

### 3.16 Description of the Malta Mean Sea Level Aquifer System case study, Malta

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|----------------------------|--------------------------------------------|
| Title of Case Study        | Malta Mean Sea Level Aquifer System (MSLA) |
| Location (region, Country) | Malta                                      |
| Other information          |                                            |

#### Description of Case Study (background information on the region)

The Malta Mean Sea Level Aquifer system extends over an area of 216.6km<sup>2</sup>, underlying almost the whole land-area of the island of Malta. Over this area, a freshwater lens is developed in the Lower Coralline Limestone, a permeable carbonate formation which extends to depth beneath the island. The groundwater body essentially takes the form of a freshwater lens floating on the denser sea-water and hence is in lateral vertical and horizontal contact with the bounding sea-water in the bedrock. It is therefore highly vulnerable to sea-water intrusion in response to abstraction activities, and therefore groundwater abstraction needs to be carefully managed to protect the quality of the abstracted water from the direct intrusion of sea-water under the abstraction point (sea-water upconing).

#### Description of problem (why is this location chosen for a Cases Study)

The Malta mean sea-level aquifer (MSLA) system is by far the most important groundwater body in the Maltese islands, providing around 65% of the total mean annual groundwater yield. The strategic importance of this groundwater body for the water supply of the Maltese islands warrants an increased understanding of the aquifer system in order to increasingly ensure its sustainable use.

The conceptual models of this aquifer system project a slow responding groundwater body as a result of its high storage capacity to annual recharge ratio. The aim of this case study was focused on the assessment of the groundwater residence time in the saturated zone, and therefore confirming the understanding of the conceptual model of the aquifer system. A slow responding groundwater body offers more resilience to the quantitative impacts of prolonged droughts and therefore offers broader management possibilities.

#### Methods to be used in the Case Study (analytical and isotope techniques, modelling)

The case study involves the application of <sup>3</sup>H as an isotopic tracer reflecting the expected age-range derived from the conceptual model of the groundwater body, supported by CFCs and SF<sub>6</sub> as additional tracers.

#### Results from this Case Study

A key finding of this case-study is the confirmation of the long saturated zone residence times in the Malta mean sea-level aquifer system. This result has important implications from a water management perspective. The long residence times confirm:

- (i) the high recharge to storage ratio characteristics of the groundwater body, thereby increasing its resilience to short-term over-abstraction; and
- (ii) the long expected response times of the groundwater body to the implementation of measures in its surface catchment area.

**Impact - how this Case Study contributes to the overall project aims (see objectives WP6)**

This case study focuses on groundwater residence times and the response function of the aquifer system to groundwater management actions. It therefore contributes to the objectives of WP6 related to the assessment of groundwater age. Other aspects of the case study which focused on the source tracing of nitrate contamination, support further assessments under HOVER WP5 related to the determination of travel times for nitrate to groundwater.

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| <b>Name of pilot area / aquifers / type:</b><br>Malta Mean Sea Level Aquifer                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Country:</b> Malta<br><br><b>Region:</b> Malta |  |
| <b>Study level</b>                                                                                                                                         | Transboundary : <input type="checkbox"/> Regional: x      Local: <input type="checkbox"/> Single well(s): <input type="checkbox"/>                                                                                                                                                                                                                                                                                                            |                                                   |  |
| <b>Type of observations</b><br><i>(choose one of the options, create separate template if needed for each type if each type need specific information)</i> | <input type="checkbox"/> Short screened observation wells (not pumped)<br><input type="checkbox"/> Long screened observation wells (not pumped)<br><input type="checkbox"/> Pumped wells, long screens in one aquifer<br><input type="checkbox"/> Pumped wells, long screens over multiple aquifers<br><input type="checkbox"/> Springs<br>x Other (unscreened observation and pumping wells, drilled in a consolidated carbonate formation): |                                                   |  |
| <b>Approximate location of pilot:</b>                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                   |  |
| <b>Geological cross section / conceptual model of the pilot area:</b>                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                   |  |

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| Name of Shape- / Geopackage file defining the area:                                                                                                                                                                                                                                                    |                                               | Projection to be used:<br>WGS84 (Epsg4326)                                                                                                                                                                                                                                                                                                                                                                                                 |                                                   |                                                                                   |
| Hydrological parameters:                                                                                                                                                                                                                                                                               | Mean annual precipitation (mm or range in mm) | Mean annual groundwater recharge (mm or range in mm)                                                                                                                                                                                                                                                                                                                                                                                       | Mean annual groundwater recharge temperature (°C) | Thickness of unsaturated zone (range in m)                                        |
|                                                                                                                                                                                                                                                                                                        | 550mm                                         | 135                                                                                                                                                                                                                                                                                                                                                                                                                                        | 19                                                | 50 - 100                                                                          |
| Pumped wells only                                                                                                                                                                                                                                                                                      |                                               | Typical pump discharge of sampled individual well (m <sup>3</sup> /day): 200                                                                                                                                                                                                                                                                                                                                                               |                                                   | Typical pump discharge of complete well field (m <sup>3</sup> /day): Not Relevant |
| List of aquifers and aquitards in pilot area                                                                                                                                                                                                                                                           |                                               | No. of confined or semiconfined aquifers in pilot area:                                                                                                                                                                                                                                                                                                                                                                                    |                                                   | No. of unconfined aquifers in pilot area: 1                                       |
| Aquifer no. (aqf): 1<br>Aquitard no. (aqt):<br>Aquiclude no. (aqc):                                                                                                                                                                                                                                    | Aquifer/aquitard type and/or name             | Lithology ( <i>Resource WP6 terminology</i> )                                                                                                                                                                                                                                                                                                                                                                                              | Depth range (m)                                   | GW age range (yr)                                                                 |
| Aqf-1:                                                                                                                                                                                                                                                                                                 | Lower Coralline Limestone                     | Limestone                                                                                                                                                                                                                                                                                                                                                                                                                                  | +150 - -160                                       | 15 – 40 (residence time)                                                          |
| Porosity type                                                                                                                                                                                                                                                                                          | Porous: <input type="checkbox"/>              | Fissured: <input type="checkbox"/>                                                                                                                                                                                                                                                                                                                                                                                                         | Karst: <input type="checkbox"/>                   | Fissured and porous / dual porosity: x                                            |
| Applied tracer age indicators ( <sup>3</sup> H, <sup>3</sup> H/ <sup>3</sup> He, <sup>85</sup> Kr, <sup>39</sup> Ar, <sup>14</sup> C, <sup>36</sup> Cl, <sup>81</sup> Kr, <sup>4</sup> He, CFCs, SF <sub>6</sub> , etc.)<br>Applied recharge temperature indicators ( <sup>18</sup> O, D, noble gases) |                                               | Aquifer-1<br><sup>3</sup> H, CFCs, SF <sub>6</sub>                                                                                                                                                                                                                                                                                                                                                                                         |                                                   |                                                                                   |
| Number of sites (wells/springs) with age indicators                                                                                                                                                                                                                                                    |                                               | Aquifer-1<br>1-5: <input type="checkbox"/> 5-10: <input type="checkbox"/> 10-25: x >25: x                                                                                                                                                                                                                                                                                                                                                  |                                                   |                                                                                   |
| GW age range (GAR)<br>GAR-1: Modern (< 60 yr)<br>GAR-2: Old (> 60 yr and 10 kyr)<br>GAR-3: Paleowaters (> 10 kyr)                                                                                                                                                                                      |                                               | Aquifer-1<br>GAR-1: 1-10%: <input type="checkbox"/> 10-25%: <input type="checkbox"/> 25-50%: <input type="checkbox"/> >50%: <input type="checkbox"/><br>GAR-2: 1-10%: <input type="checkbox"/> 10-25%: <input type="checkbox"/> 25-50%: <input type="checkbox"/> >50%: <input type="checkbox"/><br>GAR-3: 1-10%: <input type="checkbox"/> 10-25%: <input type="checkbox"/> 25-50%: <input type="checkbox"/> >50%: <input type="checkbox"/> |                                                   |                                                                                   |
| Groundwater age ranges (GAR) estimated by:                                                                                                                                                                                                                                                             |                                               | Tracer based estimates x<br>Flow and age model simulations <input type="checkbox"/><br>Combination of model and tracer estimates <input type="checkbox"/><br>Expert judgement: <input type="checkbox"/>                                                                                                                                                                                                                                    |                                                   |                                                                                   |
| Objective of age dating studies:                                                                                                                                                                                                                                                                       |                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                   |                                                                                   |
| Basic research or General groundwater management                                                                                                                                                                                                                                                       | Assessment of pollutant history               | Assessment of the efficiency of remediation and mitigation measures                                                                                                                                                                                                                                                                                                                                                                        |                                                   | Indication of vulnerability of aquifers and water supply wells                    |



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| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | X                             |                   |                                                   |                 |                            |                               |
| <b>Water Usage</b><br><i>(not relevant for observation wells)</i>                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Water supply</b>           |                   | <b>Irrigation</b>                                 | <b>Industry</b> | <b>Other</b>               |                               |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | X                             |                   | X                                                 | X               |                            |                               |
| <b>Geoenery related activities</b><br><i>(not relevant for observation wells)</i>                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Shallow Geo-T</b>          | <b>Deep Geo-T</b> | <b>Hydrocarbons</b>                               |                 | <b>Nuclear waste disp.</b> | <b>CO<sub>2</sub> storage</b> |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                               |                   |                                                   |                 |                            |                               |
| <b>Mining activities</b><br><i>(not relevant for observation wells)</i>                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Construction materials</b> |                   | <b>Minerals / metals</b>                          | <b>Coal</b>     | <b>Other</b>               |                               |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | X                             |                   |                                                   |                 |                            |                               |
| <b>REFERENCES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                               |                   |                                                   |                 |                            |                               |
| <b>OPEN Access reports and papers</b> (PDF versions made available in EGDI repository making them downloadable via maps and keyword / free text searches):<br><br>BGS (2008) A Preliminary Study on the Identification of the Sources of Nitrate Contamination in Groundwater in Malta Results and Interpretation. British Geological Survey, UK.<br><br>EWA (2015) Second Water Catchment Management Plan for the Malta Water Catchment District 2015-2021. Energy and Water Agency, Malta. |                               |                   | <b>Reports and papers with restricted access:</b> |                 |                            |                               |
| <b>Remarks / other relevant information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                               |                   |                                                   |                 |                            |                               |