



**THE AFFORDABILITY OF FLOOD RISK PROPERTY-LEVEL
ADAPTATION MEASURES**

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PROPERTY-LEVEL ADAPTATION

Part one of affordability, is it a worthwhile investment

WHAT CAN PEOPLE DO?

Dry flood-proofing



Wet flood-proofing



IS IT EFFECTIVE?

Table 1 Damage-reducing effects of precautionary measures undertaken by private households on the building level

Measure	Reduction	Source
Wet proofing		
Flood-adapted use	46–48 %, 30–40 %	Kreibich et al. 2005a; ICPR 2002
Flood-adapted interior fitting	53 %, 15–35 %, 35–45 %	Kreibich et al. 2005a; ICPR 2002; DEFRA 2008
Installation of heating and electrical utilities in higher storeys	36 %	Kreibich et al. 2005a
Avoidance of contamination	35–52 %, >50 %	Kreibich et al. 2005a; ICPR 2002
Dry proofing		
Temporary resistance, e.g. mobile water barriers	29 %, 60–80 %, 50 %	Kreibich et al. 2005a; ICPR 2002; DEFRA 2008
Flood-adapted building structure, e.g. cellar sealing, permanent flood proof doors and windows	24 %, 10–85 %, 65–84 %	Kreibich et al. 2005a; ICPR 2002; DEFRA 2008
Building without cellar	22–24 %	Kreibich et al. 2005a

[35%,50%]

[24%,60%]

Kreibich et al. (2015)

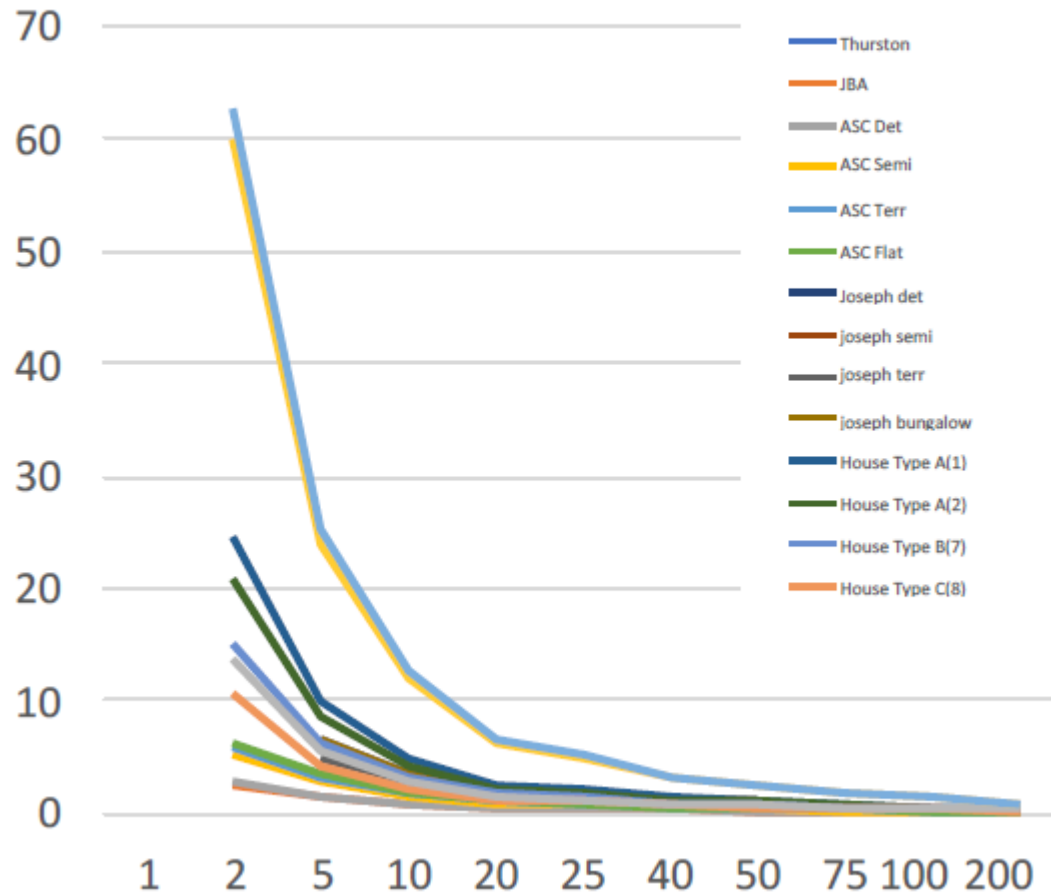


IS IT COST-EFFECTIVE AND...

Wet proofing

Figure 16: Benefit cost ratio curves (flood resilience packages) by return period

Dry proofing



A2
 -Terraced
 Area: 37m²
 Package
 - plaster
 - door
 - door and timber door
 - ceramic tiles to floor
 - for internal doors
 - cabinet doors
 - on return valve
£7,420
Comparison: £5,530
Repairability: £1,890

C8
 -Terraced
 Area: 72m²
 Package
 - and sacrificial gypsum (horizontal)
 - on
 - for
 - doors with UPVC
 - s and ceramic tiles to floor
 - for internal doors
 - cabinet doors
 - on return valve
£12,540
Comparison: £7,770
Repairability: £4,770
Substrate: £3,230

Lamond et al. (2018)

...ARE THEY AFFORDABLE?

Table 7: Summary of flood repairable packages from Lamond et al. (2016b)

<p>Package Number: A1 House Type 1: Semi-detached Net Internal floor area: 49m²</p> <p>Repairable Package Salt resistance added to lime plaster Retain timber floor and door Removable carpets and vinyl flooring Rising butt hinges for internal doors Removable kitchen cabinet doors Acrylic bath panel and wall mounted vanity unit Raised sockets + Non return valve</p> <p>Cost of package: £11,420 Like for like comparison: £8,950 Additional cost of reparability: £2,470</p>	<p>Package Number: A2 House Type 2: Mid-Terraced Net Internal floor area: 37m²</p> <p>Repairable Package Sand and cement render Closed cell insulation Retain concrete floor and timber door Quarry tiles and ceramic tiles to floor Rising butt hinges for internal doors Removable kitchen cabinet doors Raised sockets + Non return valve</p> <p>Cost of package: £7,420 Like for like comparison: £5,530 Additional cost of reparability: £1,890</p>
<p>Package Number: B7 House Type 7: Semi-detached Net Internal floor area: 48m²</p> <p>Repairable Package Water resistant wall boards Closed cell insulation Retain timber floor Replace door with UPVC Ceramic tiles to floor Rising butt hinges for internal doors Removable kitchen cabinet doors Raised sockets + Non return valve</p> <p>Cost of package: £10,930 Like for like comparison: £7,410 Additional cost of reparability: £3,520</p>	<p>Package Number: C8 House Type 8: Mid-Terraced Net Internal floor area: 72m²</p> <p>Repairable Package Cavity membrane and sacrificial gypsum (horizontal) Closed cell insulation Retain concrete floor Replace external doors with UPVC Removable carpets and ceramic tiles to floor Rising butt hinges for internal doors Removable kitchen cabinet doors Raised sockets + Non return valve</p> <p>Cost of package: £12,540 Like for like comparison: £7,770 Additional cost of reparability: £4,770 Cost without membrane: £3,230</p>

- Affordability is a common policy objective for flood risk management or climate change adaptation...
- ...however its subjective nature means it is difficult to measure.
- But we need to!
 - But still has kinks





AFFORDABILITY DEFINITIONS

...the subjective part

WHAT IS AFFORDABILITY?

- That an expenditure doesn't overly burden a person's budget
 - Still subjective
- Some proposed definitions (from within flooding)
 - Doesn't cost more than X% of annual income (expenditure)
 - 5% of disposable income, following Kousky and Kunreuther (2014)
 - Doesn't reduce a person's disposal income to a level lower than the poverty line (residual income)
 - 60% of national median disposable income



STILL A BIT MORE WORK NEEDED

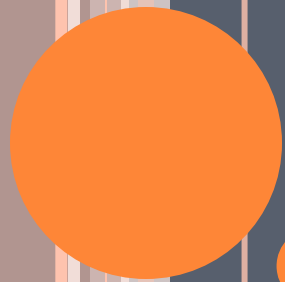
Purchase affordability

- Can we afford it all in one go
 - Income + savings
- Assumes, in essence, that there are no other cost spreading mechanisms

Payment affordability

- Can we afford payments if the cost is spread overtime
 - Like a loan
 - 20 years
 - Interest rate = rate of inflation
- Can be from a bank, charity, govt. or a combination



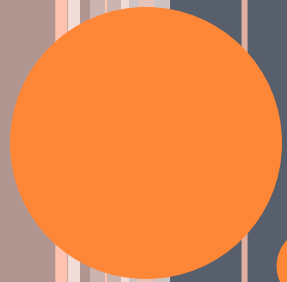


COST ESTIMATES

ONE TABLE OF COSTS TO RULE THEM ALL

	Flood-proofing adaptation costs				
	(scheme 1) Average Cost per building (Aerts, 2018)	(scheme 2) Adjusted average costs per building	(scheme 3) Cost per square/linear meter on European costs (~1m)	(scheme 4) Cost per square/line ar meter on American costs (~1m) based on Aerts et al. 2013	Size of dwelling (across the European Union and income groups)
Wet flood-proofing	€2,100 to €20,600	€1,700 to €23,000	€104 to €332 per m ²	€33 per m ²	96m ²
Dry flood-proofing	€7,900 to €20,200	€6,300 to €23,000	€423 and €695 per linear meter	€285 per linear meter	39m perimeter

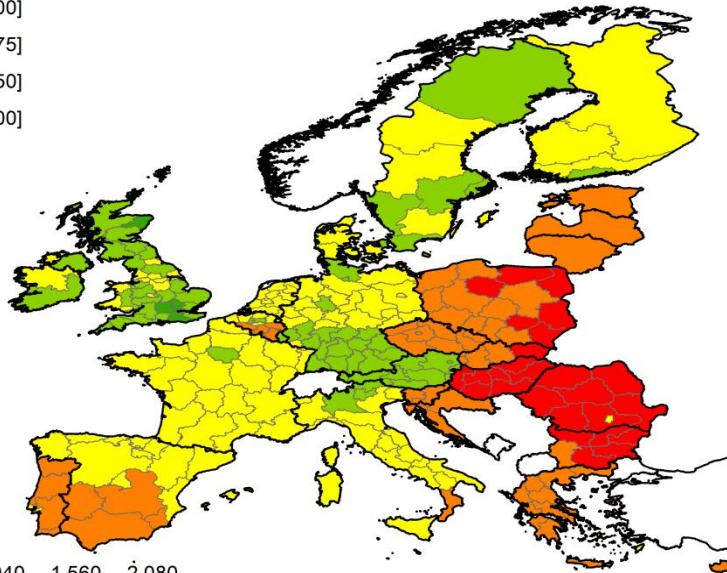
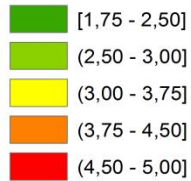




RESULTS

THE HIGHEST QUINTILE FOR WHICH FLOOD-PROOFING IS FOUND PURCHASE UNAFFORDABLE, ON AVERAGE ACROSS COST SCHEMES

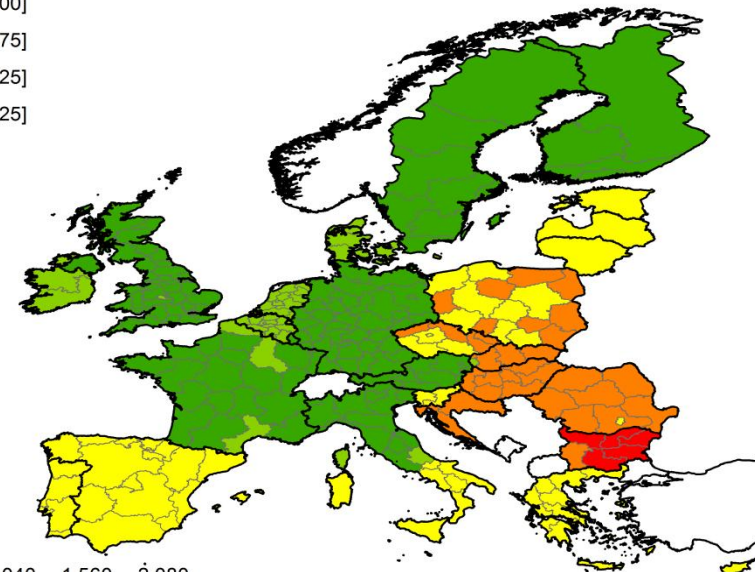
A) Average Quintile in which dry flood-proofing is found to be unaffordable



0 260 520 1.040 1.560 2.080
Kilometers

Legend

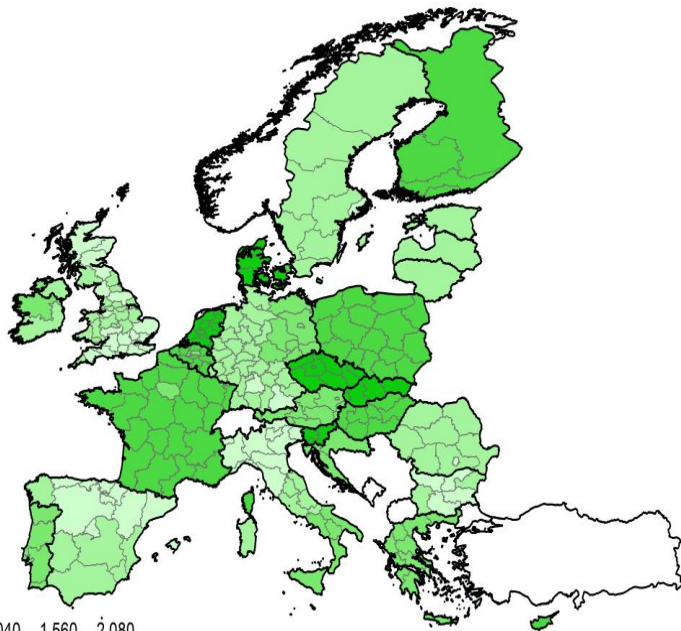
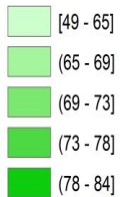
B) Highest average quintile finding wet flood-proofing unaffordable



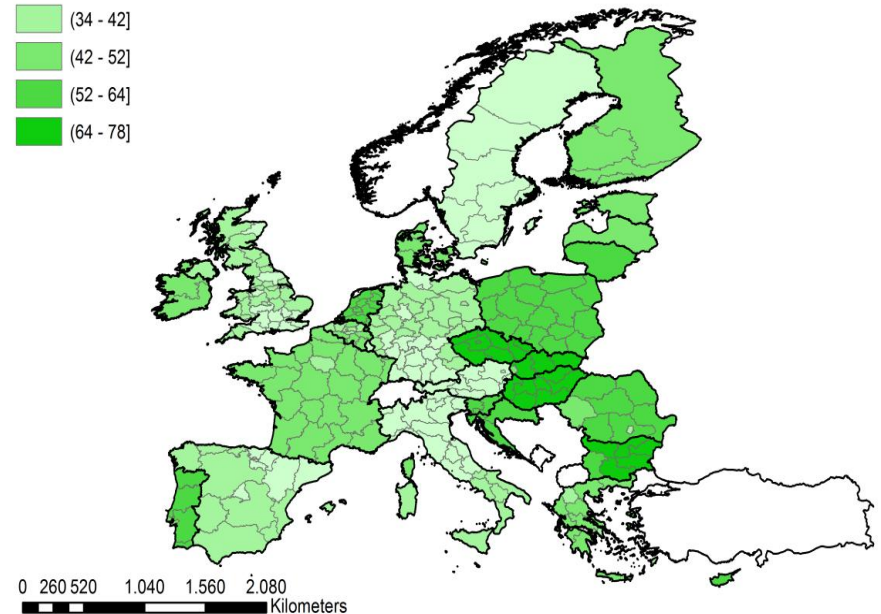
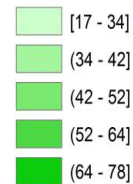
0 260 520 1.040 1.560 2.080
Kilometers

PERCENTAGE CHANGE IN THE RATE OF UNAFFORDABILITY DUE TO LOW COST LOANS UNDER THE RESIDUAL INCOME DEFINITION

A) Percentage decrease in the rate of unaffordability (percentile) for dry flood-proofing



B) Percentage decrease in the rate of unaffordability (percentile) for wet flood-proofing



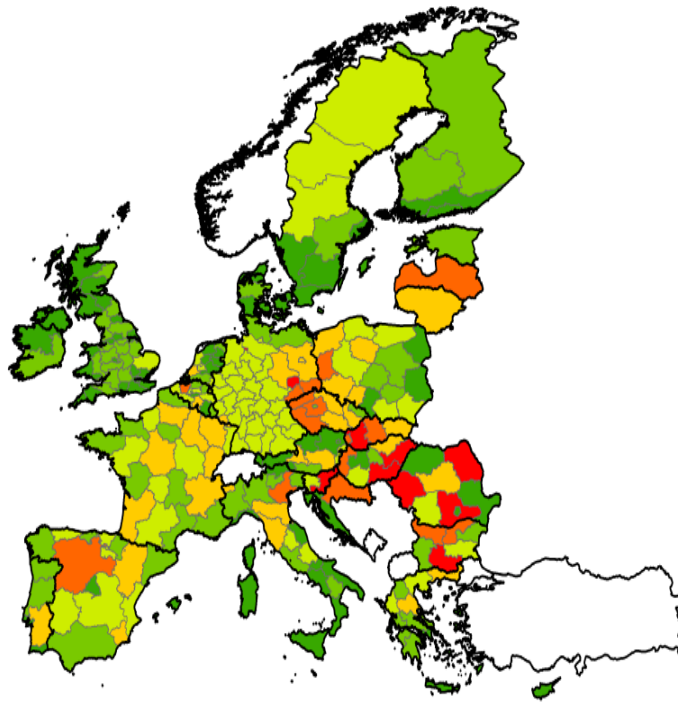
FLOOD IMPACT INDICATORS AND AREAS OF OVERLAP WITH UNAFFORDABILITY

$$VHI = \overline{RU} \frac{EAP}{P}$$

$$REP = \overline{RU} \frac{EAD}{\bar{I}}$$

N
Legend

C) VHI

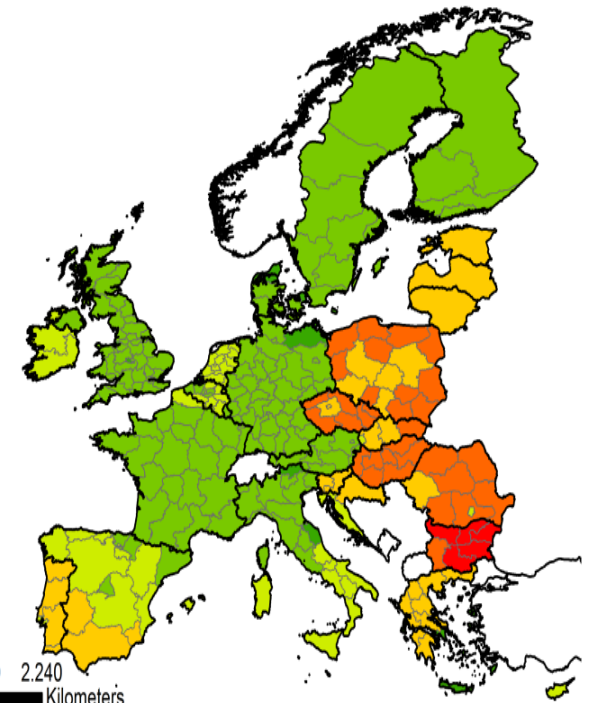


0 280 560 1.120 1.680 2.240
Kilometers

N

Legend

D) REP



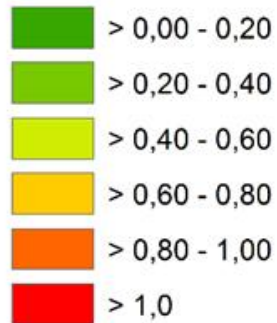
0 280 560 1.120 1.680 2.240
Kilometers

COMBINED SCORE OF VHI AND REP UNDER PURCHASE AFFORDABILITY

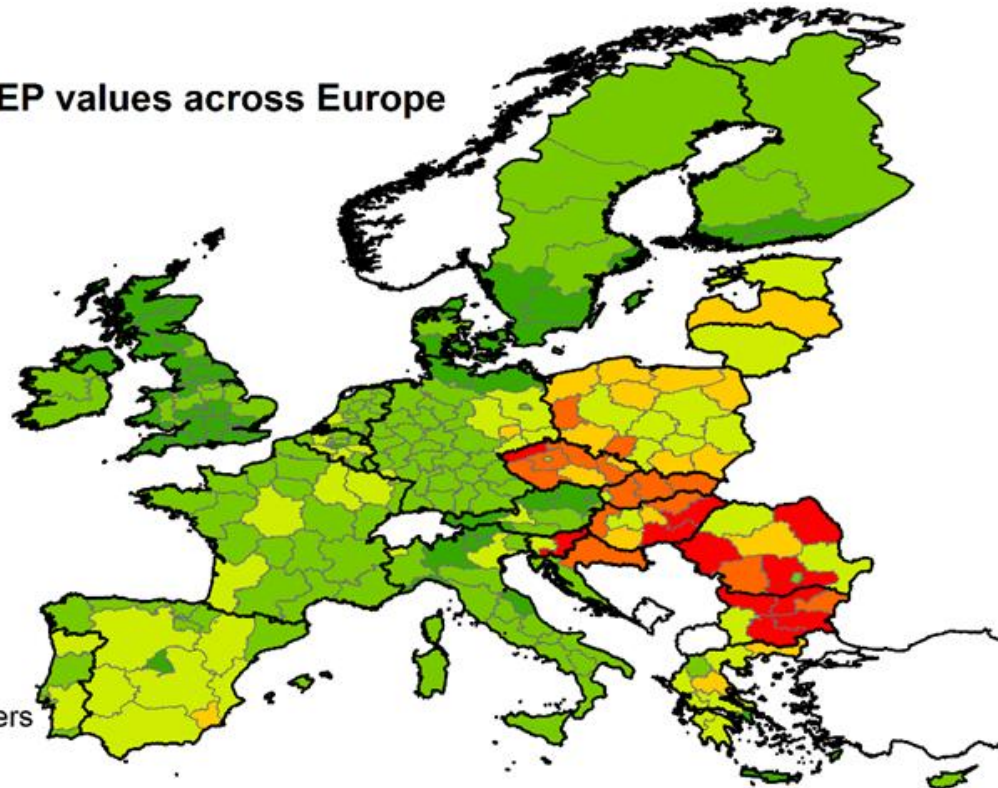


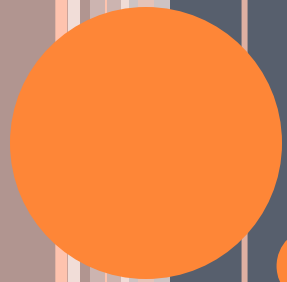
Legend

Sum of normalised VHI and REP values across Europe
(Residual Income)



0 280 560 1.120 1.680 2.240
Kilometers



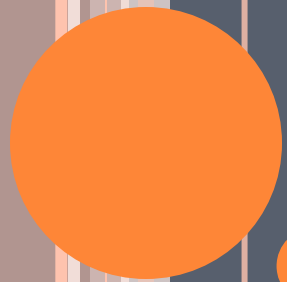


CONCLUSIONS

TAKE HOME MESSAGES

- We seem to assume that people have mechanisms, or resources, in place to buy these measures
- If we don't then we can have high rates of unaffordability
- Introducing this idea of social loans might help
 - Can be a partnership across sectors
- Still some issues to work out with how a social loan scheme might work
 - Moral hazard
 - Social transfers if people don't pay the loan back?





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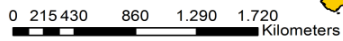
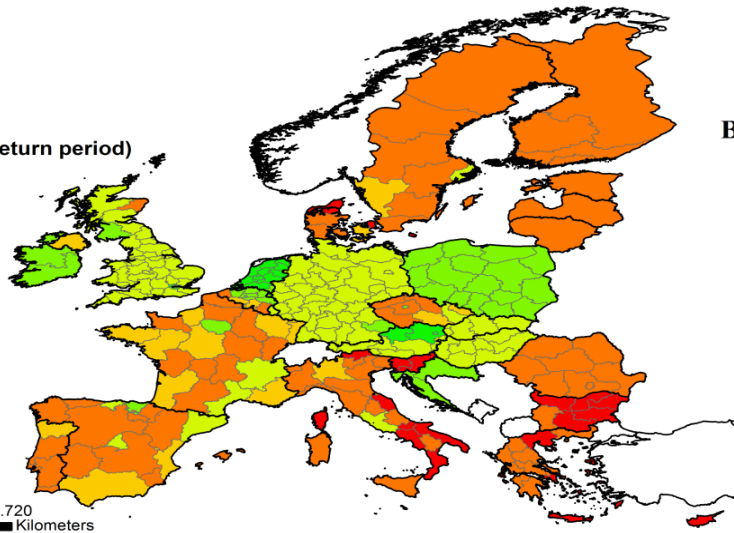
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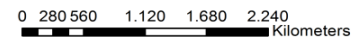
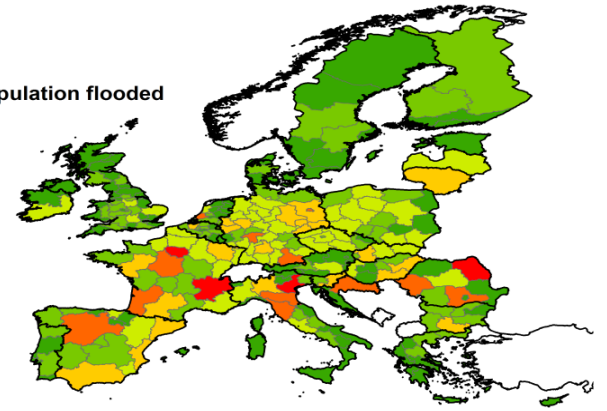
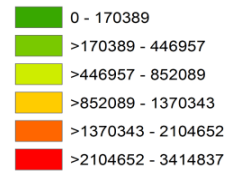
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A) Protection standards (return period)



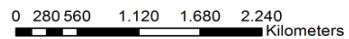
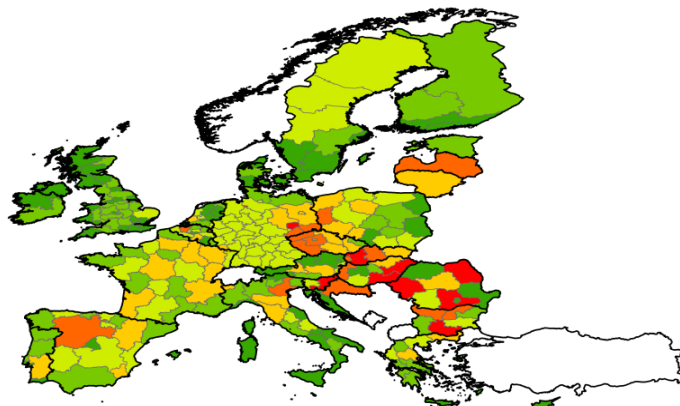
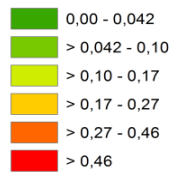
Legend

B) Annual expected population flooded



Legend

C) VHI



Legend

D) REP

