



CHANGE

D1.1 - ASSESSMENT REPORT DOCUMENT

CLIMATE-HEALTH ADAPTATION THROUGH NEW
GENERATION EARTH OBSERVATIONS (CHANGE)

Prepared by: IZSAM

Approved by: Annamaria Conte

Authorized by: Carlos Domenech

Code: D1.1

Version: 3.1

Date: 25/09/2026

Internal code: GMV 26523/25 V5/26



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 2 of 80

DOCUMENT STATUS SHEET

Version	Date	Pages	Changes
1.0	07/01/2026	10	First version of the document
2.0	09/03/2026	54	Draft version of the document with Chapter 3 updated
2.1	27/03/2026	55	Version with changes requested by ESA at the RM1 applied
3.0	09/09/2026	79	Final version prepared for the AM1
3.1	25/09/2026	80	Version with changes requested by ESA at the AM1 applied



TABLE OF CONTENTS

1. INTRODUCTION	7
1.1. PURPOSE	7
1.2. SCOPE	7
1.3. ACRONYMS	7
1.4. APPLICABLE DOCUMENTS	9
2. OBJECTIVES.....	10
3. METHODOLOGY	11
3.1. SOTA METHODOLOGY	11
3.1.1. Literature sources and selection approach.....	11
3.1.1.1. Grey literature	12
3.1.2. Eligibility criteria for scientific literature	12
3.1.3. Screening, review and data extraction procedures	14
3.1.4. Identification and synthesis of climate-related health risks.....	22
3.2. EO-DRIVEN METHODS FOR CLIMATE-HEALTH RISK ANALYSIS	24
3.3. METHODOLOGICAL CONSIDERATIONS AND LIMITATIONS.....	24
4. OVERVIEW OF CLIMATE-RELATED HEALTH IMPACTS	25
4.1. SYNTHESIS OF THE SOTA EVIDENCE	25
4.2. IDENTIFICATION AND CHARACTERISATION OF THE TEN MAIN CLIMATE-RELATED HEALTH RISKS.....	30
4.3. COMPARATIVE ANALYSIS OF GREY LITERATURE AND SOTA FINDINGS	35
5. SATELLITE EARTH OBSERVATIONS AND CLIMATE-RELATED HEALTH IMPACTS	38
5.1. TEMPORAL AND GEOGRAPHICAL INSIGHTS IN THE EO LITERATURE OF THE TEN PRIORITY HEALTH AREAS	41
5.2. REPRESENTATION OF ESSENTIAL CLIMATE VARIABLES IN THE EO LITERATURE OF THE TEN PRIORITY HEALTH AREAS.....	41
5.3. CLIMATE MODEL APPLICATIONS IN THE CLIMATE AND HEALTH LITERATURE.....	42
6. KNOWLEDGE GAPS	46
6.1. KNOWLEDGE GAPS EMERGING FROM THE SOTA AND CLIMATE-HEALTH LITERATURE	46
6.2. KNOWLEDGE GAPS RELATED TO EO-BASED CLIMATE-HEALTH ANALYSES	48
7. SCIENTIFIC AND TECHNICAL REQUIREMENTS	50
7.1. PURPOSE AND LINK WITH THE SOTA AND GAP ANALYSIS.....	50
7.2. GAP-DRIVEN FORMULATION OF REQUIREMENTS.....	50
7.3. GAP 1: LIMITED INTEGRATION OF EO WITHIN A COMPLETE CLIMATE-HEALTH RISK FRAMEWORK	50
7.4. GAP 2: INSUFFICIENT EXPLOITATION AND DOCUMENTATION OF EO DATASETS.....	51
7.5. GAP 3: LIMITED INTEGRATION OF VULNERABILITY, ADAPTIVE CAPACITY AND SOCIAL DETERMINANTS	52
7.6. GAP 4: UNDERREPRESENTATION OF HEALTH SYSTEMS, FACILITIES, WELL-BEING AND MIGRATION	52
7.7. GAP 5: LIMITED CAPACITY TO ASSESS COMPOUND AND CASCADING CLIMATE EVENTS.....	53
7.8. GAP 6: LIMITED REPRODUCIBILITY, INTEROPERABILITY AND OPERATIONAL SCALABILITY ..	53
7.9. GAP 7: INSUFFICIENT UNCERTAINTY CHARACTERISATION AND VALIDATION.....	54



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 4 of 80

7.10. GAP 8: LIMITED PREDICTIVE CAPABILITY FOR FUTURE CLIMATE-HEALTH RISKS AND ADAPTATION PLANNING	54
7.11. TRACEABILITY BETWEEN GAPS AND SCIENTIFIC AND TECHNICAL REQUIREMENTS	55
7.12. COMPARISON OF RESULTS WITH THE IPCC AR7 HEALTH AND WELL-BEING CHAPTER OUTLINE	56
8. CONCLUSIONS.....	57
8.1. OVERVIEW OF THE ASSESSMENT	57
8.2. ROLE OF EARTH OBSERVATION IN CLIMATE-HEALTH RESEARCH	58
8.3. KNOWLEDGE GAPS	58
8.4. SCIENTIFIC AND TECHNICAL REQUIREMENTS	59
9. REFERENCES	60
10. APPENDICES	62
10.1. LIST OF SELECTED PAPERS AND REPORTS.....	62
10.2. SEARCH QUERY STRINGS	62
10.2.1. PubMed	62
10.2.2. Web of Science.....	65
10.2.3. Scopus	68
10.2.4. PROQUEST.....	72
10.2.5. COCHRANE	75
10.3. EO CLASSIFICATION DICTIONARIES AND SEARCH TERMS	77
10.4. PROMPT ENGINEERING USED FOR AI-ASSISTED REVIEW	78



LIST OF TABLES AND FIGURES

Table 1-1: Acronyms.	7
Table 1-2: Applicable Documents.	9
Table 3-1: Bibliographic sources.	12
Table 3-2: Keywords for SOTA analysis. The asterisk (*) is used as a wildcard operator to retrieve all variants of a root term.	13
Table 3-3: Structured Data Extraction Framework. Overview of screening, validation and analytical extraction fields (Literature Database).	17
Table 3-4: Comparison of FullText and ScreenText inclusion screening performance against the manually reviewed overlap dataset.	19
Table 3-5: Reliability assessment of AI-assisted FullText annotations based on comparison with the manually reviewed overlap dataset (n = 83 included studies).	20
Table 3-6: Climate drivers implemented.	22
Table 3-7: Health domains implemented.	23
Table 4-1: Summary of the comparison between the SOTA assessment and the grey literature.	35
Table 5-1: Overview of EO applications in the climate and health literature, based on studies from the SOTA analysis (overlap between P1 and EO corpus).	38
Table 5-2: Overview of ECVs present in the climate and health literature, restricted to those that specified EO products used.	42
Table 5-3: Overview of climate model applications in the climate and health literature identified through the SOTA analysis.	43
Table 6-1: Representation of health-risk categories in the overlap dataset and in the broader P1 climate-health literature. Counts indicate the number of reviews assigned to each health-risk category. Reviews may contribute to multiple categories.	46
Table 7-1: Traceability between knowledge gaps identified in the SOTA and EO-based climate-health analyses, corresponding scientific and technical requirements.	55
Table 7-2: Comparison of the five thematic elements identified by the IPCC Working Group II with the scientific and technical requirements from D1.1.	56
Table 10-1: EO-explicit dictionary.	78
Table 10-2: Extended EO corpus dictionary.	78
Figure 3-1: Automated pre-screening, manual and AI-assisted review and extraction workflow for the SOTA literature analysis.	16
Figure 3-2: Overlap between the Climate-Health corpus, P1 subset, EO and EO-explicit records	17
Figure 3-3: Confusion matrices comparing FullText and ScreenText inclusion decisions against the manually reviewed overlap dataset.	20
Figure 3-4: Agreement between manual annotations and AI-assisted FullText extraction for scientific-content variables. F1-score and Jaccard similarity are shown for health, climate and EO-related fields based on the 83 manually included overlap records.	21
Figure 3-5: Validation of geographical and temporal variables. Completeness and agreement metrics are reported for continents, countries, regions, study start year, and study end year. The figure also illustrates agreement between manually extracted and AI-extracted study start years for records where both values were available.	21
Figure 3-6: The figure reports aggregate agreement metrics (Precision, Recall, F1-score, and Jaccard similarity), the distribution of record-level F1-scores, and the comparison of the most frequently assigned population categories between manual and AI-assisted annotations.	22



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 6 of 80

Figure 4-1: Number of papers by health categories (overlap dataset, 2019-jan 2026). The blue box highlights the top 10 climate-related health risks (discussed in section 4.2)	25
Figure 4-2: Number of papers by climate categories (overlap dataset, 2019- Jan 2026)	26
Figure 4-3: Climate-Health co-occurrence matrix (overlap dataset, 2019- Jan 2026). <i>Multi-label co-occurrence counts between climate-driver categories (rows) and health domains (columns) across 83 systematic reviews included in the overlap dataset (2019–Jan 2026). Each cell indicates the number of reviews in which the corresponding driver and health domain were jointly identified. Because tagging is multi-label, individual reviews may contribute to multiple cells across rows and columns.</i>	26
Figure 4-4: Temporal distribution of health domains (overlap dataset, 2019- Jan 2026). The blue box highlights the top 10 climate-related health risks (discussed in section 4.2)	27
Figure 4-5: Distribution of the study period duration (overlap dataset, 2019- Jan 2026). <i>Histogram of study period duration (end year – start year) across included papers. The median duration is approximately 20 years; the range spans 0 to 80 years, reflecting both short-term event studies (e.g., single extreme weather events) and long-term longitudinal analyses (e.g., multi-decadal climate-health trend studies). The distribution is right-skewed, with most studies covering 10–30-year periods</i>	28
Figure 4-6: Geographical distribution by health domains (overlap dataset, 2019- Jan 2026)	30
Figure 4-7: Study period durations for papers associated with the ten main health risks	32
Figure 4-8: Geographical distribution of ten main health domains by Country – when explicitly reported in literature (overlap dataset, 2019- Jan2026).....	33
Figure 4-9: Climate-health interaction patterns for top 10 health risks (overlap dataset). <i>Values indicate the number of included systematic reviews and meta-analyses in which each climate-driver and health-risk combination was identified</i>	33
Figure 4-10: Relative contribution of climate drivers to the ten main health risks. Bars show the percentage distribution of climate-driver associations within each health risk category, based on the co-occurrence counts presented in the previous figure	34
Figure 4-11: Network representation of climate–health associations across the ten main health risks. Link widths are proportional to the number of included reviews identifying a given climate-driver and health-risk combination	35
Figure 6-1: Representation of climate-driver categories in the overlap dataset and in the broader P1 climate–health literature. Counts indicate the number of reviews assigned to each climate-driver category. Reviews may contribute to multiple categories	48



1. INTRODUCTION

1.1. PURPOSE

This document is the Assessment Report Document (D1.1) of the Climate–Health Adaptation through New Generation Earth Observations (CHANGE) project (European Space Agency -ESA- Contract No. 4000149181/25/I-LR).

The Assessment Report Document reviews how Earth Observation (EO) is supporting the description of the climate-related health impacts, reviewing the state-of-the-art and knowledge gaps, and defining science and technical requirements for addressing these knowledge gaps. The Document reports the analyses of the state of the art (SOTA) on the relationship between climate change and health, identifying the main areas of risk and related knowledge gaps, with particular attention to the One Health approach and the use of EO data, and to outline EO-based impact analysis. The report will serve as the basis for consolidating the scientific and technical requirements of subsequent Work Packages.

1.2. SCOPE

The present version 3.0 of the Assessment Report Document (ARD) (D1.1) has been prepared under Work Package (WP) 100 and submitted in support of the Annual Meeting 1 milestone.

The ARD defines the scientific and analytical framework for the CHANGE project by:

- Reviewing the current state of knowledge on climate-related health impacts through a structured SOTA assessment;
- Identifying and characterising the main climate-related health risks;
- Assessing how EO data and products are currently used to support climate–health analyses;
- Identifying scientific, methodological, and data-related knowledge gaps;
- Deriving preliminary scientific and technical requirements to guide subsequent Work Packages.

The document establishes the evidence base upon which WP200 and WP300 will build. It therefore acts as the conceptual and methodological backbone of the project.

This document is structured according to the following sections:

- Section 1 defines the purpose, scope, acronyms, and applicable documents.
- Section 2 presents the objectives of the assessment.
- Section 3 describes the methodology adopted for the SOTA and EO analyses.
- Section 4 synthesises climate-related health impacts and identifies the ten main risks.
- Section 5 analyses the role of Satellite Earth Observation in climate–health research.
- Section 6 consolidates knowledge gaps.
- Section 7 defines the scientific and technical requirements.
- Section 8 presents conclusions and links to subsequent Work Packages.
- Section 9–10 provide references and appendices.

1.3. ACRONYMS

Acronyms used in this document and needing a definition are included in the following table:

Table 1-1: Acronyms.

Acronym	Definition
ABG	Above-Ground Biomass
AD	Applicable Document
ALOS	Advanced Land Observing Satellite

**CHANGE**

Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 8 of 80

Acronym	Definition
AMSTAR-2	A Measurement Tool to Assess Systematic Reviews (Version 2)
AQUM	Atmospheric Quality and Urban Model
ARD	Assessment Report Document
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
AVHRR	Advanced Very High Resolution Radiometer
CCI	Climate Change Initiative
CENTRAL	Cochrane Central Register of Controlled Trials
CHANGE	Climate-Health Adaptation through New Generation Earth Observations
CMIP	Coupled Model Intercomparison Project
CO	Carbon Monoxide
COPERNICUS	European Union Earth Observation Programme
CSV	Comma-Separated Values
DEM	Digital Elevation Model
DMSP-OLS	Defence Meteorological Satellite Program - Operational Linescan System
DOI	Digital Object Identifier
ECV	Essential Climate Variable
ENVISAT	Environmental Satellite
EO	Earth Observation
ESA	European Space Agency
EVI	Enhanced Vegetation Index
FAPAR	Fraction of Absorbed Photosynthetically Active Radiation
GCM	General Circulation Model
GHG	Greenhouse Gases
GIS	Geographic Information System
GFDL	Geophysical Fluid Dynamics Laboratory
GOES-16	Geostationary Operational Environmental Satellite-16
IPCC	Intergovernmental Panel on Climate Change
JPSS-1	Joint Polar Satellite System-1
LAI	Leaf Area Index
LST	Land Surface Temperature
LULC	Land Use / Land Cover
MEDLINE	Medical Literature Analysis and Retrieval System Online
METOP-B	Meteorological Operational Satellite-B
MODIS	Moderate Resolution Imaging Spectroradiometer
MSG-3	Meteosat Second Generation-3
NDVI	Normalized Difference Vegetation Index
NOAA	National Oceanic and Atmospheric Administration
NOAA-12, 18, 19	National Oceanic and Atmospheric Administration - 12, 18, 18
NO2	Nitrogen Dioxide
NPP	Suomi National Polar-orbiting Partnership
PALSAR	Phased Array type L-band Synthetic Aperture Radar
PEO	Population-Exposure-Outcome
PM2.5	Particulate Matter with aerodynamic diameter ≤ 2.5 micrometres
PMID	PubMed Identifier
PRISMA-ScR	Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews
PROBA-V	Project for On-Board Autonomy – Vegetation
RCP	Representative Concentration Pathways
SAVI	Soil-Adjusted Vegetation Index
SO2	Sulphur Dioxide
SOTA	State-of-the-art



Acronym	Definition
SPOT	Satellite Pour l'Observation de la Terre (Satellite for Observation of Earth)
SRES	Special Report on Emissions Scenarios
SRTM	Shuttle Radar Topography Mission
SSH	Sea Surface Height
SSM	Surface Soil Moisture
SSP	Shared Socioeconomic Pathways
SSS	Sea Surface Salinity
SST	Sea Surface Temperature
SWH	Significant Wave Height
TOMS	Total Ozone Mapping Spectrometer
VIIRS	Visible Infrared Imaging Radiometer Suite
WP	Work Package
WRF	Weather Research and Forecasting

1.4. APPLICABLE DOCUMENTS

The following documents, of the exact issue shown, form part of this document to the extent specified herein. Applicable documents are those referenced in the Contract or approved by the Approval Authority. They are referenced in this document in the form [AD.x]:

Table 1-2: Applicable Documents.

Ref.	Title	Code	Version	Date
[AD.1]	Technical Proposal	GMV 10334/25 v1/25	1.0	14/04/2025
[AD.2]	ESA Contract	4000149181/25/I-LR	1.0	22/08/2025
[AD.3]	ITT Statement-Of-Work	ESA-EOP-SC-RS-2024-55	1.0	03/12/2024



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 10 of 80

2. OBJECTIVES

This Assessment Report Document presents the outcomes of the EO, climate, and health assessment carried out within the project. The report addresses three main goals:

- to synthesise the current scientific evidence on the observed and projected impacts of climate change on human health, identifying the principal climate drivers, affected health domains, and determinants of vulnerability, while considering the potential contribution of Earth Observation data to climate–health risk assessment;
- to review the existing knowledge gaps regarding climate-related health impacts;
- to define the scientific and technical requirements needed to address these knowledge gaps using EO data.

To meet these goals, a SOTA analysis on climate-related health impacts is developed. This analysis explains how climate change impacts such as increasing temperatures, sea level rise, extreme weather events, and air quality degradation negatively affect various health domains, including health systems and facilities, human health and well-being, and migration. Ten major climate-related health risks are identified and examined in detail.

The SOTA is based on an extensive literature review covering high-impact scientific publications, policy papers, and climate and health reports, including the most recent IPCC Assessment Reports and other relevant sources.

The assessment also reviews past and current knowledge on climate-related health impacts, identifying areas where satellite-derived climate data records have already been successfully applied, as well as gaps where EO data could provide added value.

Based on the SOTA and the knowledge gap analysis, the document defines a set of scientific and technical requirements. These requirements will guide the activities under WP200 and support the developments foreseen in WP300.



3. METHODOLOGY

This chapter describes the methodological framework adopted to achieve the objectives of the Assessment Report Document (ARD). It details the analytical approach used to conduct SOTA review on climate-related health impacts and to assess the role of EO in supporting climate–health analyses.

Given the breadth and interdisciplinary nature of the climate–health domain, the methodology combines structured literature review procedures, automated data processing techniques, and qualitative synthesis. The approach is designed to ensure transparency, reproducibility, and consistency across thematic areas, while remaining adaptable to the evolving scope of the project.

The methodological workflow is organised into two complementary components:

- A systematic scoping review of scientific and selected grey literature to identify, classify, and synthesise evidence on climate-related health impacts;
- Automated pre-screening, structured manual review and AI-assisted data extraction to characterise health domains, climate drivers and Earth Observation variables.

The chapter focusses on describing the bibliographic sources consulted, the eligibility criteria applied, the automated pre-screening procedures implemented to manage large datasets, and the structured data extraction framework used to enable quantitative and relational analyses. It also explains the analytical logic used to derive climate–health matrices, co-occurrence patterns, and risk clustering.

3.1. SOTA METHODOLOGY

This scoping review is conducted and reported in accordance with the PRISMA Extension for Scoping Reviews (PRISMA-ScR), drawing on established principles of systematic evidence synthesis and adapted to the interdisciplinary nature of climate change–public health–EO research.

Developing an appropriate methodological approach for this SOTA required extensive preliminary work. The definition of a tractable review strategy was itself an iterative process, involving the exploration and testing of multiple approaches before converging on the framework described below.

The breadth of the climate–health interface (spanning virtually the entire spectrum of human pathology, from cardiovascular and respiratory diseases to infectious, mental health, nutritional, and occupational conditions) generates an exceptionally large and heterogeneous body of primary literature. In this context, **systematic reviews and meta-analyses** represent the most appropriate evidence base: they provide syntheses that are already methodologically appraised, consolidated across multiple primary studies, and comparable across disease domains. Focusing on this layer of evidence therefore reflects both the epistemological objectives of the review and the multidisciplinary scope of the field.

This review-of-reviews approach was deliberately adopted to identify convergence, consistency and broader consensus across existing evidence syntheses, rather than to provide an exhaustive inventory of all primary studies.

A comparable higher-order evidence-synthesis approach was adopted by Rocque et al. (2021), who conducted an overview of systematic reviews to provide a broad assessment of the health impacts of climate change. Their search covered the literature up to June 2019, providing a relevant methodological and temporal baseline for the present assessment.

Consistent with this evidence-synthesis approach, the consortium agreed to adopt a common analytical subset for the detailed assessment, ensuring a coherent basis for the subsequent analyses. The criteria used to define this analytical subset are described in Section 3.1.3.

3.1.1. LITERATURE SOURCES AND SELECTION APPROACH

The bibliographic sources include core databases — Scopus (Elsevier), PubMed/MEDLINE (National Library of Medicine), Web of Science Core Collection (Clarivate), and the Cochrane Library — alongside ProQuest databases accessed via the ProQuest platform (including the Health Research Premium Collection, Health & Medical Collection, Healthcare Administration Database, Psychology Database, and Public Health Database). Embase (Elsevier) was also considered as an optional source. Cochrane Library was included as a complementary source because it provides access to systematic reviews, review protocols, and the Cochrane Central Register of Controlled Trials (CENTRAL), which is a concentrated source of reports of randomized and quasi-randomized controlled trials. In the context of



climate change and health, this is relevant because the literature spans a wide range of topics—including heat-related health outcomes, infectious and vector-borne diseases, water- and food-related risks, respiratory impacts, nutrition and food security, mental health, maternal and child health, occupational health, and health-system adaptation—and may include both evidence syntheses and intervention-oriented studies. Cochrane also maintains a dedicated collection on climate change and sustainability focused on evidence relevant to climate change and human health.

Table 3-1: Bibliographic sources.

Core bibliographic databases	ProQuest databases (via ProQuest platform)	Complementary/optional sources
PubMed	Health Research Premium Collection	Google Scholar (optional)
Scopus	Health & Medical Collection	Embase (optional)
Web of Science	Healthcare Administration Database	
Cochrane Library	Psychology Database	
	Public Health Database	

3.1.1.1. GREY LITERATURE

To identify policy-relevant and operational evidence a targeted grey literature search was conducted and the identified documents were added to the overall literature dataset.

This was considered especially important in the climate-health field, where a substantial proportion of relevant evidence may be produced by public institutions, international organisations, research bodies, and policy agencies rather than published exclusively in peer-reviewed journals. The inclusion of institutional reports was therefore intended to strengthen the comprehensiveness of the review and reduce the likelihood of missing relevant evidence not consistently indexed in conventional bibliographic databases.

Fifteen documents were retained and analysed separately from the scientific literature used for the prioritisation of climate-health risks. A comparative analysis examines the degree to which the thematic priorities identified in the grey literature corpus (15 documents, 2020–2026) align with the findings of the SOTA overlap dataset, as described in Chapters 4, 5, and 6 of the present report. The comparison is structured along three dimensions: (1) the distribution of health domains, (2) the distribution of climate drivers, and (3) areas of convergence, divergence, and exclusive contribution from the grey literature.

3.1.2. ELIGIBILITY CRITERIA FOR SCIENTIFIC LITERATURE

Inclusion criteria

- Language: English
- Availability of abstract: required
- Time frame considered: from January 2019 to January 2026.

This time frame was selected to extend the evidence available since base beyond the period covered by Rocque et al. (2021) while supporting the development of the present EO-oriented SOTA assessment.

Query structure

Queries combine climate-related environmental drivers with human health outcomes using a three-block Boolean structure. Within each conceptual category, specific terms are grouped using OR, while the three categories are linked using AND.

The first block captures health outcomes (e.g., cardiovascular disease*, respiratory disease*, mortality); the second block captures climate/environmental exposures (e.g., heat waves, floods, droughts) and the third block includes relational and impact-related terms (impact*, association*, burden*, attributable, effect*) to ensure retrieval of studies explicitly assessing the exposure–outcome relationship. The asterisk (*) is used as a wildcard operator to retrieve all variants of a root term. The following table reports the complete list of keywords included in the search strategy.



Table 3-2: Keywords for SOTA analysis. The asterisk (*) is used as a wildcard operator to retrieve all variants of a root term.

Impacts on human health	Climate and environmental drivers	Relational and impact related
access to healthcare	climate change	impact*
health system*	global warming	association*
food safety	climate variability	burden*
food security	temperature extremes	attributable
migration*	extreme heat	effect*
population displacement	heat wave*	
mortality	extreme cold	
morbidity	drought	
heat-related illness*	water scarcity	
heat stress	flood	
cardiovascular disease*	heavy precipitation	
cerebrovascular disease*	sea level rise	
respiratory disease*	coastal flooding	
infectious disease*	storm surge	
vector-borne disease*	wildfires	
waterborne disease*	fire weather	
foodborne disease*	air pollution	
zoonotic disease*	air quality	
mental health	particulate matter	
sleep disorder*	PM2.5	
neurological disorder*	ozone	
neurodegenerative disease*	urban heat island	
cognitive decline	land use change	
pregnancy outcome*	deforestation	
occupational health	ecosystem degradation	
undernutrition	desertification	
malnutrition	water availability	
Parkinson's disease	water quality	
Alzheimer's disease	freshwater contamination	
dementia	salinity intrusion	
amyotrophic lateral sclerosis	ENSO	
motor neuron disease	El Niño	
circadian rhythm disruption	La Niña	
cancer	urban green	
food insecurity	tropical cyclones	
health infrastructure*	landslide*	
health service disruption	mudflow*	
vaccination	NO2	
Escherichia coli	CO	
intestinal Enterococci	SO2	



Impacts on human health	Climate and environmental drivers	Relational and impact related
Leptospirosis	algal bloom*	
	Ozone at ground-level	

Quotation marks are used for multi-word phrases (e.g., "air quality"), and truncation/wildcards are applied as permitted by each platform to capture spelling and morphological variants (e.g., disease*, variabl*). Any limits (e.g., years, language) are explicitly reported. Full database-specific search strings are reported in Appendix 10.2.

In the initial version of the search query, the "Impacts on human health" and "Climate and environmental drivers/ hazards" groups were considered. Analysis of the resulting records showed that a third group "Relational and impact related" was needed to avoid major noise.

Eligibility criteria were defined using a Population–Exposure–Outcome (PEO) framework, considering studies examining the relationship between climate-related exposures and human health outcomes. Records were considered eligible if they addressed the review question(s), reported relevant outcomes, and provided sufficient methodological detail to support data extraction and synthesis.

Records were excluded if they were clearly outside the scope of the review, did not report relevant outcomes, or lacked sufficient information to allow screening or data extraction (e.g., missing or irretrievable full text when required). Non-eligible publication types (e.g., editorials, commentaries, opinion pieces) were also excluded, except when used solely for reference checking.

3.1.3. SCREENING, REVIEW AND DATA EXTRACTION PROCEDURES

All retrieved records were exported from each database (including full bibliographic metadata and abstracts where available) in CSV or Excel format and merged into a master dataset for structured processing and screening. The dataset was imported into R software for data harmonisation, deduplication, and structured processing prior to screening.

Records were harmonised across sources and deduplicated through a multi-key procedure using PMID, DOI, and Title + Year. Document types were subsequently standardised using a cross-database classification scheme to ensure consistent categorisation across bibliographic sources.

Given the large number of records retrieved from the bibliographic searches, performing a full manual screening of the entire dataset was not feasible within the scope of the SOTA analysis. To address this challenge, an automated pre-screening workflow was implemented in R software. This procedure aimed to define a structured analytical perimeter aligned with the conceptual scope of the review while reducing the volume of records requiring subsequent manual and AI-assisted assessment.

The automated workflow was based on the construction of a derived *ScreenText* field obtained by concatenating *Title*, *Abstract*, *Author_Keywords*, *Index_Keywords*, and *MeSH_Headings*. The resulting text field was subsequently normalised and cleaned to minimise formatting inconsistencies and improve keyword matching.

The first analytical layer relied on harmonised keyword dictionaries representing the two conceptual dimensions of the review: climate-related exposures and health-related outcomes. Records were classified as belonging to the Climate–Health corpus when at least one climate-related term and one health-related term were simultaneously detected within the *ScreenText* field.

In parallel, an independent EO-related classification layer was applied using dedicated Earth Observation and remote-sensing keyword dictionaries. Matching was performed using case-insensitive regular expressions. This procedure generated two complementary EO-related datasets: an EO-explicit corpus, based on a conservative dictionary restricted to explicit references to EO and satellite-based observations, and a broader EO corpus generated using an extended dictionary including satellite missions, EO-derived environmental indicators, geospatial datasets, and spatial-analysis terminology (Appendix 10.3 presents the complete EO dictionaries, including all terms used to generate the EO corpus and the EO-explicit corpus).

The literature search across Scopus, PubMed, Web of Science, Cochrane Library and ProQuest produced a deduplicated master dataset of 42,147 unique records. Following the application of a predefined exclusion taxonomy (e.g., publisher material, editorial-like publications, conference-related material,



CHANGE



Code: D1.1
Date: 25/09/2026
Version: 3.1
Page: 15 of 80

corrections/retractions, reports, and other non-eligible document types), 38,812 records were retained in the final bibliographic master corpus used for analytical synthesis. Grey literature reports were retained separately for the complementary analysis described in Section 4.3.

Application of the Climate–Health classification criterion identified a Climate–Health corpus of 32,226 records, which defines the primary analytical perimeter of the SOTA.

Records not meeting the Climate–Health criterion were retained separately to ensure full traceability of the screening process.

The P1 subset, consisting of **systematic reviews and meta-analyses** addressing climate–health relationships, was prioritised for the synthesis of evidence across the ten climate-related health risk areas and for the identification of research gaps, methodological limitations, and future research needs.

In parallel, EO-related datasets were generated to support the assessment of how Earth Observation data, satellite products, and remote-sensing approaches have been applied within climate–health research. The EO-explicit classification identified 1,918 records, of which 1,899 were also included within the Climate–Health corpus. The broader EO corpus comprised 5,316 records. The EO-explicit corpus was retained as the primary EO classification layer because it provides a transparent and reproducible estimate of literature explicitly referring to EO data and satellite-based methodologies.

To optimise the balance between analytical coverage and screening feasibility, the Consortium agreed to adopt an overlap dataset combining climate–health relevance and explicit EO content as the common analytical subset for detailed review. This overlap subset comprised 150 publications.

The automated pre-screening workflow and the subsequent manual and AI assisted screening and extraction stages planned for the SOTA analysis are illustrated in Figure 3-1. The structure of the analytical datasets and the overlap between the Climate–Health corpus, the P1 subset, the EO corpus, and the EO-explicit records are summarised in Figure 3-2.



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 16 of 80

PRISMA-Adopted SOTA Workflow with automated pre-screening, Manual Eligibility Assessment and AI screening

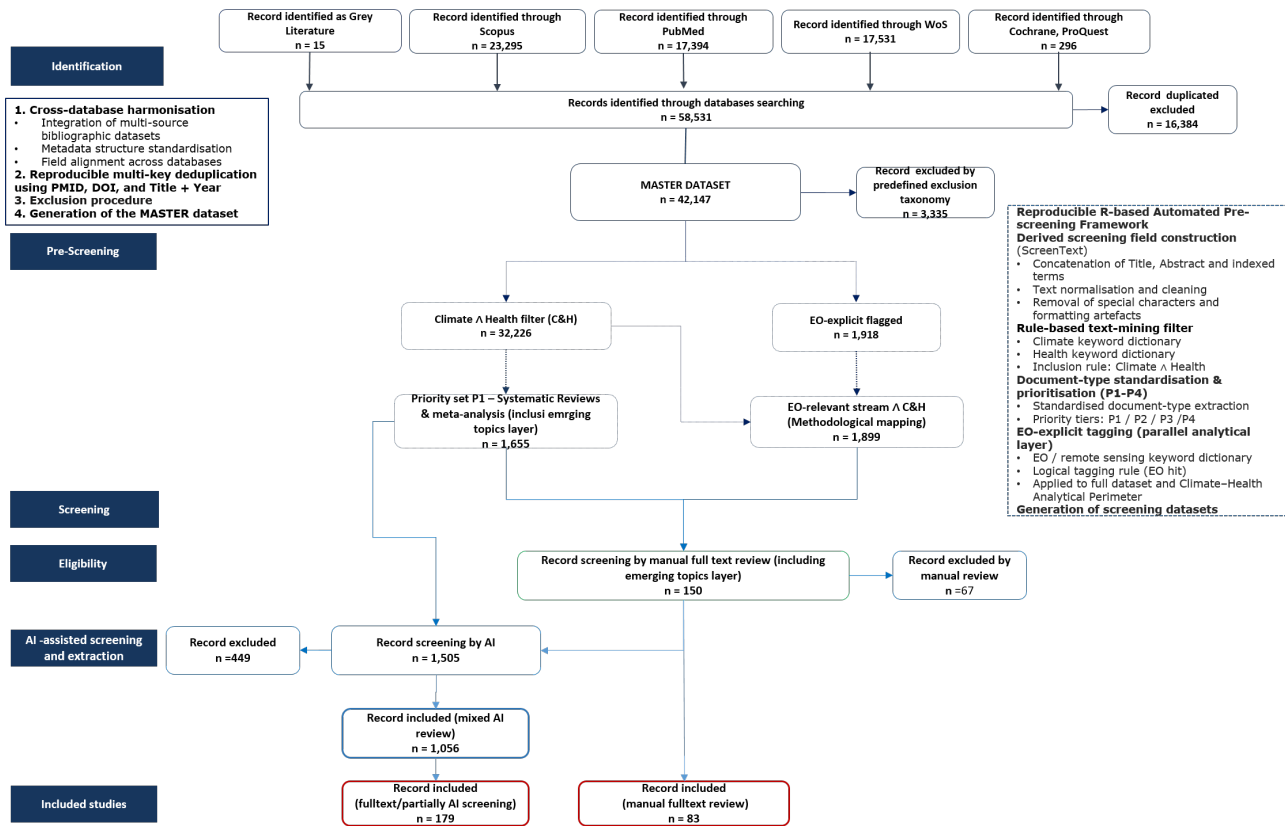


Figure 3-1: Automated pre-screening, manual and AI-assisted review and extraction workflow for the SOTA literature analysis.

Figure 3-1 illustrates the literature selection process combining automated preprocessing in R (database harmonisation, deduplication, Climate-Health tagging, study-type classification and EO identification) with subsequent manual review of the overlap subset and AI-assisted screening, annotation and data extraction. Full-text review was performed whenever available, leading to the final analytical datasets used for the SOTA synthesis and gap analysis.

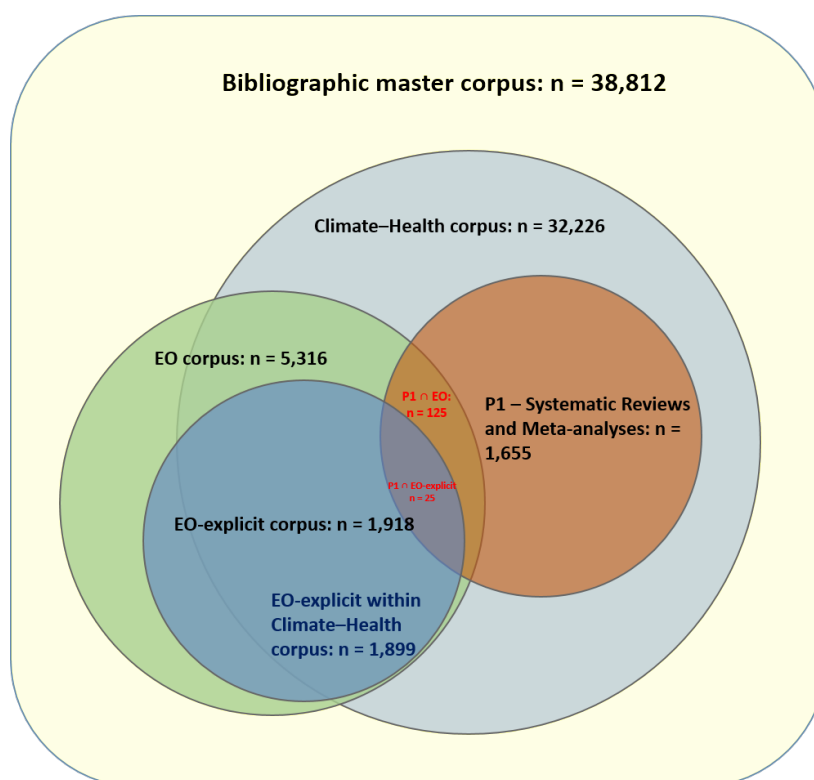


Figure 3-2: Overlap between the Climate-Health corpus, P1 subset, EO and EO-explicit records.

All analytical datasets were managed within a structured literature database shared across project partners.

The database was organised into three main groups of fields:

1. Bibliographic metadata and automated classification fields, generated during the automated preprocessing stage in R. These included: core bibliographic information (e.g., ID, source, authors, year, title, DOI, abstract, author and indexed keywords, MeSH headings) together with automated classification variables such as *hit_climate*, *hit_health*, *eo_explicit*, and *priority_group*.
2. Screening and validation workflow fields, used to document manual review decisions and ensure traceability across reviewers. These fields included reviewer identification, screening status, exclusion reasons, validation outcomes, and final inclusion status.
3. Analytical extraction fields, populated during manual and AI-assisted full-text review to capture the variables required for the SOTA synthesis. These included geographical scope, study context, health domains and pathologies investigated, examined populations, climate drivers, Earth Observation datasets, missions, sensors, climate projection data, key findings, and identified research gaps or limitations.

The complete structured extraction framework is summarised in Table 3-3.

Table 3-3: Structured Data Extraction Framework. Overview of screening, validation and analytical extraction fields (Literature Database).

1. Bibliographic Metadata & Automated Flags	2. Screening & Validation Workflow	3. Geographical & Study Context
Core Metadata ID; Source; Source type (List); Authors; Year; Title; Journal / Source; DOI / URL; Abstract; Author_Keywords; Index_Keywords; MeSH_Headings	Partner Reviewer; Screening Status (List); Reason for exclusion (List); Source of record (Central / Partner-proposed); Proposed by (Initials); Second Reviewer (Initials);	Geographical scope (List); Continent(s); Country(ies); Region(s); Study_period_reported; Study_period_start_year;



Automated Flags hit_climate; hit_health; eo_explicit; priority_group	Validation (List); Final Inclusion Status	Study_period_end_year
4. Core Climate–Health Analytical Variables Health Domain (descriptive keywords); Pathologies; Examined population; Climate factor category (List); Climate Driver(s) analysed (descriptive keywords)	5. Earth Observation (EO) Variables EO Data Included (List); ECV variables; EO Datasets; EO mission; EO sensors; CCI (List); Climate Projection Data (List); Climate_projection_source; Climate projection scenario(s); Climate projection period(s)	6. Synthesis & Gap Identification Key Findings; Gaps / Limitations; Notes
7. Core categories FINAL_OUTPUT:Health Risks; FINAL_OUTPUT:CLIMATE_ITEMS; FINAL_10_CLIMATE_HEALTH_RISKS; MAPPING_NOTE		

Dedicated Excel files, structured into separate worksheets, are shared through a common consortium workspace. They contain both the datasets and the rules, dictionaries and criteria used to build them, supporting transparent interpretation, traceability and future reuse by project partners. In addition, a folder of automatically retrieved PDFs has been provided, including 150 scientific papers comprising to the Overlap dataset.

Manual screening and overlap review

A dedicated manual review was conducted on the overlap dataset, comprising 150 publications identified as relevant to both the climate–health and EO dimensions of the project.

Each record was independently assessed by two reviewers. Reviewers evaluated whether the study addressed climate-related exposures, reported relevant human health outcomes, and provided sufficient information to support subsequent data extraction and synthesis.

During the review process, records were assigned a final inclusion status ("Included" or "Excluded"), and exclusion reasons were documented where applicable. For included studies, reviewers manually annotated the structured extraction fields defined in the literature database, including health domains, climate drivers, geographical information, EO-related variables, key findings, and limitations (as in Table 3-3).

The manually reviewed overlap dataset served as the reference dataset for the subsequent AI-assisted screening and extraction workflow. In addition to providing the common evidence base for the detailed climate–health research, it was used to harmonise annotation procedures, validate AI-generated outputs, and support the quality-control process applied to the broader P1 dataset.

AI-assisted screening and extraction

Following the automated pre-screening and manual review of the overlap subset, an AI-assisted screening and structured data extraction workflow was implemented using SciSpace. The manually reviewed overlap dataset was used as a reference framework to calibrate and harmonise the AI-assisted review process.

SciSpace was instructed to reproduce the screening and annotation logic applied during manual review, including eligibility assessment, climate-driver identification, health-domain characterisation, EO-related information extraction, geographical classification, and structured evidence extraction. The manually reviewed overlap dataset therefore served as a training and quality-control reference for the subsequent AI-assisted annotation workflow.

The AI-assisted workflow was then applied to the broader **P1 subset**. Full texts were reviewed whenever available through SciSpace. When full-text access was not available, screening and extraction relied on titles, abstracts, author keywords, indexed keywords, MeSH headings, and other available bibliographic metadata. In such cases, missing information was recorded as "Not reported" rather than inferred.



The AI-assisted procedure supported the completion of the structured extraction fields defined in the literature database, including geographical scope, study context, health domains, pathologies investigated, climate drivers, EO relevance, EO datasets, key findings, limitations, and identified research gaps. This approach enabled the extension of the structured review framework developed during manual review to the broader P1 corpus while maintaining methodological consistency across the SOTA analysis.

Across the P1 subset, full-text or partial full-text content was available for 179 of the 1,056 records retained after AI-assisted screening (approximately 17%). The remaining records were reviewed using titles, abstracts, author keywords, indexed keywords, MeSH headings, and other available bibliographic metadata. In addition, 449 records were classified as excluded during the AI-assisted screening process.

Additional details on the AI-assisted workflow and prompt-engineering strategy are provided in Appendix 10.4.

Validation of AI-assisted screening

To evaluate the reliability of the AI-assisted workflow, a validation exercise was conducted using the manually reviewed overlap dataset as the reference standard. Three harmonised datasets were considered: (i) the manually reviewed overlap dataset, (ii) an AI-assisted FullText overlap dataset generated using the same SciSpace workflow subsequently applied to P1 and based on all available full-text documents (150 pdfs), and (iii) an AI-assisted ScreenText overlap dataset generated using only the screening information available through titles, abstracts, author keywords, indexed keywords and MeSH headings. To ensure comparability, the three datasets were harmonised through an automated standardisation procedure implemented in SciSpace, which standardised field names, controlled vocabularies and multi-label annotations across health, climate, EO, geographical and temporal variables.

The validation exercise was designed to provide an objective assessment of the reliability of AI-assisted screening and extraction and to support evidence-based decisions regarding the subsequent use of AI-generated annotations within the SOTA analysis. More specifically, the validation aimed to: (i) compare FullText and ScreenText extraction strategies; (ii) quantify agreement between manual and AI-assisted annotations; and (iii) determine which variables could be used directly, used with caution, or required additional manual review before inclusion in subsequent analyses.

Agreement was evaluated using precision, recall, F1-score, exact agreement and Jaccard similarity, depending on the nature of the variable being assessed. Inclusion/exclusion decisions generated through the FullText and ScreenText workflows were first compared against the manually reviewed overlap dataset.

Results showed that the ScreenText workflow achieved a substantially higher recall (91.6%) than the FullText workflow (56.6%), correctly identifying most manually included studies (Table 3-4; Figure 3-3). However, this performance was associated with a considerably larger number of false positives ($n = 60$), indicating a strong tendency to over-include records. In contrast, the FullText workflow generated fewer false positives ($n = 29$) and provided a more conservative and interpretable basis for subsequent structured extraction. Although ScreenText achieved a higher overall F1-score, its reduced specificity and elevated false-positive rate made it less suitable for downstream analyses. Consequently, FullText annotations were retained for subsequent analyses, whereas ScreenText annotations were not used beyond the validation exercise.

Table 3-4: Comparison of FullText and ScreenText inclusion screening performance against the manually reviewed overlap dataset.

Method	Precision	Recall	F1
FullText	61.8	56.6	59.1
ScreenText	55.9	91.6	69.4

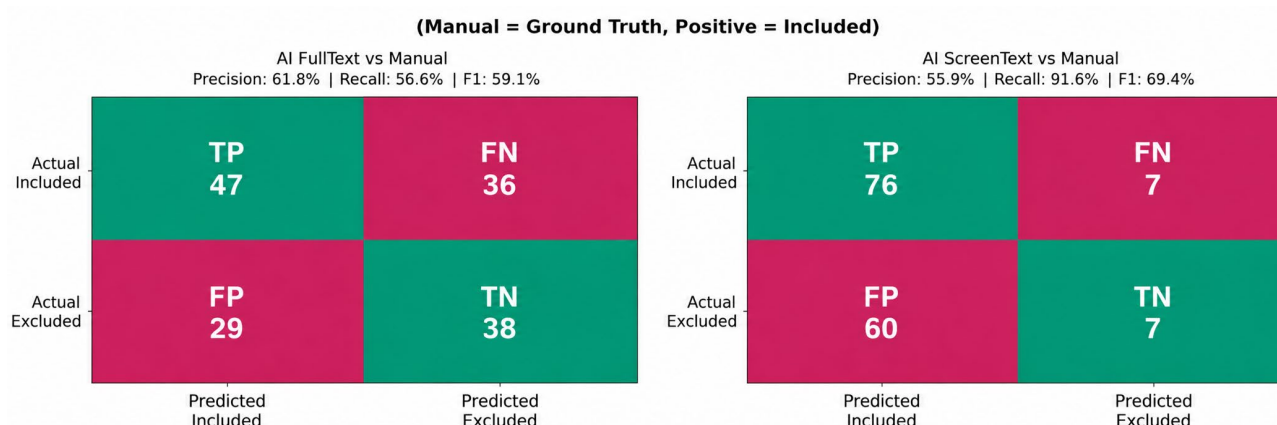


Figure 3-3: Confusion matrices comparing FullText and ScreenText inclusion decisions against the manually reviewed overlap dataset.

The figure highlights the substantially higher number of false positives generated by the ScreenText workflow.

Following the exclusion of ScreenText from subsequent analyses, a second validation step focused exclusively on the FullText annotations generated for the 83 manually included overlap records. The objective was to assess which scientific-content variables could be reliably extracted and subsequently used within the gap analysis.

To support interpretation, field-level agreement results were translated into operational recommendation categories based on mean F1-scores. Three recommendation levels were defined: Reliable ($F1 \geq 70\%$), Usable with caution ($F1 = 40\text{--}69\%$), and Manual review required ($F1 < 40\%$). These thresholds were intended as practical decision-support criteria rather than formal statistical significance thresholds.

Agreement was highest for EO sensors and EO missions ($F1 > 70\%$). Health Domains also showed good agreement after correction of the compared fields ($F1 = 71.9\%$; Jaccard = 64.4%). EO Data Included, EO Datasets, and Climate Drivers showed moderate agreement and should therefore be used with caution.

Table 3-5: Reliability assessment of AI-assisted FullText annotations based on comparison with the manually reviewed overlap dataset (n = 83 included studies).

Field	Mean Jaccard (%)	Mean F1 (%)	Reliability Zone
EO Sensors	73,5	73,5	✓ Reliable
EO Mission	72,3	72,3	✓ Reliable
Health Domains	64,4	71,9	✓ Reliable
EO Data Included	57,8	57,8	⚠ Use with caution
Climate Drivers	56	65,8	⚠ Use with caution
EO Datasets	51,8	51,8	⚠ Use with caution

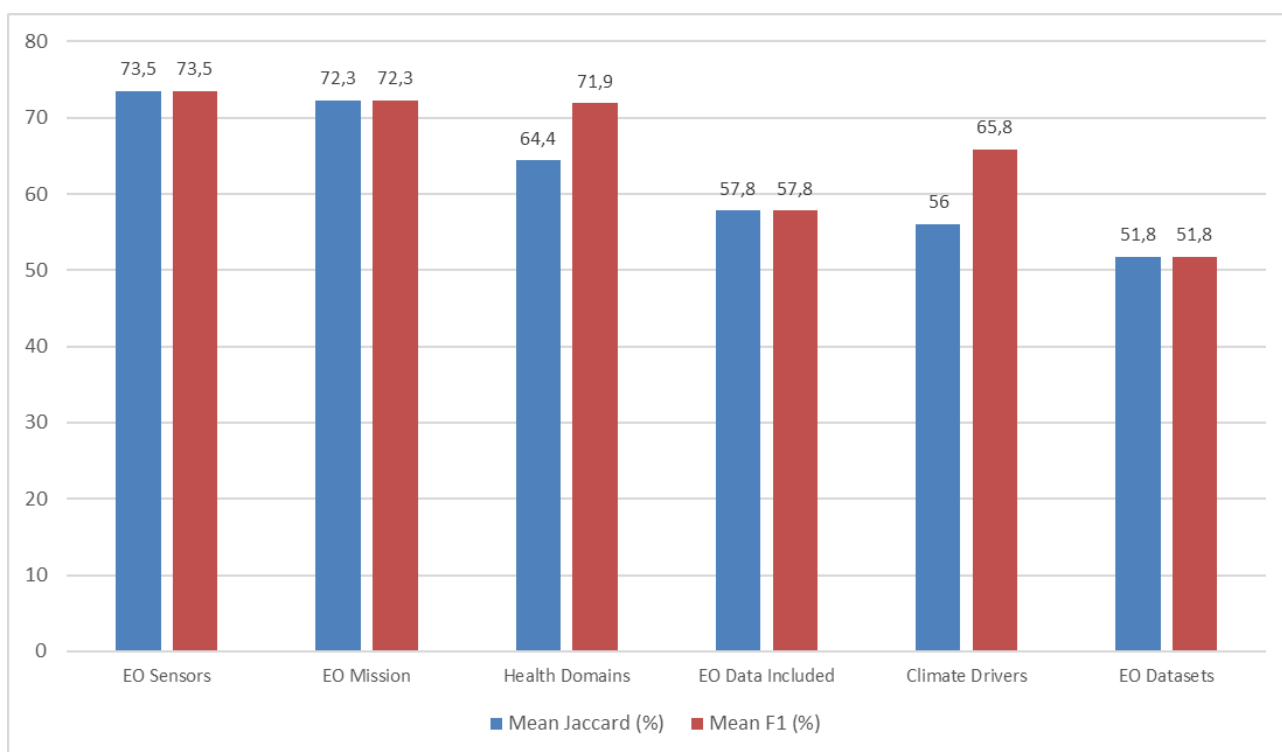


Figure 3-4: Agreement between manual annotations and AI-assisted FullText extraction for scientific-content variables. F1-score and Jaccard similarity are shown for health, climate and EO-related fields based on the 83 manually included overlap records.

Additional validation analyses were conducted for geographical, temporal, and population-related variables (Figure 3-5). Geographical and temporal descriptors showed moderate agreement and may be used for broad descriptive purposes, although with caution. In contrast, examined population showed very low agreement with the manually reviewed overlap dataset (F1 = 11.6%; Jaccard = 8.6%; Figure 3-6). Despite high completeness in the AI-assisted FullText extraction, the low agreement indicates that population-related annotations are not sufficiently reliable for direct analytical use and require manual verification.

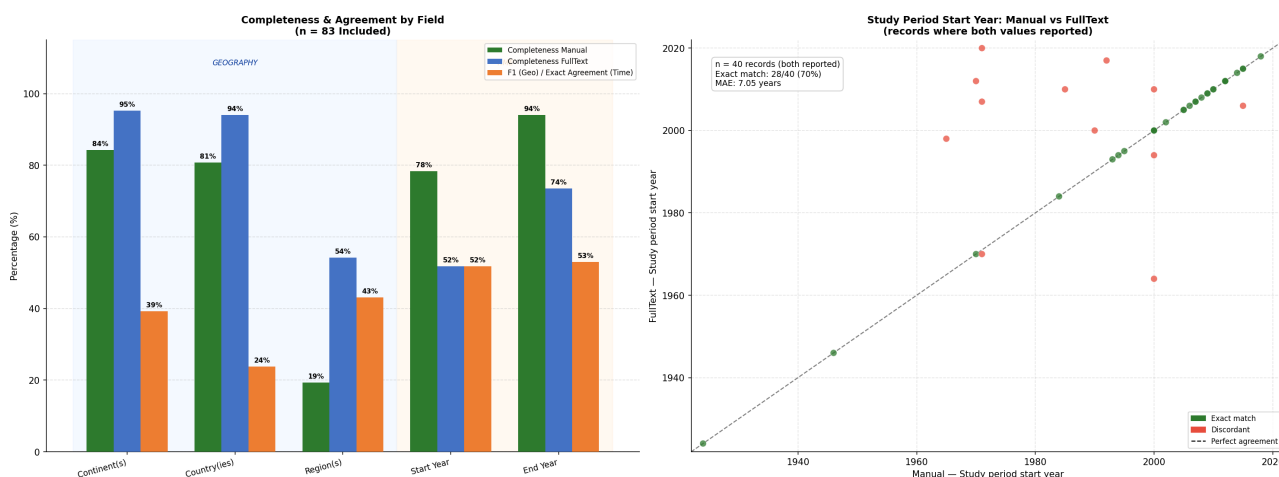


Figure 3-5: Validation of geographical and temporal variables. Completeness and agreement metrics are reported for continents, countries, regions, study start year, and



study end year. The figure also illustrates agreement between manually extracted and AI-extracted study start years for records where both values were available.

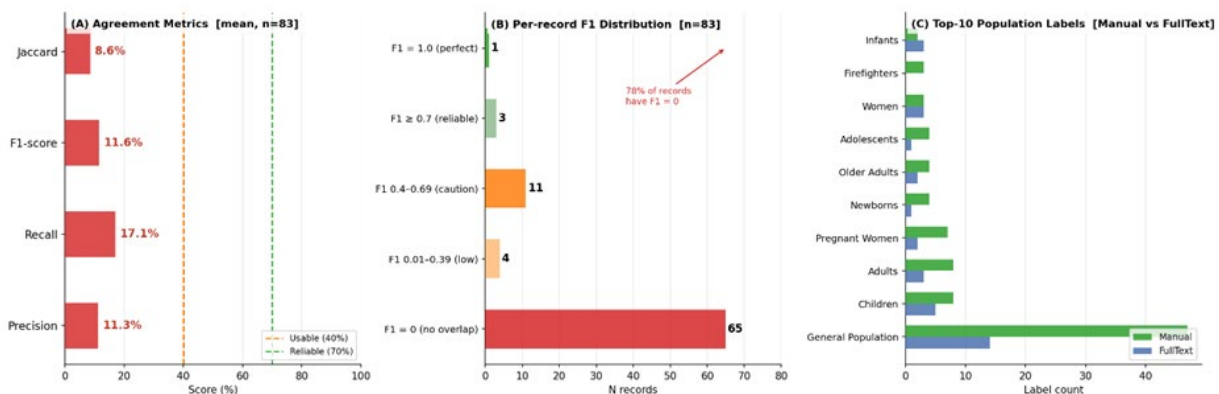


Figure 3-6: The figure reports aggregate agreement metrics (Precision, Recall, F1-score, and Jaccard similarity), the distribution of record-level F1-scores, and the comparison of the most frequently assigned population categories between manual and AI-assisted annotations.

3.1.4. IDENTIFICATION AND SYNTHESIS OF CLIMATE-RELATED HEALTH RISKS

The identification and synthesis of climate-related health risks are based on the structured SOTA analysis described above.

Climate drivers and health domains are systematically mapped within a structured climate–health matrix derived from the harmonised literature database, using the fields “Climate factor category”, “Climate Driver(s) analysed”, “Health Domain”, and “Pathologies”.

This mapping allows the organisation of evidence according to the intersections between specific climate exposures and health outcomes. The relationships between climate factors and health domains are examined through qualitative synthesis, considering the consistency, recurrence, and robustness of associations reported in the literature.

The identification of recurrent climate–health interaction patterns is supported by quantitative evidence mapping (e.g., frequency of associations and co-occurrence patterns) and a structured qualitative interpretation of recurring climate–health relationships.

The identification and synthesis of climate-related health risks presented here are based on the manual screening and full-text review of the overlap dataset.

The following tables report the regex patterns applied for each climate driver and health domain category, derived from the keyword dictionaries used in the R workflow.

Table 3-6: Climate drivers implemented.

CLIMATE ITEMS	Specific climate elements
AIR POLLUTION	"air pollution" OR pollution OR pollutant* OR "particulate matter" OR PM2.5 OR PM10 OR particle* OR ozone OR NO2 OR SO2 OR CO OR "nitrogen dioxide" OR "sulfur dioxide" OR "carbon monoxide" OR smog OR emission* OR exhaust OR "traffic-related" OR "air quality" OR AQI OR "ambient air"
TEMPERATURE & HEAT	temperature* OR heat* OR cold* OR "thermal" OR "diurnal temperature range" OR DTR OR hyperthermia OR hypothermia OR "extreme temperature*" OR "weather exposure"
EXTREME WEATHER EVENTS - FLOODS AND STORMS	flood* OR hurricane* OR typhoon* OR cyclone* OR storm* OR rainfall OR precipitation OR landslide* OR "sea level" OR "coastal"
EXTREME WEATHER EVENTS - FIRES	wildfire* OR fire*
EXTREME WEATHER EVENTS - DROUGHT	drought*



CLIMATE ITEMS	Specific climate elements
EXTREME WEATHER EVENTS - OTHERS	"extreme weather" OR disaster* OR "natural hazard*"
CLIMATE CHANGE (GENERAL)	climate* OR "global warming" OR warming OR "climate variability" OR "climate change" OR "climate risk*" OR "climate impact*" OR "climate adaptation" OR "climate mitigation"
WATER & HYDROLOGICAL	water OR "water quality" OR "drinking water" OR groundwater OR hydrolog* OR salin* OR "water scarcity" OR "water stress" OR "water availability" OR "surface water" OR "freshwater"
LAND USE & URBAN ENVIRONMENT	urban* OR "urban heat island" OR UHI OR "built environment" OR "green space*" OR greenness OR vegetation OR NDVI OR "land use" OR deforest* OR reforest* OR "land cover"
ENVIRONMENTAL CHEMICAL EXPOSURES (NON AIR)	chemical* OR pesticide* OR herbicide* OR insecticide* OR metal* OR "heavy metal*" OR lead OR mercury OR cadmium OR arsenic OR toxin* OR contaminant* OR PFAS OR phthalate* OR bisphenol* OR BPA OR "endocrine disruptor*" OR POPs
FOOD SYSTEMS & AGRICULTURE	agricultur* OR crop* OR livestock OR farming OR irrigation OR "food production" OR "food supply" OR "food system*" OR soil OR "soil moisture"
OCCUPATIONAL CLIMATE EXPOSURE	work* OR worker* OR workplace* OR occupation* OR occupational* OR labour* OR labor* OR farmworker* OR "outdoor worker*" OR "construction worker*"

Table 3-7: Health domains implemented.

Health domain	Regex pattern applied (OR list)
CARDIOVASCULAR AND CEREBROVASCULAR	cardiovascular\w* cerebrovascular\w* stroke\w* ischemic stroke\w* ischaemic stroke\w* hemorrhagic stroke\w* haemorrhagic stroke\w* myocardial infarction\w* heart failure\w* coronary artery disease\w* hypertension\w* high blood pressure atrial fibrillation\w* peripheral artery disease\w* thrombo\w* embolism\w* ischemic heart disease\w* ischaemic heart disease\w* cardiac arrest\w* angina atherosclerosis\w*
NEUROLOGICAL DISEASES	neurolog\w* neurodegenerat\w* dementia\w* Alzheimer\w* Parkinson\w* epilep\w* multiple sclerosis cognitive decline\w* cognitive impairment\w* neurodevelopment\w* autism\w* neuropath\w* brain injur\w* traumatic brain injur\w* bTBI\b neuroinflammation\w* motor neuron disease\w* bALS\b encephalopath\w* seizure\w*
RESPIRATORY DISEASES	respirator\w* asthma\w* bCOPD\b chronic obstructive pulmonary pneumonia\w* lung function\w* pulmonary\w* bronchitis bARDS\b acute respiratory distress\w* influenza\w* tubercul\w* airway disease\w* wheez\w* dyspnea\w* dyspnoea\w*
CANCER	cancer\w* carcinoma\w* tumor\w* tumour\w* neoplasm\w* malignan\w* oncolog\w* leukemia\w* leukaemia\w* lymphoma\w* metastas\w* adenocarcinoma\w* sarcoma\w* glioma\w* melanoma\w* colorectal cancer\w* breast cancer\w* lung cancer\w* prostate cancer\w*
INFECTIOUS DISEASES (NON-VECTOR / NON-FOODBORNE)	infectious disease\w* infection\w* communicable disease\w* viral infection\w* bacterial infection\w* parasitic infection\w* sepsis bHIV\b bAIDS\b hepatitis COVID\w* SARS-CoV\w* meningitis
VECTORBORNE DISEASES	vector-borne vector borne mosquito\w* tick-borne tick borne dengue\w* malaria\w* zika\w* chikungunya\w* west nile leishmania\w* leishmaniasis lyme disease borrelia\w* arbovirus\w* aedes anopheles culex
FOOD_ WATERBORNE DISEASES	foodborne food-borne waterborne water-borne diarrh\w* cholera\w* salmonella\w* campylobacter\w* E. coli Escherichia coli norovirus\w* gastrointestinal infection\w* gastroenteritis drinking water contamination enteric infection\w*
METABOLIC & ENDOCRINE DISEASES	diabet\w* obesity obese overweight body mass index bBMI\b metabolic syndrome metabol\w* disorder\w* dyslipidemia\w* hyperglyc\w* insulin resistance endocrin\w*
RENAL DISEASES	renal kidney nephro\w* chronic kidney disease\w* bCKD\b uremia liver hepatic hepat\w* cirrhosis liver disease\w*
LIVER DISEASES	liver hepatic hepat\w* cirrhosis liver disease\w*
HEAT-RELATED DISEASES	heatwave\w* heat wave\w* heat-related heat related heat stress\w* heatstroke\w* heat stroke\w* extreme heat high temperature\w* thermal stress\w* hyperthermia\w* temperature-related mortality hot weather exposure
MENTAL HEALTH	mental health depression\w* depressive symptom\w* anxiety\w* suicide\w* suicidal ideation bPTSD\b post-traumatic stress\w* psychological distress psychiatric\w* bipolar disorder\w* schizophrenia\w* mood disorder\w* stress-related disorder\w* self-harm



Health domain	Regex pattern applied (OR list)
MATERNAL – PREGNANCY OUTCOMES	maternal pregnancy pregnancies pregnant women birth outcome\w* preterm birth\w* low birth weight stillbirth\w* gestational diabetes preeclampsia pre-eclampsia neonatal outcome\w* neonatal mortality miscarriage\w* fetal growth restriction perinatal outcome\w*
FOOD SECURITY	food security food insecurity malnutrition\w* undernutrition\w* hunger nutritional status dietary diversity famine\w* household food security stunting wasting micronutrient deficiency\w*
FOOD SAFETY	food safety food contamination pesticide residue\w* heavy metal\w* in food aflatoxin\w* mycotoxin\w* risk assessment bHACCP b food regulation\w* microbial contamination chemical contamination food quality control food hygiene
HEALTH SYSTEMS DISRUPTION	health system\w* healthcare system\w* health service\w* healthcare access health policy\w* health infrastructure\w* health workforce primary care hospital capacity health expenditure\w* service delivery universal health coverage health resilience
OCCUPATIONAL HEALTH	occupational exposure\w* workplace\w* worker\w* occupational disease\w* work-related industrial exposure\w* farmworker\w* labourer\w* laborer\w* workplace injury\w* occupational hazard\w* work environment\w* occupational safety
ALLERGIC – ATOPIC DISEASES	allergy\w* atopic\w* atopic dermatitis eczema\w* allergic rhinitis hay fever urticaria\w* hypersensitivity\w* food allergy\w* contact dermatitis
MIGRATION – DISPLACEMENT	migration\w* migrant\w* refugee\w* displacement\w* displaced population\w* climate migration internally displaced asylum seeker\w* forced migration migration health

3.2. EO-DRIVEN METHODS FOR CLIMATE–HEALTH RISK ANALYSIS

The systematic reviews and meta-analyses included in the assessment report (common overlap subset) were further analysed to identify EO-related information, including specific datasets, missions, sensors, and other relevant technical details. Where reported, the role of EO-derived information within the climate-health analysis (e.g., as an exposure variable) was also characterised. Specific examples of the information above were then provided and, from these, summaries could be drawn and knowledge gaps for future research identified.

3.3. METHODOLOGICAL CONSIDERATIONS AND LIMITATIONS

The present assessment adopted a review-of-reviews approach, as in Rocque et al, 2021, prioritising systematic reviews and meta-analyses as the principal evidence base for the climate-health component of the SOTA analysis. This methodological choice was considered appropriate given the breadth and heterogeneity of the climate-health domain, which spans a wide range of environmental exposures, health outcomes and geographical contexts. By focusing on existing evidence syntheses, the approach was intended to identify recurring patterns, areas of convergence and broader consensus across the literature, while maintaining comparability across health domains.

This approach also entails limitations in the level of detail that can be captured from the underlying primary literature. By working at the level of systematic reviews and meta-analyses, the assessment necessarily relies on the information selected, synthesised and reported by the authors of those reviews. As a result, methodological details, study-specific characteristics and contextual information available in individual primary studies may not be retained in the evidence syntheses.

The review-of-reviews approach provides a robust overview of the main climate and health domains and of the associations represented in the literature, reflecting the established use of systematic reviews and meta-analyses for evidence synthesis in medical and public health research. The EO component was examined within the common overlap subset, where available information on EO datasets, missions, sensors and related methodological characteristics was extracted. For a rapidly evolving field such as EO, specific information is often reported only at a general level in these sources, limiting the possibility of fully characterising how EO data are actually used within climate-health research.

These methodological considerations should be considered when interpreting the findings and knowledge gaps identified in this assessment.



4. OVERVIEW OF CLIMATE-RELATED HEALTH IMPACTS

This chapter summarises the main findings emerging from the climate–health literature included in the overlap dataset. It describes the distribution of health domains and climate drivers across the reviewed studies, examines their interactions, and identifies the ten most frequently represented climate-related health risks.

4.1. SYNTHESIS OF THE SOTA EVIDENCE

Distribution of health domains

The overlap dataset encompasses a broad range of health outcomes, reflecting the diversity of topics currently addressed within the climate–health literature. Studies were classified into multiple health domains when relevant, allowing a single publication to contribute to more than one category. Cardiovascular and cerebrovascular diseases emerged as the most frequently represented health domain ($n = 30$), followed by respiratory diseases ($n = 29$). Mental health ($n = 24$), infectious diseases excluding vector- and foodborne diseases ($n = 23$), and food- and waterborne diseases ($n = 21$) were also prominently represented. Maternal and pregnancy-related outcomes, metabolic and endocrine diseases, cancer, neurological diseases, and vector-borne diseases appeared with intermediate frequency, while domains such as food safety, health systems disruption, migration and displacement, occupational health, and liver diseases were less commonly addressed. The complete distribution of health domains across the overlap dataset is shown in Figure 4-1.

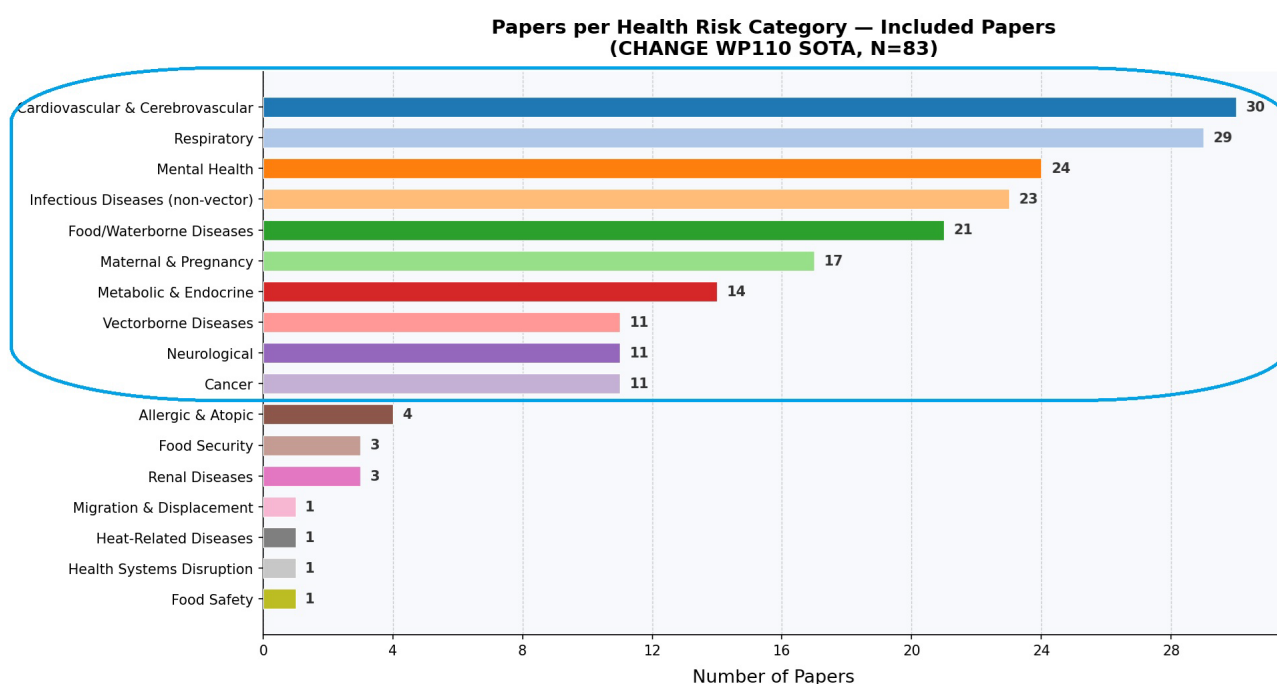


Figure 4-1: Number of papers by health categories (overlap dataset, 2019-jan 2026). The blue box highlights the top 10 climate-related health risks (discussed in section 4.2).

Distribution of climate drivers

The climate drivers identified in the overlap dataset cover a broad range of environmental exposures and climate-related hazards represented within the reviewed literature. As studies could be associated with multiple climate drivers, the counts presented reflect the number of studies linked to each category rather than mutually exclusive classifications. Air pollution emerged as the most frequently represented climate driver ($n = 51$), followed by extreme weather events related to fires ($n = 35$), temperature and heat ($n = 32$), and floods and storms ($n = 30$). Land use and urban environment, climate change (general), and water and hydrological factors were also commonly represented. Other categories, including food systems and agriculture, droughts, occupational climate exposure, and environmental



chemical exposures other than air pollution, appeared less frequently. The complete distribution of climate drivers across the overlap dataset is shown in Figure 4-2.

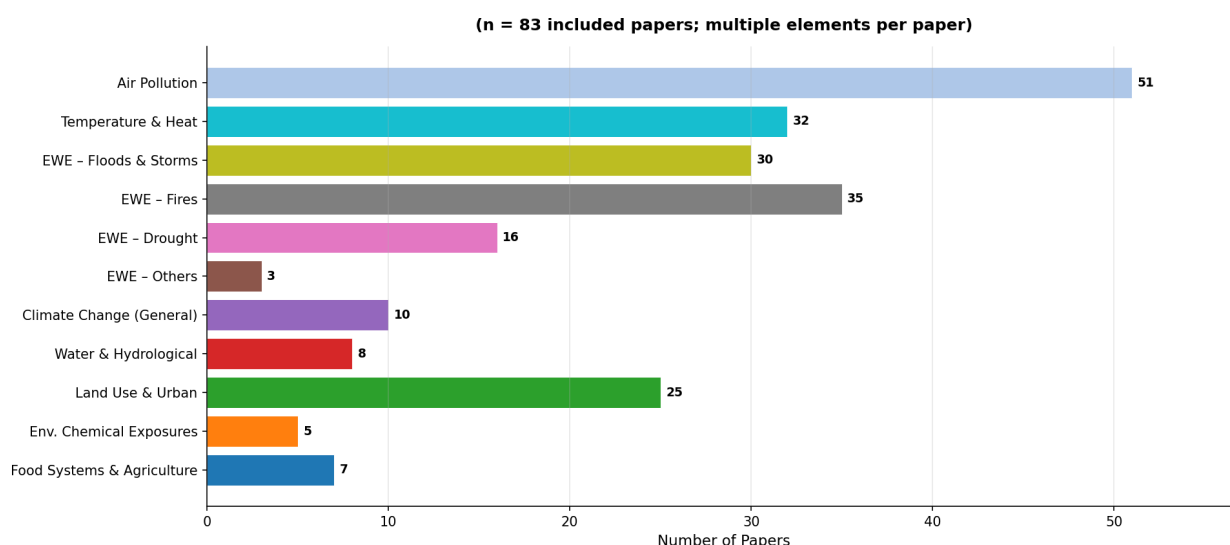


Figure 4-2: Number of papers by climate categories (overlap dataset, 2019- Jan 2026).

Climate-health interaction patterns

While Figure 4-1 and Figure 4-2 describe the distribution of health domains and climate drivers separately, the climate-health co-occurrence matrix provides an integrated view of how these dimensions interact across the reviewed literature. Because studies could be assigned to multiple health domains and climate drivers, the matrix highlights recurring patterns of association rather than exclusive exposure-outcome relationships. The resulting structure reveals the complexity of climate-related health impacts and the diversity of pathways through which environmental factors may affect health.

	CARDIOVASCULAR AND CEREBROVASCULAR DISEASES	RESPIRATORY DISEASES	MENTAL HEALTH ISSUES	INFECTIOUS DISEASES (NON VECTOR / NON FOODBORNE)	FOOD- WATERBORNE DISEASES	MATERNAL – PREGNANCY OUTCOMES	METABOLIC & ENDOCRINE DISEASES	CANCER	NEUROLOGICAL DISEASES	VECTORBORNE DISEASES	ALLERGIC – ATOPIC DISEASES	FOOD SECURITY	RENAL DISEASES	FOOD SAFETY	HEALTH SYSTEMS DISRUPTION	HEAT-RELATED DISEASES	MIGRATION – DISPLACEMENT
AIR POLLUTION	24	26	9	16	13	13	10	9	7	4	4	2	3	0	1	1	1
CLIMATE CHANGE (GENERAL)	3	3	3	4	3	1	1	2	0	3	0	1	1	0	0	0	0
ENVIRONMENTAL CHEMICAL EXPOSURES (NON AIR)	2	2	1	1	1	3	1	2	3	2	1	1	1	0	1	1	0
EXTREME WEATHER EVENTS - DROUGHT	6	6	10	5	5	2	2	1	2	4	1	2	3	1	1	1	0
EXTREME WEATHER EVENTS - FIRES	15	19	16	8	6	8	4	4	3	3	1	1	2	0	1	1	0
EXTREME WEATHER EVENTS - FLOODS AND STORMS	4	5	11	13	13	4	1	2	2	10	2	2	2	1	1	1	0
EXTREME WEATHER EVENTS - OTHERS	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0
FOOD SYSTEMS & AGRICULTURE	1	2	1	4	4	0	0	1	0	1	0	2	1	0	0	0	1
LAND USE & URBAN ENVIRONMENT	9	9	5	11	9	5	8	5	4	4	3	1	0	0	0	0	1
TEMPERATURE & HEAT	10	9	12	15	15	3	3	4	3	10	2	2	3	1	1	1	0
WATER & HYDROLOGICAL	1	1	1	5	5	2	1	1	1	5	1	2	2	0	1	1	1

Figure 4-3: Climate-Health co-occurrence matrix (overlap dataset, 2019- Jan 2026). Multi-label co-occurrence counts between climate-driver categories (rows) and health domains (columns) across 83 systematic reviews included in the overlap dataset (2019-Jan 2026). Each cell indicates the number of reviews in which the corresponding driver and health domain were jointly identified. Because tagging is multi-label, individual reviews may contribute to multiple cells across rows and columns.

Figure 4-3 highlights the existence of distinct climate–health interaction patterns across the reviewed literature. Air pollution is predominantly associated with cardiovascular and cerebrovascular diseases and respiratory diseases, but also shows substantial links with infectious diseases, maternal and pregnancy-related outcomes, and cancer.

In contrast, floods and storms are more frequently associated with infectious diseases, food- and waterborne diseases, and vector-borne diseases, reflecting the importance of water-related and ecological pathways in shaping health risks. Temperature and heat display a broader spectrum of associations, spanning both chronic and infectious health outcomes, including cardiovascular diseases, mental health issues, food- and waterborne diseases, infectious diseases, and vector-borne diseases.

Fires appear most strongly connected to respiratory, cardiovascular, and mental health outcomes, while land-use and urban-environment factors show more diffuse associations across several health domains.



Overall, the matrix suggests that different climate drivers tend to be associated with characteristic health profiles, indicating that climate-related health impacts are mediated through multiple and partially distinct pathways.

Temporal distribution of health domains

The temporal distribution of health domains provides an overview of how different climate-related health topics have been represented in the literature over time.

Figure 4-4 shows the number of included reviews associated with each health domain by publication year. Cardiovascular and cerebrovascular diseases, respiratory diseases, mental health, infectious diseases, and food- and waterborne diseases were consistently represented throughout the study period and accounted for a substantial proportion of the literature published between 2021 and 2025.

Several other domains, including maternal and pregnancy-related outcomes, metabolic and endocrine diseases, cancer, and neurological diseases, also appeared regularly, although with lower frequencies.

In contrast, categories such as food safety, health systems disruption, migration and displacement, heat-related diseases, and renal diseases were represented by only a small number of publications. Overall, the figure suggests that while a core group of health domains has attracted sustained attention within the climate-health literature, other areas remain comparatively underrepresented and may warrant further investigation.

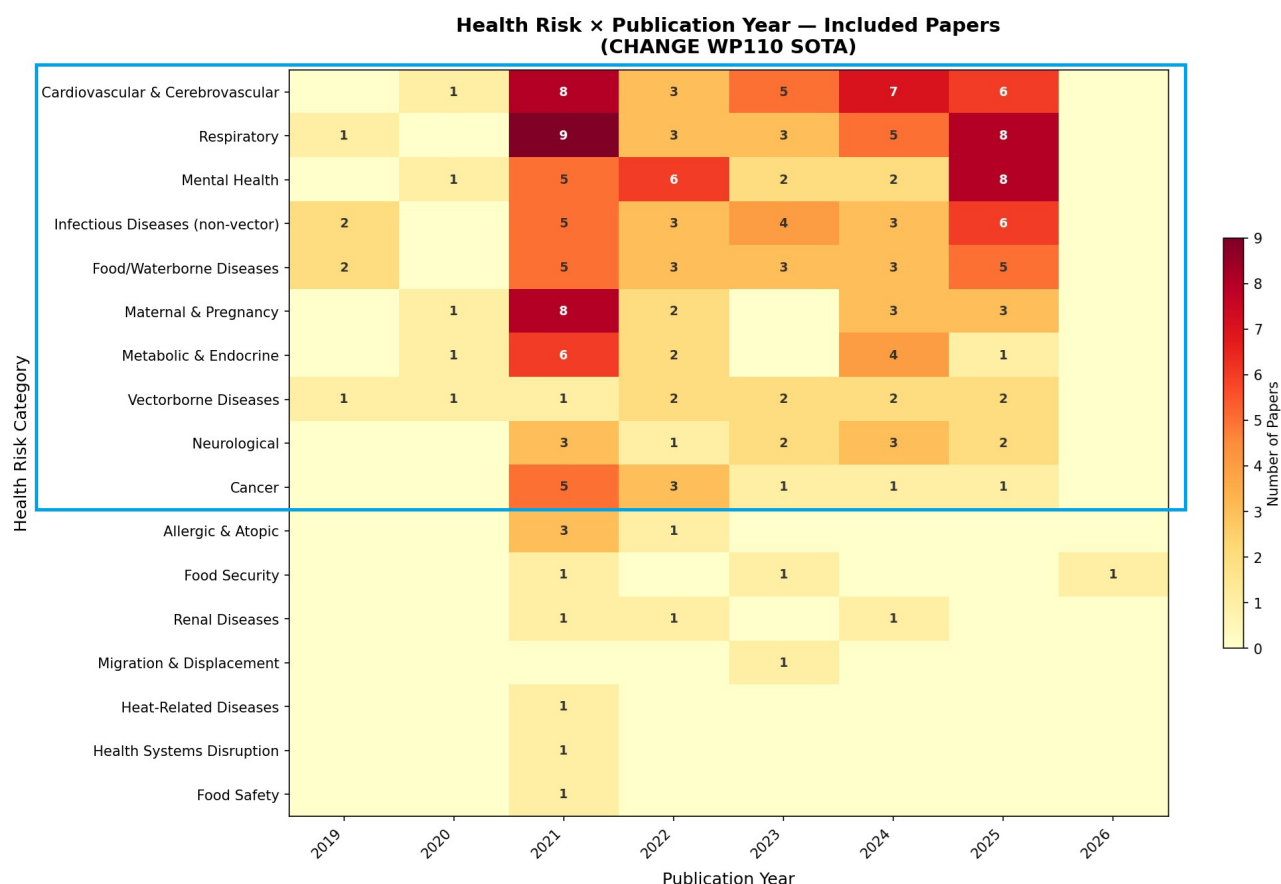


Figure 4-4: Temporal distribution of health domains (overlap dataset, 2019- Jan 2026). The blue box highlights the top 10 climate-related health risks (discussed in section 4.2).

Study period duration

The duration of the study periods covered by the reviewed literature provides an indication of the temporal depth of the evidence base. Figure 4-5 summarises the distribution of primary study period durations across the included reviews for which both start and end years were available. Because climate-related health impacts may emerge over different timescales, the duration of the underlying study periods represents an important characteristic of the evidence considered in this assessment.



Study period durations ranged from less than one year to approximately 80 years, with a median duration of 20 years. Most studies covered periods between 10 and 30 years, indicating that the climate–health evidence base is largely derived from medium- and long-term observations. A smaller number of studies were based on very short observation periods, typically associated with specific events or outbreaks, while a limited number extended over several decades, reflecting long-term assessments of environmental and health trends.

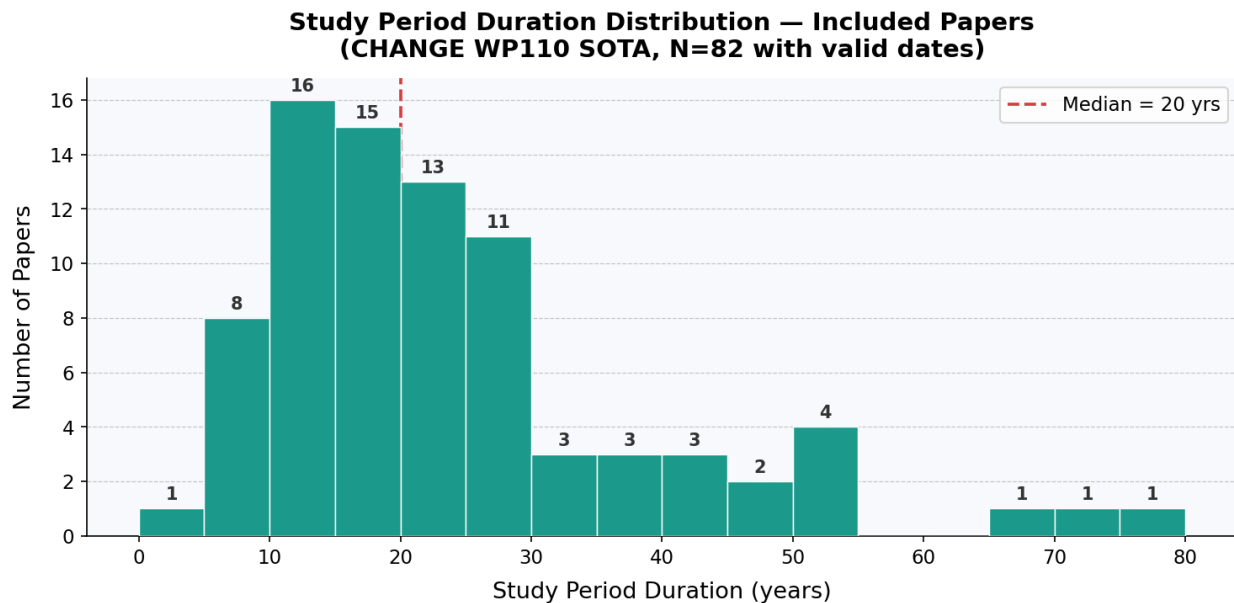


Figure 4-5: Distribution of the study period duration (overlap dataset, 2019– Jan 2026). *Histogram of study period duration (end year – start year) across included papers. The median duration is approximately 20 years; the range spans 0 to 80 years, reflecting both short-term event studies (e.g., single extreme weather events) and long-term longitudinal analyses (e.g., multi-decadal climate–health trend studies). The distribution is right-skewed, with most studies covering 10–30-year periods.*

Geographical distribution

The geographical distribution of the reviewed literature provides an indication of the regions and continents most frequently represented in climate–health research.

Figure 4-6 summarises the occurrence of health domains across continents within the overlap dataset. Because individual studies may contribute to multiple health domains and may cover more than one geographical area, the values shown should be interpreted as an indication of geographical representation rather than as mutually exclusive counts.

Examining the geographical distribution of the evidence helps identify areas where climate–health relationships have been more extensively investigated, as well as regions that may remain comparatively underrepresented in the current literature.

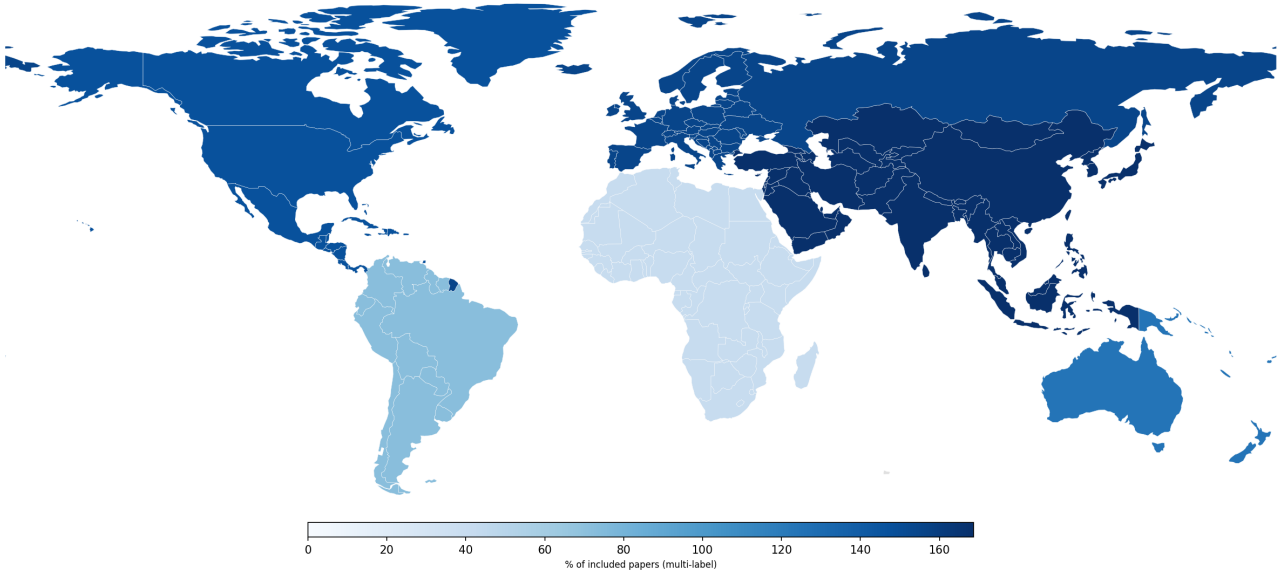


CHANGE

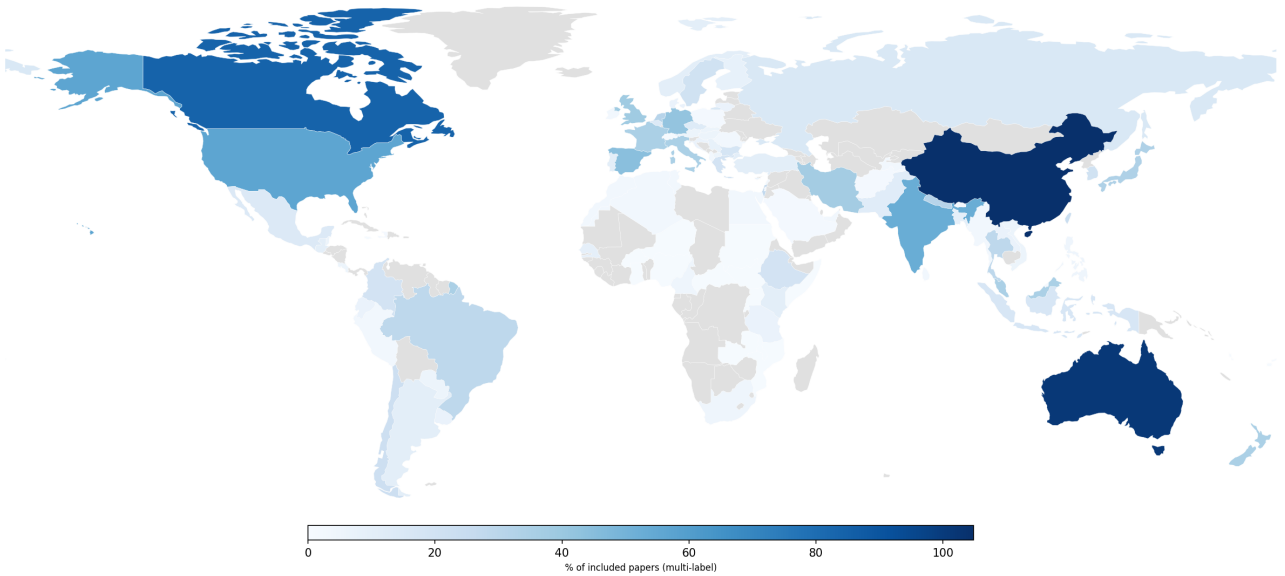


Code: D1.1
Date: 25/09/2026
Version: 3.1
Page: 29 of 80

Map Set A - All 19 Health Risk Categories
Continent-level (% of 83 included papers)



Map Set A - All 19 Health Risk Categories
Country-level (% of 83 included papers)



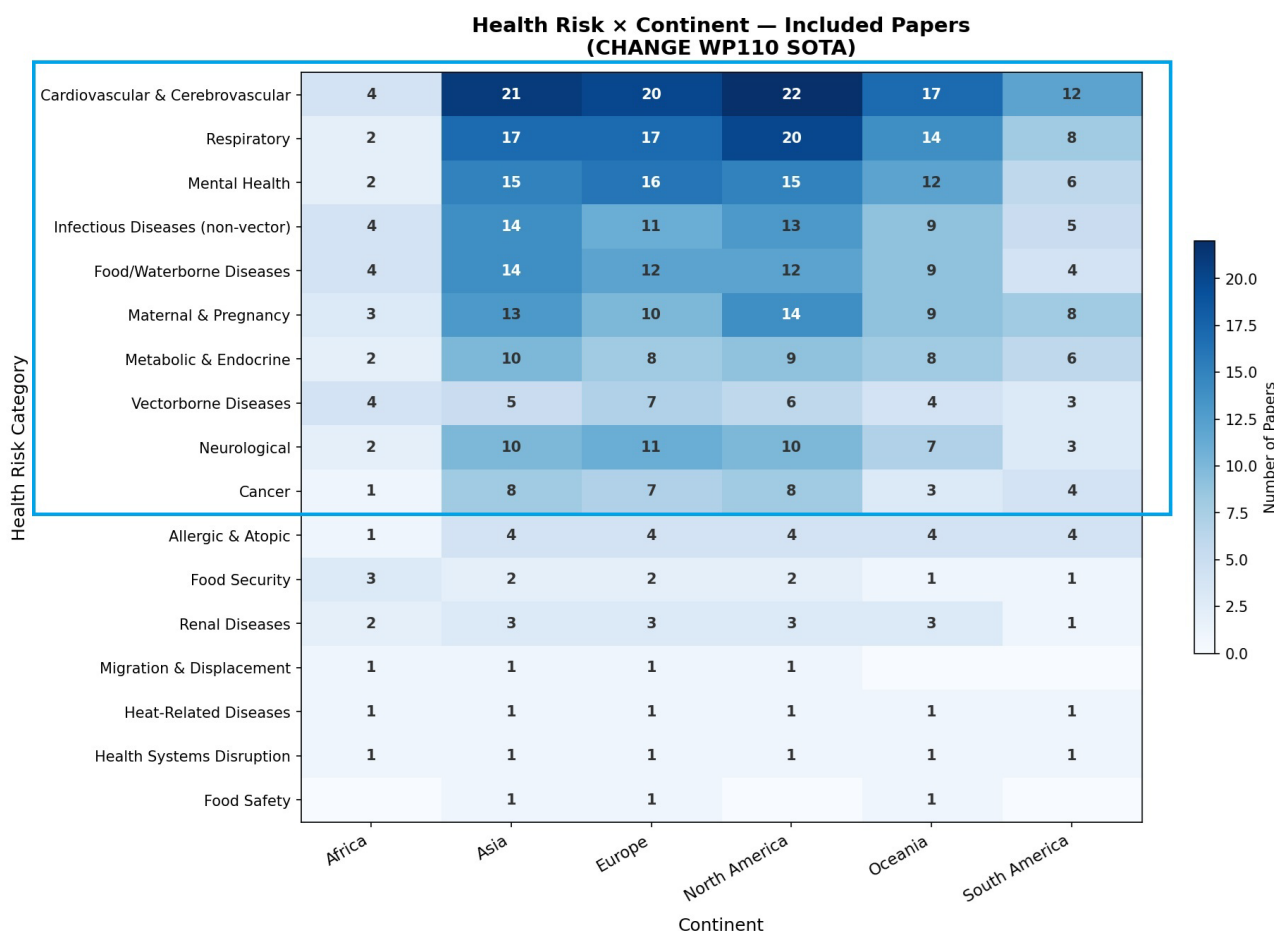


Figure 4-6: Geographical distribution by health domains (overlap dataset, 2019- Jan 2026).

The geographical distribution is uneven across continents. Across nearly all health domains, the largest number of studies is associated with North America, Europe, and Asia, while Africa and South America are represented by substantially smaller numbers of publications. This pattern is observed consistently across both communicable and non-communicable health outcomes.

The most frequently represented health domains, including cardiovascular and cerebrovascular diseases, respiratory diseases, mental health, infectious diseases, and food- and waterborne diseases, exhibit broad geographical coverage and are investigated across all continents. However, the intensity of research activity differs markedly between regions. Rather than indicating continent-specific health profiles, the observed distribution primarily reflects where climate–health evidence has been generated and synthesised.

Overall, the figure suggests that the current climate–health evidence base is disproportionately concentrated in regions with greater research capacity and data availability. While important contributions are present from Africa and South America, their comparatively limited representation highlights a geographical imbalance in the literature that may influence the global understanding of climate-related health risks.

Comparison of climate-driver frequencies before and after refinement of keyword patterns. Broad wildcard expressions (e.g., climate*, work*, heat*, and generic \bpollution\b) were restricted or removed to reduce over-tagging and improve hazard specificity. The refined definitions were adopted for all subsequent analyses.

4.2. IDENTIFICATION AND CHARACTERISATION OF THE TEN MAIN CLIMATE-RELATED HEALTH RISKS

The 10 climate-related health risks



The ten most frequently represented health risk categories identified across the studies included in the overlap dataset are highlighted with a blue box in Figure 4-1.

Cardiovascular and cerebrovascular diseases emerged as the most frequently represented health risk category ($n = 30$), closely followed by respiratory diseases ($n = 29$). Mental health ($n = 24$), infectious diseases excluding vector-borne and foodborne diseases ($n = 23$), and food- and waterborne diseases ($n = 21$) were also prominently represented. Maternal and pregnancy-related outcomes ($n = 17$) and metabolic and endocrine diseases ($n = 14$) occupied an intermediate position, while cancer, neurological diseases, and vector-borne diseases each appeared in 11 studies.

Together, these ten health risk categories account for a substantial proportion of the climate–health literature represented in the overlap dataset and provide the basis for the more detailed analyses.

Temporal distribution of the ten main health risks

The temporal distribution of the literature associated with the ten main health risks provides an indication of how scientific attention to climate-related health impacts has evolved over the study period. The first ten rows (blue box) in Figure 4-4 shows the annual distribution of systematic reviews and meta-analyses associated with the ten main climate-related health risks identified in the overlap dataset (2019–Jan 2026).

The number of reviews associated with the ten main health risks increased markedly from 2021 onwards, with the largest volume of publications observed in 2025. This pattern reflects the growing scientific attention devoted to the health implications of climate and environmental change over recent years. While publications were already present in 2019 and 2020, the evidence base expanded substantially during the subsequent period and remained consistently represented through 2025. The low number of records observed for 2026 should be interpreted with caution, as the dataset includes only publications available up to January 2026.

Several of the most frequently represented health risks show sustained activity throughout the study period. Cardiovascular and cerebrovascular diseases, respiratory diseases, infectious diseases, and food- and waterborne diseases are consistently represented from 2021 onwards and remain among the dominant themes of the climate–health literature. Mental health also shows a strong presence across recent years, reaching some of its highest levels in 2022 and 2025.

Other health domains display more episodic patterns. Maternal and pregnancy-related outcomes and metabolic and endocrine diseases show a marked concentration of publications in 2021, followed by lower but continued representation in subsequent years. Cancer, neurological diseases, and vector-borne diseases remain less frequently represented overall, although they continue to appear throughout the study period.

The marked increase observed from 2021 onwards coincides with a period of growing scientific attention to health resilience, vulnerability, and environmental determinants of health, although the present analysis does not permit attribution of this trend to specific drivers. Taken together, these patterns suggest that the recent expansion of the climate–health literature has been driven primarily by a relatively stable group of health domains, while other areas remain more specialised or comparatively less developed.

Study period duration across the ten main health risks

The temporal depth of the evidence base may vary across health risks depending on the characteristics of the underlying studies. Figure 4-7 compares study period durations for papers associated with the ten main health risks identified in the overlap dataset, providing an indication of the time horizons over which climate–health relationships have been investigated.

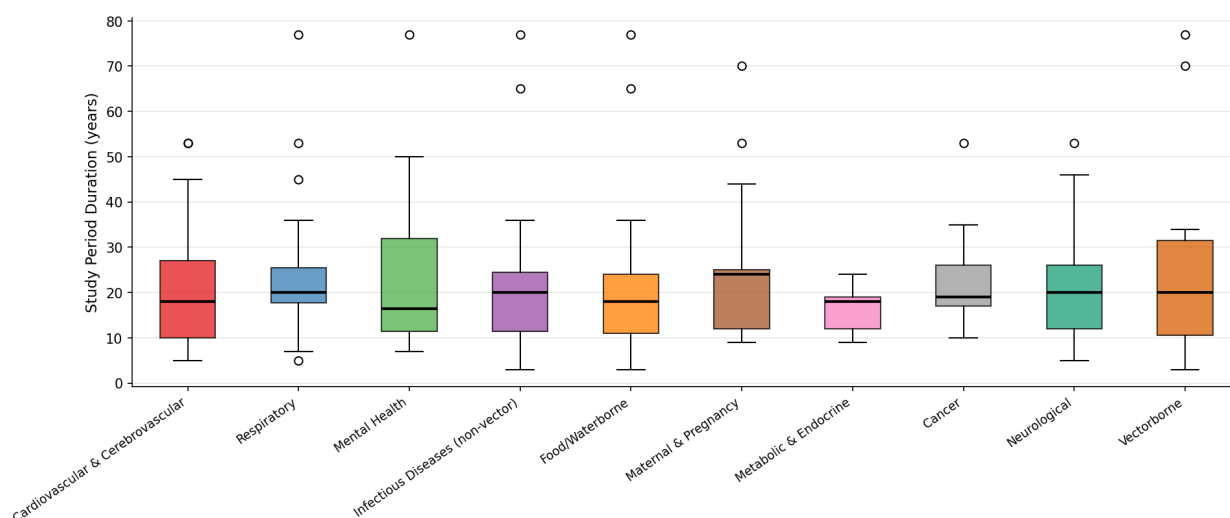


Figure 4-7: Study period durations for papers associated with the ten main health risks.

The ten main health risks are generally characterised by study periods of comparable duration, with median values typically ranging between approximately 15 and 25 years. This suggests that much of the evidence underpinning the principal climate-related health risks is derived from medium- and long-term observations. Cardiovascular and cerebrovascular diseases, respiratory diseases, maternal and pregnancy-related outcomes, and metabolic and endocrine diseases are supported predominantly by medium- and long-term study periods, reflecting a relatively consistent temporal depth of evidence across these domains.

Variability is particularly evident for mental health, infectious diseases, food- and waterborne diseases, and vector-borne diseases, reflecting the coexistence of studies covering different temporal scales.

Several health risks also include a limited number of exceptionally long study periods extending beyond 50 years, indicating the availability of long-term datasets for investigating climate-health relationships across a range of health domains.

Geographical Coverage of the 10 main health risks

The ten main health domains show a geographical imbalance, with most studies concentrated in North America, Asia and Europe, while Africa and South America are less represented (Figure 4-8). Overall, this distribution arguably reflects differences in research capacity and data availability and may limit the global representativeness of the climate-health evidence base.

Country-level patterns should be interpreted with caution. Since the analysis is based on systematic reviews and meta-analyses, geographical information is often reported at the continental or regional level, while individual countries are not always specified. Country-level data therefore provide only a partial representation of the geographical coverage of the underlying evidence.

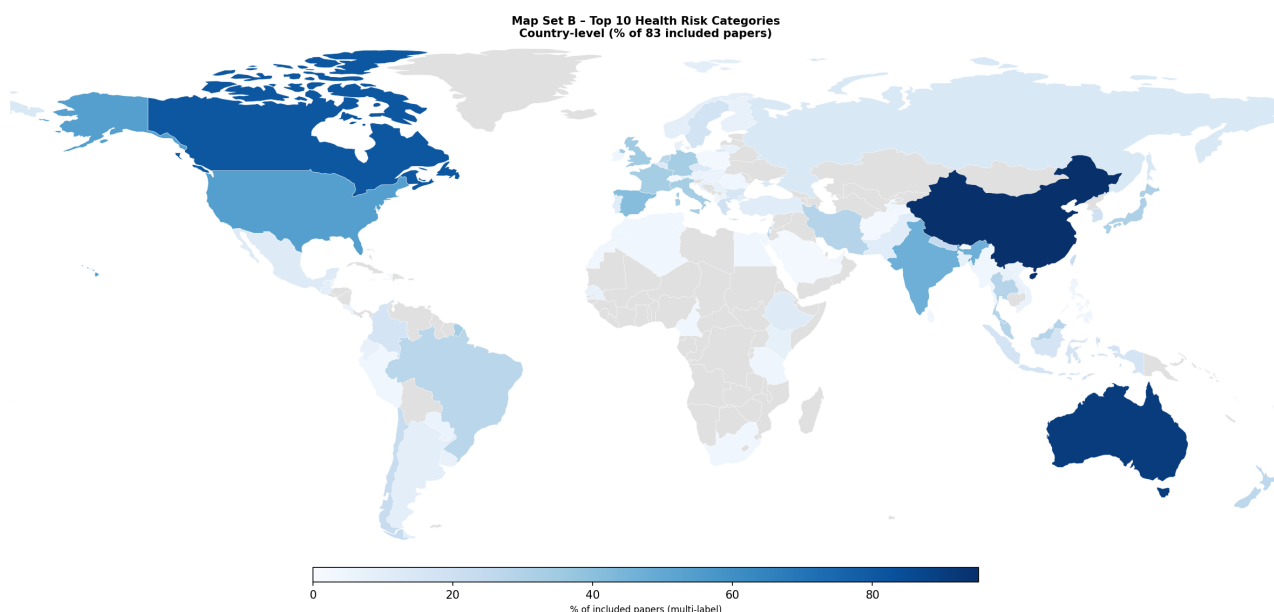


Figure 4-8: Geographical distribution of ten main health domains by Country – when explicitly reported in literature (overlap dataset, 2019- Jan2026).

Climate-health interaction patterns

The ten main health risks identified in the overlap dataset exhibit distinct patterns of association with climate drivers. To explore these relationships, the climate–health interaction structure was examined using three complementary visualisations. The first highlights the absolute frequency of associations between climate drivers and health risks, the second illustrates the relative climate-driver profile of each health risk, and the third provides a network representation of the overall climate–health interaction structure. Together, these visualisations help identify recurring patterns and reveal how different climate drivers contribute to the principal health risks represented in the climate–health literature.

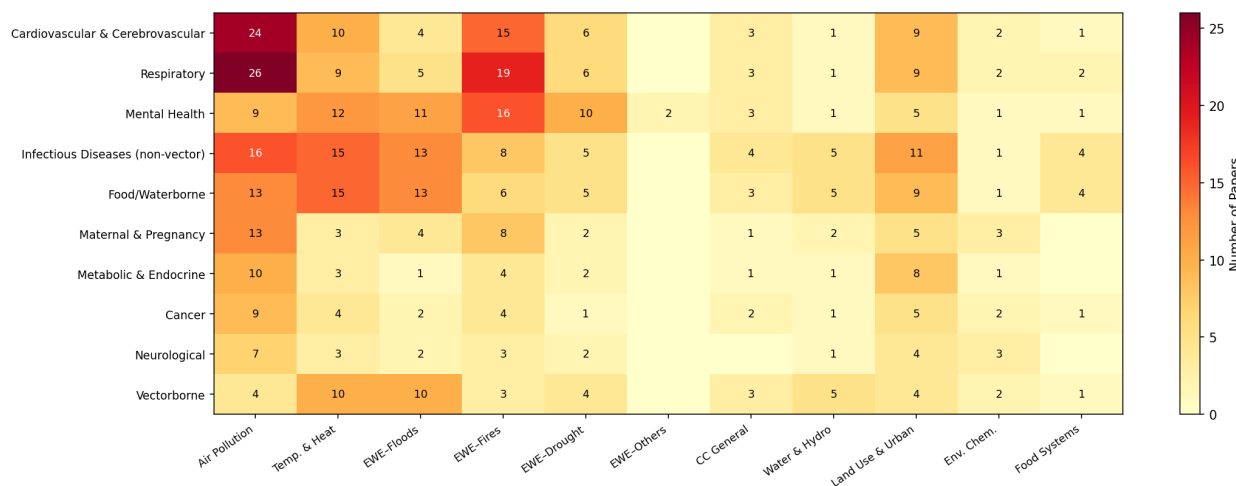


Figure 4-9: Climate-health interaction patterns for top 10 health risks (overlap dataset). Values indicate the number of included systematic reviews and meta-analyses in which each climate-driver and health-risk combination was identified.

The co-occurrence matrix reveals marked differences in the climate-driver profiles of the ten main health risks.

Air pollution emerges as the most frequently associated climate driver across several health domains, particularly cardiovascular and cerebrovascular diseases, respiratory diseases, infectious diseases, and maternal and pregnancy-related outcomes.



Extreme weather events linked to fires show strong associations with respiratory diseases, cardiovascular diseases, and mental health, while temperature and heat are frequently associated with infectious diseases, food- and waterborne diseases, mental health, and vector-borne diseases.

Floods and storms display a similar pattern, with particularly strong links to infectious and food- and waterborne diseases.

These results suggest that different health risks tend to be associated with distinct combinations of climate drivers rather than a single dominant environmental factor.

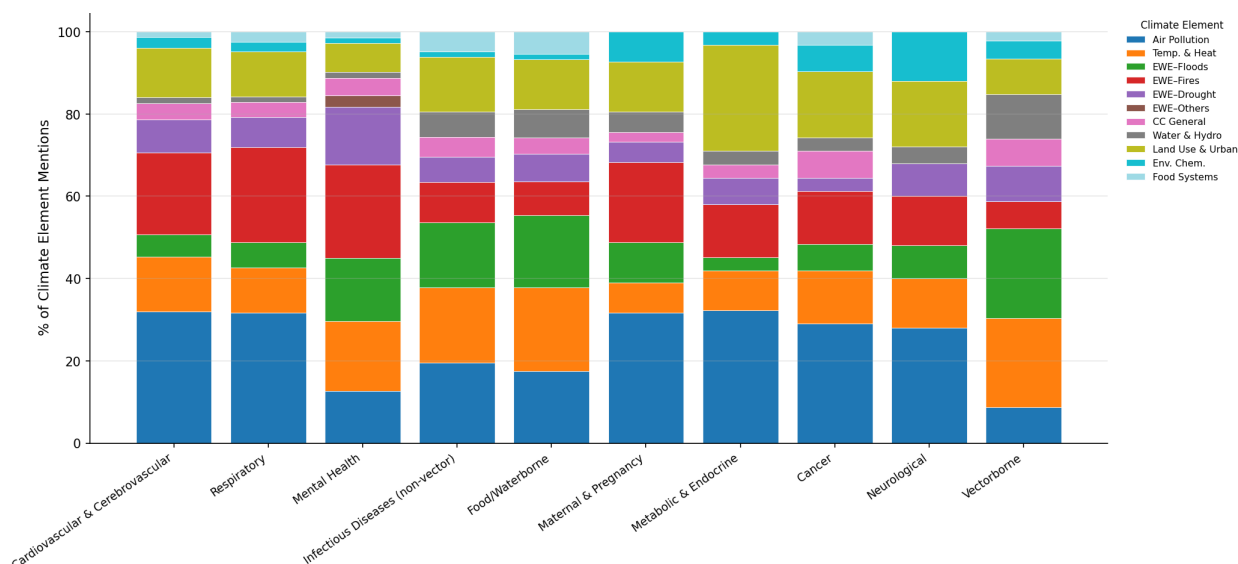


Figure 4-10: Relative contribution of climate drivers to the ten main health risks. Bars show the percentage distribution of climate-driver associations within each health risk category, based on the co-occurrence counts presented in the previous figure.

Expressing the same relationships as percentages highlights differences in the relative importance of climate drivers within each health risk category. Cardiovascular and cerebrovascular diseases and respiratory diseases are strongly dominated by air pollution, whereas mental health exhibits a more balanced distribution across air pollution, temperature and heat, floods, and fires. Infectious diseases and food- and waterborne diseases display particularly strong contributions from temperature-related factors, floods and storms, and land-use and urban-environment factors. Vector-borne diseases show one of the most diversified climate profiles, with no single driver clearly dominating the observed associations. These patterns indicate that the principal health risks differ not only in frequency but also in the structure of their climate-related determinants.

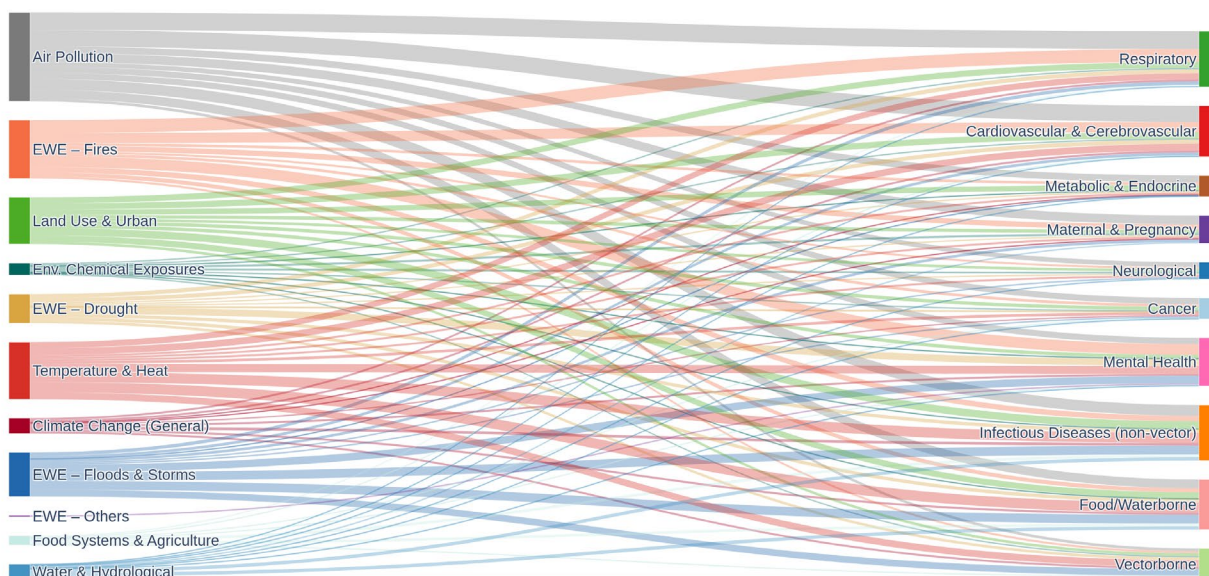


Figure 4-11: Network representation of climate-health associations across the ten main health risks. Link widths are proportional to the number of included reviews identifying a given climate-driver and health-risk combination.

However, although the analysis identifies associations between multiple climate drivers and health outcomes, it does not necessarily capture whether hazards occur jointly or trigger cascading impacts across several health outcomes and health-system functions. The frequency-based selection of the ten main risks may therefore favour individual outcomes, while compound and cascading climate-health risks may be underrepresented.

The network representation provides an integrated view of the climate-health interaction structure identified in the overlap dataset. The concentration of links around air pollution, fires, temperature and heat, and floods and storms confirms their central role within the literature, while the multiple connections linking individual climate drivers to several health risks illustrate the interconnected nature of climate-related health impacts. At the same time, the figure highlights that most health risks are associated with multiple environmental drivers, reinforcing the need for integrated approaches when assessing climate-health relationships.

4.3. COMPARATIVE ANALYSIS OF GREY LITERATURE AND SOTA FINDINGS

To complement the evidence emerging from the SOTA assessment, a targeted review of authoritative grey literature was conducted, including reports and strategic assessments produced by major international organisations, including the IPCC Sixth Assessment Report (AR6) Synthesis Report. The grey literature was analysed independently from the scientific evidence used to identify the ten main climate-related health risks and did not contribute to their prioritisation. The comparison was undertaken to identify areas of convergence, highlight thematic differences, and explore how institutional assessments may broaden the understanding of climate-health interactions beyond the scientific literature alone. Taken together, the two evidence bases provide a broader and more balanced picture of the climate-health landscape than either could offer in isolation.

Table 4-1: Summary of the comparison between the SOTA assessment and the grey literature.

Type	Topic	Relationship between evidence bases	Key interpretation
Health domain	Cardiovascular and respiratory diseases	Strong convergence	Consistently identified as major climate-sensitive health outcomes across both peer-reviewed and institutional evidence.



Health domain	Mental health	Strong convergence	Both evidence bases recognise mental health as a major climate-health priority, with strong representation across international assessments.
Health domain	Infectious diseases (vector-, water- and food-borne)	Convergence	Broad agreement on their importance, although institutional reports place greater emphasis on surveillance, preparedness and adaptation measures.
Health domain	Health systems disruption	Divergence (greater emphasis in grey literature)	Institutional assessments consistently prioritise health-system resilience, adaptive capacity and service continuity, whereas peer-reviewed syntheses focus mainly on direct health outcomes.
Health domain	Food security	Divergence (greater emphasis in grey literature)	Food security is treated as a central climate-health issue in institutional assessments, while remaining comparatively underrepresented in the SOTA overlap dataset.
Health domain	Migration and displacement	Divergence (greater emphasis in grey literature)	Climate-related migration is recognised as an emerging health priority in institutional assessments but receives limited attention in the SOTA overlap dataset.
Health domain	Occupational health	Divergence (greater emphasis in grey literature)	Occupational climate exposure is primarily addressed through policy and regulatory perspectives rather than systematic review evidence.
Climate drivers	Fires as a climate driver	Inverse divergence (greater emphasis in EO-focused overlap)	Fire-related hazards are more prominently represented in the overlap dataset than in the grey literature, consistent with their extensive representation in EO-based environmental monitoring.
Climate drivers	Drought	Divergence (greater emphasis in grey literature)	Institutional assessments consistently identify drought as a priority driver, particularly in relation to food security and water systems.
Other cross-cutting themes	Health sector decarbonisation, mitigation, adaptation governance and SSP-based projections	Distinctive contribution of grey literature	Institutional assessments broaden the evidence base by introducing mitigation within health systems, governance, scenario-based planning and long-term policy perspectives that receive comparatively little attention in the SOTA evidence base.

Convergences between evidence bases

Despite their different nature and objectives, the two evidence bases show substantial agreement across the principal climate-related health domains. Cardiovascular and respiratory diseases, mental health, and infectious diseases consistently emerge among the most prominent health outcomes in both corpora. In the grey literature, mental health is addressed in 12 of 15 documents, respiratory diseases in 11 of 15, cardiovascular and cerebrovascular diseases in 10 of 15, vector-borne diseases in 12 of 15, and food- and water-borne diseases in 9 of 15. These findings closely mirror the thematic priorities identified in the SOTA overlap dataset, where cardiovascular and cerebrovascular diseases (n = 30), respiratory diseases (n = 29), mental health (n = 24), and food- and water-borne diseases (n = 21) rank among the most frequently represented health domains.

A similarly consistent pattern is observed for the principal climate drivers. Temperature and heat, floods and storms, and air pollution are prominently represented across both evidence bases. In the grey literature, temperature and heat, as well as climate change in general terms, are each addressed in 14 of 15 documents, while floods and storms and air pollution appear in 12 of 15. These findings are consistent with the SOTA assessment, where temperature and heat (n = 32), floods and storms (n = 30), and air pollution (n = 51) represent some of the most frequently investigated climate drivers.



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 37 of 80

Divergences and complementary perspectives

Alongside these areas of agreement, the comparison reveals several themes that receive substantially greater attention in the grey literature than in the SOTA evidence base. The most evident example is health systems disruption, which is addressed in 14 of the 15 institutional reports but appears only marginally in the overlap dataset ($n = 3$). Similar patterns are observed for food security (12/15 versus $n = 5$), migration and displacement (10/15 versus $n = 1$), occupational health (8/15 versus no representation in the EO-focused overlap), and drought (12/15 versus $n = 22$). These themes are predominantly discussed from operational, governance and adaptation perspectives that complement the epidemiological focus of the SOTA overlap dataset.

An inverse pattern is observed for fire-related hazards. Fires represent the second most frequently addressed climate driver in the SOTA overlap dataset ($n = 35$), whereas they appear in 8 of the 15 grey literature documents. This pattern is consistent with the EO-focused nature of the SOTA overlap dataset, where wildfire monitoring benefits from the wide availability of Earth Observation products, including burned area, smoke and aerosol datasets.

Added value of the grey literature

Beyond confirming many of the thematic priorities emerging from the SOTA assessment, the grey literature expands the overall evidence base by introducing perspectives that are only marginally represented in the SOTA overlap dataset. These include health sector decarbonisation, mitigation, adaptation governance, forward-looking assessments based on Shared Socioeconomic Pathways (SSPs), and occupational health from a labour rights and social protection perspective. Together, these themes strengthen the policy, governance and long-term planning dimensions of the assessment, complementing the epidemiological evidence provided by the peer-reviewed literature and offering a broader perspective on the climate–health nexus.



5. SATELLITE EARTH OBSERVATIONS AND CLIMATE-RELATED HEALTH IMPACTS

The EO analysis then focused on the 10 priority health risks identified in the studies. For each of these health risks, the literature in the overlap between P1 and the EO corpus were used to present examples of EO used in climate and health research and knowledge gaps were identified.

Table 5-1: Overview of EO applications in the climate and health literature, based on studies from the SOTA analysis (overlap between P1 and EO corpus).

Priority health area	EO applications and uses	Examples of EO satellites, instruments and products in the literature	Case studies
<i>Cardiovascular and cerebrovascular diseases</i>	Studies examining the effect of air pollution on heart failure use EO data for the hazard of air pollution	Data from MODIS used for aerosol optical depth (AOD) "Satellite data" used for PM2.5 and ozone, however specific sensors/missions not specified. CORINE product (Copernicus, Sentinel-1, Sentinel-2) used to characterise land cover	Studies are those included in the review by Jia et al. (2023): Bai et al. (2019), Danesh Yazdi et al. (2019), and Downward et al. (2018)
	EO data used in studies on short-term exposure studies on cardiovascular disease risk.	This review mentions the importance of satellite-derived air pollution estimates as well as other geospatial methods for land use quantification, spatial interpretation, GIS-based exposure assessment, etc. No specific examples of EO products or missions given	Mahakalkar et al. (2024)
<i>Respiratory diseases</i>	Studies on associations between wildfire smoke exposure and respiratory-related healthcare visits among children use EO data to quantify air quality.	Data from MODIS (250m) used to quantify air quality	A study included in the review by Henry et al. (2021): Delfino et al. (2009)
	In studies on health impacts of wildfire smoke on adolescents, EO is used to quantify exposure.	Earth Probe's TOMS instrument used for continuous daily aerosol index Data from MODIS used to develop a binary indicator representing fire occurrence or a continuous variable indicating the number of fires occurred Data from MODIS used to calculate the Aerosol optical depth (AOD) NOAA Hazard Mapping System Fire and Smoke Product used determine fire status	Examples from review by Zhang et al. (2024): Jayachandran (2009), Singh & Dey (2021), Stowell et al. (2019), and Lipner et al. (2019)



Priority health area	EO applications and uses	Examples of EO satellites, instruments and products in the literature	Case studies
	EO data used to characterise greenspace as an exposure metric in studies on respiratory mortality, lung cancer, respiratory hospital visits, asthma, lung function, respiratory symptoms, rhinitis, and other respiratory health impacts	Data from MODIS (250m, 1km), Landsat (30m), ASTER (15m), and IKONOS (15m) used to calculate NDVI Data from Landsat (30m) and MODIS (250m) used to calculate LAI Data from Landsat (30m) used to calculate SAVI Data from MODIS (250m) and Landsat (30m) used to calculate EVI CORINE product (Copernicus, Sentinel-1, Sentinel-2) and Urban Atlas product (Copernicus, various sources) used to calculate greenspace coverage National land cover / land use databases (e.g., national land-use database of the Netherlands; Taiwan Land-use Investigation; Belgian National Geographic Institute; USA National Agriculture Imagery Program) used for land cover Local databases (e.g., Los Angeles Region Imagery Acquisition Consortium (LARIAC)) used for land cover LiDAR data used for tree canopy structure and tree cover metric SPOT satellite images used to calculate vegetation cover greenness Google Earth imagery used to quantify vegetation cover	All examples are from the studies included in the review by Mueller et al. (2022): Zeng et al. (2020), Bauwelinck et al. (2021), Kim (2021), Lovasi et al. (2013), Zhang et al. (2021)
<i>Mental health issues</i>	Studies on the links between Artificial Light At Night (ALAN) and mental health	DMSP-OLS used to extract data on light at night	Studies included in the review by Tancredi et al. (2022): Min & Min (2018), Paksarian et al. (2020), and Xie et al. (2022)
<i>Infectious diseases, excluding vector-borne and foodborne diseases</i>	Studies on soil-transmitted helminth infection in South Asia use EO data for environmental variables	Data from MODIS (250m) used to calculate LST, NDVI, and land cover Data from SRTM mission (30m) used to identify water bodies	Lai et al. (2019)
<i>Food- and waterborne diseases</i>	None identified in this literature	N/A	N/A



Priority health area	EO applications and uses	Examples of EO satellites, instruments and products in the literature	Case studies
Maternal and pregnancy-related outcomes	In a study on the impacts of wildfire smoke during pregnancy on perinatal, obstetric, and early childhood health outcomes, EO data was used to characterise exposure to wildfire smoke	Data from TOMS instrument used for the aerosol index Hazard Mapping System Fire and Smoke product used for smoke-day exposure estimates ESA CCI Fire used for quantifying burned areas Data from NOAA-18, NOAA-19, METOP-B, MODIS, VIIRS, GOES-16, and MSG-3 were used to generate wildfire records through the National Institute of Spatial Research in Brazil Images from Terra and Aqua satellites (sensors not specified) are used to delineate wildfire smoke plumes MODIS data used to derive PM2.5 estimates	Studies included in the review by Foo et al. (2024)
	A study which considers exposure to green space during pregnancy compared to subsequent childhood used EO data to characterise greenness	Data from Landsat (30m) used to calculate NDVI to represent green space. Urban Atlas product (Copernicus, various sources) used for land cover maps	Fernandes et al. (2024)
	EO products are used in studies on exposure to wildfire smoke during pregnancy and adverse birth outcomes to characterise exposure	MODIS imagery used for PM2.5 and PM10 TOMS aerosol index used as wildfire exposure proxy NOAA-12 satellite images used for heat spots	Amjad et al. (2021)
Metabolic and endocrine diseases	None identified in this literature	N/A	N/A
Cancer	A study on wildfire exposure and cancer incidence in Canada used a GIS database which is based on EO sources to quantify burned areas over time.	National Burned Area Composite (NBAC) is a GIS database used to map burned areas and is developed from three sources: the Canadian National Fire Database; the Multi-Acquisition Fire Mapping System (MAFiMS) (which uses Landsat data), and the Hotspot and Normalized Difference Vegetation Index Differencing Synergy (HANDS) algorithm (which can be used with a variety of EO data including NOAA-AVHRR, MODIS, etc.)	Study included in review by Gao et al. (2023)
Neurological diseases	Studies on diseases of the nervous system use remote sensing data to characterise greenness	NDVI used by many studies in this review, however the EO data/mission used to calculate NDVI was not specified	Li et al. (2023)
	Studies on neurodegenerative diseases increasingly use remote sensing data.	No specific examples given, but it mentions that remote sensing was used in 45.7% of the studies.	Oliveira et al. (2024)



Priority health area	EO applications and uses	Examples of EO satellites, instruments and products in the literature	Case studies
Vector-borne diseases	Remote sensing products are used to link weather conditions with the local abundance of dengue virus mosquito vector <i>Aedes aegypti</i>	MODIS data (250m) used to calculate LST Data from the TRMM satellite used to quantify rainfall DEM used for elevation (specific DEM not provided)	A study included in the review by Molina-Guzmán et al. (2022); Moreno-Madriñán et al. (2014)
	EO data are used in studies on climate change and mosquito-borne diseases in southern Europe	CORINE product (Copernicus, Sentinel-1, Sentinel-2) used to characterise land cover NDVI also used, but data source not mentioned	Brugueras et al. (2020)
	Studies on links between scrub typhus and meteorological factors have included EO data to characterise land surface temperature	LST was used as one of the variables, but the data source, sensor, or satellite were not specified	Yang et al. (2025)

The literature review found that Earth Observation (EO) data were especially prominent in studies on respiratory health, particularly wildfire-related impacts, as well as vector-borne diseases and maternity and pregnancy-related outcomes. In many cases, EO data supported the analysis of environmental exposures through indices such as NDVI, which were widely used to characterise vegetation cover, greenness, and land cover. EO data were less frequently applied to hazard or vulnerability dimensions of health risk, although exposure measures often incorporated the hazard itself, such as wildfire smoke exposure.

The review also found that the most used EO information was obtained from Landsat and MODIS, with more limited use of products such as CORINE, data from Sentinel-1 and Sentinel-2 satellites, and data from instruments such as TOMS. Many studies referred generally to "satellite data" or "remote sensing data," sometimes mentioning providers such as NASA, NOAA, or ESA without specifying the exact missions or sensors used. Overall, EO applications in climate and health research focused mainly on broad environmental and atmospheric indicators, with fewer examples involving direct measurement of specific health hazards or highly localised environmental conditions.

5.1. TEMPORAL AND GEOGRAPHICAL INSIGHTS IN THE EO LITERATURE OF THE TEN PRIORITY HEALTH AREAS

The studies which included information on EO products, missions, sensors, etc. in the climate and health literature had a range of temporal and geographic characteristics. Of the fourteen climate and health studies which specified EO products twelve were multi-country studies whereas two were global. The multi-country studies covered all continents and many countries. One study was exclusively in Asia and one in Europe. One of the global studies was on vector-borne diseases and focused on tropical regions whereas the other was on wildfires and so focused on countries impacted by wildfires such as Australia, Canada, and Brazil.

The fourteen review papers were published between 2019 and 2024. The most common timeframe for inclusion in the literature reviews was from around the early 1990s until early 2020s. However, one review searched the literature as far back as 1950 and another as 1924. Three of the studies did not have a lower threshold for publication date. The narrowest timeframe was five years (2018 to 2023).

5.2. REPRESENTATION OF ESSENTIAL CLIMATE VARIABLES IN THE EO LITERATURE OF THE TEN PRIORITY HEALTH AREAS

There are 33 Essential Climate Variables (ECVs) in ESA's Climate Change Initiative (CCI) programme. Out of the fourteen studies included in the previous section, which specify EO products and are



associated with at least one of the ten priority health areas, eleven of these studies involved ECVs. Table 5-2 summarises how these ECVs were present in the EO literature on climate and health.

Table 5-2: Overview of ECVs present in the climate and health literature, restricted to those that specified EO products used.

Essential Climate Variable	Priority health area	EO products	Reference
Fire	Respiratory diseases	MODIS, GOES	Henry et al. (2021)
Land Surface Temperature	Vector-borne diseases	MODIS	Molina-Guzmán et al. (2022)
Fire; Precursors for aerosol and ozone; Ozone	Cancer	Landsat for fire; Unspecified for Precursors for aerosol and ozone; Unspecified for Ozone	Gao et al. (2023)
Aerosol; Precursors for aerosol and ozone; Ozone	Cardiovascular and cerebrovascular diseases	MODIS for Aerosol; Unspecified for Precursors for aerosol and ozone; Unspecified for Ozone	Jia et al. (2023)
Fire; Aerosol; Precursor for aerosol and ozone; Ozone	Maternal and pregnancy-related outcomes	TOMS for Aerosol; Unspecified for Precursor for aerosol and ozone; NOAA-18, NOAA-19, METOP-B, MODIS, VIIRS, GOES-16, MSG-3 for Fire	Foo et al. (2024)
Aerosol; Fire	Respiratory diseases	TOMS and MODIS for Aerosol; MODIS for Fire	Zhang et al. (2024)
Aerosol; Ozone	Cardiovascular and cerebrovascular diseases	MODIS for Aerosol; Unspecified for Ozone	Mahakalkar et al. (2024)
Vegetation Parameters	Maternal and pregnancy-related outcomes	Landsat	Fernandes et al. (2024)
Aerosol	Neurological diseases	Unspecified	Oliveira et al. (2024)
Land Cover; Vegetation Parameters	Neurological diseases	Unspecified for both	Li et al. (2023)
Land Surface Temperature; Vegetation Parameters; Land Cover; Soil Moisture	Infectious diseases, excluding vector-borne and foodborne diseases	MODIS for Land Surface Temperature; MODIS for Vegetation Parameters; MODIS, SRTM for Land Cover; Unspecified for Soil Moisture	Lai et al. (2019)

The presence of ECVs was fairly spread out among the ten health priority areas, but with no examples for Mental health issues, Food- and waterborne diseases, and Metabolic and endocrine diseases (the last two of which had no literature with specific EO applications anyways). Studies contained between one and four ECVs each, with different EO products being used for each ECV.

The most common ECVs included in this collection of literature were Fire, Aerosol, and Ozone, followed by Land Surface Temperature and Vegetation Parameters. Some studies did not specify the EO product used for a given ECV but simply stated something like “satellite data was used to calculate...”. Moderate and coarse resolution EO products were most used for the quantification of ECVs. Seven out of the eleven studies in Table 5-2 used MODIS data for ECVs.

5.3. CLIMATE MODEL APPLICATIONS IN THE CLIMATE AND HEALTH LITERATURE

Among the papers reviewed, only three review papers addressed the use of climate models (general circulation models, regional climate models, or coupled atmosphere-ocean models) for forward-looking health projections. The three papers are separate from the 14 studies discussed in the preceding sections that specified EO products or missions (Table 5-1 and Table 5-2). Within them, ten studies were found to use a climate model to project a future health outcome, covering four of the ten priority



health areas: cardiovascular and cerebrovascular diseases, respiratory diseases, mental health, and vector-borne diseases (Table 5-3).

Table 5-3: Overview of climate model applications in the climate and health literature identified through the SOTA analysis.

Priority health area	Climate Model Uses	Climate Model(s)	Scenario(s)	Projection Timescales	Reference
Respiratory diseases	Projected ozone-attributable respiratory mortality using a coupled chemistry-climate model, with no separate air-quality model.	GFDL-global coupled chemistry-climate model	SRES A1B	Baseline 1981-2000; projection 2081-2100 (end-of-century)	A study included in the review by Karim et al. (2024): Fang et al. (2013)
Respiratory diseases	Projected NO ₂ -attributable respiratory hospital admissions using a regional climate model coupled to a dedicated air-quality model.	NA/GCM-AQUM (regional climate model coupled to air quality model)	RCP2.6, RCP6.0, RCP8.5	Baseline 2007-2011; projection to 2050 (mid-century)	A study included in the review by Karim et al. (2024): Pannullo et al. (2017)
Respiratory diseases	Projected NO ₂ /PM _{2.5} /O ₃ -attributable mortality using a global climate model linked through a regional weather model and a national energy system model.	GCM-WRF, coupled with UK TIMES energy system model	UK Climate Change Act-aligned "nuclear power" and "low-GHG" scenarios	Baseline 2011; projection 2035-2050 (mid-century)	A study included in the review by Karim et al. (2024): Williams et al. (2018)
Cardiovascular and cerebrovascular diseases	Projected cardiovascular and respiratory mortality attributable to ozone using a single model for both climate and air-quality projection; found higher ozone-related mortality in colder months under the high-emissions scenario.	GFDL-CM3 under CMIP5	RCP4.5, RCP8.5, combined with SSPs	Baseline 2013-2015; projection 2053-2055 (mid-century)	A study included in the review by Karim et al. (2024): Chen et al. (2018)
Vector-borne diseases	Projected geographic expansion of Aedes-borne virus transmission risk using a mechanistic transmission model driven by climate scenario data.	Not specified	RCP8.5	Projection to 2080	A study included in the review by Gizaw et al. (2024): Ryan et al. (2019)
Vector-borne diseases	Projected Zika virus transmission risk using an experimentally derived mechanistic model driven by climate scenario data.	Not specified	RCP4.5, RCP8.5	Projection to 2050	A study included in the review by Gizaw et al. (2024): Ryan et al. (2021)
Vector-borne diseases	Projected Aedes aegypti vector invasion area (infestation risk) using a process-based model; measured outcome is vector invasion area, not a dengue-specific transmission metric.	Not specified	RCP8.5	Projection to end of 21st century (by 2100)	A study included in the review by Gizaw et al. (2024): Liu-Helmersson et al. (2019b)



Priority health area	Climate Model Uses	Climate Model(s)	Scenario(s)	Projection Timescales	Reference
Vector-borne diseases	Compared historical and future Anopheles-borne malaria transmission stability using climate scenario data.	Not specified	RCP8.5	Historical 1985-2005 vs future 2040-2060 and 2080-2100	A study included in the review by Gizaw et al. (2024): Hertig (2019)
Vector-borne diseases	Projected dengue epidemic potential using a mechanistic virus transmission model under two contrasting emissions scenarios.	Not specified	SRES A2, SRES B1	Not stated beyond "future" in source text	A study included in the review by Gizaw et al. (2024): Williams et al. (2016)
Mental health	Projected drought-attributable suicide risk using a drought severity index and exposure-response function within modelled climate scenarios; specific climate model not named.	Not specified at the individual-study level	RCP4.5	Baseline 1970-1999; projection 2000-2099	A study included in the review by Lee et al. (2023): Hanigan & Chaston (2022)
Regional health vulnerability (climate context, not a direct health outcome projection)	Used a regional climate modelling project to characterize future temperature, rainfall, and fire-danger conditions; regional context only, not linked to a health outcome projection.	NARCIIM (CMIP3-based regional climate modelling project)	A2	Near-future 2020-2039; far-future 2060-2079	Lee et al. (2023)

Four studies addressed air pollution-related disease burden, projecting future concentrations of PM_{2.5}, ozone, and NO₂ and their associated mortality or morbidity, across studies covering the UK, China, and one global-scope study. The specific climate model was named in each study, though how it was linked to air-quality modelling varied: one study used the climate model alone, with no separate air-quality model; one used a single model to perform both roles; and two coupled separate, linked climate and air-quality models. Scenarios spanned moderate to high emissions pathways, and projected health outcomes did not follow a consistent pattern across studies: in some cases, higher-emissions scenarios projected larger increases in mortality than moderate-emissions scenarios, while in at least one study, a health outcome was projected to decrease under all emissions scenarios tested, including the highest. Scenarios applied included SRES A1B, RCP2.6/4.5/6.0/8.5, and Shared Socioeconomic Pathways (SSPs), with projections extending from mid-century to end-of-century.

Five studies addressed vector-borne disease transmission, using climate scenarios, primarily a high-emissions pathway, within mechanistic or process-based transmission models to project future geographic and seasonal expansion of mosquito-borne disease risk, including Zika virus, dengue, Aedes-borne disease more broadly, and Anopheles-borne malaria. Scenarios applied included RCP4.5, RCP8.5, and the earlier SRES A2 and B1 pathways, with RCP8.5 used in most of these studies. These studies covered Europe, the Mediterranean area, Australia, and two global-scope studies reporting regional exposure estimates for Europe and North America. Unlike the air pollution studies, the specific driving climate model was not named at the individual-study level in any of these five studies; only the emissions scenario was reported. These studies generally projected an expansion of suitable transmission conditions or exposed populations over the projection period, though this was not exclusively tied to higher-emissions scenarios: at least one study projected increased outbreak probability under a lower-emissions scenario. Projection horizons extended to mid-century, 2080, and end-of-century.

One study addressed mental health issues, using a drought severity index within modelled climate change scenarios to project drought-attributable suicide risk in New South Wales, Australia. As with the vector-borne disease studies, the specific climate model used was not named. This study projected an



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 45 of 80

84% increase in drought-related suicides among rural males by 2099 under the driest of the scenarios modelled (RCP4.5), with no such association found in urban populations. One further example was identified in the same source material but is not counted among the 10. A regional climate model was used to describe general future climate conditions for a health district in Northern NSW, Australia, rather than to project a specific health outcome.

Across this set of ten studies, plus the one further related example, climate models supported a narrow set of variables, mainly temperature, precipitation, and chemistry-driving inputs, at decadal-to-century resolution. Geographically, this literature spanned national-scale studies, regional studies, and global-scope studies reporting more granular regional exposure estimates within their global analysis. Climate models have been used across a range of emissions scenarios in this literature, from moderate to high-emissions pathways, with the magnitude and, in some cases, the direction of projected health impact varying accordingly.



6. KNOWLEDGE GAPS

This chapter consolidates the main knowledge gaps identified through the SOTA analysis and the review of EO-based applications. It integrates scientific, methodological, and data-related limitations affecting the assessment of climate-related health impacts, providing a structured basis for the definition of scientific and technical requirements.

6.1. KNOWLEDGE GAPS EMERGING FROM THE SOTA AND CLIMATE-HEALTH LITERATURE

The analyses presented in the previous sections provide a detailed overview of the climate–health evidence base captured within the EO-focused overlap dataset. Beyond identifying the most frequently represented health risks and climate drivers, these analyses also reveal areas where evidence remains limited, unevenly distributed, or characterised by significant uncertainty.

Knowledge gaps identified in this review emerge from multiple sources. Some are apparent within the overlap dataset itself, including geographical imbalances and uneven representation across health domains. Others become evident through comparison with the broader P1 climate–health literature, helping to distinguish between areas where climate–health evidence remains limited overall and areas where research exists, but the integration of Earth Observation approaches appears less developed. The following sections summarise the principal geographical, thematic, and methodological gaps emerging from this analysis.

Geographical gaps

The geographical analyses presented in Section 4 reveal a marked concentration of evidence in North America, Europe, Asia, and Oceania, with substantially lower representation from Africa and parts of South America. While this pattern is common across many areas of environmental health research, it represents an important source of uncertainty when assessing climate-related health risks at the global scale.

The limited representation of several highly climate-vulnerable regions raises questions regarding the transferability of current evidence to different environmental, socio-economic, and health-system contexts. As a result, some climate–health relationships may be well characterised in regions with strong monitoring and research infrastructures, while remaining comparatively understudied elsewhere. Expanding climate–health and EO-enabled research in underrepresented regions therefore remains an important priority for reducing geographical biases in the evidence base.

Health domain gaps

Differences between the overlap dataset and the broader AI-assisted review of P1 climate–health literature, provide additional insight into the distribution of research effort across health domains. Comparing the representation of health risks in the two datasets helps identify areas where climate–health evidence remains limited overall, as well as domains where a substantial body of climate–health research exists but the integration of Earth Observation approaches appears less developed. Table 6-1 summarises the frequency of occurrence of the different health-risk categories in the overlap and P1 datasets.

Table 6-1: Representation of health-risk categories in the overlap dataset and in the broader P1 climate–health literature. Counts indicate the number of reviews assigned to each health-risk category. Reviews may contribute to multiple categories.

Health Risk	Overlap (83)	P1 Full Text (179)
	Count	Count
Cardiovascular and cerebrovascular diseases	30	43
Respiratory diseases	29	61
Mental health issues	24	35
Infectious diseases (non-vector / non foodborne)	23	43



	Overlap (83)	P1 Full Text (179)
Food/waterborne diseases	21	13
Maternal – pregnancy outcomes	17	22
Metabolic & endocrine diseases	14	23
Cancer	11	22
Vector borne diseases	11	13
Neurological diseases	11	11
Allergic – atopic diseases	4	7
Food security	3	25
Renal diseases	3	10
Food safety	1	26
Health systems disruption	1	26
Heat-related diseases	1	22
Migration – displacement	1	11
Occupational health	0	14
Liver diseases	0	4

Several health domains, including cardiovascular and cerebrovascular diseases, respiratory diseases, mental health, and infectious diseases, are prominently represented in both datasets, suggesting a relatively mature integration between climate–health research and EO-based approaches. In contrast, several domains display substantial differences between the two evidence bases. Food security, food safety, and health systems disruption are well represented within the broader climate–health literature but appear only marginally within the overlap dataset. A similar pattern is observed for occupational health, which is represented in the P1 literature but absent from the EO-focused subset.

These discrepancies suggest that the principal gaps do not necessarily reflect a lack of climate–health research. Rather, they point to domains in which the integration of EO approaches remains comparatively limited. This may reflect challenges related to the availability of suitable EO indicators, the complexity of the underlying causal pathways, or the predominance of socio-economic, behavioural, and health-system determinants that are less directly observable through environmental monitoring. As a result, these domains represent important opportunities for future methodological development and interdisciplinary research.

Climate-driver gaps

Knowledge gaps are also apparent when comparing the representation of climate drivers in the overlap dataset and in the broader P1 climate–health literature. Comparing the representation of climate-driver categories across the overlap and P1 datasets provides an indirect indication of those domains in which EO-enabled climate–health research is relatively well represented, and of others where EO applications appear less developed. Figure 6-1 summarises the frequency of occurrence of the climate-driver categories across the two datasets.



Overlap dataset	AIR POLLUTION	CLIMATE CHANGE (GENERAL)	TEMPERATURE & HEAT	LAND USE & URBAN ENVIRONMENT	EXTREME WEATHER EVENTS - FLOODS AND STORMS	EXTREME WEATHER EVENTS - FIRES	EXTREME WEATHER EVENTS - DROUGHT	WATER & HYDROLOGICAL	ENVIRONMENTAL CHEMICAL EXPOSURE - AIR/NOISE	FOOD SYSTEMS & AGRICULTURE	EXTREME WEATHER EVENTS - OTHERS	OCCUPATIONAL CLIMATE EXPOSURE	
CARDIOVASCULAR AND CEREBROVASCULAR DISEASES	32	4	13.3	12	5.3	20	8	1.3	2.7	1.3	0	0	100
RESPIRATORY DISEASES	31.7	3.7	11	11	6.1	23.2	7.3	1.2	2.4	2.4	0	0	100
MENTAL HEALTH ISSUES	12.7	4.2	16.9	7	15.3	22.5	14.1	1.4	1.4	1.4	2.8	0	100
INFECTIOUS DISEASES (NON VECTOR / NON FOODBORNE)	19.5	4.9	18.3	13.4	15.9	9.8	6.1	1.2	4.9	0	0	0	100
FOOD, WATERBORNE DISEASES	17.6	4.1	20.3	12.2	17.8	8.1	6.8	1.4	5.9	0	0	0	100
MATERNAL - PREGNANCY OUTCOMES	31.7	2.4	12.2	12.2	9.8	19.5	4.9	4.9	7.3	0	0	0	100
METABOLIC & ENDOCRINE DISEASES	32.5	3.2	9.7	35.8	3.2	12.9	6.5	3.2	3.2	0	0	0	100
NEUROLOGICAL DISEASES	28	0	12	16	5	28	4	12	0	0	0	0	100
CANCER	28	6.5	13.9	16.1	6.5	12.8	3.2	3.2	6.5	3.2	0	0	100
VECTORBORNE DISEASES	8.7	6.5	21.7	8.7	21.7	6.5	8.7	10.9	4.3	2.2	0	0	100
		Contribution											
	>20	High											
	10-20	Medium											
	<10	Low											
P1 dataset without overlap	AIR POLLUTION	CLIMATE CHANGE (GENERAL)	OCCUPATIONAL CLIMATE EXPOSURE	TEMPERATURE & HEAT	FOOD SYSTEMS & AGRICULTURE	WATER & HYDROLOGICAL	LAND USE & URBAN ENVIRONMENT	EXTREME WEATHER EVENTS - OTHERS	ENVIRONMENTAL CHEMICAL EXPOSURE - AIR/NOISE	EXTREME WEATHER EVENTS - FLOODS AND STORMS	EXTREME WEATHER EVENTS - FIRES	EXTREME WEATHER EVENTS - DROUGHT	
RESPIRATORY DISEASES	43.0	11.6	13.2	9.1	2.5	3.3	5.8	2.5	6.8	1.7	0.8	0.0	100
CARDIOVASCULAR AND CEREBROVASCULAR DISEASES	30.7	11.9	15.8	4.0	6.9	3.0	3.0	5.9	4.0	1.0	3.0	0.0	100
INFECTIOUS DISEASES (NON VECTOR / NON FOODBORNE)	22.1	20.0	8.4	7.4	6.3	9.5	8.4	5.3	6.3	1.1	0.0	0.0	100
MENTAL HEALTH ISSUE	10.9	23.8	7.8	22.7	7.8	6.9	6.9	3.9	7.8	2.0	2.0	0.0	100
FOOD SAFETY	27.9	13.1	13.1	8.2	8.2	6.8	4.9	6.8	6.8	0.0	0.0	0.0	100
HEALTH SYSTEMS DISRUPTION	16.9	20.0	7.7	12.3	4.6	6.2	4.6	15.4	1.5	9.3	1.5	0.0	100
FOOD SECURITY	8.1	25.7	5.4	8.1	17.6	13.8	4.1	6.8	4.1	4.1	1.4	1.4	100
METABOLIC & ENDOCRINE DISEASES	25.8	18.2	10.9	22.7	9.1	1.8	7.3	3.6	9.1	1.8	0.0	0.0	100
MATERNAL - PREGNANCY OUTCOMES	32.0	14.0	14.0	6.0	4.0	8.0	8.0	2.0	6.0	4.0	0.0	0.0	100
CANCER	62.8	2.9	14.3	2.9	5.7	0.0	5.7	0.0	2.9	0.0	2.9	0.0	100

Figure 6-1: Representation of climate-driver categories in the overlap dataset and in the broader P1 climate-health literature. Counts indicate the number of reviews assigned to each climate-driver category. Reviews may contribute to multiple categories.

Several climate-driver categories are strongly represented in both datasets, particularly air pollution and temperature and heat, suggesting that these domains already benefit from substantial integration between climate-health research and EO-based approaches. Floods and storms, land use and urban environment, and water-related factors also show representation across both evidence bases, although with lower frequencies.

In contrast, notable discrepancies emerge for climate change (general) and occupational climate exposure. Both categories are prominent within the broader P1 climate-health literature but are comparatively underrepresented, or entirely absent, within the overlap dataset. This pattern suggests that many studies address climate change as a broad conceptual or contextual driver without relying on environmental indicators that can be directly linked to EO observations. Similarly, occupational climate exposure often relies on individual, workplace, or socio-economic exposure assessments that may be less readily captured through EO-derived variables.

An opposite pattern is observed for extreme weather events related to fires, which are highly represented in the overlap dataset but only marginally represented in the broader P1 literature. This likely reflects the strong compatibility between wildfire-related health research and EO products, including burned area, active fire, aerosol, and smoke-monitoring datasets. Overall, these findings suggest that the integration of EO approaches varies considerably across climate-driver categories and remains more advanced in domains characterised by clearly observable environmental phenomena.

6.2. KNOWLEDGE GAPS RELATED TO EO-BASED CLIMATE-HEALTH ANALYSES

Based on the literature review and summary relative to the ten priority health areas, it was found that EO data are often used to quantify land cover, greenness, and some meteorological or atmospheric factors (such as aerosols, particulate matter, rainfall, etc.). This is primarily in the exposure dimension of climate and health studies. EO data are less commonly used for hazard or vulnerability components of studies. However, it should be noted that in these studies the term exposure often encompasses the hazard itself (e.g., exposure to wildfire smoke).

In the literature that was reviewed, there were several examples of EO data being used in studies on respiratory health (especially those looking at wildfires), vector-borne diseases, and maternity and pregnancy-related outcomes. This could be because those were the studies most likely to quantify air quality and green space, which were more likely to use EO data. There were no specific EO examples from studies on metabolic and endocrine diseases as well as food and waterborne diseases. This could potentially be due to a lack of studies linking climate and environmental change to these diseases, rather than a lack of EO used within the studies. More evidence is needed on whether (and if so, how) EO is used in studies on these health impacts.

Many studies used EO data to calculate indices such as NDVI to characterise land cover, vegetation cover, greenness etc. in their analysis of exposure. There were fewer examples of EO data being used for the measurement of specific variables related to health hazards (besides wildfires, which used EO for characterising smoke, aerosols, etc.). This is to be expected given the inability of EO to measure the presence of disease vectors or highly local meteorological variables for health impacts.



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 49 of 80

The most used EO datasets included Landsat and MODIS, and to a lesser extent CORINE (Sentinel-1, Sentinel-2) and TOMS. More knowledge is needed on how other EO data are used in climate and health, such as those from LiDAR sensors, VIIRS, IKONOS, and others. This could be achieved by reviewing the methods sections of all the studies included in these reviews and meta-analyses or by expanding the SOTA analysis to include studies outside of this corpus of reviews and meta-analyses. Similarly, none of the studies in this review provided links to repositories or workflows for accessing, postprocessing, and analysing EO data. It would be worth investigating which studies provide these resources for replicability, and this could be achieved by analysing the individual studies that make up these review studies.

Some of the studies mention “satellite data” or “remote sensing data” but did not specify the satellite, mission, sensor, or data source itself. This reflects the level of methodological detail retained in the systematic reviews and meta-analyses examined here. Sometimes an EO provider is mentioned, such as NASA, NOAA, ESA, etc. but the specific EO sensor or mission is not specified. Sometimes a mission was mentioned, but not the sensor, or a sensor was mentioned and the mission could be deduced. More detailed information is needed on specific missions and sensors used in these studies.

Given that this review was conducted on literature reviews and meta-analyses, there are additional details that would provide more information on EO uses in climate and health research. These include details on specific data used (which bands, at what spectral resolution, etc.), temporal resolution, spatial resolution (although this was sometimes provided in the studies reviewed here), justification for selecting the dataset, etc. Additional analysis could begin to fill these gaps.

Only three of the reviewed papers addressed the use of climate models (general circulation models, regional climate models, or coupled atmosphere-ocean models) for forward-looking health projections. Climate model use was found in studies on respiratory and cardiovascular disease linked to air pollution, in studies on vector-borne disease, and in one study on mental health. No examples were found in the other six priority health areas. This could reflect a lack of climate model use in these areas, or simply that the small number of papers checked did not happen to include any. More evidence is needed on whether, and how, climate models are used in studies on these other health impacts.

Reporting detail also varied. For the air pollution studies, the specific climate model was named in each case, along with how it was coupled to other models such as air-quality or energy system models. For the vector-borne disease and mental health studies, only the emissions scenario was reported; the specific climate model used was not stated for individual studies. As with the EO literature discussed above, this reflects the level of methodological detail retained in literature reviews and meta-analyses rather than primary studies: details on which climate model was used, and how it was linked to health outcomes, are not always carried through into the review text.



7. SCIENTIFIC AND TECHNICAL REQUIREMENTS

7.1. PURPOSE AND LINK WITH THE SOTA AND GAP ANALYSIS

This chapter translates the findings of SOTA analysis and the EO-based climate–health gap assessment into a set of scientific and technical requirements. The requirements are therefore not defined as generic specifications, but as a direct response to the limitations identified in the current evidence base.

The preceding chapters reviewed how climate change affects health systems and facilities, human health and well-being, and migration, and examined how EO data have already been used to describe and analyse climate-related health impacts. The analysis showed that EO has significant potential to support climate–health risk assessment, particularly through spatially continuous, long-term and repeatable environmental observations. However, it also identified important gaps in scientific knowledge, data availability, methodological integration, uncertainty treatment, predictive capacity and operational uptake.

This chapter defines the science and technical requirements needed to address those gaps with the support of EO data. These requirements will be used in Task 2 to support the full description of the selected climate and health case study or case studies and the development of the risk assessment methodology. They will also support Task 4 by providing the technical and scientific basis for the climate and health adaptation roadmap.

The requirements follow a needs-driven approach. This means that they start from the climate–health problem to be addressed, rather than from the availability of specific EO products. EO-derived indicators, data integration workflows and analytical or modelling tools are assessed according to their ability to respond to the identified gaps and to support decision-relevant climate–health applications.

7.2. GAP-DRIVEN FORMULATION OF REQUIREMENTS

The SOTA and gap analyses identified several recurring limitations in current EO-enabled climate–health research. These gaps can be grouped into eight main areas:

1. limited integration of EO within a complete climate–health risk framework;
2. insufficient exploitation and documentation of EO datasets;
3. limited integration of vulnerability, adaptive capacity and social determinants;
4. underrepresentation of health systems, facilities, well-being and migration;
5. limited capacity to assess compound and cascading climate events;
6. limited reproducibility, interoperability and operational scalability;
7. insufficient uncertainty characterisation and validation;
8. limited predictive capability for future climate–health risks and adaptation planning.

Each gap is described below and translated into scientific and technical requirements.

7.3. GAP 1: LIMITED INTEGRATION OF EO WITHIN A COMPLETE CLIMATE–HEALTH RISK FRAMEWORK

The analysis shows that EO is often used to characterise individual environmental exposure variables, such as land surface temperature, vegetation, air quality proxies, flooding or drought conditions. However, these variables are not always embedded in a complete risk framework linking climate hazards, exposure, vulnerability, adaptive capacity and health outcomes.

This limits the interpretability of EO-derived information and reduces its usefulness for climate–health risk assessment and adaptation planning.

Scientific requirements

- SR-01: The project shall adopt a climate–health risk framework that explicitly links climate hazards, exposure, vulnerability, adaptive capacity and health outcomes.



- SR-02: The project shall ensure that EO-derived variables are linked to clearly defined climate-health pathways and are not treated as isolated environmental descriptors.
- SR-03: The risk framework shall cover the three main domains required by the activity: health systems and facilities, human health and well-being, and migration.

Technical requirements

- TR-01: The project shall define data structures and workflows that allow EO-derived indicators to be integrated with epidemiological, demographic, socio-economic and health-system datasets.
- TR-02: Each EO-derived indicator shall be classified according to the risk component it represents: hazard, exposure, vulnerability or adaptive capacity.
- TR-03: The project shall document the intended use of each indicator within the risk-assessment chain.

These requirements provide the conceptual basis for Task 2, where the selected case study or case studies will be described and the climate-health risk assessment methodology will be developed. They also support Task 4 by ensuring that satellite-based information can be positioned within an adaptation and mitigation decision chain.

7.4. GAP 2: INSUFFICIENT EXPLOITATION AND DOCUMENTATION OF EO DATASETS

The EO review indicates that many studies refer generically to “satellite data” or “remote sensing data” without specifying the EO mission, sensor, product version, processing level or uncertainty characteristics. In addition, EO use in climate-health studies is often concentrated on a limited set of products, while the broader potential of ESA CCI ECV datasets, ESA EO archives and other satellite products remains insufficiently represented and documented within the reviewed evidence base. These findings should be interpreted in relation to the review methodology, which deliberately focused on systematic reviews and meta-analyses, as these provide a consolidated synthesis of the available medical and public-health evidence across climate-health domains, as reported in section 3.3.

Scientific requirements

- SR-04: The project shall identify EO datasets according to their relevance to the selected climate-health pathways, rather than according to availability alone.
- SR-05: The project shall assess the contribution of ESA CCI ECV datasets and ESA EO data archives to the fullest extent possible.
- SR-06: The project shall identify where additional EO products, EO-based climate reanalysis or forecast datasets, in situ data or non-EO datasets are required to complement ESA datasets.

Technical requirements

- TR-04: All EO datasets used in the project shall be documented with mission, sensor, product name, product version, processing level, spatial resolution, temporal resolution, temporal coverage, access source and uncertainty information where available.
- TR-05: Candidate EO datasets shall be assessed for scientific relevance, geographical coverage, temporal continuity, latency, licensing conditions, computational requirements and operational suitability.
- TR-06: The project shall maintain traceability from source EO datasets to derived indicators and final analytical outputs.

These requirements support Task 2 by ensuring that the case-study methodology is based on well-documented and appropriate EO inputs. They also support Task 4 by identifying which satellite-based datasets are suitable for sustained adaptation and mitigation applications.



7.5. GAP 3: LIMITED INTEGRATION OF VULNERABILITY, ADAPTIVE CAPACITY AND SOCIAL DETERMINANTS

The SOTA analysis confirms that climate-related health impacts are strongly shaped by vulnerability, exposure and adaptive capacity. However, EO-based studies frequently focus on environmental hazards or exposure and give less attention to social determinants, demographic change, health-system access and adaptive capacity.

This creates a risk of producing environmental risk maps that do not fully capture the populations, facilities or communities most at risk.

Scientific requirements

- SR-07: The project shall integrate vulnerability and adaptive-capacity dimensions into climate-health risk assessment wherever data availability allows.
- SR-08: The assessment shall consider social inequality-aggravating determinants, including age, socio-economic status, population density, housing, health status, access to health services and territorial inequalities.
- SR-09: The project shall account for population dynamics where relevant, including urbanisation, demographic ageing, mobility, migration and displacement.

Technical requirements

- TR-07: EO-derived indicators shall be combined with demographic, socio-economic, public-health and health-system datasets to support multi-dimensional vulnerability assessment.
- TR-08: The project shall define spatial and temporal harmonisation procedures to integrate EO data with vulnerability and health datasets.
- TR-09: The project shall document limitations where vulnerability or adaptive-capacity dimensions cannot be represented because of missing, incomplete or non-comparable data.

These requirements support Task 2 by ensuring that the risk assessment goes beyond hazard characterisation. They also prepare the basis for Task 3, where health burden must be assessed while accounting for social inequality-aggravating determinants and geographical variability in risks.

7.6. GAP 4: UNDERREPRESENTATION OF HEALTH SYSTEMS, FACILITIES, WELL-BEING AND MIGRATION

The broader climate-health literature recognises impacts on health systems and facilities, human well-being and migration. However, EO-enabled studies remain more strongly focused on direct morbidity and mortality outcomes, particularly those associated with heat, air pollution or vector-borne diseases.

Less attention has been given to the exposure of healthcare infrastructure, disruption of essential services, accessibility to health facilities, mental health and well-being impacts, or environmental drivers of migration and displacement.

Scientific requirements

- SR-10: The project shall identify EO-enabled approaches that can support the assessment of climate risks to health systems and facilities.
- SR-11: The project shall consider EO-derived indicators relevant to human health and well-being, including environmental stressors that may affect physical and mental health.
- SR-12: Where relevant to the selected case study, the project shall consider EO-derived indicators that help characterise environmental drivers of migration and displacement.

Technical requirements

- TR-10: The project shall assess the feasibility of combining EO-derived hazard layers with health-facility location data, accessibility information, infrastructure data and population distribution datasets.
- TR-11: EO-derived indicators for health systems and facilities shall consider exposure to heatwaves, heavy rainfall and floods, droughts, or compound events, depending on the selected case study.



- TR-12: Migration- and displacement-related applications shall combine EO-derived environmental indicators with contextual socio-economic and demographic information, recognising that EO alone cannot explain migration dynamics.

These requirements support Task 2 by expanding the risk assessment beyond traditional health outcomes. They also support Task 4 by identifying satellite-based information that can contribute to adaptation planning for health systems, critical infrastructure and vulnerable communities.

7.7. GAP 5: LIMITED CAPACITY TO ASSESS COMPOUND AND CASCADING CLIMATE EVENTS

The SOTA analysis shows that climate-related health impacts may result from interacting hazards, including heatwaves combined with drought, flooding combined with infrastructure disruption, or drought conditions contributing to wildfire, air-quality degradation, food insecurity or infectious disease dynamics.

However, many EO-health applications assess hazards separately, which may underestimate risk in contexts where compound or cascading events are important.

Scientific requirements

- SR-13: The project shall address at least one of the three high-impact climate events prioritised in the activity: heatwaves, heavy rainfall and floods, or droughts.
- SR-14: Where feasible, the project shall assess compound or cascading events involving at least one of these high-impact hazards.
- SR-15: The project shall identify climate–health pathways where interactions between hazards may amplify health risks.

Technical requirements

- TR-13: EO-derived indicators shall be designed to support the analysis of multi-hazard conditions where relevant.
- TR-14: The workflow shall allow the combination of multiple environmental indicators, such as land surface temperature, precipitation, flood extent, soil moisture, vegetation stress, burned area or air-quality proxies.
- TR-15: The project shall document methodological assumptions when combining indicators representing different hazards, temporal scales or spatial resolutions.

These requirements support Task 2 by enabling the case-study methodology to represent more realistic climate–health risk pathways. They also support Task 4 by identifying where adaptation responses need to address multi-hazard and cascading risks rather than single hazards only.

7.8. GAP 6: LIMITED REPRODUCIBILITY, INTEROPERABILITY AND OPERATIONAL SCALABILITY

The gap analysis shows that many EO-enabled climate–health studies do not provide sufficient information on processing workflows, data harmonisation, code availability or reproducibility. This limits the capacity to compare studies, repeat analyses, transfer methods to other regions, or develop operational climate–health services.

Scientific requirements

- SR-16: The project shall ensure that methods are transparent, reproducible and suitable for scientific review.
- SR-17: The project shall consider the transferability of methods across geographical contexts and spatial scales.
- SR-18: The project shall ensure that outputs are suitable for use by climate, health and adaptation stakeholders.

Technical requirements



- TR-16: The project shall implement reproducible workflows for EO data access, preprocessing, harmonisation, indicator generation, spatial aggregation, temporal aggregation and export.
- TR-17: The project shall use interoperable formats and metadata structures for EO, climate, GIS, health and socio-economic datasets.
- TR-18: The project shall develop workflows capable of handling heterogeneous datasets with different spatial resolutions, temporal frequencies, projections and administrative boundaries.
- TR-19: The project shall support scalable processing for large EO datasets and long time series, including cloud-based processing or automated pipelines where appropriate.
- TR-20: The project shall ensure that algorithms, data links, methodology descriptions and results can be made available through the required open-access public repository.

These requirements directly support Task 2 by ensuring that the methodology can be implemented, reviewed and reused. They also support Task 4 by enabling the roadmap to consider operational and scalable EO-based solutions for adaptation planning.

7.9. GAP 7: INSUFFICIENT UNCERTAINTY CHARACTERISATION AND VALIDATION

The SOTA and EO analyses indicate that uncertainty is often insufficiently treated in EO-enabled climate–health studies. Sources of uncertainty may arise from EO retrievals, exposure modelling, spatial aggregation, health data, vulnerability indicators, climate models, scenario assumptions and statistical or machine-learning methods.

Limited uncertainty characterisation reduces confidence in climate–health risk estimates and limits their usefulness for decision-making.

Scientific requirements

- SR-19: The project shall identify and document the main sources of uncertainty affecting climate–health risk assessment.
- SR-20: The project shall assess how uncertainty influences the interpretation of EO-derived indicators, exposure estimates, model outputs and risk estimates.
- SR-21: The project shall define validation approaches appropriate to the selected case study and available data.

Technical requirements

- TR-21: The project shall map uncertainty sources across the full processing chain, from input datasets to final outputs.
- TR-22: Uncertainty shall be quantified and propagated where possible, using suitable methods such as confidence intervals, prediction intervals, ensemble approaches, sensitivity analysis or comparison of alternative models.
- TR-23: The project shall implement verification and validation procedures for the main analytical outputs.
- TR-24: Validation may include comparison with independent observations, cross-validation, temporal validation, spatial validation, benchmarking against published results or expert review.

These requirements directly support the uncertainty and validation analysis required in Task 2 and Task 3. They also strengthen the credibility of the adaptation recommendations developed in Task 4.

7.10. GAP 8: LIMITED PREDICTIVE CAPABILITY FOR FUTURE CLIMATE–HEALTH RISKS AND ADAPTATION PLANNING

Most EO-enabled climate–health studies remain retrospective, focusing on historical exposure–response relationships. Fewer studies integrate EO-derived indicators with climate projections, scenarios or future socio-economic change to estimate future health risks or support adaptation planning.

This limits the ability to use EO-derived information for forward-looking climate–health services.



Scientific requirements

- SR-22: The project shall develop methodologies that can support both historical climate–health risk assessment and future-oriented analysis.
- SR-23: The project shall identify how EO-derived indicators can be linked with climate projections, scenario-based simulations and adaptation-relevant datasets.
- SR-24: The project shall support the future quantification of health burden attributable to climate change, including projected warming scenarios and social determinants.

Technical requirements

- TR-25: The project shall design indicators and workflows that can be integrated with regional or global climate projection datasets.
- TR-26: The methodology shall consider compatibility with datasets such as CMIP6, Shared Socioeconomic Pathways, Destination Earth datasets or other relevant projection sources.
- TR-27: Analytical and modelling tools shall support scenario-based risk estimation where data availability and case-study design allow.
- TR-28: Outputs shall be designed to inform adaptation and mitigation planning, including identification of exposed populations, vulnerable areas, health-system risks and potential adaptation priorities.

These requirements provide the methodological bridge from Task 2 to Task 3 and Task 4. They ensure that the risk-assessment methodology can support the later quantification of health burden and the development of a climate and health adaptation roadmap.

7.11. TRACEABILITY BETWEEN GAPS AND SCIENTIFIC AND TECHNICAL REQUIREMENTS

Table 7-1 summarises the traceability between the main gaps identified in the SOTA and EO analyses and the corresponding scientific and technical requirements defined in this chapter.

Table 7-1: Traceability between knowledge gaps identified in the SOTA and EO-based climate–health analyses, corresponding scientific and technical requirements.

Gaps identified	Scientific requirements	Technical requirements
Limited integration of EO within a complete climate–health risk framework	SR-01, SR-02, SR-03	TR-01, TR-02, TR-03
Insufficient exploitation and documentation of EO datasets	SR-04, SR-05, SR-06	TR-04, TR-05, TR-06
Limited integration of vulnerability, adaptive capacity and social determinants	SR-07, SR-08, SR-09	TR-07, TR-08, TR-09
Underrepresentation of health systems, facilities, well-being and migration	SR-10, SR-11, SR-12	TR-10, TR-11, TR-12
Limited capacity to assess compound and cascading climate events	SR-13, SR-14, SR-15	TR-13, TR-14, TR-15
Limited reproducibility, interoperability and operational scalability	SR-16, SR-17, SR-18	TR-16, TR-17, TR-18, TR-19, TR-20
Insufficient uncertainty characterisation and validation	SR-19, SR-20, SR-21	TR-21, TR-22, TR-23, TR-24
Limited predictive capability for future climate–health risks and adaptation planning	SR-22, SR-23, SR-24	TR-25, TR-26, TR-27, TR-28



7.12. COMPARISON OF RESULTS WITH THE IPCC AR7 HEALTH AND WELL-BEING CHAPTER OUTLINE

As an external cross-check, the scientific and technical requirements identified in this assessment were compared with the outline of Chapter 19, Health and well-being, of the IPCC Working Group II contribution to the Seventh Assessment Report (AR7).

The comparison focuses on the five thematic elements explicitly identified in the Chapter 19 outline and assesses their correspondence with the scientific and technical requirements developed in D1.1. Table 7-2 summarises the results of this comparison.

Table 7-2: Comparison of the five thematic elements identified by the IPCC Working Group II with the scientific and technical requirements from D1.1.

Relevant IPCC AR7 Chapter 19 theme	Corresponding D1.1 requirements	Relationship
Observed impacts and projected risks from factors such as extreme weather, emerging pathogens, and infectious diseases to physical and mental health and well-being due to multi-scale climate change, extremes, compound and cascading events	SR-11, SR-13–15, SR-22–24; TR-13–15, TR-25–28	Strong alignment / EO-specific extension
Intersectionality of drivers of vulnerability and exposure to climate hazards within populations and communities	SR-01, SR-07–09; TR-01, TR-07–09	Strong alignment
Adapting health systems, and health prevention and promotion activities to reduce risk and build capacity at multiple levels	SR-03, SR-10–11; TR-10–11	Direct alignment / EO-specific extension
Intersection between climate change, health and wellbeing, and non-climatic drivers of health, and other health determining factors	SR-02, SR-07–09; TR-01, TR-07–09	Strong alignment / EO-specific extension
Innovative and collaborative partnerships in the health sector involving different stakeholders	—	No direct correspondence

The comparison shows substantial correspondence between the D1.1 requirements and four of the five thematic elements identified in the IPCC Chapter 19 outline. This is particularly evident for vulnerability and exposure, health-system adaptation, the interaction between climatic and non-climatic determinants of health, and the assessment of observed and projected health impacts, including compound and cascading events. In these areas, CHANGE translates the broader themes identified in the IPCC outline into requirements for EO-enabled climate–health risk assessment and data integration.

The fifth thematic element, concerning innovative and collaborative partnerships in the health sector, has no direct correspondence among the scientific and technical requirements defined in D1.1. Conversely, several D1.1 requirements address aspects that are not explicitly covered in the Chapter 19 outline, particularly EO dataset identification and documentation, methodological reproducibility, interoperability and operational scalability. Uncertainty characterisation and validation are also not explicitly included in the Chapter 19 outline, although uncertainty assessment is addressed in the broader AR7 framework and in the outline of the Technical Guidelines for Assessing Climate Change Impacts and Adaptation. Overall, the comparison indicates broad consistency between the D1.1 requirements and the climate–health themes identified for AR7, while also reflecting the specific EO and technical scope of CHANGE.



CHANGE



Code: D1.1
Date: 25/09/2026
Version: 3.1
Page: 57 of 80

8. CONCLUSIONS

8.1. OVERVIEW OF THE ASSESSMENT

This document presents version 3.1 of the Assessment Report Document (D1.1) produced under Work Package 100 of the CHANGE project (ESA Contract No. 4000149181/25/I-LR). It provides a comprehensive, evidence-based synthesis of the state of the art on climate–health impacts, an assessment of how Earth Observation (EO) data currently support climate–health analyses, a structured identification of knowledge gaps, and a formal set of scientific and technical requirements to guide the subsequent phases of the project.

The assessment was conducted in accordance with the PRISMA Extension for Scoping Reviews (PRISMA-ScR) and draws on a multi-database literature search spanning PubMed, Web of Science, Scopus, ProQuest, and the Cochrane Library. Within the broader evidence base identified through this process, the consortium agreed to adopt the intersection of climate–health and EO-relevant literature as the common analytical subset for detailed assessment. This overlap dataset comprised 150 records for detailed manual and AI-assisted review, of which 83 were retained as included following full-text assessment.

The search covered the period 2019 to January 2026, extending the evidence base beyond the period covered by Rocque et al. (2021), whose systematic review of climate–health systematic reviews searched the literature up to June 2019 and identified 94 eligible systematic reviews. Rocque et al. represent the most directly comparable prior synthesis of systematic reviews on the health effects of climate change (BMJ Open, 2021; DOI: 10.1136/bmjopen-2020-046333).

The present review confirms several of the broad patterns identified by Rocque et al., including the continued prominence of cardiovascular and respiratory diseases, while also documenting important developments in the climate–health evidence base over the subsequent six years. Given differences in search strategies and classification frameworks, these developments are interpreted primarily in terms of continuity and shifts in the representation of health domains and climate drivers, rather than through direct comparison of frequencies between the two assessments. Mental health has emerged as an increasingly central research domain, reflecting growing recognition of the indirect and psychosocial consequences of climate change. The stronger representation of air pollution and fire-related hazards likewise reflects both the rapid expansion of research in these areas and the EO-oriented focus of the present assessment.

The assessment explicitly addresses the intersection between climate–health research and Earth Observation, a dimension absent from the earlier review, and applies a more granular classification of both health domains and climate drivers. It also incorporates structured extraction of climate drivers, health domains, EO datasets, Essential Climate Variables, and climate projection methods. The inclusion of grey literature further complements the scientific evidence base by providing an additional policy-oriented perspective. Together, these elements position the present assessment as an extension of the Rocque et al. synthesis rather than a replacement, extending the evidence base while introducing an explicit EO dimension.

The integrated methodology — combining automated pre-screening in R, manual dual-reviewer assessment, and structured AI-assisted data extraction — ensured both scientific rigour and operational scalability across a large and heterogeneous body of evidence.

Grey literature comprising 15 institutional reports and policy documents was additionally reviewed through a dedicated search, providing a complementary evidence layer that confirmed and extended the findings of the scientific corpus. The grey literature shows strong convergence with the scientific evidence base in identifying air pollution, temperature and heat, as major drivers of health impacts, while also confirming the importance of cardiovascular and respiratory diseases, mental health, and infectious diseases. At the same time, it assigns greater prominence to health systems disruption, food security, migration, and occupational health—domains that remain comparatively underrepresented in the overlap corpus. These divergences should not be interpreted as inconsistencies but as complementary perspectives arising from the different objectives of institutional and peer-reviewed literature.

The findings of this assessment should be interpreted within the scope of the adopted evidence-synthesis approach. While this approach enables the identification of broad patterns, convergence and recurring evidence across existing syntheses, it may not capture relevant individual studies that were not included in the systematic reviews and meta-analyses considered. Accordingly, areas of limited representation



identified in the report should be interpreted as gaps in the synthesised evidence base rather than necessarily as an absence of primary research. Principal findings on climate-related health impacts

The synthesis of the 83 included systematic reviews and meta-analyses reveals a diverse and growing evidence base on the health consequences of climate change. Cardiovascular and cerebrovascular diseases constitute the most frequently represented health domain ($n = 30$), followed closely by respiratory diseases ($n = 29$). Mental health ($n = 24$), infectious diseases excluding vector-borne and foodborne conditions ($n = 23$), and food- and waterborne diseases ($n = 21$) were also prominently represented. Maternal and pregnancy-related outcomes ($n = 17$), metabolic and endocrine diseases ($n = 14$), cancer, neurological diseases, and vector-borne diseases (each $n = 11$) occupied intermediate positions.

Air pollution emerged as the dominant climate driver across the reviewed literature ($n = 51$ included reviews), with particularly strong associations with cardiovascular and respiratory diseases, infectious diseases, maternal outcomes, and cancer. Extreme weather events linked to fires ($n = 35$) showed concentrated connections with respiratory, cardiovascular, and mental health outcomes. Temperature and heat ($n = 32$), floods and storms ($n = 30$), and land use and urban environment ($n = 25$) were also extensively represented, reflecting the multi-driver nature of contemporary climate-health research.

Climate-health interaction patterns indicate that different drivers tend to be associated with characteristic health profiles. Air pollution dominates the cardiovascular and respiratory domains; floods and storms show strong associations with infectious and food- and waterborne diseases; temperature and heat demonstrate broad pathways spanning chronic, infectious, and mental health outcomes. These findings confirm the need for multi-driver, integrated approaches to climate-health risk assessment.

Geographically, the evidence base remains disproportionately concentrated in North America, Europe, Asia, and Oceania. Africa and parts of South America are substantially underrepresented, raising important questions about the transferability of current risk estimates to highly climate-vulnerable regions with limited research infrastructure. This geographical imbalance constitutes one of the most significant limitations of the current evidence base and represents a key priority for future research investment.

8.2. ROLE OF EARTH OBSERVATION IN CLIMATE-HEALTH RESEARCH

The EO-focused analysis was conducted on the 83 included papers of the overlap dataset. Fourteen of the 83 included papers provided sufficiently detailed EO information to enable structured extraction of missions, sensors, and ECVs.

EO applications were most prominent in studies addressing respiratory health (particularly wildfire-related impacts), vector-borne diseases, and maternal and pregnancy-related outcomes. The most used EO datasets were MODIS and Landsat, with more limited use of CORINE, Sentinel-1, Sentinel-2, and TOMS. Many studies referred generically to 'satellite data' or 'remote sensing data' without specifying missions or sensors, reflecting the level of EO-specific methodological detail available within the reviewed evidence base.

Among the 14 EO-specific papers, eleven involved ESA CCI ECVs. The most frequently represented ECVs were Fire, Aerosol, and Ozone, followed by Land Surface Temperature and Vegetation Parameters. EO was most used to characterise environmental exposures — particularly vegetation cover (via NDVI), air quality proxies, and wildfire-related aerosol and smoke — rather than hazard or vulnerability dimensions of risk. This pattern suggests that EO integration in climate-health research is currently more mature at the level of exposure characterisation and comparatively underdeveloped for vulnerability mapping and adaptive capacity assessment.

Only three of the reviewed papers incorporated climate projection models for forward-looking health assessments, covering cardiovascular and respiratory diseases linked to air pollution, vector-borne disease transmission, and mental health outcomes related to drought. This limited representation indicates that future-oriented analyses are comparatively underrepresented within the reviewed evidence base.

8.3. KNOWLEDGE GAPS

The SOTA and EO analyses identified eight principal knowledge gaps structuring the agenda for future research and informing the scientific and technical requirements of the CHANGE project:



- Gap 1 – Limited integration of EO within a complete climate–health risk framework. EO is frequently used to characterise individual exposure variables (land surface temperature, vegetation, air quality proxies, flood extent), but these are not always embedded within a complete risk framework linking hazard, exposure, vulnerability, adaptive capacity, and health outcomes.
- Gap 2 – Insufficient exploitation and documentation of EO datasets. Many studies refer to satellite data without documenting the EO mission, sensor, product version, processing level, or uncertainty characteristics. The broader potential of ESA CCI ECV datasets remains insufficiently exploited.
- Gap 3 – Limited integration of vulnerability, adaptive capacity, and social determinants. EO-based studies frequently prioritise environmental hazards over social determinants, demographic factors, health-system access, and adaptive capacity, producing environmental risk maps that may not fully capture the most exposed or vulnerable populations.
- Gap 4 – Underrepresentation of health systems, facilities, well-being, and migration. Health systems and facilities, human well-being, and migration and displacement remain underrepresented in EO-enabled climate–health analyses, relative to direct morbidity and mortality outcomes.
- Gap 5 – Limited capacity to assess compound and cascading climate events. Many EO-health applications assess hazards separately, while climate-related health risks may result from compound or cascading events such as heatwaves combined with drought or flooding combined with infrastructure disruption.
- Gap 6 – Limited reproducibility, interoperability, and operational scalability. Many EO-enabled studies lack sufficient information on processing workflows, data harmonisation, code availability, or reproducibility, limiting the capacity to compare studies, repeat analyses, or transfer methods to other regions.
- Gap 7 – Insufficient uncertainty characterisation and validation. Uncertainty is often insufficiently treated in EO-enabled climate–health studies. Sources of uncertainty in EO retrievals, exposure modelling, health data, and scenario assumptions are rarely systematically characterised or propagated.
- Gap 8 – Limited predictive capability for future climate–health risks and adaptation planning. Most EO-enabled climate–health studies are retrospective. Fewer integrate EO-derived indicators with climate projections, scenario-based simulations, or future socio-economic change to estimate future health risks or support adaptation planning.

8.4. SCIENTIFIC AND TECHNICAL REQUIREMENTS

In response to the eight knowledge gaps identified, this document defines 24 scientific requirements (SR-01 to SR-24) and 28 technical requirements (TR-01 to TR-28). These requirements are not generic specifications but need-driven responses to the limitations identified in the current evidence base, designed to guide the methodological development of subsequent Work Packages.

The scientific requirements establish the conceptual and analytical standards the project must meet adopting an explicit climate–health risk framework; ensuring full traceability of EO datasets; integrating vulnerability and social determinants; addressing compound and cascading events; and developing methodologies that bridge historical risk assessment and future climate–health projections. The technical requirements translate these principles into operational specifications for data structures, processing workflows, harmonisation procedures, uncertainty quantification, validation approaches, and open-access outputs.

The complete traceability from identified gaps to scientific and technical requirements is provided in Table 7-1. Together, these requirements establish the evidence-based and methodological backbone upon which WP200 case studies and the WP300 adaptation roadmap will be developed.



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 60 of 80

9. REFERENCES

Brazeau A, Ogden N. Earth observation, public health and One Health. Wallingford (UK): CABI; 2022. ISBN: 9781800621183.

Campbell, A. M., Racault, M.-F., Goult, S., & Laurenson, A. (2020). Cholera Risk: A Machine Learning Approach Applied to Essential Climate Variables. *International Journal of Environmental Research and Public Health*, 17(24), 9378. <https://doi.org/10.3390/ijerph17249378>

Cardona OD, van Aalst MK, Birkmann J, Fordham M, McGregor G, Perez R, Pulwarty RS, Schipper ELF, Sinh BT. Determinants of risk: exposure and vulnerability. In: Field CB, Barros V, Stocker TF, Qin D, Dokken DJ, Ebi KL, et al., editors. *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)*. Cambridge (UK); New York (NY): Cambridge University Press; 2012. p. 65–108. [RD19]

Cissé G, McLeman R, Adams H, Aldunce P, Bowen K, Campbell-Lendrum D, Clayton S, Ebi KL, Hess J, Huang C, Liu Q, McGregor G, Semenza J, Tirado MC. Health, wellbeing, and the changing structure of communities. In: Pörtner HO, Roberts DC, Tignor M, Poloczanska ES, Mintenbeck K, Alegría A, et al., editors. *Climate change 2022: impacts, adaptation and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)*. Cambridge (UK); New York (NY): Cambridge University Press; 2022. p. 1041–1170. doi:10.1017/9781009325844.009. [RD20]

Di Napoli, C., Romanello, M., Minor, K., Chambers, J., Dasgupta, S., Escobar, L.E., Hang, Y., Hänninen, R., Liu, Y., Lotto Batista, M. and Lowe, R., 2023. The role of global reanalyses in climate services for health: Insights from the Lancet Countdown. *Meteorological applications*, 30(2), p.e2122.

Ebi KL, Bi P, Bowen K, Brauer M, Chua PL, Colón-González FJ, et al. Priority climate and health modelling needs. *Lancet Planet Health*. 2025;9(9).

EEA 2022. Climate change as a threat to health and well-being in Europe: focus on heat and infectious diseases <https://www.eea.europa.eu/en/analysis/publications/climate-change-impacts-on-health>

EEA 2022. European Climate Risk Assessment <https://www.eea.europa.eu/en/analysis/publications/european-climate-risk-assessment>

GBD 2023. Disease and Injury and Risk Factor Collaborators. Burden of 375 diseases and injuries, risk-attributable burden of 88 risk factors, and healthy life expectancy in 204 countries and territories, including 660 subnational locations, 1990–2023: a systematic analysis for the Global Burden of Disease Study 2023. *Lancet*. 2025;406(10513):1873–1922. doi:10.1016/S0140-6736(25)01637-X.

IPCC. 2025. Working Group II contribution to the Seventh Assessment Report (AR7): Chapter Outline. Chapter 19: Health and well-being. Intergovernmental Panel on Climate Change. https://www.ipcc.ch/site/assets/uploads/2025/03/Doc_12-WGII_AR7_Chapter_Outline.pdf

Rocque RJ, Beaudoin C, Ndjaboue R, Cameron L, Poirier-Bergeron L, Poulin-Rheault RA, Fallon C, Michon B, Dagenais C. Health effects of climate change: an overview of systematic reviews. *BMJ Open*. 2021;11(6):e046333. doi:10.1136/bmjopen-2020-046333.

Romanello M, Napoli C, Pezzulo C, et al. The 2023 report of the Lancet Countdown on health and climate change: the imperative for a health-centred response in the face of an unequal and fragmented world. *The Lancet*. 2023;402(10417):2022–2060. doi:10.1016/s0140-6736(23)01859-7

Romanello, M., Walawender, M., Hsu, S.C., Moskeland, A., Palmeiro-Silva, Y., Scamman, D., Smallcombe, J.W., Abdullah, S., Ades, M., Al-Maruf, A. and Ameli, N., 2025. The 2025 report of the Lancet Countdown on health and climate change. *The Lancet*. 2025; Published online Oct 29. doi:10.1016/S0140-6736(25)01919-1.

Sengupta D, Brandão FG, Sathyendranath S, Kulk G, Conte A, Ippoliti C, et al. Sensing human health from space: an assessment of applications and big data platforms. *Remote Sens Appl Soc Environ*. 2025;101701. doi:10.1016/j.rsase.2025.101701.

Shea BJ, Reeves BC, Wells G, Thuku M, Hamel C, Moran J, Moher D, Tugwell P, Welch V, Kristjansson E, Henry DA. AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. *BMJ*. 2017 Sep 21;358:j4008



CHANGE



Code: D1.1
Date: 25/09/2026
Version: 3.1
Page: 61 of 80

Sogno M, Gamba P, Lisini G. Earth observation for monitoring non-communicable diseases. *Remote Sens.* 2020;12(16):2541. doi:10.3390/rs12162541.

Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Annals of Internal Medicine.* 2018;169(7):467–473. doi:10.7326/M18-0850.

Van Daalen KR, Romanello M, Rocklöv J, Semenza JC, Tonne C, The Lancet Countdown Collaboration. The 2022 report of the Lancet Countdown on health and climate change: health at the mercy of fossil fuels. *Lancet Public Health.* 2022;7(11):e890–e930. doi:10.1016/S2468-2667(22)00197-9

Van Daalen, K.R., Tonne, C., Semenza, J.C., Rocklöv, J., Markandya, A., Dasandi, N., Jankin, S., Achebak, H., Ballester, J., Bechara, H. and Beck, T.M., 2024. The 2024 Europe report of the Lancet Countdown on health and climate change: unprecedented warming demands unprecedented action. *The Lancet Public Health*, 9(7), pp.e495-e522.

Yenew, C., Bayeh, G.M., Gebeyehu, A.A. et al. Scoping review on assessing climate-sensitive health risks. *BMC Public Health* 25, 914 (2025). <https://doi.org/10.1186/s12889-025-22148-x>

Zhao, Q.; Yu, L.; Du, Z.; Peng, D.; Hao, P.; Zhang, Y.; Gong, P. An Overview of the Applications of Earth Observation Satellite Data: Impacts and Future Trends. *Remote Sens.* 2022, 14, 1863. <https://doi.org/10.3390/rs14081863>

WMO 2023. State of Climate Services for Health <https://wmo.int/publication-series/2023-state-of-climate-services-health>



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 62 of 80

10. APPENDICES

10.1. LIST OF SELECTED PAPERS AND REPORTS

The list of systematic reviews and meta-analysis composing the overlap corpus dataset is available in Zenodo repository:

- Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise G. Caporale, GMV Innovating Solutions (Spain), & Barcelona Supercomputing Center. (2026). Climate-Health and Earth Observation selected literature database [Data set]. Zenodo.
<https://doi.org/10.5281/zenodo.20844563>

10.2. SEARCH QUERY STRINGS

10.2.1. PUBMED

Refined by:

Publication years: 2019-2026

Language: English

Search string:

(

"access to healthcare"[Title/Abstract] OR

"health system*"[Title/Abstract] OR

"health infrastructure*"[Title/Abstract] OR

"health service disruption"[Title/Abstract] OR

"food safety"[Mesh] OR

"food security"[Mesh] OR

"food insecurity"[Title/Abstract] OR

migration*[Title/Abstract] OR

"population displacement"[Title/Abstract] OR

"Mortality"[Mesh] OR

"Morbidity"[Mesh] OR

"heat-related illness*"[Title/Abstract] OR

"heat stress"[Title/Abstract] OR

("Cardiovascular Diseases"[Mesh] OR "cardiovascular disease*"[Title/Abstract]) OR

("Cerebrovascular Disorders"[Mesh] OR "cerebrovascular disease*"[Title/Abstract]) OR

("Respiratory Tract Diseases"[Mesh] OR "respiratory disease*"[Title/Abstract]) OR

("Infectious Disease"[Mesh] OR "infectious disease*"[Title/Abstract]) OR



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 63 of 80

("Vector-Borne Diseases"[Mesh] OR "vector-borne disease*"[Title/Abstract]) OR
 ("Waterborne Diseases"[Mesh] OR "waterborne disease*"[Title/Abstract]) OR
 ("Foodborne Diseases"[Mesh] OR "foodborne disease*"[Title/Abstract]) OR
 ("Zoonoses"[Mesh] OR "zoonotic disease*"[Title/Abstract]) OR

"Mental Health"[Mesh] OR
 "sleep disorder*"[Title/Abstract] OR

("Neurologic Disorders"[Mesh] OR "neurological disorder*"[Title/Abstract]) OR
 ("Neurodegenerative Diseases"[Mesh] OR "neurodegenerative disease*"[Title/Abstract]) OR
 "cognitive decline"[Title/Abstract] OR

"pregnancy outcome*"[Title/Abstract] OR
 "Occupational Health"[Mesh] OR

"undernutrition"[Title/Abstract] OR
 "malnutrition"[Mesh] OR

"Parkinson Disease"[Mesh] OR
 "Alzheimer Disease"[Mesh] OR
 "Dementia"[Mesh] OR
 "Amyotrophic Lateral Sclerosis"[Mesh] OR
 "Motor Neuron Disease"[Mesh] OR

"circadian rhythm disruption"[Title/Abstract] OR
 "Neoplasms"[Mesh] OR
 vaccination[Title/Abstract] OR

"Escherichia coli"[Mesh] OR
 "Enterococcus"[Mesh] OR
 "Leptospirosis"[Mesh]

)

AND

(

"Climate Change"[Mesh] OR
 "Global Warming"[Mesh] OR
 "Climate Variability"[Title/Abstract] OR



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 64 of 80

"Temperature Extremes"[Mesh] OR

"Heat Waves"[Mesh] OR

"Extreme Cold"[Mesh] OR

"Droughts"[Mesh] OR

"Floods"[Mesh] OR

"Heavy Precipitation"[Title/Abstract] OR

"Sea Level Rise"[Mesh] OR

"Coastal Flooding"[Title/Abstract] OR

"Storm Surge"[Mesh] OR

"Wildfires"[Mesh] OR

"Fire Weather"[Title/Abstract] OR

"Air Pollution"[Mesh] OR

"Air Quality"[Title/Abstract] OR

"Particulate Matter"[Mesh] OR

"PM2.5"[Title/Abstract] OR

"Ozone"[Mesh] OR

"Nitrogen Dioxide"[Mesh] OR

"Carbon Monoxide"[Mesh] OR

"Sulfur Dioxide"[Mesh] OR

"Urban Heat Island"[Mesh] OR

"Land Use Change"[Title/Abstract] OR

"Deforestation"[Mesh] OR

"Ecosystem Degradation"[Title/Abstract] OR

"Desertification"[Mesh] OR

"Water Availability"[Title/Abstract] OR

"Water Quality"[Mesh] OR

"Freshwater Contamination"[Title/Abstract] OR

"Salinity Intrusion"[Title/Abstract] OR

"El Niño-Southern Oscillation"[Mesh] OR

"El Niño"[Title/Abstract] OR

"La Niña"[Title/Abstract] OR

"Urban Green"[Title/Abstract] OR

"Tropical Cyclones"[Mesh] OR



CHANGE



Code: D1.1
 Date: 25/09/2026
 Version: 3.1
 Page: 65 of 80

landslide*[Title/Abstract] OR
 mudflow*[Title/Abstract] OR
 "algal bloom*" [Title/Abstract] OR
 "ground-level ozone" [Title/Abstract]

)

AND

(

impact*[Title/Abstract] OR
 association*[Title/Abstract] OR
 burden*[Title/Abstract] OR
 attributable[Title/Abstract] OR
 effect*[Title/Abstract]

)

10.2.2. WEB OF SCIENCE

Refined By:

Publication Years: 2026 or 2025 or 2024 or 2023 or 2022 or 2021 or 2020 or 2019.

Languages: English

Search String:

(

TS=(

"access to healthcare" OR
 (health NEAR/1 system*) OR
 (health NEAR/1 infrastructure*) OR
 "health service disruption" OR

"food safety" OR
 "food security" OR
 "food insecurity" OR

migration* OR
 "population displacement" OR

mortality OR
 morbidity OR

"heat-related illness*" OR



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 66 of 80

"heat stress" OR

"cardiovascular diseases" OR "cardiovascular disease*" OR

"cerebrovascular disorders" OR "cerebrovascular disease*" OR

"respiratory tract diseases" OR "respiratory disease*" OR

"infectious disease" OR "infectious disease*" OR

"vector-borne diseases" OR "vector-borne disease*" OR

"waterborne diseases" OR "waterborne disease*" OR

"foodborne diseases" OR "foodborne disease*" OR

zoonos* OR "zoonotic disease*" OR

"mental health" OR

"sleep disorder*" OR

"neurologic disorders" OR "neurological disorder*" OR

"neurodegenerative diseases" OR "neurodegenerative disease*" OR

"cognitive decline" OR

"pregnancy outcome*" OR

"occupational health" OR

undernutrition OR

malnutrition OR

"parkinson disease" OR

"alzheimer disease" OR

dementia OR

"amyotrophic lateral sclerosis" OR

"motor neuron disease" OR

"circadian rhythm disruption" OR

neoplasms OR

vaccination OR

"escherichia coli" OR

enterococcus OR

leptospirosis

)

)



CHANGE



Code: D1.1
Date: 25/09/2026
Version: 3.1
Page: 67 of 80

AND

(

TS=(

"climate change" OR
"global warming" OR
"climate variability" OR

"temperature extremes" OR
"heat waves" OR
"extreme cold" OR

drought* OR
flood* OR
"heavy precipitation" OR
"sea level rise" OR
"coastal flooding" OR
"storm surge" OR

wildfire* OR
"fire weather" OR

"air pollution" OR
"air quality" OR
"particulate matter" OR
"pm2.5" OR
ozone OR
"nitrogen dioxide" OR
"carbon monoxide" OR
"sulfur dioxide" OR

"urban heat island" OR
"land use change" OR
deforestation OR
"ecosystem degradation" OR
desertification OR

"water availability" OR
"water quality" OR



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 68 of 80

"freshwater contamination" OR

"salinity intrusion" OR

"el niño-southern oscillation" OR

"el niño" OR

"la niña" OR

"urban green" OR

"tropical cyclones" OR

landslide* OR

mudflow* OR

"algal bloom*" OR

"ground-level ozone"

)

)

AND

(

TS=(

impact* OR

association* OR

burden* OR

attributable OR

effect*

)

)

AND

(

TS=(

"systematic review" OR

meta-analysis

)

)

10.2.3. SCOPUS

Refined By:

Publication Years: 2019 or 2020 or 2021 or 2022 or 2023 or 2024 or 2025 or 2026.



CHANGE



Code: D1.1
Date: 25/09/2026
Version: 3.1
Page: 69 of 80

Languages: English

Search string:

(

TITLE-ABS-KEY(

"access to healthcare" OR

(health PRE/1 system*) OR

(health PRE/1 infrastructure*) OR

"health service disruption" OR

"food safety" OR

"food security" OR

"food insecurity" OR

migration* OR

"population displacement" OR

mortality OR

morbidity OR

"heat-related illness*" OR

"heat stress" OR

"cardiovascular diseases" OR "cardiovascular disease*" OR

"cerebrovascular disorders" OR "cerebrovascular disease*" OR

"respiratory tract diseases" OR "respiratory disease*" OR

"infectious disease" OR "infectious disease*" OR

"vector-borne diseases" OR "vector-borne disease*" OR

"waterborne diseases" OR "waterborne disease*" OR

"foodborne diseases" OR "foodborne disease*" OR

zoonos* OR "zoonotic disease*" OR

"mental health" OR

"sleep disorder*" OR

"neurologic disorders" OR "neurological disorder*" OR

"neurodegenerative diseases" OR "neurodegenerative disease*" OR

"cognitive decline" OR



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 70 of 80

"pregnancy outcome*" OR

"occupational health" OR

undernutrition OR

malnutrition OR

"parkinson disease" OR

"alzheimer disease" OR

dementia OR

"amyotrophic lateral sclerosis" OR

"motor neuron disease" OR

"circadian rhythm disruption" OR

neoplasms OR

vaccination OR

"escherichia coli" OR

enterococcus OR

leptospirosis

)

)

AND

(

TITLE-ABS-KEY(

"climate change" OR

"global warming" OR

"climate variability" OR

"temperature extremes" OR

"heat waves" OR

"extreme cold" OR

drought* OR

flood* OR

"heavy precipitation" OR

"sea level rise" OR

"coastal flooding" OR



CHANGE



Code: D1.1
Date: 25/09/2026
Version: 3.1
Page: 71 of 80

"storm surge" OR

wildfire* OR

"fire weather" OR

"air pollution" OR

"air quality" OR

"particulate matter" OR

"pm2.5" OR

ozone OR

"nitrogen dioxide" OR

"carbon monoxide" OR

"sulfur dioxide" OR

"urban heat island" OR

"land use change" OR

deforestation OR

"ecosystem degradation" OR

desertification OR

"water availability" OR

"water quality" OR

"freshwater contamination" OR

"salinity intrusion" OR

"el niño-southern oscillation" OR

"el niño" OR

"la niña" OR

"urban green" OR

"tropical cyclones" OR

landslide* OR

mudflow* OR

"algal bloom*" OR

"ground-level ozone"

)

)

AND



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 72 of 80

(
TITLE-ABS-KEY(
 impact* OR
 association* OR
 burden* OR
 attributable OR
 effect*
)
)

10.2.4. PROQUEST

("access to healthcare"
OR "health system*"
OR "health infrastructure*"
OR "health service disruption"
OR "food safety"
OR "food security"
OR "food insecurity"
OR migration*
OR "population displacement"
OR "Mortality"
OR "Morbidity"
OR "heat-related illness*"
OR "heat stress"
OR "Cardiovascular Diseases" "cardiovascular disease*"
OR "Cerebrovascular Disorders" "cerebrovascular disease*"
OR "Respiratory Tract Diseases" "respiratory disease*"
OR "Infectious Disease" "infectious disease*"
OR "Vector-Borne Diseases" "vector-borne disease*"
OR "Waterborne Diseases" "waterborne disease*"
OR "Foodborne Diseases" "foodborne disease*"
OR "Zoonoses" "zoonotic disease*"
OR "Mental Health"
OR "sleep disorder*"
OR "Neurologic Disorders" "neurological disorder*"
OR "Neurodegenerative Diseases" "neurodegenerative disease*")



CHANGE



Code: D1.1
Date: 25/09/2026
Version: 3.1
Page: 73 of 80

OR "cognitive decline"
OR "pregnancy outcome*"
OR "Occupational Health"
OR "undernutrition"
OR "malnutrition"
OR "Parkinson Disease"
OR "Alzheimer Disease"
OR "Dementia"
OR "Amyotrophic Lateral Sclerosis"
OR "Mot
OR Neuron Disease"
OR "circadian rhythm disruption"
OR "Neoplasms"
OR vaccination
OR "Escherichia coli"
OR "Enterococcus"
OR "Leptospirosis")

AND

("Climate Change"
OR "Global Warming"
OR "Climate Variability"
OR "Temperature Extremes"
OR "Heat Waves"
OR "Extreme Cold"
OR "Droughts"
OR "Floods"
OR "Heavy Precipitation"
OR "Sea Level Rise"
OR "Coastal Flooding"
OR "Storm Surge"
OR "Wildfires"
OR "Fire Weather"



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 74 of 80

OR "Air Pollution"
OR "Air Quality"
OR "Particulate Matter"
OR "PM2.5"
OR "Ozone"
OR "Nitrogen Dioxide"
OR "Carbon Monoxide"
OR "Sulfur Dioxide"
OR "Urban Heat Island"
OR "Land Use Change"
OR "Deforestation"
OR "Ecosystem Degradation"
OR "Desertification"
OR "Water Availability"
OR "Water Quality"
OR "Freshwater Contamination"
OR "Salinity Intrusion"
OR "El Niño-Southern Oscillation"
OR "El Niño"
OR "La Niña"
OR "Urban Green"
OR "Tropical Cyclones"
OR landslide*
OR mudflow*
OR "algal bloom*"
OR "ground-level ozone")

AND

(impact*

OR association*

OR burden*

OR attributable

OR effect*)



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 75 of 80

10.2.5. COCHRANE

("access to healthcare"

OR "health system*"

OR "health infrastructure*"

OR "health service disruption"

OR "food safety"

OR "food security"

OR "food insecurity"

OR migration*

OR "population displacement"

OR "Mortality"

OR "Morbidity"

OR "heat-related illness*"

OR "heat stress"

OR "Cardiovascular Diseases" "cardiovascular disease*"

OR "Cerebrovascular Disorders" "cerebrovascular disease*"

OR "Respiratory Tract Diseases" "respiratory disease*"

OR "Infectious Disease" "infectious disease*"

OR "Vector-Borne Diseases" "vector-borne disease*"

OR "Waterborne Diseases" "waterborne disease*"

OR "Foodborne Diseases" "foodborne disease*"

OR "Zoonoses" "zoonotic disease*"

OR "Mental Health"

OR "sleep disorder*"

OR "Neurologic Disorders" "neurological disorder*"

OR "Neurodegenerative Diseases" "neurodegenerative disease*"

OR "cognitive decline"

OR "pregnancy outcome*"

OR "Occupational Health"

OR "undernutrition"

OR "malnutrition"



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 76 of 80

OR "Parkinson Disease"
OR "Alzheimer Disease"
OR "Dementia"
OR "Amyotrophic Lateral Sclerosis"
OR "Mot
OR Neuron Disease"
OR "circadian rhythm disruption"
OR "Neoplasms"
OR vaccination
OR "Escherichia coli"
OR "Enterococcus"
OR "Leptospirosis")

AND

("Climate Change"
OR "Global Warming"
OR "Climate Variability"
OR "Temperature Extremes"
OR "Heat Waves"
OR "Extreme Cold"
OR "Droughts"
OR "Floods"
OR "Heavy Precipitation"
OR "Sea Level Rise"
OR "Coastal Flooding"
OR "Storm Surge"
OR "Wildfires"
OR "Fire Weather"
OR "Air Pollution"
OR "Air Quality"
OR "Particulate Matter"
OR "PM2.5"
OR "Ozone"



CHANGE



Code: D1.1
Date: 25/09/2026
Version: 3.1
Page: 77 of 80

OR "Nitrogen Dioxide"
OR "Carbon Monoxide"
OR "Sulfur Dioxide"
OR "Urban Heat Island"
OR "Land Use Change"
OR "Deforestation"
OR "Ecosystem Degradation"
OR "Desertification"
OR "Water Availability"
OR "Water Quality"
OR "Freshwater Contamination"
OR "Salinity Intrusion"
OR "El Niño-Southern Oscillation"
OR "El Niño"
OR "La Niña"
OR "Urban Green"
OR "Tropical Cyclones"
OR landslide*
OR mudflow*
OR "algal bloom*"
OR "ground-level ozone")

AND

(impact*
OR association*
OR burden*
OR attributable
OR effect*)

10.3. EO CLASSIFICATION DICTIONARIES AND SEARCH TERMS

To characterise the presence of EO content within the bibliographic database, two complementary EO dictionaries were implemented.

The first dictionary ("EO-explicit") was designed as a conservative classification scheme aimed at identifying publications making explicit reference to EO, remote sensing or satellite-derived information.



The second dictionary ("EO corpus") was developed as an extended audit dictionary to capture a broader range of EO-related concepts, including specific satellite missions, EO-derived environmental indicators, geospatial products and spatial-analysis terminology.

Both dictionaries were applied to the combined text fields used for screening (Title, Abstract, Author Keywords, Index Keywords and, where available, MeSH headings). Records were classified as positive when at least one term from the corresponding dictionary was detected.

Table 10-1: EO-explicit dictionary.

Category	Terms
Earth Observation	earth observation
Remote Sensing	remote sensing
Satellite	satellite
Sentinel	sentinel
MODIS	modis
Landsat	landsat
VIIRS	viirs
Copernicus	copernicus
NDVI	ndvi
LST	lst, land surface temperature

Table 10-2: Extended EO corpus dictionary.

Category	Examples of terms included
Earth Observation	earth observation, EO data, earth observation data
Remote Sensing	remote sensing, remote sensing data
Satellite Data	satellite imagery, satellite-derived, spaceborne
Copernicus/Sentinel missions	Sentinel-1 to Sentinel-6, Copernicus
MODIS products	MODIS Terra, MODIS Aqua
Landsat missions	Landsat-1 to Landsat-9
VIIRS products	NPP-VIIRS, NOAA-20
Commercial EO missions	PlanetScope, Planet Labs, WorldView, DigitalGlobe, Maxar
NOAA missions	AVHRR, NOAA satellites
Other EO missions	GeoEye, IKONOS, QuickBird, Radarsat, ALOS, Envisat, ASTER, PROBA-V
Vegetation indicators	NDVI, EVI
Surface temperature	Land Surface Temperature (LST), Sea Surface Temperature (SST)
Ocean variables	SSS, SSH, Chlorophyll-a
Land variables	Soil Moisture, LAI, FAPAR, Burned Area, Land Cover
Spatial analysis	GIS, geospatial analysis, spatial epidemiology, raster, gridded data, pixel-based analysis

10.4. PROMPT ENGINEERING USED FOR AI-ASSISTED REVIEW

SciSpace was used as an AI-assisted review environment to support structured screening, annotation, and information extraction across P1 dataset. The prompt was designed to ensure consistency with the



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 79 of 80

manually reviewed overlap dataset, which served as the reference framework. Instructions included preservation of the original spreadsheet structure, use of controlled vocabularies for health and climate categories, prioritisation of full-text information when available, explicit handling of uncertainty, and avoidance of unsupported inference.



CHANGE



Code: D1.1

Date: 25/09/2026

Version: 3.1

Page: 80 of 80

END OF DOCUMENT