Supplemental material for

"Climate Change Adaptation in European Mountain Systems: A Systematic Mapping of Academic Research", by Sumit Vij, Robbert Biesbroek, Carolina Adler, and Veruska Muccione, published in *Mountain Research and Development* (41)1, 2021. (See https://bioone.org/toc/mred/41/1)

APPENDIX S1 Protocol: 01-07-2019

1. Background

Climate change is a reality and the evidence of melting glaciers in the mountain areas is strong evidence of it. Scientists believe that the changes occurring in the mountain regions shape the changes in the lower mid-hills and floodplain environments. Mountain systems have a complex topography and may change considerably over short distances. Change in temperature at different altitudes has different impacts. For instance, areas at the snow line will go through drastic effects, as they might undergo a shift from snow-covered to snow-free.

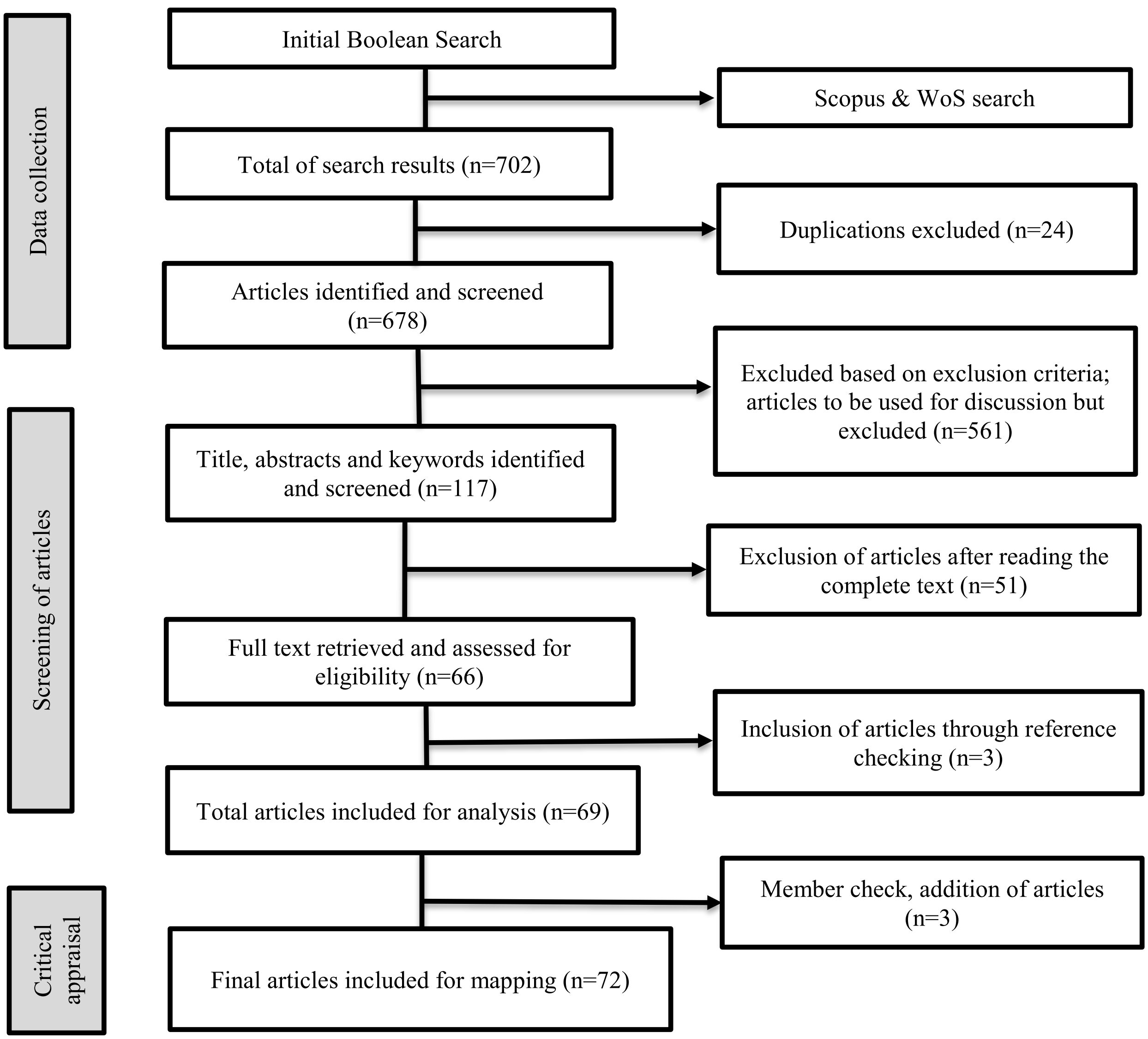
In such a complex system, there is a need for climate change adaptation (CCA) to increase the resilience of vulnerable communities. So far, there is a limited understanding of the type of CCA actions taking place across Europe, with some regions more than others. There are gaps in CCA knowledge and available information for designing appropriate CCA governance in mountain regions of Europe. For instance, reliable long-term records of mountain climate which allow verification and planning of CCA is available for very few areas such as the European Alps.

It is important to understand the CCA governance via interventions, monitoring and evaluation of progress and accountability of (non) governmental actions. Different CCA actions are being implemented. Some actions are reactive and short term focused; others long term focused; some are incremental others are transformational. Little we know about who is adapting (governments, civil society, private actors, businesses etc.) and what kind of actions they are taking in the mountain regions of Europe. Against this background, we answer the question of what are the adaptation actions taking place across the European mountain ranges? We use a systematic literature review to answer this question. In the following section, we have detailed out the protocol followed to map out the key CCA studies that explain the variety of CCA actions implemented in European mountain regions.

2. Methodological approach

We use a systematic mapping approach that builds on the ROSES protocol. A systematic understanding on adaptation option in mountain regions of Europe is missing and therefore such an approach will predominantly help to conduct a formal, transparent, standardized mapping of the literature. The following steps will be taken to implement the approach, see figure 1. We used Scopus and Web of Science (WoS) for data collection. Several search queries were formulated and used to generate results in the two search engines. All articles were screened after reading the abstract, title and keywords. In the next step, articles were screened based on the complete text of the articles. In the last step, articles were screened using the critical appraisal step and expert check.

Figure 1: Selection procedure for identifying articles following the ROSES protocol

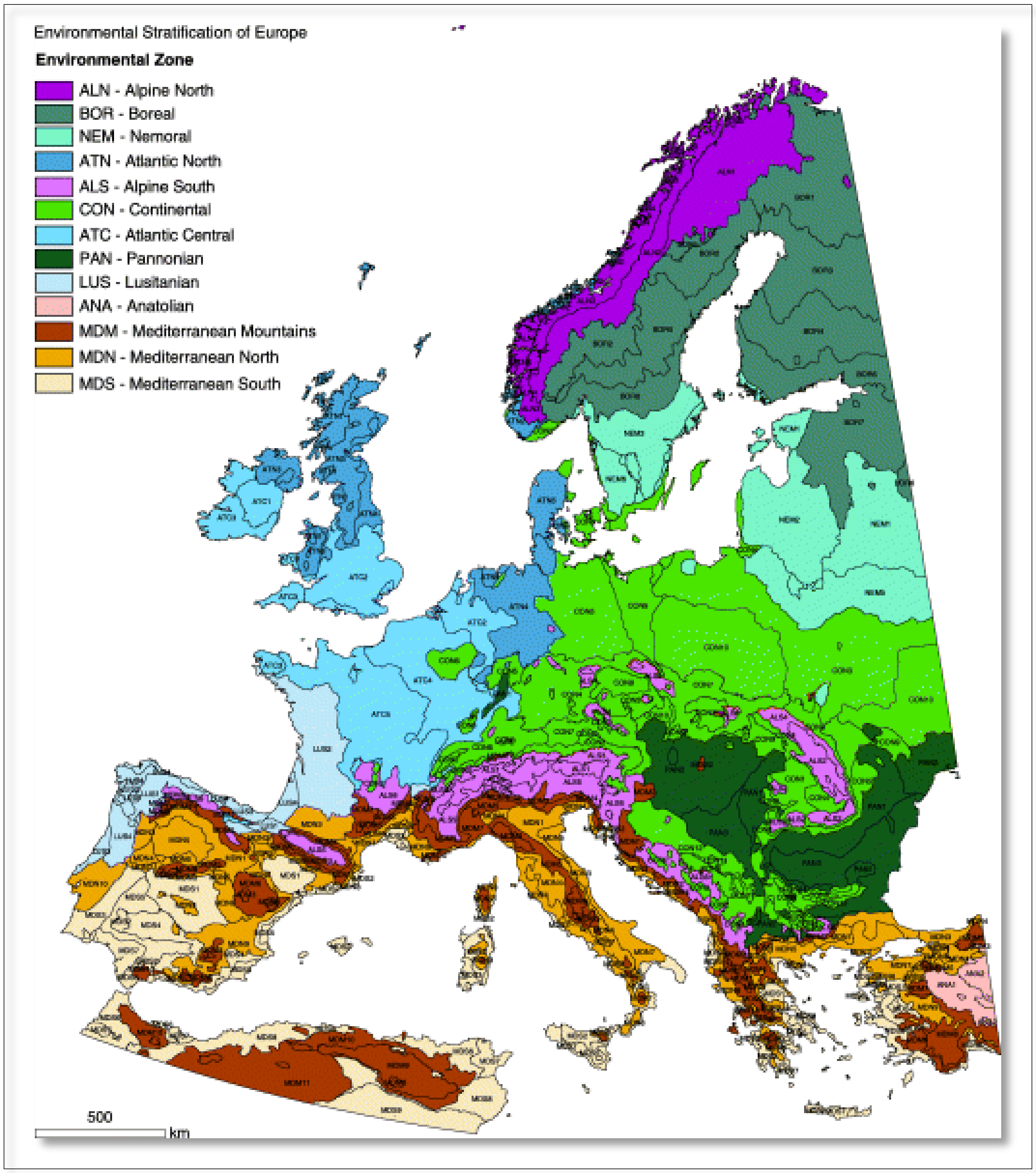


The following sections of this document will overall describe the various steps of the protocol. Apart from the steps the section will elaborate on (A) geographical boundaries of this study (see section 3); (B) key concepts used (section 4); (C) data collection protocol and steps (section 5 and 6); and (D) data extraction protocol (section 6 and 7). The timeline to implement the protocol steps and to write the manuscript from the analyzed data is as follows:

3. Defining mountain ranges in Europe

There are no agreed-upon boundaries of what mountain ranges in Europe mean. Below are the two maps used to show the geographical and regional boundaries of mountains in Europe use for this study. Based on the definition of a mountain and the two maps below, we have identified the mountain/mountain ranges in Europe. Please see table 1. Price (1981) defined mountain as an elevated platform of high local relief (1000 ft~ 304 meters) with distinct biological phenomenon areas from its base to the summit. Further, scientists made a distinction between high and low mountains. Low mountains are with the elevation of 1000-3000 ft (304-914 meters) and high mountains are above 3000 ft (914 m) (Hammond, 1954). For the purpose of this study, we use the distinction consider only high mountains, geographically positioned in Europe and parts of Russia (the Ural Mountains and the Caucasus). For more details on the definition of a mountain, please see section 4.

Map below has been prepared by Metzger, 2005 (Metzger, M. J., Bunce, R. G. H., Jongman, R. H., Mücher, C. A., & Watkins, J. W. (2005). A climatic stratification of the environment of Europe. Global ecology and biogeography, 14(6), 549-563.) and is used by IPCC AR 5 report on EU.



Map of European ranges in IPCC (AR 5, 2014)

The map below has been used in AR5 to classify Europe mountain system, see Kovats, R.S., R. Valentini, L.M. Bouwer, E. Georgopoulou, D. Jacob, E. Martin, M. Rounsevell, and J.-F. Soussana, 2014: Europe. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1267-1326.

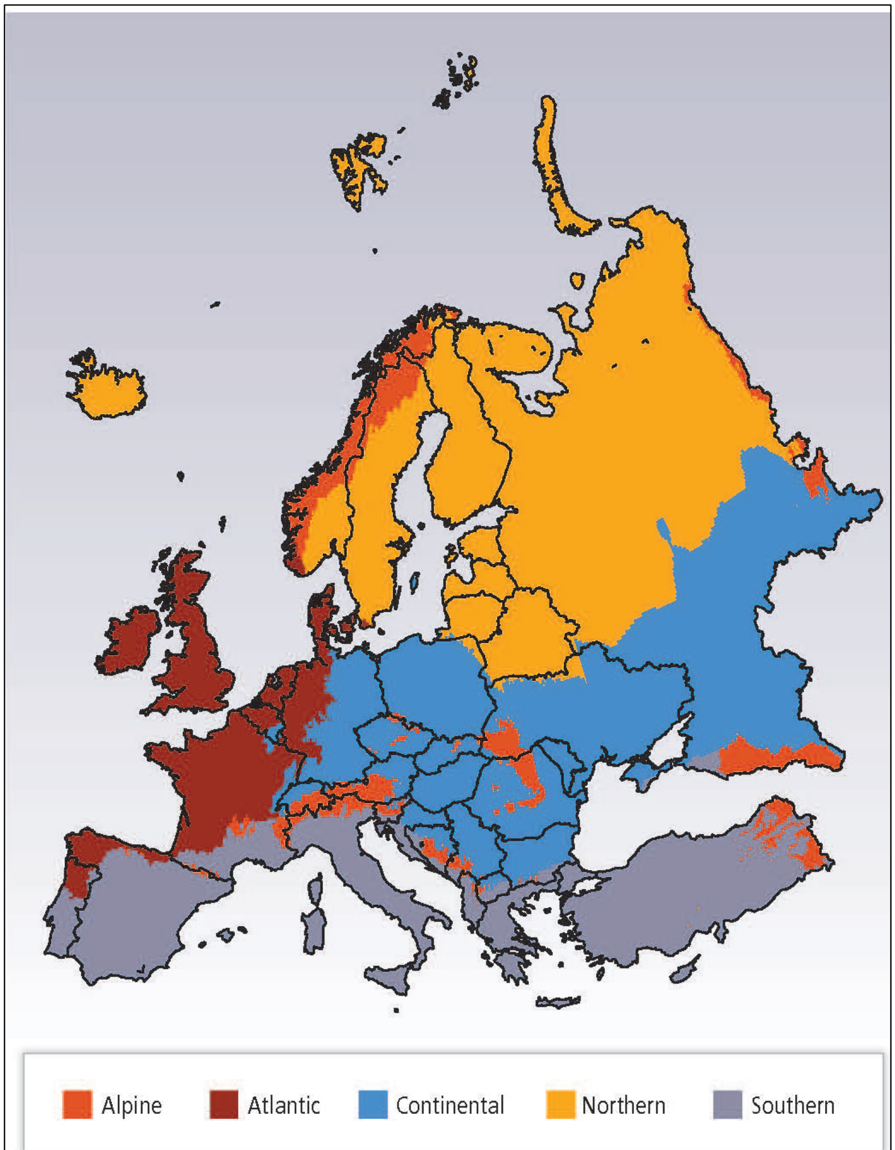


Figure 23-1 | Sub-regional classification of the IPCC Europe region. Based on Metzger et al., 2005.

4. Definitions of the keywords

The following concepts are central to the review and are defined as follows:

A. ***Climate change adaptation:*** The Intergovernmental Panel on Climate Change (IPCC) defines climate change adaptation as "the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects" (IPCC, 2014, p. 5). Adaptation can be realised from the local to the global scale and be focused on incremental or transformative actions (Tàbara et al., 2018; IPCC, 2014; Pelling, 2010).

B. **Autonomous adaptation measures** are considered to be those actions that are undertaken by affected species or communities without the direct intervention of a public/private agencies; planned adaptation consists of deliberate policy strategies and actions on the part of public agencies to reduce the impact of climate change (Forsyth & Evans, 2013; IPCC, 2007).

C. Incremental and transformative adaptation actions: Incremental adaptation actions maintain the essence and integrity of the existing technological, institutional, governance, and value systems. For example, adjustments to cropping systems via new varieties, changing planting times, or using more efficient irrigation (IPCC, 2014). While, transformative adaptation actions refer to change the fundamental attributes of systems in response to actual or expected climate and its effects. For example, changing livelihoods from cropping to livestock or by migrating to take up a livelihood elsewhere, and also changes in our perceptions and paradigms about the nature of climate change, adaptation, and their relationship to other natural and human systems (IPCC, 2014).

D. Resilience: The Intergovernmental Panel on Climate Change (IPCC) defines resilience as the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions (IPCC, 2012).

E. Mountains: There is no internationally agreed upon definition of mountains. The Oxford English dictionary define a mountain as 'a natural elevation of the earther surface rising more or less abruptly from the surrounding level and attaining an altitude which, relatively to adjacent elevation, is impressive or notable'. According to Merriam-Webster dictionary, mountain is defined as a landmass that projects conspicuously above its surroundings and is higher than a hill. Defining a mountain based on its elevation is very contentious. Scientists working on mountains argued that distance between ridges and valleys are just as fundamental to the delineation of a mountain as are the vertical distribution that establishes a relief. Price (1981) defined mountain as an elevated platform of high local relief (1000 ft~ 304 meters) with distinct biological phenomenon areas from its base to the summit. Further, scientists made a distinction between high and low mountains. Low mountains are with the elevation of 1000-3000 ft (304-914 meters) and high mountains are above 3000 ft (914 m) (Hammond, 1954). For the purpose of this study, we use the distinction consider only high mountains, geographically positioned in Europe and parts of Russia (Ural Mountains and Caucasus). This is congruent with the region map of mountains in Europe used by IPCC (AR 5, 2014).

References

- ***Forsyth T, Evans N.*** 2013 What is autonomous adaption? Resource scarcity and smallholder agency in Thailand. World Development. 43:56–66.
- ***Mountain Agenda.*** 2000. *Mountains of the World. Mountain Forests and Sustainable Development.* [Price M, Kohler T, Wachs T, editors]. Bern, Switzerland: Mountain Agenda.
- ***IPCC [Intergovernmental Panel on Climate Change].*** 2007. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* [Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE, editors.] Cambridge, United Kingdom: Cambridge University Press.
- ***IPCC [Intergovernmental Panel on Climate Change].*** 2014. Summary for policymakers. *In:* IPCC. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* [Field CB, Barros VR, Dokken DJ, Mach KJ, Mastrandrea MD, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, et al, editors.] Cambridge, United Kingdom, and New York, NY: Cambridge University Press, pp 1–32.
- ***IPCC [Intergovernmental Panel on Climate Change].*** 2012: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, 582 pp.

Table 2 presents the mountain ranges and the highest peaks of these mountain ranges used in this review. The table was compiled by following the below 4 steps.

a. **Step 1** – Through google search, all the mountain/mountain ranges in Europe were compiled in a word file.
b. **Step 2** – Based on the definition of the mountain/mountain range (above 903 meters) considered in the manuscript, the compiled list was screened. Mountain ranges above 903 m are considered.
c. **Step 3** – For each mountain range, the highest peak and geographical scope (countries) were identified.
d. **Step 4** – Based on the IPCC AR5 classification of regions, the mountain/mountains ranges were classified.

Table 1: Mountain/mountain ranges in Europe and elevation

Sr. No.	**Name of the Mountain range** (elevation of the highest peak in meters)	**Countries**	**Region (following IPCC AR5)**
1	Alps (4808.73 m) – Mont. Blanc*	France, Italy, Switzerland, Monaco, Liechtenstein, Austria, Germany and Slovenia	Alpine
1.1	Eastern (4049 m) – Piz Bernia	Austria, Germany, Italy, Liechtenstein, Slovenia, Switzerland	Alpine
1.2	Western (4808.73 m) – Mont. Blanc	France, Italy, and Switzerland	Alpine
2	Apennine mountains (2912 m) – Corno Grande	Italy	Southern
3	Balkan mountain range (2376 m) – Botev Peak	Bulgaria, Serbia	Continental
4	Black forest range (1493 m)	Germany	Continental
5	Cantabrian mountain (2648 m) - Torre de Cerredo	Spain	Southern
6	Carpathian mountain (2655 m) - Gerlachovský štít	Czech Republic, Hungary, Poland, Romania, Serbia, Slovakia, Ukraine	Continental
7	Caucasus mountain range (5642 m) – mount Elbrus	Azerbaijan, Georgia, Russia	Atlantic
8	Dinaric Alps (2694 m) – Maja Jezerce	Albania, Bosnia and Herzegovina, Croatia, Montenegro, North Macedonia, Serbia, Slovenia	Continental
9	Vosges mountain range (1424 m) – Grand Ballon	France	Atlantic
10	Ural Mountains (1895 m) - Mount Narodnaya	Russia	Northern
11	Wicklow Mountains (925 m) – Lugnaquilla	Ireland	Atlantic

12	Scafells (978 m) – Scafell Pike	UK	Atlantic
13	Rhodope Mountains (2191 m) – Golyam Perelik	Bulgaria and Greece	Southern
14	Olympus mountain (2919 m) – Mytikas	Greece	Southern
15	Scandinavian mountains (2469 m) – Galdhøpiggen	Finland, Norway and Sweden	Alpine
16	Scottish Highlands (1345 m) – Ben Nevis	UK	Atlantic
17	Sudetes (1603 m) – mount Sněžka	Czech Republic, Poland and Germany	Continental
17.1	Owl mountains (part of Sudetes) (1014 m) – Wielka Sowa	Czech Republic, Poland and Germany	Continental
18	Blue mountains (1189 m) – unnamed	UK	Atlantic
19	Sar Mountains (2748 m) – Titov Vrv	Albania, Macedonia	Southern
20	Gennargentu (1834 m) – Punta La Marmora	Italy	Southern
21	Jura mountains (1720 m) – Crêt de la Neige	France and Switzerland	Continental
22	Ore mountains (1244 m) – Klínovec	Czech Republic, Germany	Continental
23	Pindus mountains (2637 m) – Smolikas	Greece and Albania	Southern
24	Pyrenees mountains (3404 m) – Aneto	Spain and France	Southern
25	Rila mountains (2925 m) – Musala	Bulgaria	Southern
26	Rhodope mountains (2191 m) – Golyam Perelik	Bulgaria and Greece	Southern
27	Sierra Morena (1332 m) -- Bañuela	Spain	Southern
28	Baetic Ranges (3478.6 m) – Mulhacén	Spain	Southern
29	Sistema central (2592 m) – Pico Almanzor	Spain and Portugal	Southern
30	Sistema Ibérico (2313 m) – Moncayo	Spain	Southern
31	Serra de Tramuntana* (1445 m) – Puig major	Spain (Mallorca)	Southern
32	Baba mountain (2601 m) – Pelister	Macedonia	Southern
33	Jakupica mountain (2540 m) – Solunska Glava	Macedonia	Continental
34	Voras mountain (2524 m) – Kaimakchalan	Greece and Macedonia	Southern
35	Kozuf mountain (2171 m) – Zelenbeg or Portes	Greece and Macedonia	Southern

*World Heritage Site

5. Keywords for search queries

Based on the key question and Table 2, the following search queries were developed to search relevant articles in SCOPUS and Web of Science. Keywords such as ‘adaptation’, ‘mountain’ and ‘name of the mountain’, ‘climate change’ and ‘name of the country/countries’ where mountains are geographically located are used to develop search queries. We aim to run various combinations of search queries in the two search engines to cover a large part of the literature landscape (mountain+adaptation+governance+Europe). For each mountain/ mountain range, a unique set of queries will be used to search scientific literature. In section 6, a few examples of search queries are illustrated.

Table 2: Keywords and description of search queries

Keywords for search queries	Description
Mounta OR [Name of the mountain – E.g. *Alp*]	Captures the general concept of mountain and its highest peak
Europ OR [Country name – E.g. Franc*, German*]	Geographical demarcation, focusing on Europe and/or the country(ies) the mountain range is located in.
Climate Change OR Global Warming OR Climatic Change OR Anthropogenic warming	Focus on climate change (not weather)
Adapt OR *Resilien*	Focus on climate change adaptation

6. Search queries (initial searches – to be completed)

Following are the examples of the search queries that will be used to generate articles from the two search engines. As mentioned in section 5, various combinations of search queries will be used to create a repository of articles, followed by screening, analyzing and mapping of adaptation options in mountain regions of Europe.

Table 3: Examples of search queries

Sr. No.	Queries (SCOPUS) – No.	Queries (Web of Science) – No.
1	(TITLE-ABS-KEY (*alp*) AND TITLE-ABS-KEY (mountain) AND TITLE-ABS-KEY (*adapt* OR resilienc*) AND TITLE-ABS-KEY (europ*)) – **155**	(Alps*) AND TOPIC: (mountain) AND TOPIC: (adapt* OR resilienc*) AND TOPIC: (Europ*) – **166**
2	(TITLE-ABS-KEY (mountain*) AND TITLE-ABS-KEY (alp*) AND TITLE-ABS-KEY (climat* OR global AND warming OR climatic AND	(mountain*) AND TOPIC: (Alp*) AND TOPIC: (climat* OR global warming OR climatic change OR anthropogenic warming) AND

	change OR anthropogenic AND warming) AND TITLE-ABS-KEY (*adapt* OR *resilien*) AND TITLE-ABS-KEY (europe)) – 15	TOPIC: (*adapt* OR *resilien*) AND TOPIC: (Europe) – 41
3	(TITLE-ABS-KEY (western AND *alps*) AND TITLE-ABS-KEY (mountain) AND TITLE-ABS-KEY (*adapt* OR resilienc*) AND TITLE-ABS-KEY (europ*)) AND (LIMIT-TO (SUBJAREA , "SOCI")) – **27**	(Western Alps*) AND TOPIC: (Adapt* OR resilienc*) AND TOPIC: (Europe) – **40**
4	(TITLE-ABS-KEY (*ural*) AND TITLE-ABS-KEY (mountain) AND TITLE-ABS-KEY (*adapt* OR resilienc*) AND TITLE-ABS-KEY (europ* OR russ*)) – **335**	(Ural*) AND TOPIC: (Mountai*) AND TOPIC: (Adapt* OR resilienc*) AND TOPIC: (Europ* OR Russ*) – **14**
5	(TITLE-ABS-KEY (*balkan*) AND TITLE-ABS-KEY (mountain) AND TITLE-ABS-KEY (*adapt* OR *resilien*) AND TITLE-ABS-KEY (europ* OR bulgaria OR serbia)) – **37**	(Balkan*) AND TOPIC: (Mountai*) AND TOPIC: (Adapt* OR resilienc*) AND TOPIC: (Europ*) – **28**
6	(TITLE-ABS-KEY (*baetic*) AND TITLE-ABS-KEY (*mounta*) AND TITLE-ABS-KEY (*adapt* OR *resilien*) AND TITLE-ABS-KEY (europ*)) –**1** (try without the name of the mountain)	(Baetic*) AND TOPIC: (Mountai*) AND TOPIC: (Adapt* OR resilienc*) AND TOPIC: (Europ*) – **0**

7. Exclusion and Inclusion criteria

Table 4 presents the criteria for selecting articles from the repository of search results. Two sets of criteria will be used in two rounds for the screening of articles. The first set of criteria will be applied to abstract, keywords and texts of the articles. In the second round of critical appraisal, methodology and adaptation option will be meticulously screened for selection of articles.

Table 4: Inclusion and exclusion criteria

Sr. No.	Inclusion criteria	Exclusion criteria
1	Time period between 2011 - 2019	Not before 2011 and 2019
2	Focus on climate change impacts and adaptation in mountain/mountain ranges of Europe and Russia	Exclude mountain/mountain ranges outside Europe
3	Articles included discussing the concept of climate change and related impacts.	Exclude articles not discussing climate change impacts
4	Climate change adaptation is defined as the process of adjustment to actual or expected climate and its effects. Articulation of detailed definition in section 4 will be used for inclusion of article.	Exclude articles not discussing the concept of adaptation and adaptation actions.
5	Only peer-reviewed articles published in English including empirical studies and review articles.	Exclude book chapters and reports, not in English
Screening of articles during critical appraisal		
1	Explanation of clear adaptation options in the article. Adaptation options should fall under the incremental/ transformational category.	Articles with unclear (not concrete) adaptation option will be excluded.
2	Clear methodology of deriving adaptation options should be included.	Lacking methodology in the articles will be excluded.

8. Reference checking (expert check)

Expert check is the last step of the search protocol. For comprehensive coverage of literature, a repository of articles after the critical appraisal step will be shared with a few experts. The experts will suggest if there are any articles missing in the repository and will check the overall quality of literature included through search queries. Experts will be chosen from different mountain regions of Europe.

Articles added:

1. Gariano, S. L., & Guzzetti, F. (2016). Landslides in a changing climate. Earth-Science Reviews, 162, 227-252.
2. Kellner, E. (2019). Social acceptance of a multi-purpose reservoir in a recently deglaciated landscape in the Swiss Alps. *Sustainability*, *11*(14), 3819.

3. Duvillard, P. A., Ravanel, L., Marcer, M., & Schoeneich, P. (2019). Recent evolution of damage to infrastructure on permafrost in the French Alps. *Regional Environmental Change*, *19*(5), 1281-1293.

9. Extraction tables:

Table 5: Overall table (example)

Sr. No.	Title of the article	Journal	Author(s) name	Year	Abstract	Keywords	Mountain range/mountain discussed	Climate impacts*	Sector (impact) focus*	Adaptation actions discussed		Who adapts?
										I	T	

Based on AR 5 (IPCC, 2014). Incremental and Transformative adaptation actions. Explained in section 2.

Based on the EEA assessment and detailed out in the table below.
1= govt
2= non-govt
3= mixed

Table 6: Impacts and sectors (example)

Climate impacts (indicators)								Sector (impact) focus in Mountains					
Temperature rise	**Decrease in glacier rise**	**Upward shift in animal & plant species**	**Species extinction**	**Increase in landslides**	**Decrease in Ski tourism**	**Increase in forests pests**	**Others**	**Agriculture**	**Energy**	**Transport**	**Tourism**	**Multi-sector**	**Others**

Various impacts are explained below:

a) **Temperature rise**: European land temperatures in the decade 2006–2015 were around 1.5 °C warmer than the pre-industrial level, and they are projected to continue increasing by more than the global average temperature increase (EEA, 2016). Articles discussing temperature rise with these conditions will be considered.

b) **Decrease in glacier rise**: The nine lowest Arctic sea ice minima since records began in 1979 have been the September ice cover in each of the last nine years (2007–2015), and the annual maximum ice cover in March 2015 and March 2016 were the lowest on record. Article discussing such impacts will be considered for the mapping exercise.

c) **Upward shift in animal & plant species:** Climate warming has resulted in a significant upwards shift in species optimum elevation averaging 29 m per decade, but with a wide range from + 238 to – 171 m per decade (Lenoir et al., 2008). If similar trends are discussed in the screened articles, they will be considered for mapping exercise.

d) **Decrease in landslides:** Articles discussing Mass movements (landslides, mud and debris flows) causing damage will be considered for mapping exercise.

e) **Decrease in Ski tourism:** Warm winters have already affected Alpine winter tourism. Studies have estimated that an increase in mean temperatures of 1°C which can reduce the Skiing season by 4-6 weeks. Articles discussing skiing tourism in Alpine and impacts will be considered for the mapping.

f) **Increase in forests impacts: Due to climate change the** populations of forest insect pests can be influenced. For instance, climate change can lead to a longer growing season, variations in precipitation patterns, modifications in food availability, and qualitative and quantitative changes in their predator and parasite populations (Netherer and Schopf, 2010). Evidence shows that these changes can affect the distribution and relative abundance of pest species in forest ecosystems. Articles discussing such changes will be included in the review.

Final list of articles included

- Abeli, T., Rossi, G., Gentili, R., Mondoni, A., & Cristofanelli, P. (2012). Response of alpine plant flower production to temperature and snow cover fluctuation at the species range boundary. *Plant Ecology*, *213*(1), 1-13.
- Alvarez, S., Ortiz, C., Díaz-Pinés, E., & Rubio, A. (2016). Influence of tree species composition, thinning intensity and climate change on carbon sequestration in Mediterranean mountain forests: a case study using the CO2Fix model. *Mitigation and Adaptation Strategies for Global Change*, *21*(7), 1045-1058.
- Beniston, M., & Stoffel, M. (2014). Assessing the impacts of climatic change on mountain water resources. *Science of the Total Environment*, *493*, 1129-1137.
- Beniston, M., Farinotti, D., Stoffel, M., Andreassen, L. M., Coppola, E., Eckert, N., ... & Huwald, H. (2018). The European mountain cryosphere: a review of its current state, trends, and future challenges. *Cryosphere*, *12*(2), 759-794.
- Beniston, M., Stoffel, M., & Hill, M. (2011). Impacts of climatic change on water and natural hazards in the Alps: can current water governance cope with future challenges? Examples from the European "ACQWA" project. *Environmental Science & Policy*, *14*(7), 734-743.
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- Brunette, M., Costa, S., & Lecocq, F. (2014). Economics of species change subject to risk of climate change and increasing information: a (quasi-) option value analysis. *Annals of forest science*, *71*(2), 279-290.
- Campos Rodrigues, L., Freire-González, J., González Puig, A., & Puig-Ventosa, I. (2018). Climate change adaptation of Alpine ski tourism in Spain. *Climate*, *6*(2), 29.
- Cannone, N., & Pignatti, S. (2014). Ecological responses of plant species and communities to climate warming: upward shift or range filling processes?. *Climatic Change*, *123*(2), 201-214.
- Caubel, J., de Cortazar-Atauri, I. G., Vivant, A. C., Launay, M., & de Noblet-Ducoudré, N. (2018). Assessing future meteorological stresses for grain maize in France. *Agricultural systems*, *159*, 237-247.
- Colucci, R. R. (2016). Geomorphic influence on small glacier response to post-Little Ice Age climate warming: Julian Alps, Europe. *Earth Surface Processes and Landforms*, *41*(9), 1227-1240.
- Croce, P., Formichi, P., Landi, F., Mercogliano, P., Bucchignani, E., Dosio, A., & Dimova, S. (2018). The snow load in Europe and the climate change. *Climate Risk Management*, *20*, 138-154.

- De Sanjosé, J. J., Berenguer, F., Atkinson, A. D. J., De Matías, J., Serrano, E., Gómez-Ortiz, A., ... & Rico, I. (2014). Geomatics techniques applied to glaciers, rock glaciers, and ice patches in Spain (1991–2012). *Geografiska Annaler: Series A, Physical Geography*, *96*(3), 307-321.
- Delay, E., Piou, C., & Quénol, H. (2015). The mountain environment, a driver for adaptation to climate change. *Land Use Policy*, *48*, 51-62.
- Djukic, I., Zehetner, F., Watzinger, A., Horacek, M., & Gerzabek, M. H. (2013). In situ carbon turnover dynamics and the role of soil microorganisms therein: a climate warming study in an Alpine ecosystem. *FEMS Microbiology Ecology*, *83*(1), 112-124.
- Duvillard, P. A., Ravanel, L., & Deline, P. (2015). Risk assessment of infrastructure destabilisation due to global warming in the high French Alps. *Journal of Alpine Research| Revue de géographie alpine*, (103-2).
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- Fernández-Giménez, M. E., & Fillat, F. (2012). Pyrenean pastoralists observations of environmental change: an exploratory study in Los Valles Occidentales of Aragón.
- Fernàndez-Martínez, J., & Fleck, I. (2016). Photosynthetic limitation of several representative subalpine species in the Catalan Pyrenees in summer. *Plant Biology*, *18*(4), 638-648.
- Feurdean, A., Florescu, G., Vannière, B., Tanţău, I., O'Hara, R. B., Pfeiffer, M., ... & Hickler, T. (2017). Fire has been an important driver of forest dynamics in the Carpathian Mountains during the Holocene. *Forest Ecology and Management*, *389*, 15-26.
- Fischer, A., Olefs, M., & Abermann, J. (2011). Glaciers, snow and ski tourism in Austria's changing climate. *Annals of glaciology*, *52*(58), 89-96.
- Frei, E. R., Ghazoul, J., Matter, P., Heggli, M., & Pluess, A. R. (2014). Plant population differentiation and climate change: responses of grassland species along an elevational gradient. *Global change biology*, *20*(2), 441-455.
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