IN THE MED

Innovative and Sustainable Groundwater Management in the Mediterranean

D2.2 Report on the Existing Historical Groundwater Data in the MED Region

VERSION 1

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Executive Summary

The overall objective of the InTheMED project is to implement innovative and sustainable management tools and remediation strategies for MED aquifers (inland and coastal) in order to mitigate anthropogenic and climate-change threats by creating new long-lasting spaces of social learning among different interdependent stakeholders, NGOs, and scientific researchers in five field case studies. These are located at the two shores of the MED basin, namely in Spain, Greece, Portugal, Tunisia, and Turkey.

InTheMED will develop an inclusive process that will establish an ensemble of innovative assessment and management tools and methodologies including a high-resolution monitoring approach, smart modelling, a socio-economic assessment, web-based decision support systems (DSS) and new configurations for governance to validate efficient and sustainable integrated groundwater management in the MED considering both the quantitative and qualitative aspects.

This is the Deliverable 2.2, which summarises the work of Task 2.2: “Review and collect the available groundwater quantity and quality data sets in the MED region". The groundwater data in the Mediterranean has a very contrasting distribution. A large portion of them is not centralized and openly accessible, resulting in a lack of detailed assessment of groundwater status at the regional Mediterranean scale. The groundwater monitoring networks of the partner InTheMED countries were analysed to understand the existing data. Furthermore, data that was openly accessible was collected, developing a database with over 9,500 piezometers. Collecting groundwater quality data, however, remains a challenge for most of the cases.

1. Introduction

The Mediterranean region is expected to experience one of the most extensive freshwater availability decreases at a global scale due to climate change (Cramer et al., 2018). Groundwater resources will become even more critical as water demands increase in an already water-limited region. A robust database of spatially distributed and long-term measurements is necessary to identify long-term trends of storage change or chemical composition. However, the heterogeneity and low data density across the region are significant constraints for present and future management (Leduc et al., 2017).

Groundwater is a strategic resource for domestic supply, agriculture, and other economic activities but is also an essential part of ecosystems. Intense groundwater abstractions exceeding recharge can lead to long-term depletion with catastrophic consequences on streamflow and groundwater-dependent ecosystems, as well as land subsidence and salt-water intrusion in aquifers. The chemical composition of groundwater is also of concern, as the concentration of certain compounds can compromise the safety of the water for people, economic activities, and ecosystems. To determine groundwater status, data on quantity and chemical quality are monitored.

One of the objectives of InTheMED is to strengthen the understanding of groundwater functioning and trends. Work Package 2 is focused on acquiring historical MED data, analyzing and sharing of collected data, and enriching data availability, using the High-Resolution Monitoring Approach (HRMA) in case studies characterized by limited data conditions. This report aims to describe the existing data and its availability. First, an overview of the public monitoring systems within the partner countries, as well as available data in global datasets, is conducted. Then, a description of the collected data is reported.

In the assessed monitoring systems, groundwater data is generally collected, processed, and stored by monitoring systems managed by public institutions related to water supply, risk management, or environmental protection. Authorities then create public reports on the current status of groundwater. However, the data is not always publicly shared for external scientific analysis.

2. Groundwater quantity

As an approximation to changes in water storage in groundwater systems, groundwater levels are measured as the distance between the surface and the saturated zone or the elevation of the water table, the top of the saturated zone in a groundwater body. It naturally fluctuates as precipitation, or other groundwater bodies recharge the aquifer or by discharge, and groundwater withdrawals by boreholes. This section focuses on describing the existing data on groundwater quantity.

2.1. Global databases

One of the most used national-scale water budget data sources is FAO's Global Information System on Water and Agriculture (AQUASTAT). Based on national statistics voluntarily given by the countries, based on their accounting, AQUASTAT collects, analyses and provides free access to variables such as long-term hydrological averages such as precipitation and renewable water resources, time-bound water use per sector and source, as well as irrigation extent. While the level of disaggregation is not suited for local groundwater management, it provides context. Most countries account for groundwater withdrawals below the annual renewable volume in the last two decades, except for Tunisia and one year Portugal (Table 1).

Table 1. AQUASTAT Groundwater long-term renewal and annual withdrawals

Country	Total renewable groundwater km^3/yr	Groundwater withdrawal km^3/yr						
		1992	1997	2002	2007	2012	2017	2018
Greece	10.3	3.0	3.3	3.5	3.6	5.6	6.2	6.2
Italy	43.0	-	-	-	-	-	-	-
Portugal	4.0	-	-	-	4.8	3.7	1.9	1.9
Spain	29.9	5.3	4.3	5.9	6.5	6.5	6.4	6.4
Tunisia	1.6	-	-	1.9	2.0	2.2	2.7	2.7
Turkey	67.8	-	-	10.0	12.0	13.6	15.5	16.2

Source: (FAO, 2020)

The International Groundwater Resources Assessment Center (IGRAC) created the Global Groundwater Monitoring Network (GGMN), a participative network of networks to improve access to groundwater monitoring information. The GGMN web-based platform collects and openly shares groundwater level data. However, in all the Mediterranean countries, the only available data is from Portugal and a handful of observation wells in south France.

2.2. National databases

All MED partner countries have groundwater level monitoring systems (Table 2). National scale authorities enforce monitoring requirements, while subnational authorities, either province or river basin operators, handle monitoring and data production for the local groundwater bodies. In some cases, like Greece, Portugal, Spain, and Turkey, the data is collated and centralized by the national authority to build a national database. In other cases, the data are sparse in the different subnational authorities with different formats, captured variables, and quality standards, like in Italy and Tunisia.

Annual or five-year reports summarize the current status of groundwater levels compared to the available time series or the few years previous. In the case of the European countries, these reports inform management and the advances of the River Basin Management Plans to comply with the European Water Framework Directive. Only Greece, Portugal, and Spain disseminate data in a centralized format available for open download online. The networks of Spain and Portugal include historical data in the publicly available database. While in Greece, the uploaded database only accounts for a three-year campaign during 2013-2015. In Italy, the monitoring authorities only have print records of data from the last century, and digital versions are available only from the previous two decades. In Tunisia and Turkey, the data is not openly shared.

Altogether, the six countries accumulate up to 15 thousand stations in their monitoring networks. The networks follow a similar trajectory where initially, the measurements were done manually, and later on, some sites were automatized. In most cases, the measurement of groundwater levels is done monthly

Table 2. Groundwater quantity monitoring scheme per InTheMED consortium countries

Country	Institutions in charge of monitoring, storing, and disseminating	Institutional data storage	Approximate amount of stations in the network	Approximate frequency of measurement	Publicly available online	Data dissemination
Greece	Special Secretariat for Water, Institute of Geology and Mineral Exploration (IGME)	Centralized	1,392	monthly	Yes	Three-year monitoring campaign available online
Italy	Regional authorities, either hydrology service or risk protection service	Regional	3,970	varies within regions from every three days to monthly	No	Annual reports of the measured data made by each region
Portugal	Portuguese Environmental Agency, National System of Water Resources Information (SNIRH)	Centralized	990	monthly (some daily)	Yes	Complete and updated database available online. Annual report for the whole country.
Spain	Ministry for Ecological Transition and the Demographic Challenge	Centralized	2,890	monthly	Yes	Complete and updated database available online. Report per river basin.
Tunisia	General Directorate of Water Resources (DGRE) and the National Water Distribution Utility (SONEDE)	Regional	3,100	twice a year	No	Annual reports made by GDRE of groundwater level status are not available online
Turkey	State Hydraulic Works (DSI) , Ministry of Forestry and Water	Regional	2,748	varies from weekly to monthly	No	Reports made by the Ministry of Forestry and Water

Sources: (Closas et al., 2017; Harmancioglu and Altinbilek, 2020; IGRAC, 2020)

Information about groundwater withdrawals is crucial to understanding the anthropogenic influence on groundwater storage. The six countries have control systems where groundwater withdrawal above a specific volume requires official permits that the authorities give based on groundwater availability. In all cases, the data about extraction permits was sparse, not openly available, or inexistent. But even accounting for the volumes of allocated water, according to different studies in the region, there is still a large proportion of water that is extracted beyond the permitted volumes (Closas et al., 2017; Harmancioglu and Altinbilek, 2020; Novo et al., 2015).

2.3. Collected data

We are building a database by obtaining data from several sources, processing it for quality checks and metadata creation, and then structuring the data into a standard format (Figure 1). We tailored a strategy for each country with the rationale of obtaining the most extended possible time series from official sources. These strategies have included so far:

- Downloading data from centralized national monitoring systems. This was the case for Portugal and Spain. Portugal's website (https://snirh.apambiente.pt/ respectively) has easy access to bulk download options, while in the case of Spain (https://www.miteco.gob.es/es/cartografia-y-sig/ide/descargas/agua/red-piezometrica.aspx), a web-scrapping tool was developed to obtain the data.

- Requesting the data from sub-national authorities without a centralized national system. This was the case for Italy, where it was necessary to establish contact by email or phone with all the agencies in charge of collecting the groundwater level data. Some of it was digital, and other was received in the form of scanned documents (especially for data before the year 2000). This work was possible with the assistance of the team at the University of Parma

- Requesting local researchers to help obtain data where language barriers or data sharing policies made it difficult to consult directly with the relevant authorities. This was the case for Greece and Tunisia. For the former, a national system that collects groundwater level data exists, but the data in most cases only starts in 2012. So, with the team's help in the Technical University of Crete more extended time series have been collected. In the case of Tunisia, the data has been shared by strategic contacts that have access to it.

- We have also collected data from public reports and published research. In Turkey groundwater level data sharing is very restricted. So with the help of the team from Boğaziçi University, we have retrieved time series data by digitizing figures in national reports about groundwater levels. We have also collected some data from published papers.

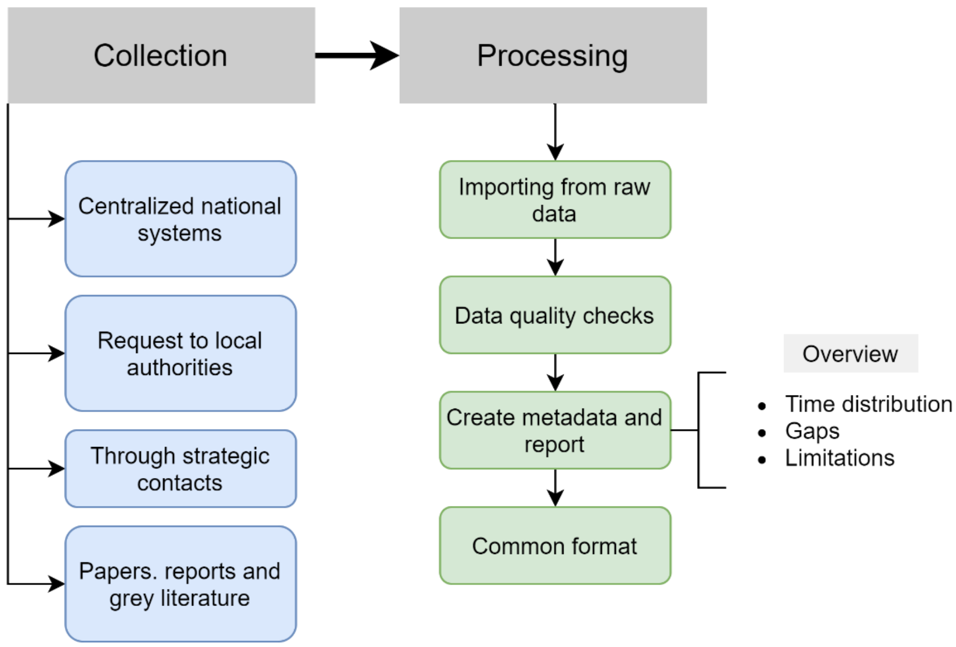

Figure 1. Collection and processing workflow for the groundwater database

At the moment this report is being made, groundwater level data have been collected from 9,500 piezometers across the region, including all the countries in study cases of the InTheMED project. We have found the time series to have very contrasting time series lengths, measuring frequency and completeness. The additional data describing the piezometers are also contrasting according to the region. More data has been collected from countries with a central monitoring network that provide for a data sharing platform (Portugal and Spain). This also means that for other countries, the increase of available data will be more gradual as we collect data from the different subnational authorities.

The spatial distribution of the collected piezometers (Figure 2) has a denser coverage in the European countries compared to Turkey and Tunisia due to the nature of the monitoring systems and data sharing. In Italy, it hasn't been possible to obtain data from some of the subnational authorities, and in some cases, an entire province has only a few piezometers. When looking at a regional scale, it's clear that further efforts are necessary to collect data for the southern Mediterranean countries.

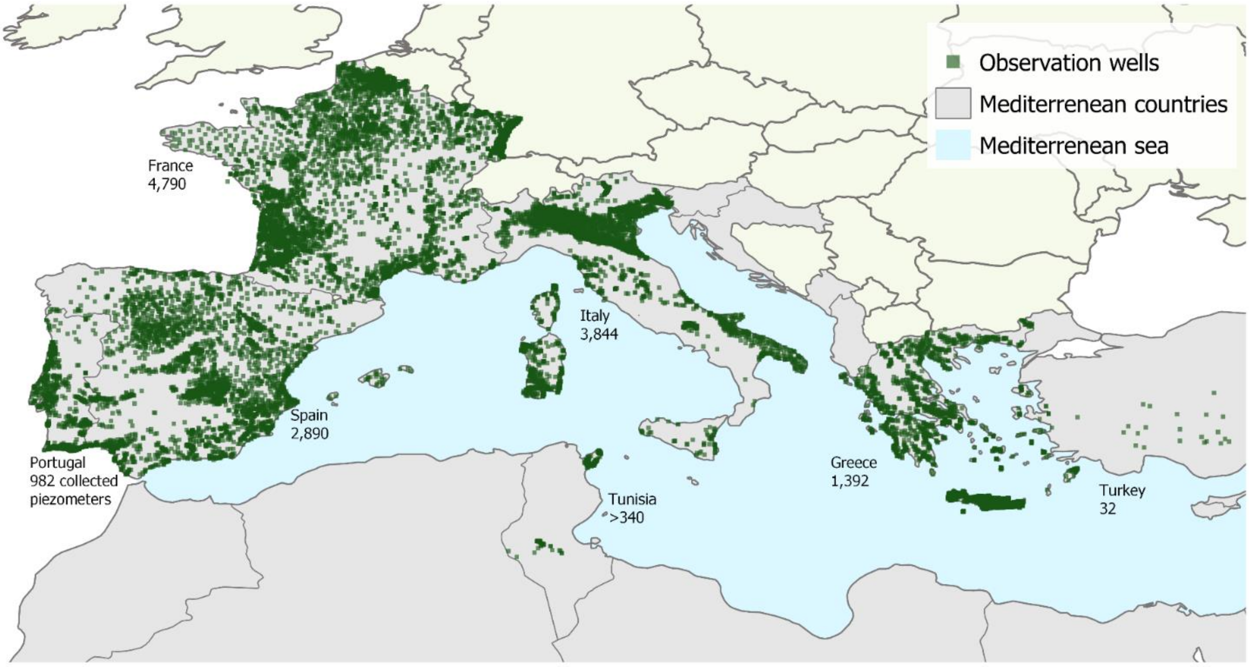

Figure 2. Spatial distribution of collected observation wells

From the collected and processed data, groundwater level measurements started concentrating after 1980 (Figure 3). Cumulatively, only 13% of the time series have 30 years or more of measurements, making it challenging to do long-term analysis. In Turkey, we collected data from only 27 stations; the figure doesn't reflect the growth of the network. After 2000, there was a significant increase in European monitoring sites, which the Water Framework Directive could drive.

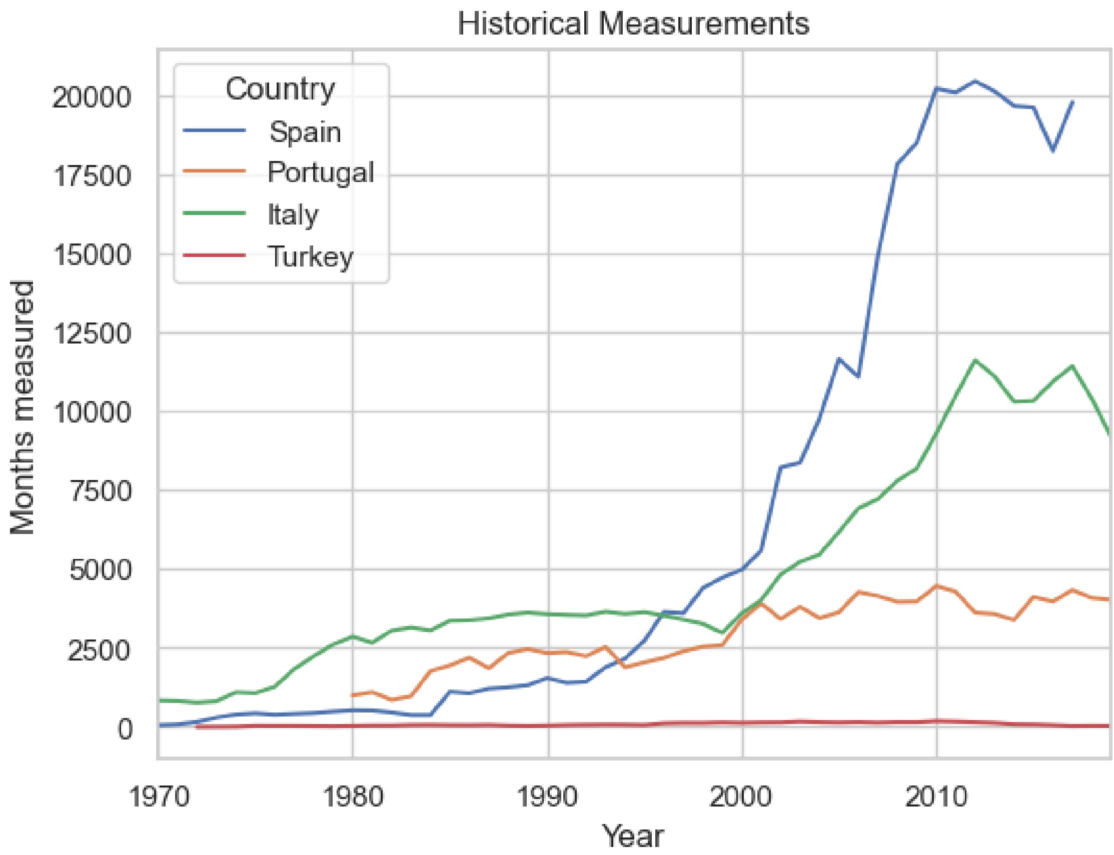

Figure 3. Time distribution of historical measurements

3. Groundwater quality

Water quality refers to water's chemical, physical and biological characteristics that make it safe for use or the environment. High concentrations of certain substances pose severe risks to human health and ecosystems. While there are several water quality risks related to groundwater, two of the most studied are nitrates and salinity. The application of nitrogen fertilizer usually drives a high concentration of nitrates. Some related issues are the legacy of nitrates staying in the soil matrix for a long time and re-polluting surface waters even decades after fertilizer application. Increasing salinization in groundwater can occur from irrigation return flows and saline intrusion on coasts due to inland lowering groundwater levels. This section focuses on the existing data sources for nitrates and salinity as priority parameters of groundwater quality.

3.1. Global databases

UNEP's Global Freshwater Quality Database (GEMStat) is a platform for data and information on the state and global inland water quality trends. The online platform hosts time series of a myriad of parameters for water quality stations in rivers, lakes, wetlands, reservoirs, and groundwater. The availability depends on contributions made by the countries; most of the coverage is in Latin America and Europe. In the case of the InTheMED countries, groundwater data is only available in four points in Tunisia, belonging to a sampling campaign from 1980-1982.

In a recent article, Abascal et al. (2022) reviewed and compiled literature with groundwater quality measurements, focusing on nitrate. In this review, there is at least one measurement of groundwater quality in each InTheMED country (Table 3). The water quality measurements are reported only at one point in time to identify where they are beyond the 50 mg/L threshold recommended by the World Health Organization. Several sites in Italy and Tunisia are above this level, one in Spain and one in Turkey.

Table 3. Groundwater quality review by Abasco et al. (2022)

Region	Country	NO_3^- (mg/L) Max/min	NO3- (mg/L) average	Ca^{2+} (mg/L)	Mg^{2+} (mg/L)	Na^+ (mg/L)	K+ (mg/L)	SO_4^{2-} (mg/L)	Cl^- (mg/L)	HCO_3^- (mg/L)	F^- (mg/L)	EC (µS/cm)	pH	TDS	Reference
Scopia basin (spring)	Greece	6.2-90.2	38.9	75.2-215.2	5.5-46.6	2.5-36.3	0.39-11.4	2.5-131.4	10.6-67.4	244-488	n.a.-0.71	283-1138	6.9-7.4	350.5-1035	(Charizopoulos et al., 2018)
Scopia basin (boreholes)	Greece	11.9-134.6	43.6	8.8-155.2	12.9-91.4	0.94-61.5	n.a.-2	0.5-91.2	7.1-95.7	280.6-549	n.a.-0.65	416-947	7.11-8.2	456.7-965.1	(Charizopoulos et al., 2018)
Marathon basin	Greece	4-175	44.16	102-382	11.0-69	38-494	1.8-15	41-340	75-1220	77-763	n.a.	1025-4720	6.26-7.36	609-2639	(Papazotos et al., 2019)
Basilicata	Italy	0.1-8.1	1.21	40.8-74.2	4.7-20.1	3.6-6.3	0.2-1.5	0.8-9.5	3.8-8.5	220-297	n.a.	365-550	7.2-7.8	n.a.	(Canora et al., 2019)
Vibrata aquifer (November)	Italy	2-151	66.3	n.a.	n.a.	n.a.	n.a.	11-230	6-160	n.a.	n.a.	381-1551	n.a.	n.a.	(Di Lorenzo et al., 2012)
Agro-Aversano area	Italy	6.4-170.2	75.8	19.4-138.5	3.1-35.1	43.9-175.5	n.a.	5.1-156.2	20-180.9	99.4-804.2	0.5-6.7	440-1917	n.a.	321-1229.4	(Rufino et al., 2019)
Vibrata aquifer (July)	Italy	0.1-148	77.2	n.a.	n.a.	n.a.	n.a.	32-195	35-172	n.a.	n.a.	838-1560	n.a.	n.a.	(Di Lorenzo et al., 2012)
Central region	Portugal	2.22-2.66	2.26	1.62-19.92	1.34-33.22	4.9-16.35	0.02-0.36	2.0-41	n.a.	1.0-146	n.a.	n.a.	n.a.	n.a.	(Carvalho et al., 2019)
Amurga Mountain Range	Spain	0.16-189	9.28	5-1182	13.2-821	97-1660	8.2-92	24-932	125-4200	55-562	n.a.	152-13410	6.9-9.85	100-11135	(Ruiz-García et al., 2019)
Argamasón	Spain	11.7-28.3	14.2	51-81	29-63.7	11.2-17.6	1-1.9	30.9-62	20.4-34.3	274.6-395.5	n.a.	618-889	n.a.	n.a.	(Moratalla et al., 2009)
The Jarales site	Spain	0-85	21	1751-3621	246-720	39464-70000	159-298	4907-8326	63105-113581	185-268	n.a.	120.6-167.8	n.a.	n.a.	(Gil-Márquez et al., 2019)
Los Anguijes	Spain	17.6-25.8	21.9	71-92	36-60	10.4-35.4	0.9-1.4	72.9-103.8	19.3-37.9	272.7-474	n.a.	702-1160	n.a.	n.a.	(Moratalla et al., 2009)
Pozuelo	Spain	21.2-30.7	25.3	65.5-97	40-67	8.7-24	0.8-1.7	30-65.8	43.9-57.4	290.8-461.3	n.a.	675-1136	n.a.	n.a.	(Moratalla et al., 2009)
Aguas Nuevas	Spain	13.1-44.2	26.2	141.4-216	60.7-108	10.9-25.8	1.5-2.8	313.9-666.5	26.9-45.2	130.9-404.2	n.a.	1309-2180	n.a.	n.a.	(Moratalla et al., 2009)

El Salobral	Spain	18.7-54.1	26.3	66-114	43.6-66	11.4-16.4	1.0-1.6	158.2-242.4	21-37.5	186.9-379	n.a.	815-1290	n.a.	n.a.	(Moratalla et al., 2009)
Aluviales: Jarama-Tajuña	Spain	n.a.	27.12	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	(Mostaza-Colado et al., 2018)
Santa Ana	Spain	20.2-44.2	31	55-81	38.7-82.7	9.6-16.9	1.0-1.5	31.2-45.9	20.5-26.7	288.5-404.3	n.a.	519-900	n.a.	n.a.	(Moratalla et al., 2009)
Industrial area in Barcelona	Spain	<20-130.5	46.02	77.9-287	27.3-166.5	32.9-412.7	0.3-1.9	94.2-1435.1	30.5-711.3	251.9-652.3	n.a.	1100-4300	7.2-7.8	n.a.	(Blázquez-Pallí et al., 2019b)
Cenozoic Duero Basin	Spain	0.4-240	48.6	1-260	1.0-78	13-468	0-118	2-154	5-360	55-550	n.a.	225-1995	6.85-9.87	n.a.	(Giménez-Forcada et al., 2017)
Limia River basin Spain	Spain	4.137-329.02	79.65	0.91-61.295	1.02-11.43	n.a.	0.934-114.4	1.139-68.787	5.696-180.616	n.a.	0.007-2.48	n.a.	n.a.	n.a.	(Rodriguez et al., 2020)
Skhira phreatic aquifer	Tunisia	5.79-130.7	52.13	256-680	101-529	410-3795	11;59	750-6848	654-3552	101-1690	0.03-10.3	2820-17200	6.45-7.19	n.a.	(Melki et al., 2019)
MPQ aquifer of the Sidi Bouzid plain	Tunisia	14.3-110	52.69	n.a.	n.a.	97-1058	n.a.	579-2300	80-1480	n.a.	n.a.	1740-8860	6.26-7.36	1200-6200	(Ncibi et al., 2020)
Grombalia Basin (Deep)	Tunisia	2.0-230.6	55.7	31.6-696.5	12.7-557.3	72.8-1888.4	4.2-63.6	2.8-3105	107.3-3436	128.1-688	n.a.	1000-7100	7.0-7.7	n.a.	(Re et al., 2017)
Medjerda Lower Valley Aquifer	Tunisia	4.83-596	73.53	44-1610	27.36-825.6	142.6-3698.4	1.95-795.6	90-5756.88	255.14-5968	1-806	0.23-52.63	n.a.	6.9-8.8	1005-19254	(Ferchichi et al., 2018)
Grombalia Basin (Shallow)	Tunisia	0-514.7	148	69.0-677.4	26.1-186.6	111.1-734.7	0.0-40.3	145.3-723.1	112.4-1450	164.7-481.9	n.a.	1000-9200	6.9-7.8	n.a.	(Re et al., 2017)
Balikligol Basin, Sanliurfa (7)	Turkey	2.2-3.9	3.3	53.4-64.2	5.9-6.5	4.5-5.8	0.9-1.6	2.0-16	4.3-28.6	129.5-194.8	0.1-1.1	331-351	7.6-7.7	105.6-164.2	(Yetiş et al., 2019)
Balikligol Basin, Sanliurfa (1)	Turkey	2.2-5.3	3.6	48.7-59.8	7.5-11.5	2.6-3.86	0.8-1.2	04:41	5.3-20.8	132.9-192.2	0.1-0.4	319-349	7.9-7.9	127.6-166.9	(Yetiş et al., 2019)
Balikligol Basin, Sanliurfa (8)	Turkey	1.9-5.3	3.7	66.6-74.2	6.9-8.6	7-15.2	2.1-9.3	11.0-41	12.7-26.8	160.3-251.5	0.1-0.6	363-499	7.6-7.8	164.4	(Yetiş et al., 2019)

Balikligol Basin, Sanliurfa (3)	Turkey	1.5-8.3	3.9	53.7-63.4	6-6.8	3.6-5.2	0.8-1.1	6;96	6.9-26.3	59.1-184	0.1-0.4	337-342	7.6-7.7	102.6-254.8	(Yetiş et al., 2019)
Balikligol Basin, Sanliurfa, (6)	Turkey	2.6-8.9	5.4	57.1-67.3	5.8-6.6	4;6	1.3-1.7	9;32	5-20.6	155.3-175.5	0.1-0.6	344-361	7.5	88.7-163.9	(Yetiş et al., 2019)
Balikligol Basin, Sanliurfa, (5)	Turkey	4.1-7.6	5.5	80.3-94	8-9.4	28.3-34.7	11-16.4	15-26	23.6-76.3	240.2-335.4	0.1-0.3	626-732	7.5-7.8	115.3-299	(Yetiş et al., 2019)
Balikligol Basin, Sanliurfa (2)	Turkey	53.6-59.4	55.3	4.2-5.2	3.8-4.7	2.6-3.3	2;37	10.2-18.1	137.4-165.8	0.1-0.6	326-345	7.7-7.9	19.7-24	n.a.	(Yetiş et al., 2019)
Sivas province (Wet season)	Turkey	0.01-84.59	7.69	16.63-494.47	4.24-197.81	6.75-193.61	0.44-17.23	7.2-1154.92	7.05-160.07	36.79-360.53	n.a.	n.a.	7.1-9.15	202.31-1913.9	(Karakuş, 2019)
Sivas province (Dry season)	Turkey	0.03-90.47	9.47	28.04-416.78	8.98-114.57	10.25-292.77	0.5-20.13	5.95-1199.86	9.65-436.76	61.01-548.94	n.a.	n.a.	6.99-9.05	210.81-2329.82	(Karakuş, 2019)
Balikligol Basin, Sanliurfa (4)	Turkey	11.3-15.9	13.5	115.2-130	7.6-13.6	15.5-49.6	1.3-4.5	5-161	28.9-158.6	65.5-346.3	0.1-0.9	745-820	7.1-7.2	115.9-368	(Yetiş et al., 2019)
Antalya (Dry season)	Turkey	5.57-37.34	19.94	59.49-100.17	13.04-79.06	4.63-70.46	0.48-2.26	21.07-132.73	2.19-21.34	225.7-506.3	n.a.	288.8-794	8.54-9.36	187.72-516.1	(Varol and Şekerci, 2018)
Antalya (Wet season)	Turkey	4.9-52.14	28.81	62.55-94.96	12.59-79.54	4.08-74.48	0.45-2.18	30.09-155.8	1.99-27.2	234.63-517.8	n.a.	279.8-809	8.85-9.6	181.87-525.85	(Varol and Şekerci, 2018)

Source: (Abascal et al., 2022)

3.2. National databases

All InTheMED countries have some form of groundwater quality monitoring. The quality networks are even more decentralized when compared to groundwater level. Only Portugal and Greece have platforms that store and share groundwater quality data for all the countries. And in the Greek network, data is only openly available from a 2012-2015 campaign. In the rest of the cases, the information is sparse in regional environmental or river basin management authorities. In Spain and Portugal, monitoring started around the 1970 decade. In the other countries, consistent measurement started around the start of the 2000 decade(Ben Salah, 2010; Harmancioglu and Altinbilek, 2020; Onorati et al., 2006). In the case of European countries, a bigger effort to organize groundwater quality monitoring was in part triggered by the integration of the European Union and their environmental objectives (Koreimann et al., 1996).

Table 4. Groundwater quality monitoring systems

Country	Approximate start time	Approximate amount of stations in network	Approximate frequency of measurement	Publicly available online	Description of monitoring program
Greece	2012	1,392	Up to three times a year	Yes	In parallel to the national monitoring network, the 14 prefectures of Greece have each their own monitoring networks.
Italy	1999	>3000	At least twice a year	Available for consultation in some regions	Environmental agencies in each region have the task to measure and report groundwater quality.
Portugal	1970 decade	848	Varies	Yes	
Spain	1970 decade	6,186	Varies	Available for consultation in some regions	Since 2002 the Environment Ministry is in charge of the network, while the River Basin authorities make the measurements

Tunisia	1998	1,200	Twice a year	No	Monitoring of TDS (salinity) and nitrates. Analysis done by the Water Resources General Direction. The collected data are published by the Water Resources General Direction in an annual report called « Annuaire de la qualité des eaux souterraines en Tunisie »
Turkey	-	-	-	No	Monitoring is not widespread and the results are not publicly available

Sources: (Ben Salah, 2010; Harmancioglu and Altinbilek, 2020; IGRAC, 2020; Koreimann et al., 1996; Ministerio para la Transicion Ecologica y el Reto Demografico, n.d.; Onorati et al., 2006)

3.3. Collected Data

Currently, only data from Greece has been collected from the national database's 1,392 stations. It covers from the span of 2013-2015 with one or two measurements per year.

4. Closing remarks

- Groundwater data is produced and processed in the six assessed countries, however, in most cases it is not openly available for external analysis and assessment. Information about groundwater levels is more consistently measured and overall easier to access when compared to groundwater quality.

- Groundwater level measurements have an uneven distribution in time and space in the assessed countries. Furthermore, data access is minimal due to sparse and decentralized data storage or a lack of data-sharing policies. As a result, less than half of the collected stations have time series longer than 10 years.

- Monitoring for groundwater quality is not as vast as for groundwater levels. And the access is even more limited. While evidence tells that all countries create groundwater quality data, the collection of this data for analysis has been challenging.

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