ACTION AGAINST HUNGER

Scale-up of the Pastoral Early Warning System in the Sahel

Final Report

Lead Organization	Action Against Hunger
Collaborators	VITO, HSS, The Regional Office for Production of Animal Industries (Gao, Mali), The Regional Office of Veterinary Services (Gao, Mali), The Pastoral Development Office of the Ministry of Agriculture and Livestock in Niger and the Office of Fisheries and Animal Resources of Burkina-Faso
SDGs	1. No poverty, 2. zero hunger, 3. good health and well-being, 8. Decent work and economic growth, 15. life on land.
Countries	Burkina Faso, Senegal, Mali, Niger
Data types & Technologies	Data types: Satellite imageries, spatial georeferenced data, automatic field data as SMS. Technologies: Remote sensing, Geographic Information Systems, ODK.
Project Objective	1) Expansion of field data coverage across the Sahel and, 2) Improvement of satellite data processing and outputs by automating data treatment, publishing the code-base and making raw data accessible to all.

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Executive Summary

In 2010, ACF began to regularly track drought in West Africa using satellite images and geospatial technologies for a Pastoral Early Warning System (PEWS). While we were by no means the first to do so (such imagery has been used to track drought in Africa since the 1980s), our early warning information has quickly gained reputation for its reliability and regularity. The rationale behind it is Early Warning/Early Action. Early predictions of drought normally allow for sufficient time to prepare and implement adequate response. In 2014 ACF enhanced its pastoral early warning system, initially based only on satellite imagery, with additional data collected from the ground on sentinel sites. Therefore, the current PEWS incorporates two sets of data that are complementary. The first is a near-real time data collected from field as SMS/Phone surveys about livestock conditions on 107 "sentinel sites" in Burkina Faso, Mali, Niger and Senegal. The second are satellite images used to generate biomass and surface water productions and accessibility. The outputs of this pastoral drought monitoring system are interactive maps, graphs and time series that are available on the website (www.geosahel.info) designed for their visualization and queries. Besides, bi-monthly reports and alerts are published on another website (www.sigsahel.info). These bulletins or reports are also distributed through a mailing list to key stakeholders in these countries, as well as to regional and international humanitarian organizations.

The scaleup of the project, funded by the world bank, had two principal aims : (i) Expansion of field data coverage across the Sahel, and (ii) Improvement of satellite data outputs by automating data treatment, publishing the code-base and making raw data accessible to all. Both goals have been achieved. First, the number of sentinel sites has increased from 50 up to 107 in 4 countries (Mali, Niger, Senegal and Burkina Faso). This has considerably improved the monitoring coverage over the Sahelian region and the accuracy of the data. ACF has published 36 bi-mensual national bulletins on the pastoral situation in the (9 bulletins x 4 countries). These bulletins are disseminated through a mailing list and via the website (www.sigsahel.info).

The satellite data outputs have also been improved with the whole imagery treatment being automatic, the codebase published on git hub and all data (both satellite-derived products and field data) are freely accessible from the web platform (www.geosahel.info). This web platform shows an annual number of visitors of 25 000. The website (www.sigsahel.info) where bulletins and reports are published records more than 130 000 visits for the last 365 days. For now, it is difficult to tell the gender of the visitors on the web site. However, we have 31% of female and 69% of male recipients on the mailing list.

Taking advantages of recent improvements of the Pastoral Early Warning System fulfilled in this project, we will push this system further to increase its use and reputation.

Risk mitigation

Did you need to address any risks? If yes, what were the risks and how were they managed or mitigated?

The main risk of the PEWS is the hacking of websites and servers. As we work with HSS Solutions for the maintaining of servers, these risks are limited. Besides, we have some protections measures for the websites.

Output indicator questions

1. Have there been any final results or outcomes in which data or methods have allowed data to be produced: faster; more cheaply; at a higher resolution or granularity, or where there was no data before? If yes, please describe.

Yes,

(1) The increase of sentinel sites in number yields to a higher granularity and a better spatial resolution in the four countries where we are actives: Mali, Niger, Burkina Faso and Senegal. Thanks to that, we now have access to data in places where no data have been collected before.
(2) The automated upload of biomass and water surface anomalies to the web platform has allowed a quick and easy access to the data. Now All users can easily download the data free of charge and use them for their own purposes. The data is also uploaded on the ACF page of Humanitarian Data Exchange (https://data.humdata.org/organization/acf-west-africa).
(3) The reinforcement of methods to select and train new sentinel sites has allowed to ease the launch of new sites. This leads to more data being collected faster and cheaply.
(4) The harmonization of the field surveys across the four countries of the project has allowed data to be produced faster and with a better fusion.

2. Has the project contributed to the production and/or use of data disaggregated by a) sex b) disability c) age, d) geography (or other)? If yes, please summarize the of types of disaggregation and the context.

Yes, the project produces data disaggregated by geography as the sentinel sites are in different places. Besides, satellite information offers exhaustive information on the entire study region which is a plus of the project. As most of the indicators collected pertain to biomass production, surface water availability and animal health, our data are not disaggregated by sex, age or disability.

3. Has the project contributed to the use and/or production of gender statistics? If yes, please describe.

No. Data collected concerns mainly environment and animals, so it is not related to people making gender statistics difficult. However, some of our sentinel relays are women. Besides, we have 31% of female and 69% of male recipients on the mailing list.

Deliverables and outputs (with links)

1) Selection of new sentinel sites in Mali, Niger, Burkina Faso and Senegal: 1st May 2018 – 31 august 2018

Status: Completed

The expansion of sentinel sites has been completed. The total number of sites is 107 (details in the table to the right). The focus of the expansion has been Senegal where we had no sites before the project. This attention to Senegal is due to several other factors including the severity of recent droughts in the country and the type of end-users of the data. While in the other countries covered by the project, the end-users of the sentinel site data tend to be mainly State and humanitarian actors, in Senegal, they tend to be pastoral organisations. As a result, there is a greater need for more granular data, given the more local nature of decisions taken based on this data.

Country	2017	2018	2019
Burkina Faso	14	29	29
Mali	14	20	30
Niger	22	15	18
Senegal	0	30	30
Total	50	94	107

In Niger, the number of sites has declined in 2018 due to the end of a partner project that was supplying data. In fact, Veterinaries Without Borders - Belgium (VSF-B), had provided ACF with data from its own sentinel sites in the Tillabéry and Dosso regions. The project that financed their sentinel sites has ended. Nevertheless, ACF has increased the number of sentinel sites in 2019. Besides, ACF has relaunched the partnership with VSF-B with a project launched in July 2019 and granted by Enabel (Belgium cooperation) named: "Système d'information digitalisé pour une transhumance apaisée au Sahel central – SIT Sahel LAHIYA". This project plan to increase the number of sentinel sites thanks to a better collaboration between VSF-B and ACF in three countries: Mali, Niger and Burkina Faso.

In Burkina Faso, Sentinel sites were expanded in the Eastern Region of the country. The province of Tapoa was added to collection already occurring in the Gngagna Province. In Mali, the number of sites in the Gao Region has increased, with additional surveys now being done in 16 new sites.

Sentinel sites will continue to remain operational after the end of this project. ACF has secured additional finance for the next phase of pastoral surveillance and we will keep increasing the number of sentinel sites.

2) Training of sentinel site focal points and start of data collection: 1st july 2018 – 30 September 2018

Status: Completed

The field data collectors (focal points) underwent training during the summer of 2018. Additional training sessions were conducted in 2019 in Niger and Mali according to the expansion of the sentinel sites. All sites in the previous section are currently active and responding to questionnaires via SMS (or phone call surveys in the case of Mali). Training was conducted in person with the collectors through a series of workshops in Northern Senegal, Niger, Burkina Faso and Mali. Technical support to the focal points is provided through regular contact by the project manager based in Dakar.

3) Data collection: 1st September 2018 – end of project

Status: Completed

Data collection is occurring on a weekly basis at the sentinel sites. Satellite data about biomass and surface water is collected every 10 days. Both datasets (satellite imagery and field data) are stored on a virtual server and analyzed to produce biomass and water availability information that are published on ACF web platform (www.geosahel.info). The field dataset is now automated and available with an update every 2 months on http://geosahel.info/Viewer.aspx?map=veille_pastorale. The near real time availability of field data on the web platform was not a deliverable of this project. Nevertheless, we really believe that this was necessary and adds a plus-value for the system.

Bulletins from the collected data are published every 2 months and available on sigsahel.info. A bulletin is published for each country in French. As they were not included in the list of deliverables to be given to the World Bank, and there is currently no anglophone audience for these reports, they will not be translated. However, if is requested by a user, an English version of a country report could be provided. An example of map representing all sentinel sites translated in English is presented figure 1 below.

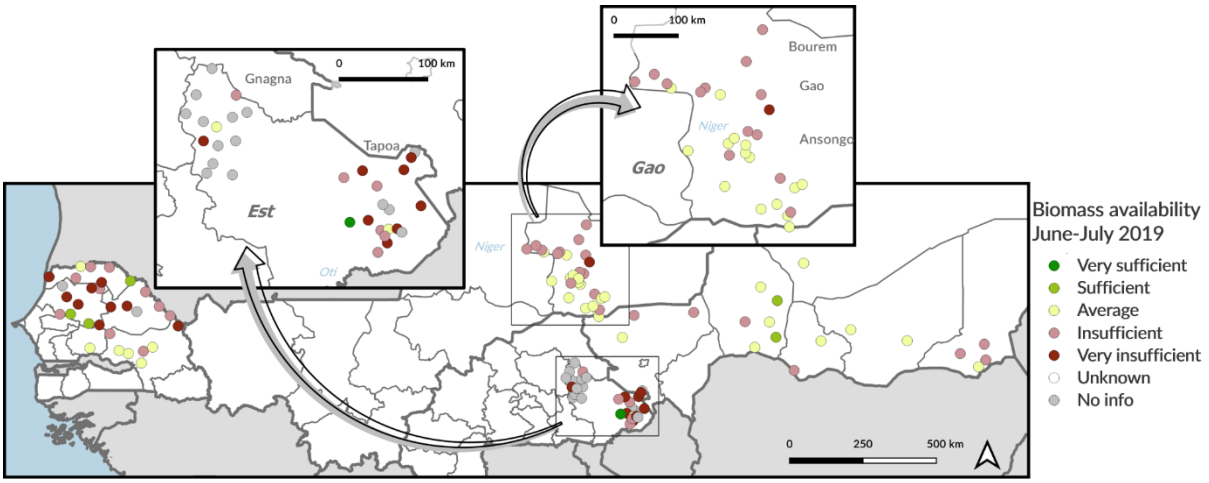

Figure 1- Biomass availability collected by the sentinel sites in June and July 2019.

As already explained, the data collection, publication and the production of bulletins will keep going in the future thanks to other sources of finance.

4) Biomass Reports for the Sahel and automated dataset- 1st October – 15 October 2018; 1st October – 15 October 2019

Status: Ongoing

The biomass reports written by ACF provide an analysis of drought conditions in the Sahel. These reports use remote-sensing data to measure the production of biomass (vegetation) during the rainy season and highlight areas with biomass deficits (drought). The 2018 Biomass reports have been written and published (See Table below, number 2). The biomass dataset is now automated and available with an update every 10 days on http://geosahel.info/Viewer.aspx?map=Analyse-Biomasse-Finale. A bulletin reporting the situation of 2019 mid-season was published at the end of August 2019 (See the link imbedded in row number 3 of the Table below). The final report for this project was the 2019 biomass report which has recently been published on the website (See Table below, number 4).

The list of the biomass report for the Sahel is available here

N°	Tittle	Date	Link
1	Bulletin sur la production de biomasse et l'eau de surface sur le Sahel mi-saison d'hivernage 2018	07/09/2018	http://sigsahel.info/index.php/2018/09/07/bulletin-sur-la-production-de-biomasse-et-leau-de-surface-sur-le-sahel-mi-saison-dhivernage-2018/
2	2018 Biomass production analysis and perspective for 2020	19/10/2018	http://sigsahel.info/index.php/2018/10/19/rapport-danalyse-de-biomasse-sahel-2018/
3	Etat de la biomasse et eau de surface au Sahel à la mi-saison de l'hivernage 2019	05/09/2019	http://sigsahel.info/index.php/2019/09/05/bulletin-dinformation-etat-de-la-biomasse-et-de-leau-de-surface-au-sahel-a-la-mi-saison-de-lhivernage-2019/
4	2019 Biomass production analysis and perspective for 2020	22/10/2019	http://sigsahel.info/index.php/2019/10/21/rapport-danalyse-de-biomasse-sahel-2019/

The biomass reports include visual information as maps that show:

- Total production of biomass;
- Production anomaly (current production VS the 21-year average);
- Production anomaly sigma (anomaly measured in standard deviations from 21-year average);
- Vulnerability Index (short-term multi-year trends to identify areas of consecutive drought).

An example of biomass information on September 2nd, 2019 is shown on Figure 2 and an example of biomass profile for the region of Saint Louis is shown on Figure 3.

Access to our data has also been eased for some other international organizations as ICRC (International Committee of the Red Cross) and OCHA thanks to a WMS connexion.

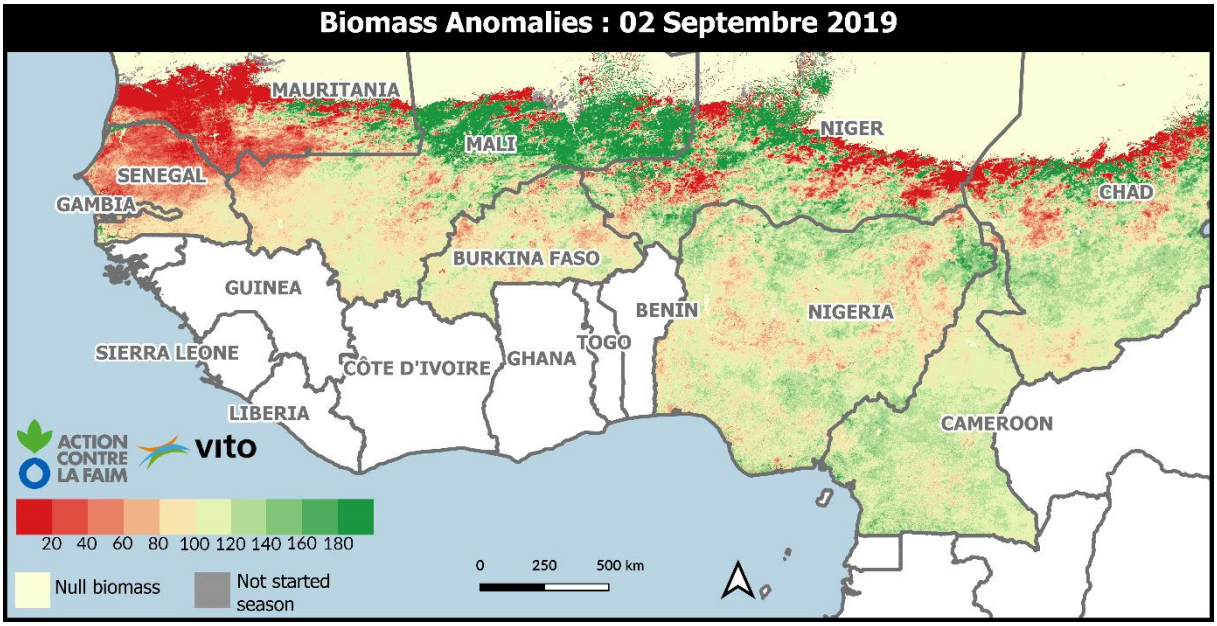

Figure 2: Biomass anomalies at the 2 of September for 2019.

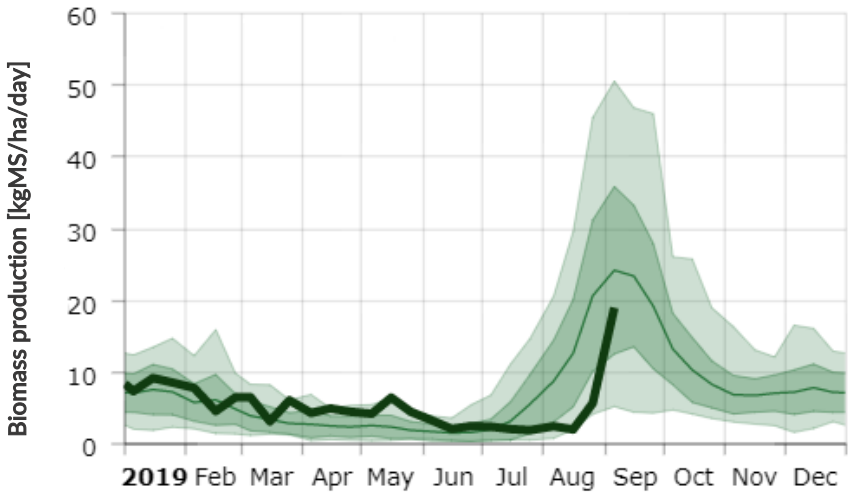

Figure 3: Biomass production profile for the region of Saint Louis in Senegal in 2019 compared with the mean, the standard deviation and the minimum and maximum.

5) Surface Water Analysis- Every 2 months starting August 2018

Status: Ongoing

The timing of this deliverable has changed. Rather than provide an analysis every 2 months, new data can be visualized every 10 days on Geosahel.info . Figure 4 shows an example of the water availability anomalies map. Users can generate their own reports by clicking on an area of interest and creating time-series datasets.

Besides, each bulletin generated from the data collected on the field includes an analysis of surface water anomalies. The map is thus published in the bulletin every two months. Again, these bulletins are only published in French due to the audience. An example can be found at

this link : http://sigsahel.info/index.php/2019/08/27/bulletin-de-surveillance-au-senegal-juin-juillet-2019/ with the surface water analysis map on page 4 of the report.

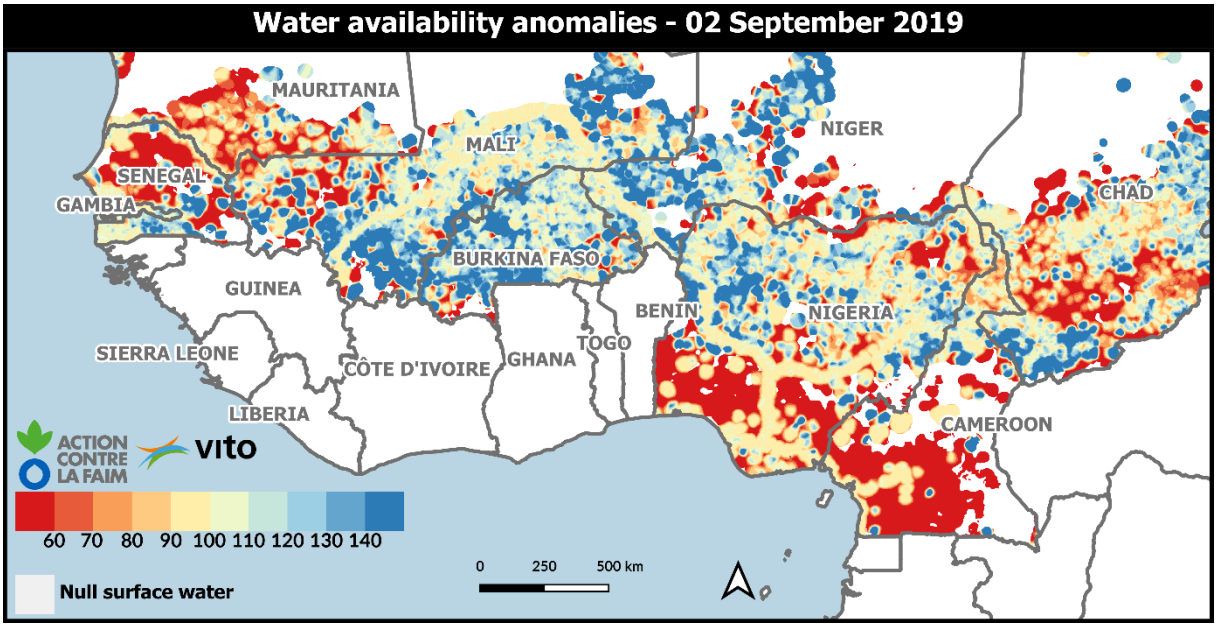

Figure 4: Water availability anomalies at the second of September.

6) Publication of Biogenerator and HydroGenerator Algorithyms on Github- 1st January – 28 February 2019

Status: Completed

The codebase has been cleaned up and published on Github (American company providing hosting for software development version control). It is now available for download and use at https://github.com/ACF-WARO/BioHydroGenerator.

7) Final Evaluation results and close of project

Status: Completed

The internal final evaluation report has been delivered to the World Bank. As this evaluation is internal, it will not be published on the website. This evaluation report aims at assessing the relevance, effectiveness, efficiency, impacts and sustainability of activities achieaved during the project. It will also try to highlight the areas of improvements and recommendations for future project implementation. This evaluation also encompassed two specific evaluation sources: the revue of a capitalization workshop held in Niger in September 2019 by ACF and detailed statistics on the use of the Pastoral Early Warning System web platforms.

Results and impacts

Expansion of Sentinel Sites to Senegal and increase on Sentinel Sites in Mali and Burkina Faso

Thanks to the support of the World Bank, sentinel sites have been established in Senegal and their number has been increased in Mali and Burkina Faso. These sentinel sites provide accurate and timely information to humanitarian and state actors in all 4 countries. In Senegal, information is also provided to pastoral civil society organizations and communities. This data includes indicators on pasture and water availability, market prices, herd movements, security issues and animal health. Before this project, this kind of data did not exist at all in Senegal. ACF offers the only real time information on pastoral conditions. Besides, before this project the data collection in Burkina Faso and Mali was limited to some specific areas. As the partners in the different countries were convinced of the usefulness of these data, we have expanded the field data collection coverage to new areas where data was not collected before.

Automated biomass and water maps for the Sahel

The support of the World Bank allowed ACF to develop an automated system that produces data and maps every 10 days about the state of water and biomass in the Sahel. This is a unique dataset of its kind in the region especially with regards to its geographic coverage, the near real time of the dataset and its free access by any end user with computer and internet connection. Data on the total annual production of biomass (above-ground dry matter vegetation) and surface water can be downloaded with a resolution of 1km. Users can download the data in raster (gridded) or CSVs (tabular) formats for individual areas of interest. The web platform also offers possibilities to directly download graphs illustrating the biomass or water surface profiles for a region of interest (country, region and department/province levels).

Automated field data on pastoral conditions for the Sahel

Recently, we added to the web platform the possibility to visualize and download field data as they are collected on the field. Every two month, in the same time as the bulletins are published on our website sigsahel.info, the raw data are uploaded to the web platform for a better diffusion. To our knowledge, there is no other platform delivering ground information on the pastoral situation every two months and for free in the Sahel region. ACF is well known in the region for this work.

Data use by ACF

ACF used the biomass data to prepare response plans to incoming droughts by the end of the 2018 rainy season. This data has been a key element used to trigger humanitarian response in Mauritania and Senegal last year. The automatic update of the data has allowed for analyses to be generated faster than ever, and thus allow response plans to begin earlier than before. Also this year (2019), important droughts have occurred in Senegal and Mauritania with a delay in the start of the season of approximately 2 months. This gap directly affects the development of biomass and the stock of biomass. Again, the biomass data have been used to alert different humanitarian actors in order to get ready for the response.

Use by other actors

The data produced by the scale-up project of the Pastoral Early Warning system has featured prominently in analyses by other actors. It is currently a critical input to the “Cadre Harmonisé Integrated Phase Classification for Food Security in the Sahel” (the main institutional early

warning system in the subregion). It is further used regularly by the World Food Programme's Vulnerability Assessment Mapping unit, The Réseau Billatal Maroobé (a network of pastoral organisations in West Africa), The Food Security and Nutrition Working Group and others. As an example, in August 2019 the cluster of Food Security and Nutrition Working Group for West Africa grouping actors such as FAO, OCHA, WFP, CICR, MSF, Unicef, etc used the biomass data to alert on the potential food security crisis in Senegal and Mauritania.

During the duration of the project, a few articles were published regarding the system and the maps.

In 2018, the data was used in an article published on IRIN regarding the humanitarian response to early warning alerts in Northern Senegal.

https://www.thenewhumanitarian.org/special-report/2018/10/18/early-warnings-climate-change-senegal-food-crisis

Thanks to this project, ACF gains more and more importance in mapping the pastoral's situation in the Sahel. One of the maps that we produced - in collaboration with RBM - was published in the journal Le Monde in April 2019.

https://www.lemonde.fr/afrique/article/2019/04/11/changement-climatique-et-pression-demographique-terreau-de-la-violence-au-sahel_5448954_3212.html

The data was recently used in an article published on REUTERS regarding the important droughts affecting Mauritania and Northern Senegal.

https://af.reuters.com/article/nigeriaNews/idAFL5N25P574

Presentations of the Pastoral Early Warning System have been made at different international conferences:

Name of conference	Time	Title	Link to the presentation/ conference
FOSS4G	August 2019	Real time mapping with SMS where there is no internet	https://media.ccc.de/v/bucharest-176-real-time-mapping-with-sms-where-there-is-no-internet
GSTIC	November 2018	Using open EO data to respond to drought in West Africa	https://2018.gstic.org/speakers/orenstein-alexander
GeoONG conference	October 2018	Building a GIS early warning system	https://www.cartong.org/geong/2018
GEOGLAM	May 2018	Pastoral surveillance and early warning system over West Africa	https://www.geo-rapp.org/event/6th-geoglam-rapp-workshop-in-kenya/
PROBA-V Symposium	May 2018	Lessons learned from the Sahel using PROBA-V data for pastoral early warning	https://nikal.eventsair.com/QuickEventWebsitePortal/proba-v-symposium-2018/esa/ExtraContent/ContentSubPage?page=6&subPage=1

International workshop on Nutrition and Heath by ACF	September 23-27th 2019	Improving respond capacity to food and nutrition crises in pastoral and agro-pastoral areas in the Sahel	The presentations of this workshop are not externally available.

Lessons learned

Lots of lessons have been learned regarding the approach of the system (satellite imagery analysis and field data collection).

First, about the satellite imagery analysis:

- There is a need to balance temporal and spatial resolution of satellite imagery. 10m spatial resolution Sentinel data are only available every 5 days which is not enough to have cloud-free image on a recurrent basis (example 5 days) during the rainy season. The 1km spatial resolution seems adequate for pastoral resources monitoring however to increase data accuracy, ACF is now studying the possibility to scale up the system to 300 m spatial resolution using the 300m PROBA-V data available since 2014.
- Even a fully automated system has some weakness. Therefore, we have to be ready for some adjustments of the system when needed.
- There is a big need to keep the data on a server to ease the automation.

Second, about the field data collection:

- As said by S.C. Lazenby in 2017, “Check yourself before you tech yourself”. Sometimes no technology is better than best technology. In our situation, simple automated SMS survey are recommended in regions where the connection to internet is still sparse especially in remote areas with a moving population like the pastoralists. This low-cost system is very efficient and more sustainable on a long term.
- There is a need to collect simple indicator to guarantee the sustainability of the project. Keep it simple is important to ensure the continuation of data collection.
- Qualitative data as the one collected on the field are key. In fact, even the best earth observation data is worthless if you don’t know the story behind what you’re looking at.

Other lessons have been also learned. These include:

- There is a huge need to broaden awareness about the system to make it well known by user communities. At the moment there is a real disconnection between data providers and the end users, so we need to close as much as possible this gap by talking about the system, sharing knowledge and experiences.
- Our system is often seen as very technical and not so user friendly. To address this issue, we need to ease the perceived technical barriers and tailor the information in formats suitable to anyone capacity and understanding.
- Our system delivers all the data as open source. Nevertheless, the open source culture is lacking among humanitarian and development actors, in part due to competition for funding and willingness to protect their data.

Conclusions

The project « Scale-up of the pastoral early warning system in the Sahel" was a success. Its two main objectives were achieved. The system has been expanded to a fourth country, Senegal, where sentinel sites have been set up and trained. New sentinel sites have also been created in the other three countries in order to increase data representativity. Now, data derived from satellite imagery analysis and those collected by sentinel sites are automatically updated and available for end-users. The codebase has been published and is freely downloadable.

Thanks to this project, the ACF pastoral early warning system was significantly improved with specific positive impacts on sustainable development goals. This improvement is an on-going effort that is needed to provide more accurate information to end users and also to monitor the impact of climate change in the region. To that end, ACF is also working to expand the experience in Senegal to reach pastoral communities through radio broadcasts. In order to provide a comprehensive early warning information in the region, ACF start integrating multi sectorial monitoring indicators that can help trigger alerts and early responses ahead of crisis (food insecurity, health and nutrition). At the moment, the system is implemented only in four countries out of the 14 covered by the ACF Regional Office for West and Central Africa. To facilitate the expansion to the other countries, to improve the resolution of satellite outputs, and to reinforce the multi sectorial monitoring, ACF needs to secure extra funding in the future.

This project, Scale-up of the Pastoral Early Warning System in the Sahel, submitted in response to the 2017 call for proposals by the World Bank's Development Data Group (DECDG) and the Global Partnership for Sustainable Development Data (GPSDD), is supported by the World Bank's Trust Fund for Statistical Capacity Building (TFSCB) with financing from the United Kingdom's Department for International Development (DFID), the Government of Korea, and the Department of Foreign Affairs and Trade of Ireland.