Comments from Public Consultation on ECV Requirements 13/01 – 13/03 2020 for:

# Groundwater

## ECV Product: Groundwater quality

### Groundwater quality has been officially removed from the ECV Groundwater products since it is not directly related to climate change or the climate cycle.

### Comment 1

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| --- | --- |
| Author: Andrew Ferrone | Email: pr.wmo.luxembourg@gmail.com |
| Luxembourg considers that it would be important to reinstate groundwater quality as ECV because climate change will cause variations in temperatures and precipitation. These changes will have an impact on water consumption and the recharge of groundwater. With higher consumption and lower recharge, the pollutant concentrations will be higher (reduced dilution effect). The quality of groundwater can therefore indirectly be linked to climate change. | |

## ECV Product: Wellhead Level

Wellhead level has been officially removed from the ECV Groundwater Products. It is interesting to monitor changes in elevation to know if there is land subsidence, but this escapes from the scope of the ECV Groundwater.

## ECV Product: Groundwater Discharge

Groundwater discharge is rarely measured directly but it is often estimated via indirect methods (e.g. models) and is not monitored on a regular base, either globally or regionally. If groundwater discharge is part of the ECV groundwater products, it would be extremely difficult for the users to try to comply with its requirements, and the added value of it will not be substantial. Therefore, groundwater discharge has been officially removed from the ECV Groundwater Products.

### Comment 1

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| --- | --- |
| Author: Andrew Ferrone | Email: pr.wmo.luxembourg@gmail.com |
| Luxembourg considers that it would be important to reinstate groundwater quality as ECV because knowing the exact quantities of groundwater makes it possible to know whether the recharge of water is decreasing or not with climate change. If a decrease is visible, this might influence the drinking water consumption and alternative resources will be needed. In terms of adaptation to climate change, this is important information. | |

## ECV Product: Groundwater Recharge

Groundwater recharge is usually derived from other observed parameters and not directly measured. At the moment, WHYMAP ([www.whymap.org](http://www.whymap.org/)) presents a global overview of groundwater recharge, but with static values - it requires considerable efforts to keep it updated at the same pace of other climate change variables that influence it, e.g. precipitation changes. Therefore, groundwater discharge has been officially removed from the ECV Groundwater Products.

However, there are some efforts in monitoring groundwater recharge, for example <http://www.amma-catch.org/> at a regional level. However, it is not possible to generalize this activity to define global requirements.

## ECV Product: Groundwater Storage Change

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | Groundwater Storage Change | | | | |
| **Definition** | The volumetric loss or gain of groundwater between two times period | | | | |
| **Unit** | km3/year or mm/year | | | | |
| **Note** | Ground water storage change is monitored at large spatial scales by satellite gravimetry. To isolate groundwater storage change from the total mass variations observed by satellite gravimetry, all other mass changes in the Earth system need to be subtracted by complementary observations or models. | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | km | Length/width of area that can be resolved | G | ≤ 100 | depends on size of aquifer, hydrogeological characateristics, and type of application. 100 km is defined as a goal/target value by ref#1 |
| B |  |  |
| T | 200-300 | horizontal resolution of GRACE water storage data, depending on product, signal strength, geographical location and time scale (ref #1,#2,#3) |
| **Vertical Resolution** | N/A |  | G |  |  |
| B |  |  |
| T |  |  |
| **Temporal Resolution** |  | time | G | Biweekly | Requirement for the analysis of the groundwater response to, e.g., recharge events or changes in (human) withdrawals |
| B | Monthly |  |
| T | Seasonal | Requirement for assessing, e.g., the climatology of groundwater storage variations and long-term variations / trends |
| **Timeliness** |  | time | G | Near-real time | Requirement for risk management (droughts), short-term forecasts |
| B | monthly | Requirement for, e.g., seasonal forecasts |
| T | annually | Minimum requirement to assess long-term storage varations |
| **Required Measurement Uncertainty** | mm/yr | Change in water storage in water equivalents (volume per area) between two time periods | G | 1 | Goal value to allow for a much larger number of aquifers or river basins of smaller size to be monitored than for threshold value (ref #1), or for detecting more subtle rates of groundwater storage change. Depending on the time scale of application (e.g., for the assessment of monthly anomalies or long-term trends), the required measurement uncertainties may vary. It should be noted that the measurement uncertainty based on satellite gravimetry varies largely and in a non-linear way with spatial resolution, i.e., it is given as 0.05, 1, 5, 50 mm/year for 400, 200, 150, 100 km spatial resolution (ref #1). Additional uncertainty is added by isolating groundwater storage from total mass changes observed by satellite gravimetry. |
| B |  |  |
| T | 10 | Expert judgement, based on long-term groundwater trends as observed with GRACE for large aquifers (≥ 50000 km²) (ref #2, #4), given that these observations already provided valuable information on the status of large aquifers. Depending on the time scale of application (e.g., for the assessment of monthly anomalies or long-term trends), the required measurement uncertainties may vary. |
| **Stability** | mm/yr |  | G | 1 | Based on subtle expected long-term groundwater trends in large aquifers |
| B |  |  |
| T | 10 | Based on expected long-term groundwater trends as observed with GRACE for large aquifers (≥ 50000 km²) (ref #2, #4) |
| **Standards and References** | #1 Pail, R., Bingham, R., Braitenberg, C., Dobslaw, H., Eicker, A., Güntner, A., Horwath, M., Ivins, E., Longuevergne, L., Panet, I., Wouters, B., and the IUGG Expert Panel (2015): Science and User Needs for Observing Global Mass Transport to Understand Global Change and to Benefit Society. Surveys in Geophysics, 36, 743-772, 10.1007/s10712-015-9348-9.  #2 Frappart, F., and Ramillien, G. (2018): Monitoring Groundwater Storage Changes Using the Gravity Recovery and Climate Experiment (GRACE) Satellite Mission: A Review. Remote Sensing, 10, 10.3390/rs10060829.  #3 Rodell, M., Famiglietti, J. S., Wiese, D. N., Reager, J. T., Beaudoing, H. K., Landerer, F. W., and Lo, M. H. (2018): Emerging trends in global freshwater availability, Nature, 557, 650-+, 10.1038/s41586-018-0123-1.  #4 Chen, J. L., Famiglietti, J. S., Scanlon, B. R., and Rodell, M. (2016): Groundwater Storage Changes: Present Status from GRACE Observations. Surveys in Geophysics, 37, 397-417, 10.1007/s10712-015-9332-4. | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** | yes | yes | Groundwater storage change is a direct indicator whether groundwater resources are at risk due to unstainable water withdrawals and/or environmental change. As a consequence, groundwater may not sufficiently serve anymore its function of supplying human and/or ecosystem water demand. This ECV product is therefore directly relevant for designing and evaluating the performance of adaptation measures towards sustainable groundwater management and use. | | |
| **Extremes[3]** | yes | yes | The ECV product groundwater storage change can be used to monitor the effects of the climate extremes heat waves and meteorological droughts on groundwater resources. | | |

[1]Goal (G); Breakthrough (B)(not mandatory, more as one possible); Threshold (T), for definitions see [Guidelines](http://tiny.cc/ecv-review)

[2] Is the ECV Product directly relevant to support Climate Adaptation?

[3] Can the ECV Product be used to monitor climate extremes or aspects of extremes?

NO COMMENT

## ECV Product: Groundwater Level

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| --- | --- | --- | --- | --- | --- |
| **Name** | Groundwater Level | | | | |
| **Definition** | The level (depth or elevation) of the water table, the upper surface of the saturated portion of the soil or bedrock | | | | |
| **Unit** | m | | | | |
| **Note** | Groundwater levels are measured in monitoring wells. The measurements are expressed in m (below ground surface or above sea level, depending on the reference system). | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** |  | Density of wells (number of wells/area) | G | Depends on hydrogeology | Expert judgment |
| B | Depends on hydrogeology | Expert judgment |
| T | Minimum of 1 well per 100 km2 | This is the horizontal resolution recommended by the U.S. Geological Survey (USGS). |
| **Vertical Resolution** | N/A |  | G |  |  |
| B |  |  |
| T |  |  |
| **Temporal Resolution** |  | time | G | Biweekly | Expert judgment |
| B | Monthly | Expert judgment |
| T | Seasonal (wet/dry) | Expert judgment |
| **Timeliness** |  | time | G | Real-time | Expert judgment. When resources are available, a real-time monitoring network with telemetry can be set up, allowing the public to get data immediately. When quality checks are performed, international experience shows that data can be released in 2 or 3 days. |
| B | Twice per year | Expert judgment. International experience shows that when missions have to be carry out to measure groundwater levels, half a year is an adequate time span to go over all locations, measure the levels, come back to the office, perform data quality tests and upload the final data in the online database to make it available to the public through official channels. |
| T | Annually | Timeliness is directly related to the use of technology to get the data (telemetry vs going to the field to collect the data). |
| **Required Measurement Uncertainty** |  |  | G | 1 mm or less | Depending on the size and gradient of the aquifer, higher uncertainties may have a significant impact on the estimation of the water table. Also, there are other parameters that could have a higher impact on the uncertainty of the recording, as ill-defined vertical datums, pumping wells disrupting groundwater flow patterns, inadequate location of the well, inadequate length of screen setting, etc. |
| B |  |  |
| T |  |  |
| **Stability** | cm | A stable trend can be defined as an average monthly change in groundwater levels that is less than a certain value (e.g. 10 cm), for a series of consecutive years (for example, 5, 10 or 20 years). A specific number and density of point data are needed depending on the period to be considered: | G | 10 cm | \*For 5 years trend, 10 or more data points are required, and at least one reading per year for 4 years out of the 5.  \*For 10 years trend, 20 or more data points are required, and at least one reading from each consecutive two year period.  \*For 20 years trend, 40 or more data points are required, and at least one reading from each consecutive four year period.    This method is the one used by the Bureau of Meteorology (Australia), which is one of the several methods used around the world to estimate a stable trend in groundwater levels. |
| B |  |  |
| T |  | \*It is important to notice that each country might have its own threshold value depending on how marked seasonal fluctuations are (depending on precipitation regimen and hydrogeology, among others) |
| **Standards and References** |  | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** | Yes | Yes | This product is relevant to study whether an aquifer is being depleted an at what rate, to study trends and periodic fluctuations (caused either by precipitation or seasonal abstraction), and in general, to see if groundwater is available in places where more water is needed (especially places suffering from floods or droughts). | | |
| **Extremes[3]** | Yes | Yes | The ECV product groundwater level can be used to monitor the effects of the climate extremes heat waves and meteorological droughts on groundwater resources. | | |

[1]Goal (G); Breakthrough (B)(not mandatory, more as one possible); Threshold (T), for definitions see [Guidelines](http://tiny.cc/ecv-review)

[2] Is the ECV Product directly relevant to support Climate Adaptation?

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NO COMMENT