



## Underwater annular irradiance: New concept to measure the light diffuse attenuation coefficient through the KduSTICK, a Do-It-Yourself device

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Measuring water transparency allows us to monitor the water body's environmental status. One parameter to estimate water transparency is the light diffuse attenuation coefficient ( $K_d$ ). This coefficient is of particular interest in water quality monitoring programs.

The  $K_d$  describes the light extinction as function as the depth of downwelling irradiance,  $E_d$ . However, self-shading by the instrument itself can cause errors in  $E_d$  estimations. To avoid this effect, relative complex structures must be required to install the sensors that limit the vertical resolution of  $E_d$  measurements. Here we propose to use optical sensors in an annular-shape distribution to mitigate these limitations. For this, we introduce a new concept: the annular irradiance,  $E_a$ . We first compute the optimal angle to avoid self-shading while maximizing the light captured by the sensor. Second, we assess the robustness of the corresponding diffuse attenuation coefficient,  $K_a$ , in different scenarios of water types, solar angle and cloud coverage. Finally, we correlate  $K_a$  measurements with  $K_d$  at PAR region, and we derive empirical functions from translating  $K_a$  to  $K_d$  measurements.

This new coefficient is the basis of the new generation of the KduINO instrument (Bardaji et al., 2016) as a KduSTICK, which estimates the near-surface light extinction coefficient based on  $K_a$  measurements. Since the design of the instrument avoids self-shading, the device is expected to be particularly useful in those underwater environments where high vertical  $E_d$  resolution is required.

Furthermore, instruments based on this light-sensing approach are much simpler to deploy and maintain, and it is possible to design low-cost and Do-It-Yourself (DIY) versions. All these features facilitate its use for non-academic users, making the KduSTICK an optimal instrument to be used in Citizen Science water quality monitoring programs.