seasons

According to Abban et al. (2000), there are four main seasons that can affect fishing in the Volta basin namely; dry season, January to March (lowest water level); pre flood season, April to June (water level rising); flood season, July to September (highest water level); and post flood season, October to December (water level drawdown). The study was part of a Master of Science thesis research which fell within the post flood and the dry seasons.

Water levels

The water levels of three points at the center (the coordinates stored on the GPS) of the water and perpendicular to the landing site were measured monthly with speedtech hand eco sounder.

Fishing effort and catch per unit effort (CPUE)

Fishing effort was measured as the number of fishermen per day and catch per unit effort (CPUE) was defined in this study as kilogram of fish per canoe per day (kg/canoe/day).

Data analysis

Descriptive statistics of the Software STATISICA 8.1 and Microsoft Excel 2010 were used to analyze catches data for means, medians, frequencies, percentages, and linear relationships.

RESULTS

Fishing effort and catch per unit effort (CPUE)

The highest mean number of fishermen per day was 15 and it was recorded in Porturto in October 2011. The lowest mean number of fishermen per day was 3 and it was recorded in Pataplapei and Aglassipei in February 2012. Generally, the fishing effort was higher in the post flood season (October 2011 to December 2011) than the dry season (January 2012 to March 2012) as shown in Figure 2.

The highest mean CPUE was 6.3 kg/canoe/day and it

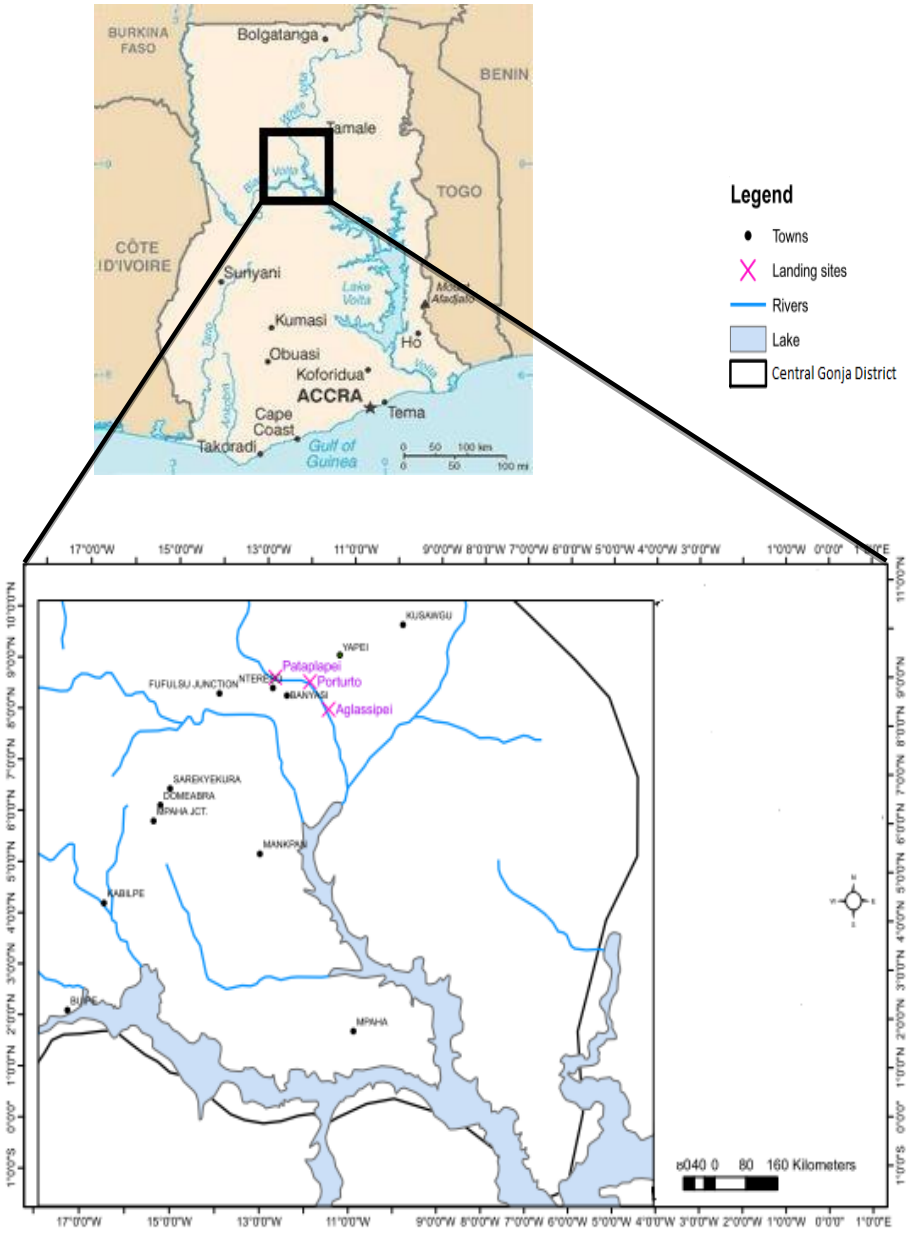

Figure 1. Map of Ghana with an insert of the detailed study area showing Yapei, and the three landing sites; Pataplapei, Porturto, and Aglassipei.

was obtained from Aglassipei. Pataplapei had the lowest mean CPUE of 5.1 kg/canoe/day (Table 1). Figure 3 shows the monthly variations in the mean CPUE. Two landing sites namely Porturto and Aglassipei had their highest mean CPUE in March 2012. Pataplapei had its highest mean CPUE in December 2011. The lowest mean CPUE for Pataplapei and Aglassipei was in October 2011. Porturto on the other hand, had its lowest mean CPUE in February 2012. The overall mean CPUE during the dry season was 6.09 kg/canoe/day (January 2012 to March 2012) whereas the overall mean CPUE of the post flood season (October 2011 to December 2011) was 5.06 kg/trip. The mean CPUE during the dry season in the lower reaches of the White Volta was thus 1.03 kg/canoe/day higher than mean CPUE of the post flood season (October 2011 to December 2011).

Water levels

The highest water depth was 6.5 m and it was recorded in October 2011 at the downstream site Aglassipei. The lowest was 3.9 m and it was recorded in March 2012 at upstream site Pataplapei. All the landing sites had the

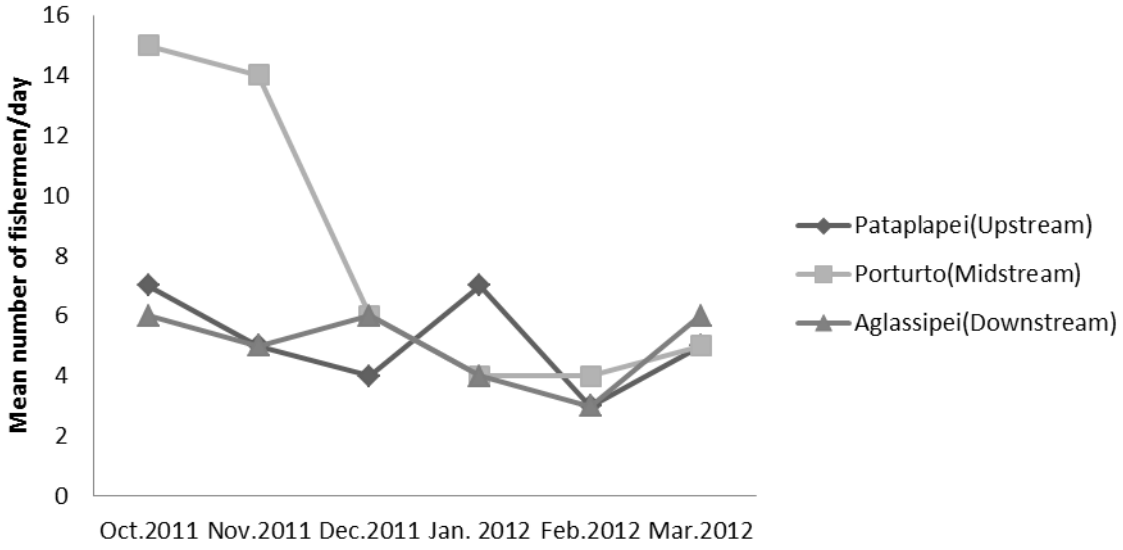

Figure 2. Fishing effort of the fisheries in the lower reaches of the lower reaches of the White Volta River from October 2011 to March 2012.

Table 1. Catch per Unit Effort of the fisheries from three landing sites in the lower reaches of the White Volta River from October 2011 to March 2012.

		CPUE(kg/canoe/day)				
Parameters/ Landing site	**Number**	**Minimum/trip**	**Maximum/trip**	**Mean**	**Median**	**SD(±)**
Pataplapei	23	1.1	11.6	5.1	4.5	2.8
Porturto	45	0	14.5	4.6	3.5	3.1
Aglassipei	22	1.8	18.5	6.3	5	5

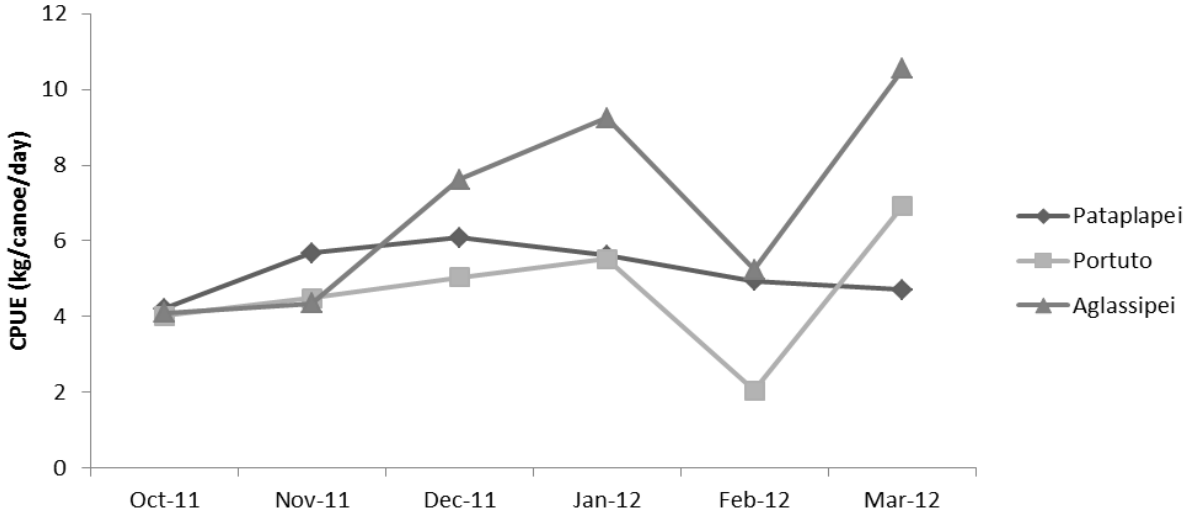

Figure 3. Variation in mean CPUE of three landing sites in the lower reaches of the White Volta River from October 2011 to March 2012.

highest water level in October 2011 and the water level starting that month (October 2011) consistently decreased month by month in all the sites and subsequently the lowest water level at all the sites was

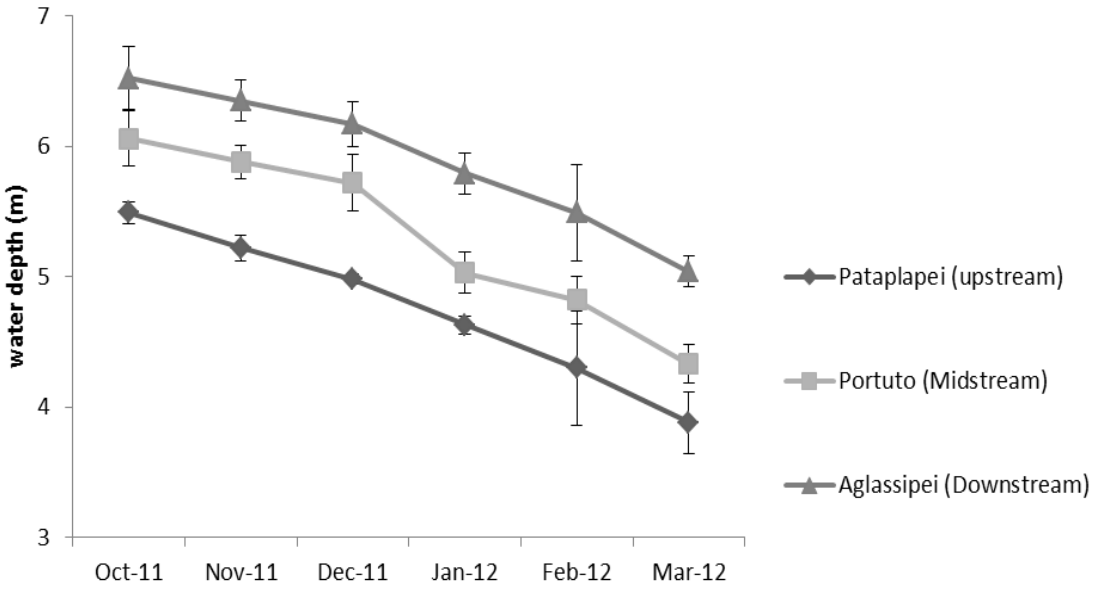

Figure 4. Mean and Standard Deviation (±) of the water depth of three landing sites in the lower reaches of the White Volta River from October 2011 to March 2012.

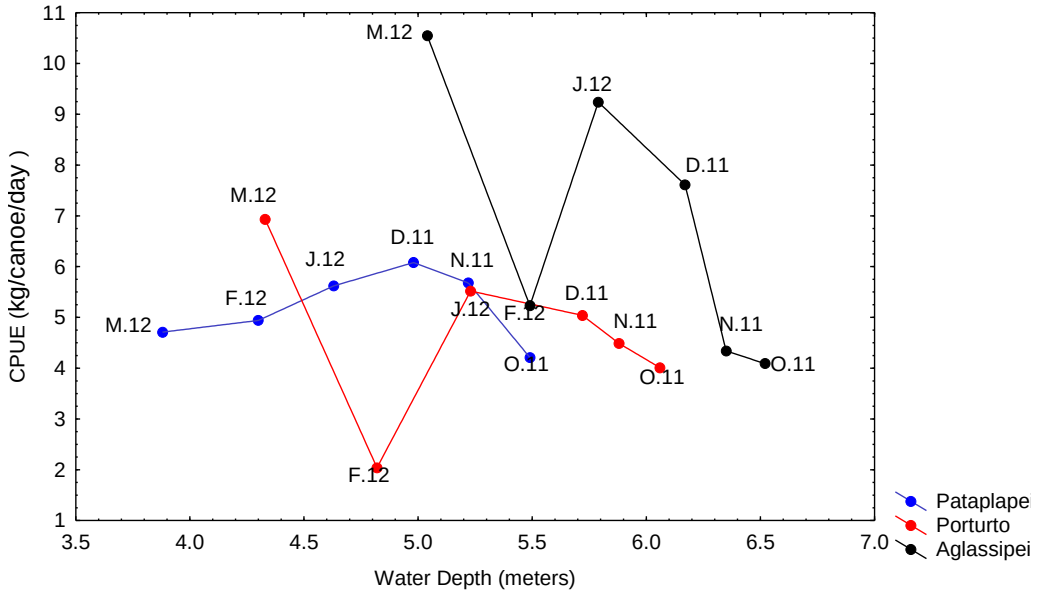

Figure 5. CPUE dependence on water depth in the lower reaches of the White Volta. On each line graph are the points representing the months of the study: O.11 (October, 2011), N.11 (November, 2011), D.11 (December, 2011), J.12 (January, 2012), F.12 (February, 2012) and M.12 (March, 2012).

recorded in March 2012 (Figure 4). Pataplapei which is upstream was the shallowest. It was followed by Porturto (midstream). Aglassipei had the deepest water levels.

The relationship between CPUE and water levels

As the high water levels in the post flood season (October 2011 to December 2012) began to draw down, the low CPUE values started to rise. Figure 5 shows that the catch per unit effort depended on the water levels. Pataplapei which is the shallowest among the three landing sites had its CPUE rising against decreasing water levels up to December 2011 and then the decreasing water levels in the remaining months came with decreasing CPUE values. Porturto and Aglassipei,

on the other hand, had a different situation. The increasing CPUE against decreasing water levels of these two landing sites peaked in January 2012 and there was a sharp decrease in CPUE in February 2012 even with the water levels still decreasing. As the month March marks the peak of the dry season with lowest water levels, the highest CPUE values for landing sites Porturto and Aglassipei were recorded whilst Pataplapei had its highest CPUE in January 2012.

DISCUSSION

The Yapei fishery is affected by changes in the water levels. Although, the study of the relationship between water levels and catch per unit effort (CPUE) did not produce a statistically significant relationship between the two variables, it is clear in the Figure 5 that CPUE depends on water level. Increasing CPUE with decreasing water levels was observed in all the landing sites during the post flood season (the first three months of the study: October 2011 to December 2012). This is agreeable to the increasing CPUE related to decreasing water levels that Quarcoopome et al. (2008) observed in the Bontanga reservoir in the Northern region of Ghana between September 1995 and January 1996. It is thus clear from both studies that from October to December, increasing CPUE against decreasing water levels should be expected. The dry season (January 2012 to March 2012), on the other hand, had fluctuating CPUE with the decreasing water levels.

Similar to this dry season observation is the fluctuating CPUE which was associated with decreasing water levels from January to May 1996 in the Libga reservoir, also in the Northern region of Ghana as reported by Quarcoopome et al. (2008). This means that the relationship between CPUE and water levels during the dry season in the lower reaches of the White Volta River and the Libga reservoir are not different. This trend may thus be applicable to other freshwater bodies in the West Africa sub-region. The highest catch per unit effort (Figure 3) of all the landing sites was in March 2012 as a result of the lowest water levels which were recorded in the same month, March 2012 (Figure 4). Narrow channels and reduced volume of the water during the dry season as the water levels drew down, made it relatively easier for fishermen to set nets, and use a lot of their traps and subsequently had more access to catch more fish during their fishing operations. Similarly, the lowest CPUE of the landing sites Pataplapei and Aglassipei which was in October 2011 was as a result of the high water levels at the time which made fishing quite compelling for fishermen, especially those who did not possess strong and heavy fishing gears since fishing on high water levels require; more effort and skills, best quality and strong nets, which most of these artisanal fishermen do not possess. Porturto with its lowest average CPUE in February 2012 could be as a result of the fishermen unexplained social activities which impacted negatively on their fishing expeditions including their fishing operation time during the month; this is probable, because among the landing sites, Porturto had the lowest catches in February 2012 and those catches were the lowest recorded catches throughout the entire period of the study in the lower reaches of the White Volta River. It is thus unsurprising that the few fishing activities reflected a low CPUE.

In this case, the low CPUE was much related to the fishermen social activities and fishing time rather than the changes in the water levels. However, it should be noted that, the unexplained social activities of the fishermen meant that they spent limited time on fishing and as such less competition among fishermen could not have been a factor that should have increased CPUE during the month. A sharp decline in CPUE in the landing site Aglassipei in the same month February 2012 was also probably as a result of the same unexplained social activities of the fishermen which impacted negatively on their fishing expeditions and their operation time. Another trend during the dry season was the decreasing CPUE with decreasing water level particularly in Pataplapei (upstream). From January to April 1996, Quarcoopome et al. (2008) observed that decreasing CPUE was also associated with decreasing water level in the Bontanga reservoir. These two studies are comparable and suggest that during the dry season, decreasing CPUE with decreasing water levels in the lower reaches of the White Volta River should be expected.

The effects associated with changing water levels on the catch per unit effort (CPUE) and fishing effort in the lower reaches of the White Volta River were that, there was slightly higher CPUE in dry season than post flood season, mainly as a result of the water levels fluctuations between the dry seasons. Water fluctuations affecting catch and CPUE in the lower reaches of the White Volta River was not uncharacteristic since according to van Zwieten et al. (2011), the total annual production of the Volta reservoir could fluctuate greatly as a result of high annual variability in the area flooded by the annual increases in discharge. The total catches declining as the water levels decrease or draw down had an effect on fishing effort as fewer fishermen tended to fish during the dry season (January to March) (Figure 2). The low fishing effort during the dry season is also another factor that influenced the CPUE. Fewer fishermen meant that less competition for fish and thus fishermen might have increased catches per their fishing operations due to less competition rather than decreased water levels.

However, the cumulative effect of fewer fishermen fishing during the dry season was very proposed in terms of catches. As expected, the high fishing effort of the post flood season (October to December) yielded more catches than the dry season with its low fishing effort. Some fishermen abandoned fishing temporarily during

the dry season to do other income generating activities like farming and charcoal production. According to Pauly et al. (2002), global fishing effort is estimated to exceed the optimum by a factor of three to four. It is likely that during flood season (June to September) in the lower reaches of the White Volta, the fishing effort far exceed the post flood and dry seasons fishing efforts. The effects of fishing high above the optimum fishing effort are obvious as the whole fishery resource is put under enormous pressure and as such declining fish stocks are experienced or expected. Fishermen would also have to put in more effort for less catch.

Conclusion

It was realized from the study that, there is a relationship between catch per unit effort (CPUE) and water level variations. Increasing CPUE with decreasing water levels was observed in all the landing sites during the post flood season (October 2011 to December 2012). The dry season (January 2012 to March 2012), on the other hand, had fluctuating CPUE with the decreasing water levels. CPUE can thus be modeled from water levels.

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