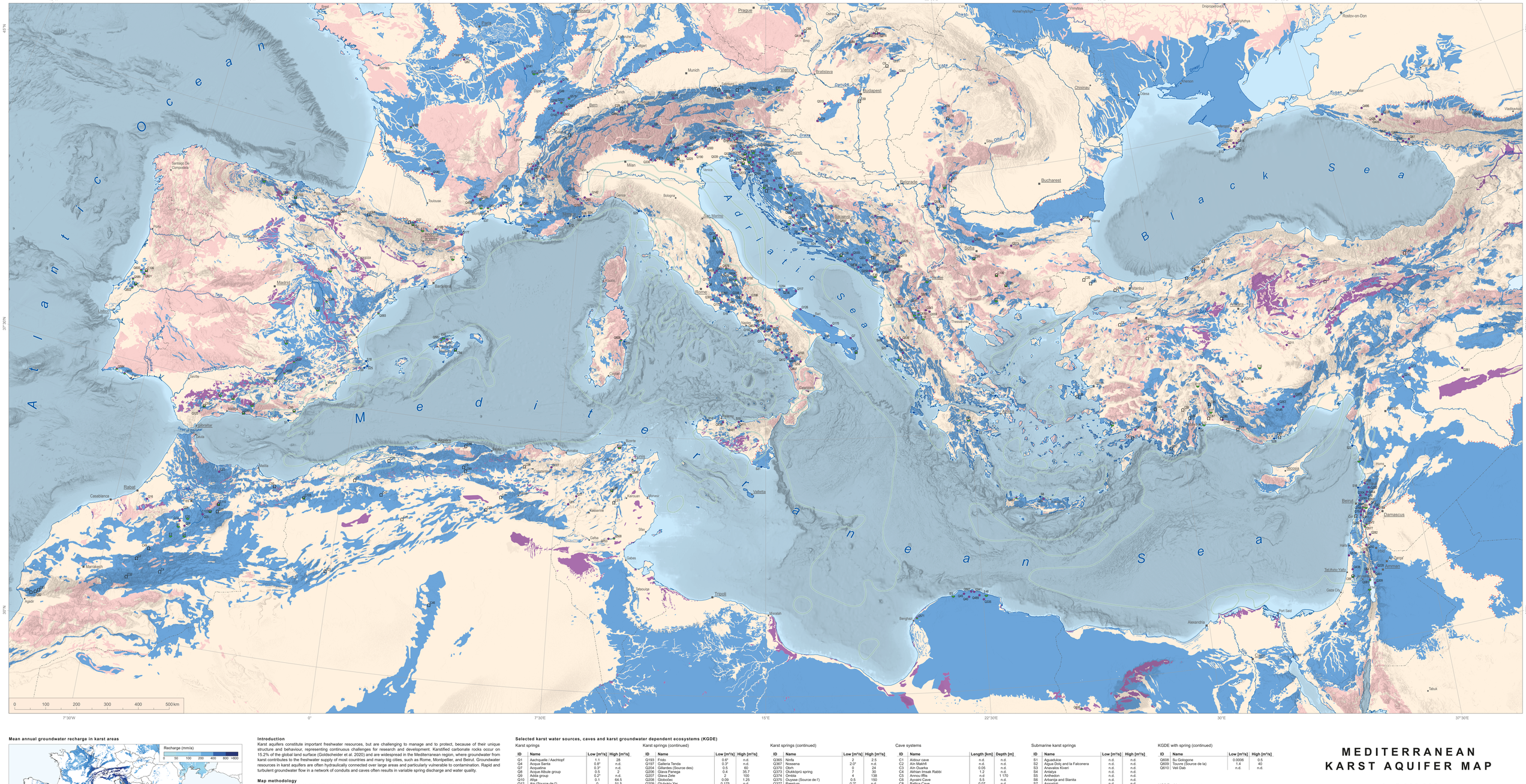
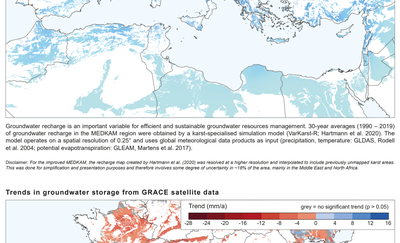
Mediterranean Karst Aquifer Map



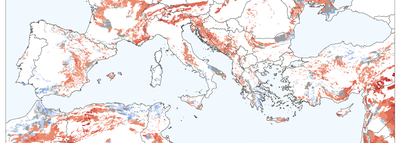
Mean annual groundwater recharge in karst areas



Groundwater recharge is an important variable for efficient and sustainable groundwater resources management. 30-year averages (1990 – 2019) of groundwater recharge in the MEDKAM region were obtained by a karst-specialised simulation model (VarKarst-R; Hartmann et al. 2020). The model operates on a spatial resolution of 0.25° and uses global meteorological data products as input (precipitation, temperature: GLDAS, Rodell et al. 2004; potential evapotranspiration: GLEAM, Martens et al. 2017).

Disclaimer: For the improved MEDKAM, the recharge map created by Hartmann et al. (2020) was resolved at a higher resolution and interpolated to include previously unmapped karst areas. This was done for simplification and presentation purposes and therefore involves some degree of uncertainty in ~18% of the area, mainly in the Middle East and North Africa.

Trends in groundwater storage from GRACE satellite data



Extent of changes in groundwater storage (GWS) over the period 2003–2020 for the Euro-Mediterranean region using the latest data from the Gravity Recovery and Climate Experiment (GRACE/GRACE-FO; NASA 2021) satellite mission and recently reanalyzed ERA5 land climate data (Muñoz Sabater 2019) from the European Centre for Medium-Range Weather Forecasts. The results show significant declines in groundwater storage in many countries in Europe, North Africa, and the entire Arabian Peninsula, with significant negative trends overall in about 70% of the study region (Xanke and Liesch 2022).

Introduction

Karst aquifers constitute important freshwater resources, but are challenging to manage and to protect, because of their unique structure and behaviour, representing continuous challenges for research and development. Karstified carbonate rocks occur on 15.2% of the global land surface (Goldscheider et al. 2020) and are widespread in the Mediterranean region, where groundwater from karst contributes to the freshwater supply of most countries and many big cities, such as Rome, Montpellier, and Beirut. Groundwater resources in karst aquifers are often hydraulically connected over large areas and particularly vulnerable to contamination. Rapid and turbulent groundwater flow in a network of conduits and caves often results in variable spring discharge and water quality.

Map methodology

The preparation of the Mediterranean Karst Aquifer Map and Database (MEDKAM) generally followed the workflow used for the World Karst Aquifer Map (WOKAM; Chen et al. 2017). The topographic basis for MEDKAM is the digitized version of the International Hydrogeological Map of Europe (IHME; BGR & UNESCO 2019) and its recently digitized extension to North Africa. To complete missing parts in the North African countries and the Arabian Peninsula, the digital versions of the Quantitative maps of groundwater resources in Africa from the British Geological Survey (MacDonald et al. 2012) and the Bedrock geology of the Arabian Peninsula from the United States Geological Survey (Pollastro 1998) were used.

IHME is a series of general hydrogeological maps with 30 map sheets at a scale of 1:1,500,000 compiled by hydrogeologists and national experts in related sciences under the auspices of the International Association of Hydrogeologists (IAH). A new hydrological classification has been developed for MEDKAM, similar to that of WOKAM, which groups the geological units into four meaningful hydrogeological units.

1. Karst aquifers in sedimentary and metamorphic carbonate rocks
2. Karst aquifers in evaporite rocks
3. Various hydrogeological settings in other sedimentary and volcanic formations (karst aquifers are possibly present at depth)
4. Local, poor and shallow aquifers in other metamorphic rocks and igneous rocks (no karst aquifers present at depth)

Map preparation and editing

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Project associates and scientific advisory board (in alphabetical order)

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Cartographic editing and technical support: Martin Krombholz, Stefanie Richter

Spatial data sources: Natural Earth 1:10m Cultural Vectors, modified in accordance to the United Nations Clear Map (2018) (national borders); NOAA National Centers for Environmental Information. 2022: ETOPO 2022 15 Arc-Second Global Relief Model. NOAA National Centers for Environmental Information. DOI: 10.25921/fd45-gt74. Accessed 2022-10-19 (hillshade & sea floor); WHYMAP (rivers and cities)

Map projection: ETRS 1989 UTM Zone 33N (WKID: 25833)

The data and information on this map were collected and prepared by the Federal Institute for Geosciences and Natural Resources (BGR) and Karlsruhe Institute of Technology (KIT).

Recommended citation

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Project Consortium

The Mediterranean karst aquifer map and database (MEDKAM) was developed within the framework of the Karst Aquifer Resources availability and quality in the Mediterranean Area (KARMA) project. KARMA is implemented under the umbrella of the Partnership for Research and Innovation in the Mediterranean Area (PRIMA), which aims to develop new R&I approaches to improve water availability and sustainable agriculture production in a region heavily distressed by climate change, urbanisation and population growth. The PRIMA programme is an Art.185 initiative supported and funded under Horizon 2020, the European Union's Framework Programme for Research and Innovation.

MEDKAM is a contribution to the World-wide Hydrogeological Mapping and Assessment Programme (WHYMAP) of the UNESCO Intergovernmental Hydrological Programme (IHP).

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Selected karst water sources, caves and karst groundwater dependent ecosystems (KGDE)

Karst springs

ID	Name	Low [m³/s]	High [m³/s]
Q1	Aachquelle / Aachtopf	1.1	28
Q4	Acqua Santa	0.8*	n.d.
Q7	Acquatina	0.3*	n.d.
Q8	Acque Albule group	0.5	2
Q9	Adige group	0.2*	64.5
Q12	Ain (Source de l')	0.1	84.5
Q14	Ain Aghbal	n.d.	n.d.
Q15	Ain Al Baazaran	<0.001	n.d.
Q16	Ain Al Loffa	2.7*	n.d.
Q19	Ain El Gudeirat	0.02	0.2
Q23	Ain Maasrouf	n.d.	n.d.
Q24	Ain Ribaa	1.0*	n.d.
Q25	Ain Sebou	n.d.	n.d.
Q27	Ain Zerga	n.d.	n.d.
Q29	Ain Zerrouka	n.d.	n.d.
Q37	Aliou	0.026	23.7
Q38	Alpaka spring	2.5	7
Q39	Almyros of Heraklion	3.3	30
Q40	Alstrypos	0.000*	n.d.
Q43	Anjar	0.48	9.2
Q45	Apollo	0.02*	n.d.
Q46	Arava stone	0.85	40
Q47	Archanes	0.8*	n.d.
Q48	Archiane (Source d')	0.15	>10
Q49	Arcier (Source d')	0.007	6.7
Q53	Atzgara	1.5	4.5
Q54	Auja	0.3	0.5
Q57	Ayan	0.2	10
Q58	Bagni Termali group	0.23*	n.d.
Q61	Bandito	0.6*	n.d.
Q63	Barada spring	4.0*	n.d.
Q67	Bataiy	10.0*	n.d.
Q69	Beinette	0.01*	n.d.
Q70	Bel Sheen	2.7*	n.d.
Q73	Beyazsu	4.23	5.4
Q74	Bize (Source de)	0.41	18.8
Q75	Bistrica (Syri i Kalter)	13.5	36
Q76	Blautopf	3.3	32.5
Q79	Bolle	2	100
Q80	Bou Saadre	0.3*	5
Q81	Boulaouane	n.d.	n.d.
Q82	Bouillon (Source du Loiret)	0.1	2.8
Q83	Bournillon (Source du)	0	30
Q85	Buchbrunnenquelle	0.6	1.4
Q86	Bucone	1.8*	n.d.
Q87	Buk	3.5	23.5
Q88	Buna	2.95	380
Q92	Canetra	1.8	2.2
Q113	Capore	0.5*	n.d.
Q114	Caposele group	4.0*	n.d.
Q117	Carusu	0.2*	n.d.
Q123	Charco del Moro	10	n.d.
Q125	Cilburno	1.6*	n.d.
Q126	Collettore Destro	0.5*	n.d.
Q127	Confusa Terme group	0.6*	n.d.
Q128	Cornino-Pakar group	2.5*	n.d.
Q132	Cmo vrelo	0.3*	n.d.
Q133	Crveni vrelo	2.34	4.27
Q137	Dmyakzem	n.d.	60
Q140	Doubs (Source du)	0.02	32.9
Q141	Douix (Source de la)	0.6	3
Q142	Drac, Vene + Fuse	0.2*	n.d.
Q144	Dretulja	1	28.7
Q145	Dodenica	0.1	16.7
Q146	Dumani [1]	25	50
Q147	Durzon (Source du)	0.47	19.9
Q149	Dzhur-Dzhur	0.06	1.05
Q150	Dzhylykhva	n.d.	2.5
Q153	Ein Hadeg	9.5*	197
Q159	Fontaine Blanco	1.2*	n.d.
Q164	Figeh	2.1	23.4
Q169	Fiume Latte	0.3*	n.d.
Q170	Fiume Morello	0.4*	n.d.
Q171	Fiume Pescello	0.3*	n.d.
Q173	Foran group	0.3*	40
Q176	Font-Estramp/Lampdamy	0.193	17.7
Q178	Font-Estramar	0.286	48.6
Q179	Fontaine de Nîmes	0.085	18.38
Q180	Fontaine des Chartreux	1	50
Q181	Fontaine L'Evêque	2.2	19
Q182	Fontaine Grande	0.2*	n.d.
Q185	Fontana S. Elmo	0.3*	n.d.
Q189	Fontanefores (Source de)	0	16
Q190	Forame	2.0*	n.d.
Q192	Foro group	1	10

Karst springs (continued)

ID	Name	Low [m³/s]	High [m³/s]
Q193	Fridio	0.6*	n.d.
Q197	Galleria Tenda	0.3*	n.d.
Q204	Gillardes (Source des)	0.5	60
Q206	Glava Panega	0.4	35.1
Q207	Glava Zete	1	100
Q208	Globokoy	0.5	1.25
Q209	Gloshko Yar	0.175	1.4
Q210	Göksunsu; Mugla	6.2	15
Q211	Göksunsu; Sivas	3.1	6.3
Q212	Gollinger Wasserfall	0.49	8.8
Q214	Gorgo Vivo	0.3	n.d.
Q215	Goryckowa Vaucluse	0.143	40
Q217	Goule Noire	2	34
Q218	Grab	0.7	33.5
Q219	Gradac	0.4	10
Q220	Gradole	0.5	11
Q222	Groin (Source du)	0	>30
Q226	Gruppo Ortucchio	0.4*	n.d.
Q227	Hamma	n.d.	n.d.
Q228	Hazzir	0.04*	n.d.
Q229	Hévriz lake	0.3	0.6
Q232	Hubelj	0.035	60
Q236	Ichac	0.7*	n.d.
Q237	Ichkeulenko	0.3	4
Q239	Izbitelnjy	0.049	3.98
Q240	Izverna	1	3
Q241	Izvor Krke	1.2	135
Q242	Izvor Kupe	1.1	100
Q243	Izvor na Crna reka	0.491	5.6
Q245	Izvori na reka Treska	0.48	3
Q248	Jarmak	<1	n.d.
Q249	Jelta	1.55	n.d.
Q250	Jordan River sources	15.9	n.d.
Q251	Jõevallt	0.063	7
Q252	Kadisha	<1	n.d.
Q253	Kamačnik	0.5	15
Q254	Karstdítka Bistrica	2.1	62.6
Q255	Karasu-Bashi	0.1	39.2
Q257	Karstpoy Istochnik	0.003	1.24
Q258	Kaczyce	25	25
Q259	Kaliakouda	0.3*	5
Q262	Khaldia-Bash	0.012	2.3
Q263	Kirkgöz	7.09	62.77
Q265	Klafferquelle	0.4	34
Q266	Klokot	2.3	70
Q267	Klokun	3.52	19.4
Q268	Kolpa/Kupa	1.1	100
Q270	Krka	0.8	80
Q271	Krioi Isalos	1.4	3.5
Q272	Krupaja	0.2	12.3
Q273	Kumandras	0.5	3
Q275	La Calda	0.3*	n.d.
Q282	Lake Tiberias spring	1.0*	n.d.
Q284	Lauro	0.5*	n.d.
Q286	Lazce	0.318	1.4
Q290	Le Monache group	1.3*	n.d.
Q293	Lete group	0.4*	n.d.
Q294	Lez spring	0.5*	18
Q299	Loiron (Source du)	0.003	58.6
Q300	Ljubljanica	11.4*	n.d.
Q301	Ljubljanica	1.5	120
Q302	Lodowe Vaucluse	0.079	10.4
Q304	Madre	0.02*	n.d.
Q309	Ma'in hot spring	n.d.	n.d.
Q310	Maina group	0.6*	n.d.
Q311	Majerovo vrelo	1	21
Q312	Makenitsa	1.1	9.9
Q314	Manoza spring	2	20
Q315	Massandra waterfall	0.02	4.03
Q319	Mchishta	9.5*	197
Q325	Mesotino	0.3*	n.d.
Q330	Mompiano	0.2*	n.d.
Q331	Montorio group	4.8*	n.d.
Q334	Morinj spring	0.55	10
Q335	Morpeto	0.3*	n.d.
Q337	Mouliere	0.3*	40
Q338	Mulino Carpello	1.2*	n.d.
Q339	Mucur	30.43	150
Q340	Muriel	0.05	0.9
Q341	Murgus	0.01*	n.d.
Q348	Nabaa Barouk	<10	n.d.
Q351	Nabaa Jezzine	0.05	n.d.
Q352	Nabaa Khoraizat	<0.01	0.37
Q357	Nabaa Qas el Reem	0	16
Q358	Nabaa Rachine	<0.1	n.d.
Q360	New well Miskolctapolca	0.028	1.9

Cave systems

ID	Name	Length [km]	Depth [m]
C1	Aldour cave	n.d.	n.d.
C2	Ain Makhfi	n.d.	n.d.
C3	Ain Ouarka	n.d.	n.d.
C4	Akhiam Imsak Rabbi	1.2	n.d.
C5	Anou Iffis	1.5	1170
C7	Oueisse (Source de l')	0.5	n.d.
C8	Aquedoc	1.2	107
C9	Baradla - Domica C.S.	25.5	112
C10	Beldibi Cave	n.d.	n.d.
C11	Caves of Hercules	n.d.	n.d.
C13	Cehennemağzı Cave	n.d.	1.500
C14	Çeltik 2	5.54	1.502
C15	Charreau cave	1.2	50
C16	Clot d'Aspres C.S.	40	1.066
C17	Coume Ouarnède C.S.	105.8	975
C18	Damlataş Cave	n.d.	n.d.
C20	Dupnisa Cave	3.2	n.d.
C23	Gémenos Cave	0.56	n.d.
C24	Gökgöl Cave	3.4	11
C27	Hammam Trozza	120.4	23
C29	Hölloch	200.4	939
C32	Ifri N'Ammoucha	3.8	n.d.
C33	Ifri Oudadan	2.4	n.d.
C34	Ifri N'Ta Tamfourine	0.04	45.8
C35	Inkaye Cave	0.9	21
C39	Insuyu Cave	8.1	n.d.
C40	Jean Bernard C.S.	20.5	1.602
C41	Jeita Grotto	9	n.d.
C43	Kaklik Cave	n.d.	n.d.
C44	Karaca Cave	0.11	n.d.
C46	Kef Aïcha	0.1	0.2
C47	Kef el Kaous	4.1	n.d.
C48	Kef Toghbodt	3.9	722
C49	Kehf D'bouba	n.d.	n.d.
C50	Kehf Jmel (camel cave)	1.2	n.d.
C54	Kita Gacesina - Drazenova puhaljka	26.4	737
C55	Kozlerina Cave	0.5	n.d.
C56	Kocain Cave	0.63	n.d.
C58	Mahaneh	1.8	4.3
C59	Monsar d'ons Cave	6	130
C61	Ogosta Cave	0.8	n.d.
C62	Ojtal Cave	0.73	n.d.
C63	Pesters Topolnita	20.5	127
C64	Pierre Saint-Martin C.S.	80.2	1.408
C65	Pinargözü Cave	16	720
C66	Purkevci jeskyně Cave	3.9	138
C68	Rhar Amalou/Rhar Kab Sihir	2	n.d.
C69	Rhar Medjraba (Gîle gr. de l'Arou)	1.5	n.d.
C72	Riesending-Schachthöhle	19.1	1.148
C73	Rouina Caves	n.d.	n.d.
C74	Saint-Marcel d'Ardèche Cave	51.2	233
C75	Schönberg-Höhlensystem	140.1	1061
C76	Sistemul Vârăşoaia	19.3	653
C77	Sustav Lukina jama - Trojama	3.7	1.431
C80	Tikkler Cave	6.8	159
C81	Wielka Śnieżna Cave	23.1	824
C82	Wintimoulne	7.3	200
C83	Yarımca Cave	0.1	54
C84	Yarımca Cave	0.6	n.d.
C85	Yeneru Cave	1.8	n.d.
C86	Železna jama	17.5	1.027
C87	Zeytinlar Cave	0.14	14
C88	Zlotska pećina	9.8	60
C111	Tolminski Migovec	43	972

Submarine karst springs

ID	Name	Low [m³/s]	High [m³/s]
S1	Aguadulce	n.d.	n.d.
S2	Agua Dolç and la Falconera	n.d.	n.d.
S3	Anavalos Kivari	n.d.	n.d.
S4	Antalya	n.d.	n.d.
S5	Anthedon	n.d.	n.d.
S7	Arbonja and Slanita	n.d.	n.d.
S8	Arillas	n.d.	n.d.
S9	Baiá	n.d.	n.d.
S10	Benissa and Calpe	n.d.	n.d.
S11	Brac Island	n.d.	n.d.
S12	Bue Marino	n.d.	n.d.
S13	Cannes	n.d.	n.d.
S14	Cape Aya	n.d.	n.d.
S15	Castellamare	n.d.	n.d.
S16	Cefaló	n.d.	n.d.
S17	Chiaro	n.d.	n.d.
S18	Denia	n.d.	n.d.
S19	Gaeta	n.d.	n.d.
S21	Gurdžuf and Škurda	n.d.	n.d.
S22	Latakia	n.d.	n.d.
S23	Lava Pass	0.4*	n.d.
S24	Makarska	n.d.	n.d.
S25	Mallorca and Toix	n.d.	n.d.
S26	Mortola	0.02	0.2
S27	Novi Vinodolski	n.d.	n.d.
S28	Ovacik	0.9	1.0*
S29	Polla di Cadimare	n.d.	n.d.
S30	Port-Miou (source sous-marine de)	3	50
S31	Pozzalo	n.d.	n.d.
S32	Roquebrune-Cap Martin	0.1	0.2
S33	Rosas springs	n.d.	n.d.
S34	San Remo	n.d.	n.d.
S35	Serç	n.d.	n.d.
S36	Sibenik	n.d.	n.d.
S37	Source de la Vise	<0	0.45
S38	Tartaria	n.d.	n.d.
S39	Nabrežina	n.d.	n.d.
S40	Vodice	n.d.	n.d.
S41	Volovasko	n.d.	n.d.

KGDE with spring

ID	Name	Low [m³/s]	High [m³/s]
Q567	Agyia springs	n.d.	n.d.
Q568	Ain Chanchara. Hammam Haddej	n.d.	n.d.
Q569	Argens	0.005	6.43
Q570	Aulas	0.001	>10
Q571	Ayn Zayanah	5.0*	n.d.
Q572	Banyas	n.d.	n.d.
Q573	Bilpanini springs	0.3	1.5
Q574	Capo Pescara springs	5.5	7.5
Q575	Cefina	n.d.	60
Q576	Cheurfou springs	0.05	0.5
Q577	Dan	0.3*	n.d.
Q578	Dessoubre	0.102	>30
Q579	Doliczka, Jelavnik	n.d.	n.d.
Q581	Lez Festhiks. Zugzin	n.d.	n.d.
Q582	Lez (Source du)	n.d.	n.d.
Q583	Fontaine-de-Vaucluse	3.12	81.4
Q584	Fontes de Estombar	n.d.	n.d.
Q585	Fontes do Lis	n.d.	n.d.
Q586	Foux de la Vis	1.18	>30
Q588	Jadro	2.2	28.5
Q589	Jebel Zaghouan	n.d.	n.d.
Q590	Lappenbach tufa springs	n.d.	n.d.
Q591	Laz (Source du)	0.1*	11.9
Q592	Loue (Source de la)	0.025	13.3
Q593	Manantial de Alcoceabre	n.d.	n.d.
Q594	Manantial de Arleta	n.d.	n.d.
Q595	Olero group	n.d.	n.d.
Q596	Nacimiento del río Guadalquivir	n.d.	n.d.
Q597	Nacimiento del río Mundo	0	100
Q598	Nacimiento del río Segura	n.d.	n.d.
Q599	Nacimiento del río Tus	n.d.	n.d.
Q600	Nacimiento del Río Andos	n.d.	n.d.
Q601	Nacimiento do Río Rabdo	n.d.	n.d.
Q602	Nacimiento do río Alhelá	n.d.	n.d.
Q603	Olhos das Agua	n.d.	n.d.
Q604	Resurgencia springs	1.8	2
Q605	Safa and Baruuk springs	1.9*	n.d.
Q606	Sea Oasis	<0.1	n.d.
Q607	St Naum	2.5	15

KGDE with spring (continued)

ID	Name	Low [m³/s]	High [m³/s]
Q608	Su Gologone	0.0006	0.5
Q609	Touvre (Source de la)	1.4	40
Q610	Veli Dab	n.d.	n.d.

KGDE with cave system

ID	Name	Length [km]	Depth [m]
C89	Ayalon	2.7	100
C90	Baume Sainte Catherine system	1.5	70
C91	Buso della Rana	24	n.d.
C92	Cueva de Nerja	4.8	158
C93	Cueva del Gallo	4.5	n.d.
C94	Cueva del Drach	1.2	25
C95	Duhlata	18.2	73
C96	Frasassi caves	20	n.d.
C97	Grotta Zinzulusa	0.26	n.d.
C98	Grotte an Diabl	3	n.d.
C99	Karst en yesos de Sorbas	50	n.d.
C100	Lepenitsa	1.5	10
C101	Molinos Velhos C.S.	9	n.d.
C102	Oyo Guarena	0.2	n.d.
C103	Duad Chaara	7.7	n.d.
C104	Ghomrassen Jame	24.12	>15
C105	Rhar Bou Marza	18.4	35
C106	Sistema Espeleológico do Dueca	7	n.d.
C107	Škocjanske Jame	6.14	254
C108	Vjetrenica Cave. Popovo Polje	7	n.d.
C109	Yagodinska	10.5	n.d.
C110	Friouatto	0.27	n.d.
C112	Planinska Jama	6.66	65

KGDE with ID

ID	Name	Description
E1	Afennourir lake	lake
E2	Aggiba river	river
E3	Agueliman Aregza	lake
E4	Agueliman Sidi Ali - Tifounassine	wetland, lake, river
E5	Ain Ouarka	wetland
E6	Ammiq wetland	wetland
E7	Bernadouze bog	peat bog
E8	Butrint	lake, marsh
E9	Cent-fonts	cave, springs, river
E10	Cerknica lake	intermittent lake
E11	Djerdap gorge	river, deep gorge, springs
E12	Dozon	river, waterfall
E13	Egridir	lake
E14	Ein Gedi	springs, river, cave
E15	Göllük Lagoon	lagoon, springs
E16	Kizören Cibrouk	lake, doline
E17	Köprüçay river, Olük Köprü spring	river canyon, spring
E18	Krka river, Skradinski buk	river, waterfalls, springs, caves
E19	Lac Ichkeul	lake, wetland, marsh, spring
E20	Lac d'Imouzzer du kandar	lakes
E21	Lago de Banyoles	lake
E22	Laguna de Fuente de Piedra	lake
E23	Laguna de Fuente de Piedra	wetland
E24	Laguna del Padul	wetland
E25	Lagunas de Archidona	wetland, lake, spring
E26	Lagunas de Ruidera	lakes
E27	Langres Plateau peat swamp	peat swamp
E28	Matka	river canyon, potholes. caves
E29	Nahr al Marqiyah	river, spring
E30	Nassiklohr bogs	bogs, mires, fens
E31	Ohrid lake	lake
E32	Parque del Monasterio de Piedra	springs, river, waterfalls
E33	Prespir polje	polje, springs, sinking streams
E34	Piva and Tara river (Durmitor)	rivers, canyons
E35	Pivka lakes	intermittent lake, polje
E36	Planinsko polje	intermittent lake, polje
E37	Plitvice Lakes	river, lakes, springs, cascades
E38	Prespa lake	lake
E39	Rio Mundo	lake
E40	streams of Sierra de Tramuntana	rivers, springs, pools
E42	Shymfalia lake	lake
E43	Torcas de Palancares	sinkholes, doline, ovala
E44	Una	river, waterfalls
E45	Vruljas of Velebit channel	springs, river
E46	Wadi Derna	river, spring, waterfall

The Low and High discharge values indicated in the tables represent the range of reported discharge data, but do not necessarily represent minimum and maximum values. When only one value was available, it was assigned to the appropriate category (Low or High). In cases where only the mean discharge was available, the numeric value is marked with an asterisk (*).

[1] Formerly one of the largest karst springs in the world, but sub-merged in a reservoir since 1982.

MEDITERRANEAN KARST AQUIFER MAP

1 : 5 000 000

Karstifiable rocks and others

- Karst aquifers in sedimentary and metamorphic carbonate rocks
- Karst aquifers in evaporite rocks
- Various hydrogeological settings in other sedimentary and volcanic formations (karst aquifers are possibly present at depth)
- Local, poor and shallow aquifers in other metamorphic and igneous rocks (no karst aquifers at depth)
- Border between exposed and non-exposed karst aquifer

Selected karst water sources, caves and karst groundwater dependent ecosystems (KGDE)

- Karst spring
- Submarine karst spring
- Cave system
- KGDE
- KGDE with spring
- KGDE with cave system

Geography

- Selected city < 1 Mio.
- Selected city > 1 Mio.

National capital cities are underlined

Surface water

- Lake
- River
- Sea level of the Mediterranean Sea during the Messinian Salinity Crisis (7.25 – 5.3 million years before present), as documented by sediments

Surface water

Disclaimer

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Mediterranean Karst Aquifer Map 1:5,000,000	BGR, KIT, UNESCO	Berlin, Karlsruhe, Paris 2022