Project dissemination and exploitation plan, including reporting on activities undertaken

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About this document

Work package in charge: WP7: Dissemination and Exploitation, Business Model and Market Development

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1. Abstract /publishable summary

This report presents a last update (3rd version) of the plan for the AQ-WATCH Dissemination, Communication and Exploitation strategy. The report starts with the identification of the high-level strategy and phases of the dissemination and exploitation plan. It includes the identification of relevant audience and a mapping of the identified stakeholders of AQ-WATCH. It describes the tools and channels, and more generally the approach followed by AQ-WATCH project, in order to reach and engage all interested parties, including online (such as website, social media and newsletter) and offline activities (such as events, publications and synergies with other projects). Dissemination and communication are complemented by the materials which have already been implemented or planned to be implemented in this report. A set of measures (Key Performance Indicators) has also been developed to evaluate the impacts of the plan a reach a higher impact. In addition to the dissemination and communication plan, an exploitation plan is designed. Exploitation opportunities have been identified with the consortium and the contribution of a major European company operating worldwide, and the methodology for the exploitation is described.

2. Conclusion & Results

The Dissemination, Communication and Exploitation Plan aims at describing the measures proposed by the AQ-WATCH consortium to disseminate project results, to communicate its activities and to exploit the project outcomes. The document highlights the methods through which these measures have increased the overall impact of the project. These actions take into consideration a variety of communication channels and target groups.

The deliverable also presents how the consortium plans to exploit project outcomes and results. It presents in detail the key exploitable results of the project and the five modules that embody them. The possible products and modules that embody these results were selected based on a holistic view of the market and an understanding of the current customer segmentation in relation to what AQ-WATCH has developed, in terms of products and services. An Innovation Management Roadmap has been provided for the AQ-WATCH solutions and the main target markets have been described for each of them. Besides, a competition study completes the exploitation plan.

Finally, the potential exploitation pathways are explored, the concept of exploitation of intermediate results is explained and the plan for joint exploitation with a major worldwide service provider is introduced.

The plan for exploitation and dissemination of the results serves as an innovation management tool for both the consortium and the European Commission to ensure that the AQ-WATCH dissemination and exploitation activities are adequately and timely planned and implemented.

3. Project objectives

This deliverable contributes directly and indirectly to the achievement of specific objectives indicated in section 1.1 of the Description of the Action:

Specific objectives of the project	Contribution of this deliverable?
[1] To design and produce new global and regional air pollution atlases that include the climatological distribution of chemical pollutants complemented by quantities such as the diurnal and seasonal variations, air quality and related health indices, premature mortality exceedance frequency, long-term trends, etc.	Yes
[2] To develop software packages with the capability to provide more accurate daily forecasts of air quality at the regional scale including tailored high-resolution fire smoke and wind-blown dust forecasts; downscaling of air quality forecasts to 2 km resolution in urban areas.	Yes
[3] To develop a source apportionment service to mitigate air pollution and hence increase the life expectancy of the population in different regions of the world, with special focus on the role of agricultural sources of air pollution and the potentially important effects of fracking operations.	Yes
[4] To develop a new toolbox that will be user-friendly and accessible to decision-makers to evaluate the efficiency of proposed mitigation measures in different industrial sectors on the resulting level of air pollutants in three different regions of the world. This will establish the basis for their wider adoption and generalization.	Yes
[5] To co-design, co-produce and co-evaluate for the first time prototype products and services with prime users in three regions of the world chosen for their specific level of economic, social and environmental development.	Yes

This deliverable directly contributes to the achievement of specific objectives indicated in the description of the Work Package.

Objectives of WP7	Relevance in this deliverable?
7.1 Clustering with major EU and international projects and initiatives relevant for the project to guarantee the use of available knowledge (state-of-the-art);	Yes
7.2 Establishing contact with potential international end-users by building a community interested and capable to make the best use of the project results;	Yes

7.3 Providing information and technological briefings to the competent authorities to make them aware of project results;	Yes
7.4 Providing support for standardization activities;	Yes
7.5 Preparing the AQ-WATCH Plan for Use and Dissemination of Foreground Knowledge;	Yes
7.6 Develop business cases in the regions of the world of the pilot-cases.	Yes

4. Detailed report on the deliverable

4.1. Introduction

The WP7 consists in operating dedicated communication channels and tailored dissemination activities, interacting with the main stakeholders in the field of air quality and clustering with other projects to make sure that the results of AQ-WATCH will be used and implemented as soon as they are available, and to establish potential exploitation paths for the project results.

This document defines AQ-WATCH dissemination and exploitation plans, refining and broadening the features laid out in the Description of Action (DoA).

Section 4.2 describes the integrated approach of the dissemination, communication and exploitation strategy and details how the dissemination performance is monitored and evaluated through key performance indicators (KPIs), dissemination rules as well as potential challenges.

Sections 4.3 and 4.4 of the document detail how this approach translates in terms of message, targeted audience, timing, formats, relevant channels for communication and dissemination activities. These activities promote the project, raise awareness, and engage air quality community members.

Section 4.5 focuses on the exploitation plan detailing the strategy to implement the results and the project outcomes.

This document is a contractual deliverable (D7.6) of the project due at M42.

4.2. Dissemination, communication and exploitation: An integrated approach

Effectively carrying out dissemination, communication and exploitation activities requires an integrated approach (Figure 1). While the dissemination and communication activities consist in monitoring results and informing about it, the exploitation activities at the same time consider a strategy for intellectual property protection. These activities are to be considered as horizontal issues and to be integrated into the day-to-day activities of the project.

Figure 1: Communication, Dissemination and Exploitation toolbox "Choose the right tools to address the challenges of the call and contribute to the expected impact!" (Source: European IPR Helpdesk Guide - Making the most of your H2020 project [28])

The AQ-WATCH project follows the recommendations and approach described in the guide mentioned in Figure 1 and adapts the activities to the specificity of the project.

4.2.1. Dissemination

Definition: "The public disclosure of the results by any appropriate means (other than resulting from protecting or exploiting the results), including by scientific publications in any medium." *(Source: EC Research & Innovation Participant portal Glossary/Reference Terms)*

Objective: Transfer knowledge & results with the aim to enable others to use and take up results, thus maximising the impact of EU-funded research.

Focus: Describe and ensure results available for others to use.

Targeted audience: Audiences that may take an interest in the potential use of the results (e.g. scientific community, industrial partner, policymakers).

4.2.2. Communication

Definition: "Communication on projects is a strategically planned process that starts at the outset of the action and continues throughout its entire lifetime, aimed at promoting the action and its results. It requires strategic and targeted measures for communicating about (i) the action and (ii) its results to a multitude of audiences, including the media and the public and possibly engaging in two-way exchange." *(Source: EC Research & Innovation Participant portal Glossary/Reference Terms)*

Objective: Reach out to society and show the impact and benefits of EU-funded R&I activities, e.g. by addressing and providing possible solutions to fundamental societal challenges.

Focus: Inform about and promote the project and its results/success.

Targeted audience: Multiple audiences beyond the project's own community incl. media and the broad public.

4.2.3. Exploitation

Definition: "The utilisation of results in further research activities other than those covered by the action concerned, or in developing, creating and marketing a product or process, or in creating and providing a service, or in standardisation activities." *(Source: EC Research & Innovation Participant portal Glossary/Reference Terms)*

Objective: Effectively use project results through scientific, economic, political or societal exploitation routes aiming to turn R&I actions into concrete value and impact for society.

Focus: Make concrete use of research results (not restricted to commercial use.)

Targeted audience: People/organisations including project partners themselves that make concrete use of the project results, as well as user groups outside the project.

4.2.4. Roadmap

The strategic planning of communication, dissemination and exploitation activities has already started before the project at the proposal stage. The plan needs to be constantly monitored, reviewed and potentially adjusted throughout the course of the project.
The objectives that have been mentioned in the previous section has been accomplished according to the following roadmap:

1. Activity plan (M1 – M6)
This period served for identifying the most effective communication and dissemination strategy ensuring the best possible AQ-WATCH visibility and impact. It included planning relevant activities and starting dissemination, such as participation on events, appearing in journals as well as on the social media. For example, creating an initial leaflet, launching initial version of the website, preliminary listing of stakeholders, drafting and publishing first newsletter were part of this activity.

2. Implementation (M4 – M42)
During this phase, key stakeholders and target audience have been reached with the communication and dissemination activities of the project. Various communication actions have been initiated in order to create awareness among researchers, policy makers, industry actors and projects related to the theme and scope of AQ-WATCH. Additionally, a comprehensive set of tools (supports and channels) have been identified to diffuse key messages extracted from research results to the identified targeted groups in a way that encourages them to factor the research implications into their work. The dissemination material and website have been continuously updated with more information on project achievements. Initial exploitation plan has been created to help drawing the way for the final year dissemination and exploitation activities. The delay for the availability of the user interface platform has hampered the intensity of the dissemination activities.

3. Monitoring activities (M5 – M42)
During that period, a detailed analysis and an assessment of the dissemination and communication activities' success have been performed. The activities and metrics will be monitored. The impact of the related activities have been measured using a list of pre-established key performance indicators (KPI's).

4. Exploitation and sustainability (M18 – M42)
During this phase, given the project maturity and availability of specific results, the partners have used the expertise and knowledge already acquired within the project to develop strategies and initiate activities that will ensure the project long-lasting visibility, and sustainability, which will maximize its impact on society, economy and science even after its end.

4.2.4.1. Key Performance Indicators

A series of Key Performance Indicators (KPIs) are detailed in Table 1. These KPIs, in addition to monitoring tools such as Google Analytics, Twitter Analytics, etc., are used to evaluate the overall impact of the project dissemination and communication activities.

The initial set of KPIs has been defined and agreed among the Editorial Committee set up to organize and assure the quality and relevancy of the content published by AQ-WATCH on its website and in the social media.

Several dissemination activities have been postponed until the prototypes of the modules in the user interface platform were up and running.

The table below shows the target goals for each KPI at M12 , M24 and M36. The last column indicates the actual achievement at M42.

Table 1: Dissemination and Communication KPIs list and target goals

		M12	M24	M36	Actual
Website	Number of visitors (total)	250	600	1000	1991
	Average duration of visits	1m	1m15s	1m30s	9m08
	Number of posts published (including news) (total)	3	10	20	20
	Number of documents available in the website repository (total)	7	15	24	27
Publications (Number of journal, conference and trade publications) (total)		0	0	6	7
Participation in **external events** (total)		0	12	24	35
Project events	Number of AQ-WATCH regional workshops (total)	0	0	3	3
	Participants per AQ-WATCH regional workshops	0	0	20	n.a.*
	Number of AQ-WATCH webinars (total)	0	4	4	n.a.*
	Participants per AQ-WATCH webinars	0	15-20	15-20	n.a.*
	Number of AQ-WATCH annual meetings and final conference (total)	1	2	3	3
	Participants per AQ-WATCH annual meetings	25	35	45	25*
Promotional material	Number of project flyer editions (total)	1	2	4	5
	Number of events where the project flyer is used (total)	1	5	10	n.a.
	Number of events where the poster is used (total)	1	5	10	n.a.
	Number of videos to be produced (total)	2	8	12	7**
	Number of video views (total)	0	100	400	n.a.**
Social media	Size of the LinkedIn Group (total)	20	40	80	46***
	Number of Twitter followers (total)	25	60	120	95***
	Number of tweets / retweets (total)	48	96	144	90***
Number of AQ-WATCH **e-newsletters** published (total)		2	6	9	4****

** See 4.3.5.5.1 for more detail.*
*** See 4.3.5.5.2 for more detail.*
**** See 4.4.2.6 for more detail.*
***** See 4.4.2.7 for more detail.*

Overall, the late delivery of the toolkit at the end of the project has considerably impacted the potential for dissemination activities. Indeed, it was not possible to showcase the toolkit to stakeholders before the end of May 2023. Besides, it foreseen to convene a Core-Stakeholder Network meeting to reinforce the capacity of exploitation as soon as the partnership with exploiters is established (cf. 4.5.7)

4.2.4.2. Editorial Committee

An Editorial Committee has been set up at the beginning of the project. It is composed of representatives from INEDEV as dissemination manager, MPG as coordinator and BreezoMeter as the solution integrator and developer of the user interface platform.
The Editorial Committee defines the dissemination and communication strategy, to suggest and produce dissemination content and to review dissemination activities (Figure 2).

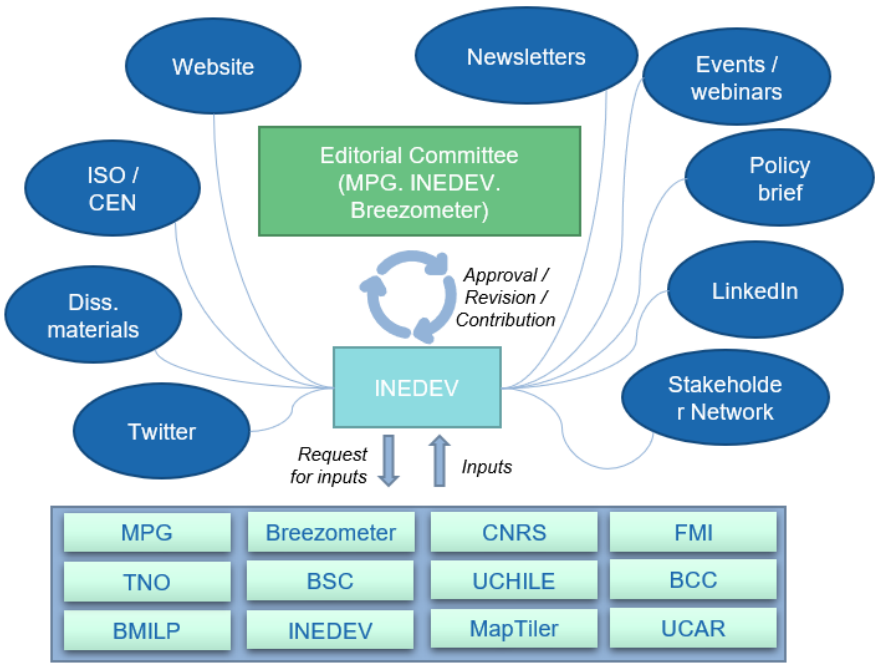


Figure 2: Role and composition of the Editorial Committee in interface with the consortium

4.2.4.3. Monitoring procedures

In order to monitor the dissemination activities and make sure that the project meets the EC expectations and the objectives described in the Description of Action of the project, two online forms are being used:

- For the application of dissemination activities: https://forms.gle/x84R1UnjLSHW2QTDA
- For the reporting of dissemination activities: https://forms.gle/KGCoEHuM2TqoCXWK8

The inputs collected in these on-line forms serve to monitor and report about the dissemination and communication activities carried out by all partners of the project.

4.3. Dissemination

4.3.1. Strategy and objectives

The dissemination strategy for AQ-WATCH aims to ensure that the project's research outcomes and practical results are as widely disseminated as possible to the target communities at appropriate times, and that those who can contribute to the development, evaluation, uptake and exploitation of the AQ-WATCH outcomes are identified and encouraged to participate.

The objectives of the dissemination activities are to:

- **Plan** - Identify targets, messages, tools, and channels; to develop an adequate and effective communication and dissemination plan to ensure the best impact of project results.
- **Design** - Produce dissemination tools: design a comprehensive set of dissemination material (including the project logo) to ensure an easy identification and a major exposure of the project.
- **Distribute and represent** - Use the dissemination channels. Organize project events and participate in workshops, conferences, and international/EC meetings.
- **Sustain** - Ensure a persistent and long-lasting visibility of the project activities and outcomes.

The dissemination of AQ-WATCH is closely linked to the project communication and exploitation activities. The wide exposure and publicity of AQ-WATCH results aims at increasing the engagement of the interested stakeholders that will also benefit the project's sustainability and impact even after the project end. The organized dissemination activities enable dialogues, cooperation, and coordination, and establish connections between stakeholders within and outside Europe.

4.3.2. Main dissemination players

- **MPG intentions and achievements**:
  Three projects/initiatives that are led by MPG (Max Planck Institute for Meteorology) can benefit from the dissemination of AQ-WATCH products: (a) the Klimapolis Laboratory funded by the German Federal Ministry of Education and Research, 2018-2023) , with multiple partners in Germany and Brazil, looking at impacts of air pollution and climate change in metropolitan areas in Brazil; (b) the H2020 Papila project (2018-2023), an EU mobility project between European and Latin American institutions that has established a sustained network of partners with complementary expertise that develops and implements an analysis and forecast system for air quality with downscaling capability for Latin America and the Caribbean region (LAC region); and (c) MAP-AQ, an international initiative that has been endorsed as an emerging activity of the International Global Atmospheric Chemistry (IGAC) project and a contributing activity to the Global Atmosphere Watch (GAW) program of the WMO. MPG will also take lead on peer-reviewed

publications and international conference presentations on the general aspects of the whole AQ-WATCH project.

- **BreezoMeter intentions:**
  There are intentions for potential blog pieces highlighting the AQ-WATCH members in interview form, and potentially a live webinar format with the same interview style, which will be produced by BreezoMeter and disseminated across the company's network in promotion of the project. Both BreezoMeter employees' and company accounts have followed all the groups and social accounts created for the project. When a post is shared from AQ-WATCH social account, the BreezoMeter team will share.
- **CNRS intentions:**
  CNRS will participate in international conferences and workshops, such as AGU, and the conferences of the projects of the International Global Atmospheric Chemistry project (September 2022 in Manchester, UK) and of IGAC projects such as GEIA, AMIGO and MAP-AQ which might take place in 2022. CNRS will also present the global atlas at the 35th Annual Conference of the International Association of Climatology in Toulouse, France in July 2022. CNRS will lead or collaborate on scientific publications discussing the AQ-WATCH results.
- **FMI intentions:**
  There are two groups actively contributing to the AQ-WATCH developments: atmospheric composition modelling with the FMI SILAM model and satellite data provision from several instruments and merged datasets. In both cases, the primary contribution to dissemination are the peer-reviewed research papers, press releases, presentations at the workshops, etc. A somewhat specific dissemination effort is the SILAM website, where the model forecasts are made public. Being the raw data behind the AQ-WATCH products, these forecasts represent the "data for professionals" rather than to general users. These are (i) not tailored to specifics of any user, i.e. require certain skills to process and interpret, (ii) much more complete in terms of variables, dimensions, and chemical species than the AQ-WATCH products.
- **BSC intentions:**
  BSC intends to participate in national/regional/international events such as the annual EGU/AGU conferences, the International Technical Meeting on air pollution modelling and its application (ITM) or the ESA phi-week. Besides, BSC also intends to publish in scientific journals or magazines (e.g.: Atmospheric Chemistry and Physics) and news within the institution's network (e.g.: corporate magazine, corporate newsletters…).
- **INEDEV intentions:**
  INEDEV is leading the dissemination and exploitation of the results activities in close link with the editorial committee (INEDEV, MPG, BREEZOMETER). Therefore, INEDEV creates and updates the dissemination material (flyer, poster and website) during the project lifetime. INEDEV manages the social media presence of the project to attract interested parties and disseminate continuously project news and

achievements. INEDEV is also in charge of preparing the AQ-WATCH newsletter with the support of the project partners. Furthermore, INEDEV, together with MPG, establishes connections with the relevant projects and initiatives. INEDEV will intensify its participation to international events to promote the AQ-WATCH products during the last year of the project.

- **TNO intentions:**
  TNO will present the developments and results of the AQ-WATCH activities at national and international conferences and workshops. These include International Technical Meeting on air pollution modelling and its application (ITM) (in spring 2023 in US), The LOTOS-EUROS workshop (January 2022), and meetings with collaborators in Latin America. The results will also be shared in corporate newsletters, and via social channels (Twitter, LinkedIn). TNO also intends to publish the work (as lead or co-author) in peer-reviewed journals e.g. Atmospheric Environment, Atmospheric Chemistry and Physics.
- **MapTiler intentions:**
  MapTiler announced the participation in the project via social media. Deliverables of the projects shall be presented on blog post and newsletters to our existing customer user-base (over 100k subscribers). As the effort in AQ-WATCH project leads to improvements of our products, MapTiler plans to announce the related functionality to its customers and reach to them with the list of new features and ability to visualize air quality once these parts of the software are developed and released. The project deliverables such as the regional atlas are going to be promoted also on conferences and as demonstrator of our mapping platform capabilities.
- **UCHILE intentions:**
  At present UChile has presented AQ-WATCH and its products in two occasions to the Chilean Association of Renewable Energies (ACERA), which is a primary user for the project, and to the Ministry of Environment and Public Health officials. During 2022, a finalized version of the products will be presented to the aforementioned stakeholders and other relevant parties. Furthermore, the AQ-WATCH products will also be presented and promoted in national and international conferences (e.g. EGU) and the dust forecast modelling system developed by UCHILE will be submitted to peer-review journals (e.g. Atmospheric Chemistry and Physics, Solar Energy).
- **UCAR intentions:**
  UCAR intends to share flyers and posters with Prime User (CDPHE) and other relevant parties in Colorado (e.g. Regional Air Quality Council, Boulder County) and to establish links to AQ-WATCH website from UCAR/NCAR CONUS AQ prediction website. Moreover, UCAR will highlight AQ-WATCH results and achievements at scientific presentations and potential public lectures.
- **BCC intentions:**
  In the AQ-WATCH, BCC participates in the construction of Chinese informatization software and simulation platform. BCC will study the research approaches and

models of AQ-WATCH, and intends to promote the achievements of AQ-WATCH among partners in Beijing and Chengdu.

- **BMILP intentions:**
  BMILP intends to share flyers and posters created and updated by INEDEV with Prime User (Taoranting Substrict) and other relevant parties/institutes/universities in China (e.g. Xinhua District, Cangzhou City, Hebei Province, CDC…). Besides, BMILP also intends to publish in scientific journals or magazines (e.g.: Atmospheric Chemistry and Physics) and news within the institution network (e.g. cooperation newsletters on BMILP website…). BMILP will participate in national/regional/international conferences and workshops, such as AGU. Moreover, BMILP will highlight AQ-WATCH results and achievements in scientific presentations and potential public lectures.

4.3.3. Target audience and stakeholders

AQ-WATCH aims at providing a wide range of functionalities to a wide range of end-users. The users' needs and user scenarios may vary from user to user, so we need to identify all potential cases, their added value and impact. This helps the consortium to justify the added value of AQ-WATCH when implementing dissemination and exploitation activities. In order for AQ-WATCH to realize its full potential and achieve all of the expected impacts, the consortium has identified five target groups for its dissemination, exploitation and communication activities. Particular effort is being made to enlarge the innovation impact of the project through effective engagement with these Target Groups (TG):

- **TG1: International client communities consisting of public services (including public authorities) and the private sector – the dedicated end-users from the 3 pilot regions and potential other end-users**

  Objectives: *Raise interest in the AQ-WATCH activities and generate business opportunities with end-users*

  This key audience requires detailed input from AQ-WATCH, the 3 pilot end-users are integrated into the project (WP6). AQ-WATCH will provide 7 user-driven products and services that will help the users monitor, improve and mitigate air quality in their regions. A toolkit that contains a smart alert system for extreme pollution events, daily multi-model forecasts (up to 96 hours), scenarios for air pollution changes in response to mitigation actions and other user- driven tools providing advanced graphical and numerical information at regional and sub-urban scale has been developed and co-designed with users. The three pilot regions are the Colorado Northern Front Range, Santiago de Chile and Beijing and its region (BTH). This toolkit, which includes the prototype of the products and services, has been used as much as possible to reach out to other potential international client communities and is intended to be commercialized within 3 years after the end of the project lifetime. The toolkit or some of its component will be adapted to a certain extend to each regional market and customer needs.

- **TG2: Policy and decision makers in regional government departments (strategic support or prescribers to potential end-users)**

Objectives: *Raise interest in the AQ-WATCH activities and provide information useful for policy planning and preparation/implementation of regulations.*

For this target group, AQ-WATCH can make an impact through the development of more accurate and effective tools, scenarios, visualizations and integrations of data and information on regional air quality allowing policy and decision makers to take appropriate actions and make more efficient mitigation strategies. To reach out to this group, in addition to the integrated pilot users in WP6, AQ-WATCH approached and invited a selected number of policymakers from Europe and other regions of the world to interactive workshops where they can address their needs and questions regarding air quality and risk assessment. To this end, AQ-WATCH will build on established channels between national climate services responsible for issuing the air quality and its related scenarios, and tailor communication and information for this specialist and/or non-specialist audience. It was planned that the TG2 will also have access to the UIP and can directly test the toolkit created within the AQ-WATCH framework but it was not done due to the delay in the delivery of the toolkit except of the prime-users. Policy-relevant synthesis will be made available at the end of the project in the form of factsheets and presentations.

- **TG3: NGOs and wider industries (potential users)**

Objectives: *Raise interest and include them in the AQ-WATCH communities as future potential end-users.*

AQ-WATCH will make an impact with companies and NGOs through the production of a range of scenarios of regional air quality and the risk framework relevant for the development of adaptation/mitigation policies. These were presented in a progressive on- going series of papers and technical reports. These were backed up by offering to undertake joint analyses with companies and NGOs on any data sets or background studies to these scenarios or other aspects of particular interest to them. Representatives from industry and NGOs from environmental sector, health, energy, cosmetic, IT environment that are linked to our SME partners (e.g. WRI) whose core-business directly relates to air quality issues were invited to participate in workshops and to identify case studies. They were also be invited to join the Stakeholder Network (SN). This international network covers additional economic and geographic sectors than those covered by the three pilot case studies (WP6).

- **TG4: The specific scientific community applying Copernicus facilities and beyond, as well as the future research community (research users and capacity building)**

Objectives: *Engage research and innovation actors & collaborate on specific (funding) programmes if synergies are found.*

AQ-WATCH established relations with relevant H2020 EO projects and other international projects, such as InDust COST Action, DustClim, PAPILA, KLIMAPOLIS, ICARUS, HERA, the ERC AdG project IntelliAQ and various CAMS projects. This allowed experts to work closely together and therefore to save resources. At the same time, it promoted Copernicus services and data, and the efforts achieved by AQ-WATCH.

During the project lifetime, consortium partners have been involved in scientific presentations to scientific conferences (such as AGU, EPA national AQ conference and EGU) and/or the development of peer reviewed articles in their research field domains. The success of these activities has been measured through the use of the AQ-WATCH KPIs.

AQ-WATCH stressed their dissemination activities to early career researchers (e.g. Master's and PhD students) and SMEs, as well as into regional areas with limited access to research capabilities (e.g. Africa, south-east Asia and south America). For that purpose, the AQ-WATCH team organized workshops such as the regional consortium partners in the US, Chile and China in order to demonstrate the benefits of AQ-WATCH.

- **TG5: Society at large, general public: e.g. journalists and the interested public**

Objectives: *Raise the interest to invest in the future funding programmes.*

For this target group, the AQ-WATCH website and explanatory videos were intended to be the main tools for disseminating project results and communicating project progress. However, due to the lack of available results to showcase during the project, the number of videos was reduced. In addition, public lectures and presentations were given by the Coordinator, WP-leaders and other team members to engage with the wider public in all the participating countries and regions. Moreover, the synthesis of the project effort and output were rewritten in form of flyers to be distributed to the wider public at targeted events and made available at public spaces in research institutes. Societal high impact findings were disseminated and communicated through newsletters and social media channels. Finally, the project and its main findings were advertised through various social media channels.

4.3.4. Messages disseminated

Different messages and key results for dissemination were identified at the early stages of the project for each work package. They are summarized in the Table 2 below.

Table 2: Main messages disseminated per WP / Tasks

Work Package	Messages and key results for dissemination
WP1 - Identification of User's Needs and Service Design	• Development of the AQ-WATCH products and services specifications • Analysis of the end-users (industry, policymakers, governments…) needs and requirements • Successive evaluations of the products and services by the prime users, in connection with the developers of the AQ toolkits and services to deliver • Presentation of the products and services (e.g.: dedicated leaflets or videos)
WP2 - Exploitation and Visualization of Satellite and in situ Data	• Building of an air quality dataset from various sources • Development of global and regional atlases of air quality • Development of innovative methods to calculate health indices and mortality rates • Global and regional atlases of air quality ready for review by the prime-users (module 1) • Global and regional atlases of air quality final product available (module 1)

WP3 - Daily AQ Forecasts at Regional Scales	• high-resolution forecast models developed (module 5) • fire and fire-smoke forecast methodology developed (module 3) • distribution and deposition of wind-blown dust methodology developed (module 3) • high-resolution forecast prototypes ready for review by the prime users (module 5) • fire and fire-smoke forecast prototypes ready for review by the prime users (module 3) • distribution and deposition of wind-blown dust prototypes ready for review by the prime users (module 3) • high-resolution forecast final product available (module 5) • fire and fire-smoke forecast final product available (module 3) • distribution and deposition of wind-blown dust final product available (module 3)
WP4 - Policy Strategy: Attribution of Air Pollution Sources and Analysis of Emission Reduction Strategies	• Development of source attribution tool for identification of key source regions and source sectors for PM and NO2 in Santiago de Chile and Colorado (US) • Development of source attribution tool for identification of key sources and source regions for CO in Colorado (US) • Webtool to visualize the impact of mitigation measures (emission reductions) on air pollution levels (NO2, PM and CO) in Santiago de Chile and Colorado • Identification of the contribution of agricultural activities on particulate matter pollution levels in Santiago de Chile and Colorado • Webtool to visualize the impact of mitigation measures (emission reductions) on air pollution levels in Cangzhou, China • Development of fracking information service for identifying impact of fracking operations on pollution levels (November 2021)
WP5 - Development of a prototype Operational Service	• Development of a toolkit containing all the AQ-WATCH products and services • Products and services handbook • Training material
WP6 - Regional co-production and pilot implementation	• Feedback from the implementation in Denver/Colorado, Santiago/Chile and BTH (Beijing-Tianjin-Hebei) /China • Identification of specific solutions from AQ-WATCH products to end-users • Lessons learnt from the implementation within the project and future developments/extensions • Identification of usefulness and value of products • Example case studies for which applications might have been used

4.3.5. Dissemination tools and channels

In order to maximize the dissemination impact and the outreach of the project results, several types of dissemination activities are planned: (i) online and interactive tools and channels, (ii) non-electronic tools and channels, and (iii) physical interactive tools and channels. Dissemination tools include all material supports used to present the content of the project to an external audience, whereas dissemination channels involve all media through which the project results are conveyed and disseminated to target audience. Some of the dissemination tools and channels are also used for communication purposes.

Concerning mailing lists and contact databases, the AQ-WATCH project pursues its efforts to expand its stakeholders' network that is used for targeted communications, discussion and consultation. In addition, each partner has been using its own database of contacts to disseminate information on the project to their networks.

4.3.5.1. Website

The project website (http://AQ-WATCH.eu/) has been set up to provide visibility to the project and access to public relevant non-IP-sensitive sources and results. The project website is updated periodically with news, results and events that the project will participate. A methodology has been put in place that aims to ensure that news, events, and achievements will be collected.
The roles of the website are the following: It provides the public image of the project and serves as the basic online point of reference for the different target groups. It is the project information source that presents the project's objectives, activities, achievements and the new knowledge related to AQ-WATCH topics of interest. It also serves as a repository of information on various access layers, making available project resources, documentation, dissemination material, publications and deliverables to the general public, to selected target groups and to project partners.
The website design is modern and addresses the latest state of the art functionalities that are available at WIX (e.g.: "responsive" design for tablets and smartphones), which is one of the most popular platforms for web content management. The website is optimized for the web search engines and has been monitored with the use of a Google Analytics Tool. The Table 3 summarizes the current main website sections.

Table 3: Website sections / webpages

Sections	Content
Home	This part contains links to project related information, to a brief description of the methodology, to the list of the 7 products, to news and social networks, to events and to project partner information. The subsections of the home page are: Products (Figure 3) / Project / Consortium / News / Contact
Publications	This webpage has been periodically updated with the obtained project results, to demonstrate the AQ-WATCH progress and achievements. They will also highlight the most concrete outputs of the deliverables, and thus spread the project excellence and disseminate knowledge as widely as possible.
News	This webpage contains news related to the project and relevant information from the air quality topics of interest.

Figure 3: Homepage (project title and description of the 7 products)

The graphs below (Figure 4, Figure 5, Figure 6) show traffic over the time for the first and second versions of the website. As expected, the number of visitors has increased during the last period. The total number of visitors of the website (from February 2020 to September 2020) is 674 for an average duration of the visit of 5m47s. For the second version of the website (from October 2020 to June 2023), 1317 site sessions and 492 unique visitors were recorded with an average duration of the visits of 9m08s which is assessed as very good performance (industry standard for a good average visit duration is 2-3 minutes[1]).

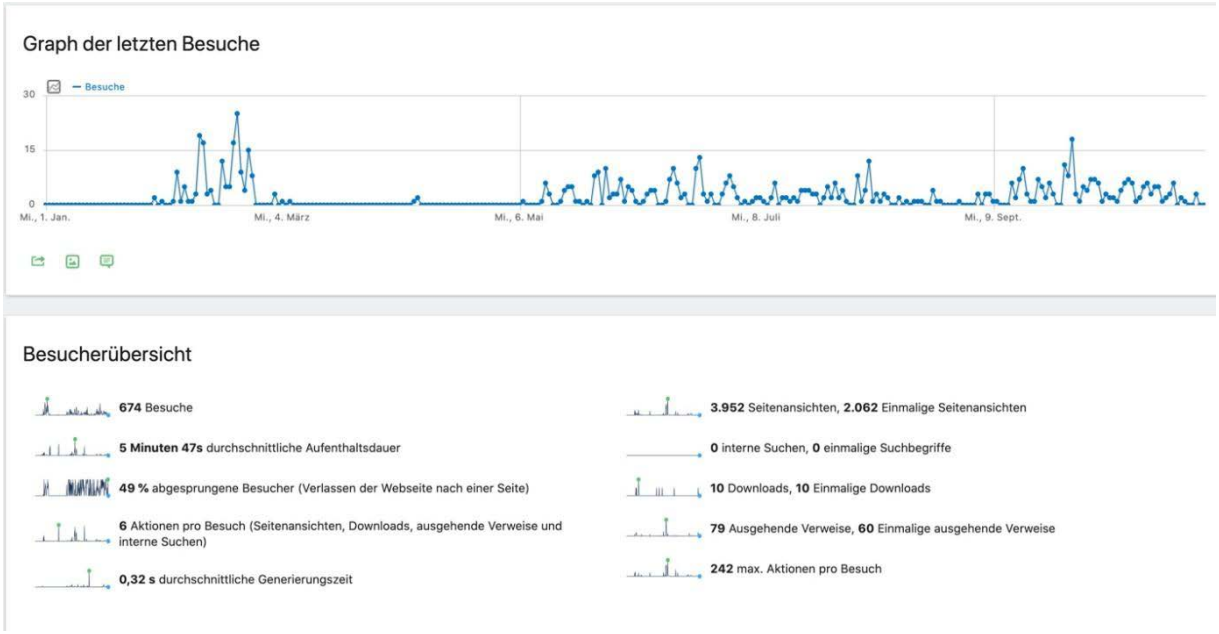


Figure 4: Statistics of the first version of the website

[1] https://www.spinutech.com/blog/digital-marketing/7-website-analytics-that-matter-most/#AvgSessionDuration

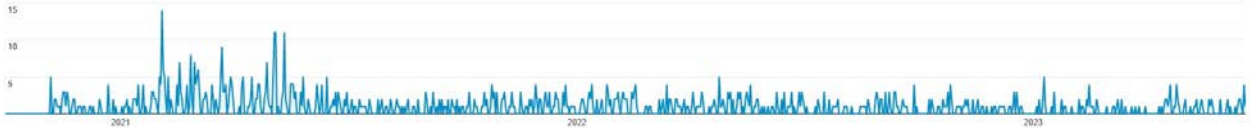


Figure 5: Traffic over time (second version of the website)

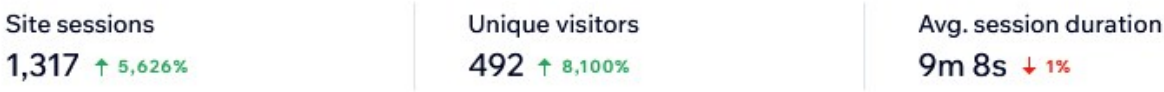


Figure 6: Statistics of the second version of the website

The graph below (Figure 7) presents the visits that are sourced by search engines. It shows that most of the visits comes from people visiting directly the project website demonstrating that the communication actions towards the community are efficient and that AQ-WATCH has been identified by the stakeholders.

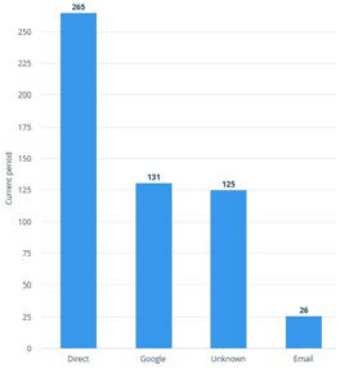


Figure 7: Website hits from sources

The geographical coverage below (Figure 8) shows that visitors come mainly from Europe but also that there is an interest from all over the world. Compared to the previous periods, the interest has grown in south east Asia and in Africa.

Figure 8: Traffic by location

ACTION PLAN & PROGRESS
M01-M02 (DONE): MPG drafted specifications for website development and starts implementing the strategy. Search Engine optimization (SEO) parameters and web statistics were performed and planned to be regularly analysed to drive more visit to the AQ-WATCH website. (Note: The website has been reshaped by INEDEV in October 2020)
M02-M36 (DONE): The website is enriched with contents by all partners, in line with the project progress and the achievement of results and it is regularly updated. It also shows recent tweets connected or addressed to the AQ-WATCH Twitter entity. Finally, the activity of the website is monitored through google analytics or similar.
From M36 on (PLANNED): The website is maintained beyond the end of the project lifetime. For the 3 years after the end of the project funding, it will be operated by INEDEV.

4.3.5.2. Dissemination to other online channels

Apart from the project website, project results and activities are disseminated on multiple external websites to increase the visibility of the project, targeting selected audience of stakeholders (Table 4).

Table 4: Non-exhaustive list of online dissemination channels

Other online channels	Actions
AQ-WATCH partners websites	Partners already providing links to the project website: - https://www.bsc.es/research-and-development/projects/AQ-WATCH-air-quality-worldwide-analysis-and-forecasting - http://www.cr2.cl/cr2-participara-en-proyecto-de-la-union-europea-sobre-calidad-del-aire/ - https://blog.BreezoMeter.com/BreezoMeter-wins-prestigious-eu-horizon-2020-grant-to-advance-air-quality-research - https://blog.breezometer.com/breezometer-teams-up-with-experts-to-improve-air-quality-monitoring - https://www.bsc.es/research-and-development/projects/aq-watch-air-quality-worldwide-analysis-and-forecasting - https://mpimet.mpg.de/en/communication/news/single-news/aq-watch-new-eu-project-to-help-mitigate-air-pollution
EC websites and social networks	Horizon Magazine, research*eu results magazine, research*eu focus
Other related projects to be contacted for organising joint dissemination activities	See section 4.3.5.9

Websites of related ongoing and newly launched H2020 projects	Community Research and Development Information Service (CORDIS)
ZENODO & OPENAIR	https://zenodo.org/communities/aqwatch/

ACTION PLAN & PROGRESS
M03-M36 (DONE): All partners continue to pursue links with other sites and increase project visibility.

4.3.5.3. Project deliverables

Project deliverables play a major role in the project's external dissemination. The ones that are characterized as "public" are made available in pdf format in order to spread the project excellence and disseminate knowledge as widely as possible.

ACTION PLAN & PROGRESS
M01-M36 (DONE): The final compressed PDF version of public deliverables are uploaded immediately on the project website and the ZENODO platform after they have been submitted to EC.

4.3.5.4. Project publications

The knowledge gained within AQ-WATCH is made public by the academic partners of AQ-WATCH through articles in leading peer-reviewed scientific journals. These papers aim at an expert level and cover a wide range of the innovative aspects of the project. Concerning the measures to provide open access (OA) to peer reviewed scientific publications, AQ-WATCH (a) follows the "Golden OA" option (publications available directly from the publisher) for open access to peer-reviewed journal articles where possible, and funding is provided for this, (b) in parallel, "Green OA option" version is available either on an author's institutional website, or in a repository and is also accessible by using the institutional and subject-based repositories that is made publicly available through all the AQ-WATCH partners after the shortest embargo period allowed by the respective publication. Authors avoid entering into copyright agreements with publishers that do not allow them to fulfil the EC Open Access requirement and (c) the abstracts and the publications are made available in the open access community ZENODO, a free open repository powered by CERN and the European Commission, and OpenAIRE. All the published material contains an acknowledgement to the research funding from Horizon 2020, as described in Deliverable 8.2. These measures also apply, where relevant, to other target groups.
In addition, project partners consider any opportunity to contribute to e-Journals, blogs and newsletters targeting a larger public with shorter articles and news, as well as to policy-oriented publications to enhance project outreach to policymakers. Those publications are based on the results of the activities, including but not limited to development guides, study reports, recommendations, lessons learnt and event outcomes. As well as deliverables, publications may only contain non-confidential and non-classified information.

Before submitting a scientific publication, partners are invited to send a draft version to the consortium members. According to the Article 29.1 of the Grant Agreement (Extract: *"A beneficiary that intends to disseminate its results must give advance notice to the other beneficiaries of — unless agreed otherwise — at least 45 days, together with sufficient information on the results it will disseminate.")*
Therefore, "Any other beneficiary may object within — unless agreed otherwise — 30 days of receiving notification, if it can show that its legitimate interests in relation to the results or background would be significantly harmed. In such cases, the dissemination may not take place unless appropriate steps are taken to safeguard these legitimate interests».
According to Art. 29 of the Annotated Model Grant Agreement of the European Commission, "Each beneficiary must ensure open access (free of charge, online access for any user) to all peer-reviewed scientific publications relating to its results". All partners contribute to the promotion and dissemination of the various publications.

The Table 5 below presents the list of publications as of June 30, 2023. So far, a total of 7 publications have been made. Once the system is up and running, publications will intensify.

Table 5: List of publications as of December 31, 2021

Title	Type	Authors	Title of journal / proceedings / book	Year	Peer-reviewed
Evaluation of anthropogenic air pollutant emission inventories for South America at national and city scale	Article in a Journal	Nicolas Huneeus, Hugo Denier van der Gon, Paula Castesana, Camilo Menares, Claire Granier, Louise Granier, Marcelo Alonso, …	Atmospheric Environment https://doi.org/10.1016/j.atmosenv.2020.117606	2020	Yes
Increasing trends (2001–2018) in photochemical activity and secondary aerosols in Santiago, Chile	Article in a Journal	Camilo Menares , Laura Gallardo , Maria Kanakidou , Rodrigo Seguel & Nicolas Huneeus	Tellus B: Chemical and Physical Meteorology, 72:1, 1-18, DOI: 10.1080/16000889.2020.1821512	2020	Yes
El aire que respiramos: pasado, presente y future Contaminacion atmosferica por MP2,5 en el centro y sur de Chile	Report	Huneeus, N. et al.	www.cr2.cl/contaminacion/	2020	No
An International Initiative for Monitoring, Analysis, and Prediction of Global to Regional and Local scale Air Quality	Publication in Conference proceedings/Workshop	Brasseur, G., Kumar, R., and Pfister, G. G.	Proceedings of the AGU Fall Meeting, Virtual, 2020, 1-17 Dec 2020	2020	No
The impact of Los Angeles Basin pollution and stratospheric intrusions on the surrounding San Gabriel Mountains as seen by surface measurements, lidar, and numerical models	Article in a Journal	Kumar, R., and Pfister, G.	Atmospheric Chemistry and Physics (EGU) https://acp.copernicus.org/articles/21/6129/2021/ac	2021	Yes

			p-21-6129-2021.html		
Evaluation and intercomparison of wildfire smoke forecasts from multiple modeling systems for the 2019 Williams Flats fire	Article in a Journal	Ye, X., Pargoal Arab, Ravan Ahmadov, Eric James, Georg A. Grell, Bradley Pierce, Aditya Kumar, Paul Makar, Jack Chen, Didier Davignon, Greg Carmichael, Gonzalo Ferrada, Jeff McQueen, Jianping Huang, R. Kumar, Louisa Emmons, Farren L. Herron-Thorpe, Mark Parrington, Richard Engelen, Vincent-Henri Peuch, Arlindo da Silva, Amber Soja, Emily Gargulinski, Elizabeth Wiggins, Johnathan W. Hair, Marta Fenn, Taylor Shingler, Shobha Kondragunta, Alexei Lyapustin, Yujie Wang, Brent Holben, David Giles, and Pablo E. Saide	Atmospheric Chemistry and Physics (EGU) https://doi.org/10.5194/acp-21-14427-2021	2021	Yes
Potential of TROPOMI for understanding spatio-temporal variations in surface NO2 and their dependencies upon land use over the Iberian Peninsula	Article in a Journal	Petetin, H., M. Guevara, S. Compernolle, D. Bowdalo, P.-A. Bretonnière, S. Enciso, O. Jorba, F. Lopez, A. Soret, and C. Pérez García-Pando	Atmospheric Chemistry and Physics, 23, 3905–3935, doi:10.5194/acp-23-3905-2023	2023	Yes

Besides, a final publication is under preparation by the coordinator.

ACTION PLAN & PROGRESS
M01-M36 (DONE): Project partners have published 7 scientific publications.

4.3.5.5. Physical interactive dissemination

Various internal and external dissemination activities are pursued such as the organization of project events, the participation in conferences/workshops/international or EU meetings, the presence in stakeholders' fora and the cooperation with other related EU projects. The Consortium is engaging with external stakeholders and entities by participating in workshops/webinars organized throughout the duration of the project, in order to present to a wider audience, the results and progress of the project. These workshops and webinars contribute to the general dissemination of the project mainly during its last year. Furthermore, a final conference linking public stakeholders, the research community and other potential contributors will be developed close to the end of the project.

The consortium partners continue to identify relevant third-party conferences and working groups wherein the outputs of the project can be promoted, shared and discussed. Partners leverage their respective networks to identify relevant projects, contributors, and communities of interest (both physical and virtual) with whom project findings and results can be shared and discussed. It is expected that they will integrate the project's findings into their on-going research and commercial activities. The networking efforts of AQ-WATCH in this regard serve as a "force multiplier", generating greater interest in and attention to the project and its outputs.

4.3.5.5.1. Project events

Project events come as a dissemination support to the work done within WP1-6. They enable the spreading of the project outputs to the respective target audience and facilitate valuable feedback from related stakeholders, providing ground for discussion and brainstorming.
In addition, different types of communities were invited to actively participate in the project through the involvement in initiatives such as open dialogs and consultation, workshops, etc. However, the COVID crisis and the late release of the toolkit has required to adapt the plan of project events.
In the following paragraphs, more details are given concerning specific activities and events organized by AQ-WATCH.

Four webinars
The webinars consisted in online sessions to present the project (activities, results) and attract the services' next users. The webinars were planned to be organized once the maturity level of the products and services is high enough to be presented. The webinars took place during the meetings with the Core Stakeholder-Network and with the prime users in their respective regions.

ACTION PLAN & PROGRESS
M18-M24 (POSTPONED): The organisation and the content of the webinars are developed. Announcements are sent out to the Stakeholders Network members.
M36-M42 (DONE): The online sessions to present the project results and the toolkit tool place.

Three regional workshops
The Consortium engaged with external end-users (primarily public authorities, cities and municipalities) in regional workshops organized throughout the duration of the project in the countries where the pilot cases will take place. The near-final version of the AQ-WATCH toolbox has been presented to and discussed with the prime users in all three regions. Feedback was collected on the value and functionality of the products with emphasis on the modules that are of most interest to the different users. Prime users expressed distinct feedback based on their needs, highlighting the most appropriate modules that can provide useful information to them. The prime users appreciated that the latest version of the toolkit has addressed and implemented many of the feedback and particular needs that have been collected in previous prime user meetings.

- Chile: Individual workshops will be conducted for the air quality and attributions products, dust forecast product and the forest fires product. In each workshop, representatives from both public and private organisations and/or institutions related to each one of these products will be invited. An interactive, hands-on workshop will be held where each potential user will be able to explore the capabilities of the corresponding tool. A survey will be conducted at the end to capture their feedback on the strength and weaknesses of the products.
- United States: The prime users at CDPHE and other stake holders in Colorado such as the Regional Air Quality Council, City Councils and EPA Region 8 will be invited to a meeting in the second half of project year 3 to demonstrate the products and the applicability to Colorado. The meeting objectives are (1) to raise awareness of AQ-WATCH products and (2) gather feedback on the usefulness of the products from a larger group and determine their level of interest in such products. The meeting will be held in person at the UCAR/NCAR facilities, but virtual participation will also be enabled to accommodate non-local groups.
- China: In China, three training workshops will be organized for the prime users (local government officers at TRT and Cangzhou, Scientists from Chinese institutes and universities). The objectives will be to (1) Show the prime users the AQ-WATCH products and train them how to use them, and (2) Collect their feedbacks. The first one will take place in June 2021 and will focus on the Regional Atlas, while the second one will take place in June 2022 with a particular focus on the mitigation tool. Finally, the third workshop will be organized in July 2022 and will be dedicated to the source attribution products, dust, solar energy and wildfire products (if the tools are available and readable by persons who know only Chinese).

ACTION PLAN & PROGRESS
M24-M30 (DONE): The organisation and the content of the 3 regional workshops are developed. Announcements are sent out to the Stakeholders Network members.
M30-M42 (DONE): The regional workshops take place.
Summer 2023 (PLANNED): A final round of meetings and discussions in the three regions is planned for summer 2023 as an extra activity after the end of funding.

Two annual consortium meetings

Two annual consortium meetings are scheduled in connection, when possible, with major international events to facilitate dissemination by the partners participating in these international events.

ACTION PLAN & PROGRESS
M06-M42 (DONE): Organization of the 2 annual meetings.

One final conference

A final conference was planned to be organized at the last project meeting targeting EU stakeholders. The final conference was to be organised, if possible, in combination with major international events to facilitate dissemination. However, due to the late delivery of

the toolkit, it was not possible to organize such event and the coordinator decided to replace it by an online event.

ACTION PLAN & PROGRESS
M24-M36 (DONE): Identifying the major international events taking place end of 2022.
M36-M42 (REPLACED BY AN ONLINE EVENT): Organization of the final online event on June 16, 2023.

4.3.5.5.2. Participation in external events

This type of dissemination facilitates knowledge exchange, face-to-face interaction and community building with targeted audience during related events, trade fairs and exhibitions. The AQ-WATCH partners have been using their participation in external events as an opportunity to establish synergies with other initiatives having similar scope in order to avoid duplication of effort and save resources.

The consortium partners have been participating to 35 events where AQ-WATCH activities were promoted (Table 6).

Table 6: List of events where AQ-WATCH was promoted

Date	Place	Event	Comments
15/06/2020	Virtual meeting	Development of an interactive platform for forecasting and attributing air quality	General presentation of AQ-WATCH followed by a presentation of the web platform followed by a discussion session and ended by a survey.
23/06/2020	Virtual meeting	The Coronavirus Pandemic &Global Changes' International Forum"	Prof. Guy P. Brasseur gave a lecture "Air Pollution during the COVID-19" at the "The Coronavirus Pandemic & Global Changes International Forum" hosted by Beijing Academy of Science and Technology (BJAST)- the superior institute of BMILP. The lecture broadcast on Bilibili – one of the most popular public broadcast platforms in China.
19/10/2020	Virtual meeting	Annual meeting of the WMO SDS-WAS	Regular meeting of the WMO SDS-WAS activities (about 20 UN agencies) in which AQ-WATCH objectives were presented.
01/12/2020	Virtual meeting	AGU Fall Meeting 2020	Presentations at AGU Fall Meeting 2020: Brasseur, G., Kumar, R., and Pfister, G. G.: MAP-AQ: An International Initiative for Monitoring, Analysis, and Prediction of Global to Regional and Local scale Air Quality, AGU Fall Meeting, Virtual, 2020, 1-17 Dec 2020, available at: https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/672198
15/12/2020	Virtual meeting	Dust diagnosis for solar energy systems of an interactive platform for the forecasting and attribution of air quality	Presentations of the AQ-WATCH partners to the members of Unconventional renewable energies trade association followed by a session of discussion and at the end a survey was conducted.

10/01/2021	Virtual meeting	AMS 101st annual meeting	AQ-WATCH was presented
13/01/2021	Virtual meeting	LOTOSEUROS workshop	Presentation by TNO on LOTOS_EUROS developments for application over Chile and Colorado at LOTOS-EUROS workshop where also participants from Colombia participated
17/03/2021	Virtual meeting	Seminar on air quality forecasting activities at NCAR	A presentation on the air quality forecasting activities at NCAR including the description and evaluation of the Colorado system developed under the AQ-WATCH project was made to the Kuwait Institute for Scientific Research
23/03/2021	Virtual meeting	Improving Scientific Software Conference	AQ-WATCH was presented
14/04/2021	Virtual meeting	Seminar on air quality forecasting	A presentation on air quality forecasting developed for Colorado under the AQ-WATCH project and also other air quality forecasting activities at NCAR was made to the National Center of Meteorology (NCM).
11/05/2021	Virtual meeting	DustClim: Development of dust climate services for solar energy	Presentation - Dust products for solar power industry in northern Chile https://cost-indust.eu/events/indust-events
12/06/2021	Virtual meeting	Sustainability Research & Innovation Congress 2021	Sean Khan from UNEP is part of the Core-SN and invited the coordinator to present the project at the SRI2021 in the GEMS air session
24/09/2021	China	2021 Zhongguancun Forum	The theme of the 2021 Zhongguancun Forum is "Wisdom, Health and Carbon neutrality". BMILP teams participated to this event and promoted AQ-WATCH products.
06/10/2021	Santiago de Chile	Bilateral meeting with public authorities from Chile (Prime-users)	Meeting with representatives of the Ministry of Environment and Public Health officials (Chile) focusing on the regional atlas and the air quality mitigation & attribution module.
07/10/2021	Santiago de Chile	Bilateral meeting with industry association from Chile (Prime-users)	Meeting with members from the Chilean Association of Renewable Energies (ACERA) focusing on the regional atlas and dust forecast modules
18/10/2021	Barcelona, Spain	ITM2021	Oral presentation with the overview of the model developments for providing accurate dust forecast based on MONARCH model over the Chilean domain. https://itm2021.vito.be/en/programme/conference-schedule-and-program
07/07/2021	Virtual meeting & Lyon, France	Goldschmidt 2021 Conference	Presentation - Regional and Local Mineral Dust Characterisation over South America by UCHILE https://2021.goldschmidt.info/goldschmidt/2021/meetingapp.cgi
09/11/2021	Virtual meeting	International conference on air pollution – Moving towards clean air for Europe	The project and the 5 modules were presented to the audience

09/11/2021	Virtual meeting	BLOWING SOUTH: SOUTHERN HEMISPHERE DUST SYMPOSIUM	Oral presentation entitled "Regional and Local Mineral Dust Activity over South America" by UCHILE http://dust2021.cima.fcen.uba.ar
04/12/2021	China	ENVIRONMENT CHANGE AND WASTEWATER EPIDEMIOLOGY SURVEILLANCE AROUND COVID-19	Discussion about the environment change and wastewater epidemiology surveillance around COVID-19. AQ-WATCH was mentioned and discussed.
26/01/2022	Utrecht and online	LOTOS-EUROS workshop	Presentation at workshop for LOTOS-EUROS users and other stakeholders, on different applications of the air quality model
20-27/05/2022	Bonn, Germany	ESA living planet symposium in 2022	Poster “Inference of surface NO2 concentration from space using TROPOMI observations and machine learning”. Petetin et al.
22/5/2023 – 26/6/2023	Chapel Hill, US	International Technical Meeting on air pollution modeling and its applications (ITM)	Presentation on air quality attribution and mitigation service
26/05/2022	Vienna, Austria	EGU General Assembly 2022	Presentation at EGU General Assembly 2022: Brasseur, G., Li, C., Granier, C., Doumbia, T., Sofiev, M., Timmermans, R., Pfister, G., Kumar, R., Basart, S., Salvi, O., Caillard, B., and Boose, Y.: Air Quality: From Science to Action, EGU General Assembly 2022, Vienna, Austria, 23–27 May 2022, EGU22-900, https://doi.org/10.5194/egusphere-egu22-900, 2022. Available at: https://meetingorganizer.copernicus.org/EGU22/EGU22-900.html
27/6/2022 – 1/7/2022	Virtual meeting & Thessaloniki (Greece)	International conference on Air quality – Science and application	Presentation on air quality attribution and mitigation service
05/09/2022	Bonn. Germany	EMS Annual Meeting 2022	Session on "Analysis, monitoring and prediction of chemical weather, air pollution, and the effects of COVID-19” co-convened by Guy Brasseur, Cathy Li and Rajesh Kumar. More information at: https://meetingorganizer.copernicus.org/EMS2022/session/44439
05/09/2022	Bonn, Germany	EMS Annual Meeting 2022	Presentation at EMS Annual Meeting 2022: Li, C. W. Y., Brasseur, G., Sofiev, M., Timmermans, R., Kumar, R., Pfister, G., Mo, D., Granier, C., Doumbia, T., Basart, S., Salvi, O., Caillard, B., and Boose, Y.: Introduction to the AQ-WATCH project and its multi-model air quality forecast system, EMS Annual Meeting 2022, Bonn, Germany, 5–9 Sep 2022, EMS2022-164, https://doi.org/10.5194/ems2022-164, 2022. Available at: https://meetingorganizer.copernicus.org/EMS2022/EMS2022-164.html
12/09/2022	Manchester, UK	iCACGP/IGAC joint	Poster presentations at iCACGP/IGAC joint International Atmospheric Chemistry Conference

		International Atmospheric Chemistry Conference	2022: Li, C. W. Y., Brasseur, G., Sofiev, M., Timmermans, R., Pfister, G., Kumar, R., Mo, D., Leufen, L. K., Kleinert, F., Schultz, M. G., Granier, C., Doumbia, T., Basart, S., Salvi, O., Caillard, B., and Boose, Y.: Introduction to the AQ-WATCH project and its multi-model air quality forecast system, iCACGP/IGAC joint International Atmospheric Chemistry Conference, Manchester, UK, 10–15 Sep 2022.
12/10/2022	Hamburg, Germany	DKRZ User Meeting	Poster presentations of the AQ-WATCH toolkit and the forecasting system and how the AQ-WATCH tools have been implemented using DKRZ resources.
10/11/2022	Berlin, Germany	European Public Health Conference 2022	Poster display at European Public Health Conference 2022 titled: Introduction to the AQ-WATCH Project and the AQ-WATCH Toolkit to fight air pollution
16/12/2022	Chicago, USA	AGU Fall Meeting 2022	Presentation at AGU Fall Meeting 2022: Li, C.W.Y., Brasseur, G.P., Granier, C., Doumbia, T., Sofiev, M., Timmermans, R., Pfister, G., Kumar, R., Basart, S., Huneeus, N. and Mo, D., 2022, December. From Science to Application: The AQ-WATCH Project and the AQ-WATCH Toolkit to Address Air Pollution Issues. In AGU Fall Meeting Abstracts (Vol. 2022, pp. A53A-04). Available at: https://agu.confex.com/agu/fm22/meetingapp.cgi/Paper/1086128
17/12/2022	Chicago, USA	AGU Fall Meeting 2022	Presentation at AGU Fall Meeting 2022: Soulie, A., Doumbia, T., Granier, C., Denier Van Der Gon, H., Kuenen, J.J., Arellano, S.R., Darras, S., Galle, B., Gauss, M., Guevara, M. and Jalkanen, J.P., 2022, December. An Atlas of Air Pollution Based on a Reanalysis and Emissions for the Past Two Decades. In AGU Fall Meeting Abstracts (Vol. 2022, pp. A56E-07). Available at: https://agu.confex.com/agu/fm22/meetingapp.cgi/Paper/1061712
12/01/2023	Boulder, USA	AMS Annual Meeting 2023	Presentation at AMS Annual Meeting 2023: Doumbia, E.T., Li, C., Brasseur, G., Granier, C., Soulie, A., Keita, S., Sofiev, M., Timmermans, R., Pfister, G., Kumar, R. and Huneesus, N., 2023, January. The AQ-Watch Air Quality Atlas: Global and Regional Analysis of Air Quality Using Online Systems. In 103rd AMS Annual Meeting. AMS. Available at: https://ams.confex.com/ams/103ANNUAL/meetingapp.cgi/Paper/413601
18/01/2023	Kigali, Rwanda	Follow up Workshop on a Pilot Design for Air Quality in Africa	A presentation on AQ atlas titled: The Use of Chemical Reanalyses to Address African Air Pollution Issues.
28/04/2023	Vienna, Austria	EGU General Assembly 2023	Presentation at EGU General Assembly 2023: Li, C.W.Y., Sofiev, M., Timmermans, R., Kranenburg, R., Pfister, G., Kumar, R., Deroubaix, A., Huneeus, N., Opazo, M., Caballero, T. and Mo, D., 2023. Introduction to the AQ-WATCH multi-model air quality forecast system (No. EGU23-15547). Copernicus Meetings. Available at: https://meetingorganizer.copernicus.org/EGU23/EGU23-15547.html

13-15/06/2023	Valencia, Spain	7th CAMS General Assembly	Several partners participated to this event and promoted AQ-WATCH results
21-23/06/2023	Brussels, Belgium	20th GEIA Conference "Towards mitigating air pollutant and greenhouse gas emissions" 21-23 June 2023	MPG and CNRS participated to this event and promoted AQ-WATCH results

The AQ-WATCH Work Package leaders are proactive in organising sessions and workshops at these major conferences whenever possible. Besides, all partners look for major events in the field to contribute to and report their contributions to INEDEV.

ACTION PLAN & PROGRESS
M01-M02 (DONE): INEDEV together with MPG drafts an indicative list of target events and circulates it among partners to complete and update.
M03-M36 (DONE): Partners continuously inform and give details to INEDEV on their planned participation to future events so that these can be included in the project website and LinkedIn group announcement. After attending an external event they contributed to, the partners send to INEDEV a short summary providing info on their participation, to be posted on the project website.
35 participations to events where AQ-WATCH was presented have been recorded.

4.3.5.6. Policy briefing

Policy briefing towards policy makers from the REA (DG GROWTH and DG ENV), and other national policy makers. In this dissemination activity, the consortium will propose improvement of policy based on AQ-WATCH results, in particular to make known good practices and inform the policy makers in charge of the air quality management and environmental protection.

ACTION PLAN & PROGRESS
M01-M36 (DONE): The project results are monitored, and the relevant policy makers are regularly informed about the project progress.

4.3.5.7. Stakeholders Network (SN)

The Stakeholders Network is organized in two groups:

- **The Open Stakeholders Network:**
  This group consists in all the social medias followers and newsletter subscribers whom the consortium interacts with. It is mostly a one-way communication.
- **The Core Stakeholders Network:**
  A number of users who have accepted to directly contribute to the joint development and evaluation of prototype projects and services have been identified (Table 7). Several users are full participants of the present project, while, in an effort to broaden the participation and the influence of the project, other potential users and customers are invited to become members of the Core SN. The Core SN members is invited to project meetings and workshops to inform them about the progress, to test ideas with customers and get feedback about the products & services that the consortium has developed. The CORE SN, in particular:
    - **Reflect on project findings and results** from a technical and End-User point of view
    - Periodically **advices the Project Team** in refining activities based on project results
    - **Advises and influences the development** of the products and services.
    - **Establishes links** with other End Users, Industry and Research Communities internationally
    - **Forwards project findings and results** to stakeholders and consumer testing for Peer review and policy recommendations

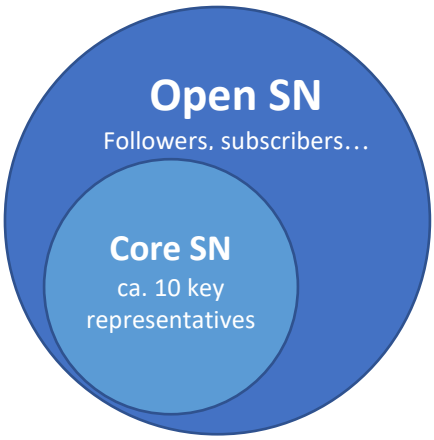


Figure 9: The Stakeholders Network concept

The SN is considered to be a central tool for implementing a co-production process, for developing a market strategy and a sustained business model and for developing dissemination activities.

Table 7: Core Stakeholders Network members

Last name	First name	Affiliation	Profile	Country
Aminata	MBOW DIOKHANE	Head of Air Quality Management Centre	Directorate in charge of environment	Sénégal
Ben	GREBOT	Director - Environmental Policy & Economics	Air Quality Consultants Ltd	United Kingdom
Deo	OKURE	Air Quality Scientist	Airqo	Uganda
Gufran	BEIG	Scientist-G, Fellow Indian Academy of Sciences	Indian Institute of Tropical Meteorology	India
Hartwig	KREMER	Head of the Global Environment Monitoring Unit, liaison to GCOS, GFCS and Future Earth	UN Environment Programme, UNEP	Kenya
Hazou	ABI	Director for Data and Environment Monitoring (DISE)	National Agency for Environmental Management	Togo

Jessica	SEDDON	Global Lead - Air quality	World Resource Institute	USA
Kenneth	LEUNG	Principal Environmental Protection Officer	Environmental Department of Hong Kong SAR (Special Administrative Region)	Hong Kong
Langley	DEWITT	Director	International Global Atmospheric Chemistry	USA
Michael	GIORDANO	Directeur du Groupe Afriqair	Afriqair	Rwanda
Pallavi	PANT	Senior Scientist Leader Global Programme	Health Effect Institute	USA
Sean	KHAN	Leader of UNEP's Global Environment Monitoring System for Air (GEMS Air)	UN Environment Programme, UNEP	Kenya
Stuart	SNEDDON	Air Quality director	RICARDO	United Kingdom

ACTION PLAN & PROGRESS
M01-M12 (DONE): Recruitment for the "Open SN" and the "Core SN" (T1.2 - MPG).
M13-M36 (DONE): Invitation of the Core SN members to project meetings and workshops to present the prototypes of the products & services and get their first feedback.
M01-M36 (DONE): Interaction through the social networks ("Open SN" - INEDEV).

4.3.5.8. Project Advisory Board

An international Project Advisory Board (PAB) consisting of experts on Air Quality monitoring, analysis, prediction and related dissemination has been established with the core objective to provide the GA and the PEB with relevant input and advice (cf. WP8). In addition, such a group of experts represents also an opportunity for the dissemination of the project results. The Project Office has been in contact closely with the members of the PABs to inform them the project results. In particularly, Prof. Dr. Alexander Baklanov has invited the AQ-WATCH team to give a solicited presentation in the EGU General Assembly 2023 in one of the sessions that he co-convened. His successor in WMO, Sara Basart, also attended the AQ-WATCH final conference.

ACTION PLAN & PROGRESS
M01-M14 (DONE): Invitation of the PAB members to General Assembly 2021.
M14-M36 (DONE): Regular information (project progress, news, dissemination material…) shared with the PAB members.

4.3.5.9. Ongoing initiatives

AQ-WATCH has been extending its dissemination activities beyond the goals of awareness and understanding, with the objective to trigger the involvement and endorsement of its activities and achievements, and to enhance links and synergies with initiatives that have similar target topics of interest.
Different types of cooperation are considered: Dissemination events and related news can be mutually promoted by exchanging announcements that can be uploaded on the project websites or on e-newsletters. The project logo(s) can be included in communication materials such as banners, flyers etc. Members of both AQ-WATCH and the other initiative can give invited/guest speeches and lectures at project workshops, seminars, conferences

and other related dissemination events. Also, such dissemination events can be jointly organized by AQ-WATCH and other projects/initiatives. Finally, there can be a provision to exchange feedback, opinions and ideas on projects publications and deliverables.
AQ-WATCH was member of ECREAM, the "European Cluster of Research projects for Environmental and Agri-food Monitoring" (https://triage-project.info/links/ecream), which comprises the following projects:

- TRIAGE; Ultra-broadband infrared gas sensor for pollution detection
- ULISSES; Ultra-low-power integrated optical sensor systems for networked environmental multichannel gas Sensing
- MONPLAS; The training of early-stage researchers for the development of technologies to MONitor concentrations of micro and nanoPLAStics in water for their presence, uptake and threat to animal and human life.
- h-ALO; photonic system for Adaptable muLtiple-analyte monitoring of fOod-quality
- PHOTON-FOOD; Flexible mid-infrared photonic solutions for rapid farm-to-fork sensing of food contaminants
- MOLOKO; Multiplex phOtonic sensor for pLasmonic-based Online detection of contaminants in milK
- AEOLUs; An Affordable, miniaturisEd, clOud-connected system powered by deep Learning algorithms for comprehensive air qUality measurements based on highly integrated mid-IR photonic
- GRACED; Ultra-compact, low-cost plasmo-photonic bimodal multiplexing sensor platforms as part of a holistic solution for food quality monitoring

The synergies with the projects above have been rather limited.

However, through the activities of the project partners, AQ-WATCH is well connected with the communities of InDust COST Action, DustClim, PAPILA, KLIMAPOLIS, MAP-AQ and various CAMS projects.
The MAP-AQ initiative (Monitoring, Analysis, and Prediction of Air Quality) is of particular interest for the AQ-WATCH activities. Indeed, its objective is to develop and implement a global air pollution monitoring, analysis, and prediction system for air quality with downscaling capability in regions of the world affected by high levels of atmospheric pollutants, in particular in Asia, Latin America, and Africa. A close link is ensured by Guy Brasseur (MPG) and Rajesh Kumar (NCAR) who are acting as MAP-AQ co-chairs.
AQ-WATCH partners intend to participate to the MAP-AQ workshop that will be organized in Kigali on October 22nd, 2023 just before the World Climate Research Programme (WCRP) Opens Science Conference (https://wcrp-osc2023.org) to present the AQ-WATCH results and seek for further co-exploitation opportunities.

ACTION PLAN & PROGRESS
M01-M12 (DONE): The relevant existing initiatives are identified by the partners and the editorial committee defines the appropriate strategy and actions for each of them (e.g.: Invite representatives to the project meetings, following them of social media, cross-invitation to the advisory boards…).
M13-M36 (DONE): Implementation of the strategies.

4.3.5.10. Standardisation

The project results are monitored to assess their potential for standardization. Links to relevant standardization organizations and committees are ensured by the project partners already involved in the TCs. The following technical committees were identified at the CEN and ISO levels:

- **ISO/TC 146 "Air quality"** and in particular the sub-committee **SC 3 "Ambient atmospheres":**
  Standardization of tools for air quality characterisation of emissions, workspace air, ambient air, indoor air, in particular measurement methods for air pollutants (particles, gases, odours, micro-organisms) and for meteorological parameters, measurement planning, procedures for Quality Assurance/Quality Control (QA/QC) and methods for the evaluation of results including the determination of uncertainty.
  Excluded : the establishment of limit values for air pollutants; the air quality in clean rooms; radioactive substances.
  Secretariat: DIN (TC146) and ANSI (SC3)
  https://www.iso.org/committee/52702.html
- **ISO/TC 20/SC 6 "Standard atmosphere":**
  Secretariat: GOST R
  https://www.iso.org/committee/46560.html
- **CEN/SS S08 "Air quality":**
  Secretariat: CCMC
  https://standards.cencenelec.eu/dyn/www/f?p=205:32:0::::FSP_ORG_ID,FSP_LANG_ID:776231,25&cs=1CA7BEDB892A140E1E82E77CA21679182
- **CEN/TC 264 "Air quality":**
  Standardisation of methods for air quality characterisation of emissions, ambient air, indoor air, gases in and from the ground and deposition, in particular measurement methods for air pollutants (for example particles, gases, odours, microorganisms), meteorological parameters and methods for determination of the efficiency of gas cleaning systems.
  Excluded are: determination of limit values for air pollutants, workplaces and clean rooms, radioactive substances.
  Secretariat: DIN
  https://standards.cencenelec.eu/dyn/www/f?p=205:7:0::::FSP_ORG_ID:6245&cs=117BA2254E50182356461DD64BD01CC05

However, the work done in AQ-WATCH did not lead to standardization opportunities such as a New Work Item Proposal submitted to existing Technical Committees. However, the project consisted in the demonstration of the capacity of the team to deliver the services developed in AQ-WATCH. The data and the procedures described in the technical deliverables reflect good practices that constitute new reference documents in the community. In addition, some of the results are used to improve the techniques

implemented in the framework of Copernicus programme and CAMS (Copernicus Atmosphere Monitoring Service[2]).

ACTION PLAN & PROGRESS
M01-M06 (DONE): The relevant Technical Committees are identified.
M07-M36 (DONE): Contacts established (directly by the partners participating to the TC activities) and preliminary discussions initiated.

4.3.6. Monitoring of the dissemination activities

The monitoring results of the dissemination activities will be presented in the periodic reports.
An editorial committee composed of INEDEV, MPG and BreezoMeter (until its termination) has been created. Its main missions are to define the dissemination and communication strategy, suggest and produce dissemination content and review dissemination activities.

4.4. Communication

4.4.1. Objectives of the communication actions

In parallel to the aforementioned target dissemination activities, a series of communication actions is planned to enhance the project visibility and to raise awareness of the AQ-WATCH activities and results in a clear and intelligible way.
They aim at raising public awareness and ensuring maximum visibility of the project key facts, objectives, activities and findings. It uses communication channels to announce and promote AQ-WATCH events in order to maximize the expected attendance and the potential for stakeholders' engagement, effectively supporting and promoting the aforementioned dissemination objectives. The communication element of the project involves all consortium partners and their respective staff. There is awareness that communication is a continuous process, not a one-time effort when the project ends since one of the main targets is to ensure the project sustainability in the long term.
INEDEV maintains the most appropriate mechanisms and tools for maximum visibility and impact ensuring that all partners contribute to communication activities and assess the communication results. The following list summarizes the selected communication actions:

- **Visual identity:** Development of the project logo and visual identity, preparation of templates for deliverables, reports, presentations etc.
- **Printed material:** Production and distribution of project communication materials: project flyers and poster
- **Videos:** Creation of videos
- **Newsletters:** Production of quarterly newsletters
- **Website:** Creation & Management of the website
- **Social media:** Update and management of the social networks, project LinkedIn group and Twitter accounts

[2] https://atmosphere.copernicus.eu/

- **Assessment and reorientation of communication activities:** Assessment of the project communication and dissemination activities, Re-organization of the communication and dissemination strategy

4.4.2. Communication tools

The following subsections provide information about the communication tools and channels that have been used, some of which may also be used for dissemination purposes.

4.4.2.1. Visual identity

A project logo has been developed by MPG and a palette of colours proposed by INEDEV.

Figure 10: The AQ-WATCH logo

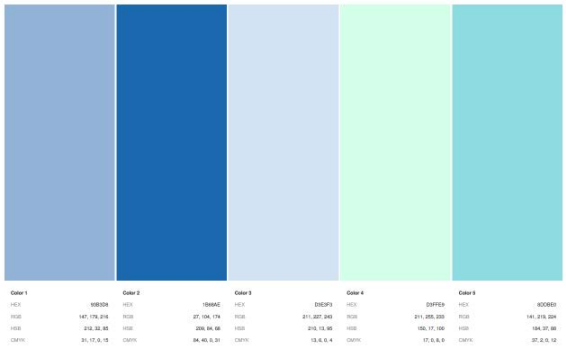


Figure 11: The AQ-WATCH palette

Additionally, a set of templates using the abovementioned logo and palette- have been designed by MPG and INEDEV. The templates ensure that the AQ-WATCH visual identity is consistent through the duration of the project. There are available templates for agendas, PowerPoint presentations, reports and letters.

ACTION PLAN & PROGRESS
M01-M02 (DONE): MPG designs a draft project logo and visual identity.
M01-M36 (DONE): MPG and INEDEV design and maintain the set of templates for agendas, presentations, reports and letters. Project partners approve the project logo, the visual identity and the various templates before they are used for any project communication purpose.

4.4.2.2. Media kit

A set of promotional material of the project has been developed and distributed through various mass media channels for publicity use. This media kit designed by INEDEV includes project flyers, a poster that allows the project consortium to reach a large audience over a short period of time. These releases are being distributed, e.g. promotional project flyers to the large non-specialist community as well as to the community of relevant stakeholders. Printouts are being distributed to partners' institutions (in order to be further distributed through their networks and channels) and on public events.

ACTION PLAN & PROGRESS

M01-M09 (DONE): A set of dissemination material (flyer, poster, presentation) is created to promote the key concepts and messages of AQ-WATCH, including clear and appealing info-graphics to be distributed on the web (social media, communities, partners' networks, external blogs, etc.). Printed copies are only circulated in external events where online promotion may not be sufficient or possible. The project flyers are uploaded in electronic format onto the project website as from their production in order to be easily downloaded and publicly shared.

M09-M36 (DONE): Revised versions of the dissemination material are prepared when needed. Partners send electronic copies to relevant contacts in order to enhance the project visibility and promote the AQ-WATCH contributions.

4.4.2.3. Promotional videos

A project video interview of the project coordinator was shared on youtube.

Taking into account that the development of the tool kit was delayed, the videos presenting them, and their features could not be done before M34. As soon as the tool kit was mature enough to be shared outside of the consortium, Core -SN and prime-users, a set of videos has been developed. These videos have been uploaded on YouTube and other relevant sites on the internet in order to reach a wide range of communities possibly interested in the project outcomes.

The following have been planned:

- Project coordinator interview and overview of the project
- Overview of the toolkit
- Demonstration of the module #1
- Demonstration of the module #2
- Demonstration of the module #3
- Demonstration of the module #4
- Demonstration of the module #5

ACTION PLAN & PROGRESS

M01-M12 (DONE): Definition of the planning of the interviews and video release.

M12-M36 (ON-GOING): Implementation of the plan.

4.4.2.4. AQ-WATCH website

The project website serves as a main dissemination as well as communication tool. It is a gateway to diffuse project information to wide audience. The website includes multimedia content and informative pages presenting the AQ-WATCH consortium, the project concepts, visions, objectives and activities. It is accessible by the citizens at large with tablets and smartphones and is linked to and from other tools and content developed by other related on-going EU initiatives and projects. More information about the website and the related action plan are included in section 4.3.5.1.

4.4.2.5. User Interface Platform (UIP)

A User Interface Platform (UIP - https://www.aq-watch.eu/uip) is in operation since 2021 and periodically provides information on progress and achievements which can be accessed by the pilot users and registered stakeholders/potential users. Besides the link to the toolkit has been publicly released (https://breezometer-horizon-2020.web.app/#/aqatlas/country).
The UIP that is linked to the project website is not only a platform for TG1, but accessible for all potential audiences (System developed in Task 8.4 and content for users in Task 7.1).

ACTION PLAN & PROGRESS
M01-M14 (DONE): Creation of the platform.
M15-M36 (DONE): Maintenance of the platform.

4.4.2.6. Social media

Social media activities help increase the project impact and relay information as widely as possible. Social media are considered to be powerful interactive tools and serve as platforms to discuss, comment, consult and suggest research and policy topics with different stakeholders at different levels.
The AQ-WATCH social media presence includes the following:

- A twitter account (https://twitter.com/AQ_WATCH):
  A AQ-WATCH account has been created to provide information about AQ-WATCH (concepts, initiatives, events etc.) to the wide community (Figure 12). A twitter link has been included in the project website to be easily accessible by any interested visitor of the AQ-WATCH webpages.
  The hashtag #AQWATCH is being used for related posts on Twitter. The social interaction statistics (e.g., number of tweets, number of followers etc.) are regularly monitored by INEDEV to assess the projects' positioning with tools like Twitter analytics.

Figure 12: AQ-WATCH twitter account screenshot

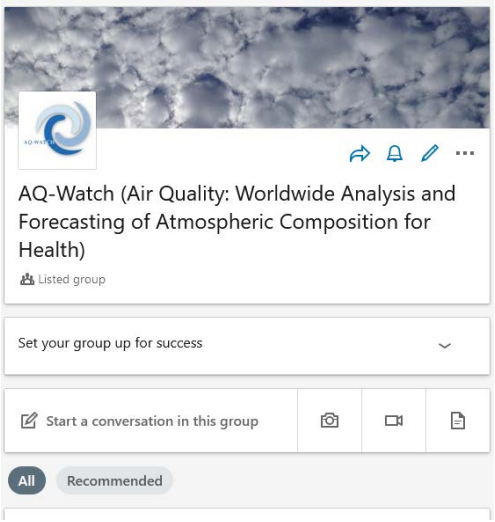


Figure 13: AQ-WATCH LinkedIn Group screenshot

- A LinkedIn group https://www.linkedin.com/groups/13906579/) and profile (https://www.linkedin.com/company/68890874/):
  The AQ-WATCH project LinkedIn account has already been setup (Figure 13) and serves as a platform for formal discussions, interaction, collection of information, and communication of the project outputs to experts. Individual invitations were sent out soon to targeted contacts in order to attract interested members/stakeholders.

On an average, the tweets from AQ-WATCH has had 400 impressions per month. The fact that the tool kit has not been ready for public communications until M36, the opportunity for publications has been rather limited.

ACTION PLAN & PROGRESS
M01-M09 (DONE): The social media accounts are set up.
M10-M36 (DONE): Regular tweets and articles are posted on the social media accounts.

4.4.2.7. E-newsletters

Electronic project newsletters, released on a quarter basis, enable the consortium to update the project community with latest project activities and results and to provide to relevant audience up-to-date information about the project (Figure 14). The newsletter are sent out to all relevant stakeholders beyond the project community through electronic means. They are also uploaded to the public project website.
As of June 30, 2023, 77 persons subscribed to the newsletter.

Figure 14: AQ-WATCH newsletter template

ACTION PLAN & PROGRESS
M01-M03 (DONE): A template for the project newsletters is developed.
M04-M36 (DONE): 3 newsletters have been issued. INEDEV leads the activity and the partners provide content for the newsletter and invite additional contacts to subscribe in the related mailing list in order to receive it regularly. Due to the lack of results available for dissemination, only 3 newsletters have been released so far. As soon as the modules are ready, dedicated newsletter will be prepared.

4.5. Preliminary Market Analysis and Exploitation Plan

4.5.1. Innovation Management Methodology

The successful delivery of an innovation depends on several parameters such as the market maturity, the stakeholders' acceptance, and the availability of the supporting infrastructure. Too often, product launches fail due to the lack of consideration for these aspects.
Consequently, bridging the well-known "Valley of Death" [8] (Figure 15) in the commercialization of EU research results can only be realized with holistic Innovation Management. This includes a combined strategy for the intellectual protection, the exploitation and dissemination of results throughout the whole project lifecycle.

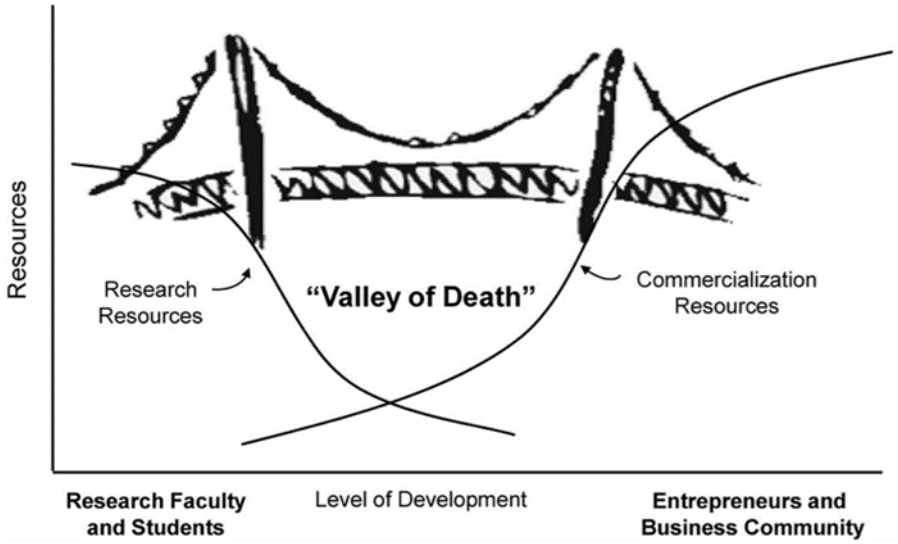


Figure 15: The valley of death

This holistic approach can not only meet the requirements of the grant agreement, but also respond to the nature of innovation management in collaborative research projects. In these projects, the management of innovation goes beyond the ownership of the research results, it must therefore also be able to reflect these results. The Figure 16 illustrates the main steps that make up the overall innovation management method and the expected results of each step. The following sections describe in detail the work carried out at each stage, the results of each stage, the conclusions and future work.

Figure 16: Innovation Management in Horizon2020 projects

The method combines the strategies of intellectual property management, data management, dissemination and use of results. It specifies the actions plan to manage the innovations and products generated during the project, and to ensure the proper acquisition, protection and use of intellectual property rights before and after the project.

The main activities are:

- the development of the Consortium Agreement,
- the development of an IP Registry and joint ownership agreements if needed,

- a data management plan,
- the Dissemination Management (taking into account the IP protection plan),
- the design of the exploitation pathway for the results including: a thorough market analysis, a communication & innovation delivery plan that will include the stakeholders and policy makers,
- a commercialization plan & actions to ensure future funding resources.

4.5.1.1. Innovation Management Tools

During the different phases of the exploitation plan elaboration, several tools for innovation management will support the work of the consortium. The table below presents the tools and the corresponding steps of the innovation management (IM) methodology.

Table 8: List of Innovation Management Tools

IM Templates & Tools	Steps of the IM methodology covered
IP Registry	I. Results table II. Ownership model for results and products III. IP strategy
Innovation Management Roadmap	IV. Dissemination plan V. Exploitation plan VI. Communication plan
Business Model Canvas	VII. Customer adoption plan VIII. Commercialisation planning IX. Reassessment of business plans

The business model for the AQ-WATCH package will be described in the D7.5 "Impact analysis, business models and value proposition". The current exploitation plan will be taken as basis for the business model development that will follow the CANVAS approach.

4.5.2. Key Exploitable Results (KER)

This section presents the overview of the Key Exploitable Results of the project and the partners who claim interest in exploiting them as of end of June 2023.

Table 9: Key Exploitable Results

KER No.	Key Exploitable result	Contributors	Exploited by	Potential exploitation form (patent, know-how, publication etc.)
KER 1	Global air quality atlas	CNRS, FMI	All partners involved in the AQ-WATCH partnership (see the chapters 4.5.10 & 4.5.11)	Demonstration of capacities to the future customers, Publications
KER 2	Regional air quality atlas for CONUS	UCAR	All partners involved in the AQ-WATCH partnership (see the chapters 4.5.10 & 4.5.11)	Demonstration of capacities to the future customers, Publications
KER3	Regional air quality atlas for Central Chile	UChile	All partners involved in the AQ-WATCH partnership (see the chapters 4.5.10 & 4.5.11)	Demonstration of capacities to the future customers, Publications

KER 4	Regional air quality atlas for Beijing-Tianjin-Hebei (BTH)	FMI, BMILP	All partners involved in the AQ-WATCH partnership (see the chapters 4.5.10 & 4.5.11)	Demonstration of capacities to the future customers, Publications
KER 5	Attribution and Mitigation tool for Colorado Northern Front Range	TNO, UCAR	All partners involved in the AQ-WATCH partnership (see the chapters 4.5.10 & 4.5.11)	Demonstration of capacities to the future customers, Publications
KER 6	Attribution and Mitigation tool for Santiago de Chile	TNO	All partners involved in the AQ-WATCH partnership (see the chapters 4.5.10 & 4.5.11)	Demonstration of capacities to the future customers, Publications
KER 7	Attribution and Mitigation tool for Xinhua district in Cangzhou	BMILP, BCC, TNO	All partners involved in the AQ-WATCH partnership (see the chapters 4.5.10 & 4.5.11)	Demonstration of capacities to the future customers, Publications
KER 8	Dust forecast for west coast of USA	BSC	All partners involved in the AQ-WATCH partnership (see the chapters 4.5.10 & 4.5.11)	Demonstration of capacities to the future customers, Publications
KER 9	Dust forecast for Chile	BSC	All partners involved in the AQ-WATCH partnership (see the chapters 4.5.10 & 4.5.11)	Demonstration of capacities to the future customers, Publications
KER 10	Dust forecast for the northern part of China	BSC	All partners involved in the AQ-WATCH partnership (see the chapters 4.5.10 & 4.5.11)	Demonstration of capacities to the future customers, Publications
KER 11	Fire forecast for Colorado	UCAR, FMI	All partners involved in the AQ-WATCH partnership (see the chapters 4.5.10 & 4.5.11)	Demonstration of capacities to the future customers, Publications
KER 12	Fire forecast for Chile	FMI	All partners involved in the AQ-WATCH partnership (see the chapters 4.5.10 & 4.5.11)	Demonstration of capacities to the future customers, Publications
KER 13	Fire forecast for the northern part of China	FMI	All partners involved in the AQ-WATCH partnership (see the chapters 4.5.10 & 4.5.11)	Demonstration of capacities to the future customers, Publications
KER 14	Source point analysis for fracking activities in Colorado Northern Front Range	UCAR	All partners involved in the AQ-WATCH partnership (see the chapters 4.5.10 & 4.5.11)	Demonstration of capacities to the future customers, Publications
KER 15	Air quality forecast for Colorado Northern Front Range	FMI, TNO, UCAR, MPG	All partners involved in the AQ-WATCH partnership (see the chapters 4.5.10 & 4.5.11)	Demonstration of capacities to the future customers, Publications
KER 16	Air quality forecast for Santiago de Chile	FMI, TNO, MPG, UChile	All partners involved in the AQ-WATCH partnership (see the chapters 4.5.10 & 4.5.11)	Demonstration of capacities to the future customers, Publications
KER 17	Air quality forecast for Beijing Urban Area and Beijing-Tianjin-Hebei region	FMI, TNO, BMILP, BCC, MPG	All partners involved in the AQ-WATCH partnership (see the chapters 4.5.10 & 4.5.11)	Demonstration of capacities to the future customers, Publications
KER 18	Mapping capacities	MapTiler	All partners involved in the AQ-WATCH partnership (see the chapters 4.5.10 & 4.5.11)	Demonstration of capacities to the future customers, Publications
KER 19	Web interface	All partners	All partners involved in the AQ-WATCH partnership (see the chapters 4.5.10 & 4.5.11)	Demonstration of capacities to the future customers, Publications

KER 20	Capacity to deliver joint high quality services	All partners	All partners involved in the AQ-WATCH partnership (see the chapters 4.5.10 & 4.5.11)	Provide commercial services (development of AQ monitoring and forecasting tools, consulting, training, etc.)

4.5.3. Intellectual Property Registry

To ensure the effective management of intellectual property (IP), a comprehensive IP registry has been prepared, as outlined in Table 9. The purpose of this table is to offer a user-friendly, concrete, and practical list of the IP utilized in the toolkit. It serves as a valuable resource for facilitating the commercial exploitation of the project's outcomes. By compiling this information in one place, stakeholders can easily identify and comprehend the IP assets critical to the successful commercialization of the project.

Each entry in the IP registry provides essential information about the corresponding IP, including its nature, scope, and ownership. This facilitates a clear understanding of the intellectual property landscape surrounding the project, enabling stakeholders to make informed decisions regarding its commercial potential.

Furthermore, the IP registry acts as a reference point for potential organizations who are interested in exploiting the project results. It provides a transparent and easily accessible overview of the intellectual property involved, fostering trust, facilitating negotiations, and streamlining the commercialization process.

The ownership rights are defined following the rule of the Article 26.1 of the Grant Agreement [5], Results are owned by the beneficiary that generates them and joint ownership is based on the rule of Article26.2 of the Grant Agreement [5]:

Article 26.1 "Ownership by the beneficiary that generates the results"
"Results are owned by the beneficiary that generates them. 'Results' means any (tangible or intangible) output of the action such as data, knowledge or information — whatever its form or nature, whether it can be protected or not — that is generated in the action, as well as any rights attached to it, including intellectual property rights.

Article 26.2 "Joint ownership by several beneficiaries"
Two or more beneficiaries own results jointly if:
(a) they have jointly generated them and
(b) it is not possible to: (i) establish the respective contribution of each beneficiary, or (ii) separate them for the purpose of applying for, obtaining or maintaining their protection (see Article 27).
The joint owners must agree (in writing) on the allocation and terms of exercise of their joint ownership ('joint ownership agreement'), to ensure compliance with their obligations under this Agreement.
Unless otherwise agreed in the joint ownership agreement, each joint owner may grant non-exclusive licences to third parties to exploit jointly-owned results (without any right to sub-license), if the other joint owners are given:
(a) at least 45 days advance notice and
(b) fair and reasonable compensation.

Once the results have been generated, joint owners may agree (in writing) to apply another regime than joint ownership (such as, for instance, transfer to a single owner (see Article 30) with access rights for the others).

Initially, the plan was to develop a toolkit intended for commercial exploitation, for example by Breezometer. However, due to Breezometer's departure from the consortium in late 2022, and considering that the toolkit created during the AQ-WATCH project will be publicly available solely for demonstration purposes, the emphasis has been rather put on the background IP needed to deliver similar services in other regions than to protect the foreground generated in the project.

Besides, considering that each new customer request will essentially become a distinct project, with varying datasets, models, interface requirements and background IP. The exploitable innovation from AQ-WATCH is the experience and the capacity to work together to deliver high level services in the field of air quality monitoring and forecasting where every organisation was formerly working on its own. For example, the project allowed the partner to realize the ensemble of several models.

However, the dataset and models used for the development of the toolkit prototype demonstration in the 3 regions considered and the associated background IP were identified in the table below. The objective is to identifying any IP-related barrier to the commercial exploitation of the solutions. However, it is important to note that these models and datasets won’t necessarily be the ones to be used for the future customer requests.

Table 10: Dataset and models used for the development of the toolkit prototype demonstration

Module	Product	Domain	Parameters/Resolution	Partner in charge	Right to use it for commercial activities
AQ Atlas (Global atlas)	CAMS reanalysis datasets	Global	PM1, PM2.5, PM10, NO2, SO2, CO, O3, OC & BC optical depth/ 80 km x 80 km	CNRS	Use of ECMWF open data is governed by the Creative Commons CC-4.0-BY licence (https://creativecommons.org/licenses/by/4.0/) and the ECMWF Terms of Use (https://www.ecmwf.int/en/terms-use). The Creative Commons CC-4.0-BY licence states that : *"You are free to:* • *Share — copy and redistribute the material in any medium or format* • *Adapt — remix, transform, and build upon the material* • *for any purpose, even commercially.* *Under the following terms:* • *Attribution — You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.* • *No additional restrictions — You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits."* Moreover, the License Agreement and Privacy Statement applying to CAMS services (https://atmosphere.copernicus.eu/sites/default/files/repository/CAMS_data_license.pdf) states the following: *"1.1 This License is free of charge, worldwide, non-exclusive, royalty free and perpetual.* *1.2 Access to CAMS Information is given for the purpose of the following use in so far as it is lawful:* *a) reproduction;* *b) distribution;* *c) communication to the public;* *d) adaptation, modification and combination with other data and information;* *e) any combination of points (a) to (d)."*
	Modis satellite datasets	Global	AOD/ 1° x 1°	FMI	The NASA Data and Information Policy of earth data managed (Data and Information Policy | Earthdata (nasa.gov) stipulates the following:

					"NASA promotes the full and open sharing of all data with the research and applications communities, private industry, academia, and the general public." Besides the FMI website (https://en.ilmatieteenlaitos.fi/open-data-licence) states the following: *"The Creative Commons Attribution 4.0 International license (CC BY 4.0) shall be used by the Finnish Meteorological Institute's open data service. The license shall apply to the FMI's, the Finnish Transport Agency's, and the Radiation and Nuclear Safety Authority's open data sets as well as air quality data sets that are stored in the open data web-service."* https://modis.gsfc.nasa.gov/
	OMI satellite datasets	Global	NO2 Tropospheric column/0.125° x 0.125°	CNRS	OMI, the website says: "*The data are not copyrighted and are open to all for both commercial and non-commercial uses. If you used TEMIS NO2 data for a publication (research or otherwise), or for any other purpose, please refer to the reference page*" https://www.temis.nl/airpollution/no2.php
AQ Atlas (Regional atlas)	WRF-Chem reanalysis dataset	CONUS	AQI, NO2, SO2, CO, O3 (MDA8), PM2.5 & PM10/ 12 km x 12 km	UCAR	Extract of the "Terms of use for UCAR data repositories" (https://www.ucar.edu/terms-of-use/data) *"To the extent that any materials published in a UCAR data repository are protected by copyright, you are hereby granted a license to use such material, unless otherwise stated, subject to the terms and conditions of the Creative Commons Attribution 4.0 International license (https://creativecommons.org/licenses/by/4.0/legalcode). To the extent that any materials published in a UCAR data repository are not protected by copyright, you are hereby granted permission to use such materials for any lawful purpose. When using any materials obtained from a UCAR data repository, you agree to use the recommended data citation format provided by that UCAR data repository."* https://www2.mmm.ucar.edu/wrf/users/download/get_sources_new.php
	MarcoPolo-Panda dataset	Eastern China	AQI, NO2, SO2, CO, O3 (MDA8), PM2.5 & PM10/ 0.125° x 0.125	FMI	The results of the MarcoPolo-Panda projects are governed by the Creative Commons Attribution 4.0 International (https://creativecommons.org/licenses/by/4.0/legalcode) that allow commercial use. https://zenodo.org/record/1205329
	WRF-CHIMERE dataset	South- Central Chile	AQI, NO2, SO2, CO, O3 (MDA8), PM2.5 & PM10/ 0.1ºx0.1º	UChile	Can you please add a few words about the right to use the dataset for commercial purpose? Please add a link to the reference webpage or document.

AQ mitigation	LOTOS-EUROS source attribution	Colorado	NO2, SO2, PM2.5 & PM10 (16 country/ 13 sector contributions)/ 0.1o x 0.05o (Colorado) or 0.05o x 0.025o (Chile) PM2.5 (16 country/ 13 Sector contributions)/ 0.1o x 0.05o	TNO	Extract from the website (https://airqualitymodeling.tno.nl/lotos-euros/open-source-version/): *"It is our belief that a model is improved when more people use and develop it. In line with this vision, LOTOS-EUROS has been made available without charge in an open-source version. This open-source version is based on LOTOS-EUROS v2.0 and contains all functionality described in the v2.0 Reference Guide"* TNO has no profit motive, but focuses on people and the environment. The part of LOTOS-EUROS for which version control has been established is available as open source software on request. For scientific or societal purposes, use is encouraged. For commercial exploiters, a contract will be negotiated on a case-by-case basis, with societal benefit and the likelihood of further development by TNO having a favorable effect on any usage costs. The attribution and mitigation modules and data from them are not part of the open source code, but any use is encouraged if it contributes to clean air for all. TNO is happy to adapt and optimize the products fit for purpose.
	LOTOS-EUROS source attribution	Region around Santiago de Chile	NO2, SO2, PM2.5 & PM10 (20 country/ 13 sector contributions)/ 0.05o x 0.025o PM2.5 (20 country/ 13 sector contributions)/ 0.05o x 0.025o	TNO	Extract from the website (https://airqualitymodeling.tno.nl/lotos-euros/open-source-version/): *"It is our belief that a model is improved when more people use and develop it. In line with this vision, LOTOS-EUROS has been made available without charge in an open-source version. This open-source version is based on LOTOS-EUROS v2.0 and contains all functionality described in the v2.0 Reference Guide"* TNO has no profit motive, but focuses on people and the environment. The part of LOTOS-EUROS for which version control has been established is available as open source software on request. For scientific or societal purposes, use is encouraged. For commercial exploiters, a contract will be negotiated on a case-by-case basis, with societal benefit and the likelihood of further development by TNO having a favorable effect on any usage costs. The attribution and mitigation modules and data from them are not part of the open source code, but any use is encouraged if it contributes to clean air for all. TNO is happy to adapt and optimize the products fit for purpose.
	WRF-Chem source attribution & mitigation	Colorado	CO (5 sector contributions)/ 4 km x 4 km	UCAR	Extract of the "Terms of use for UCAR data repositories" (https://www.ucar.edu/terms-of-use/data) *"To the extent that any materials published in a UCAR data repository are protected by copyright, you are hereby granted a license to use such material, unless otherwise stated, subject to the terms and conditions of the Creative Commons Attribution 4.0*

					International license (https://creativecommons.org/licenses/by/4.0/legalcode). To the extent that any materials published in a UCAR data repository are not protected by copyright, you are hereby granted permission to use such materials for any lawful purpose. When using any materials obtained from a UCAR data repository, you agree to use the recommended data citation format provided by that UCAR data repository." https://www2.mmm.ucar.edu/wrf/users/download/get_sources_new.php
Dust & Fire forecasts (dust forecasts)	Multimodel dust forecast ensemble (mean of CAMS, SILAM & MONARCH)	Western US, Northern China, Central Chile	AOD, PM2.5, PM10, Dust wet & dry deposition, Total dust column, surface extinction, DNI, GHI/ 0.2o x 0.2o	BSC	No restriction identified for the use of CAMS products (see above), SILAM (see below) nor MONARCH (see the GNU general public license https://earth.bsc.es/gitlab/es/monarch/-/blob/production/LICENSE).
Dust & Fires forecasts (Fires forecast)	IS4FIRES fire forecast	Colorado, Northern China, Central Chile	AOD fires, PM2.5 fires/ 0.2o x 0.2o	FMI	Extract from the FMI website (https://en.ilmatieteenlaitos.fi/open-data-licence): *"The Creative Commons Attribution 4.0 International license (CC BY 4.0) shall be used by the Finnish Meteorological Institute's open data service. The license shall apply to the FMI's, the Finnish Transport Agency's, and the Radiation and Nuclear Safety Authority's open data sets as well as air quality data sets that are stored in the open data web-service."* http://is4fires.fmi.fi/
	WRF-Chem forecast	CONUS	CO fire, CO fire emissions/ 12 km x 12 km	UCAR	Link: https://www.acom.ucar.edu/firex-aq/forecast.shtml & https://www2.mmm.ucar.edu/wrf/users/download/get_sources_new.php Extract of the "Terms of use for UCAR data repositories" (https://www.ucar.edu/terms-of-use/data) *"To the extent that any materials published in a UCAR data repository are protected by copyright, you are hereby granted a license to use such material, unless otherwise stated, subject to the terms and conditions of the Creative Commons Attribution 4.0 International license (https://creativecommons.org/licenses/by/4.0/legalcode). To the extent that any materials published in a UCAR data repository are not protected by copyright, you are hereby granted permission to use such materials for any lawful purpose. When using any materials obtained from a UCAR data repository, you agree to use the recommended data citation format provided by that UCAR data repository."*

Source point analysis	FRAPPE WRF-CMAQ model simulation	Colorado	NO2 (24h), O3 (MDA8), Toluene (24h), NOx (24h), Propane (24h), HCHO (24h), Ethane (24h), Ethane emission (24h), Benzene (24h)/ 4 km x 4 km	UCAR	Extract of the "Terms of use for UCAR data repositories" (https://www.ucar.edu/terms-of-use/data) *"To the extent that any materials published in a UCAR data repository are protected by copyright, you are hereby granted a license to use such material, unless otherwise stated, subject to the terms and conditions of the Creative Commons Attribution 4.0 International license (https://creativecommons.org/licenses/by/4.0/legalcode). To the extent that any materials published in a UCAR data repository are not protected by copyright, you are hereby granted permission to use such materials for any lawful purpose. When using any materials obtained from a UCAR data repository, you agree to use the recommended data citation format provided by that UCAR data repository."* https://www2.acom.ucar.edu/frappe (model output available on request)
AQ forecasts (Colorado)	SILAM forecast	Colorado Northern Front Range, CONUS	PM2.5, PM10, CO, O3, NO2 and SO2 / 0.2o x 0.2o	FMI	Extract from the FMI website (https://en.ilmatieteenlaitos.fi/open-data-licence): *"The Creative Commons Attribution 4.0 International license (CC BY 4.0) shall be used by the Finnish Meteorological Institute's open data service. The license shall apply to the FMI's, the Finnish Transport Agency's, and the Radiation and Nuclear Safety Authority's open data sets as well as air quality data sets that are stored in the open data web-service."* http://silam.fmi.fi/
	LOTOS-EUROS forecast	Colorado Northern Front Range, CONUS	PM2.5, PM10, CO, O3, NO2 and SO2 / 0.1o x 0.05o	TNO	Extract from the website (https://airqualitymodeling.tno.nl/lotos-euros/open-source-version/): *"It is our belief that a model is improved when more people use and develop it. In line with this vision, LOTOS-EUROS has been made available without charge in an open-source version. This open-source version is based on LOTOS-EUROS v2.0 and contains all functionality described in the v2.0 Reference Guide"* TNO has no profit motive, but focuses on people and the environment. The part of LOTOS-EUROS for which version control has been established is available as open source software on request. For scientific or societal purposes, use is encouraged. For commercial exploiters, a contract will be negotiated on a case-by-case basis, with societal benefit and the likelihood of further development by TNO having a favorable effect on any usage costs..
	WRF-Chem forecast	Colorado Northern Front Range, CONUS	PM2.5, PM10, CO, O3, NO2 and SO2 / 4 km x 4 km	UCAR	Extract of the "Terms of use for UCAR data repositories" (https://www.ucar.edu/terms-of-use/data) *"To the extent that any materials published in a UCAR data repository are protected by copyright, you are hereby granted a license to use such material, unless otherwise stated,*

					subject to the terms and conditions of the Creative Commons Attribution 4.0 International license (https://creativecommons.org/licenses/by/4.0/legalcode). To the extent that any materials published in a UCAR data repository are not protected by copyright, you are hereby granted permission to use such materials for any lawful purpose. When using any materials obtained from a UCAR data repository, you agree to use the recommended data citation format provided by that UCAR data repository." https://www2.mmm.ucar.edu/wrf/users/download/get_sources_new.php
	Observation data from AirNow network (for model comparison)	Colorado Northern Front Range, CONUS	PM2.5, PM10, CO, O3, NO2 and SO2 /-	MPG	The US EPA AirNow data are publicly available via https://www.airnow.gov/ & https://www.epa.gov/outdoor-air-quality-data Extract from the EPA FAQ (https://www.epa.gov/outdoor-air-quality-data/do-i-need-request-permission-use-monitoring-data-and-graphics-airdata): *"The ambient monitoring data in EPA's Air Quality System (AQS) are public domain. You are welcome to download the data and use freely, without submitting a request."* Extract from the EPA Disclaimers (https://www.epa.gov/web-policies-and-procedures/epa-disclaimers) : *"Copyright Status: The U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce these documents, or allow others to do so, for U.S. Government purposes. These documents may be freely distributed and used for non-commercial, scientific and educational purposes. Commercial use of the documents available from the EPA websites may be protected under the U.S. and Foreign Copyright Laws. Individual documents on the EPA website may have different copyright conditions, and that will be noted in those documents."*
AQ forecasts (Chile)	SILAM forecast	Region around Santiago, Chile	PM2.5, PM10, CO, O3, NO2 and SO2 / 0.2o x 0.2o	FMI	Extract from the FMI website (https://en.ilmatieteenlaitos.fi/open-data-licence): *"The Creative Commons Attribution 4.0 International license (CC BY 4.0) shall be used by the Finnish Meteorological Institute's open data service. The license shall apply to the FMI's, the Finnish Transport Agency's, and the Radiation and Nuclear Safety Authority's open data sets as well as air quality data sets that are stored in the open data web-service."* http://silam.fmi.fi/
	LOTOS-EUROS forecast	Region around Santiago, Chile	PM2.5, PM10, CO, O3, NO2 and SO2 / 0.05o x 0.025o	TNO	Extract from the website (https://airqualitymodeling.tno.nl/lotos-euros/open-source-version/): *"It is our belief that a model is improved when more people use and develop it. In line with this vision, LOTOS-EUROS has been made available without charge in an open-*

					source version. This open-source version is based on LOTOS-EUROS v2.0 and contains all functionality described in the v2.0 Reference Guide" TNO has no profit motive, but focuses on people and the environment. The part of LOTOS-EUROS for which version control has been established is available as open source software on request. For scientific or societal purposes, use is encouraged. For commercial exploiters, a contract will be negotiated on a case-by-case basis, with societal benefit and the likelihood of further development by TNO having a favorable effect on any usage costs.
	WRF-Chem-MPIM forecast	Region around Santiago, Chile	PM2.5, PM10, CO, O3, NO2 and SO2 / 10 km x 10 km	MPG	The MPI-M WRF-Chem version is based on Deroubaix et al. (2022) (https://doi.org/10.5194/egusphere-egu22-11591). Please contact the MPI-M team for the request of usage of model outputs from the MPI-M WRF-Chem forecasts.
	WRF-Chimere-UChile forecast	Region around Santiago, Chile	PM2.5, PM10, CO, O3, NO2 and SO2 / 10 km x 10 km	UChile	Can you please add a few words about the right to use the dataset for commercial purpose? Please add a link to the reference webpage or document.
	Observation data from SINCA network (for model comparison)	Region around Santiago, Chile	PM2.5, PM10, CO, O3, NO2 and SO2 /-	MPG	The observation data form the SINCA network can be obtained publicly from the SINCA website: https://sinca.mma.gob.cl/index.php/
AQ forecasts (China)	SILAM-MarcoPolo-Panda forecast	BTH region, China	PM2.5, PM10, CO, O3, NO2 and SO2 / 0.125o x 0.125o	FMI	Extract from the FMI website (https://en.ilmatieteenlaitos.fi/open-data-licence): *"The Creative Commons Attribution 4.0 International license (CC BY 4.0) shall be used by the Finnish Meteorological Institute's open data service. The license shall apply to the FMI's, the Finnish Transport Agency's, and the Radiation and Nuclear Safety Authority's open data sets as well as air quality data sets that are stored in the open data web-service."* http://silam.fmi.fi/
	LOTOS-EUROS-MarcoPolo-Panda forecast	BTH region, China	PM2.5, PM10, CO, O3, NO2 and SO2 / 0.25o x 0.25o	TNO	Extract from the website (https://airqualitymodeling.tno.nl/lotos-euros/open-source-version/): *"It is our belief that a model is improved when more people use and develop it. In line with this vision, LOTOS-EUROS has been made available without charge in an open-source version. This open-source version is based on LOTOS-EUROS v2.0 and contains all functionality described in the v2.0 Reference Guide"*

					TNO has no profit motive, but focuses on people and the environment. The part of LOTOS-EUROS for which version control has been established is available as open source software on request. For scientific or societal purposes, use is encouraged. For commercial exploiters, a contract will be negotiated on a case-by-case basis, with societal benefit and the likelihood of further development by TNO having a favorable effect on any usage costs.
	WRF-Chimere-IUSE forecast	BTH region, China	PM2.5, PM10, CO, O3, NO2 and SO2 / 2 km x 2 km	BMILP	Can you please add a few words about the right to use the dataset for commercial purpose? Please add a link to the reference webpage or document.
	Observation data from CNEMC network (for model comparison)	BTH region, China	PM2.5, PM10, CO, O3, NO2 and SO2 /-	MPG	The near-real time air quality monitoring data in Beijing and the BTH region can be downloaded from the IQAir World air quality website: https://www.iqair.com/world-air-quality. The IQAir site terms of condition (https://www.iqair.com/legal/terms-conditions) precises the following: *"Without limitation to the generality of the foregoing, we specifically prohibit the following:* - *using this Site or any IQAir Content other than for your own internal business or personal use strictly in accordance with these Terms of Use and our Terms of Sale"* The data being used for model comparison, it enters under the internal business category.

In conclusion, after careful analysis, it has been determined that there are no identifiable intellectual property (IP) barriers that would impede the partners from developing similar tools for other commercial requests. With regards to the specific issue of IP barriers, the partners can confidently proceed with developing similar tools for other commercial requests without any identified impediments.

4.5.4. Products and Services identification

The requirements of AQ-WATCH products and services are based on discussion among project partners and the identification of the prime users' needs done in the WP1 through a set of meetings. In addition, the analysis of the market trends has been taken under consideration, trying to anticipate or somewhat predict the market characteristics by the time the project is completed.

The first analysis is the natural and most obvious one and stems from each partner's understanding of its own business domain and associated competitors, as well as the holistic view of the market and an understanding of the current customer segmentation in relation to what AQ-WATCH is trying to achieve and develop, in terms of product and services.

The second analysis is more ambitious as it tries to capture the trends of the market over the coming years, challenging -to the extent possible- the current view of the market and specifically the view of the market.

Since the technology and the layout of some of these products has clear similarities, the consortium decided to combine some of these products in the format of modules as shown in Figure 17. Requirements for each of the products and modules are described in detail in Deliverable 5.1. The prototypes are described in detail in Deliverable 5.2.

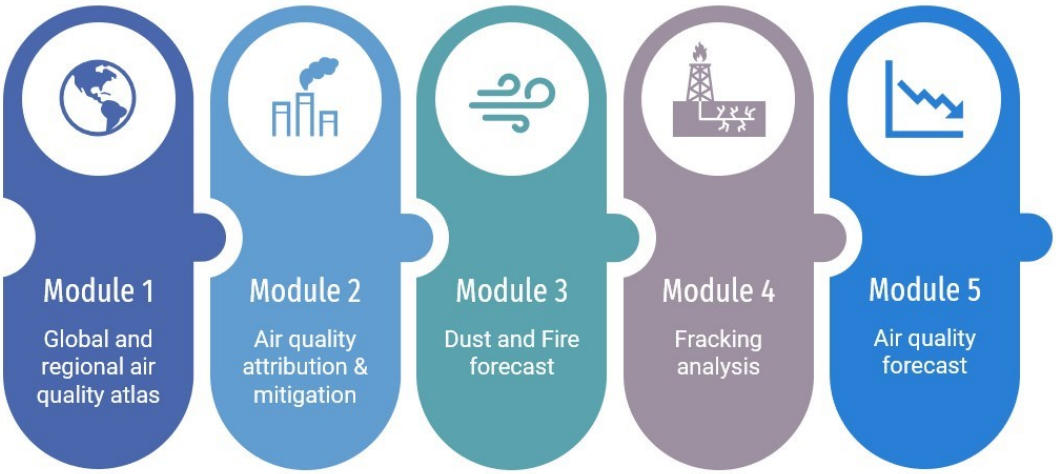


Figure 17: The 5 modules of products

4.5.4.1. Module 1 – Global and regional air quality atlas

What does this module do?

The module 1 presents the Global and Regional Air Quality Atlases. It allows users to easily understand the air quality and its change over time in different areas in their country or region. This will help policymakers and local authorities to take informed decisions to improve air quality, provide NGOs with necessary information to act, and grant researchers and students easy access to global and regional air quality data.

It includes global and regional atlases of individual air pollutants, graphical and numerical information on the regional climatology of air pollutants based on the Copernicus CAMS model global reanalysis and regional reanalyses for three regions, the Contiguous United States (CONUS), Chile and China, as well as satellite information on AOD and NO2.

Who this module is designed for?

☒ Public authorities & Municipalities
☒ Research centres
☐ Impacted industries (e.g.: solar plant and electricity grid operators, health industry…)
☒ Emitting Industries (e.g.: Fracking)
☐ Emergency services
☐ Airports and flight control authorities
☐ Citizens

Geographical coverage (Figure 18)

For the global atlas, all countries of the world in addition to states/provinces for the largest countries (USA, Canada, Russia, China and India).

For the regional atlas, central and southern Chile (Chile), CONUS area (USA) and China will be available and other regions may be developed afterwards depending on the demand.

Figure 18: Geographical coverage of the module 1 - CONUS, Chile, China

Layout of the module (Figure 19)

In the topmost part **(A),** the user can choose between the Global and the Regional Atlas, select the country and target city or region, the data type and the time frame and resolution. The atlases both consist of a map **(B)** with zooming capability for each of the pollutants, a time series and statistical analysis tools. In the Global Atlas, air quality maps of the entire world at 80 km grid resolution are shown based on historical Copernicus Atmosphere Monitoring Service (CAMS) reanalysis data, NO2 column integrated data from the satellite-based Ozone Monitoring Instrument (OMI) and aerosol optical depth (AOD) from the Moderate Resolution Imaging Spectroradiometer (MODIS).

The Regional Atlas allows the user to understand and research historical and current air pollutants in a specific area. It is based on modelling data from the WRF-Chem and SILAM models, and satellite-based observations of NO2 from OMI and the TROPOspheric Monitoring Instrument (TROPOMI) and AOD from MODIS.

Below the map **(C)**, the user can choose between a statistical summary at country level or from a manually selected area. Depending on the selection, in **(D)** a summary (mean, standard deviation and total relative change within the chosen time frame) and in **(E)** a time series for each pollutant are shown below, averaged either for the selected country or the area selected on the map.

If the Country Data tab was selected above, the next plot allows the user to relate air quality data to demographic data over time for different pollutants and different demographic variables such as gross domestic product or population density for the selected country **(F)**.

The last plot **(G)** sets the selected country in relation to other countries. A time series of the relative change of each pollutant since the beginning of the chosen time frame is shown. On the right side, an overview of the total change since the beginning of the chosen time frame until the end is shown for the selected country and a list of other countries.

If the Surface Data tab was chosen, polygons can be drawn on the map in **(B)**. The Pollutant Summary graph **(D)** below shows then the overview of all pollutants for the selected area (mean, standard deviation and total relative change within the chosen time frame), the Pollutants Time Series graph **(E)** shows the absolute levels of each pollutant with time in the selected area and the Pollutants Change over Time graph **(G)** shows the relative levels with time for each pollutant in the selected area.

The data can be exported by clicking on the Export Data button **(H)** on the bottom of the page.

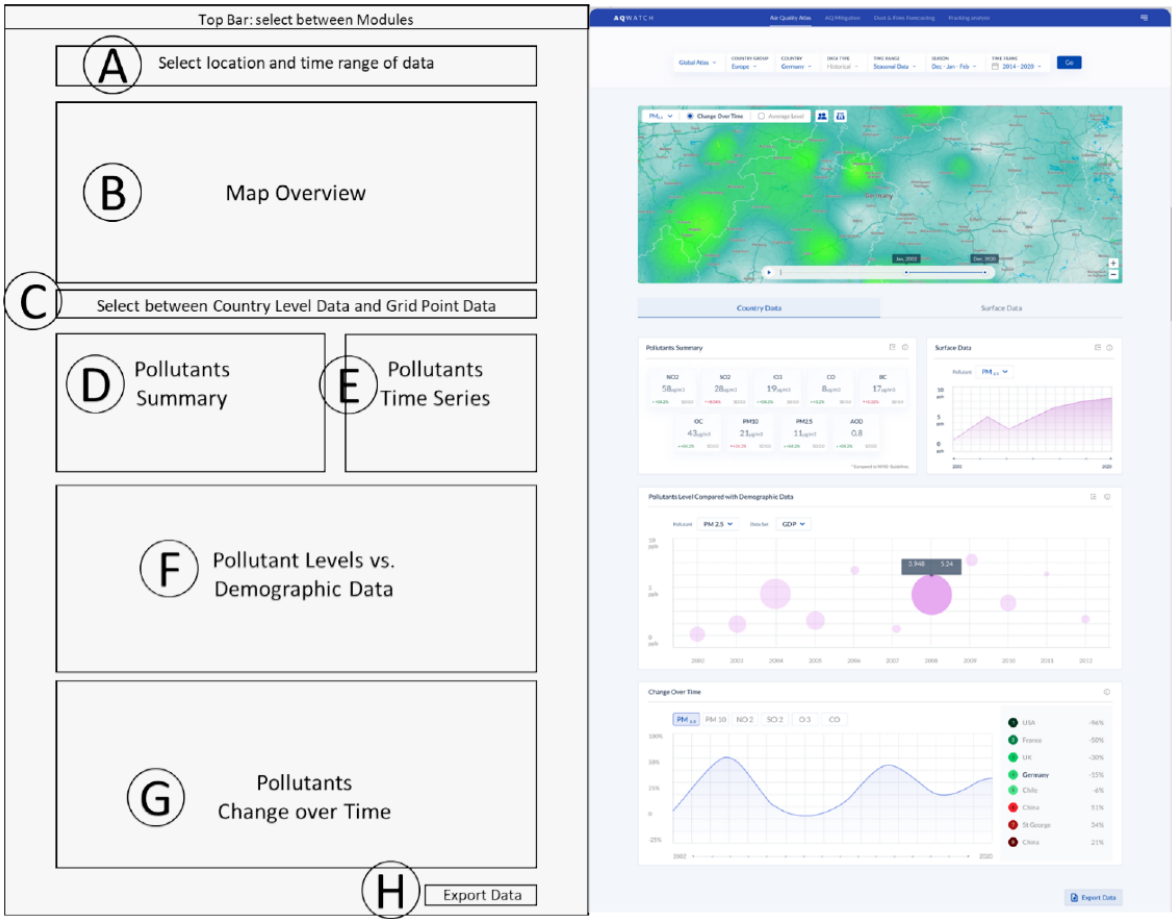


Figure 19: Layout of the module 1

Value-chain (Figure 20)

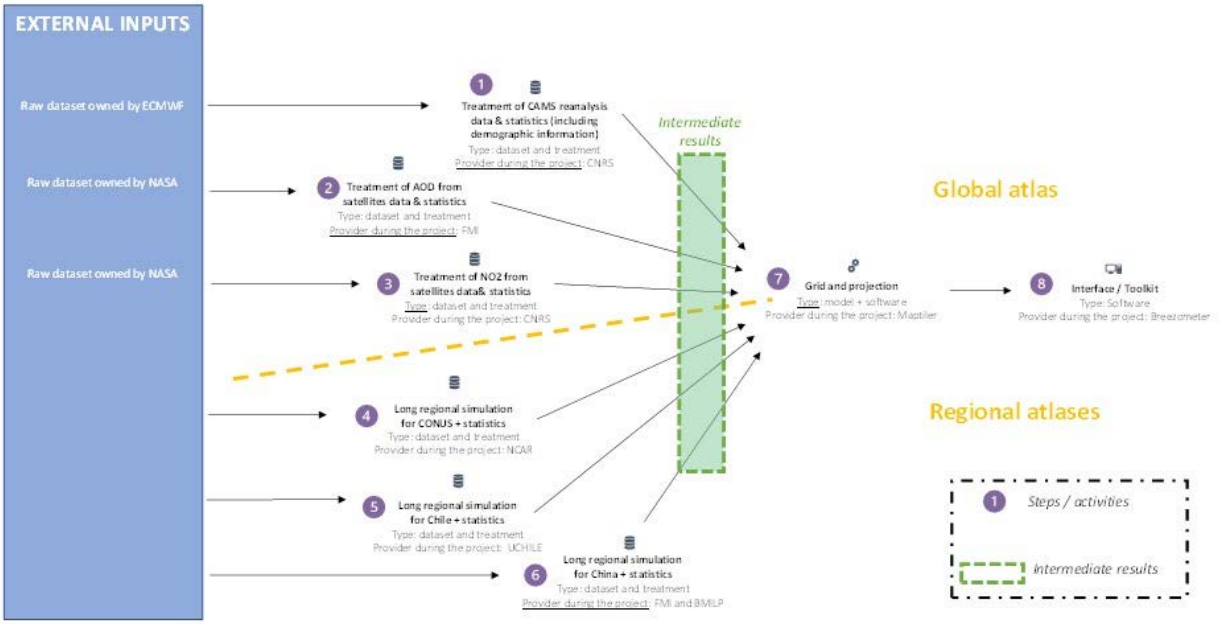


Figure 20: Module 1 – Value-chain (during the project)

What is the added-value of the module?

An atlas of historical atmospheric pollutants concentrations would be useful for public authorities in several ways:

- **Data Analysis and Trends**: The atlas provides a comprehensive collection of historical data on atmospheric pollutant concentrations. Public authorities can analyze this data to identify long-term trends and patterns in air pollution. It helps them understand the historical context of air quality and assess changes over time. This information is valuable for policy evaluation, identifying hotspots, and targeting areas where pollution reduction efforts are needed.
- **Policy Development:** The historical data presented in the atlas can inform the development of air quality management policies and regulations. By analyzing past pollutant concentrations and their sources, authorities can identify key contributors to air pollution and design targeted measures to address those sources effectively. The atlas provides a basis for evidence-based decision-making and allows authorities to set realistic air quality goals and develop strategies to achieve them.
- **Environmental Impact Assessment:** Public authorities often conduct environmental impact assessments (EIAs) for proposed development projects or policy changes. An atlas of historical atmospheric pollutants concentrations can serve as a valuable reference during EIAs. It helps authorities assess the potential impacts of new projects or policies on air quality by comparing historical data with predicted changes. This supports informed decision-making and ensures that new developments are in line with air quality objectives.
- **Public Awareness and Education:** The atlas can be used to raise public awareness about air pollution and its historical trends. Public authorities can share this information with the general public through educational campaigns, websites, and public outreach initiatives. By illustrating the historical impact of pollution on air quality, authorities can encourage individuals and communities to take actions to reduce pollution, promote behavioral changes, and support public engagement in air quality improvement efforts.
- **International Comparisons:** An atlas of historical atmospheric pollutants concentrations allows public authorities to compare air quality trends and pollution levels with other regions or countries. Such comparisons help identify best practices, benchmark performance, and learn from successful approaches implemented elsewhere. It supports international collaboration and facilitates the exchange of knowledge and experiences in air quality management.
- **Research and Scientific Studies:** The atlas serves as a valuable resource for researchers and scientists conducting studies on air pollution and its impacts. It provides a comprehensive dataset for analyses, modelling, and validation of air quality models. Researchers can use the historical data to investigate long-term trends, assess the effectiveness of previous interventions, and contribute to the scientific understanding of air pollution dynamics.

Overall, an atlas of historical atmospheric pollutants concentrations provides public authorities with essential data and insights for policy development, environmental impact assessments, public awareness campaigns, international comparisons, research, and informed decision-making. It supports evidence-based approaches to air quality management and facilitates targeted actions to improve air quality and protect public health.

4.5.4.2. Module 2 – Air quality attribution & mitigation

What does this module do?

The purpose of this module is to provide information on various sources of air pollution and simulate potential changes in air quality in response to proposed mitigation strategies.

It allows the user to reduce the emissions of one type of pollution source and demonstrates the effect on the pollution levels in the area. Furthermore, it provides attribution information of air pollution in regard to different sectors (e.g. agriculture, traffic, industry) and to different regional origins (e.g. countries or states, local versus transboundary), allowing more informed decisions on an air pollution mitigation strategy.

It includes two products as support for air quality policy: The product #6 providing information on the attribution of emission sources for different regions and economic sectors with emphasis on the role of agricultural emissions and the product #7 allowing the assessment of the efficiency of alternative actions to mitigate air pollution as well as the development of effective strategy options for air pollution abatement.

Who this module is designed for?

☒ Public authorities & Municipalities
☒ Research centres
☐ Impacted industries (e.g.: solar plant and electricity grid operators, health industry…)
☒ Emitting Industries (e.g.: Fracking)
☐ Emergency services
☐ Airports and flight control authorities
☒ Citizens

Geographical coverage (Figure 21)

Beijing (China), Colorado (USA), Santiago de Chile (Chile) will be available at the end of the project.

Other regions may be developed afterwards depending on the demand.

Figure 21: Geographical coverage of the module 2 - Colorado, Beijing, Santiago de Chile

Layout of the module (Figure 22)

In the upper most part **(A)** of the module the user can choose the location (Santiago de Chile, Chile; Colorado, USA; Beijing, China). Below, a map **(C)** shows the current level for a chosen pollutant or the change over time. On the panel left of the map **(B)**, the user can individually reduce different emission sources (agriculture, traffic, combustion etc.). The resulting pollution levels are then displayed on the map. After that, the user can choose a location on the map and the following graphs below show the results for that location. Directly below the pollutant map, a time series **(D)** shows the actual concentrations as well as the simulated concentrations if the pollution source is reduced on the panel next to the map. When hovering over the lines in **(D)**, a popup appears summarizing the mitigated pollutant concentrations at a certain moment in time. The "Country/Region Contribution" panel (E) indicates the contribution by various regions/countries to the concentration level of the selected pollutant at the chosen location:

- Santiago de Chile: PM, NO2 (+ possibly at a later stage SO2/ health index): Santiago, Chile, all South American countries separately, Intercontinental (from outside South America)
- Front Range, Colorado: PM, NO2 (+ possibly at a later stage SO2/ health index): Colorado, neighbouring states, other US, Canada, Mexico, other
- Front Range, Colorado CO: U.S. anthropogenic sources, U.S. biomass burning, non-U.S. fires, non-U.S.total, CO transported from Asia.

Hereby, the health indices will follow the definition of the respective countries.

The “Sector Contribution” panel (F) shows the source contribution by sector for the chosen pollutant. The contribution of the following sectors will be shown:

- Santiago and Colorado (for PM and NO2): Agriculture, residential combustion, road traffic, non-road traffic, power plants, industry, mining and extraction, wildfires, marine, dust, boundary
- Front Range Colorado (CO only): Anthropogenic, fires, chemical, boundary, boundary fires
- Beijing (PM, O3, NO2): Traffic, Industry, Residential.

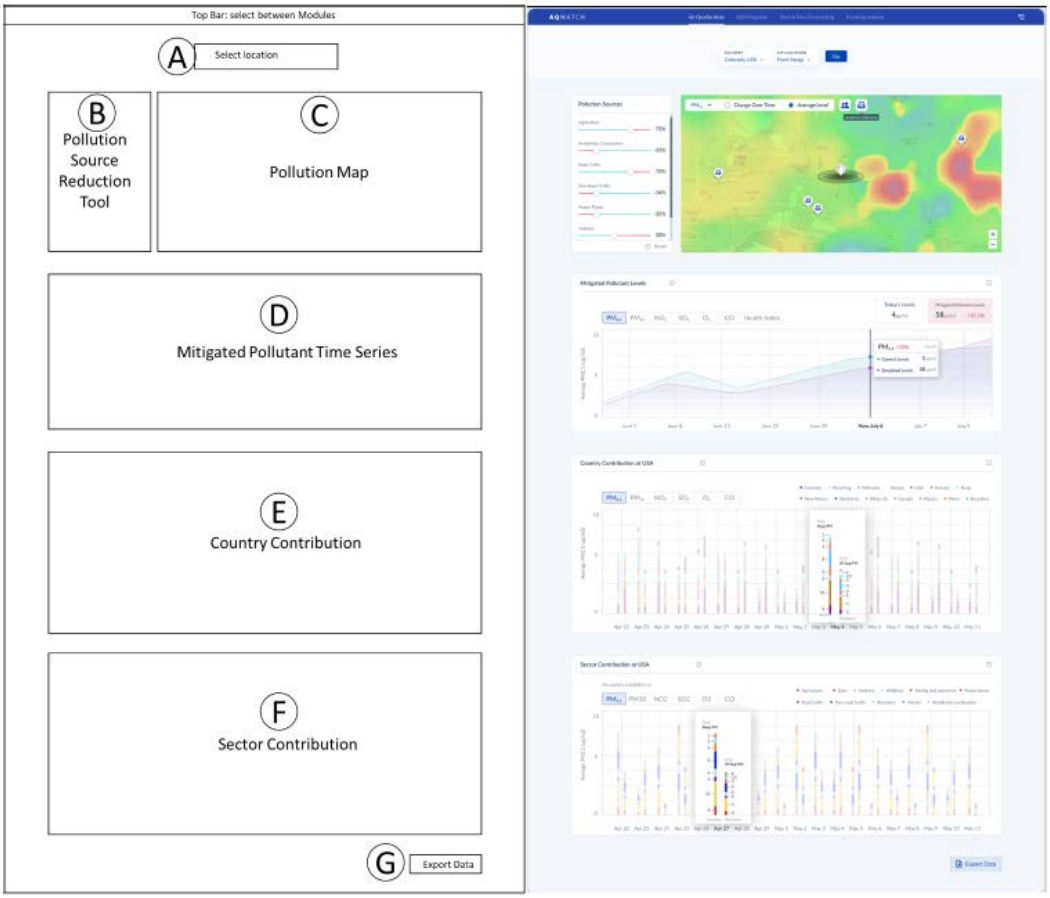


Figure 22: Layout of the module 2

Value-chain (Figure 23)

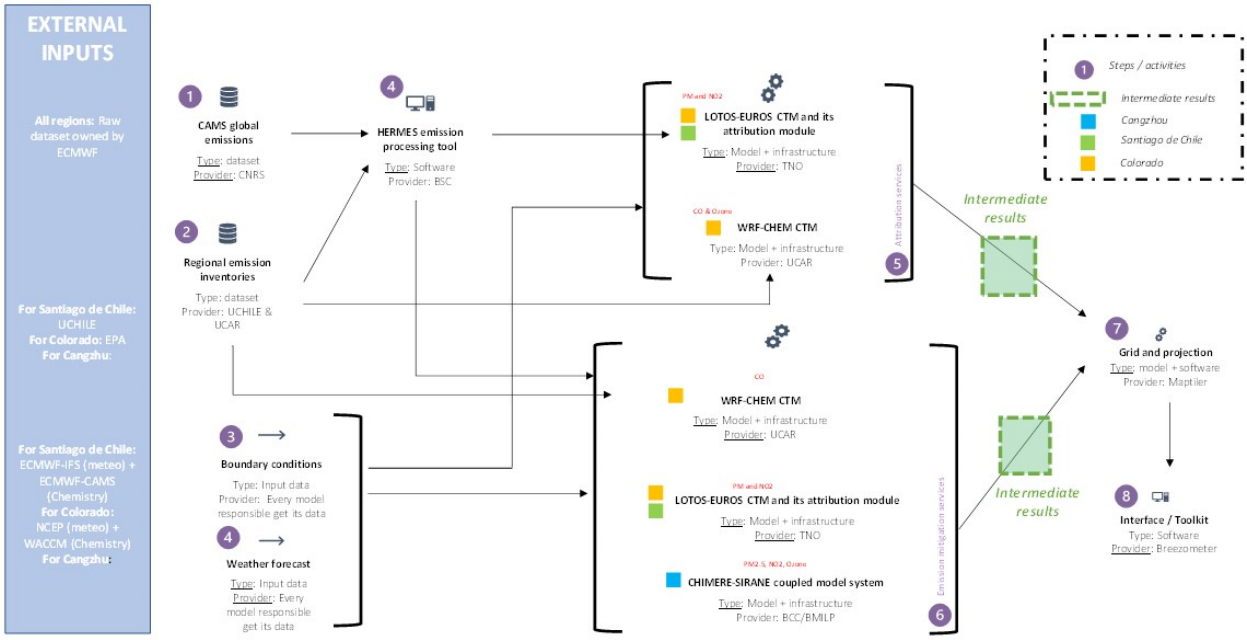


Figure 23: Module 2 – Value-chain (during the project)

Table 11: Module 2 – Matrix Domains/Pollutants

ATTRIBUTION SERVICE			
	Colorado	Santiago de Chile	Cangzhu
PM	LOTOS-EUROS	LOTOS-EUROS	n.a.
NO2	LOTOS-EUROS	LOTOS-EUROS	n.a.
CO	WRF-CHEM	n.a.	n.a.
O3	tbc	n.a.	n.a.
EMISSION MITIGATION SERVICE			
	Colorado	**Santiago de Chile**	**Cangzhu**
PM	LOTOS-EUROS	LOTOS-EUROS	CHIMERE-SIRANE coupled model system
NO2	LOTOS-EUROS	LOTOS-EUROS	CHIMERE-SIRANE coupled model system
CO	WRF-CHEM	n.a.	n.a.

What is the added-value of the module?

Source apportionment of atmospheric pollutants is useful in several ways:

- **Identifying Pollution Sources:** Source apportionment helps public authorities determine the major contributors to air pollution in a specific region or area. It provides insights into the different sources of pollutants, such as industrial emissions, vehicle exhaust, biomass burning, or natural sources. This information is crucial for understanding the root causes of pollution and designing targeted measures to reduce emissions from specific sources.
  Besides my understanding which activities are the major contributors, industries can focus their efforts on optimizing those processes or implementing targeted emission

reduction measures. This knowledge enables them to allocate resources effectively and prioritize pollution control efforts.

- **Policy Development and Implementation:** By identifying the sources responsible for a significant portion of pollution, public authorities can develop and implement effective policies and regulations. Source apportionment data allows authorities to prioritize their efforts, focusing on the most significant pollution sources to achieve the greatest impact. It supports the development of tailored strategies and control measures, such as emission standards, technology upgrades, or industry-specific regulations.
- **Compliance with Regulations:** Source apportionment data allows emitting industries to assess their compliance with air quality regulations. By identifying the sources responsible for a significant portion of pollution, industries can compare their emissions with regulatory standards and take necessary actions to ensure compliance. It helps them understand which pollutants and sources need closer attention and facilitates adjustments to meet the required emission limits.
- **Targeted Mitigation Measures:** Source apportionment helps public authorities implement targeted and cost-effective mitigation measures. By understanding the relative contribution of different pollution sources, authorities can allocate resources efficiently and implement measures that address the specific sources responsible for the majority of pollutants. This approach ensures that mitigation efforts are directed where they will have the most significant impact on air quality improvement.
- **Stakeholder Engagement and Collaboration:** Source apportionment provides valuable information for engaging stakeholders and fostering collaboration. By sharing the results with industries, transportation agencies, and other relevant stakeholders, authorities can raise awareness about pollution sources and collaborate on finding solutions. Engaging stakeholders in the decision-making process and involving them in implementing source-specific control measures enhances the effectiveness and acceptance of pollution reduction efforts.
- **Compliance and Enforcement:** Source apportionment data helps public authorities enforce compliance with air quality regulations. By identifying the major contributors to pollution, authorities can monitor and regulate the emissions from these sources more effectively. It enables targeted inspections, emissions monitoring, and enforcement actions, ensuring that industries and other pollution sources adhere to the prescribed standards and regulations.
- **Evaluation of Policy Effectiveness:** Source apportionment provides a basis for evaluating the effectiveness of implemented policies and measures. Authorities can compare subsequent source apportionment results to assess whether targeted actions have led to a reduction in emissions from identified pollution sources. This feedback loop allows authorities to refine policies, adjust strategies, and continuously improve air quality management efforts.

By utilizing source apportionment techniques, public authorities gain valuable insights into the specific sources of pollution, enabling them to develop targeted policies, allocate

resources efficiently, engage stakeholders effectively, enforce regulations, and evaluate the impact of their actions. Source apportionment supports evidence-based decision-making and facilitates the implementation of measures that effectively reduce air pollution and improve public health.
Besides, source apportionment of atmospheric pollutants empowers emitting industries with valuable information to identify major pollution sources, ensure compliance with regulations, develop cost-effective mitigation strategies, improve environmental performance, enhance operational efficiency, and foster innovation. It supports industries in aligning their operations with sustainability goals, reducing their environmental impact, and promoting responsible and sustainable practices.

The simulation of mitigation strategies to reduce air pollution is useful for:

- **Assessing Effectiveness:** Simulating mitigation strategies allows policymakers and environmental experts to evaluate the potential impact of different measures on air pollution levels. By running simulations, they can quantify the expected reductions in pollutant emissions and assess the effectiveness of various strategies in achieving air quality goals. This information helps in prioritizing and selecting the most efficient and cost-effective measures.
- **Cost-Benefit Analysis:** Simulation models enable the assessment of the cost-benefit ratio of different mitigation strategies. By estimating the costs associated with implementing and maintaining the strategies against the projected reduction in air pollution, decision-makers can evaluate the economic feasibility of each option. This helps in making informed decisions and allocating resources effectively to maximize the benefits of pollution reduction.
- **Policy Planning and Development:** Simulations support the development and refinement of air pollution control policies. They allow policymakers to explore different scenarios and examine the potential outcomes of implementing specific regulations, incentives, or technological improvements. By simulating different policy options, policymakers can identify the most suitable strategies to achieve desired air quality improvements and meet regulatory targets.
- **Stakeholder Engagement:** Simulation models facilitate stakeholder engagement and collaboration. They provide a platform for different stakeholders, including government agencies, industries, environmental organizations, and communities, to come together and evaluate the potential impacts of various mitigation strategies. This collaborative approach fosters dialogue, builds consensus, and increases the likelihood of successful implementation and acceptance of pollution reduction measures.

Overall, the simulation of mitigation strategies to reduce air pollution provides a valuable tool for policymakers, experts, and stakeholders to assess effectiveness, conduct cost-benefit analysis, plan policies, engage stakeholders, plan for the long term, and assess risks. It supports evidence-based decision-making and enables the development of effective and efficient strategies to improve air quality and protect public health.

4.5.4.1. Module 3 – Dust and Fire forecast

What does this module do?

The purpose of this module is to provide information on the occurrence of episodic events as it is sand and dust storms and wildfires. This product aims to help air quality and solar energy stakeholder by providing predictions of the degradation of air quality and reduction in visibility caused by sand and dust storm and wildfires.

It includes two products:

- The product #3 predicting the degradation of air quality and reduction in visibility caused by dust mobilization and impact of the presence of mineral dust on solar irradiance forecasts. The purpose of this module is to provide information on airborne mineral dust, mineral dust deposition and solar irradiance forecast products. These products are providing added-value information to assist air quality and solar energy stakeholders, for example in planning cleaning and maintenance times of solar panels.
- The product #4 predicting the degradation of air quality and reduction in visibility caused by the occurrence of wildfires and the development of a related regional alert system.

The purpose of this module is to provide a forecast of air pollution data related to wildfires to assist stakeholders such as policymakers, local authorities and emergency services.

Who is this module designed for?

☒ Public authorities & Municipalities
☒ Research centres
☒ Impacted industries (e.g.: solar plant and electricity grid operators, health industry…)
☐ Emitting Industries (e.g.: Fracking)
☒ Emergency services
☒ Airports and flight control authorities
☒ Citizens

Geographical coverage (Figure 24)

China, Colorado, Northern Chile will be available at the end of the project. Other regions may be developed afterwards depending on the demand.

Figure 24: Geographical coverage of the module 3 - Colorado, China, Northern Chile

Layout of the module

Dust product (Figure 25)	**Fire product (Figure 26)**

The user can select the location and submodule type (i.e., dust or fire product) in **(A)**. This module will be available for three regions in the first phase. In the upper part of the module a map **(B)** presents the mineral dust or solar irradiance parameters on a 0.2ºx0.2º grid. The map presents one of the following:
<u>Dust:</u>
• Dust concentration at the surface for different size fractions:
  o Dust PM2.5
  o Dust PM10
• Dust surface extinction at 550 nm
• Dust Optical Depth at 550 nm (Dust AOD)
• Wet dust deposition
• Dry dust deposition
<u>Solar Radiation:</u>
• DNI (Direct Normal Irradiance)
• GHI (Global Horizontal Irradiance)
After the user selects a location on the map, additional graphs are presented below the map: The Dust Forecast Graph **(C)** presents a time series of 72 hours of forecast on an hourly time resolution and a daily refresh rate for the dust concentrations at the surface (PM2.5 and PM10) and the AOD. The Solar Radiation Graph **(D)** presents a time series of the 72 hours of forecast for DNI (Direct Normal Irradiance) and GHI (Global Horizontal Irradiance).
The data can be exported in **(E)**.
	The user first needs to select the location and the forecast type in **(A)**. At the top of the fire product a map **(B)** shows the location of fires and the distribution of air pollutants (PM2.5, PM10, AOD and fire tracers for carbon monoxide) on a grid resolution of about 10 km. A time lapse will show forecasted progress of the fire and the pollution dispersion for the next 96 hours. After the user chooses a location on the map a summary of the pollutants is presented in **(C)**. Below the Summary Panel, the "Pollution Forecast" panel **(D)** shows a time series of either PM2.5, PM10, CO tracers or AOD. When hovering over the lines a pop-up appears presenting the current pollutant level and the pollutant level forecasted at that moment in time. The data can be exported in **(E)**.

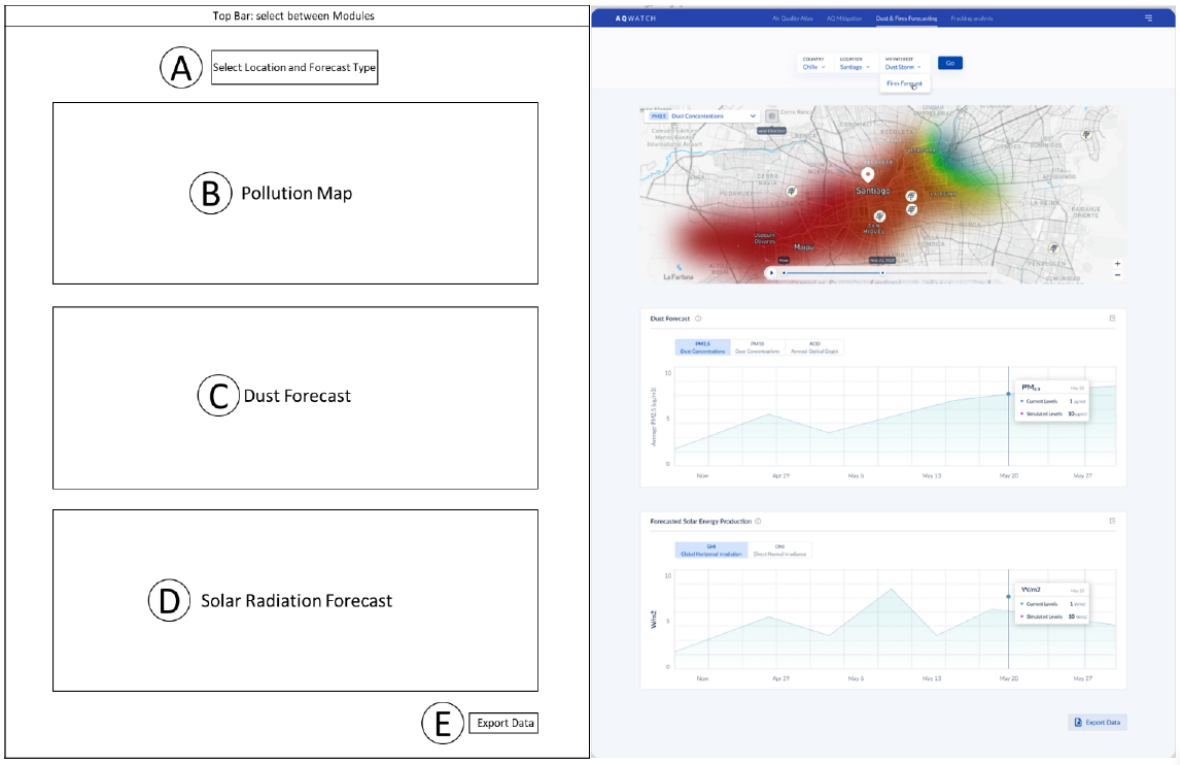


Figure 25: Layout of the module 3 (dust)

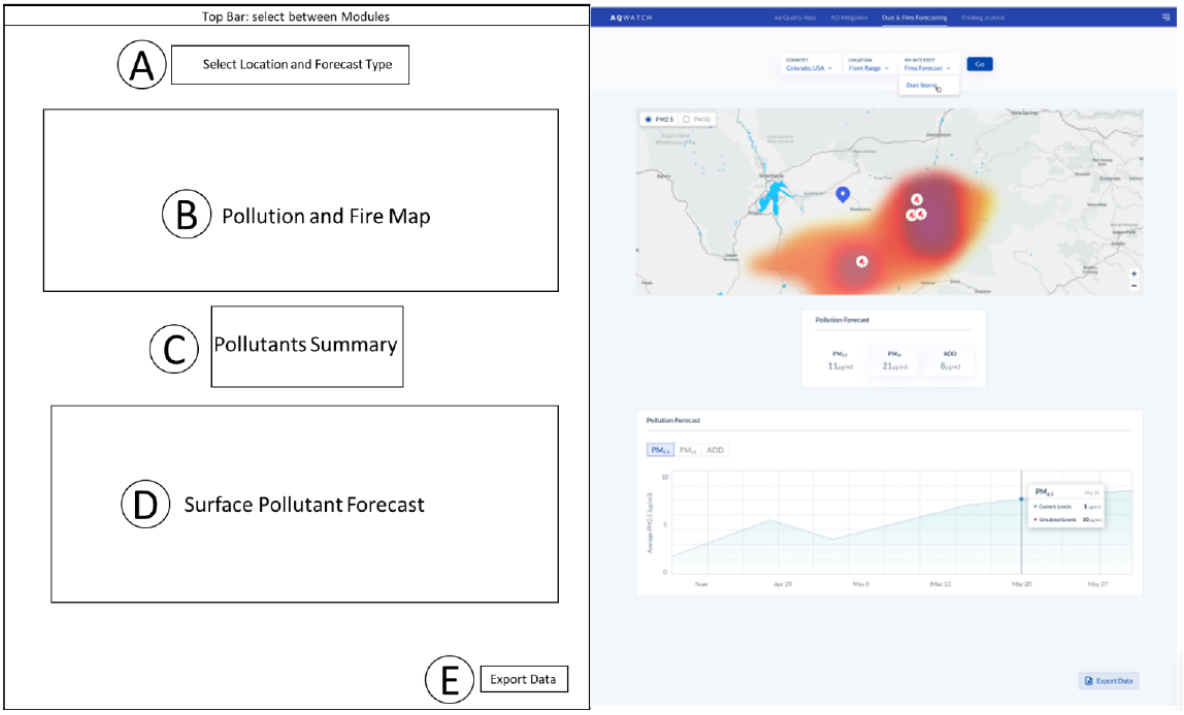


Figure 26: Layout of the module 3 (fire)

Value-chain (Figure 27)

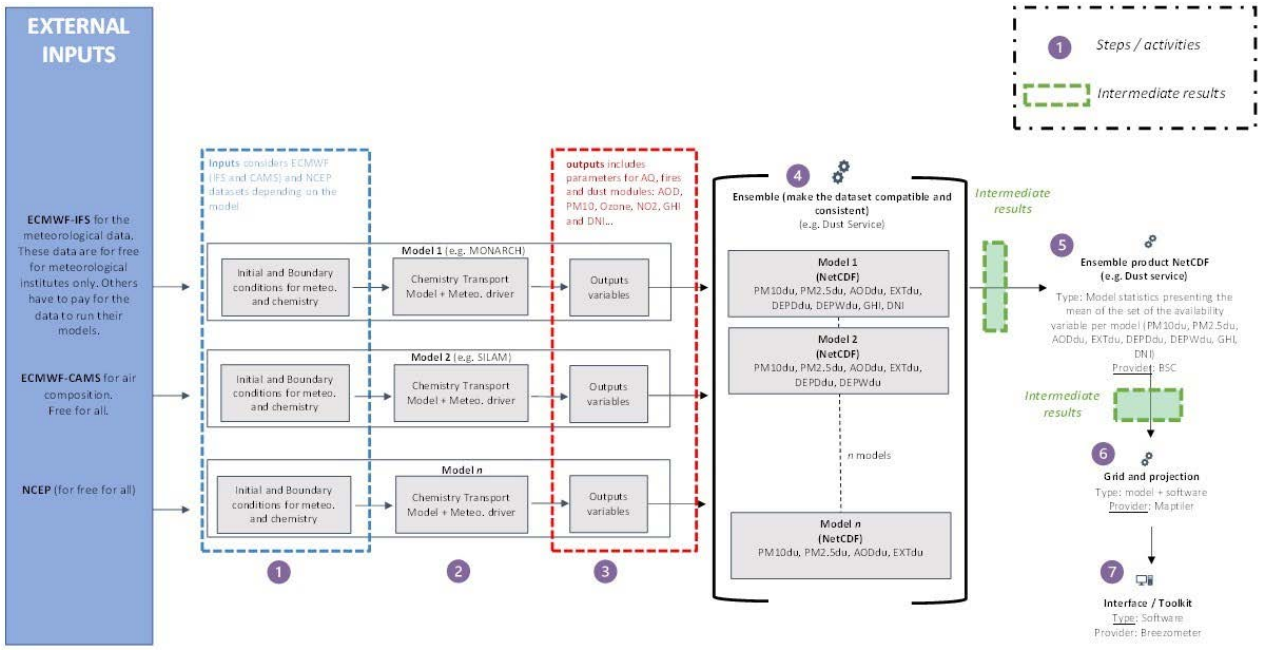


Figure 27: Module 3 – Value-chain (during the project)

Table 12: Module 3 – Matrix Domains/Pollutants

DUST			
	Colorado	**Northern Chile**	**China**
Dust Optical Depth (DOD)	SILAM / MONARCH / CAMS-glob	SILAM / MONARCH / CHIMERE / CAMS-glob	SILAM / MONARCH / CAMS-glob
Dust surface concentration (DSC)	SILAM / MONARCH / CAMS-glob	SILAM / MONARCH / CHIMERE / CAMS-glob	SILAM / MONARCH / CAMS-glob
Dust deposition (DD)	SILAM / MONARCH	SILAM / MONARCH / CHIMERE	SILAM / MONARCH
Dust surface extinction (DES)	SILAM / MONARCH / CAMS-glob	SILAM / MONARCH / CHIMERE / CAMS-glob	SILAM / MONARCH / CAMS-glob
SOLAR RADIATION			
	Colorado	**Northern Chile**	**China**
Direct Normal Irradiance (DNI)	MONARCH	MONARCH	MONARCH
Global Horizontal Irradiance (GHI)	MONARCH	MONARCH	MONARCH

What is the added-value of the module?

Dust and fire forecasts are useful for public authorities for the following reasons:

- **Public Health Protection:** Dust and fire forecasts help public authorities in protecting public health. Dust storms and wildfires can have significant impacts on air quality, leading to the release of harmful pollutants and particles into the atmosphere. By providing forecasts, authorities can issue public health advisories and warnings to vulnerable populations, such as individuals with respiratory conditions or those residing in affected areas. This allows people to take necessary precautions, such as staying indoors, wearing masks, or evacuating if required.

- **Emergency Preparedness and Response:** Dust and fire forecasts enable public authorities to enhance emergency preparedness and response efforts. By predicting the occurrence and movement of dust storms and wildfires, authorities can allocate resources, coordinate emergency services, and implement evacuation plans in a timely manner. Early warnings and accurate forecasts provide valuable time for authorities to mobilize firefighting teams, deploy resources to affected areas, and ensure the safety of both responders and the general public.
- **Environmental Management:** Dust and fire forecasts support effective environmental management. Dust storms can cause soil erosion, degrade agricultural lands, and impact ecosystems. By anticipating dust events, authorities can implement preventive measures such as land management practices, vegetation cover, and dust suppression techniques. Similarly, fire forecasts allow authorities to plan and implement fire management strategies, including controlled burns, firebreaks, and early detection systems, to mitigate the risk of wildfires and minimize their environmental impact.
- **Infrastructure Protection:** Dust storms and wildfires can pose risks to infrastructure, including buildings, roads, power lines, and communication networks. By providing forecasts, public authorities can take proactive measures to protect critical infrastructure. For example, road and transportation agencies can implement visibility alerts and speed restrictions during dust storms to reduce accidents. Power utility companies can assess the risk to power lines and take preventive measures to minimize the potential for disruptions.
- **Air Quality Management:** Dust and fire forecasts contribute to air quality management efforts. By predicting the movement and dispersion of dust particles and smoke from wildfires, authorities can assess the potential impacts on air quality in different regions. This information helps in issuing air quality alerts, implementing control measures, and monitoring pollution levels. Authorities can take steps to minimize exposure, adjust industrial operations if necessary, and assess the effectiveness of pollution control strategies during such events.
- **Planning and Decision-Making:** Dust and fire forecasts provide valuable information for planning and decision-making by public authorities. Authorities can incorporate these forecasts into land use planning, infrastructure development, and emergency response plans. By considering the potential risks associated with dust storms and wildfires, authorities can make informed decisions about building codes, land management practices, and the allocation of resources in high-risk areas. This proactive approach minimizes the potential for damage and improves overall resilience.

The air transport sector would also benefit from a dust forecasting service for:

- **Safety of Flight Operations:** Dust forecasts provide crucial information about the presence and movement of dust storms and airborne dust particles in the vicinity of airports. This information is vital for ensuring the safety of flight operations. Flight control authorities can utilize dust forecasts to assess the potential hazards posed

by reduced visibility, turbulence, or engine ingestion of dust particles. By proactively identifying areas affected by dust storms, authorities can issue relevant advisories, implement safety protocols, and adjust flight schedules to minimize risks and ensure safe operations.

- **Flight Planning and Route Optimization:** Dust forecasts enable flight control authorities and airlines to optimize flight planning and routing. By incorporating dust information into their decision-making processes, authorities can identify areas with high dust concentrations and reroute flights accordingly. This helps in avoiding areas of severe dust storms or high dust particle concentrations, minimizing the risk of encounters with hazardous conditions. It allows for efficient and safe flight operations while optimizing fuel consumption and reducing potential delays.
- **Operational Efficiency and Cost Savings:** Accurate dust forecasts contribute to the operational efficiency of airports and airlines. By having advance knowledge of potential dust events, airports can proactively prepare infrastructure, such as airfield maintenance and runway cleaning, to mitigate the impacts of dust deposition. Airlines can adjust their maintenance schedules, inspect filters, and take preventive measures to minimize the impact of dust on aircraft performance and engine efficiency. These proactive actions can reduce maintenance costs, increase operational efficiency, and minimize potential disruptions caused by dust-related issues.
- **Collaborative Decision Making:** Dust forecasts facilitate collaborative decision making among flight control authorities, airlines, and airport operators. By sharing accurate and timely dust information, stakeholders can engage in collaborative planning and decision making to mitigate the impacts of dust on flight operations. This collaboration ensures a coordinated response, effective resource allocation, and consistent communication, leading to more efficient and resilient operations in the face of dust events.

Dust forecasts are also useful to operators of electricity grids and solar power plants for:

- **Solar Power Generation Planning:** Solar power plants rely on the availability of sunlight to generate electricity. Dust in the atmosphere can reduce the amount of sunlight reaching the solar panels, thereby impacting the energy output. Dust forecasts provide valuable information about the expected levels of dust in the air, enabling solar plant operators to anticipate potential reductions in solar radiation and adjust their energy generation forecasts accordingly. This helps in better planning and managing the output of solar power plants.
- **Maintenance and Cleaning Schedules:** Dust accumulation on solar panels can significantly affect their efficiency and performance. By monitoring dust forecasts, operators can anticipate periods of high dust concentrations and plan maintenance activities, such as panel cleaning, accordingly. Regular cleaning schedules can be optimized based on forecasted dust levels, ensuring optimal performance of the solar panels and maximizing energy generation.

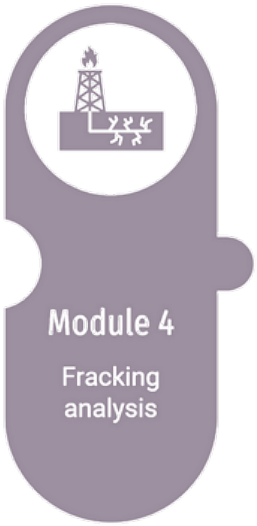
- **Grid Stability and Reliability:** Electricity grid operators need to maintain stability and reliability in power supply. Dust storms or high dust concentrations in the air can impact transmission lines, insulators, and other grid infrastructure. By utilizing dust forecasts, grid operators can prepare for potential disruptions caused by dust, assess the risk to the infrastructure, and take preventive measures such as conducting inspections, reinforcing equipment, or implementing mitigation strategies.
- **Energy Demand and Load Forecasting:** Dust forecasts can indirectly impact electricity demand and load forecasting. In regions prone to dust events, solar power generation may be affected, leading to a decrease in available renewable energy supply. This reduction in solar power output may necessitate adjustments in energy demand management, load balancing, or alternative energy sources to meet the electricity requirements of the grid and consumers.
- **Investment Planning and Risk Assessment:** Dust forecasts can also be valuable for operators considering new solar power plant installations or expanding existing facilities. By analyzing historical dust patterns and using forecasted data, operators can assess the long-term impact of dust on solar energy generation potential in a particular region. This information helps in making informed decisions about site selection, technology choices, and risk assessment associated with dust-related performance variability.

Finally, fire smoke forecasts offer significant added value for firefighters in their firefighting and emergency response efforts. Here are some key benefits:

- **Early Warning and Situational Awareness:** Fire smoke forecasts provide firefighters with early warning and situational awareness of the movement and dispersion of smoke from wildfires. This information allows firefighters to anticipate the direction and intensity of smoke, helping them plan their operations effectively. It helps in identifying areas at high risk of smoke inhalation, determining safe evacuation routes, and allocating resources appropriately.
- **Health and Safety of Firefighters:** By providing information about the composition, concentration, and duration of smoke exposure, forecasts enable firefighters to take necessary precautions to minimize their exposure to harmful smoke particles and toxic gases. It helps in determining appropriate personal protective equipment (PPE) and respiratory protection measures, ensuring the well-being of firefighters during firefighting operations.
- **Tactical Decision Making:** Fire smoke forecasts assist firefighters in making tactical decisions during firefighting operations. By understanding the behavior of smoke plumes, including their transport, dispersion, and potential impacts, firefighters can adjust their firefighting strategies and tactics accordingly. It helps in identifying safe access points, establishing fire lines, and positioning firefighting resources effectively. Forecasts enable firefighters to allocate resources based on the predicted movement of smoke, ensuring efficient and targeted firefighting efforts.
- **Evacuation and Public Safety:** Fire smoke forecasts support evacuation planning and public safety measures. By understanding the trajectory and intensity of smoke,

authorities can issue timely evacuation orders, establish evacuation routes, and communicate with the public effectively. Forecasts help in identifying areas at high risk of smoke exposure, enabling authorities to take necessary measures to protect the public, including vulnerable populations. It aids in managing evacuation operations and minimizing the potential health impacts of smoke on nearby communities.

4.5.4.2. Module 4 – Source point analysis



What does this module do?
The purpose of this module is to provide information on the possible impact of fracking activities (or more general oil and gas extraction activities) on the air quality in nearby and distant areas. As opposed to the other modules in the AQ-WATCH system, this module is not real-time and is rather an informational tool.
For this module, we are demonstrating the abilities of the tool for a specific region (Front Range, CO, USA) and showing the impact on neighbourhoods near the fracking and related activities and distant to them as well as on sensitive locations (e.g. hospitals, schools).
The product provides predictions of the potential impact on regional air quality (e.g., ozone levels) due to fracking and related operations and determination of the exposure of the local population to related emissions of hydrocarbons.

Who this module is designed for?
☒ Public authorities & Municipalities
☒ Research centres
☐ Impacted industries (e.g.: solar plant and electricity grid operators, health industry…)
☒ Emitting Industries (e.g.: Fracking)
☐ Emergency services
☐ Airports and flight control authorities
☐ Citizens

Geographical coverage (Figure 28)
Colorado will be available at the end of the project but only with data dated from 2014. Updated analysis for Colorado or for other regions may be developed afterwards depending on the demand.

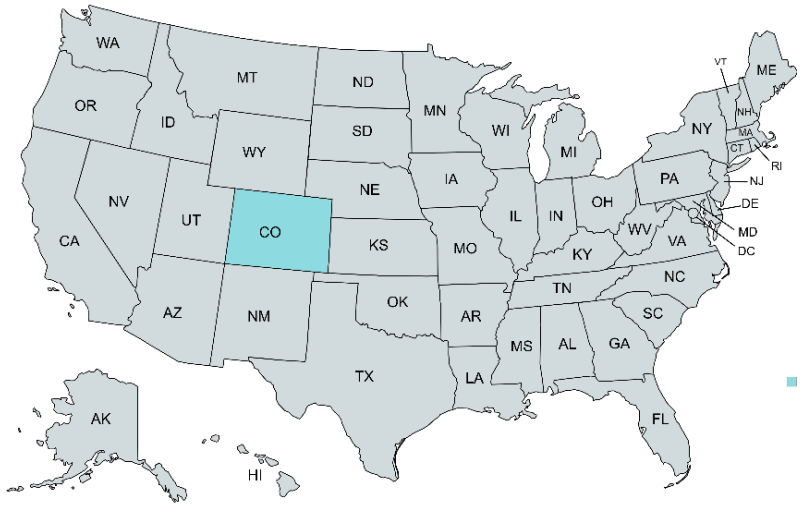


Figure 28: Geographical coverage of the module 4 - Colorado

Layout of the module (Figure 29)

The location can be chosen in **(A)**. The top part of the module shows a map **(B)** where fracking activities are indicated and the concentration of several pollutants either with or without the fracking activities are shown. The grid resolution of the map is 4 km. The user will be able to choose between the following pollutants to be displayed: O3, Benzene, Toluene, NOx, Ethane, Propane and HCHO.

Below the map a time series of each pollutant with and without the impacts of oil and gas extraction is shown based on the location that the user chooses on the map above **(C)**. When hovering over the lines, a pop-up shows the pollutant levels with vs. without the fracking activities at the chosen point in time.

The data can be exported in **(D)**.

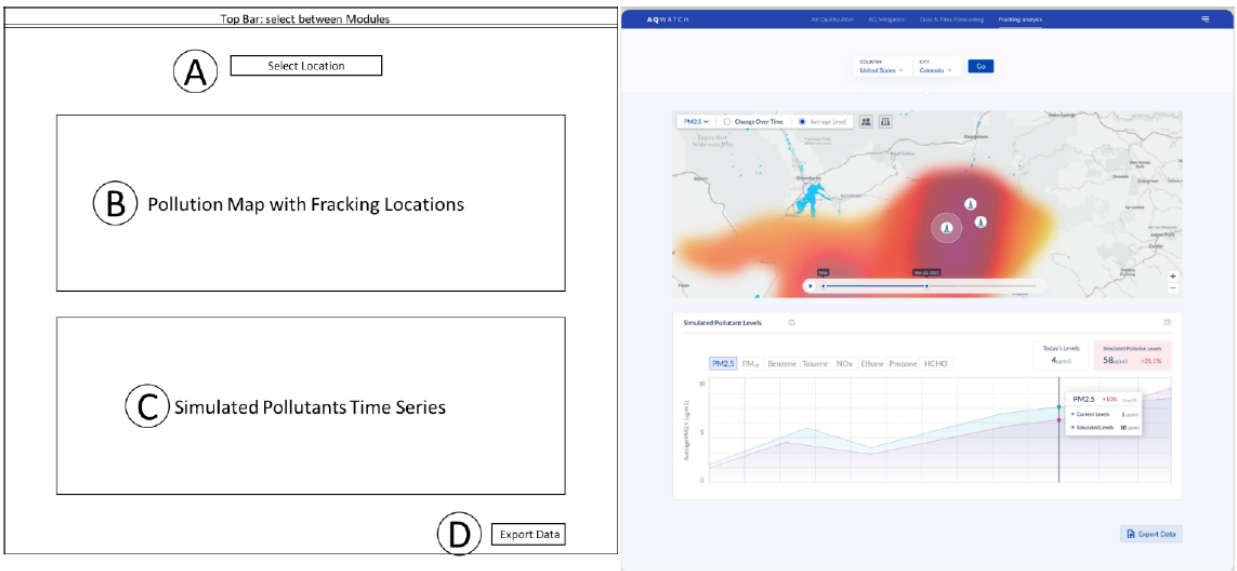


Figure 29: Layout of the module 4

Value-chain (Figure 30)

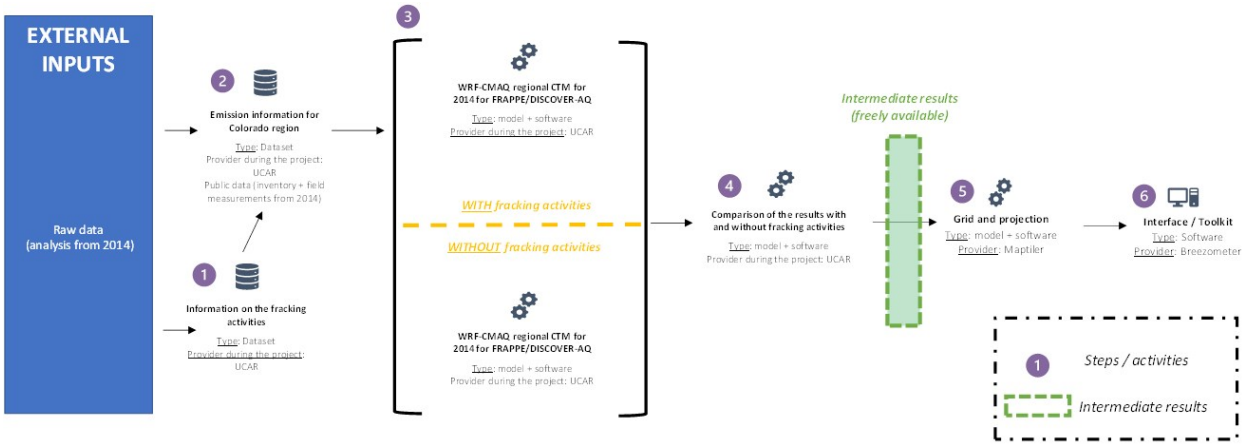


Figure 30: Product 5 – Value-chain (during the project)

What is the added-value of the module?

This module analysing the impact of atmospheric emissions from a specific source offers several added-values:

- **Compliance Monitoring:** Analyzing the impact of air pollution from a specific source facilitates compliance monitoring with environmental regulations and standards. The tool can compare pollutant concentrations near the source with permissible limits. It helps regulatory authorities ensure that the site operates within the prescribed emission limits and takes necessary actions to reduce pollution levels if required.
- **Environmental Impact Assessment:** Assessing the impact of air pollution from a specific source supports environmental impact assessments. The tool can evaluate the potential effects of the emissions source on air quality, including the dispersion of pollutants and their potential health and ecological impacts. This information is valuable for evaluating the overall environmental sustainability of the site and informing decision-making processes.
- **Health and Risk Assessment:** Assessing the impact of air pollution from a specific source helps in evaluating potential health risks associated with exposure to pollutants emitted by the quarry. The tool can estimate the dispersion of pollutants and their potential health effects on nearby populations. This information is crucial for public health agencies and local authorities to prioritize health interventions, develop risk mitigation strategies, and protect the health of individuals living or working in the vicinity of the quarry.
- **Mitigation Strategies:** Tools analyzing the impact of air pollution from a specific source assist in developing effective mitigation strategies. By understanding the emissions and dispersion patterns, stakeholders can identify the most appropriate mitigation measures to reduce the impact of pollution from the site. This may include implementing emission control technologies, optimizing operational practices, or implementing buffer zones to minimize the exposure of nearby communities to pollutants.

- **Sustainable Development Planning:** Analyzing the impact of air pollution from a specific source aligns with sustainable development planning. The tool's insights can guide land-use planning, urban development, and infrastructure projects by considering the potential air pollution impacts from the quarry. This ensures that future developments are designed to minimize conflicts between industrial activities and surrounding communities, promoting sustainable and livable environments.
- **Community Engagement and Communication:** Analyzing the impact of air pollution from a specific source facilitates community engagement and communication. The tool's results can be communicated to nearby communities, stakeholders, and the general public to increase awareness about the site's impact on air quality. This promotes transparency, fosters dialogue between the quarry operator and the community, and enables collaborative efforts to address concerns and develop mutually beneficial solutions.

4.5.4.3. Module 5 – Air quality forecast

What does this module do?

This module provides up to 96h of hourly forecast of air pollution at the regional scale based on different predictive models for the following pollutants:

- PM2.5 (1h & 24h average)
- PM10 (1h & 24h average)
- NO2 (1h average)
- SO2 (1h average)
- CO (1h average)
- O3 (1h average & MDA8)

It consists in an air quality map which allows the users to understand and research the forecasted AQ statistics in a specific area including forecast of air pollution at the regional scale

Who this module is designed for?

☒ Public authorities & Municipalities
☒ Research centres
☒ Impacted industries (e.g.: solar plant and electricity grid operators, health industry…)
☒ Emitting Industries (e.g.: Fracking)
☐ Emergency services
☐ Airports and flight control authorities
☐ Citizens

Geographical coverage (Figure 31)

Beijing (China), Colorado (USA) and Santiago de Chile (Chile) will be available at the end of the project. Other regions may be developed afterwards depending on the demand.

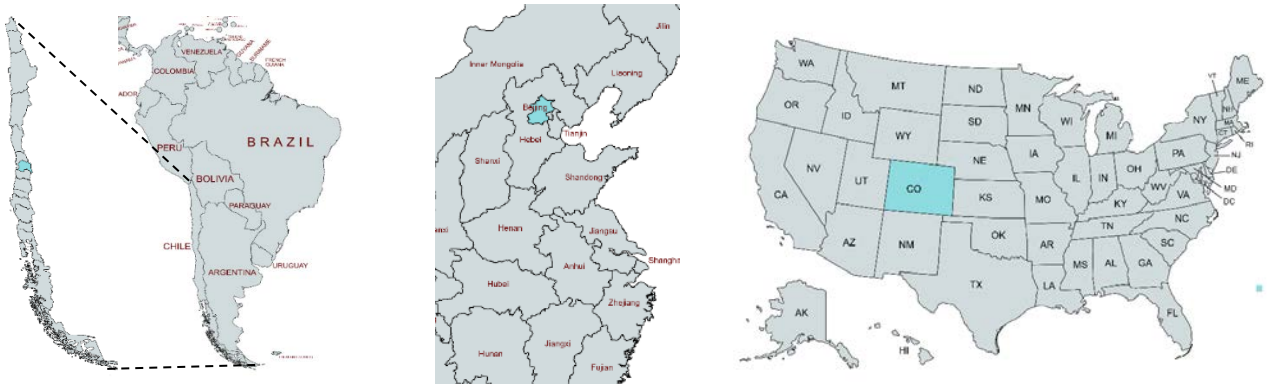


Figure 31: Geographical coverage of the module 5 - Colorado, Beijing, Santiago de Chile

Layout of the module (Figure 32)

The layout of the module is shown below. In the topmost part **(A)** the user can select the location of the forecast. After clicking the "Go" button, the map below **(B)** automatically moves and adjusts the zoom level to the chosen location. The user can choose on the pull-down menu in the upper left corner which pollutant to display on the map. The color legend is provided on the right side of the map. The maps can either automatically move forward in forecast time when clicking the little white arrow in the lower part of the map, or the user can manually select a forecast time step on the time slider.

When selecting a point on the map, the current levels of all pollutants at this location are displayed in the "Pollutant Current Level" panel **(C)**. Below, the forecasted time series of this point appears in the "Pollutant Forecast" **(D).** In the upper right corner of this panel the displayed pollutant can be selected.

A model evaluation panel is provided in the lower part of the module **(E)** and **(F)** for ozone **(O_3)** and $PM_{2.5}$. The map in **(E)** shows a smaller version of the map in **(B)** for forecast time step 0, overlayed with ground-level observations from measurement stations in the core regions during the same time. The user can choose between O_3 and $PM_{2.5}$ on the drop-down menu above the map and if the 1h or 24h averages are shown. On the right graph **(F)** a time series of the last week of measurements at a certain station and the interpolated model data for the location of that station are provided. The station can be chosen in the drop-down menu, while the pollutant is the same as displayed on the map on the left. When hovering the cursor over the lines in the graph, a pop-up shows the measured and simulated values for each time step and the relative difference. The ground-level observations are compared to the daily first 24 hours of forecast.

The data that is presented in the time series graphs can be exported when pressing the export data button **(G).**

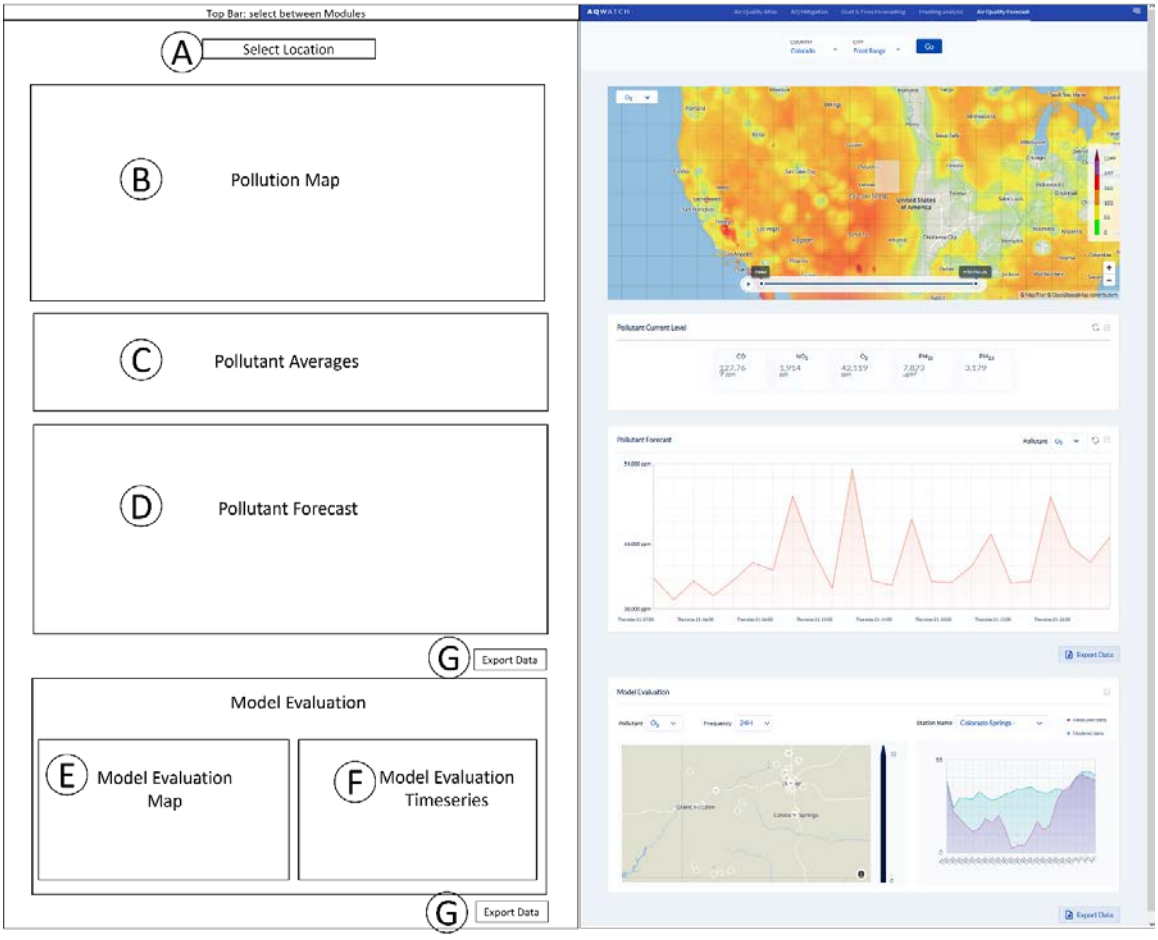


Figure 32: Layout of the module 5

Value-chain (Figure 33)

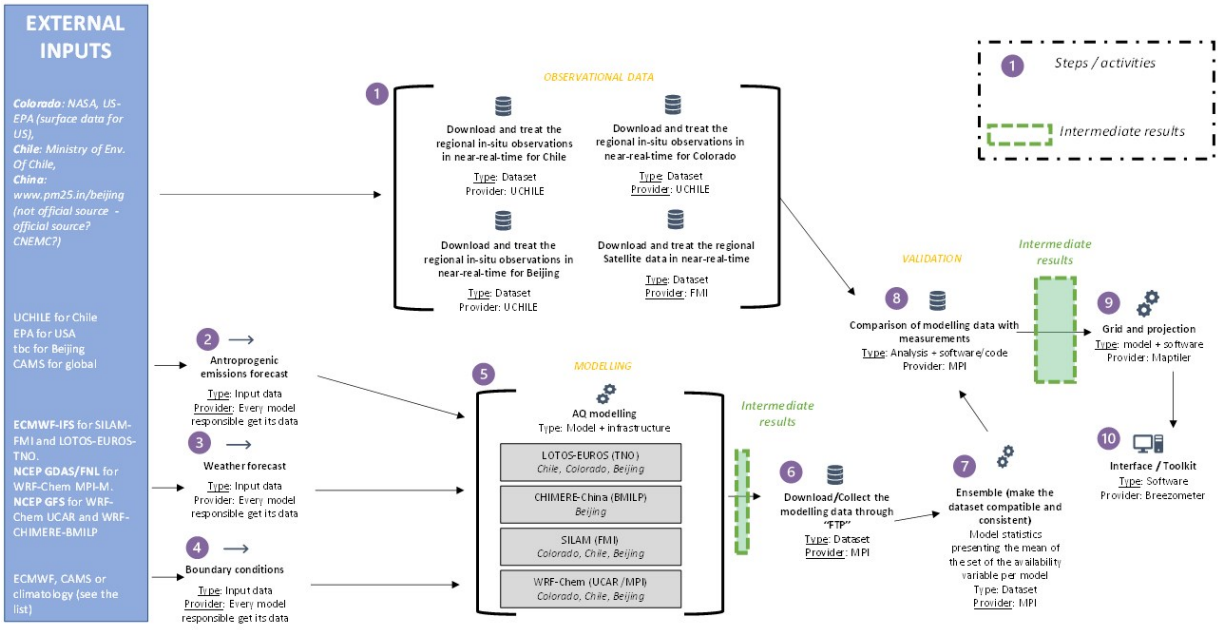


Figure 33: Product 5 – Value-chain (during the project)

Table 13: Module 5 – Matrix Domains/Pollutants

	Colorado	Santiago de Chile	Beijing
PM	LOTOS-EUROS SILAM WRF-Chem-UCAR	LOTOS-EUROS SILAM WRF-Chem-MPIM	CHIMERE-SIRANE coupled model system LOTOS-EUROS SILAM MarcoPolo-Panda models
NO2	LOTOS-EUROS SILAM WRF-Chem-UCAR	LOTOS-EUROS SILAM WRF-Chem-MPIM	CHIMERE-SIRANE coupled model system LOTOS-EUROS SILAM MarcoPolo-Panda models
CO	LOTOS-EUROS WRF-Chem-UCAR SILAM	LOTOS-EUROS SILAM WRF-Chem-MPIM	LOTOS-EUROS SILAM MarcoPolo-Panda models
O3	LOTOS-EUROS SILAM WRF-Chem-UCAR	LOTOS-EUROS SILAM WRF-Chem-MPIM	CHIMERE-SIRANE coupled model system LOTOS-EUROS SILAM MarcoPolo-Panda models
SO2	LOTOS-EUROS SILAM WRF-Chem-UCAR (tbc)	LOTOS-EUROS SILAM WRF-Chem-MPIM	LOTOS-EUROS SILAM MarcoPolo-Panda models

What is the added-value of the module?

Air quality forecasts are useful for a wide range of stakeholders. Here are some key beneficiaries of air quality forecasts:

- **Policy Makers and Government Agencies:** Air quality forecasts support policy makers and government agencies in developing and implementing effective air quality management strategies. Forecasts provide valuable data for decision making, allowing policymakers to design evidence-based policies and regulations. It helps in setting emission standards, implementing pollution control measures, and evaluating the impact of policy interventions on air quality.
- **Transportation Authorities:** Air quality forecasts help transportation authorities manage traffic and reduce emissions. By integrating air quality information into transportation planning and management systems, authorities can optimize traffic flow, implement congestion pricing strategies, and encourage the use of public transportation during periods of poor air quality. It helps in minimizing emissions from vehicles and improving overall air quality in urban areas.
- **Environmental Agencies:** Air quality forecasts are crucial for environmental agencies responsible for monitoring and managing air pollution. Forecasts help agencies identify pollution hotspots, assess compliance with air quality standards, and prioritize resources and actions. It aids in conducting targeted monitoring, implementing emission reduction initiatives, and evaluating the effectiveness of pollution control strategies.
- **Health Professionals:** Air quality forecasts are essential tools for health professionals, enabling them to anticipate and respond to potential health impacts associated with air pollution. By accessing air quality forecasts, healthcare providers

can better manage patients with respiratory conditions, adjust treatment plans, and provide appropriate advice to individuals at risk.

- **Industries:** Air quality forecasts benefit industries and businesses by providing them with information to plan and optimize their operations. For example, industries can adjust production schedules or implement emission reduction measures during periods of high pollution to minimize their impact on air quality. Businesses in the tourism and hospitality sectors can use air quality forecasts to inform tourists about the current air quality conditions and promote activities that are less affected by pollution.
- **General Public:** Air quality forecasts provide valuable information to the general public, allowing individuals to make informed decisions about outdoor activities, especially for vulnerable groups such as children, elderly, and people with respiratory conditions. It helps people plan their day, adjust outdoor exercise routines, and take necessary precautions to minimize exposure to poor air quality.

4.5.5. Innovation Management Roadmap, definitions of Markets addressed

The Innovation Management Roadmap aims at analysing the key results of the project. Through the building of the SWOT matrix (Strengths, Weaknesses, Opportunities, and Threats), it is not only possible to understand the characteristics that will build the Unique Value Preposition but also to define the targeted markets and the customer segments that would benefit from each result and their respective communication strategy. The dissemination and communication actions are designed to reach the main customer segments. Taking also the stakeholder analysis into consideration, this serves to ensure that the communication & innovation delivery plan will include the stakeholders and policy makers. The Innovation Management Roadmap of AQ-WATCH is presented in Table 7 below.

Table 14: Innovation Management Roadmap

RESULTS TABLE	SWOT ANALYSIS		TARGET GROUPS (TG)	METHOD FOR REACHING THE TG
RESULT NAME/ Short Description	**STRENGTHS of the Result**	**WEAKNESSES of the Result**	**WHO WILL BENEFIT From the Result**	**DISSEMINATION/ COMMUNICATION METHOD**
AQ-WATCH solution made of 5 modules to fight against air pollution.	**High level expertise:** The AQ-WATCH solution has been developed collectively by well-recognized research institutes. **High resolutions:** Unlike the current available solutions, AQ-WATCH allows high resolution forecasts and analysis and covers regions which Copernicus data are not fully exploited for yet. **Wide Coverage:** AQ-WATCH air quality systems offer a broad geographical coverage, allowing monitoring of air pollution on a global scale. They can provide valuable data for remote or inaccessible areas where ground-based monitoring is limited or non-existent. **Timeliness:** Satellite observations provide near-real-time data, enabling timely assessment of air quality conditions. This allows for the identification of pollution events and the implementation of rapid response measures. **Continuous Monitoring:** Satellites can observe air quality continuously, providing a comprehensive and continuous monitoring capability. This allows for the detection of long-term trends, seasonal variations, and the identification of persistent pollution hotspots. **Multi-Spectral Measurements:** Satellites can capture a wide range of	**Financial resources:** Final products delivery will not be hindered by the lack of stakeholders' acceptance - on the contrary. However, clients, in particular from public organisations, may also be under the burden of the availability of public funding and decide to stay with the existing solutions. **Spatial Resolution:** Satellite observations typically have lower spatial resolution compared to ground-based monitoring stations. This limitation can make it challenging to capture local-scale variations and detect pollution sources at a detailed level. **Vertical Resolution:** Satellite observations often have limited vertical resolution, which can impact the accuracy of vertical profiles of pollutants. Vertical information is crucial for understanding the vertical distribution of pollutants in the atmosphere, including near-surface concentrations and vertical transport processes.	Public authorities, municipalities, citizens, emitting industries, impacted industries, research centres	The end-users are reached through the participation in external events, project meetings with the Core Stakeholders-Network for example and interactions with exploiters having existing relations with public authorities. General public and other stakeholders will be reached via social media.

	measurements, including various atmospheric pollutants, such as nitrogen dioxide (NO2), particulate matter (PM), and ozone (O3). This multispectral approach provides a comprehensive understanding of air quality and the ability to track multiple pollutants simultaneously.			
OWNER SHIP	**OPPORTUNITIES for the Result**	**THREATS For the Result**	**HOW WILL THIS GROUP BENEFIT**	**DATE AND PLACE**
A joint ownership agreement is being prepared under the leadership of the coordinator	**Public demand and political awareness:** Air pollution is considered as one of the most important environmental risk to human health. There is a growing political, media and public interest in air quality issues and an increase of the public support for action. It has led to more important support and demand for air quality improvement measures. Besides, air pollution has considerable impacts on market and non-market costs through its effects on health, crop and forest yields, ecosystems, the climate and on the built environment such as the solar energy sector. **Complementary Data:** Satellite observations can complement ground-based monitoring by providing a broader spatial coverage and capturing pollution sources that may not be detected locally. Integrating satellite data with ground-based measurements can enhance the accuracy and reliability of air quality assessments.	**Illegal copy:** Illegal copy of parts of the AQ-WATCH solution is always a threat as most of the models and datasets are public. However, the combination of strong background and experience of high calibre scientists from AQ-WATCH would be hard to replicate. The investment would include the same amount of effort, resources and time in order to achieve an alternative solution. Besides, the products and services rely on the data freely provided by the Copernicus programme. The competition among the project partners might be a threat, too; therefore it is necessary to develop the exploitation plan with all of them, taking into account their strengths and wishes. **Atmospheric Interference:** Satellite observations can be affected by atmospheric conditions, such as clouds, aerosols, and solar radiation. These factors can limit the accuracy and reliability of satellite-derived air quality data, especially in regions with persistent cloud cover or high aerosol concentrations. **Data Validation and Calibration:** Satellite data require validation and calibration against ground-based measurements to ensure accuracy and reliability. Establishing and maintaining an extensive ground-based	Accurate and high resolution AQ forecasts provides valuable information to stakeholders across various sectors, enabling them to make informed decisions, implement targeted interventions, and work towards improving air quality, protecting public health, and preserving the environment.	Due to the ongoing COVID-19 situation, the main conferences/workshops have been all digital and the plan for the AQ-WATCH webinars and regional workshops were adapted during a large part of the project. Meetings with prime users have taken place as part of the spiral process. Meetings with other potential interested exploiters have been organized and will continue in 2023/2024.

	Improved Technology: Advancements in satellite technology, sensor capabilities, and data processing techniques continue to enhance the accuracy and resolution of satellite-based air quality observations. Ongoing technological developments offer opportunities for more precise and detailed monitoring of air pollutants. **Integration into Decision-Making Processes:** Integrating earth observation air quality data into decision-making processes at various levels can support the development and implementation of effective air pollution control strategies. Public authorities can utilize this data to inform policy development, urban planning, and emission reduction initiatives.	validation network can be challenging and resource-intensive. **Cost and Accessibility:** Access to satellite data and the necessary infrastructure for data processing and analysis can pose challenges, particularly for resource-constrained regions and developing countries. The costs associated with data acquisition and processing can be a barrier to widespread adoption and utilization of satellite-based air quality systems.		

4.5.6. Customer segmentation

As of 2018, the EO data on atmospheric composition remains a niche market. However, it is expected to grow thanks to the improvements in terms of availability, accuracy and quality of satellite data and model results.
Intermediate users remain mostly public actors (public authorities, meteorological and environmental agencies, research centres, etc.) but a market is starting to develop among private companies.
As demonstrated below, the markets for the AQ-WATCH products are, by order of potential market size:

- Public authorities & municipalities
- Infrastructure operators & industries impacted by the pollution
- Emitting industries
- Emergency services
- Airports and flight control authorities
- Research centres
- Citizens.

4.5.6.1. Customer segment "Public authorities and Municipalities"

Public authorities need air quality monitoring and forecasting systems for several reasons:

- **Protecting Public Health:** Air pollution can have significant adverse effects on human health, leading to respiratory problems, cardiovascular diseases, and other health issues. By implementing air quality monitoring systems, public authorities can assess the levels of pollutants in the air and identify areas where air pollution exceeds acceptable limits. This information allows them to issue timely health advisories, implement mitigation measures, and take necessary actions to protect public health.
- **Environmental Compliance:** Public authorities have a responsibility to enforce environmental regulations and standards related to air quality. Air quality monitoring systems enable them to assess compliance with these regulations, identify sources of pollution, and take enforcement actions when necessary. Monitoring data provides evidence of air quality conditions and supports decision-making processes related to regulatory measures and enforcement actions.
- **Policy Development and Planning:** Accurate and up-to-date air quality monitoring data is essential for developing effective policies and strategies to improve air quality. Public authorities can use this data to identify areas with high pollution levels, determine trends, and assess the effectiveness of existing measures. Monitoring systems help in setting priorities, formulating targeted interventions, and evaluating the impacts of air quality improvement programs.
- **Early Warning Systems:** Air quality forecasting systems provide valuable information about the expected air quality conditions in the future. By utilizing these systems, public

authorities can anticipate pollution events, such as episodes of high pollution or smog, and take proactive measures. Early warnings allow them to implement control strategies, issue alerts to the public, and mitigate the impacts of poor air quality on health, the environment, and economic activities.

- **Emergency Preparedness and Response:** During unexpected air pollution events, such as industrial accidents or wildfires, public authorities need to respond quickly and effectively. Air quality monitoring systems help in detecting and characterizing pollution incidents, enabling prompt response actions. By monitoring pollution levels in real-time, authorities can implement emergency plans, evacuate affected areas, and coordinate response efforts with relevant agencies and stakeholders.
- **Public Awareness and Engagement:** Air quality monitoring and reporting systems play a crucial role in raising public awareness about air pollution issues. Public authorities can share monitoring data, pollution alerts, and forecasts with the public through various communication channels. This information empowers individuals to take necessary precautions, make informed decisions, and participate in collective efforts to improve air quality.

Overall, air quality monitoring and forecasting systems are essential tools for public authorities to protect public health, ensure environmental compliance, develop effective policies, respond to emergencies, and engage with the public in addressing air pollution challenges. These systems enable evidence-based decision-making, promote transparency, and support the development of sustainable strategies for air quality management.

Public authorities are traditionally the organizations dealing with air quality issues and they pay more and more attention to air quality products in order to implement the right policies on pollutant emission controls, as well as to provide information and advice to citizens through applications and services freely available to inhabitants of a city or tourists. Free EO data can be seen as a source of data but even if air quality is an issue to be dealt with at global level, the products and services must address local areas. It implies that high resolution data is needed, and this data is most of the time fee-based or it requires dedicated infrastructure such as modelling or measurement efforts by local authorities themselves. For most local authorities, this is out of their possibilities due to a lack of funding, knowledge or manpower. However, end users from public authorities are still reluctant to pay for air quality information even though the improvement of the services offered is helping to change this. They are also under the burden of the availability of public funding. Therefore, the cost of the AQ-WATCH services will be an important criterion for many public authorities. Already 39 public agencies in the EU and 143 in the US dealing with the issue of air quality have been identified (see the preliminary and non-exhaustive list in annex 2).
Municipalities are also dealing with air quality issues. City air quality plans typically include a series of measures based on an assessment of air quality and trend forecasts for the future and detailed analysis of high levels of concentrations, including the responsible sources. Understanding the reasons for high levels of air pollution in cities is crucial for decision-making

on urban air quality management. According to the EEA report "Europe's urban air quality – re-assessing implementation challenges in cities"[15], prepared in cooperation with 12 large cities, the main needs for the cities are:

- More guidance on how best to communicate information on air quality to the public and ensure active engagement and interest from citizens.
- More guidance on how best to find information on and include real-world vehicle emissions in modelling. These issues are considered important given the need for robust information to properly design and estimate the future impacts of possible measures addressing the transport sector in cities.
- Need to bridge the gap concerning the enforcement of certain EU and national requirements that lie outside the competency of local authorities to define and manage.
- Better guidance on how to best coordinate measures on air quality with other measures addressing, for example, local climate change mitigation and energy measures, noise and health, and well-being.
- Better guidance on the use of cost-benefit analysis tools (emissions, modelling, health impact analysis).

The C40 initiative[3] gathers cities committed to delivering on the most ambitious goals of the Paris Agreement at the local level, as well as to cleaning the air. 97 of the world's greatest cities representing 700+ million citizens and one quarter of the global economy are engaged in the C40 initiative.

The Environmental Defends Fund has led a study in 2020 [29] providing a landscape of regional demand drivers, public funding opportunities and key policy contexts in key markets for air quality monitoring. The key findings are listed in the table below.

Table 15: Key findings of the "Public investment, private innovation: The global market for air quality monitoring" report [29]

Key takeaways	Meaning for AQ-WATCH
National air quality standards drive air quality monitoring programs and investments in regulatory-grade equipment. Technology providers can look to pollution standards to indicate where governments might be expanding their monitoring efforts.	AQ-WATCH should identify and focus on countries with air pollution standards.
Regional and local agencies are the primary funders and implementers of air quality monitoring networks. While ambient air quality standards are set at the national level, regional and local agencies are primarily responsible for funding and implementing regulatory-grade monitoring with support from national government agencies and international investors.	AQ-WATCH should not address only public organisations at national level but also at local level.
Public demand for lower-cost sensors has increased significantly in the past decade and is expected to continue to increase as a result of pressure from environmental advocates and the public's desire to better understand personal exposure to air pollutants and toxics.	There is a desire from citizens to be better informed about the air pollution that they are exposed to. This should be taken into account

[3] https://www.c40.org/

Agencies view lower-cost sensors as complementary to regulatory-grade monitoring. Since regulators and researchers remain sceptical of data produced by lower-cost sensors, government agencies and academic institutions are evaluating how lower-cost sensors can complement existing networks.	The use of low-cost sensors are expanding. They will be strong competitors but could also be combined with AQ-WATCH modules.
As countries, regions and cities expand their air pollution monitoring networks, the need for data validation and analysis will also grow, especially due to regional and local governments' lack of capacity. There is an opportunity for technology providers to support government agencies in drawing informative insights from the data generated from these monitors, as well as to improve reference monitoring sites.	AQ-WATCH consortium, with its leading research institutes, is in a unique position to address this need for support.
Effective communication of air quality data is a critical component of air quality management systems. Technology providers can fill the communications gaps by providing services that ensure real-time data is accurate and placed into an appropriate context – especially as public interest in how pollution monitoring data can be interpreted for health outcomes increases.	The interface and the air quality index should be developed with extreme care.
Multilateral agencies are important sources of funding for beginning air quality monitoring efforts in locales where none exists and for building capacity for nascent efforts. Funders, such as the World Bank and the United Nations Development Programme, are investing in better monitoring and management capacities. In countries where monitoring efforts are either in the early stages or scaling up, public spending on air quality monitoring consists of regulatory-grade monitoring equipment.	Funders, such as the World Bank and the United Nations Development Programme, are key investors in better monitoring and management capacities
Air pollution is not yet a priority government issue in some countries. Some programs are underfunded and understaffed — with growth opportunities in the areas of quality assurance and quality control. In many cities, conventional air monitoring is defective or non-existent, particularly in developing countries. This limits the availability of reference air quality data at a local scale, which might delay deployment of lower-cost sensors.	AQ-WATCH, with its satellites-based system, answers perfectly this issue.

North America:

Federal agencies from USA provide key funding support for air quality monitoring networks, but subnational entities provide a higher portion of overall costs to operate and maintain equipment. Funding for air quality monitoring at federal levels has been consistent over the past 10 years. Based on an analysis of expenditures between 2010 and 2019, the EPA allocated over 10.4 million Euros in grants involving air quality monitoring

Between 2010-2020, for-profit organizations received over 91.5 million Euros to perform a wide range of services such as:

- Supplying monitoring equipment to the U.S. EPA
- and other public agencies;
- Spatial and temporal analysis of air pollutant data;
- Operation and maintenance of monitoring sites; and
- Software support and technical assistance.

Highlights from the EPA's budget for the fiscal year 2022:

- The FY 2022 President's Budget includes 304.6 million Euros [19] for grants to support State and Local and Tribal Air Quality Management programs. Grant funds for State and Local Air Quality Management and Tribal Air Quality Management are requested in the amounts of 285.6 million Euros and 19 million Euros, respectively[19]. These funds provide resources to multi-state, state, local, and tribal air pollution control agencies for

the development and implementation of programs for the prevention and control of air pollution and for the implementation of National Ambient Air Quality Standards (NAAQS) set to protect public health and the environment.

- In FY 2022, the EPA will continue to work with state and local air pollution control agencies to develop and implement State Implementation Plans (SIPs) for NAAQS, monitor industry compliance with EPA stationary source regulations, develop plans for regional haze, and develop and operate air quality monitoring networks. Through the Tribal Air Quality Management program, EPA will continue to work with federally recognized tribal governments nationwide to develop and implement tribal air quality management programs and to build tribal air quality management capacity.
- Increased funding requested in both grant programs will help expand the efforts of state, local and tribal air pollution control agencies to implement their programs and to accelerate immediate on the-ground efforts to reduce greenhouse gases, such as expanding deployment of renewable energy sources and energy efficiency programs; capping of oil and gas wells to reduce volatile organic compounds (VOC) and methane emissions; developing policies and programs to facilitate buildout of electric vehicle charging station infrastructure; and supporting programs to improve transportation options and reduce disproportionate exposure to traffic emissions in disadvantaged communities. Through this funding, the EPA will support environmental justice by increasing air quality monitoring in minority, low-income and marginalized communities that are and have been overburdened with disproportionate environmental or public health risks resulting from exposure to pollution.

	FY 2020 Actuals	FY 2021 Enacted	FY 2022 Pres Budget	FY 2022 Pres Budget v. FY 2021 Enacted
Science & Technology				
Clean Air and Climate				
Clean Air Allowance Trading Programs	$7,537.7	$6,793.0	$8,800.0	$2,007.0
Climate Protection	$7,326.8	$7,895.0	$9,997.0	$2,102.0
Federal Support for Air Quality Management	$8,974.6	$7,154.0	$10,222.0	$3,068.0
Federal Vehicle and Fuels Standards and Certification	$98,543.9	$96,783.0	$110,169.0	$13,386.0
Subtotal, Clean Air and Climate	**$122,383.0**	**$118,625.0**	**$139,188.0**	**$20,563.0**
Environmental Programs & Management				
Clean Air and Climate				
Clean Air Allowance Trading Programs	$15,503.2	$13,153.0	$18,138.0	$4,985.0
Climate Protection	$103,054.5	$97,000.0	$103,689.0	$6,689.0
Federal Stationary Source Regulations	$21,244.6	$20,733.0	$26,618.0	$5,885.0
Federal Support for Air Quality Management	$131,855.1	$138,020.0	$257,808.0	$119,788.0
Stratospheric Ozone: Domestic Programs	$4,872.4	$4,633.0	$10,901.0	$6,268.0
Stratospheric Ozone: Multilateral Fund	$8,347.0	$8,711.0	$18,000.0	$9,289.0
Subtotal, Clean Air and Climate	**$284,876.8**	**$282,250.0**	**$435,154.0**	**$152,904.0**
Categorical Grants				
Categorical Grant: Nonpoint Source (Sec. 319)	$171,125.7	$177,000.0	$180,000.0	$3,000.0
Categorical Grant: Public Water System Supervision (PWSS)	$109,075.2	$112,000.0	$122,000.0	$10,000.0
Categorical Grant: State and Local Air Quality Management	$222,318.8	$229,500.0	$321,500.0	$92,000.0
Categorical Grant: Radon	$7,646.0	$7,795.0	$8,951.0	$1,156.0
Categorical Grant: Pollution Control (Sec. 106)				
Monitoring Grants	$18,586.9	$17,267.0	$17,267.0	$0.0
Categorical Grant: Pollution Control (Sec. 106) (other activities)	$215,906.4	$212,733.0	$217,333.0	$4,600.0
Subtotal, Categorical Grant: Pollution Control (Sec. 106)	$234,493.3	$230,000.0	$234,600.0	$4,600.0

Figure 34: Extract from the Categorical Program Grants by National Program and Media (EPA) [19]

Meanwhile, in Canada, Environment and Climate Change Canada (ECCC), also known as the Department of the Environment, implements an Air Quality Management System (AQMS) — formed in 2012 as an agreement between federal, provincial and territorial governments — to implement a comprehensive and collaborative approach for reducing air pollution. In the past 10 years, notable investments in air quality monitoring for Canada include: ensuring monitoring instruments are properly maintained and replacing instruments that have reached their end of life; investing in the Canadian Air Health Index and real time mapping websites; and expanding laboratories and analytical equipment for detailed chemical analysis, e.g., VOC and PM2.5 speciation [10].

According to a survey by ECCC staff, provinces and territories contribute approximately 22 million Euros, while ECCC contributes 5.3 million Euros annually to the NAPS network. In the past 10 years, ECCC's expenditures for the NAPS network total 41.2 million Euros with spending spread across provinces and territories. The Air Quality program of the ECCC has an annual budget of ca. 51.6 million Euros [24].

30 Provinces and territories assume most of the costs in monitoring networks, such as providing infrastructure and collecting the data. A memorandum of understanding between ECCC and the provinces and territories of Canada was signed in October 2019. ECCC's responsibilities include collaborating with the provinces and territories in overall management of the NAPS program, locating NAPS sites, and coordinating a national quality assurance and audit program.

Meanwhile, provinces and territories' responsibilities include providing land and infrastructure and associated costs for each NAPS site and collecting, processing, managing, analyzing and reporting continuous air quality monitoring data [29].

Beyond the NAPS program, provinces and territories are independently funding air pollution monitoring to address regional or local issues. For example, the province of Nova Scotia uses revenue generated from its pollution tax to fund air quality monitoring programs. Similarly, in the province of Alberta, revenue generated from pollution pricing fund monitoring programs led by non-profit organizations in the province's airsheds [29].

Latin America:

Many governments from Latin America are facing difficulties with the availability of resources to develop and implement strategies to monitor the air quality. Properly operated air monitoring networks are still the exception and reliability of air quality data from conventional monitoring is a challenge in many countries. However, international organizations such as the World Bank and the United Nations Development Programme (UNDP) provide critical support for national government agencies to establish ground-level and regulatory-grade monitors (See below).

Table 16: Top Five Funding Organizations by Total Amount, 2010–2020 [29]

Name of Funding Organization	Recipient countries	Total Amount	Project Description(s)
The World Bank (International Bank for Reconstruction and Development)	Peru	28.4 million Euros loan	Establish ground-level monitoring network throughout Peru (project scoped for a total of 35.5 million Euros committed 2017-2021).
Swiss Agency for Development and Cooperation	Bolivia	3.38 million Euros loan	Establish ground-level monitoring network throughout Bolivia.
Germany Federal Ministry of Education and Research	Brazil	0.88 million Euros	KLIMAPOLIS program to establish cooperation between Germany and Brazil on issues including air pollution in urban areas.
Chile Federal Ministry of Environment	Chile	0.83 million Euros	Annual budget allocation for air quality forecast modelling
Argentina Federal Ministry of Environment and Sustainable Development	Argentina	0.87 million Euros	Investment under a UNDP program to setup an automatic monitoring network.

Asia:

According to the state of global air quality funding report[50] published by the Clean and Air initiate in 2022, between 2015 and 2021, 88% of air quality funding provided by international development funders was concentrated in five countries in Asia: China (42%), the Philippines (26%), Bangladesh (12%), Mongolia (6%) and Pakistan (4%). This is largely because the top four funders (i.e., Japan, Asian Development Bank, Asian Infrastructure Investment Bank, and the Republic of Korea) - which account for 45% of total air quality funding – have a regional focus on Asia. Regions such as Africa and Latin America receive significantly lower funding, accounting for only 3.7% and 0.3% of the total during the same period.

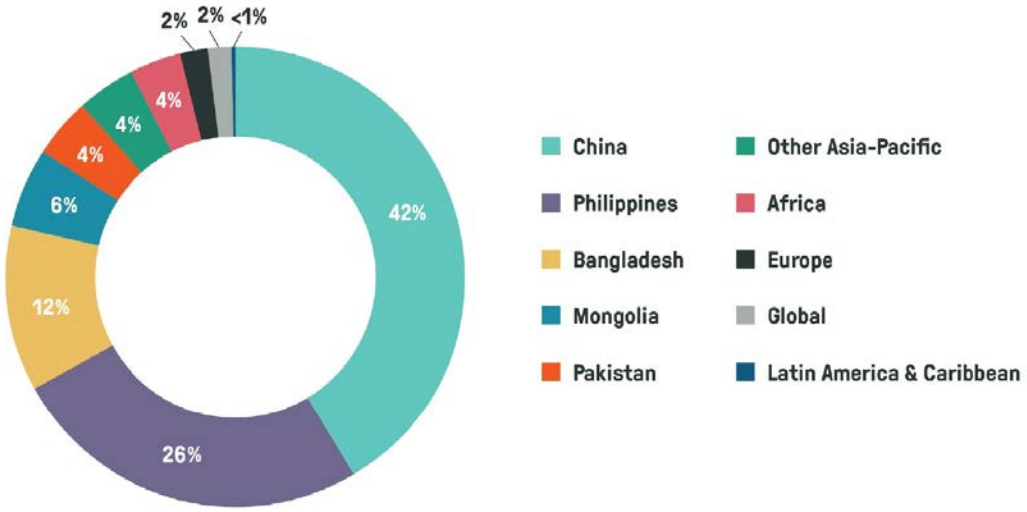


Figure 35: International development funding to air quality by region of destination, 2015-2021 (source : The state of global air quality funding [50])

Based on data from the Health Effects Institute's State of Global Air 2021 report, it is evident that China and India have the highest number of air pollution-related deaths. In 2019, China recorded 1.5 million deaths, while India had 1.1 million deaths. China consistently receives a significant portion (42%) of the total air quality finance, whereas India's share is much lower at 2%. However, considering India's severe air quality issues and its substantial receipt of international development finance (averaging 5% of total flows annually between 2015 and 2020), there is an opportunity to increase funding for clean air initiatives. This can be achieved by ensuring that the clean air agenda becomes an integral part of development interventions in India. The text below address more specifically the cases of India and Chine

India:

In India, the National Clean Air Programme (NCAP) serves as the national program for ambient air quality monitoring, implemented by the Central Pollution Control Board (CPCB), State Pollution Control Boards (SPCBs), Pollution Control Committees, National Environmental Engineering Research Institute (CSIR NEERI) and various monitoring agencies. Targets are driving the expansion of the national ambient air quality monitoring network and investments in alternative monitoring technologies.

The implementation of the NCAP, as well as other pollution control activities such as satellite-based monitoring are funded by the CPCB which has seen it budget increased by 16% reaching 394.38 million Euros for the period 2019-2020.

Foreign governments (e.g.: the United States, Norway and Sweden) have also provided funding to research institutions, government agencies and NGOs to build capacity on air quality management efforts broadly, by funding over 163.17 million Euros in the past 5 years (see Figure 39) according to the grants recorded in the Organisation for Economic Co-operation and Development's Creditor Reporting System (CRS) [1].

China:

Tens of billions of Euros have been spent over the last decade in China. China has committed to spending over 49.74 billion Euros [11] for air pollution mitigation efforts according to official reports. China's rapid expansion of its national ambient air quality monitoring network has primarily relied on central government funding with support from cities which are responsible for funding localized monitoring networks. Between 2013 and 2017, the government invested 143 million Euros and local governments contributed 87 million Euros to expand the air quality monitoring network [11].

To strengthen supervision over local monitoring initiatives and to provide further information for local governments on inspection and pollution control measures to achieve national targets, various research initiatives have been funded using emerging monitoring technologies, such as sensor-based fixed and mobile air quality monitor and satellite monitors.

In total, the analysis made by the Environmental Defense Fund [11] identified over 249.6 million Euros invested in air quality monitoring from 2010-2020.

Table 17: Key Public Funding Mechanisms for Air Quality Monitoring in Region (2010-2020) [29]

Name of Public Funding Mechanism or Program	Amount Provided Between 2010-2020	Overview of Public Funding Mechanism
Ministry of Ecology and Environment	RMB 1.13 billion (160 million Euros) between 2013 and 2017	Expansion of national ambient air quality monitoring network
Local and Regional Governments	RMB 690 million (96.2 million Euros) between 2013 and 2017	Support for expansion of national ambient air quality network; funding local monitoring networks
International & Multilateral agencies, development funders	3.43 million Euros between 2010 and 2019	Focused broadly on capacity building initiatives for air pollution control measures

Africa:

Despite the pressing urgency to address air pollution in Africa, the continent continues to receive a disproportionately low amount of funding allocated for improving air quality according to Clean and Air Initiative [50]. Between 2015 and 2021, international development funders committed a mere $403.6 million to tackle air pollution in the region, which represents a paltry 3.7% of the total air quality funding. Although there has been an increase in this share over time, rising from 1.1% in 2015-2016 to 8% in 2020-2021, it still remains woefully inadequate, especially when considering that Africa accounts for 26% of global deaths caused by outdoor air pollution. Given their strategic position, international development funders have a crucial role to play in advancing the air quality agenda, and it is imperative for them to significantly ramp up their commitments to promoting clean air in the region.

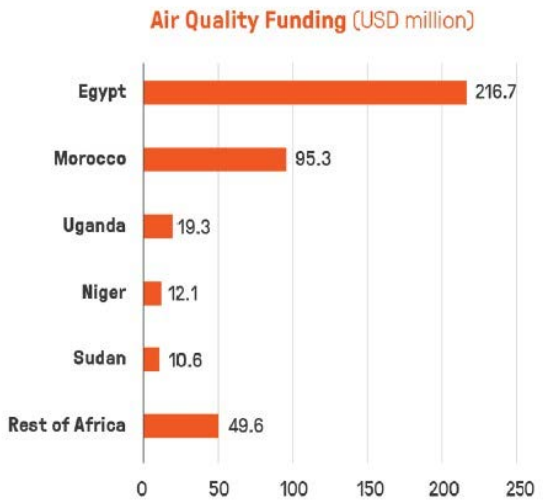


Figure 36: Top 5 African countries receiving air quality funding by international development funders, 2015-2020 (source: The state of global air quality funding [50])

Official development funders:

Over 1.24 billion Euros in official development spending was disbursed in 2019 to projects with the objective of improving air quality. Among the large number of funders, the Asian Development Bank and World Bank have been the most active, providing the bulk of the spending

as loans while the national government agencies such as the US Agency for International Development (USAID) or the Germany Development Agency (GIZ), fund projects bilaterally. They also co-finance alongside various multilateral actors, such as the regional development banks, United Nations' agencies, and specialist vertical funds, such as the Global Environment Facility. The Table 17 shows the amounts of fundings spent by the main development funders.

Table 18: Official development spending on air quality, including spending on primary and secondary projects, and the corresponding percentages of each development funder's total aid budget [38].

RANKING	DEVELOPMENT FUNDER	PRIMARY SPENDING (AVG. 2018-19 USD MILLIONS)	PRIMARY SPENDING AS % OF FUNDER'S TOTAL AID BUDGET 2018-19	COMBINED PRIMARY AND SECONDARY SPENDING (AVG. 2018-19 USD MILLIONS)	PRIMARY AND SECONDARY SPENDING AS % OF FUNDERS TOTAL AID BUDGET 2018-19	GRANT % OF PRIMARY AND SECONDARY SPENDING 2018-19 (AS OPPOSED TO LOANS)
1	ASIAN DEVELOPMENT BANK	325.4	2.11%	592.9	3.84%	0.99%
2	WORLD BANK - INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT	264.8	1.45%	272.1	1.49%	0.00%
3	JAPAN	183.8	1.31%	196.2	1.40%	0.09%
4	INTER-AMERICAN DEVELOPMENT BANK (IADB)	0.0	0.00%	55.7	0.61%	1.16%
5	KOREA	30.1	0.42%	30.2	0.42%	0.79%
6	GERMANY	1.6	0.01%	24.0	0.10%	50.48%
7	SWEDEN	2.1	0.06%	20.5	0.53%	100.00%
8	EU INSTITUTIONS	3.7	0.02%	16.4	0.08%	100.00%
9	WORLD BANK - INTERNATIONAL DEVELOPMENT ASSOCIATION	11.1	0.06%	11.1	0.06%	0.00%
10	UNITED STATES	2.8	0.01%	11.0	0.04%	100.00%
11	ARAB FUND (AFESD)	0.0	0.00%	10.4	1.62%	0.00%
12	CLIMATE INVESTMENT FUNDS: MULTILATERAL/REGIONAL DEVELOPMENT BANKS GLOBAL FINANCING INSTRUMENT	0.0	0.00%	8.5	3.35%	37.03%
13	FRANCE	8.4	0.08%	8.4	0.08%	0.51%
14	UNITED KINGDOM	6.1	0.04%	8.0	0.06%	100.00%
15	SWITZERLAND	3.4	0.14%	7.2	0.29%	100.00%
16	AUSTRIA	0.0	0.00%	5.1	0.69%	97.49%
17	GLOBAL ENVIRONMENT FACILITY	1.3	0.84%	4.4	2.78%	100.00%
18	EUROPEAN BANK FOR RECONSTRUCTION & DEVELOPMENT (EBRD)	0.0	0.00%	3.0	0.05%	0.00%
19	NORWAY	0.1	0.01%	2.3	0.06%	100.00%
20	BELGIUM	0.0	0.00%	1.3	0.11%	100.00%

According to the official figures from OECD-DAC database (Figure 37) [1], 798.1 million Euros of the 1.24 billion spent by the development funders in 2019 were on projects with the primary objective of reducing air pollution.

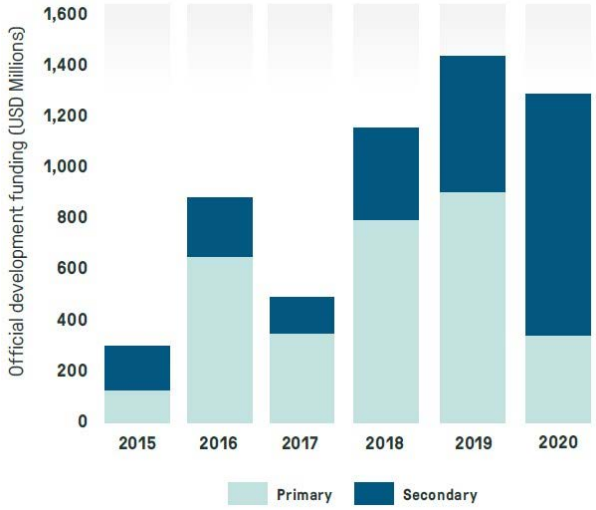


Figure 37: Annual primary & secondary official development funding to air quality, 2015–2020 [38].

In total, countries in Asia (including China) received over 80% of development funding to fight air pollution between 2015 and 2020. Countries in Latin America received 10%, and just 5% was spent in Africa. Within these regions, the funding is concentrated in a small number of countries, with the top 10 recipients accounting for 88% of disbursements. China, the largest recipient (Figure 39) accounted for 45% of disbursements over the period 2015-2020. For the top three recipients, China, Mongolia, and the Philippines, most pollution-related funding was in projects where air quality is a primary objective (Figure 38). The substantial amount of funding for large-scale projects in Ulaanbaatar, Mongolia, and the Beijing-Hebei area of China contributes significantly to this ranking. The biggest air quality funder, Asian Development Bank, is situated in a region with many cities suffering from air pollution.

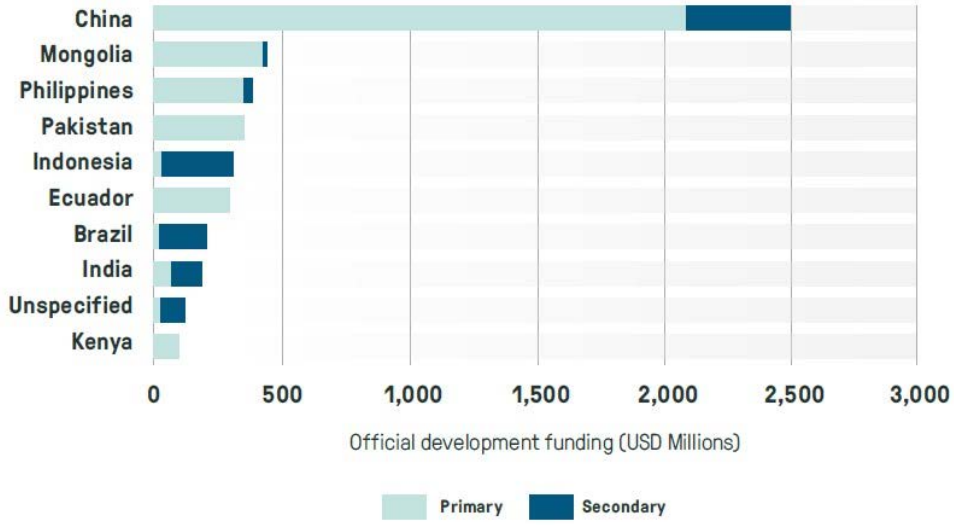


Figure 38: Top recipients of primary and secondary official development funding, 2015-2020.

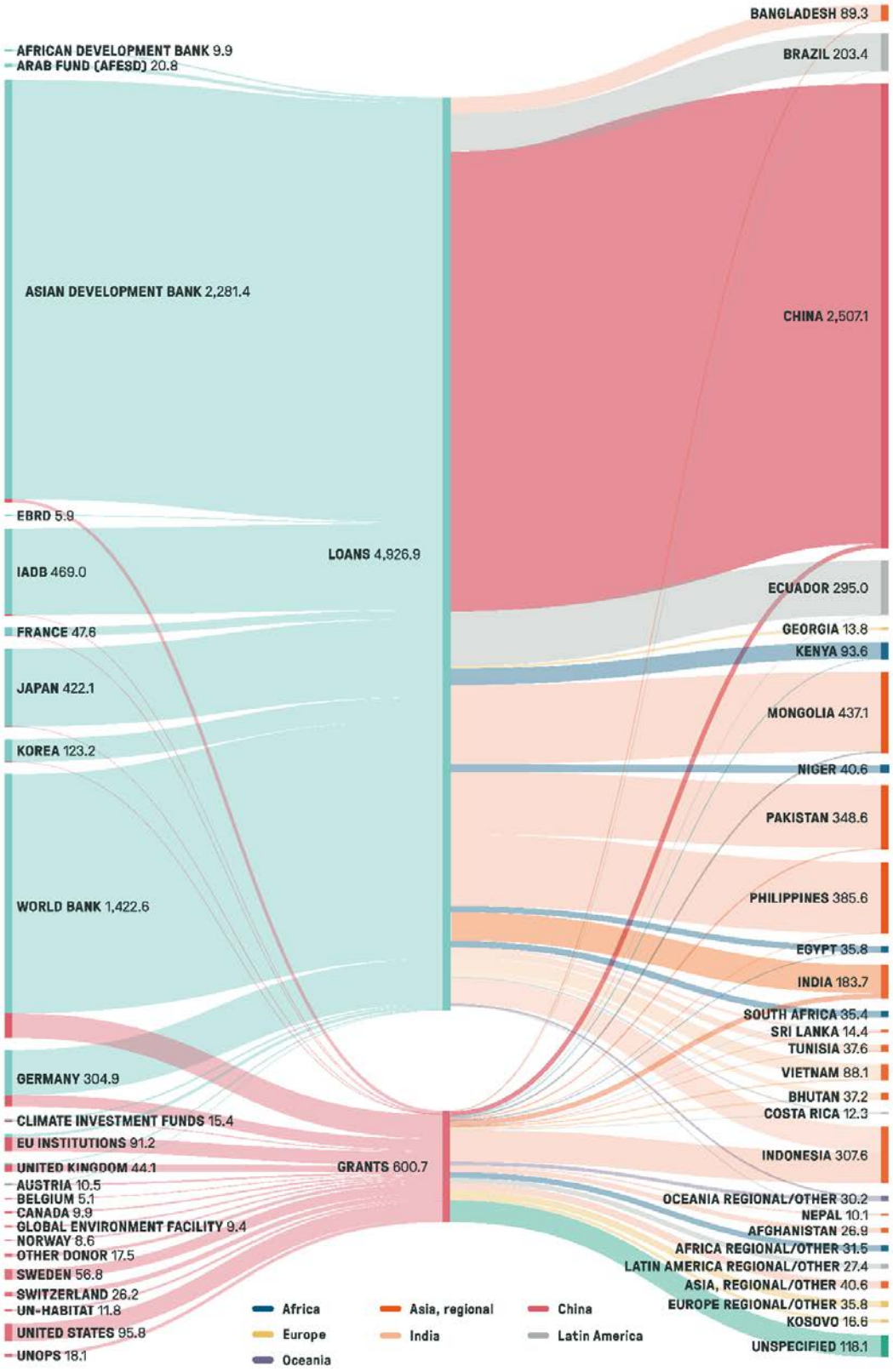


Figure 39: The flow of official development funding to air quality (primary & secondary combined), 2015-2020 (USD millions) [38].

Key figures for public funding:

- **International & Multilateral agencies, development funders:**
  Between 2015-2021, international development funders committed $11 billion (around $1.5 billion per year) to projects that purposely work to improve outdoor air quality.
  Air quality funding was concentrated in a handful of Asian countries, while in regions such as Africa and Latin America it lagged behind.
- **USA:**
  For the FY 2022, EPA's budget includes 304.4 million Euros for grants to support State and Local and Tribal Air Quality Management programs.
- **Canada:**
  The Air Quality program of the ECCC has an annual budget of 51.5 million Euros.
- **Latin America:**
  Most fundings come from development funders. Between 2015 and 2020, countries in Latin America received about 10% of the official development funding to air quality corresponding to 465.5 million Euros.
- **Asia:**
  between 2015 and 2021, 88% of air quality funding provided by international development funders was concentrated in five countries in Asia: China (42%), the Philippines (26%), Bangladesh (12%), Mongolia (6%) and Pakistan (4%).
- **Africa**:
  international development funders committed a mere $403.6 million to tackle air pollution in the region, which represents a paltry 3.7% of the total air quality funding
- **India:**
  The implementation of the NCAP, as well as other pollution control activities such as satellite-based monitoring are funded by the CPCB which has a budget of 394.38 million Euros for the period 2019-2020.
  International & Multilateral agencies, development funders distributed over 163.17 million Euros in the past 5 years to build capacity on air quality management efforts.
- **China:**
  China has committed to spending over 49.74 billion Euros for air pollution mitigation efforts. Between 2013 and 2017, the central government and local governments respectively invested 143 million Euros and 87 million Euros to expand the air quality monitoring network. In total, over 249.6 million Euros have been invested in air quality monitoring from 2010-2020.
  Besides, international & multilateral agencies and development funders distributed over 2.2 billion Euros for projects related to air quality in China between 2015 and 2020.

Public authorities need AQ-WATCH services to:

- Support policy-making related to air quality
- Estimation of policy efficiency and target achievement
- Identification of air pollution peaks and of best measures to adopt or mitigate such situations
- Ability to inform citizens on current, historical and forecasted air quality
- Survey pollutants dispersion over large areas

4.5.6.2. Customer segment "Impacted industries" (Solar plant and electricity grid operators, cosmetic industry…)"

Several industry sectors are impacted by the atmospheric pollution and in particular the skin care industry and the solar energy industries (power plants and electricity grid operators) but also the tourism industry.

Air pollution can have significant impacts on various industry sectors. Here are some industry sectors that are commonly affected by air pollution:

- **Agriculture and Crop Production:** Air pollution can have detrimental effects on agriculture and crop production. Particulate matter and pollutants can deposit on crops, affecting their growth and quality. Additionally, some pollutants can interfere with photosynthesis and reduce crop productivity. Agricultural workers may also face health risks due to prolonged exposure to polluted air.
- **Tourism and Hospitality:** Air pollution can negatively impact the tourism and hospitality sector. Poor air quality in popular tourist destinations can discourage visitors and affect the overall tourism industry. Additionally, air pollution can diminish the attractiveness of outdoor recreational activities and impact the hospitality sector, including hotels, resorts, and restaurants.
- **Manufacturing and Industrial Processes:** Industries that emit pollutants as part of their manufacturing processes are directly impacted by air pollution regulations. Sectors such as power generation, chemical production, refining, metal processing, and cement manufacturing often need to invest in pollution control technologies and comply with emission standards to mitigate their environmental impact.
- **Energy Generation and grid operators:** With dust predictions, operators of electricity grids and solar power plants can optimize energy generation, plan maintenance activities, ensure grid stability, and enhance energy demand management.
- **Cosmetics:** By leveraging air quality forecasts, the cosmetic industry can adapt their product offerings, enhance consumer education, and align with sustainability goals, ultimately providing added value to their customers and addressing the specific challenges associated with air pollution and its impact on skin and hair health.

Focus on the solar energy producers

According to the report "Solar PV" issued by IEA in 2021 [33], solar PV generation increased 22% (+131 TWh) in 2019 and represented the second-largest absolute generation growth of all renewable technologies, slightly behind wind and ahead of hydropower. Despite decelerating growth due to recent policy changes and uncertainties in China (the largest PV market globally), 2019 was a year of record global growth in PV capacity. As competitiveness continues to improve, solar PV is still on track to reach the levels envisioned in the IEA's Sustainable Development Scenario (SDS) which will require average annual growth of 15% between 2019 and 2030. Growth in the United States was stable, with 13.2 GW of solar PV becoming operational in 2019, 25% more than the 2018 additions, as a result of federal tax incentives and state-level policies. In the European Union, solar PV additions increased 98% year-on-year in 2019 owing to faster deployment in Spain, Germany and the Netherlands.

Brazil installed a record-level 2.1 GW of new solar PV capacity in 2019, more than doubling its achievement in 2018 [33]. Generous net metering incentives stimulated this rapid expansion, as residential and small commercial consumers receive significant returns on their investments.

Stimulated by strong policy support concentrated mostly in Europe, the United States and Japan, deployment of distributed solar PV systems in homes, commercial buildings and industry has been growing exponentially over the last decade [33].

Mohammad Reza and Mohammad Mood, in a study of the effects of soil on large grid-connected PV panels in California [31], state that annual losses due to the accumulation of soil in solar PV panels range from 1.5% to 6.2%. As production is lost, the solar system must rely on power from the grid to supply the lost energy, and, of course, there will be a charge for that. Even for the most efficient solar systems, production will be reduced if the panels are not being cleaned. System owners need to make sure that they keep their solar panels free from dust, dirt, birds droppings, etc. so the panels can keep operating at peak performance.

Tests performed by Exosun on a 70 MW plant in the Middle East showed that the yearly cost to clean 4.5 MW panels for standard manual cleaning using cleaning trucks is in the range of 26 000 Euros [33]. With robotic solution such as Exosun machines, it yearly cost is reduced to 16 000 Euros for 4.5 MW panels [33]. The biggest solar plants easy reach several hundreds, if not thousands, of MW capacity [49]. Then, the annual cost for cleaning a whole solar plant can easily reach several hundred thousand Euros.

As shown in the Figure 40,the Middle East, Southwestern U.S., Chile and parts of India and China are the most exposed to dust and moisture and offer market potential any system helping the operators to optimize the cleaning costs.

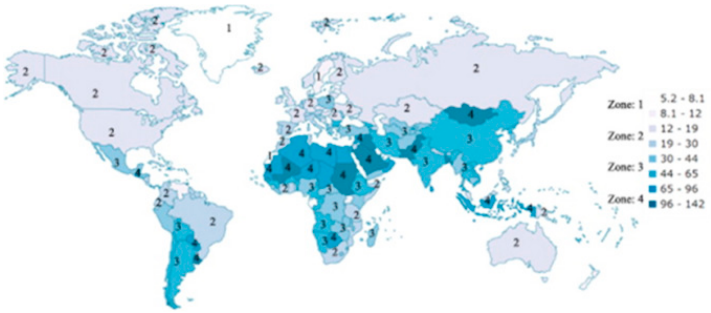


Figure 40: Global dust intensity levels [31]

Use of EO data on factors impacting solar energy yields such as aerosol optical depth, ozone concentration or cloud cover can support both site selection, efficiency monitoring and yield forecast of solar power plants. Site selection is particularly key, as it is not only about determining the irradiance on a site, but is also about ensuring shading effects of solar panels e.g. due to dust are avoided and that sky conditions will be clear the majority of the time. As for energy monitoring and forecasting, the main interest of EO is to reduce uncertainties and ensure reliability of the estimations whose errors can lead to unforeseen costs.

The 15 largest solar power plants in the world in 2021 [49]:

- Bhadla Solar Park, India - 2,245 MW
- Huanghe Hydropower Hainan Solar Park, China - 2,200 MW
- Pavagada Solar Park, India - 2,050 MW
- Benban Solar Park, Egypt - 1,650 MW
- Tengger Desert Solar Park, China - 1,547 MW
- Noor Abu Dhabi, United Arab Emirates - 1,177 MW
- Mohammed bin Rashid Al Maktoum Solar Park, United Arab Emirates - 1,013 MW
- Kurnool Ultra Mega Solar Park, India - 1,000 MW
- Datong Solar Power Top Runner Base, China - 1,000 MW
- NP Kunta, India - 978 MW
- Longyangxia Dam Solar Park, China - 850 MW
- Villanueva Solar Park, Mexico - 828 MW
- Copper Mountain Solar Facility, United States - 802 MW
- Mount Signal Solar, United States - 794 MW
- Rewa Ultra Mega Solar, India - 750 MW

As of January 2021, China is the global leader in terms of solar plant capacity, but India, the United Arab Emirates, and the United States are significant solar generators too [49].

The needs of the solar energy industry are:

- Optimize the selection of solar plants locations and design
- Better estimate of the outputs (e. g. based on plant characteristics coupled with forecasts)
- On demand maintenance
- Production of forecasts (e.g. irradiance forecasts) for a better integration to the electricity grid

Focus on the cosmetic industry

The cosmetic industry is also impacted by air pollution as it is potentially damaging to the skin. Beauty products with anti-pollution battling skin care are on the rise. Increasing pollution levels and thus deteriorating air quality, the depleting ozone layer and a wider awareness of climate change and environmental topics, have all caused a huge shift in consumers' attitude over the past few years and is driving demand for anti-pollution skincare products. According to the World

Health Organization, over 90% of the world's population lives in places where air pollution is above WHO guidelines [38]. This is one of the reasons why almost every skincare brand across the world have developed a new range of anti-pollution products today. Almost every skincare brand today has an anti-pollution line to its name [6]. This evolution in the cosmetic industry is an opportunity for AQ-WATCH to offer innovative solutions. Indeed, each pollutant has a different effect on the skin, along with the exposure time. Real-time data provide accurate, and specific information that in turn allows beauty companies to offer customized and relevant solutions to their consumers such as a cosmetics app or feature on how to treat your skin before and after being immersed in polluted air, and based on the pollutants you have been exposed.
Furthermore, cosmetic companies have a range of products to help consumers prevent premature aging, clogged pores and other skin damages caused by air pollution. Customized campaigns with a sense of urgency based on air quality data could drive sales. Beauty products and the marketing efforts of the cosmetics industry will evolve with real-time air quality data.
The global anti-pollution skincare products market size was estimated at 8.05 billion Euros in 2018 and is likely to expand further at a CAGR of 4.2% from 2019 to 2025 [7].

The needs of the cosmetic industry are:

- Real-time data of specific pollutants or overall air quality
- Daily forecasts of specific pollutants or overall air quality at a regional or urban scale.

The major players in the skincare market [27]: L'Oreal S.A, Unilever PLC, The Estee Lauder Companies Inc, Procter & Gamble, Shiseido and Coty.

Focus on the tourism industry

The air quality as of the overall environmental quality is to be taken into account as an important factor in the decision-making process of tourists to choose their destinations. Indeed, environmental quality can have a significant effect on the tourism destinations competitiveness [42]. In many touristic regions such as Egypt, China and India, the air quality and the environmental quality is deteriorating often because of the urbanization and industrialization trends. Beyond the more usual environmental problems that garbage disposal and water pollution can be, the increase of haze pollution in recent years has become a problem and the air quality is now a universal concern [15].
In a literature review study published in March 2020 in the Journal of Tourism Futures [38], several impacts of air pollution have been highlighted such as the impact on travel behaviour, travel intention and destination choice, the impact on visitors' satisfaction or the impact on global tourism demand. Even if the number of publications on this issue is limited, some trends have been identified. Indeed, both research on global tourism demand and on individual perceptions reveal that air quality tends to have a positive influence on tourism demand, with decreases in air quality leading to decreases in tourism flows or to a lower likelihood of visiting certain destinations.

The needs of the tourism industry are:

- Monitor the visibility and air quality in touristic areas in order to define appropriate strategies for haze reduction,
- Generate statistics on average visibility in order to better communicate to the potential tourists.

4.5.6.3. Customer segment "Emitting industries"

By investing in air quality monitoring and forecasting systems, emitting industries can achieve:

- **Regulatory Compliance:** Emitting industries are subject to strict environmental regulations and emission limits. An air quality forecasting system helps these industries proactively monitor and predict air pollution levels in their vicinity. By having real-time information on air quality, emitting industries can ensure compliance with regulatory standards and take necessary measures to minimize their emissions, avoiding potential penalties or legal consequences.
- **Operational Optimization:** An air quality forecasting system enables emitting industries to optimize their operations based on anticipated air pollution levels. By knowing in advance when pollution levels are expected to be high, industries can plan their production schedules, adjust processes, and implement control measures to minimize emissions during periods of poor air quality. This optimization can lead to improved efficiency, reduced waste, and cost savings.
- **Risk Mitigation:** Air pollution incidents can have negative consequences for emitting industries, including reputational damage, public outcry, and potential legal liabilities. An air quality forecasting system helps identify periods of high pollution levels, enabling industries to proactively manage and mitigate potential risks. By taking preventive measures, such as adjusting production or implementing emission reduction strategies, industries can reduce the likelihood of pollution incidents and associated negative impacts.
- **Stakeholder Communication:** Emitting industries often face scrutiny from local communities, environmental groups, and regulatory authorities regarding their environmental performance. An air quality forecasting system provides industries with accurate and up-to-date data on air pollution levels. This information can be shared with stakeholders to demonstrate transparency, engage in informed dialogue, and showcase efforts to monitor and manage air quality effectively.
- **Reputation enhancement**: Implementing an air quality forecasting system demonstrates the commitment of emitting industries towards environmental stewardship and responsible business practices. It showcases their efforts to monitor and mitigate air pollution, contributing to the overall improvement of air quality in the surrounding environment. This commitment can enhance the reputation of emitting industries, attract environmentally conscious customers, and foster positive relationships with stakeholders.

Hereby, “emitting industries” refers to: energy supply; metal (ferrous and non-ferrous) production; non-metallic minerals production; extractive industries; chemicals; other manufacturing; waste (including water and sewage management).
A significant majority of countries have legal instruments containing ambient air quality standards.
The United Nations Environment Programme (UNEP) conducted a survey in 2020 among its members. It appeared that 124 countries had ambient air quality standards implemented (Figure 41), in comparison, 107 countries in the last study in 2016. Besides, more than one fifth of countries are in the process of reviewing or updating those standards and nearly another fifth has plans to introduce standards in legislation in the near future.

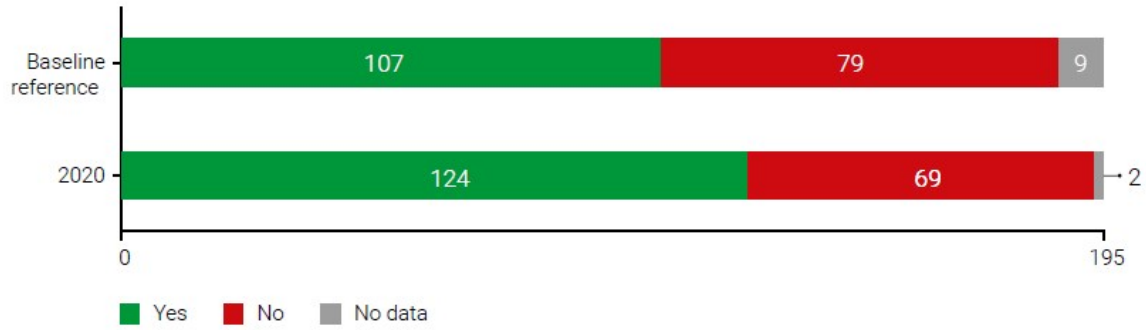


Figure 41: Countries with ambient air quality standards embedded within a legal Instrument (source: UNEP survey data) [1]

Due to stricter regulations in force in those countries prescribing the maximum concentration of pollutants, there is a need for the emitting industries to know better their impact on air quality and to assess the efficiency of the mitigation measures applied (Figure 42). Besides, often industrial areas and residential neighbourhoods are very close to each other such that industrial pollution might affect citizens and communities.
The list of potential customers worldwide is incredibly large. Only in the US, there are thousands of industrial sources, which are responsible for emissions of various types of pollutants, including “Criteria Pollutants” and other hazardous (or toxic) air pollutants, which are regulated under the Clean Air Act. If considering Europe only, the number of industrial facilities emitting suspended particles, NO_x/NO_2 and SO_X/SO_2 is 7473 according to the industrial reporting database under the Industrial Emission Directive 2010/75/EU [23]. The European Pollutant Release and Transfer Register comes to a similar conclusion: 2333 facilities emit NO_x/NO_2 in the air, 362 facilities emit PM_{10} and 952 facilities emit SO_X/SO_2 [21].
Even if the EU is not the primary target of the AQ-WATCH products and services, these numbers give a good indication on the market potential.

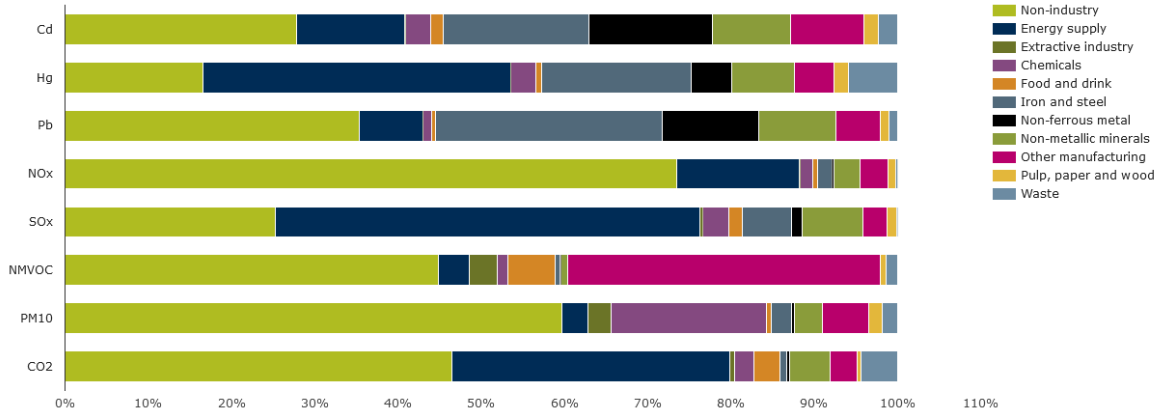


Figure 42: Air emissions as a percentage of total EEA-33 pollutant emissions in 2017, by sector (source: European Environment Agency [1])

In any country where there is a regulation on industrial emissions, emitting industries may:

- Have to ensure compliance with emission limits set for private companies with real time data.
- Want to anticipate the adaptation of their production according to air quality forecasts.

4.5.6.4. Customer segment "Emergency services"

Air quality forecast and monitoring can provide valuable support to emergency services, including firefighters, in several ways:

- **Safety of Firefighters:** Air quality monitoring systems can help assess the level of pollutants, such as smoke, particulate matter, and toxic gases, in the vicinity of a fire. This information allows firefighters to gauge the potential health risks and take appropriate precautions, such as wearing personal protective equipment (PPE) and respiratory masks, to minimize exposure to harmful substances during firefighting operations.
- **Planning and Resource Allocation:** Air quality forecasts can assist emergency services in planning their operations and allocating resources effectively. By knowing the expected air quality conditions, firefighters can prioritize their response efforts, allocate personnel and equipment accordingly, and strategize their firefighting tactics based on the anticipated challenges posed by the air pollution associated with the fire.
- **Incident Management and Evacuation:** Air quality monitoring systems can help emergency services in managing fire incidents and coordinating evacuation procedures. Real-time monitoring of air pollution levels allows authorities to assess the spread of smoke and toxic gases, identify areas at higher risk, and make informed decisions regarding evacuation orders to protect the public and ensure the safety of both affected and surrounding communities.
- **Communication and Public Alerts:** Air quality monitoring systems enable emergency services to provide accurate and timely information to the public regarding air pollution risks during fire incidents. This includes issuing air quality alerts, recommending protective measures, and advising vulnerable populations, such as individuals with

respiratory conditions, to take necessary precautions. Effective communication helps in minimizing the potential health impacts on the affected communities.

- **Post-Fire Assessment and Recovery:** Air quality monitoring and assessment continue to be important even after a fire is extinguished. Monitoring systems help in evaluating air quality in the aftermath of a fire, identifying any lingering pollutants or hazardous materials, and assessing the potential risks to public health during the recovery and cleanup phase. This information aids in implementing appropriate remediation measures and ensuring a safe environment during the post-fire recovery process.

Extreme wildfires have profound consequences, leading to substantial disruptions in social, environmental, and economic aspects. The social costs incurred by these wildfires extend beyond the loss of lives and encompass widespread health impacts. As a global example, air pollution resulting from wildfires is associated with approximately 340,000 premature deaths annually[51]. Moreover, extreme wildfires can inflict long-lasting and potentially irreversible damage on ecosystems. For instance, following the 2017 wildfires in Chile, nearly 40% of critically endangered habitats suffered significant harm[51]. Additionally, certain regions in the United States experienced a doubling of areas where vegetation failed to regenerate between 2000 and 2011 due to wildfires. In economic terms, the impact of extreme wildfires has reached unprecedented levels. The 2018 California Camp Fire alone incurred direct costs of approximately USD 19 billion, while the 2019-20 wildfires in Australia resulted in direct costs amounting to USD 23 billion [51].
By integrating air quality forecast and monitoring systems into emergency services' operations, firefighters can make informed decisions, enhance the safety of their personnel, protect public health, and effectively respond to fire incidents while considering the potential risks associated with air pollution.

Wildfires are common throughout the world and a warmer and drier climate is expected to lead to more frequent and more intense fires near or within populated areas. Recent headlines are full of wildfire stories. In 2020, many countries have experienced their worst wildfires in decades [26].
According to the European Space Agency, “Fire affects an estimated four million square kilometres of Earth’s land each year and is responsible for releasing aerosols and greenhouse gases to the atmosphere” (Figure 43) [30]. To put that in context, that is about half the size of the United States, larger than India, or roughly four times the size of Nigeria.

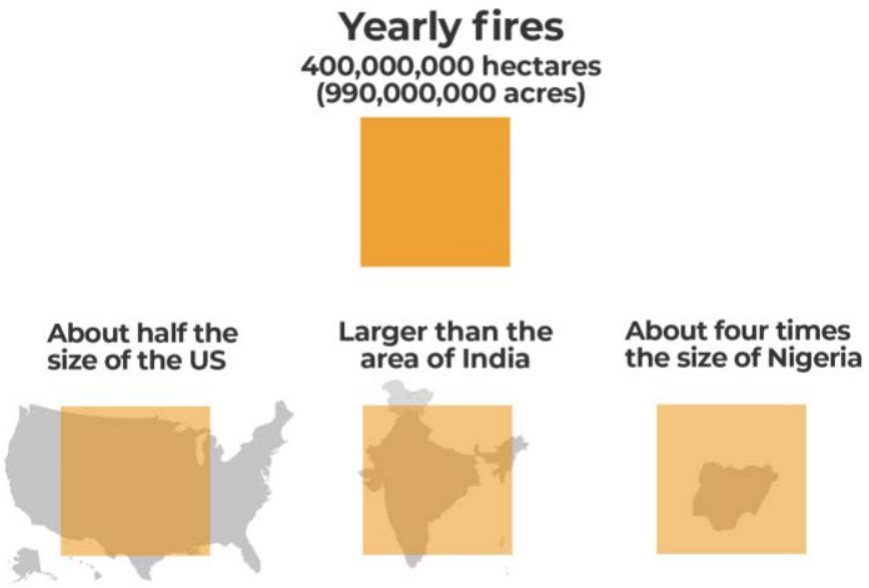


Figure 43: 4 million km² burned each year (source: www.aljazeera.com [29])

Smoke generated by wildfires is a mixture of various pollutants, amongst which are particulate matter below 2.5 um ($PM_{2.5}$) and various gases. Direst emissions of toxic pollutants can affect first responders and local residents. Breathing in smoke can have immediate health effects, including coughing, trouble breathing normally, stinging eyes, a scratchy throat, runny nose, irritated sinuses, wheezing and shortness of breath, chest pain, headaches, an asthma attack, tiredness and fast heartbeat.

Weather conditions such as wind, temperature, and humidity contribute to fire behaviour and smoke accumulation. Once smoke enters the atmosphere, its concentration at any one place and time depends on mechanisms of transport and dispersion. Winds move smoke away from the fire and contribute to atmospheric mixing meaning smoke impacts to the public may be lessened near the fire while winds can move smoke long distances into communities far from where the wildfire is burning.

Communicating air quality conditions during wildfires is one of the measures to reduce their impacts on the public health. Accurate real-time monitoring of smoke and of the air quality can be very challenging. On-site air quality sensors can easily become damaged, causing them to fail to report accurately or not to report at all because of the fire itself. They may also be too far away and not measuring the right information.

By combining ground observation and satellites data, AQ-WATCH can help to provide more accurate information on the wildfires to the emergency services.

As indicate above, most parts of the world are facing larger and more frequent wildfires. It is expected that most of the emergency services and national/regional agencies in charge of these events will have increasing needs which can be:

- Information on emissions, especially from different source materials
- Information on transport of and chemical reactions in fire plumes
- Information on evolution and dynamics of fires and fire plumes

- Improved fire weather analysis to aid first responders and fire managers
- Quantitative assessment of population exposures to toxics from fires
- Measures of air quality impairment from ozone and primary or secondary particles

4.5.6.5. Customer segment "Airports and flight control authorities"

The air transport sector would also benefit from a dust forecasting service for:

- **Safety of Flight Operations:** Dust forecasts provide crucial information about the presence and movement of dust storms and airborne dust particles in the vicinity of airports. This information is vital for ensuring the safety of flight operations. Flight control authorities can utilize dust forecasts to assess the potential hazards posed by reduced visibility, turbulence, or engine ingestion of dust particles. By proactively identifying areas affected by dust storms, authorities can issue relevant advisories, implement safety protocols, and adjust flight schedules to minimize risks and ensure safe operations.
- **Flight Planning and Route Optimization:** Dust forecasts enable flight control authorities and airlines to optimize flight planning and routing. By incorporating dust information into their decision-making processes, authorities can identify areas with high dust concentrations and reroute flights accordingly. This helps in avoiding areas of severe dust storms or high dust particle concentrations, minimizing the risk of encounters with hazardous conditions. It allows for efficient and safe flight operations while optimizing fuel consumption and reducing potential delays.
- **Operational Efficiency and Cost Savings:** Accurate dust forecasts contribute to the operational efficiency of airports and airlines. By having advance knowledge of potential dust events, airports can proactively prepare infrastructure, such as airfield maintenance and runway cleaning, to mitigate the impacts of dust deposition. Airlines can adjust their maintenance schedules, inspect filters, and take preventive measures to minimize the impact of dust on aircraft performance and engine efficiency. These proactive actions can reduce maintenance costs, increase operational efficiency, and minimize potential disruptions caused by dust-related issues.
- **Collaborative Decision Making:** Dust forecasts facilitate collaborative decision making among flight control authorities, airlines, and airport operators. By sharing accurate and timely dust information, stakeholders can engage in collaborative planning and decision making to mitigate the impacts of dust on flight operations. This collaboration ensures a coordinated response, effective resource allocation, and consistent communication, leading to more efficient and resilient operations in the face of dust events.

Volcano eruptions (Figure 44), wildfires as well as dust storms also pose unique problems for the aviation community. The most common problem is the reduction of visibility because of the smoke which strongly depends on the wind direction. Airports may close and reroute air traffic because of visibility problems, unstable air currents caused by the fires and dust storms, or damage to aviation facilities and runways.

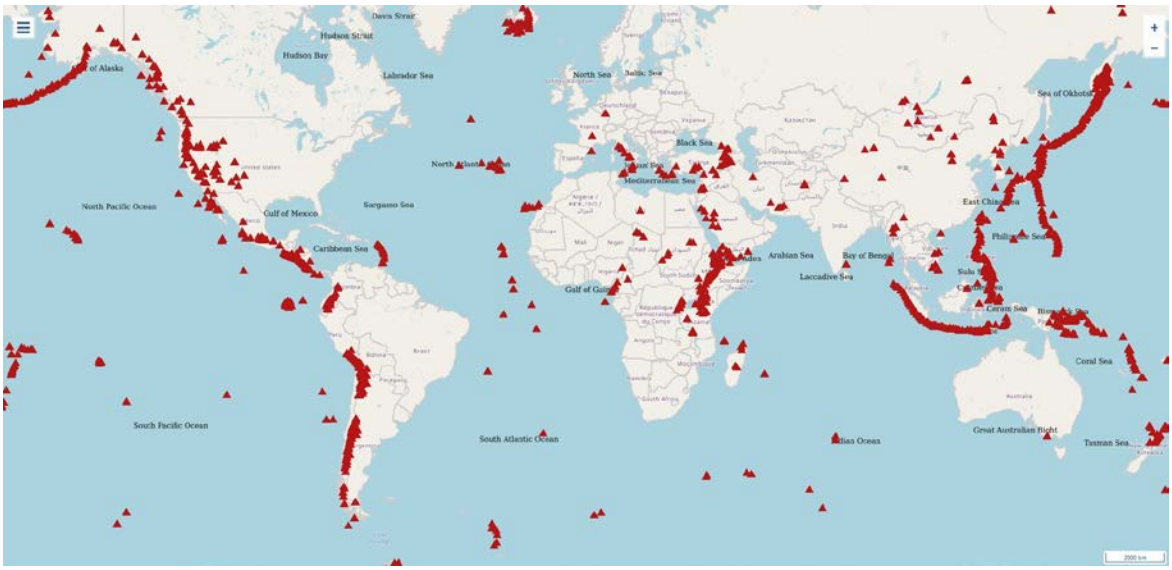


Figure 44: Volcanoes world map (source: https://worldinmaps.com/volcanoes/)

In April 2010, global attention shifted towards Iceland where the volcano named Eyjafjallajökull had erupted for the first time since 1823 (see the Figure 45), spewing a massive ash cloud and causing the largest shutdown of European airspace since World War II.
The air traffic suspension resulted in over 108 000 flights being cancelled [41]. Over five days, the most affected countries (UK, Ireland, and Finland) experienced a 90% decrease in air traffic resulting in about 7 million passengers left stranded and in effects extending to trade, business, and general production.

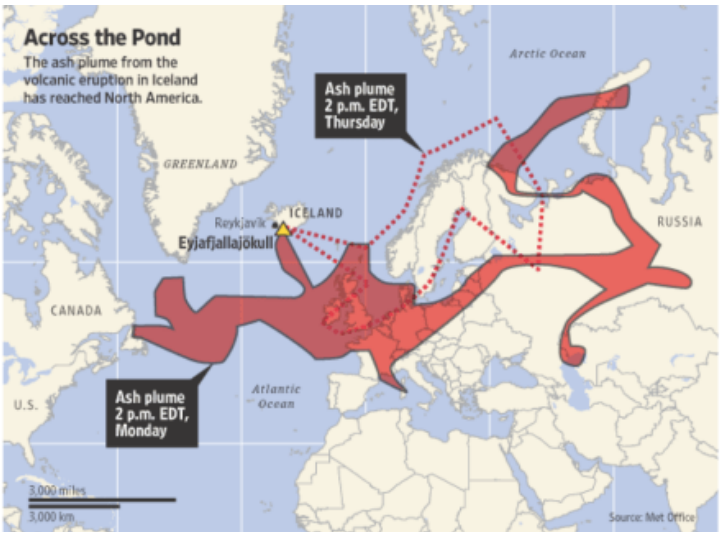


Figure 45: The spread and shift of the plume (source: The Economist, UK Met Office)

The International Air Transport Association (IATA) estimates that airlines were losing 355 million Euros in revenues a day at the peak of cancellations during the weekend and on Monday (April 17th-19th, 2021)[45]. According to IATA, the Icelandic volcano crisis cost more than 1.51 billion

Euros in lost revenue to airlines through Tuesday (April 20th, 2010) [45]. For instance, British airways and Air France-KLM reported a loss of 23.4 million Euros per day during the five most disruptive days [41]. The extensive losses suffered by the airline industry in a week of suspended flights, indicate that a longer shutdown could easily send aviation companies into bankruptcy [41]

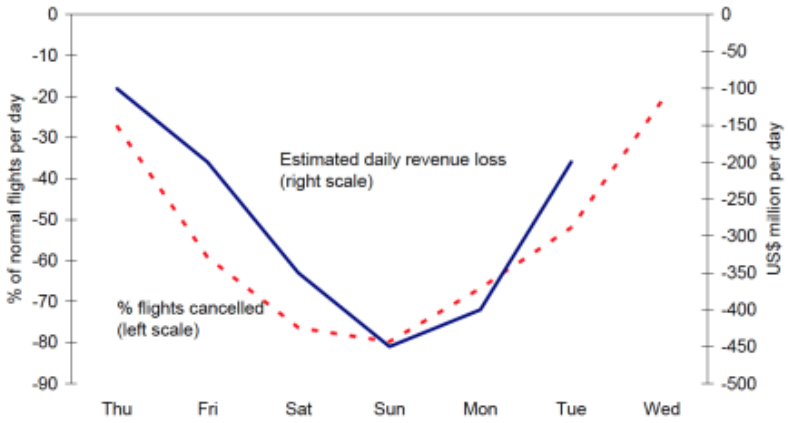


Figure 46: Impact on airline revenues per day (source: IATA Economics, Eurocontrol)

The global GDP losses, resulting from the prolonged inability to move people or goods including the net airline industry and destination losses, along with general productivity losses, are estimated at approximately 4.7 billion US dollars[36].
Giovani Bisignani, IATA General Director from 2002 to 2011, said that "this crisis is not the result of running our business badly. It is an extra-ordinary situation exaggerated with a poor decision-making process by national governments. The airlines could not do business normally. Governments should help carriers recover the cost of this disruption" and added that "Airspace was being closed based on theoretical models not on facts. Test flights by our members showed that the models were wrong. Our top priority is safety" (Figure 46). Without compromising on safety, Europe needed to find a way to make decisions based on facts and risk assessment, not theories".

The Eyjafjallajökull crisis demonstrated that airport operators, airlines and flight control authorities may benefit from:

- more accurate real time visibility monitoring
- better forecasts for air quality and haze phenomenon's

It will allow them to better anticipate and decide the rerouting or cancellation of flights or even closure of the airport in the case of volcano eruption or wildfire which have an important economic impact for both the airports and the airline companies.

4.5.6.6. Customer segment "Research centres"

Most partners in AQ-WATCH are research centres that have developed or improved the models that are being used by the project. The joint expertise from these centres, in specific ways, is what set AQ-WATCH apart from other enterprises. However, many other research centres in the world, particularly in developing countries, may be able to use AQ-WATCH products for research

purposes only, given the large number of models used, with different setups and resolutions. This in turn has the potential to improve the quality of the models used, and therefore, the products.

The needs from these research centres may be:

- Understand the impact of model resolution in air quality simulations
- Understand the role of meteorological fields in air quality
- Understand the role of different parameterizations in air quality simulations

Similarly, some research centres may deliver environmental services and they may use AQ-WATCH products to provide information to customers, through the interpretation of the model simulations and forecasts.

4.5.6.7. Customer segment "Citizens"

According to the Ambient Air Quality Database from WHO [4], around 91% of the world's population lives in places where air quality levels exceed WHO limits [38]. While ambient air pollution affects developed and developing countries alike, low- and middle-income countries experience the highest-burden, with the greatest toll in the Western Pacific and South-East Asia regions.

Citizens pay bigger attention to air quality and how pollution affects them [14]. Citizens often prefer to receive information for the relatively small area in which they live and/or operate. This information must be tailored to their specific needs and distributed directly to them, for example by social media or through specialized mobile apps or websites. There are now significant attempts to further downscale the data provided by regional models into data that are valid at the city block and even the street scale.

To help people to track air pollution, and stay out of harm's way, many actors such as IQAir's AirVisual, Air Care, Breezometer but also government agencies have developed mobile applications. The information provided by these apps use a mix of data from satellites, ambient air quality stations, as well as sensors and systems run by private organisations. Some of these apps are also crowdsourced from affordable air quality sensors provided by private companies such as PurpleAir and IQAir. However, the accuracy and reliability of the information given by such applications can be difficult to access. According to senior mobile insights analyst Jonathan Briskman of Sensor Tower, the top-rated apps for outdoor air quality monitoring in the U.S. between January 2020 and July 2021 have been AirCare, AirVisual, and South Coast AQMD (based on ratings from the App Store, and Google Play).

AQ-WATCH products will include specific information at spatial scale smaller than 1 km, which is considerably better than in most currently available applications. AQ-WATCH will allow individuals, through air quality alerts, to reduce their exposure to air pollution via preventive measures. By providing personalized information on (forecasted) exposure, it will help individuals to manage their life, to navigate and choose outdoor places to live, work, go to school, shop, travel, exercise, plan activities ahead, and better manage treatments – enhance disease management and medical decisions by allowing a patient's physician access to this information.

However, if interest from citizens on air quality products and services is growing, they are still reluctant to pay a significant price to access such products. Citizens are actually more a potential user of a service offered by a public authority or a municipality.

The needs of the citizens are:

- maps providing air quality information at local level enabling conscious decisions to be taken
- Information and forecasts for individual citizen to enable them to adapt their behaviour to reduce the health impacts of pollution episodes.

4.5.7. Competition Study

The competitive study will support the understanding of the market conditions, the identification of the strengths and weaknesses and the design of the Go-to-market strategy.
AQ-WATCH will be providing highly innovative solutions which do not have direct competitors with similar resolution capacities. Thus, the competition won't be on the side of the scientific and technical aspects but more on the cost efficiency and reputation of the brand. The two main competitor types are to be considered, namely the low-cost sensors and the main players in the field of air quality monitoring.

4.5.7.1. Data analytics and software providers

Data analytics and software providers play a crucial role in the development of air quality forecasting systems. These companies leverage advanced algorithms and machine learning techniques to analyze air quality data and provide real-time insights. One prominent competitor in this space is BreezoMeter, known for its comprehensive coverage of air quality data on a global scale. They offer integration with various platforms and devices, focusing on user engagement and personalized recommendations to drive awareness and action on air quality issues.
Hereunder the non-exhaustive list of some prominent data analytics and software providers that specialize in air quality monitoring and forecasting:

- BreezoMeter: BreezoMeter offers comprehensive air quality data analytics and software solutions. Their platform provides real-time air quality information, personalized insights, and actionable recommendations to individuals, businesses, and cities.
- Plume Labs: Plume Labs focuses on providing air quality monitoring and forecasting solutions for individuals and communities. They offer mobile apps and devices that provide real-time air quality data and personalized air quality forecasts.
- EarthSense: EarthSense specializes in the development of air quality modeling and data analytics solutions. Their products include advanced air quality sensors, data analysis software, and predictive modeling tools for accurate air quality assessment.
- Aclima: Aclima is a data analytics company that focuses on environmental sensing and analysis. They use advanced sensor networks and data analytics techniques to provide insights into air quality, enabling businesses and governments to make informed decisions.
- Environmental Systems Research Institute (ESRI): ESRI offers Geographic Information System (GIS) software and solutions that include air quality monitoring and modeling

capabilities. Their software enables users to analyze, visualize, and interpret air quality data in a spatial context.

- OpenAQ: OpenAQ is a non-profit organization that collects and shares air quality data from various sources worldwide. They provide an open data platform and API that enables researchers, developers, and policymakers to access and analyze air quality data.
- IQAir: IQAir specializes in air quality monitoring devices and software solutions. Their products include indoor and outdoor air quality monitors, data visualization software, and mobile apps for personalized air quality insights.
- Envirosuite: Envirosuite offers a range of software solutions for environmental monitoring and management. Their platform includes air quality monitoring and forecasting modules that provide real-time data analysis, visualization, and reporting.
- Airnowtech: Airnowtech provides software solutions and data analytics services for air quality monitoring and management. They offer cloud-based platforms for data collection, analysis, and reporting, helping organizations track and improve air quality.
- ATMO-SELECT: ATMO-SELECT focuses on providing air quality analytics and decision-support systems. Their software combines air quality data, meteorological information, and emission inventories to provide accurate and actionable insights for air quality management.

Table 19: Data Analytics and Software Providers - SWOT

Strengths	Weaknesses
• Advanced algorithms and machine learning techniques for air quality analysis. • Comprehensive and real-time air quality data coverage on a global scale. • Integration with various platforms and devices, including mobile applications and smart home systems. • Strong focus on user engagement and education through personalized insights and recommendations.	• Reliance on multiple data sources, including satellites, ground-level monitors, and weather stations. • Limited transparency in data sources and validation methods. • Potential challenges in accurately predicting localized air quality conditions. • Competing with other established players in the air quality monitoring industry.
Opportunities	**Threats**
• Expansion into new markets and regions with high demand for air quality information. • Collaboration with government agencies and environmental organizations for data validation and partnerships. • Integration with wearable devices and personal health tracking applications. • Continuous improvement of algorithms and models through research and development.	• Increasing competition from both established players and new entrants. • Evolving government regulations and data privacy concerns. • Dependence on third-party data sources and potential disruptions in the data supply chain. • Negative perception or loss of trust due to inaccurate or misleading air quality information.

4.5.7.2. Environmental consulting companies

Environmental consulting companies play a vital role in assisting organizations and governments in their air quality management efforts. These firms offer expertise in regulatory compliance, pollution control strategies, and environmental impact assessments.
For AQ-WATCH, these stakeholders are also potential exploiters (see section 4.5.8 in this document).
Hereunder, the non-exhaustive list of some prominent environmental consulting companies that work on air quality monitoring and forecasting:

- ARIA Technologies: ARIA Technologies is a renowned environmental consulting company specializing in air quality management and forecasting. They offer comprehensive services such as air pollution modelling, impact assessments, and regulatory compliance. ARIA Technologies leverages advanced technologies and data analysis techniques to provide accurate and reliable air quality information, enabling clients to make informed decisions and implement effective mitigation strategies.
- Ricardo: RICARDO consulting company is actively involved in the field of ambient air quality, offering a diverse range of services and expertise. Their activities encompass air quality monitoring and assessment, emission inventories and modelling, air pollution control strategies, indoor air quality assessments, and environmental impact assessments. They contribute to the development and implementation of air quality policies, engaging with stakeholders and conducting educational initiatives. Research and innovation are at the forefront of their approach, as they continuously strive to develop new technologies and methodologies to address emerging air pollution challenges. With a comprehensive understanding of the social, environmental, and economic impacts of air pollution, RICARDO plays a significant role in supporting organizations and governments in their efforts to improve ambient air quality and protect public health.
- Ramboll: Ramboll is a global environmental consultancy with expertise in various domains, including air quality monitoring and forecasting. They provide comprehensive solutions for assessing air pollution, conducting modeling studies, and developing strategies for emission reduction. Ramboll combines scientific expertise, advanced technology, and regulatory knowledge to help clients improve air quality, comply with environmental regulations, and enhance sustainable practices.
- ERM (Environmental Resources Management): ERM is a leading environmental consultancy that offers a wide range of services, including air quality monitoring and management. Their air quality experts assist clients in assessing the impact of industrial activities, developing emission reduction strategies, and implementing effective monitoring systems. ERM's holistic approach incorporates scientific research, data analysis, and stakeholder engagement to deliver tailored solutions for air quality improvement.
- ENVIRON (now part of Ramboll): ENVIRON, now part of Ramboll, is a renowned environmental consultancy known for its expertise in air quality management. They provide services such as air quality monitoring, impact assessments, and regulatory

compliance support. ENVIRON's multidisciplinary teams of experts help clients understand the implications of air pollution, mitigate risks, and develop sustainable strategies for better air quality.

- AECOM: AECOM is a global environmental consulting firm that provides comprehensive air quality services. They offer expertise in air monitoring, modeling, emission inventories, and regulatory compliance. AECOM's multidisciplinary teams help clients develop sustainable strategies to improve air quality and mitigate the impacts of pollution.
- GHD: GHD is an international professional services company offering environmental consulting solutions, including air quality monitoring and management. They provide comprehensive services ranging from air quality assessments to pollution control strategies and compliance support. GHD helps clients navigate environmental challenges and achieve sustainable air quality outcomes.
- SLR Consulting: SLR Consulting is a global environmental firm specializing in air quality consulting and monitoring. They assist clients in assessing air pollution impacts, developing emission reduction strategies, and conducting air quality modeling studies. SLR Consulting's expertise spans various industries, including energy, manufacturing, and infrastructure.
- Amec Foster Wheeler (now part of Wood Group): Amec Foster Wheeler, now part of Wood Group, is a global consulting firm with a focus on environmental and engineering services. They provide air quality monitoring, modeling, and assessment services to assist clients in understanding and managing air pollution impacts. Amec Foster Wheeler offers comprehensive solutions for industries, government agencies, and infrastructure projects.
- Tetra Tech: Tetra Tech is an environmental consulting company that offers a range of services, including air quality monitoring and management. They provide expertise in emissions inventory, air dispersion modeling, and regulatory compliance. Tetra Tech assists clients in evaluating and improving air quality conditions through innovative approaches and sustainable practices.
- Mott MacDonald: Mott MacDonald is a global engineering and environmental consultancy known for its air quality expertise. They offer comprehensive services, including air quality assessments, modeling, and pollution control strategies. Mott MacDonald's multidisciplinary teams collaborate with clients to deliver effective solutions for air quality management.
- ICF International: ICF International is a consulting firm that provides a wide range of environmental services, including air quality monitoring and forecasting. They offer expertise in emission inventories, regulatory compliance, and air quality modeling. ICF International helps clients navigate complex air quality challenges and implement effective mitigation measures.
- Jacobs: Jacobs is a global engineering and consulting firm that offers comprehensive environmental services, including air quality monitoring and management. They provide

expertise in air pollution assessment, emission reduction strategies, and regulatory compliance support. Jacobs assists clients in achieving and maintaining healthy air quality standards.

Table 20: Environmental consulting companies - SWOT

Strengths	Weaknesses
• Extensive experience in environmental consulting and air quality management. • Expertise in regulatory compliance and pollution control strategies. • Strong network of industry connections and government partnerships. • Comprehensive understanding of air quality monitoring and assessment methodologies.	• Relatively slower in adopting advanced data analytics and satellite-based technologies. • Potential challenges in keeping up with rapid advancements in the air quality forecasting field. • Limited focus specifically on air quality forecasting and more diversified service offerings. • Potential higher costs associated with consulting services compared to software-based solutions.
Opportunities	**Threats**
• Integration of satellite-based data and advanced modeling techniques into consulting services. • Collaboration with technology partners for enhanced air quality analysis capabilities. • Expansion of consulting services into emerging markets with increasing air quality concerns. • Offering comprehensive air quality management solutions, including forecasting, monitoring, and mitigation strategies.	• Competition from specialized software providers and data analytics companies. • Potential challenges in data acquisition and access to proprietary satellite data.

4.5.7.3. Research organisations

Research organizations play a significant role in advancing the field of air quality monitoring and forecasting through scientific research, modeling, and data analysis. These institutions contribute to the development of innovative methodologies and techniques for understanding and predicting air quality patterns. It's important to recognize that research organizations often collaborate with other types of competitors, such as data analytics providers or sensor manufacturers, to combine their expertise and deliver comprehensive air quality solutions. The inclusion of research organizations as competitors emphasizes the collaborative and interdisciplinary nature of the air quality monitoring and forecasting domain.

Hereunder, the non-exhaustive list of some prominent research organizations that are actively involved in air quality monitoring and forecasting:

- National Aeronautics and Space Administration (NASA) - United States
- National Oceanic and Atmospheric Administration (NOAA) - United States
- European Space Agency (ESA) - Europe
- National Center for Atmospheric Research (NCAR) - United States
- Centre for Atmospheric Science (CAS) - United Kingdom
- Max Planck Institute for Chemistry (MPIC) - Germany
- National Institute of Environmental Research (NIER) - South Korea

- National Institute for Space Research (INPE) - Brazil
- China National Environmental Monitoring Center (CNEMC) - China
- National Institute of Water and Atmospheric Research (NIWA) - New Zealand
- Institute of Atmospheric Physics, Chinese Academy of Sciences (IAP-CAS) - China
- Finnish Meteorological Institute (FMI) - Finland
- Swiss Federal Laboratories for Materials Science and Technology (EMPA) - Switzerland
- Institute for Environmental Assessment and Water Research (IDAEA-CSIC) - Spain
- Norwegian Institute for Air Research (NILU) - Norway
- Research Centre for Energy, Environment and Technology (CIEMAT) - Spain
- Institute of Environmental Assessment and Water Research (IDAEA-CSIC) - Spain
- Netherlands Organization for Applied Scientific Research (TNO) - Netherlands
- National Institute for Public Health and the Environment (RIVM) - Netherlands
- Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) – Italy
- French National Institute for Industrial Environment and Risks (Ineris) - France

Table 21: Research organisations - SWOT

Strengths	Weaknesses
• Extensive expertise in atmospheric science, modelling, and data analysis. • Access to advanced research infrastructure, including high-performance computing systems. • Strong emphasis on scientific research and innovation in air quality forecasting. • Collaborative partnerships with other research institutions, government agencies, and industry stakeholders. • Scientific reputation • Quality of the measurements and modelling	• Limited commercialization of research outcomes and direct market presence. • Potential challenges in translating research findings into practical applications. • Reliance on government funding and research grants for sustained operations. • Limited capacity of investment • Longer timelines for developing and implementing new methodologies and technologies.
Opportunities	**Threats**
• Collaboration with industry partners to transfer research knowledge into operational air quality systems. • Integration of research findings and models into existing air quality forecasting platforms. • Contribution to policy development and decision-making processes through scientific expertise. • Exploration of emerging technologies and methodologies for improved air quality monitoring and prediction.	• Competition from other research organizations and private companies in the air quality space. • Budget constraints and uncertainty in government funding for research projects. • Rapid technological advancements and the need to keep pace with evolving techniques. • Balancing the academic pursuit of knowledge with the practical application of research outcomes. • Generalisation of the low-cost sensor networks

4.5.7.4. Micro sensors manufacturers

Sensor manufacturers play a critical role in air quality monitoring by producing and supplying the necessary equipment for pollutant detection. These companies develop and manufacture air quality sensors that measure various pollutants in real-time. Their expertise lies in manufacturing air quality sensors and providing strong customer support, making them a trusted choice for organizations seeking reliable and accurate air quality monitoring solutions.
As indicated in the Environmental Defense Fund report named "Public investment, private innovation: The global market for air quality monitoring" [29], "Agencies view lower-cost sensors as complementary to regulatory-grade monitoring". The development and use of low-cost sensors to monitor reactive air pollutants, particulate matter, and greenhouse gases has continued to accelerate and is a tool used throughout academic research, regulatory surveillance, and serves the public interest by individual, government, and business users.
The strategy for AQ-WATCH could be to offer the possibility to integrate the results of the low-costs sensors network to the datasets from earth observation.

Hereunder, the non-exhaustive list of some of the main low-cost sensor manufacturers working in the field of air quality monitoring and forecasting

- Atmotrack: Atmotrack offers portable air quality monitors that provide real-time data on particulate matter (PM2.5 and PM10), temperature, and humidity. Their compact devices are designed for personal air quality monitoring, allowing individuals to assess the air they breathe and make informed decisions based on the data.
- Bosch: Bosch is a well-known technology company that produces air quality sensors for indoor and outdoor applications. Their sensors measure various pollutants such as nitrogen dioxide, ozone, and VOCs. Bosch's sensors are designed for integration into smart home systems, IoT applications, and air quality monitoring networks.
- Bernard gruppe / Hawadawa: The BERNARD Gruppe, an internationally active family-owned engineering services company, has acquired the product portfolio of Hawa Dawa in 2023. From now on, the technology and know-how for monitoring air quality are part of the specialized solutions of the BERNARD Gruppe. In environmental monitoring, the BERNARD Gruppe now offers noise, vibration and air quality solutions. According to the respective application, an enhancement with additional BERNARD monitoring solutions for traffic, buildings and natural hazards is possible.
  Hawa Dawa air quality monitoring allows area-wide real-time determining and evaluating air quality. The accuracy of the measurement method meets regulatory requirements, as confirmed by TÜV Süd. The data is available on intuitive dashboards or as an API for integration without media discontinuity.
- Airqo: Airqo is actively engaged in a multitude of activities in the field of ambient air quality. They specialize in the deployment of low-cost air quality monitoring networks, utilizing innovative sensor technologies to collect real-time data on pollutants. With a focus on data-driven insights, Airqo conducts comprehensive air quality assessments, analyzing the collected information to identify pollution sources and assess their impact

on public health. They work closely with local communities, governments, and organizations to raise awareness about air pollution and its consequences. Airqo also contributes to policy development by providing evidence-based recommendations and supporting the implementation of air quality regulations. Through their research and collaborations, Airqo aims to promote sustainable solutions and empower communities to take action towards improving ambient air quality.

- Pollutrack: Pollutrack specializes in developing compact air quality monitoring devices that measure multiple pollutants, including gases and particulate matter. Their portable sensors provide real-time data, allowing users to monitor air quality levels and identify pollution sources in urban environments.
- PurpleAir: PurpleAir specializes in producing low-cost, high-quality air quality sensors for both indoor and outdoor applications. Their sensors utilize laser particle counters to measure PM2.5 and PM10 particles, providing real-time data that contributes to understanding and monitoring air pollution levels.
- Aeroqual: Aeroqual is known for its range of portable and fixed air quality monitors. Their sensors measure various pollutants, including gases like ozone, nitrogen dioxide, and volatile organic compounds (VOCs), as well as particulate matter. Aeroqual's solutions are widely used for ambient air quality monitoring, research studies, and industrial applications.
- Alphasense: Alphasense specializes in manufacturing high-performance gas sensors that are widely used in air quality monitoring applications. Their sensors cover a range of gases, including carbon monoxide, ozone, nitrogen dioxide, sulfur dioxide, and VOCs. Alphasense sensors are known for their accuracy, reliability, and long-term stability.
- Sensirion: Sensirion produces a variety of environmental sensors, including those for measuring particulate matter and gas pollutants. Their sensors use innovative technologies, such as laser scattering, to provide accurate and reliable measurements. Sensirion's sensors are used in both indoor and outdoor air quality monitoring systems.
- Luftdaten: Luftdaten is an open-source initiative that promotes citizen science in air quality monitoring. They offer DIY kits that allow individuals to build their own air quality sensors using low-cost components. The collected data is shared on their platform, contributing to a wider network of air quality information.
- SPEC Sensors: SPEC Sensors specializes in manufacturing electrochemical gas sensors that detect various gases, including carbon monoxide, nitrogen dioxide, ozone, and sulfur dioxide. Their sensors are designed for both indoor and outdoor air quality monitoring applications and provide accurate and reliable measurements.
- Seeed Studio: Seeed Studio offers air quality sensor modules that can be integrated into various applications. Their sensor modules combine multiple sensors to measure gases, particulate matter, temperature, and humidity. Seeed Studio's modular approach allows for flexibility and customization in air quality monitoring projects.

- Libelium: Libelium provides a wide range of sensor platforms for environmental monitoring, including air quality sensors. Their platforms support multiple sensors, enabling the measurement of various pollutants such as gases and particulate matter. Libelium's solutions are suitable for both urban and industrial air quality monitoring.

Table 22: micro sensors - SWOT

Strengths	Weaknesses
• Manufacturing expertise in air quality sensors and monitoring equipment. • Wide range of sensor products for measuring various pollutants. • Strong customer support and technical expertise. • Established reputation and customer base in the air quality monitoring industry. • Low maintenance requirement making them an easy-to-use and convenient device. • Scalability of pollutant detection is also an advantage by complementing the already existing fixed sensor networks.	• Reliance on ground-level monitoring rather than satellite-based data. • Design compromises making their readings less trustworthy and data less reliable • Limited ability to provide comprehensive and real-time air quality information on a global scale. • Potential challenges in data integration and analysis compared to software-based solutions. • Higher upfront costs associated with purchasing and deploying sensor networks. • Suffer from high cross-sensitivity and interference from other pollutants. • Sensitive to changes in ambient conditions • Suffer from a drift in calibration over a period of time
Opportunities	**Threats**
• Integration of satellite data into sensor networks for improved accuracy and coverage. • Collaboration with software providers for data analysis and visualization. • Expansion into emerging markets with increasing demand for air quality monitoring. • Development of innovative sensor technologies for enhanced pollutant detection and measurement. • Improvement of calibration curves with regression modelling techniques or artificial neural networks. • Creating controlled conditions for calibration can help in most calibrations. • Compensation of the cross-sensitivity by using a sensor array having multiple gas-sensing technologies. • Due to their portability, it could also be possible to conduct personal pollutant monitoring.	• Increasing competition from both traditional and new sensor manufacturers. • Rapid advancements in sensor technologies making older models obsolete. • Potential limitations in data validation and calibration of sensor measurements. • Reliance on partnerships or collaborations for data analysis and interpretation. • Further, partial or false information provided by vendors regarding the modules including calibration drift, signal to noise ratio, or the stability for either MOS or EC sensors can hamper the practical usage of such sensors.

Overall, the strategy prioritized by AQ-WATCH is to include some of the competitors into joint exploitation in order to better cover the spectrum of air quality monitoring and forecasting services. The collaboration between consulting companies and research organizations fosters a symbiotic relationship, where the consulting companies gain access to specialized knowledge, innovative technologies, and credibility, while research organizations benefit from practical industry insights and opportunities for real-world application of their research findings. Meanwhile, by collaborating with research organizations, air quality micro sensor providers can

leverage their scientific expertise, research data, and technological advancements to enhance the accuracy, reliability, and performance of their sensor products.

4.5.8. Exploitation strategy

4.5.8.1. Pathways for exploitation

Several pathways for the exploitation of the results have been considered by the consortium. Indeed, the exploitation may be done by some partners directly but also with the involvement of external exploiters who would implement the whole AQ-WATCH solutions or only some parts of them (Figure 47).

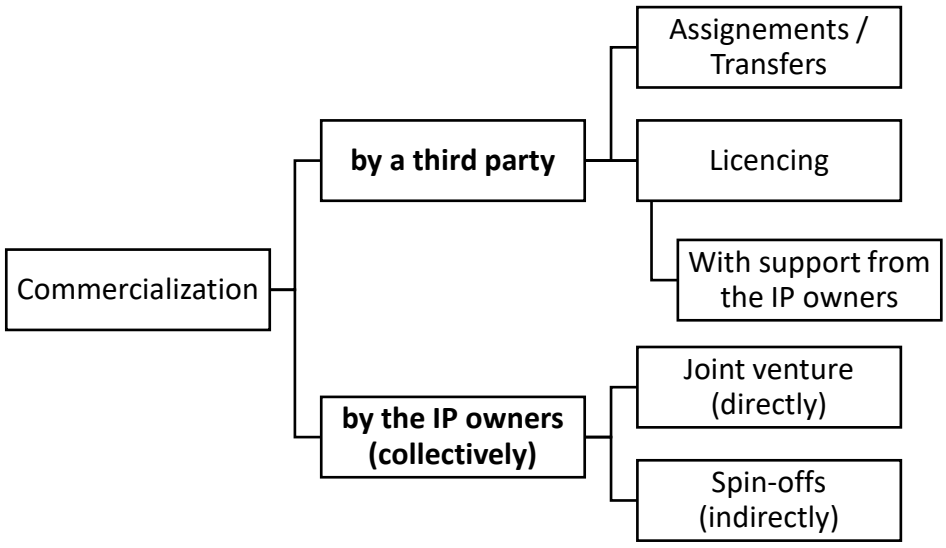


Figure 47: Pathways for exploitation

Several exploitation models have been considered, as presented hereunder:

- **Exploitation by the IP owners (joint venture and spin-offs):**

Joint ventures are business alliances of two or more independent organisations (venturers) to undertake a specific project or achieve a certain goal by sharing risks. IP has an important role in the creation of such collaborations, since venturers bring their own intellectual assets for the success of a JV and they should agree on their initial contributions, responsibilities and obligations within the alliance as set out in JV agreements

Spin-offs (or spin-outs) are separate legal entities created by a parent organisation (PO) to bring its IP assets into the market. It is generally an efficient solution for the parent organisations, who may not be fully capable of commercialisation of their own IP assets, such as for universities and research institutions. Spin-offs are seen as an important means of technology transfer since they are acting as an intermediary between the research environment and industries while putting research results into the commercial market with a marketable product.

Moreover, through spin-offs, research organisations can focus on their main task of “research” instead of “marketing”, which is the main task of commercial companies (spin-off).

However, following the feedback from the partners, this option is not to be further envisaged as most of them are not allowed to take part to such commercial initiatives.

- **Exploitation by a third party through a transfer of ownership or licensing:**

An IP assignment is a transfer of ownership of an IPR, such as a patent, trademark or design, from one party (the assignor) to another party (the assignee). Consequently, the assignee becomes the new owner of the IPR. Assignments are useful tools for commercialisation, when the owner of the IP does not have enough capabilities (financial, HR, marketing, etc.) to market the developed intellectual asset and/or when the owner would like to realise an immediate cash flow from an IP asset, which he does not plan to exploit with its own resources.
A licence is a contract under which the holder of an intellectual property (licensor) grants permission for the use of its intellectual property to another person (licensee), within the limits set by the provisions of the contract. Hence, in business language, a licence allows the licensor to make money from its intellectual asset by charging the licensee in return for its use. Licensing has a vital role in companies' commercialisation strategies, since there are significant advantages of licensing IP, creating a win-win situation for both parties.
Following the exchanges within the consortium partners, it appears that the systems used in the modules are most of the time too complex to be transferred or licensed to a third party.

- **Exploitation by a third party with support from the IP owner through the provision of services:**

The self-exploitation and the transfer/licensing of ownership being not appropriate for the exploitation of the modules, therefore a service contract approach for a third-party exploiter has been further investigated to operate in the future.

In the end, the consortium decided to go for a hybrid solution between a self-exploitation and the transfer to a third party. Indeed, the consortium has identified "External exploiters" to team up with.
Therefore, early 2023, a global offer of services and a partnership agreement has been developed to enable external exploiters and consortium partners to work together to answer call for tenders or consultations. Several workshops have taken place to align the vision and validate the content of the global offer of services and consider the partnership agreement describing the rights and duties of the partners and exploiters.

4.5.8.2. Intermediate results approach

Depending on its available resources and level of expertise, the future exploiters may decide to take over the activities at different stages of the value-chains.
Basically, the AQ-WATCH module value-chains can be simplified into 4 main steps: (1) Collect and treat data, (2) Run the models, (3) Map the results and (4) provide access through a user interface.
Depending on the wishes of the consortium partners and future exploiter, the exploiter may fully takeover some of the steps but also contract some partners to obtain the dataset for example.

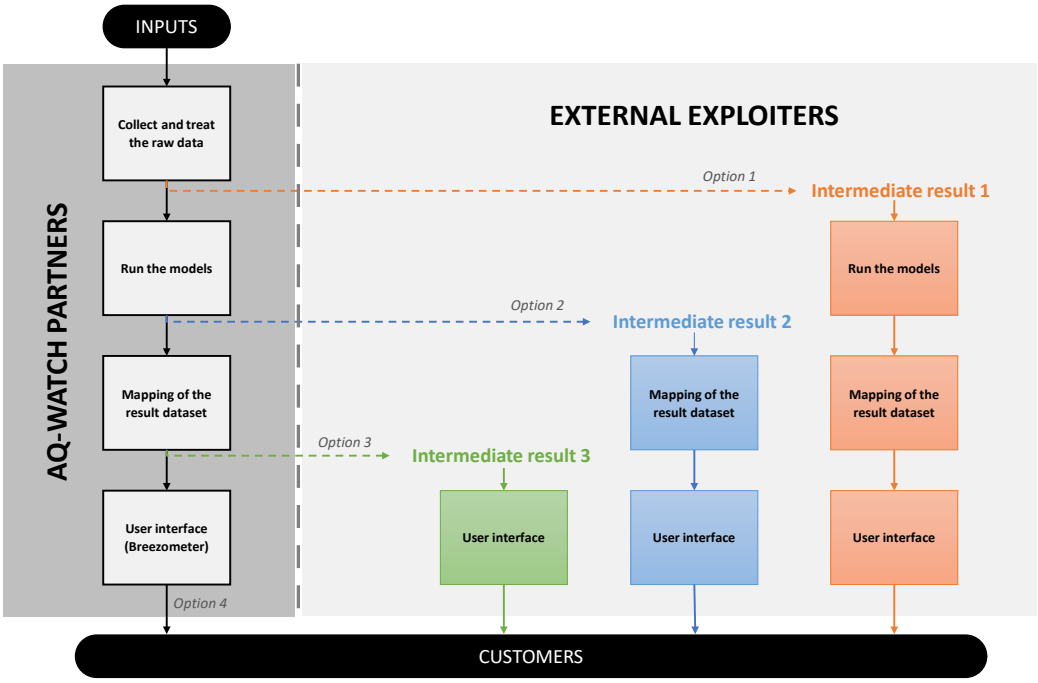


Figure 48: Intermediate results and external exploiter approach

The Figure 48 presents a simplified value chain of the AQ-WATCH modules where intermediate results can be extracted and directly exploited by the exploiter with its own resources (dashboard, use interface platform…). It can be at different steps depending on their capabilities. This is why it is critical to clearly describe and characterise each intermediate result to start interacting with the potential exploiters.

The potential exploiters are for instance: ARIA Technology within SUEZ, BOSCH, MeteoGroup, RICARDO, INERIS, ATMOTRACK, Windy, Breezometer.

4.5.9. Targeted markets: Public authorities from developing countries

Air quality management in developing countries has significant market potential due to several factors:

1. **Rapid Urbanization:** Developing countries are experiencing rapid urbanization, leading to increased industrial activities, transportation, and construction. These factors contribute to high levels of air pollution. As governments and citizens become more aware of the health risks associated with poor air quality, there is a growing demand for effective air quality management solutions.
2. **Health Concerns:** Poor air quality has severe health implications, including respiratory diseases, cardiovascular issues, and increased mortality rates. Developing countries often face higher pollution levels and limited access to healthcare, making air quality management a critical priority. This creates a market demand for technologies and services that can monitor, mitigate, and improve air quality to safeguard public health.

3. **Environmental Regulations:** Governments and international organizations are recognizing the importance of addressing air pollution and are implementing stricter environmental regulations. These regulations may require industries to adopt cleaner technologies, leading to a demand for pollution control equipment, emission monitoring systems, and air filtration technologies.
4. **Funding and Investments:** International organizations, governments, and private investors are increasingly investing in environmental projects, including air quality management, in developing countries. These investments can provide financial support for the development and implementation of air pollution control measures, creating opportunities for technology providers, consultants, and service providers.
5. **Technological Advancements:** Advances in technology have made air quality monitoring and management more accessible and cost-effective. Sensor technologies, data analytics, and remote monitoring systems have improved the ability to measure and track air pollution levels accurately. These advancements enable the development of innovative solutions and provide opportunities for businesses to offer effective air quality management products and services.
6. **Climate Change Mitigation:** Air quality management is closely linked to climate change mitigation efforts. Many developing countries are striving to reduce their greenhouse gas emissions and improve air quality simultaneously. This alignment of objectives creates a market for clean energy technologies, renewable energy solutions, and sustainable urban planning, all of which contribute to air quality improvement.
7. **International Cooperation and Support:** International organizations, such as the World Health Organization (WHO), World Bank and other development banks, and United Nations, actively collaborate with developing countries to address air pollution challenges. They provide technical assistance, knowledge sharing platforms, and funding opportunities, fostering an environment that supports the growth of air quality management initiatives.

Several developing countries and regions face significant challenges related to air quality, such as:

- **India**: India is often cited as one of the countries with the most significant air quality issues. Rapid industrialization, population growth, urbanization, and reliance on coal for energy production contribute to high levels of air pollution. Factors such as vehicular emissions, industrial pollution, biomass burning, and dust from construction sites contribute to poor air quality, particularly in cities like Delhi.
- **China**: China has been grappling with severe air pollution issues for many years. Factors such as industrial emissions, coal-fired power plants, heavy traffic, and high population density contribute to poor air quality. Major cities like Beijing and Shanghai have experienced episodes of heavy smog, primarily due to high levels of particulate matter and pollutants emitted from various sources.
- **Southeast Asia (specifically Indonesia)**: The region faces challenges related to transboundary haze caused by forest fires, primarily from land clearing practices, agricultural activities, and peatland fires. The smoke from these fires contributes to

severe air pollution, affecting not only Indonesia but also neighboring countries like Malaysia and Singapore.

- **Sub-Saharan Africa:** Many countries in Sub-Saharan Africa face air quality challenges due to factors such as industrial emissions for example in port areas, open burning of waste and biomass, use of solid fuels for cooking, and urbanization. Rapid economic development and inadequate regulations contribute to poor air quality in major cities across the region.
- **Middle East (specifically Iran):** Iran experiences significant air pollution issues, particularly in urban centers like Tehran. Factors such as industrial emissions, traffic congestion, reliance on fossil fuels, dust storms, and geographical factors contribute to high levels of air pollution in the country.

Public authorities from those regions often require support to effectively manage air quality due to several key reasons:

1. **Limited Resources:** Developing countries may have limited financial, technical, and human resources to allocate towards comprehensive air quality management. They often face competing priorities in sectors such as healthcare, education, and infrastructure development. Support from international organizations, governments, and investors can provide the necessary resources to establish and strengthen air quality management systems.
2. **Capacity Building:** Developing countries may require assistance in building the technical expertise and knowledge base needed to effectively monitor and manage air quality. This includes training in data collection, analysis, modelling, and interpretation. Support can help strengthen the capacity of local authorities to understand and address air pollution issues.
3. **Infrastructure and Technology:** Establishing a robust air quality monitoring infrastructure requires investments in equipment, sensors, laboratories, and data management systems. Developing countries may need support to set up and maintain such infrastructure, including access to reliable monitoring networks, quality assurance protocols, and data-sharing platforms.
4. **Policy and Regulatory Frameworks:** Developing countries may require assistance in formulating and implementing policies, standards, and regulations related to air quality management. This includes the development of emission control measures, enforcement mechanisms, and compliance monitoring systems. Support can help align national frameworks with international best practices and guidelines.
5. **Data and Information Exchange:** Access to accurate and up-to-date air quality data and information is crucial for informed decision-making and public awareness. Developing countries may require support in establishing data collection networks, data analysis methodologies, and platforms for data sharing and dissemination. International collaboration and support can facilitate access to global datasets and expertise.
6. **International Cooperation and Knowledge Exchange:** Developing countries can benefit from international cooperation, knowledge exchange, and peer-to-peer learning in air

quality management. Collaboration with developed countries and sharing of best practices can help identify effective strategies, technologies, and approaches that can be adapted to local contexts.

The list of the ministries and national agencies in charge of the ambient air quality issue that the consortium could target for the exploitation of the results is available in Annexe 1.

One major challenge of this market (public authorities in developing countries) is the limited available financial resources. Several organizations and institutions provide funding for research projects related to air pollution. Here are some prominent funders or sponsors that support such initiatives:

1. **World Bank**: The World Bank supports projects in Africa that address environmental challenges, including air pollution. They provide funding for research and initiatives aimed at improving air quality.
2. **Regional Development Banks (e.g.: Asian Development Bank, African Development Bank, and Inter-American Development Bank):** The regional development banks provides funding for various projects, including those related to environmental sustainability and climate change adaptation, which may encompass air pollution research.
3. **United Nations Environment Programme (UNEP)**: UNEP promotes environmental sustainability globally and supports research on various environmental issues, including air pollution. They may provide funding for research projects in developing countries.
4. **Global Environmental Funds:** Global environmental funds, such as the Global Environment Facility (GEF), provide financial resources for projects that address environmental challenges, including air quality improvement. The GEF supports initiatives in developing countries through grants, concessional funding, and technical support.
5. **European Commission:** The European Commission offers funding opportunities for research and innovation projects through programs such as Horizon Europe. These projects often address global challenges, including air pollution.
6. **International organizations:** Various international organizations, such as the United Nations Development Programme (UNDP), United Nations Industrial Development Organization (UNIDO), and the World Health Organization (WHO), may provide funding for research projects focused on air pollution in developing countries.
7. **National funding agencies:** National governments and their respective funding agencies in developed countries may provide grants and support for air pollution research. These agencies may include ministries of environment, health, or science and technology.
8. **Non-governmental organizations (NGOs):** Environmental NGOs and foundations, such as the Bill and Melinda Gates Foundation and the Wellcome Trust, often support research projects related to air pollution and public health in developing countries.

The list of organizations that could potentially fund ambient air quality monitoring and forecasting projects are listed in Annexe 2.

The market size of ambient air quality management solutions has been steadily growing due to increasing awareness and concerns regarding air pollution. According to market research reports, the global air quality monitoring market was valued at around $4.53 billion in 2020 and is projected to reach $6.9 billion by 2026, with a compound annual growth rate of approximately 7.3% during the forecast period. Factors driving the market growth include rising pollution levels, stricter environmental regulations, technological advancements in monitoring equipment, and the need for effective air pollution control measures. The market encompasses various solutions, including monitoring devices, software platforms, data analysis tools, and consulting services, provided by both established companies and emerging startups in the environmental sector.

In conclusion, the market potential for air quality management in developing countries is substantial. Growing concerns about health, environmental regulations, funding support, technological advancements, climate change mitigation, and international cooperation are all contributing factors. This creates opportunities for businesses and organizations to offer solutions that can monitor, control, and improve air quality, promoting healthier and more sustainable environments in these countries.

4.5.10. Partnership with SUEZ / ARIA Technologies

The first round of meetings with potential exploiters took place early 2022 after the consortium decided to exploit the project results with co-exploiters. Several expressed their interests for the joint exploitation e.g. ARIA/SUEZ, INERIS, ATMOTRACK.
The next agreed step was to present the prototypes as soon as the toolkit was available mid-2022. However, due to the delay in the technical development of the toolkit, the next round of exchanges took place only from January 2023 to explain the proposal of the Partnership and discuss how the exploiters would imagine their involvement in the exploitation. The common interest was confirmed, and it was decided to elaborate a Non-Disclosure Agreement, a Prototype global offer for an African country and a Partnership agreement.
Another meeting took place in May 2023 to further discuss the content of the preliminary drafts of the joint offer and of the partnership agreement.

ARIA Technologies

ARIA Technologies is a highly reputable company located in France, specializing in environmental consulting and air quality management solutions. With a strong focus on air pollution and atmospheric sciences, they have established themselves as a leading provider of services to public authorities, industries, and organizations worldwide. ARIA Technologies has about 50 employees in France, Italy, Spain, Chile, UK and Brazil.
One of the key services offered by ARIA Technologies is air quality monitoring and assessment. They excel in designing and deploying state-of-the-art monitoring stations, analysing collected data, and utilizing advanced modelling techniques. By assisting public authorities, they help evaluate air quality levels, identify pollution sources, and develop effective strategies for mitigating environmental impact.

In addition to monitoring, ARIA Technologies conducts comprehensive environmental impact assessments. Their expertise in air quality allows them to evaluate the potential consequences of various projects and developments. By providing valuable insights, they assist public authorities in minimizing negative environmental impacts and ensuring sustainable practices.
ARIA Technologies also specializes in air quality forecasting enabling public authorities to anticipate pollution episodes, issue timely warnings, and implement appropriate measures to safeguard public health.
Their consulting services extend beyond technical expertise. ARIA Technologies offers invaluable support to public authorities in formulating air quality management policies and strategies. They provide guidance in policy development, regulatory compliance, and the implementation of sustainable measures to improve air quality.
ARIA Technologies has significantly expanded its reach beyond Europe, engaging in activities worldwide. They actively participate in international projects, collaborating with governments, organizations, and industries to address air quality challenges in different regions. Their involvement includes capacity building, assisting with the implementation of air quality monitoring systems, and supporting the development of effective policies.

The SUEZ Group has recently acquired ARIA Technologies in order to enrich its platform of solutions for monitoring and treatment of atmospheric pollutants, odors and greenhouse gases, thereby meeting increasing demand from all of its clients (local communities, institutions, industrial customers).
SUEZ is a globally recognized leader in water and waste management, with a strong emphasis on sustainability and environmental solutions. SUEZ operates across five continents, serving millions of people and businesses around the world.
Within SUEZ, the Air Division is dedicated to providing comprehensive air quality services to help address the growing challenges associated with air pollution. Leveraging their expertise in environmental sciences, technology, and data analysis, the Air Division offers innovative solutions for air quality monitoring, assessment, and management.
By combining their global presence, technical expertise, and commitment to sustainable practices, SUEZ's Air Division aims to assist public authorities, industries, and communities in tackling air pollution challenges effectively. Their comprehensive range of air quality services enables clients to monitor, assess, and manage air pollution to protect public health, preserve the environment, and promote sustainable development.
https://www.suez.com/en/about-us/innovation-approach/protecting-air-quality

Added-value of a collaboration with SUEZ Air Division

SUEZ possesses extensive knowledge and experience in environmental management, including air quality monitoring. Their established expertise in the water and waste management sector translates into valuable insights that can be applied to develop effective air quality solutions.

SUEZ offers a wide range of services and technologies tailored to air quality monitoring and forecasting needs. From the installation and maintenance of monitoring equipment to data analysis, modelling, and reporting, SUEZ provides integrated solutions that address the specific requirements of public authorities.
SUEZ's multinational presence and extensive network of clients and partners offer significant advantages to the consortium. Collaborating with SUEZ facilitates access to a broad market, enabling the dissemination of AQ-WATCH solutions to a wide range of public authorities worldwide.
Besides, SUEZ already collaborates with several AQ-WATCH partners such as NCAR, TNO and CNRS, and other interested exploiters such as INERIS and AtmoTrack.

Feedback from SUEZ/ARIA TECHNOLOGIES

ARIA Technologies is currently defining their roadmap following the acquisition from SUEZ but has already confirmed its strong interest in all the modules developed in AQ-WATCH.
The managers indicated that AQ-WATCH might be used to provide the best observation in areas where there is no reference station for air quality (e.g. in some African countries).
During the last meeting organized between AQ-WATCH and SUEZ/ARIA TECHNOLOGIES on May 5th 2023, it was agreed to develop a template for a joint offer of services to public authorities. To define the legal, technical and financial conditions under which the willing partners will collaborate, it was decided to prepare a partnership agreement.

The joint offer

It was decided to develop a standard joint offer presenting all services that AQ-WATCH partners and SUEZ/ARIA TECHNOLOGIES could propose together to public authorities. The offer covers the solutions from AQ-WATCH but also other services that will be required by the potential clients before they can implement AQ-WATCH solutions. These additional services include the support to install real time AQ monitoring stations, the preparation of an inventory of emissions and the capacity building to interpretate the data collected and monitored.
The joint offer has been elaborated as a global catalogue of capabilities of the consortium and the exploiters, that will be the basis for adaptation to answer any specific consultation.
The figure below presents the steps toward an efficient air quality management.

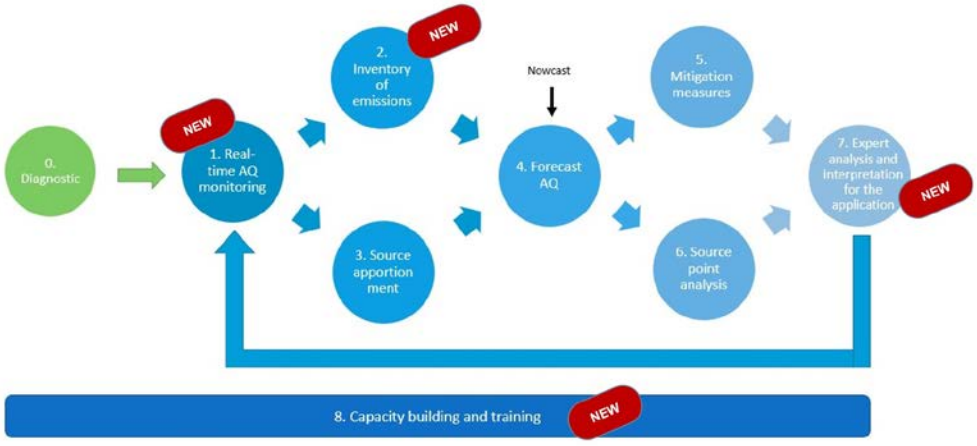


Figure 49: The Joint offer structure

The joint offer includes all parts of a technical and commercial offer that will be used as the basis to answer any consultation. This global joint offer will be adapted on a case-by-case basis.
Content of the joint offer

1. Introduction
   1.1. Context of the demand
   1.2. Your request
   1.3. Our proposal
2. Description of the available services (catalogue)
   2.1. Diagnostic of the situation
   2.2. Real-time monitoring
   2.3. Emissions inventory
   2.4. Source apportionment
   2.5. Air quality forecast (up to 96 hours)
   2.6. Mitigation strategies
   2.7. Source point analysis
   2.8. Capacity building and coaching
   2.9. Expert analysis and interpretation
3. AQ-WATCH partnership and description of the team
   3.1. Description of the partnership in general
   3.2. Organisation of the team (specific for the offer)
4. Organisation of the work, description of the tasks and planning
   4.1. Overview of the proposed service
   4.2. Step 1: Diagnostic of the situation
   4.3. Step 2: Real-time monitoring
   4.n. Step n: xyz
   4.5. Planning
5. Confidentiality
6. Execution and price conditions
   6.1. Execution conditions
   6.2. Lump-sum price
7. Invoicing conditions and payment
   7.1. Invoices
   7.2. Payments
8. Legal terms

The partnership agreement

The purpose of the Agreement is to define the legal, technical and financial conditions under which the willing Partners shall:

- identify opportunities for providing services and promoting the expertise of the Partners to Clients relative to air quality monitoring and prediction services with the procedure defined in the deontological rules of governance of AQ-WATCH Project (in appendix 3 of this Agreement),
- draw up and submit joint service Offers for these services,
- execute the Service given by the Client, if an Offer is accepted.

The operation of the partnership is ensured via the following organs as presented in the Figure 50:

- The Steering Committee which serves as a board of directors of the partnership;
- The partnership secretariat;
- The Project integrator;
- The exploiters;
- The pool of experts.

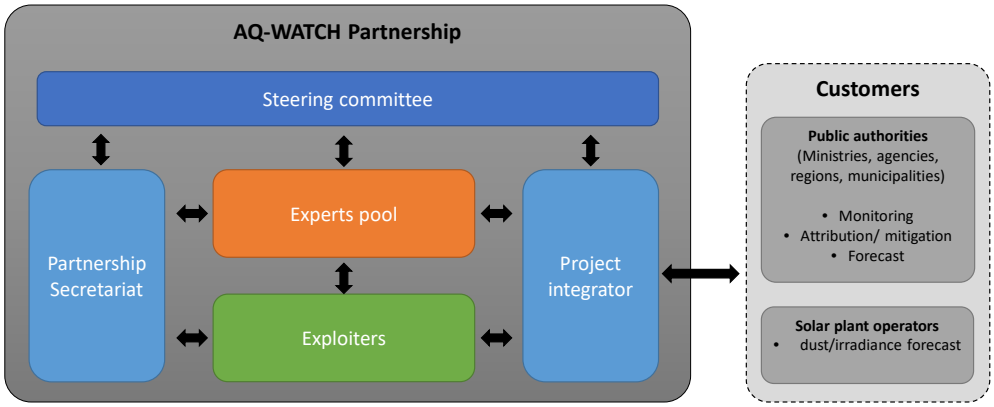


Figure 50: AQ-WATCH partnership concept

The strategy is to start with limited resources and focus on few promising opportunities in order to test the concept of the partnership, to confirm the market potential, and to position our solutions in a competing landscape.

Content of the Partnership agreement

Article 1: Definitions
Article 2: Purpose
Article 3: Nature of the Partnership
Article 4: Duration - modification
Article 5: Partnership
- 5.1 Conditions for membership
- 5.2 Termination of Partnership
- 5.3 Financial participation

Article 6: Organization of the Partnership
- 6.1 General structure
- 6.2 Steering Committee
- 6.3 Partnership Management / Secretariat
- 6.4 Experts pool

Article 7: Mandatory national law/ Applicable law
Article 8: Civil liability
Article 9: Ownership of the Results – Operation – Industrial property rights Intellectual property rights
Article 10: Language
Article 11: Confidentiality – non-disclosure of information
Article 12: Publication
Article 13: Contract documents - interpretation
Article 14: Signature

Appendix 1: List of signatory Partners
Appendix 2: Accession document
Appendix 3: Deontological rules of governance
Appendix 4: Template of the joint offer

The joint offer and the partnership agreement are currently under review by the different parties interested in the co-exploitation.

4.5.11. Next steps after the end of the project

Among AQ-WATCH consortium members, by end of June 2023, MPG, TNO, FMI, UCAR, TNO, INDEV have already confirmed their interest in the joint exploitation with SUEZ group and are willing to take part in the discussions that will follow after the official end of the project.
Following the end of the project, the objective will be to finalize and sign the partnership agreement together with the consortium partners willing to continue and SUEZ, and to present the joint offer to the Environment Protection Agency of Sierra Leone as first prospect.
Maintaining regular interactions with UNEP, UNDP and GEMS AIR to reinforce the funding opportunities has been also identified as a key activity to foresee in the partnership missions.

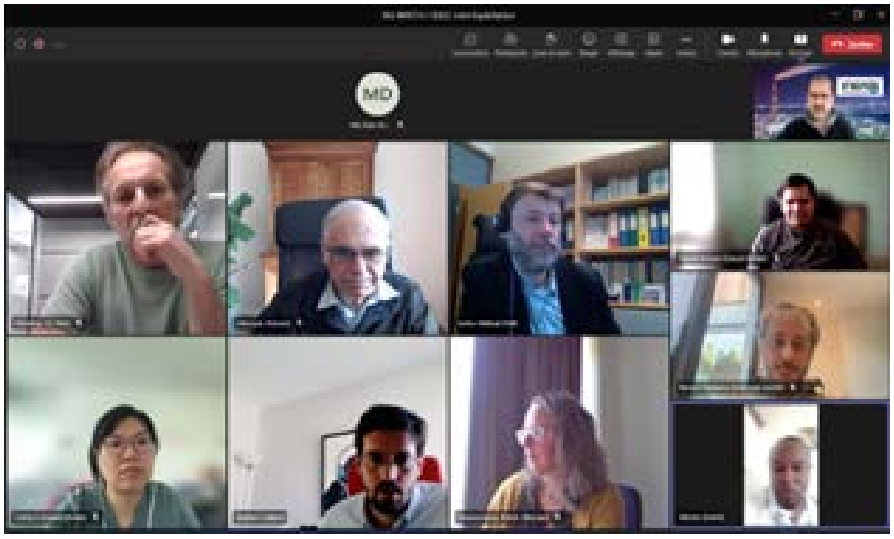


Figure 51: SUEZ/AQ-WATCH meeting on May 5, 2023

The consortium is aware that the implementation of the exploitation strategy will require additional investment after the end of the funding by the commission.
Each interested partner and exploiter will share business opportunities so that the AQ-WATCH partnership can undertake the exploitation of the results and the implementation of AQ-WATCH solutions, in new context for new clients.

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6. Dissemination and uptake

The website will be used to promote the joint offer supported by the partners and the exploiters willing to exploit the project results.
Any opportunity for communication (workshops, conferences…) will be used to promote the AQ-WATCH Partnership and the joint offer of services.

7. Uptake by the targeted audience

As indicated in the Description of the Action, the audience for this deliverable is *(mark with an X here below):*

	The general public (PU)
	The project partners, including the Commission services (PP)
	A group specified by the consortium, including the Commission services (RE)
X	This report is confidential, only for members of the consortium, including the Commission services (CO)

8. This is how we are going to ensure the uptake of the deliverables by the targeted audience

This deliverable will guide AQ-WATCH partners on the development of the dissemination and exploitation activities, and will have a close link to the development of the business plan for AQ-WATCH.

9. Deliverable timeliness

Is the deliverable delayed?
☐ Yes ☒ No

10. Sustainability

Not applicable for the D7.6.

11. Links built with other deliverables, WPs, and synergies created with other projects

Interactions with all partners and all WPs have taken place to elaboration the second version of the dissemination and exploitation plan.

12. Full track of dissemination activities

Not applicable for the D7.6.

13. Full track of publications and IP

Not applicable for the D7.6.

14. Full track of dissemination activities

Not applicable for the D7.6.

15. Full track of publications and IP

Not applicable for the D7.6.

16.Peer reviewed articles

Not applicable for the D7.6.

17.Publications in preparation OR submitted:

Not applicable for the D7.6.

18.Intellectual property rights resulting from this deliverable:

Not applicable for the D7.6.

Annexe 1 List of ministries and agencies in the target countries

List of the ministries and national agencies in charge of the air quality issue in Africa:

- Algeria:
  - Ministry of Environment and Renewable Energy: www.mre.gov.dz
- Angola:
  - Ministry of Environment: www.minamb.gov.ao
- Benin:
  - Ministry of Living Environment and Sustainable Development: www.environnement.gouv.bj
- Botswana:
  - Department of Environmental Affairs: www.environment.gov.bw
- Burkina Faso:
  - Ministry of Environment, Green Economy, and Climate Change: www.environnement.gov.bf
- Burundi:
  - Ministry of Environment, Agriculture, and Livestock: www.minagrie.gov.bi
- Cabo Verde:
  - Ministry of Environment and Housing: www.mavot.cv
- Cameroon:
  - Ministry of Environment, Protection of Nature, and Sustainable Development: www.minep.gov.cm
- Central African Republic:
  - Ministry of Environment and Sustainable Development
- Chad:
  - Ministry of Water, Environment, and Fisheries
- Comoros:
  - Ministry of Production, Environment, Energy, Industry, and Crafts
- Congo (Brazzaville):
  - Ministry of Tourism and Environment
- Congo (Kinshasa):
  - Ministry of Environment and Sustainable Development: www.environnement-rdc.org
- Côte d'Ivoire:
  - Ministry of Environment and Sustainable Development: www.environnement.gouv.ci
- Djibouti:
  - Ministry of Equipment and Transport
- Egypt:
  - Ministry of Environment: www.eeaa.gov.eg

- Equatorial Guinea:
  - Ministry of Agriculture, Livestock, Forestry, and Environment
- Eritrea:
  - Ministry of Land, Water, and Environment
- Eswatini:
  - Ministry of Tourism and Environmental Affairs: www.environment.gov.sz
  - Environmental Authority: www.environmentalauthority.sz
- Ethiopia:
  - Ministry of Environment, Forest, and Climate Change: www.moefcc.gov.et
- Gabon:
  - Ministry of Water and Forests: www.eauxetforets.ga
  - National Agency for National Parks
- Gambia:
  - Ministry of Environment, Climate Change, and Natural Resources: www.moenr.gm
- Ghana:
  - Environmental Protection Agency: www.epa.gov.gh
- Guinea:
  - Ministry of Environment, Water, and Forests
  - National Agency of Environment and Sustainable Development
- Guinea-Bissau:
  - Ministry of Agriculture and Rural Development
  - Directorate-General for the Environment
- Kenya:
  - Ministry of Environment and Forestry: www.environment.go.ke
- Lesotho:
  - Ministry of Tourism, Environment, and Culture: www.tourism.gov.ls
- Liberia:
  - Environmental Protection Agency: www.epa.gov.lr
- Libya:
  - Ministry of Environment
  - National Center for Environmental Health and Research
- Madagascar:
  - Ministry of Environment, Ecology, and Forests: www.meeft.gov.mg
- Malawi:
  - Department of Environmental Affairs: www.environment.gov.mw
- Mali:
  - Ministry of Environment, Sanitation, and Sustainable Development
  - National Directorate of Sanitation and Environmental Engineering
  - National Agency of Meteorology
- Mauritania:

    - Ministry of Environment and Sustainable Development
- Mauritius:
    - Ministry of Environment, Solid Waste Management, and Climate Change: www.govmu.org
- Morocco:
    - Ministry of Energy, Mines, and Environment: www.mem.gov.ma
    - National Agency for the Environment (ANDE): www.ande.ma
- Mozambique:
    - Ministry of Land and Environment: www.mintm.gov.mz
- Namibia:
    - Ministry of Environment, Forestry, and Tourism: www.met.gov.na
- Niger:
    - Ministry of Environment, Urban Sanitation, and Sustainable Development
    - National Agency of Meteorology
- Nigeria:
    - Federal Ministry of Environment: www.environment.gov.ng
    - National Environmental Standards and Regulations Enforcement Agency (NESREA): www.nesrea.gov.ng
- Rwanda:
    - Ministry of Environment: www.minecofin.gov.rw
    - Rwanda Environment Management Authority (REMA): www.rema.gov.rw
- São Tomé and Príncipe:
    - Ministry of Infrastructure, Natural Resources, and Environment
    - National Directorate of Environment
- Senegal:
    - Ministry of Environment and Sustainable Development
- Seychelles:
    - Ministry of Environment, Energy, and Climate Change: www.environment.gov.sc
    - Seychelles National Parks Authority: www.snpa.gov.sc
- Sierra Leone:
    - Environmental Protection Agency: www.epa.gov.sl
- Somalia:
    - Ministry of Energy and Water Resources
    - Ministry of Environment and Rural Development
- South Africa:
    - Department of Environment, Forestry, and Fisheries: www.environment.gov.za
    - South African Air Quality Information System (SAAQIS): www.saaqis.environment.gov.za
- South Sudan:
    - Ministry of Environment and Forestry Conservation
- Sudan:

    - Ministry of Environment, Natural Resources, and Physical Development
    - General Directorate for Environmental Health
- Tanzania:
    - Vice President's Office Division of Environment: www.tanzania.go.tz
    - National Environment Management Council (NEMC): www.nemc.or.tz
- Togo:
    - Ministry of Environment and Forest Resources: www.environnement.gouv.tg
    - National Agency for the Environment: www.ange.tg
- Tunisia:
    - Ministry of Local Affairs and Environment: www.environnement.gov.tn
    - National Agency for Environmental Protection: www.anpe.nat.tn
- Uganda:
    - Ministry of Water and Environment: www.mwe.go.ug
    - National Environment Management Authority (NEMA): www.nemaug.org
- Zambia:
    - Ministry of Water Development, Sanitation, and Environmental Protection: www.mwdsep.gov.zm
    - Environmental Management Agency (ZEMA): www.zema.org.zm
- Zimbabwe:
    - Ministry of Environment, Climate, Tourism, and Hospitality Industry: www.environment.gov.zw
    - Environmental Management Agency (EMA): www.ema.co.zw

List of the ministries and national agencies in charge of the air quality issue in ASEAN (Association of Southeast Asian Nations):

- Brunei Darussalam:
    - Environmental Protection and Management Department: www.env.gov.bn
- Cambodia:
    - General Directorate of Environmental Protection: www.moe.gov.kh
- Indonesia:
    - Badan Meteorologi, Klimatologi, dan Geofisika (BMKG): www.bmkg.go.id
- Laos:
    - Department of Pollution Control
- Malaysia:
    - Department of Environment: www.doe.gov.my
- Myanmar:
    - Department of Environmental Conservation
- Philippines:
    - Environmental Management Bureau: www.emb.gov.ph
- Singapore:
    - National Environment Agency: www.nea.gov.sg

- Thailand:
  - Pollution Control Department: www.pcd.go.th
- Timor-Leste:
  - National Directorate for Environment and Climate Change
- Vietnam:
  - Vietnam Environment Administration: www.vea.gov.vn

List of the ministries and national agencies in charge of the air quality issue for other developing countries:

- Argentina:
  - Ministry of Environment and Sustainable Development: www.argentina.gob.ar/ambiente
- Brazil:
  - Ministry of the Environment: www.gov.br/mma
- Chile:
  - Ministry of the Environment: www.mma.gob.cl
- Colombia:
  - Ministry of Environment and Sustainable Development: www.minambiente.gov.co
- India:
  - Central Pollution Control Board: www.cpcb.nic.in
- Mexico:
  - Ministry of the Environment and Natural Resources: www.gob.mx/semarnat
- Peru:
  - Ministry of the Environment: www.minam.gob.pe
- Turkey:
  - Ministry of Environment and Urbanization: www.csb.gov.tr

Annexe 2 List of potential funding organisations

Development banks and international organisations:

These institutions and programs provide financial support for development projects, including those related to environmental protection, climate change adaptation, and sustainable development.

- World Bank Group: www.worldbank.org
- Asian Development Bank (ADB): www.adb.org
- African Development Bank (AfDB): www.afdb.org
- Inter-American Development Bank (IDB): www.iadb.org
- European Bank for Reconstruction and Development (EBRD): www.ebrd.com
- Islamic Development Bank (IsDB): www.isdb.org
- Asian Infrastructure Investment Bank (AIIB): www.aiib.org
- Green Climate Fund (GCF): www.greenclimate.fund
- Global Environment Facility (GEF): www.thegef.org
- Climate Investment Funds (CIF): www.climateinvestmentfunds.org
- Adaptation Fund: www.adaptation-fund.org
- United Nations Development Programme (UNDP): www.undp.org
- Global Fund for Cities Development (FMDV): www.fmdv.net
- International Fund for Agricultural Development (IFAD): www.ifad.org
- United Nations Environment Programme (UNEP) - Climate and Clean Air Coalition (CCAC): www.ccacoalition.org
- Global Partnership for Sustainable Development Data: www.data4sdgs.org
- European Investment Bank (EIB): www.eib.org
- Nordic Development Fund (NDF): www.ndf.fi
- OPEC Fund for International Development (OFID): www.ofid.org
- Caribbean Development Bank (CDB): www.caribank.org
- Central American Bank for Economic Integration (CABEI): www.bcie.org
- Development Bank of Southern Africa (DBSA): www.dbsa.org
- Arab Fund for Economic and Social Development (AFESD): www.arabfund.org
- South Asian Association for Regional Cooperation (SAARC) Development Fund: www.saarc-sdf.org
- European Regional Development Fund (ERDF): www.ec.europa.eu/regional_policy
- Caribbean Development Fund (CDF): www.caricomdevelopmentfund.org
- Latin American Integration Association (ALADI) - AL-Invest Program: www.aladi.org

Trusts and foundations:

These foundations and trusts support various causes, including environmental conservation, public health, and sustainable development. It is important to review their specific areas of focus and funding priorities to determine alignment with ambient air quality monitoring and forecasting projects.

- Bill and Melinda Gates Foundation: www.gatesfoundation.org
- Rockefeller Foundation: www.rockefellerfoundation.org
- Ford Foundation: www.fordfoundation.org
- Open Society Foundations: www.opensocietyfoundations.org
- MacArthur Foundation: www.macfound.org
- Bloomberg Philanthropies: www.bloomberg.org
- Wellcome Trust: www.wellcome.ac.uk
- ClimateWorks Foundation: www.climateworks.org
- Global Green Grants Fund: www.globalgreengrants.org
- David and Lucile Packard Foundation: www.packard.org
- Oak Foundation: www.oakfnd.org
- Hewlett Foundation: www.hewlett.org
- Gordon and Betty Moore Foundation: www.moore.org
- Skoll Foundation: www.skoll.org
- Wallace Global Fund: www.wallaceglobal.org
- Blue Moon Fund: www.bluemoonfund.org
- Grantham Foundation for the Protection of the Environment: www.granthamfoundation.org
- Kresge Foundation: www.kresge.org
- Schmidt Futures: www.schmidtfutures.com
- Barr Foundation: www.barrfoundation.org