Application Note
April, 2019

Tidal Energy Feasibility Study in the challenging waters of Larantuka Strait using a SonTek Argonaut-XR

The Republic of Indonesia is a vast archipelago with over 17,508 officially listed islands. The physical oceanographic characteristics in Indonesian waters lend itself to many opportunities for potential tidal current energy developments and feasibility studies have been and continue to be undertaken to determine the commercial viability of constructing tidal power plants.

One such site is the Larantuka Strait, located between eastern Flores Island and Adonara Island, Nusa Tenggara Province. The Larantuka Strait, which is approximately 8km in length and 4.5km wide, links the Banda Sea and Savu Sea via a tapered channel. At the narrowest part, the width of the strait is approximately 600m with a depth of 20m. [1]

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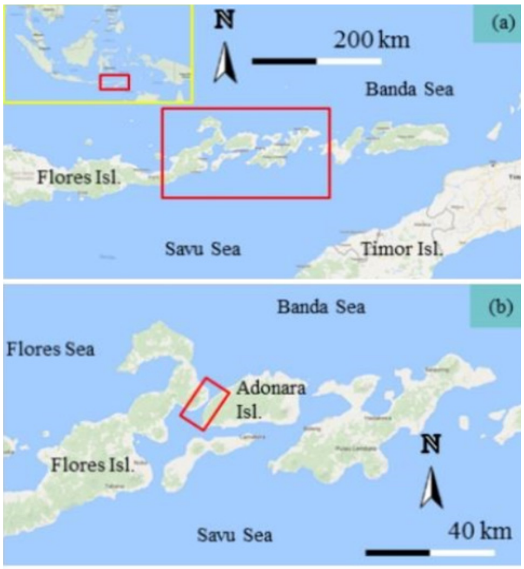

Fig.1 Location of (a) East Nusa Tenggara and (b) Larantuka Strait. Source: [1]

The Challenge

For each tidal power system implementation there is a range of current velocities and directions at which the system will operate at peak efficiency. Therefore it is important to understand the current velocity and direction regime that will be experienced at an installation site.

As such, prior to engineering and commercializing the project, an in depth feasibility study had to be completed. The Larantuka Strait, with its strong tidal currents, has tremendous potential tidal power densities, up to 6 kW/m2. These high force conditions pose a great challenge to collect the necessary current velocity data to calibrate and verify hydrodynamic models.

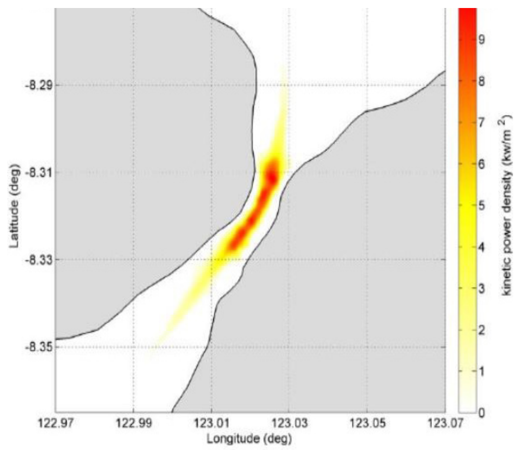

Fig.2 Larantuka Strait Kinetic Power Density Variation Source: [2]

Expected current speeds at the proposed site were over 360 cm/s, and thus the careful selection of instrumentation and installation methodology was critical. The industry standard for measuring current velocity profiles is the acoustic Doppler current profiler (ADCP).

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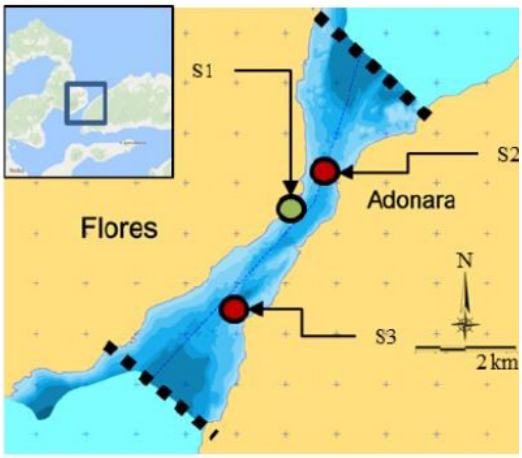
The Solution

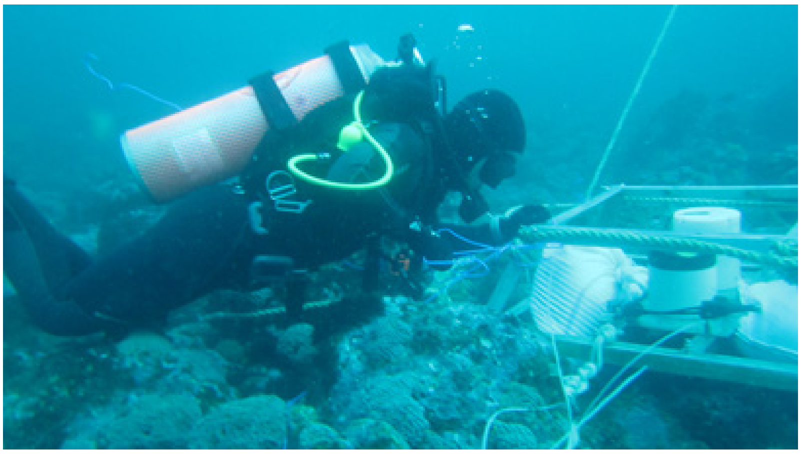
Adi Pranata, a coastal engineer from Pranata, was engaged to conduct the feasibility study. He has used [SonTek Argonaut -XR acoustic Doppler current profilers] for over 8 years at more than 100 locations around the archipelago, including the challenging, high flow waters of the many straits in Indonesia.

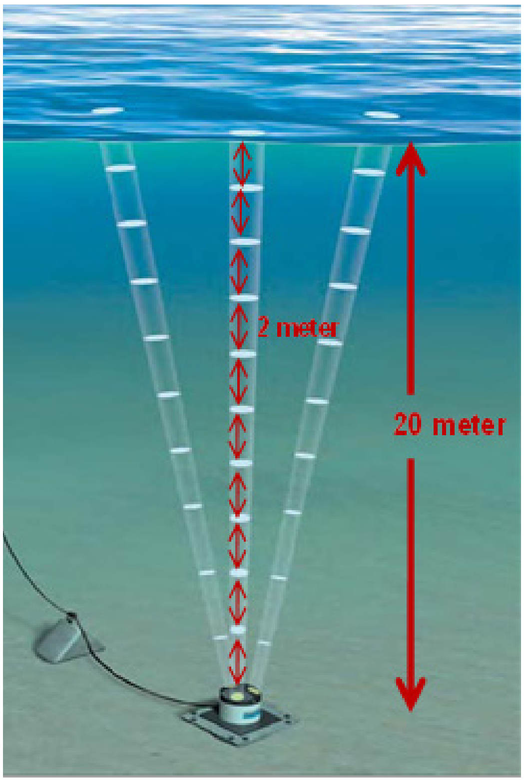


SonTek Argonaut-XR Measurement Locations marked by red dot. Source: [1]

The Argonaut-XR 0.75MHz was deployed in a bottom mount to operate autonomously, recording a velocity profile from 10 cells using a 2m cell size. Simultaneously, the Argonaut-XR was measuring a depth-averaged velocity over the entire water column using the Auto-Tide feature of the Argonaut-XR's main measurement cell, where the cell was configured to dynamically change in size as the water level changed due to tidal cycles.

Current data for the profile average as well as the 10 layers is collected, with the size of each layer being 2 meters.





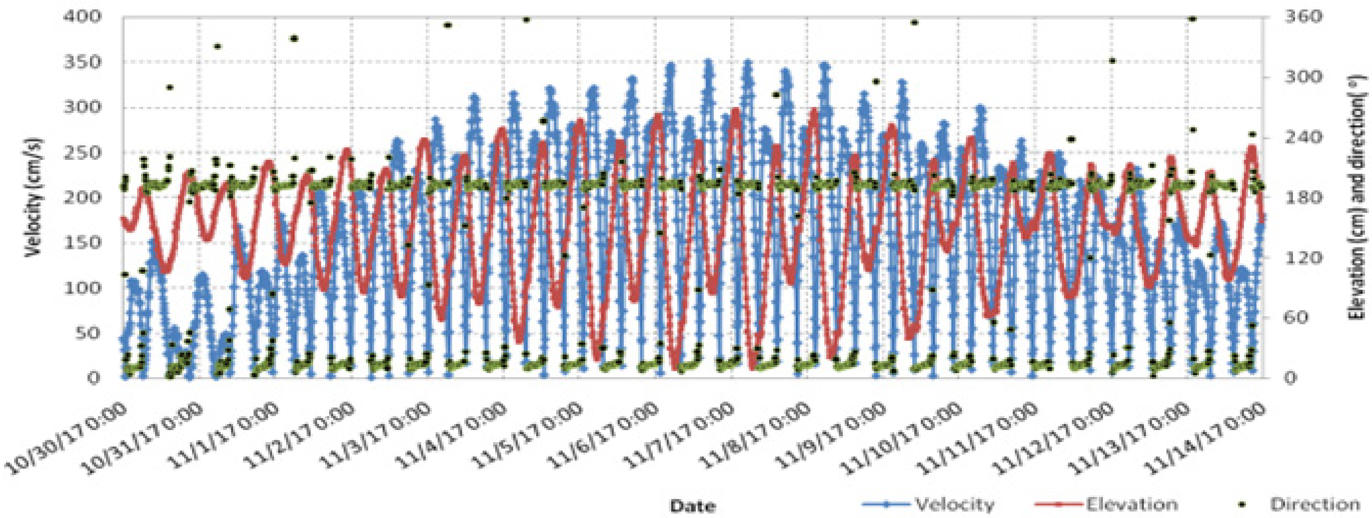
SonTek Argonaut-XR Current Profiling Settings

Results

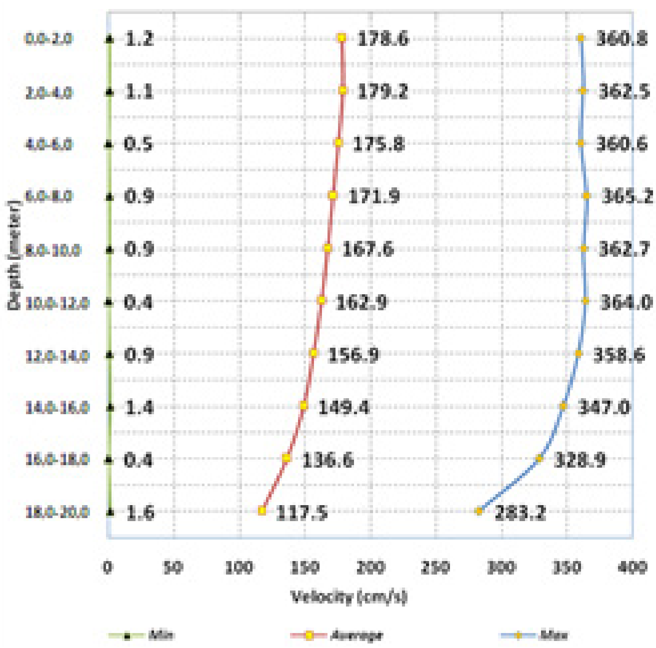
As part of the feasibility study, Adi built a numerical model using DHI's 3D flow model, MIKE 3. Field measurements of detailed bathymetry, tidal surface elevation, and tidal current velocity data were used to validate the model. The numerical model showed good agreement with the field measurement data. [1]

The current velocity and direction varies with the tidal cycle, with average speeds ranging from 117.5 to179.2 cm/s, minimum current speeds of 0.3 to 1.6 cm/s, and maximum current speeds of 283.2 to 365.2 cm/s.

The direction of the dominant current at the average depth is to the south with the current frequency of 52.43%. The dominant current velocity is> 100 cm/s - 150 cm/s with an event frequency of 18.39%. The maximum speed that occurs is >350 cm/s to 400 cm/s with an event frequency of 0.05%. [1]



Average and Maximum Profiles Current Velocity



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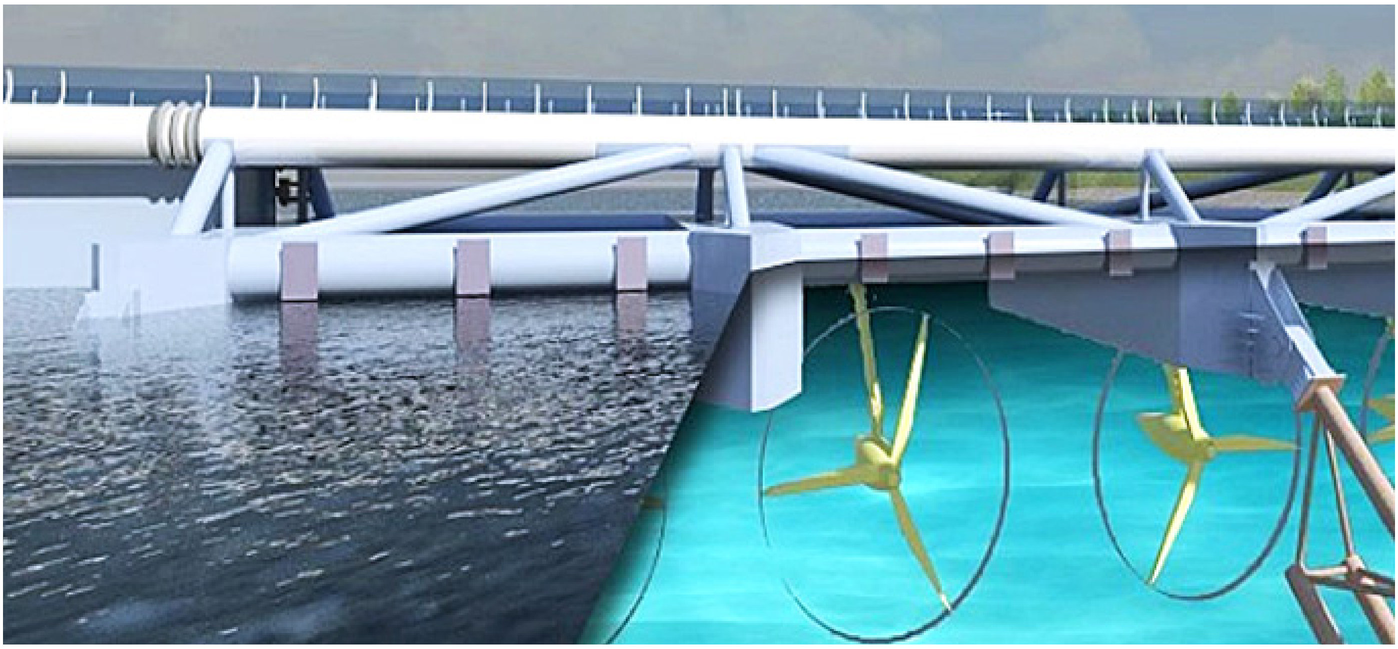
Conclusion

Adi, along with his SonTek Argonaut-XR, has contributed greatly in progressing the Tidal Bridge Project in Indonesia, and it should be noted that the Palmerah Tidal Bridge project has National Strategic Project status, emphasizing a project of national interest for the people of Indonesia. He is a long-term user of SonTek products, which are locally supported by Xylem's partner, Sea and Land Technologies, and has successfully used them in the most challenging of marine environments.



Conceptual design of the 800m floating bridge crossing the Larantuka Strait and connecting the islands of Flores and Andonara. The bridge would include a tidal energy power plant with a capacity of 18 to 23 MW.

Reproduced courtesy of Tidal Bridge BV, www.tidalbridge.com

Project Source Information

[1] Ajiwibowo, Harman & Lodiwa, K.s & Pratama, Munawir & Wurjanto, A. (2017). Field measurement and numerical modeling of tidal current in Larantuka Strait for renewable energy utilization. International Journal of GEOMATE. 13. 124-131. 10.21660/2017.39.98548.

[2] Orhan, Kadir & Mayerle, Roberto. (2017). Assessment of the tidal stream power potential and impacts of tidal current turbines in the Strait of Larantuka, Indonesia. Energy Procedia. 125. 230-239. 10.1016/j.egypro.2017.08.199.

SonTek
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SonTek
inquiry@sontek.com
www.sontek.com

Xylem Analytics Australia
salesAus@xyleminc.com
www.xylem-analytics.com.au

Xylem Analytics South Asia
analytics.india@xyleminc.com
www.xylem-analytics.in

Xylem Analytics Korea
junjae.won@xyleminc.com
www.xylemanalytics.krau

Xylem Analytics Asia Pacific
analytics.asia-pacific@xyleminc.com
www.xylem-analytics.asia

Xylem Analytics New Zealand
analytics.nz-pacific@xyleminc.com
www.xylem-analytics.com.au

Xylem Analytics Vietnam
analytics.vietnam@xyleminc.com
www.xylem-analytics.vn

Xylem Analytics Japan
ysijapan.support@xyleminc.com
www.xylem-analytics.jp