

Fish Cage Site Selection at Kibuyuni in Kwale County, Kenya: Tidal Variations, Waves Height, Current Speed and Direction Status

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ABSTRACT

The objective of the study was to select a suitable site for cage fish farming in the South Coast of Kenya at Kibuyuni, by investigating the status of tidal variation, wave height, and current speed and direction, which was done using the Acoustic Wave and Current Profiler (AWAC). The AWAC was deployed at 13.6 m depth; the study showed that the current speed of Kibuyuni was varying from the surface to the seabed; surface water 0.8690 m/s, 6 m depth 0.6090 m/s, 8.5 m depth 0.5590 m/s, respectively. According to Norwegian fish cage site classification, current speed should not exceed 1.5 m/s because this can cause the cage to move if not well fitted with heavy weights. Therefore these current speeds indicate that the area is suitable for cage installation. The highest tide was 13.5680 m while the lowest was 9.6840 m. The tidal fluctuation/difference is 3.8840 m which is good for adequate water exchange that will enable the flow of nutrients through the cage. The significant wave height (H_s) recorded was 0.36 m. Note: (Maximum wave height= $H_s \times 1.9$). Therefore the theoretical maximum wave height= $0.36 \times 1.9=0.684$ m. According to Norwegian fish cage site classification, maximum wave height should range between 0.5-1.0 m for a considerable moderate for fish cage site. Therefore this site is considered moderate for fish cage.

Keywords: Cage; Aquaculture/mariculture; Current speed; Tidal variation; Wave height

INTRODUCTION

Fish cage culture refers to an open aquaculture/mariculture system where the rearing environment is the environment itself, such as the ocean or lakes. As such, there are interactions between cages and the environment in both directions - cages affect the environment, and vice versa. When doing the site selection process, all possible interactions and their impacts on the cage aquaculture/mariculture, including both environment and human related, should be evaluated and assessed in order to minimize threats, hazards and overexploitation. A good fish cage site depends on its exposure characteristic. This refers to the amount of wind and waves to which the site is subjected. Current speed has a direct influence on the cages as it accounts for 70-75 percent of total forces on a typical mid-size cage farm, it mainly affects: water exchange in the cage, feed dispersion, cage net weights and sinkers, cage movements and fish transfers. Waves account for approximately 20-25 percent of the total forces affecting the mooring and the equipment on a typical mid-size cage farm. Tidal characteristics; preferably with average elevation that can be watered by ordinary high tides and drained by ordinary low tides; tidal fluctuation preferably moderate at 2-3 m [2].

OBJECTIVES

1. To assess the response of the cages to tidal variations in the creek.
2. To assess the strength of the currents and waves in the area.

METHODS

Oceanic observations

Acoustic Wave and Current profiler (AWAC) that was bought from Norway through Nortek group was deployed within Kibuyuni in Kwale County at (04° 38' 5 11" S 039° 21'247" E). Tidal variation, waves, temperature, current speed and direction data collection and retrieval were done using AWAC AST software, while quality control of the data was done using storm-64 software. The current speed and direction were measured at surface and bottom waters from 1-11 m in (m/s) and in degrees respectively. The data was analyzed and visualized using MATLAB (Figures 1-7).

RESULTS

The hydrodynamics characteristics of current shown by the graphs

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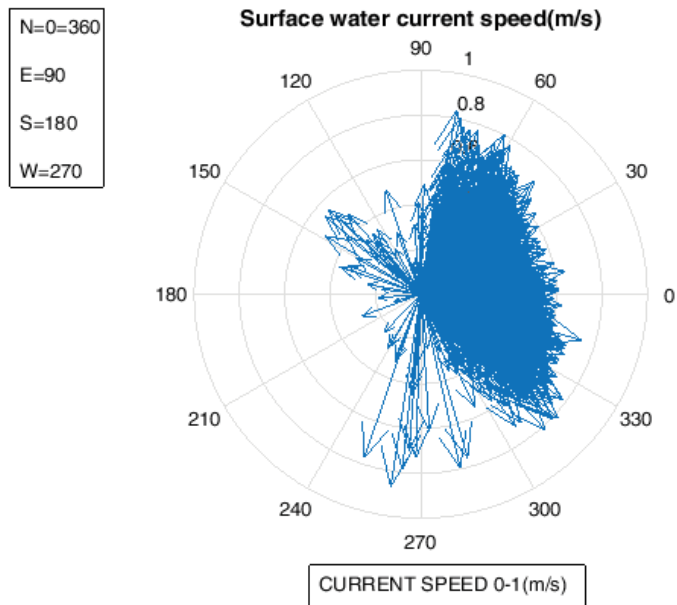


Figure 1: Surface water current speed (m/s).

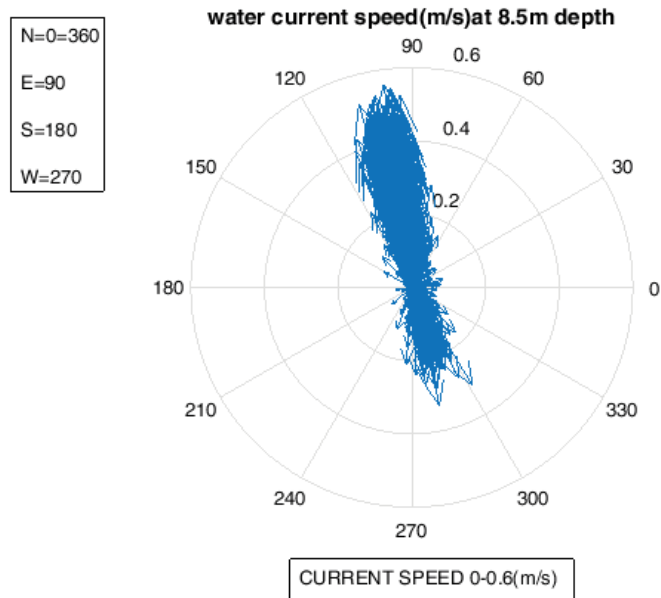


Figure 3: Water current speed (m/s) at 8.5 m depth.

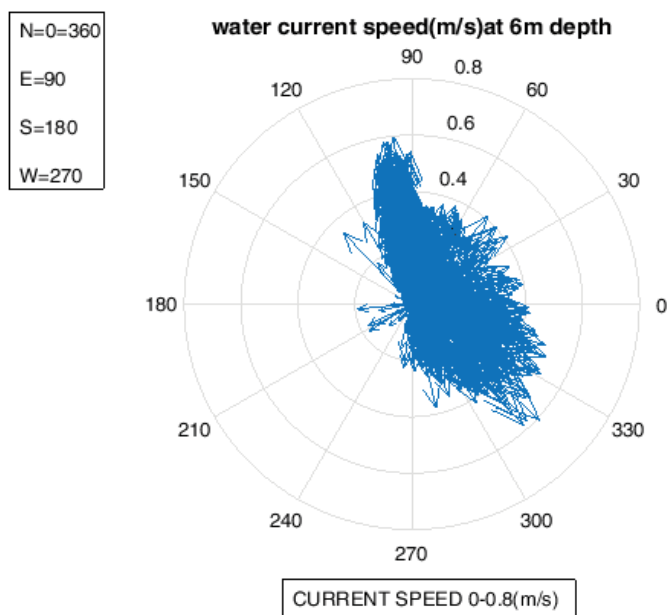


Figure 2: Water current speed (m/s) at 6 m depth.

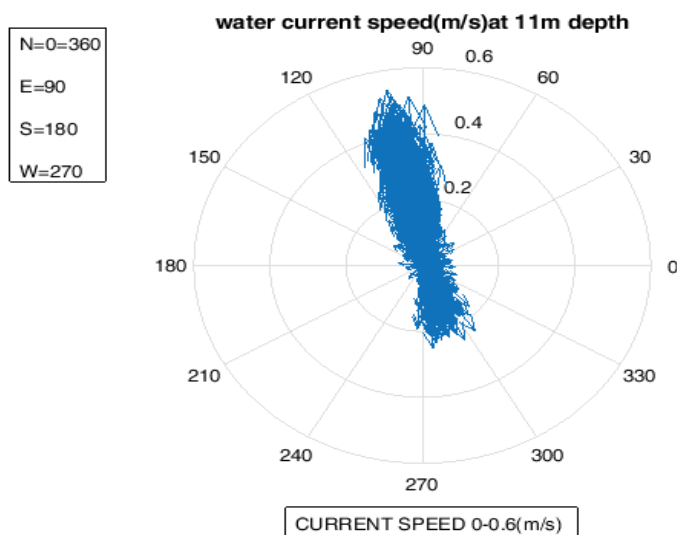


Figure 4: Water current speed (m/s) at 11 m depth.

above from surface water to bottom water, characterize the currents as unidirectional as well as wind current. The unidirectional currents are caused by tides while wind currents are caused by wind. From the graphs the surface water current seems to be strong and spreads towards NE as well as NW with a maximum speed of 0.8690 m/s, the spread is due to wind blowing over the surface water, while the other depths seem to be decreasing gradually as you go down. According to Norwegian fish cage site classification, current speed should not exceed 1.5 m/s [1] because this can cause the cage to move if not well fitted with heavy weights.

Tidal variation graph

The graph above shows tidal variation at Kibuyuni in Kwale County. The results indicated tidal variations in both Neap and spring. The highest tide was 13.5680 m while the lowest was 9.6840 m. The tidal fluctuation/difference is 3.8840 m which is good for adequate water exchange that will enable the flow of nutrients through the

cage. Site with tidal fluctuation/difference that is 4 m or above is not recommended since it can cause uplift of the cage and move if the ropes holding the cage from the bottom are not long enough, while site with tidal fluctuation/difference of 1 m or less could not drained or filled properly.

Wave heights graph

The graph above shows wave heights at different time as observed at the proposed fish cage site at Kibuyuni in Kwale County. The wave amplitudes variation indicated wind variation as well. The significant wave height (Hs) recorded was 0.36 m. Note: (Maximum wave height=Hs × 1.9). Therefore the theoretical maximum wave height= 0.36 × 1.9=0.684 m. According to Norwegian fish cage site classification, maximum wave height should range between 0.5-1.0 m for a considerable moderate for fish cage site. Therefore this site is considered moderate for fish cage.

Temperature

The graph above shows temperature variation at the fish cage site at Kibuyuni in Kwale County. The highest temperature recorded

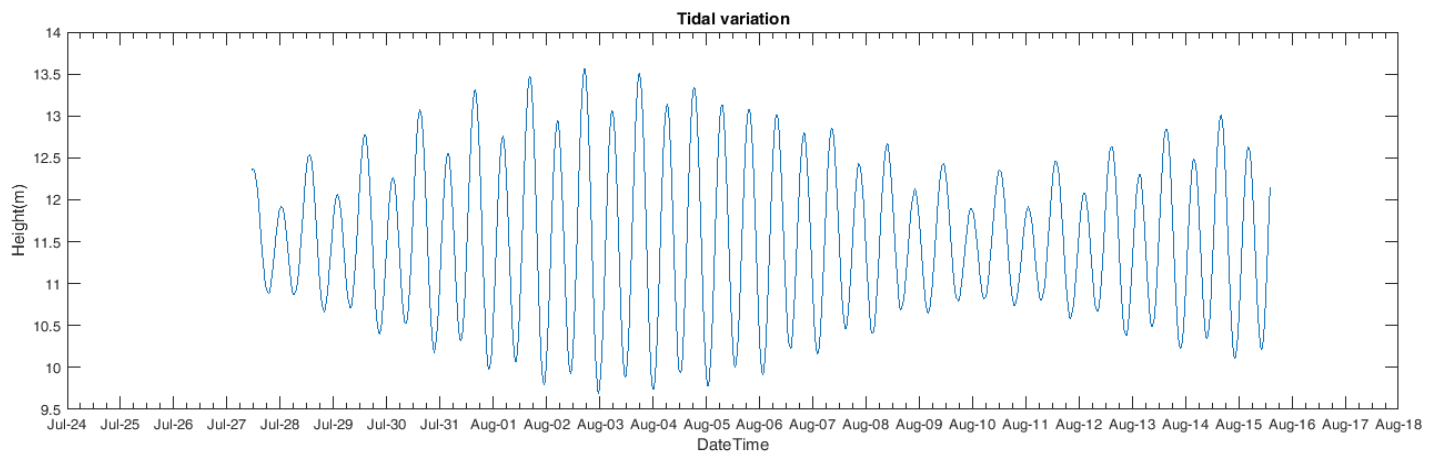


Figure 5: Tidal Variation graph.

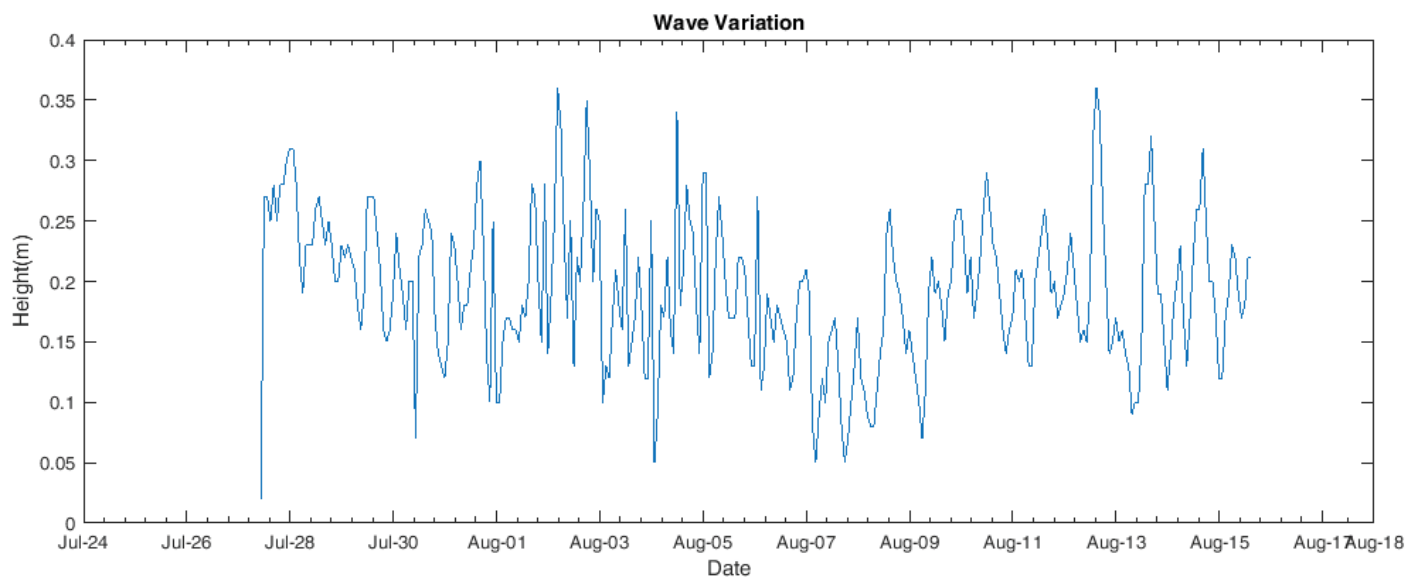


Figure 6: Wave heights graph.

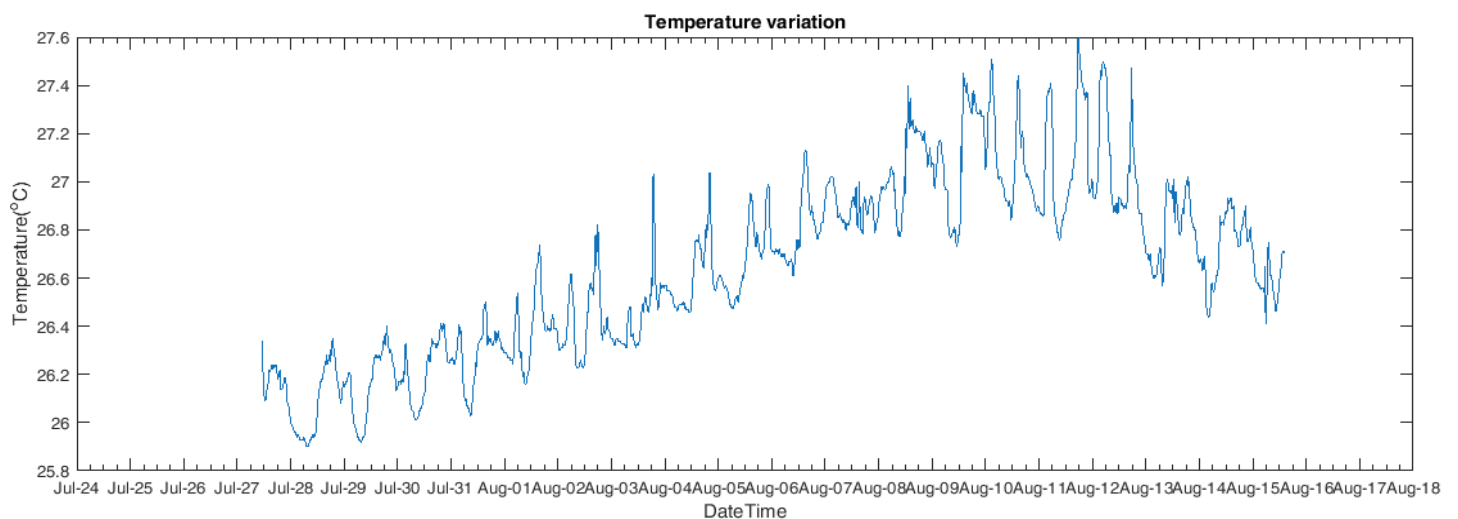


Figure 7: Temperature variation graph.

was 27.6°C, while the lowest temperature was 25.9°C. Water temperature in coastal areas/creeks is influenced by freshwater influx from streams and rivers, which are influenced by seasonal variation in rainfall. Temperature range is usually greater in shallower waters; solar radiation received by a body of water is

absorbed solely by the first few meters of water. If there is no water mixing due to net blockage from algae, the water will become stratified and the water column temperature may vary dramatically from the surface to the cage base. This may be a source of stress to the fish and may facilitate disease outbreaks.

Table 1: Summary of the current speed and direction results

Water level	Current Speed (m/s)	Direction
Surface waters	0.8690	WSW
6m depth	0.6090	NW and ESE
8.5m depth	0.5590	ESE
Bottom waters	0.5410	ESE

DISCUSSION AND CONCLUSION

Exposed site will have a better hydrodynamics, with a resulting lower environmental impact, better fish welfare and a better product quality. A sheltered and protected site will be less exposed to waves and currents, which implies reduced maintenance and costs.

The chain underwater holding the weight must be set parallel to the current direction as shown on the current speed graphs. The width of the cage in case of a rectangular cage must face the direction

of the current flow to reduce the surface area, and hence reduce impacted force on the cage by the current.

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