A Topography of Climate Change Research

Max Callaghan

with Jan Minx, Piers Forster

January 27, 2019

Figure: Portrait of map-makers, Gerardus Mercator and Jodocus Hondius (Jodocus Hondius) source: Wikipedia Commons

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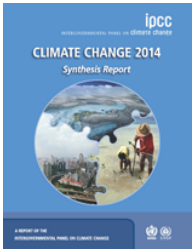

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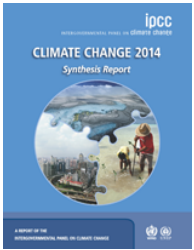

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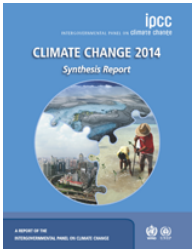

- The IPCC has a *cartographic* role at the science policy interface (Edenhofer and Minx, 2014; Edenhofer and Kowarsch, 2015)

- A topography is a description of a landscape
- Topics (from the Greek "topos", place) can describe the features of a body of text

Outline

1. Motivation
2. Methods
3. Results

1 Motivation

2 Methods

3 Results

Context - Big Literature

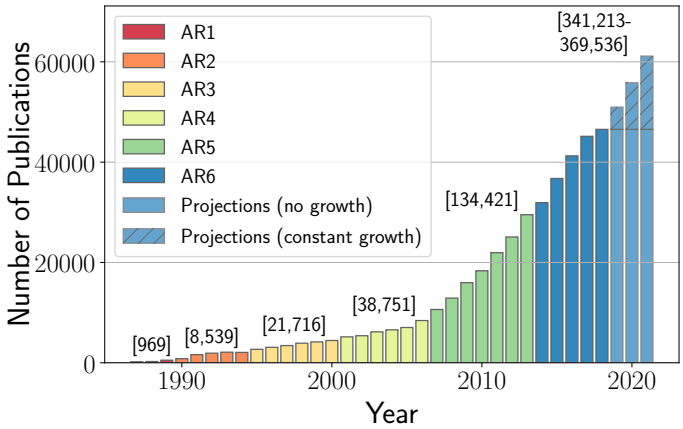

Figure: Articles on climate change in the Web of Science

A challenge for

- Global environmental assessments
- Our understanding of global environmental assessments
- Evidence synthesis more generally

The IPCC in the age of Big Literature

- We entrust the IPCC with providing a *comprehensive* and *transparent* assessment of the literature

The IPCC in the age of Big Literature

- We entrust the IPCC with providing a *comprehensive* and *transparent* assessment of the literature
- Although IPCC reports cite ever greater numbers of papers, this number decreases in proportion to the number of papers in literature

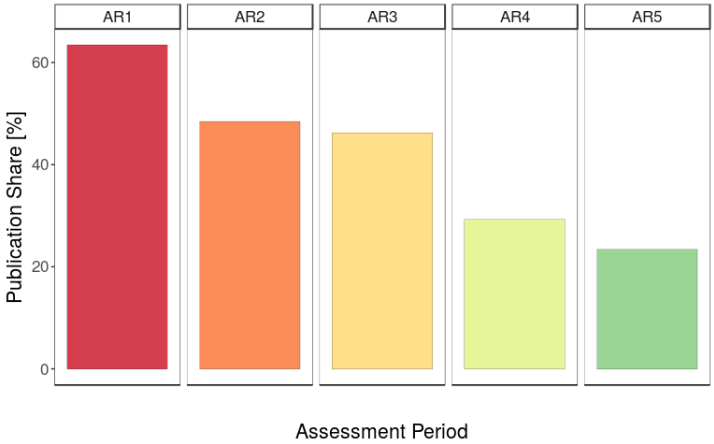

Figure: (Minx et al., 2017)

What Do We Know About the IPCC?

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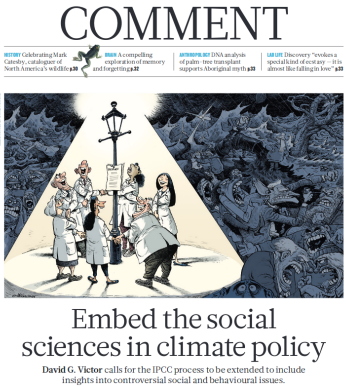
COMMENT

HISTORY Celebrating Mark Catesby, cataloguer of North America's wildlife p30 | VISION A compelling exploration of memory and forgetting p32 | ANTHROPOLOGY DNA analysis of palm-tree transplant supports Aboriginal myth p33 | LAB LIFE Discovery "evokes a special kind of ecstasy — it is almost like falling in love" p33

Embed the social sciences in climate policy

David G. Victor calls for the IPCC process to be extended to include insights into controversial social and behavioural issues.

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- The evidence is simply the relative shares of the different disciplines in IPCC citations


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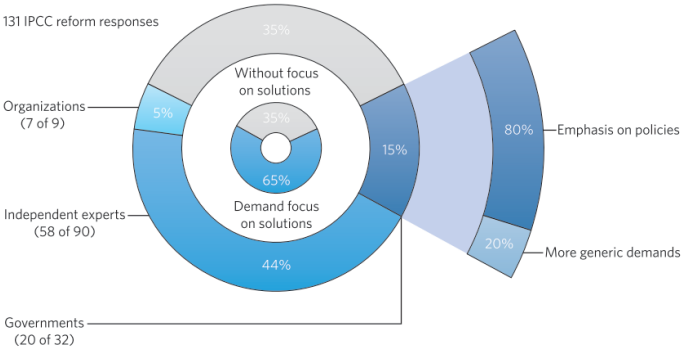

Figure: (Kowarsch et al., 2017)

- Demand for solutions is increasing

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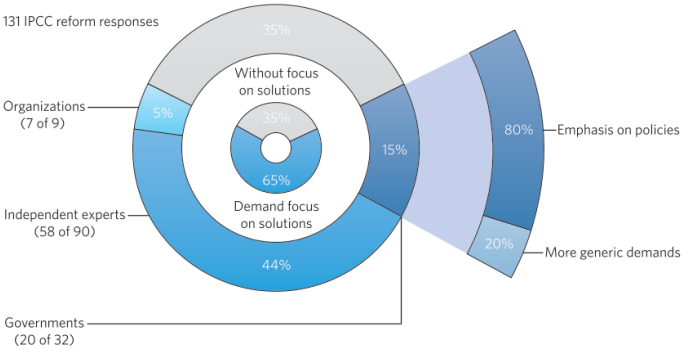

Figure: (Kowarsch et al., 2017)

- Demand for solutions is increasing
- We know little about the supply of solutions in the literature

1 Motivation

2 Methods

3 Results

Investigating bibliometric and text data

To understand the representation of social science and solutions relevant knowledge in IPCC reports, we look at journal classification and document abstracts

Data:
400,000 papers on climate change from the Web of Science (query following Grieneisen and Zhang (2011)), matched with 70,000 IPCC citations (Using Doc2Vec)

Topic modelling:
We use topic modelling (with NMF (Lee and Seung, 1999)) to understand the thematic content of papers

Topographic mapping:
We project the documents' topical locations into 2 dimensions using t-SNE (van der Maaten and Hinton, 2008)

Measuring representation:
We compare the proportions of categories of documents in the whole of the literature with the subset of the literature that is cited by the IPCC

Words, words, words

	AR1	AR2	AR3	AR4	AR5	AR6
Years	1986-1989	1990-1994	1995-2000	2001-2006	2007-2013	2014-
Documents	1,167	8,539	21,716	38,750	134,413	201,606
Unique words	2,000	12,480	23,346	34,637	71,867	94,746
New words	change (560)	oil (287)	downscaling (217)	sres (234)	biochar (1,791)	mmms (313)
	climate (428)	deltac (283)	degreesc (187)	petm (95)	redd (1,113)	cop21 (234)
	co2 (318)	whole (256)	ncep (130)	amf (88)	cmip5 (679)	c3n4 (214)
	climatic (289)	tax (254)	fco (107)	sf5cf3 (86)	cmip3 (587)	sdg (187)
	model (288)	landscape (249)	pfc (98)	clc (81)	mofs (299)	zika (182)
	atmospheric (281)	alternative (243)	otcs (98)	embankment (81)	sdm (297)	ndcs (168)
	effect (280)	availability (242)	dtr (95)	cwd (79)	mof (275)	indc (164)
	global (224)	life (239)	nee (89)	etm (75)	biochars (252)	indcs (134)

Table: Growth in climate change literature

Data from WoS Core Collection, query following Grieneisen and Zhang (2011)

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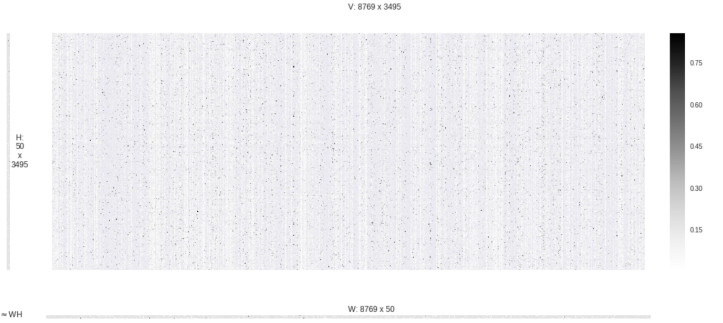
$$V_{i\mu} \approx (WH)_{i\mu} = \sum_{a=1}^{r} W_{ia} H_{a\mu}$$

V is approximated by the product of W and H



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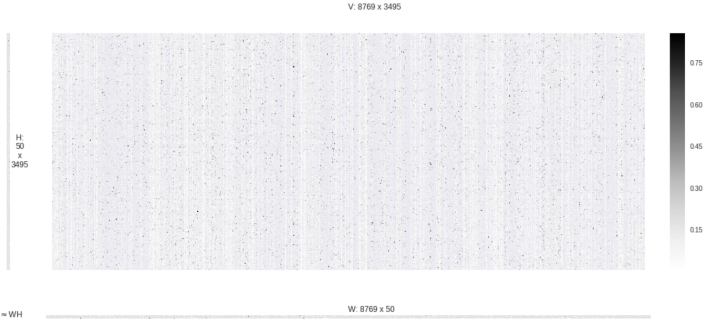

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- A document's topic scores describe its association with each topic

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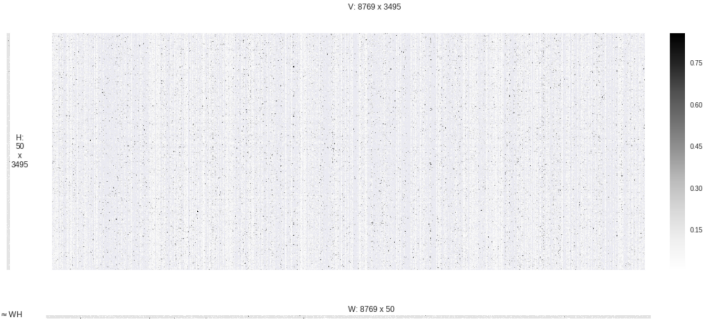
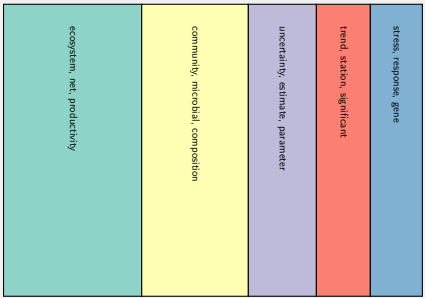
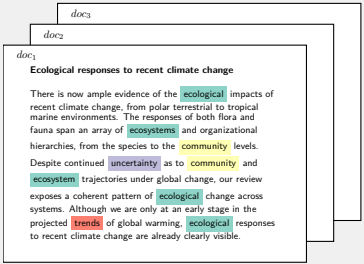


Doc Topic Example





Topic / Doc	ecosystem net productivity	community microbial composition	uncertainty estimate parameter	trend station significant
doc_1	0.022	0.017	0.011	0.009
doc_2	...	...	...	...
doc_3	...	...	...	...

Doc Topic Matrix

×

Term / Topic	ecological	ecosystem	recent	community
ecosystem net productivity	1.08	9.18	0	0
community microbial composition	0.19	0	0	9.76
uncertainty estimate parameter	0	0	0.01	0

Topic Term Matrix

≈

Term / Doc	ecological	ecosystem	recent	community
doc_1	3	2	2	2
doc_2	...	...	...	...
doc_3	...	...	...	...
doc_4	...	...	...	...

Doc Term Matrix

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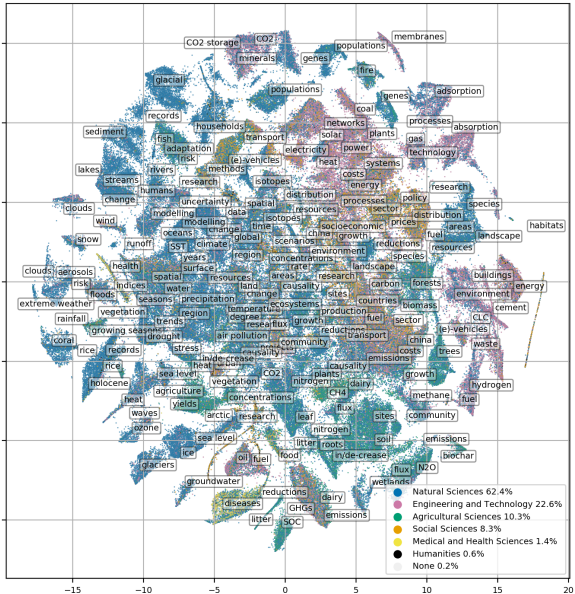

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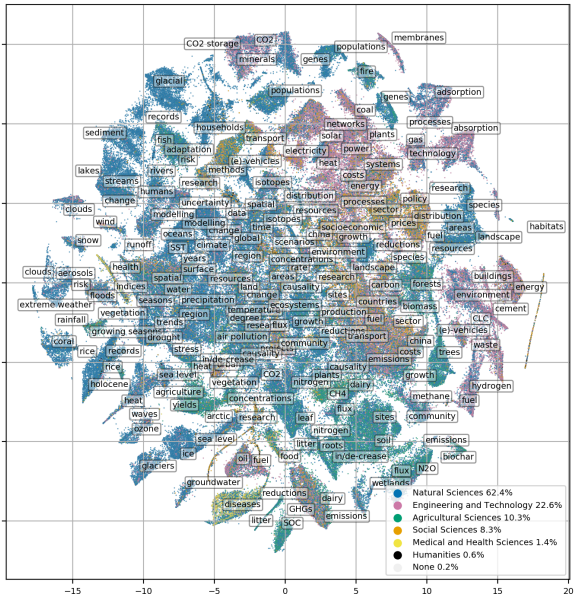

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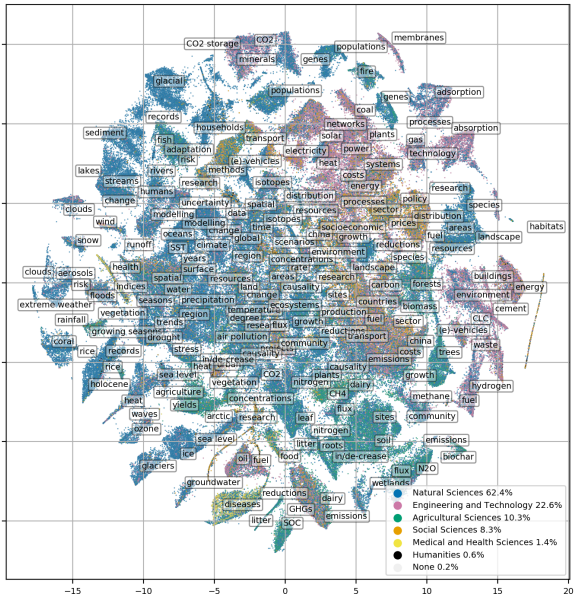

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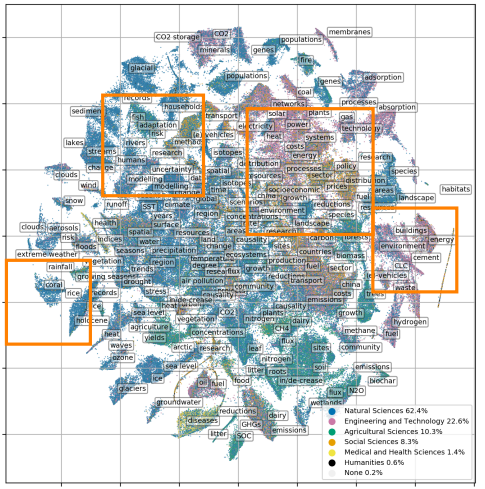
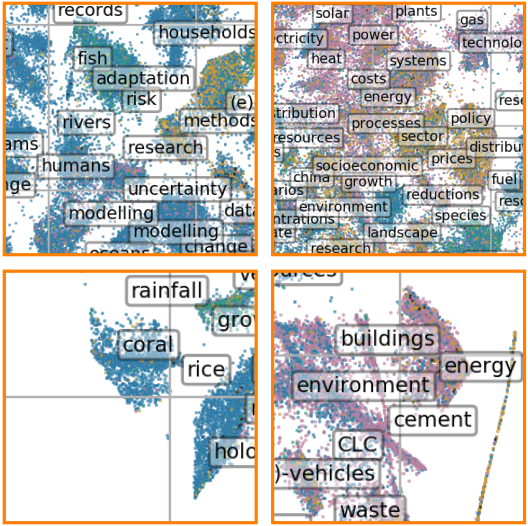
- We can see the preponderance of natural sciences, and the greater or lesser clustering of disciplines in certain topic areas


Natural Sciences 62.4%
Engineering and Technology 22.6%
Agricultural Sciences 10.3%
Social Sciences 8.3%
Medical and Health Sciences 1.4%
Humanities 0.6%
None 0.2%

(a)


records
households
fish
adaptation
risk
rivers
methods
research
humans
uncertainty
modelling
solar
plants
gas
power
heat
systems
costs
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policy
processes
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sector
socioeconomic
prices
growth
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environment
species
landscape
rainfall
coral
rice
buildings
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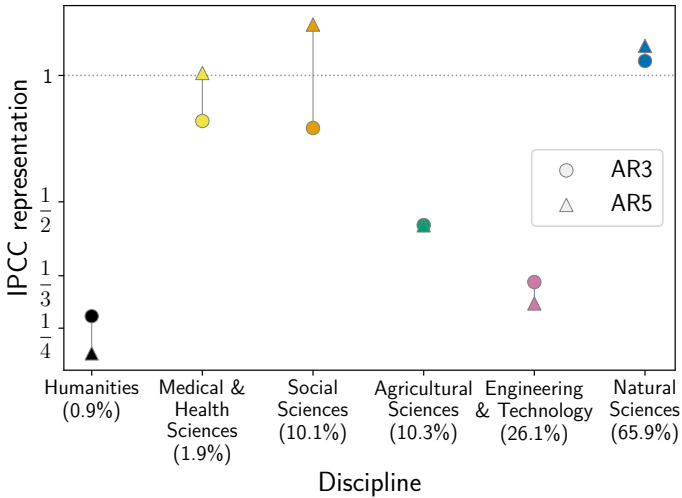
environment
cement
CLC
waste

(b)

The Social Sciences are No Longer Under-Represented in IPCC reports

- The social sciences were under-represented in AR3, but by AR5 are over-represented



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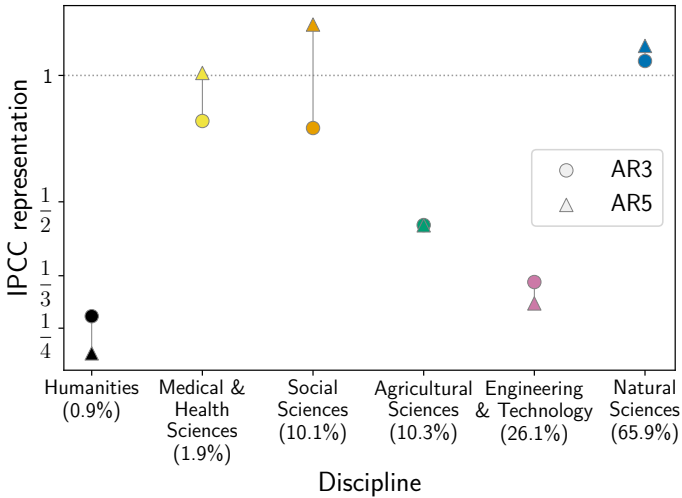

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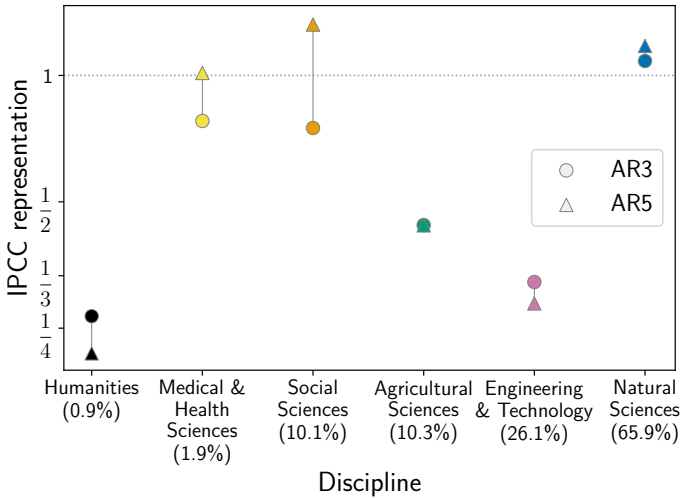
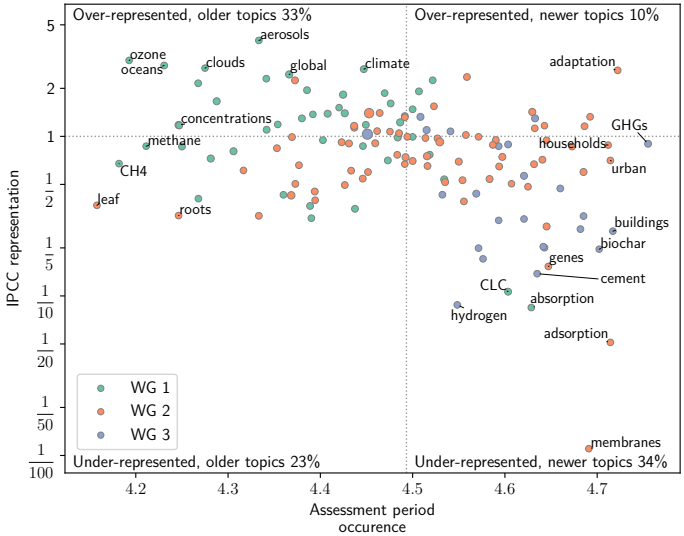


Topics on solutions are newer and under-represented



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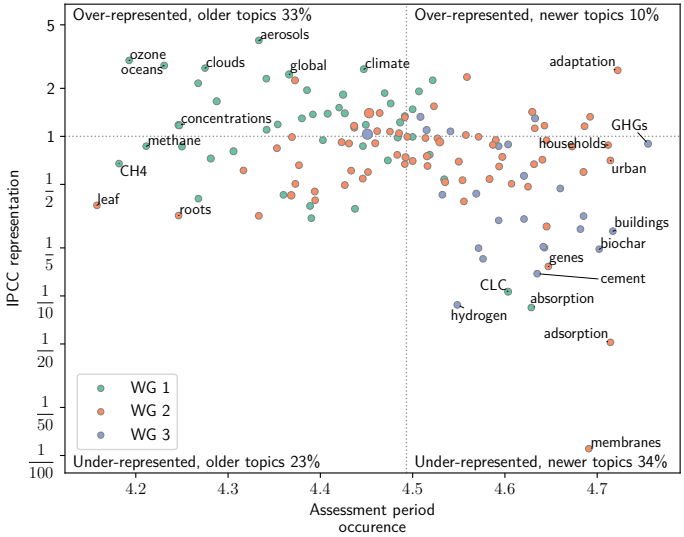

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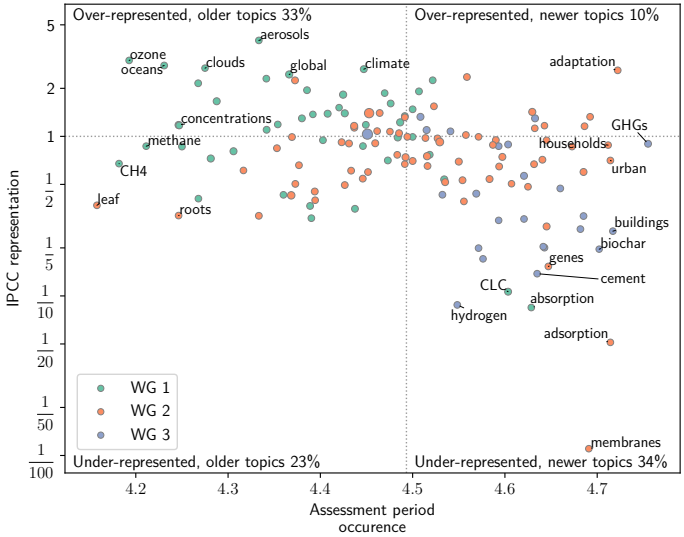

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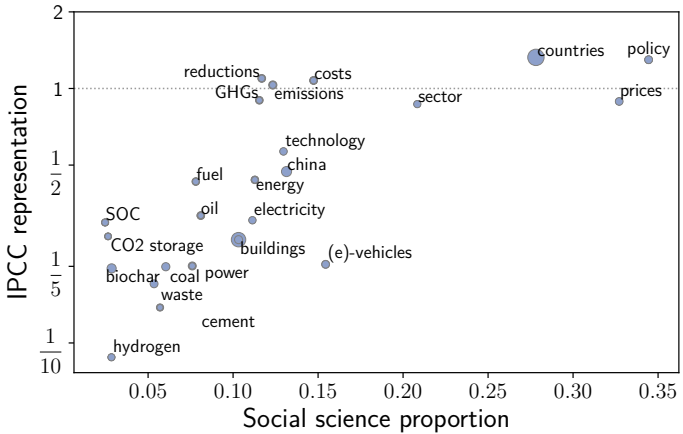
- Newer WGII topics are better covered than newer WGIII topics

WGIII topics with little social science are under-represented



- Technical solutions topics in WGIII contain little social science research and are under-represented

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`callaghan@mcc-berlin.net`

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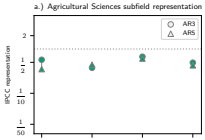
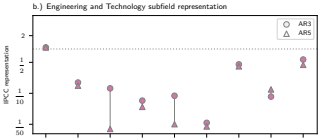
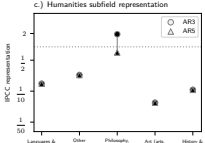
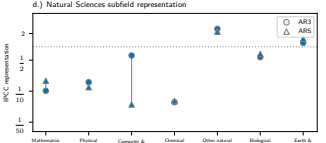
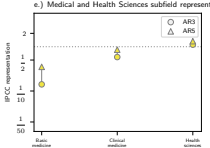
Topic disciplinary entropy and subdiscipline representation

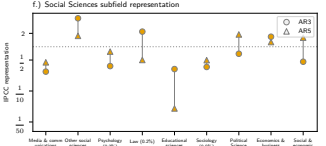




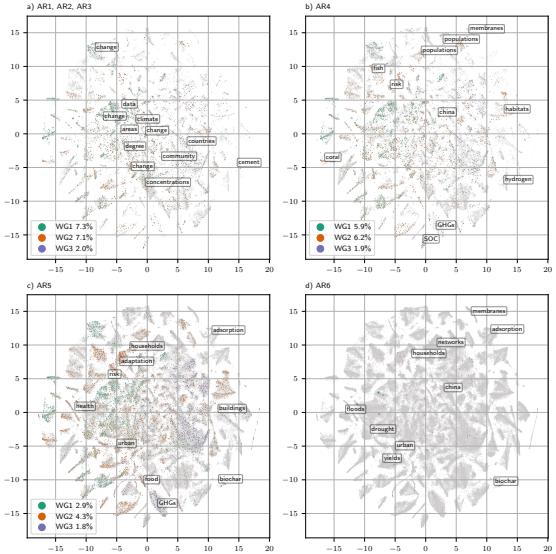




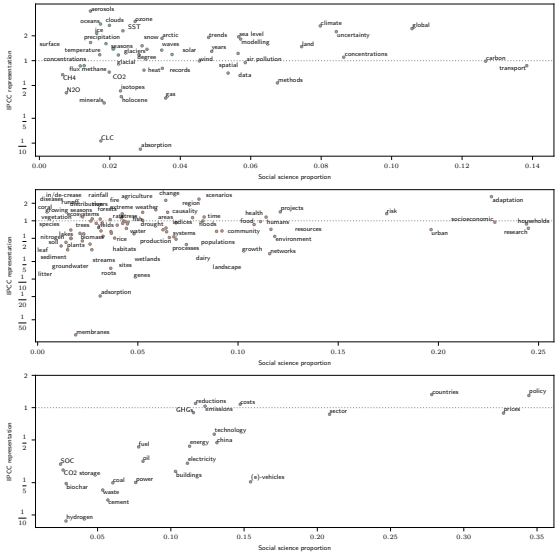




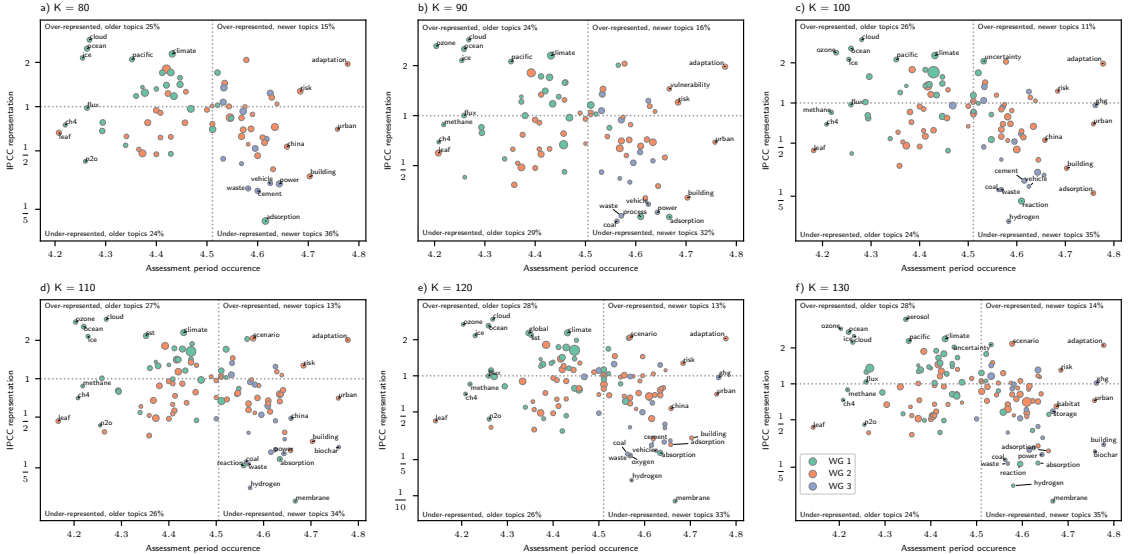
Topic growth



Social sciences and topic representation



n Topics


a) K = 80
Over-represented, older topics 25%
Over-represented, newer topics 15%
Under-represented, older topics 24%
Under-represented, newer topics 36%
b) K = 90
Over-represented, older topics 24%
Over-represented, newer topics 16%
Under-represented, older topics 29%
Under-represented, newer topics 32%
c) K = 100
Over-represented, older topics 26%
Over-represented, newer topics 11%
Under-represented, older topics 24%
Under-represented, newer topics 35%
d) K = 110
Over-represented, older topics 27%
Over-represented, newer topics 13%
Under-represented, older topics 26%
Under-represented, newer topics 34%
e) K = 120
Over-represented, older topics 28%
Over-represented, newer topics 13%
Under-represented, older topics 26%
Under-represented, newer topics 33%
f) K = 130
Over-represented, older topics 28%
Over-represented, newer topics 14%
Under-represented, older topics 24%
Under-represented, newer topics 35%
WG 1
WG 2
WG 3
IPCC representation
Assessment period occurence