



EDUCATIONAL MATERIALS FOR INCREASED REGIONAL CC RESILIENCE

ClimEmpower Work Package 4, D4.1, v1



Project ClimEmpower: User Driven Climate Applications Empowering
Regional Resilience

Work package 4, Deliverable D4.1

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Deliverable details	
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List of Acronyms

AI	Artificial Intelligence
AIT	Austrian Institute of Technology GMBH
CC	Climate Change
CCA	Climate Change Adaptation
CIC	Climate Interaction Context
CoP	Community of Practice
DRR	Disaster Risk Reduction
FER	University of Zagreb Faculty of Electrical Engineering and Computing
PDF	Portable Document Format
SO	Strategic Objective
URL	Universal Resource Locator
WP	Work Package

Glossary

Case Study Facilitator	Designated entities in each Case Study that are responsible for maintaining oversight and keeping the WP (Work Package) leaders informed about the progress and development of the CoP (Community of Practice). These entities play a vital role in establishing synergies with other Work Packages and ensure the project activities at local level meet end-users needs.
Climate impacts	The consequences of realized risks on natural and human systems, where risks result from the interaction of climate-related hazards (including extreme weather and climate events), exposure, and vulnerability. Impacts generally refer to effects on lives; livelihoods; health and well-being; ecosystems and species; economic, social and cultural assets; services (including ecosystem services); and infrastructure (based on IPCC, 2018).
Community of Practice	Group of people who share a common interest or concern for a specific activity, practice or topic who engage in a process of collective learning within a shared domain by supporting each other and exchanging information through collaborative activities.
Disinformation	Deliberate dissemination of false or inaccurate information in order to discredit a person or organization. (from https://library.csi.cuny.edu/misinformation#s-lg-box-13619221)
Exposure	Exposure is the situation of people, infrastructure, housing, production capacities and other tangible (human) assets located in hazard-prone areas.
Hazard	Hazards have the potential to cause loss of life, injury or other health impacts, property damage, social and economic disruption, or environmental degradation.
Misinformation	The sharing of inaccurate and misleading information in an unintentional way. (from https://library.csi.cuny.edu/misinformation#s-lg-box-1361922).
Quadruple helix model of innovation	Collaborative approach in research and development that involves four key sectors of society: industry, government (public sector), academia and civil society, to involve a greater public in innovation processes.
Stakeholder	A person with an interest or concern in something.
Vulnerability	Vulnerability refers to the conditions determined by physical, social, economic, and environmental factors or processes which increase the susceptibility of an individual, a community, assets, or systems to the impacts of hazards.

Executive summary (publishable)

D4.1 “Educational materials for increased regional CCresilience v1” is the first deliverable of ClimEmpower’s WP4 – “Empowering the regions” work package and provides an overview of already existing educational materials that are deemed useful for the ClimEmpower Communities of Practice (CoP) and other regional stakeholders, including the general public. Therefore, a wide range of training materials, such as tutorials, serious games, courses etc. have been investigated.

The deliverable starts with a project presentation (Section 1) and structured introduction explaining the deliverable inputs, outputs, expectations, and relation to other work (section 2).

Section 3 explains the motivation behind this deliverable: from a generic need for climate literacy and education, over the expectations set up by the ClimEmpower Grant Agreement, to the needs of the case study regions, as expressed by the regional project partners and CoP members. This section also explains that our target audience has no interest in becoming climate change experts, but needs to integrate actionable knowledge on hazards, risks and potential adaptation and mitigation actions in their daily work and life. Consequently, this document emphasises on materials that can be easily understood with low effort, such as educational videos, short popular science articles and serious games. Our understanding, based on bilateral talks, CoP meetings, and literature (Senadheera, Muthukumarana, Ediriweera, & Rupasinghe, 2024; Lopez, 2024), is that this type of stakeholders is best served with “microlearning” content that they can easily consume within minutes, relate it to their own expertise, and subsequently use for more informed individual and collective decision making.

Section 4 explains the methodology used in preparing the deliverable. In short, we first identified a handful of web pages that act as hubs for educational content that offer different types of educational materials, as well as the topics of interest for the ClimEmpower stakeholders. In the next step, the hubs were scanned, and the relevant materials summarised for easier discovery and access.

Part of the curated materials is presented in section 5, whereas the full list is available on ClimEmpower’s Zenodo community (<https://zenodo.org/communities/climempower/>, <https://doi.org/10.5281/zenodo.13944851>) and will be updated throughout the project by removing the materials that are deemed uninteresting by the CoPs and adding new materials as needed.

Finally, section 6 concludes the document with a summary of achievements and a discussion of the future work of task T4.1 which explains: (1) how the materials that we have already collected will be made visible through ClimEmpower’s Quora space (<https://climempower.quora.com/>) and incorporated into (semi-)formal microlearning courses, and (2) what other educational materials will be developed by the project and why. It also explains how the gathered materials will be used for further educational material development (e.g. using videos to set up micro-learning courses).

1 ClimEmpower summary

ClimEmpower is a Horizon Europe collaborative research project dedicated to addressing the ongoing Climate Crisis in Europe by empowering the regional stakeholders in some of the most vulnerable European regions (Figure 1).

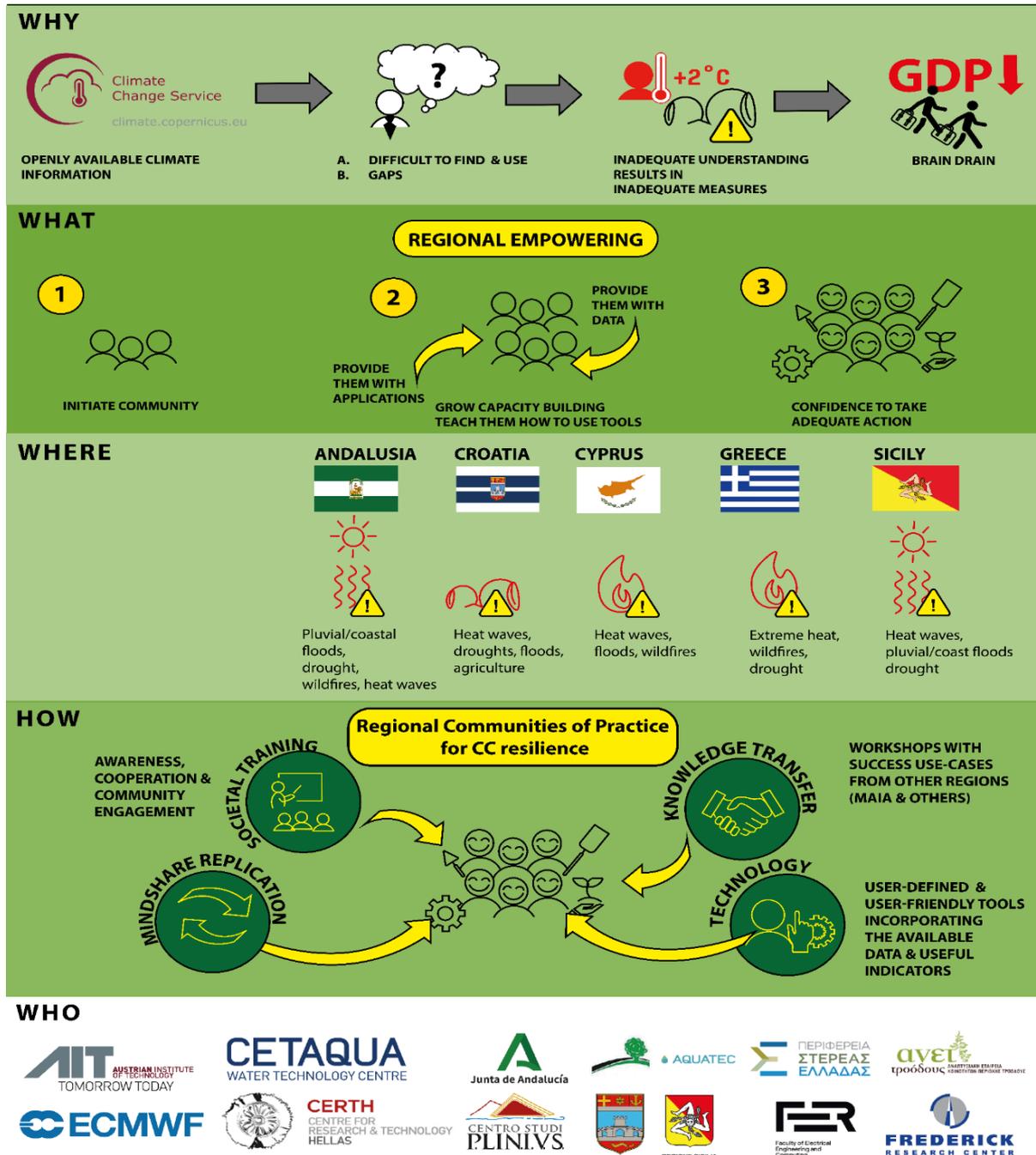


Figure 1: ClimEmpower at a glance: why, what, where, how, and who.

1.1 Project Context

Climate risks result from a combination of a hazard, exposure, and vulnerability. Addressing all three aspects is crucial for effective increase of regional resilience. However, exposure, vulnerability, and related aspects, such as adaptive capacity, strongly depend on available knowledge and climate literacy. Consequently, global climate crisis frequently has a higher impact on socioeconomically vulnerable regions, thanks to a higher human and economic potential for addressing the issue in more affluent regions. To maximize its impact, ClimEmpower has therefore chosen to address the EU regions featuring a combination of high potential CC impacts and low and/or stagnant regional GDP/capita. This is mainly the case for regions in South and Southeast Europe (Figure 2).

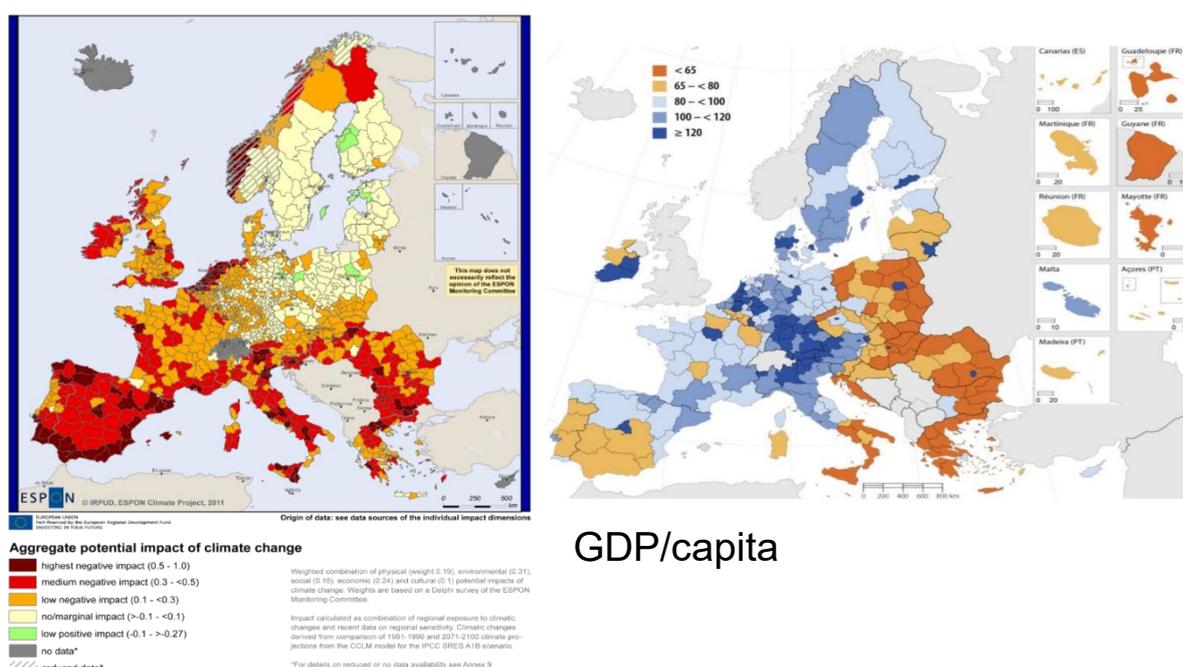


Figure 2: Aggregated potential impact of climate change (<https://www.espon.eu/climate-2012>); GDP/capita (based on <https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20210303-1>)

The context the project addresses is thus one of an ongoing global warming, high regional vulnerability and low coping capacity of the participating regions, and the **overarching strategic objective of ClimEmpower** is to empower the Regional Authorities (RAs) and other Mission Users (MUs) in five EU-regions featuring a combination of exceptionally high climate hazards and exceptionally low coping capacity by improving their collective understanding of the Climate Change (CC) hazards, risks and resilient development pathways and supporting their knowledge-based regional planning and development through provision of relevant data, knowledge and user-defined and user-friendly decision support applications.

1.2 Project Objectives

To achieve this overarching goal, **ClimEmpower has identified six SMART¹ Strategic Objectives (SO)**, each one related to one or several work packages. The SOs have also been classified according to different categories: societal, contributing to improved dialogue, awareness, cooperation and community engagement as highlighted by the European Climate Pact (SO1, SO5); scientific, corresponding to research activities for advances beyond the state of the art (SO2, SO3); technological, suggesting and/or developing novel solutions, integrating state-of-the-art and digital advances (SO4); and outreach, aimed at sharing ClimEmpower results to a broader scientific and non-scientific audience, including additional regions and communities, to maximize project impact (SO6).

- SO1 Understand regional background, challenges, and expectation (WP1, societal)
- SO2 Addressing the gaps in availability and usability of CC data and services (WP2 and WP4, scientific)
- SO3 Identification, definition, estimating, and communication of climate impact/resilience indicators suitable for local end-users (WP2 and WP4, scientific)
- SO4 Simplify access to CC data and development of end user applications (WP3, technological)
- SO5 Empower the regions to activate and enhance their potential for addressing the climate change challenge. (WP4, societal)
- SO6 Ensure the use and impact of the ClimEmpower outputs (WP4 and WP5, scientific and societal)

ClimEmpower's key ambition is to **prove beyond doubt that CC-resilience should, and can, be an integral part of regional development everywhere in EU and beyond it**. That is, we anticipate that the regional stakeholders will recognise that CC-resilient development pathways offer multiple benefits to them, including but not limited to higher quality of life and reviving economy, and that these can be understood using available data, tools, and services. Second key ambition of the project is to **help the regions address the CC resilience in key community systems addressed in five ClimEmpower trials**.

Underlying philosophy of the project is to **"help the regions to help themselves"**. This will be achieved through various mechanisms, including co-creation and mediation of the regional **"Communities of Practice"**, provision of the **Climate Change -resilience training materials**, as well as in provision and training in use of the **user-centric data and services** – including those that have already been made available through previous research projects and EU initiatives.

¹ Specific (related to WPs), Measurable (by relevant KPIs), Achievable (the WPs in which they will be achieved are listed), Realistic (since they are referred and explained in the methodology section), and Timebound (each KPI is related to a deliverable and a month of achievement).

2 Introduction

2.1 Deliverable summary

This Deliverable is the first result of ClimEmpower WP4 “Regional CC-resilience background” work package and contributes to the project requirement of “... guaranteeing the provision of educational/training materials and interactive tools for use within ClimEmpower and beyond it.”.

It provides the motivation for the decision of curating existing educational materials, explains how the requirements for the materials were gathered, presents the materials discovered, and discloses future steps regarding the planned development of new materials, tools, and approaches in collaboration with WP2 “Addressing the CC data and knowledge Gaps” and WP3 “User-centric CC resilience enhancing services”, to enhance/enable the usage of existing data/services and the ones developed by ClimEmpower.

2.2 Results and expected impacts

This deliverable presents various types of existing educational materials and connects these materials to stakeholder needs that were expressed in the deliverable D1.2 – “ClimEmpower scenarios”. Short descriptions, alongside supporting information that can help any viewer decide whether the material will prove useful for their undertaking, are provided for each of the analysed materials, along with the URL (often referred to as “link” in the following chapters) to the material source. It also presents an overview of types of educational materials that were analysed by the project team, which will help the users to identify possible educational material type gaps that can be filled later in the project. Finally, as described in more detail in section 6, the gathered materials will be used as a base for developing microlearning courses that will help our stakeholders to assess the knowledge gained by digesting the materials provided and boost their knowledge retention (Senadheera, Muthukumarana, Ediriweera, & Rupasinghe, 2024).

This deliverable contributes mainly to **SO4 “Empower the regions to activate and enhance their potential for addressing the climate change challenge”**, as the provided knowledge should lead to the empowerment of the regions, as well as boost their capability of constructing solutions to existing problems, and problem solving for expected future issues. Knowledge is the first step that needs to be taken for change to start happening.

In addition, it also contributes to:

- **SO2 “Addressing the gaps in availability and usability of CC data and services”** since the educational materials found as part of this deliverable address some of the gaps in information that were identified after speaking to regional representatives.
- **SO3 “Identification, definition, estimating, and communication of climate impact/resilience indicators suitable for local end-users”**, as the provided materials will help stakeholders to better understand the relevant climate change hazards, risks, possible adaptation and mitigation actions and relations between these elements.
- **SO5 “Ensure the use and impact of the ClimEmpower outputs”**, since the materials provided in this deliverable will be used to support CoP activities with relevant and quality materials that will educate, challenge, and inspire the regional stakeholders.

Curated list of educational materials will also be shared beyond the project, thus raising awareness of ClimEmpower and Europe's efforts in mitigating climate change and its impacts, adapting to the changes that climate change brings, and enhancing the climate change resilience.

2.3 Relation to other work

This deliverable answers to the needs ClimEmpower regions previously expressed in deliverable D1.2 "ClimEmpower scenarios" and directly depends on the work of climate change educators, content creators, and experts that have decided to publish their materials and therefore allow (free) access to climate change information and education.

The tables produced as part of this deliverable and the deliverable itself will help educate the regional stakeholders and spark debate and discussion in future CoP meetings in the project task T4.2 "Involve and empower regional actors". Furthermore, they can be used by any of the stakeholders to inform those that are not directly present at the meetings or to organise events in their community that could further disseminate knowledge and raise awareness.

2.4 Data, security, and ethics

Several tables of curated climate change related educational materials have been produced as part of this deliverable. The educational materials have been screened for security and ethics concerns and only the non-controversial ones have been included in the deliverable outputs.

2.4.1 Data interoperability

The tables produced as part of this deliverable are Microsoft Excel documents with the extension ".xlsx". Since no such prior tables have been encountered during our search for educational materials, the way they were organised, and the meta-information gathered were decided upon by project members and signed off by experts in the field of education.

Accessing the tables requires either Microsoft Excel or other software capable of displaying ".xlsx" type files, such as Apache OpenOffice or Google Sheets. Most of the materials listed in the tables can be accessed using an Internet browser and can be utilised without installing any special software on a typical office computer.

The data types of individual educational materials vary greatly and will be listed (when deemed relevant) alongside the materials themselves.

Some of them are video materials, which may be downloadable or only available for streaming, some are short articles on a web page (which will often be a combination of HTML and JavaScript and may contain interactive parts), while others may be available as downloadable documents (most likely with a ".pdf" extension). Some of the serious games presented in this deliverable are available as interactive software (their format depends on their Web GUI), but a majority of them are "role playing games" (that do not require installation, only some preparatory work by the facilitator who should then explain and moderate the game) that can be used to trigger and direct the discussion within the CoPs, activate the stakeholders' curiosity and subsequently fuel change in the community. Finally, the deliverable also lists several fully fledged training courses. These courses are proprietary and combine different types of materials. They are provided for the sake of completeness but are unlikely to be used within the project scope.

2.4.2 Data accessibility and reuse:

“Data hub” platforms, which are presented in section 5.1, are the main source of the inputs for this deliverable. Most of the platforms were either discovered by dedicated internet search, or already known to the team members.

The tables summarising the data hubs and educational materials that were discovered in preparing this deliverable are available on the open access platform Zenodo, under <https://zenodo.org/communities/climempower>. The conditions under which the educational materials can be used were defined by their respective authors and listed in the tables where relevant.

Table 1: Data produced in preparation of ClimEmpower deliverable D4.1

Data set name	Format	Size	Owner & reuse conditions	Potential utility within and outside the project	Unique ID
ClimEmpower Climate Change educational resources (Knowledge hubs and educational materials tables)	Microsoft Excel (.xlsx)	~150 KB	ClimEmpower, public	Two tables, providing a list of "aggregator pages" with (links to) curated educational materials on climate change adaptation and mitigation and examples of different types of educational materials that are resolving some of the educational needs of the ClimEmpower regional stakeholders. Within the project, these tables will be used for trainings and self-learning of the regional stakeholders, as well as to determine how useful different categories of educational materials are for the CoPs, and which additional materials need to be procured by ClimEmpower team. The tables are provided as Open Data in the hope that they will be useful for other projects and regional stakeholders looking for similar educational materials.	https://doi.org/10.5281/zenodo.13944851

The production of the tables was overseen by several experts in the field of education to ensure that the information provided is factual, useful, and clear to all those who might use the educational materials at a later date. Further quality assurance will come from the materials being used as part of the project’s planned CoP meetings, since it is difficult to gauge what will prove to be useful in practice. Any materials deemed unsuitable for further use by the CoPs will be removed from the tables in the second release of this deliverable, and new materials will be added as necessary.

The tables’ value is high due to them being a great resource for regional stakeholders in ClimEmpower CoPs and beyond them that are looking for reliable and easy to understand information on specific climate change hazards, risks, adaptations, and related topics. These tables will also support ClimEmpower CoP activities, since they can either inform the topics of

the meetings or provide a basis for discussion in the form of a short video or serious game that sparks inspiration among the participants. The materials can also be used to plan activities outside the direct scope of ClimEmpower, as well as for other scientific institutions' endeavours.

2.4.3 Security and Ethics

All educational materials discovered in preparing this deliverable have been assessed for errors and ethical issues by the project team. ClimEmpower cannot assess the authors' conduct in producing said materials, but the recommendations provided therein were of unambiguous morality and practice at a time of compilation. The materials were gathered in the period between December 2023 and October 2024.

3 Motivation

This section describes the project members' motivation and reasoning for searching for and curating educational materials that they deem valuable to the project's stakeholders, and potentially also to the general public.

3.1 The need for climate literacy and education

Despite scientific consensus and numerous research papers and reports on climate change and its effects, the public information space is still loaded with pseudoscience, appeasements, controversial, and factually wrong information. The lack of climate literacy endangers the society by fuelling mistrust in climate science and motives of the policy- and decision-makers and slowing down the efforts at climate change mitigation and adaptation.

Today, due to the Internet being a vast and prolific resource, gathering knowledge about climate change adaptation and mitigation can be perceived as a trivial task. Exactly this glut of information is partially to blame for difficulties many people encounter when searching for new ideas or solutions – there is so much to choose from, with little to no indication which elements are relevant, current, or, indeed, accurate or truthful. Furthermore, researching information regarding climate change resilience and mitigation requires at least some prior knowledge of the topic, to choose the appropriate keywords that would yield satisfactory results – a requirement not all those interested fulfil.

Misinformation and disinformation have proven an especially problematic element of the collective efforts geared towards educating people on the detrimental effects of climate change (Thapa Magar, Jung Thapa, & Li, 2024) (Ulrich, 2022). They often tie in with personal beliefs and lead to stubbornness and an unwillingness to change one's habits, making climate targets more and more difficult to reach (Colombo, Chiarella, Lefrançois, Fradin, & Raffone, 2023). These beliefs and biases are especially problematic when they appear in policy- and decision- making circles, as their decisions can have far reaching consequences for the whole society. At the general population level, a lack of climate literacy leads to several suboptimal behavioural patterns, from mistrust in authorities and voting for the populists that claim the climate change is a hoax, over irrational fear to apathy caused by lack of understanding for possibilities to boost societal and individual resilience and sustainability.

This deliverable aims to help interested parties learn more about what types of climate change connected educational materials exist, what to look for when searching for those materials, and how to use them in different settings to their advantage. It also aims to help the ClimEmpower CoPs in combating disinformation and misinformation connected to climate change and climate change resilience.

3.2 Who do we want to address?

When researching educational materials for a certain purpose, it is essential to understand the needs and capabilities of the target audience.

The identified stakeholder types and their relation to the ClimEmpower project are summarised in Table 2.

Table 2: Quadruple helix Stakeholders (Vurnek, et al., 2024)

Stakeholder type	Who	Potential needs
Public services	Regional administration Government Officials	<ul style="list-style-type: none"> • Effective implementation of climate change resilience strategies, • to integrate climate-resilient strategies into policies at the regional level, • to align development strategies with the needs of adaptation to climate change, • development of climate-resistant services that can withstand the impacts of climate change.
Academia and scientific sector	Faculties, Research institutions, R&D departments	<ul style="list-style-type: none"> • Scientific basis and expertise in the development of climate change adaptation strategies, • networking and collaboration, • sharing resources and expertise, • identifying common goals and priorities.
Industrial/economy sector	Agricultural and food producers, farmers	<ul style="list-style-type: none"> • To align climate-resilient strategies with economic goals and promote sustainable practices.
Civil society	Various experts gathered in civil society associations	<ul style="list-style-type: none"> • Active participation in the development of society and engagement of the community.
General audience	Social media and Internet users	<ul style="list-style-type: none"> • To become aware of climatic dangers, to know the possibilities of adaptation.
Related projects and associations	KNOWING, MAIA, ICARIA, CLARITY, VALORADA	<ul style="list-style-type: none"> • To exchange best practices and successful strategies with other projects of the same or similar topic, in order to ensure efficiency, connection, and joint action, and thus a wider impact of all projects.

Out of these the representatives of **public services, industrial/economy sectors and the civil society** that are participating in ClimEmpower’s CoPs are the primary targets for the materials collected for this deliverable.

These stakeholders have been carefully chosen to provide enough diversity to cover different perspectives in each of the five ClimEmpower regions, while keeping the CoPs at a

manageable number of participants. The diversity is especially important, since the variety of views and levels of understanding that can be encountered that way can and should directly inform the educational material sources and choices the project’s experts make.

To ensure that the CoPs are effective and focused, each CoP is managed by a designated Case Study Facilitator (CSF). The CSFs play a pivotal role in guiding discussions, ensuring that all participants are actively engaged, and that the dialogue remains constructive and aligned with the project’s objectives. By maintaining a manageable number of participants within the CoPs, the CSFs can foster meaningful dialogue and collaboration, ensuring that every voice is heard and considered. This approach allows for a dynamic exchange of ideas, where the insights gained from these diverse stakeholders will directly inform the creation of educational resources within the future ClimEmpower activities. The CSFs will also play a key role in tailoring content that addresses specific needs and knowledge gaps identified by the participants. This participatory approach will not only enhance the relevance of the materials, but also promotes a sense of ownership among participants, which is vital for effective learning and engagement.

To enhance the educational experience, selected materials will be utilized during CoP meetings and in a series of collaborative workshops held in WP4, particularly in task T4.2 “Involve and empower regional actors”. Each workshop, facilitated by the respective Case Study Facilitators (CSFs), will address critical issues related to the project objectives and emerging needs. This approach aims to ensure that the insights gained from **WP2, Addressing the CC data and knowledge Gaps**, and **WP3, User-centric CC-resilience enhancing services**, are effectively integrated and the needs/feedback from CoPs fed back to the experts and incorporated in WP2/WP3 work where possible. By doing so, we can create project outputs that are genuinely beneficial for both the partner regions and the follower regions, ensuring that the educational materials contribute meaningfully to understanding and addressing the challenges faced.

3.3 Expected impacts of the training activities and how to measure them

3.3.1 Project requirements

The ClimEmpower project plan has been deliberately structured with flexibility in mind, particularly concerning the types and scope of training materials to be provided. This allows the project team to adapt the content to the evolving needs of the regions involved. **Rather than (only) developing the training materials that guide users through the methodologies, data, indicators, tools, and services developed by the project, ClimEmpower (also) aims to empower regions by making the already existing knowledge on climate change hazards, risks, resilience, and adaptation more accessible and useful for the stakeholders.**

This will be achieved through provision of curated educational materials, which may include resources already developed by previous and ongoing EU projects such as BINGO, ESPRESSO, and KNOWING, by international networks like the UN, UCCRN, C40, and the Red Cross, as well as by numerous individual science popularisation groups and individuals.

ClimEmpower scientific team will play a pivotal role in this process. They will thoroughly analyse and recommend existing materials covering a range of critical topics, such as climate

change, disaster risk reduction (DRR), climate change adaptation (CCA), and community resilience. These resources will be tailored to meet the needs of regional stakeholders, including the general public and enhance regional resilience by increasing awareness, knowledge, and capacity of the local and regional actors, with additional focus on providing information about funding opportunities to support these efforts.

3.3.2 ClimEmpower CoPs and their requirements

Five regional ClimEmpower CoPs act as the primary testbed for the educational materials, but the training contents should be also usable for other stakeholders and regions that are not participating in the project. Within the project, these materials will be used both for individual education and as a basis for CoP discussions and development of the “Regional CC-resilience recommendations” (Deliverables D4.3 and D4.4).

Thanks to initial discussions with the CoP members, which have been summarised in D1.2 “ClimEmpower scenarios”, we already have a good understanding of their needs and interests regarding the hazards and risks they face and expect to face in the coming years, regional knowledge gaps and expectations. This knowledge has guided us in our search for and curation of the materials that are presented in chapter 5 of this document.

After the finalization of this deliverable, the CSFs will conduct a validation process. This will involve distributing a detailed questionnaire to members of the (CoPs) to gather specific feedback on the content, including its relevance, clarity, and any knowledge gaps. The CSFs will then analyse the responses and share their findings with the ClimEmpower team. This analysis will allow the project team to address any identified gaps and refine the materials accordingly in the next step of the work – either by incorporating additional existing materials to ClimEmpower educational resources, or by resolving these needs through new educational materials that will be developed by WP2 and WP3 teams.

By incorporating the feedback from the CoPs, we will maximize that relevance and effectiveness of the training materials provided by the project and insure they are aligned with the needs of our audience as we move to the next stage of development.

3.3.3 Beyond CoPs

To maximise the impact within the five ClimEmpower regions and beyond them, as well as gather additional insights from stakeholders and experts that are not directly participating in the project, ClimEmpower team will advertise the materials discovered when preparing this document and the lessons learnt in the project through various social media channels, as well as through participation in other projects’ events, scientific conferences, and other events related to climate change resilience.

3.3.3.1 Conferences and events

As indicated on <https://climempower.eu/> and <https://zenodo.org/communities/climempower/>, the project team has already been active at different scientific and popular science events throughout Europe, especially in partner regions. Participation in such events can help us further solidify our understanding of the needs of the stakeholders and vulnerable communities and connect with scientists, experts, and stakeholders from other regions. Such interaction will help maximize the project impacts, both by sharing our insights with the relevant communities and improving our understanding of the educational needs of the relevant stakeholders that are not directly participating in the project.

3.3.3.2 Quora

Quora is one of the ways the project plans to have a greater impact, achieve a higher outreach, and gather the opinions, knowledge, and suggestions of other experts and enthusiasts (<https://climempower.quora.com/>).



Figure 3: First posts on the ClimEmpower Quora space (screenshot taken on 16/07/2024)

Thanks to the way Quora questions and answers are referenced in Google search, the question/answer pairs and other materials posted in this space will gain a long-lasting visibility in Google search, thus effectively turning the space into an effective knowledge hub that will continue helping large numbers of stakeholders from all over the world to discover scientifically sound and actionable knowledge on climate change adaptation and mitigation long after the end of the project.

3.3.4 Impact indicators

To comprehensively measure the impact of educational materials, we will implement a detailed methodology that combines both qualitative and quantitative approaches. Our priority is validation by five regional CoPs, which will be achieved by actively engaging these groups to solicit their feedback, endorsements, and participation. Surveys, group discussions and individual consultations (if needed) will allow the ClimEmpower team to gauge how well our

content meets the specific needs and priorities of the CoP members. The level of CoP engagement, such as contributions to discussions or the sharing of our Quora content within their networks, will be used as additional success/impact indicators.

In addition to validation by CoPs, we will track the number of views, followers, and interactions within our Quora space. These metrics will be monitored using Quora's native analytics tools, which provide real-time data on how the users are engaging with the contents. We will look at trends to identify which topics resonate most with the audience and adjust the contents strategy accordingly.

Finally, we will monitor the citation and referencing of the content in external articles, reports, academic papers, and other publications. This will be done through regular searches on academic databases, citation tools, and monitoring services like Google Alerts. By tracking how often and in what context our content is cited, we can assess its long-term influence and credibility within the scientific and policy-making communities. This will provide a clear and nuanced picture of the impact our Quora initiative and educational materials is having on the global dialogue surrounding climate change adaptation and mitigation.

4 Information gathering methodology

4.1 Introduction

Numerous national and international initiatives (e.g., the European Commission's European Mission "Adaptation to Climate Change", the environmental conference "EU Green Week 2024: Towards a water resilient Europe", etc.) aim to increase public awareness and societal resilience to climate change. These initiatives are directed at various target populations, from children, lower economical circles and communities, over general population, specific professions, industries, and regions, to high level decision and policy makers. They have resulted in an abundance of materials aiming to raise awareness, to educate or to offer solutions that build resilience. Even more materials have been produced by various research projects, media houses and science educators.

However, navigating the produced materials is a difficult task and the overall visibility of this work among the stakeholders is low. Potential users of this information need and want a quick route to the knowledge they are missing at a specific moment. The main goal of this deliverable is to provide such an easy pathway to existing knowledge of interest for ClimEmpower CoPs and other regional stakeholders.

The process of creating such pathway can be divided into three essential steps:

1. **Figure out what information and materials the ClimEmpower stakeholders need, in which form, and for what purpose.** This has at least partially been achieved during WP1 work and the results of our efforts have been published in deliverable D1.2 ClimEmpower scenarios (Argamasilla Ruiz, et al., 2024).
2. **Identify existing resources**, group, and summarise them, to facilitate uptake.

3. **Devise and implement an appropriate structure and channels** to organize and intuitively lead the stakeholders to resources most suitable for their needs, as well as to help them to assess their knowledge.

The following subchapters describe the process of information and educational material gathering in more detail. The plans for making these resources easily discoverable and searchable, as well as how we plan to complement them with easily accessible self-assessment are described in section 6 of this document.

4.2 Gathering needs and interests

We approached the first assignment, namely the assessment of ClimEmpower stakeholders' knowledge needs in following ways:

- Firstly, **CoP meetings** in all regions were used to gauge the stakeholders' awareness, competence, motivation, and needs (Argamasilla Ruiz, et al., 2024). The meetings themselves were also observed to gain insight into probable future dynamics, since the meeting format should also help identify what types of materials are needed for what purpose. The results of these observations were reported to the WP leader and working taxonomies were drafted.
- Secondly, **public events and conferences** were attended (e.g., the conference "4th SCIENTIFIC-EXPERT CONFERENCE Adaptations to climate change and preservation of marine ecosystems of the Adriatic Sea", a networking/knowledge exchange event held by the Mission Implementation Platform (MIP4Adapt), an event held by the LIFE-IP AdaptInGR - Boosting the implementation of adaptation policy across Greece project, etc.) and used to gather pertinent information that may not have been discussed during CoP meetings. Also, fresh outside perspectives and the sharing of knowledge with experts from adjacent fields has proven an invaluable resource. These discussions often result in the discovery of a valuable source of educational materials that was previously unknown to ClimEmpower's experts that also comes with a recommendation from those in the know.
- All the gathered information was presented and discussed at **monthly WP4 meetings and cross-WP meetings**. This allowed the partners more insight into discovered issues and knowledge gaps, alongside allowing greater creativity in how to cater to the needs of the stakeholders.

Our understanding of these needs and interests is expected to further evolve based on the feedback on materials provided by this deliverable and discussions in regional CoP meetings, other project meetings and project-external stakeholders.

4.3 Identification of sources and interests

Since the goal of this deliverable is to provide our stakeholders with existing and easy to access educational materials, the decision was made to prioritise the materials that can be easily accessed online. This also reduces the need for printed material, allows for frequent updates, and removes some of the obstacles for using the materials within and beyond the project.

We started with a broad search for terms such as "climate change educational material" and "climate resilience educational material", combined with "climate change adaptation", "climate

change mitigation”, or “climate change risks” to garner insight into the various types of pertinent educational material. In parallel, the project partners were asked to identify trusted sources of information on climate change such as:

- Intergovernmental Panel on Climate Change (IPCC) [<https://www.ipcc.ch>]
- The United Nations Framework Convention on Climate Change (UNFCCC) [<https://unfccc.int/>]
- The United Nations Office for Disaster Risk Reduction (UNDRR) [<http://www.undrr.org/undrr-homepage>]
- The World Bank [<https://www.worldbank.org/en/topic/climatechange>]
- NASA Climate Change [<https://science.nasa.gov/climate-change/>]
- National Geographic [<https://www.nationalgeographic.com/environment/topic/climate-change>]
- The Nature Conservancy [<https://www.nature.org/en-us/>]
- Etc.

This broad search yielded multiple pages that aggregate other sources of educational materials. We consider these **aggregator pages** or “**knowledge hubs**” vitally important due to providing multiple vetted materials, often in multiple languages, from various sources, often with an integrated search engine. These pages could also be used to identify educational material types, and possible gaps that could be filled by the project.

During this initial phase, we already identified some **types of educational material** that could prove useful for educating/empowering our stakeholders and further educational material development. Ultimately, we decided to include following types of educational materials in this deliverable:

- Popular science texts,
- Educational videos,
- Lessons learned & case studies,
- Serious games,
- Scientific articles,
- Tutorials,
- Adaptation plans,
- Courses,
- Other.

In addition, the first CoP meetings were used to ask the regions to **identify key hazards, sectors, and perceived threats/risks** of interest to the stakeholders, as well as any materials they were already aware of or considered interesting. The results of this work were published

in D1.2 “ClimEmpower Scenarios” deliverable (Argamasilla Ruiz, et al., 2024) and summarised in Table 3².

Table 3: Topics of interest for the regions as identified from D1.2 (Argamasilla Ruiz, et al., 2024)

Hazards	Vulnerable sectors and elements a risk	Threats / Risks	Expectations (of ClimEmpower)
<ul style="list-style-type: none"> • Droughts • Wildfires • Forest fires • Pluvial floods • Coastal floods • Urban floods • Heatwaves • Hail 	<ul style="list-style-type: none"> • Agriculture • Farming • Forestry • Environment and natural areas • Biodiversity • Tourism • Health • Inhabited areas • Urban drainage systems 	<p>To agriculture:</p> <ul style="list-style-type: none"> • Desiccation of farming land • Crop loss <p>To health:</p> <ul style="list-style-type: none"> • Water contamination • Saharan dust <p>To habitat (human or natural)</p> <ul style="list-style-type: none"> • Desertification • Disappearance and reduction of protected areas • Biodiversity loss • Ground water salinization • Seasonal overload due to tourists 	<p>Training</p> <p>In general</p> <ul style="list-style-type: none"> • Training tools • Training materials <p>Educational initiatives</p> <ul style="list-style-type: none"> • Raising public awareness <p>(Project) management support</p> <ul style="list-style-type: none"> • Strategy implementation • Plan implementation • Policy decision making support. • Policy planning

Based on previous experiences of the project partners, we also identified “**design and implementation of climate change education**”, “**climate misinformation**” and “**climate disinformation**” as topics of interest that our stakeholders should be educated about.

Once this information was available, our search was refined and narrowed down meaningfully, to identify *relevant* educational materials in the sea of information available online.

In the next step, main deliverable contributors identified some representative educational materials of different types on previously identified knowledge hubs. In addition, all project partners were asked to indicate the materials they may be familiar with or that they may have used in the past and that they deemed suitable for use by ClimEmpower stakeholders. This was especially important when trying to identify educational materials in local languages (Croatian, German, Greek, Italian, Spanish) since not all partners speak the languages of the

² It is important to understand that Table 3. merely indicates the fears and interests the ClimEmpower CoP members indicated at initial interactions with the project team. It may not be complete or fully representative and could change in the second release of this deliverable.

other regions, and not all stakeholders are so well versed in English they can consume educational content without difficulty.

All the materials or sources deemed relevant were manually analysed, verified, and annotated so they could be added to the educational material lists. In addition, an experimental annotation of some materials by AI was performed in cooperation with the MAIA project (<https://maia-project.eu/>, see section 6.4 and Annex 1)

5 Educational training materials for regional resilience

This section provides an overview and examples of educational materials that were identified in preparation of this deliverable.

In order to make the gathered materials and material types easier to view, assess and search through, we have devised a system of tables in which we reference and annotate different types of educational materials, ranging from short educational videos to fully fledged training courses. These tables enable us to focus on the most important aspects of each of the types of materials, reduce the possibility of information accidentally being left out, and provide a quick summary and keywords any viewer can use to their advantage.

The full list of identified materials is available on **ClimEmpower Zenodo channel** <https://zenodo.org/communities/climempower>, (<https://doi.org/10.5281/zenodo.13944851>). This list will evolve over time, as new knowledge gaps are discovered and addressed by the project.

5.1 Knowledge hubs

As explained in section 4, knowledge hubs are websites that aggregate other educational resources on climate change in an appropriate manner. They are essentially aggregator pages that provide links to educational materials from other web pages. Knowledge hubs pre-select materials, and usually provide relevant tags and short descriptions, as well as a way of searching through the materials with the help of detailed filters.

One essential feature of a knowledge hub resource is that it includes only pre-selected materials that can be trusted by our stakeholders. This is why certain sources of our chosen educational materials are not themselves included as “knowledge hubs” in this collection. Most notably, YouTube is a great source of educational videos, but this platform lacks quality control and also provides enormous amounts of misinformation and disinformation.

Knowledge hubs identified by the project are documented in the accompanying “**Knowledge hubs**” table, which is available on Zenodo (<https://doi.org/10.5281/zenodo.13944851>). The organisation of this table is explained below:

Table 4: Knowledge hub table organisation

Name	Name in English (when applicable)	Summary	Importance	Target group	Language	Other	Link

The following are the descriptions of the expected content for each of the columns:

- **Name** – The name of the knowledge hub.
- **Name in English** (when applicable) – Not all knowledge hubs must necessarily be in English, especially since ClimEmpower encompasses different regions speaking different languages. This allows other partners to get an idea of what the hub is about without knowing the language.

- **Summary** – A short description of what can be expected from the hub, such as whether it is focused on a certain region, on a certain type of content, whether it emphasises a certain topic, etc.
- **Importance** (or relevance) – A short explanation of why the hub has been included on the list.
- **Target group** – Who the materials the page summarises are for, e.g. children, general public, experts, farmers, etc.
- **Language** – Which language or languages can be encountered when searching through the materials. There will be a focus on the languages spoken in the ClimEmpower consortium.
- **Other** – Any notable information about the knowledge hub that does not fit into any of the previously listed categories.
- **Link** – The URL that can be used to access the resource.

Table 5 presents four examples of resources that are documented in the “Knowledge hub” table. Each of the entries has a detailed description of what can be expected from the resource and the reasoning why this is considered important in the context of ClimEmpower. To format the table in a more compact manner, the columns “Name” and “Name in English” were merged, and the “Other” column omitted. In the original document, the column “Other” mostly indicates whether acquiring educational materials from the listed knowledge hub requires payment, but it can contain any information considered relevant that is not covered by the other column categories.

Table 5: Excerpt from the document "Knowledge hubs" (available at: <https://doi.org/10.5281/zenodo.13944851>)

Name	Summary	Importance	Target group	Language	Link
OER Commons- Open Educational Resources	This resource has varied educational materials regarding climate change organised according to the age group the materials are intended for. It has detailed filters that allow you to find what you are interested in. It is focused on North America. The types of materials it provides are textbooks, activities, full courses, lesson plans, simulations, etc.	This is a large collection of materials for various age groups. The materials are free to use, and their use does not require permission from the author(s). It also provides a list of climate education content providers and even has its own Community of Practice for climate education. Its search is also very comprehensive, allowing anyone interested to locate suitable materials.	all ages, educators	English	https://oercommons.org/hubs/climate
UNESCO - Education for climate change	This resource provides news of various climate change education in the form of webinars and textual documents describing lesson plans and suggestions on climate change education.	This resource provides guidelines on how to educate about climate change complete with curricula and assessments of current programs.	general public, educators	English	https://www.unesco.org/en/climate-change/education
UN CC:Learn - The One UN Climate Change Learning Partnership	This resource provides stories, events and learning materials, as well as funding opportunities. It offers self-paced courses, a library, podcasts, tools, and other materials.	This resource provides self-paced learning opportunities with certification for all those interested.	general public, educators	English, Spanish, French	https://www.uncclearn.org/
Glas prirode (The voice of Nature)	The website is dedicated to environmental issues and nature conservation in Croatia. It serves as a platform for raising awareness about ecological topics, promoting sustainable practices, and advocating for the protection of natural resources.	The site features articles, news updates, and resources related to environmental protection, biodiversity, and climate change, aiming to engage the public and encourage active participation in preserving the environment. It also highlights various initiatives and events focused on environmental education and activism within the region.	general public	Croatian	https://glasprirode.hr/

5.2 Educational material types and examples

This section gives an overview of the chosen categories of educational materials relevant for this deliverable. Each type has a short explanation as to why it was decided it should be included in the deliverable, a table excerpt from the accompanying document containing educational materials (<https://doi.org/10.5281/zenodo.13944851>), as well as comments regarding any particularly notable examples included in the excerpt.

Educational materials tables are organised by material type and used to summarise the most important attributes of a single piece of educational material, as explained hereafter.

Table 6: Individual educational material table organisation

Title	Title in English (when applicable)	Summary	Importance	Type*	Target group	Language	Other	Link

The following are the descriptions of the expected content for each of the columns:

- **Title** – The title of the material, e.g., “Why Do We Release So Much Gas?: Crash Course Climate & Energy #2”, “How Trees Bring Water”, etc.
- **Title in English** (when applicable) – Since the ClimEmpower consortium comprises of regions from different nations, the materials might be in one of our regional languages. This enables everyone to get an overview of the materials that were covered by this deliverable.
- **Summary** – A short description of what the educational material is about, ideally with an explanation of what the material hopes to achieve and which problems it addresses (as applicable).
- **Importance** – The reasoning behind the inclusion of said material in this deliverable.
- **Type** – A finer granularity of material type. For example, when talking about educational videos present on YouTube, the resources could be a single video, a curated playlist or even a full channel that produces educational material connected to climate change. Therefore, all these material subtypes will be listed as video materials, but they will further be described with either “video”, “playlist” or “channel”. This is not a mandatory column (as indicated by the asterisk) and might therefore be omitted from some of the educational material tables.
- **Target group** – Who the material is aimed at, e.g. “general public”, “farmers”, “experts”, etc.
- **Language** – Which language the material is in. Since ClimEmpower is an international project, we decided to cover the languages spoken in the collaborating regions, namely Croatian, German, Greek, Italian, and Spanish. We also included English as it provides a way of communicating between different regions.
- **Other** – Any notable information about the material that does not fit into previously listed categories.

- **Link** – The URL that can be used to access the resource.

Sub-sections 5.2.1 to 5.2.9 provide descriptions and examples of different types of educational materials. These examples, and even the full list of sources (available at <https://doi.org/10.5281/zenodo.13944851>), are by no means complete, nor considered final in the context of the project. However, they provide a good variety of examples of available materials that are deemed useful for different types of stakeholders.

The presentation of information in this deliverable is slightly different from the one available in Table 6. For the sake of a more compact presentation, the “Title” and “Title in English” columns have been merged, and the “Type”, “Language” and “Other” columns omitted. The column “Topic of interest” has also been added to further help the intended readers of this deliverable quickly discern which topics the provided examples cover.

The order in which the materials are presented is loosely based on the perceived effort required to consume them and internalise them. The term “loosely” is used since the exact time needed for each material varies depending on the material itself and the person consuming it. Regardless of that fact, stakeholders are on average expected to need around ten to fifteen minutes to read a popular science blogpost, half an hour or less to watch an educational video, several hours for a serious game, up to a day for a scientific text, all the way up to several months for full climate change resilience courses.

5.2.1 Popular science texts

This category was chosen because it covers educational materials that can serve as a good introduction to a topic. A short blogpost or well-referenced opinion piece regarding climate change can serve as a starting point for a discussion, spark one’s interest or fuel further research. Easily digestible texts are a great resource for the non-scientific community that seeks to learn how to make a change, which is essential to ClimEmpower.

As can be seen in Table 7, the popular science texts can cover a wide variety of topics and can take different forms. Each of the chosen resources aims to describe the current situation and gives advice on how to change the current situation. We attempted to gather as many resources as possible in different ClimEmpower connected languages, but resources in English proved to be the easiest to find.

5.2.2 Educational videos

This category has been chosen for its availability, ease of use, and enormous popularity.

The visual and auditory nature of (short) educational videos appeals to a wide audience and allows each user to process information in a way that is natural to them, resulting in high acceptance, efficient processing, and high memory recall. According to data collected by Statista, 92.3% of all internet users have watched streaming or downloaded video at least once per month in 2023 (Stoll, 2024). “Tutorials” and “educational videos” rank third and fourth in the ranking of most popular video types, with more than 25% weekly usage outreach.

The use of videos in teaching and learning serves to not only benefit students, but also teachers, their affiliated institutions, and the entire school system. A 2022 study conducted by software company Kaltura concluded that 97% of education professionals believe that video is essential to students’ academic experiences (The State of Video in Education 2022, 2024).

They also serve to break down barriers, such as student and campus location, which were once insurmountable.

Table 8 shows a mixture of educational channels and videos that were deemed relevant for ClimEmpower. The accompanying document also contains playlists curated by both the YouTube community and ClimEmpower members, which provide multiple relevant videos and are constantly being updated.

5.2.3 Lessons learned & case studies

This category collects various studies of what has already been implemented and the assessments of what has been learned from the problem and solution, and how that can be applied to other similar situations. Table 9 shows several entries from the full table in the accompanying document.

The value of these documents stems from the implementation and assessment of what the chosen projects achieved during their lifetime and beyond.

5.2.4 Serious games

This category is also well represented in our accompanying document due to its relevance. Studies have shown (Forrest, Kubíková, & Macháč, 2022; Arias-Calderón, Castro, & Gayol, 2022) that serious gaming supports a shift in perspective and fosters a greater engagement in players while also providing learning outcomes. Therefore, climate change related serious games have been included in our categories.

The collected games come in different formats (a more detailed list can be found in the accompanying document). They can be board games, card games, action games or even video games. They can also be suitable for few players or many players. They are also often suitable for different age groups and educational backgrounds, which makes them a powerful tool in trying to teach new concepts in an approachable way. Table 10 shows several serious games collected for this project.

5.2.5 Scientific articles

Even though scientific articles may not be suitable for everyone, they are still a valuable source of knowledge. Various more approachable materials can be created from them in order to make their findings more easily available to the general public.

Table 11 shows some scientific articles collected for this deliverable. Since there are likely thousands of scientific papers regarding climate change and climate change related topics, we decided to focus on papers on the topic of climate change misinformation, impact of tourism on the climate, and what makes a successful and useful climate service. All these topics are closely related to the project since we are trying to: mitigate climate change misinformation by producing this deliverable and its accompanying educational material list, learn what can be done about tourism since many of our regions are heavily dependent on it, and develop climate services that would help our stakeholders learn what they need without being overly difficult to understand or without requiring a climate expert to interpret the information obtained from the service.

(cont. after Table 7, Table 8, Table 9, Table 10, and Table 11)

Table 7: Excerpt from the document “Educational resources”, sheet “Popular science texts” (available at: <https://doi.org/10.5281/zenodo.13944851>)

Title (EN translation when applicable)	Summary	Importance	Topic of interest	Target group	Link
Creating Climate Change Curriculum	This article gives guidelines as to how to design and implement climate change education in a slow and archaic education system. It is focused on the USA.	This is a relatively short read that can help educators design their own courses around climate change.	Climate change education	educators	https://www.theclimatchangeangereview.com/post/creating-climate-change-curriculum
Why soil is disappearing from farms?	The article showcases the issues with traditional agriculture and how it leads to soil degradation. It then reports on various methods that can mitigate and solve the issues.	The status quo is carefully compared to the greener and more sustainable alternative.	Desiccation of farmland, soil degradation	general public	https://www.bbc.com/future/bespoke/follow-the-food/why-soil-is-disappearing-from-farms/
Andalucía y el cambio climático (Andalusia and climate change)	This visual report describes the relationship between planet Earth and human beings, the background and causes of climate change, the evidence of this change and the scenarios to estimate its effects, and the response of administrations and citizens to it.	The document serves to raise awareness, explain with simple words and schemes the evidence pointing to climate change and our responsibilities in mitigating what is happening.	Global warming, climate change	general public	https://www.juntadeandalucia.es/medioambiente/portal/documents/2015/1100160/dossiercambioclimatico.pdf/79dd1361-662c-3e6b-2188-63923b7c4ebd?t=1334143453000
Gradovi za oprašivače (Cities for pollinators)	This article explains the importance of green areas in cities and how they should be improved to foster more biologically diverse pollinator populations.	Tips for making green areas more pollinator friendly are shared in a local language.	Biodiversity loss, urban green areas	general public	https://glaspirode.hr/profesionalci-u-akciji/gradovi-za-oprasivace/
Wildfires: Is Europe doing enough to prevent them?	The article reports on the current and past state of the EU regarding its forest fires, asks important questions and lists strategies for wildfire mitigation.	The article gives wildfire mitigation strategies, sources, and important graphs that explain the matter further.	Wildfires	general public	https://www.dw.com/en/wildfires-is-europe-prepared/a-69232846

Table 8: Excerpt from the document “Educational resources”, sheet “Educational videos” (available at: <https://doi.org/10.5281/zenodo.13944851>)

Title (EN translation when applicable)	Summary	Importance	Topic interest	of Target group	Link
No-till growers	This channel discusses practical aspects of various no-dig, low-dig and more generally sustainable farming practices.	The channel showcases practical examples and techniques for sustainable agriculture.	Sustainable agriculture	farmers	https://www.youtube.com/@notillgrowers
Just Have a Think	This channel discusses a great variety of topics related to energy transition and sustainability - photovoltaics, wind, battery technologies and their prices, other innovative methods for energy production and storage, global warming, innovative materials, low energy heating and cooling technologies and more.	The channel helps with understanding modern issues and with finding solutions to such problems.	Energy transition, sustainable energy, green energy	general public	https://www.youtube.com/@JustHaveaThink
Traditional Farm Design vs. Permaculture Design: What's the Difference?	This video provides a comparison of classical farming and permaculture and lists the benefits of changing the way we think about food production.	The video contrasts the two approaches at the same time, providing a more solid argument for change.	Permaculture	general public, farmers, gardeners	https://youtu.be/oxknbKXx_CE?si=ScZmlzY6JwAhhpgN
Europe's climate in 2050	This video shows a prediction of what the climate in Europe will be like in 2050.	The video explains what could be expected of climate in the not-so-distant year of 2050 in clear terms that should be understandable for all.	Future events, future climate	general public	https://youtu.be/n9Ej5E47TNI?si=WWbT0wxnI80kY-f0
The destruction of nature and the emergence of infectious diseases (Presentation)	Neil M. Vora, an expert in pandemic prevention, points out the great increase in infectious diseases in recent decades due to global warming and assures that human health is very clearly related to the health of the environment. Human activities such as deforestation play a key role in the increase in infectious diseases.	The video explains how interconnected the ecosystem is and how that impacts humans.	Human health and the environment	general public	https://vimeo.com/841120320/93e628eaf1?share=copied

Table 9: Excerpt from the document “Educational resources”, sheet “Lessons learned & case studies” (available at: <https://doi.org/10.5281/zenodo.13944851>)

Title (EN translation when applicable)	Summary	Importance	Topic of interest	Target group	Link
Using Demonstration Storms to Prepare for Extreme Rainfall	An extreme precipitation event in 2008 cost one town more than a million dollars in infrastructure repairs. Now, other municipalities can simulate how their homes, businesses, and facilities might fare if they experienced a similar event.	This case study not only explains what happened but provides a comprehensive list of tools that can be used to simulate the potential results of a flood.	Weather modelling, risk mitigation	communities, decision makers	https://toolkit.climate.gov/case-studies/using-demonstration-storms-prepare-extreme-rainfall
Minimizing the Impacts of Coastal Flooding Helps City Prepare for Sea Level Rise	Several times per year, seawater floods some of the streets in Charleston, South Carolina. Taking steps to deal with this "nuisance" flooding can help the city prepare for sea level rise.	Coastal flooding is a threat to our stakeholder regions, and they could benefit from case studies dealing with the problem.	Climate change adaptation in action	communities, decision makers	https://toolkit.climate.gov/case-studies/minimizing-impacts-coastal-flooding-helps-city-prepare-sea-level-rise
Improving Communication of Flood Forecasts	When a flood is forecast for the Red River of the North, community leaders, emergency responders, and residents around Fargo, North Dakota, and Moorhead, Minnesota, can gauge their need for preparation by accessing visualizations showing the extent, depth, and timing of expected flooding.	Forecasting elements of floods and possibly flooding events could help communities have a more appropriate response to them, as well as help them decide which infrastructure to build to mitigate said floods.	Flood modelling, risk mitigation	communities, decision makers	https://toolkit.climate.gov/case-studies/improving-communication-flood-forecasts
ESPRESSO Vision Paper	The document is the outcome of extensive networking activities conducted over the past two and a half years through the ESPRESSO Stakeholder Forums and Think Tanks, which concentrated on the identified key challenges, as well as through the involvement of project partners in external events promoted by relevant EU and global institutions.	Provide a general framework that helps focus the issues and topic that will emerge during the project, combining climate change adaptation and disaster risk reduction.	Clear communication, collaboration	institutional stakeholders, experts	https://www.researchgate.net/publication/329737303_ESPRESSO_Vision_Paper_on_future_research_strategies_following_the_Sendai_Framework_for_DRR_2015-2030

Table 10: Excerpt from the document “Educational resources”, sheet “Serious games” (available at: <https://doi.org/10.5281/zenodo.13944851>)

Title (EN translation when applicable)	Summary	Importance	Topic of interest	Target group	Link
Play and learn to stop disasters	Provides educational experience on how to build safer and disaster resilient communities. Emphasizes to lessons from disasters and build the capacity to reduce disaster risk than respond to emergency events.	UNDRR develop this game with the ambition to help decision makers have better understanding and act on risk. There must be a switching to managing risk and not disasters.	Disaster mitigation , disaster resilience	Adults and children	https://www.stopdisaster.org/
Climate Risk Card Game	This is a card game that focuses mainly on learning strategies to increase resilience: Players should work together to identify and address climate-related risks that could affect their business and to build and build climate resilience.	This resource is a good tool for learning basic concepts related to climate change and resilience and can be used as an icebreaker in a situation such as a focus group or similar.	Building resilience , climate risks	general public, educators, institutional stakeholders	https://www.tcfhub.org/wp-content/uploads/2021/11/TCFDHub_ClimateRisk_CARDS_Multiple_Layout_PRINT.pdf
Climate action board game	This is a simple board game that can introduce children to green concepts and spark debate regarding what should and should not be done to benefit the environment.	The resource is suited for young generations that will have to deal with the consequences of climate change the most.	Green concepts, recycling, saving the environment	children from 9 to 12 years of age	https://learning-corner.learning.europa.eu/learning-materials/climate-action-board-game_en
Broken Cities	Broken Cities is a competitive city-building game where players compete as landlords to become the wealthiest land baron in the city. The purpose of the game is to raise awareness about green choices.	This resource is free and can be used as an interactive tool in CoP workshops.	Green choices, sustainability	general public, institutional stakeholders	https://www.helsinki.fi/en/researchgroups/urban-environmental-policy/broken-cities-game
Play and learn to stop disasters	Provides educational experience on how to build safer and disaster resilient communities. Emphasizes to lessons from disasters and build the capacity to reduce disaster risk than respond to emergency events.	UNDRR develop this game with the ambition to help decision makers have better understanding and act on risk. There must be a switching to managing risk and not disasters.	Disaster mitigation , disaster resilience	Adults and children	https://www.stopdisaster.org/

Table 11: Excerpt from the document “Educational resources”, sheet “Scientific articles” (available at: <https://doi.org/10.5281/zenodo.13944851>)

Title (EN translation when applicable)	Summary	Importance	Topic of interest	of Target group	Link
Defining successful climate services for adaptation with experts	The study identified 12 elements that lead to successful climate services. It also proposes global definitions for successful climate services.	The on identified elements could be used to develop ClimEmpower climate services.	Climate services	scientists, experts	https://www.sciencedirect.com/science/article/pii/S1462901123002903
Matching supply and demand: A typology of climate services	Using a method based on Constructive Technology Assessment (CTA), a framework articulating ideal types of climate services is set-up.	The study could be used for better understanding of different service types, their level of complexity and maybe related costs.	Climate services	scientists, experts	https://www.sciencedirect.com/science/article/pii/S2405880719300779
Implications of Global Climate Change for Tourism Flows and Seasonality	This study gives an analysis of tourism evolution according to climatic scenarios and global changes.	Implications of climate change for the global tourism industry	Tourism, impact of tourism on the environment	scientists, experts	https://www.researchgate.net/publication/249701105_Implications_of_Global_Climate_Change_for_Tourism_Flows_and_Seasonality
Climate Misinformation: Communicating Climate Science in an Era of Misinformation	This paper reviews current research regarding climate misinformation, discusses strategies to combat it, and highlights methods for effective climate communication.	Climate misinformation is one of the biggest problems when it comes to climate change education and needs to be addressed. The methods for effective climate communication could be of great use.	Climate misinformation, climate communication	scientists, experts	https://ojs.stanford.edu/ojs/index.php/intersect/article/download/2395/1507/8870
Climate Change Misinformation in the United States: An Actor–Network Analysis	This paper tries to identify the mechanisms behind climate change misinformation to learn more about how it spreads.	Learning how and why climate misinformation spreads can greatly help with its mitigation.	Climate misinformation	scientists, experts	https://www.mdpi.com/2673-5172/5/2/40

5.2.6 Tutorials

This category encompasses documents that give their readers instructions on how to achieve a desired result or how to use a certain service. They are not quite lessons but give those who want to learn a certain topic a set of succinct and clear instructions on what should be done. This category is important for ClimEmpower because the climate services developed as part of the project will need instructions on how to use them. The instructions will become part of the next iteration of this deliverable.

Table 12 gives a short overview of some tutorials available in the accompanying document.

5.2.7 Adaptation plans

Adaptation plans are documents made by governing bodies that aim to change the *status quo* regarding climate change. They showcase strategies that will be implemented in areas to mitigate climate change and build resilience with solutions tailored to the area the plan was made for. These plans are invaluable to our stakeholders, since they can see what an adaptation plan should look like and which elements it should consist of, significantly reducing the amount of time necessary to create a new plan for a new area.

Table 13 lists several adaptation plans available in the accompanying document. The available plans range from plans developed for cities, to whole regions in a country to full-on national adaptation plans available for whole countries.

5.2.8 Courses

In our case, courses mostly cover either university courses, online courses or lifelong learning courses that could be found, all regarding climate change, climate change adaptation and climate change mitigation. Certification is often available as part of the courses. We included paid courses as well.

Table 14 gives a quick overview of courses that can be found in the accompanying document.

5.2.9 Other

This category is a catch-all for those materials that we consider relevant, but it is hard to sort them into any of the other categories of educational materials.

Table 15 holds several examples of the different materials.

Table 12: Excerpt from the document “Educational resources”, sheet “Tutorials” (available at: <https://doi.org/10.5281/zenodo.13944851>)

Title (EN translation when applicable)	Summary	Importance	Topic of interest	Target group	Link
Misinformation and Disinformation: Thinking Critically about Information Sources	Generic tutorial explaining how to raise awareness, foster critical thinking, and empower stakeholders when searching for information.	Recognising misinformation and disinformation is difficult for many people - this tutorial can help.	Battling misinformation and disinformation	journalists, social media users, general public	https://library.csi.cuny.edu/misinformation
The climate change empowerment handbook	Practical guide on countering misinformation and disinformation on climate change.	Countering disinformation and misinformation is very difficult and often counterproductive. This handbook explains how it should be done from the point of view of psychology.	Battling misinformation and disinformation, climate change misinformation	journalists, public speakers, general public	https://psychology.org.au/getmedia/88ee1716-2604-44ceb87a-ca0408dfaa12/climate-change-empowerment-handbook.pdf
Επιμόρφωση των εκπαιδευτικών στις δεξιότητες μέσω εργαστηρίων - θεματική φροντίζω το περιβάλλον, Κλιματική αλλαγή - φυσικές καταστροφές, Πολιτική Προστασία - Από το νερό στην πλημμύρα (Training of teachers in skills through workshops - Take care of environment - climate change, natural disasters, civil protection (From waterto floods))	The main expectation from this workshop is the understanding of natural disasters and especially floods, which are the principles of flooding, give an opportunity on how to assess flood risks in different regions using geographic and environmental data and discuss strategies for flood mitigation and adaptation. Additionally use role-playing and simulations to help trainers understand the decision-making processes.	All these materials will help trainers to have a deeper understanding of natural disasters and give them critical thinking to address these challenges.	Teacher training, dissemination	students 12-18 years old, general public	https://bit.ly/3XELAI n

Table 13: Excerpt from the document “Educational resources”, sheet “Adaptation plans” (available at: <https://doi.org/10.5281/zenodo.13944851>)

Title (EN translation when applicable)	Summary	Importance	Topic of interest	Target group	Link
Rotterdam Climate Change Adaptation Strategy	The Rotterdam Adaptation Strategy is a comprehensive plan developed by the city of Rotterdam in the Netherlands to address the challenges of climate change, with a particular focus on urban resilience, water and flood management, and sustainability.	The documents can be used to present best practices for the creation of a plan and the implementation of adaptation measures.	Adaptation strategy, urban resilience	General public, public actors	https://static1.squarespace.com/static/5f082078d610926644d22e00/t/621e3a61f6c1665ece53bf4d/1646148232693/UB_RAS_EN_Ir.pdf
Barcelona’s Climate Action Plan 2018 - 2030	Barcelona’s Climate Plan 2018 - 2030 is an ambitious, Paris Agreement-compatible plan released in April 2018. It sets out Barcelona’s strategy to reduce emissions by 45% on route to becoming carbon neutral by 2050. It was coproduced with citizens and integrates mitigation, adaptation, climate justice and citizen action, putting the most vulnerable people at the centre of its policies.	The documents can be used to present best practices for the creation of a plan and the implementation of adaptation measures.	Citizen action, reduction of carbon emissions	General public, public actors	https://cdn.locomotive.works/sites/5ab410c8a2f42204838f797e/content_entry5ae2f905a2f4220ae645f026/5afc10d27478206be9209e60/files/Bcn_Climate_Plan.pdf?1526468818
Copenhagen Climate Adaptation Plan	The Copenhagen Climate Adaptation Plan is a strategic initiative developed by the city of Copenhagen, Denmark, to address the challenges posed by climate change. It focuses on making the city more resilient to the impacts of extreme weather events such as heavy rainfall, rising sea levels, and heatwaves. The plan aims to safeguard Copenhagen's infrastructure, environment, and citizens while maintaining the city's growth and development goals.	The documents can be used to present best practices for the creation of a plan and the implementation of adaptation measures.	Building resilience, sustainability	General public, public actors	https://en.klimatilpasning.dk/media/568851/copenhagen_adaption_plan.pdf

Table 14: Excerpt from the document “Educational resources”, sheet “Courses” (available at: <https://doi.org/10.5281/zenodo.13944851>)

Title (EN translation when applicable)	Summary	Importance	Topic of interest	Target group	Link
Climate Change: From Learning to Action	This course provides “everything you need to know” about the basics of climate change. The course features lectures and exclusive interviews from UN experts on key climate change topics. The course is divided into six modules, each taking an average of 2 hours to complete. Each module features videos, lessons and exercises that give you an overview of a different aspect of climate change.	This is a short and varied course that can provide those interested with the basics which should give them the knowledge necessary to search for further resources.	Introduction to climate change	students, general public	https://unccelearn.org/course/view.php?id=48&page=overview&lang=en
Environment and Society in a Changing World	This course introduces the theory, methods, history, and contemporary issues in global and regional relationships between human activities and the physical environment. GEOG 30N is an integrative study, inter-domain general education course.	This course covers interdisciplinary topics regarding climate change.	Societal impact on the climate	students	https://roam.libraries.psu.edu/node/1317
Human Health and Climate Change	This course provides an introduction to the health challenges, as well as the opportunities, that can be associated to climate change. It includes one module divided into 3 sections and takes around 2 hours to complete.	This course gives an overview of health risks climate change poses. It also provides further materials that can give the learner an opportunity to delve into the subject deeper.	How climate change impacts human health	students, general public	https://unccelearn.org/course/view.php?id=20&page=overview
ClimAlt	The ClimAlt course offers training specifically designed for young people, focused on the causes, impacts, and	The main topics covered in the lessons are climate change science; energy consumption, food	Raising awareness, climate	students, general public	https://asud.net/ultima/corso-online-gratuito-

Title (EN translation when applicable)	Summary	Importance	Topic of interest	Target group	Link
	<p>possible solutions to the climate crisis. The training aims to provide young people with an opportunity to deepen their knowledge of the causes and effects, identify the key actors involved in the fight against climate change, and discover innovative counteractive experiences. The main goal of the course is to strengthen young people's awareness of possible socio-environmental changes and to encourage their ability to generate or be part of them.</p>	<p>systems, and the linear economy and their influence on climate change; environmental and socio-economic impacts of climate change; the political framework and international climate agreements; climate justice, circular economy, zero waste, energy transition, and agricultural mitigation and adaptation options to respond to climate change.</p>	<p>change resilience</p>		<p>sui-cambiamenti-climatici/</p>

Table 15: Excerpt from the document “Educational resources”, sheet “Other” (available at: <https://doi.org/10.5281/zenodo.13944851>)

Title (EN translation when applicable)	Summary	Importance	Topic of interest	Target group	Link
NBS Comics	NBS Comics is an interdisciplinary project that works together with artists, scientists, and NbS (Nature-based Solutions) experts to commission and empower comic creators to tell their stories of nature and people.	The comics raise awareness to climate connected problems affecting the world and call to action.	Outreach through art	general public	https://nbscomics.com/
NASA Climate Kids	The website houses various games, activities, videos, articles, etc. appropriate for kids.	Climate change relevant content is presented in a fun and interactive way to boost its retention and kids' interest in climate change. The information is vetted by NASA, a very reliable source.	Outreach to younger generations	children, ages 8 and up	https://climatekids.nasa.gov/
PROGRAMME BRIEF: Harnessing the Transformative Potential of Education for Climate Change Mitigation, Adaptation and Resilience Building in Europe and Central Asia	This Brief presents the approach of UNICEF in Europe and Central Asia (ECA) Region in supporting education systems, education stakeholders and children and adolescents in ECA to develop the policies, structures and skills to mitigate and adapt to climate change and become more resilient to the environmental challenges and natural hazards ahead.	This document describes the importance of climate change education and lays out detailed plans and efforts to boost it in listed regions.	Importance of education and dissemination	educators, experts	https://www.unicef.org/ec/media/32381/file/Education%20for%20climate%20change%20mitigation.pdf
Stanford School of Sustainability - Climate Change Education, curriculum	This page gives a detailed description of two curricula for different student age groups that help educators plan their own courses.	This is a great resource for educators because it can help them develop their own courses by using vetted material.	Guidance when teaching about climate change	educators	https://climatechange.stanford.edu/curriculum

Title (EN translation when applicable)	Summary	Importance	Topic of interest	Target group	Link
CLIMATE-RESILIENT URBAN DESIGN Regenerating cities through adaptive mitigation solutions	This document discusses the critical importance of integrating climate resilience into urban design and planning, emphasizing the need for innovative, multi-disciplinary approaches to address the challenges posed by climate change. It discusses a planning workshop in Naples.	The document provides a very detailed description of the workshop, and the results obtained, which could be inspirational for similar events.	Urban resilience to climate change	institutional stakeholders, experts	https://needlecrowd.com/wp-content/uploads/2019/01/Crud-Book-2018.pdf

6 Conclusions and next steps

Many different types of educational materials on the topic of climate change have been analysed and considered for this deliverable. Even though searching for them may seem relatively easy, selecting appropriate materials, organising them in a meaningful manner, and annotating them with the appropriate keywords has proven a lot of work. However, we expect that the effort will prove fruitful for both the project’s future work (explained in following subsections) and for anyone that is interested in the topics covered by the selected educational materials.

Finding educational materials in regional languages has proven difficult. Knowledge hubs in regional languages were especially difficult to find, due to them often depending on either volunteer work or a regional project being carried out. However, the listed hubs provide current news regarding climate change, presentations, courses with certification, calls to action, activities, labs, libraries, podcasts, and the like. Combined with the rest of the gathered knowledge hubs they provide a comprehensive list of resources that can help all those interested in finding what interests them or to further refine their search for educational materials.

On a positive side, automated transcripts, and translation of educational videos on YouTube platform has proven better than expected and the quality of translation of texts and complete documents by DeepL (<https://www.deepl.com/>) is nearing the point where translating from and to any of the supported languages can be almost completely automated³.

6.1 Coverage of ClimEmpower’s regional topics

Table 16 shows the current coverage of the topics of interest indicated by the regional stakeholders, along with the type of educational material that covers it. Unfortunately, finding the suitable materials on some of the topics of interest (e.g. hail) proved more difficult than anticipated. Likewise, finding the materials in regional languages is a challenge.

While not perfect, the coverage is nevertheless deemed sufficient to support the CoPs in their work and to gather feedback on use and usability and ways to improve the usability of this micro-learning library. We intend to further improve the coverage in the second release of his document, through combination of discovery of additional existing educational materials and production of new materials by the project.

³ Unfortunately, as of November 2024 Croatian language is still not supported by DepL.

Table 16: Which of the project identified hazards have been covered and by what type of material

Topic of interest	Popular science texts	Videos	Serious games	Scientific articles	Lessons learned and case studies	Tutorials	Courses	Other
Heatwaves	+	+						
Droughts		+						
Wildfires	+	+						
Forest fires								
Pluvial floods		+	+				+	
Coastal floods					+		+	
Urban floods			+		+		+	
Desiccation of farmland	+	+						
Hail								
Desertification		+						
Disappearance and reduction of protected areas	+					+		+
Groundwater salinization								
Water contamination								
Saharan dust								
Biodiversity loss	+	+						
Seasonal exponential population growth		+						
Climate misinformation		+		+		+		
Climate change induced health issues	+	+					+	

6.2 Educational materials to be produced by ClimEmpower

Due to abundance of freely available educational materials for a variety of topics, users, and their needs, one of the major contributions of this project (and in particular this work package) will be the **selection of the most relevant materials and designing a system of navigation through them**. Decision trees will be utilized to facilitate navigation. In addition, we will experiment with AI tools as a more advanced form of assisting the user in identifying the most appropriate educational material for their needs.

Furthermore, these materials will be embedded in **microlearning courses** to allow the users to digest the relevant materials at their own pace and self-assess their competences and knowledge learnt from the (micro-) educational materials that were selected by the project.

In addition, ClimEmpower team will produce **tutorials for the methods, data/algorithms, tools, and services developed as part of the project**. Clear and concise instructions produced by the project team will help our stakeholders and other users use the project outputs effectively and efficiently for boosting their climate change resilience.

In case no existing, freely available educational material covering our stakeholders' needs can be found, the project partners might also decide to generate new content connecting, amending, or explaining existing materials, or even completely new educational materials. For example, if any of existing data sets, tools or services recommended by ClimEmpower prove difficult to use due to a lack of clear instructions, ClimEmpower team might decide to remedy that gap by producing tutorials that explain why and how to use such resources.

Independently from the topic, our focus will be on creating **educational materials that are easy to use and deemed useful by regional stakeholders**. Maps, charts, mind maps, diagrams, cartoons, and other non-traditional forms of educational materials will be explored and created when appropriate.

All the ClimEmpower produced learning materials will be available through an online learning platform set up by the project.

6.3 Validation of educational materials

Selecting the most relevant and appropriate existing educational materials and creating valuable new materials for our target audiences is a highly ambitious task. The key to its success is the validation of the materials. We plan to validate our materials in three ways.

Firstly, we plan on directly asking our users to rate the materials' relevance (for themselves), clarity of content, its presentation and ease of use. The users' feedback will be collected through rating scales and the results will be analysed thoroughly.

Secondly, we intend to monitor usage statistics and analytics available through the planned online learning platform. Whenever possible it is important to measure how long a user spent on the same educational material and their number of visits to the same material.

Thirdly, we will utilise self-assessment tools before and after the users' use of our newly produced educational materials to gauge the difference in our users' knowledge and therefore validity of our materials. We will both monitor all users and perform some targeted monitoring of focus groups in order to gauge the quality of our educational materials.

Finally, the Quora platform will be used both to boost the project's outreach, and to gather information on knowledge gaps and misleading opinions among the public that might be detrimental to the human efforts of combating climate change (climate change mitigation) and/or building a more resilient society (climate change adaptation). Since the ClimEmpower tutorials and microlearning courses will be public, we also intend to utilise Quora for gathering opinions on the educational materials that we provide and produce.

6.4 AI summarisation of documents

Analysing educational materials is tedious work that non-experts are unable to do on their own, and experts are not eager to do. The ClimEmpower team has therefore decided to explore the possibilities for making this work less tedious for the experts by letting AI analyse the materials instead, an undertaking done in cooperation with the MAIA coordination action (<https://maia-project.eu/>). First AI-summarisation experiments have been performed and a summary of the results is provided in Annex 1 of this document.

While not perfect, the results of first experiments clearly show the potential of the AI to indeed speed up the work. More experiments are under way and/or planned, to answer various research questions, such as:

- Initial test shows that the quality of the answers does not improve if more details are added to the question (at least not in the one experiment that we conducted). **Would the quality of results improve (or deteriorate?) if such information is included in the system prompt instead?**
- **To what extent is the quality of the results influenced by choice of the generative model?**
- **Would it be helpful for the operator to see the responses generated by several models? E.g. to see if/where they disagree or to profit from differences in their writing style?**
- **To what extent can the generative models help us to categorise the documents, e.g. by addressed hazards, elements at risk etc.?**

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Annex 1: First AI summarisation experiments

This annex document summarises the results of first AI summarisation experiments in ClimEmpower. All experiments were performed in cooperation with the MAIA - Making Adaptation Innovation more Accessible to regions and communities support and coordination action (<https://maia-project.eu/>). MAIA CSA is financed by the EU under a grant agreement No. [101056935](#) and aims to maximize the impact of European climate change research and innovation by exploring the synergies and enhancing the outreach of all related projects and activities.

AIT leads the work on AI-assisted knowledge extraction and management in MAIA. The goal of this work is to explore the possibilities and limitations of using existing Large Language Models (LLMs), or more accurately “off the shelf” Generative Pre-trained Transformer (GPT) models such as Mixtral, Llama, Gemma and the commercial GPT models developed by OpenAI to help human expert extract the knowledge from semi-structured documents. Most importantly for ClimEmpower, MAIA team has developed an experimental AI powered document question answering web application that automatizes the process of processing input documents – SumQA (Figure 4).

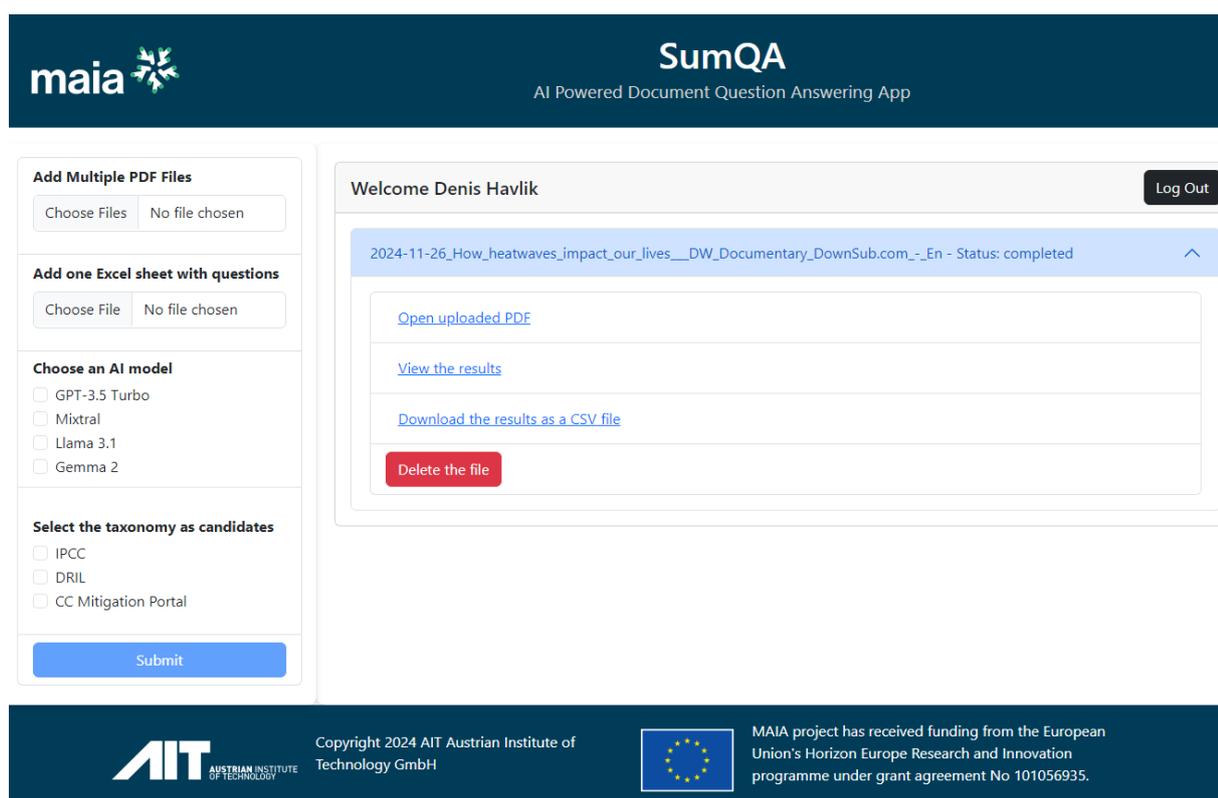


Figure 4: Maia SumQA application interface

In short, this application allows the user to define a set of questions and then directs one or more GPT models to analyse each of the input documents and answers the same set of questions for each of them. The results can be inspected online or downloaded as a Comma Separated Value (CSV) file.

First Experiment: how to pose questions?

For a first test, the transcript of an approximately 40-minute-long Deutsche Welle documentary on heatwaves (in English) was processed by the service and different formulations of the questions tested to get a better grasp on the way questions should be formulated. Decision to let the AI analyse the video and not some document is, among other, based on the observation that automatically generated video transcripts are terribly formatted and usually contain some transcription errors. This makes them very difficult for human experts and we wanted to see if this is also the case for the AI.

This educational video addresses the general population and may be of use to policy makers, too. It provides an excellent introduction to causes, consequences, and possible solutions for heat waves in and outside cities, with real world examples of actual events and activities in several European regions. The results of the analysis by OpenAI’s GPT3.5 model are discussed in Table 17. Please keep in mind that the “answer quality” indicator (Table 17) only states how useful the AI generated answer appears to be for the task at hand and to the researcher assessing the AI results. Since the “task at hand” is merely to help the CoP members find relevant materials, answer quality will be high (4 or 5 on a 1-5 Likert scale), as long as the AI generated answers capture the essence of the analysed resources and provide answers in a reasonably well written form.

Second Experiment: how well can the AI (re-)generate resource descriptions?

Based on encouraging results of the first experiment, we decided to try re-generating the resource descriptions for some of the resources that were already described in section 5.2 of this document. The results are summarised in Table 19.

For the second run, the tool <https://tactiq.io/tools/youtube-transcript> was used for generating a transcript for the video “Traditional Farm Design vs. Permaculture Design: What’s the Difference?”, because it automatically includes the video title in the transcript. Responses generated by CPT 3.1 model clearly indicate that this type of AI-supported analysis of resources has a huge potential for saving precious time for experts working on knowledge extraction. Although the analysis of the answers indicated that some of the answers are useless or even factually wrong, all such cases were easily recognised by the experts and could be easily fixed by extrapolating the information from other answers.

Verdict

Although not perfect, the results of the initial experiments are encouraging and indicate that AI generation of resource description will indeed be helpful for knowledge curators but shouldn’t be blindly trusted. Possibility to summarise video transcripts by the AI is particularly interesting, as these transcripts are ill suited for reading by the human experts.

One somewhat surprising finding of the first experiment was that adding details and instructions how to answer the questions in the questions can lead to deterioration of the answers. Presumably, the instructions added in the questions are colliding with the system prompt and confusing the AI.

In addition, the usability and correctness of the “citations” (Table 18) is questionable and needs to be double-checked with the MAIA development team.

Further experiments with different GPT models, with a tailored system prompt, and with a larger number of analysed resources will be reported in the second version of this deliverable.

Table 17: GPT3.5 analysis of the DW documentary “How heatwaves impact our lives” video (from <https://youtu.be/JKEJ9p9YVY8?si=mQgxDFBmaQQGoVC->)

Question	Answer	Answer quality, Likert 1-5 scale	Discussion
What is the title of the input text?	The title of the input text is "Urban Heat Islands and Coping with Heat Waves" [1][2][3][4][5][6][7][8][9][10][11][12][13].	3	The title of the video was not included in the transcript, so GPT 3.5 invented one. The references provided by the AI are somewhat relevant, but obviously not pointing to the real title, which can easily be inspected by an expert.
Input data is a transcript of a video discussing some aspects of Climate Change. What is the title of the video?	The title of the video discussing Climate Change is "Heat Waves and Their Impact on Land and Sea" [1][2][3][4][5][6][7][8][9][10][11][12][13].	3	The title of the video was not included in the transcript, so GPT 3.5 invented one.
Summarise the Input text in 30 to 80 words.	The input text discusses the impact of rising temperatures on urban areas, agriculture, and marine ecosystems due to heat waves and climate change. It highlights the challenges faced by cities like Paris in managing urban heat islands [6][7][8], the threat to olive farming in Spain from extreme heat and drought [11][12][13], and the disruption of marine ecosystems by invasive species due to rising sea temperatures [14][15]. The text emphasizes the need for adaptation and mitigation strategies to address these issues [10].	4	Good summarisation. However, it fails to emphasise the impacts of heat waves on humans and fails to mention the resilient pathways and solutions that are introduced in the video.
Summarise the Input text in 30 to 80 words, using the language that's suitable for general public.	The input text discusses the impact of rising temperatures on urban areas, agriculture, and marine ecosystems due to heat waves and climate change. It highlights the challenges faced by cities like Paris in managing heat islands, the threat to olive farming in Spain, and the disruption of marine ecosystems by invasive species due to rising sea temperatures. The text emphasizes the need for adaptation and mitigation strategies to address these issues [1][2][11][12][14].	4	In this case, the answer is not very different from the previous one – presumably because the video already uses language that is suitable for the general public. However, the references mentioned are very different, which is suspicious.

Question	Answer	Answer quality, Likert 1-5 scale	Discussion
<p>Summarise the Input text in 30 to 80 words. Explain which hazard or hazards is it addressing (e.g. heat waves, drought, wildfires, torrential rain, storms)? Which sectors or elements at risk (e.g. agriculture, transport, tourism, population)? What types of impacts (e.g. health impacts, economic impacts, impacts on water or electricity supply), What types of solutions does it discuss, if any?</p>	<p>The text discusses the impacts of heat waves, drought, and wildfires on agriculture, particularly olive farming in Andalusia [1][2][3]. These hazards threaten crop production, livelihoods, and food supply [3][7]. Solutions mentioned include early detection systems for heat waves and adapting urban spaces to counteract heat effects [6][8][10][12].</p>	3	<p>Somewhat surprisingly, adding more specific instructions has lowered the quality of the answer. While olive farming in Andalusia is indeed mentioned in the video, the main emphasis is on the loss of lives in urban areas.</p>
<p>Input data is a transcript of a video discussing some aspects of Climate Change. Summarise the video in 30-80 words. Explain which hazards is it addressing (e.g. heat waves, drought, wildfires, torrential rain, storms)? Which sectors or elements at risk (e.g. agriculture, transport, tourism, population)? What types of impacts (e.g. health impacts, economic impacts, impacts on water or electricity supply), What types of solutions, if any?</p>	<p>The video discusses the impacts of climate change, focusing on hazards such as heat waves, drought, wildfires, torrential rain, and storms [2][4][5]. Sectors at risk include agriculture, with crop failures due to extreme heat and drought [4][6], and populations in regions like South Asia facing uninhabitable conditions [9]. The impacts range from economic losses in agriculture to health risks from extreme temperatures [4][9]. Solutions mentioned include designing cities to cope with heat waves and adapting urban planning to reduce urban heat islands [3][10][12].</p>	3	<p>In principle, this is a very good answer, with one main issue: the video is mainly about Europe, and South Asia is only mentioned in passing. Since Asia is only mentioned once in Table 18, in citation 1, the way citations are generated and referenced will need to be re-assessed.</p>
<p>Explain the relevance of input text for regional communities of users for Climate Change adaptation and mitigation in 20-30 words.</p>	<p>The input text provides insights into the impact of heatwaves on urban areas and offers strategies for adapting to rising temperatures, crucial for regional communities facing climate change [1][2][6].</p>	4	<p>This is indeed the main topic of the video, although it does discuss other issues, such as the impacts on agriculture and invasive species in oceans too. In fact, this could be a very useful answer for the ClimEmpower CoPs.</p>

Question	Answer	Answer quality, Likert 1-5 scale	Discussion
<p>Explain the relevance of input text for regional communities of users for Climate Change adaptation and mitigation in 20-30 words. (e.g. "it explains the origin of the issue at hand", "it explains the impacts", "it provides an overview of solutions", "it discusses one innovative solution in details", "it discusses the societal justice", "it discusses the economic aspects of climate change adaptation and mitigation")</p>	<p>The input text highlights the impact of heatwaves on regions like South Asia, emphasizing the urgent need for climate change adaptation and mitigation strategies [1][2][5].</p>	3	<p>Once again, adding more information to the question resulted in a lower answer quality. Maybe the answers would be better if "European stakeholders" or "stakeholders in European cities" were mentioned in the question?</p>
<p>Input data is a transcript of a video discussing some aspects of Climate Change. Explain why and how is this video relevant for regional communities of users for Climate Change adaptation and mitigation in 20-30 words. (e.g. "it explains the origin of the issue at hand", "it explains the impacts", "it provides an overview of solutions", "it discusses one innovative solution in details", "it discusses the societal justice", "it discusses the economic aspects of climate change adaptation and mitigation")</p>	<p>This video is relevant for regional communities as it discusses the impacts of heat waves on land and at sea, highlighting the need for adaptation strategies [1][2][3].</p>	4	<p>Not very exciting and fails to mention human lives, but correct. Interestingly, explicitly indicating to GPT3.5 that this is a video transcript seems to help improve the answer.</p>
<p>Explain what issue or issues related to Climate Change adaptation or mitigation are addressed in the input in 10-20 words.</p>	<p>The input addresses urban heat islands and cooling solutions in cities to mitigate the impact of heatwaves [1][2][3][4].</p>	4	<p>While incomplete, this answer nicely summarises the essence of the video.</p>

Question	Answer	Answer quality, Likert 1-5 scale	Discussion
<p>Explain what issue or issues related to Climate Change adaptation or mitigation are addressed in the input in 10-20 words. This could be specific hazards, vulnerability of specific sectors or elements of risk to these hazards, risk or impacts, or pathways and solutions for lowering the risks/impacts.</p>	<p>The input addresses the issue of urban heat islands and the need for cooling solutions in cities [1][2][3].</p>	<p>4</p>	<p>While incomplete, this answer nicely summarises the essence of the video. Adding instructions did not change the essence of the answer.</p>
<p>Explain what issue or issues related to Climate Change adaptation or mitigation are addressed in the input in 10-20 words. (e.g. "reasons for increase in flood frequency and intensity", "impacts of heat waves in south Europe", "Solutions for wildfires in Italy")</p>	<p>The input addresses the issue of urban heat islands and the implementation of cooling solutions in Paris [1][2][3].</p>	<p>3</p>	<p>Adding instructions resulted in an overemphasis on Paris, which is important but not the only location mentioned in the video.</p>
<p>Which target group or target groups are addressed by input text? (e.g. pre-school children, high school students, general population, regional planners, decision makers, policy makers, professionals, scientists)?</p>	<p>The input text addresses professionals, scientists, regional planners, decision makers, and policy makers [1][2][3][4][5][6][7][8][9][10][11][12][13][14][15].</p>	<p>1</p>	<p>Factually wrong. This video is mainly for the general population and may be useful to regional planners, decision makers, and policy makers. It does not address scientists. The large number of resources listed at the end and other factually wrong answers may be a sign that the service could not discover anything relevant for answering the question in the resource file.</p>

Question	Answer	Answer quality, Likert 1-5 scale	Discussion
<p>Explain which target group or target groups are addressed by input text in 10-20 words. (e.g. pre-school children, high school students, general population, regional planners, decision makers, policy makers, professionals, scientists)?</p>	<p>The input text addresses policymakers, urban planners, and city officials [10][11][12].</p>	<p>3</p>	<p>Better answer. It still omits the general population, but at least it does not claim the video is for scientists.</p>
<p>Input data is a transcript of a video discussing some aspects of Climate Change. Explain which target group or target groups this video addresses in 10-20 words. (e.g. pre-school children, highschool students, general population, regional planners, decision makers, policy makers, professionals, scientists)?</p>	<p>The video addresses policymakers, urban planners, and professionals involved in city design and climate adaptation [2][4][8].</p>	<p>4</p>	<p>Slightly better answer than the one above, as it mentions city design and climate adaptation.</p>

Table 18: GPT3.5 analysis of the DW documentary “How heatwaves impact our lives” video - citations

Citations
<p>[1] "Source 1: 31° and with higher activity levels it will decrease even further and you can also think at different populations for instance people that are older or less able to sweat this critical value will also be lower some predict huge Wes of the global population will be affected some regions may even become [Music] uninhabitable we can already see these conditions in the Caribbean in Mexico and the us but they will be even more problematic in countries like Pakistan or India or in tropical Asia where thresholds have already reached lethal limits for human beings these conditions are driving millions of people to migrate in search of places with lower humid and lower temperatures where they can survive critical thresholds could impact around 1.5 billion people in South Asia by the end of the century unlike more affluent populations in the northern hemisphere people living in this part of the world often lack the means to protect themselves against the Heat extreme temperatures coupled with high humidity means some areas could become uninhabitable the result would be a climate migration to cooler regions wet bulb temperatures in Europe are "</p>
<p>[2] "Source 2: would be a climate migration to cooler regions wet bulb temperatures in Europe are far below these critical thresholds but they still need to prepare for extreme weather scenarios there too most cities were designed and built under relatively heat stable conditions but a hotter future means Europeans will be forced to adapt their living [Music] spaces more and more cities are now attempting to counteract the heat by using the color white white reflects the sun's rays and prevents roads and buildings from heating up the brighter the shade of white the more sunlight it [Music] [Applause] reflects it's not just the materials we use to build cities that are responsible for creating Urban heat Islands [Music] either Vol Pon believes it comes down to how buildings are arranged [Music] the idea of urban physics was initially born when I was working at MIT in Boston every couple of hours I took a coffee break with a colleague the central Courtyard at MIT has a fantastic view of "</p>
<p>[3] "Source 3: coffee break with a colleague the central Courtyard at MIT has a fantastic view of Boston skyline while we chattered we noticed that the buildings resemble a row of molecules placed on differing Heights we decided to calculate the parameters and functions that allowed us to characterize the order or disorder of these [Music] molecules Boston's European style layout inspired pan to determine the correlation between how buildings are arranged and urban temperatures what he discovered was [Music] surprising we're all familiar with US cities and their perpendicular right angled grid plans in comparison European cities appear somewhat jumbled here's an example our simulations showed this kind of neatly organized square with its four buildings actually amplifies the urban heat effect thermal coupling between buildings is maximized the opposite applies in many European cities a disorganized layout reduces thermal coupling resulting in fewer Urban heat Islands thermal coupling can be compared to a pinball machine it's an interaction between buildings where "</p>
<p>[4] "Source 4: compared to a pinball machine it's an interaction between buildings where heat is instantaneously reflected from surface to surface increasing Urban Air [Music] temperatures if I had to optimize this quarter I would introduce different height buildings this minimizes the height of opposing facades let's put another small building here and this is the neighborhood of the future with minimal heat Islands but it also starts to look like an older neighborhood a neighborhood resembling those we know from the past there needs to be a fundamental shift in how we build our cities or we simply draw inspiration from the past smaller neighborhoods with a mix of buildings that are appropriately arranged with enough space to prevent thermal coupling or close enough to reduce direct sunlight by day the city of Leon's modern p district is already 4° warmer than the city's medieval quarter the difference is even greater at night when the absorbed heat is released into the cooler surrounding air some 200 million people currently "</p>

[5] "Source 5: absorbed heat is released into the cooler surrounding air some 200 million people currently live in over 350 cities where temperatures regularly exceed 35° by 2050 the figure could rise to 1. "

[6] "Source 6: 6 billion atomic [Music] bombs this is a warming that will be irreversible for thousands of years as well as leading to rising sea levels and polar ice melt warmer temperatures also influence how Marine heat waves develop their intensity and their frequency a forecasting tool to predict Marine heat waves in the Mediterranean up to 3 months in advance is currently being designed a potentially crucial service especially for the fishing industry that could then avoid over fishing an affected areas using early detection systems is not limited to Oceanic activity scientists are researching how Marine heat waves impact heat waves on land Marine heat waves not only prevent coastal areas from cooling down they can also contribute to turbulence in the lower atmosphere low-level cloud cover dissipates over the coastline leaving the land below exposed to more solar radiation Elish fisha believes this is one of the main risks associated with heat waves whether on land or at Sea they are rarely an isolated problem "

[7] "Source 7: heat waves whether on land or at Sea they are rarely an isolated problem the heat waves often end with colossal thunderstorms it usually takes a strong cold front to end a heatwave these storms are accompanied by torrential rain that falls on dry cracked soil which can't absorb the water which in turn leads to flash flooding we've seen floods follow a heatwave time and time [Music] again while not triggered directly by heat waves wildfires are another consequence when vegetation dries out the Wildfire season begins earlier pushing firefighters and local residents to their absolute [Music] limits there are so-called sixth generation fires that technically we can no longer extinguish once they break out all we can do is rescue people try and protect infrastructure and pray they'll soon burn out by themselves the amount of combustible material combined with high temperatures and winds makes these wildfires catastrophic even without such extreme events we will still have to live with the many consequences of heat waves "

[8] "Source 8: we will still have to live with the many consequences of heat waves today's heat waves are already forcing us to adapt Our Living Spaces will it be enough for the heat waves of [Music] Tomorrow every morning I tell myself that we must grasp the small window of opportunity it keeps getting smaller but it's not zero yet we need to work towards designing cities worth living in in a world where we live in harmony with nature and where we understand how to cope with heat waves it's possible but difficult [Music] "

[9] "Source 9: 6 billion adapting Urban spaces can be challenging especially in Paris with its m of protected historical sites however while there were only 14 Heatwave days in 2010 there are predicted to be 20 in 2030 while we identified warmer and cooler neighborhoods in Leon that's not the case for Paris Paris is one huge heat island caused not only by its Urban density but also by its architecture everywhere we look we see the same five-story buildings and the same street widths which makes thermal coupling particularly intense here Paris is one big heat island the temperature difference from the center to its outskirts can be up to 10° C how can this Mega City cool down one idea is to construct a giant Subterranean cooling plant 30 M below the surface [Music] we're here in a cooling system plant that produces ice cold water the network is operated by and supplies almost 800 subscribers in Paris with cold water water is drawn from the river sen and cooled down "

[10] "Source 10: in Paris with cold water water is drawn from the river sen and cooled down to 2 to 4° using renewable energy the water is then pumped across the city via a near 90 km distribution network of pipes the chilled water is circulated through museums department stores and hotels where it cools down indoor temperatures by absorbing heat once it has been used the water is around 12° before it's pumped back into the cooling system where it's chilled Again by 2042 the cooling network will be expanded to cover 252 km and will supply critical infrastructure like hospitals we offer a cooling solution that is more environmentally friendly than traditional air conditioning it does not contribute to the urban heat island effect the city's oldest department store is one

of freser De Paris subscribers for many years the store was kept cool by large- scale air conditioning units on the roof now with the new cooling Network keeping temperatures comfortable the rooftop has been transformed into a "

[11] "Source 11: new cooling Network keeping temperatures comfortable the rooftop has been transformed into a communal Garden green spaces are a simple way of reducing the impact of urban heat [Music] Islands unlike non-permeable surfaces green spaces absorb rainwater so it can evaporate and cool the air the highest temperature ever recorded in Paris is currently 42.6 de but with the 50° barrier really be broken in the [Music] future based on what we know today it's definitely possible if global warming continues we could see temperatures of 50° in Paris by the middle of the Century Paris has taken various measures to prepare for extreme weather conditions including the introduction of a heat plan if a state of emergency is declared the authorities will call and visit older and vulnerable citizens to check on their well-being the city is also establishing more green spaces and cycle paths an app shows parisians where to find their closest green and blue spaces so-called cool Islands "

[12] "Source 12: where to find their closest green and blue spaces so-called cool Islands whether it will all be enough to prevent a repeat of 2003's catastrophic events remains to be seen in October 2023 Paris simulated a state of emergency the city's resilience was put to the test as part of a large-scale training exercise it's still the very beginning towards finding proper solutions for coping with heat waves in Europe because it's often the other end of the thermometer that poses a threat to life for human beings the life in Europe was pretty much endangered by the winters I mean population in the middle age and in the in more unseen times needed to fight the winter specifically in northern Europe summer has always played a silent role in the husters of the human being although the risk of heat waves is constantly increasing we seem determined to underestimate their severity hoping life will continue on as normal but but were already witnessing serious consequences according to surveys by the European environment agency heat waves were responsible for "

[13] "Source 13: consequences according to surveys by the European environment agency heat waves were responsible for around 130 billion EUR of economic damage in the EU between 1980 and [Music] 2022 Spain has been hit hardest the heat wave in summer 2023 led to massive losses for the Spanish economy in particular for the agricultural sector some 80% of all Spain's water is used for [Music] agriculture to make any farming at all possible water is siphoned from lakes and rivers to irrigate regions that are already bone dry often "

Table 19: First attempt to generate descriptions of educational resources by GPT3.5. For comparison, the human-generated description and the one generated by AI in alternate rows and colour coding used to indicate **correct and useful responses, **useless responses** and **obvious errors**.**

Title	Summary	Importance	Topic of interest	Target group	Resource Type
Creating Climate Change Curriculum	This article gives guidelines as to how to design and implement climate change education in a slow and archaic education system. It is focused on the USA.	This is a relatively short read that can help educators design their own courses around climate change.	Climate change education	educators	Popular science text (web article)
The title of the educational resource discussing some aspects of Climate Change is "Creating Climate Change Curriculum"	Educators must teach students about the importance of sustainable practices and combat misinformation about climate change. They should engage students in discussions, use diverse teaching methods, and provide resources to make learning about climate change fun and easy	The educational resource provides guidance on climate change curriculum implementation, empowering educators to address misconceptions, engage students, and promote climate literacy	The educational resource addresses climate change hazards, risks, impacts, and solutions in American classrooms	The educational resource discussing aspects of Climate Change is made for educators	The input data is an educational curriculum on Climate Change
Traditional Farm Design vs. Permaculture Design: What's the Difference?	This video provides a comparison of classical farming and permaculture and lists the benefits of changing the way we think about food production.	The video contrasts the two approaches at the same time, providing a more solid argument for change.	Permaculture	general public, farmers, gardeners	YouTube video, educational video

Title	Summary	Importance	Topic of interest	Target group	Resource Type
<p>The title of the educational resource discussing some aspects of Climate Change is "Traditional Farm Design vs. Permaculture Design: What's the Difference?"</p>	<p>The resource discusses permaculture design principles for land management, emphasizing water retention, optimal sun exposure, and nutrient cycling through forage trees to create sustainable and resilient ecosystems</p>	<p>The educational resource provides insights on water management, land contouring, and planting strategies, crucial for European communities adapting to climate change through sustainable agriculture practices</p>	<p>Permaculture design addresses water management, erosion prevention, nutrient cycling, and sustainable agriculture practices</p>	<p>The educational resource discussing aspects of Climate Change is likely made for individuals interested in sustainable farming practices and permaculture design</p>	<p>This is an educational video transcript discussing aspects of permaculture design and sustainable land management practices</p>
<p>Using Demonstration Storms to Prepare for Extreme Rainfall</p>	<p>An extreme precipitation event in 2008 cost one town more than a million dollars in infrastructure repairs. Now, other municipalities can simulate how their homes, businesses, and facilities might fare if they experienced a similar event.</p>	<p>This case study not only explains what happened but provides a comprehensive list of tools that can be used to simulate the potential results of a flood.</p>	<p>Weather modelling, risk mitigation</p>	<p>communities, decision makers</p>	<p>Lessons learnt and case studies</p>
<p>The title of the educational resource discussing some aspects of Climate Change is "Using Demonstration Storms to Prepare for Extreme Rainfall"</p>	<p>The resource discusses how communities can prepare for extreme rainfall events by simulating past storms to identify vulnerabilities and adaptation opportunities</p>	<p>The educational resource on Climate Change adaptation and mitigation can provide valuable insights for European communities on preparing for extreme rainfall events and building resilience</p>	<p>The educational resource addresses hazards of extreme rainfall, impacts on infrastructure, and solutions for climate resilience</p>	<p>The educational resource on Climate Change is made for communities and municipalities to assess their vulnerability to extreme rainfall events without needing to experience them</p>	<p>The input data is a report on lessons learned and case studies related to Climate Change</p>

Title	Summary	Importance	Topic of interest	Target group	Resource Type
Climate Risk Card Game	This is a card game that focuses mainly on learning strategies to increase resilience: Players should work together to identify and address climate-related risks that could affect their business and to build and build climate resilience.	This resource is a good tool for learning basic concepts related to climate change and resilience and can be used as an icebreaker in a situation such as a focus group or similar.	Building resilience, climate risks	general public, educators, institutional stakeholders	Serious game
Unfortunately, none of the provided sources contain the title of the educational resource discussing Climate Change	The game focuses on identifying climate-related risks, taking actions to manage them, and assessing the company's resilience to future climate shocks based on the actions taken	The educational resource on Climate Change can help European communities understand and address climate-related risks, enabling them to adapt and mitigate the impacts effectively	The educational resource addresses climate-related risks, resilience building, and actions for companies to mitigate climate impacts	The educational resource on Climate Change is designed for players participating in a game to understand the potential impacts associated with climate change and how to integrate climate-related risks into business decision-making processes	The input data provided is a serious game designed to help players understand the potential impacts of climate change and how to integrate climate-related risks into business decision-making processes
Implications of Global Climate Change for Tourism Flows and Seasonality	This study gives an analysis of tourism evolution according to climatic scenarios and global changes.	Implications of climate change for the global tourism industry	Tourism, impact of tourism on the environment	scientists, experts	Scientific article

Title	Summary	Importance	Topic of interest	Target group	Resource Type
<p>The title of the educational resource discussing some aspects of Climate Change is "Implications of Global Climate Change for Tourism Flows and Seasonality"</p>	<p>The educational resource discusses the potential impacts of climate change on global tourism, focusing on shifts in tourism flows and seasonality due to changing climatic conditions</p>	<p>The educational resource on Climate Change is relevant for European communities to understand potential impacts on tourism</p>	<p>The educational resource addresses the hazards, risks, and impacts of climate change on the global tourism industry</p>	<p>The educational resource discussing aspects of Climate Change is likely made for individuals interested in the implications of climate change on the global tourism industry</p>	<p>The provided sources [1][2][3][4][6][11][12][13][14] are scientific articles discussing the implications of global climate change for tourism flows and seasonality.</p>