

RAINWATCH handbook: a step by step guide to using RAINWATCH, version 1.0

Book

Published Version

Creative Commons: Attribution-Noncommercial-No Derivative Works 4.0

Open Access

Asare, K., Cornforth, R. ORCID: <https://orcid.org/0000-0003-4379-9556>, Tarhule, A., Osbahr, H. ORCID: <https://orcid.org/0000-0002-0130-2313>, Ciampi, L. ORCID: <https://orcid.org/0000-0003-1240-7695> and Myers, J. (2019) RAINWATCH handbook: a step by step guide to using RAINWATCH, version 1.0. Zenodo - CERN Repository, pp43. doi: <https://doi.org/10.5281/zenodo.3366368> Available at <https://centaur.reading.ac.uk/85564/>

It is advisable to refer to the publisher's version if you intend to cite from the work. See [Guidance on citing](#).

To link to this article DOI: <http://dx.doi.org/10.5281/zenodo.3366368>

Publisher: Zenodo - CERN Repository

All outputs in CentAUR are protected by Intellectual Property Rights law, including copyright law. Copyright and IPR is retained by the creators or other copyright holders. Terms and conditions for use of this material are defined in the [End User Agreement](#).

www.reading.ac.uk/centaur

CentAUR

Central Archive at the University of Reading

Reading's research outputs online

RAINWATCH Handbook

2019



A step by step guide to using RAINWATCH

version 1.0

Table of Contents

TABLE OF CONTENTS	2
GLOSSARY	4
1 BACKGROUND	5
1-1 OVERVIEW	5
1-2 SUSTAINABILITY AND INTEGRATION WITHIN THE RAINWATCH ALLIANCE	5
1-3 ADDRESSING COMMUNICATION CHALLENGES	7
1-4 PURPOSE OF THE RAINWATCH HANDBOOK AND INTENDED USERS	7
1-5 HOW TO USE THIS HANDBOOK	8
2 HOW TO USE THE RAINWATCH PLATFORM	9
2-1 ACCESSING RAINWATCH AND HOW TO GET ONTO THE PLATFORM	9
2-2 THE RAINWATCH LANDING PAGE (HOME PAGE)	9
2-3 WHAT INFORMATION IS ON THE RAINWATCH PLATFORM?	11
2-4 HOW TO SELECT COUNTRY INFORMATION	12
2-5 HOW TO SELECT WEATHER OR GAUGE STATION INFORMATION	13
3 USING AND UNDERSTANDING THE INFORMATION	17
3-1 RAIN PRODUCTS: PERCENTILE AND YEAR	17
3.2 THE DIFFERENT TYPES OF GRAPHS OF 'PERCENTILE AND YEAR' AND HOW TO USE THEM	18
THE 'NO NORMALS' GRAPH	18
THE 'SHOW PERCENTILES' GRAPH	21
THE 'SHOW WET/DRY' GRAPH	23
3.3 RAIN PRODUCTS: BOX PLOT	24
3.4 RAIN PRODUCTS: STATION COMPARE	27

3.5 THE TEMPERATURE PRODUCT	28
3.6 SUMMARY PRODUCT	31
4 APPLICATION OF RAINWATCH INFORMATION	34
4-1 HYPOTHETICAL COMMUNITY STORY	34
4-2 SUMMARY: WHAT CAN THIS INFORMATION BE USED FOR?	39
THE BENEFITS OF COMBINING MONITORING INFORMATION WITH FORECASTS FOR EFFECTIVE DECISION MAKING PROCESS WITHIN EXISTING COMMUNICATION STRUCTURES	39
4-3 REFLECTIONS	40
ACKNOWLEDGEMENTS	41
FRIENDS OF THE RAINWATCH ALLIANCE	41
THE RAINWATCH ALLIANCE	42

Glossary

ASPIRE	Adaptive Social Protection: Information for Enhanced Resilience
BRAVE	Building Understanding of Climate Variability into Planning of Groundwater Supplies from Low Storage Aquifers in Africa
DfID	Department for International Development
FCFA	Future Climate for Africa
GIS	Geographical Information System
GSSTI	Ghana Space Science and Technology Institute
HyCRISTAL	Integrating Hydro-Climate Science Into Policy Decisions For Climate-Resilient Infrastructure And Livelihoods In East Africa
MOFA	Ministry of Food and Agriculture
NGO	Non-Governmental Organisation
NHMS	National Hydrological and Meteorological Service
RSCC	Remote Sensing and Climate Center
RW	RAINWATCH
SSA	Sub-Saharan Africa
TAMSAT	Tropical Application of Meteorology Using Satellite Data and Ground-Based Observations
UPGRo	Unlocking the Potential of Groundwater for the Poor

1 Background

1-1 Overview

RAINWATCH, is an open-source, web-based GIS platform that provides rainfall data in near-real time from national weather stations and tracks the key seasonal characteristics, important for food production, health service response and social protection systems. It has been operating since 2009 in West Africa but is now developed and sustained through a continent-wide RAINWATCH Alliance - a partnership of more than 15 African National Hydro Meteorological Services (NHMS) networked together, as part of an African solution to build an effective climate service partnership on one platform working together with Government Agencies, NGOs and Research Institutions across Sub-Saharan Africa (SSA) to build a climate resilient future for all.

The overarching goal of the RAINWATCH Alliance is to encourage collaborative work on increasing the access to and the use of climate information services to enable better targeted decision making processes across a wide-range of sectors, for example Agriculture, Disaster Risk Reduction (DRR), Integrated Water Resource Management, Energy and Health.

1-2 Sustainability and integration within the RAINWATCH Alliance

To date, RAINWATCH's unique approach has proved highly successful, becoming embedded within the NHMS of the Alliance with ownership, research and development, and direction driven by the participating members. The high degree of peer-to-peer commitment to collaboration across the Alliance has proven benefits through improved monitoring capabilities and delivery of more effective climate services for all.

The continued technological enhancement and scaled/ cross-regional engagement of the RAINWATCH platform is critical to increase the more rapid collection of daily weather observations enabling the application of resulting information in near-term to seasonal environmental monitoring and forecasting with respect to food security and disaster risk reduction. Building capacity and extending the successful and proven model of RAINWATCH across sub-Saharan Africa will be used to enhance monitoring and forecasting capabilities of NHMS for improved climate product and information services of national met services, expanding impact from use of rainfall data for food security and disaster mitigation.

RAINWATCH was designed originally to increase access to rainfall information to West African farmers and other stakeholders and help the NMHS reduce the time between rainfall data collection and climate information dissemination to users in real time (see Tarhule et al., BAMS 2009). For instance, the main climate product delivered by the National Meteorological Service of Niger is a *Dekadal (ten days) Agro-Hydro-Meteorological*

Bulletin for Monitoring the Growing Season to farmers and relevant stakeholders. The bulletin is published at the end of every ten days during the rainfall season. The dekadal bulletin is supposed to serve as a source of useful and usable weather and climate information to support agencies make climate risk management decisions but as an early warning tool this information tends to reach stakeholders late. It arrives 12 -14 days after the first event in the dekad, which renders the information less useful to users. This is a common challenge for communication of climate information services throughout parts of Africa. The implication is that users of this information may not receive an early warning of potential climate risk within the ten days; the advisory may arrive at a time when the event has passed. This type of bulletin also only presents rainfall totals for ten days over Niger, which may conceal spatial and temporal characteristics and variability that may be useful for decision-making.

RAINWATCH has been designed to help alleviate such limitations in climate services over Africa by providing a stable platform for rainfall monitoring in near real time for timely and effective decision-making by relevant stakeholders and users. Today, RAINWATCH has grown from its original standalone model desktop GIS system, which was previously only accessible locally on personal computers, to a Web-based tool available here:

<http://www.RAINWATCH-africa.org>. This makes RAINWATCH open, accessible and available to anyone with internet access. The web-based application can be used on desktop computers, laptops, tablets, and mobile phones. This development reflects efforts by the RAINWATCH Alliance Principal Coordinators to establish collaboration between National Meteorological and Hydrological Services and the appointment of Country Coordinators within each Alliance member.

The platform was originally developed by Prof Peter Lamb (the “father of African Seasonal Forecasting”), Zakari Saley Bana (as part of his MSc studies and from Niger), and Prof Aondover Tarhule (from Nigeria) at the University

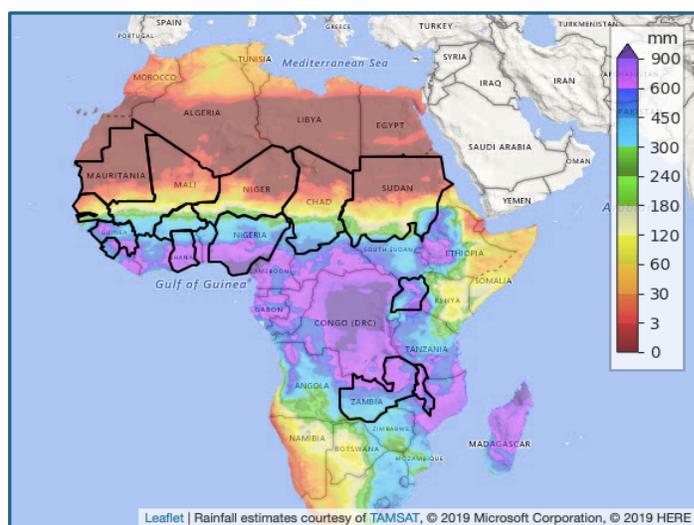


Figure 1: Map of RAINWATCH Alliance Member Countries

of Oklahoma. Today, the Walker Institute at the University of Reading (Prof. Rosalind Cornforth, RAINWATCH Co-Lead), the University of Binghamton University (Prof. Aondover Tarhule, RAINWATCH Co-Lead) and the Ghana Space Science and Technology Institute (Kofi Asare, Principal Co-ordinator) provide the backstopping research to support the platform, on demand and in partnership with, the African-led RAINWATCH Alliance. Currently, 15 SSA NMHS incorporate RAINWATCH within their climate monitoring and information systems (Figure 1). Furthermore, RAINWATCH

can be used by any organization or individual seeking season-to-date rainfall information within individual member countries and/or across the SSA region.

1-3 Addressing communication challenges

The RAINWATCH Alliance is an innovation because of its unique approach in working with African Met Services and the proven capability to support independent NHMS to collaborate, scale analysis and importantly contributes to a shared data platform. Unique among all the rainfall monitoring programs operating in SSA, the RAINWATCH Alliance adopts a philosophy that (i) seeks to enhance rainfall data access and dissemination; (ii) connects data producers and users; and (iii) provides a platform for co-evolution of sustainable and effective climate information services designed to help vulnerable populations. The unique service that the collaborative RAINWATCH Alliance plays across the Sahel enables the NHMS to improve the climate information and work together better informed/ designed dissemination metrics to different user group.

The RAINWATCH team has a common objective of fostering learning and creating dialogue among forecasters, researchers, practitioners, and decision makers. Recent RAINWATCH Regional Learning events (Dakar, Senegal 2016; Kampala, Uganda, 2017 and 2018; Dakar, Senegal 2019) and ongoing DfID co-funded projects undertaken with national meteorological agencies and social protection stakeholders in West Africa (UPGRo BRAVE; ASPIRE) and East Africa (FCFA, HyCRISTAL) have identified a number of critical training needs for RAINWATCH producers and users. Key recommendations include how climate service providers and users can better communicate and meet user information requirements, including a improved mechanisms for collaboration and dialogue across government agencies, better coordination and information exchange with non government agencies working at community level, and better understanding of the links between hydro/climate variability and livelihood impacts.

The RAINWATCH Alliance has responded to these challenges by the ongoing development of climate information products that are more tailored to specific sectors – the agricultural sector was prioritised at the RAINWATCH Regional Learning Event in Kampala in Uganda, 2018 with the integration of new agricultural planning statistics on the RAINWATCH platform. Work on the BRAVE project in 2018 showed however that many users remained unsure how to interpret the new agricultural statistics on RAINWATCH, and in particular, how knowledge brokers / 'science interpreters' might be better supported to interpret the information and communicate it to relevant users (radio stations, crop scientists, local government structures, universities, local NGOs, farmers, extension services) to improve the capacity of farmers to manage their farming livelihoods. This Handbook responds to this need and forms a new tool within the RAINWATCH toolkit and trainings to expedite communication between the networked users/producers across Alliance member countries.

1-4 Purpose of the RAINWATCH Handbook and intended users

This Handbook has been designed to help RAINWATCH users navigate the web-based RAINWATCH system. Examples of use include policy discussions within the MoFA (Ministry of Food and Agriculture) to discuss with crop scientists, extension officers and farmers the implications of the RAINWATCH information to improve decision-making through the season. Farmers who are practicing rain-fed or irrigated agriculture require timely, accurate season-to-date and forward looking rainfall information for planning purposes. Another example of use could be

to improve information provided to farmers via radio or via NGO activities that require weather information for their projects.

The Handbookl includes a series of easy to follow step-by-step visuals based on the RAINWATCH training presentations to help new users/producers of information understand the different views and content to make informed selections of the available content for their decision use cases.

1-5 How to use this handbook

This handbook has been designed as a simple visual guide with practical exercises to accommodate the varying scientific literacy levels of users.

At each step, the handbook will provide guidance on how to navigate the RAINWATCH platform to access useful climate information and how to interpret this information. We hope it will be used as a practical guide alongside the web interface so that users can navigate through the platform while they follow the instructions in the handbook. The handbook offers users visual images, supported by written steps and has direct links and buttons to click on to access rainfall information.

There are four types of learning visuals in this handbook:

1. Blue-bordered boxes are screenshots from the RAINWATCH platform, which are annotated with numbered blue boxes and arrows to explain the different platform functions. The numbered blue boxes are referred to throughout the text.
2. Green boxes have explanations of technical terms or ideas.
3. Purple boxes are 'understanding checkpoints' and provide a number of self-assessing questions that the user should try to answer based on their understanding. These questions are specific to the content covered in that particular section of the handbook and aim to help the user engage and reflect on what they have learned.
4. Case study sections provide exemplars of use.

2 How to use the RAINWATCH Platform

2-1 Accessing RAINWATCH and how to get onto the platform

RAINWATCH is available on the internet at <http://www.RAINWATCH-africa.org/> using a personal desktop computer, laptop, or an android tablet or cell phone with internet connection.

Users can get onto the platform by [clicking here](#) or by typing this website address "<http://www.RAINWATCH-africa.org/>" into the website browser on their desktop computer, laptop, or tablet or smart phone. **Note: There must be an internet connection for this to work.**

2-2 The RAINWATCH Landing Page (Home Page)

This Web link (<http://www.RAINWATCH-africa.org/>) will take you to the RAINWATCH platform home page (Figure 2).

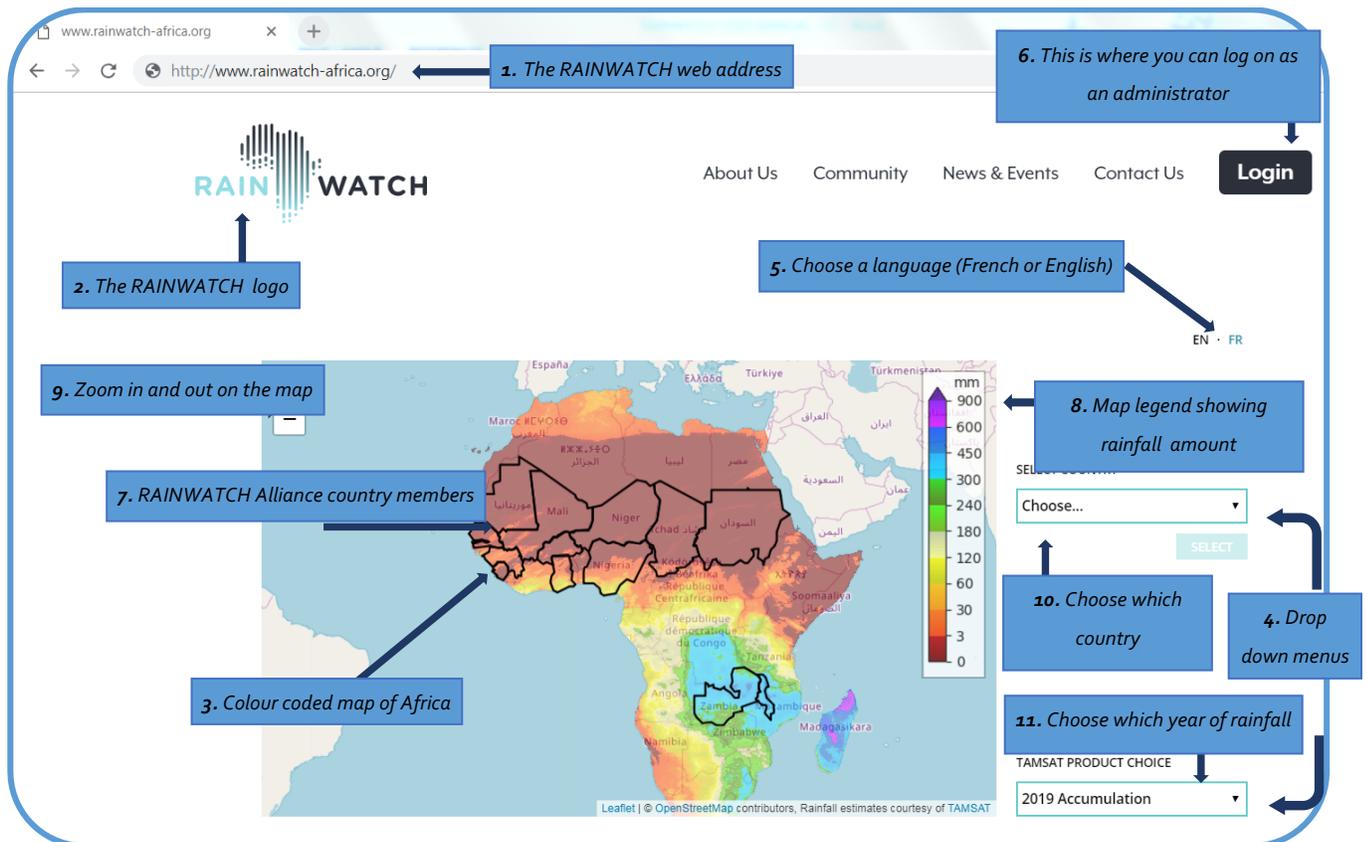


Figure 2: RAINWATCH Landing Page

The map shows cumulative rainfall totals across Africa. The rainfall information displayed on the home page is in real time so the colour of the map may change depending on when you access the platform (i.e. it may look a different colour from Figure 2 when you view the home page).

This web-page shows the RAINWATCH logo (2) in the left top corner. This is the map of Africa shown as raindrops encompassed by the words "Rain" and "watch". It also shows a colour coded map of Africa (3) at the centre with two dropdown menus (4) on the right-hand side of the map. The page has four sets of buttons (About us, Community, News and events and Contact us) on the top right side of the page.

The RAINWATCH site can be accessed in either English or French (5). The preferred language can be selected by clicking EN for English or FR for French halfway down on the right-hand side of the page.

The interface gives RAINWATCH users several options to choose from (menu bar):

- The top right corner gives the option to "login" as an administrator. The administrators (Country coordinators) regularly update the system with rainfall data for their country, and they have special permissions to do so (6). This option is enabled by clicking on the "LOG IN" button.
- To the left of the login button, there are four more buttons you can select from, these are: 'About us', 'Community', 'News and events', 'Contact us'.
- The colour coded map of Africa in the centre shows member countries of the RAINWATCH Alliance with their borders highlighted in black (7) (the full list of countries can be found in Figure 1). The Africa map shows different colour distribution that represents TAMSAT (see Box 1) and cumulative rainfall amount for a given period.
- The scale (8) on the right side of the map is the legend showing the different colours that represent rainfall amount in millimetres (mm) for a given location on the map.
- The "+" and "-" (9) allow users to zoom in and zoom out over a particular zone or country of the map.

Box 1: TAMSAT is the acronym for Tropical Application of Meteorology Using Satellite Data and Ground-Based Observations. Using satellites, TAMSAT produces daily rainfall estimates for all of Africa at 4km resolution. Rainfall estimates and other TAMSAT products are issued on the 1st, 6th, 11th, 16th, 21st, and 26th of every month. You can visit the TAMSAT website here: <https://www.tamsat.org.uk/>

Understanding checkpoint:

How many RAINWATCH member countries have between 300 and 600 mm of rainfall?

The map on the homepage allows you to look at a selection of detailed rainfall information for each country. From this page, you can use the dropdown menus (4) to choose the country that you want to look at and to select the year(s) of interest.

- The box labelled "Select Country" (10), placed to the right side of the map gives users the option to choose or select the country for which they want to monitor or assess their rainfall information for a given year or period.
- The last box labelled "TAMSAT Product Choice" (11) at the bottom right corner of the homepage allows users to choose the year for which they want the TAMSAT rainfall product (accumulation or anomaly) information to be displayed.

There is an exercise you can practice using these dropdown menus in Section 2.4. The next section of this manual will explain how to get more detailed information from the RAINWATCH online platform.

2-3 What information is on the RAINWATCH platform?

You may access information about:

- The weather stations (rainfall, temperature data collection sites) that have been made available by the RAINWATCH Alliance countries (Figure 3).
- Historical climate information for each weather station.
- The cumulative (or total) rainfall information across the country.
- Graphs showing climate variables (rainfall/temperature) (Figure 2).
- Comparing cumulative Rainfall information at different sites/locations for the same year.
- Rainfall of a particular year, including the current rainy season.
- Previous years with the current year to understand the performance of that year's rainy season.

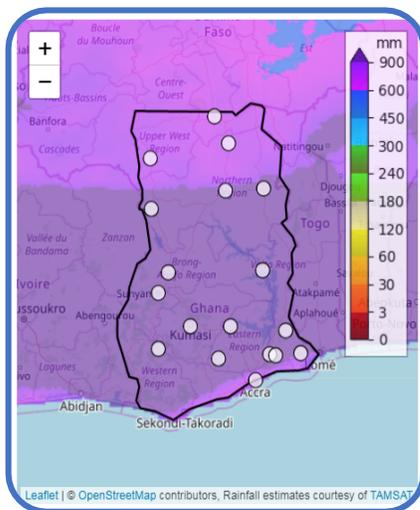


Figure 3: Weather Stations in Ghana

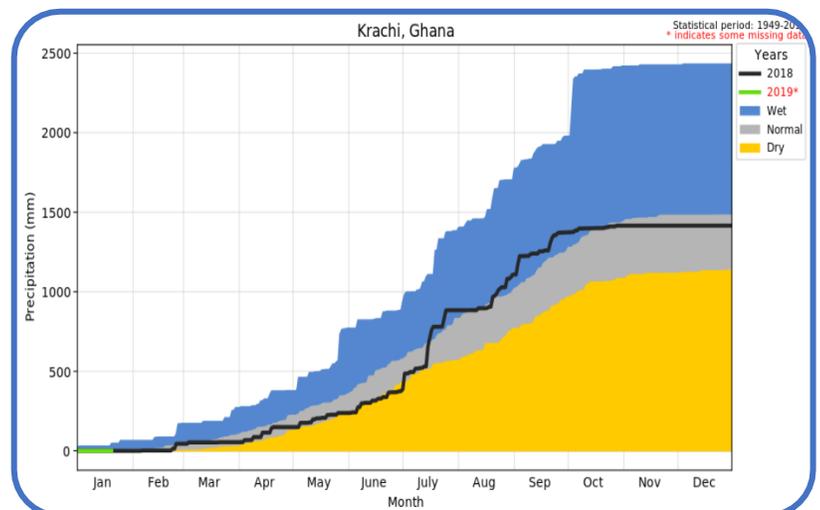


Figure 4: Graph showing whether a particular year is dry or normal or wet for Kete Krachi

For a year, users can:

- Monitor daily rainfall accumulations.
- Identify the start and end dates of the rainy season.
- Detect the occurrence and length of dry and wet spells.
- Determine the total amount of the annual rainfall recorded at specific weather stations and the length of the rainy season.

Note: Only stations belonging to the same country can be compared.

The TAMSAT option button (11 on Figure 2) offers the cumulative rainfall for a particular location from the beginning of the season to the end of the season. The TAMSAT option also allows you to compare the cumulative rainfall of the current year with the long term mean. This will help in assessing how the current year is performing against the long term mean which generally is referred to as the anomaly.

2.4 How to select country information

This section explains how to access the detailed information of your chosen country. To select a country of interest, you can either:

- Click on the country of interest on the colour coded Africa map (12), or
- Choose the country name from the "Select Country" box (13) by clicking on the drop-down arrow.

If you click on the country on the map, it will become bolder than those around it. It will also automatically change the "Choose" option of the "Select Country" box to the name of the country you have chosen. For example, you can click on Ghana on the map. After clicking on Ghana, the option in the box has changed, and it is showing "Ghana" as the selected country as shown by Figure 5.

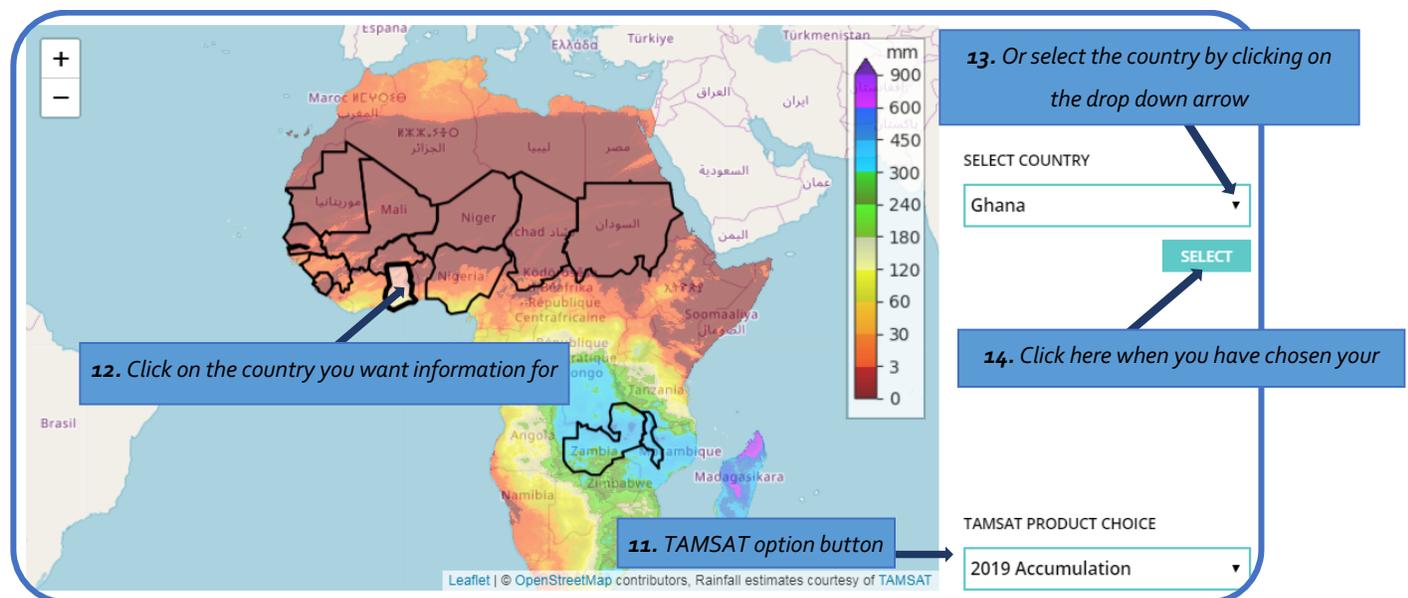


Figure 5: Selecting Your Country

Once you have chosen your country, you need to click on the 'Select' button underneath the "Select Country" box (14). When you click select you will see that the map has changed. It will have zoomed into the country you have selected (in this case we have selected Ghana) (15), and will show you a map of the country with a number of grey circles on it (16). The grey circles represent the location of the individual weather stations registered on the RAINWATCH platform across the country. You will also notice that, what used to be the "Select Country" option has now changed to "Select Station" (17). You can also zoom (18) in (click +) and out (click -) of the map to get a closer view of stations which may be close to each other.

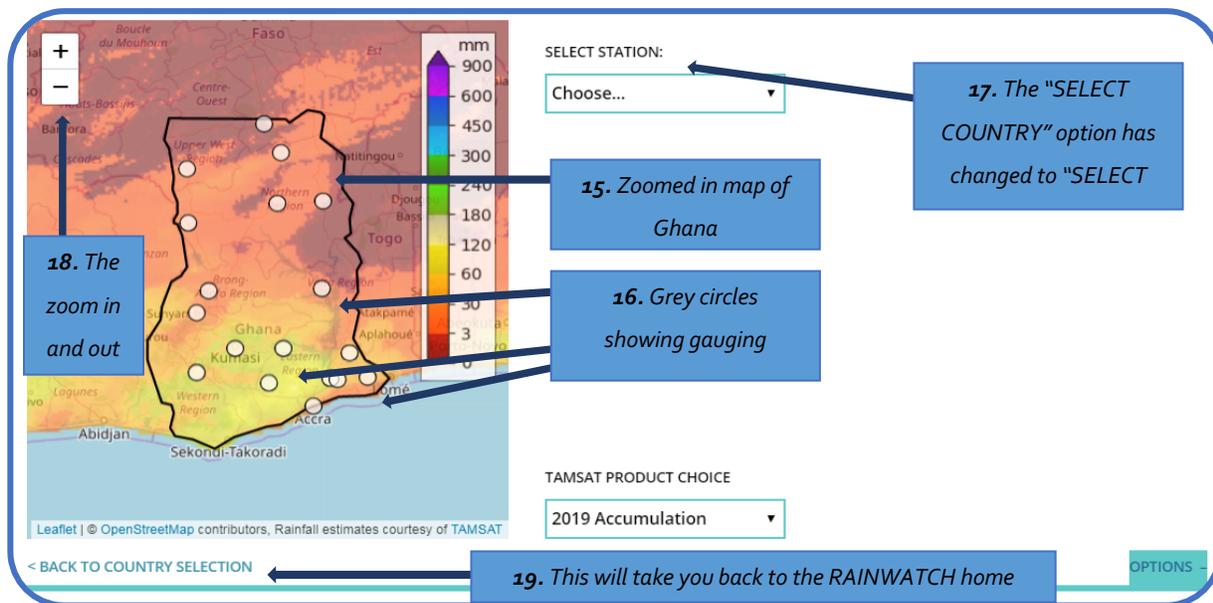


Figure 6: Chosen country in detail

Understanding checkpoint:

How many weather or gauge stations have been registered on the RAINWATCH platform by Mali?

If you want to select another country you can click on the "Back to Country Selection" button (19) on the bottom left corner.

2-5 How to select weather or gauge station information

If you want to find out more information about a specific weather station in a country, you can do this by placing your mouse pointer over the grey circle on the country map. Once you do this a box will pop up (20) which will give you three pieces of information (or metadata) about the station.

These are enlarged in Figure 7 (21a, b and c) with the example of the Tamale weather station in Ghana and show:

- The name of the station (21a) (which is often named after the town/village/community where the weather station is located).

- The station's identification (ID) number (21b) which is the ID given to that station per WMO standards
- The geographical coordinates (latitude and longitude in decimals – see Box 2) (21c) of the station.

Box 2: Geographical coordinates are based on the global positioning system (GPS). The first number shows the latitude, and the second number indicates the longitude. Where these two meet show the location on the map.

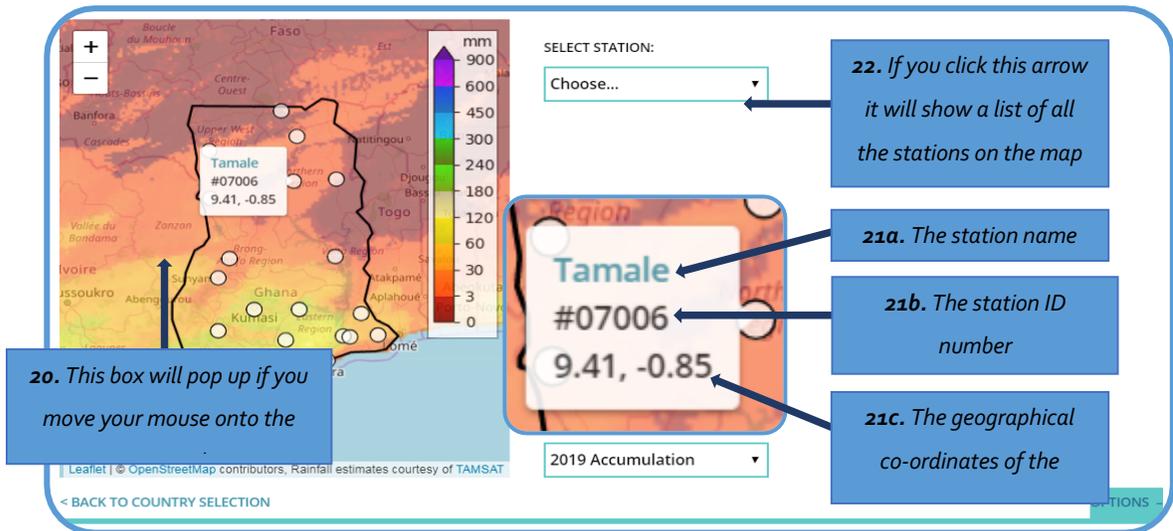


Figure 7: Details of gauge stations

You can also choose your station through the "Select Station" (22). If you use select station (22) to choose your station of interest, you will notice that the grey circle of the selected station will change to blue on the map, but **you must move your mouse over the now blue circle to find the ID number and geographical coordinates.**

Understanding checkpoint:

In the country called Sudan, find the weather station located at Khartoum (Remember, weather stations are usually named after the city/town/community, etc. where they are located). Find out what the ID number is and the geographical coordinates (latitude and longitude) of this station?

Once you have found the station you are looking for, you can also access the rainfall and other weather information that is available at the station. You can do this by either clicking on:

- the grey circle of a particular station of interest, **or**
- by using the "Select Station (22)" and clicking on the dropdown arrow.

Completing either of these will turn the selected station from grey to blue on the map (23).

You will also see that additional options appear on the right-hand side of the map underneath the “Select Station” dialogue box. The options presented show available information. There are three different information types that can be available:

- “Select Rain Product”- information about the rainfall at the station.
- “Select Temperature Product” - information about maximum and minimum temperatures at the station.
- “Select Summary Product” (this compares the dekads (ten days) with their respective long term mean to determine how each dekad deviates from its long term mean).

The term “product” refers to the selected analysed data output that is presented in a series of different graphs. All the products are shown in Figure 8 and listed in Table 1.

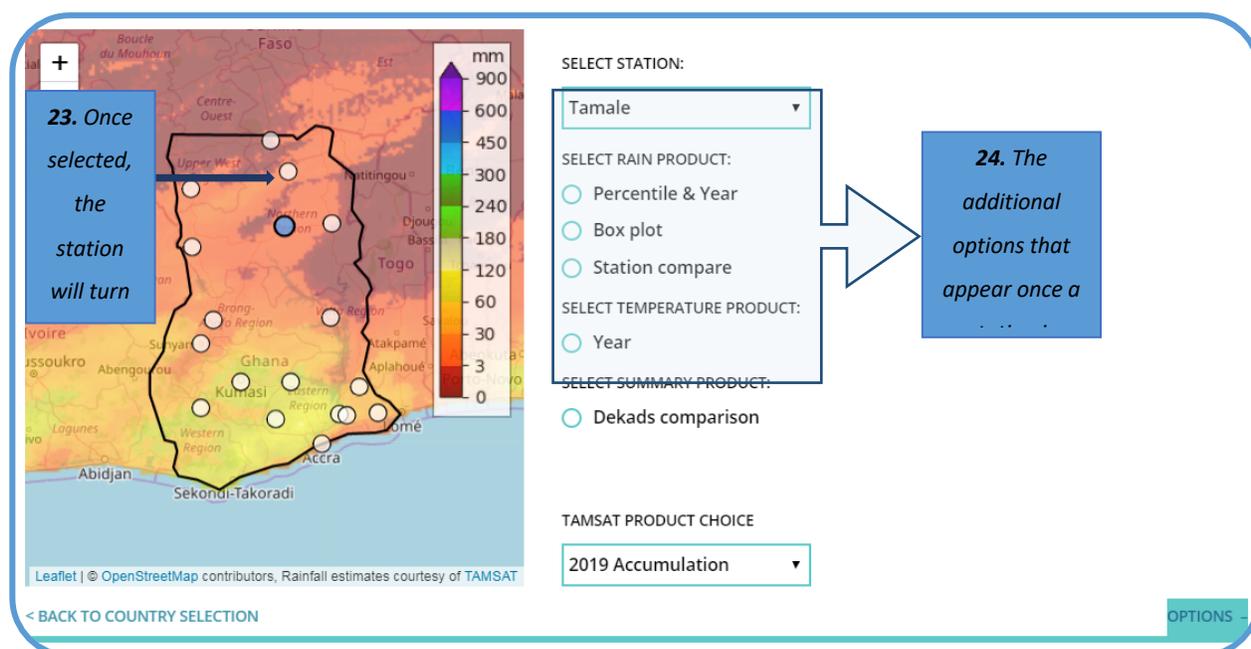


Figure 8: Gauge Station

Note: These options and products will vary from station to station depending on what information is available.

Table 1: Summary of all data products on RAINWATCH

Data heading	Data product	Data description
"Select Rain Product"	Percentile and year	<p>This section has three sub-themes:</p> <ul style="list-style-type: none"> • No normal - which shows cumulative daily rainfall from the beginning of the season until the end. This section also allows you to compare previous years daily rainfall cumulative plots (up to 6 different years) with the current year. • Show percentiles - show five percentile levels (10th, 25th, 50th, 75th, 90th) based on the historical period chosen by you.

		<ul style="list-style-type: none"> Show wet/dry - this section compares the selected year of interest with the long term mean. The colour shades will help you to determine whether it is a dry, wet or a normal year.
	Box plot	A box plot is a standard way of showing the spread of the data based on five key numbers: the minimum, the first quartile (Q ₁), the median, the third quartile (Q ₃), and the maximum. It can tell you about outliers and what their values are. The "Box plot" of monthly total rainfall can be compared for up to 6 years for the same sites or location. See more information in section 3.2.
	Station compare	This allows you to compare the cumulative rainfall total of different stations. You can compare a maximum of six stations at a time.
"Select Temperature Product"	Year	Graphs of daily maximum and minimum temperatures for one station at a time over a selected year.
"Select Summary Product"	Dekads comparison	This present's summary information of the dekadal information collected over a selected year. It compares the various dekads (ten days) with their respective long term mean. The colour shades will help you to determine whether that dekad is wet, dry or normal.

3 Using and understanding the information

This section will provide a guide to the different products (Table 1) on the RAINWATCH platform. The information can then be considered in Section 4 where real case study scenarios help you to understand, apply and make use of this information for decision-making.

3-1 Rain products: Percentile and year

The 'Percentile and Year' option allows you to visualize rainfall characteristics for a particular year (Figure 9). You can select this by clicking on the blue circle to the left of the option 'Percentile & Year' (25). Clicking on this will make the circle completely blue, and a green box with more information will appear on the right-hand side of the product (26).

25. To select a function you click on the circle next to

26. After selecting the product this box will appear

27. Options to show different information

28. Options select up to six

29. 'Load Data'

30. Options button to move from graph to options

Figure 9: Selecting Percentile and Year Information

Note: This box will look different for each product. If a product isn't on the station list, it is because the information is not available for that station.

- The green box (26) presents you with three options at the top (27) which you can select by clicking on the blue circle on the left-hand side of the options.
- The 'No normals' option generates a graph that only consists of the cumulative rainfall total. It presented in a simple line graph.

- The '**Show percentiles**' option generates a line graph that shows the total cumulative rainfall and also compares the line graph with the percentiles on the same graph.
- The '**Show wet/dry**' option creates a coloured graph that shows the cumulative rainfall line with colour codes which indicate what proportion of the year was classified as dry, normal or wet.

The green box also contains six dialogue boxes labelled 'Year 1' through to 'Year 6' (28). These boxes allow you to select the year of your interest by clicking on the dropdown arrow next to the year. You can select up to a maximum of six different years or options. This will allow you to compare information from six different years. However, if you want to see the information from just a particular year, you can select the 'None' from the options in each year box. Once you have completed your selection, click the 'Load Data' (29) button to generate the graphs.

To get back to the data selection page from the graph, you can click on the 'Options' button (30) which allows you to make changes to your selection without having to navigate back to your station every time you want to select alternative information.

3.2 The different types of graphs of 'Percentile and Year' and how to use them

This section will first explain how to generate a graph for one selected year and explore what it shows, and second, will explain how to create comparative graphs that shows comparison across different years.

Box 3: A percentile is a measure used in statistics to show the value below which a given percentage of observations in a group of observations falls. For example, the 20th percentile is the value below which 20% of the observations may be found.

The 'No Normals' graph

By following the steps in the previous section, you can select the 'No normals' option (31) (clicking on the circle to the left, which will turn blue once selected, and select a single year (32) by clicking on the little arrow on the right to get a drop-down menu - this is also how you can set the year boxes to "NONE" that is if you don't want to select any year) – see Figure 8.

The screenshot shows the application's configuration screen. On the left is a map of West Africa with a red dot indicating the station location in northern Ghana. The 'SELECT STATION:' dropdown is set to 'Tamale'. Under 'SELECT RAIN PRODUCT:', 'No normals' is selected. Under 'SELECT TEMPERATURE PRODUCT:', 'Year' is selected. Under 'SELECT SUMMARY PRODUCT:', 'Dekads comparison' is selected. The 'TAMSAT PRODUCT CHOICE' dropdown is set to '2019 Accumulation'. On the right, there are options for 'Show percentiles', 'Show wet/dry', and 'Show years'. Below these are six year selection dropdowns (YEAR 1 to YEAR 6), with YEAR 1 set to '2019' and the others to 'None'. A 'LOAD DATA' button and an 'OPTIONS' button are also visible. Callout boxes are present: 31 points to the 'No normals' radio button, and 32 points to the year dropdown menus.

Figure 3: Selecting the 'No normals' option

Make sure all the other year boxes are set to NONE after selecting your year of interest by using the dropdown options. You can generate a 'no normal' graph that will look like this:

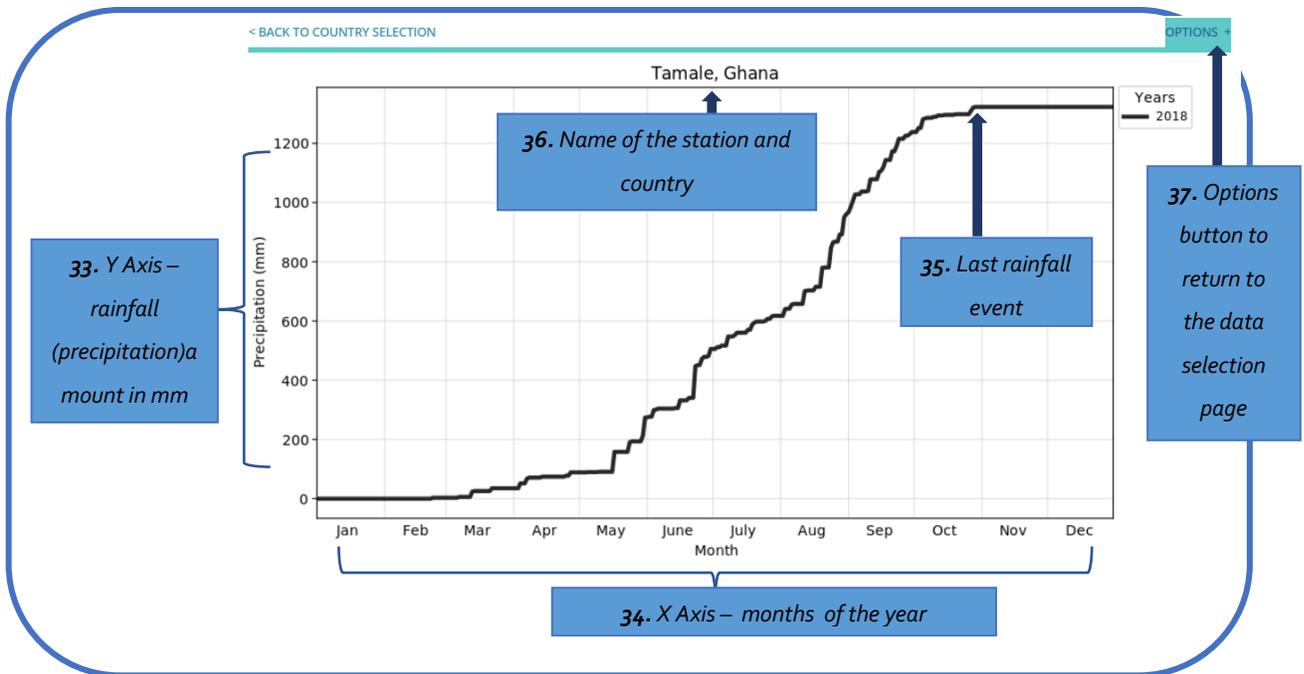


Figure 4: Example of Graph (single year) showing cumulative rainfall for Tamale for the year 2018

Figure 9 shows cumulative rainfall for the station called Tamale in northern Ghana for the selected year of 2018. This graph is not compared with any long term mean to determine whether the year in question is normal or not

normal. The graph shows the total amount of rainfall (precipitation) in millimetres (mm), which is cumulative for the year from January to December. These are labelled on the X and Y Axis's (33 & 34). Figure 9 shows that in Tamale there was just over 1300mm of rainfall in 2018 (if you trace the point of the last rainfall event (35) to the year axis). The name of the station and country are shown at the top of the graph (36).

You can compare different years for the same station (or location) by going back to the data selection page, clicking on the 'Options' button (37), and then selecting the years that you would like to compare in the 'Years' boxes (32).

Figure 10 shows a cumulative rainfall graph for Tamale, Ghana, comparing six different years (2014, 2015, 2016, 2017, 2018 and 2019). On the right-hand side there is a legend (or key) to help you identify which line represents which year (38). You will also see that the year 2019 is in red and has an asterisk – This indicates that there is some data missing for this year because the year is not yet completed.

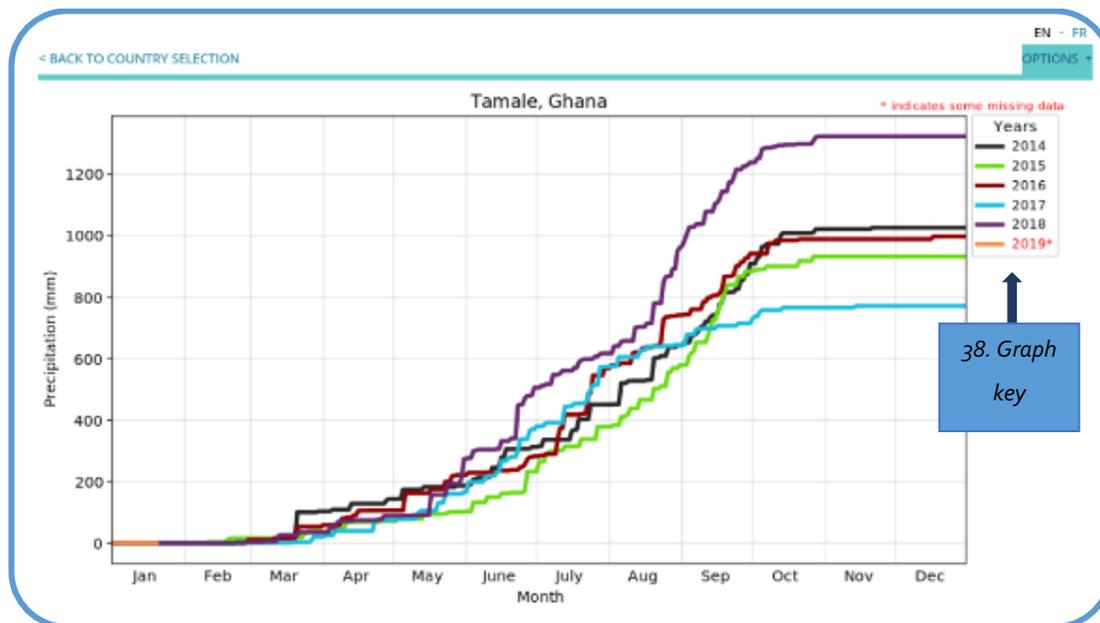


Figure 5: Example of 'No Normals' Graph (Multiple Years)

Understanding checkpoint

Looking at information presented in Figure 10, there are differences in total rainfall between years and months. Years and months with the highest amount of rain and trends over time can be identified. Use Figure 10 to answer the following questions:

When does the rainy season start and end across the years presented?

The 'Show Percentiles' graph

As part of the 'Percentile and Year' information, you can select 'Show Percentiles' option (39) (see Figure 11). When selecting the Show percentile option, an additional section will appear in the green box, called 'statistical period' (40). The statistical period section will allow you to select the baseline period upon which the percentiles will be generated.

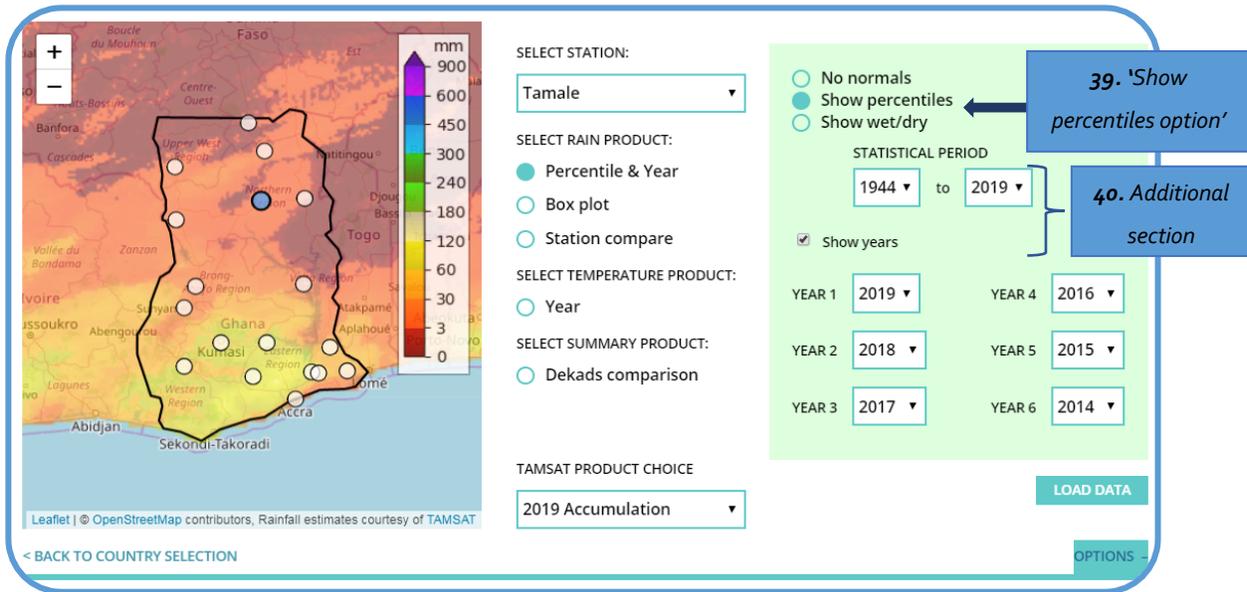


Figure 6: Selecting Percentile and Year Information - Show Percentile Option

By using this data option, the following graphs (Figure 12) can be created:

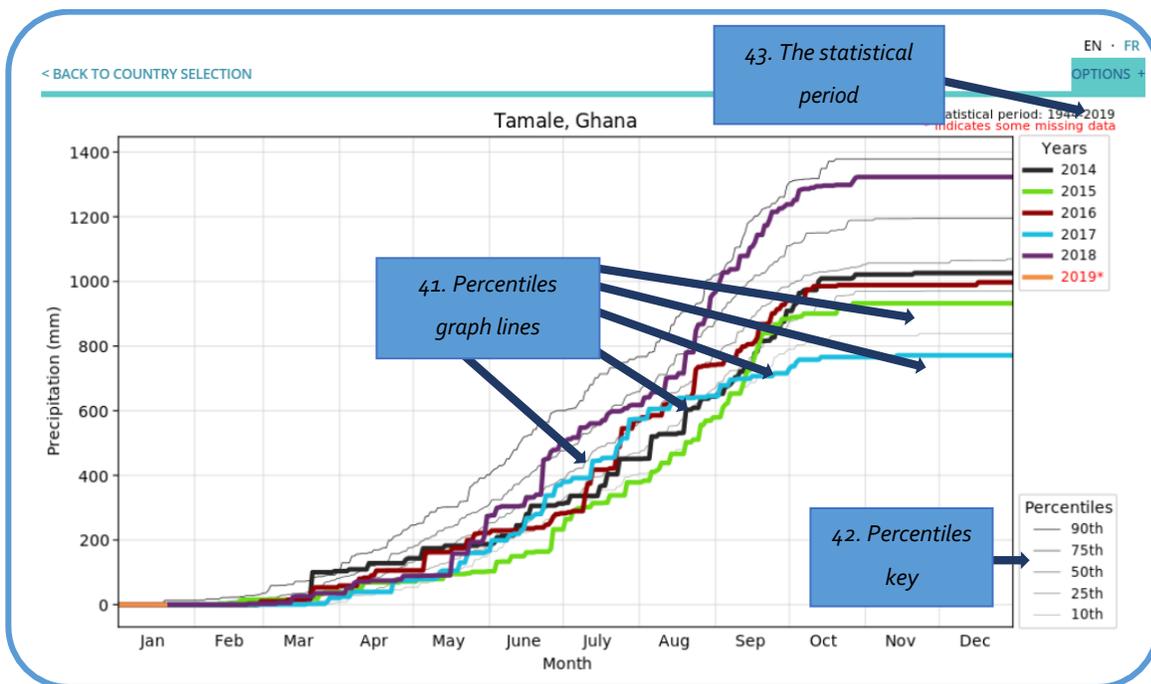


Figure 7: Example of Percentile and year graph (Multiple Years)

The graph pattern in Figure 12 is similar to the cumulative rainfall ("No Normals" option) graph in Figure 10. However, there are useful additions.

There are five thin grey lines on the graph (41) with each having a different thickness. These lines relate to the percentiles key (42) and you can use the key to interpret each line. The percentiles are based on the statistical period selected. The key shows that there are five percentile categories called the 10th, 25th, 50th, 75th, and 90th. The interpretation of these thresholds in terms of rainfall status can be describe as follows:

- Cumulative rainfall below the 10th is "very dry"
- Cumulative rainfall between the 10th and 25th is "dry"
- Cumulative rainfall between the 25th and 50th is "moderately dry"
- Cumulative rainfall between the 50th and the 75 is "moderately wet"
- Cumulative rainfall between 75th and 90th is "wet"
- Cumulative rainfall above the 90th is "very wet"

The statistical period (43) shows the period selected for the calculation of the percentiles on the green box (40).

NOTE: The graph above shows a range of years. Like the 'no normals' graph, you can simply select one or two years and set the remaining 'Year' boxes to 'NONE'.

Understanding checkpoint

Based on Figure 12 you can consider these key points: The percentile plots will help you check how the year of interest performed or is performing as compared to the historical records. This will help you to monitor the season and where appropriate share information or take management decisions. For example, you can tell whether the season is emerging to be very dry or wet.

In the light of these thresholds, on Figure 12 it can be seen that 2015 was a very dry year for Tamale. Cumulative rainfall did not reach the 25th percentile for most of the rainy season so we can describe 2015 overall as a year with less rain and a relatively bad year for rainfall.

By contrast, from Figure 12, we can describe 2018 overall as a good year because it had higher rainfall. For most of the rainy season, the rainfall amount was above the 50th percentile. We can specifically see a slow start to the rainy season in March, with a cumulative rainfall around the 50th percentile until mid-April, and then rainfall dropped to between the 10th and 25th percentile because of a dry spell. This continued problem until the end of May when rainfall conditions started improving and were sustained to the end of the season.

Note that the percentiles are generated from the historical data and based on the statistical period selected.

The 'Show Wet/Dry' graph

The final option in the 'Percentile and Year' section is the 'Show Wet/Dry' option (44), which is shown in Figure 13.

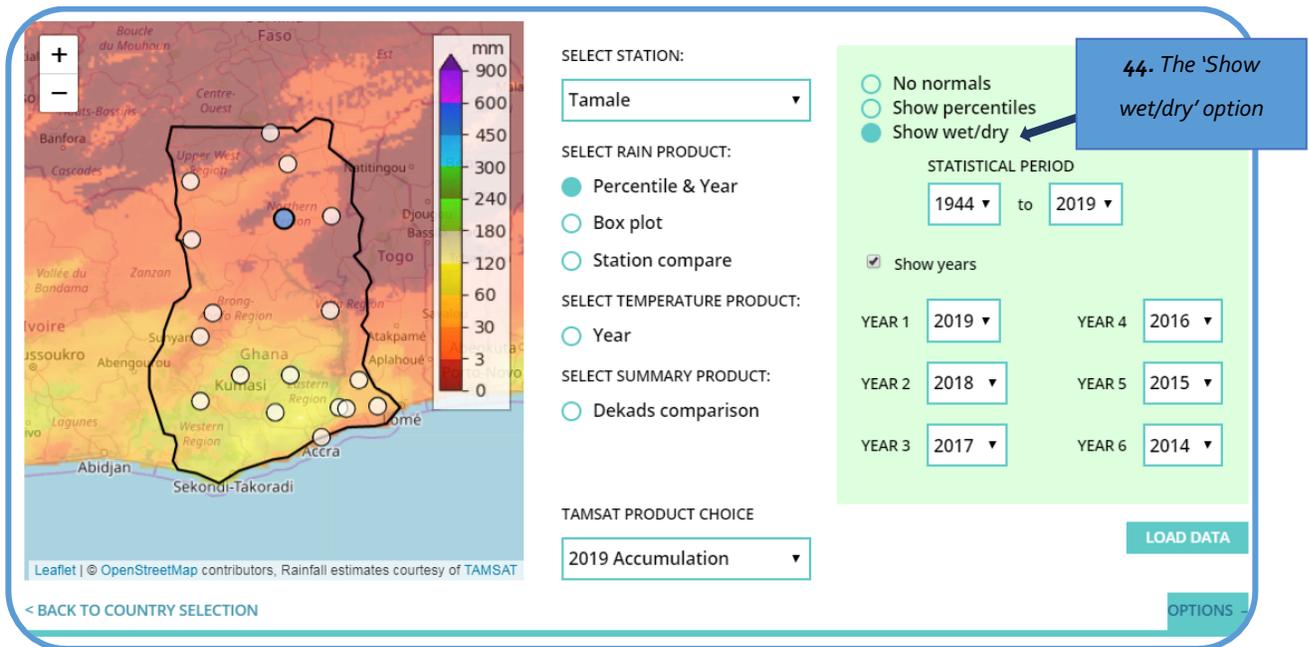


Figure 8: Selecting Percentile and Year Information - Show Wet/Dry Option

Selecting this does not add anything new to the green box, so you have the same options as above. Once the years and statistical period are select, a graph is generated (Figure 14).

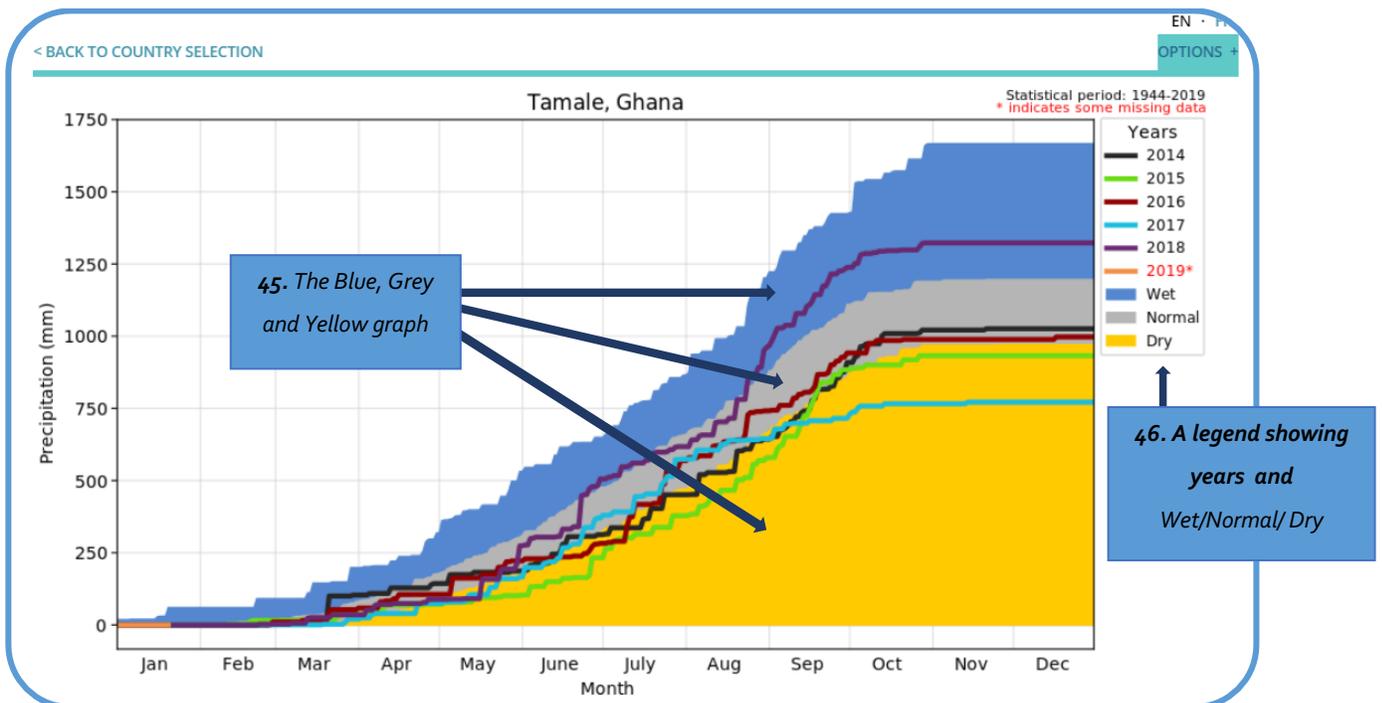


Figure 9: Example of Wet/Dry Year Graph (Multiple Year)

You will notice that the graph pattern is similar to the 'no normals' graph (Figure 10), as it shows the cumulative rainfall of all the years selected. This graph does not have any percentile information as shown in the 'Show Percentiles' graph, except the selected statistical period still visible in the top right corner. New on this graph are:

- Yellow, grey and blue areas on the graph (45)
- The Wet/Normal/Dry area key/legend (46)

The shaded area with the colour codes is based on the statistical period selected. The shaded areas are based on historical rainfall data for the location of interest. The colour codes are designed to help you to determine whether the year under study is dry, normal or wet.

- The blue area depicts wet conditions.
- The grey area shows normal rainfall conditions or an equivalent of average rainfall.
- The yellow area shows a dry state or a rainfall amount below the normal (or average).

Understanding checkpoint

Based on the information above you should reflect on these key points: The graph from the 'Show Wet/Dry' section helps you at a glance to determine whether the year under consideration is dry, normal or a wet year and how a new year is emerging. Different users will thus take reflect on this information in different ways and conclude that there might be different decisions or actions.

Using the Figure 14 try to answer the following questions:

1. Which year was dry for almost the entire rainy season?
2. Which year can be described as a wet year relative to the other years?

3.3 Rain Products: Box Plot

The 'Box Plots' function allows you to visualize rainfall characteristics for a particular year in a different way to the 'Percentile and Year' product reviewed in the previous section. You can select this option by clicking on the blue circle to the left of the option 'Box Plot' (47). Clicking on this will make the circle completely blue, and a green box with more information will appear on the right-hand side of the product (48) – see Figure 15.

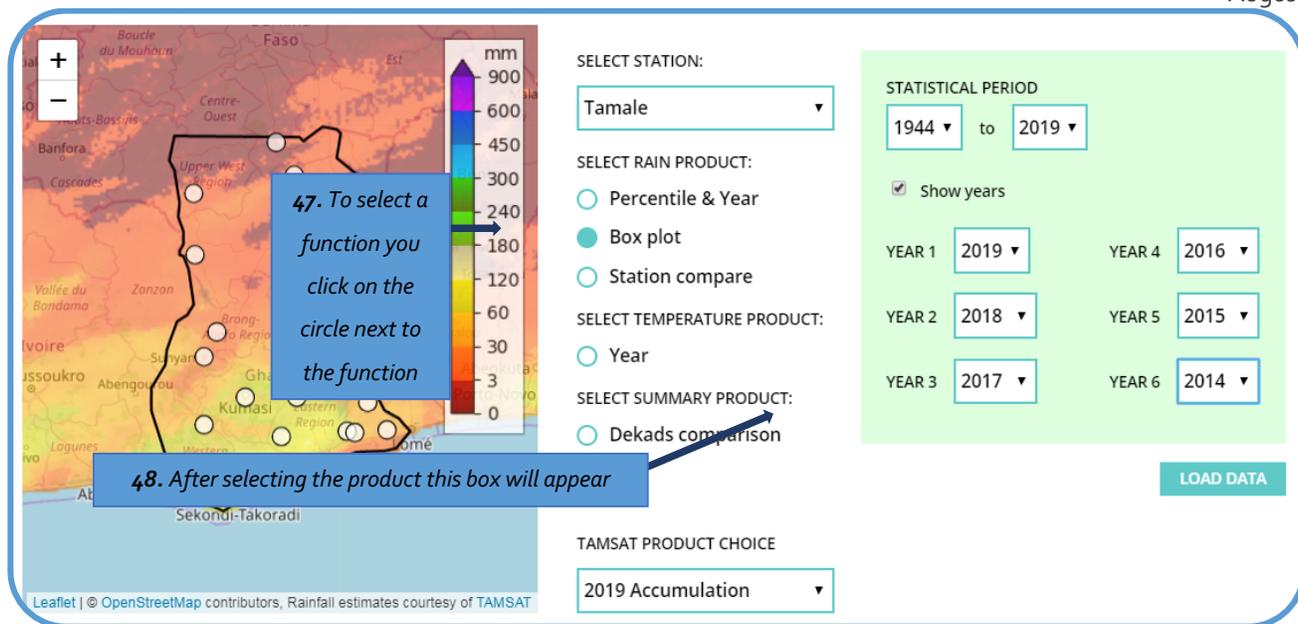


Figure 10: Selecting Box Plots Information

The green box contains the same options you had to select from in the 'Percentiles and Year' product. To find out how to use these options and what they mean to refer to section 3.1. Unlike the 'Percentile and Year' product however, there are no sub-options within the green box, so once you have selected your statistical period and relevant years, you can select 'Load Data', and a graph be generated (Figure 16).

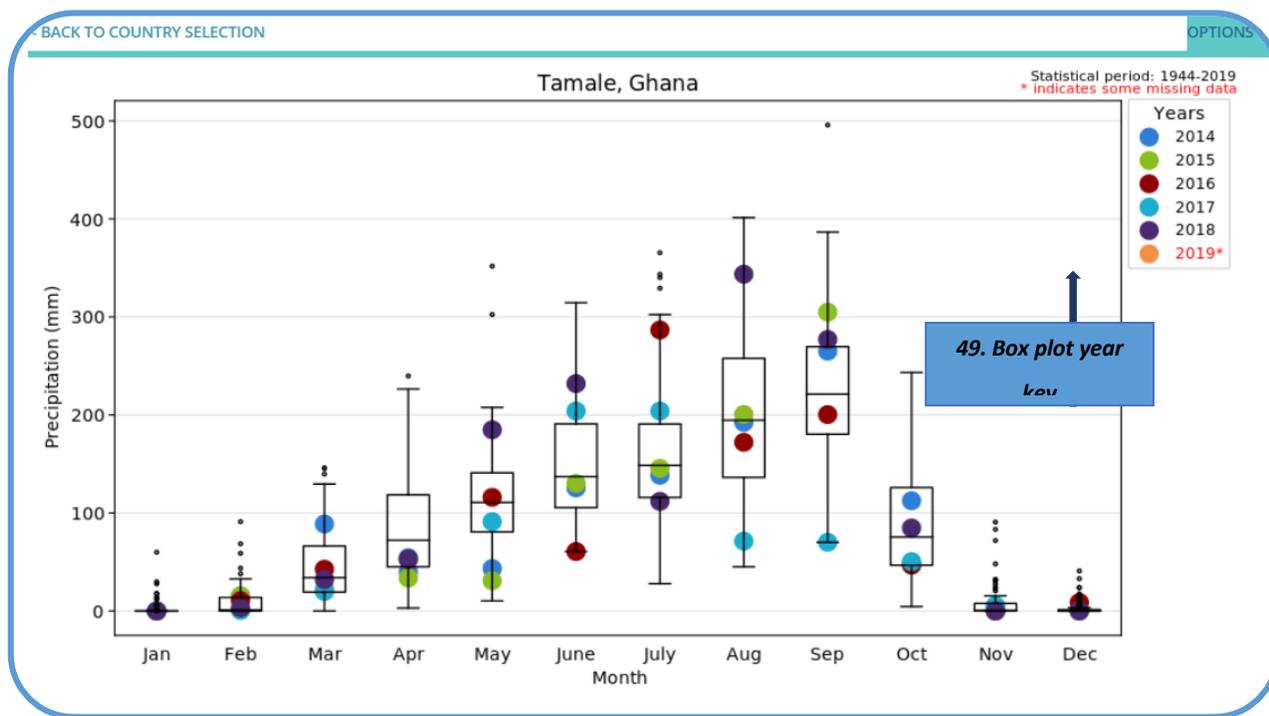


Figure 11: Example of Box Plot Graph (Multiple Years)

The graph in Figure 16 is a box plot graph. Figure 17 shows how to understand a box plot graph. For each month a box is divided into two parts which shows historical rainfall thresholds. The bottom part of the box (50) relates to dry condition and the top part to the wet condition (51). The coloured dots (the colours of the dots correspond to the years selected) on the box plot show the rainfall totals for a particular month. For example, the dark blue dot (52) on Figure 17 indicates that the rainfall total for July 2014 can be classified as a relatively dry month - the key for these can be seen in Figure 16 (49).

For a given year, if the monthly dot is located at the bottom part of the box plot, then it means that the rainfall total for that month can be described as dry. When the dot falls into the upper part of the box, rainfall for that month can be described as wet. The position of the dot against the vertical (y) axis provides information about the amount of rain in mm.

The lines on either side of the box plot are called 'whiskers' (53). The

whiskers indicate the minimum and maximum rainfall values. Any dots above the whiskers can be considered as extreme rainfall values. In the example in Figure 17, you can see that the Red, Light Blue, and Purple dots are sitting on the whiskers and outside the top and bottom boxes. The dots on the whiskers are showing low (the whisker pointing downwards) or high (the whisker looking upwards) rainfall values. The specific amount of rainfall for each of the dots can be traced to the y or vertical axis.

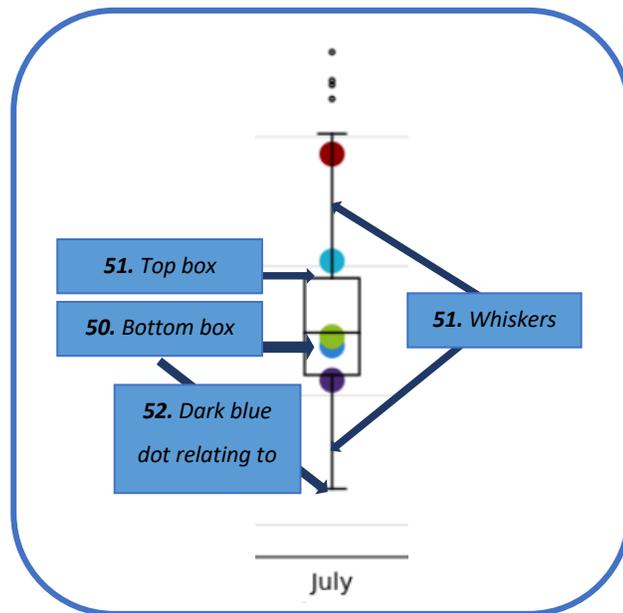


Figure 12: Breakdown of Box Plot Example

Understanding checkpoint

Based on Figure 16 you should consider these key points: The information in this section will help you understand and monitor the monthly and annual cycle of rainfall for a particular location.

You can appreciate the variable nature of rainfall and note peak/low rainfall periods.

Graphs of historical data show that rainfall starts in April, increases until a peak in August/September (the rainiest months) and then declines and ends in October.

Monthly rainfall in drier/wetter years can be tracked by their positions on the plot.

This graph helps us understand the type of rainfall regime for a given station. For example, Tamale experiences a unimodal rainfall regime, where the season starts in April, peaks in August/September and ends in October. Which month is rainiest in Tamale?

3.4 Rain Products: Station Compare

The 'Station Compare' function allows you to compare rainfall information between different stations within a RAINWATCH member country. You can select this by clicking on the blue circle to the left of the option 'Station Compare' (54) (Figure 18). Clicking on this will make the circle completely blue, and a green box with more information will appear on the right-hand side of the product (55).

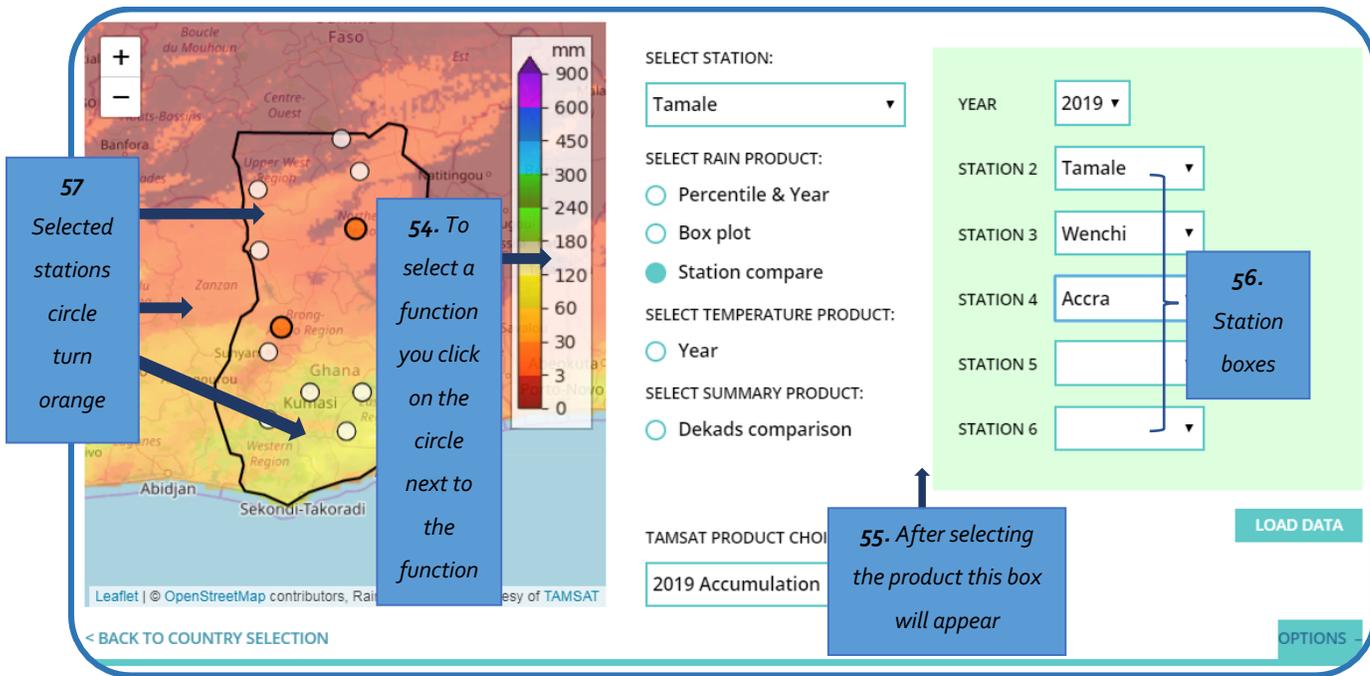


Figure 13: Selecting the Station Compare Information

In the green box, there is a 'Year' option, which allows you to choose the year that you require information about, and there are 6 'Station' boxes (56). The dropdown menus show a list of all the stations that are identified on the map with the grey circle. As you select a station, the grey dot on the map will turn to orange (57) to show you where the station is on the map. This function allows you to compare rainfall between different areas of the country.

Once you have selected your year and the stations, you can then click on 'Load' to generate the graph (Figure 19).

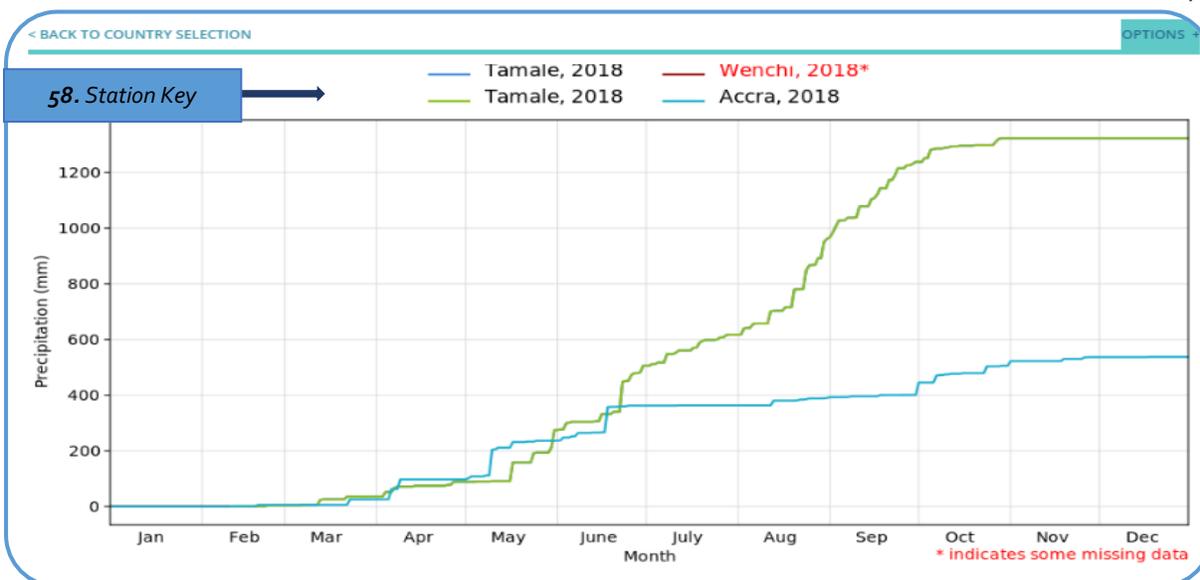


Figure 14: Example of Station Compare Graph (Multiple Years)

Figure 19 shows cumulative rainfall data for three stations in Ghana – Tamale, Wenchi, and Accra. The key/legend to the plot is found on top of the graph (58). You can see that Wenchi has an asterisk next to it to indicate that there is missing information (and this is why there is no line for Wenchi found on the graph). By looking at Figure 19, you can see that Tamale (the green line) received more rain compared to Accra (the light blue line) in 2018.

Note: You can only compare stations that are in the same country, so you cannot compare a station in Mali to a station in Ghana.

Understanding checkpoint

Looking at information like this can provide you with useful information:

You can compare different locations in a country.

You can compare stations in different climatological zones across a country.

You can identify differences in the distribution of rainfall over a year.

3.5 The Temperature Product

This section explains how to navigate and understand temperature information for a selected station. You should begin by moving to the "Select temperature product". Under the "Select temperature product", you will find "Year" (59). Select this by clicking on the circle to the right of the option called 'Year' and a green box (60) will appear on the right-hand side. This will allow you to select years or the period of interest. In the green box, there is an option called 'Statistical Period' (61) that allows you to choose the

period for which you want your long term mean to be calculated, and a 'Year' (62) box, which allows you to select the year you want the temperature information.

For the example in Figure 20, the historical statistical period has been set for 1960 to 2016, and 2016 is the year for which the data will be plotted.

The screenshot shows a web interface for selecting temperature comparison information. On the left is a map of West Africa with a rainfall scale in mm (0 to 900). The scale is color-coded from red (0) to purple (900). A callout box 59 points to a circle on the map, stating: "59. To select function you click on the circle next to the function".

In the center, there are several selection menus:

- SELECT STATION:** Tamale
- SELECT RAIN PRODUCT:**
 - Percentile & Year
 - Box plot
 - Station compare
- SELECT TEMPERATURE PRODUCT:**
 - Year
- SELECT SUMMARY PRODUCT:**
 - Dekads comparison
- TAMSAT PRODUCT CHOICE:** 2019 Accumulation

Callout box 60 points to the 'Year' radio button, stating: "60. After selecting the product this box will appear".

On the right, there are two input boxes for the statistical period:

- STATISTICAL PERIOD:** 1960 to 2016
- YEAR:** 2016

Callout box 61 points to the '2016' in the 'STATISTICAL PERIOD' box, stating: "61. Statistical period options". Callout box 62 points to the '2016' in the 'YEAR' box, stating: "62. Year options".

At the bottom right, there is a "LOAD DATA" button and an "OPTIONS" button.

Figure 15: Selecting the Temperature to Compare Information

Once you have chosen your data criteria, click the 'Load Data' button, and a graph will be generated (Figure 21).

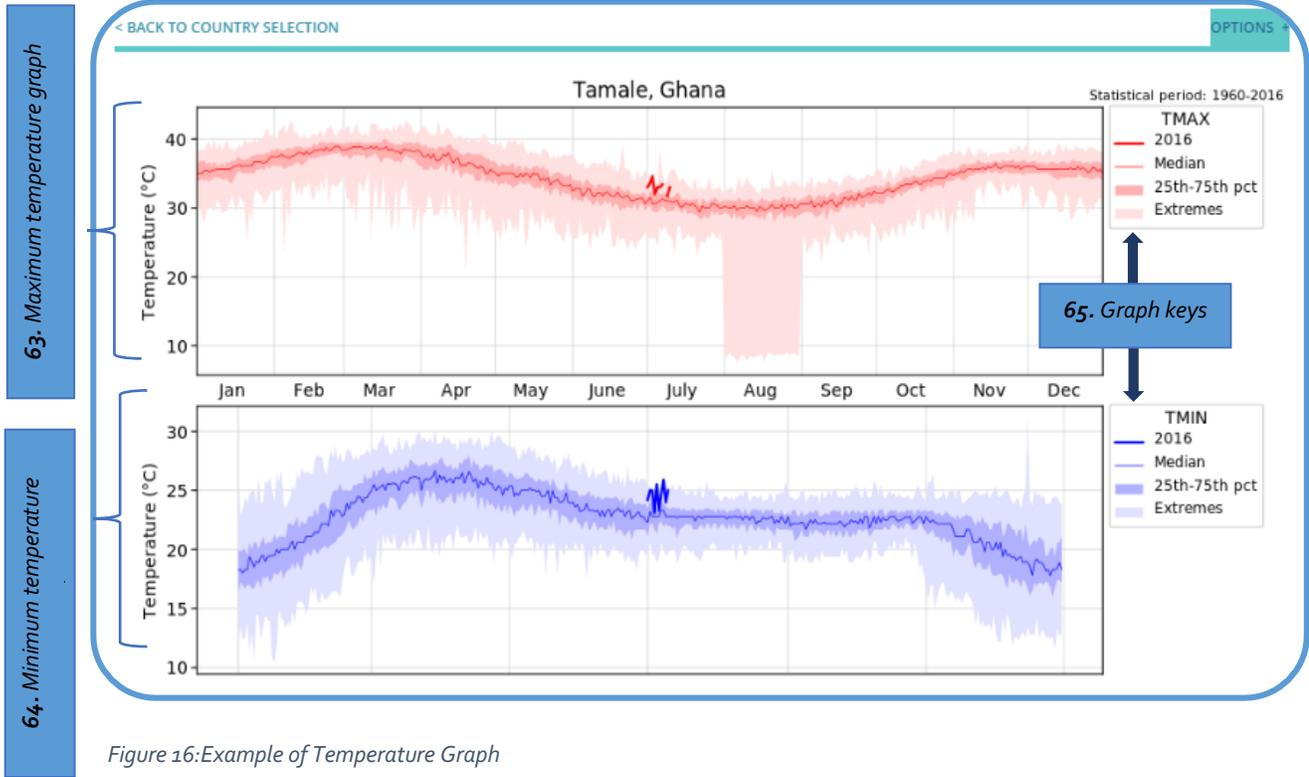


Figure 16: Example of Temperature Graph

Figure 21 shows two graphs. The top graph (63) shows the maximum daily temperature (see Box 4) over the year 2016 in Tamale, and it is red in colour. The bottom graph (64) shows the minimum daily temperatures (see Box 4) over the year 2016 in Tamale, and it is blue in colour.

You will notice there are four different shades of red and blue on both graphs – these differences are explained in the graph legend (or key) which is located at the right of each graph (65). These are shown in more detail in Figure 22:

- The year selected (66) – shows the temperature of that day.
- The median of the historical data (67) - for half of the time, the temperature will be above the 50th percentile.
- The 25th and 75th percentiles of the historical data (68) – days with high temperature (75th and above) and days with low temperature (25th and below).

Box 4: Maximum and Minimum Temperatures
 The maximum temperature is the highest temperature measured within the day. The minimum temperature is the lowest temperature measured within the day.

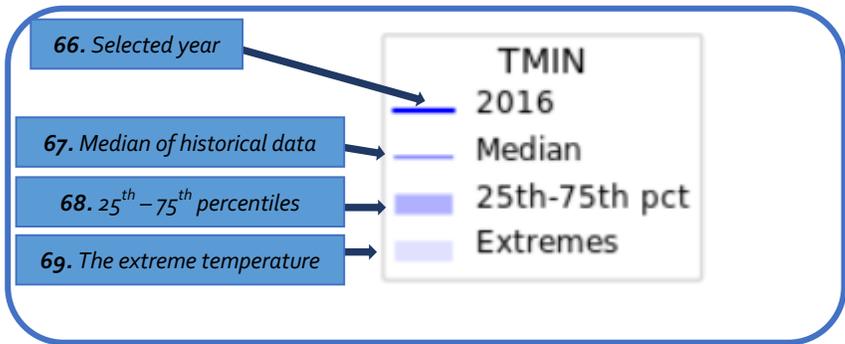


Figure 17: Breakdown of Max and Min Key

The extreme temperatures of the historical data (69) – described as very low temperature, usually below the 25th percentiles, and very high temperature, usually above the 75th percentile.

Understanding checkpoint

Looking at Figure 21, you are able to identify information about useful climate indicators:

You can learn the temperature cycle for the entire year for both day and night.

You can identify the hottest and coldest months of the year.

Using Figure 21, try to answer the following questions:

1. What is the hottest month of the year?
2. What is the coldest month of the year?

3.6 Summary Product

The final product on the RAINWATCH platform is 'Summary Product' (Figure 23). The summary product allows you to compare a dekad (ten days total) of a particular month of your interest for a specific year with the long term mean of that same dekad.

You select this by clicking on the circle to the right of the option called 'Dekads Comparison' underneath the heading '**Select Summary Product**' (70). When you click, a green box (71) will appear on the right-hand side to provide options and you can select a period of interest. In the green box, there is an option called 'Statistical Period' (72) that allows you to choose the period you would like data from, and a 'Year' (73) box that allows you to select the year you want the Dekad rainfall data.

Figure 23 has the historical statistical period set for 1960 to 2016, and 2016 is the year for which the data will be plotted.

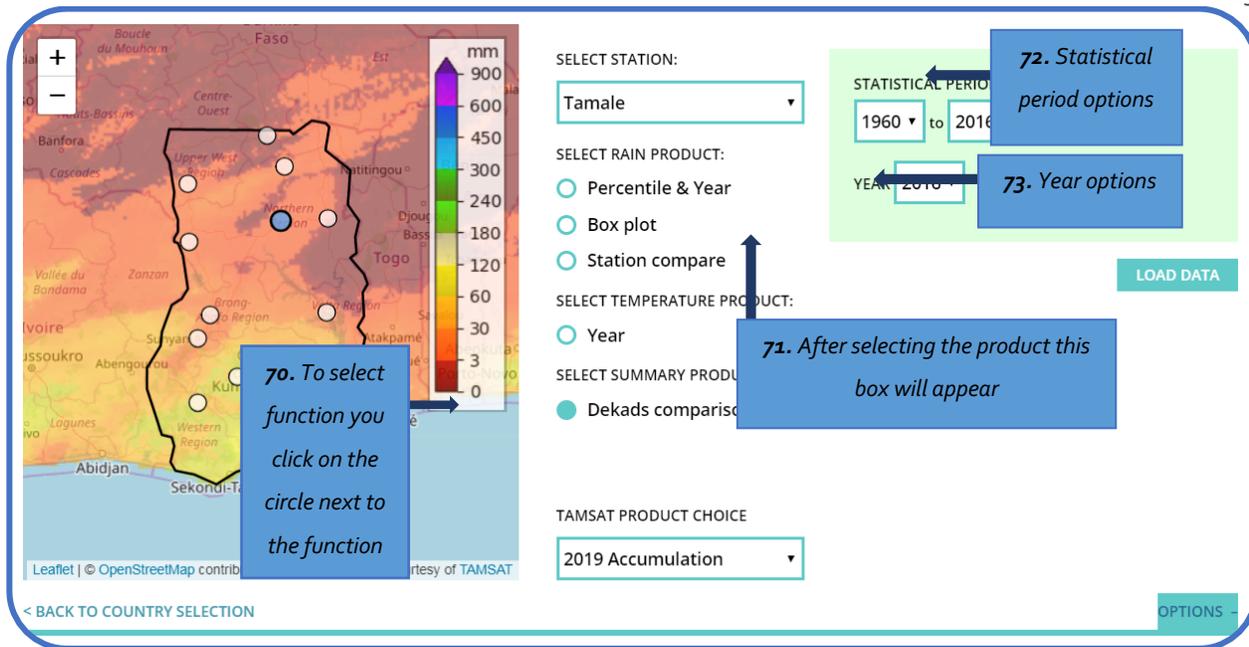


Figure 23: Selecting Summary Product Information

Once you have chosen the data criteria, you can click on the 'Load Data' button, and a graph will be generated (Figure 24).

Figure 24 provides useful summary information about rainfall and temperature. The emphasis on interpretation here will be on rainfall. The graph shows information about rainfall amount, the number of rainy days and rainfall intensity at the end of every ten days. Each blue dot with a red ring represents a dekad (ten days), so there will be three dots for each month. The first ten days of the month is called the first dekad, the second ten days is called the second dekad, and the third is called the third dekad. The colour codes of yellow, grey and blue represent below normal, normal and above normal respectively.

For example, the total rainfall for the first dekad of August as compared to the long term mean of all the first dekad of August for the statistical period selected was less than the long term mean and therefore is classified as below normal (dry - shown by colour yellow), the second dekad was normal (average - shown by colour grey) and the third dekad was above normal (wet - shown by colour blue).

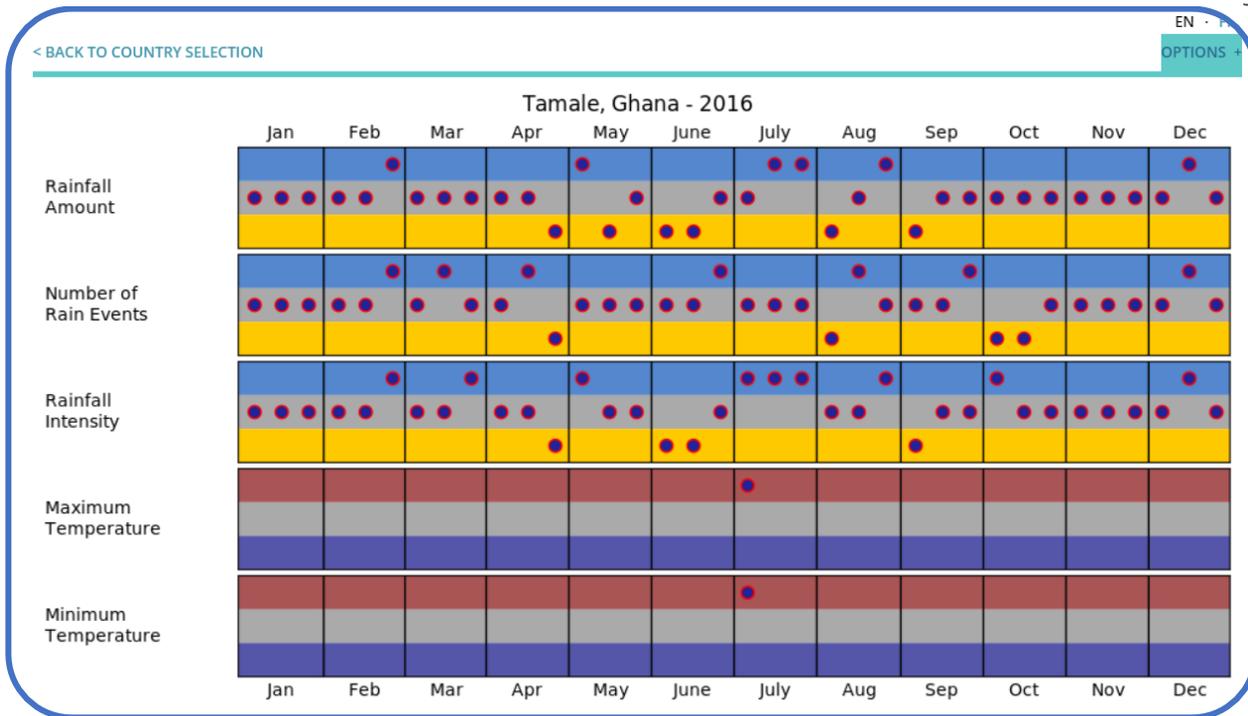


Figure 24: Example of the Summary Product Graph (Multiple Years)

4 Application of RAINWATCH Information

Now that you have learned how to use RAINWATCH and what information is available on the RAINWATCH platform, the next step is to use this information to communicate what it means in context and how it can be used to consider options by context that will help to support communities to improve their resilience and adaptive capacity.

To do this, this section presents a hypothetical community and is intended to provide scenarios that explain how the information on could be used as an information source for science communicators, knowledge brokering and for decision-making.

4-1 Hypothetical community story

In a small community in rural northern Ghana, the majority of the people practice rain-fed agriculture. Farmers grow staple crops such as Sorghum and Millet to provide their families with food and make sales of cash crops to provide an income. Farmers make critical decisions at several stages through the year to ensure a successful farming season. For example:

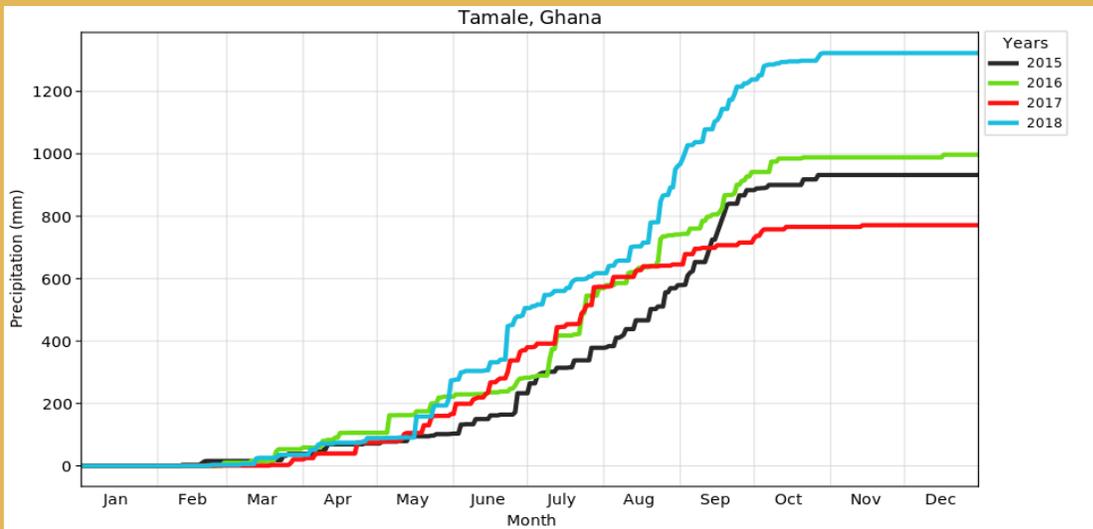
- When is the best time to plant?
- Based on this, when do they need to buy seeds and other inputs?
- Is the season emerging to be an above/normal/dry rainfall year?
- Based on this, how might they adjust their planting or crops?
- Do they need to find ways of getting more water, or buying more food?
- When will they be able to harvest and how well might their crops do?
- How can the seasonal forecast be monitored?

The information on the RAINWATCH platform and explored in the Handbook can help to answer these questions.

To explain how, three example scenarios are presented to provide interpretation techniques that can assist you when using the information and considering how you would want to communicate what you learn.

Case study 1: The start of the season – the planting window?

Finding the optimum plant date:



Planting begins (Onset)

End of the season

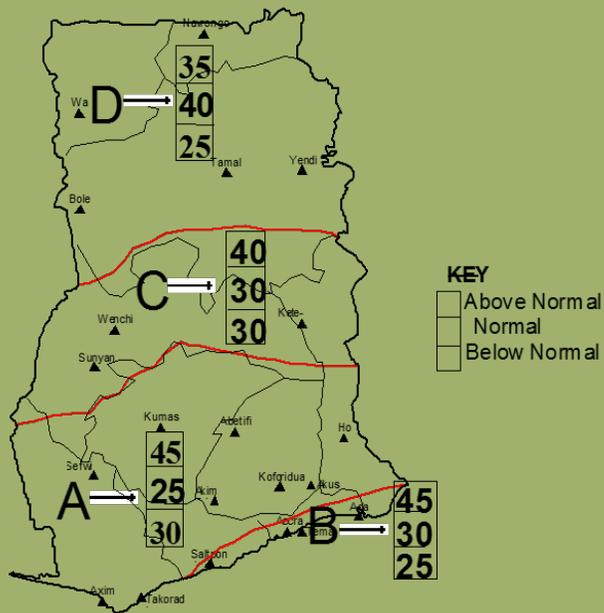
Dates	Dekad	Observation
March - April	Planning and preparation	
Mid May to late June	Planting	Sowing window to advise planting. Grow early maturing and drought resistance crop variety
July - September	Crop growth and development	Relevant and context climate and other risk management decisions are taken
October - December	Maturing and harvesting of crops	Harvesting window

Examples of Messages :

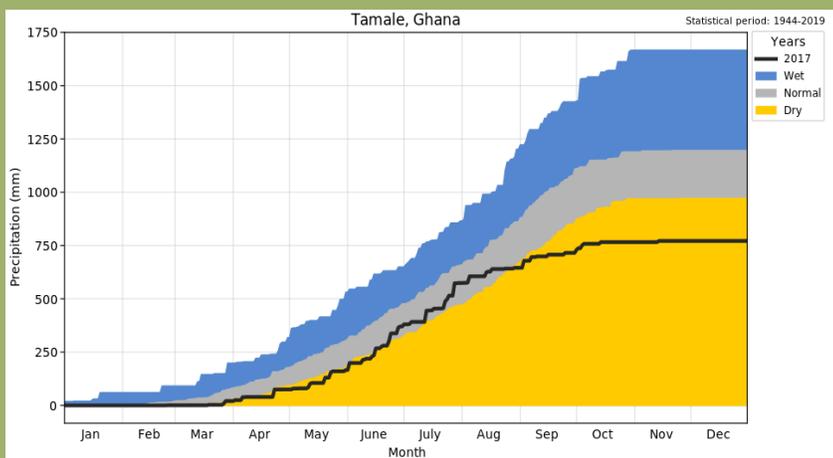
- Based on the historical climate information, it is recommended that you plant within this sowing window.
- Any delay after the sowing window will shorten the length of the season.
- Seasonal rainfall total ranges between 800mm and 1200mm.

Case study 2: How to monitor the seasonal forecast

Seasonal outlook for 2017



Monitoring the seasonal forecast using RAINWATCH



Examples of Messages :

- The seasonal rainfall can generally be described as below normal (dry) compared to the Normal to the above normal forecasted.
- Farming decisions taken based on the seasonal forecast must be reviewed by comparing with the emerging graphs from RAINWATCH to reflect actual occurrence.

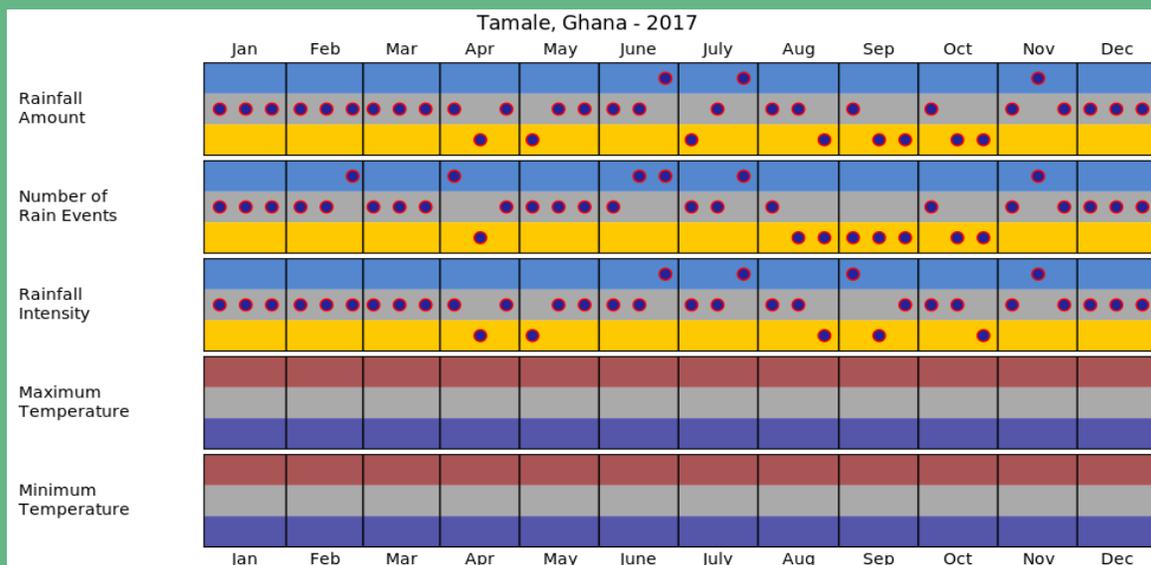
Northern Ghana experienced normal to above normal rainfall amount during the 2017 rainy season.



Case study 3: Year 2017 – a challenging season?

Using the RAINWATCH summary product, how would you describe rainfall for the second dekad of August? You want this information for your decision-making meeting and ten day climate bulletin to discuss with farmer.

How is the season emerging? Can you whether the dekad under review was wet, normal or dry? What about rainfall distribution for the same period?



Examples of Messages:

- You will notice that rainfall total received for the dekad under review was less and the distribution rainfall events were few.
- This means that the third dekad of August was relatively dry compared to the same period in the past with few rainfall events. This could affect plant growth and development depending stage of development and it will be important to communicate the implications to extension officers.

4-2 Summary: What can this information be used for?

The benefits of combining monitoring information with forecasts for effective decision making process within existing communication structures

Before the season

Reviewing historical climate information will help inform about a location's characteristics in terms of:

- Annual rainfall total
- Planting window/onset
- Length of the season
- End of the season

At the beginning of the season: information received from the seasonal forecast will help to maintain or review the decisions made before the seasonal forecast was issued

- Decide the best period for sowing (sowing window)
- To confirm crop type or variety
- Disaster risk manager can plan for potential interventions
- Policy makers can have clear policy direction
- MMDA will liaise with relevant stakeholders and CSO's to plan for the season

During the season

Regular review of information from the RAINWATCH platform will help with:

- Monitoring dekadal rainfall totals to know whether the dekad was wet, normal or dry
- Assessing the number of rainfall events
- Understanding the performance of the seasonal forecast, which will help to maintain or review climate risk management decisions based on the prior forecast
- Issuing early warning or provide appropriate adjustment guidelines by stakeholders – options by context
- Comparing monthly rainfall totals

After the season: information from the RAINWATCH platform can help:

- Identify periods for harvesting
- Rainfall events update during dry season
- Review the rainfall patterns over the season
- Reflect on climate risk management decisions taken
- Reflect on communication of adjustment guidelines by stakeholders

4-3 Reflections

This Handbook is a resource tool for both the users and producers of rainfall information in the RAINWATCH Alliance to support more effective decision making. The Handbook has focused in particular on providing an introduction to the RAINWATCH platform so that you can now use and explore, better interpret the available information and apply this knowledge in practical ways to your everyday job and your local context.

The RAINWATCH Alliance, Friends of RAINWATCH and partners will continue to work together with you to develop the practical information that you need to build climate resilient futures for all.



ACKNOWLEDGEMENTS

This Handbook was written by Kofi Asare, RAINWATCH Alliance Principal Coordinator, with technical contributions from RAINWATCH Research Leads, Prof. Rosalind Cornforth and Prof. Aonover Tarhule.

The following RAINWATCH and BRAVE team members guided the production of the Handbook based on their experience in supporting and /or implementing agricultural extension and training services in Africa:

- Assoc Prof Henny Osbahr, BRAVE Social Science Lead
- Luisa Ciampi, Walker Institute Impacts Officer and BRAVE PDRA
- Shani Haruna, BRAVE Research Assistant, University of Ghana
- Jacob Myers, Walker Institute, Knowledge Management Officer, also contributed to the content of this Handbook.

We are immensely grateful for the ongoing technical support from the RAINWATCH Development team:

- Dr Galine Yanon, WMO GFCS / RAINWATCH Technical Support and former BRAVE PDRA
- Zakari Saley-Bana, Hydrometeorologist, RAINWATCH Designer (2009)
- Nathan Bain, New York Mesonet and RAINWATCH Senior Software Engineer
- Dr Elena Tarnavsky, Walker Institute Senior Research Fellow, GIS Expert
- Dai Clegg, Evidence for Development, Senior Data Scientist
- Dr Celia Petty, Evidence for Development, Livelihoods Modelling

The RAINWATCH core team would like to thank everyone for their invaluable contribution to shaping, strengthening and making this Handbook possible on behalf of the RAINWATCH Alliance Members.

Friends of the RAINWATCH Alliance

We are very grateful for the continued support of the Friends of the RAINWATCH Alliance for their ongoing support across a wide range of expertise.

Name	Affiliation	RAINWATCH Role
Mary Allen	Practical Action, West Africa	Agriculture and Livelihoods Expert
Felipe Lucio	WMO GFCS	Climate Information Services Expert
Celia Petty	Evidence for Development	Household Economy Assessment Methods & Livelihoods

For more information, or to comment on this Handbook, please email Kofi Asare at asarefi@yahoo.com or info@RAINWATCH-africa.org

© Walker Institute, University of Reading, August 2019

This publication is copyright but the text may be used free of charge for the purposes of advocacy, campaigning, education, and research, provided that the source is acknowledged in full and copies are not being sold commercially. The copyright holder requests that all such uses be registered with them for impact assessment purposes. For online use, we ask readers to link to the original resource on the RAINWATCH website (www.RAINWATCH-africa.org) or the Walker website (www.walker.ac.uk). For copying in any other circumstances, or for re-use in other publications, or for translation or adaptation, permission must be secured. Email info@RAINWATCH-africa.org

The information in this publication is correct at the time of going to press.

Published on behalf of the RAINWATCH Alliance at <https://doi.org/10.5281/zenodo.3366368> in August 2019 by the Walker Institute, University of Reading, Earley Gate, Reading, RG6 7BE, UK.

This work is licensed under the Creative Commons Attribution-NonCommercial 4.0 International License. To view a copy of this license, visit <http://creativecommons.org/licenses/by-nc/4.0/> or send a letter to Creative Commons, PO Box 1866, Mountain View, CA 94042, USA.

To cite this Handbook:

Asare, K., Cornforth, R. J., Tarhule, A., Osbahr, H., Ciampi L., Myers J. (2019) 'RAINWATCH Handbook: A step by step guide to using RAINWATCH, version 1.0'. WIBNo819/01. <https://doi.org/10.5281/zenodo.3366368>



Friends of the RAINWATCH Alliance generously gave their time to contribute to the development of this Handbook and provide peer review. 2019 feedback fora for the RAINWATCH Handbook were financed through the BRAVE project and impact funding provided by the University of Reading. The fora were conducted with BRAVE partners and collaborators, including CARE Ghana, WASCAL, CSIR SARI, the University of Ghana, the Walker Institute at the University of Reading, University of Binghampton, the Lorna Young Foundation and the Ministry of Food and Agriculture, local NGOs and researchers from Tamale, Bolgatanga and Wa, Ghana. BRAVE is one of five research consortia funded under the Unlocking the Potential of Groundwater for the Poor (UPGRo), with financial support from the UK Government's Department for International Development (DfID), the Natural Environment Research Council (NERC) and the Economic and Social Research Council (ESRC). The Walker Institute at the University of Reading is the consortium lead of BRAVE.

The views expressed in this report are solely those of the authors and contributors, and the information contained in it are not necessarily those of or endorsed by DfID, NERC, or the ESRC which can accept no responsibility for such views or information or for any reliance placed on them. This publication has been prepared for general guidance on matters of interest only and does not constitute professional advice. No representation or warranty (express or implied) is given as to the accuracy or completeness of the information contained in this publication, and, to the extent permitted by law, DfID, NERC, their advisors and the authors and distributors of this publication do not accept or assume any liability, responsibility or duty of care for any consequences of you or anyone else acting, or refraining to act, in reliance on the information contained in this publication or for any decision based on it.

The RAINWATCH Alliance

RAINWATCH is a prototype geographic information system that provides rainfall data in near-real time from monitoring stations and tracks the key seasonal characteristics, important for food production, health service response and social protection systems. It has been operating since 2009 in Niger in West Africa. The system is developed and sustained through the RAINWATCH Alliance - a continental partnership of more than 15 African National Hydro Meteorological Services networked together, as part of an African response to build an effective climate service partnership working together with Government Agencies, DRR and

humanitarian agencies and research Institutions across Sub-Saharan Africa (SSA) to build a climate resilient future for all. The RAINWATCH Alliance is facilitated by the Principal RAINWATCH Coordinator, Mr Kofi Asare (hosted by the Ghana Space Science and Technology Institute) with underpinning research provided on demand through the joint leadership of Prof. Aondover Tarhule and Prof. Rosalind Cornforth.

RAINWATCH Alliance members are:

- Chad: Agence Nationale de la Meteorologie du Tchad
- Cote D'Ivoire: Meteo Cote D'Ivoire
- Ghana: Ghana Meteorological Agency (GMA)
- The Gambia - Department of Water Resources
- Guinea Bissau: NMHS Guinea-Bissau
- Guinee Conakry: DNM Guinee Conakry
- Malawi: Department for Climate Change and Meteorological Services (DCCMS)
- Mali: Agence Nationale de la Meteorologie
- Mauritania: Office National de la Météorologie de la Mauritanie
- Niger: DMN Niger
- Nigeria: Nigerian Meteorological Agency (NIMET)
- Senegal: Agence Nationale de l'Aviation Civile et de la Météorologie (ANACIM)
- Sierra Leone: National Meteorological Department
- Sudan: Sudan Meteorological Authority (SMA)
- Uganda: Uganda National Meteorological Authority (UNMA)
- Zambia: Zambia Met Service

Please contact the Principal RAINWATCH Coordinator to get in touch with the National RAINWATCH Co-ordinators, or visit www.RAINWATCH-africa.org.



The RAINWATCH Alliance working together at the Adaptive Social Protection Training Laboratory led by the Walker Academy in Dakar, Senegal (June 2019)