EUROPEAN SPACE AGENCY CONTRACT REPORT

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WASCIA – WATER STRESS AND CLIMATE INDICES FOR AFRICA

User Survey Results Summary Report

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TABLE OF CONTENTS

1 INTRODUCTION

1.1 *PURPOSE OF DOCUMENT*

This document has been prepared by the ESA Water Stress and Climate Indices for Africa (**WaSCIA**) project. It has been adapted from the deliverable D2 [RD. 1] for public distribution.

It contains a summary of the results from the user engagement activities which have enabled a characterisation and understanding of the African end-user organisations, based on a thorough analysis of their mandate, characteristics, technical capacity and working practices. The user engagement activities captured the problems, needs and requests of end-users and also identified the benefits that the WaSCIA project will bring.

These have all contributed to the definition of a set of User Requirements (**UR**) and a Value Proposition Canvas (not publicly available). Subsequently these have been used to define an initial set of system and operational requirements and a product specification for the WaSCIA solution (not publicly available).

1.2 *CONTENTS OF DOCUMENT*

Following this introductory section, the document layout is as follows:

Section 2 presents the User Engagement Approach.

Section 3 presents the End User Survey, including the Survey Preparation & Analysis.

Section 4 presents the Conclusion.

The User Requirements, Value Proposition Canvas, System & Operational Requirements and High-Level Product Specification have been removed from this document as they are project-restricted.

1.3 *REFERENCES DOCUMENTS*

The following reference documents are those referenced within this document. They are referenced in this document in the form [RD n.]. They are not applicable documents.

RD	Title / source	Version / Date
RD 1.	WaSCIA.TN.007 Selected African end-user organisations characterisation report and Value Proposition analysis	1.0 / 15/02/2023

1.4 *ACRONYMS AND TERMS*

The following acronyms and abbreviations have been used in this document.

Acronym	Definition
AGRHYMET	Centre Régional de Formation et d'Application en Agrométéorologie et Hydrologie Opérationnelle
ANACIM	*Agence Nationale de l'Aviation Civile et de la Météorologie*
ANAMET	Agence Nationale de la Météo Togo
API	Application Programming Interface
CILSS	Permanent Inter-State Committee against Drought in the Sahel
CSÉ	Centre de Suivi Écologique
DEM	*Digital Elevation Model*
DGPRE	Direction de la Gestion et de la Planification des Ressources en Eau
EO	Earth Observation
FTP	File Transfer Protocol
GDPR	General Data Protection Regulation
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ID	identifier
ITRA	Institut Togolais de Recherche Agronomique
LAI	Leaf Area Index
LPAOSF	Laboratoire Physique de l'Atmosphère et de l'Océan Simeon Fongang
LST	*Land Surface Temperature*
NASA	*National Aeronautics and Space Administration*
NDVI	Normalised Difference Vegetation Index
NDWI	*Normalised Difference Water Index*
NOAA	*National Oceanic and Atmospheric Administration*
OLAC	Office des Lacs et Cours d'Eau
SECNSA	Secrétariat Exécutif du Conseil National de Sécurité Alimentaire
SPEI	*Standardised Precipitation Evapotranspiration Index*
SPI	*Standard Precipitation Index*
SST	*Sea Surface Temperature*
SWDI	Severe Weather Data Inventory
UCAD	Université Cheikh Anta Diop , Université Cheikh Anta Diop
UNDP	United Nations Development Programme
UR	User Requirements
WaSCIA	Water Stress and Climate Indices for Africa

2 USER ENGAGEMENT APPROACH

2.1 *USER ENGAGEMENT OBJECTIVES*

User engagement is one of the most important aspects of the WaSCIA project and will provide critical input throughout the definition, development and refinement of the solution.

At this early stage of the project the objectives of the user engagement activities are:

- To gather **user requirements** through a survey and interviews with end users
- To collaborate with end users to create a **Value Proposition Canvas**
- To create a set of **traceable user requirements**
- To create a set of **system and operational requirements** for the proposed solution

2.2 *USER SURVEY*

The primary user engagement activity at this stage is a **user survey**, developed by all members of the WaSCIA project team and distributed to a wide audience of potential end users in West Africa.

The objectives of the **user survey** are:

- To complete a comprehensive **characterisation** of the African end-user organisations
- To understand end-user's **current practices, operations, in-house technical capacity**
- To capture end-user's **problems, needs and requirements**
- To **evaluate the benefits** that the proposed Earth Observation (**EO**)-based solution can offer

To access the end users relies on strong collaboration with the project's African partners. The African partners have committed to actively participate throughout all the steps of the project, from the initial co-design through the development, validation, service integration and benefit analysis. Each of these participating stakeholders will exploit their own significant national and regional networks to ensure extensive inputs are received from the end-users during the user survey and subsequent engagement activities.

- Centre Régional de Formation et d'Application en Agrométéorologie et Hydrologie Opérationnelle (**AGRHYMET**), a specialised agency of the Permanent Inter-State Committee against Drought in the Sahel (**CILSS**) composed of nine member States, including Senegal. It aims to achieve food security and increased agricultural production in the member States and to improve natural resources management in the Sahelian region.

- Direction de la Gestion et de la Planification des Ressources en Eau (**DGPRE**), a department under the remit of the Senegal Ministry of Water and Sanitation in Senegal, in charge of the management and planning of Senegalese water resources.
- Laboratoire Physique de l'Atmosphère et de l'Océan Simeon Fongang (**LPAOSF**), who, within the Université Cheikh Anta Diop (**UCAD**) in Dakar has a strong track record in international interdisciplinary research on climate and its impacts.

2.3 *USER INTERVIEWS*

User interviews are a good method for engaging with end users and could be useful at various different stages of this project for different purposes.

At this early stage of the project, there was an option to hold a number of follow-up interviews with participants of the user survey who had expressed an interest in being contacted. The idea of these user interviews was to discuss the topics raised in the survey, to better understand our users and gather more requirements not captured in the survey.

However, from analysing the survey results we were already able to formulate a large number of requirements, therefore it was agreed to postpone the user interviews and reserve the project resources until later in the project.

Later in the project, interviews and webinars will be useful as part of the agile development process, to present the solution as it develops and collect feedback from the stakeholders. This will allow us to better tailor the solution to their needs.

3 END USER SURVEY

3.1 *USER SURVEY PREPARATION*

The user survey was prepared with collaboration from all project partners to ensure that the survey contents, platform and distribution methods were effective and appropriate for the intended audience.

3.1.1 Approach to Survey Development

Activities for the user survey started in November 2022 and involved the following:

1) **Preparation of survey questions.** Initial survey questions were prepared by TPZ-UK. All project partners were invited to review questions, provide inputs and feedback.

2) **Project introduction material prepared.** A short project summary was prepared and translated into French. This was shared by the African project partners with a number of potential end users to introduce the project and gauge their interest and relevance in participating in the user survey.

3) **Preparation of survey distribution lists.** All African project partners were asked to prepare lists of potential end users from a range of West African organisations (including their name, role and email address). After checking data protection requirements (each person was happy for their details to be shared with the project team), the lists were passed to TPZ-UK. We reviewed the lists to ensure that the identified individuals and organisations covered a range of user groups and addressed any gaps.

4) **Survey translation.** The survey questions were finalised and translated to French by TPZ-France. The entire survey was provided in both French and English.

5) **Survey design and testing.** The survey was prepared in the online Survey Monkey platform (https://eu.surveymonkey.com/r/QSTNMBQ) and shared with partners to test.

6) **Survey launched and distributed.** The survey was live from 6th – 23rd January 2023. TPZ-UK sent the survey link to the list of identified contacts. To maximise the distribution and update of the survey the African project partners assisted by sharing the survey will further contacts and sending follow-up reminders.

3.1.2 Survey Layout

The survey comprises several different sections, as illustrated in Figure 3-1. These are briefly described below:

1) **Introduction –** This section provides a brief description of the project aims and activities. This page also contains the General Data Protection Regulation (**GDPR**) statement.

2) **You and your organisation –** This section asks a few questions about the participant's identity and organisation, which are helpful to characterise the participants and provide context

to their answers. The only mandatory questions are the company and country of the respondent, everything else is optional.

3) **Data you currently use –** This section covers questions about the data that the participant or their company use. These questions aim to help characterise the users and understand what data they are currently using, what they are using it for, and their preferences, e.g. what formats/sources etc.

4) **Services/Tools you currently use –** This section covers questions about the services and tools that the participant or their company use. These questions aim to better understand the end users' current working practices, operations and in-house technical capacity, and to understand their preferences.

5) **Needs and requirements for data and tools –** This section covers questions about the barriers, needs and requirements of the participants. It aims to capture specific problems, gaps and limitations faced by the end users that we can help to fill. It aims to identify all the benefits that the proposed WaSCIA solution will provide to the involved African end-user organisations.

6) **Water stress technical questions –** This section asks a few questions to capture specific requirements in terms of water stress and to gauge interest in the proposed WaSCIA solution.

7) **Climate indices technical questions –** This section asks a few questions to capture specific requirements in terms of climate indices and to gauge interest in the proposed WaSCIA solution.

8) **Documentation & user support –** This section covers questions about documentation and user support services to capture any specific needs and preferences from the users.

9) **End of the survey –** Participants are thanked for completing the survey. The WaSCIA team email address is provided for any queries about the survey.

Figure 3-1 User Survey Topics

3.1.3 Survey Content

Figure 3-2 provides a screenshot of the landing page of the survey. Table 3-1 lists the survey questions, including the available answers, where relevant, and whether the question was mandatory. The question ID numbers are used throughout this report to refer to specific questions. The entire survey was provided in both French and English.

WaSCIA User Survey / Enquête

Présentation du Projet

'Water Stress and Climate Indices for Africa' (**WaSCIA**) est un projet financé par l'ESA (Agence Spatiale Européenne) et qui a pour objectif de fournir des indices de haute qualité sur le stress hydrique et le climat par le biais d'une interface web intuitive, facile d'usage, pour faciliter la gestion des sécheresses et des évolutions du stress hydrique en Afrique.

Le projet est dirigé par Telespazio UK, en partenariat avec RSS-Hydro, Telespazio France, AGRHYMET (Centre Régional de Formation et d'Application en Agrométéorologie et Hydrologie Opérationnelle), LPAOSF (Laboratoire Physique de l'Atmosphère et de l'Océan Siméon Fongang) et DGPRE (Direction de la Gestion et de la Planification des Ressources en Eau Sénégal).

Voici quelques-uns des avantages d'une solution efficace de surveillance de la sécheresse :

- Détection précoce des variations du stress hydrique liés aux conditions de sécheresse, leur importance et étendue spatiale.
- Amélioration de la compréhension de la productivité eau-culture sur le long terme
- Aide aux efforts de prévision des rendements et à la sécurité alimentaire

La solution vise à fournir des informations hebdomadaires sur le stress hydrique dérivées des données d'observation de la Terre (OT) et des indices climatiques dérivés des données de réanalyse ERA5. Elle sera déployée à l'échelle du Sénégal, tout en gardant l'objectif de pouvoir l'étendre, à terme, à d'autres pays africains. Le service s'appuiera sur une technologie d'information innovante dont les codes source sont libres d'accès et sera intégré sur une plateforme existante basée sur le cloud, Web Advanced Space Developer Interface (WASDI). Un outil d'aide à la décision fournira aux utilisateurs finaux des informations sur les seuils d'alerte qui les aideront à gérer les risques associés aux conditions de sécheresse.

La première étape du projet consiste à réaliser une analyse détaillée des avantages que le service proposé pourra apporter aux utilisateurs finaux. Une analyse complète des intérêts prioritaires, du mandat, de la capacité technique et des pratiques de travail des organisations africaines, utilisateurs finaux, sera effectuée afin d'identifier les avantages que la solution WaSCIA apportera aux organisations africaines qui intègreront le projet. Les besoins de ces utilisateurs seront recueillis par le biais d'une enquête et d'entretiens.

Figure 3-2 WaSCIA User Survey – Project overview page

Table 3-1 WaSCIA User Survey Questions

	Question	French translation
	Introduction	**Introduction**
	You and your organisation	**Vous et votre organisation**
Q1	What type of organisation do you work for?	Pour quel type d'organisation travaillez-vous?
Q2	What sector does your organisation work in?	Dans quel domaine votre organisation travaille-t-elle?
Q3	Please select the user group(s) that best describes you/ your company?	Quel le type d'utilisateur vous décrit le mieux vous et votre entreprise?
Q4	Contact details: We would like to know more about you and your company. If you are happy to provide this information, please fill out the following fields: Name, Company, Role, Country	Coordonnées : Nous aimerions en savoir plus sur vous et votre entreprise. Si vous êtes d'accord, veuillez remplir les informations suivantes : Nom, Entreprise, Rôle, Pays
	Data you currently use	**Les données que vous utilisez**
Q5	What types of EO and climate data do you currently use?	Quel type de données utilisez-vous en lien avec l'observation de la terre et le climat?
Q6	What additional data would you like to access? Please indicate your top 3 priorities.	A quelles données supplémentaires aimeriez-vous accéder? Veuillez indiquer vos 3 priorités.
Q7	What data variables are you currently using? (e.g. precipitation, LAI, NDVI, Soil Moisture, LST)	Quels(les) indices/variables utilisez-vous? (p.ex. Précipitation, Indice de surface foliaire (LAI), NDVI, Humidité du sol, Température de surface (LST))
Q8	What additional data variables would you like to access? Please indicate your top 3 priorities. (e.g. any specific climate variable or climate indicator)	A quels(les) indices/variables supplémentaires aimeriez-vous accéder? Veuillez indiquer vos 3 priorités. (p.ex. quelconque variable climatique)
Q9	What do you currently use the data for?	A quelles fins utilisez-vous ces données?
Q10	Who/ where do you receive your data from?	De qui/d'où recevez-vous les données?
Q11	What is your preferred data access method?	A travers quel moyen préférez-vous accéder aux données?
Q12	If you are accessing data files, what is your preferred file format?	Quel est votre format préféré pour ces données?
Q13	When selecting your EO or climate data, what level of importance do you place on the following aspects?	Quel degré d'importance donnez-vous aux critères suivants lorsque vous choisissez des données d'observation de la terre ou climatiques?
Q14	Are there any other aspects you consider to be important? Please indicate your top 3 priorities.	Y a-t-il d'autres aspects qui vous paraissent importants?
	Services/ tools you currently use	**Services/outils que vous utilisez**

	Question	French translation
Q15	Do you perform any data processing? If yes, please provide details of any tools/ applications you use.	Réalisez-vous vous-même du traitement de la donnée ? Si oui, veuillez indiquer les outils/applications que vous utilisez.
Q16	What additional tools/ applications would you like to access? (e.g. cloud processing, storage)	A quels(les) outils/applications supplémentaires aimeriez-vous accéder ? (p.ex. Cloud processing, stockage)
Q17	What is the nature of most of the applications/code you use for this activity?	Quelle est la nature de la majorité des applications et codes dont vous vous servez?
Q18	Are you using any specific programming language in your development environment?	Utilisez-vous une langue de programmation spécifique dans votre environnement de développement?
	Needs and requirements for data and tools	**Besoin et exigences en termes de données et outils**
Q19	What barriers have you experienced in the use of EO and climate data?	Quelles difficultés/barrières avez-vous rencontrées lors de l'utilisation de données d'observation de la terre ou climatiques?
Q20	What scientific gaps would you like to be addressed?	Quelles lacunes scientifiques aimeriez-vous voir adressées?
Q21	What technological gaps would you like to be addressed?	Quelles lacunes technologiques aimeriez-vous voir adressées
Q22	When using EO and climate data, what is the minimum spatial resolution you can manage with?	Quelle est la résolution spatiale minimale des données (OT et climat) que vous pouvez utiliser?
Q23	When using EO and climate data, what is the minimum temporal resolution you can manage with?	Quelle est la résolution temporelle minimale des données (OT et climat) que vous pouvez utiliser?
Q24	When using EO and climate data, what spatial scale can you manage with?	Quelle est l'échelle spatiale avec laquelle vous pouvez travailler?
Q25	When using EO and climate data, what latency can you manage with?	Quelle est la latence minimale avec laquelle vous pouvez travailler?
Q26	What uncertainty information do you require?	De quelles informations sur la précision des mesures avez-vous besoin?
Q27	What improvements would you most like to see in data? (select top 3)	Quelles améliorations aimeriez-vous voir dans les données? (Choisissez en 3)
	Please provide more details to support your answer.	Veuillez détaillez votre réponse
Q28	What improvements would you most like to see in tools/ applications? (select top 3)	Quelles améliorations aimeriez-vous voir dans les outils/applications (sélectionner vos 3 priorités)?
	Please provide more details to support your answer.	Veuillez détaillez votre réponse
Q29	Are there any policies / frameworks that your company is working to meet? Please specify.	Y a-t-il des politiques / cadres que votre entreprise vise à respecter? Veuillez spécifier.

	Question	French translation
Q30	What EO data and tools are needed to meet this?	Quels outils et données d'observation de la terre sont nécessaires afin d'atteindre cet objectif?
	Water stress technical questions	**Questionnements sur le stress hydrique**
Q31	Which of these water stress parameters would be of interest to you? Or select not applicable.	Lequel de ces paramètres de stress hydrique vous intéresse?
Q32	Are there any other water stress parameters you would be interested in?	Y a-t-il d'autres paramètres de stress hydrique qui vous intéressent?
Q33	What type of field data for validation can you share freely under this project? (Select all that apply)	Quel type de données terrain pour la validation pourriez-vous partager librement dans le cadre de ce projet?
Q34	What is the temporal resolution of these field-measurements? (Select the highest resolution that applies)	Quelle est la résolution temporelle de ces mesures de terrain ? (Sélectionnez la résolution la plus élevée)
Q35	Do you collect data on soil moisture? If yes, how many different field sites do you operate in Senegal where you collect these data?	Collectez-vous des données sur l'humidité des sols? Si oui, combien de sites différents exploitez-vous au Sénégal où vous collectez ces données?
Q36	Do you collect data on evaporation? If yes, how many different field sites do you operate in Senegal where you collect these data?	Collectez-vous des données sur l'évaporation? Si oui, combien de sites différents exploitez-vous au Sénégal où vous collectez ces données?
Q37	Do you collect data on evapotranspiration? If yes, how many different field sites do you operate in Senegal where you collect these data?	Collectez-vous des données sur l'évapotranspiration? Si oui, combien de sites différents exploitez-vous au Sénégal où vous collectez ces données?
	Climate indices technical questions	**Questionnements sur les indices climatiques**
Q38	Which of these climate indices would be of interest to you? Or select not applicable.	Lequel de ces indices climatiques vous intéresserait?
Q39	Are there any other climate indices you would be interested in?	Y a-t-il d'autres indices climatiques qui vous intéressent?
	Documentation & support	
Q40	What documentation would you like to be provided with the WaSCIA data/ products?	Quels types de documentation souhaiteriez-vous recevoir avec les données/produits WaSCIA?
Q41	What support services would you like to be provided by WaSCIA?	Quels types de services d'assistance à l'utilisation des données/produits WaSCIA souhaiteriez-vous voir à disposition?
	Get Involved!	**Participez!**

	Question	French translation
Q42	Beyond this survey, if you would like to be part of project, by participating in a dedicated interview or being involved in workshops, please provide your contact details.	Au-delà de cette enquête, si vous souhaitez intégrer plus largement le projet, en participant à une interview dédiée ou en étant impliqué dans des ateliers, pouvez-vous nous fournir vos coordonnées.
Q43	Would you be interested in participating in a dedicated interview to complement this survey?	Seriez-vous intéressé(e) par la participation à un entretien spécifique en complément de cette enquête?
Q44	Would you be interested in participating in a dedicated workshop?	Souhaiteriez-vous participer à un atelier dédié?
Q45	Do you have any further information or comments related to this survey that you would like to provide?	Avez-vous des commentaires à ajouter?

3.2 *USER SURVEY ANALYSIS*

The total number of unique survey responses was **43**. Analysis of the survey responses has been divided into the same categories as the questions. Throughout this section text in italics indicates real responses from the survey or the English translation.

3.2.1 You and your organisation

Participants were asked to provide some information about themselves and their organisation. This is helpful to provide context to the participants' answers.

- **Organisation type [Q1]:** The majority of participants work for National public sector organisations or Academia. The response for 'other' was *farmer's organisation.*

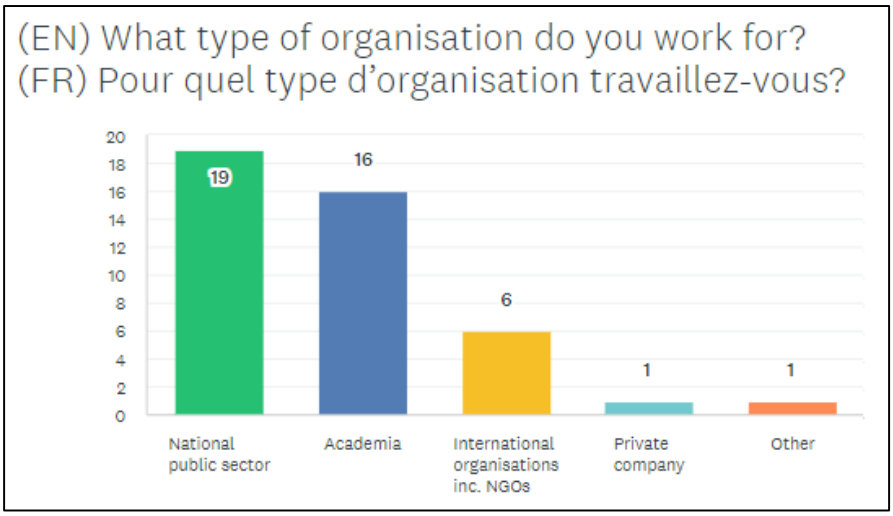

Figure 3-3 - Participant organisation type [Q1]

- **Organisation sector [Q2]:** The most surveyed sector was agriculture. The responses for 'other' were *food security, water security, hydrology, meteorology*.

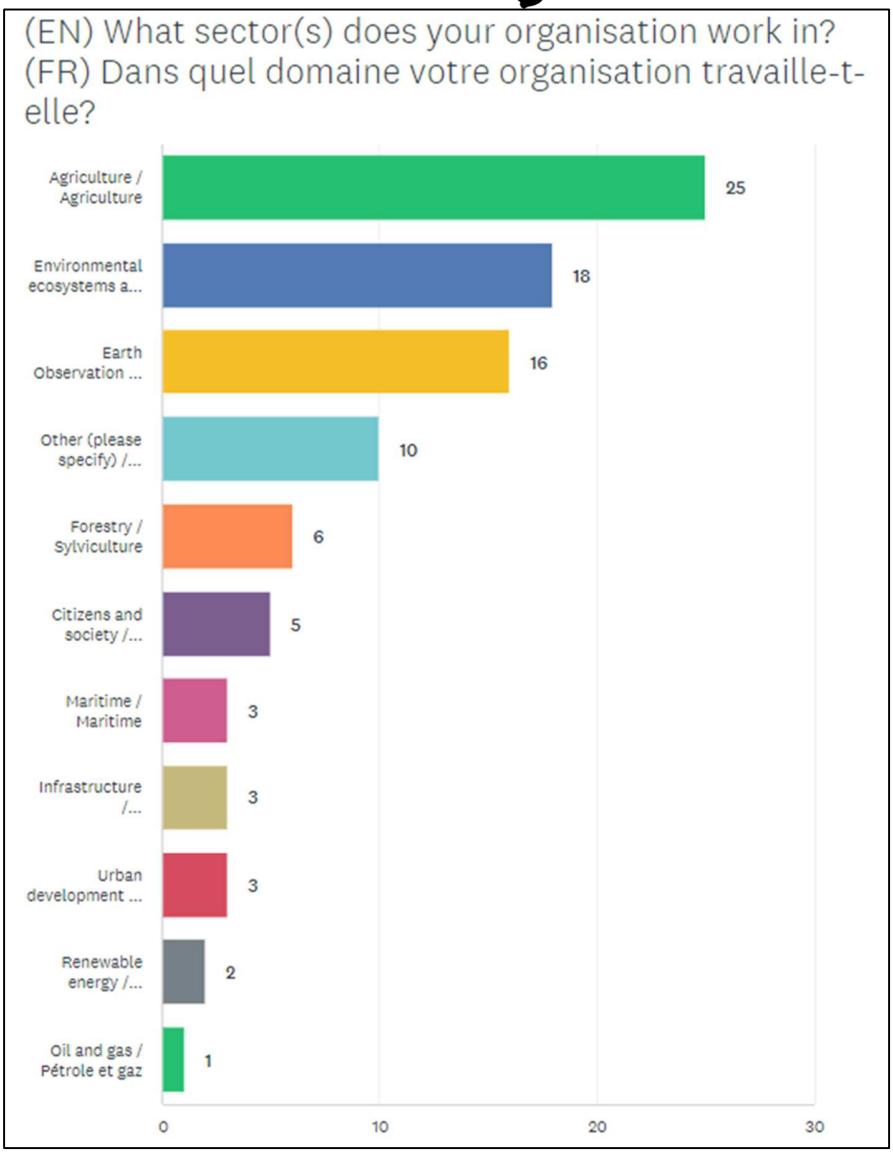

Figure 3-4 - Participant organisation sector [Q2]

- **Participant user group [Q3]:** Participants were asked to select the user profile(s) that apply to them or their company. The majority of participants were researchers or technical experts. The responses for 'other' were *monitoring and managing surface water courses, agricultural statistics, farmer's organisation.* Later in the analysis, the responses from different user profiles may be analysed separately to reveal the different perspectives from different user groups.

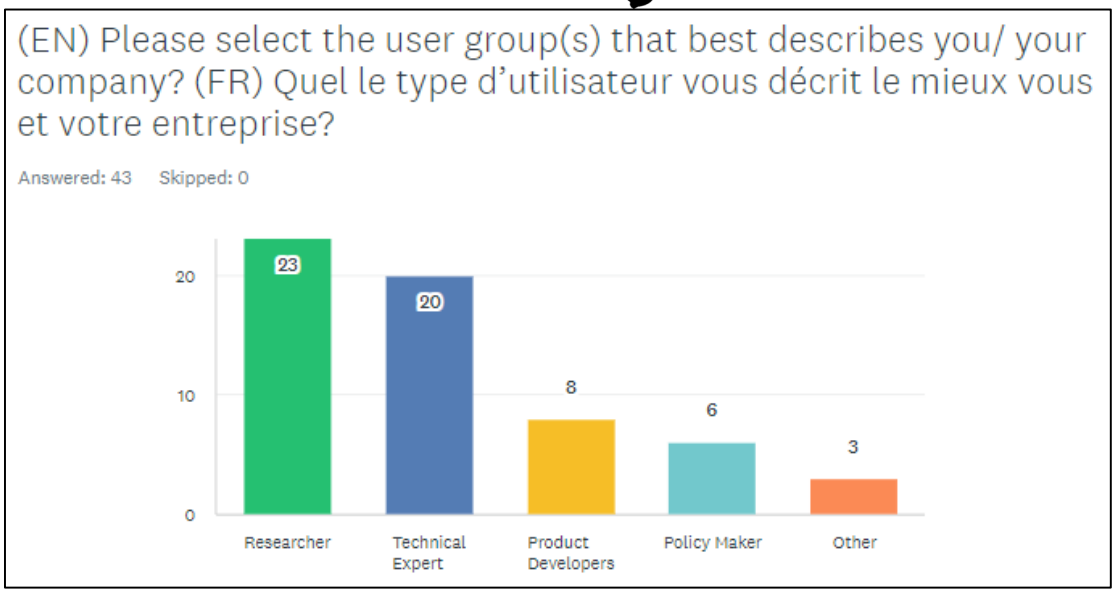

Figure 3-5 Participant user group [Q3]

- **Country [Q4]:** The survey reached a good spread of end user organisations across 8 different West African countries located within or near the Sahel region, therefore all highly relevant to this project.

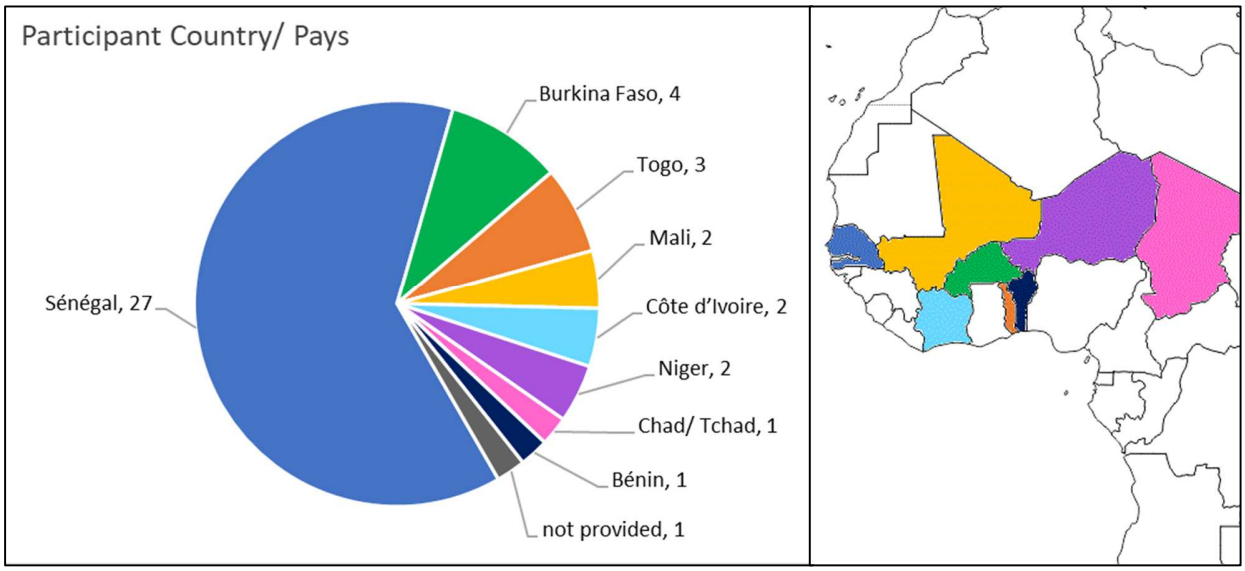

Figure 3-6 - Participant country [Q4]

- **Organisation name [Q4]:** Table 3-2 provides the full list of participant organisations.

Table 3-2 Participant organisations [Q4]

Company	Country	No. participants
Agence Nationale de la Météo Togo (**ANAMET**)	Togo	1
Agence nationale de la météorologie du Burkina Faso	Burkina Faso	1

Company	Country	No. participants
Agence Nationale de la Météorologie du Mali	Mali	2
Alliance pour l'Agroécologie en Afrique de l'Ouest (3AO)	Burkina Faso	1
Centre de Suivi Écologique (**CSÉ**) Dakar	Senegal	1
Department of Hydrology	Côte d'Ivoire	1
Direction de la Gestion et de la Planification des Ressources en Eau (DGPRE)	Senegal	2
Direction des Ressources en Eau	Tchad	1
Direction Generale des Ressources en Eau	Burkina Faso	1
Direction Nationale	Senegal	1
Institut des Sciences de l'Environnement	Senegal	1
Institut national de pédologie	Senegal	1
Institut Sénégalais de Recherche Agricole	Senegal	1
Institut Togolais de Recherche Agronomique (**ITRA**)	Togo	1
International Crops Research Institute for the Semi-Arid Tropics (**ICRISAT**)	Senegal	1
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)	Mali	1
Le Laboratoire de Physique de l'Atmosphère et de l'Océan Siméon Fongang (LPAOSF)	Senegal	6
L'Organisation pour la mise en valeur du fleuve Sénégal (OMVS)	Senegal	1
LPAOSF/ESP/UCAD	Senegal	2
MAG	Niger	1
Ministère de l'agriculture, de l'équipement rural et de la souveraineté alimentaire	Senegal	1
Ministère de l'hydraulique et de l'assainissement	Niger	1
Office des Lacs et Cours d'Eau (**OLAC**)	Senegal	1
Plateforme CCASA	Senegal	1
Réseau des Organisations Paysannes et des Producteurs Agricoles de l'Afrique de l'Ouest (ROPPA)	Burkina Faso	1
Secrétariat Exécutif du Conseil National de Sécurité Alimentaire (**SECNSA**)	Senegal	1
Terres Vertes Sahel	Senegal	1
United Nations Development Programme (**UNDP**)	-	1
Université Assane Seck de Ziguinchor	Senegal	1
Université Cheikh Anta Diop (**UCAD**)	Senegal	4
Universite Felix Houphouet-Boigny, Abidjan	Côte d'Ivoire	1
Université Nationale d'Agriculture	Benin	1

3.2.2 Data you currently use

Participants were asked about the data they currently use. The results for each question are provided here:

- **Types of EO and climate data currently used [Q5]:** The most common options selected were in-situ weather data, observational climate datasets and EO products. The responses for 'other' where *CMIP5 et CMIP6 climate simulations* and *global and regional models.*

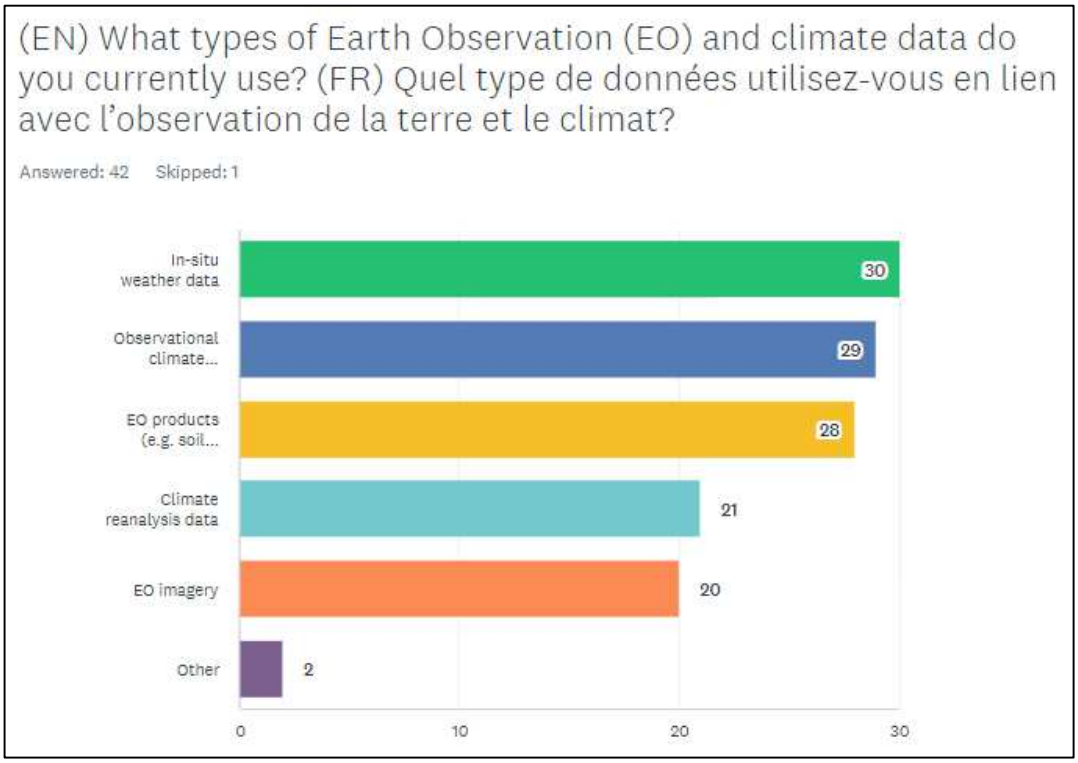

*Figure 3-7 Types of EO and climate data **used** [Q5]*

- **Types of EO and climate data requested [Q6]:** All options scored highly. The responses for other were*:*
  - *In-situ precipitation data*
  - *Localized forecast data*
  - *Radiation*
  - *Temperature forecast*
  - *Crop production (yield and Biomass), Groundwater*

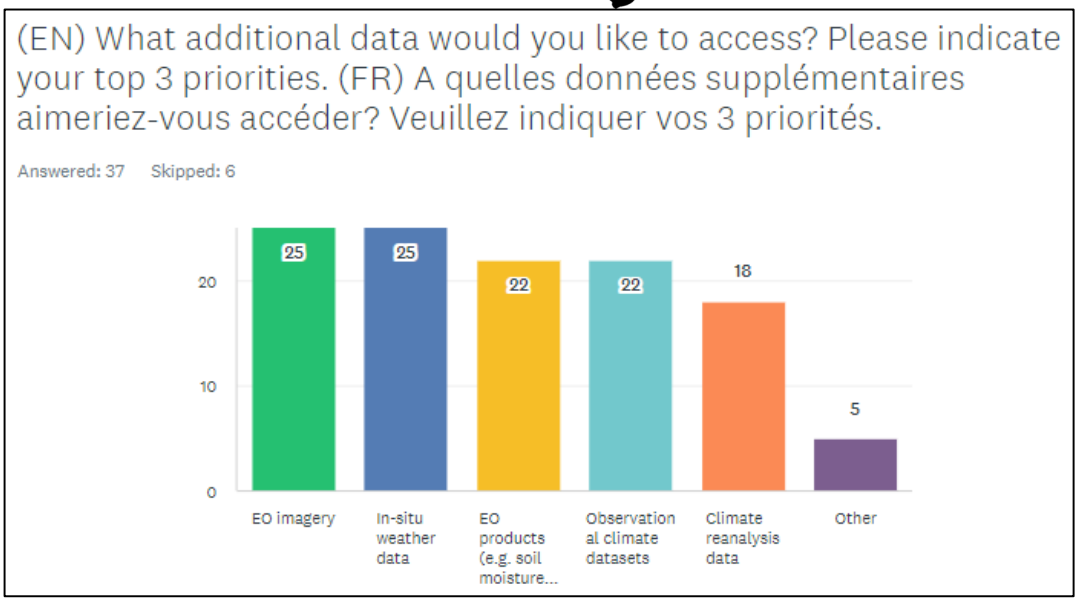

*Figure 3-8 Types of EO and climate data **requested** [Q6]*

- **Data variables currently used [Q7]:** The open text responses have been broadly sorted into the following categories (Table 3-3). Text in italics indicates real responses from the survey and/or the English translation. The most commonly mentioned data variables were precipitation, temperature and Normalised Difference Vegetation Index (**NDVI**).

Table 3-3 Data variables currently used [Q7]

Data variables (generalised)	#refs	Example responses (translated)
Precipitation	41	*Precipitation; Rainfall; Number of days without rain; Number of months of rain;*
Temperature	25	*Temperature; Temperature extremes (Min, Max); Land Surface Temperature (**LST**); Sea Surface Temperature (**SST**)*
Normalised Difference Vegetation Index (NDVI)	13	*Precipitation and NDVI*
Soil moisture	10	*Humidité du sol (soil moisture)*
Leaf Area Index (**LAI**)	7	*LAI; leaf area index*
Ground cover statistics	6	*Soil surface to be restored; burnt areas; infested areas; Soil nutrients; Land use/ Land use change (LULUC)*
Wind	5	*Wind speed and direction; Wind on different pressure levels*
Drought index	5	*Standardised Precipitation Evapotranspiration Index (**SPEI**); Standard Precipitation Index (**SPI**); drought index; Normalised Difference Water Index (**NDWI**);*
Humidity	4	*Humidity; relative humidity*
Agricultural statistics	3	*Crop yields (grain yield and Biomass); cultivated area; number of farm households;*

Data variables (generalised)	#refs	Example responses (translated)
Evaporation / Evapotranspiration	2	*Evaporation; Evapotranspiration*
Hydrological variables	2	*Infiltration, Run-off*
Climate indices	2	*ETCCDI (Expert Team on Climate Change Detection and Indices); ETsci (Expert Team on Sector Specific Climate Indices)*
Other	1	*Observation data*
	1	*Geopotential height*
	1	*Digital Elevation Model (**DEM**)*
	1	*VH, VV*
	1	*Outgoing Longwave Radiation (OLR)*

- **Data variables requested [Q8]:** The open text responses have been broadly sorted into the following categories (Table 3-4). Text in italics indicates real responses from the survey or the English translation. The three most commonly requested data variables were soil moisture, climate indices, NDVI and precipitation. There were also some interesting and relevant requests for variables relating to temperature and extreme events.

*Table 3-4 Data variables **requested** [Q8]*

Data variables (generalised)	#refs	Example responses
Soil moisture	9	*Soil moisture; soil moisture (other than SMAP); Soil moisture index;*
Climate indices	7	*Climate index; climate variable; Climate databases; climate observation index; ETCCDI (Expert Team on Climate Change Detection and Indices)*
Normalised Difference Vegetation Index (NDVI)	6	*NDVI*
Precipitation	6	*Precipitation; In-situ rainfall in Sénégal; Daily rainfall; Rainfall forecasts; Number of consecutive wet days; Standard Precipitation Index (SPI)*
Leaf Area Index (LAI)	5	*Leaf Area Index; LAI*
Temperature	5	*Temperature; Surface temperature*
Solar radiation	5	*Solar radiation, radiation; irradiation*
Humidity	3	*Humidity index, Relative humidity*
Evapotranspiration / Evaporation	3	*Evapotranspiration potential / actual; Evaporation*
Drought	3	*(Monthly) Drought index; Number of consecutive dry days; Water stress*
Extreme events	3	*Extreme events (drought, out-of-season rainfall, heavy rainfall...); Severe Weather Data Inventory (SWDI); Heat waves*

Data variables (generalised)	#refs	Example responses
Wind	3	*Wind; wind speed; high winds*
Hydrological variables	3	*Water flow; Water balance; Soil recharge / water retention capacity*
Ground cover statistics	2	*Vegetation cover; Land use data*
Satellite imagery	2	*Satellite imagery; High resolution satellite data*
Other	1	*Geopotential*
	1	*Aerosol Optical Depth (AOD)*
	1	*Nature des sols (nature of the soil)*
	1	*Greenhouse gas variable*
	1	*Pedological properties*
	1	*Reflectance*
	1	*Reanalysis data*

- **What data is currently used for [Q9]:** Participants were asked what they are using EO and climate data for. The responses covered a broad range of topics but have been broadly sorted into the following categories (Table 3-5). Text in italics indicates real responses from the survey translated to English. A high number of users are working in monitoring, modelling and planning for agriculture or hydrology.

Table 3-5 Data uses and study areas [Q9]

Data use (generalised)	#refs	Example responses (translated)
Agricultural planning, farming/ fisheries	10	*Crop yield modelling;* *For crop monitoring;* *Monitoring of the agricultural season, determination of areas under cultivation, crop yields;* *For the monitoring of the agro-sylvo-pastoral and fisheries campaign;* *To inform producers of the right time to plant crops;* *For agricultural and rural planning and advice* *For the monitoring of the agricultural campaign for better decision making, for numerical weather forecasting, in the elaboration of early warnings to limit damage*

Data use (generalised)	#refs	Example responses (translated)
Hydrological monitoring	10	*For hydrological modelling and surface water monitoring;* *To the calculation of water balance* *Flow forecasting models;* *hydrological modelling, water resource assessment, flooding, etc* *hydrological studies and its associated risks, knowledge of the state of water resources, possible problems related to threats to its scarcity, overexploitation, etc.;* *Water use planning;* *To make a climatic estimate of the meteorological parameters in the boundary layer in West Africa* *To determine the links between the height of the boundary layer and rainfall;* *Evaluation of water resources*
Research & Development	7	*Research and technical expertise; Production of scientific documents (scientific reports and articles);* *Model validation*
Forecasting	4	*Long-term forecasts and projections; For daily and seasonal forecasting; For climate forecasting;* *Establishment of decadal, monthly and seasonal climate products*
Flood monitoring	4	*Flood risk management, risk maps, reservoir management*
Drought monitoring	3	*To study drought;* *Studying drought conditions;* *Proportion of households exposed to drought at plot level, number of households exposed to drought, proportion of area exposed to rainfall delay at plot level, proportion of area exposed to long rainfall breaks, proportion of area exposed to bushfires at plot level, area exposed to diseases, length of rainy season, amount of seasonal rainfall, out-of-season rainfall;*
Environmental studies	3	*Modelling the impact of vegetation on the urban heat island and ozone pollution;* *Combating land degradation;* *For ecosystem monitoring*
Policy/ decision making	2	*To inform decision/policy makers* *To establish national communications on climate change and respond to national committement according to UNFCCC*
Climate monitoring	1	*For the analysis of the evolution of climate data*

- **Who/where data is received from [Q10]:** Participants access their data from a variety of different sources. Popular responses were:
    - *Agence Nationale de l'Aviation Civile et de la Météorologie (**ANACIM**) – the meteorological agency of Senegal (11 references)*
    - *National Oceanic and Atmospheric Administration (**NOAA**) (2 references)*
    - *National Aeronautics and Space Administration (**NASA**) (2 references)*

- **Preferred data access method [Q11]:** The most popular data access method was via Web Portal. File Transfer Protocol (**FTP**) and Application Programming Interface (**API**) scored lower, possibly because fewer people are familiar with these methods. FTP and API should only be used for data access, only if provided with sufficient instructions and training. The responses for 'other' included: *professional portal, periodic bulletin and email.*

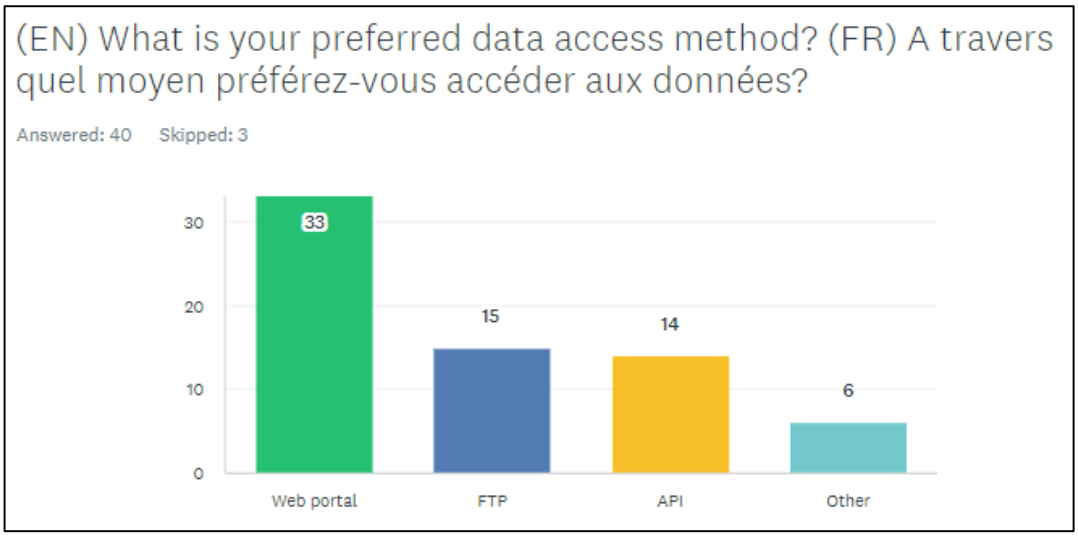

*Figure 3-9 **Preferred** data access method [Q11]*

- **Preferred data file format [Q12]:** The most popular data file formats were GIS shapefile, NetCDF and GeoTIFF. The responses for 'other' included: *CSV, excel.*

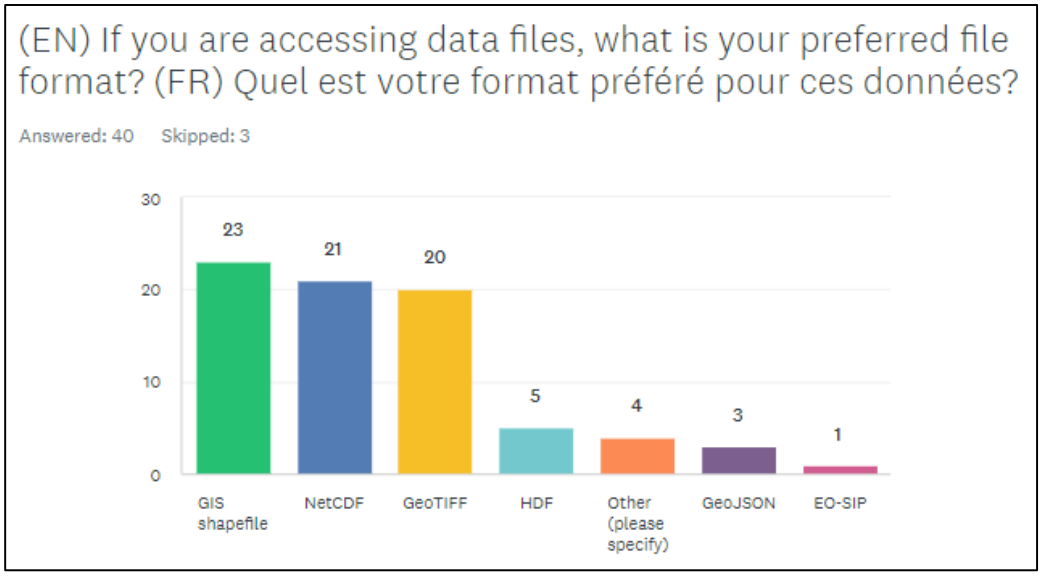

*Figure 3-10 **Preferred** data file format [Q12]*

- **Importance of different data aspects [Q13 & Q14]:** The most important aspects of EO data can be seen below. When considering the 'very important' responses data quality was selected the highest number of times. Other aspects that participants consider to be important include:

- *Type of data*
- *The possibility to download*
- *The possibility to exchange and/or ask questions*
- *Access to international laboratories*
- *Area-specific data*
- *Projection*
- *Metadata*
- *Open source format*
- *Data format*
- *Climate Data Tool (CDT)*
- *Manipulation tools*
- *Mobility grants*
- *Dynamism or evolution of the data*
- *Merging*

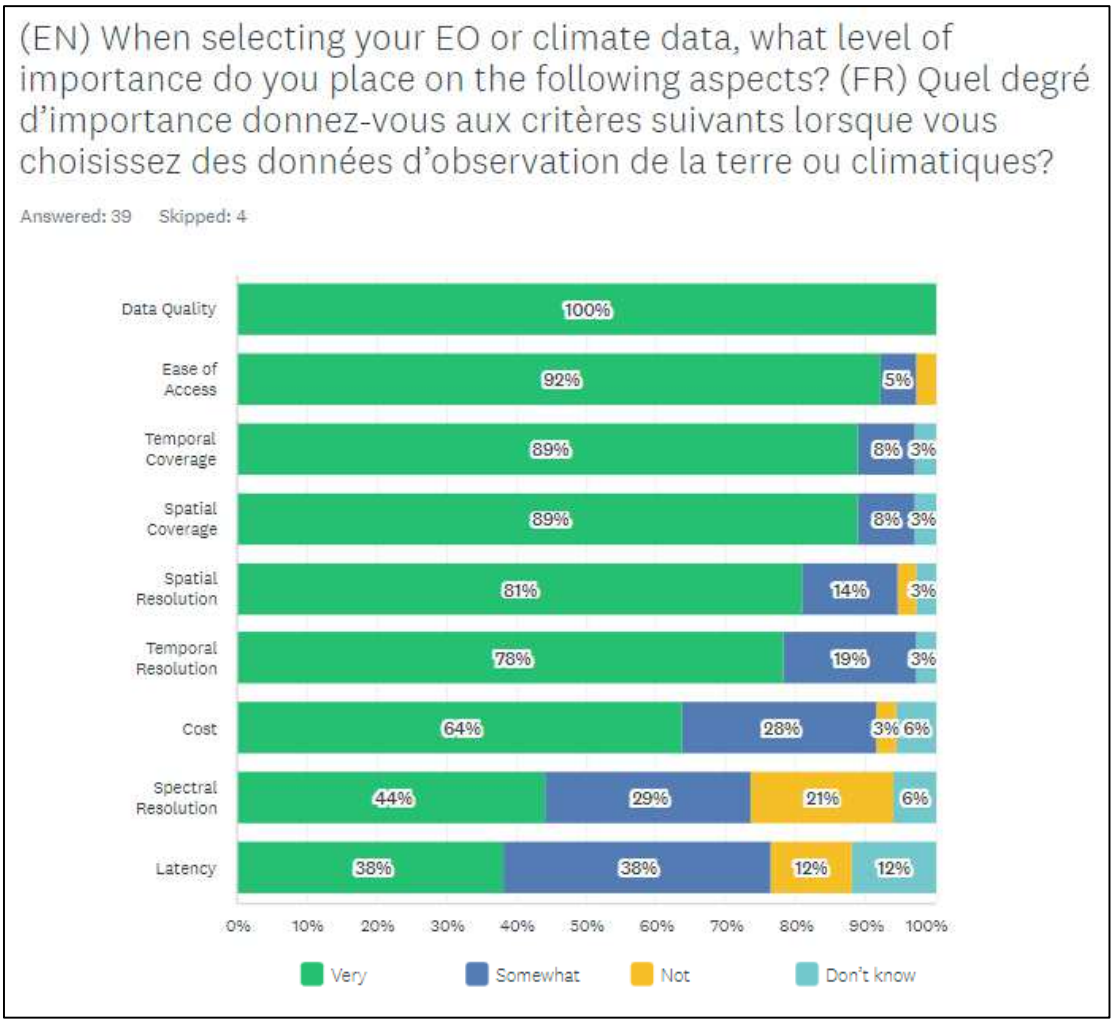

Figure 3-11 Importance of different data aspects [Q13]

3.2.3 Services and tools you currently use

Participants were asked about the services and tools they currently use. The results for each question are provided here:

- **Tools and applications used [Q15]:** Participants were asked if they perform any data processing and if 'yes' to provide details of the tools and applications they use. 75% of participants said that they perform data processing. Popular responses were:
  - Programming, e.g. *R* (14 references), *Python* (8 references), *Matlab* (7 references)
  - Mapping software e.g. *ArcGIS* (10 references), *QGIS* (4 references)
  - *Excel* (6 references)
  - Programming tools, e.g. *CDO* (6 references), *NCL* (2 references), *instat+* (2 references), *NCO* (1 reference)
  - Satellite data processing software e.g. *ENVI* (4 references), *SNAP* (1 reference)
  - Data spatialisation tools, e.g. *surfer* (2 references), *grads* (2 references)
  - Web applications, e.g. *Jupyter notebook* (1 reference)
  - Hydroclimatology software (*Hydraccess, Hydromed, Ms)*
  - Other: *Google Earth Engine, Clidata, SiG, SPCS, SPSS, Idrisi Selva*

- **Tools and applications requested [Q16]:** The open text responses have been broadly sorted into the following categories (Table 3-6). Text in italics indicates real responses from the survey or the English translation. The most common responses were for storage and cloud services (processing and storage). There were also some interesting and relevant requests for climate analysis tools and early warning systems.

*Table 3-6 Tools and applications **requested** [Q16]*

Tool/ application (generalised)	#refs	Example responses (translated)
Storage	11	*Storage server; storage*
Cloud processing	10	*cloud processing; cloud-based processes; cloud for meta-analysis*
Cloud (unspecified)	4	
Cloud storage	3	*Cloud storage, cloud management*
Programming	8	*programming models; Python; R; R Studio; CDO*
Google Earth /Engine	4	*Google Earth Engine*
Remote sensing/ mapping	4	*Remote sensing; GIS; Qgis; mapping*
Climate analysis tools	1	*any basic climate data analysis tool*
Early warning systems	1	*Hydromet*
Web interface	1	*Web interface*
Processing power	1	*very powerful machine*
Other	4	*IPCC; Kobo; SIMEAR; Models; Platform*

- **Nature of applications/code [Q17 & Q18]:** Participants were asked about the nature of applications/ code used for data processing and 87% are using open-source code. Regarding the specific programming languages used, popular responses were:
    - *Python (7 references)*
    - *R (7 references)*
    - *Matlab (2 references)*
    - *RStudio (1 references)*
    - *Fortran (1 references)*
    - *NCL (1 references)*

3.2.4 Needs and requirements for data and tools

Participants were asked about their needs and requirements for data and tools. The results for each question are provided here:

- **Barriers to use of EO and climate data [Q19]:** The barriers selected the most were data availability and data accessibility, highlighting the need for improvements in this area. When the user profiles are analysed separately, the top three results were consistent for product developers, technical experts, and policy makers. However, for researchers, the second highest option was data resolution instead of accessibility.

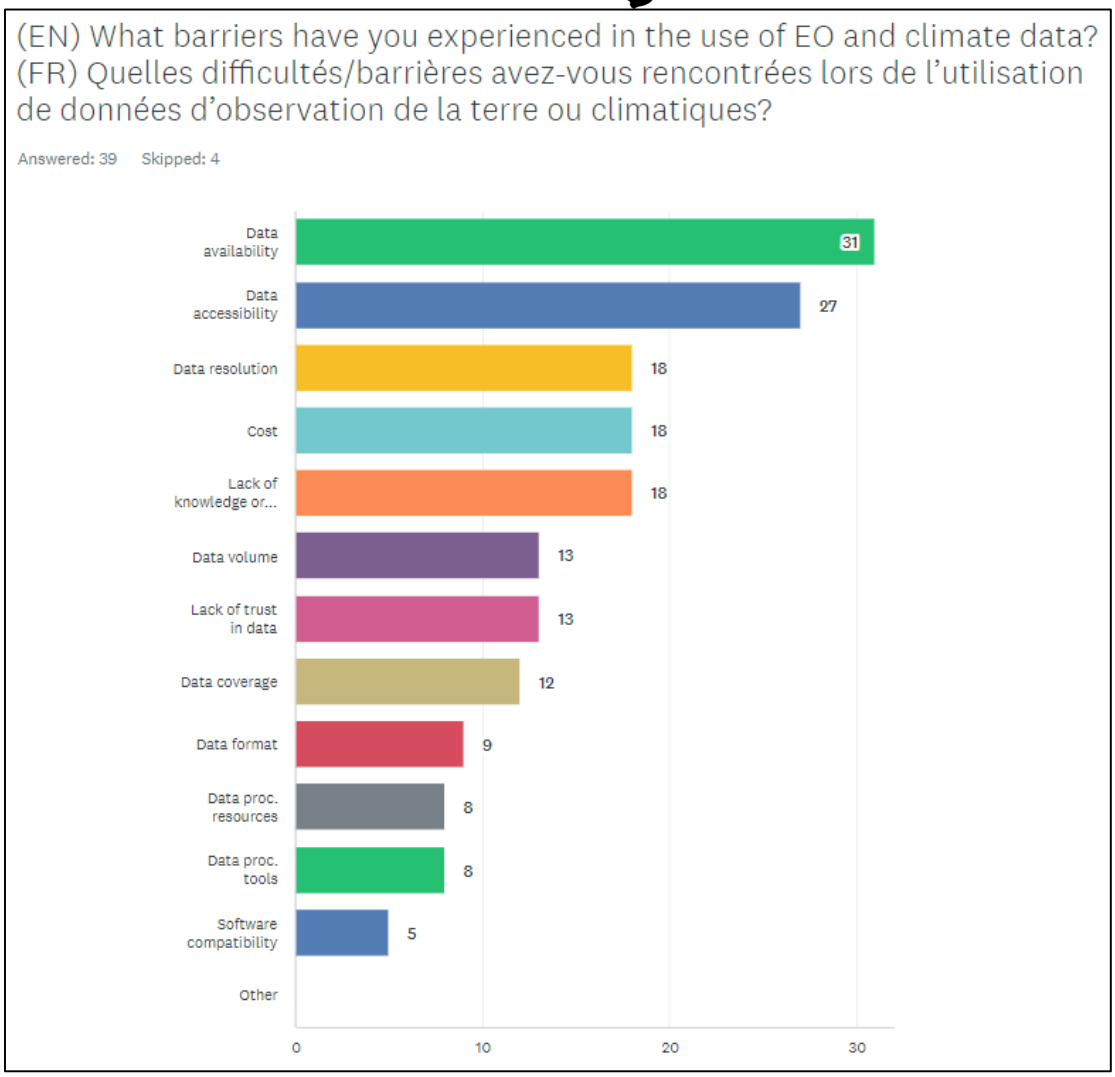

Figure 3-12 Barriers to use of EO and climate data [Q19]

- **Scientific gaps to be addressed [Q20]:** The open text responses have been broadly sorted into the following categories (Table 3-7). Text in italics indicates real responses from the survey or the English translation. The most common responses were related to training, gaps in knowledge and capacity building. There was also an interesting and relevant request for long term analysis of precipitation, temperature and drought indices.

Table 3-7 Scientific gaps to be addressed [Q20]

Gaps (generalised)	#refs	Example responses (translated)
Training/ Knowledge/ Capacity building	6	*Lack of training;* *Training in climate data processing;* *Training in the use of software for programming, processing and spatialization of data;* *Build the capacity of national experts from Universities as well as from public services and local governments;* *Knowledge of land related aspects, more specifically soil* *Provide stakeholders policy brief on climate impact on agriculture productivity;*
Data quality/ bias correction	4	*Quality of data, Erroneous data; study bias; bias correction*
Data processing/ modelling etc	4	*Downscaling methodology;* *Data assimilation in areas with few observations such as the Sahel;* *Modelling, data processing, remote sensing;* *Simple algorithm for general public*
Specific requests	2	*Do long term trend analysis of precipitation, temperature, and drought/aridity indexes for many locations in Togo;* *Prediction of Landscape erosion*
Accessibility	2	*Accessibility*
Temporal resolution	2	*Frequency of observation*
Spatial resolution	1	*Data resolution and data frequency*
Spatial accuracy	1	*Spatial accuracy*
Data tools	1	*Use and management of data*
Data format	1	*Format*

- **Technological gaps to be addressed [Q21]:** The open text responses have been broadly sorted into the following categories (Table 3-8). Text in italics indicates real responses from the survey or the English translation. The most common responses were related to a lack of data processing tools, difficulty using software/ tools, and lack of training, knowledge or understanding of technical material. There were also some interesting and relevant requests for mobile applications providing warning alerts for farmers and a web portal for researchers.

Table 3-8 Technological gaps to be addressed [Q21]

Gaps (generalised)	#refs	Example responses (translated)
Data processing tools	5	*Lack of processing tools;* *Have effective software for processing climate data;* *Processing tools;* *Data processing;* *Google engine*
Use of software tools	3	*Not being able to handle tools and software;* *Mastery of software;* *Simplify the R software package*
Training/ knowledge	2	*Training on the use of software for programming, processing and spatialization of data;* *Knowledge, understanding and technical material;*
Data storage	2	*Lack of data storage;* *Data storage*
Specific requests	2	*Mobile applications for CIS for farmers (warning alerts);* *Web portal for climate data and climate data analysis for researchers and other users*
Computer/ internet	2	*Machine power* *Download time*
Data format	1	*Format*
Data sources	1	*Mix active and passive observations*
Data quality/ bias correction	1	*Bias correction*

- **Spatial resolution required [Q22]:** When all the participant responses are presented together there is a wide spread of opinion. When the user groups are analysed separately, the highest voted option is 1-10m for product developers, technical experts and policy makers. However for researchers the highest voted option is 1-10 km. This indicates a need for different spatial resolutions for different applications and both a higher resolution and lower resolution option should be provided. The responses for 'other' were *5 km* and *30 km.*

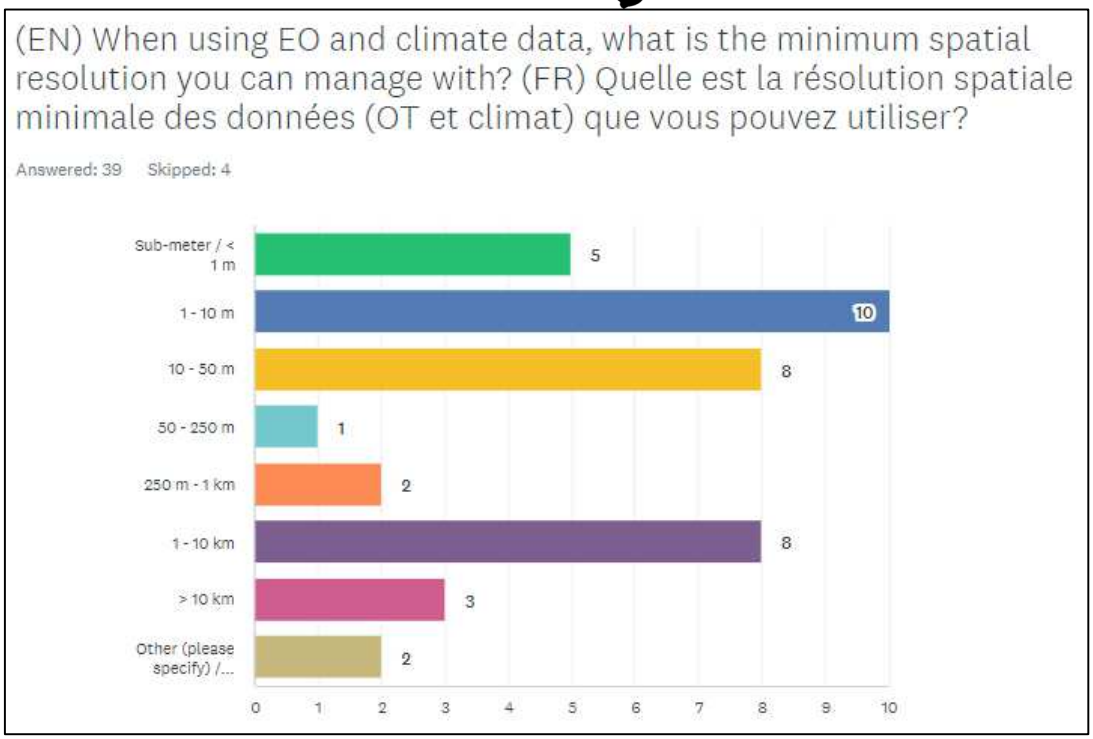

Figure 3-13 Minimum required spatial resolution [Q22]

- **Temporal resolution required [Q23]:** The highest voted option for temporal resolution is daily. This trend is consistent when the user groups are analysed separated. The responses for 'other' were *'daily, seasonal, weekly'* and *'decadal'.*

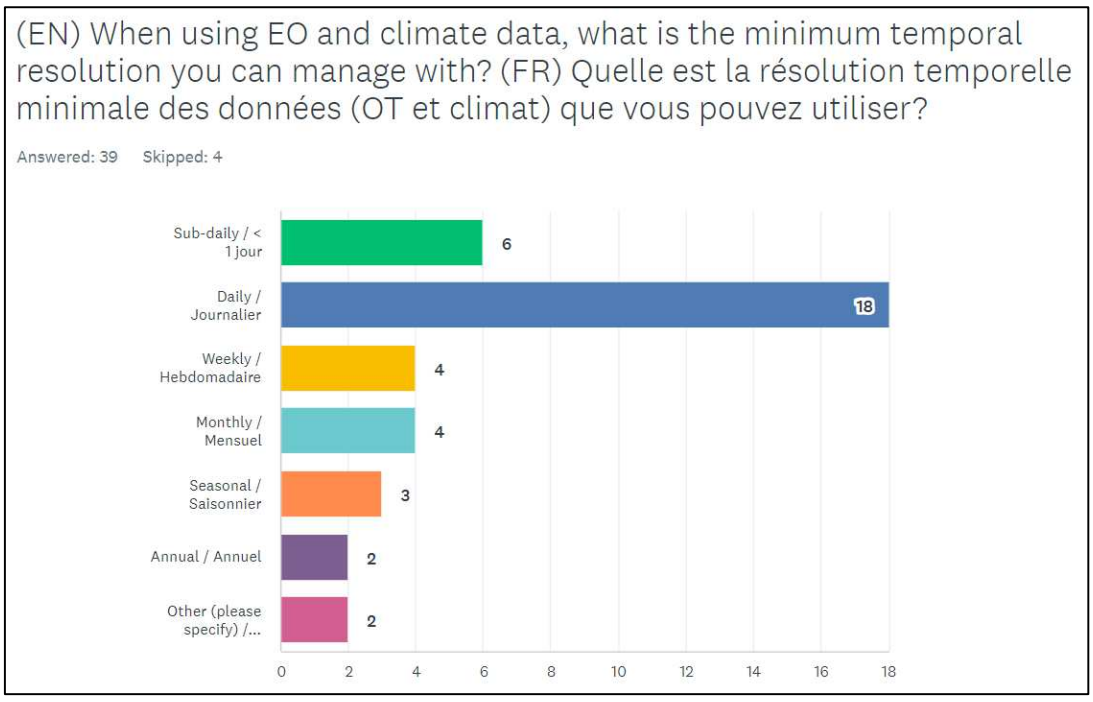

Figure 3-14 Minimum required temporal resolution [Q23]

- **Spatial scale required [Q24]:** The highest voted option for spatial scale was 'site location (latitude/ longitude), but there is also a clear need for data on a larger spatial scale (regional). The response for 'other' was *'district, regional and national'.*

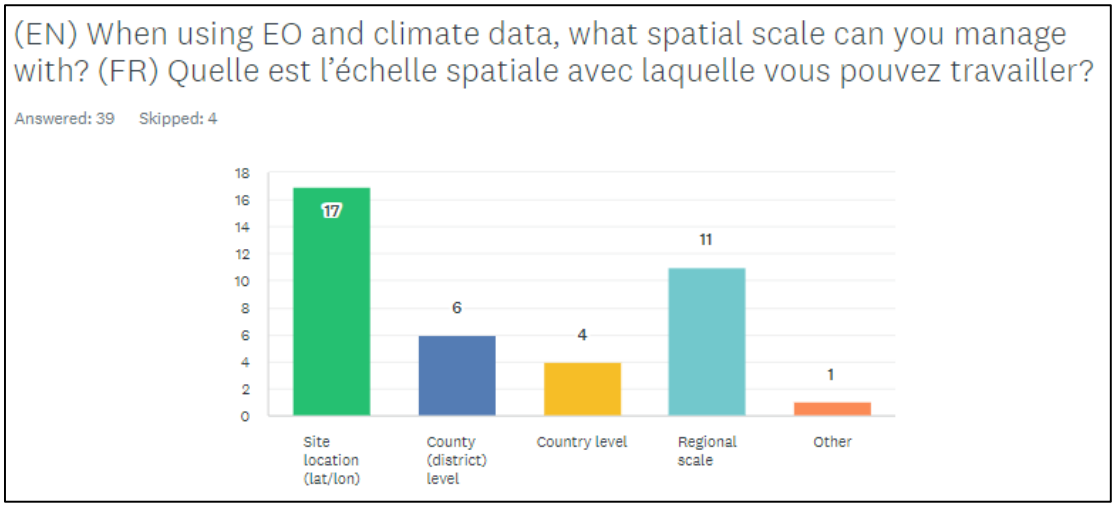

Figure 3-15 Spatial scale required [Q24]

- **Latency required [Q25]:** The highest voted option for latency was 'real-time'. 'Up to one week' also scored highly. The responses for 'other' were:
  - *Real time and/or up to 1 day (also depends on computer performance and data size)*
  - *1 day, one week, depending on the forecast*

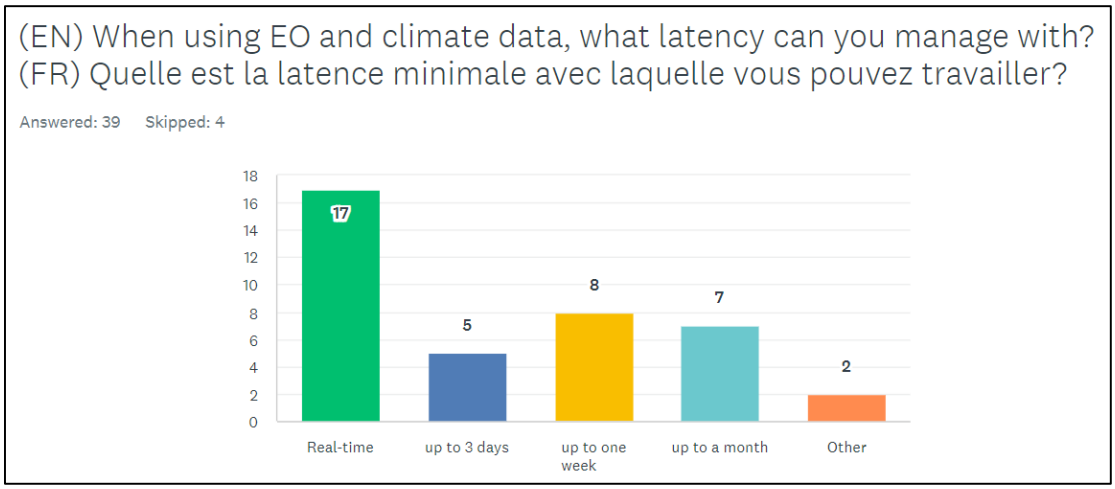

Figure 3-16 Latency required [Q25]

- **Uncertainty information required [Q26]:** The open text responses have been broadly sorted into the following categories (Table 3-9). Text in italics indicates real responses from the survey or the English translation. The most common responses were related to resolution or quality information.

Table 3-9 Uncertainty information required [Q26]

Information required (generalised)	#refs	Example responses (translated)
Resolution (spatial, temporal, etc)	8	*Spatial resolution and intensity depending on the parameter; Periodicity; information on sub-hourly (minutes, hours), daily time steps;*
Quality information	3	*Sensor specific issues; Measurement and analysis uncertainties; Accuracy*
Other	1	*Index interpretation*
	1	*The amount of water available at the depth of plant roots*
	1	*Size*
	1	*Spectrometry*

- **Priority improvements in data [Q27]:** The highest voted options (Figure 3-17) are improved data availability, improved data accessibility and field data validation.

  Participants were asked to provide more information to support their answers. The following comments were collected:

  - *Relevant indicators, improved quality and accessibility of data could help to make better use of climate information*
  - *Data already exist or will be provided. It will be more useful if these data can be analysed and give tailored insights or recommendations. This should be accessible to all requesters/users. Users need a capacity building for the use of such data or recommendations*
  - *All of this is needed to support and validate research outcome*
  - *The capacities of national actors need to be improved as well as data availability and accessibility*
  - *Much improved quality data (EO and climate) is not available or accessible in our regions while it is in other parts of the world. And most users do not have the knowledge to carry out data improvement processes. Some EO and climate data are estimated but not validated in the field, which makes them uncertain to use.*

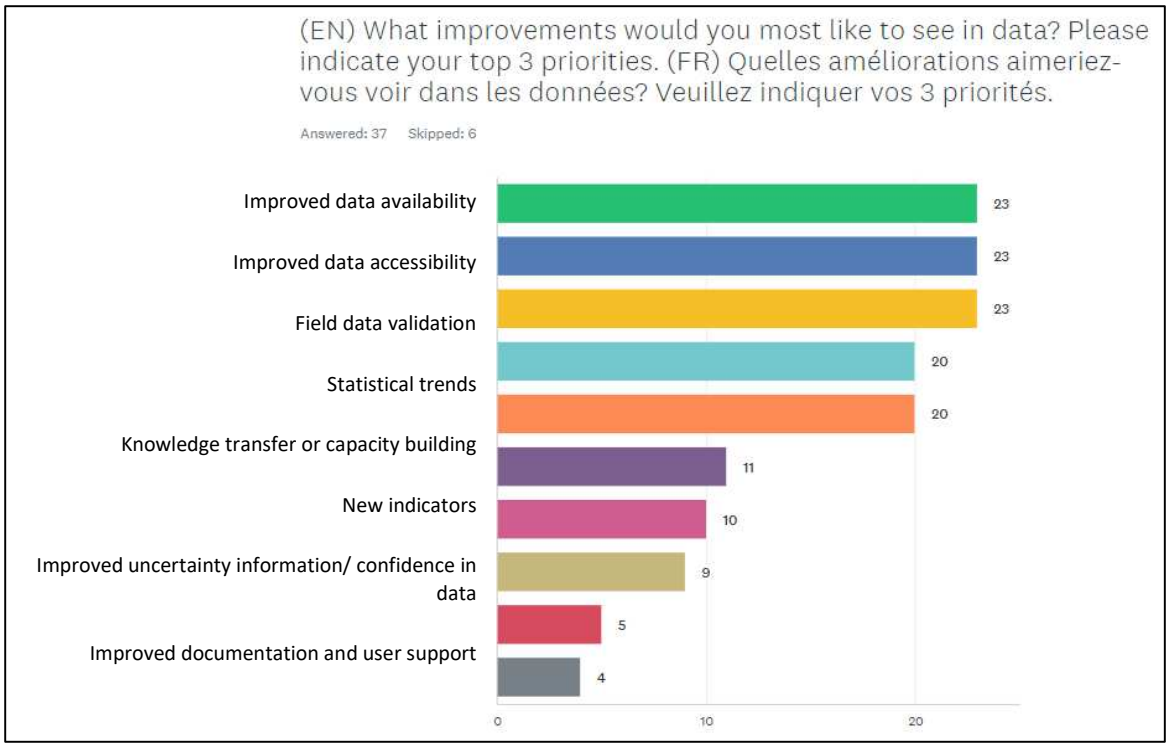

Figure 3-17 Requested improvements in data [Q27]

- **Priority improvements in tools/ applications [Q28]:** The highest voted options (Figure 3-18) are remote data access, easier to operate tools, and knowledge transfer/ capacity building. Participants were asked to provide more information to support their answers. The following comments were collected:
  - *We are interested in any improvements to the acquisition process*
  - *All of this is needed to support and validate research outcomes*
  - *National actors would love to use very simplified tools*
  - *Some of the precision EO and climate data needed for studies are expensive and therefore beyond the reach of public services whose financial resources for operation are already very limited. Technicians need capacity building, especially on the new and more efficient tools*

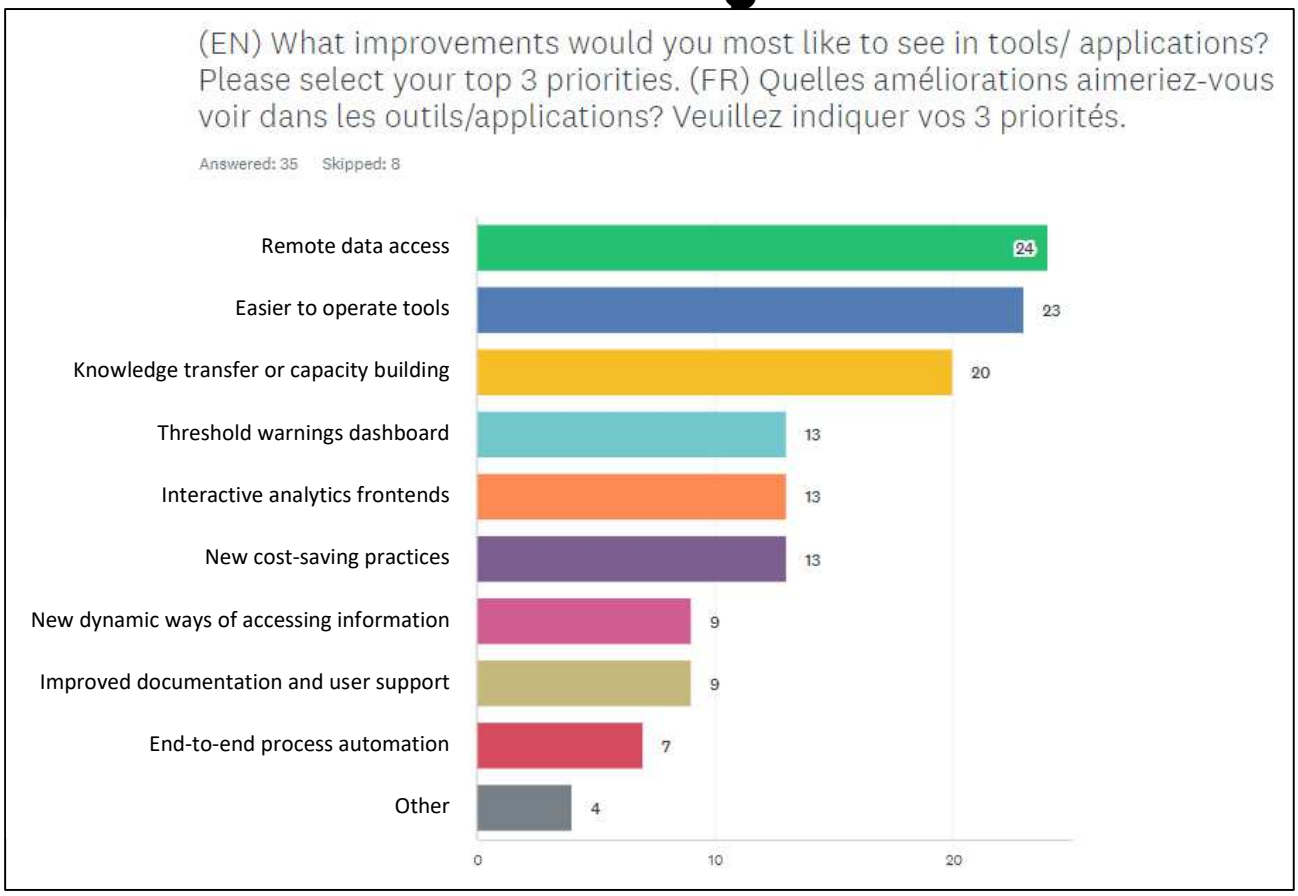

Figure 3-18 Requested improvements in tools/ applications [Q28]

- **Relevant policies/ frameworks [Q29]:** Participants were asked if there are any policies or frameworks that their organisations are working to meet:
  - *GIre*
  - *Water Code*
  - *Agenda 21 – https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf*
  - *PANGIRE (National Action Plan for Integrated Water Resources Management) - https://projectsportal.afdb.org/dataportal/VProject/show/P-NE-EAZ-004?cur=ua*
  - *Elaborate the agricultural programme document, monitor the activities of the agricultural and marketing campaigns.*
  - *Knowledge of soils and sustainable land management technologies*
  - *Policy on inventory, evaluation, planning and management of water resources;*
  - *2- Policy on monitoring and management of the measurement and observation network on the different aquifers and watercourses of Senegal (Senegal River, Gambia River, Casamance River, Sine-Saloum)*
  - *Policy for the promotion of integrated water resources management*
  - *Policy for quantitative and qualitative monitoring of water resources (application of legislative and regulatory texts with the provisions of the Water Code relating to the water police)*

- **EO data and tools needed to meet policies/ frameworks [Q30]:** The open text responses have been broadly sorted into the following categories (Table 3-10). Text in italics indicates

real responses from the survey or the English translation. The most common responses were related to satellite/ EO data, climate parameters and in situ data.

Table 3-10 EO data and tools required [Q30]

Needs (generalised)	#refs	Example responses (translated)
Satellite / EO data	6	*Satellite and/or radar tools as well as data (satellite images, radar images or photos of these tools) of earth observation are needed to achieve this objective;* *Greenhouse gas emissions from satellite;* *Satellite data; Satellite images; Remote sensing;* *Climate change, GHG, ANACIM data*
Climate parameters	3	*Accurate data on climate parameters related to agriculture;* *Necessary data: climatic, agrometeorological and meteorological* *Climate data*
In situ data	3	*Climate stations with remote management; In situ*
Other variables	2	*Runoff, rainfall, soil moisture, ETP (evapotranspiration potential)* *Agriculture, forestry and other land use*
Tools	2	*Use of GIS and machine learning;* *Programming, analysis and data processing tools;*
Statistics	1	*Statistics*
Computing facilities	1	*Supercomputer*

3.2.5 Water Stress technical requirements

Participants were asked about their opinions and technical requirements in terms of water stress. The results for each question are provided here:

- **Interest in water stress parameters [Q31 & 32]:** Participants were very interested in both surface wetness and evaporative fraction, see Figure 3-19. Other parameters of interest have been broadly sorted into the following categories (Table 3-11). Text in italics indicates real responses from the survey. The most commonly mentioned data variables were soil properties, evapotranspiration and hydrological parameters.

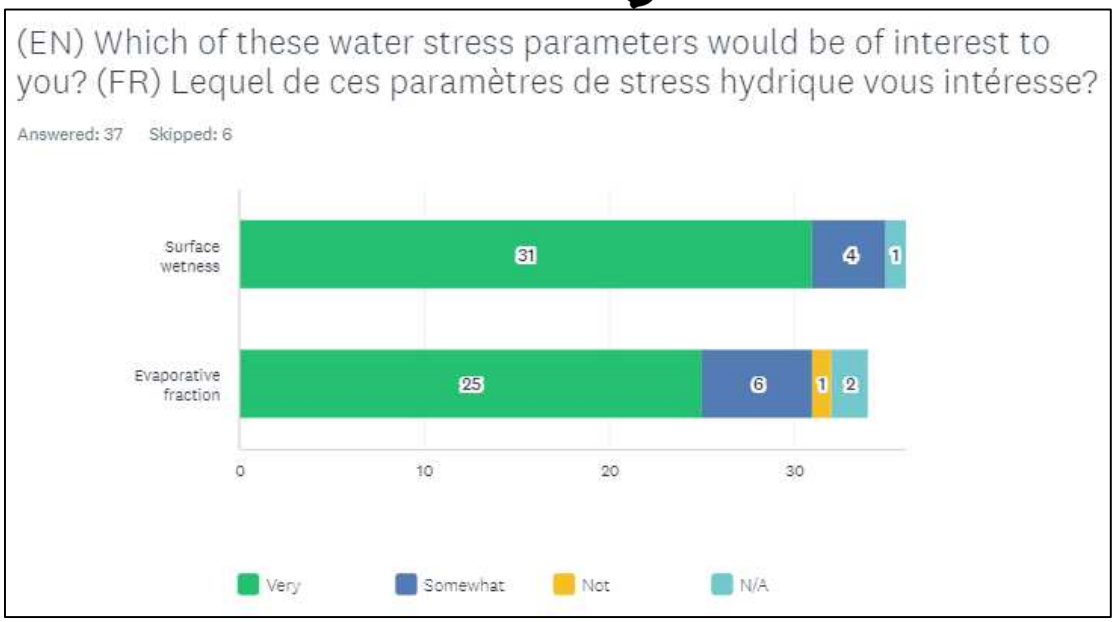

Figure 3-19 Water stress parameters of interest [Q31]

Table 3-11 Additional water stress parameters of interest [Q32]

Parameters (generalised)	#refs	Example responses (translated)
Soil properties	4	*Soil moisture; Field capacity; Infiltration; Physical parameters of the soil; structure, permeability, cohesion;*
Evapotranspiration	2	*Potential evapotranspiration; Evapotranspiration*
Hydrological parameters	2	*Runoff; Flow-based index*
Precipitation / Drought	2	*SPI; dry sequences*
Humidity	1	*Relative humidity*
Insolation	1	*Insolation*
Temperature	1	*High heat*
Wind	1	*Presence of wind*
Vegetation	1	*Leaf area withering (La fanaison de la surface foliaire)*
Crop parameters	1	*WRSI (Water Requirement Satisfaction Index)*

- **Field data available and resolution [Q33 & Q34]:** A number of participants indicated that they have access to field data for validation. The most common temporal resolution is daily.

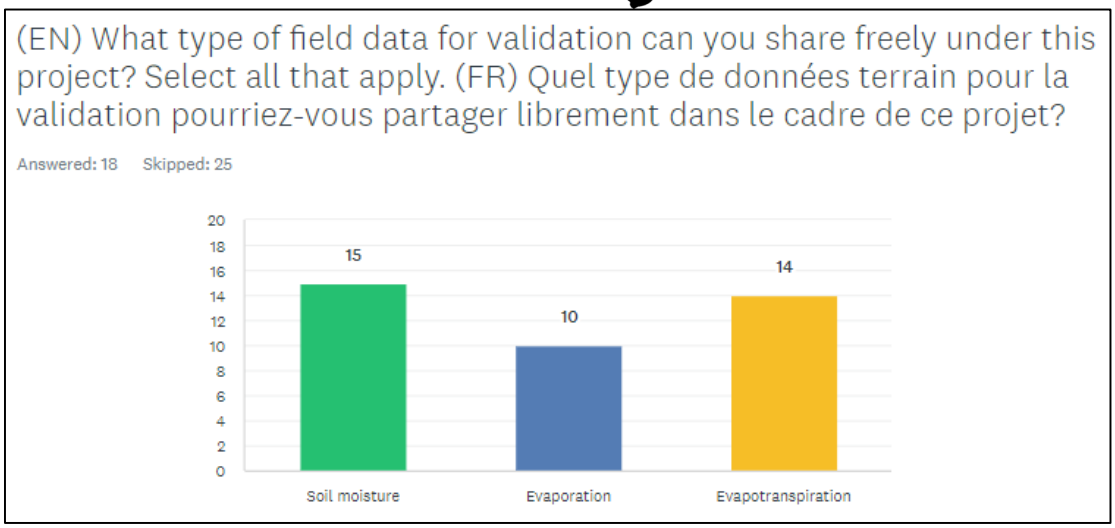

Figure 3-20 Field data for validation [Q33]

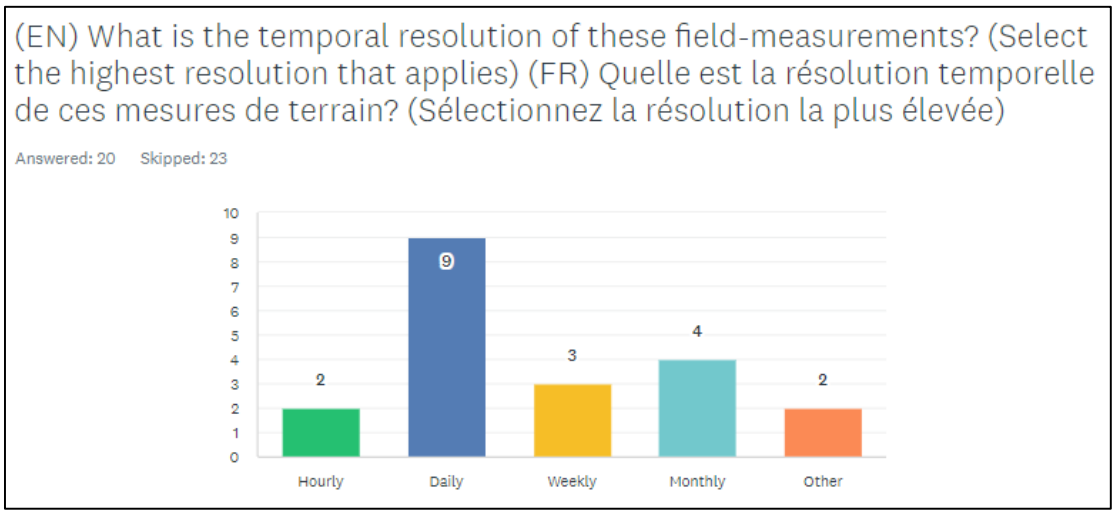

Figure 3-21 Field data temporal resolution [Q34]

- **Number of field sites [Q35, Q36 & Q37]:** A number of participants indicated that they have access to field sites where field data can be collected.

Table 3-12 Field sites for data collection

Field data	How many different field sites do you operate in your region where you collect these data?
Q35: Soil moisture	<5 (3 responses); 5-10 (2 responses); 10-50 (4 responses); 50-100 (1 response); >100 (1 response)
Q36: Evaporation	<5 (4 responses); 5-10 (2 responses); 10-50 (1 response)
Q37: Evapotranspiration	<5 (4 responses); 5-10 (1 response); 10-50 (2 responses)

3.2.6 Climate indices technical requirements

Participants were asked about their opinions and technical requirements in terms of climate indices. The results for each question are provided here:

- **Interest in climate indices [Q38 & 39]:** Participants were most interested in climate indices related to extreme weather, including maximum number of consecutive dry days, heavy precipitation days and SPEI (a drought index). Other parameters of interest mentioned by participants have been broadly sorted into the following categories (Table 3-13). Text in italics indicates real responses from the survey. The most common responses were again related to temperature and precipitation.

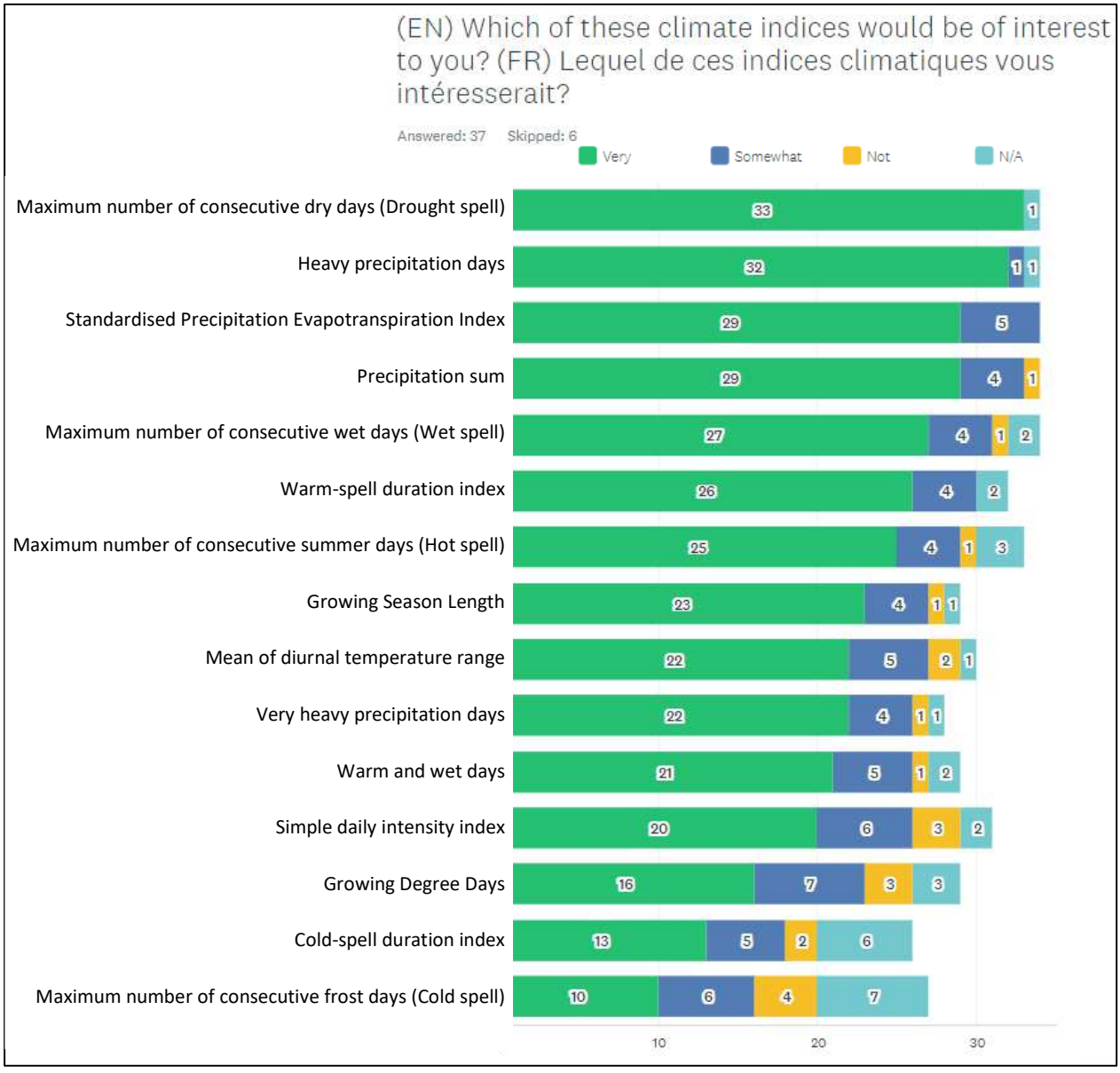

Figure 3-22 Climate indices of interest [Q38]

Table 3-13 Additional climate indices of interest [Q39]

Variables (generalised)	#refs	Example responses (translated)
Precipitation	3	*Frequency of wet days; onset of rainy season; cessation of rainy season; Rainfall distribution and regularity; Period of successive heavy rainfall*
Temperature	2	*Cold wave intensity index; heat index*
Seasonal indices	1	*Season length, season profile*
Leaf area index	1	*LAI*
Wind	1	*Average wind speed*

3.2.7 Documentation and user support

Participants were asked about their requirements in terms of documentation and user support. The results for each question are provided here:

- **Documentation requested [Q40]:** The most popular options selected were user guide/ handbook, data access documentation, technical notes and product specifications. The response for 'other' was *None.*

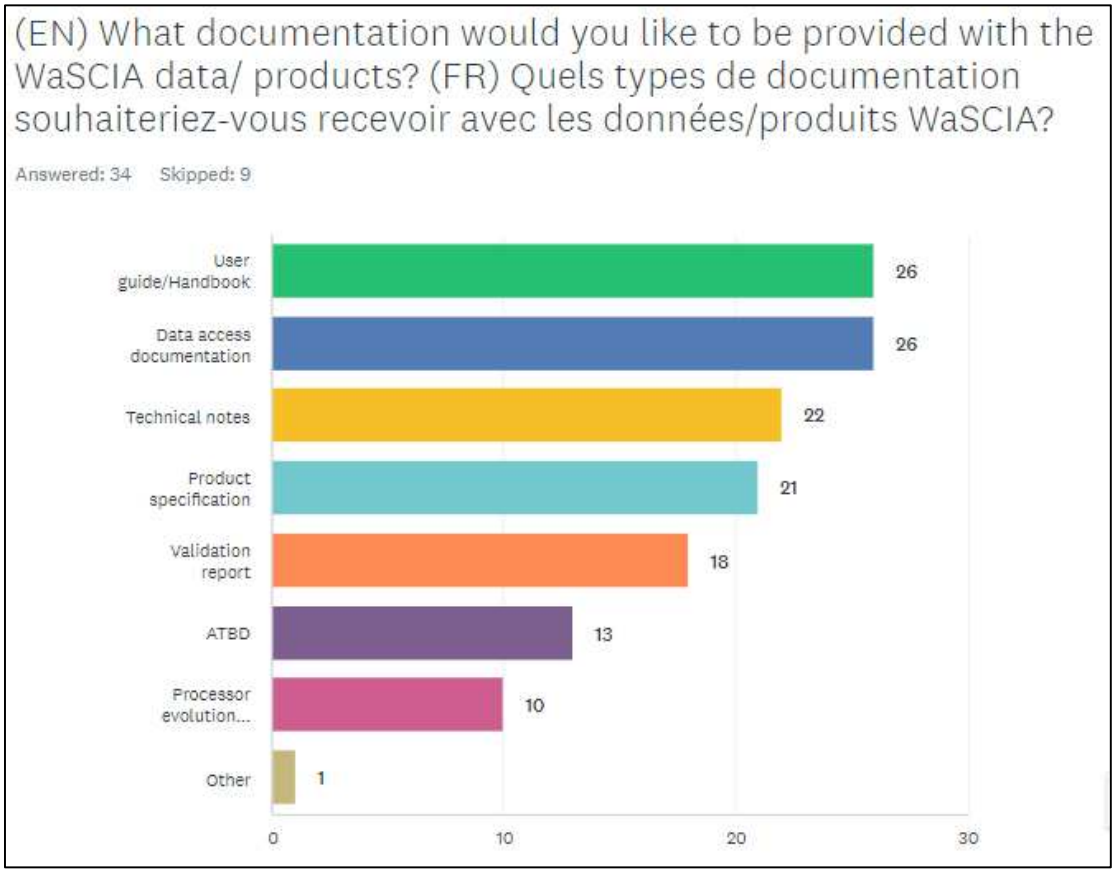

Figure 3-23 Documentation requested [Q40]

- **User support requested [Q41]:** The most popular option selected was user helpdesk, followed by tutorials, user forum and social media. The response for 'other' was *None.*

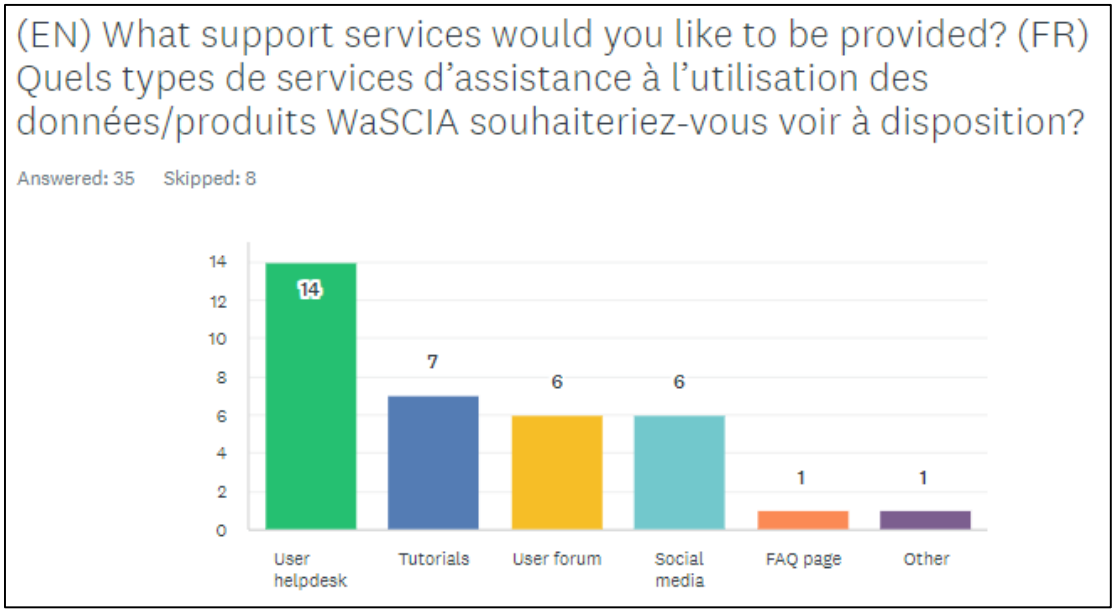

Figure 3-24 User support requested [Q41]

4 CONCLUSION

This report presents the results and analysis from the user engagement activities of the ESA Water Stress and Climate Indices for Africa (**WaSCIA**) project. The primary activity was a **user survey**, developed by the project team and distributed to a wide audience of potential end users in West Africa.

The survey was completed by **43 individuals** from a wide range of organisations in 8 different West African countries located within or near the Sahel region, and therefore all likely to be highly relevant to this project. The survey results provide important insight into the participant's roles, activities, areas of interest, current practices, available infrastructure and technical capabilities, which has helped the project to better characterise and understand the end users. The survey also captured the problems, barriers and gaps experienced by the users and their requests for improvements which will help to shape our WaSCIA solution.

The user requirements extracted from this survey cover a range of topics: data variables, data requirements, tools/ software, data processing/ storage, user interface/ platform and capacity building. These have helped to define a detailed Value Proposition Canvas, along with system and operational requirements for the WasSCIA solution (not publicly available).

All user, system and operational requirements captured through this activity will be held in a database so that they can be readily traced through the design, implementation and verification of the solution. It is expected that, throughout the agile development process, all requirements will be periodically reviewed and additional requirements may be gathered, in order to further refine the solution and tailor it precisely to the user's needs.