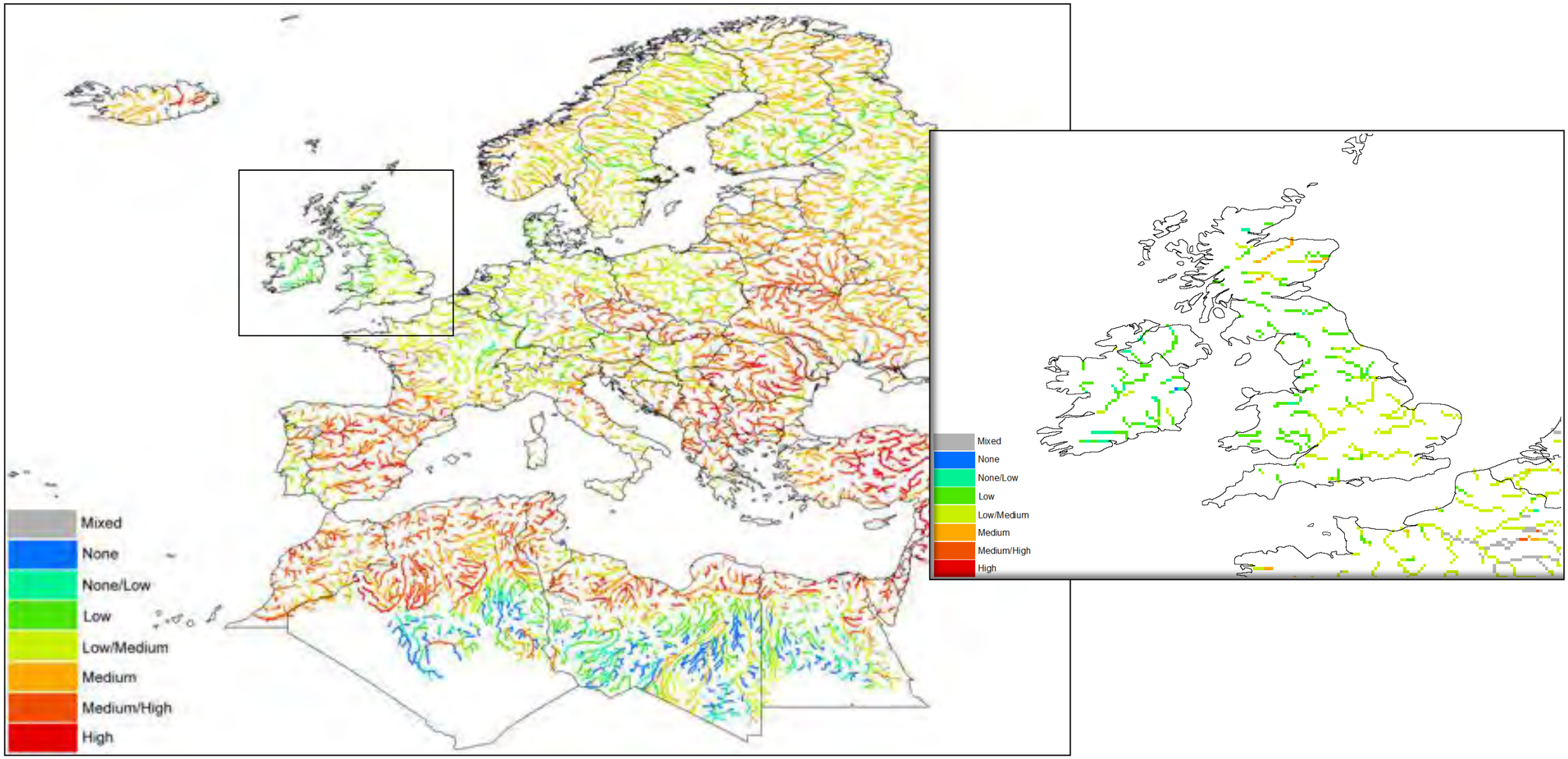
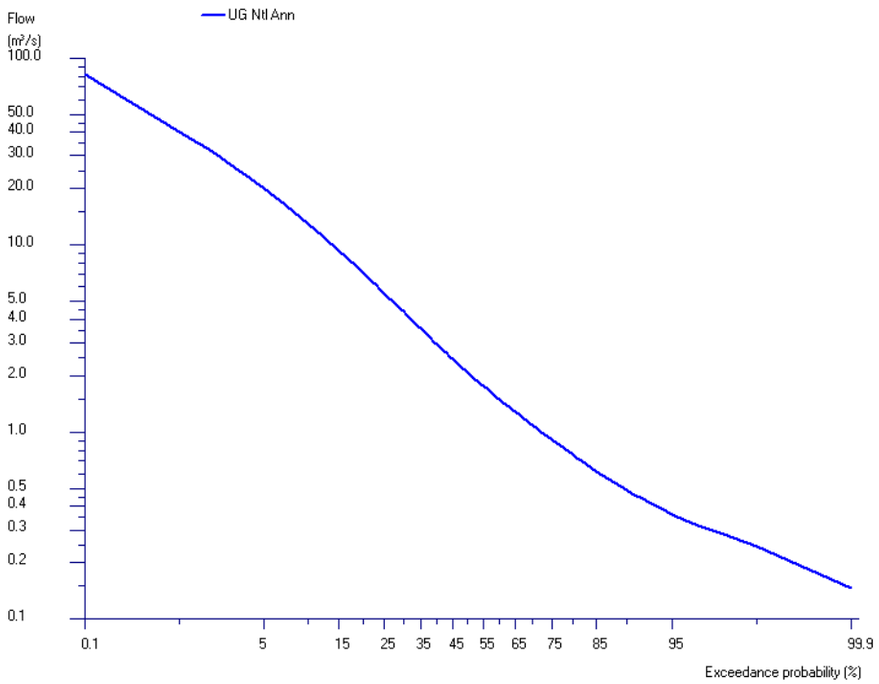
Abstraction and Climate Change in Europe

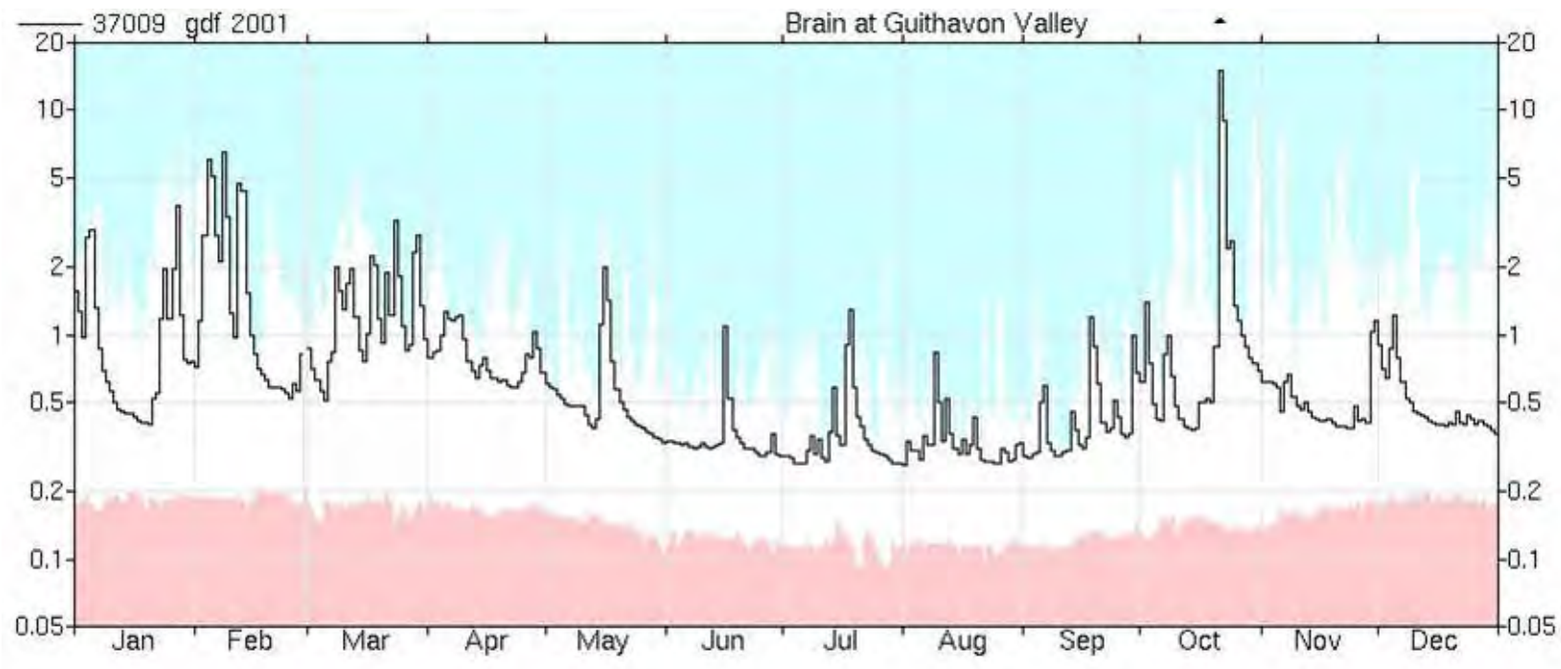


Cédric Laizé Centre for Ecology and Hydrology

Introduction



- Climate change and abstraction scenarios considered together
- Whole flow regime characterised (moving away from flow duration curves)
- Extent geographical scale



Study Flowchart

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Historical climate data

Climate models (x2)

WaterGAP Model

Climate model only

Abstraction Scenarios (x4)

Naturalised monthly river flows 1961-1990
BASELINE

2 x naturalised monthly river flow series 2040-2069
IPCM4 Natural / MIMR Natural

8 x monthly river flow series 2040-2069
IPCM4 EcF, FoE, PoR, SuE
MIMR EcF, FoE, PoR, SuE

Nine variables (one value per year of record per site) / **16 indicators** (one value per period of record per site)

Absolute **differences** between **baseline** and **modelled** indicators

Indicators flagged as different from baseline if change > **thresholds**

Colour-coding system: blue, green, amber, or red (no impact, low, medium, high)

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Four Abstraction Scenarios:

Economy First

Fortress Europe

Policy Rules

Sustainability Eventually

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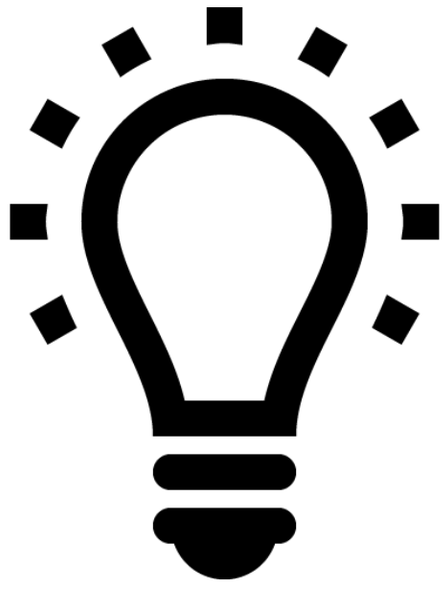
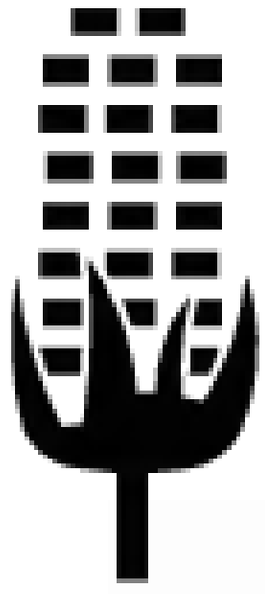
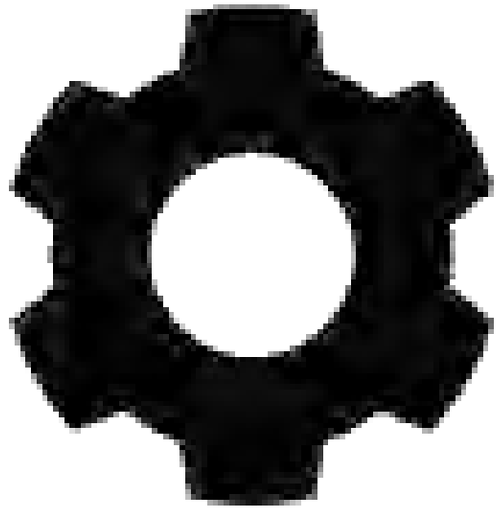
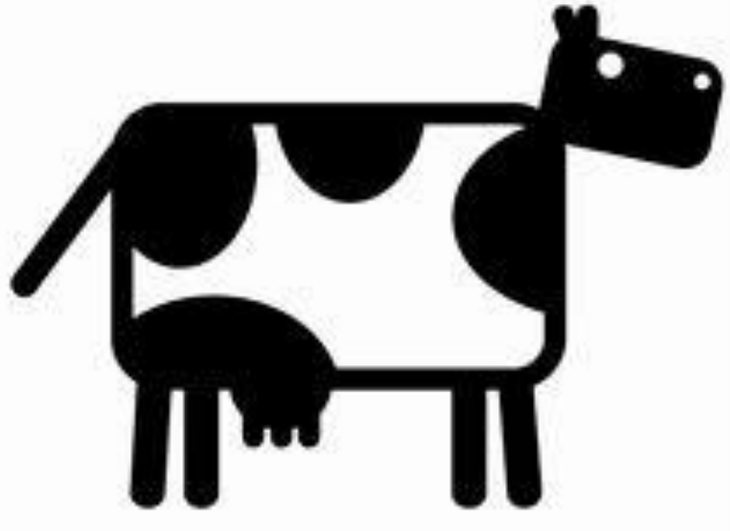
Scenarios include abstractions for five sectors: domestic, electricity production, industry, irrigation, livestock









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Monthly Flow Regime Indicators (MFRI)

Regime characteristic	*MFRI variables (x 9)* *(one value per year)*	*MFRIs (x 16)* *(one value per record)*
Flood Magnitude & Frequency	Number of times that monthly flow exceeds threshold (all-data naturalised Q5 from 1961-1990)	Median & Interquartile Range
Flood Timing	Month of maximum flow (as number 1 to 12)	Mode
Seasonal Flow	January flow (mm runoff)	Median & IQR
	April flow (mm runoff)	Median & IQR
	July flow (mm runoff)	Median & IQR
	October flow (mm runoff)	Median & IQR
Low Flow Magnitude & Frequency	Number of months that flow is less than threshold (thresholds = all-data naturalised Q95 from 1961-1990)	Median & IQR
Minimum Flow Timing	Month of minimum flow (as number 1 to 12)	Mode
Low Flow Duration	Number of times that two consecutive months are less than threshold (all-data naturalised Q95 from 1961-1990)	Median & IQR

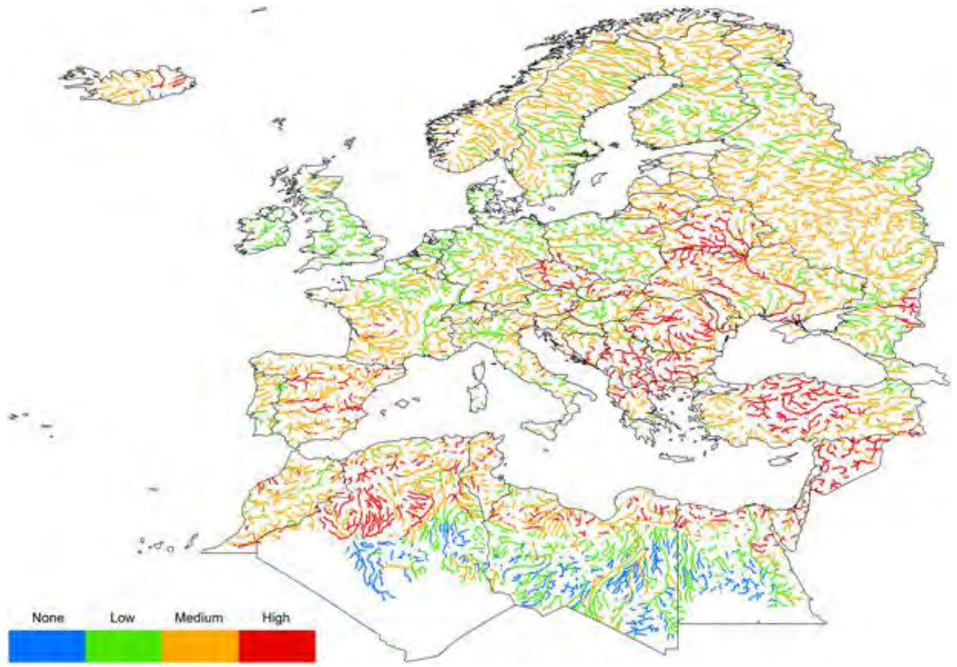
Percentile-based MFRIs:
Median magnitude; IQR variability
Significantly different from the baseline if absolute difference is > 30%

Mode-based MFRIs (flood timing, minimum flow timing):
Significantly different from the baseline if the absolute difference is > 1 month

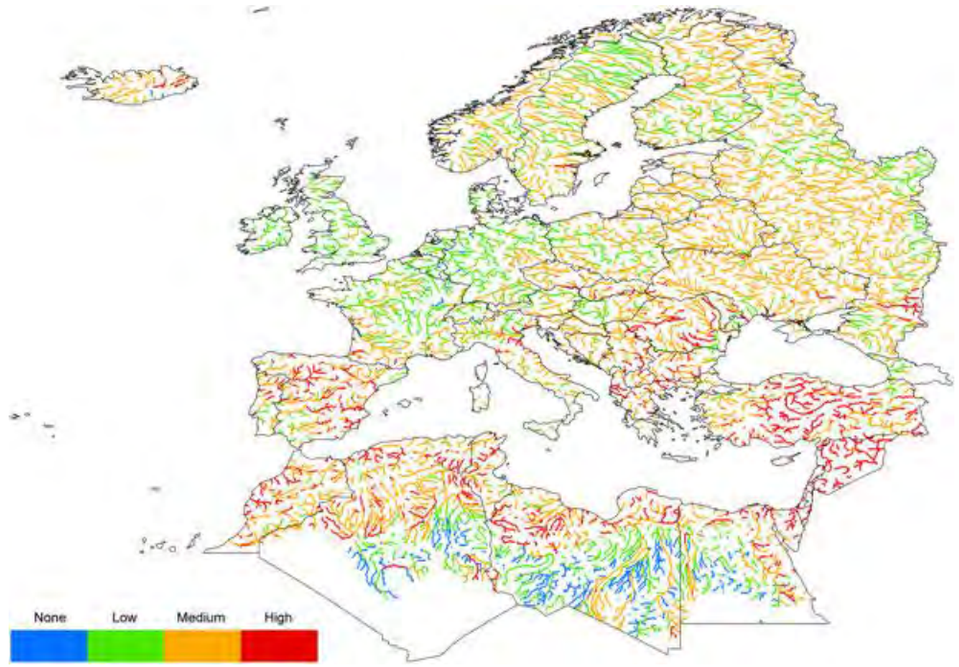
ERFA class:
Blue = no MFRI differs from baseline
Green = 1-5 MFRIs differ from baseline
Amber = 6-10
Red = 11-16

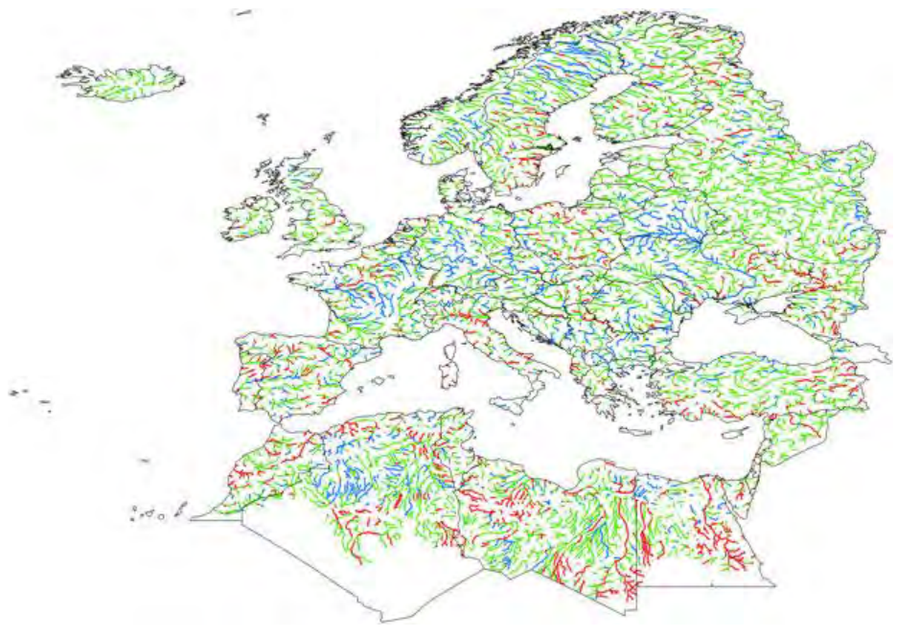
Climate models

ERFA classes for Natural IPCM4 2050s model run



ERFA classes for Natural MIMR 2050s model run





Changes between IPCM4 Natural and MIMR Natural green, same ERFA; blue, MIMR less severe than IPCM4; red, MIMR more severe

Climate models

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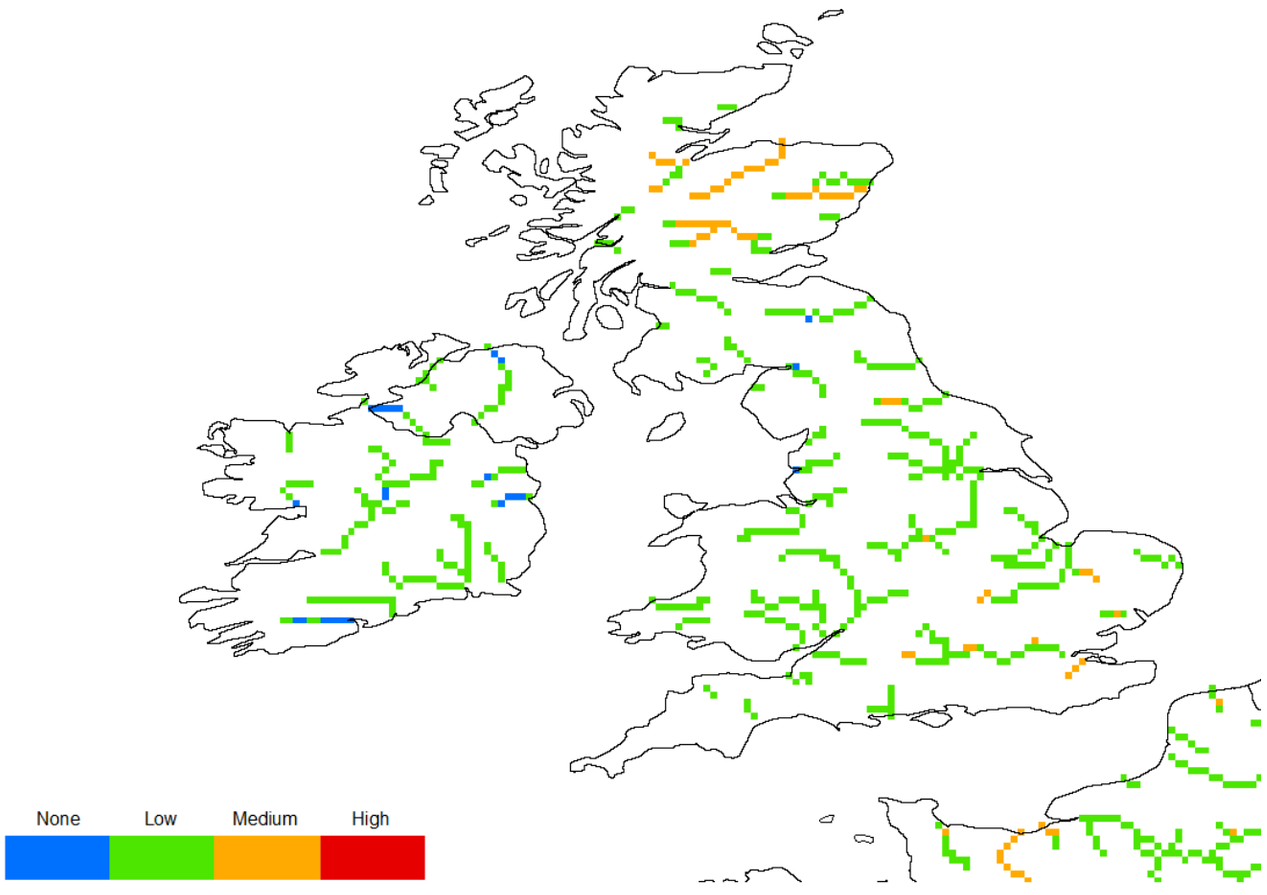
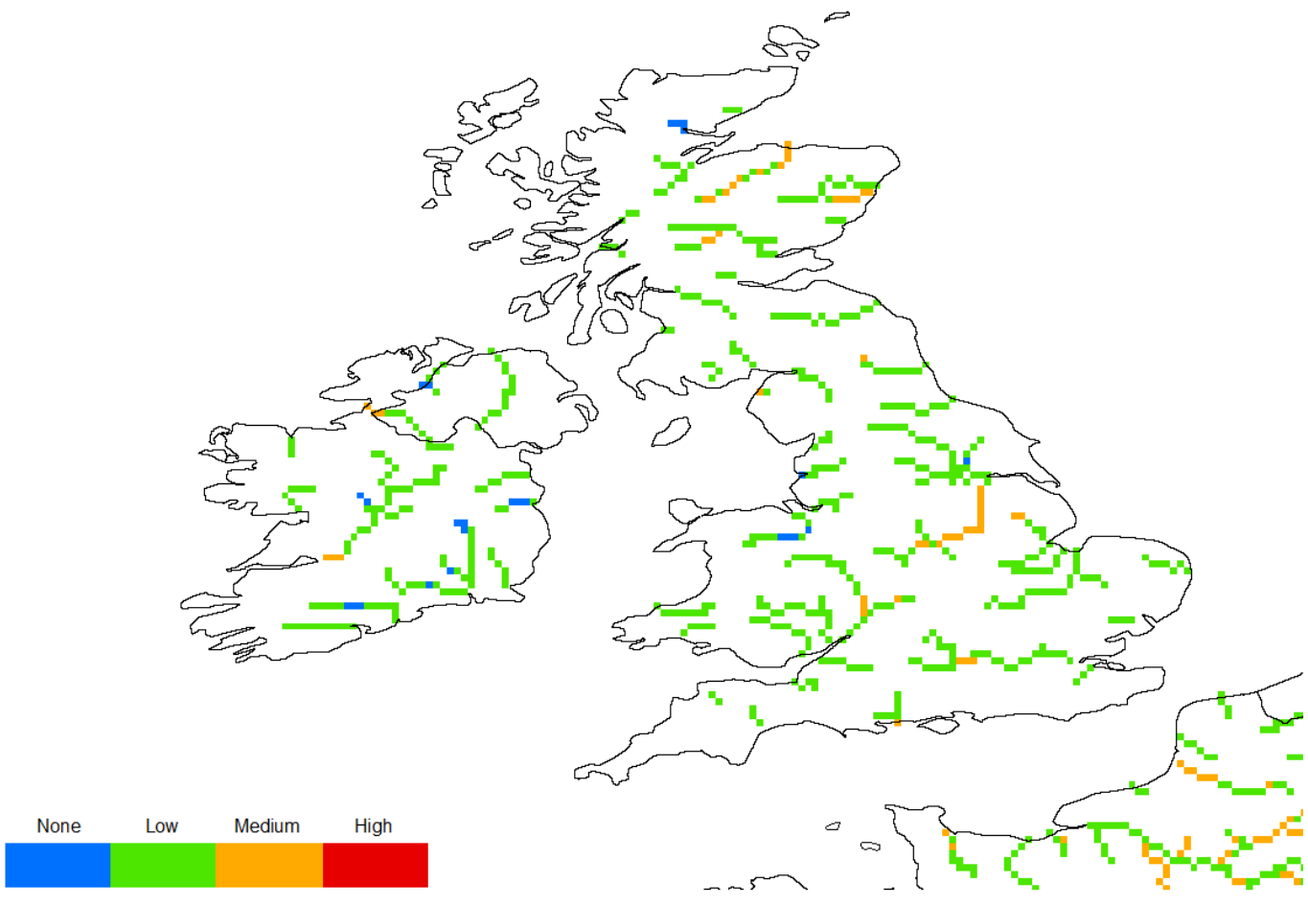
ERFA classes for Natural IPCM4 2050s model run



ERFA classes for Natural MIMR 2050s model run



Socio-economic scenarios

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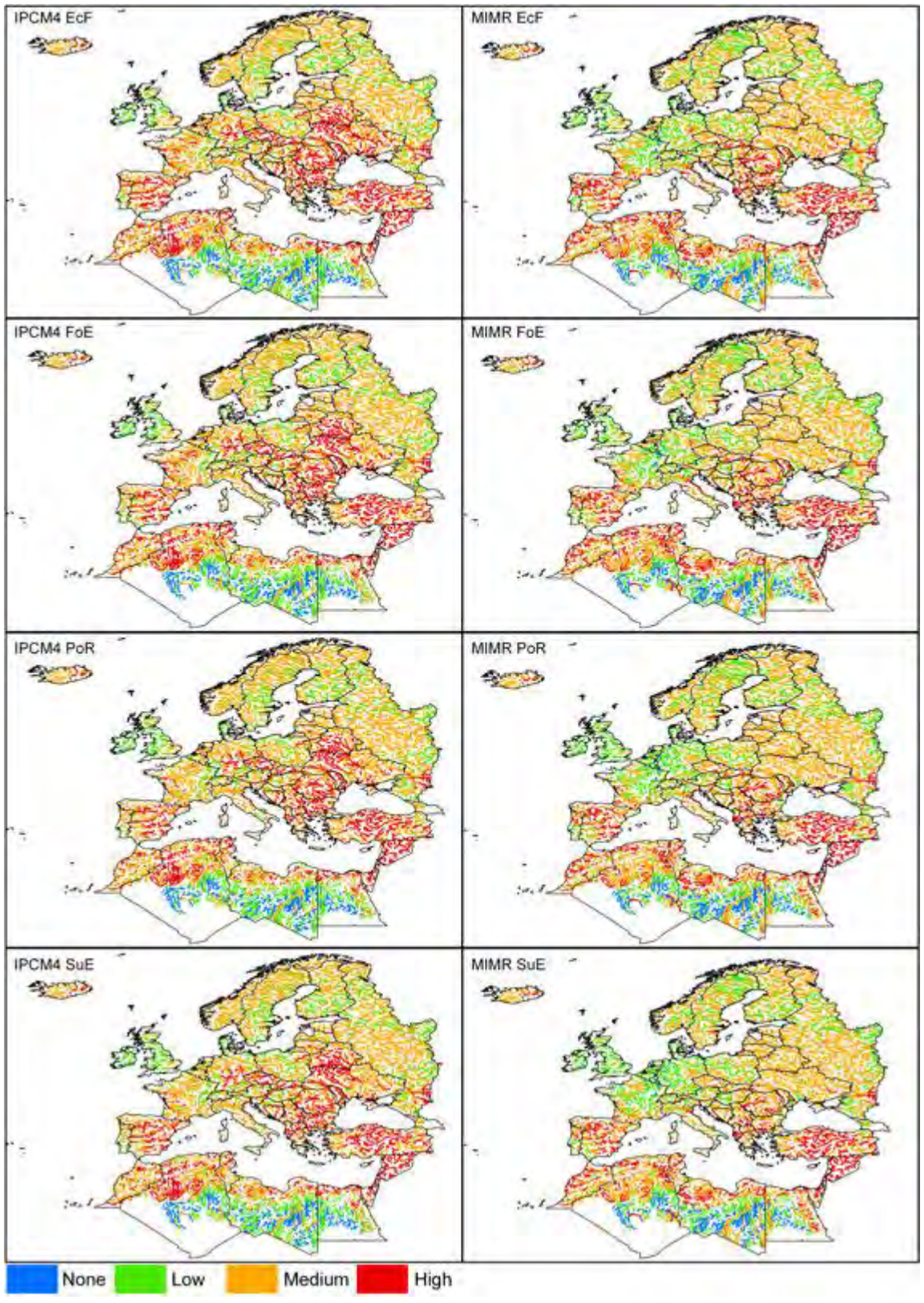
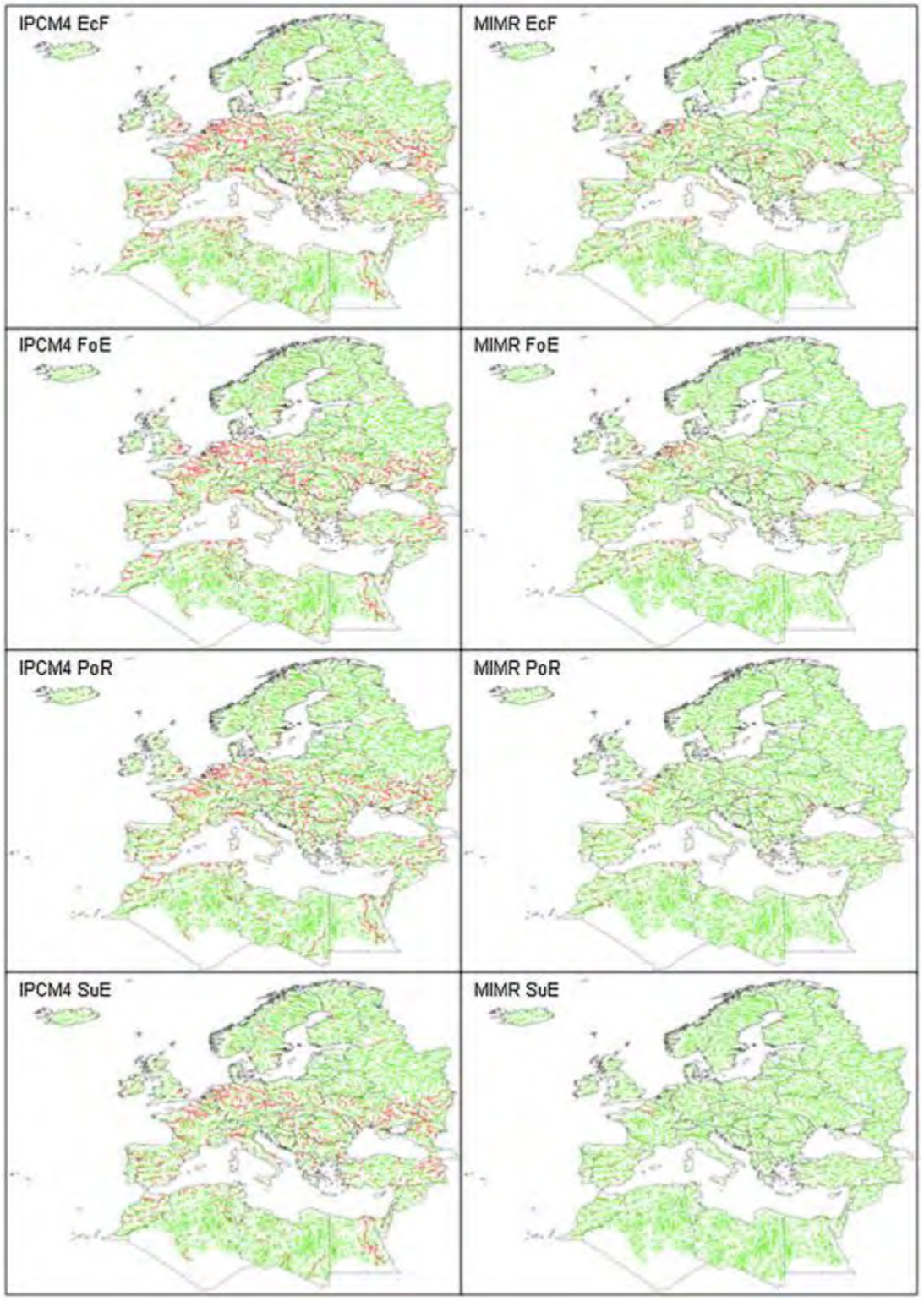
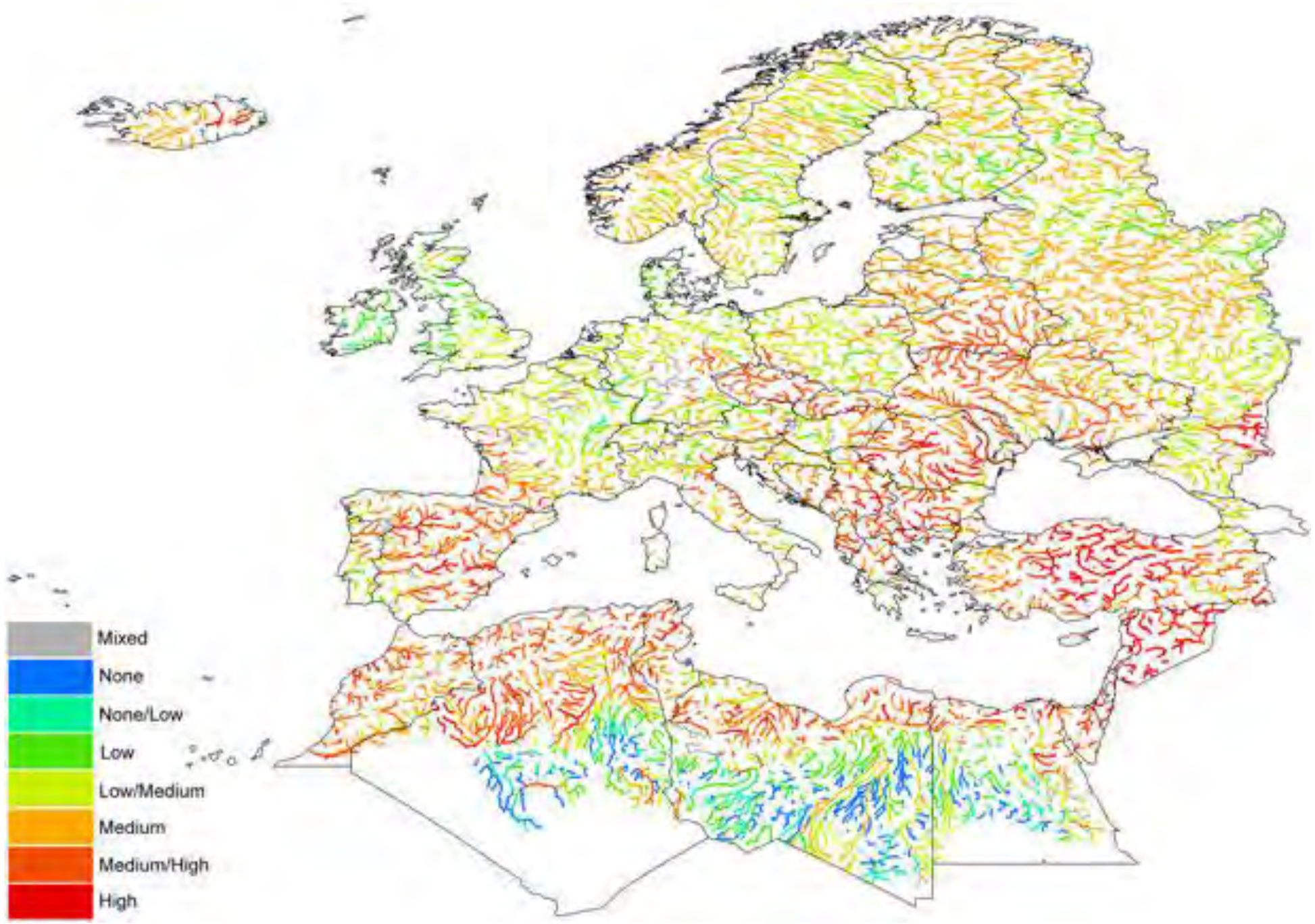


ERFA classes for model runs including abstraction scenarios



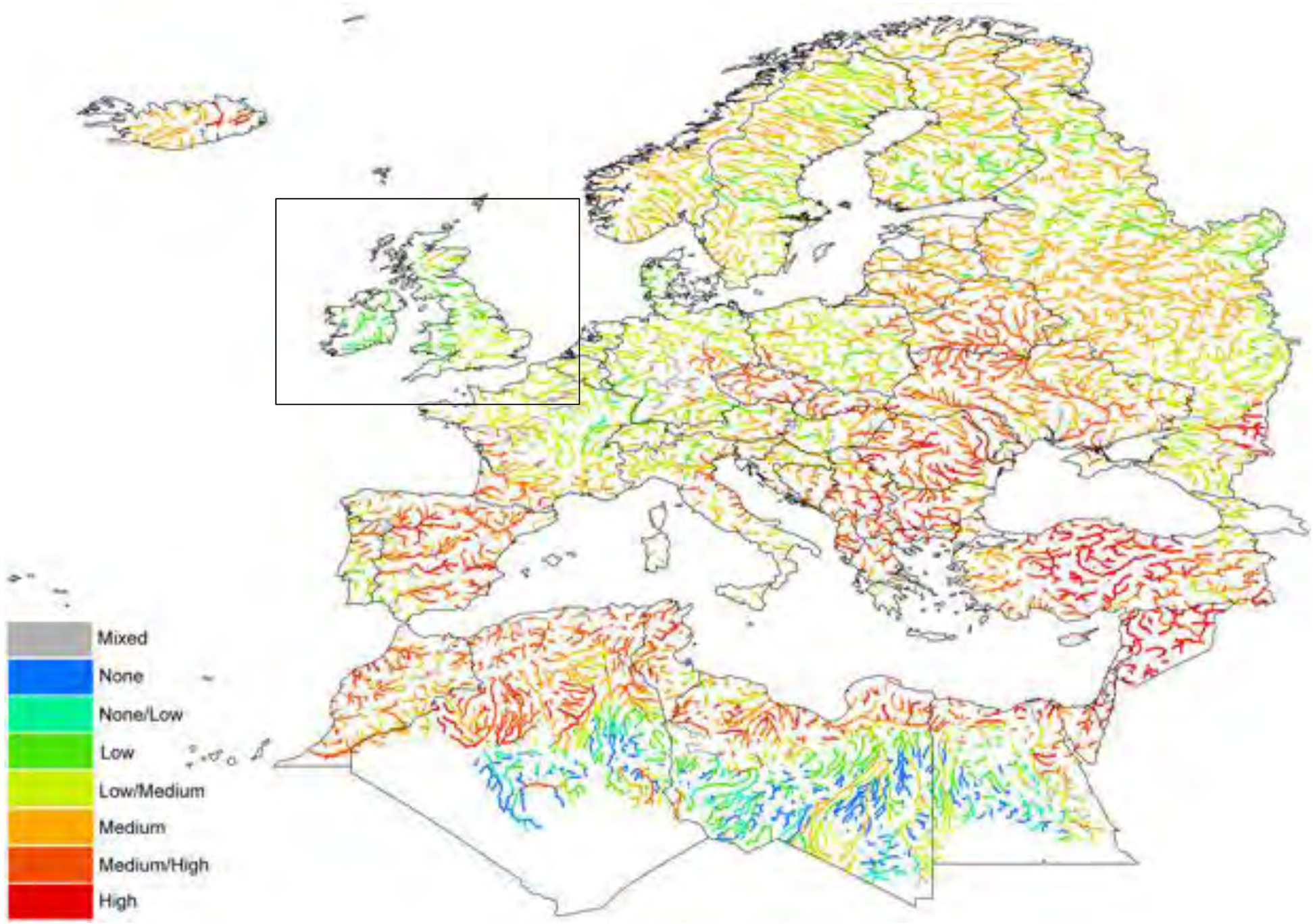
Changes between Natural and abstraction scenarios

Overall pattern



Summary of ERFA classes across all 10 model runs

Overall pattern



Summary of ERFA classes across all 10 model runs

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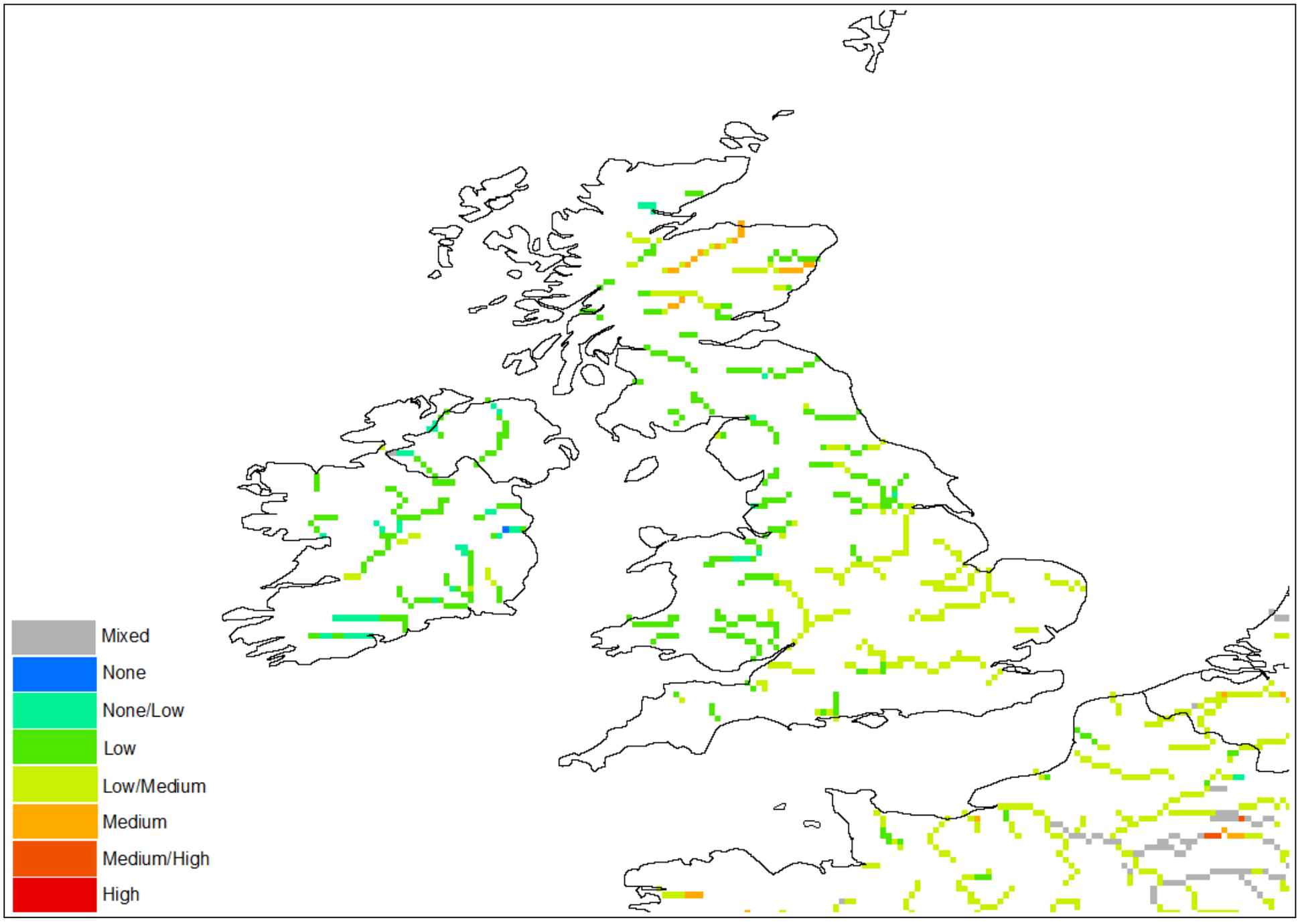

Summary of ERFA classes across all 10 model runs

Concluding remarks

- Two-thirds of the European rivers are at medium or high ecological risk by 2050s.

- UK is in region of low/medium risk (Western and Eastern Europe)

- All model runs yield very consistent patterns in terms of breakdowns of risk classes; the main difference relates to the geographical location of the risks

- Patterns are primarily driven by climate; abstraction scenarios are secondary drivers

- These flow alterations could manifest as changes to species and communities, and loss of current ecosystem functions and services

Laizé CLR; Acreman MC; Schneider C; Dunbar MJ; Houghton-Carr HA; Florke M; Hannah DM. 2013 Projected flow alteration and ecological risk for pan-European rivers. *River Research and Applications*. 10.1002/rra.2645