Citizens Observatories in coastal environments
Using innovative technologies (DIY instruments and data sonification) for engaging volunteers

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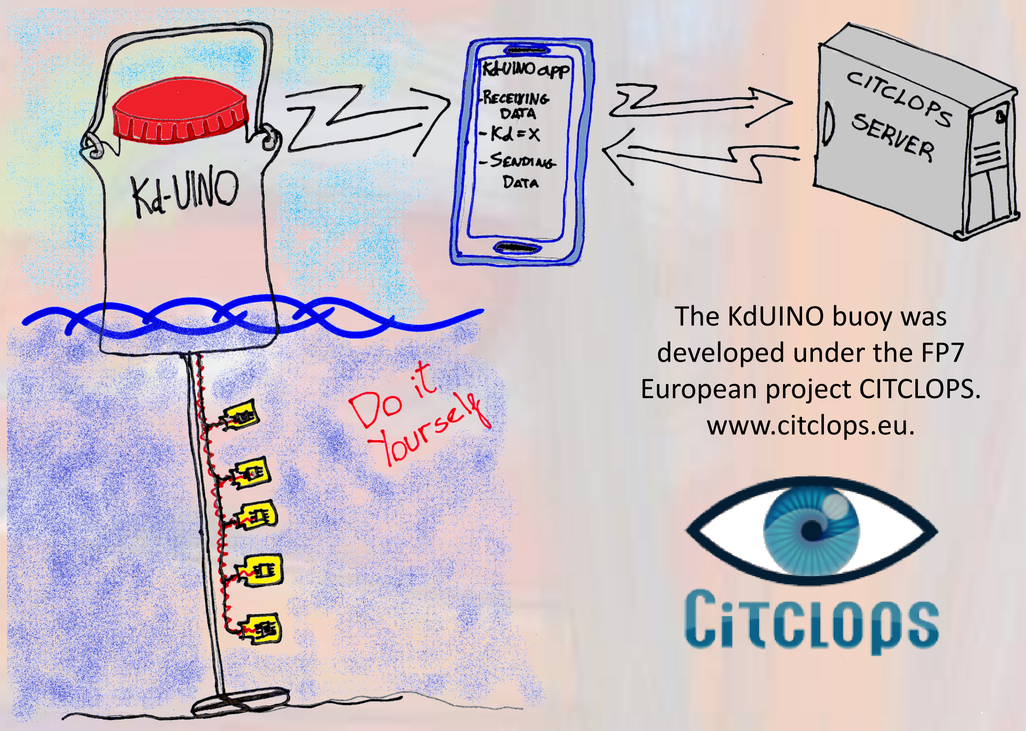
KdUINO: "DIY Electronic Secchi disk"

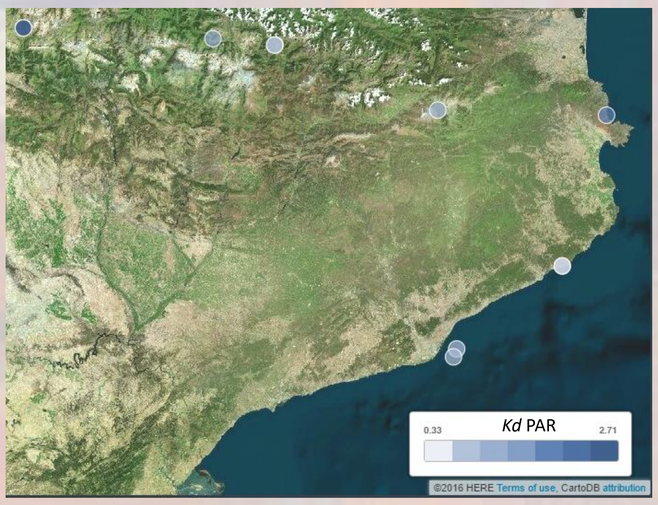
KdUINO is a Do-It-Yourself (DIY) buoy to provide continuous measurements of water transparency. **Transparency is a simple parameter that can be used as an indicator of water quality changes** in marine environmental monitoring programs. With a smartphone application, data from the buoy can be retrieved and resent to your work center.



The KdUINO buoy was developed under the FP7 European project CITCLOPS. www.citclops.eu.

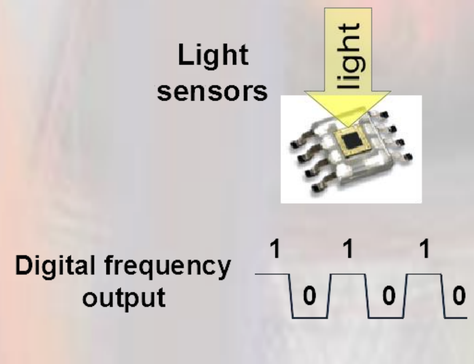
A public database with KdUINO measurements is soon to be released. If you want to contribute, please send data and GPS information to bardaji@icm.csic.es.

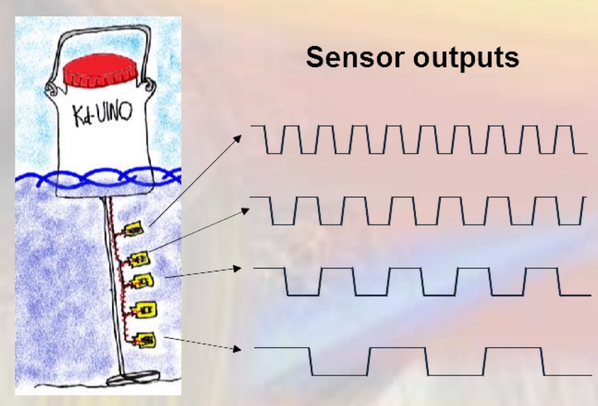
A testing data base can be seen at: http://bit.ly/kduino



Measurement principles

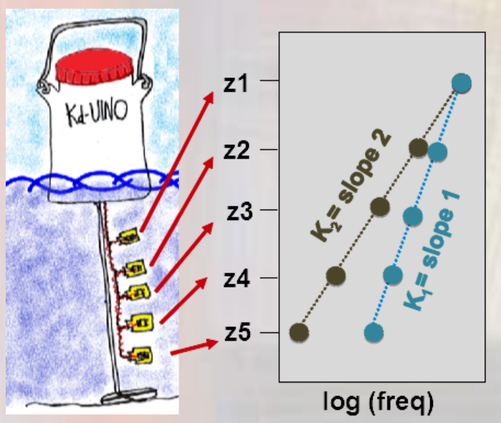
Light is measured with **low cost sensors that convert light intensity into digital oscillations** with characteristic frequency. Sensors at different depths will generate oscillations with different frequency, each one corresponding to the different levels of light intensity.





The Secchi depth (SD) is one of the most extended parameters to estimate water transparency. KdUINO provides an alternative parameter: **the diffuse light extinction coefficient** (K_d). $K_d \approx 1.7/SD$ so we may consider the KdUINO as an "electronic Secchi disk". In the example below, two different waters with different transparencies (i.e. different Secchi Depths), will have different line slope (the value of K_d) when we plot the depth versus the logarithm of the sensor outputs (frequency).

Different Kd (slopes)



Secchi disk measuring waters with different transparencies

Citizen engagement

The buoy was designed to be "**Do-It-Yourself**". Workshops were developed in different high-schools. Students were very enthusiastic in developing their own scientific instruments. Their comments were useful to improve the design and the manual. New KdUINO versions will be designed to engage more makers to build their own devices.

Naming the buoys

Makers can name their own buoys. They can easily follow their instruments in the public interactive map, which provide also access to the collected data. This is one of the rewards to their contribution.

One of the main goals is to engage different "marine communities". We are promoting the KdUINO use among sea-kayakers, sailors, snorkelers, scuba-divers, angle-fishers, etc.

Making music with science: Data sonification Art with KdUINO data

The "Musical Tentacle" is a project to create sounds and graphics out of KdUINO sensors. The system artistically expresses scientific data used to measure the transparency of the water.

References:

Bardaji, R.; Sánchez, A.-M.; Simon, C.; Wernand, M.R.; Piera, J. Estimating the Underwater Diffuse Attenuation Coefficient with a Low-Cost Instrument: The KdUINO DIY Buoy. *Sensors* **2016**, *16*, 373.

KdUINO design and development

Institut de Ciències del Mar – ICM – CSIC Consejo Superior de Investigaciones Científicas

Musical Tentacle collaborators

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EUROPEAN CITIZEN SCIENCE ASSOCIATION

Citizen Science 19-21 May 2016, Berlin