A Rapid Computer-assisted Systematic Map of Regional Climate Impacts

MCC

September 23, 2019

Context

Systematic assessments of the evidence on Climate Change like those conducted by the IPCC are vital.

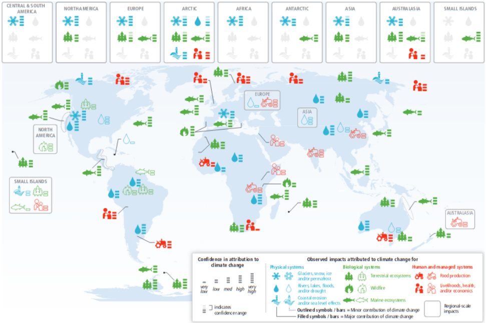

Figure 18-3 | Global patterns of observed climate change impacts reported since AR4. Each filled symbol in the top panels indicates a class of systems for which climate change has played a major role in observed changes in at least one system within that class across the respective region, with the range of confidence in attribution for those region-wide impacts indicated by the bars. Regional-scale impacts where climate change has played a minor role are shown by outlined symbols in a box in the respective region. Sub-regional impacts are indicated with symbols on the map, placed in the approximate area of their occurrence. The impacted area can vary from specific locations to broad areas such as a major river basin. Impacts on physical (blue), biological (green), and human (red) systems are differentiated by color. This map represents a graphical synthesis of Tables 18-5, 18-6, 18-7, 18-8, and 18-9. Absence of climate change impacts from this figure does not imply that such impacts have not occurred.

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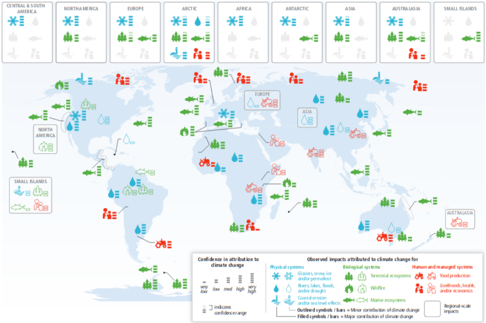

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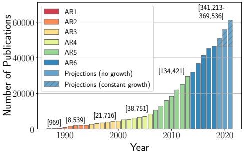

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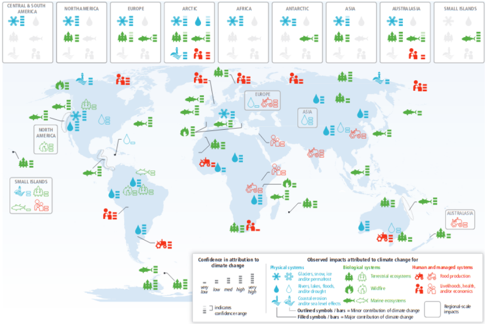

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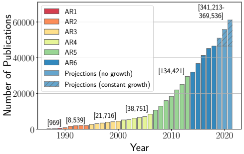

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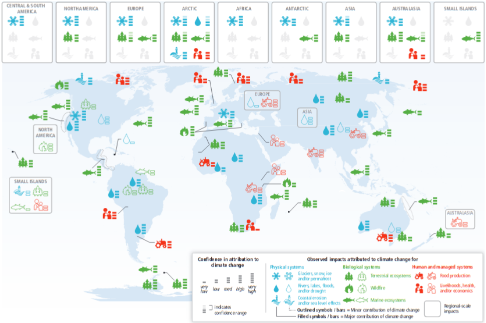

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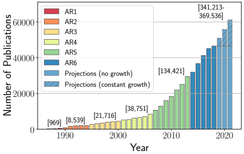

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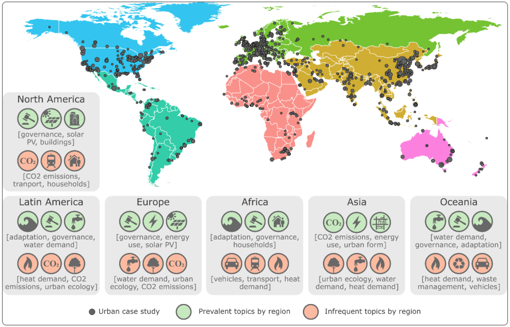
- Machine learning can help

Rapid, Computer-assisted Systematic Mapping



Lamb, W. F., Creutzig, F., Callaghan, M. W., and Minx, J. C. (2018). Learning about urban climate solutions. *Nature Climate Change*, 9(4):279–287

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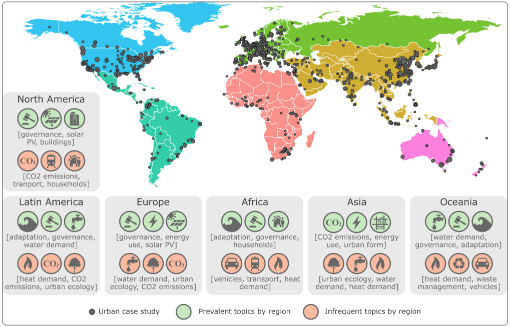

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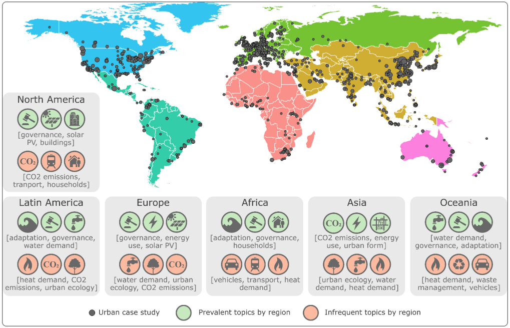

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With regional impact attribution literature, we have specific categories we are looking for, and a small dataset of labelled documents

Proposal

We plan to use the labelled data from AR5 WGII Table 18-5 - 18-9 to train a classifier that can identify literature relevant to the different impact categories, in the corresponding map.

This will require more screening, for the generation of further validation and training data

The results can

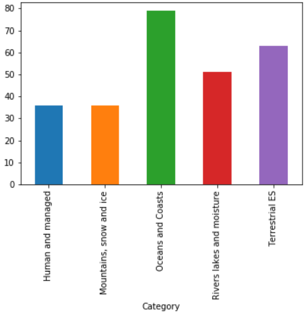
- contribute to the production of the map in AR6
- inform us about research gaps
- enhance our understanding of the what literature what was included in the last map, and what, if any, other information could have been included

AR5 Data

Table 18-5 | Observed impacts of climate change reported since AR4 on mountains, snow, and ice, over the past several decades, across major world regions, with descriptors for (1) the confidence in detection of a climate change impact; (2) the relative contribution of climate change to the observed change, compared to that of non-climatic drivers; (3) the main climatic driver(s) causing the impacts; (4) the reference behavior of the system in the absence of climate change; and (5) the confidence in attribution of the impacts to climate change. References to related chapters in this report are given as well as key references to other IPCC reports and the scientific literature. Absence of climate change impacts from this table does not imply that such impacts have not occurred.

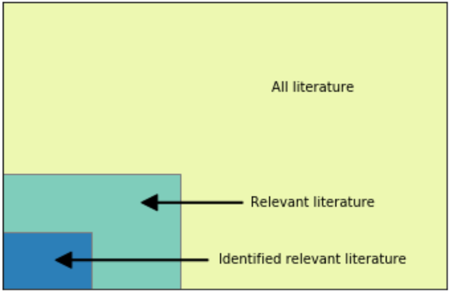
	Mountains, snow and ice	References	Confidence in detection	Role of climate	Climate driver	Reference behavior	Confidence in attribution
Africa	Retreat of tropical highland glaciers in East Africa	Mölg et al. (2008, 2012); Taylor et al. (2009)	*Very high*	Major	Warming, drying	No change	*High*
Europe	Retreat of Alpine, Scandinavian, and Icelandic glaciers	WGI AR5 Section 4.3.3; Bauder et al. (2007); Björnsson and Pálsson (2008); Paul and Haeberli (2008); WGMS (2008); Zemp et al. (2009); Andreassen et al. (2012); Marzeion et al. (2012); Gardner et al. (2013)	*Very high*	Major	Warming	No change	*High*
	Increase in rock slope failures in western Alps	Sections 18.3.1.3 and 23.3.1.4; Fischer et al. (2012); Huggel et al. (2012a)	*High*	Major	Warming	No change	*Medium*
Asia	Permafrost degradation in Siberia, Central Asia, and the Tibetan Plateau	WGI AR5 Section 4.7.2; Section 24.4.2.2; Romanovsky et al. (2010); Yang et al. (2013)	*High*	Major	Warming	No change	*High*
	Shrinking mountain glaciers across most of Asia	WGI AR5 Section 4.3.3; Section 24.4.1.2; Box 3-1; Bolch et al. (2012); Cogley (2012); Gardelle et al. (2012); Kääb et al. (2012); Yao et al. (2012); Gardner et al. (2013); Stokes et al. (2013)	*High*	Major	Warming	No change	*Medium*
Australasia	Substantial reduction in ice and glacier ice volume in New Zealand	WGI AR5 Section 4.3.3; Table 25-1; Chinn et al. (2012)	*High*	Major	Warming	No change	*Medium*
	Significant decline in late-season snow depth at three out of four alpine sites in Australia 1957–2002	Table 25-1; Nicholls (2006); Hennessy et al. (2008)	*High*	Major	Warming	No change	*Medium*
North America	Shrinkage of glaciers across western and northern North America	WGI AR5 Section 4.3.3; Gardner et al. (2013)	*High*	Major	Warming	No change	*High*
	Decreasing amount of water in spring snowpack in western North America 1960–2002	Stewart et al. (2005); Mote (2006); Barnett et al. (2008)	*High*	Major	Warming	No change	*High*
South and Central America	Shrinkage of Andean glaciers	WGI AR5 Section 4.3.3; Section 27.3.1.1; Table 27-3; Vuille et al. (2008); Bradley et al. (2009); Jomelli et al. (2009); Poveda and Pineda (2009); Marzeion et al. (2012); Gardner et al. (2013); Rabatel et al. (2013)	*High*	Major	Warming	No change	*High*
Polar regions	Decreasing Arctic sea ice cover in summer	WGI AR5 Section 4.2.2.1; ACIA (2005); AMAP (2011)	*Very high*	Major	Air and ocean warming, change in ocean circulation	No change	*High*

257 Documents available in Web of Science from AR5 WGII Table 18-5 - 18-9



Query Development

The ideal query should contain *all* documents included in the tables, along with *all* additional relevant documents (untestable) and a hopefully minimal amount of irrelevant documents



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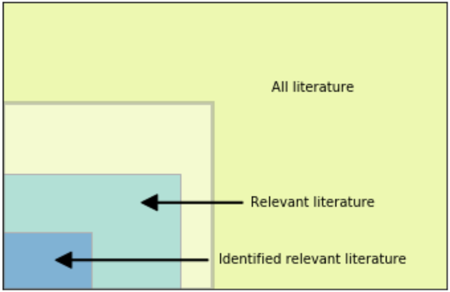

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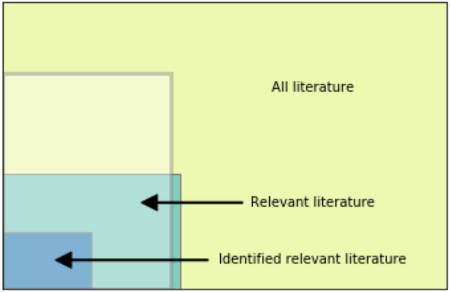

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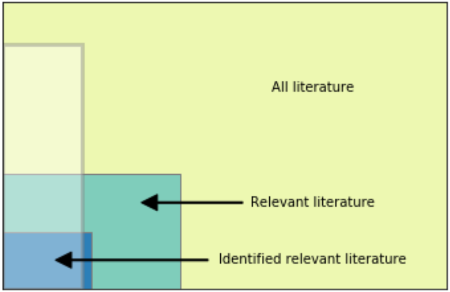


Query Development

I built a query that returns all identified documents by assembling keywords on three themes

Climate

TS=("climate model" OR "elevated* temperatur" OR "ocean* warming" OR "saline* intrusion" OR "chang* climat" OR "environment* change" OR "climat* change" OR "climat* warm" OR "warming* climat" OR "climat* varia" OR "global* warming" OR "global* change" OR "greenhouse* effect" OR "anthropogen*" OR "sea* level" OR "precipitation variabil*" OR "precipitation change*" OR "temperature* impact" OR "environmental* variab" OR "weather* pattern" OR "weather* factor*" OR "climat*") OR TS=("change* NEAR/5 cryosphere" OR "increase* NEAR/3 temperatur*")

Impacts

TS=("impact*" OR "specie*" OR "mortality*" OR "ecosystem*" OR "mass balance" OR "flood*" OR "drought" OR "disease*" OR "adaptation" OR "malaria" OR "fire" OR "water scarcity" OR "water supply" OR "permafrost" OR "biological response" OR "food availability" OR "food security" OR "vegetation dynamic*" OR "cyclone*" OR "yield*" OR "snow water equival*" OR "surface temp*") OR TS=("glacier* NEAR/3 melt*" OR "glacier* NEAR/3 mass*" OR "erosion* NEAR/5 coast*" OR "glacier* NEAR/5 retreat*" OR "rainfall* NEAR/5 reduc*" OR "coral* NEAR/5 stress*" OR "precip* NEAR/5 *crease*" OR "river NEAR/5 flow")

Attribution

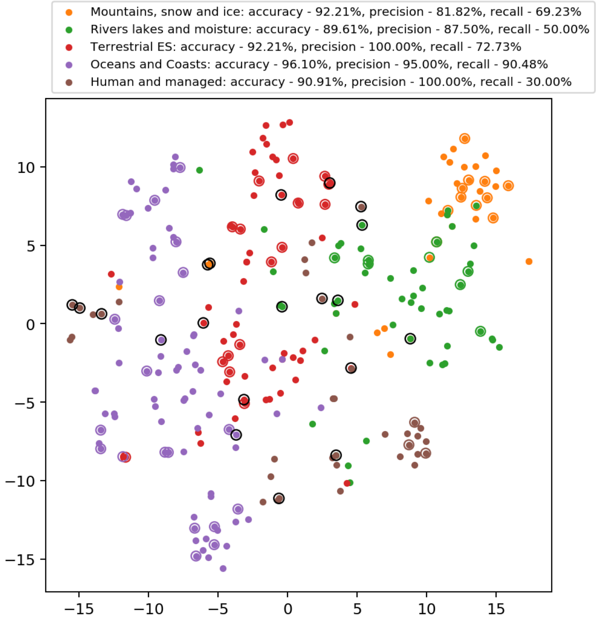
TS=("recent" OR "current" OR "modern" OR "observ*" OR "evidence*" OR "past" OR "local" OR "region*" OR "significant" OR "driver*" OR "response" OR "were responsible" OR "was responsible" OR "exhibited" OR "witnessed" OR "attribut*" OR "has increased" OR "has decreased" OR "histor*" OR "correlation" OR "evaluation")

Even after excluding sensible words that occurred in the query, but not in the AR5 references, we have 318,885 documents

Machine Learning Approach

- We use the text of the documents to train a model to categorise the documents we know the categories for
- We use that model to predict the categories of documents we haven't seen yet
- We screen these documents, providing validation and more training data

Proof of Concept



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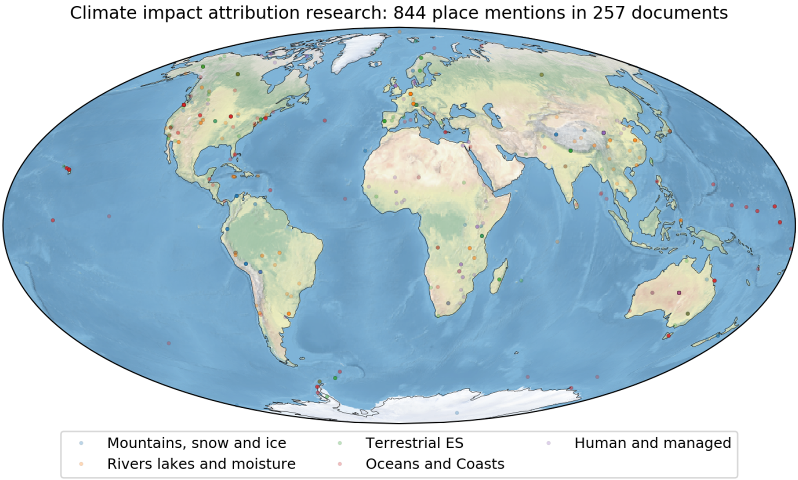

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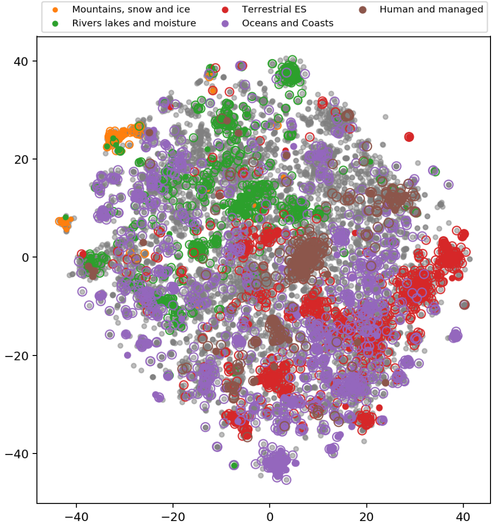

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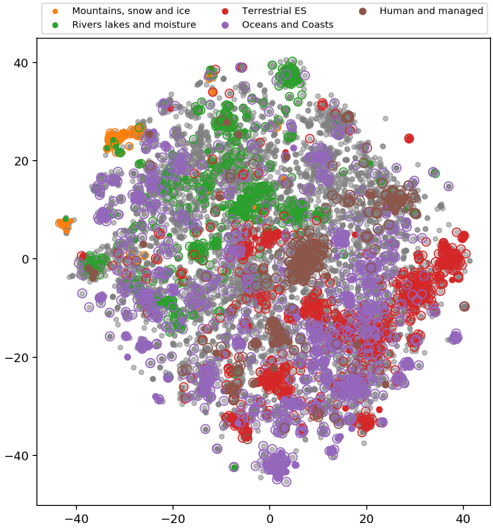
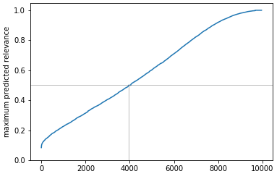
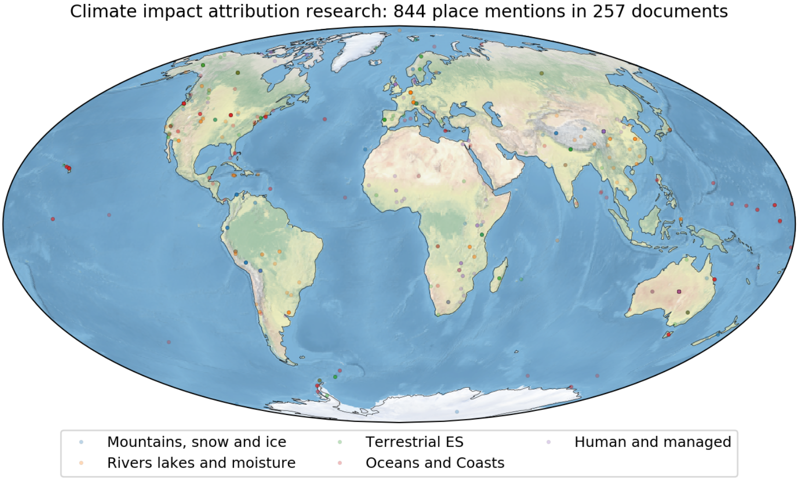


- We can train the model on the known documents, and use it to predict the categories of the unseen documents
- About 40% of documents are predicted to be relevant (!), but the model is only trained on positive cases



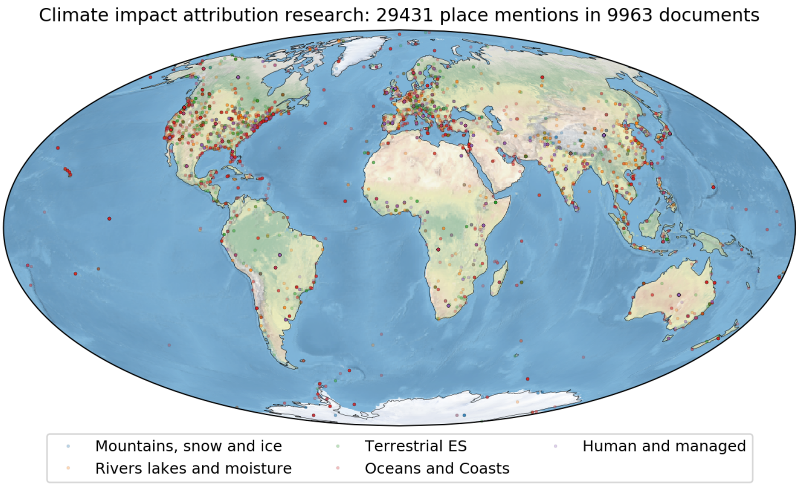
Proof of Concept - unseen data

Recall the orignal map of places mentioned in the AR5 documents

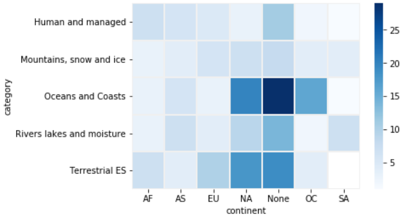


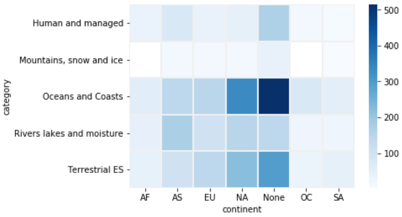
Proof of Concept - unseen data

In just a sample of 10,000 documents, we have a lot more places mentioned, and regional concentrations are clearer



Proof of Concept - regional aggregation





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- **Outputs:**
  - What does this tell us about the new literature?
  - What does this tell us about the available literature from before, and what was included or not?

References

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