Hydrokinetic energy and macro-turbulent structures assessment in a high energetic river site

University of Manitoba

CHTTC Canadian Hydrokinetic Turbine Test Centre

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Introduction

Addressing the growing demand for renewable energy is a growing concern worldwide as the present generation will be confronted to a 500 ppm atmospheric CO_2 world. With this in the mind of investors and researchers, investment and research into hydrokinetic energy has increased with the motivating factor been the weighted amount of energy found in ocean currents, river flows and tidal channels. Hydrokinetic energy is harnessed from water bodies using a hydrokinetic turbine. With little or no environmental effect, low cost of manufacturing and deployment, hydrokinetic turbines are ideal for remote communities for diesel displacement. Hence, the investment by investors and study by researchers to improve their commercial viability.

Aim

This study aims to identify the different riverine structures and the type of macro-turbulent structures at the Seven Sisters channel while quantifying their impacts in designing and optimizing the power production from a hydrokinetic turbine.

Method

The methodology employed in achieving this study involved the following

▪Identifying the data collection points along the channel shown in Figure 1.

▪Moving up to identified data collection points using a measurement platform as shown in Figure 2.

▪Obtaining flow parameters from each of the data collection points using a measuring instrument and in this case, an acoustic Doppler velocimeter (ADV).

▪And finally, analysing the obtained flow parameters using an ADV post-processing code to achieve the aim of this study.

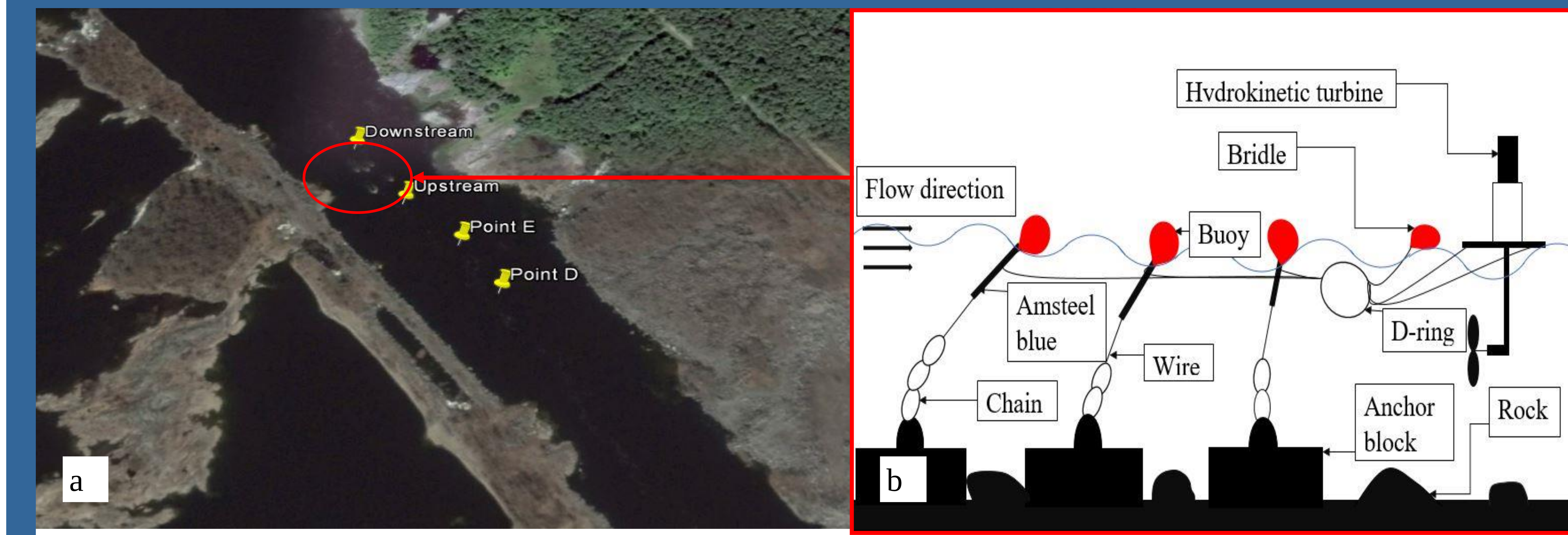

Figure 1. a) Google earth view of the Seven sisters channel showing measurement points and b) schematic view of the anchoring and mooring structure at the Seven Sisters channel.

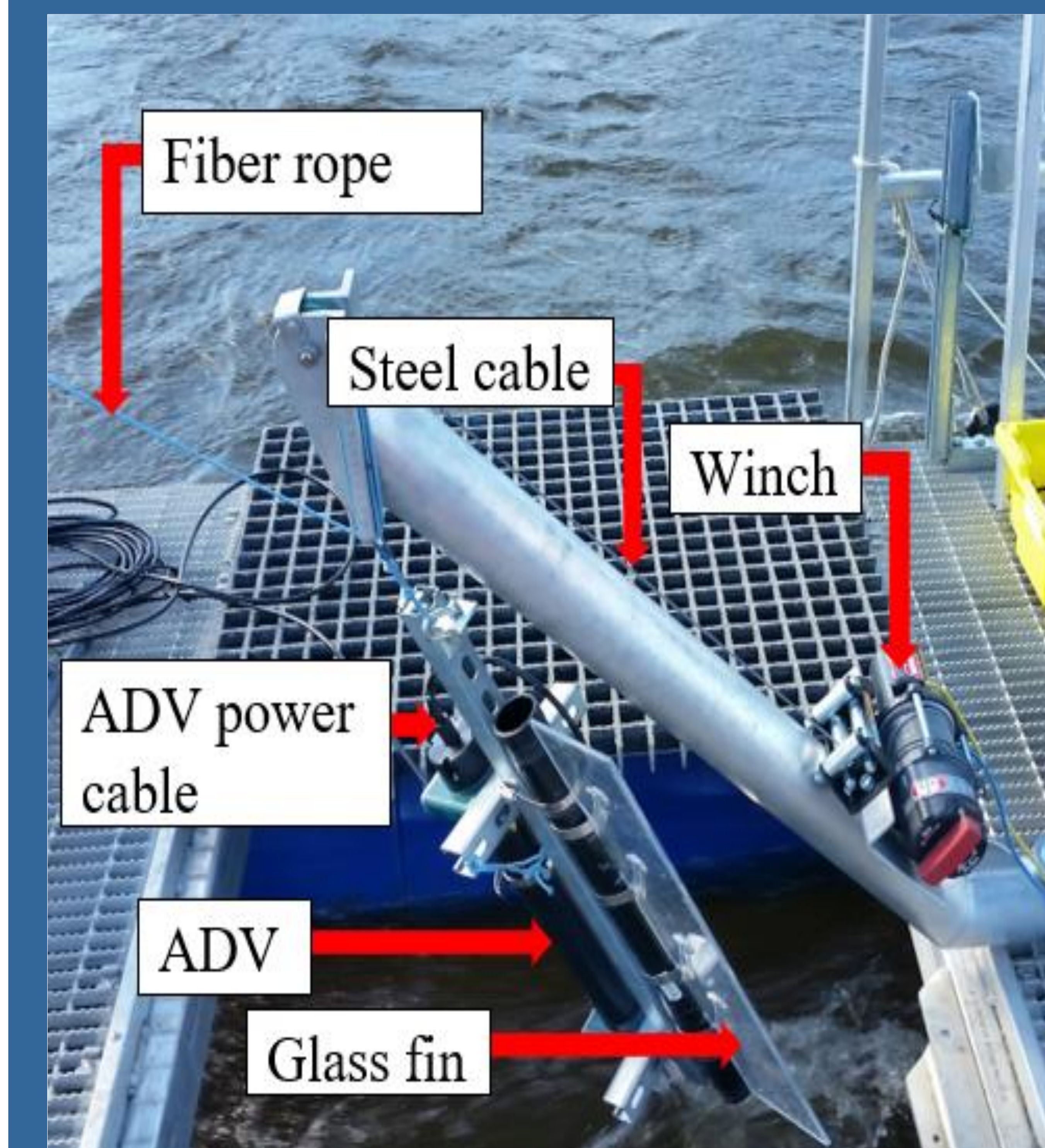

Figure 2. Measurement platform and ADV deployment set-up.

Results

From Figure 3 and 4, profile measurement results show an average velocity of 2.1 m/s and 2.2 m/s upstream and downstream the anchoring and mooring structures while the average turbulence intensity (T.I) are 9% and 14% upstream and downstream upstream the anchoring and mooring structures respectively.

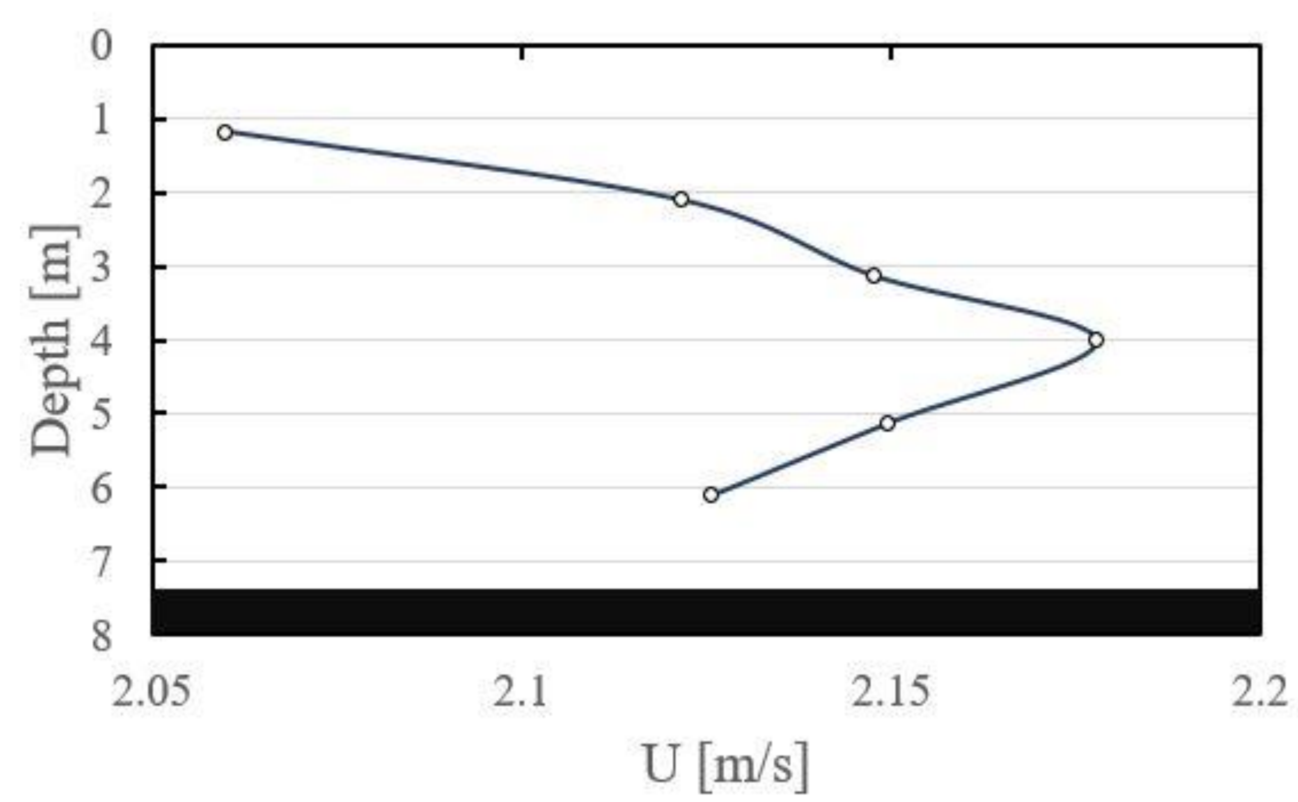

Figure 3. Streamwise velocity profile upstream the anchoring and mooring structure.

Near surface measurement shows a turbulence intensity (T.I) increase of 9.9% downstream the anchoring and mooring structure compared to that of the upstream.

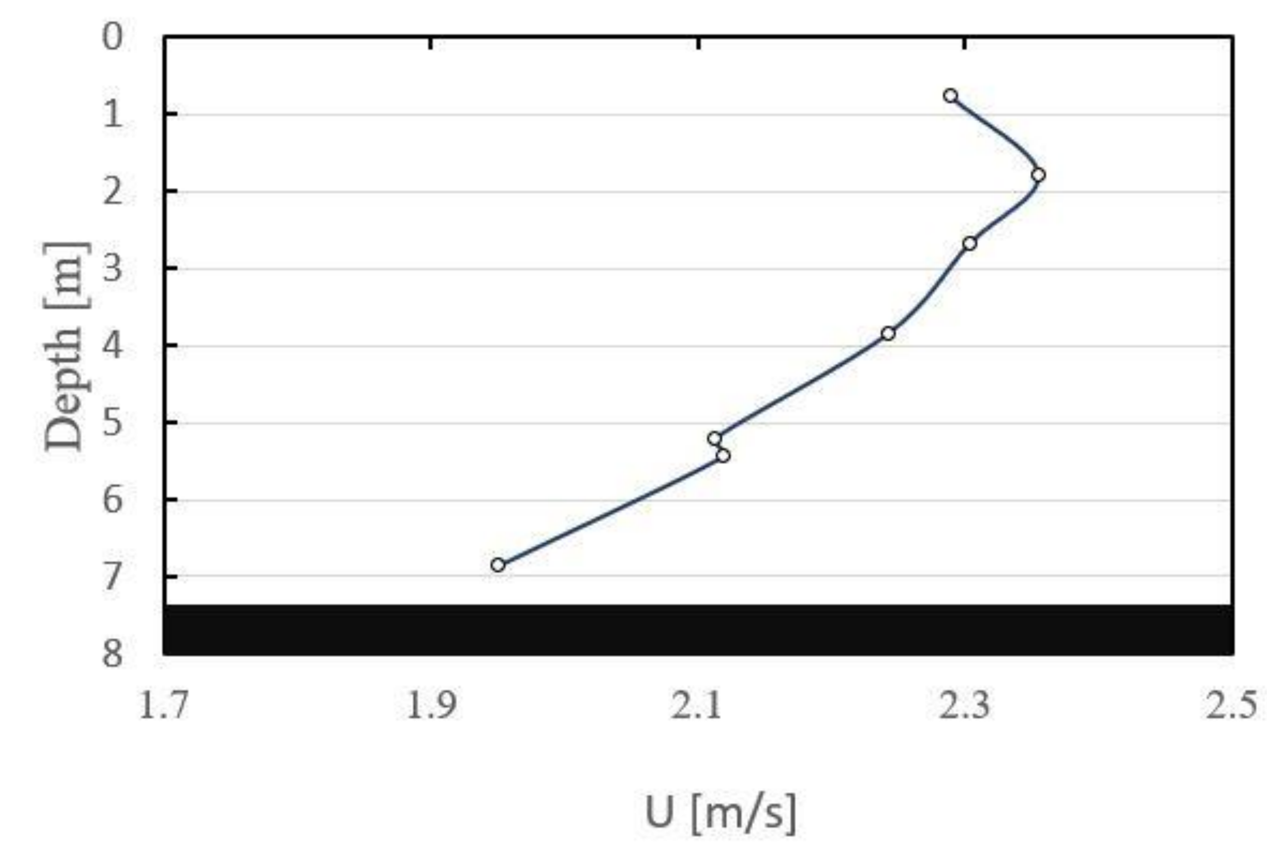

Figure 4. Streamwise velocity profile downstream the anchoring and mooring structure.

Conclusion

Based on the result obtained, optimum performance from a hydrokinetic turbine designed for optimum performance at 2 m/s is guaranteed when deployed in this channel but based on the turbulence intensity data obtained from downstream the anchoring and mooring structure, such hydrokinetic turbines should be anchored at a length to diameter ratio of 24. This ensures the hydrokinetic turbine is not deployed within the wake region which is saddled with velocity deficit as power production from a hydrokinetic turbine is a function flow velocity.

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