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SCUOLA DI INGEGNERIA INDUSTRIALE  
E DELL'INFORMAZIONE



# MyAir

Air quality monitoring

## DESIGN DOCUMENT

### DESIGN AND IMPLEMENTATION OF MOBILE APPLICATION

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# 1 Introduction

In the fast pace of our modern world, we often forget about one of the most fundamental elements sustaining our lives: the air we breathe. Each breath we take directly impacts our health and well-being. Yet, there are invisible threats in the air, pollutants that can harm our health and diminish our quality of life. The importance of monitoring air quality cannot be underestimated, as it empowers us to make informed decisions about our environment and safeguard our health.

Imagine an application designed to be your companion in this task. Imagine being able to track the air quality in the cities you have been day by day, providing valuable insights into how it changes over time. Imagine having access to live air quality data from across the world, giving you a comprehensive view of global air conditions. Moreover, stay updated with a curated collection of the most critical news on pollution, ensuring you are always informed about the air you breathe and the actions being taken to protect it.

By integrating real-time data, accurate tracking, and critical news updates, this application aims to empower you to take control of your air quality, encouraging a future where clean air is a priority and every breath is a step towards better health.

## 1.1 Project description

The developed application is called **MyAir**. The application is a health-focused project that allows users to track the air quality, to view real-time air quality across the world, and to be updated about the latest news on pollution. This app is addressed to people who are concerned about pollution and their health state and want to be aware of the air they breathe. To provide these features the application offers the following main functionalities:

- The ability to track the average AQI (Air Quality Index) based on the locations the user has been to.
- Save favourite locations to easily access the AQI of that city.
- An interactive map with AQI related data of the globe.
- A dedicated page for real time news about pollution.
- A personal diary to track down different AQI values of cities visited over time.

## 1.2 Features

### 1.2.1 Overall AQI data

The user can visualize an overall score based on the average AQI of cities he/she has visited over time. The application does not register the AQI value only, but also other relevant pollution data such as PM2.5, PM10, SO<sub>2</sub> (Sulfur dioxide), CO (Carbon dioxide), O<sub>3</sub> (Ozone), and NO<sub>2</sub> (Nitrogen Dioxide). Each value is stored in the user profile and averaged over time, the result is showed with an user-friendly UI with colors and charts. The following picture shows the official scale of AQI levels. The higher the AQI value, the greater the level of air pollution and the greater the health concern. For example, an AQI value of 50 or below represents good air quality, while an AQI value over 300 represents hazardous air quality.

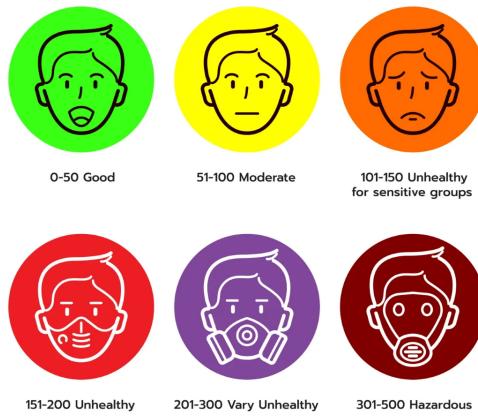


Figure 1: Official AQI levels

### 1.2.2 Saved locations

The user can save his/her favourite locations in order to easily access the air quality values of that specific city in real time.

### **1.2.3 Interactive pollution map**

The application provides an interactive Google Map widget on which we have implemented a coloured layer with AQI data from Google APIs. The map uses different range of colors, from light blue (very healthy) to dark purple (very polluted area) to intuitively show the pollution level in a specific region. Furthermore the map can be zoomed in and out and the user can explore it by moving over the world and tap a location for its specific AQI data.

### **1.2.4 User's diary**

The diary offers a calendar style view to add new visited city every day. This way the user can check data about AQI any time and keep the profile updated with personal daily travel.

### **1.2.5 News**

The user can check real-time news about pollution and health related topics. The feature offers the possibility to read news in different languages. the data are retrieved from different sources offering the possibility to access the complete news on the specific newspaper webpage.

### **1.2.6 AI chatbot**

**MyAir** also provides an in-app chatbot dedicated to answer pollution-related questions of the user. The purpose of this feature is to create a user friendly environment to easily access news, suggestions or gain healthy habits by simply interacting with AI. The chatbot has been implemented using OpenAI APIs of ChatGpt-3.5.

### **1.2.7 Notification reminder**

The user will be reminded to use the app through a scheduled notification that takes place near the end of the day. The notification is scheduled only if the user actively uses the app, so that if they decide to pause the use of the app, they're not overloaded with notifications. The purpose of the notifications is to involve the user to manually add cities every day as the application does not track GPS movement in the background.

## 2 Architectural Design

### 2.1 Overview

**MyAir** is a Flutter application, developed for Android and Tablet devices. Its architecture relies on Firebase as a safe and secure back-end for authenticating the users and store the users' data. The air quality data are all retrieved from Google Air Quality API (<https://developers.google.com/maps/documentation/air-quality/overview?>). In particular we exploit the API to retrieve real-time AQI values from coordinates values, historical AQI data and heatmaps tile overlay. The news are retrieved from newsapi.ai (<https://www.newsapi.ai/>).

#### 2.1.1 Authentication

**MyAir** logins and signs up users via Firebase Authentication (<https://firebase.google.com/docs/auth>). The supported sign-in method is Email/Password. Users are assigned a unique identifier, that will be used in the Firestore Database for identifying the user's collection. For a better login/sign-in experience we also implemented Google authentication.

#### 2.1.2 Data management

The application relies on an online and in-cloud database: Cloud Firestore (<https://firebase.google.com/docs/firestore>). The database contains data related to the user's basic information, the user's favourite cities, the visited cities for each day, as well as the related AQI data.

#### 2.1.3 Data structure

The database structure is defined as follows.

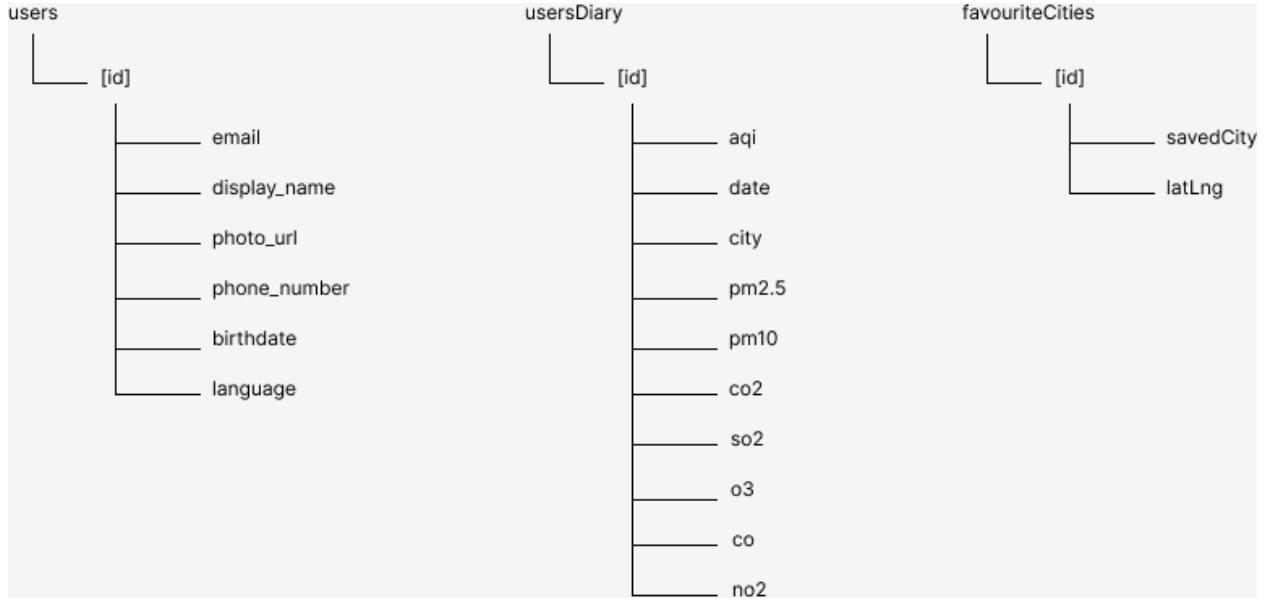


Figure 2: Database schema

The three schemes represent three different tables in our database: the **users** table for general user information, **usersDiary** for user's visited cities for each date and related AQI values and **favouriteCities** to track user's saved locations.

## 2.2 Architectural Style and Patterns

The application has been thought out to use a two-tier architecture where the back-end logic is implemented mainly on the client side (inside the UI) and Firebase is used as cloud-provider for data storage. The choice of the aforementioned implementation resides in the modest back-end logic as the application functioning is based on the retrieval of data from the DB and the dynamic generation of widgets. The app uses in practice API calls to Google to retrieve Air Quality data and shows them to the user either in real-time (AQI of favourite locations and interactive air pollution map) or in a static way (AQI values for user's diary). To manage general features of the application we've used AppState variables. For instance, notifications and language settings are managed this way.

## 2.3 Widgets

As a Flutter application, **MyAir** is built by several widgets that build the correct view and respond to the user's input.

### 2.3.1 Main screens and Navigation

The application has some main screens that are accessible from each other via a bottom navigation bar, present in (almost) all the screens:

- **Profile:** This view is the one that manage all user preferences included permissions, personal information, UI settings. It also provides access to 'Help & Support' and 'Change password' page.
- **Map:** This view provides the access to the Google style pollution map. A bottom container displays the AQI of the selected location and general health recommendation for that specific place.
- **Home:** This view provides a recap of user's data. This is the main screen as the purpose of the app is to easily access pollution data for better health care.
- **News:** This view provides a TabBar page that allows to switch from a global to a local news selection filtrated in order to show only pollution related news.
- **Diary:** This the view which provides the users the possibility to create an historical record of the daily locations.

### 2.3.2 Chatbot

The application also implements the possibility to use AI to chat with the in-app chatbot to find suggestions and tips in order to better take care of your health. This feature aims to provide a modern tool to create a friendly interaction with the user and an easy way to find answers to pollution related questions. The logic behind the chat is an API call to OpenAI services using ChatGpt-3.5 as a generative model and some prompt engineering to instruct the bot to only answer pertinent question related to the application.

### **2.3.3 Place picker**

Place Picker is the widget that is used every time the user needs to select a place. It is used in the map to move to a specific location, in the diary to enter a city, or in the homepage to add a new favorite city. Place Picker shows suggestions, provided by Google, to auto complete the research of a place.

### **2.3.4 Maps and marker**

The pollution map is a customized GoogleMap widget, it calls Google API to retrieve pollution heatmap tiles and overlays them into the GoogleMap widget. Furthermore the pollution map allows the user to tap on a specific point, creating a marker, and receiving information about the air quality of that exact spot. Otherwise, the user can search for a place through the place picker widget. All the air quality information is displayed on a flip card that on the front shows AQI and on the back shows general health recommendations related to that level of pollution.

## **2.4 Notifications**

The app provides the user the ability to receive a daily notification that reminds them to log their diet. The notification is useful to help developing healthy habits by keeping up to date the diary log. The notification has been thought out to not be intrusive, so the user will receive the daily notification only if they actively use the app. It empowers individuals to establish a consistent routine for logging their daily city without feeling overwhelmed or burdened by intrusive alerts. The app uses the Flutter Local Notifications plugin ([https://pub.dev/packages/flutter\\_local\\_notification](https://pub.dev/packages/flutter_local_notification)) to schedule and deliver the notification to the user. A local approach has been chosen, as there is no need for the back-end to deliver this notification as it is static. The notification's component is called Local Notification Service, and the code is executed while using the app, scheduling a notification for the next evening (19:00). This hour has been chosen as it is a good candidate to catch a user's free moment of the day, as it probably is after work activity and sufficiently late in the day to have a definitive location.

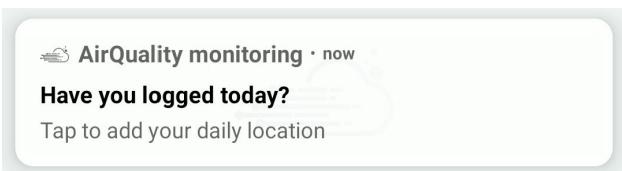
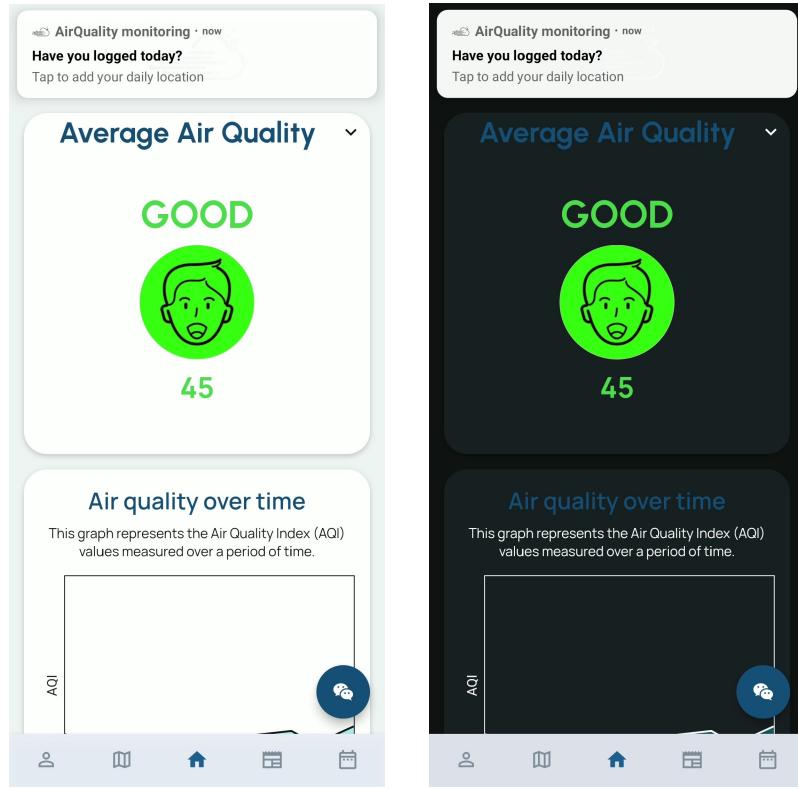


Figure 3: Notification banner

## 3 Dependencies

### 3.1 Plugins

The table provided below enumerates the noteworthy plugins that have been incorporated into the application as dependencies. Each plugin is accompanied by a rationale for its inclusion, outlining the purpose and justification behind its integration.

Plugin	Use
Cloud Firestone	Necessary to use cloud database services of Firebase.
Flutter Google Places	Necessary for searching and selecting places and coordinates of the world.
Google Maps Flutter	Necessary for the implementation of the pollution map.
Google Air Quality	Necessary for all data regarding air quality values.
News API	Necessary for retrieving news about pollution in different languages.
OpenAI API	Necessary to include ChatGpt functionalities for <b>MyAir</b> chat-bot.
Flutter Local Notifications	Allows to receive a daily notification to remind the user to log their data.

Table 1: Most significant plugins used and related description.

## 4 User Interface

### 4.1 Design of the app

The design for the mobile and tablet application was developed using the FlutterFlow platform, which facilitated the creation of pages and the selection of color palettes for both light and dark modes.

### 4.2 Mobile version

#### 4.2.1 Authentication Pages

When users open the app for the first time, or they are not logged in, a login page is displayed. The login page integrates Google authentication for a Web 2.0 login. Below the login fields, there is a link labeled "Forgot Password?" which directs users to a password reset page. Additionally, there is a button labeled "Create New Account" that takes users to a registration page for setting up a new account.

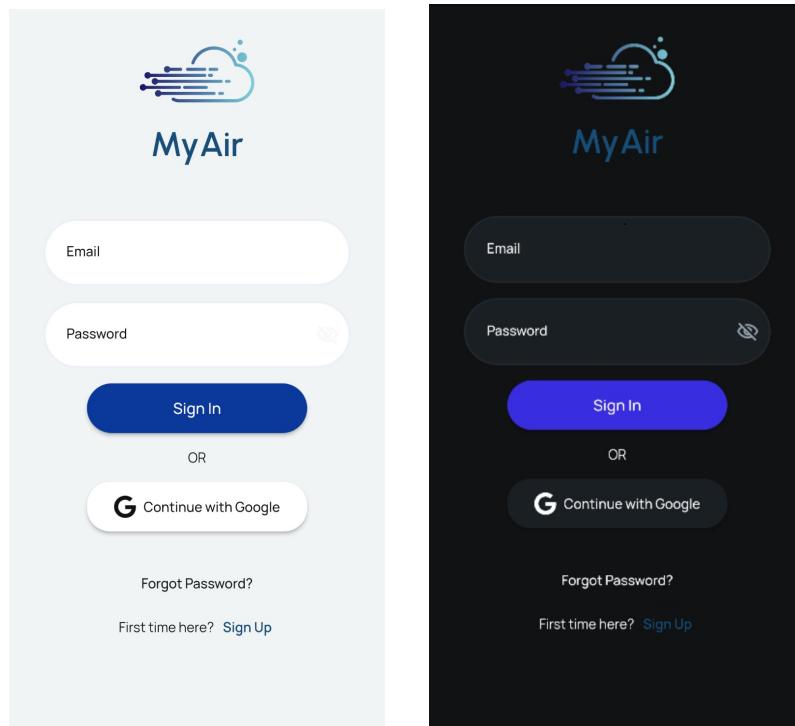


Figure 4: login page

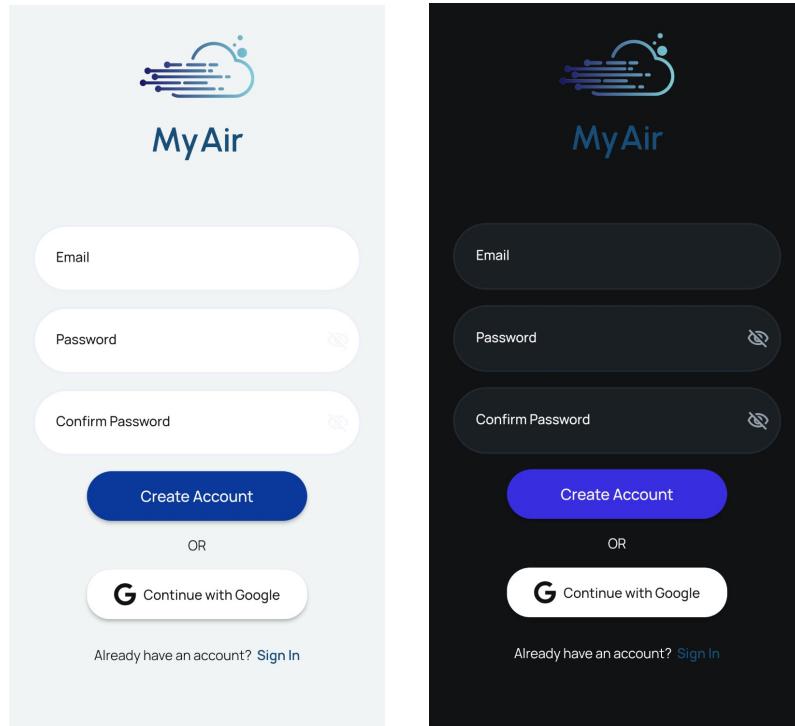


Figure 5: create account page

#### 4.2.2 Change password page

This page contains the form for updating the user's password.

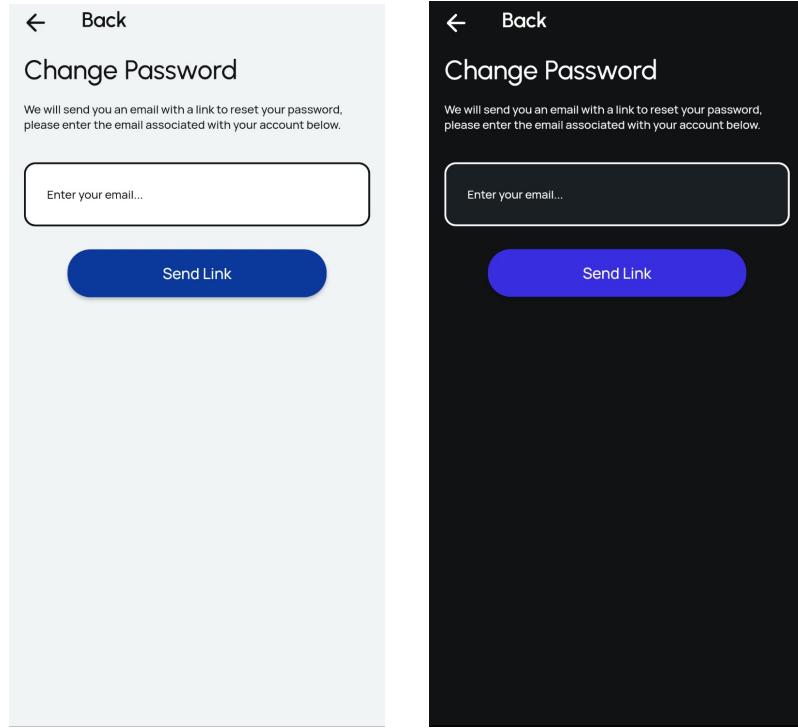


Figure 6: change password page

#### 4.2.3 Profile page

The profile page shows the user's information such as profile picture, username, and average AQI. The page also provides: a switch for changing between light and dark mode, a button "Change Password", a button "Edit Profile" which allows to change user information and a button "Settings" which allows to change preferences and get support.

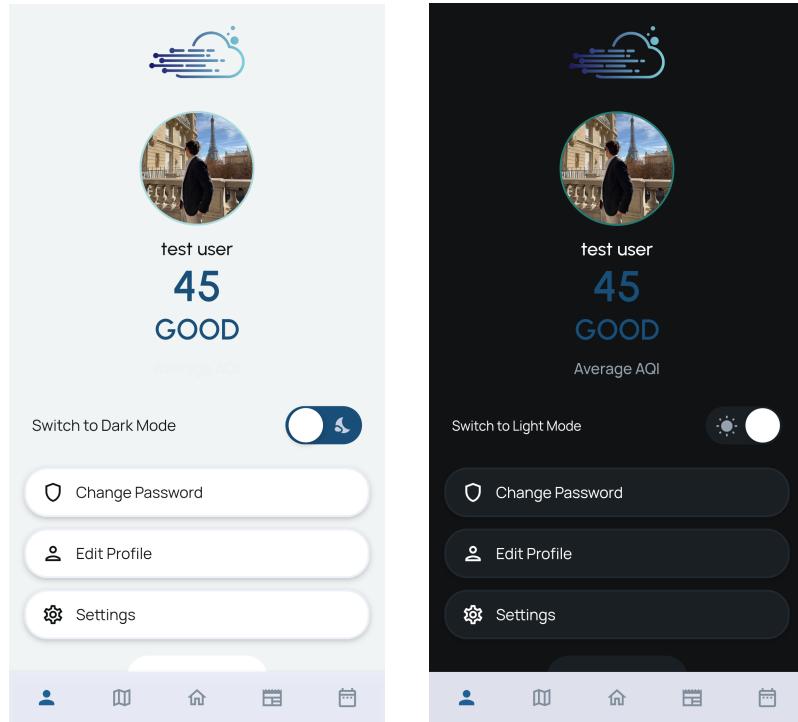


Figure 7: profile page

#### 4.2.4 Edit profile

This page has forms for updating user's information.

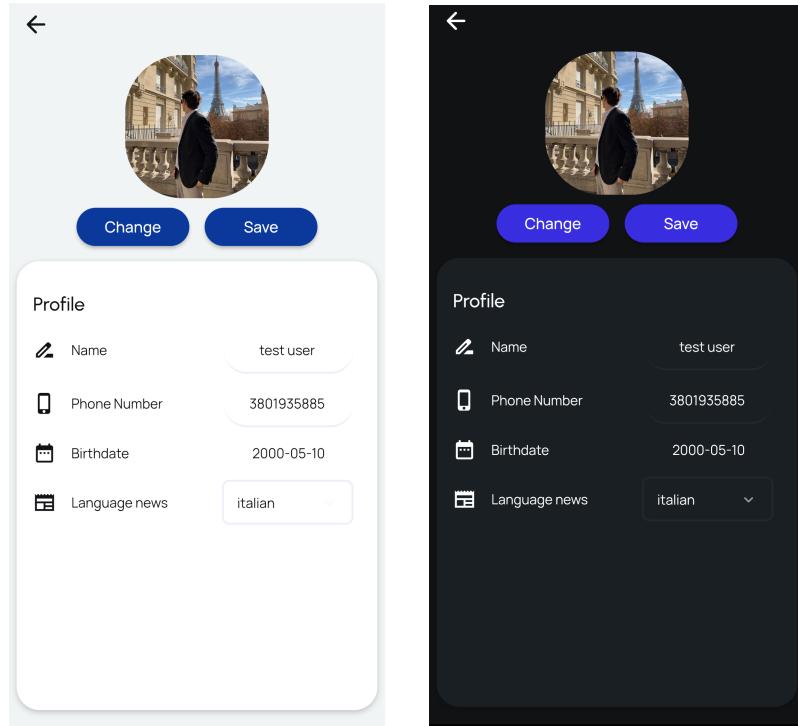


Figure 8: edit profile page

#### 4.2.5 Settings

The settings page provides toggle button for setting notifications and for enabling and disabling chat icon. Below these buttons there are: a link labeled 'position authorization' which directs the user to application's authorization, a link labeled 'Help & Support' which directs user to a FAQ page, a link labeled 'Contact us' which allows the user to send email to the application's team. At the bottom of the page there is a link for deleting the account.

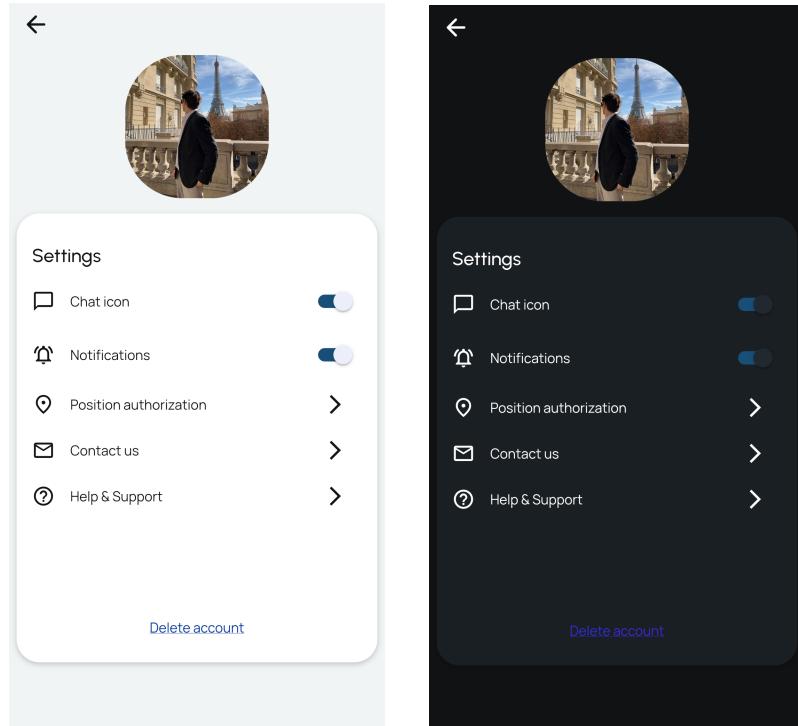


Figure 9: settings page

#### 4.2.6 Contact us

This page contains forms for writing to the application's team.

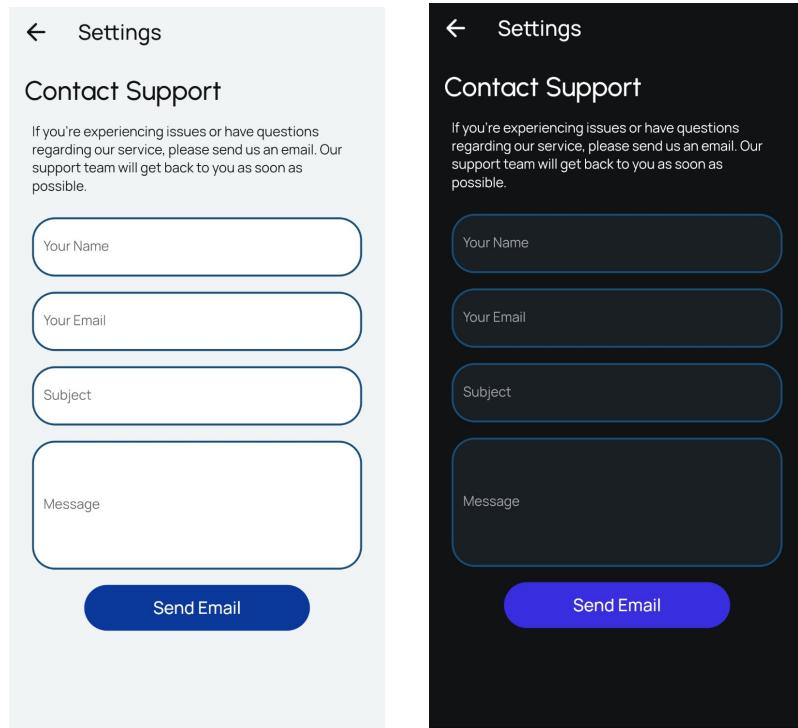


Figure 10: contact us page

#### 4.2.7 Help & support

This page contains frequently asked questions.

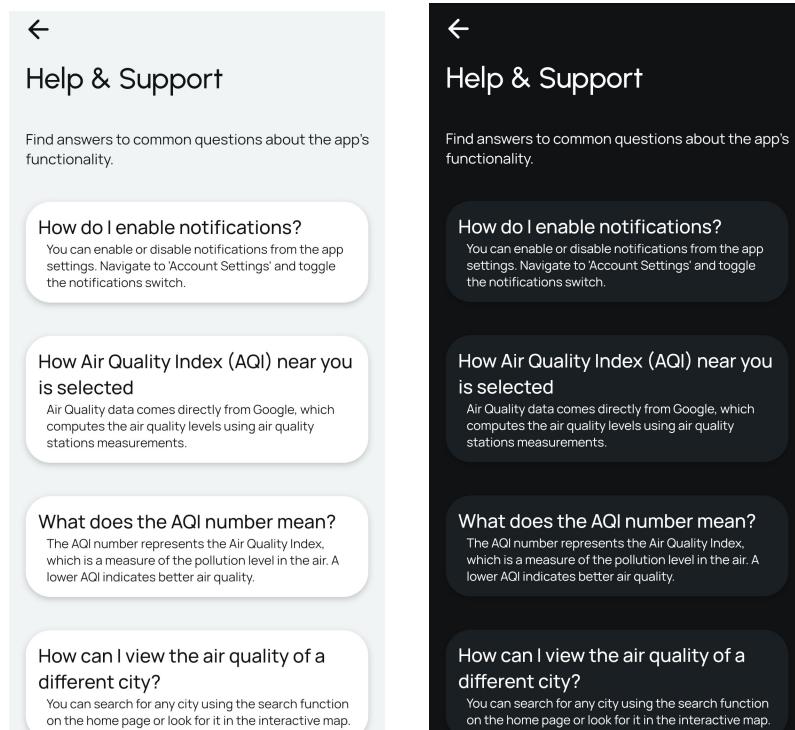


Figure 11: Help & Support page

#### 4.2.8 Pollution map

This page contains the pollution map with a search bar and a button to center the map on the user's current location. In addition, we have a flip card that shows the AQI value and on the back shows recommendations based on air quality. On the map, it is possible to tap creating markers to indicate a specific location whose AQI will be retrieved.

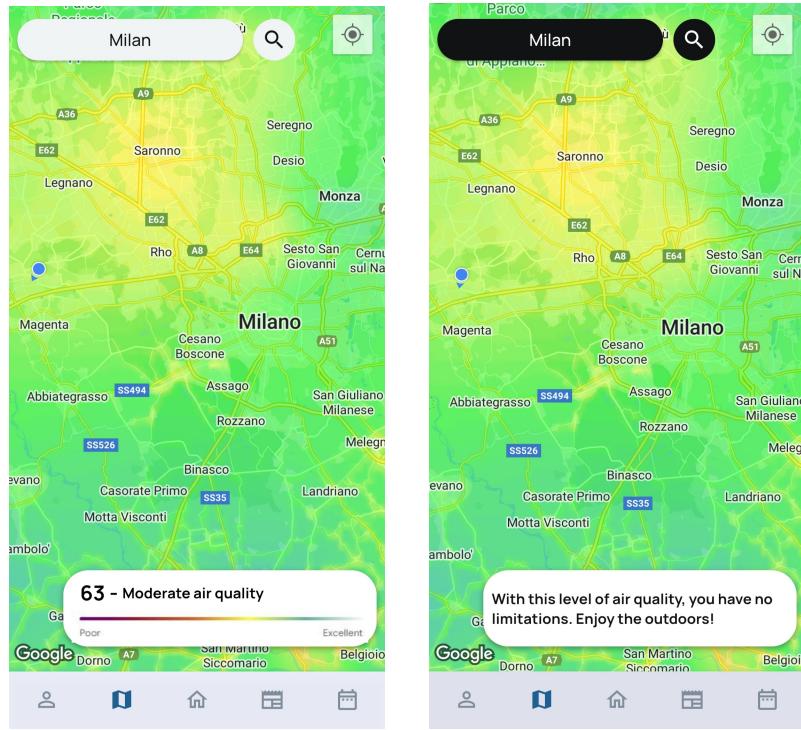


Figure 12: pollution map page

#### 4.2.9 Homepage

This page shows the user's average AQI and allows the user to view the average pollutants in detail. It contains a graph to show the evolution over time of the pollution the user is subjected to. It also contains a slider that shows the AQI in the user's favorite cities and two widgets to allow the user to add favorite cities.

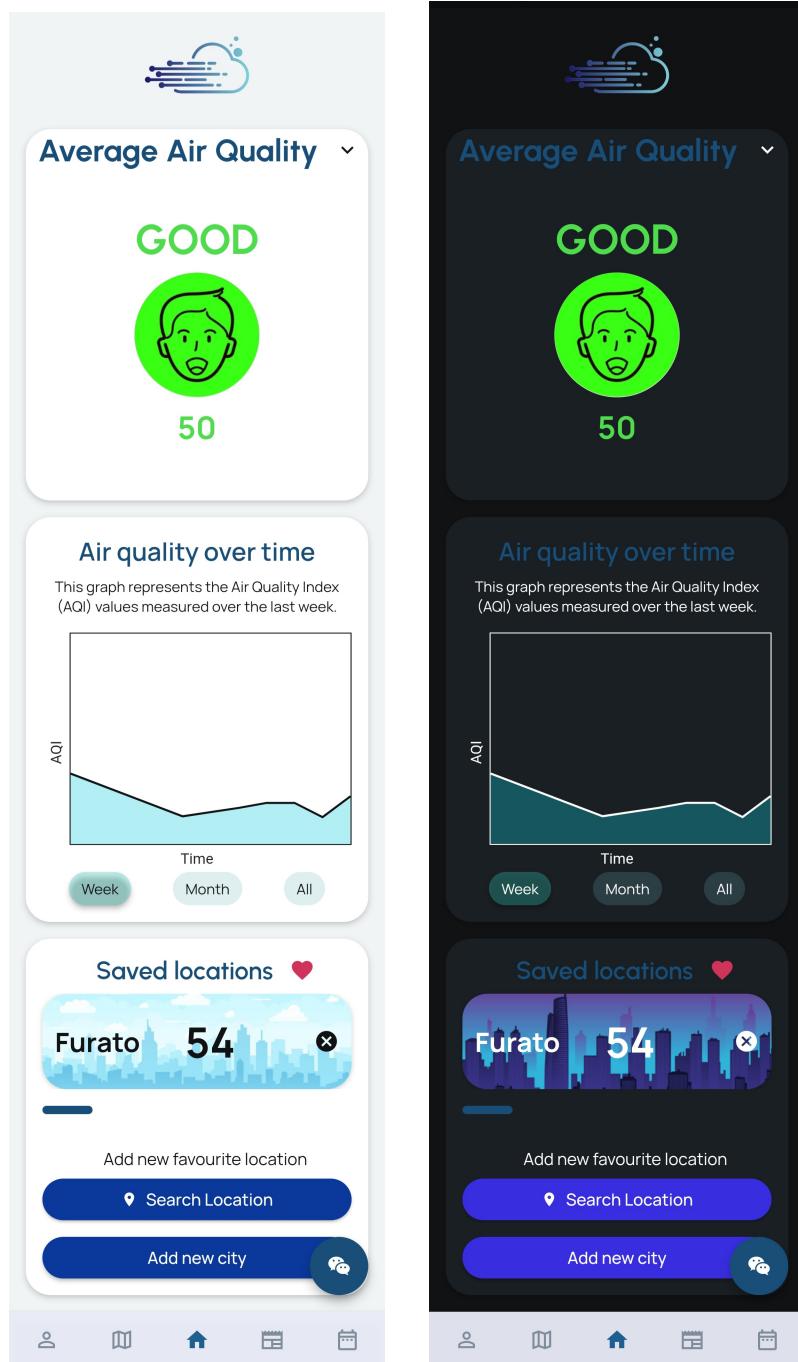


Figure 13: home page

#### 4.2.10 Diary

This page contains a calendar widget where the user can add and remove the city he has been to on a given day. The calendar then allows the user to see its entire AQI history. Calendar view can be switched between month and week.

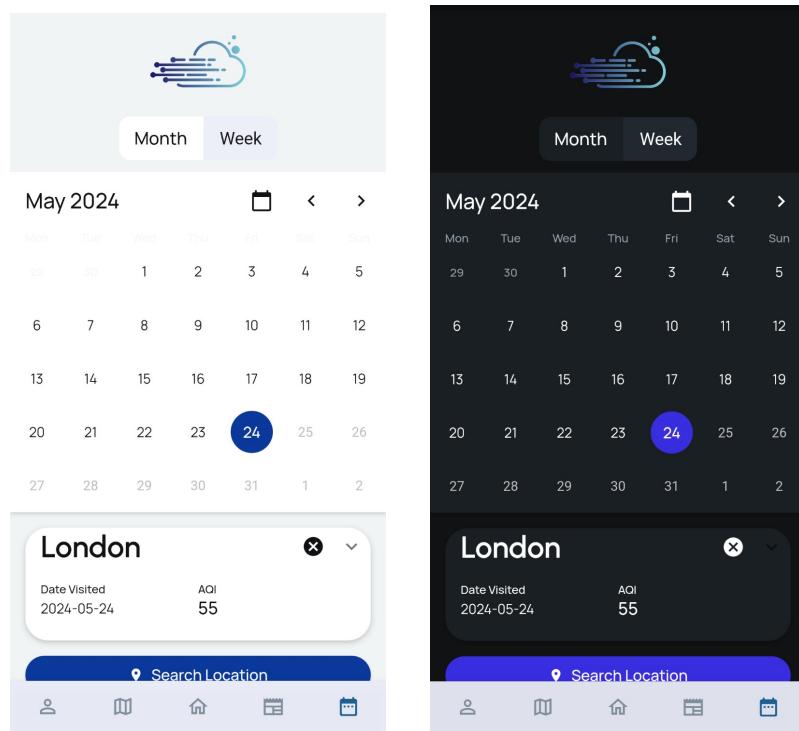


Figure 14: diary page

#### 4.2.11 News page

This page contains the latest news on pollution and allow to change from global news to local news.

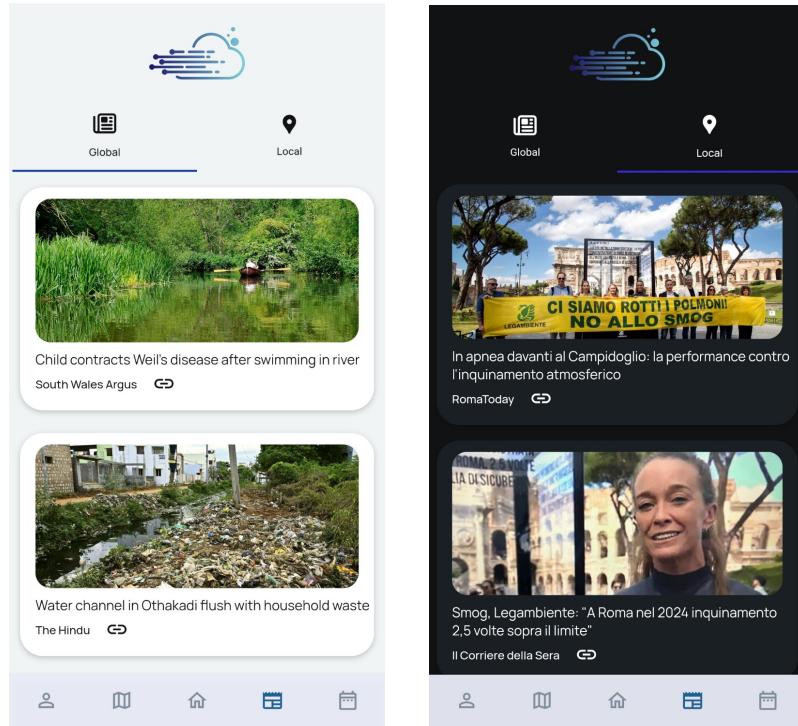


Figure 15: news page

#### 4.2.12 Chatbot page

This page contains a chat-like container to interact with the chatbot, furthermore it contains a link to a tutorial that shows some examples of questions that can be asked.

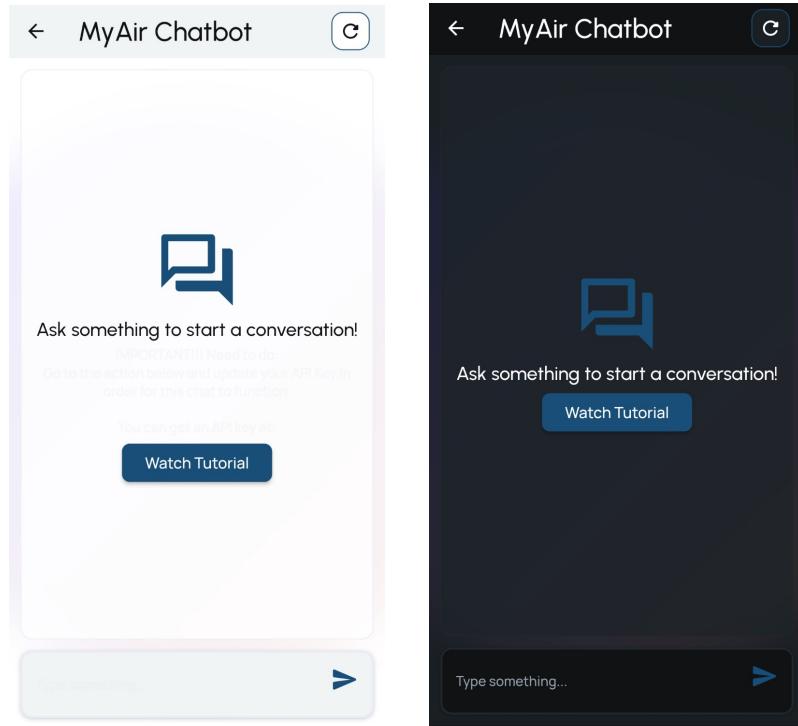


Figure 16: Chatbot page

### 4.3 Tablet version

In the following sections are shown the screens of the tablet application. Every page will be shown respectively in dark and light mode. The content and functionalities of the pages are equals to the mobile version.

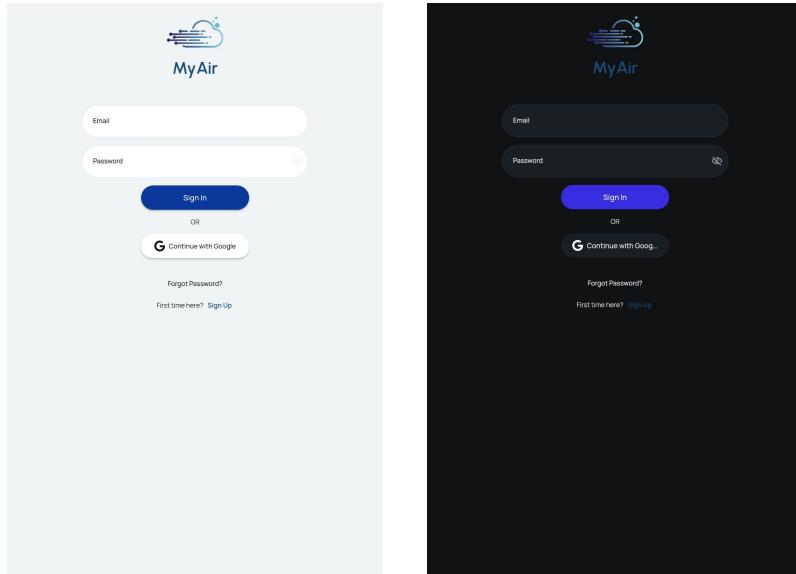


Figure 17: login page

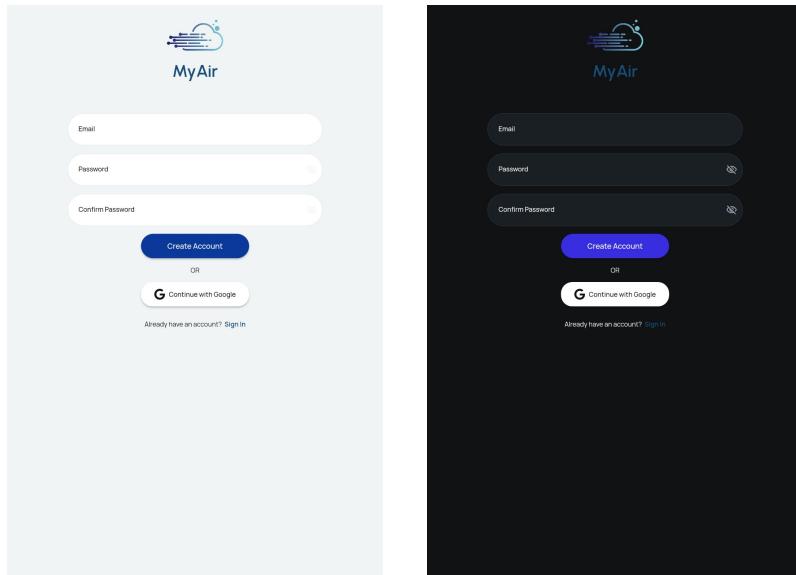


Figure 18: create account page

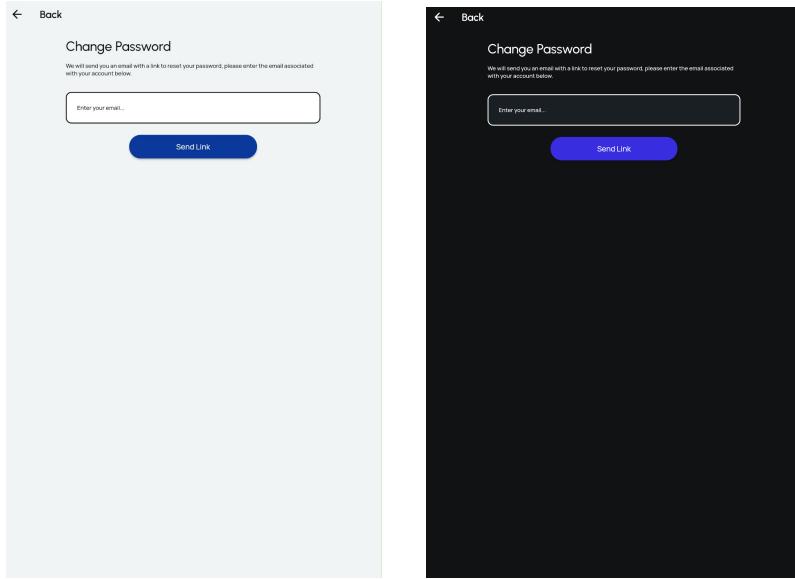


Figure 19: change password page

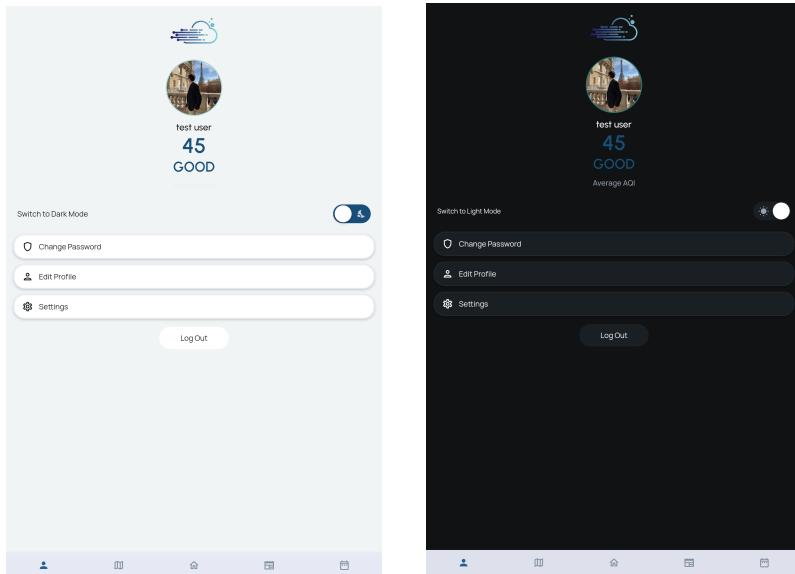


Figure 20: profile page

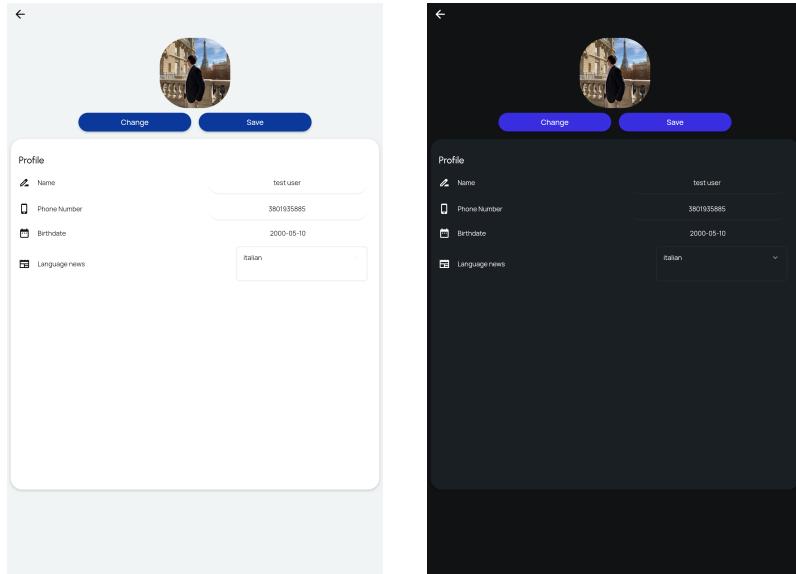


Figure 21: edit profile page

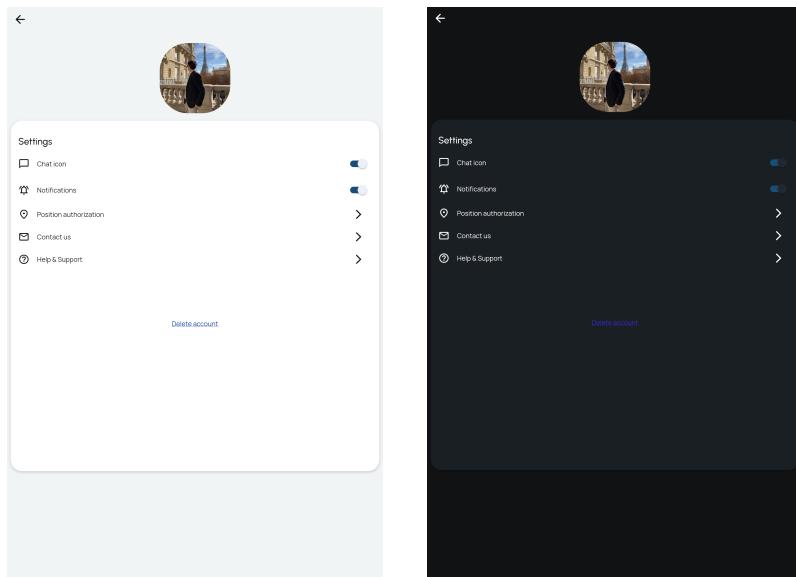


Figure 22: settings page

**Contact Support**

If you're experiencing issues or have questions regarding our service, please send us an email. Our support team will get back to you as soon as possible.

Your Name  
Your Email  
Subject  
Message

Send Email

Figure 23: contact us page

**Help & Support**

Find answers to common questions about the app's functionality.

**How do I enable notifications?**  
You can enable or disable notifications from the app settings. Navigate to Account Settings and toggle the notifications switch.

**How Air Quality Index (AQI) near you is selected?**  
Air Quality data comes directly from Google, which computes the air quality levels using air quality station measurements.

**What does the AQI number mean?**  
The AQI number represents the Air Quality Index, which is a measure of the pollution level in the air. A lower AQI indicates better air quality.

**How can I view the air quality of a different city?**  
You can search for any city using the search function on the home page or look for it in the interactive map.

**How do I update my personal information?**  
To update your personal information such as name, email, or phone number, navigate to Edit Profile in the account settings.

**How do I contact support?**  
If you need further assistance, please contact our support team by navigating to Contact Support in the account settings.

**How do I enable notifications?**  
You can enable or disable notifications from the app settings. Navigate to Account Settings and toggle the notifications switch.

**How Air Quality Index (AQI) near you is selected?**  
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**How do I contact support?**  
If you need further assistance, please contact our support team by navigating to Contact Support in the account settings.

Figure 24: Help & Support page

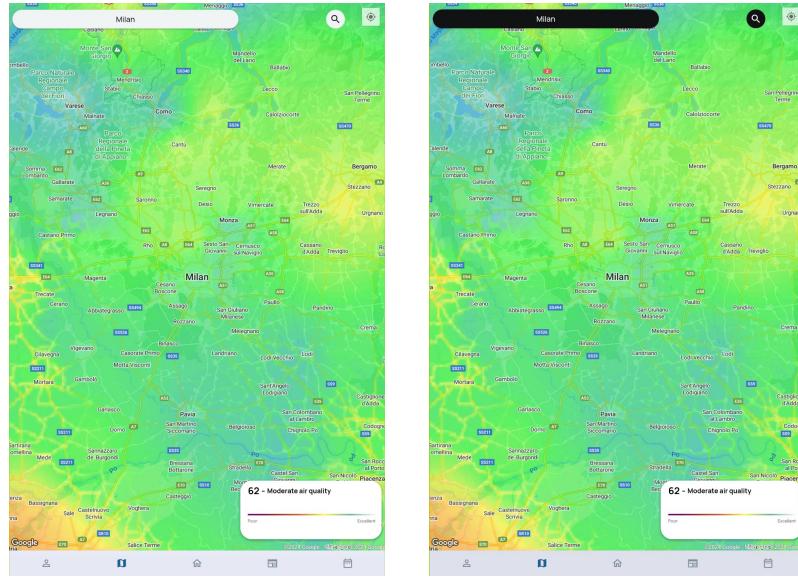


Figure 25: pollution map page

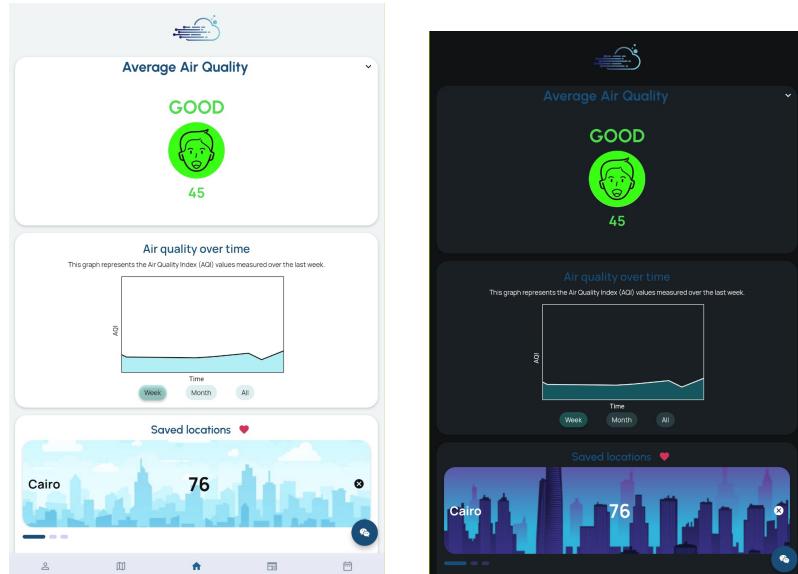


Figure 26: home page

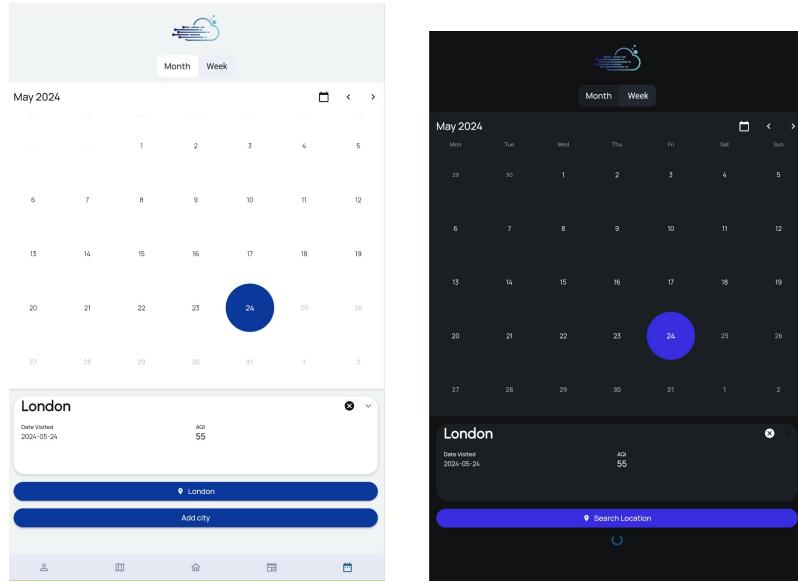


Figure 27: diary page

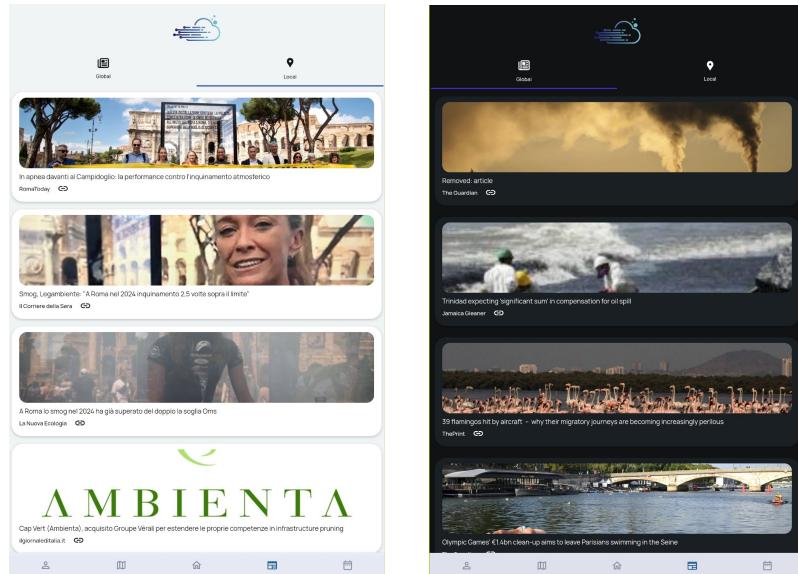


Figure 28: news page

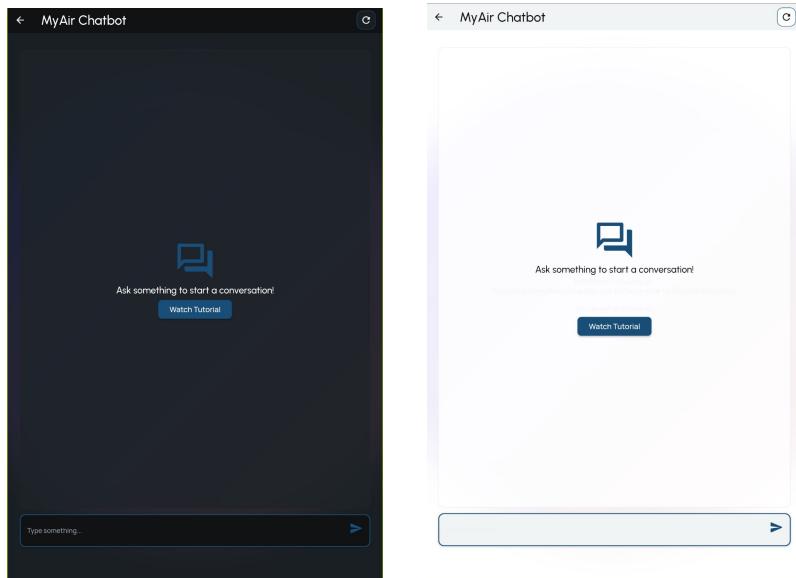
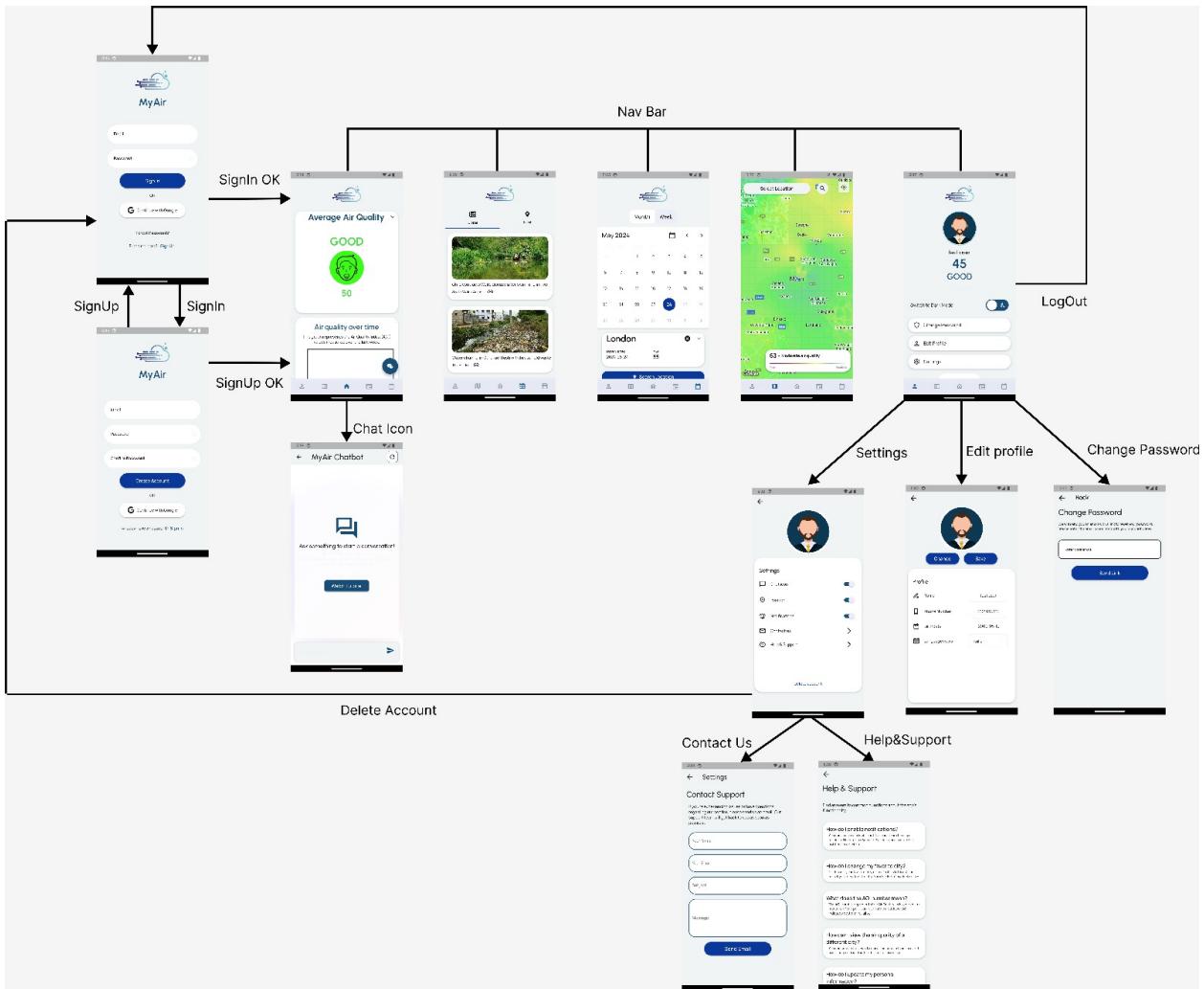


Figure 29: chatbot page

## 5 UX Flow

This diagram shows the actions that the user can perform to navigate through the screens of the app. For convenience it has been used mobile screens.



## 6 App testing

### 6.1 Unit testing

Most of the methods in the application involve either making API calls or organizing the screen's layout, making it inappropriate for unit testing.

### 6.2 Widget testing

To ensure successful testing, a mocked version was developed for most important widget in the app. These versions eliminate any Firestore queries and API calls that may lead to test failures, replacing them with static values. The primary objective of this testing approach is to confirm the presence of all expected sub-widgets within each widget's layout and validate that the displayed texts accurately match the statically inserted content.

Widget tested	Description
FlipCard Map Widget	The test verifies that the map contains the FlipCard widget with both front and back face. Then the test assert that the text coming from API is correctly displayed.
LineChart Container Widget	The test asserts the presence of LineChart Widget and the presence of every chip button
PollutionMap Widget	The test assert the presence of the GoogleMap Widget and then verifies that a tap on a place of the map creates a Marker Widget and set the values of the Place Picker Widget at the coordinates of the tap.
FavoriteCities Viewer Widget	The test assert the presence of the default image representing the empty slider, then it verifies the presence of the Place Picker Widget and of the add city button

### **6.3 Integration testing**

The integration testing has been performed by the usage of two flutter packages: flutter\_test/flutter\_test.dart , integration\_test/integration\_test.dart. The objective of this type of testing is to simulate user behavior within the app.

<b>Integration test</b>	<b>Description</b>
Creation new user	This test start from login page and simulates the creation of a new user. Then the test verifies that the current page is the homepage of the new user.
Delete Account	This test simulates a tap on 'Delete Account' in the account settings page. After that it verifies that the current page is the login page.
Logout	This test simulates a tap on 'Logout' button in the profile page. After that it verifies that the current page is the login page.
Diary	This test simulates a tap on the navbar icon 'diary', so it assert that the displayed page is the diary page. Then it switch from month to week visualization and assert that the calendar is shown correctly. Furthermore the test fix a city in the place picker widget and tap on 'Add City' and 'yes' to add that city. Then it asserts the city is actually added to the diary on today date.
Home Page	The test verifies the presence of all main widgets of the home page: container, expandable panel, line chart, favorite cities viewer, flip card, place picker. Then the test fix a city in the place picker widget, thus it emulates tap on 'Add city', so a new city is added in the favorite city viewer. Finally the test asserts the presence of the just added city.
Pollution Map	This test simulates a tap on the navbar icon 'map', thus it asserts the presence of the map and the flip card that shows the air quality. Then it emulates a change of location using the search button and fixing a place in the place picker widget. Finally the test stores the new AQI value and asserts it's different from the initial value, so the location is actually changed.
News	This test simulates a tap on the navbar icon 'news', thus it asserts the presence of the 'local' and 'global' button.
Profile	This test simulates a tap on the navbar icon 'profile' thus it asserts the presence of these buttons: 'change password', 'edit profile', 'settings', 'log out'. Then the test emulates a switch for light/dark mode and all possible navigation through pages. Finally it asserts again the presence of the initial widget to verify that the displayed page is profile page.

## 6.4 Coverage

We implemented 8 integration tests, 4 widget tests and 0 unit tests. As no unit tests were performed and widget tests used mocked version of the app we don't report the coverage table for these types of tests. As for integration testing, we covered all main functionalities of the app that includes all 5 pages of the navigation bar and the authentication pages. The reader can see the coverage percentage in the table below.

Pages	Coverage
Create account	92%
Sign In	93%
Diary Page	96%
Home Page	69%
Pollution Map	93%
News Page	88%
Profile Setting	89%
Edit Profile	72%
Change Password	94%

## 6.5 User testing

The app has undergone extensive testing on both student devices and emulators throughout the entire development process. During these daily tests, various graphical, logical, and back-end bugs were identified and resolved on a day-to-day basis. The most recurrent issue was related to the pixel overflow of some widgets.

## 7 Effort spent and contribution

Student	Database	Design	App	Documentation	Presentation	Total
Francesco Pastori	2h	36h	100h	10h	2h	150h
Ismaele Villa	2h	36h	100h	10h	2h	150h