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# Mediterranean habitat loss under future climate conditions: Assessing impacts on the Natura 2000 protected area network

**José I. Barredo, Giovanni Caudullo, Achille Mauri**

**Bioeconomy Unit (D1) - Directorate D – Sustainable Resources**
**European Commission - Joint Research Centre**

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***DG-Environment – Brussels, 7th December 2016***

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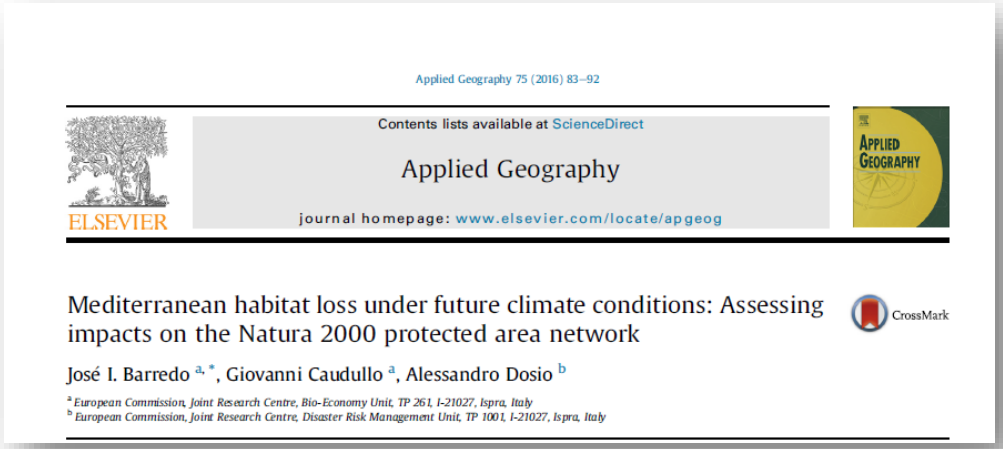
# Pilot study

- Climate-driven habitat loss
- Natura 2000 network of protected areas
- RCM data used in PESETA II Project (ENSEMBLES)
- PESETA III Project - on-going (CORDEX)



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Mediterranean habitat loss under future climate conditions: Assessing impacts on the Natura 2000 protected area network

José I. Barredo [a, *], Giovanni Caudullo [a], Alessandro Dosio [b]

[a] European Commission, Joint Research Centre, Bio-Economy Unit, TP 261, I-21027, Ispra, Italy
[b] European Commission, Joint Research Centre, Disaster Risk Management Unit, TP 1001, I-21027, Ispra, Italy

JRC SCIENTIFIC AND POLICY REPORTS

Climate Impacts in Europe
The JRC PESETA II Project

2014

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# Why the Mediterranean region?

- Global hotspot of biological diversity
- Most rich biodiversity region in Europe
- Almost half of the plants and animals and more than half of the habitats listed in the EU Habitats Directive
- More plant species than all the other European regions combined
- Climate-driven habitat loss is one of the most serious concerns for biodiversity conservation in this region

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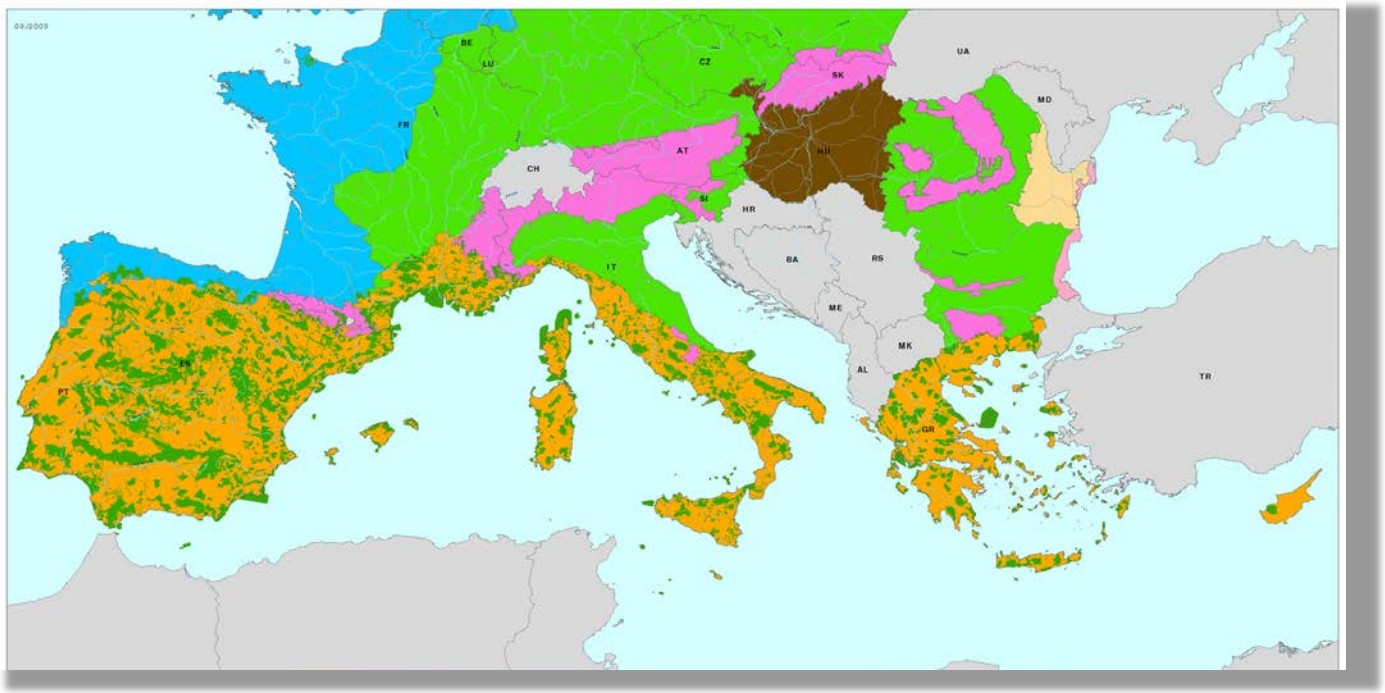
# The Mediterranean region

- 21% of EU territory: ~1 million $Km^2$
- Natura 2000 network: ~20% of the Med. region in 3,987 sites

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# The Mediterranean region

- Mediterranean climate is characterised by hot dry summers and cool wet winters
- These climatic conditions have had a deep influence on the evolution of communities of animal and plant species
- Shifts in the distribution of climates can affect the availability and distribution of suitable areas for species in space and time
- Current threats (urban growth, development of transport and tourism infrastructures, consumption patterns) could restrict migration of species, further exacerbating the effects of (climate-driven) habitat loss

# Aims and Methods

- To assess changes in the spatial range of the Mediterranean climate domain (MCD) in Europe and conversion into arid climate domain (ACD) under scenarios of climate change
- To assess Natura 2000 sites that will be affected by these changes
- Adaptation measures within and outside Natura 2000 sites

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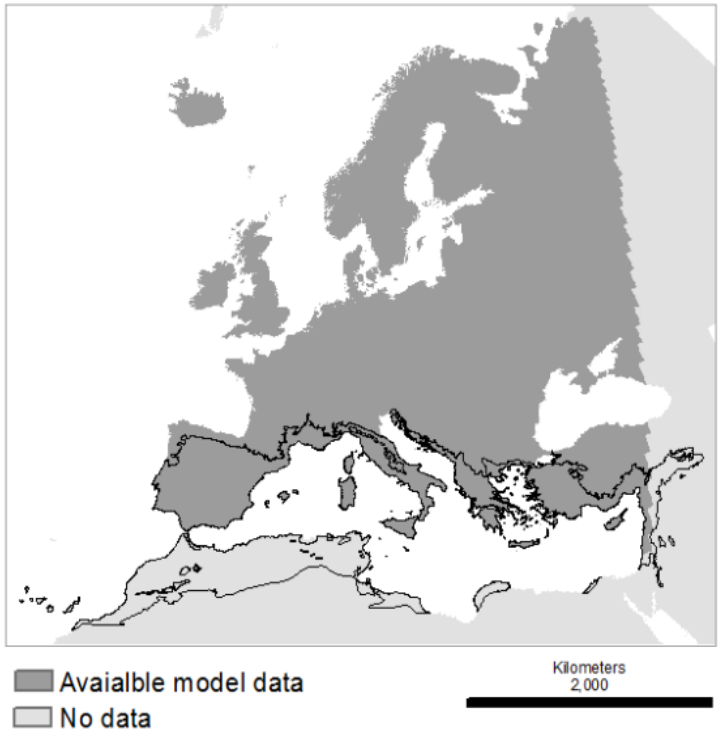
# Methods

There is no one single generally accepted definition of the Mediterranean biome

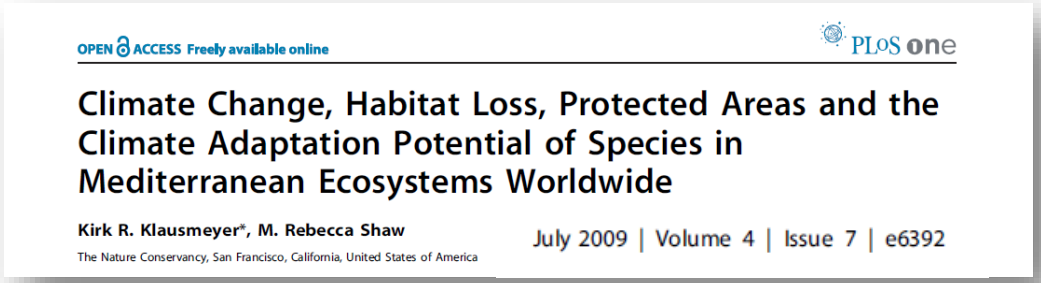



Mediterranean biome (black line) according to Olson et al. (2001) Terrestrial Ecoregions of the World

Spatial domain of the climate simulations (RCMs) used in this study (dark grey)

# Methods

- Climatic approach
- Köppen-Geiger climate classification for mapping the Mediterranean and arid climatic domains (MCD and ACD)
- The Mediterranean and arid climates are often described using respectively Cs and B climate types




Global

General circulation models (AOGCMs) ~125 km to ~550 km

Mediterranean according to Aschmann (1973)

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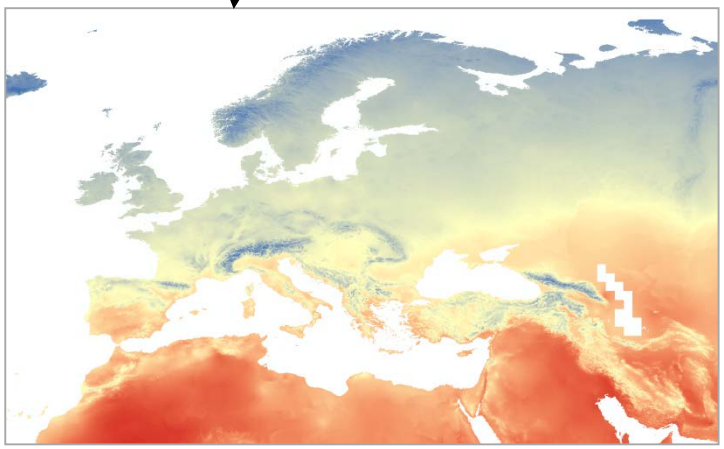
# Köppen-Geiger criteria: data needed

Series of mean monthly temperature and accumulated monthly precipitation: 30-year averages

| | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T | - | - | - | - | - | - | - | - | - | - | - | - |
| P | - | - | - | - | - | - | - | - | - | - | - | - |

August mean temperature
(1960-1990)
WorldClim data 1-km



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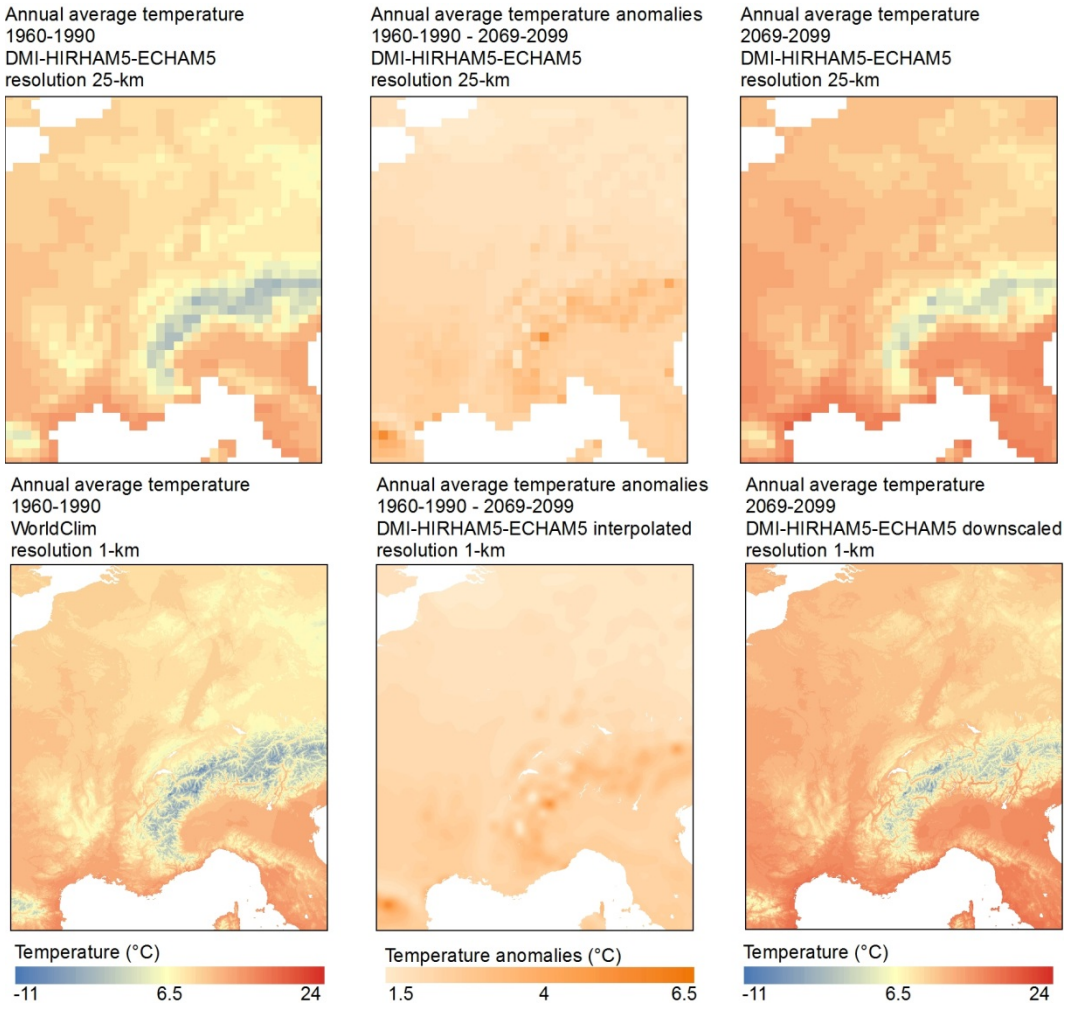
# Data and periods (PESETA II)

- Historical climate: **WorldClim data**
  - **1980s (1960-1990) at 1-km grid size**
- Future emission scenarios: **ENSEMBLES project**
  - **A1B: Three realisations (25-km grid size)**
  - **E1: One realisation (50-km grid size)**
  - Periods: **2020s** (2010-2039), **2050s** (2040-2069), **2080s** (2070-2099)

- **A1B** is a moderate emissions scenario with a balance across all sources of emissions, not relying too heavily on one particular energy source. Projected warming by 2100: **2.8 °C** (likely range: 1.7 – 4.4 °C)
- **E1** represents a stabilisation scenario and simulates matching the EU target of keeping anthropogenic global warming **below 2 °C** above pre-industrial levels in 2100

# Change factor approach – disaggregation of RCMs data
# From 25 km to 1 km grid size




Anomalies:

- T: Differences (scenario – control) of monthly mean temperature
- P: Ratios (scenario/control) of monthly precipitation

CV RMSE
T: 3.1%
P: 1.7%

i.e.
in 1 °C = 0.031 °C
in 100 mm = 1.7 mm

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# Results – Mediterranean climate domain

A1B KNMI: Reference - central

A1B METO: Warmer and drier

A1B DMI: Colder and wetter

E1 MPI: Stabilisation scenario

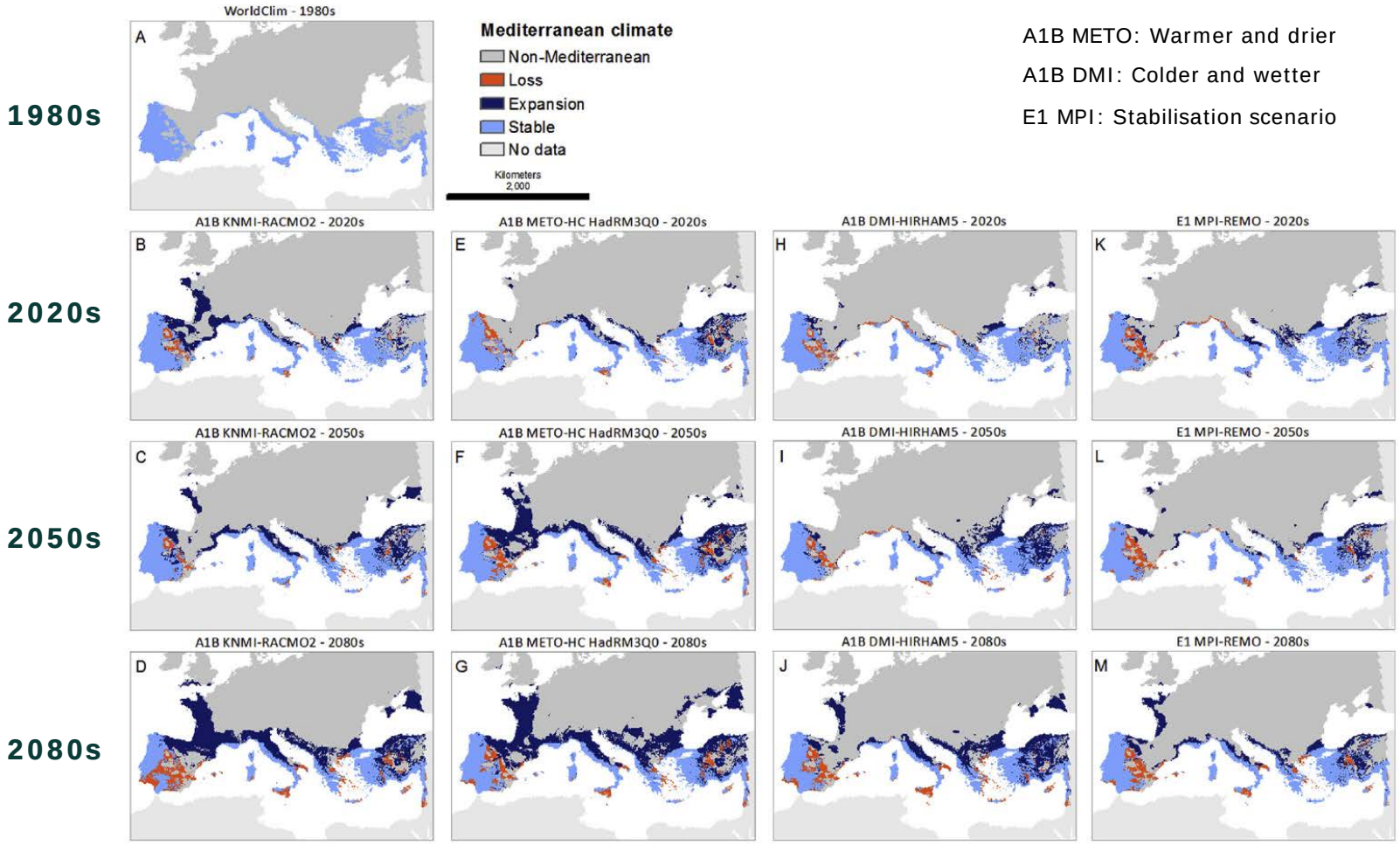


**Fig. 3.** Euro-Mediterranean climate domain under current climate (1980s) (light blue in A), and changes under scenario A1B in 2020s, 2050s and 2080s (KNMI-RACMO2: B, C and D; METO-HC HadRM3Q0: E, F and G; DMI-HIRHAM5: H, I and J); and under scenario E1 (MPI-REMO) in 2020s, 2050s and 2080s (K, L and M). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

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# Results – Arid climate domain

A1B KNMI: Reference - central

A1B METO: Warmer and drier

A1B DMI: Colder and wetter

E1 MPI: Stabilisation scenario

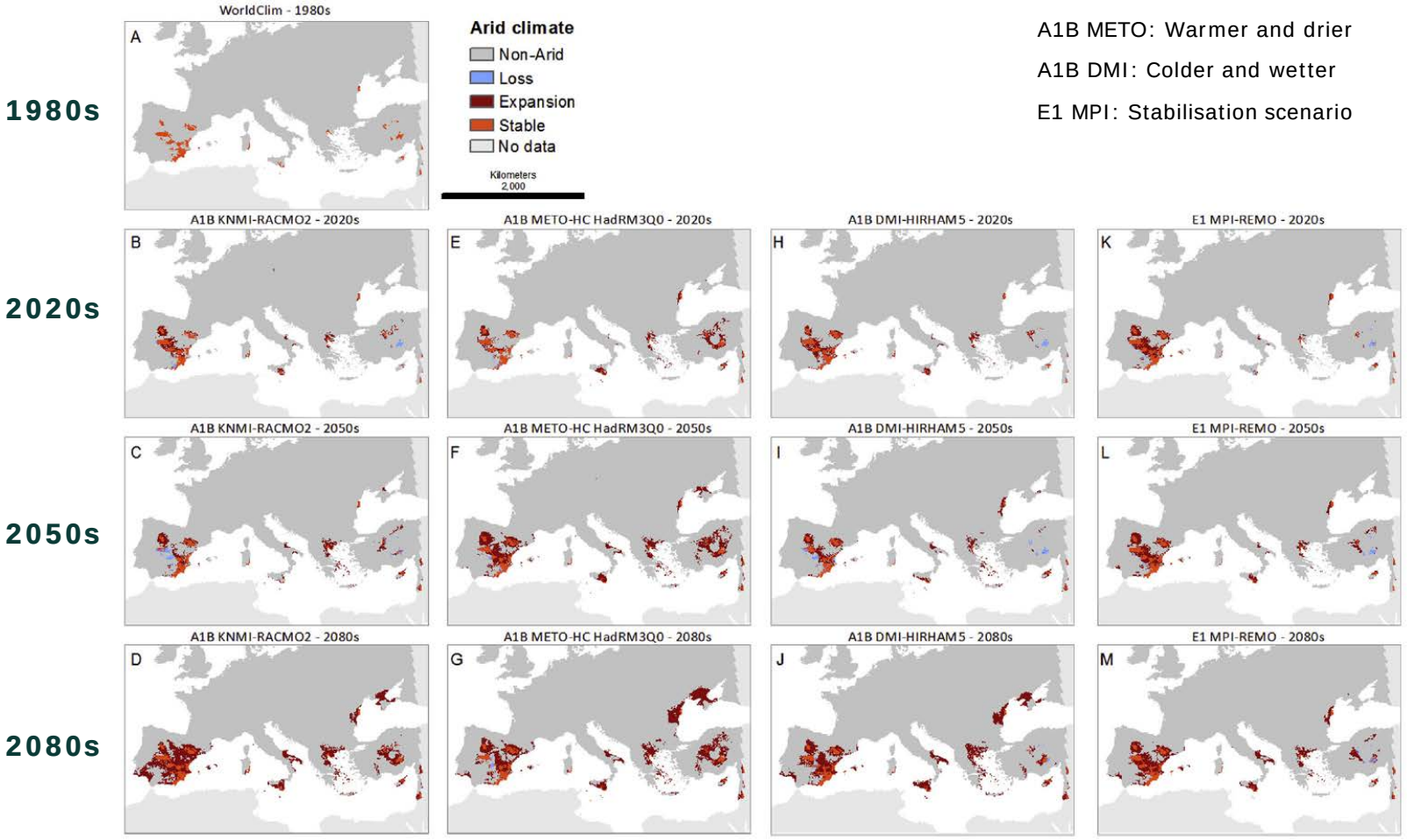


**Fig. 4.** European arid climate domain under current climate (1980s) (red in A), and changes under scenario A1B in 2020s, 2050s and 2080s (KNMI-RACMO2: B, C and D; METO-HC HadRM3Q0: E, F and G; DMI-HIRHAM5: H, I and J); and under scenario E1 (MPI-REMO) in 2020s, 2050s and 2080s (K, L and M). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

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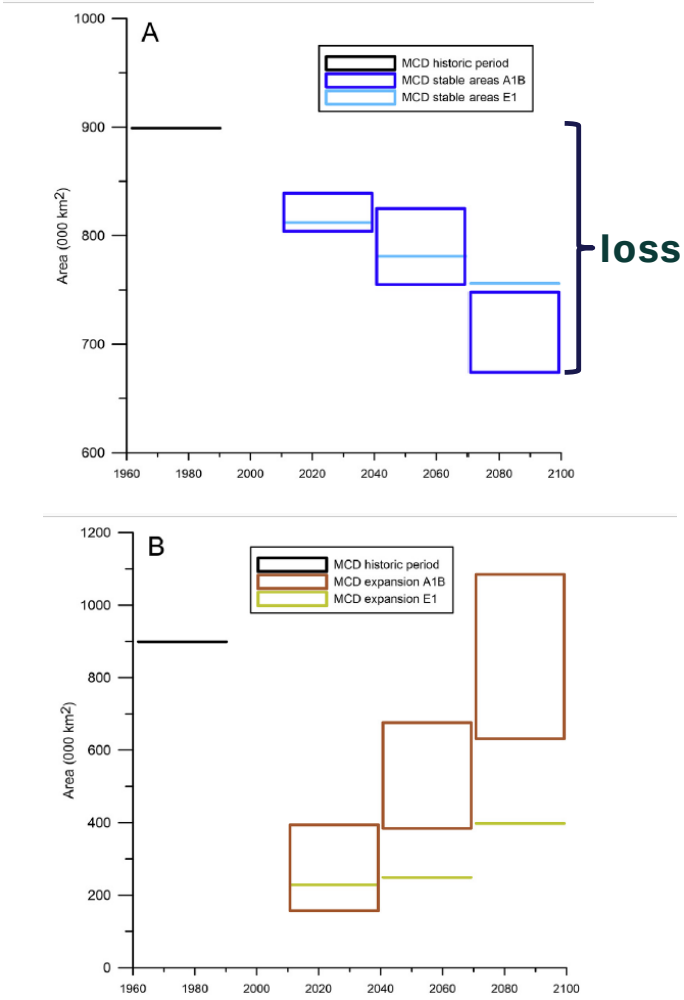
# Results – Mediterranean climate domain




**By 2080s:**

- **Loss** - A1B: 17-25%; E1: 16%
- ~ size of Greece and Portugal combined
- **Projected loss explained by shifts of the ACD**
- **Stable** - A1B: 75-83%; E1: 84%

- The MCD is projected to shift over other climatic domains
- **Expansion** - A1B: 70-121%; E1: 44%
- **MCD area projected to 2 times the current extent**

**Fig. 2.** Changes of the Euro-Mediterranean climate domain (MCD) and arid climate domain (ACD) under scenario A1B (range of KNMI-RACMO2, METO-HC and DMI-HIRHAM5) and E1 (MPI-REMO) in three future periods (2020s, 2050s and 2080s). No range was computed for E1 because only one simulation was used. A) Stable areas of the MCD. The loss is the difference with the historic period. B) Expansion (new areas) of the MCD into other climatic domains; C) Expansion (new areas) of the ACD.

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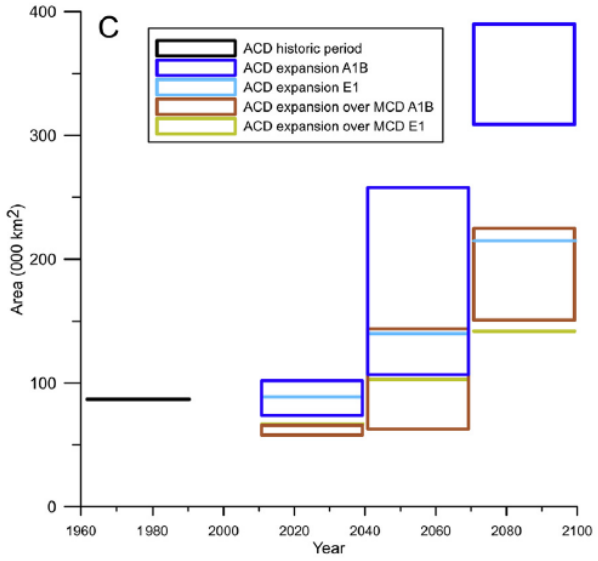
# Results – Arid climate domain




**By 2080s:**

- **Increase -** A1B: 446-550%; E1: 337%
- Projected expansion ~ 3 times the size of Greece

- The Iberian Peninsula is projected to face the largest increase of arid zones
- Other areas that are projected to be affected are Southern Italy including the island of Sicily, eastern and southern parts of Greece, Cyprus, Malta and central areas of Turkey

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# Results – MCD and Natura 2000 sites

## By 2080s:

- **Number of sites**: Contractions of the MCD are projected to affect between 15% and 23% of Mediterranean Natura 2000 sites in both scenarios (362—567 sites out of 2,475)
- **Area**: Projected MCD loss under A1B includes 13—30% (18% under E1) of the area of Natura 2000 sites (18,000—41,000 km$^2$)

**Table 2**
Area and number of Natura 2000 sites in the current Euro-Mediterranean climate domain (MCD) and in areas where the MCD persist under scenario A1B (range of KNMI-RACMO2, METO-HC and DMI-HIRHAM5) and E1 (MPI-REMO) (area: 000 km$^2$). In parenthesis: percentage loss in relation to the historical climate (1980s).

| Scenario | Natura 2000 sites | 1980s | 2020s | 2050s | 2080s |
|---|---|---|---|---|---|
| A1B | Area | 137 | 120–127 (−13to−7) | 119–127 (−13to−8) | 96–119 (−30to−13) |
| | Number of sites | 2475 | 2213–2393 (−11to−3) | 2171–2301 (−12to−7) | 1908–2113 (−23to−15 |
| E1 | Area | 137 | 121 (−12) | 116 (−15) | 112 (−18) |
| | Number of sites | 2475 | 2177 (−12) | 2172 (−12) | 2104 (−15) |

- 70—87% of the Natura 2000 area is projected to remain stable under A1B (82% under E1)

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# Projected changes in climatic parameters

## A1B

| Parameter | 1980s | 2080s | |
|---|---|---|---|
| T annual | 14.3 | +3.3—3.6 |  |
| T summer | 19.3 | +3.4—3.9 |  |
| T winter | 9.4 | +2.8—3.3 |  |
| P annual | 687 | -23 — -15% |  |
| P summer | 192 | -46 — -27% |  |
| P winter | 496 | -15 — -10% |  |

T: Temperature (°C)

P: Precipitation (mm)

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# PESETA-III Project - On-going: June 2017

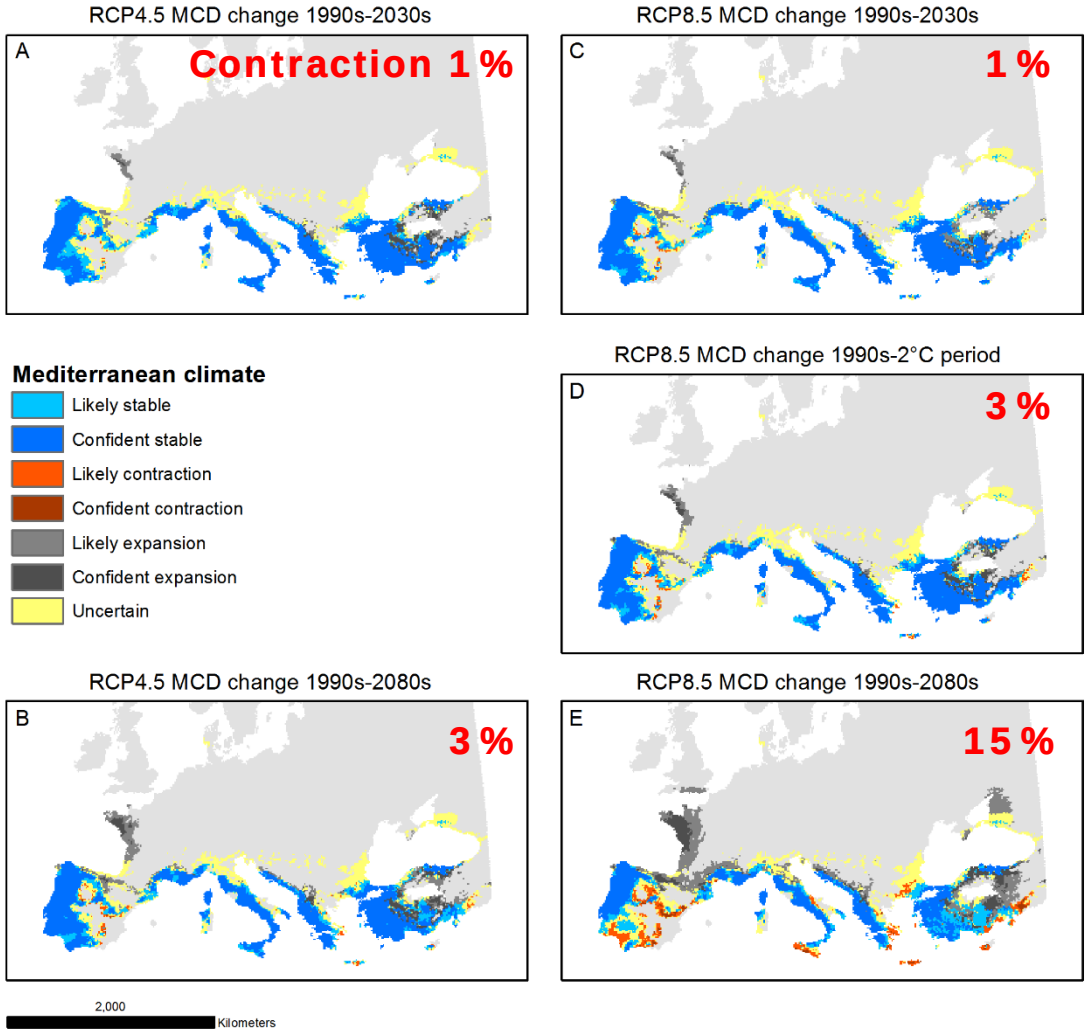
- EURO-CORDEX – RCMs - RCP4.5 and RCP8.5 – IPCC AR5
- 11 bias-adjusted simulations at 12.5 $km^2$ (Dosio, 2016)
- Ensemble approach

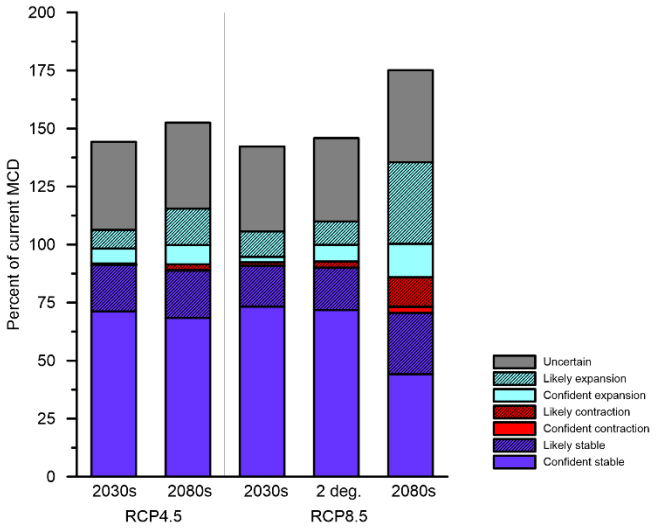
- RCP4.5 is a trajectory corresponding to policies that approximate the mitigation efforts proposed at the Paris COP21. Projected global warming increase **+1.8 °C by end of century**
- RCP8.5 is a trajectory describing a high emission scenario. Global warming increase **+3.7 °C by end of century**

Dosio, A (2016) DOI: 10.1002/2015JD024411

# PESETA-III Project – Early results

## Projected changes on the Mediterranean climate domain




By 2080s under RCP8.5:
Projected contraction of the MCD is 15%

Stable area projected to 71%, and expansion area to 50%

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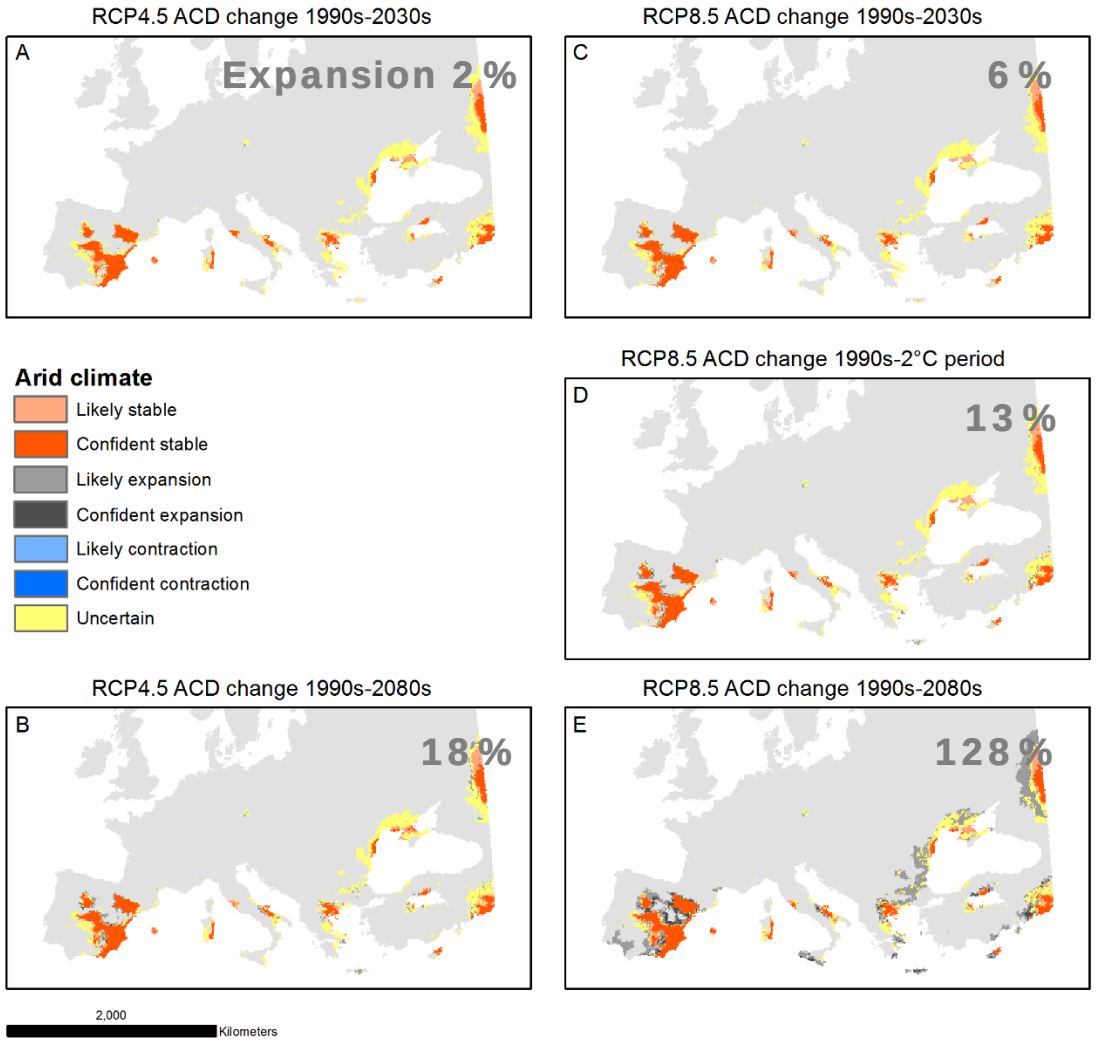
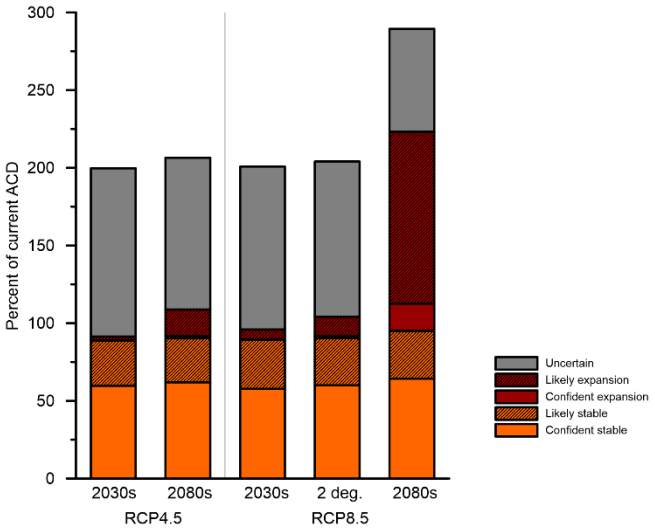
# PESETA-3 Project – Early results

## Projected changes on the arid climate domain




By 2080s under RCP8.5: 99% of MCD loss is explained by shifts of the ACD

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# Outlook

- Contraction areas of the MCD are projected to face severe habitat change due to conversion into arid habitats:
  - Species range contraction and shifts, local extinction, changes in species composition and interactions, and changes in species assemblages
- Areas where the MCD persists are priority areas for conservation
- Projected hotter and drier conditions supports the hypothesis of an increase of other concomitant effects of climate change:
  - Increasing forest fire danger
  - More frequent and longer drought
  - Establishment and spread of invasive alien species
  - Newly introduced forest pests and diseases
  - The extent of the impacts remain uncertain

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# Next steps: Options for adaptation

- Mapping critical biodiversity areas for conservation in the Mediterranean region, including Natura 2000 sites
- Adaptation options in and outside Natura 2000 sites: The Natura 2000 network database will be used for modelling adaptation of native species and mapping critical zones for conservation
- The cost of (public) adaptation will be estimated from adaptation projects implemented in Mediterranean zones (LIFE projects, Natura 2000 management,…)

- Due by mid 2017

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# Thank you

More info: Mediterranean habitat loss under future climate conditions: Assessing impacts on the Natura 2000 protected area network (2016)
http://dx.doi.org/10.1016/j.apgeog.2016.08.003

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