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Type
User Guide

WaterCopilot

A Water Management AI Virtual Assistant for the Limpopo River Basin Digital Twin

User Guide V0 202410

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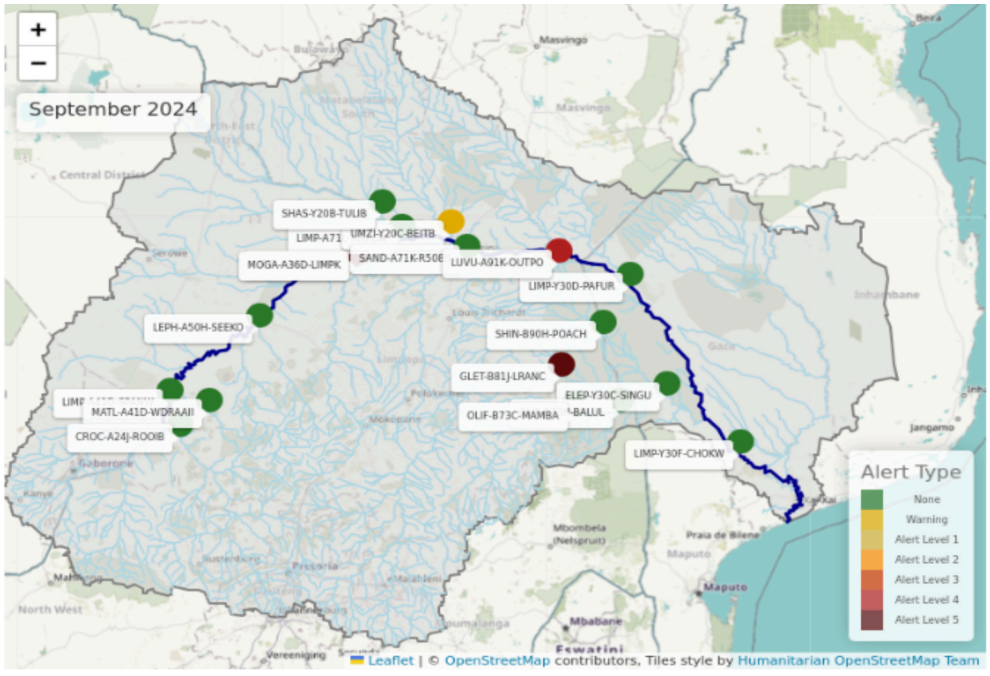
Summary

The Limpopo Digital Twin Water Management AI Virtual Assistant User Guide provides a practical guide for users to effectively navigate WaterCopilot, an AI-powered Copilot developed by the International Water Management Institute (IWMI) in collaboration with Microsoft Research. This guide offers clear instructions on using the Copilot to access crucial water-related data for the Limpopo River Basin, including rainfall insights, environmental flow alerts, and water availability.

The guide highlights key features such as a user-friendly interface, multilingual support, and interactive data retrieval, making WaterCopilot accessible to a broad range of users, from researchers and policymakers to individuals with limited technical expertise. It also explains the Copilot's ability to analyze historical and real-time data, helping users identify patterns and make informed decisions.

In addition, the user guide includes troubleshooting tips and a frequently asked questions (FAQs) section, ensuring a smooth and efficient user experience. By following this guide, users will be empowered to leverage WaterCopilot for sustainable water management within the Limpopo River Basin.



Would you like to analyze the alert for another date? If so, please provide the specific date (in YYYY-MM-DD

Yes, Could you tell me more about the rivers with Critical Alerts?

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Introduction

The WaterCopilot is an intuitive, conversational tool/ chatbot designed to simplify the process of accessing and analyzing critical water-related data for the Limpopo River Basin. By allowing users to interact through natural language, it bridges the gap between complex datasets and practical decision-making, making it accessible to a wide range of users—from experienced scientists to policymakers, community leaders, and individuals with limited technical expertise.

The WaterCopilot began as a research collaboration between IWMI and Microsoft Research under the Digital Twin project. The Digital Twin concept involves creating a virtual representation of the Limpopo River Basin that integrates real-time data, simulation models, machine learning, and reasoning tools. This digital platform enables users to visualize and simulate various scenarios, providing actionable insights for sustainable water resource management. By empowering decision-makers to analyze and forecast basin dynamics interactively, the Digital Twin fosters better understanding and informed decision-making (Garcia Andarcia et al., 2024).

Central to this project is the foundational hydrological model for the Limpopo River Basin, developed using the Soil and Water Assessment Tool Plus (SWAT+). This model provides a robust framework for analyzing water availability and flow dynamics in the basin (Gurusinghe et al., 2024). This foundational model is enhanced through automation processes, such as the dynamic integration of real-time climatic data, including rainfall updates, which transition the model from a static framework to an operational tool. By enabling accurate predictions for rainfall trends, river flows, and water availability, this operationalized SWAT+ model supports sustainable water management across diverse climatic zones in the basin (Leitão et al., 2024).

Microsoft Research previously developed Farm Vibes (Microsoft, n.d.) to support farmers in their agricultural practices. With their guidance and expertise, a similar solution for water management in the Limpopo River Basin has been built. (Vickneswaran et al., 2024).

Many applications in environmental and water management require the capability to autonomously extract useful information from vast amounts of data in real time. Information related to river environmental conditions, rainfall patterns, and water management practices is often scattered across platforms, documents, and databases, making it challenging to manage using traditional workflows (Sun & Scanlon, 2019).

WaterCopilot overcomes these barriers by providing data in an easily digestible format and offering straightforward answers to queries about water resources including rainfall, environmental flows (e-flows), water availability, and even issues alerts when problems such as water shortages arise. This makes it an effective tool for users who may not have the scientific expertise to interrogate water data, while still offering robust analytical capabilities for those needing deeper insights.

The bot goes beyond answering simple queries. It identifies patterns, detects issues, and suggests actionable recommendations based on historical data and predictive models. This makes it an indispensable tool for a wide array of users involved in managing water resources.

WaterCopilot plays a crucial role in translating complex environmental data into insights that support effective decision-making. This guide provides a detailed overview of how to utilize WaterCopilot's capabilities, from basic interactions to advanced analysis, helping users navigate and interpret critical information related to the Limpopo River Basin.

Case study: The Limpopo River Basin

The Limpopo River Basin (LRB) is an international watershed in Southern Africa (Figure 1), spanning four countries: Botswana, Mozambique, South Africa, and Zimbabwe. The basin is vital for the region's agriculture, biodiversity, and water supply (Sitoe & Qwist-Hoffman, 2013). Managing this complex and transboundary water resource requires accurate data and insightful analysis, which WaterCopilot makes accessible in a user-friendly manner.

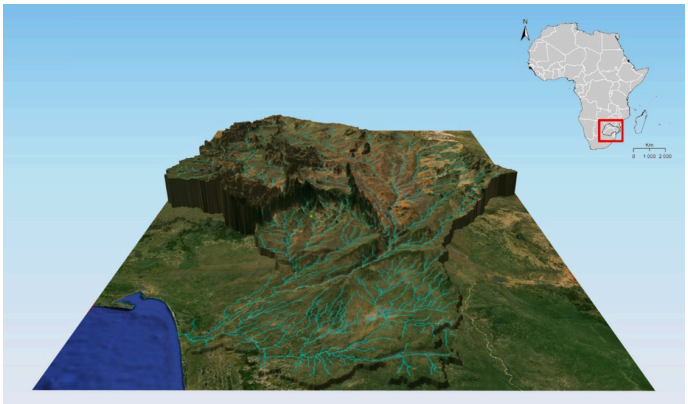

Figure 1. Base map of the Limpopo River Basin showing the 3D basin structure and location within Africa. [Source: IWMI]

Getting Started

Accessing the Copilot

To access WaterCopilot, users can visit https://digitaltwins.demos-only.iwmi.org/chatbot. This interactive platform allows users to query the latest data and analyses related to the Limpopo River Basin.

Landing Page Overview

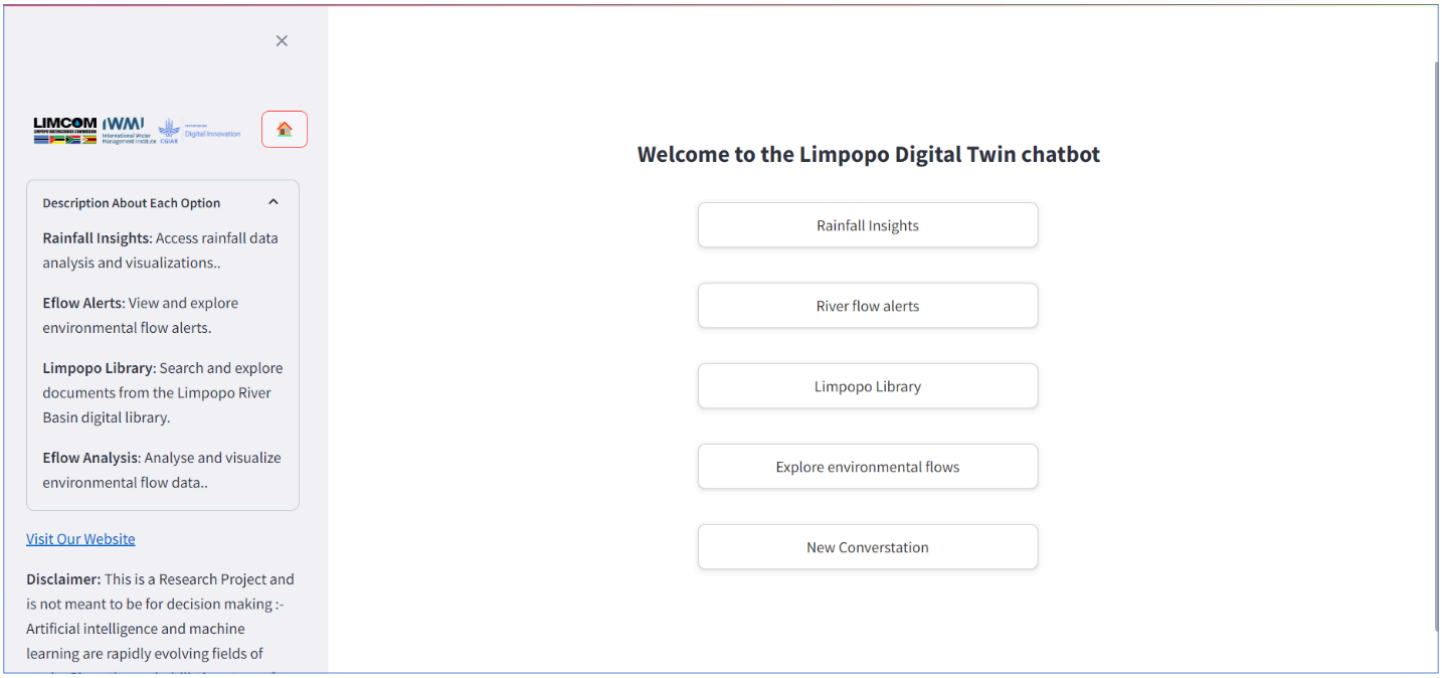

Figure 2. Landing page: On starting the Digital Twin, there are five main options on the bot's homepage, each designed to give specific insights and resources. [Source: IWMI]

The landing page is designed to provide users with quick access to the most frequently sought-after information. Whether users need rainfall data, environmental flow alerts, or want to delve into detailed reports, the landing page options streamline navigation and enhance the user experience. If users are unsure of what to explore, the landing page provides predefined options from which they can start. This helps guide their queries and ensures they have a useful starting point.

Upon entering the Copilot interface, users find the landing page featuring several options for exploration:

Rainfall Insights

Access rainfall data analysis and visualizations

Users can discover historical rainfall records and forecast predictions (Figure 3) to better understand rainfall trends and their implications. For example:

- Users can request historical rainfall data for a specific station and channel within a particular date range.
- If users are looking ahead, they can ask for forecasted rainfall data for upcoming months.
- Additionally, users can request a visual rainfall chart based on parameters they specify, which helps in analyzing trends over time.

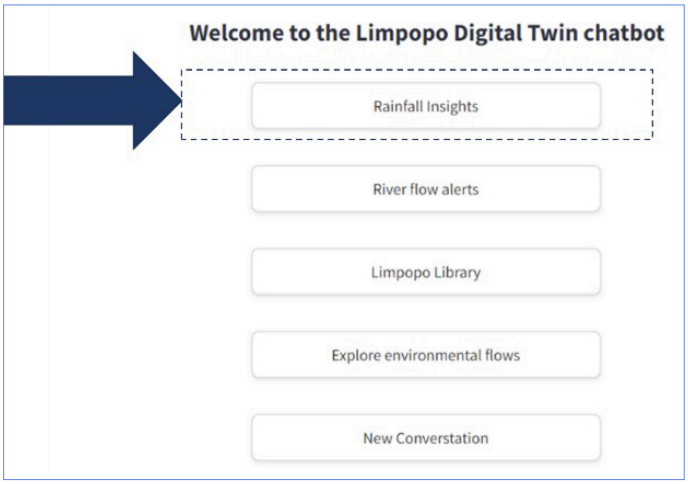

Figure 3. Screengrab indicating the button to navigate to Rainfall Insights. [Source: IWMI]

Eflow Alerts

View and explore environmental flow alerts:

Eflow alerts (Figure 4) represent river flows which are either about to, or are already transgressing defined Eflow flows, the implication of which is that the river ecosystem will soon be used in an unsustainable way. Different types of alert level can be accessed for the Eflow sites. For example:

- Users can ask for all current or future e-flow alerts related to flows in defined portions of the river basin.
- Users can request alerts for a particular month or year, depending on their need.
- Additionally, users can get a visual representation of these alerts, such as a map, to see at a glance where attention is needed.

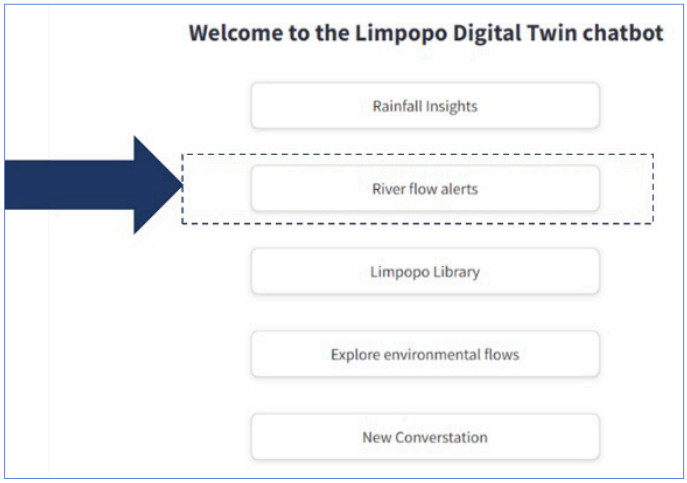

Figure 4. Screengrab indicating the button to navigate to River flow alerts. [Source: IWMI]

Limpopo Library

Search and explore knowledge found in documents from the LRB digital library:

This section provides access to a wealth of resources and reports that are key for researchers and policymakers (Figure 5). For example:

- Users can inquire about any information contained in specific reports or studies related to the Limpopo River Basin, such as ecological studies, environmental flow determination reports, general basin studies, the risk of e-flow transgressions, and the drivers of ecosystem change.
- If users are looking for specific details within these reports, the bot can help them find what they need.
- The bot can even extract from several sources of information to draft reports about the water resources of the Limpopo Basin.

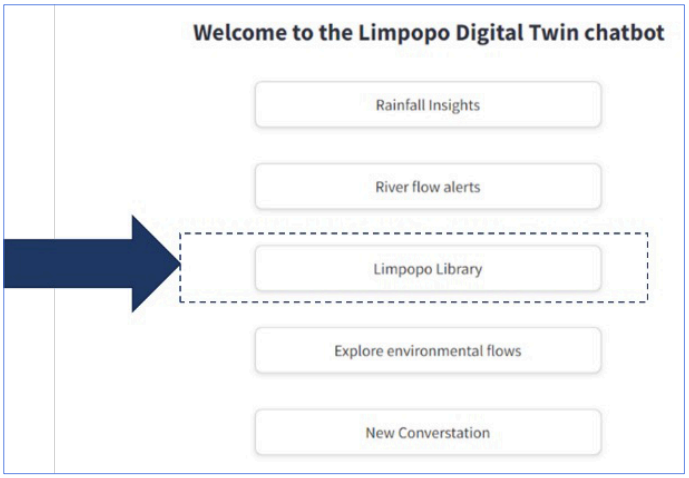

Figure 5. Screengrab indicating the button to navigate to Limpopo Library chat. [Source: IWMI]

River flow analysis

Analyze and visualize river flow data:

Users utilize this section to retrieve and examine data on river flows, e-flows, and water availability (Figure 6). For example:

- Users can ask for e-flow data for a specific river within a selected date range, as e-flows are crucial for maintaining the ecological health of the river system. This would also show if the river flows are sufficient to provide for the e-flows.
- Users can inquire about water availability, natural flow, and present flow for any river of interest over any time.
- Additionally, users can request a visual representation (a map) or chart of e-flow and water availability data, making it easier to understand the information.

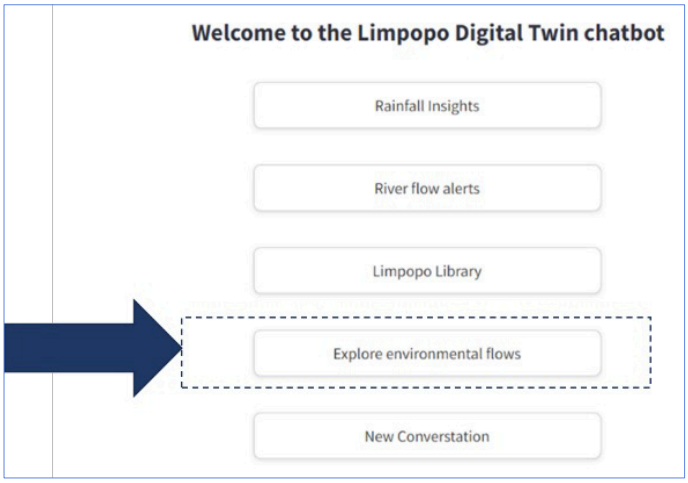

Figure 6. Screengrab indicating the button to navigate to the chat to explore river and environmental flows. [Source: IWMI]

New Conversation

If users do not want to use the predefined options, they can click here (Figure 7) to start a fresh conversation with the Copilot. Users can ask any question related to the Limpopo River Basin to receive a tailored response and data. For example:

- Users can start a new conversation to explore any other data not included above.
- The Copilot can answer a wide range of questions about the Limpopo Basin, leveraging the tools and plugins available to provide detailed and actionable insights.

Figure 7. Screengrab indicating the button to navigate to a new conversation. [Source: IWMI]

Starting a Conversation

Initiate the Chat by selecting an option:

Select one of the available options (Figure 8) on the landing page (e.g., Rainfall Insights, Eflow Alerts, Limpopo Library, Eflow Analysis or New Conversation).

Ask Your Question:

Type your question in the chat input box for example:

Figure 8. Pointer demonstrating to the user where to click to enter a conversation regarding Rainfall insights. [Source: IWMI]

Guided Interaction for Queries

The Copilot is designed to guide users through each query step by step (Figure 9), simplifying the process. For example, if users want to analyze an e-flow site, they may need to provide details like the date range or site name. However, users do not need to know everything at the start. WaterCopilot prompts users for the necessary information, ensuring that they have everything needed to complete their query. This interactive assistance makes it easy to obtain accurate and detailed responses, even for more complex questions.

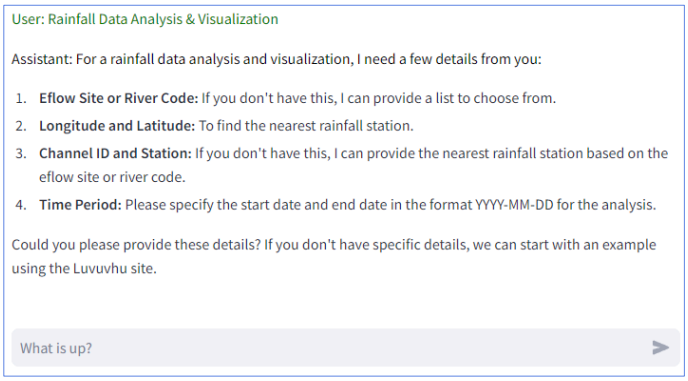

Figure 9. Example of a guiding message displayed by the Copilot when initialising a conversation around rainfall. [Source: IWMI]

Review Responses

The Copilot provides answers along with references to the sources used. This ensures transparency and allows users to verify the information provided. By following these steps, users can efficiently navigate the platform and utilize its features to gather the data and insights needed for their research or decision-making. WaterCopilot is designed to help users every step of the way, ensuring a seamless and informative experience.

Key Features of WaterCopilot

WaterCopilot offers a range of powerful features designed to enhance user interaction and provide comprehensive information about the Limpopo River Basin

Interactive Data Retrieval

WaterCopilot seamlessly interacts with multiple databases, using APIs and document indexing to fetch real-time information. It integrates data from various datasets through API connections, combining results to provide more comprehensive and updated data on topics like rainfall, e-flow management, and water availability. This ensures that users receive the most current insights for decision-making. Additionally, static documents related to the Limpopo River Basin are indexed using a pipeline that allows the Copilot to query these documents. This feature provides users with static information that remains essential for understanding the basin's long-term patterns, historical data, and official reports, complementing the real-time data retrieved from the APIs.

User-Friendly Interface

WaterCopilot is designed with an intuitive and accessible interface (Figure 10), making it easy for users to get started. When users first interact with the Copilot, they are presented with a set of predefined topics to explore. This helps eliminate any uncertainty about what type of questions to ask. Users can simply choose from options like "Rainfall Queries," "River Flow Alerts," or the "Limpopo Library." By guiding users through these initial choices, the bot assists them in understanding the kinds of questions they can ask, encouraging exploration of relevant data and insights with ease.

Guided Interaction for Queries

WaterCopilot simplifies the process of asking complex questions by guiding users step by step through each query. For every topic explored, the Copilot clearly outlines the parameters needed for accurate responses. For instance, when users inquire about rainfall data, the bot may prompt them to specify a location (Figure 11), time period, and any additional details that will help refine their query. Furthermore, WaterCopilot provides useful API endpoints to assist users; for example, rainfall stations can be returned based on a specified location, such as an e-flow site.

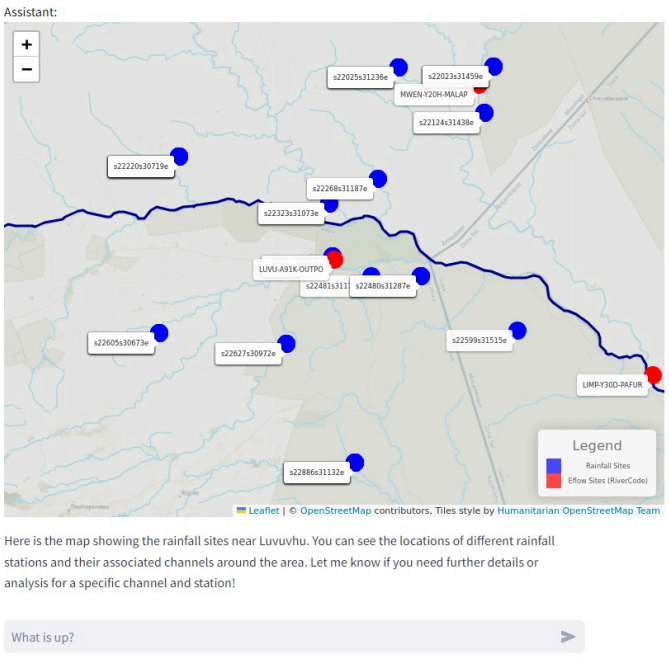

Figure 11. Map generated by the WaterCopilot showing the Luvuvhu flow site (left red button) and surrounding rainfall sites. [Source: IWMI]

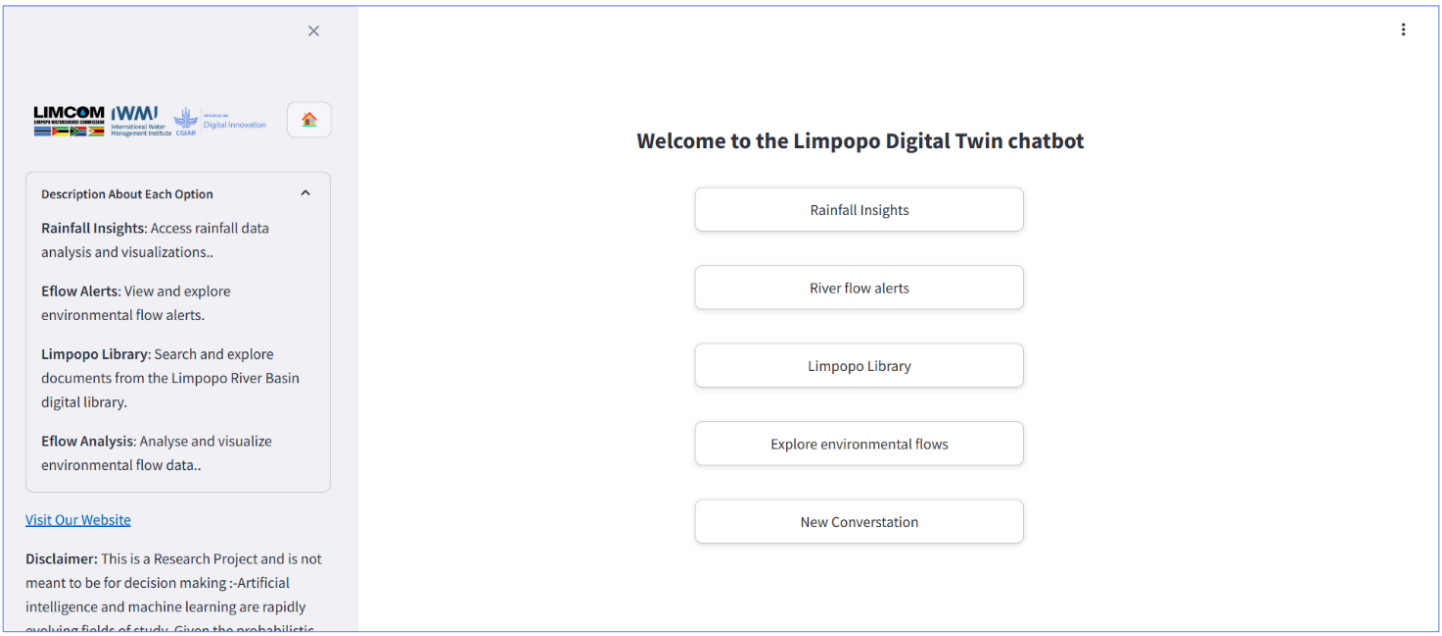

Figure 10. A screengrab highlighting how the Copilot offers various options to encourage a user-friendly interface. [Source: IWMI].

If users are unsure of what information to provide, the bot offers examples and suggestions to ensure they understand the required input (Figure 12). This feature is especially useful when a query has multiple parts, as the Copilot walks users through the process, ensuring they don't miss any crucial details. By providing these prompts and examples, WaterCopilot helps users formulate effective questions, leading to more precise and relevant answers. This structured approach not only saves time but also enhances users' understanding of the information they are seeking.

Documenting Sources

For every answer provided, WaterCopilot includes references to the sources used (Figure 13). This transparency fosters trust and allows users to verify the information, making it easier to cross-check and validate the data that was used to generate the Copilot's response. The Copilot specifies which document was referenced and highlights the specific snapshots or sections of that document that were used in formulating the response. If the data is retrieved from the IWMI-DT-API, WaterCopilot provides real-time data as a reference, ensuring that the information users receive is accurate and up to date. This level of detail enhances users' ability to trace back to the original source material, facilitating further research or inquiry as needed. Users can rely on these references to ensure the credibility of the information presented.

Memory State

WaterCopilot enhances the user experience by remembering past interactions and maintaining context throughout conversations. This memory feature allows the bot to recall previous queries, preferences, and details, so users don't need to repeat information. For example, if a user has asked about rainfall data for a specific region before, the bot can use that context in future queries, saving time. It can also offer personalized suggestions based on the user's history, making it easier to access relevant data. By retaining this information, WaterCopilot ensures that interactions are more seamless, efficient, and tailored to individual needs.

Multilingual Support

WaterCopilot is equipped with multilingual support, allowing it to understand and respond in multiple languages. This feature ensures that users from diverse linguistic backgrounds can interact with the bot without facing language barriers. Whether you ask questions in English, French, Portuguese, or another supported language, the bot can process your query and provide responses in the same language, ensuring a smooth and accessible experience. By enabling communication in various languages, WaterCopilot ensures that vital information is available to a broader audience, making its functionalities more inclusive and user-friendly.

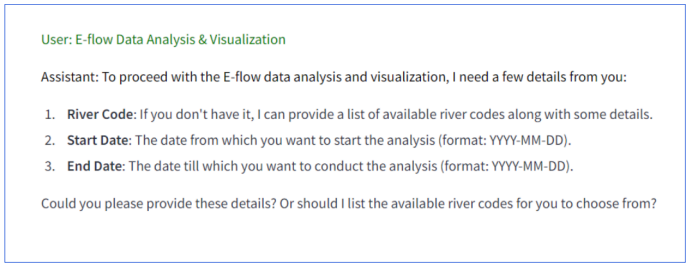

Figure 12. Screengrab highlighting how the Copilot guides the user in structuring their questions. [Source: IWMI]

Figure 13. Screengrab showing how the Copilot provides a reference for the answer provided. [Source: IWMI]

Summary and Insights

WaterCopilot has the capability to generate concise summaries and insights based on user queries. When a question is asked, the bot not only retrieves information from various sources but also processes and combines relevant data to understand the overall context. It analyzes the information, extracts key points, and provides a clear and simplified summary, making complex topics easier to grasp. Additionally, the bot offers insights by identifying patterns and highlighting important details that might otherwise be overlooked. This functionality helps users interpret data effectively, ensuring that they receive a comprehensive yet easy-to-understand response to their queries.

Calculation Capability

WaterCopilot is equipped with powerful calculation capabilities, allowing it to perform various computations based on user inputs (Figure 14). Whether users need to calculate the average rainfall for a specific period, compare precipitation or e-flow values across different regions, or sort data for analysis, the bot can handle it. This feature is particularly valuable for those involved in water management or environmental assessments, as it provides accurate and quick metrics to support decision-making. By performing these calculations seamlessly, WaterCopilot helps users analyze data efficiently and gain deeper insights into the information they are working with.

Graphical Representations

WaterCopilot offers powerful visualization capabilities by generating charts and graphs using APIs that interact with Limpopo Basin data. This feature enables users to see visual representations of various datasets, such as rainfall patterns (Figure 15), e-flow statistics (Figure 16), or trends in water levels, making it easier to understand trends and draw insights. Whether users are comparing data over time or analyzing specific environmental metrics, the bot provides tailored charts for each type of query. These visualizations help simplify complex information, allowing users to grasp critical insights quickly and make informed decisions based on the data.

Troubleshooting

Copilot Not Responding

If WaterCopilot is unresponsive, the first step for users is to ensure they have a stable internet connection, as a weak or unstable connection can hinder the Copilot's performance. If the problem persists, users should try refreshing the page or restarting their browser. Clearing the browser's cache may also help resolve loading issues. If users still encounter problems, they should consider checking for updates from the WaterCopilot service, as maintenance or downtime could be affecting accessibility.

Site Unreachable

If the WaterCopilot site is unreachable, the user should begin by checking their internet connection to ensure it is functioning properly. They can do this by attempting to access other websites. If their connection is stable and the site remains inaccessible, there may be server issues on WaterCopilot's end. In this case, they should try accessing the site later or check any service notifications on the website or social media channels for updates regarding downtime or maintenance.

Inaccurate Information

If the user feels that the information provided by WaterCopilot is incorrect, they can verify the details by checking the references directly generated by

Overall Monthly Metrics for 2024:

Month	Total Rainfall (mm)	Average Daily Rainfall (mm)	Max Daily Rainfall (mm)	Min Daily Rainfall (mm)
January	181.018	5.84	25.50806	0.0
February	70.075	2.50	25.95379	0.0
March	47.1832	1.52	12.56106	0.0
April	44.0748	1.47	22.607	0.0
May	1.5284	0.05	0.94662	0.0
June	1.1479	0.04	0.54966	0.0
July	0.0	0.0	0.0	0.0
August	0.3125	0.01	0.1875	0.0
September	2.75251	0.09	1.84381	0.0
October	3.06279	0.10	1.81925	0.0
November	72.96829	2.43	19.83982	0.0

What is up?

Figure 14. Example of a calculation results table generated by the WaterCopilot displaying the monthly rainfall metrics for 2024, demonstrating its calculation capability. [Source: IWMI]

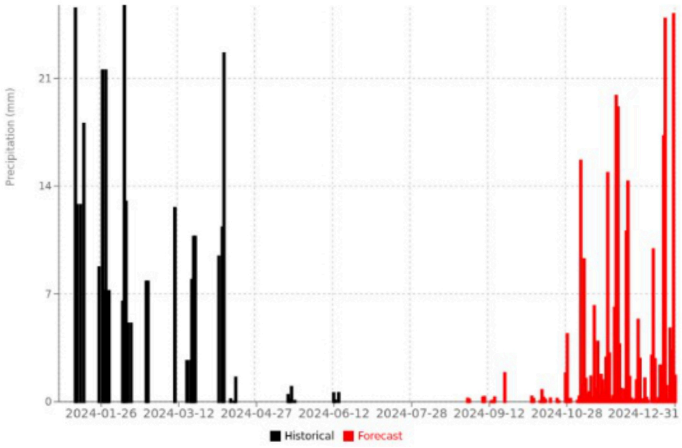

Figure 15. Rainfall chart generated by the WaterCopilot, demonstrating its ability to display rainfall data in a graphical format including a projection into the future (red graphs). [Source: IWMI]

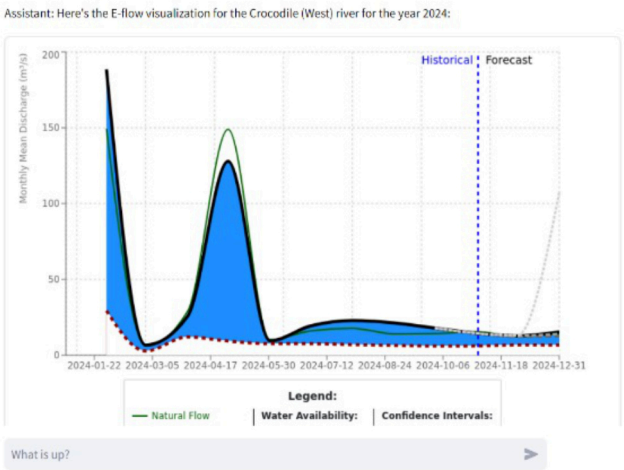

Figure 16. Water availability and Eflow chart generated by the WaterCopilot, demonstrating its ability to display river flows in a graphical format, including a forecast into the future. [Source: IWMI]

WaterCopilot. This will help confirm the accuracy of the information. If the issue persists or seems unclear, the user can mention the issue in the feedback section to help improve the service and address any potential errors in the information provided.

Image Not Displayed Properly

Occasionally, images may not display as intended, appearing as small green boxes or missing altogether. In such cases, users can refer to the reference area in the Copilot's response to find the content associated with the missing image. Alternatively, users can prompt the Copilot by saying, "I could not see the image; please generate it again." This request allows them to obtain the visual content they need. If more information or a deeper explanation about any topic is required, users are encouraged to ask the Copilot for further elaboration. It is designed to understand context and can provide comprehensive responses to enhance understanding.

FAQs

What kind of questions can I ask?

Users can ask any kind of question related to the Limpopo River Basin, including but not limited to topics such as rainfall, river flows or discharge, e-flow management, water availability and e-flow alert levels. WaterCopilot can provide answers from both live databases and static PDF documents, ensuring that users receive comprehensive and accurate information.

For example, users can ask:

a. What is the latest update for river flow conditions and how can the warning levels be analyzed?

b. Can you analyze the e-flow data for the current year and provide a summary?

c. What is the forecasted rainfall for next week in the Limpopo Basin?

How does the Copilot provide references?

Each response generated by WaterCopilot includes references to the specific sources used for accuracy. Whenever the Copilot calls an API using plugins or retrieves data from indexed documents, it takes a snapshot of the relevant information and provides it as a reference for the user. This ensures that whether the data is fetched from live databases or static documents, users can always see where the information originated and cross-verify it if needed.

Can the Copilot provide a summary or detailed document based on the information available?

Absolutely! WaterCopilot can generate both summaries and detailed documents based on the available data for the Limpopo Basin. Users can specify a time period, region, or specific data points, and the Copilot will retrieve relevant information from both real-time databases and indexed documents. For example, a user could ask, "Provide a summary and analysis of rainfall data for the past five years in the Limpopo Basin," and the Copilot will compile the data into a concise summary including an analysis of trends etc. Alternatively, a request for a detailed report will yield in-depth information, complete with references to the sources used.

Can the Copilot generate images, and how can I download them?

Yes, WaterCopilot can generate images based on real-time data, including graphs and visual representations of rainfall trends, river flows, e-flow analyses, and other relevant information. Once the Copilot provides an image, users can easily download it by right-clicking on the image and selecting "Save As." This functionality allows for convenient storage and use of the images in reports, presentations, or further analysis. For example, a user might ask, "Generate a graph showing the rainfall trends over the past month," and the Copilot will provide a downloadable image based on the latest data.

Can the Copilot save my personal data?

No, WaterCopilot does not store or save any personal data. The Copilot is designed with privacy and data security in mind, ensuring that it does not retain any information about users' identities or personal interactions. This approach guarantees that all conversations remain confidential and that users can engage with the bot without concerns about their data being collected or stored.

Can the Copilot learn from interacting with me?

Yes, WaterCopilot can learn and adapt based on previous interactions within the current dialogue. It can remember information from earlier messages in the same conversation, enabling it to provide more personalized and relevant answers for the ongoing session. For instance, if a user previously inquired about e-flow analysis for a specific location and later asks about alert status, the Copilot can infer that the user is likely referring to alerts for the same location. This feature streamlines conversations and allows users to build complex narratives and analyses through dialogue, ensuring a more efficient and user-friendly experience tailored to their engagement with WaterCopilot.

Support

If the user encounters any issues not covered in this guide or needs further assistance, they should reach out to the support team. They can contact the team via email: iwmi-digitaltwins@cgiar.org

Acknowledgments

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Disclaimer

NOTE

This is a Research Project so caution should be applied when the AI is used for decision-making, as artificial intelligence and machine learning are rapidly evolving fields of study. Given the probabilistic nature of machine learning, the use of this work may, in some situations, result in output that does not accurately reflect real people, places, or facts.