Inundation Signatures on Rocky Coastlines (ISROC) Data Standards for Coastal Boulder Deposits. Version 0.9, April 2023

Introduction

One major goal of ISROC is to develop community standards for Coastal Boulder Deposit (CBD) data, so that measurements taken at different times and using different methodologies may be compared more easily. This is a preliminary step towards developing a global database of CBD properties and all of the studies such a database can enable.

ISROC CBD data will consist of standard properties presented in standardized forms so that results may be machine-readable. All data will have a **Field** (e.g. Country), represented in the database by a **Database Variable Name** (location_country). These will have a value (e.g. Ireland) which has a **Data Type** (string) for machine storage. All data used here will be string, double precision, or integer.

Not all fields will be used by all studies. The standards are designed so that some fields may be filled out, while others may be left blank. There are some fields that are more generally applicable, and many of these are designated **First Importance Properties**. Still, not all of these are required. Other fields are designated **Second Importance Properties**, and may be used in more specialized studies.

Data may be conveniently entered into Excel spreadsheets set up for this purpose. Work is in progress to develop programs to automatically read data from these spreadsheets for greater ease in large studies. These have only been tested for some cases, but when complete will allow all data from a study to be stored in netcdf form, which is becoming standard for data storage across different computer platforms. Applications to do this are under active development.

Some fields have only a limited range of responses to ensure compatibility between different data sets. For example, a vertical datum (e.g. Mean Sea Level) is used to relate CBD elevation (e.g. 10m) to a physical elevation on earth. Other datums (e.g. Mean High Water, or terrestrial survey datums) may be used in other studies, and knowing the datum is essential. The most common choices are entered as pre-filled options on the Excel sheet, often with 'other' as one option. If 'other' is chosen, more description (e.g. name of survey datum) might be given in the Elevation Comment Field (e.g. NAVD88).

Field (category)	Explanation	Database Variable Name	Data Type
First Importance Properties			
id	Running identification of database entry.	id	String
Country	Country of database entry referring to the UN list of member states.	location_country	String
Region	Geographical entity below national level (region, island, state etc.).	location_region	String
Site name	Local site name of database entry used in literature source.	location_site	String
Latitude	Latitude of the center of the site in decimal format (at least five decimal places).	latitude	double
Longitude	Longitude of the center of the site in decimal format (at least five decimal places).	longitude	double
Minimum elevation	Minimum elevation of the CBD in m above elevation datum	first_elevation	double
Maximum elevation	Maximum elevation of the CBD in m above elevation datum	second_elevation	double
Elevation Comment	Anything more needed to explain elevations	elevation_comment	String
Reference datum	Elevation datum used *drop-down menu, categories in green below].*	reference_datum	String
MSL	Reference datum of MSL	msl	String
MHWL	Reference datum of MHW	mhwl	String
Other	Other vertical datum used – enter details in comment	other_datum	String
Density	In kg/m³; use this field in case of a homogeneous lithology	density	double
Volume	In m³	volume	double
Volume method	*Method of volume measurement [drop-down menu, categories in green below].*	volume_method	String
SfM	*Structure-from-motion, terrestrial or using drone (or combination of both)*	sfm_volume	String
LiDAR	*Terrestrial LiDAR*	lidar_volume	String
DGPS	*Measuring edges of boulders; creating and connecting surfaces in GIS or AutoCAD*	dgps_volume	String
Axes	*Multiplication of main axes (significant overestimation!)*	axes_volume	String

Axes with correction factor	*Multiplication of main axes (significant overestimation!) and a correction factor <1 that is based on boulder shape*	`axes_factor_volume`	String
Mass	In tons	`mass_tons`	double
Mass	In kg	`mass_kg`	double
Axes measurement	*Method of measuring the a-, b- and c-axes [drop-down menu, categories in green below].*	`axes_measurement`	String
Tape	*Axes measured by tape*	`tape`	String
SfM	*Axes taken from an SfM-based 3D model*	`sfm_axes`	String
LiDAR	*Axes taken from a LiDAR-based 3D model*	`lidar_axes`	String
Aerial imagery	*a- and b-axes taken from any remote sensing product with a sufficient spatial resolution. Realistically, this will be a high-resolution drone-based orthophotograph or similar*	`aerial_imagery`	String
a-axis (max.)	Largest axis of the largest boulder in m	`a_axis_max`	double
b-axis (max)	Intermediate axis of the largest boulder in m	`b_axis_max`	double
c-axis (max)	Shortest (usually vertical) axis of the largest boulder in m	`c_axis_max`	double
Lithology	*Rock type [drop-down menu, categories in green below].*	`lithology`	String
Calcareous reefrock	*Heterogeneous, fossilized coral reefs, mostly not older than late Pleistocene age*	`reefrock`	String
Other limestone	*All types of limestones and carbonate-dominated sedimentary rock*	`limestone`	String
Clastic sedimentary rock	*All types of clastic sedimentary rock*	`sedimentary`	String
Igneous rock	*All types of magmatic rock*	`igneous`	String
Metamorphic rock	*All types of metamorphic rock*	`metamorphic`	String
Anthropogenic	*Any form of anthropogenic material, e.g. concrete in tetrapods*	`anthropogenic`	String
Measurement Year	Year of measurement CE, particularly for historical or repeated measurements	`measurement_year`	Integer
Measurement Month	Month of measurement	`measurement_month`	Integer
Measurement Day	Day of measurement	`measurement_day`	Integer
Measurement Hour	Hour of measurement	`measurement_hour`	Integer
Measurement Minute	Minute of measurement	`measurement_minute`	Integer
UTC Reference	UTC Time zone (e.g. +5.5, -11, etc.)	`UTC_reference`	double

Measured Tidal range	Measured Local or near-local mean tidal range = difference between MHW and mean low water level (MLW)	tidal_range_measured	double
Database Tidal range	Local or near-local mean tidal rangefrom TOPEX or other database	tidal_range_database	double
Seaward limit	Minimum horizontal distance of the CBD to the present coastline at MHWL in m	seaward_limit	double
Landward limit	Maximum horizontal distance of the CBD to the present coastline at MHWL in m	est_min_landward_limit	double
Spatial distribution comment	Further information on the spatial distribution in reference to the coastline [free text]	est_min_landward_limit_comment	String
Source	*Origin of boulder transport. Multiple sources can be chosen. [drop-down menu, categories in green below].*	source_cause	String
EQ tsunami	*Tsunami generated by an earthquake*	Quake	String
Volc. tsunami	*Tsunami generated by submarine volcanic activity or flank collapse of a volcanic edifice*	Eruption	String
Landslide tsunami	*Tsunami generated by a submarine or subaerial landslide*	Slide	String
Other tsunami	*Any other tsunami source*	other_tsunami	String
Storm waves	*Wave-induced transport during extreme storm conditions*	storm_waves	String
Infragravity waves	*Transport by extreme infragravity waves*	infragravity	String
Higher sea level	*Relict deposits formed by long-term coastal processes during past periods of higher relative sea level (e.g. mid-Holocene sea-level highstand)*	higher_sea_level	String
Anthropogenic	*Boulders shifted by human activity (intentionally as some sort of protection or unintentionally during excavation/construction works)*	anthropogenic	String
Unknown	*The source is unknown*	unknown	String
Source Reliability	Source Reliability. We haven't figured this one out completely yet.	source_reliability	string
Data DOI	A single DOI for the data if available	doi_reference	String
Second Importance Properties			
Polygon	Upload polygon of the boulder deposit in .kml format (not entirely sorted out)	polygon	String
Deposit characteristics	Broad classification of the deposit's context [drop-down menu, categories in green below].	physical_characteristics	String

Singular boulder	Singular boulder(s) up to a number of 10.	singular_boulder	String
Boulder cluster	Small cluster of up to 10 individual boulders.	boulder_cluser	String
Boulder field	>10 singular boulders across a spatially well constrained area.	boulder_field	String
Boulder ridge	*Boulder accumulation building up an entire ridge or rampart.*	boulder_ridge	String
Further characteristics	*Any detailed observations about landforms, the nature of clustering, cracked, split or overturned boulders etc. [free text]*	*sitestatus*	String
Boulder tidal setting (elevation)	*Vertical position relative to present tidal levels. Absolute vertical distances may vary significantly based on local tidal ranges and long-term wave energy [drop-down menu, categories in green below].*	tidal_zone	String
Subtidal	*Area below the lowest local spring tide level. Always at least partially covered by water.*	subtidal	String
Intertidal	*Area between the lowest and highest spring tide level. Aligns with the definition of foreshore in Bird (2008).*	intertidal	String
Supratidal	*Area above the highest spring tide level, only reached by storm surege and waves. It is characterized by sea spray and semi-endolithic Cyanophyceae and Chlorophyceae at rocky coasts (e.g. Bokuniewicz, 2005; Kelletat, 2013). Aligns with the definition of backshore in Bird (2008).*	supratidal	String
Terrestrial	*Area lying above the zone of colonization by Cyanophyceae and Chlorophyceae and above the influence of sea spray.*	terrestrial	String
Geomorphic environment	*Larger-scale landform where the boulders are situated [drop-down menu, categories in green below].*	geomorphic_environment	String
Cliff top	*Boulder deposit distributed over an elevated rocky platform with a cliff, usually several meters above sea level. Usually classified as terrestrial, sometimes supratidal.*	cliff_top	String
Cliff toe	*Boulder deposit accumulated at the toe of a cliff, usually in the intertidal to lowermost supratidal zone; often associated with an abrasional platform.*	cliff_toe	String

Intertidal reef flat or shore platform	*Boulders distributed over an intertidal shore platform, including (at least partially living) coral reefs; boulders mostly sourced from the seaward edge of the reef/platform.*	`reef_flat_platform`	String
Elevated shore platform	*Boulders distributed over uppermost intertidal to supratidal zone; boulders mostly sourced from the seaward edge of the shore platform.*	`elevated_platform`	String
Beach/coastal plain/coastal dunes	*Boulders distributed over a beach or the back-beach environment; boulders mostly sourced from reefs, promontories or other rocky coastal sections offshore or surrounding the beach section, respectively.*	`coastline`	String
Developed environment	*Any coastal environment that is urban or in any form heavily overprinted by anthropogenic development*	`developed_environment`	String
Age category	*Broad age classification using fixed categories [drop-down menu, categories in green below].*	`classification`	String
Recent	*Deposition or dislocation unequivocally documented since the year 2000 CE.*	`recent`	String
Subrecent	*Deposition or dislocation unequivocally documented between ~1950 CE and 2000 CE using pre- and post-event surveys, any kind of remote-sensing technique or eyewitness accounts.*	`Historical`	String
Historical	*Deposition or dislocation during the period which is covered by the historical record at the site of interest. Chronological indication is usually based on historical information and/or physical or chemical age dating.*	`Prehistoric_AD`	String
Prehistoric	*Deposition or dislocation during the Holocene, but before the period which is covered by the historical record at the site of interest. Chronological indication is usually based on physical or chemical age dating.*	`Prehistoric_BC`	String
Pleistocene	*Deposition or dislocation during the Pleistocene, in most cases this will be MIS5. Chronological indication is usually based on stratigraphical, physical or chemical age dating.*	`pleistocene`	String
Unknown	*No reliable indication for age of transport available.*	`Unknown`	String

Combined	*Two or more of the previous categories apply based on various indicators such as survey, remote sensing data, historical accounts or physical or chemical dating.*	`combined`	String
Age, earliest	Estimate of the earliest age of the earliest transport event(s) inducing boulder transport based on survey, remote sensing data, historical accounts or physical or chemical dating; ages are given in years BCE/CE.	`date_min` [Integer]	double
Age, latest	Estimate of the latest age of the latest transport event(s) inducing boulder transport based on survey, remote sensing data, historical accounts or physical or chemical dating; ages given in years BCE/CE.	`date_max`	double
Age comment	Add explanations regarding assumed age distribution, age scale and the basis of age interpretation	`datingtechnique`	String
Dating technique	*Evidence that the age estimation for boulder transport is based on [drop-down menu, categories in green below].*	*`geodatingtechnique`*	String
Field survey	*Time of transport identified during field surveys and specific geological/environmental indicators*	`field_survey`	String
Remote sensing	*Time of transport identified based on multitemporal analysis of precisely dated satellite or aerial images*	`remote_sensing`	String
Comparative photography	*Time of transport identified based on comparison of historical photography*	`comp_photo`	String
Historical accounts	*Time of transport identified based on other historical evidence*	`historical_acc`	String
Eyewitness accounts	*Time of transport identified based on eyewitness interviews*	`eyewitness_acc`	String
^{14}C	*Time of transport identified based on interpretation of radiocarbon data*	*`Radiocarbon`*	String
U/Th	*Time of transport identified based on interpretation of uranium series data*	*`Cs137`*	double
OSL	*Time of transport identified based on interpretation of optically stimulated luminescence data*	*`Optically Stimulated Luminescence`*	String
ESR	*Time of transport identified based on interpretation of electron spin resonance data*	`esr`	String

AAR	*Time of transport identified based on interpretation of amino acid racemization data*	`aar`	String
Lichenometry	*Time of transport identified based on interpretation of lichen growth patterns*	`lichenometry`	String
Archaeological findings	*Time of transport identified based on any type of archaeological context*	*`Archaeological information`*	String
Evidence for recent transport	List all indicators for recent transport based on post-event surveys, if applicable *[drop-down menu, categories in green below].*	`evidence_recent_transport`	String
Fixed biological	*Sessil marine organisms attached to a boulder in supratidal or terrestrial setting (e.g. oysters, barnacles), including traces of such organisms (e.g. holes of boring mussels).*	`fixed_biological`	String
Plant growth	*Any form of post-depositional plant growth*	`plant_growth`	String
Geomorphic	*Breakage or surface scratches from sliding or rolling transport; Niches in the cliff, where the boulder was sourced; Traces of rock pools or an intertidal notch from the pre-transport setting etc.*	`geomorphic`	String
Remote sensing	*Evidence from multitemporal analysis of satellite or aerial images*	`remote_sensing`	String
Eyewitness report	*Evidence from interviews*	`eyewitness_report`	String
Historical sources	*Evidence based on any form of historical sources (photographies, paintings, written descriptions)*	`historical_sources`	String
Other	*Any other form of evidence not listed above*	*`transport_other`*	String
Comment size	General description of size distribution of boulders at the spatial scale of the entire CBD site.	`comment_size`	String
a-axis orientation (max.)	Deviation of the orientation of the longest axis of the largest boulder from the orientation of the closest shoreline (in °). Min = 0°; max = 90°.	`a_axis_orient`	double
Comment orientation	General description of the orientation of the main axes of boulders (see definition	`comment_orient`	String

	above) at the spatial scale of the entire CBD site.		
Thickness	Deposit thickness in m	thickness	double
Density low	Lowest density in kg/m³ (in case of heterogeneous lithology such as in reefrock)	density_low	double
Bulk density	Estimated average density in kg/m³ (in case of heterogeneous lithology such as in reefrock)	bulk_density	double
Shape (max)	*Shape of the largest boulder of the deposit on the Sneed and Folk (1958) diagram and categories in Terry and Goff (2014) (Figure 1). [drop-down menu, categories in green below].*	shape_max	String
Equant block	*Ratio between c-axis and b-axis is between 0.8 and 1, ratio between b-axis and a-axis is between 0.8 and 1*	equant_block	String
Sub-equant block	*c/b = 0.6–0.8 and b/a = 0.6–0.8*	sub_equant_block	String
Flat block	*c/b = 0.4–0.6 and b/a = 0.6–1.0*	flat_block	String
Elongate block	*c/b = 0.6–1.0 and b/a = 0.4–0.6*	elongate_block	String
Slab	*c/b = 0.2–0.4 and b/a = 0.6–1.0*	slab	String
Plate	*c/b = 0.0–0.2 and b/a = 0.6–1.0*	plate	String
Blade	*c/b = 0.0–0.6 and b/a = 0.0–0.6*	blade	String
Rod	*c/b = 0.6–1.0 and b/a = 0.0–0.4*	rod	String
FI (max)	Flatness index of the largest boulder: FI = (a+b)/2c. The index is based on Cailleux and Tricart (1959) and was adapted for CBD research e.g. by Etienne et al. (2011) and Nandasena and Tanaka (2013).	fl_max	double
EI (max)	Elongated index of the largest boulder: EI = a^2/bc (Wentworth, 1922a)	el_max	double
Comment shape	General descriptions of boulder shapes at the spatial scale of the entire CBD site	comment_shape	
Roundness R_c	Quantitative value for R_c using the formula in Cox et al. (2018), which is based on the length of a-, b- and c-axes as well as the radius of curvature based on Kirkbride (2005) (in case these were all measured systematically). One single value or an average value should be entered, depending on the nature of the CBD and the availability of data.	roundness	double

Wentworth Roundness Index (WRI)	*WRI = R_i/r, where r is the mean clast radius, calculated on the basis of a triaxial ellipsoid (Wentworth, 1922b), see definition in Cox et al. (2018). Categories after Powers (1953). One single value or an average value should be entered, depending on the nature of the CBD and the availability of data.*	`wentworth_index`	double
Very Angular	*<0.17*	`very_angular`	String
Angular	*0.17–0.25*	`angular`	String
Sub-angular	*0.25–0.35*	`sub_angular`	String
Sub-rounded	*0.35–0.49*	`sub_rounded`	String
Rounded	*0.49–0.70*	`rounded`	String
Well-rounded	*>0.70*	`well_rounded`	String
Comment roundness	General description of roundness at the spatial scale of the entire CBD site.	`comment_roundness`	String
No. of boulders	Estimated number of singular clasts with b-axis >256 mm	`number_boulders`	double
Spatial extent	Estimated size of the boulder site in m²	`spatial_extent`	double
Event	If the specific event of deposition is known (dd/mm/yyyy)	`event`	String