Supplementary Material for "Severe impacts on water resources projected for the Mediterranean Basin"

J.P.C. Eekhout[1,*], J.P. Nunes[2], Y. Tramblay[3], and J. de Vente[1]

[1]Soil and Water Conservation Research Group, CEBAS-CSIC, Spanish Research Council, Murcia, Spain
[2]Soil Physics and Land Management Group, Wageningen University, Wageningen, the Netherlands
[3]Espace Dev, Université de Montpellier-IRD, Montpellier, France
[*]Corresponding author: Joris Eekhout, joriseekhout@gmail.com

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Text S1: Systematic review

The systematic literature review (SLR) process was performed following the SALSA framework (Search, AppraisaL, Synthesis and Analysis; Grant and Booth, 2009), which is a structured and contextual approach widely used for SLRs based on 4 steps. It includes the definition of the research questions, the search term, the criteria used based on which publications are included or excluded, the list of variables extracted from the publications, and the way the data were used to extract conclusions from the publications.

Step 1: Search

The first step of the SLR defines the research scope, leading to the main research questions. The framework of Population, Intervention, Comparison, Outcome, and Context (PICOC) (Booth et al., 2012) was applied to determine the research scope. The PICOC framework is listed in Table S3. The refined objectives of the SLR presented in the form of research questions are listed below:

1. What is the relative change in water resources in the Mediterranean Basin under climate change?
2. What is the relative change in runoff for different periods and emissions scenarios?
3. Are there spatial differences in runoff projections in the Mediterranean Basin?
4. Which variables explain most of the variability in runoff projections in the Mediterranean Basin?

Table S3. SLR research scope based on the application of the PICOC framework to the determined objectives.

Concept	Definition (Booth et al., 2012)	SLR application
Population	The problem or situation the research is dealing with.	Scientific research that quantifies the impact of climate change on water resources in the Mediterranean Basin.
Intervention	Existing techniques utilised to address the problem identified.	Hydrological models forced by climate model output.
Comparison	Techniques to contrast the intervention against.	Future periods, emissions scenarios and methods applied to quantify the change in runoff under climate change.
Outcome	The measures to assess the effect of the techniques in the population.	Relative change in water resources due to climate change.
Context	The particular settings or areas of the population.	The use of climate model data, based on established emission scenarios and application in the Mediterranean Basin.

This step also describes the search strategy applied. We used the SCOPUS search database, with the following search string (19 February, 2024):

(TITLE-ABS-KEY ("green water" OR "blue water" OR "water resource*" OR "runoff" OR "run off" OR "discharge" OR "river flow" OR “stream flow” OR “water availability” OR “water yield” OR "reservoir stor*" OR "reservoir inflow" OR "lake stor*" OR "lake inflow" OR "soil moisture" OR "soil water" OR "recharge" OR "irrigation water" OR "irrigation requirement*" OR "irrigation need*") AND TITLE ("climate change*" OR "changing climate" OR "future" OR "expect*" OR "projected" OR "projection*" OR "global change*" OR "climate and land use change*" OR "21st century" OR "climate impact*" OR "global warming") AND (TITLE-ABS-KEY ("Mediterranean" OR "France" OR "Ital*" OR "Spain" OR "Spanish" OR "Greece" OR "Greek" OR "Portug*" OR "Turkey" OR "Turkish" OR "Israel*" OR "Egypt*" OR "Morocc*" OR "Iraq*" OR "Slovenia*" OR "Tunisia*" OR "Algeria*" OR "Croatia*" OR "Bulgaria*" OR "Jordan*" OR "Lebanon" OR "Lebanese" OR "Cyprus" OR "Cypriot" OR "Bosnia and Herzegovina" OR "Bosnia*" OR "Syria*" OR "Albania*" OR "Montenegro" OR "North Macedonia*" OR "Libya*" OR "Monaco" OR "Malt*" OR "Gibraltar" OR "Kosovo" OR "Monaco" OR "Palestine" OR "San Marino" OR "Vatican") OR AFFILCOUNTRY ("France" OR "Italy" OR "Spain" OR "Greece" OR "Portugal" OR "Turkey" OR "Israel" OR "Egypt" OR "Morocco" OR "Iraq" OR "Slovenia" OR "Tunisia" OR "Algeria" OR "Croatia" OR "Bulgaria" OR "Jordan" OR "Lebanon" OR "Cyprus" OR "Bosnia and Herzegovina" OR "Syrian Arab Republic" OR "Albania" OR "Montenegro" OR "North Macedonia" OR "Libyan Arab Jamahiriya" OR "Monaco" OR "Malta" OR "Gibraltar" OR "Kosovo" OR "Monaco" OR "Northern Cyprus" OR "Palestine" OR "San Marino" OR "Vatican")))

We included all search results that were published up to 2023. The search string resulted in a total of 3977 documents, which were further evaluated in the next step.

Step 2: Appraisal

The second step of the SLR describes how the search results were evaluated in order to select only those studies that are relevant according to the research scope. We used a set of predetermined inclusion and exclusion criteria to make the process as systematic and reproducible as possible (Table S4). The process resulted in a selection of 258 papers that comply with the selection criteria.

Step 3: Synthesis

The third step of the SLR consists of the extraction and classification of relevant data from the selected papers. The variables of interests were divided over five main themes, which include bibliographic information, study area, climate models, hydrological model, and water resources projections (Table S5). The data were extracted into an Excel spread sheet and analysis was performed using R (version 4.3.1).

The projected change in water resources was calculated from the reported reference values and the projected values under climate change. Data were extracted from the reported text, tables and graphs, using image analysis software (WebPlotDigitizer) when necessary. In the case relative changes were reported, we used those values directly. We determined the ensemble

Table S4. SLR appraisal: study selection inclusion and exclusion criteria.

Criteria	Decision
Papers that apply a hydrological model	Inclusion
Papers that apply established climate change scenarios based on climate model output	Inclusion
Papers with at least 50% of the study area inside the Mediterranean ecoregion	Inclusion
Papers that are published after 2023	Exclusion
Papers not written in English	Exclusion
Papers that are not accessible	Exclusion

average in the case the values were reported per individual climate model. We determined the average among the methods in the case of method comparison studies.

Table S5. SLR synthesis: definition of main and specific variables used for data extraction and identified categories in data synthesis.

Variable	Category	Definition
Bibliographical information		
Year of publication	-	-
Name of journal	-	-
Study catchment		
Number of study catchments	-	-
Name of the study catchment	-	-
Size of the study catchment (km^2)	In number	-
	Micro-scale	$<$ 100 km^2
	Small-scale	100-1,000 km^2
	Medium-scale	1,000-10,000 km^2
	Large-scale	$\geq$ 10,000 km^2
Latitude ($^\circ$)	-	Latitude at the center of the study site
Longitude ($^\circ$)	-	Longitude at the center of the study site
Polygon	-	For study sites >100 km^2. Obtained from HydroSHEDS (Lehner et al., 2008), Natural Earth (https://www.naturalearthdata.com/) or other sources
Climate models		
Generation of emission scenarios	IS92	IPCC Scenarios 1992 (Leggett et al., 1992)
	SRES	Special Report on Emissions Scenarios (IPCC, 2000)
	RCP	Representative Concentration Pathways (Moss et al., 2008)
Emission scenarios	IS92a	From the IS92 generation of emission scenarios
	A1B	From the SRES generation of emission scenarios
	A1FI	From the SRES generation of emission scenarios
	A2	From the SRES generation of emission scenarios
	B1	From the SRES generation of emission scenarios
	B2	From the SRES generation of emission scenarios

	RCP2.6	From the RCP generation of emission scenarios
	RCP4.5	From the RCP generation of emission scenarios
	RCP6.0	From the RCP generation of emission scenarios
	RCP8.5	From the RCP generation of emission scenarios
Emission scenario categories	Low emissions	B1, RCP2.6, RCP4.5
	Intermediate emissions	IS92a, B2, A1B, RCP6.0
	High emissions	A1FI, A2, RCP8.5
Number of climate models	-	-
Downscaling methods	No downscaling	-
	Statistical downscaling	-
	Dynamical downscaling	-
Statistical downscaling	Temporal and spatial analogues	ANA, analog approach, analogues, Analogues-FIC, Analogues-INM, SDSM,FIC analog method, fragments method, local intensity scaling, synthetic fragments, PGWM, two-step analogue/regression statistical method
	Regression methods	Automated Statistical Downscaling Tool, expanded downscaling, GEN-BALAN, linear regression (monthly), multiple regression, weather-type method
	Stochastic weather generators	Auto Regressive Model Average, AWE-GEN, CCAReg, CCWorldWeatherGen, ClimGen, GOTILWA+, HiReS-WG, LARS-WG, Markov chain stochastic daily rainfall generator, MarkSim, multi-site stochastic weather model, multi-fractal approach, Neyman-Scott Rectangular Pulse model, RainSim, SDSM, stochastic autoregressive model, stochastic daily rainfall generator, Stochastic Rainfall Generation Process, Stochastic Space Random Cascade, stochastic weather generator, weather generator (Black et al., 2009), WGEN, WXGEN
	Other techniques	ANN, Climate Change Toolkit, Piani et al. (2010)

Application of downscaling and bias correction	No downscaling and no bias correction	-
	Bias correction only	-
	Downscaling only	-
	Downscaling and bias correction	-
Bias correction method	Combination of different techniques	-
	Change factor	Change factor, delta change
	Quantile mapping	Quantile mapping, BCQM, cumulative distribution functions transformation
	Distribution mapping	Distribution mapping, multi-segment bias correction
	Trend-preserving quantile methods	BCSD, daily translation method, Distribution Based Scaling, Hempel et al. (2013), ISI-MIP, MidAS, multivariate bias correction, quantile delta mapping
Reference period	-	-
Future period	Early	Period centre $<$ 2035
	Mid	Period centre $\geq$ 2035 & Period centre $<$ 2065
	End	Period centre $\geq$ 2065
Hydrological model		
Name of the model	-	-
Time step	Sub-daily	< 1 day
	Daily	1-2 days
	Monthly	30 days
	Yearly	365 days
Output variable	Runoff	Annual runoff, annual volume, aquifer discharge, discharge, flow, flow rate, freshwater inflow, median flow (Q50), overland flow, overland storage, peak discharge, river runoff, runoff, stream discharge, stream flow, streamflow, surface flow, surface runoff, surface runoff + ground water, surface water, total runoff, water flow
	Reservoir/lake inflow	Dam storage, inflow, rainwater harvesting, reservoir volume, reservoir inflow, lake inflow, lake water level

	Soil moisture	Green water footprint, infiltration, relative soil water content, soil moisture, soil moisture content, soil water, soil water content, soil water storage, subsurface storage
	Aquifer recharge	Aquifer inflow, aquifer recharge, deep infiltration, groundwater, groundwater potential, groundwater recharge, groundwater storage, recharge, renewable groundwater, renewable water, total aquifer recharge
	Irrigation demand	Agricultural demand, crop water demand, green water use agriculture, irrigation demand, irrigation need, irrigation needs, irrigation requirements, irrigation supply, irrigation water demand, irrigation water requirements, net hydric needs, potential soil moisture deficit, required irrigation water volume, soil moisture deficit, water demand
	Other water resources	Blue water footprint, blue water use agriculture, Total Actual Renewable Water Resources, total water yield, water availability, water resources, water supply, water yield
Water resources projections		
Precipitation in the reference scenario	-	-
Temperature in the reference scenario	-	-
Water resources in the reference scenario	-	-
Precipitation projections under climate change	-	Specified per emission scenario and future period
Temperature projections under climate change	-	Specified per emission scenario and future period

Water resources projections under climate change	-	Specified per emission scenario and future period

Step 4: Analysis

The fourth step of the SLR consists of the extraction of meaningful conclusions from the synthesized data, which serves to answer the formulated research questions from the first step. We divided the analysis step into two parts. The first part encompasses the analysis of the methods used, subdivided by the main themes defined in step 3 (Table S5). From this analysis we determined which methodological aspects of the model chain show significant differences in the projected change in water resources among their categories. We assigned weights to those methodological aspects that show significant differences, which we obtained from an online questionnaire, as explained further in Text S4. In the second part of the analysis we aim to answer the research questions, based on the weighted water resources projections under climate change.

Figures

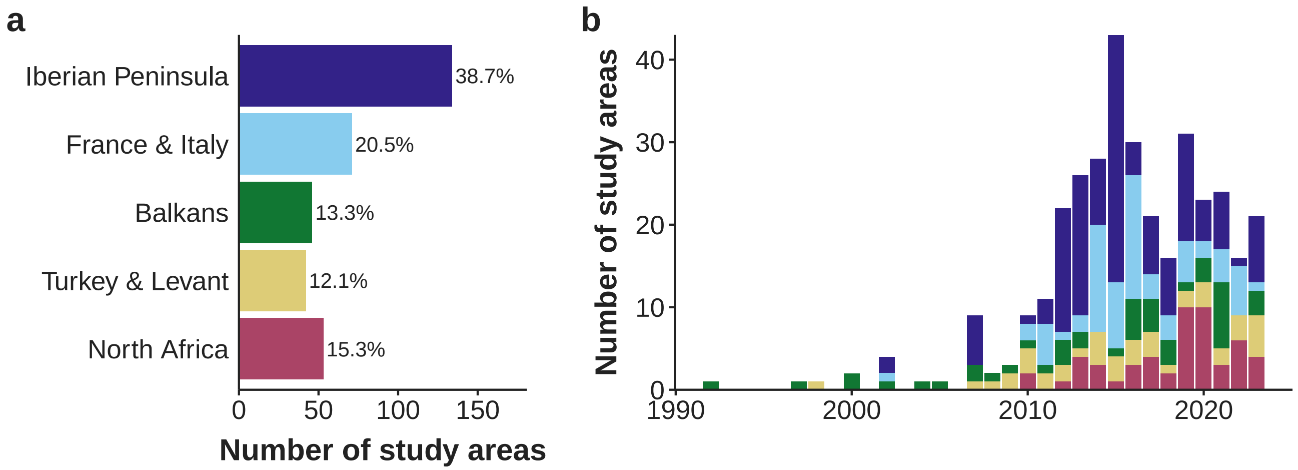

Figure S1. (a) Number of study areas per Mediterranean sub-region, with Iberian Peninsula (Portugal and Spain), France and Italy, Balkan (Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Albania, Kosovo and Greece), Turkey and Levant (Turkey, Cyprus, Syria, Lebanon, Israel, Jordan and Palestine) and North Africa (Egypt, Lybia, Tunisia, Algeria and Morocco). (b) Yearly contribution of study areas per Mediterranean sub-region.

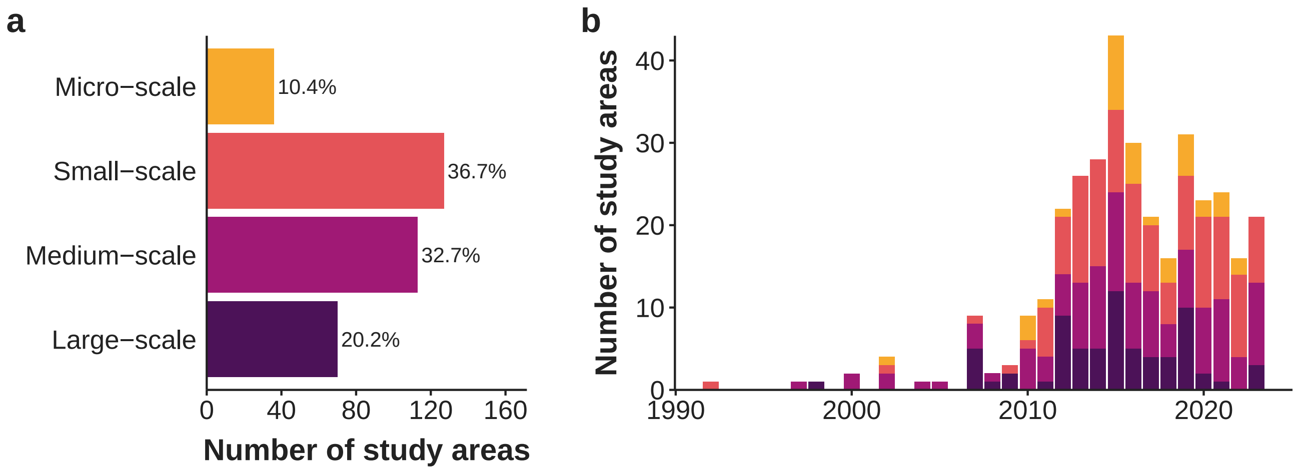

Figure S2. (a) Number of study areas per study area size class, with micro-scale (< 100 km^2), small-scale (100-1,000 km^2), medium-scale (1,000-10,000 km^2) and large-scale ($\geq$ 10,000 km^2). (b) Yearly contribution of study areas per study area size class.

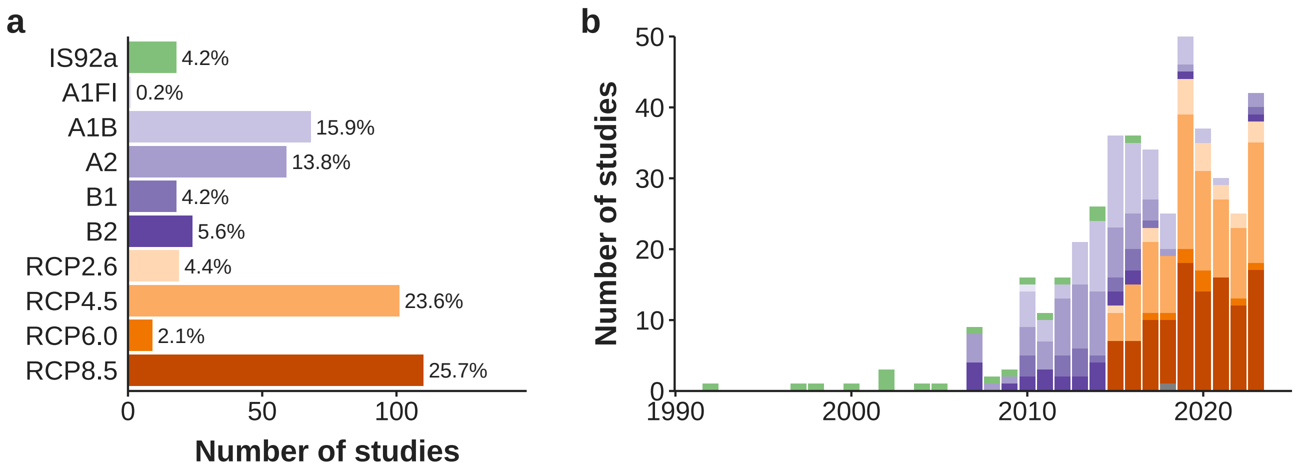

Figure S3. (a) Number of studies per emission scenarios. (b) Yearly contribution of studies per emission scenarios.

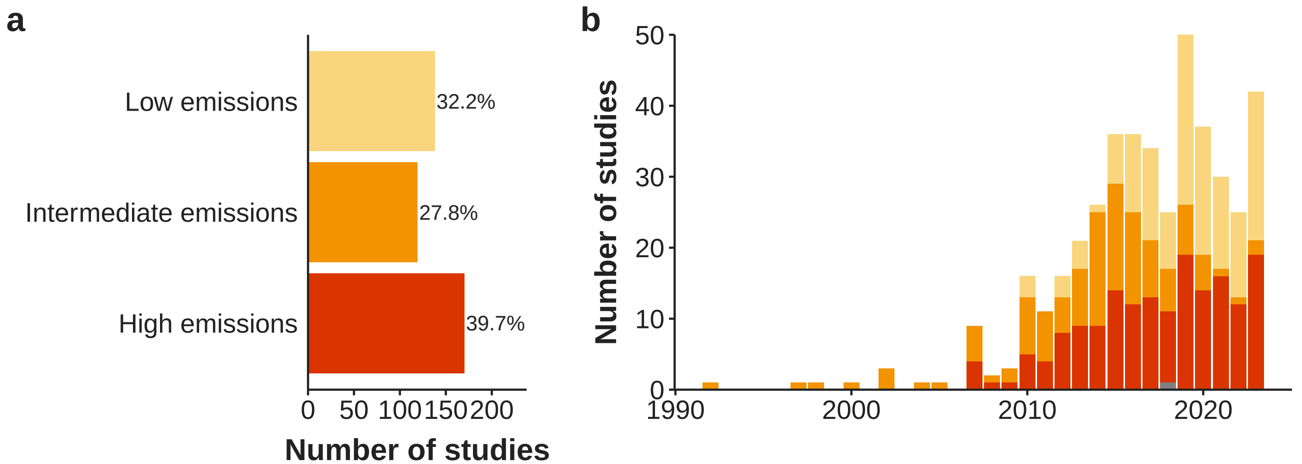

Figure S4. (a) Number of studies per emission scenario category, with low emissions scenarios (B1, RCP2.6, RCP4.5), intermediate emission scenarios (IS92a, B2, A1B, RCP6.0) and high emission scenarios (A2, A1FI, RCP8.5). (b) Yearly contribution of studies per emission scenarios.

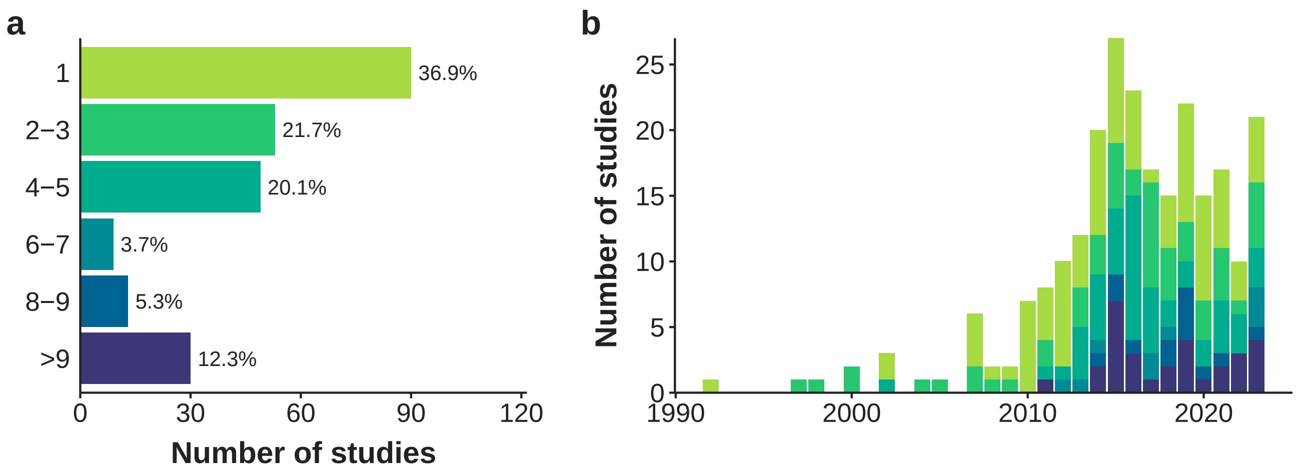

Figure S5. (a) Number of studies per climate model ensemble size class. (b) Yearly contribution of studies per climate model ensemble size class.

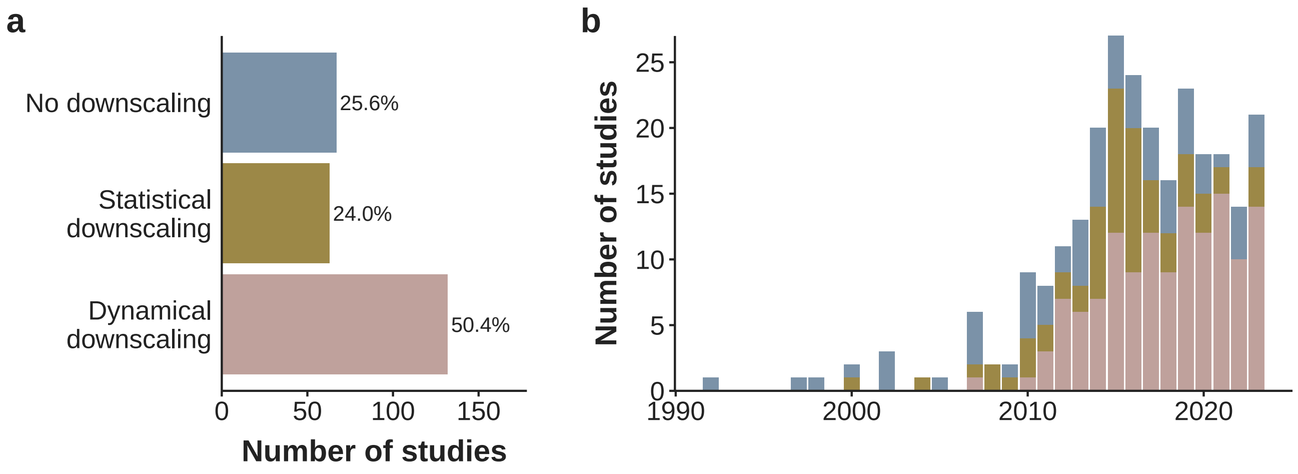

Figure S6. (a) Number of studies per downscaling method. (b) Yearly contribution of studies per statistical downscaling method.

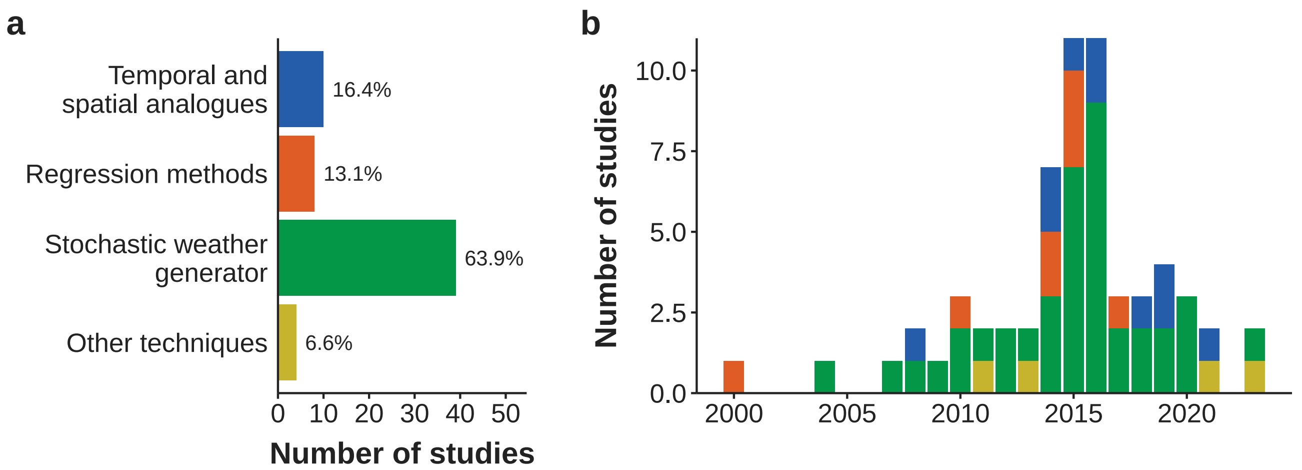

Figure S7. (a) Number of studies per statistical downscaling method. (b) Yearly contribution of studies per statistical downscaling method.

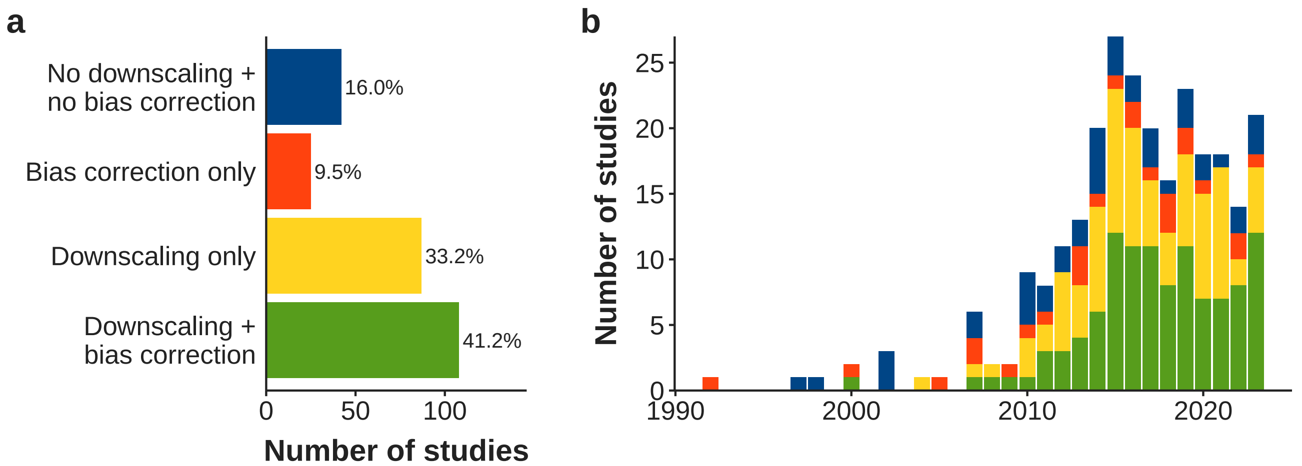

Figure S8. (a) Number of studies that apply downscaling and/or bias correction. (b) Yearly contribution of studies that apply downscaling and/or bias correction.

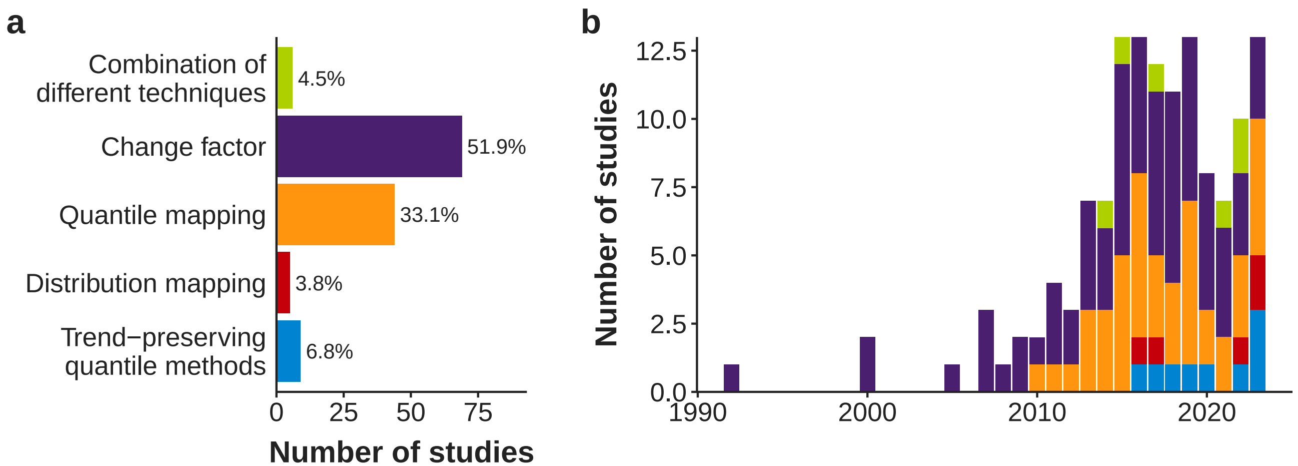

Figure S9. (a) Number of studies per bias correction method. (b) Yearly contribution of studies per bias correction method.

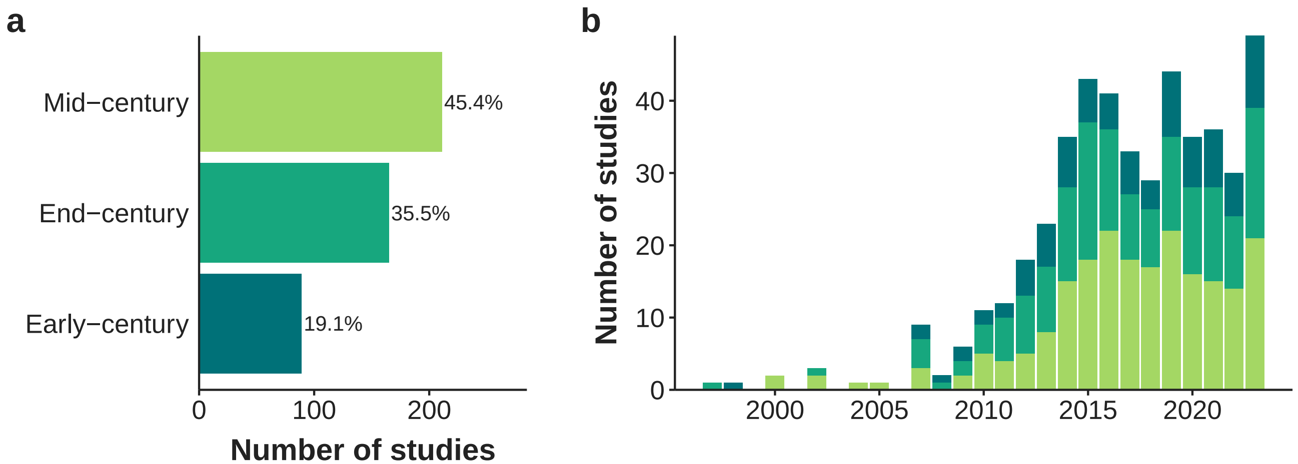

Figure S10. (a) Number of studies per future period, where early-century is centred before 2035, mid-century is centred in the period 2035-2065 and end-century is centred after 2065. (b) Yearly contribution of studies per future period.

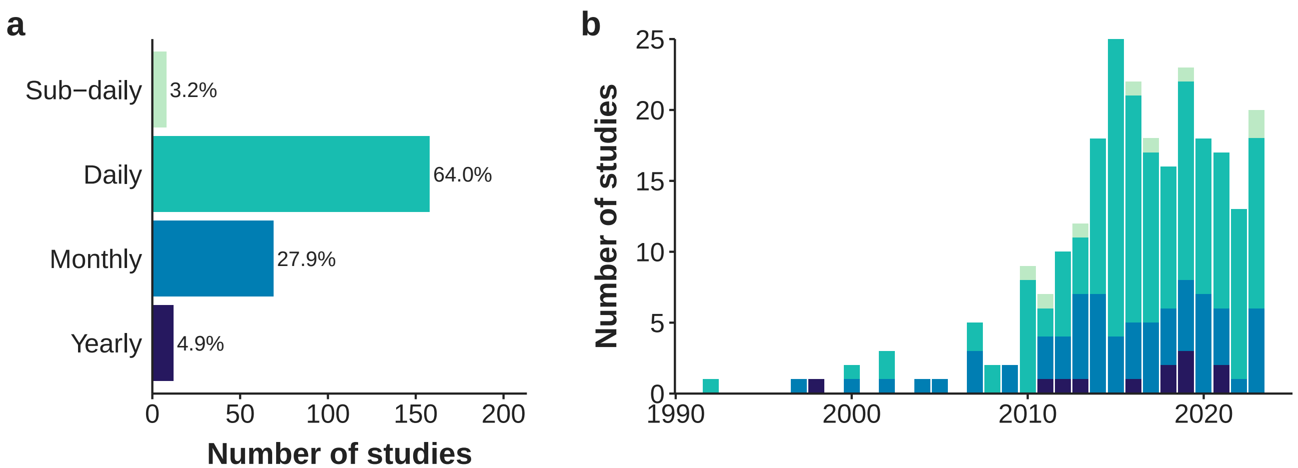

Figure S11. (a) Number of studies per time step class. (b) Yearly contribution of studies per time step class.

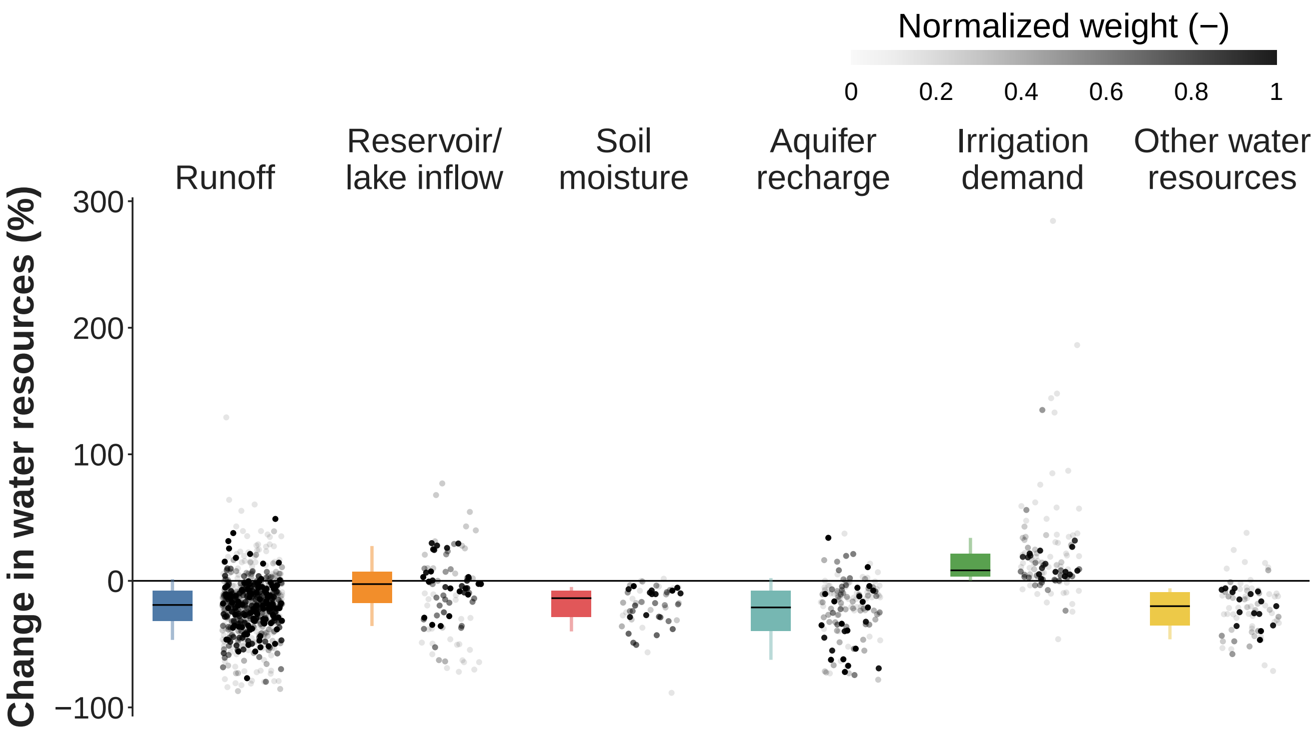

Figure S12. Projected change per water resource category (%). The colored boxes indicate the weighted interquantile range (25th and 75th percentiles), the black horizontal line the weighted median (50th percentile) and the whiskers extend to the weighted 10th and 90th percentiles. The jitter plot shows the projected change in water resources per study, considering the different study areas, periods and emission scenarios. The grey shades indicate the robustness of the studies, quantified with the normalized weight.

Tables

Table S6. Climate change impacts obtained from large-scale impact assessments in the Mediterranean Basin.

Water resource (unit)	Change (%)	Future period	Future scenario	Model	Reference
Precipitation - evaporation (mm)	-21.5	2070-2099	A1B	GCM output	Mariotti et al. (2008)
Water discharge (km^3 yr^{-1})	-10.3	2030	Millenium Ecosystem Assessment	IMAGE[a]	Ludwig et al. (2010)
Water discharge (km^3 yr^{-1})	-16.2	2050	Millenium Ecosystem Assessment	IMAGE[a]	Ludwig et al. (2010)
Freshwater availability (mm)	-25 to -50	2041-2060	A2	Conceptual water balance model	Milano et al. (2013)
Runoff (mm)	-14.8	2071-2098	RCP4.5	GCM output	Mariotti et al. (2015)
Soil moisture (mm)	-4.7	2071-2098	RCP4.5	GCM output	Mariotti et al. (2015)
Irrigation demand (km^3)	+5.1	n/a	+2 °C	LPJmL[c]	Fader et al. (2016)
Irrigation demand (km^3)	+7.8	n/a	+3 °C	LPJmL[c]	Fader et al. (2016)
Irrigation demand (km^3)	+9.5	n/a	+4 °C	LPJmL[c]	Fader et al. (2016)
Irrigation demand (km^3)	+12.2	n/a	+5 °C	LPJmL[c]	Fader et al. (2016)
Recharge (mm)	-16.8	n/a	+1 °C	Global hydrological models	Reinecke et al. (2021)
Recharge (mm)	-21.3	n/a	+1.5 °C	Global hydrological models	Reinecke et al. (2021)
Recharge (mm)	-27.9	n/a	+2 °C	Global hydrological models	Reinecke et al. (2021)
Recharge (mm)	-34.0	n/a	+3 °C	Global hydrological models	Reinecke et al. (2021)
Precipitation - evaporation (mm)	-20	2071-2100	SSP5-8.5	GCM output	Arjdal et al. (2023)
Soil moisture (%)	-9	2071-2100	SSP5-8.5	GCM output	Arjdal et al. (2023)
Soil moisture (%)	-6	2071-2100	SSP2-4.5	GCM output	Arjdal et al. (2023)

[a] Bouwman et al. (2009); [b] (Yates, 1997); [c] Bondeau et al. (2007)

Table S7. Number of publications per journal, with a minimum of 4 published studies.

Journal	Number of publications
Science of the Total Environment	29
Water (Switzerland)	23
Journal of Hydrology	22
Water Resources Management	15
Hydrological Sciences Journal	10
Hydrology and Earth System Sciences	9
Environmental Earth Sciences	7
Journal of Hydrology: Regional Studies	7
Hydrological Processes	5
Journal of Hydrometeorology	5
Sustainability (Switzerland)	5
Agricultural Systems	4
Agricultural Water Management	4
International Journal of Water Resources Development	4

Table S8. Number of publications per hydrological model, with a minimum of 3 published studies.

Hydrological model	Number of studies
SWAT (Arnold et al., 2012)	57
GR2M (Mouelhi et al., 2006)	18
water balance model (various sources)	12
HEC-HMS (Scharffenberg, 2013)	10
WaSiM (Schulla, 1997)	8
HBV (Bergström and Forsman, 1973)	7
MODFLOW (McDonald and Harbaugh, 1988)	6
SWIM (Krysanova et al., 1998)	6
MIKE-SHE (DHI, 2017)	5
WBUDG (Mimikou et al., 1991)	5
Temez (Témez, 1977)	4
GR4J/GR6J (Perrin et al., 2003)	4
UTHBAL (Loukas et al., 2007)	3
InVEST (Nelson et al., 2009)	3
SHETRAN (Ewen et al., 2000)	3
SPHY (Terink et al., 2015)	3

Table S9. Keywords per water security issue used to search for relevant articles for the informative review.

Water security issue	Keywords
Hydrological extremes	
Extreme precipitation	extreme precipitation, heavy precipitation, intense precipitation, extreme rainfall, heavy rainfall, intense rainfall
Flood duration/magnitude	flood, peak discharge, high flow, peak flow, storm runoff
Dry spells	dry spell
Low flow duration/magnitude	low flow
Water and soil quality	
Nutrient concentration/load	water quality, nutrient
Soil salinity	soil quality, salinity
Soil erosion	soil erosion, soil loss
Sediment yield	sedimentation, sediment yield
Climate change adaptation	
Climate change adaptation	adaptation, nature-based solution, sustainable land management, measure

Table S10. Change in meteorological and hydrological extremes obtained from the studies included in the database.

Reference	Catchment, country	Metric	Change
Extreme precipitation			
Nunes et al. (2013)	Odeleite/Alenquer (Portugal)	90th percentile of daily precipitation	0
Piras et al. (2014)	Sardinia (Italy)	Mean precipitation intensity in rainy days	0
Smiatek and Kunstmann (2016)	Upper Jordan River (Syria/Lebanon)	Daily precipitation intensity over 1mm	– –
Eekhout et al. (2018)	Segura River catchment (Spain)	95th percentile of daily precipitation	++
Marras et al. (2021)	Sardinia (Italy)	95th/99.9th percentile of daily precipitation	++
Flood duration			
Mourato et al. (2018)	Lis River Basin (Portugal)	Number of floods within the 100 years return period	++
Ledesma et al. (2019)	Catchment at Montseny (Spain)	Frequency Q $>$ 30 mm/day	–
Yıldırım et al. (2021)	Alata River Basin (Turkey)	Number of floods exceeding 40 m3/s	0
Flood magnitude			
Varanou et al. (2000)	Pinios river (Greece)	1000-year flood	++
Varanou et al. (2002)	Pinios River (Greece)	10, 20, 100, and 1,000 year floods	++
Fujihara et al. (2008)	Seyhan River Basin (Turkey)	Flow exceeded 95% of the time	0
Abouabdillah et al. (2010)	Merguellil basin (Tunisia)	Magnitude of the 1-, 3-, 7-, 30- and 90-day maxima	– –
Wade et al. (2010)	Upper Jordan River (Syria/Lebanon)	Exceeded 10% of the time	– –
Brocca et al. (2011)	Upper Tiber River basin (Italy)	Flood frequency curves	0
Majone et al. (2012)	Gállego catchment (Spain)	20th percentile	–
Nunes et al. (2013)	Odeleite/Alenquer (Portugal)	Peak runoff rate	0
Versini et al. (2013)	Llobregat basin (Spain)	30-year return period	++
Brilly et al. (2014)	Soča watershed (Slovenia)	100-year return period flood	++

Vezzoli et al. (2015)	Po River Basin (Italy)	10-, 20-, 50-, 100-year return period	0
Von Gunten et al. (2015)	Lerma (Spain)	Annual maximum discharges	+
Papadaki et al. (2016)	Mesochora catchment and Voidomatis tributary (Greece)	1-day, 3-day, 7-day, 30-day, 90-day maximum	−−
Sellami et al. (2016a)	Chiba catchment (Tunisia)/Thau catchment (France)	Flow percentile less than 10%	−−
Sellami et al. (2016b)	Chiba catchment (Tunisia)	Flow percentile less than 10%	−−
Cervi et al. (2018)	Mulino delle Vene springs (Italy)	5th percentile of the FDC	++
Eekhout and de Vente (2019)	Segura River catchment (Spain)	Median yearly maximum discharge	++
Almeida et al. (2019)	Montargil Reservoir (Portugal)	Q10%	−
Sirigu and Montaldo (2022)	Rio Fluminimaggiore Basin (Italy)	Return periods of 100 years	++
Senatore et al. (2022)	Crati River Basin (Italy)	Daily flow equal or exceeding for 10% of the time	−−
Mouris et al. (2023)	Devoll catchment (Albania)	Floods with a 50-year return period	++
Dry spells			
Smiatek and Kunstmann (2016)	Upper Jordan River (Syria/Lebanon)	Number of dry days	++
Eekhout et al. (2018)	Segura River catchment (Spain)	95th percentile of the duration of at least 5 consecutive dry days	++
Low flow duration			
Senatore et al. (2011)	Crati River Basin (Italy)	Low flow rate frequency	++
Piras et al. (2014)	Sardinia (Italy)	Max consecutive length of low flow days	++
Vezzoli et al. (2015)	Po River Basin (Italy)	Low flow duration	++
Ledesma et al. (2019)	Catchment at Montseny (Spain)	Streamflow below Qlow of reference period	++
El Khalki et al. (2021)	Oued El Abid basin (Morocco)	Frequency of months below the 5% quantile of historical period	++
Low flow magnitude			

Majone et al. (2012)	Gállego catchment (Spain)	Flows with probability of exceedance larger than 95%	++
Girard et al. (2015)	Orb river basin (France)	5-year monthly low flows	−−
Papadaki et al. (2016)	Mesochora catchment and Voidomatis tributary (Greece)	1-day, 3-day, 7-day, 30-day, 90-day maximum	−−
Papadimitriou et al. (2016)	Guadiana catchment (Spain/-Portugal)	Annual 10th percentile flow	−−
Sellami et al. (2016b)	Chiba catchment (Tunisia)	Flow percentile higher than 50%	−−
Sellami et al. (2016a)	Chiba catchment (Tunisia)/Thau catchment (France)	Low flows intensity	−−
Cervi et al. (2018)	Mulino delle Vene springs (Italy)	95th percentile of the FDC	−−
Almeida et al. (2019)	Montargil Reservoir (Portugal)	Q95%	−−
Senatore et al. (2022)	Crati River Basin (Italy)	Daily flow equal or exceeding for 90% of the time	−−

Table S11. Change in water and soil quality indicators obtained from the studies included in the database.

Reference	Catchment (country)	Indicator	Change
Nutrient concentration			
Mimikou et al. (2000)	Ali Efenti sub basin (Greece)	BOD concentration	++
Mimikou et al. (2000)	Ali Efenti sub basin (Greece)	DO concentration	−−
Mimikou et al. (2000)	Ali Efenti sub basin (Greece)	NH4+ concentration	++
Younger et al. (2002)	Anoia Unit/Serra de Tramuntana (Spain)	CCa2+ concentration	++
Dimitriou and Moussoulis (2010)	Lake Trichonis catchment (Greece)	N concentration	++
Rimmer et al. (2011)	Lake Kinneret watershed (Israel/Lebanon/Syria)	Cl- concentration	++
Molina-Navarro et al. (2014)	Ompólveda River catchment (Spain)	N-NO3 concentration	0
Molina-Navarro et al. (2014)	Ompólveda River catchment (Spain)	TP concentration	++
Pulido-Velazquez et al. (2015)	Serral-Salinas aquifer (Spain)	NO3 leaching	++
Almeida et al. (2018)	Sorraia River (Portugal)	P concentration	++
Almeida et al. (2018)	Sorraia River (Portugal)	N concentration	++
Pesce et al. (2018)	Zero river basin (Italy)	DO concentration	−−
Pesce et al. (2018)	Zero river basin (Italy)	Chl-a concentration	++
Avcı et al. (2023)	North Aegean Basin (Turkey)	TP concentration	++
Avcı et al. (2023)	North Aegean Basin (Turkey)	TN concentration	++
Lyra and Loukas (2023)	Almyros basin (Greece)	Groundwater nitrates	−−
Lyra and Loukas (2023)	Almyros basin (Greece)	Groundwater chlorides	+
Vagheei et al. (2023)	Albaida Valley (Spain)	NO3- concentration	++
Vagheei et al. (2023)	Albaida Valley (Spain)	NH4 concentration	++
Vagheei et al. (2023)	Albaida Valley (Spain)	TP concentration	++
Nutrient load			
Varanou et al. (2002)	Pinios River (Greece)	NO3-N loss	−−
Rimmer et al. (2011)	Lake Kinneret watershed (Israel/Lebanon/Syria)	Cl- inflow	−
Molina-Navarro et al. (2014)	Ompólveda River catchment (Spain)	N-NO3 export	−
Molina-Navarro et al. (2014)	Ompólveda River catchment (Spain)	TP export	0

Pesce et al. (2018)	Zero river basin (Italy)	NO3 load	0
Pesce et al. (2018)	Zero river basin (Italy)	NH4 load	0
Pesce et al. (2018)	Zero river basin (Italy)	PO4 3- load	++
Stefanidis et al. (2018)	Pinios river basin (Greece)	TP loss	−−
Stefanidis et al. (2018)	Pinios river basin (Greece)	TN loss	++
Stefanova et al. (2019)	Mar Menor catchment (Spain)	NO3-N load	−
Stefanova et al. (2019)	Mar Menor catchment (Spain)	NH4-N load	++
Stefanova et al. (2019)	Mar Menor catchment (Spain)	PO4-P load	++
Rocha et al. (2020)	Monte Novo catchment/Vigia catchment (Portugal)	P load	−
Avcı et al. (2023)	North Aegean Basin (Turkey)	TP load	−−
Avcı et al. (2023)	North Aegean Basin (Turkey)	TN load	−−
Oduor et al. (2023)	Cidacos River watershed (Spain)	NO3 load	−−
Van Der Laan et al. (2023)	Sorraia catchment (Portugal)	TP load	−−
Soil salinity			
Carneiro et al. (2010)	Plain of Saïdia (Morocco)	Groundwater salinity	++
Pulido-Velazquez et al. (2018)	Plana Oropesa-Torreblanca aquifer (Spain)	Salinity concentration	+
El Hamidi et al. (2021)	Rmel-Oulad Ogbane coastal aquifer (Morocco)	Salinity concentration	++
Soil erosion			
Nunes et al. (2013)	Odeleite (Portugal)	Within-watershed erosion	−−
Nunes et al. (2013)	Alenquer (Portugal)	Within-watershed erosion	++
Cilek et al. (2015)	Egribuk Subcatchment (Turkey)	Erosion	++
Ramos and Martínez-Casasnovas (2015)	Basin in Anoia region (Spain)	Soil loss	0
Eekhout et al. (2018)	Segura River catchment (Spain)	Hillslope erosion	++
Stefanidis et al. (2018)	Pinios river basin (Greece)	Erosion rate	0
Pastor et al. (2019)	Macieira de Alcôba experimental watershed (Portugal)	Soil loss	++
Zhang et al. (2019)	Cobres basin (Portugal)	Soil erosion	−−
Luetzenburg et al. (2020)	Can Revull (Spain)	Hillslope soil loss	0
Sediment yield			
Nunes et al. (2013)	Odeleite (Portugal)	Sediment yield	−−

Nunes et al. (2013)	Alenquer (Portugal)	Sediment yield	++
Zabaleta et al. (2014)	Aixola watershed (Spain)	Sediment yield	−−
Serpa et al. (2015)	Sao Lourenco catchment (Portugal)	Sediment export	−−
Serpa et al. (2015)	Guadalupe catchment (Portugal)	Sediment export	++
Eekhout et al. (2018)	Segura River catchment (Spain)	Sediment yield	−−
Mouris et al. (2023)	Devoll catchment (Albania)	Suspended sediment yield	+
Pesci et al. (2023)	Devoll catchment (Albania)	Sediment yield	0

Table S12. Change in water and soil quality indicators obtained from the studies included in the database.

Reference	Catchment (country)	Indicator	Adaptation strategy	Change	Reverse impact
Irrigation					
Rochdane et al. (2012)	Rheraya catchment (Morocco)	Unmet demand	Drip irrigation	++	
Monaco et al. (2014)	Destra Sele (Italy)	Irrigation demand	Reduced deficit irrigation	−−	×
De Lorenzi et al. (2017)	Irrigated district Destra Sele (Italy)	Irrigation demand	Reduced deficit irrigation	−−	
Stigter et al. (2017)	Querença-Silves aquifer (Portugal)	Irrigation demand	Agricultural abandonment	−−	×
Stigter et al. (2017)	Querença-Silves aquifer (Portugal)	Irrigation demand	Agricultural intensification	++	
Jorda-Capdevila et al. (2019)	Ebro basin (Spain)	Water consumption	Increase irrigated agriculture	+	
Jorda-Capdevila et al. (2019)	Ebro basin (Spain)	Water consumption	Decrease irrigated agriculture	-	×
Kolokytha and Malamataris (2020)	Mygdonia basin (Greece)	Water demand	Reduction of irrigated agriculture	−−	×
Pool et al. (2021)	Plana de Valencia Sur aquifer (Spain)	Recharge	Drip irrigation	−	
Naulleau et al. (2022)	Rieutort watershed (France)	Irrigation demand	Water stress limitation strategies	++	
Marcos-Garcia et al. (2023)	Jucar River Basin (Spain)	Inflow	Drip irrigation	−−	
Van Der Laan et al. (2023)	Sorraia catchment (Portugal)	Reservoir volume	Precision irrigation	++	×
Tillage practices					
Brouziyne et al. (2018)	R'dom watershed (Morocco)	Water yield	No-tillage	−−	
Eekhout and de Vente (2019)	Segura River catchment (Spain)	Soil moisture	Reduced tillage + green manure	+	×
Eekhout and de Vente (2019)	Segura River catchment (Spain)	Reservoir inflow	Reduced tillage + green manure	−	

Luetzenburg et al. (2020)	Can Revull (Spain)	Runoff	Reduced tillage	−−	×
Large-scale measures					
Guyennon et al. (2017)	Capitanata Plain (Italy)	Reservoir and groundwater volume	Managed aquifer recharge	−−	
Guyennon et al. (2017)	Capitanata Plain (Italy)	Reservoir and groundwater volume	Increasing maximum reservoir capacity	−−	
Other adaptation measures					
Spyrou et al. (2021)	Spercheios River (Greece)	Subsurface storage	Nature-based Solutions	0	

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