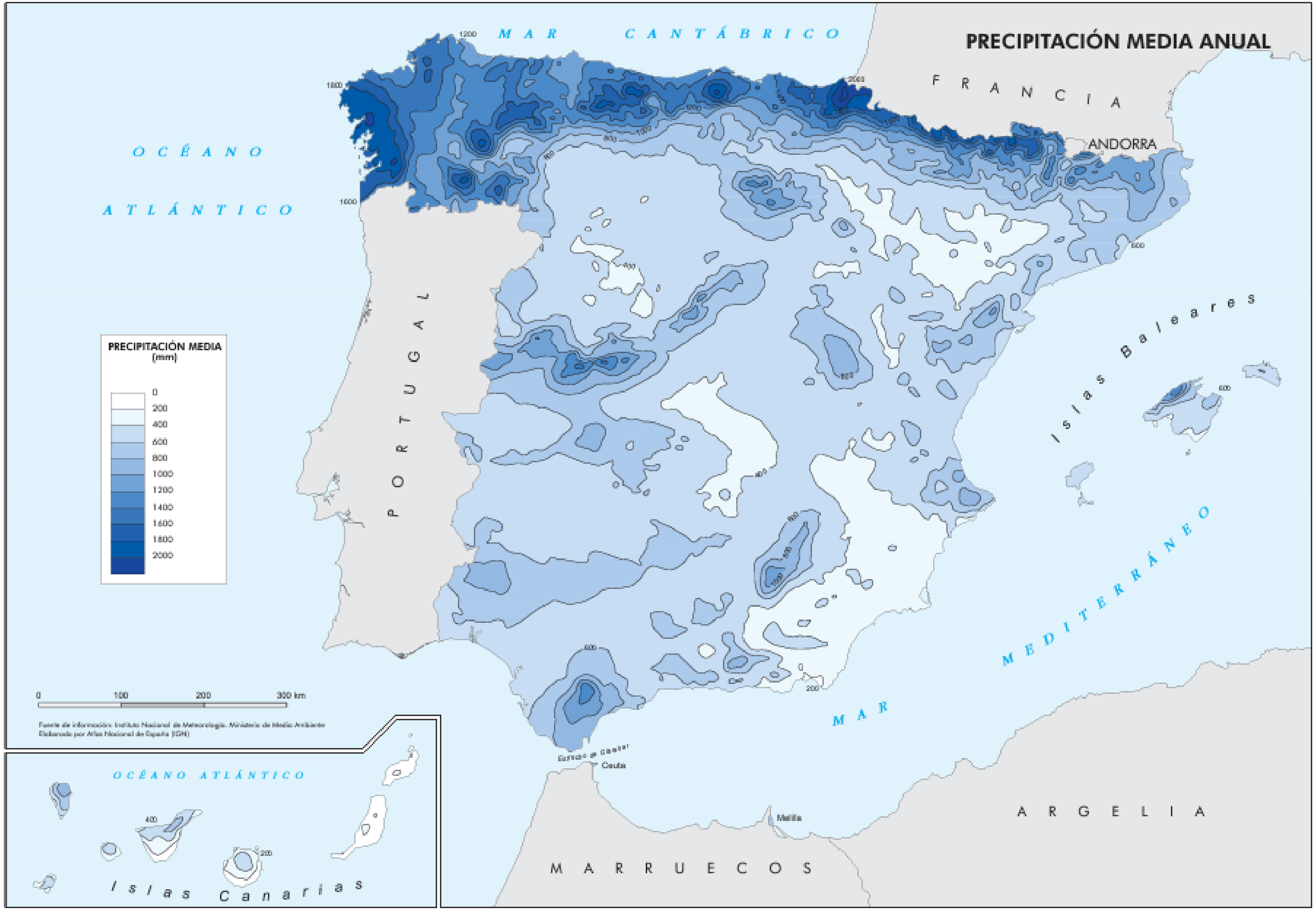
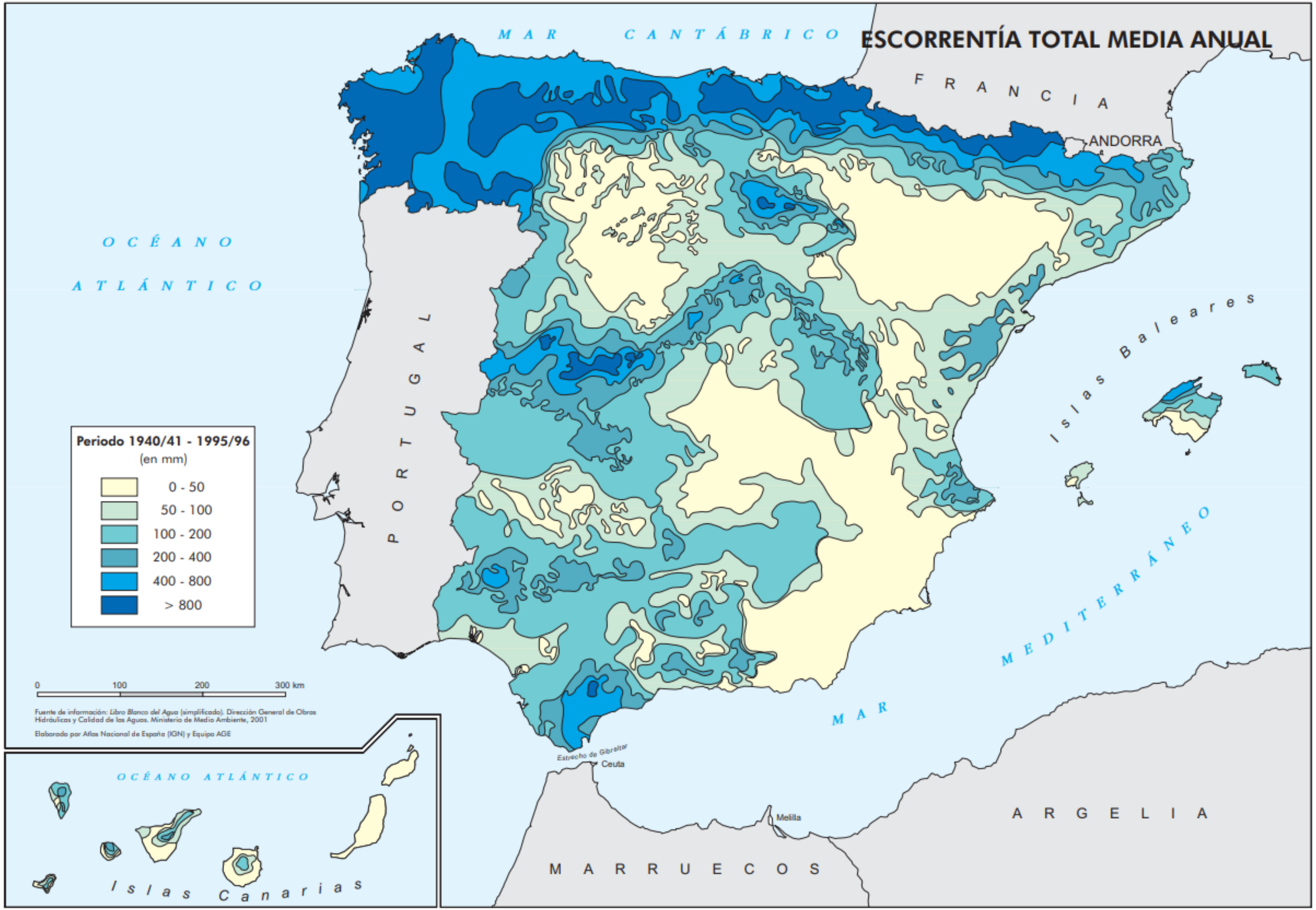
Cambios en la disponibilidad de agua en España: la influencia de la gestion del territorio y las demandas de agua en un scenario de cambio climático.

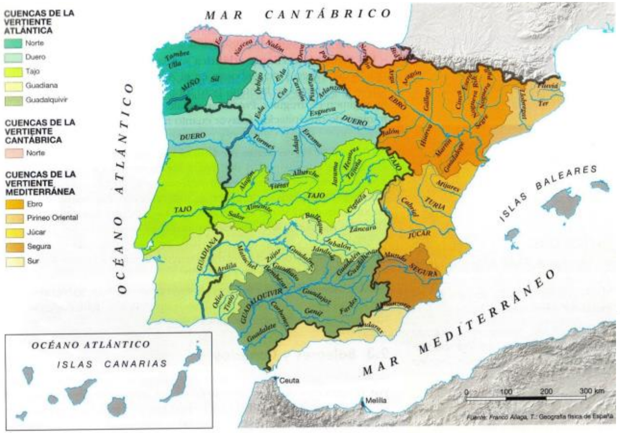
Sergio Vicente Serrano

CSIC
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

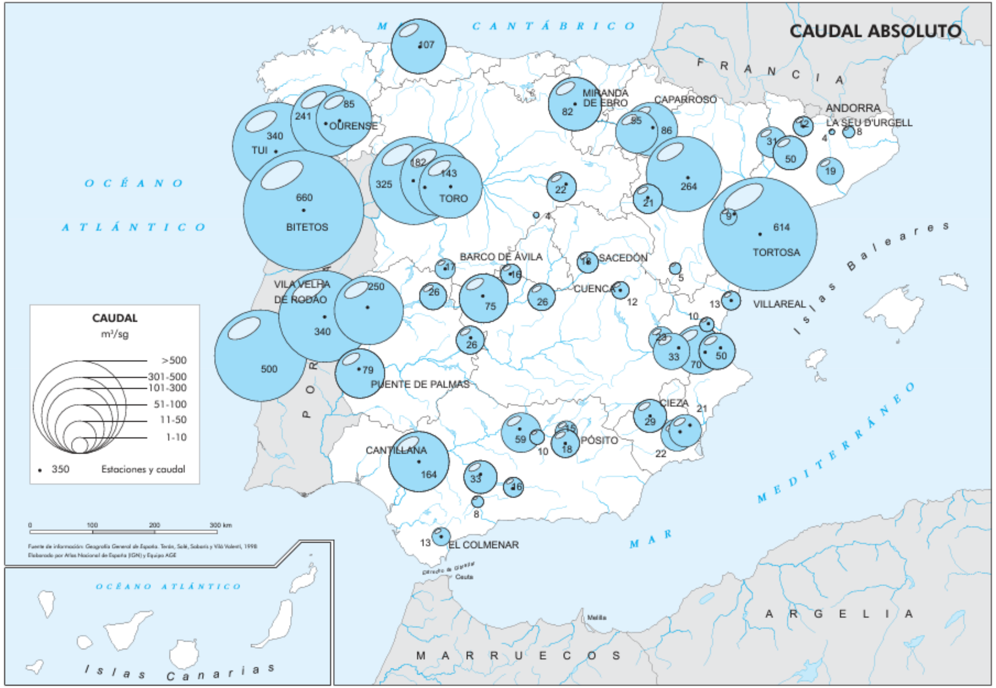
IPE
INSTITUTO PIRENAICO DE ECOLOGÍA
CSIC


PRECIPITACIÓN MEDIA ANUAL
MAR CANTÁBRICO
OCÉANO ATLÁNTICO
FRANCIA
ANDORRA
PORTUGAL
Islas Baleares
MAR MEDITERRÁNEO
MARRUECOS
ARGELIA
Ceuta
Melilla
PRECIPITACIÓN MEDIA (mm)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0 100 200 300 km
Fuente de información: Instituto Nacional de Meteorología. Ministerio de Medio Ambiente
Elaborado por Atlas Nacional de España (IGN)
OCÉANO ATLÁNTICO
Islas Canarias


ESCORRENTÍA TOTAL MEDIA ANUAL
MAR CANTÁBRICO
FRANCIA
ANDORRA
OCÉANO ATLÁNTICO
PORTUGAL
Islas Baleares
MAR MEDITERRÁNEO
Estrecho de Gibraltar
Ceuta
Melilla
MARRUECOS
ARGELIA
Periodo 1940/41 - 1995/96
(en mm)
0 - 50
50 - 100
100 - 200
200 - 400
400 - 800
> 800
0
100
200
300 km
Fuente de información: Libro Blanco del Agua (simplificado). Dirección General de Obras Hidráulicas y Calidad de las Aguas. Ministerio de Medio Ambiente, 2001
Elaborado por Atlas Nacional de España (IGN) y Equipo AGE
OCÉANO ATLÁNTICO
Islas Canarias



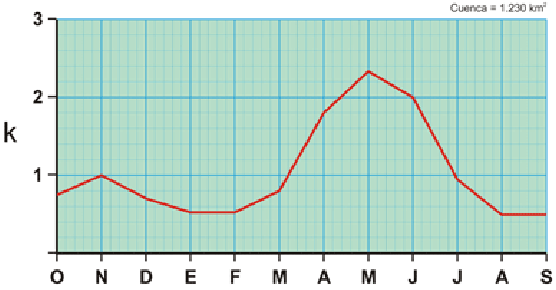
Mapa de cuencas y vertientes bidrográficas.



RÍO SEGRE, EN LA SEU D' URGELL.

	Oct.	Nov.	Dic.	Ene.	Feb.	Mar.	Abr.	May.	Jun.	Jul.	Ago.	Sep.	Σ/12	Mr
m^3/s	9	13	9	7	7	12	16	29	25	11	6	6	12,5	10,16
k	0,72	1,04	0,72	0,56	0,56	0,96	1,78	2,32	2,00	0,88	0,48	0,48		

Cuenca = 1.230 km^2

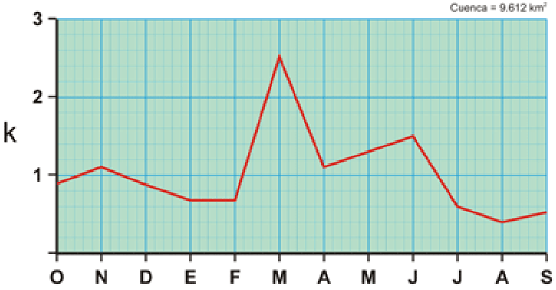


m^3/s	Caudal medio mensual
k	Relación entre el caudal medio mensual y el módulo o caudal absoluto
Σ/12	Módulo o caudal absoluto que es la suma de los caudales medios mensuales dividida entre los doce meses del año.
Mr	Módulo o caudal relativo es la relación que existe entre el módulo absoluto multiplicado por mil y la superficie de la cuenca en kilómetros cuadrados.

RÍO CINCA, EN FRAGA.

	Oct.	Nov.	Dic.	Ene.	Feb.	Mar.	Abr.	May.	Jun.	Jul.	Ago.	Sep.	Σ/12	Mr
m^3/s	76	102	78	64	66	224	99	117	131	57	36	49	91,58	9,52
k	0,83	1,11	0,85	0,70	0,72	2,44	1,08	1,28	1,43	0,62	0,38	0,53		

Cuenca = 9.612 km^2

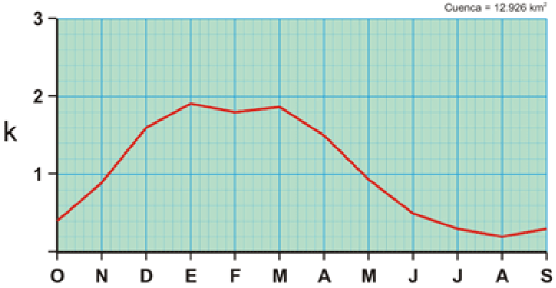


m^3/s	Caudal medio mensual
k	Relación entre el caudal medio mensual y el módulo o caudal absoluto
Σ/12	Módulo o caudal absoluto que es la suma de los caudales medios mensuales dividida entre los doce meses del año.
Mr	Módulo o caudal relativo es la relación que existe entre el módulo absoluto multiplicado por mil y la superficie de la cuenca en kilómetros cuadrados.

RÍO MIÑO, EN FUENTE MAYOR.

	Oct.	Nov.	Dic.	Ene.	Feb.	Mar.	Abr.	May.	Jun.	Jul.	Ago.	Sep.	Σ/12	Mr
m^3/s	109	253	446	544	501	501	377	235	147	74	55	64	275,5	21,31
k	0,39	0,92	1,62	1,93	1,82	1,82	1,37	0,85	0,53	0,26	0,20	0,23		

Cuenca = 12.926 km^2

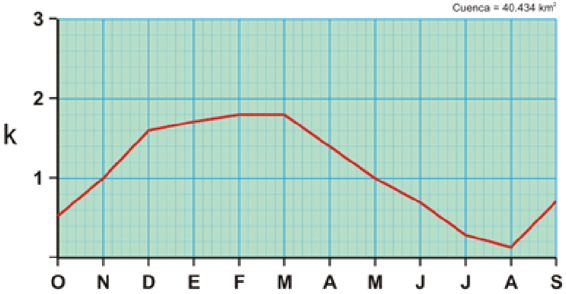


m^3/s	Caudal medio mensual
k	Relación entre el caudal medio mensual y el módulo o caudal absoluto
Σ/12	Módulo o caudal absoluto que es la suma de los caudales medios mensuales dividida entre los doce meses del año.
Mr	Módulo o caudal relativo es la relación que existe entre el módulo absoluto multiplicado por mil y la superficie de la cuenca en kilómetros cuadrados.

RÍO EBRO, EN ZARAGOZA.

	Oct.	Nov.	Dic.	Ene.	Feb.	Mar.	Abr.	May.	Jun.	Jul.	Ago.	Sep.	Σ/12	Mr
m^3/s	118	243	401	415	436	434	341	249	152	58	31	49	243,9	6,033
k	0,48	0,99	1,64	1,70	1,79	1,77	1,40	1,02	0,62	0,24	0,12	0,70		

Cuenca = 40.434 km^2



m^3/s	Caudal medio mensual
k	Relación entre el caudal medio mensual y el módulo o caudal absoluto
Σ/12	Módulo o caudal absoluto que es la suma de los caudales medios mensuales dividida entre los doce meses del año.
Mr	Módulo o caudal relativo es la relación que existe entre el módulo absoluto multiplicado por mil y la superficie de la cuenca en kilómetros cuadrados.

HYDROLOGICAL SCIENCES JOURNAL – JOURNAL DES SCIENCES HYDROLOGIQUES, 2016
VOL. 61, NO. 3, 568–584
http://dx.doi.org/10.1080/02626667.2015.1081202

Trends in low flows in Spain in the period 1949–2009

Antonio Coch and Luis Mediero

Department of Civil Engineering: Hydraulics, Energy and Environment, Technical University of Madrid, Madrid, Spain

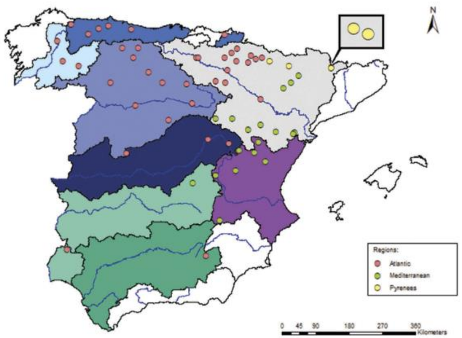


Figure 3. Catchments grouped into the three regions identified in terms of mean monthly flows.

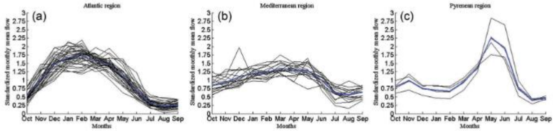


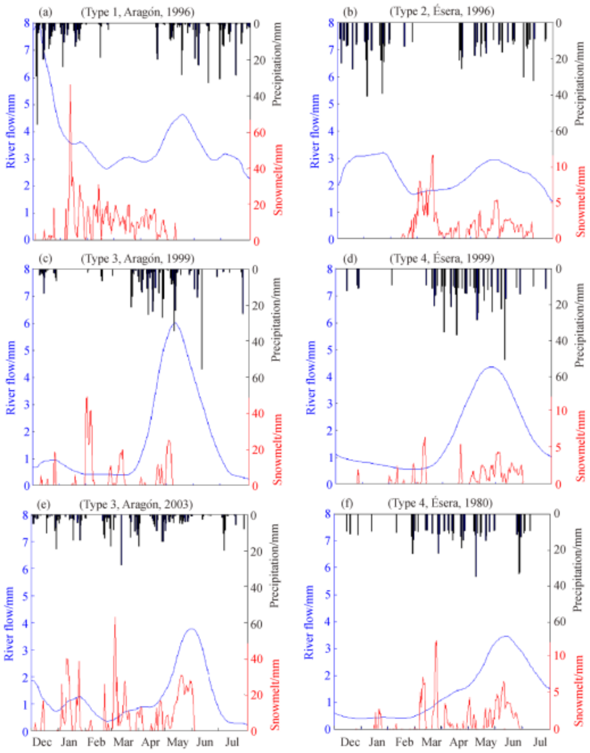
Figure 4. Standardized monthly mean flows, considering all available data from 1949 to 2009 in each region: (a) Atlantic; (b) Mediterranean, and (c) Pyrenean. The blue line represents the mean of the standardized monthly mean flows.

Front. Earth Sci. 2017, 11(3): 515–530
DOI 10.1007/s11707-016-0630-z

RESEARCH ARTICLE

Effect of snow on mountain river regimes: an example from the Pyrenees

Alba SANMIGUEL-VALLELADO (✉)[1], Enrique MORÁN-TEJEDA[1,2], Esteban ALONSO-GONZÁLEZ[1], Juan Ignacio LÓPEZ-MORENO[1]



Journal of Hydrology 414–415 (2012) 463–475

Contents lists available at SciVerse ScienceDirect

Journal of Hydrology

journal homepage: www.elsevier.com/locate/jhydrol

Recent trends in Iberian streamflows (1945–2005)

J. Lorenzo-Lacruz *, S.M. Vicente-Serrano, J.I. López-Moreno, E. Morán-Tejeda, J. Zabalza

Instituto Pirenaico de Ecología, CSIC (Spanish Research Council), Campus de Aula Dei, P.O. Box 202, Zaragoza 50080, Spain

Geophysical Research Letters

RESEARCH LETTER

10.1029/2018GL079725

Observed Trends in Global Indicators of Mean and Extreme Streamflow

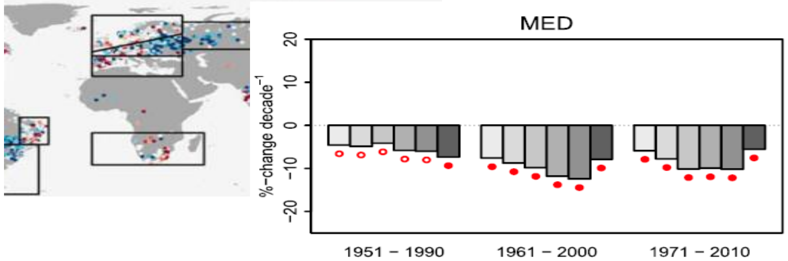
L. Gudmundsson[1], M. Leonard[2], H. X. Do[2,3], S. Westra[2], and S. I. Seneviratne[1]

[1]Institute for Atmospheric and Climate Science, Department of Environmental Systems Science, ETH, Zurich, Switzerland, [2]School of Civil, Environmental and Mining Engineering, University of Adelaide, Adelaide, South Australia, Australia, [3]Faculty of Environment and Natural Resources, Nong Lam University, Ho Chi Minh City, Vietnam

Key Points:

- A global assessment of trends in streamflow covering 1951–2010 and 14 subcontinental regions
- The significance of regional trends is assessed, revealing complex spatiotemporal change patterns

1961 - 2000



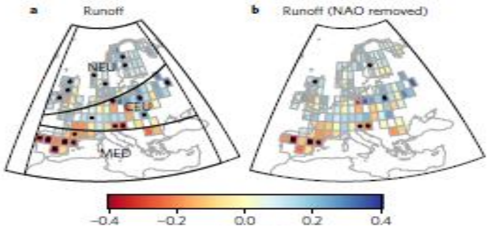
nature climate change

LETTERS

PUBLISHED ONLINE: 16 OCTOBER 2017 | DOI: 10.1038/NCLIMATE3416

Anthropogenic climate change detected in European renewable freshwater resources

Lukas Gudmundsson[1]*, Sonia I. Seneviratne[1] and Xuebin Zhang[2]



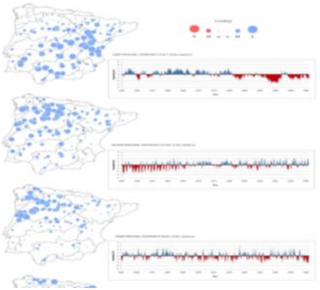
Hydrol. Earth Syst. Sci., 17, 119–134, 2013
www.hydrol-earth-syst-sci.net/17/119/2013/
doi:10.5194/hess-17-119-2013

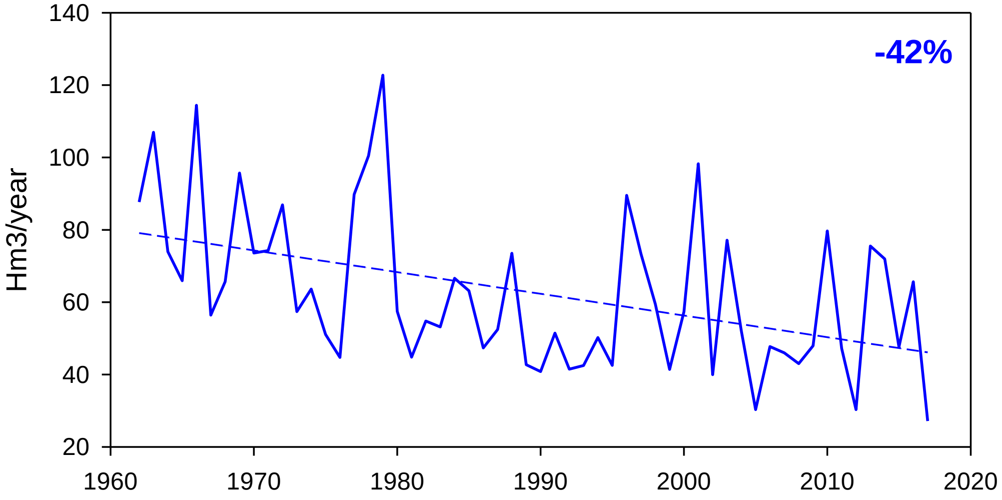
Hydrology and Earth System Sciences

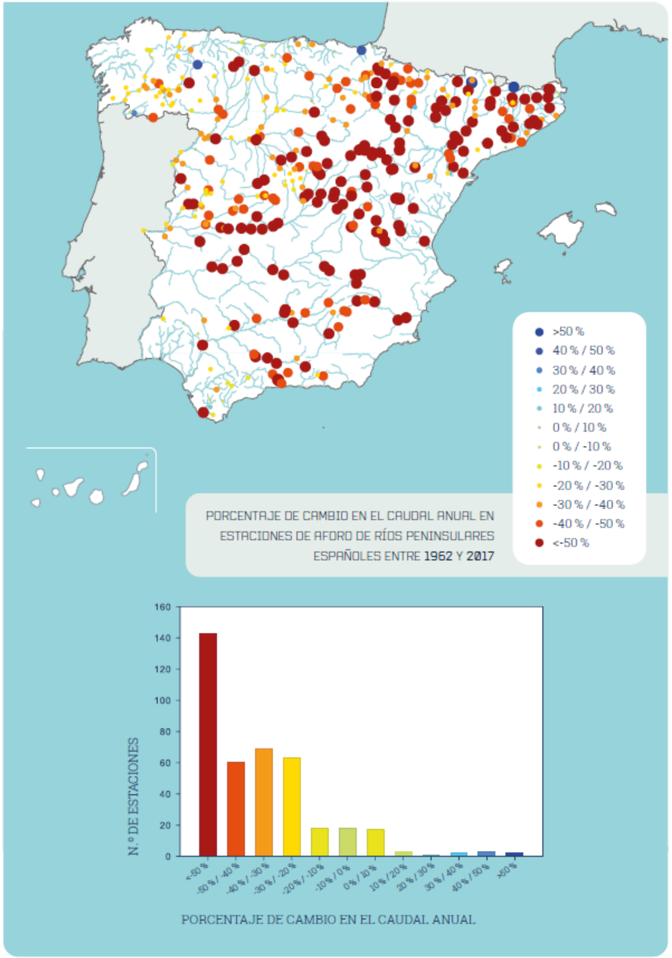
Streamflow droughts in the Iberian Peninsula between 1945 and 2005: spatial and temporal patterns

J. Lorenzo-Lacruz, E. Morán-Tejeda, S. M. Vicente-Serrano, and J. I. López-Moreno

Pyrenean Institute of Ecology (CSIC), Department of Geoenvironmental Processes and Global Change, Campus de Aula Dei, P.O. Box 202, Zaragoza 50080, Spain




Hm3/year
-42%
140
120
100
80
60
40
20
1960
1970
1980
1990
2000
2010
2020


>50 %
40 % / 50 %
30 % / 40 %
20 % / 30 %
10 % / 20 %
0 % / 10 %
0 % / -10 %
-10 % / -20 %
-20 % / -30 %
-30 % / -40 %
-40 % / -50 %
<-50 %
PORCENTAJE DE CAMBIO EN EL CAUDAL ANUAL EN
ESTACIONES DE AFORO DE RÍOS PENINSULARES
ESPAÑOLES ENTRE 1962 Y 2017
N.º DE ESTACIONES
PORCENTAJE DE CAMBIO EN EL CAUDAL ANUAL

Environ. Res. Lett. 15 (2020) 094070 https://doi.org/10.1088/1748-9326/ab9c4f

Environmental Research Letters

LETTER

Long-term precipitation in Southwestern Europe reveals no clear trend attributable to anthropogenic forcing

D Peña-Angulo[1,15], S M Vicente-Serrano[1,15,16], F Domínguez-Castro[2,3], C Murphy[4], F Reig[1], Y Tramblay[5], R M Trigo[6,7], M Y Luna[8], M Turco[9], I Noguera[1], M Aznárez-Balta[1], R García-Herrera[12,13], M Tomas-Burguera[14] and A El Kenawy[10,11]

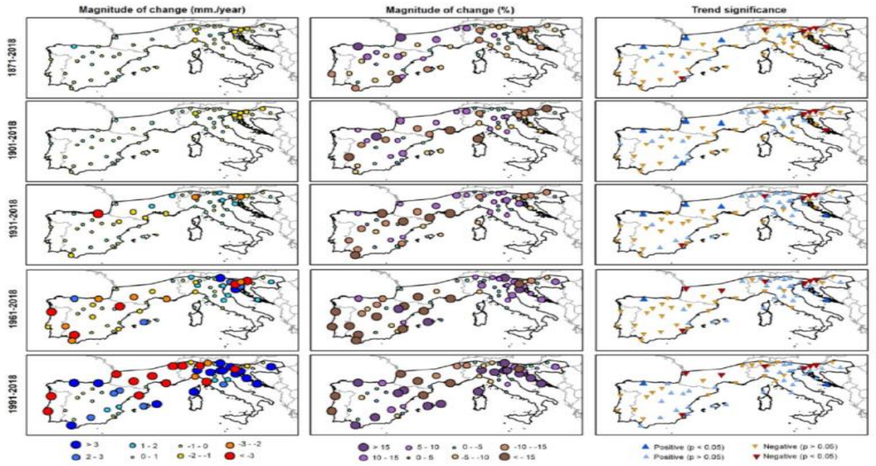
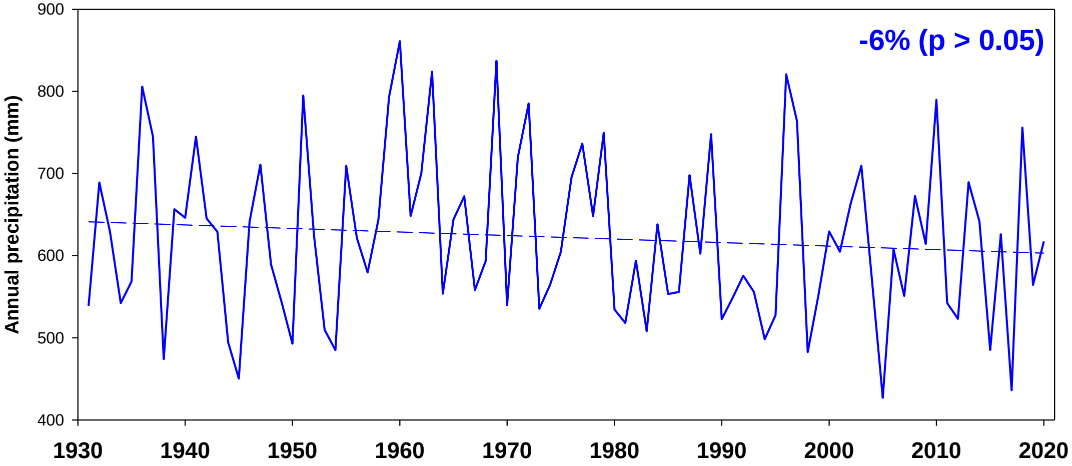


Figure 3. Annual precipitation trends in the station based observations for periods starting in 1871, 1901, 1931, 1961 and 1991 and ending in 2018. The magnitude of change is given in mm/year and in %.



Received: 20 February 2020 | Revised: 14 July 2020 | Accepted: 25 August 2020
DOI: 10.1002/joc.6817

RESEARCH ARTICLE

International Journal of Climatology RMetS

Climatology and trends of reference evapotranspiration in Spain

Miquel Tomas-Burguera[1] | Santiago Beguería[1] | Sergio M. Vicente-Serrano[2]

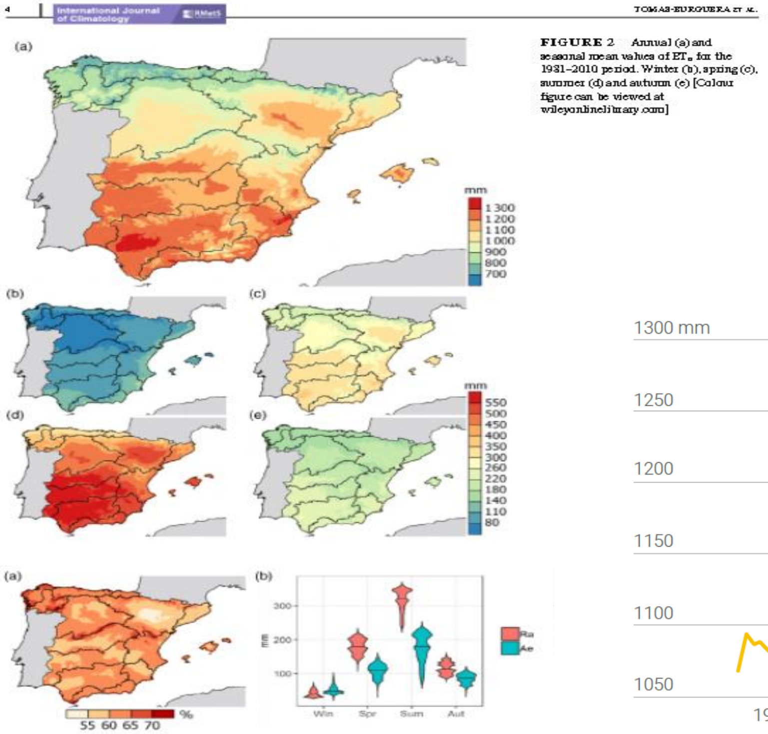


FIGURE 2 Annual (a) and seasonal mean values of ET_o for the 1981–2010 period. Winter (b), spring (c), summer (d) and autumn (e) [Colour figure can be viewed at wileyonlinelibrary.com]

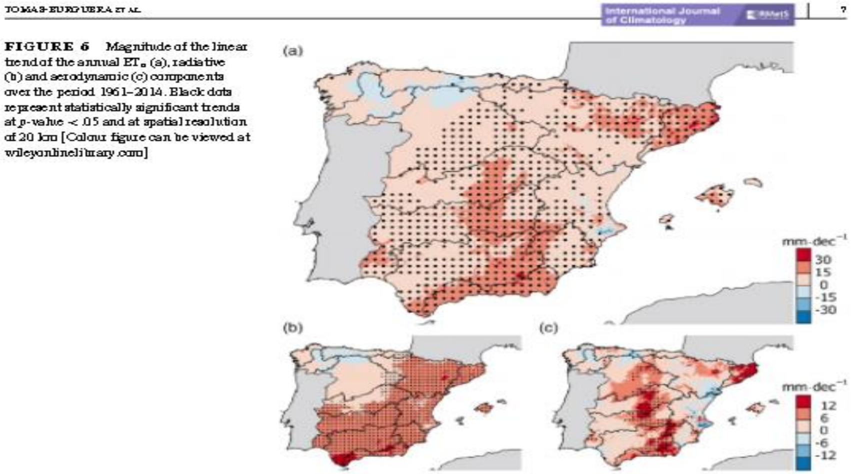
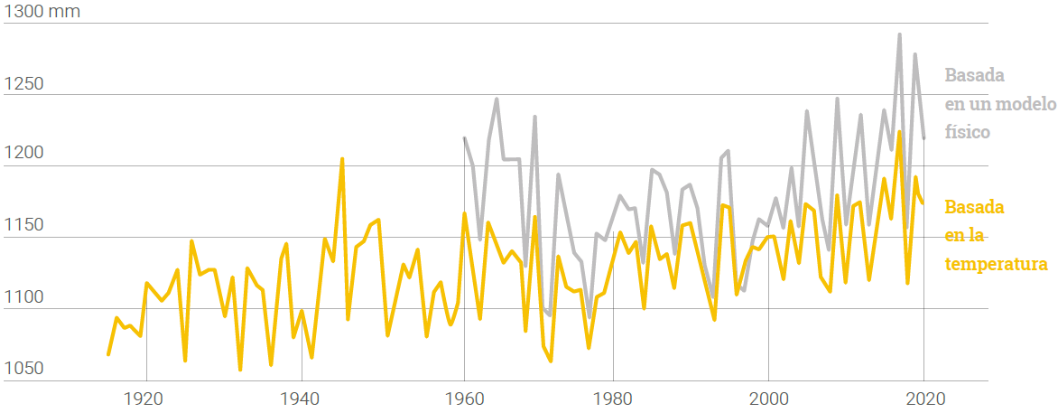


FIGURE 6 Magnitude of the linear trend of the annual ET_o (a), radiative (b) and aerodynamic (c) components over the period 1961–2014. Black dots represent statistically significant trends at p-value < .05 and at spatial resolution of 20 km [Colour figure can be viewed at wileyonlinelibrary.com]



OPEN ACCESS
IOP Publishing

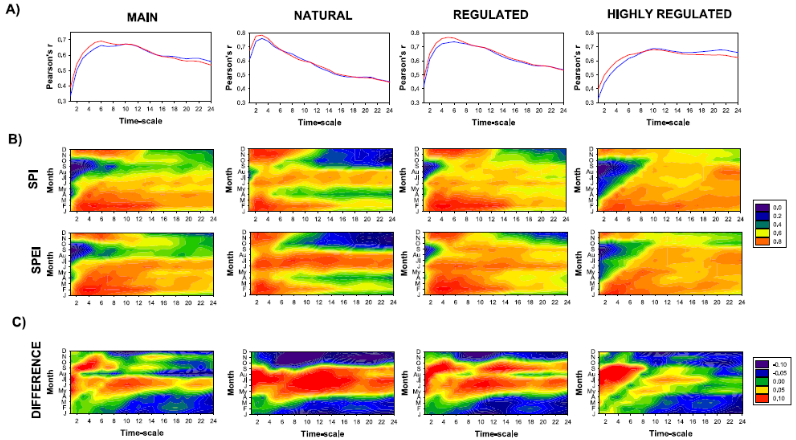
Environmental Research Letters

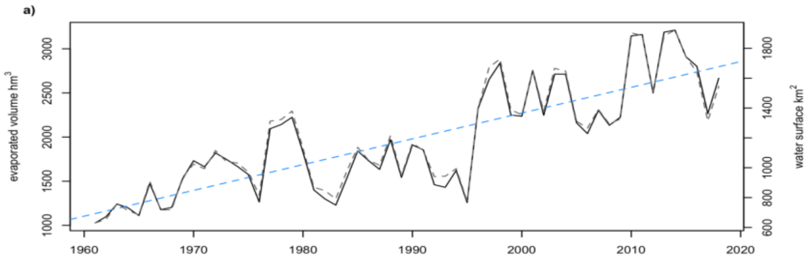
Environ. Res. Lett. 9 (2014) 044001 (9pp)

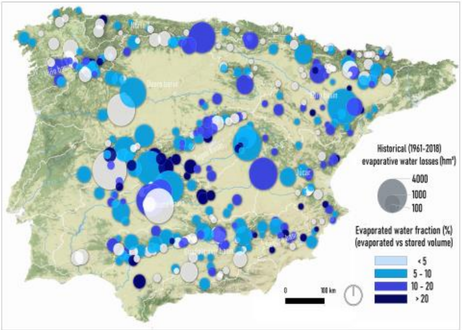
doi:10.1088/1748-9326/9/4/044001

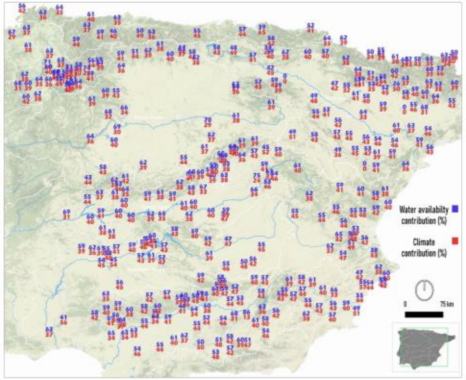
Evidence of increasing drought severity caused by temperature rise in southern Europe

Sergio M Vicente-Serrano[1], Juan-I Lopez-Moreno[1], Santiago Beguería[2], Jorge Lorenzo-Lacruz[1], Arturo Sanchez-Lorenzo[3], José M García-Ruiz[1], Cesar Azorin-Molina[1], Enrique Morán-Tejeda[1], Jesús Revuelto[1], Ricardo Trigo[4], Fatima Coelho[5] and Francisco Espejo[6]









AGU100 ADVANCING EARTH AND SPACE SCIENCE

Geophysical Research Letters

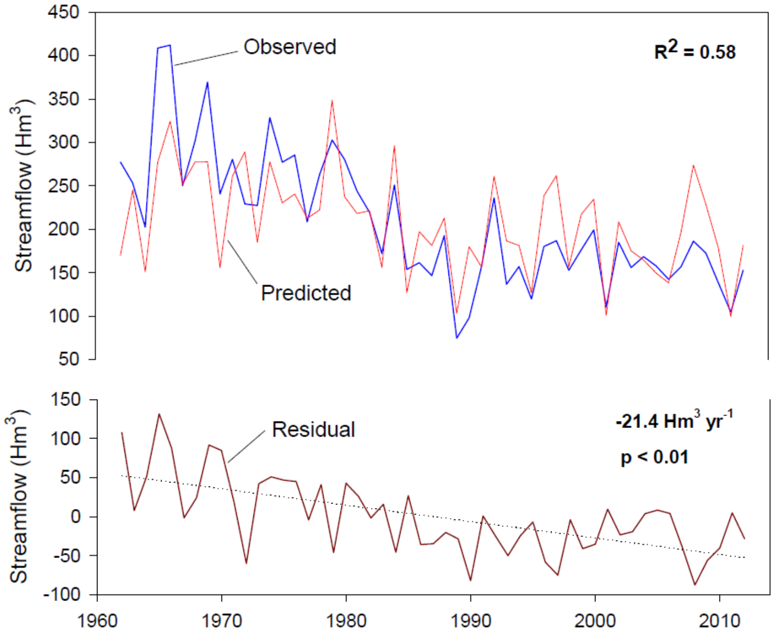
RESEARCH LETTER
10.1029/2019GL084084

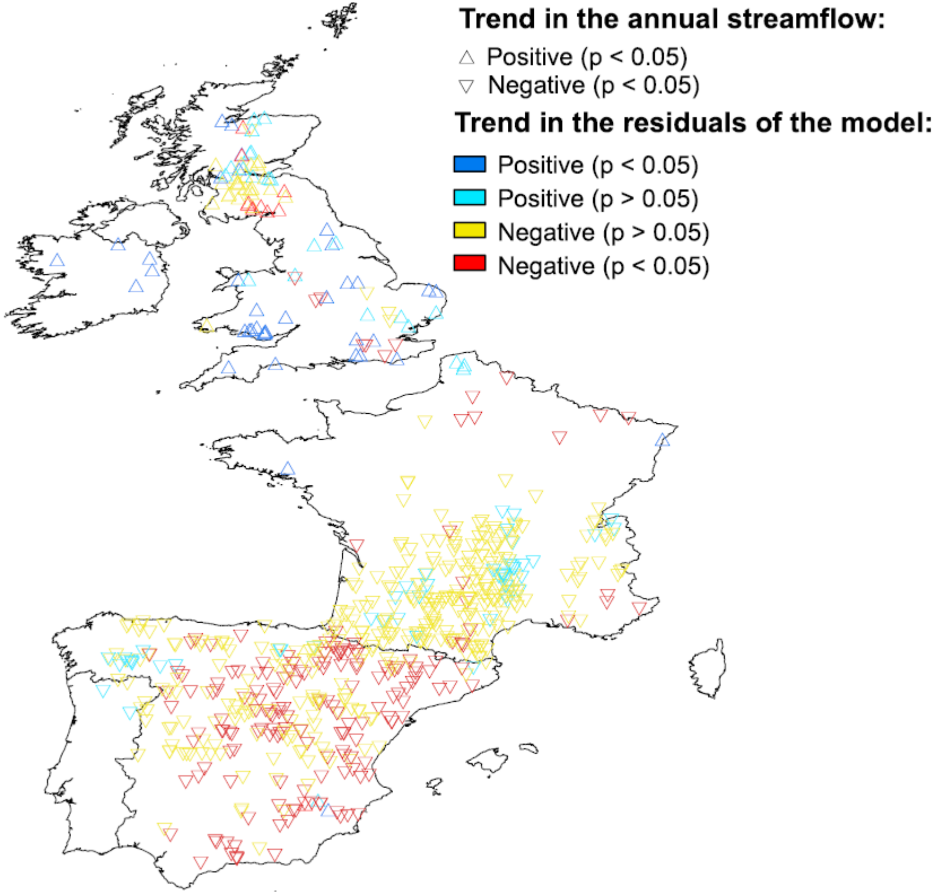
Climate, Irrigation, and Land Cover Change Explain Streamflow Trends in Countries Bordering the Northeast Atlantic

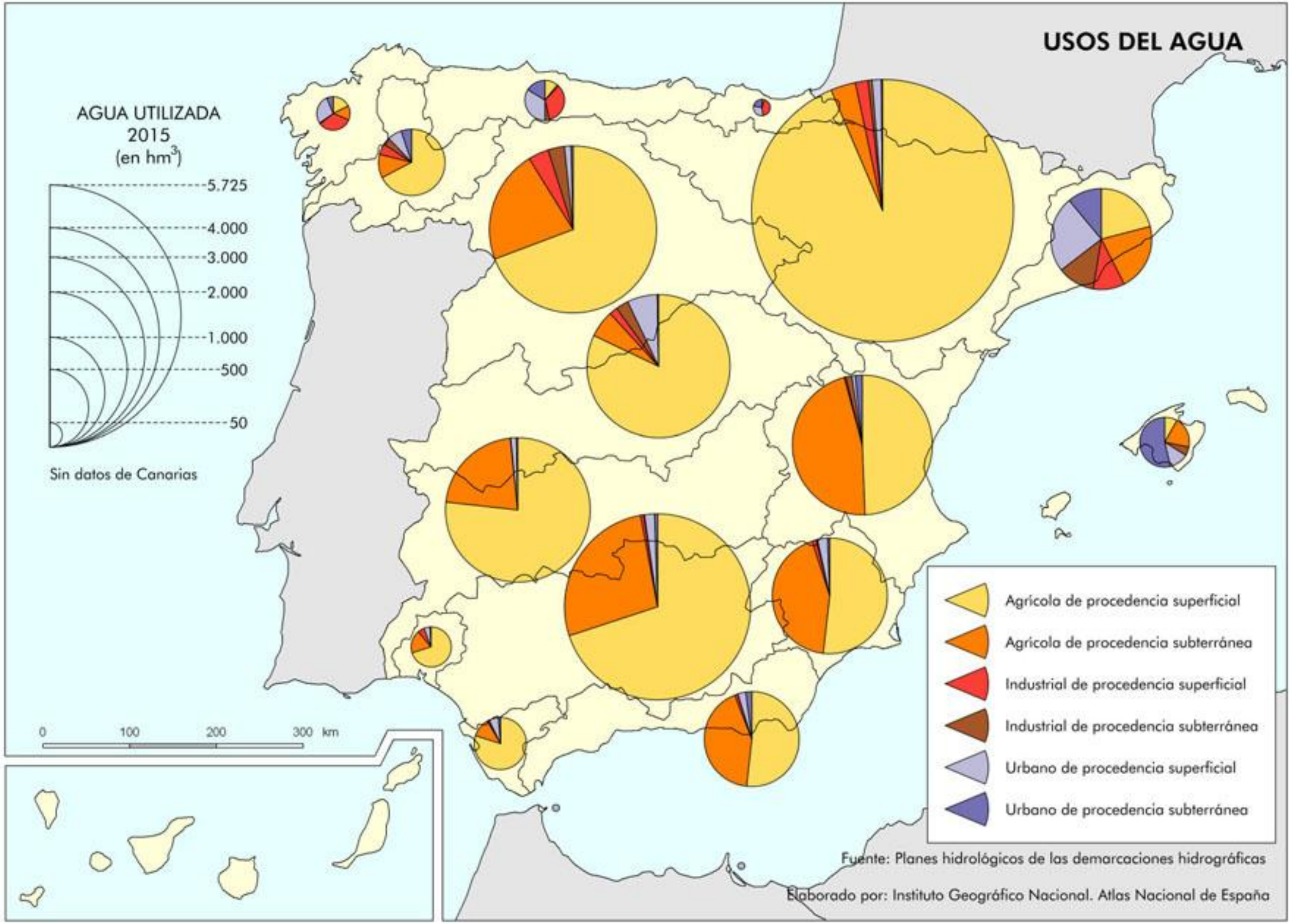
S. M. Vicente-Serrano[1], M. Peña-Gallardo[1], J. Hannaford[2,3], C. Murphy[3], J. Lorenzo-Lacruz[4], F. Dominguez-Castro[1], J. I. López-Moreno[1], S. Beguería[5], I. Noguera[1], S. Harrigan[6], and J.-P. Vidal[7]

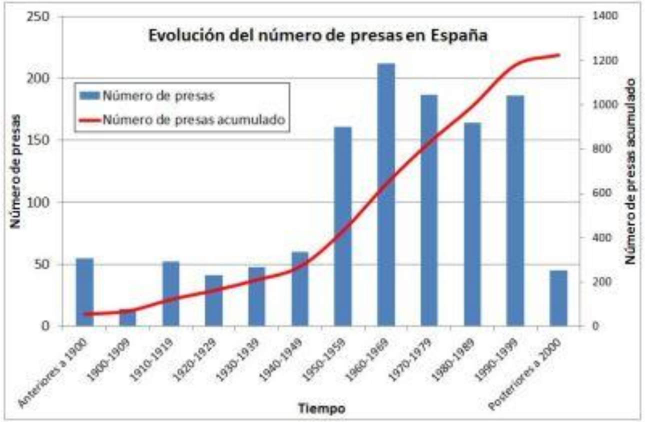
[1]Instituto Pirenaico de Ecología, Consejo Superior de Investigaciones Científicas, Zaragoza, Spain, [2]Centre for Ecology a Hydrology, Wallingford, UK, [3]Department of Geography, Maynooth University, Irish Climate Analysis and Research UnitS, Maynooth, Ireland, [4]Department of Geography, University of the Balearic Islands, Palma, Spain, [5]Estación Experimental de Aula Dei, Consejo Superior de Investigaciones Científicas, Zaragoza, Spain, [6]European Centre for Medium-Range Weather Forecasts, Reading, UK, [7]Irstea, UR RiverLy, Villeurbanne Cedex, France

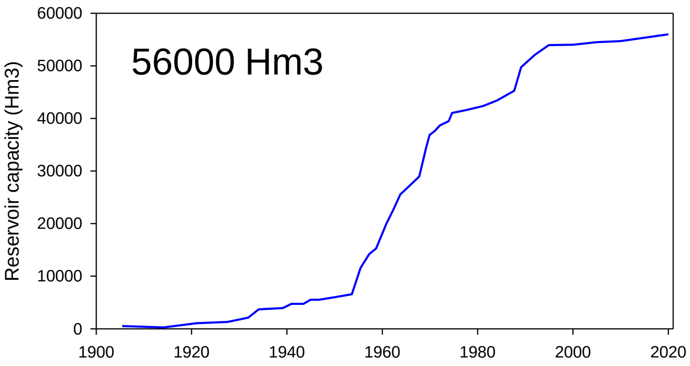
Key Points:
- Streamflow trends in countries bordering the northeast Atlantic show a north-south latitudinal gradient, with strong decreasing trends in southern regions
- Climate trends largely explain the evolution of annual streamflow in northwestern Europe
- Climate trends cannot fully explain the large reductions in annual streamflow in southwest Europe, with land use changes and water demand from irrigation playing an

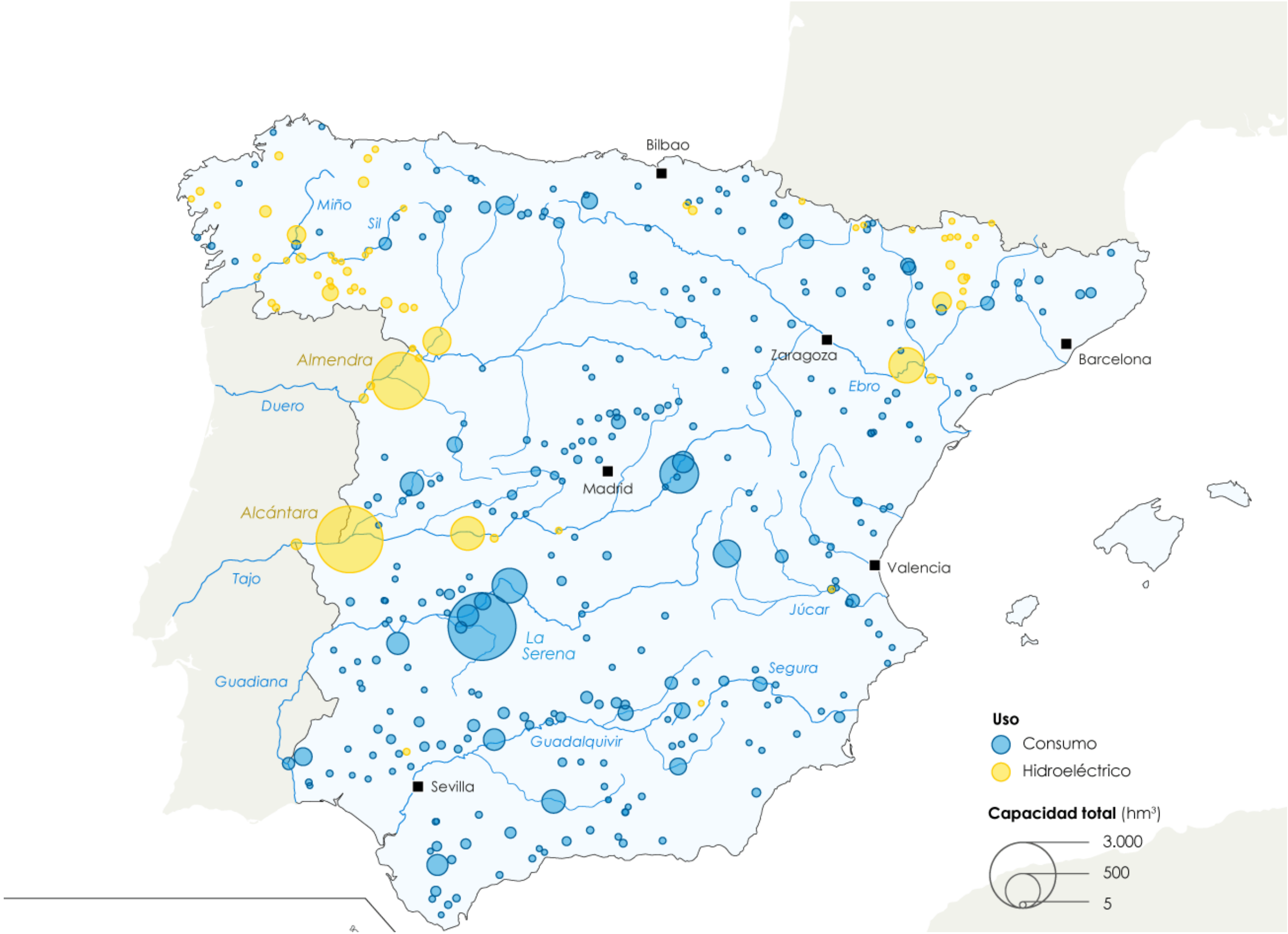


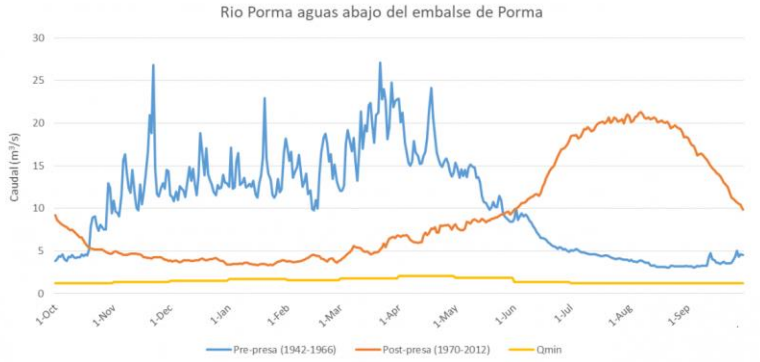



USOS DEL AGUA
AGUA UTILIZADA
2015
(en hm3)
5.725
4.000
3.000
2.000
1.000
500
50
Sin datos de Canarias
0
100
200
300 km
Agrícola de procedencia superficial
Agrícola de procedencia subterránea
Industrial de procedencia superficial
Industrial de procedencia subterránea
Urbano de procedencia superficial
Urbano de procedencia subterránea
Fuente: Planes hidrológicos de las demarcaciones hidrográficas
Elaborado por: Instituto Geográfico Nacional. Atlas Nacional de España

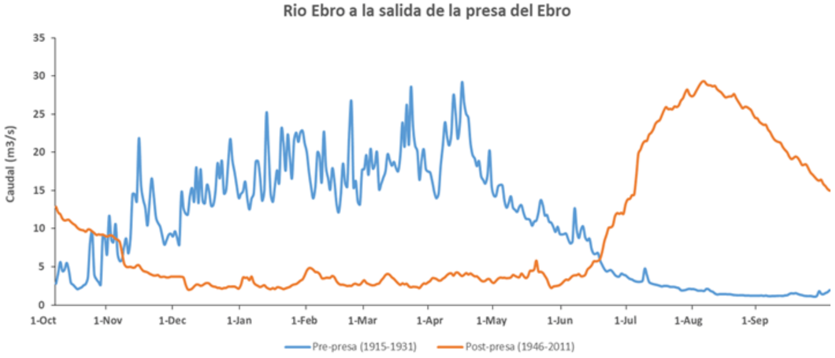

Evolución del número de presas en España
Número de presas
Número de presas acumulado
Número de presas
Número de presas acumulado
Tiempo
250
200
150
100
50
0
1400
1200
1000
800
600
400
200
0
Anteriores a 1900
1900-1909
1910-1919
1920-1929
1930-1939
1940-1949
1950-1959
1960-1969
1970-1979
1980-1989
1990-1999
Posteriores a 2000

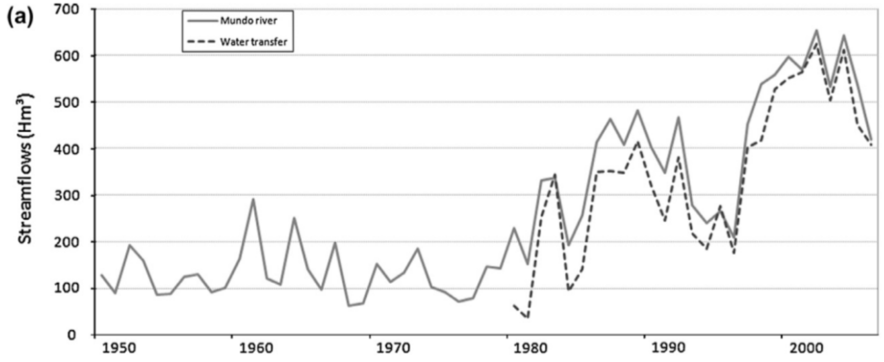

56000 Hm3
Reservoir capacity (Hm3)
60000
50000
40000
30000
20000
10000
0
1900
1920
1940
1960
1980
2000
2020


Bilbao
Miño
Sil
Almendra
Duero
Zaragoza
Barcelona
Ebro
Madrid
Alcántara
Tajo
Valencia
Júcar
La Serena
Guadiana
Segura
Guadalquivir
Sevilla
Uso
Consumo
Hidroeléctrico
Capacidad total (hm³)
3.000
500
5



Hidrograma medio del río Porma aguas abajo del embalse del Porma. En azul, el régimen hidrológico antes de la construcción de la presa. En naranja, el régimen hidrológico tras la construcción de la presa. En amarillo, el caudal ecológico mínimo definido en el Plan Hidrológico de la Demarcación del Duero (2015-2021)





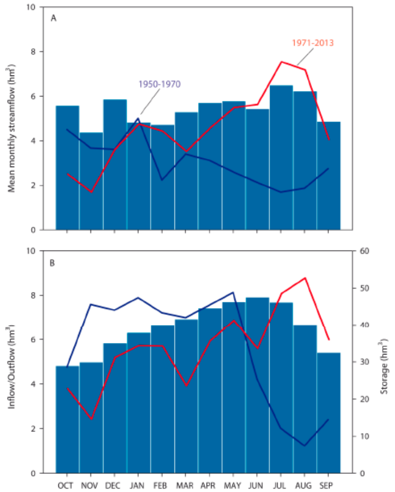
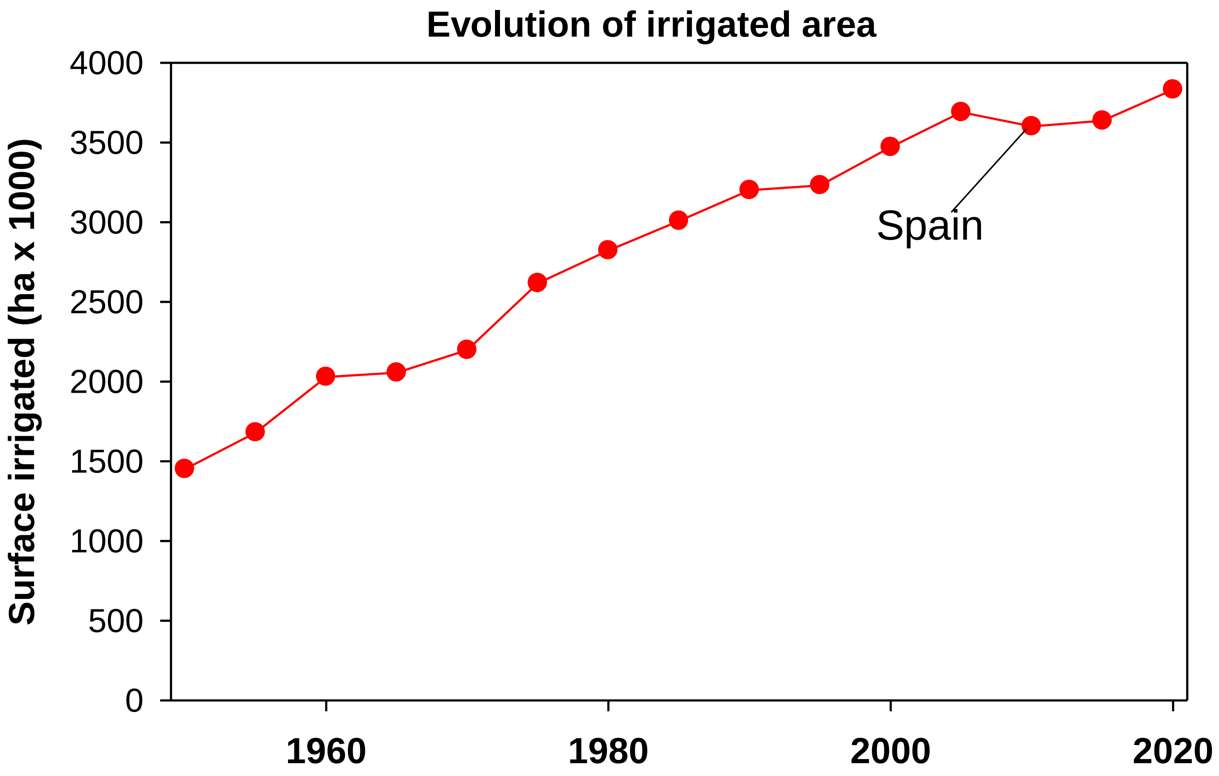
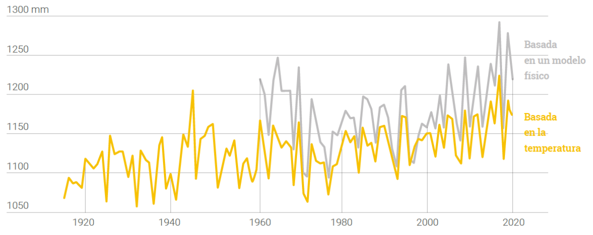


Figure 3. (**A**) Average river regimes in Boadella gauge station: blue bars: (1950–2013), blue line (1950–1970), and red line (1971–2013). (**B**) Average monthly values of inflows (blue), outflows (red), and storages (blue bars) in the reservoir of Boadella between 1971 and 2013.

SUPERFICIES BRUTAS DE RIEGO
MAR CANTÁBRICO
OCÉANO ATLÁNTICO
FRANCIA
ANDORRA
PORTUGAL
Islas Baleares
MAR MEDITERRÁNEO
Superficies brutas de riego
0 100 200 300 km
Fuente de información: Dirección General de Obras Hidráulicas y Calidad de las Aguas. Ministerio de Medio Ambiente. Año 2001
Elaborado por Atlas Nacional de España (IGN) y Equipo AGE
Estrecho de Gibraltar
Ceuta
Melilla
ARGELIA
MARRUECOS
OCÉANO ATLÁNTICO
Islas Canarias


Evolution of irrigated area
Surface irrigated (ha x 1000)
4000
3500
3000
2500
2000
1500
1000
500
0
1960
1980
2000
2020
Spain


1300 mm
1250
1200
1150
1100
1050
1920
1940
1960
1980
2000
2020
Basada en un modelo físico
Basada en la temperatura

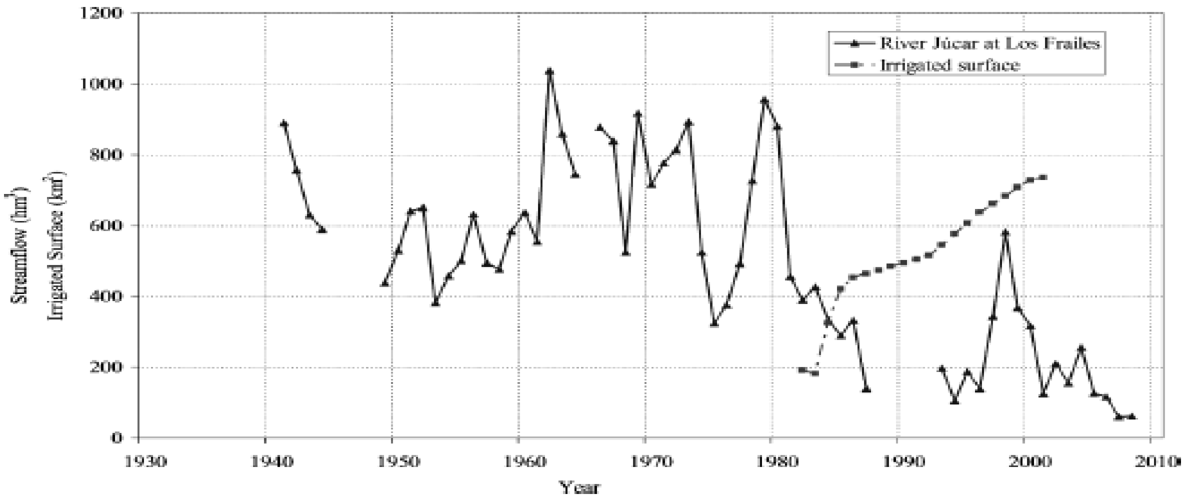
Hydrological Sciences Journal

ISSN: 0262-6667 (Print) 2150-3435 (Online) Journal homepage: https://www.tandfonline.com/loi/thsj20

Impacts of climate change on water resources in Spain

T. Estrela , M.A. Pérez-Martin & E. Vargas

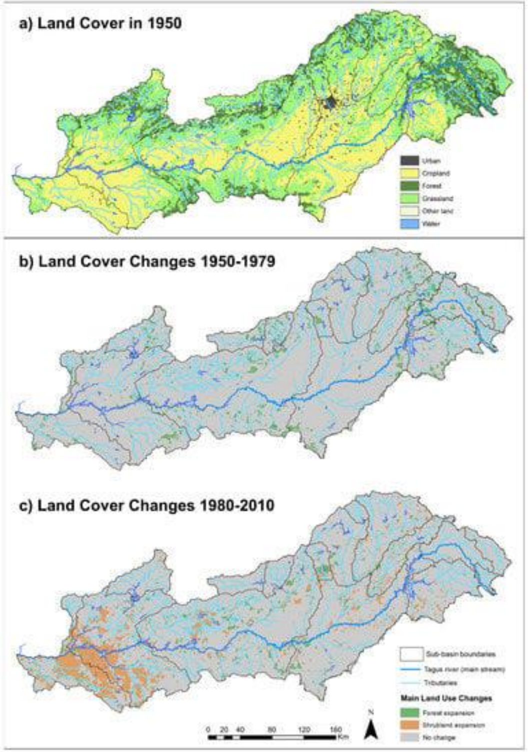
Impacts of climate change on water resources in Spain

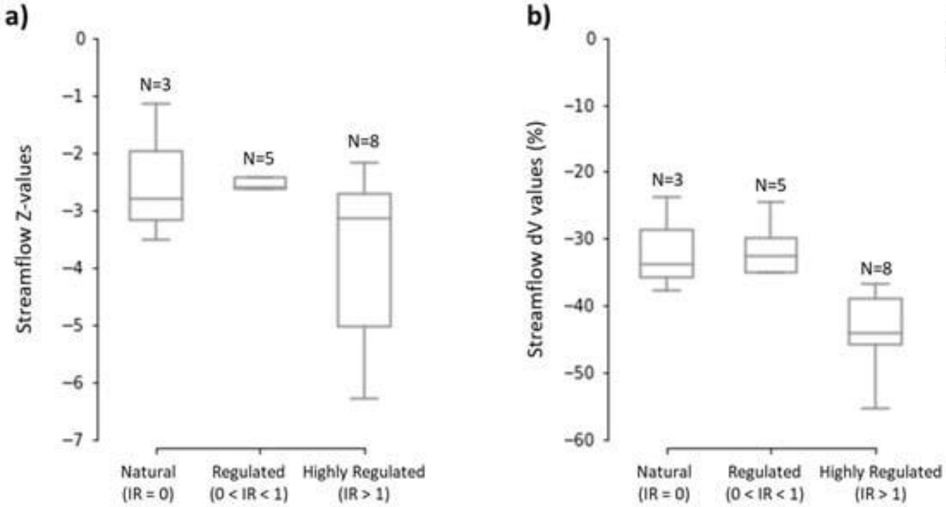


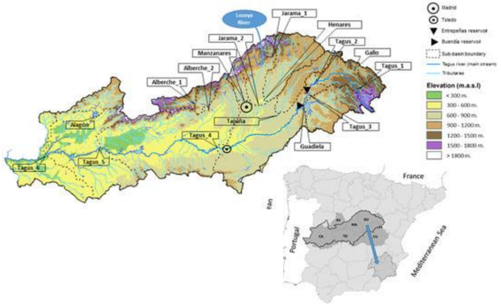
Open Access Article

Analysis of the Evolution of Climatic and Hydrological Variables in the Tagus River Basin, Spain

by Gabriel Mezger [1,2,*], Lucia De Stefano [1,2] and Marta González del Tánago [3]







Journal of Hydrology 386 (2010) 13–26

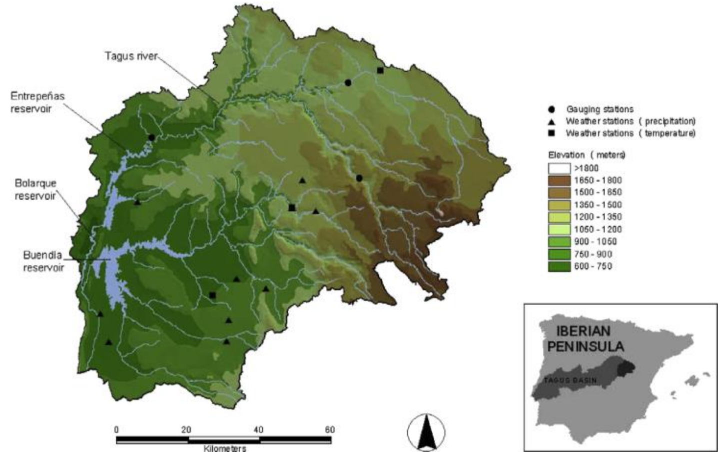
Contents lists available at ScienceDirect

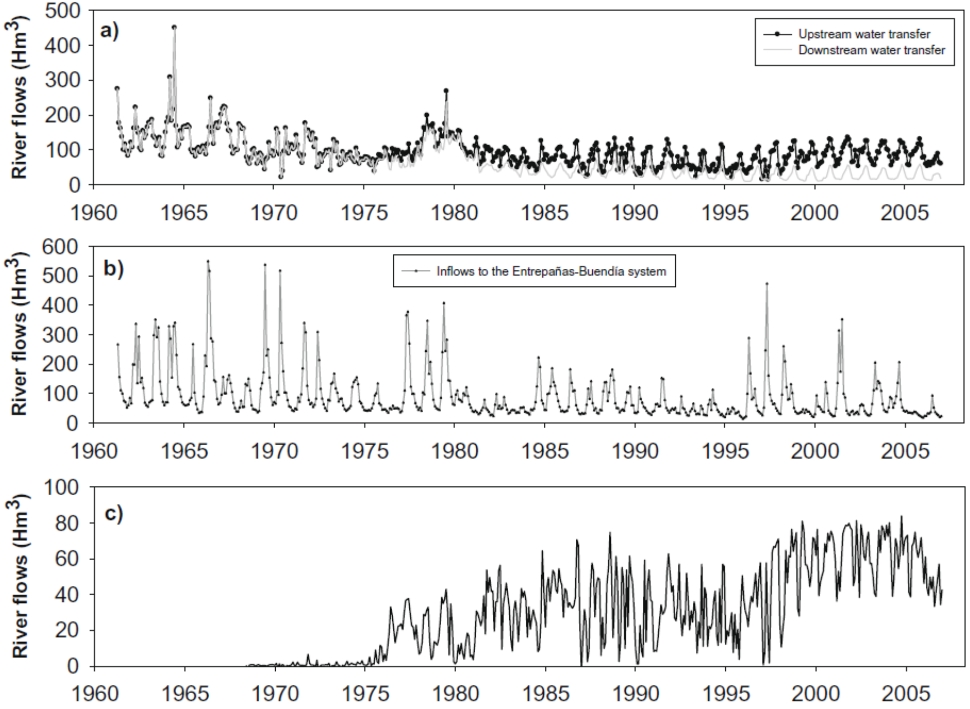
Journal of Hydrology

journal homepage: www.elsevier.com/locate/jhydrol

The impact of droughts and water management on various hydrological systems in the headwaters of the Tagus River (central Spain)

J. Lorenzo-Lacruz [a], S.M. Vicente-Serrano [a,*], J.I. López-Moreno [a], S. Beguería [b], J.M. García-Ruiz [a], J.M. Cuadrat [c]





Catena 149 (2017) 727–741

Contents lists available at ScienceDirect

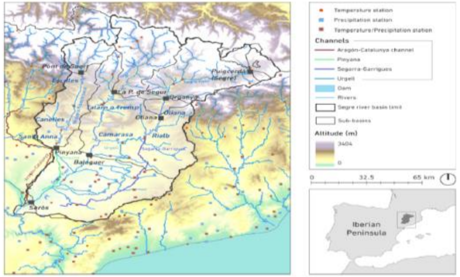
Catena

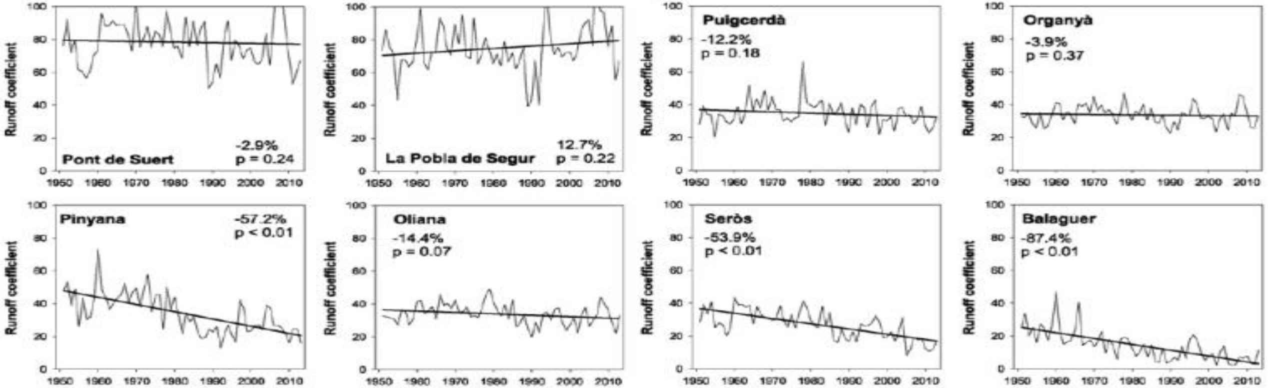
journal homepage: www.elsevier.com/locate/catena

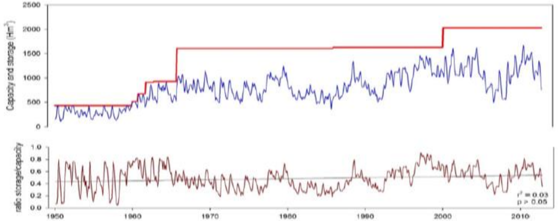
Effect of reservoirs on streamflow and river regimes in a heavily regulated river basin of Northeast Spain

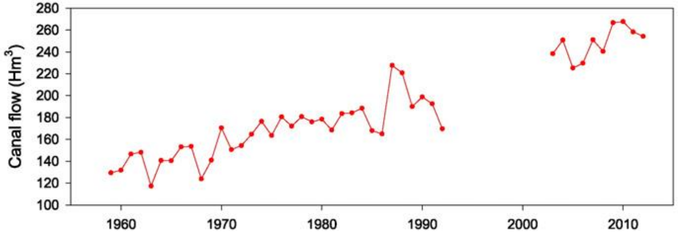
S.M. Vicente-Serrano [a,*], J. Zabalza-Martínez [a], G. Borràs [b], J.I. López-Moreno [a], E. Pla [c], D. Pascual [c], R. Savé [d], C. Biel [d], I. Funes [d], N. Martín-Hernández [a], M. Peña-Gallardo [a], S. Beguería [e], M. Tomas-Burguera [e]

[a] Instituto Pirenaico de Ecología, Consejo Superior de Investigaciones Científicas (IPE-CSIC), Zaragoza, Spain
[b] Oficina Catalana del Canvi Climàtic, Generalitat de Catalunya, Barcelona, Spain
[c] Centre de Recerca Ecològica i Aplicacions Forestals (CREAF), Bellaterra, Barcelona, Spain
[d] IRTA, Environmental Horticulture, Torre Marimon, Caldes de Montbui, Barcelona, Spain
[e] Estación Experimental de Aula Dei (EEAD-CSIC), Zaragoza, Spain









Science of the Total Environment 769 (2021) 144702

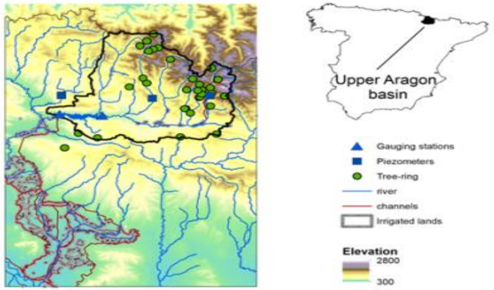
Contents lists available at ScienceDirect

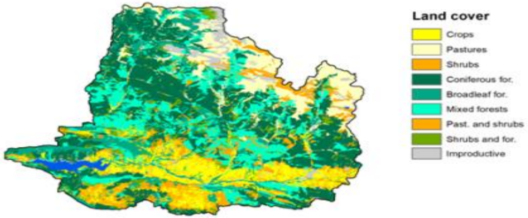
Science of the Total Environment

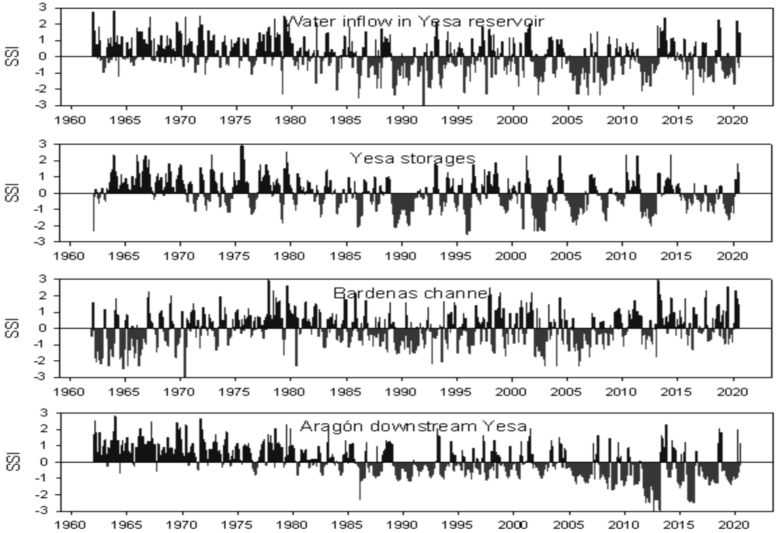
journal homepage: www.elsevier.com/locate/scitotenv

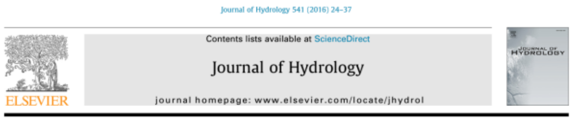
The complex multi-sectoral impacts of drought: Evidence from a mountainous basin in the Central Spanish Pyrenees

S.M. Vicente-Serrano [a,*], D. Peña-Angulo [a], C. Murphy [b], J.I. López-Moreno [a], M. Tomas-Burguera [c], F. Domínguez-Castro [d,e], F. Tian [f], L. Eklundh [f], Z. Cai [f], B. Alvarez-Farizo [a], I. Noguera [a], J.J. Camarero [a], R. Sánchez-Salguero [g], A. Gazol [a], S. Grainger [b], T. Conradt [h], B. Boincean [i], A. El Kenawy [j,k]



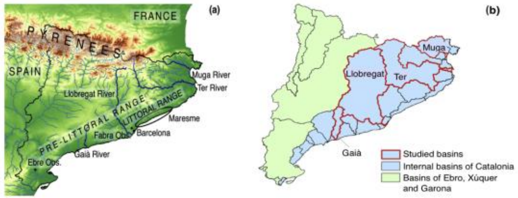


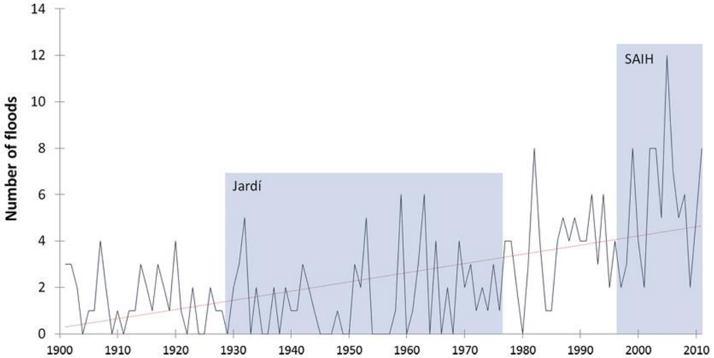


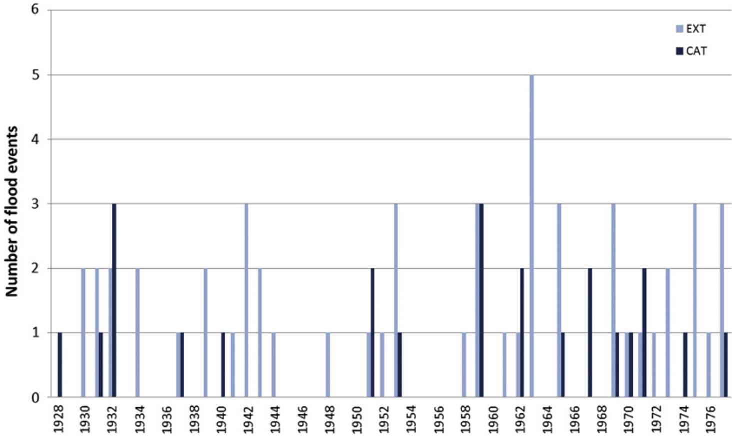

Journal of Hydrology 541 (2016) 24–37
Contents lists available at ScienceDirect
Journal of Hydrology
journal homepage: www.elsevier.com/locate/jhydrol

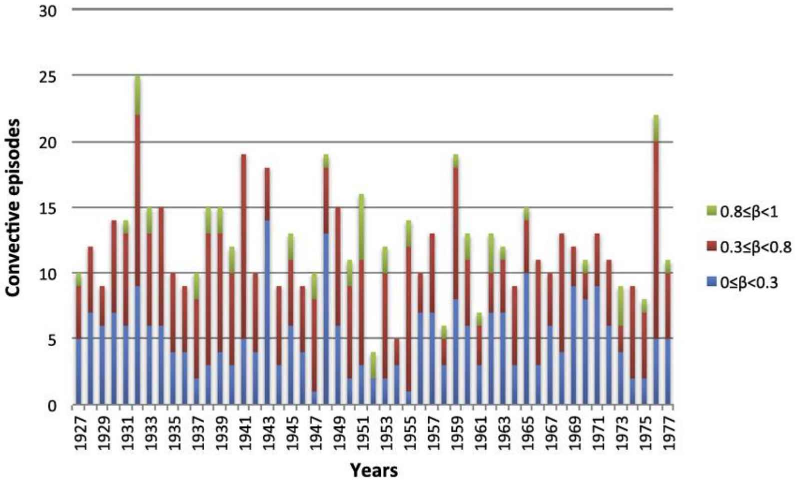
Trends in flash flood events versus convective precipitation in the Mediterranean region: The case of Catalonia

Maria Carmen Llasat [a,*], Raul Marcos [b], Marco Turco [b], Joan Gilabert [a], Montserrat Llasat-Botija [a]









Journal of Hydrology 517 (2014) 1072–1088

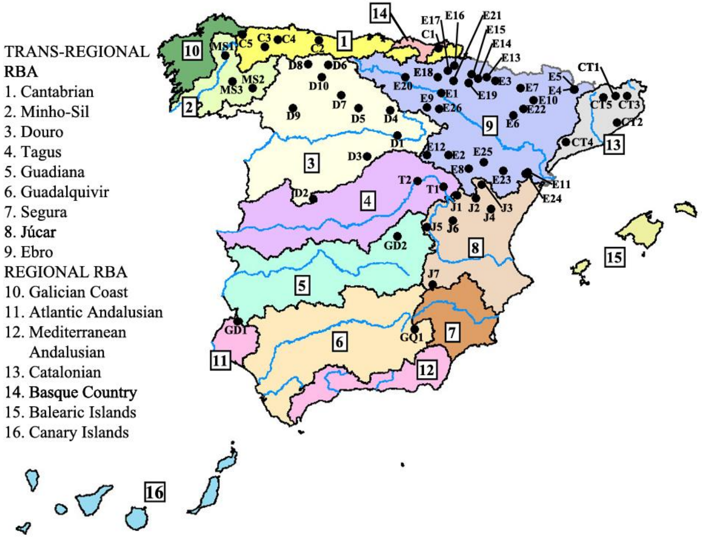
Contents lists available at ScienceDirect

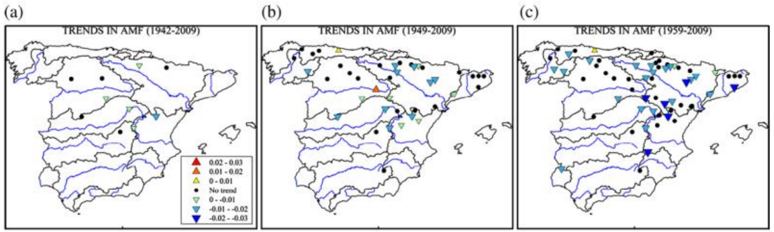
Journal of Hydrology

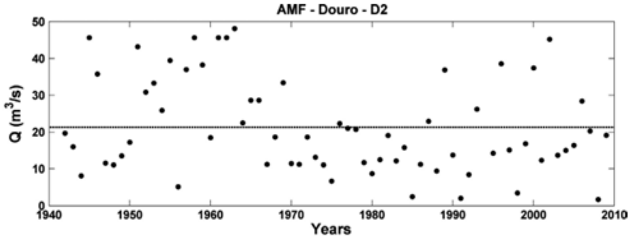
journal homepage: www.elsevier.com/locate/jhydrol

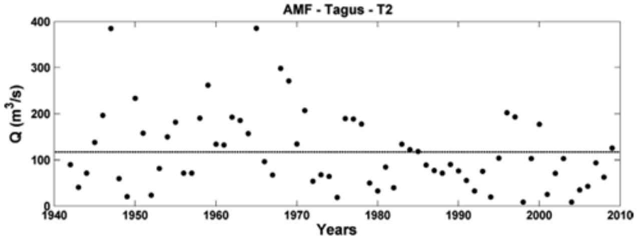
Detection and attribution of trends in magnitude, frequency and timing of floods in Spain

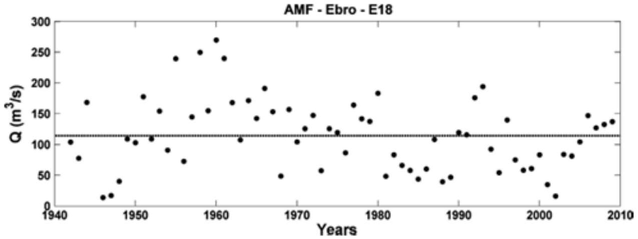
Luis Mediero *, David Santillán, Luis Garrote, Alfredo Granados

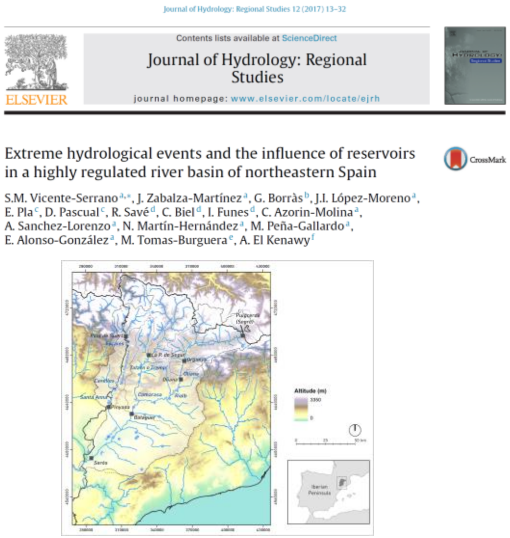











Journal of Hydrology: Regional Studies 12 (2017) 13–32

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Journal of Hydrology: Regional Studies

journal homepage: www.elsevier.com/locate/ejrh

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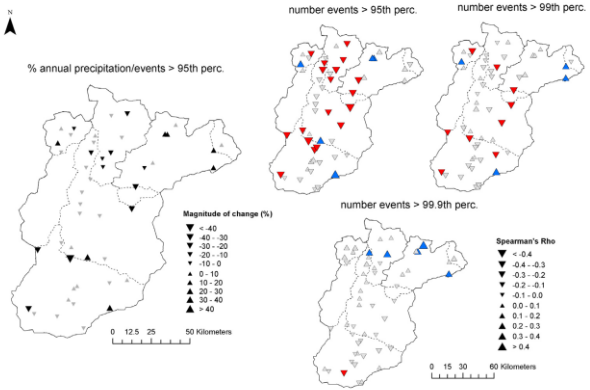
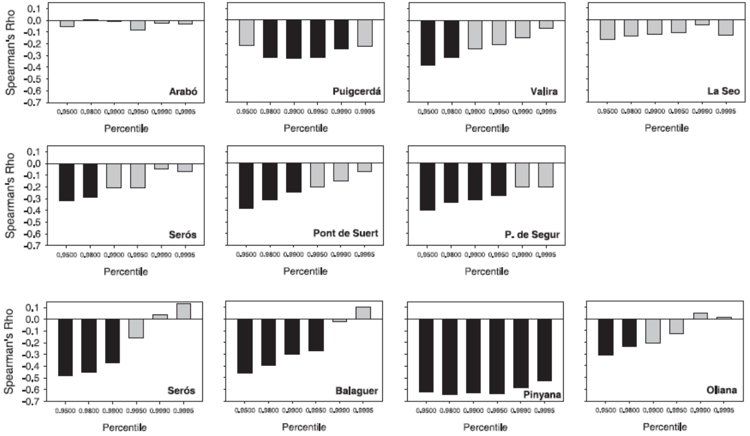
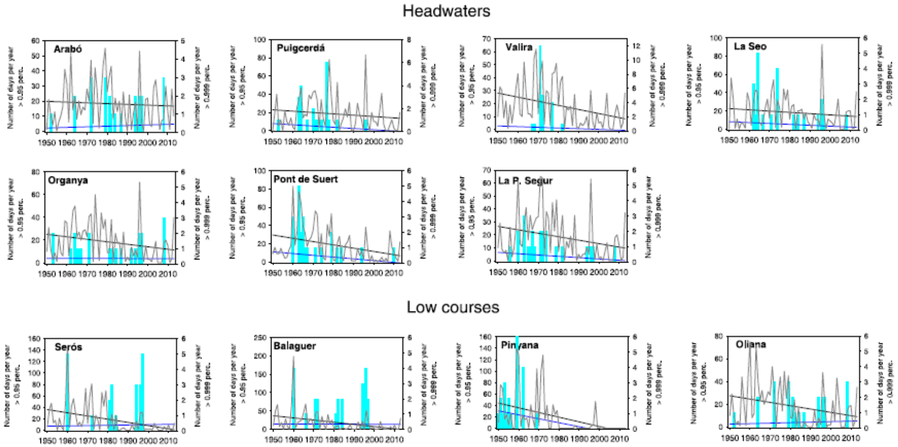
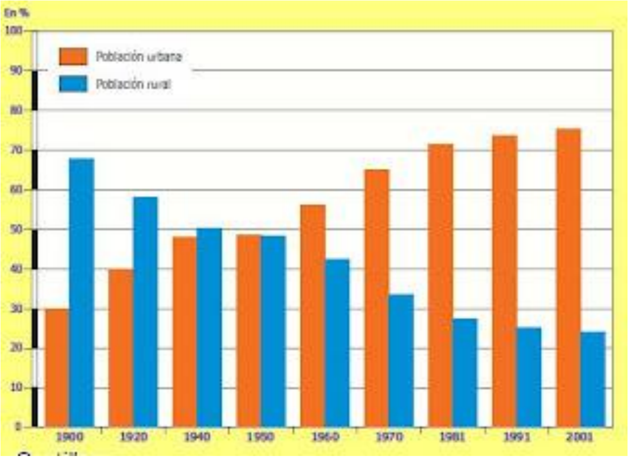
Extreme hydrological events and the influence of reservoirs in a highly regulated river basin of northeastern Spain

S.M. Vicente-Serrano[a,*], J. Zabalza-Martínez[a], G. Borràs[b], J.I. López-Moreno[a], E. Pla[c], D. Pascual[c], R. Savé[d], C. Biel[d], I. Funes[d], C. Azorin-Molina[a], A. Sanchez-Lorenzo[a], N. Martín-Hernández[a], M. Peña-Gallardo[a], E. Alonso-González[a], M. Tomas-Burguera[e], A. El Kenawy[f]

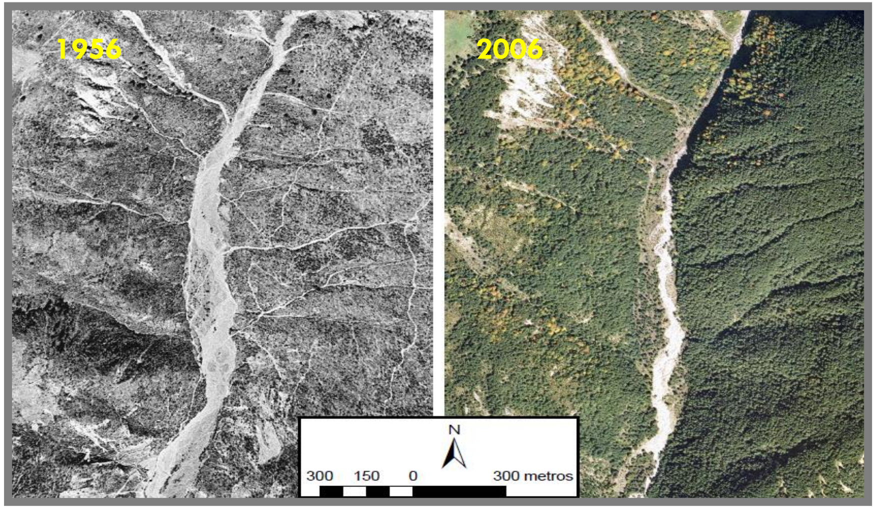




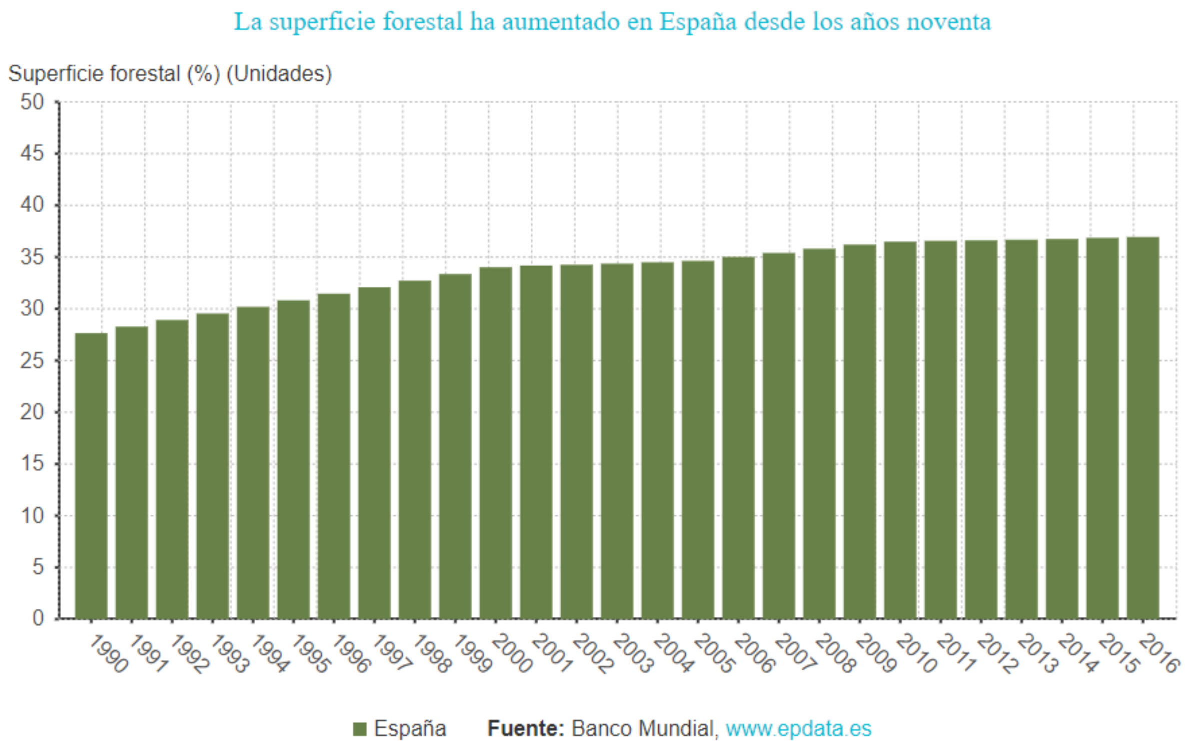




En %
Población urbana
Población rural
1900
1920
1940
1950
1960
1970
1981
1991
2001

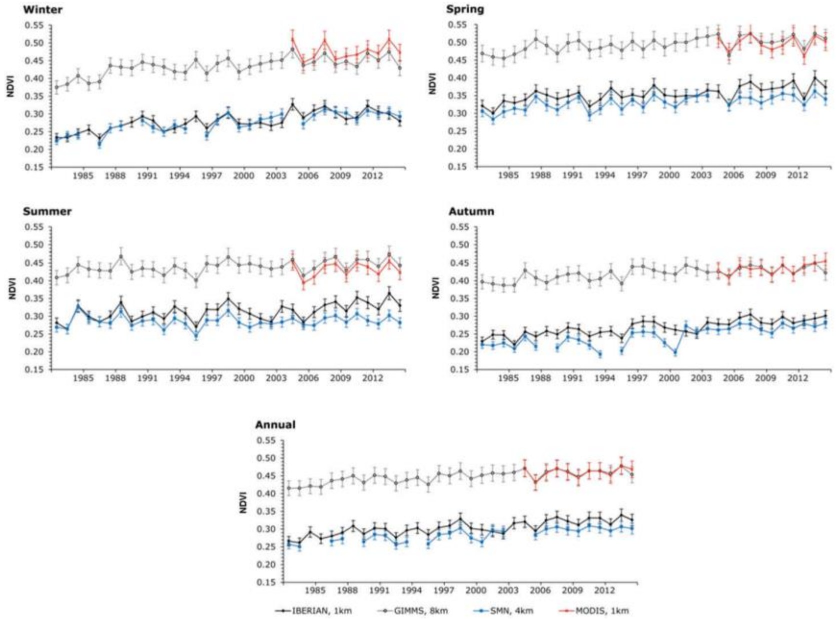

1956
2006
N
300 150 0 300 metros

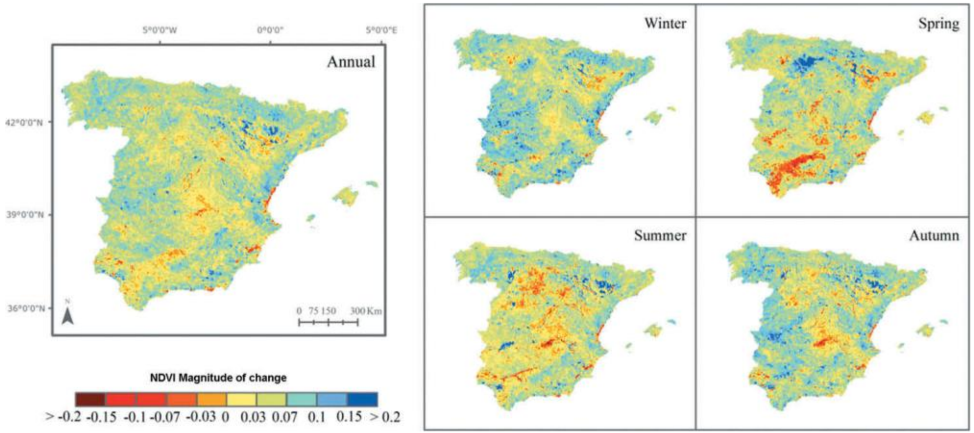
1978. 11.7 millions of hectars covered by forests.
2020. 18.4 millions of hectars
64,5 % of increase

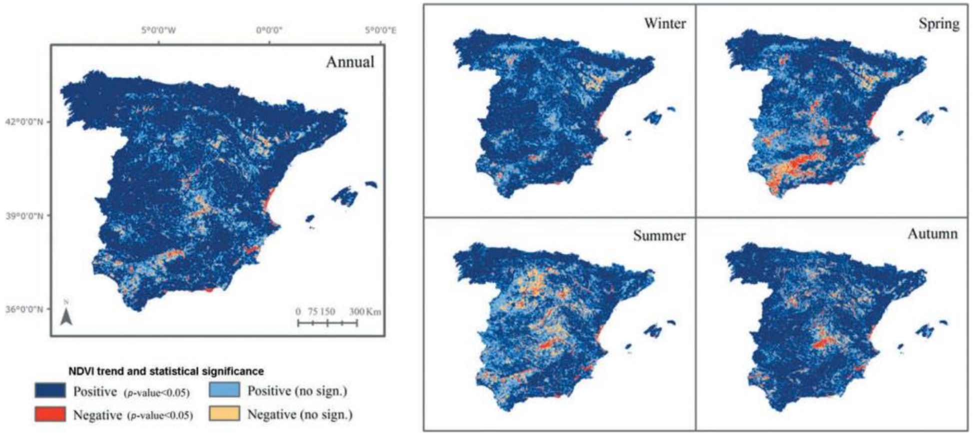


Vegetation greening in Spain detected from long term data (1981–2015)

Sergio M. Vicente-Serrano, Natalia Martín-Hernández, Fergus Reig, Cesar Azorin-Molina, Javier Zabalza, Santiago Beguería, Fernando Domínguez-Castro, Ahmed El Kenawy, Marina Peña-Gallardo, Iván Noguera & Mónica García







nature geoscience

ARTICLES

https://doi.org/10.1038/s41561-022-00935-0

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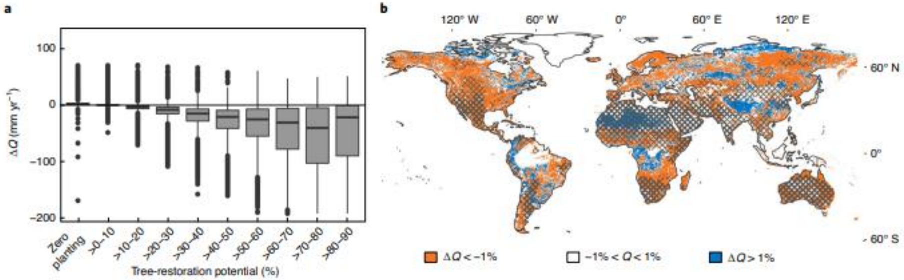
Shifts in regional water availability due to global tree restoration

Anne J. Hoek van Dijke[1,2,3], Martin Herold[2,4], Kaniska Mallick[1], Imme Benedict[5], Miriam Machwitz[1], Martin Schlerf[1], Agnes Pranindita[6,7], Jolanda J. E. Theeuwen[8,9], Jean-François Bastin[10] and Adriaan J. Teuling[3]



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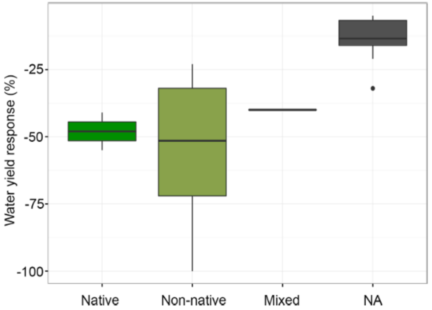
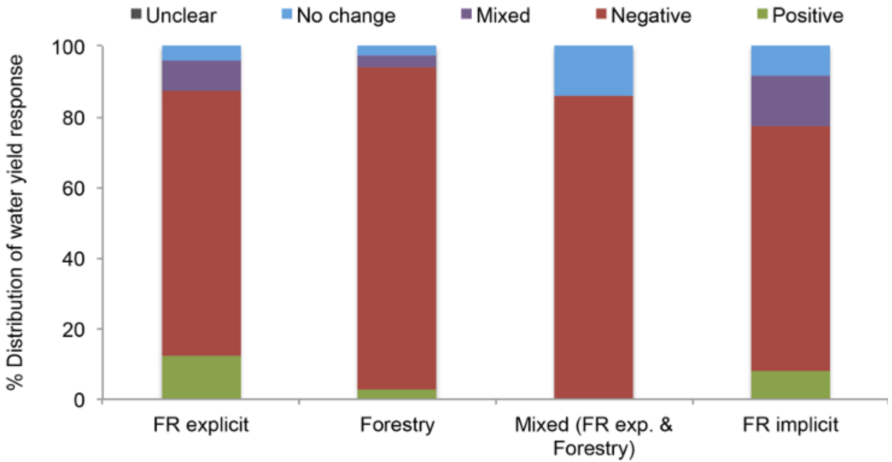
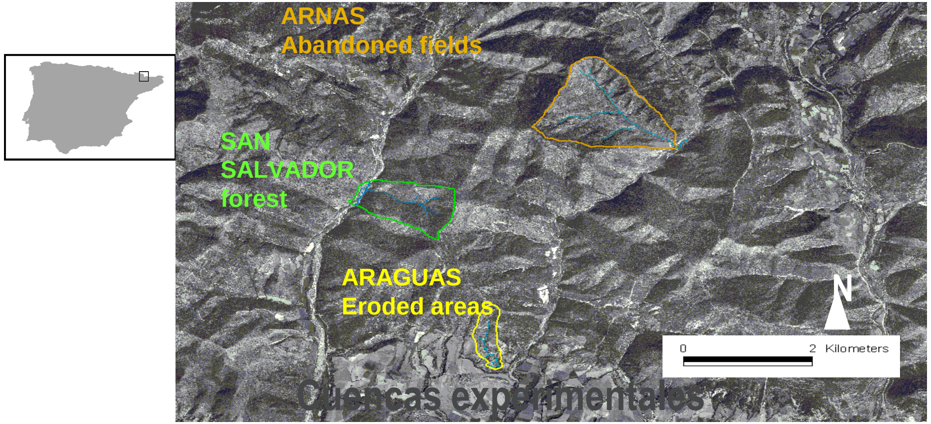
RESEARCH ARTICLE

Impacts of forest restoration on water yield: A systematic review

Solange Filoso[1]*, Maíra Ometto Bezerra[1,2,3], Katherine C. B. Weiss[2], Margaret A. Palmer[1,2,3]





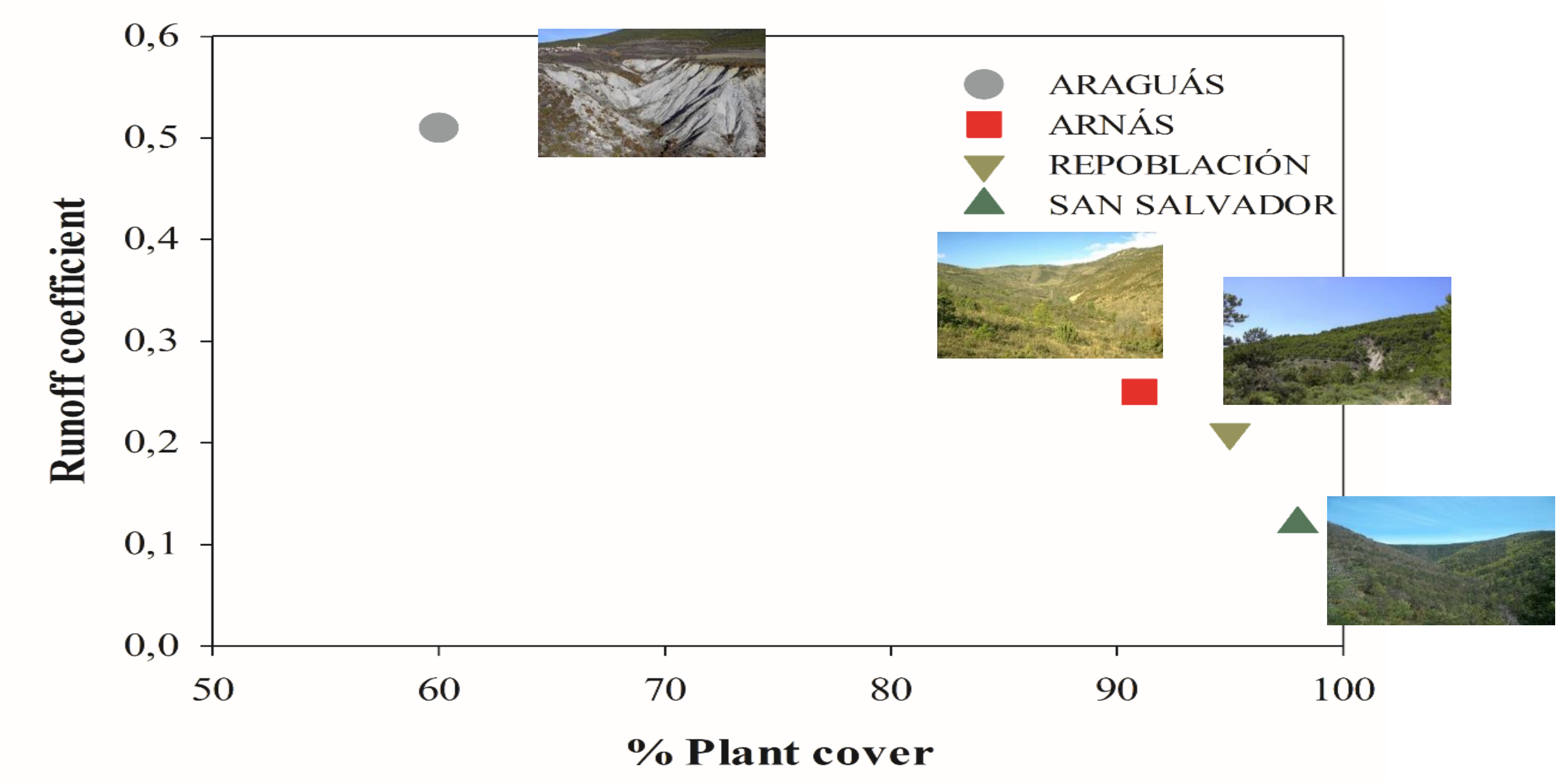

ARNAS
Abandoned fields
SAN
SALVADOR
forest
ARAGUAS
Eroded areas
N
0
2 Kilometers
Cuencas experimentales


Arnás


San Salvador


Araguás

Vegetation trends are the most reasonable driver of the general decrease of runoff in the areas in which water is generated in Spain as demosntrated by strong differences in runoff as a function of the plant coverage.



Anthropocene 36 (2021) 100309

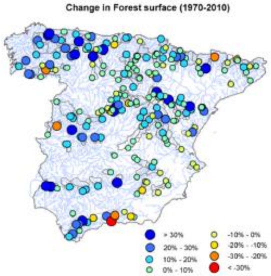
Contents lists available at ScienceDirect

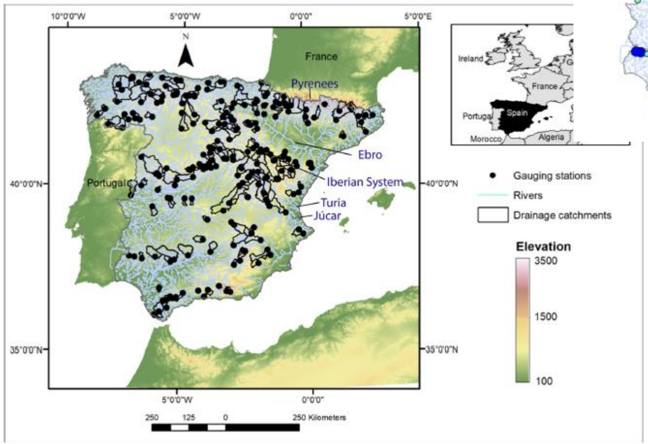
Anthropocene

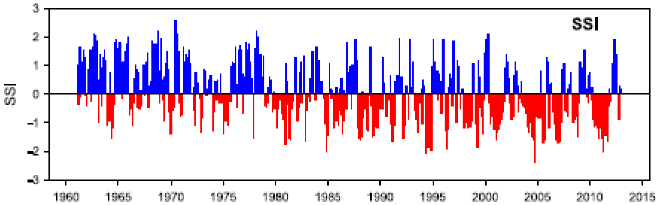
journal homepage: www.elsevier.com/locate/ancene

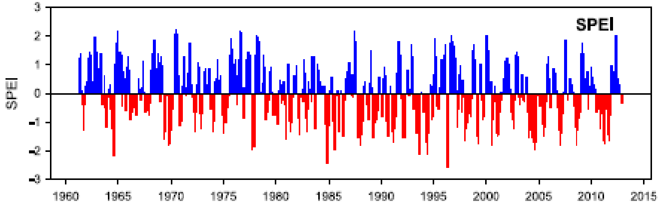
Unravelling the role of vegetation on the different trends between climatic and hydrologic drought in headwater catchments of Spain

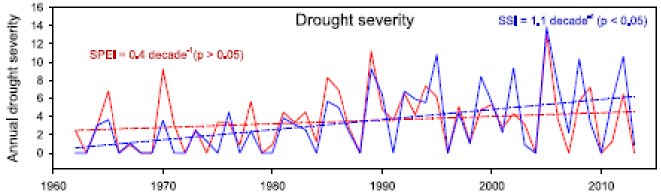
D. Peña-Angulo[a,*], S.M. Vicente-Serrano[a], F. Domínguez-Castro[b,c], I. Noguera[a], M. Tomas-Burguera[d], J.I. López-Moreno[a], J. Lorenzo-Lacruz[e], A. El Kenawy[f,g]

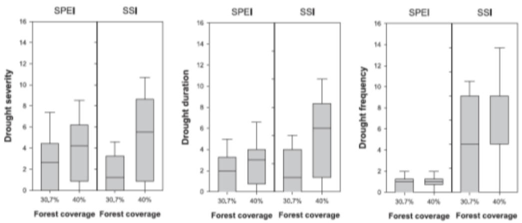












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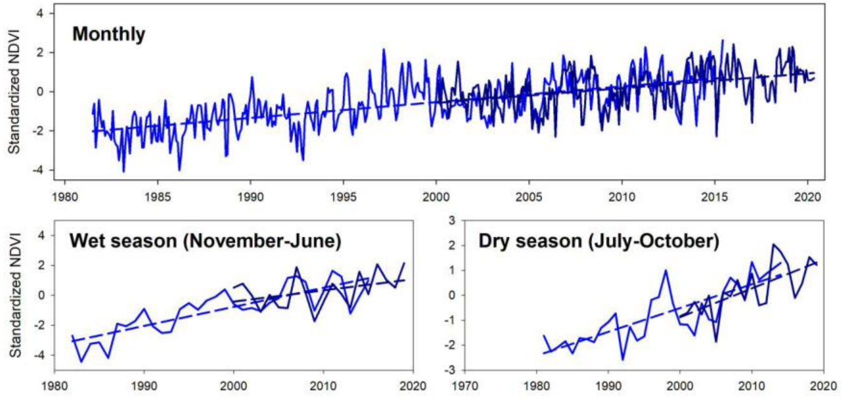
10.1029/2021GL094672

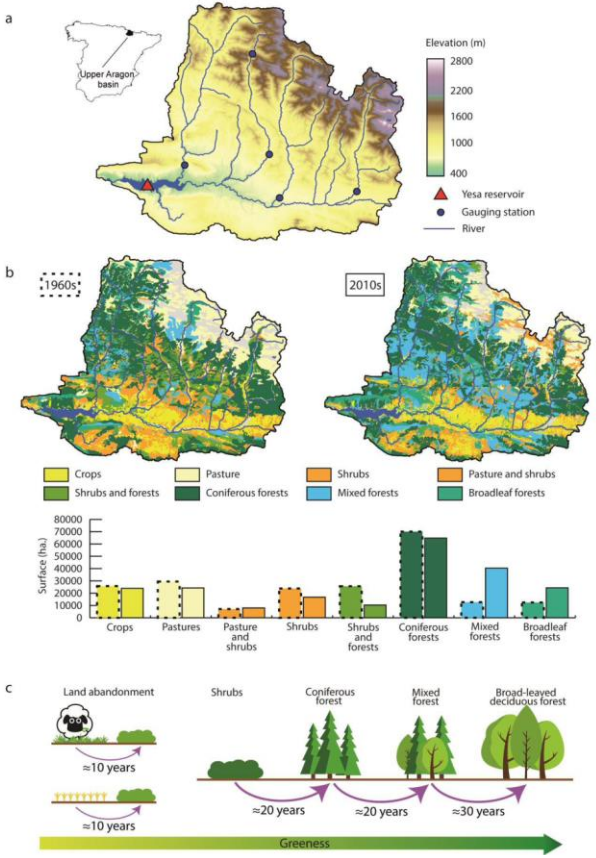
Increased Vegetation in Mountainous Headwaters Amplifies Water Stress During Dry Periods

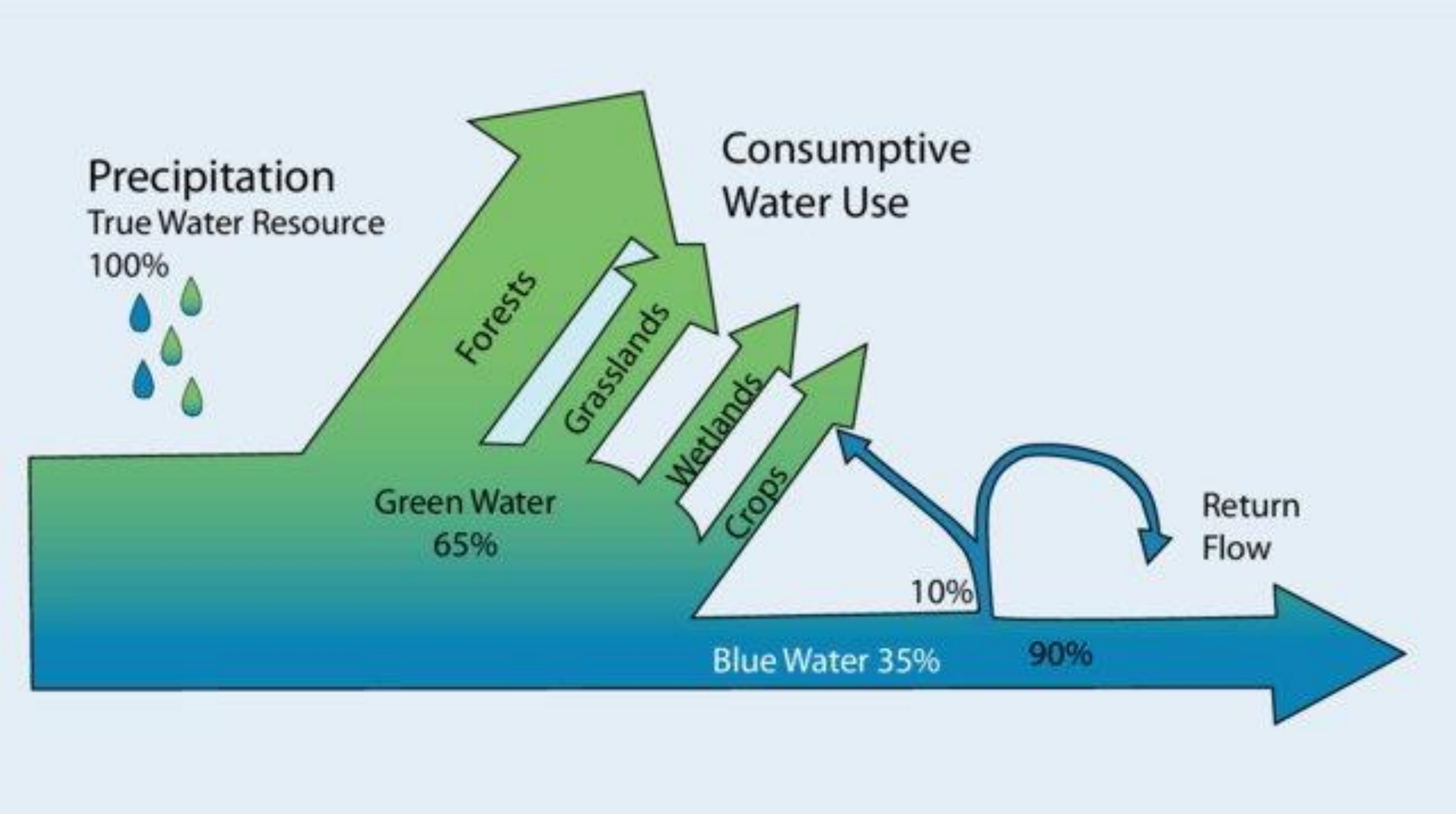
S. M. Vicente-Serrano[1], F. Domínguez-Castro[2,3], C. Murphy[4], D. Peña-Angulo[1], M. Tomas-Burguera[1], I. Noguera[1], J. I. López-Moreno[1], C. Juez[1], S. Grainger[4], L. Eklundh[5], T. Conradt[6], C. Azorin-Molina[7], and A. El Kenawy[8,9]

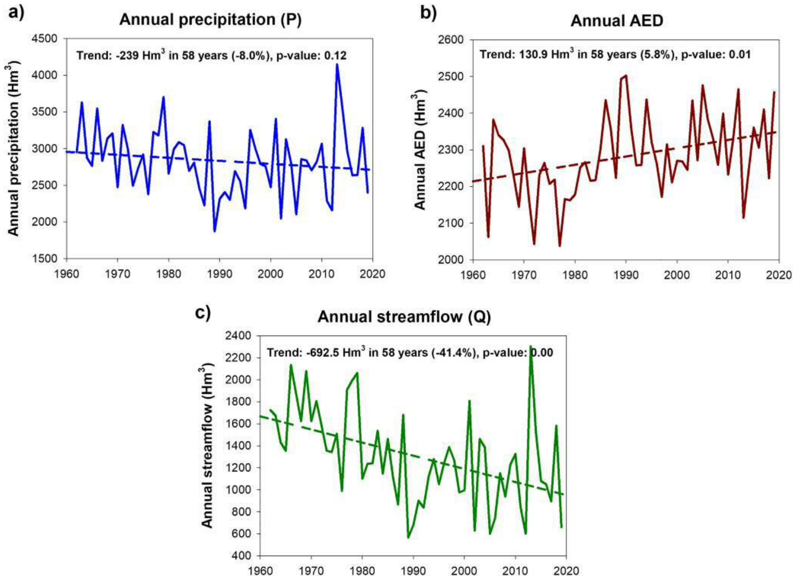
Key Points:

- Forest secondary succession is the main driver of streamflow trends in mountain Mediterranean areas

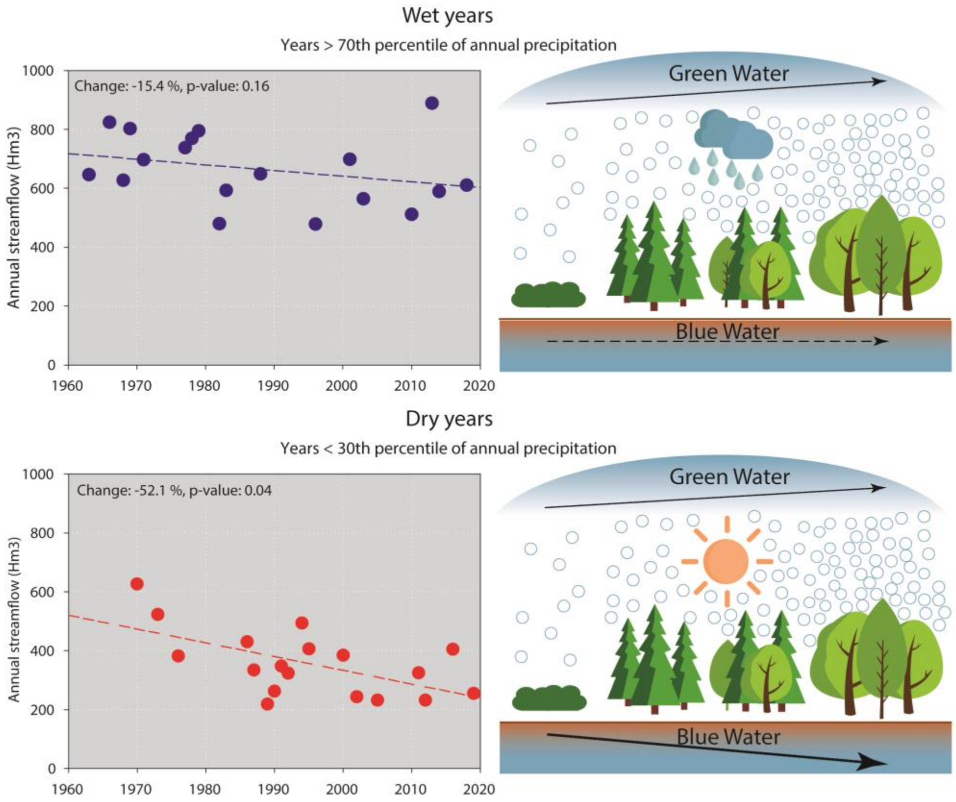





Precipitation
True Water Resource
100%
Consumptive
Water Use
Forests
Grasslands
Wetlands
Crops
Green Water
65%
10%
Return
Flow
Blue Water 35%
90%

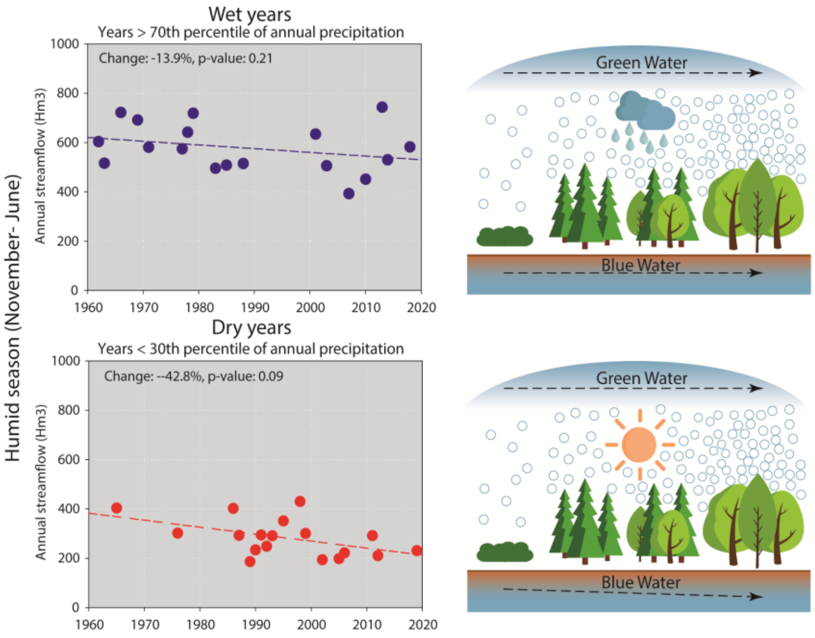


a)
Annual precipitation (P)
Trend: -239 Hm3 in 58 years (-8.0%), p-value: 0.12
Annual precipitation (Hm3)
b)
Annual AED
Trend: 130.9 Hm3 in 58 years (5.8%), p-value: 0.01
Annual AED (Hm3)
c)
Annual streamflow (Q)
Trend: -692.5 Hm3 in 58 years (-41.4%), p-value: 0.00
Annual streamflow (Hm3)

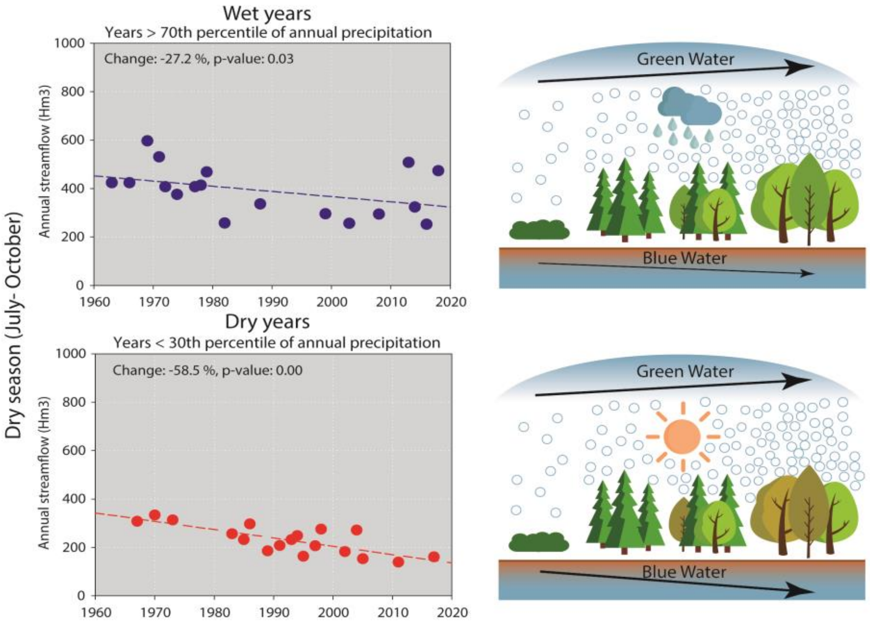


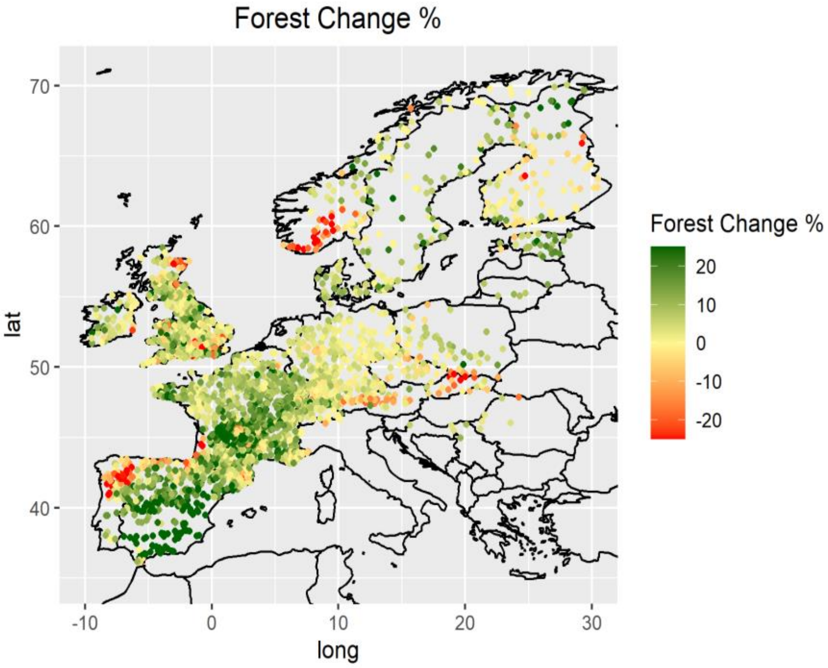
Wet years
Years > 70th percentile of annual precipitation
Change: -15.4 %, p-value: 0.16
Annual streamflow (Hm3)
Green Water
Blue Water
Dry years
Years < 30th percentile of annual precipitation
Change: -52.1 %, p-value: 0.04
Annual streamflow (Hm3)
Green Water
Blue Water

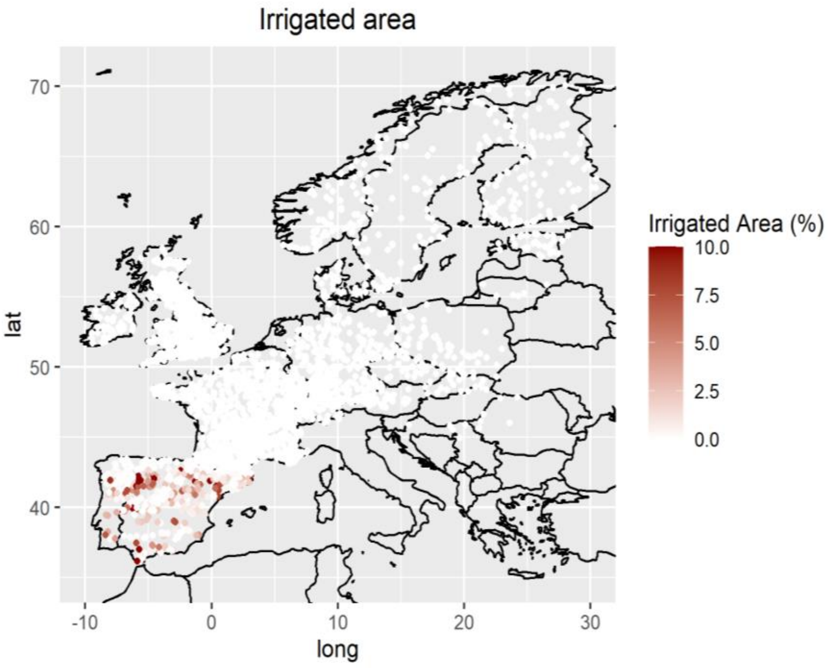
Humid season (November-June)

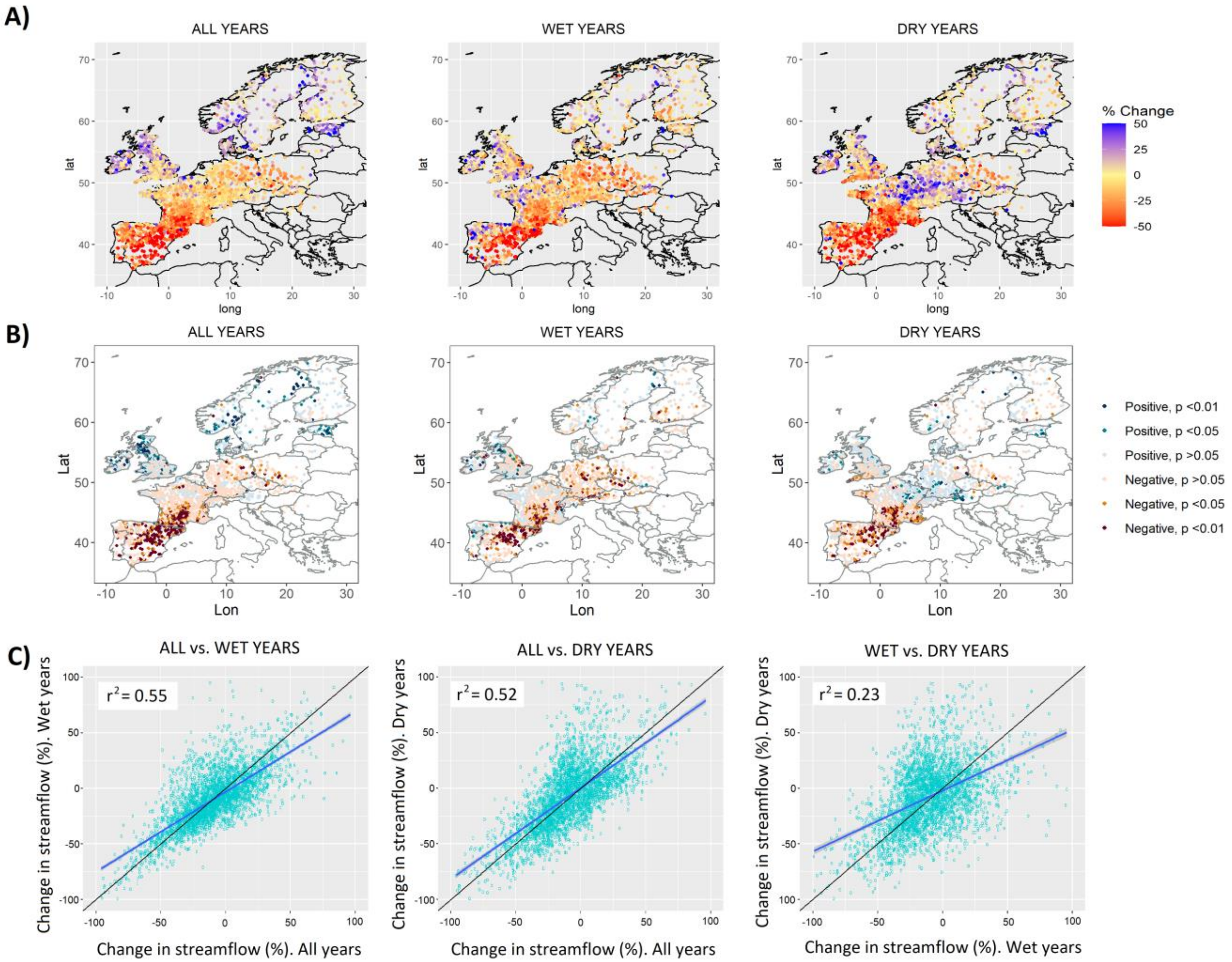


Dry season (July-October)

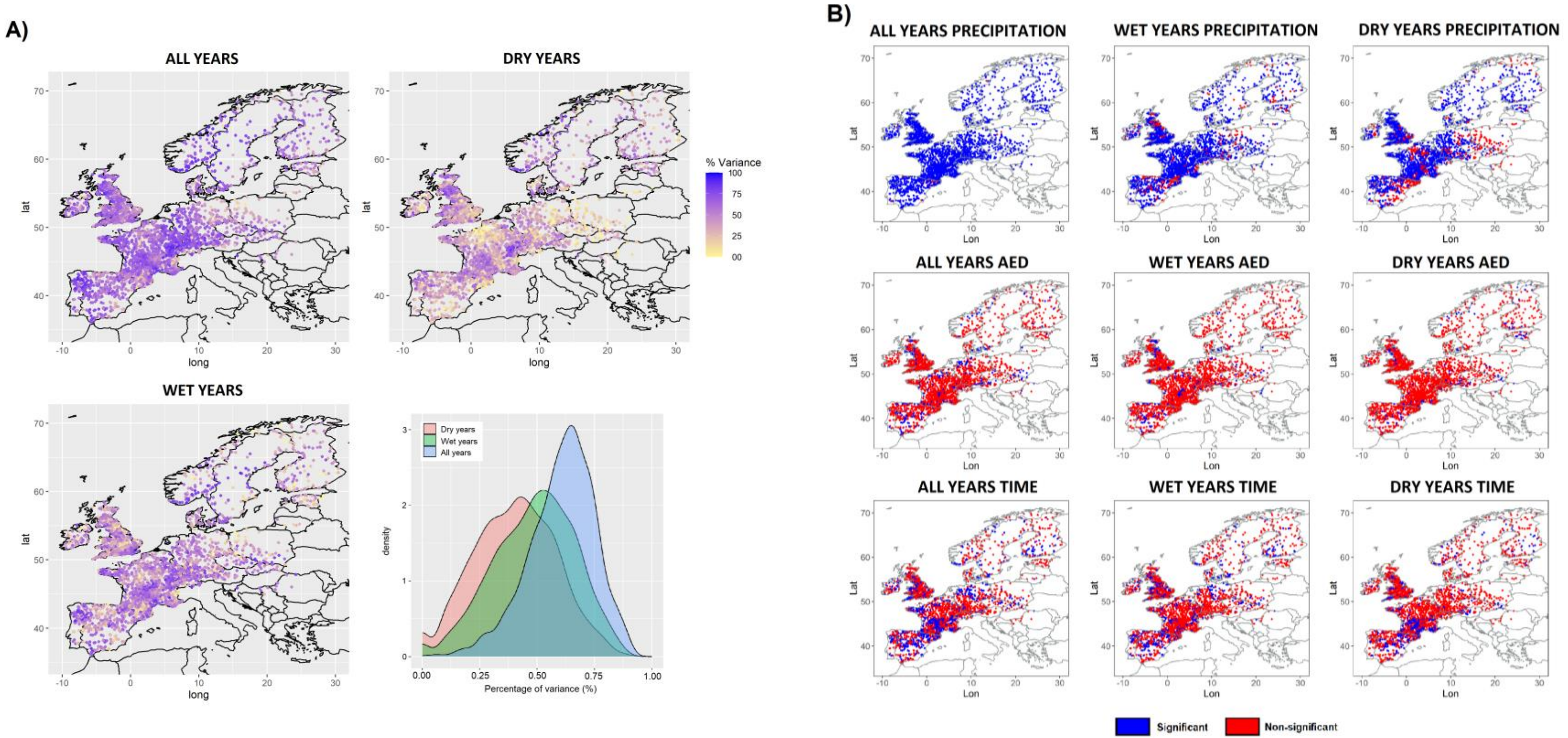


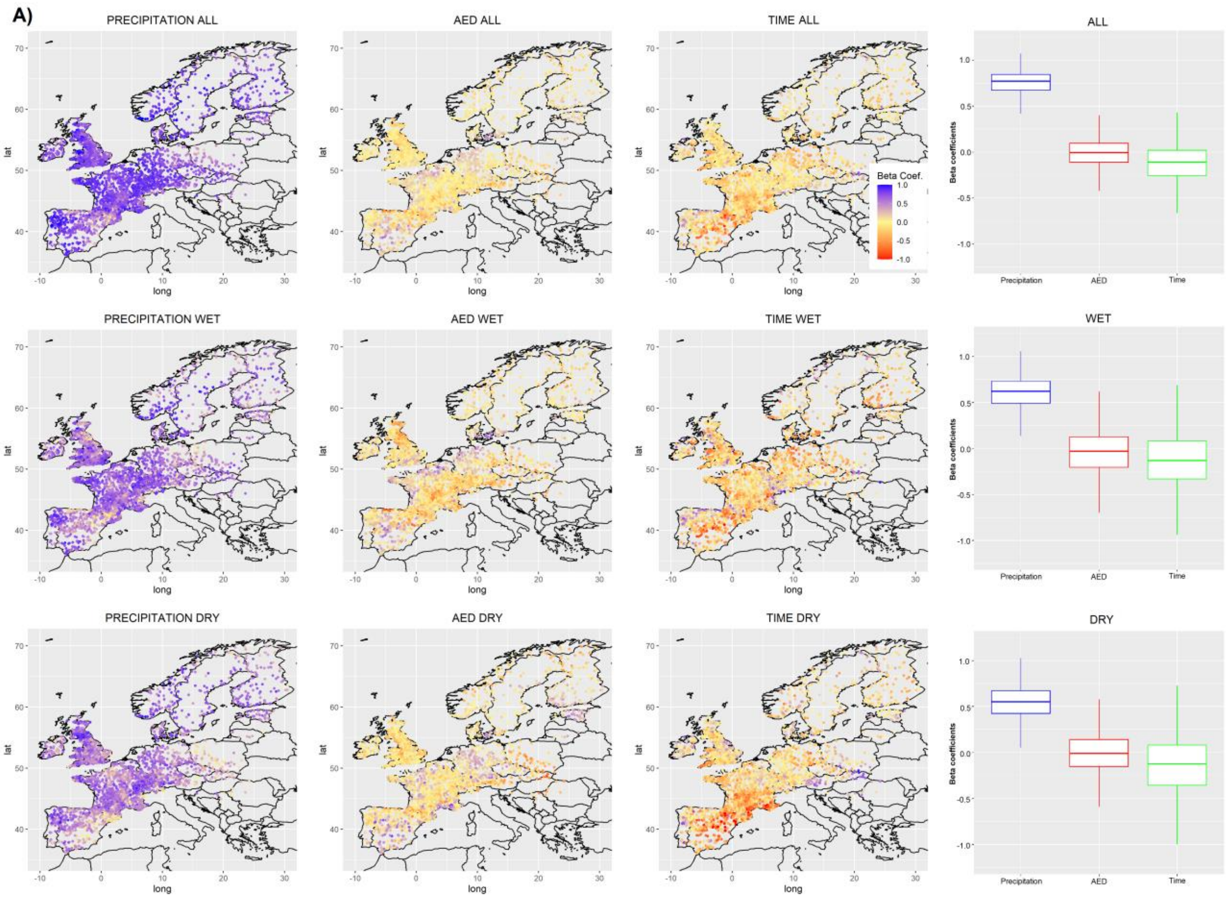

Forest Change %
70
60
50
40
lat
-10
0
10
20
30
long
Forest Change %
20
10
0
-10
-20


Irrigated area
70
60
50
40
lat
-10
0
10
20
30
long
Irrigated Area (%)
10.0
7.5
5.0
2.5
0.0



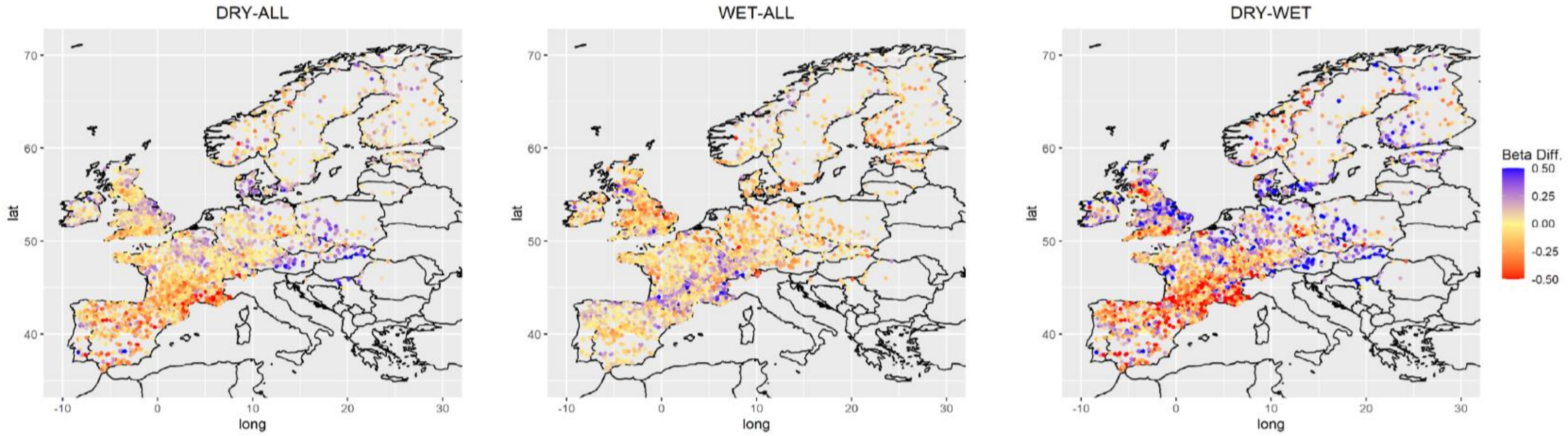
A)
ALL YEARS
WET YEARS
DRY YEARS
lat
long
% Change
50
25
0
-25
-50
B)
ALL YEARS
WET YEARS
DRY YEARS
Lat
Lon
Positive, p <0.01
Positive, p <0.05
Positive, p >0.05
Negative, p >0.05
Negative, p <0.05
Negative, p <0.01
C)
ALL vs. WET YEARS
ALL vs. DRY YEARS
WET vs. DRY YEARS
r² = 0.55
r² = 0.52
r² = 0.23
Change in streamflow (%). Wet years
Change in streamflow (%). Dry years
Change in streamflow (%). All years
Change in streamflow (%). Wet years

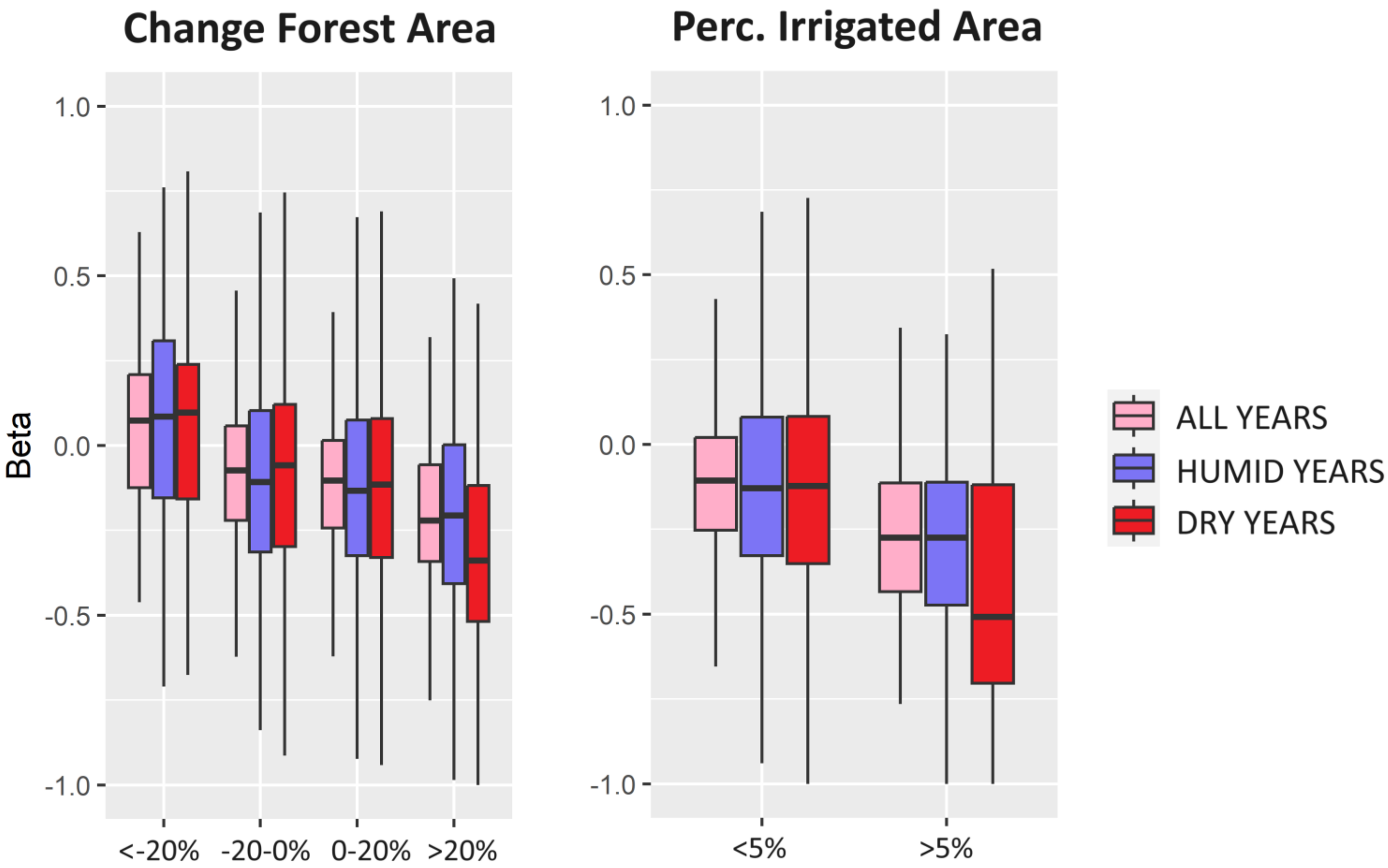

A)
ALL YEARS
DRY YEARS
WET YEARS
lat
long
% Variance
100
75
50
25
00
Dry years
Wet years
All years
density
Percentage of variance (%)
B)
ALL YEARS PRECIPITATION
WET YEARS PRECIPITATION
DRY YEARS PRECIPITATION
ALL YEARS AED
WET YEARS AED
DRY YEARS AED
ALL YEARS TIME
WET YEARS TIME
DRY YEARS TIME
Lat
Lon
Significant
Non-significant



A)
PRECIPITATION ALL
AED ALL
TIME ALL
ALL
PRECIPITATION WET
AED WET
TIME WET
WET
PRECIPITATION DRY
AED DRY
TIME DRY
DRY
lat
long
Beta Coef.
1.0
0.5
0.0
-0.5
-1.0
Beta coefficients
Precipitation
AED
Time

B)


DRY-ALL
WET-ALL
DRY-WET
lat
long
70
60
50
40
-10
0
10
20
30
Beta Diff.
0.50
0.25
0.00
-0.25
-0.50


Change Forest Area
Perc. Irrigated Area
Beta
1.0
0.5
0.0
-0.5
-1.0
<-20%
-20-0%
0-20%
>20%
<5%
>5%
ALL YEARS
HUMID YEARS
DRY YEARS

¡MUCHAS GRACIAS!