# QuaternaryInfo

Quaternary catchment dashboard – in-browser app • Hydrogeological Repository

## What it does

QuaternaryInfo puts everything the national datasets hold for a quaternary catchment on one page. Pick catchments on a map or from a list and it charts **90 years of naturalised monthly flow and rainfall**, **50 years of daily climate**, the WR2012 hydrology and baseflow figures, all 43 GRAII groundwater parameters, the three national hydrogeological covers – borehole yield, Vegter and DRASTIC – and the 2022 census population – for up to six catchments at once, so they can be compared rather than looked up one at a time.

The quaternary catchment is the smallest unit the national water resource studies report on. South Africa has 1 946 of them, and the numbers describing each are scattered across a spreadsheet study, an Access database, a shapefile and 1 946 daily text files. This app joins them on the catchment code and puts them behind one selection.

## Where the data comes from

Seven sources, joined on the quaternary catchment code. **WR2012** is the surface water study; **GRAII** is the groundwater assessment; the last three are the national hydrogeological covers, sampled onto the catchment boundaries here.

| Source | Covers | Period | What it holds |
|---|---|---|---|
| **WR2012 – surface water** | 1 946 | 1920–2009 | Hydrology, baseflow and groundwater use, naturalised monthly flow and monthly rainfall – the datasets listed below. |
| **GRAII – groundwater** | 1 945 | – | 43 parameters over five projects, each a national 1 km grid reduced to one value per catchment – listed below. |
| **Hydroclimatic Data** | 1 946 | 1950–1999 | Daily rainfall, temperature, soil water stores and deficits, runoff, humidity, radiation and reference evaporation – 35.5 million records. |
| **Census** | 1 946 | 2022 | Population within the catchment. |
| **Borehole yield – DWAF** | 1 871 | – | The yield sheet of the 1:500 000 hydrogeological series: median borehole yield and how the water is held, as polygons. |
| **Vegter – groundwater resources** | 1 946 | – | Vegter and Seymour's 1:500 000 resource series: region, recharge, effective rainfall, water level, quality and storage. |
| **DRASTIC – vulnerability** | 1 946 | 2005 | GEOSS's aquifer vulnerability index for DWAF, a 1 km grid running 38 to 197. |

The map also carries the national river network – 10 178 reaches, classed perennial, non-perennial, dry or unclassified, and named where the source names them. It is drawn for context only; nothing in the app is derived from it.

**WR2012** is the *Water Resources of South Africa 2012* study, at waterresourceswr2012.co.za. **GRAII** is the *Groundwater Resources Assessment Phase II*, at www.dws.gov.za/groundwater/GRAII.aspx. The app reports these datasets and does not modify or reinterpret them.

## The WR2012 datasets

| Dataset | Covers | Period | What it holds |
|---|---|---|---|
| **Hydrology** | 1 946 | – | Evaporation and rainfall zone, MAE, MAR, MAP, and recharge as a percentage of rainfall. |
| **Baseflow** | 1 872 | – | Pitman, Hughes and Schultz baseflow estimates, and groundwater use. |
| **Naturalised flow** | 1 944 | 1920–2009 | Monthly naturalised streamflow in million m³, October to September. |
| **Rainfall** | 470 zones | 1920–2009 | Monthly rainfall as a percentage of the zone's mean annual precipitation. |

## The GRAII datasets

GRAII ran as five projects. Each produced national 1 km grids, and the app carries every one of them: the value shown for a catchment is the mean of the grid cells inside it. The project reports supplied with the grids describe how each parameter was derived and are the definitive reference for all of them.

| Project | Subject | Parameters carried |
|---|---|---|
| **1** | Groundwater quantification | Depth to and thickness of the weathered and fractured zones, storativity, transmissivity, groundwater level, and groundwater stored – in total, in the upper 5 m, and above the water-level limit (18 parameters). |
| **2** | Resource and exploitation potential | Drought index, exploitability and potability factors, and the six potential levels – AGRP, AGEP, PGEP, UGRP, UGEP and UPGEP – each for a normal and a drought year (16 parameters). |
| **3** | Recharge, and groundwater–surface water interaction | Mean annual recharge in mm/a and as a percentage of rainfall, recharge in a normal and a drought year, baseflow, and groundwater and rainfall chloride (7 parameters). |
| **4** | Groundwater level change | Change in groundwater level (1 parameter). |
| **5** | Groundwater use | Groundwater use (1 parameter). |

The potential levels build on one another: AGRP is the Average Groundwater Resource Potential, AGEP the Average Groundwater Exploitation Potential, PGEP the Potable Groundwater Exploitation Potential, UGRP the Utilisable Groundwater Resource Potential, UGEP the Utilisable Groundwater Exploitation Potential, and UPGEP the Utilisable Potable Groundwater Exploitation Potential. Transmissivity is the one parameter that comes from the GRAII database rather than a grid – 1.46 million points on the same 1 km lattice, summarised the same way.

**Volumes are per 1 km cell.** Storage, the potential levels and groundwater use are quantities per grid cell, so a catchment total is the value shown multiplied by the cell count, which the app reports alongside them. This was checked rather than assumed: the storage grids sum to 234 km³ nationally, GRAII's published figure for South Africa's groundwater storage.

## The hydrogeological covers

Three national datasets, sampled onto the catchment boundaries for this app rather than supplied per catchment by their authors. Each has a different shape, so each is reduced differently – 27 parameters in all, listed in the attribute table under their own headings. Areas are computed in the same equal-area projection the GRAII grids use, so a share of catchment area means the same here as it does there.

| Cover | How it is reduced | What the app carries |
|---|---|---|
| **Borehole yield** | Share of the mapped area in each class | Five yield bands from 0.0–0.1 to over 5 L/s, four occurrence types, the band and type holding most of the catchment, an area-weighted mean yield, and how much of the catchment the sheet maps (5 parameters). |
| **Vegter** | Area-weighted mean, or the class holding most of the area | Groundwater region and its main rock type, recharge from rainfall, effective rainfall, depth to water level and its standard deviation, TDS, the fluoride and nitrate exceedance indices, and the storage medium, coefficient and optimal drilling depth (13 parameters). |
| **DRASTIC** | Distribution over the 1 km cells in the catchment | Lowest cell, quartiles, median, highest cell, mean, standard deviation, the class holding most of the catchment, and the cell count – 41 to 16 607 of them (9 parameters). |

A catchment is rarely one class, so the yield bands, the occurrence types and the six DRASTIC classes are also carried as **shares of catchment area** and charted as a stacked bar next to the attribute table. A mean can be a value almost none of the ground has: A21A's DRASTIC cells average 107, the middle of the range, while 41 per cent of it is Low (77–90) and 20 per cent Very high (149–197). The quartiles give the spread and the stack gives the shape.

Six of Vegter's nine polygon covers are carried. The baseflow cover is not: its BASE_FLOW_MM is WR2012's Pitman baseflow to a rounding – over the 1 192 catchments both hold, the median difference is 0.024 mm/a – and a second copy of Pitman under another name would read as an independent estimate when it is nothing of the kind. The water-type cover carries a cartographic shading key rather than a value, and the drilling-prospects cover carries banded index codes that its documentation does not resolve.

**Two figures are floors, not measurements.** The yield sheet's top band is open above 5 L/s, so the area-weighted mean yield is a lower bound wherever that band appears. And the sheet stops at the South African border: 1 731 catchments are mapped in full, 140 in part and 75 – Lesotho and the northern border – not at all. Shares are of the part of the catchment the sheet maps, and the app reports that percentage alongside them.

## Two conversions the numbers depend on

**The rainfall table is a percentage, not a depth.** Each monthly value in the WR2012 rainfall file is that month's rainfall as a percentage of the rainfall zone's mean annual precipitation. The app converts it as **mm = percent ÷ 100 × MAP**, using the catchment's own MAP, which is why two catchments in the same rainfall zone share a seasonal pattern but differ in magnitude. Read straight out of the table the values are percentages and are not comparable with anything measured in millimetres.

**Flow and rainfall run October to September.** Both tables are indexed by hydrological year, so the year labelled 1920 covers October 1920 to September 1921. The daily climate record is calendar-based and is carried onto the same hydrological year here, so a runoff series and a rainfall series line up on one axis. Monthly averages are shown in that order too, October first.

## What you get

| Output | Detail |
|---|---|
| **Map** | All 1 946 catchments with labels, shaded by any numeric attribute the app holds – MAP, MAR, population, any GRAII parameter, borehole yield, Vegter recharge or DRASTIC – over the river network, on a street, aerial or hybrid base map. Perennial rivers are solid, the rest dashed. Click to select; Ctrl+click to add; click again to remove. |
| **Attributes** | Every single-value property of the selection – WR2012, all 43 GRAII parameters grouped by project, the 27 hydrogeological parameters grouped by cover, and the census – one column per catchment. |
| **Aquifer character** | How each catchment's area divides between the yield bands, the occurrence types or the DRASTIC classes, as a stacked bar. |
| **Time series** | Any of sixteen quantities, annual or monthly, optionally as a cumulative departure from the mean. |
| **Monthly averages** | The long-term mean of each calendar month – the seasonal signature of the catchment. |
| **Statistics** | Mean, median, standard deviation, coefficient of variation, and the 10th to 90th percentiles of the annual series, with a box plot. |
| **Exports** | CSV of the attributes, flow, rainfall, monthly or daily climate, the chart on screen or the monthly averages; PNG of the map and of every chart; and a printable report. |

## How a run works

| Step | What happens |
|---|---|
| **1. Catchments** | Select on the map or from the searchable list, up to six at a time. |
| **2. Attributes** | The WR2012, GRAII and hydrogeological properties side by side, with the aquifer character chart under them. |
| **3. Time series** | Choose the quantity, the interval, and whether to plot the cumulative departure. |
| **4. Monthly averages** | The seasonal pattern, month by month. |
| **5. Statistics** | Summary statistics of the annual series, and their distribution. |
| **6. Report** | A standalone report of the selection, ready to print or save as PDF. |
| **7. Export** | CSV of any part of the selection. |

## Why this one is not entirely in your browser

The other apps in this collection download their dataset and compute everything on your machine. This one cannot: the database behind it is 2.4 GB, most of it the 35.5 million daily climate records. The catchment boundaries are downloaded once (0.7 MB) and the map, the charts and the statistics are all drawn in the browser, but the numbers for a selection are queried from the server as you select. Nothing about your selection is stored.

## Reducing a grid to one number per catchment

Every GRAII parameter is national and gridded, so each has to be reduced to a single value for a catchment. That value is the **mean of the 1 km cells falling inside the catchment** – between about 55 and 20 000 of them, and the app reports the cell count so the basis is visible.

Four parameters are not averaged that way. Transmissivity, the two storativities and the two chlorides span orders of magnitude and are log-normally distributed – transmissivity's national arithmetic mean is 28.3 m²/d against a median of 19.7 – so those carry the **geometric mean**, which is the conventional representative value. The database records which statistic each parameter uses, and the app shows it when a row is hovered.

## Limitations worth knowing

- These are modelled national datasets, not measurements at a point. Naturalised flow is what the catchment would have yielded without dams, abstraction or afforestation – it is not gauged flow and it is not what the river does today.
- The rainfall series is a zone average scaled to a catchment MAP, so every catchment in a rainfall zone has the same year-to-year pattern. The 470 zones cover 1 946 catchments.
- Every GRAII parameter is a regional interpolation averaged over the catchment. They are the right starting point for a regional assessment and the wrong basis for siting a borehole.
- The records do not overlap fully. Flow and rainfall run 1920–2009, the hydroclimatic record 1950–1999, and the census is a single 2022 snapshot, so a statistic from one is not a like-for-like comparison with another.
- A few catchments are reported jointly in WR2012 – B20A and B20B, for instance, share one set of figures – and a handful have no naturalised flow at all in the arid interior. The app shows what the source holds and leaves the gaps empty rather than filling them.
- Not every dataset reaches every catchment, so the Covers column above is the count that matters rather than 1 946 – the borehole yield sheet reaches 1 871 of them and the naturalised flow file 1 944.
- The boundaries are DWAF's national quaternary cover, with one change: it draws A80E and A80F as a single polygon, and WR2012 reports them as two catchments with their own hydrology, flow and census. They are shown separately here, divided on the line the previous edition of the cover used, so that each can carry its own figures.
- The hydrogeological covers are 1:500 000 mapping from the 1990s and a 2005 grid. They describe a catchment, not a site, and they are older than the WR2012 hydrology beside them.
- DRASTIC is built partly on GRAII's recharge and water level, so it is not an independent check on the GRAII rows in the same table.
- Six catchments is the limit for one selection. More makes the charts unreadable before it makes them slow.
- The Map (OpenStreetMap) base map may be dropped from an exported PNG by the browser. Aerial and Hybrid export cleanly.

**Checked against the sources.** Every WR2012 value was compared cell by cell with the source workbook, the monthly climate summaries reproduce the daily record exactly (35 537 852 days, identical totals), and the mean annual flow of a catchment matches its published MAR. The rainfall percentage conversion was verified against MAP across all 470 zones and 90 years. The sampled hydrogeology was checked the same way: the catchment areas sum to the GRAII mapped area to within 1 km², and the area-weighted DRASTIC mean reproduces the mean of the raw grid. Vegter's recharge is the one figure with two independent counterparts – nationally it gives 25.9 mm/a against GRAII's 24.0 and WR2012's 24.0, correlated at r = 0.83.

## Credit

The data is the work of the WR2012 study team, of the Groundwater Resources Assessment Phase II, of the compilers of the hydroclimatic record, of J R Vegter and A Seymour, of the DWAF 1:500 000 hydrogeological mapping programme, and of GEOSS for the DRASTIC index. This app presents their published datasets and claims no authorship of them. The sampling of the three hydrogeological covers onto the catchment boundaries is the app's own work; the covers themselves are unaltered.

**Beta.** QuaternaryInfo is published for evaluation and feedback. Check any figure you rely on against the original study before using it in an assessment.