Nortek Vector with IMU Helps Researchers Keep Up the Quality of Japan's Waters

Although Nortek's Vector velocimeter is more accustomed to highly energetic environments such as those found in surf zones, researchers in Japan have recently showed that it is equally at home in much more gentle — yet just as challenging — conditions.

A team from **Tottori University**, led by Dr. Hiroshi Yajima, has been using the Nortek Vector in a study aimed at improving Japan's fresh water reservoir's operational efficiency and water quality (Fig. 1). Many of the world's manmade reservoirs present stratified conditions, where water at depth may have a significantly different temperature and oxygen content than water closer to the surface. This condition varies throughout the year and between different basins. Reservoir operators therefore withdraw water from different depths depending on these conditions. But, because of the temporal and spatial variability in these conditions, knowing the right depth from where to draw water is an imprecise endeavor: too much cold (or warm) water can negatively affect the fauna, flora and the quality of the water that is distributed to the population.

Figure 1. Aerial photo of Tono Dam and its reservoir. Intake tower can be seen at end of pier to the right of the dam. Photo courtesy of Tono Dam Reservoir Management Office.

Figure 2. Reservoir Intake Tower at Tono Dam Reservoir.

Water intake structures at reservoirs (Fig. 2) are often built with gates or openings at different levels to deal with this variability in water conditions. But knowing just the temperature or oxygen content is not enough. Operators must also take into consideration the approach velocity of the water, as it has a significant impact on how much of each water mass gets taken, as well as how well these masses mix.

Water velocity inside a reservoir is often very slow — less than one cm/s on average. But in the immediate vicinity of an intake opening, this normally gentle flow gets rapidly accelerated over a short distance (typically 20-60 cm), not unlike water going over a waterfall. Therefore, precise measurement of 3D velocity must be obtained within a small sampling volume — just the task for the Nortek Vector.

The team, led by Dr. Yajima, designed a system to deploy the Nortek Vector (Fig. 3) at different depths over the face of the intake tower at the Tono Dam Reservoir, operated by the Japanese Ministry of Land, Infrastructure, Transport, and Tourism (Fig. 4). This allowed Dr. Yajima to generate a profile of 3D approach velocity around the intake tower, especially at the opening of each intake siphon. Although

Figure 3. Nortek Vector used in study

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Doppler profiling systems can be used to give 3D velocities over multiple depth layers, the divergent geometry of their beams makes Doppler profilers impractical for this application, but perfect for the Vector's small sampling volume. Additionally, the Vector's optional Inertial Motion Unit (IMU) sensor ensured that the instrument's own motion during the deployment does not affect the quality of the very low velocities at the sampling points farthest away from each intake opening.

The data from the Nortek Vector, together with temperature and other parameters, is being used by Tottori University researchers to develop a 3D reservoir water quality prediction model (Figs. 5 & 6). The goal of the model is to understand the processes involved in improving water quality at Japan's reservoirs, and giving reservoir operators the tools they need to predict future conditions and be able to adjust their operational parameters to guarantee a steady supply of high quality water to the population.

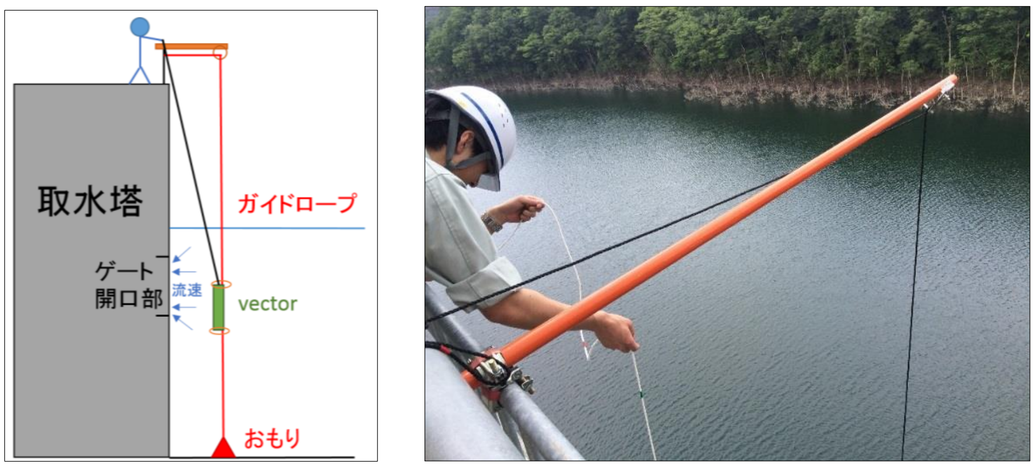

Figure 4. Deployment schematic and photo

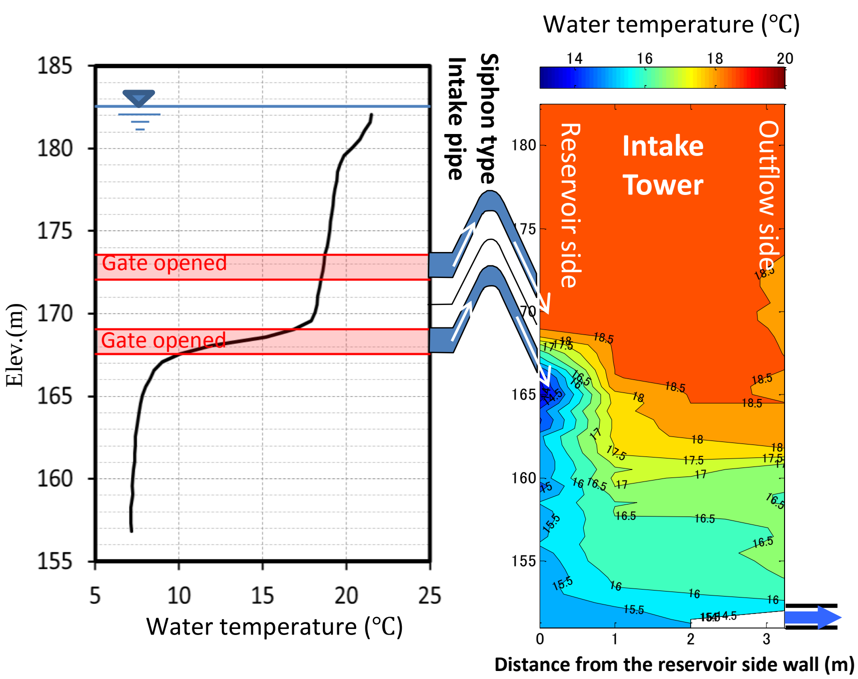

Figure 5. Observed water temperature in front of the intake tower (Left) and inside the intake tower (Right).

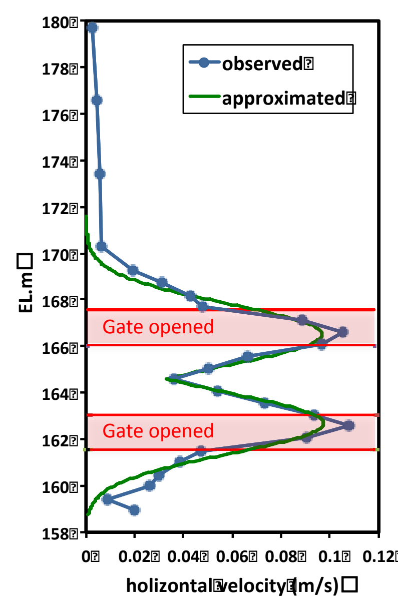

Figure 6. Horizontal velocity in front of intake tower measured by Vector, and with its approximation.

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