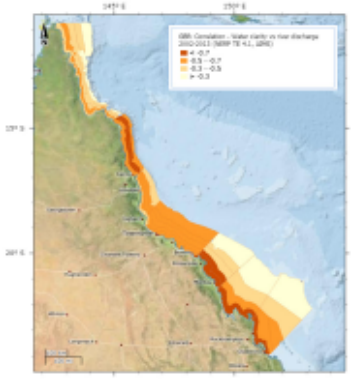
# EATLAS DATA CATALOGUE (AIMS)

## Inter- and intra-annual relationships between water clarity and river loads in the Great Barrier Reef 2002-2013 (NERP TE 4.1, AIMS, sources: NASA, DEHP, DERM, BOM, UQ)



Metadata | Metadata (XML)
| Visualization service URL (WMS) () |

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| Title | Inter- and intra-annual relationships between water clarity and river loads in the Great Barrier Reef 2002-2013 (NERP TE 4.1, AIMS, sources: NASA, DEHP, DERM, BOM, UQ) |
| Date | 2015-10-20 |
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| Abstract | This dataset shows various statistics of photic depth across the Great Barrier Reef (GBR). Data are broken into 35 zones along and across the GBR and photic depth is derived from 11 years of MODIS Aqua data. The data included is:<br>1. The statistical strength of correlation between standardized photic depth and freshwater discharges the GBR.<br>2. The mean photic depth and the main physical environmental variables that need to be controlled for when assessing how volumes of river freshwater discharges influence photic depth.<br>3. Statistics of photic depth controlled to remove the effects of main physical environmental variables (wave height, tidal range) used when assessing how volumes of river freshwater discharges. Data are into dry years (2002 to 2006) or wet years (2007 – 2012).<br><br>Water clarity is a key parameter affecting the health of coastal marine systems and their tourism values. We investigated the relationship between volumes of river freshwater discharges of major rivers (from DERM) and the water clarity in 35 zones along and across the GBR waters within the Fitzroy, Whitsundays, Burdekin, Southern and Northern Wet Tropics. For Cape York, water clarity was related to rainfall as a proxy, since river data were incomplete. We used daily 11-years (2002-2013) MODIS-Aqua remote sensing data at 1 km2 resolution, to investigate time scales and processes affecting water clarity in these regions. In all coastal, inshore and lagoonal regions except for Cape York, photic depth was strongly negatively related to the freshwater discharge of the main rivers. The declines started with the onset of river floods, and water clarity typically took 150– 260 days until complete recovery. The relationship between photic depth and rivers was strongest in the Northern Wet Tropics, the initiation area of outbreaks of crown-of-thorns starfish, where effects were strong even on the outer shelf. Previous conclusions that river runoff predominantly affects the inshore of the GBR have therefore to be revised for the Central and Northern GBR. The results were used in the setting of regional ecologically relevant targets for fine sediment in the Burnett-Mary and Wet Tropics WQIPs, and will likely be used for other WQIPs.<br><br>The analyses are based on three sets of data:<br>1) Daily Modis Aqua satellite data from 2002 - 2013, processed as described previously (Weeks et al. 2012, Logan et al. 2013, Fabricius et al. 2014).<br>2) Daily data of freshwater discharge volumes of the main rivers for the same time period, provided by the State of Queensland, Department of Environment and Heritage Protection (DEHP).<br>3) For the Normanby River, the discharge station only came online late 2005. Therefore, most of the first four years of daily discharge data for the main river in this region are missing (Stewart and Endeavour Rivers are much smaller than the large Normanby). Also missing |

are any form of river discharge information for the whole northern half of the region. As an alternative to river discharge data, we used daily rainfall data from the Lockhart River rainfall gauge for Cape York, which is located relatively centrally in this ~400 km long band. Daily rainfall data were obtained from the Australian Bureau of Meteorology (http://www.bom.gov.au/oceanography/projects/abslmp/data/index.shtml).

Method:

We spatially aggregated the data into 15 zones for the Fitzroy and Whitsundays region, and 5 zones each for the Burdekin, Southern and Northern Wet Tropics, and Cape York regions. For the Whitsundays, Burdekin, Wet Tropics and Cape York, five bands were defined parallel to the coastline:
- Coastal: 0 – 0.1 fractional units across the GBR
- Inshore: 0.1 – 0.25 fractional units across the GBR
- Lagoon: 0.25 – 0.45 fractional units across the GBR
- Midshelf: 0.45 – 0.65 fractional units across the GBR
- Outer shelf: 0.65 – 1 fractional units across the GBR

The Fitzroy region cannot be partitioned up into simple coast-parallel bands, due to its geomorphology around to the Capricorn-Bunkers and Swains complex, and the estuarine Keppel Bay. Consequently, the Fitzroy region was partitioned according to a combination of geomorphological regions and boundary rules (based on distances from coastlines and bioregions) so to reflect its oceanographic and geomorphological characteristics. The Broad Sound was analyzed separately, as its high tidal range and distance from the major Whitsundays and Fitzroy Rivers make this area unrepresentative of the more intensely used and populated areas of the Whitsundays and Fitzroy NRM Regions. The boundaries were chosen to best match those of both the Whitsundays and Fitzroy areas.

The Cape York and Wet Tropics NRM regions were subdivided into three long-shore bands, with the ‘Cape York’ band extending to 14.5 degrees latitude (Lizard Island), and a northern Wet Tropics region, split at Cape Grafton south of Cairns), and the southern Wet Tropics to best capture their differences in geomorphology, rainfall, agricultural use patterns, and population outbreak dynamics of crown-of-thorns starfish.
The statistical methods to relate photic depth to river discharges are described in Fabricius KE, Logan M, Weeks S, Brodie J (2014) The effects of river run-off on water clarity across the central Great Barrier Reef. Marine Pollution Bulletin 84: 191-200, and in Murray Logan, Katharina Fabricius, Scarla Weeks, Ana Rodriguez, Stephen Lewis and Jon Brodie (2014) NERP Project 4.1: Tracking coastal turbidity over time and demonstrating the effects of river discharge events on regional turbidity in the GBR. NERP Progress Report: Southern and Northern NRM Regions. 63 pp
Photic depth: The daily 1 km2 MODIS-Aqua remote sensing data were processed as described by Weeks et al. 2012, Fabricius et al. 2014. Masks were generated to excise optically shallow waters (reefs and very shallow coastal sections of the seabed), and offshore to >200 m bathymetry. As the full gridded daily data series is too large to reside in memory (153,177 grid points per day, over 11 years), it was spatially aggregated into the 35 zones. Data were aggregated to water years (1st October to 30th September) rather than calendar years. Data availability varied greatly between days and months due to cloud cover. To explore temporal differences in photic depth between wet and dry years, the analyses were also performed separately for dry (2002-2006) and wet (2007-2012) years.

Predicted daily tidal amplitudes as a proxy for tidal currents were obtained from the Australian Navy. For each zone, a single tidal location or a set of ‘representative’ tidal locations was chosen, and the mean tidal range per day was calculated across these locations, to reduce computational exhaustion.

Hourly data on wave heights and wave frequencies were obtained from the Queensland State Government, Department of Environment and Heritage Protection (DEHP), from the 4 wave rider buoys available in the study region: Emu Point Buoy for the southern zones, Mackay Buoy for the Whitsunday zones, Townsville Buoy for the Burdekin zone, and Cairns Buoy for the Northern and Southern Wet Tropics. For the Cape York zones, wind data from the Bureau of Meteorology (http://www.bom.gov.au/oceanography/projects/abslmp/data/index.shtml) from Lockhart River were considered more representative than the wave data from the Cairns buoy.

The analyses was based on daily values and performed separately for each zone. In order to explore the long-term photic depth signals, the data were seasonally detrended and smoothed. Gradient boosted model (GBM) and generalized additive mixed effects models (GAMM) were fitted to remove the effects of tides and wind/waves. The residuals

from these GAMM (which thus reflect the photic depth signal after the extraction of wave, tidal and bathymetry signals) were then decomposed to derive the intra-annual trends (i.e., seasonal based on 365.25 day cyclicity) and inter-annual trends in photic depth. Seasonal decomposition was chosen which applies a smoother (typically either a moving average or locally weighted regression smoother) through a time series to separate periodic fluctuations due to cyclical reoccurring influences and long-term trends. Following temporal decomposition, seasonal cycles were re-centered around mean GAMM fitted values, and transformed back into the original photic depth scale via exponentiation.

Limitations:

The analyses only investigated the effects of river runoff on water clarity. This does not indicate that other factors (e.g. coastal developments, dredging) do not additionally affect water clarity; such relationships would have to be investigated separately.

Format:

This dataset comprises 2 shape files and a csv file:
- FabriciusAndLoganNerpDataCorrelations.* (142 kb) (dbf, shp and shx files),
- FabriciusAndLoganNerpDataSummaries.* (142 kb) (dbf, shp and shx files) and
- FabriciusAndLoganNerpSeasonalStatsDataRound.csv (3 kb).

Data Dictionary:

FabriciusAndLoganNerpDataCorrelations.shp:

The shapefile contains a set of polygon zones for 35 zones in the entire. The attributes table contains the strength of the correlation between daily river discharge and daily satellite photic depth, over 11 years.

The attributes are:
- SP_ID: shape id
- Correlatio: correlation value

FabriciusAndLoganNerpDataSummaries.shp:

The shapefile contains a set of polygon zones for 35 zones in the entire GBR. In each zone, we calculated the mean values of hourly or daily values, over 11 years.

The attributes are:
- SP_ID: shape id
- Photic_dep: photic depth (meters), means over 11 years of daily photic depth values, calculated based on an algorithm developed by Scarla Weeks (UQ) and NASA, (equivalent to Secchi depth)
- Tidal_rang: tidal range (meters), means over 11 years of tidal range values (difference between highest and lowest sea-level within each day), calculated from tidal predictions of the Australian Navy.
- Wave_heigh: wave height (meters), means over 11 years of wave height values, calculated from the nearest one of the four coastal DERM Wave Rider Buoys.
- Wind_speed: wind speed (ms-1), means over 11 years of wind speed values, from the nearest BOM station.

FabriciusAndLoganNerpSeasonalStatsDataRound.csv:

Statistics of photic depth controlled to remove the effects of main physical environmental variables (wave height, tidal range) used when assessing how volumes of river freshwater discharges. Data are broken into 35 zones along and across the GBR as well as into dry years (2002 to 2006) or wet years (2007 – 2012).

The attributes are:
- Region: geographical region
- Zone: Coastal, Inshore, Lagoon, Midshelf, Outershelf
- Period: Wet or Dry years
- Maximum: (m) the maximum smoothed photic depth over the year
- MaxDate: (calendar date) date within a year cycle corresponding to the maximum photic depth, typically middle to end of dry season

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| | - Minimum: (m) the minimum smoothed photic depth over the year, showing the difference between dry and wet years in some of the inshore zones<br>- MinDate: (calendar date) date within a year cycle corresponding to the minimum photic depth, typically middle to end of wet season<br>- DeclineTime: (days) duration of time elapsed between the max photic depth and the NEXT minimum photic depth (in the continuous cycle)<br>- Decline: (m) absolute difference between max and min photic depth, showing how much photic depth is lost (in absolute terms) between seasons in wet and dry years in some of the inshore zones.<br>- PercentDecline: the relative decline expressed as a percentage of the max photic depth (unit: percent)<br>- DeclineRate: (m/day) rate of decline<br>- RecoveryTime: (days) duration of time elapsed between the min photic depth and the NEXT max photic depth (in the continuous cycle). Note, DeclineTime and RecoveryTime complete the 365(ish) day cycle. Showing how long it takes to re-establish clear water<br>- RecoveryRate: (m/day) rate of recovery (Decline/RecoveryTime)<br>- Recovery95Date: date within a year cycle corresponding to a recovery of 95% (up to max - decline*0.05)<br>- Recovery95Time: (days) duration of time elapsed between the min photic depth and the NEXT 95% recovery in photic depth (in the continuous cycle). Showing how long it takes to re-establish clear water after wet and dry wet seasons<br>- Recovery95Rate: (m/day) same as RecoveryRate, yet based on 95% recovery (Decline/Recovery95Time) |

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| Metadata language | eng |
| Character set | UTF8 |
| Hierarchy level | Dataset |

## OnLine resource

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| Linkage | https://eatlas.org.au/data/uuid/f9163e51-247e-4bbf-88ec-32fe1616195a |
| Protocol | WWW:LINK-1.0-http--metadata-URL |
| Linkage | https://eatlas.org.au/pydio/data/public/nerp-te-4-1_aims_gbr-water-clarity-vs-river-load_2002-2013-zip.php |
| Protocol | WWW:LINK-1.0-http--downloaddata |
| Linkage | https://maps.eatlas.org.au/index.html?intro=false&z=7&ll=148.95581,-17.70720&l0=ea_nerp%3AGBR_NERP-TE-4-1_AIMS_Water-clarity-vs-rivers_2002-2013_Correlations,ea_ea-be%3AWorld_Bright-Earth-e-Atlas-basemap,google_TERRAIN,google_SATELLITE&v0=,,f,f |
| Protocol | WWW:LINK-1.0-http--related |
| Linkage | https://maps.eatlas.org.au/maps/wms |
| Protocol | OGC:WMS-1.1.1-http-get-map |
| Linkage | https://eatlas.org.au/nerp-te/gbr-aims-coastal-turbidity-river-discharge-4-1 |
| Protocol | WWW:LINK-1.0-http--related |
| Linkage | http://doi.org/10.1016/j.marpolbul.2014.05.012 |
| Protocol | WWW:LINK-1.0-http--link |
| Linkage | http://www.nerptropical.edu.au/publication/project-41-final-report-tracking-gbr-water-clarity-over-time-and-demonstrating-effects |
| Protocol | WWW:LINK-1.0-http--link |
| Linkage | http://doi.org/10.3390/rs4123781 |
| Protocol | WWW:LINK-1.0-http--link |
| Linkage | http://www.nerptropical.edu.au/sites/default/files/publications/files/The%20relationship%20between%20Burdekin%20River...%20Logan%20et%20al%202013.pdf |
| Protocol | WWW:LINK-1.0-http--link |

## Point of contact

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| Role | Point of contact |
| Topic category | Biota |

## Extent

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| Description | Great Barrier Reef, Australia |

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| File identifier | f9163e51-247e-4bbf-88ec-32fe1616195a |
| Metadata language | eng |
| Character set | UTF8 |

## Metadata author

| | |
|---|---|
| Individual name | eAtlas Data Manager |
| Organisation name | Australian Institute of Marine Science (AIMS) |
| Role | metadataContact |
| Date stamp | 2015-12-16T13:58:21 |