GCRF AFRICAN SWIFT
SCIENCE FOR WEATHER INFORMATION AND FORECASTING TECHNIQUES

Application of Nowcasting and its Impact in Ghana

SWIFT Science Meeting
15th February 2022

By:
Ms. Maureen Abla Ahiataku (GMet)
Dr. Jeffery N. A. Aryee (KNUST)

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Pre-SWIFT Nowcasting

Forecast updated every 6 hour using NWP and Satellite imagery

Products used: ECMWF, UK MetOffice, NOAA, Meteo France, etc

GHANA METEOROLOGICAL AGENCY

P.O Box LG 87, Accra
Tel/Fax: +233-302-543252
Tel: +233-0302-776171 ext. 3267/2534/3244
Digital Address: GA-485-3581
E-mail: kiamo@meteo.gov.gh
Website: www.meteo.gov.gh
@GhanaMet
Ghana Meteorological Agency (GMet)

24-HOUR FORECAST FOR GHANA
VALID FROM 12PM, 09/02/2022

SUMMARY: The Southern strip of Ghana is expected to experience partly cloudy weather condition with improved visibility. There is a likelihood of localized showers at the coastline and slightly north of the coastline from late afternoon into the evening. Dry and hazy weather is still expected to persist over the northern sector and portions of the transition belt with visibility ranging from **3 km to 8 km**.

CITIES	WEATHER BRIEF					
	AFTERNOON (09/02/2022)	TEMP °C 1200UTC	EVENING (09/02/2022)	TEMP °C 1800UTC	MORNING (10/02/2022)	TEMP°C 0600UTC
AFLAO	FEW CLOUDS	33	FEW CLOUDS	28	MIST (70%)	25
ACCRA	P'CLOUDY	32	P'CLOUDY	29	MIST (70%)	26
KASOA	P'CLOUDY	33	FEW CLOUDS	28	MIST (70%)	26
CAPE COAST	P'CLOUDY	33	P'CLOUDY	28	MIST (70%)	25
TAKORADI	P'CLOUDY	32	P'CLOUDY	27	MIST (70%)	24
AXIM	P'CLOUDY	32	P'CLOUDY	28	MIST (70%)	25
HO	SHOWERS	35	FEW CLOUDS	29	MIST (60%)	25
KOFORIDUA	SHOWERS	35	FEW CLOUDS	29	MIST (60%)	25
AKIM ODA	SHOWERS	34	FEW CLOUDS	28	MIST (60%)	25
KUMASI	P'CLOUDY	34	FEW CLOUDS	28	MIST (60%)	24
OBUASI	FEW CLOUDS	35	S'TLY HAZY	29	MIST (60%)	23
TARKWA	SHOWERS	33	FEW CLOUDS	29	MIST (60%)	23
SEFWI BEKWAI	S'TLY HAZY	35	S'TLY HAZY	28	MIST (60%)	20
KETE KRACHI	S'TLY HAZY	34	S'TLY HAZY	29	S'TLY HAZY	21
KINTAMPO	P'CLOUDY	35	S'TLY HAZY	30	S'TLY HAZY	22
GOASO	P'CLOUDY	34	S'TLY HAZY	30	S'TLY HAZY	22
SUNYANI	P'CLOUDY	35	S'TLY HAZY	27	MIST (60%)	23
TECHIMAN	P'CLOUDY	34	S'TLY HAZY	28	MIST (60%)	23
YENDI	DRY AND HAZY	37	DRY AND HAZY	30	DRY AND HAZY	23
TAMALE	DRY AND HAZY	38	DRY & S'TLY HAZY	31	DRY AND HAZY	22
BOLE	DRY AND HAZY	36	DRY & S'TLY HAZY	30	DRY AND HAZY	21
DAMONGO	DRY AND HAZY	37	DRY AND HAZY	31	DRY AND HAZY	21
BOLGATANGA	DRY AND HAZY	38	DRY AND HAZY	31	DRY AND HAZY	20
NALERIGU	DRY AND HAZY	37	DRY AND HAZY	31	DRY AND HAZY	21
WA	DRY AND HAZY	35	DRY AND HAZY	30	DRY AND HAZY	20

✓ **The state of the sea is CALM (1)**

NB: % - PROBABILITY OF OCCURRENCE * S'TLY – SLIGHTLY * P' - PARTLY

ISSUED AT 1100 UTC **DATE: 09/02/2022**

SIGNED

GHANA METEOROLOGICAL AGENCY

24-HOUR FORECAST FOR GHANA
VALID FROM 12PM TODAY

SUMMARY:
Variably cloudy weather with sunny intervals are expected over the middle and coastal sectors. Slight rain or drizzle is expected over few areas within the forecast period. The north will generally be cloudy with moderate rains over few areas. Early morning mist is expected over the forest and high ground areas of southern Ghana.

RAINFALL PROBABILITY
High (> 60%)
Moderate (40% - 60%)
Low (< 40%)

WEATHER DEFINITION
Showers, Rain, Partly Cloudy, Cloudy, Drizzle

ISSUED AT 1100 UTC **DATE:29/07/2021**
SIGNED: Central Analysis and Forecast Office (CAFO)

GHANA METEOROLOGICAL AGENCY, FORECAST DIVISION — MAIN FORECAST OFFICE, ACCRA

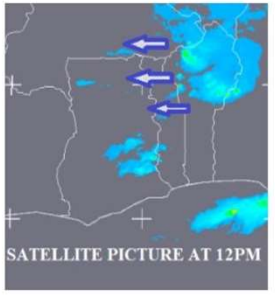
WeatherWarning

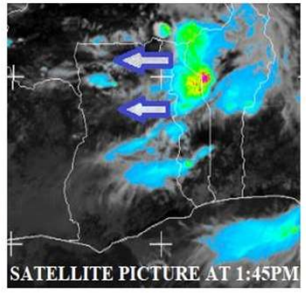
GHANA METEOROLOGICAL AGENCY

www.meteo.gov.gh / +233 302543252 / info@meteo.gov.gh/kiamo@meteo.gov.gh

WEATHER WARNING THURSDAY 23/07/2020

- A rainstorm is observed today **July 23, 2020** over the Northeastern border of Ghana.
- The storm is expected to continue its movement towards the west to produce thunder with rain of varying intensities over the Northern sector.
- Areas (and surroundings) to be affected include:
  Yendi, Tatale, Chereponi, Gushiegu, Bimbila, Tamale, Kpalbe, Karaga, Damongo, Salaga, Bawku, Zebila, Nakpanduri, Gambaga, Bolgatanga, Paga, Walewale, Tumu, Funsi, Wa, Sawla, Bole, Buipe.





- Parts of the Oti, Bono East, Ashanti, Bono and Ahafo regions are also expected to experience slight to moderate thundery showers this afternoon.

Estimated time of occurrence is between 1500GMT and 2000GMT (**3:00PM to 8PM**).

PROBABILITY OF OCCURRENCE: 70%

ISSUED AT **1430 GMT**
DATE: **23/07/2020**

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"How to support users' understanding and use of climate and weather services in Ghana"

Engagement began on Impact-Base Forecasting (IBF)

User Workshop in Accra (Nov. 2018)

Practical maki

Group photo of participants of the Tamale workshop in Aug 2019

Policy Brief Developed

GCRF *African* SWIFT - Science for Weather Information and Forecasting Techniques

Strand 1: User engagement and forecast valuation — Policy Brief No. 1

User needs for weather and climate services in Ghana

The African SWIFT project workshop *"How to support users' understanding and use of climate and weather services in Ghana"* took place in Accra on 8th – 9th November 2018. The workshop was the first in a series of national user need workshops to be held in SWIFT partner countries across Africa. It brought together over 35 practitioners, forecasters, academics, and decision makers from Ministries, National Meteorological and Hydrological Services (NMHSs), research institutions and non-governmental organisations. The workshop focused on:

- Identifying key meteorological hazards for different sectors.
- Exploring the potential for Impact Based Forecasting in Ghana.
- User-evaluation of current forecast provision with national and regional decision makers.
- Exploring how the communication of forecast products and tools could be improved.

Key lessons from the workshop can be grouped under five themes: Impact Based Forecasting, accessibility, communication, public and private collaboration and scientific development.

A. Impact based forecasting

Impact based forecasting combines information about the severity of weather impacts with the likelihood of these impacts occuring to provide a measure of risk. This approach is recommended by the WMO. The UK Met Office's template for the development of Impact Based Forecasting systems is increasingly being adopted around the world.

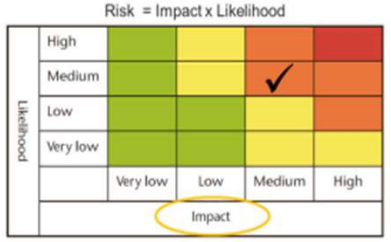

Figure 1. Example of impact based forecast produced using the Met Office template, which combines information about impact severity with likelihood of impact occurring.

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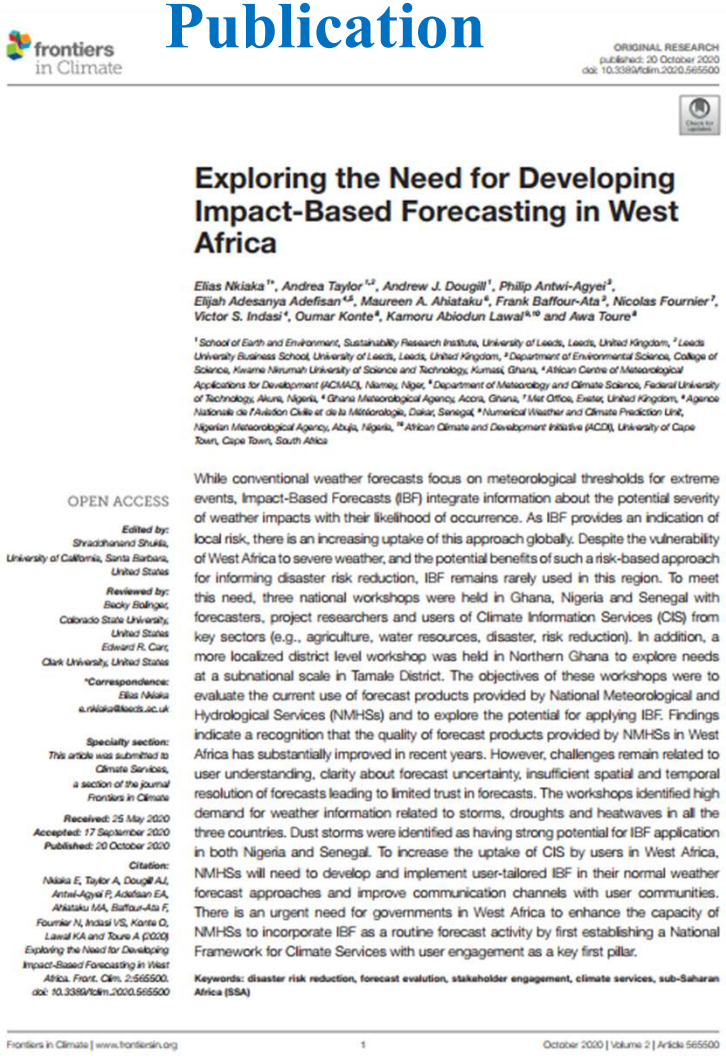
Co-production, Research & Nowcast

Publication



frontiers in Climate

ORIGINAL RESEARCH
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doi: 10.3389/fclim.2020.565500

Exploring the Need for Developing Impact-Based Forecasting in West Africa

Elias Nkiaka[1*], Andrea Taylor[1,2], Andrew J. Dougill[1], Philip Antwi-Agyei[3], Elijah Adesanya Adefisan[4,5], Maureen A. Ahiataku[6], Frank Baffour-Ata[3], Nicolas Fournier[7], Victor S. Indasi[4], Oumar Konte[8], Kamoru Abiodun Lawal[9,10] and Awa Toure[4]

[1] School of Earth and Environment, Sustainability Research Institute, University of Leeds, Leeds, United Kingdom, [2] Leeds University Business School, University of Leeds, Leeds, United Kingdom, [3] Department of Environmental Science, College of Science, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana, [4] African Centre of Meteorological Applications for Development (ACMAD), Niamey, Niger, [5] Department of Meteorology and Climate Science, Federal University of Technology, Akure, Nigeria, [6] Ghana Meteorological Agency, Accra, Ghana, [7] Met Office, Exeter, United Kingdom, [8] Agence Nationale de l'Aviation Civile et de la Météorologie, Dakar, Senegal, [9] Numerical Weather and Climate Prediction Unit, Nigerian Meteorological Agency, Abuja, Nigeria, [10] African Climate and Development Initiative (ACDI), University of Cape Town, Cape Town, South Africa

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Edited by:
Shraddhanand Shukla, University of California, Santa Barbara, United States

Reviewed by:
Becky Bolinger, Colorado State University, United States
Edward R. Carr, Clark University, United States

***Correspondence:**
Elias Nkiaka
e.nkiaka@leeds.ac.uk

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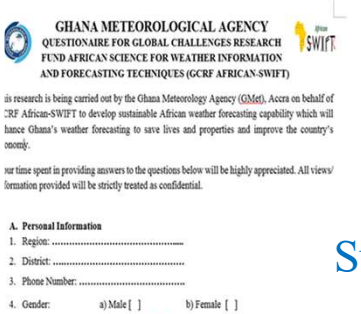
While conventional weather forecasts focus on meteorological thresholds for extreme events, Impact-Based Forecasts (IBF) integrate information about the potential severity of weather impacts with their likelihood of occurrence. As IBF provides an indication of local risk, there is an increasing uptake of this approach globally. Despite the vulnerability of West Africa to severe weather, and the potential benefits of such a risk-based approach for informing disaster risk reduction, IBF remains rarely used in this region. To meet this need, three national workshops were held in Ghana, Nigeria and Senegal with forecasters, project researchers and users of Climate Information Services (CIS) from key sectors (e.g., agriculture, water resources, disaster, risk reduction). In addition, a more localized district level workshop was held in Northern Ghana to explore needs at a subnational scale in Tamale District. The objectives of these workshops were to evaluate the current use of forecast products provided by National Meteorological and Hydrological Services (NMHSs) and to explore the potential for applying IBF. Findings indicate a recognition that the quality of forecast products provided by NMHSs in West Africa has substantially improved in recent years. However, challenges remain related to user understanding, clarity about forecast uncertainty, insufficient spatial and temporal resolution of forecasts leading to limited trust in forecasts. The workshops identified high demand for weather information related to storms, droughts and heatwaves in all the three countries. Dust storms were identified as having strong potential for IBF application in both Nigeria and Senegal. To increase the uptake of CIS by users in West Africa, NMHSs will need to develop and implement user-tailored IBF in their normal weather forecast approaches and improve communication channels with user communities. There is an urgent need for governments in West Africa to enhance the capacity of NMHSs to incorporate IBF as a routine forecast activity by first establishing a National Framework for Climate Services with user engagement as a key first pillar.

Keywords: disaster risk reduction, forecast evalution, stakeholder engagement, climate services, sub-Saharan Africa (SSA)

Successful implementation of the IBF



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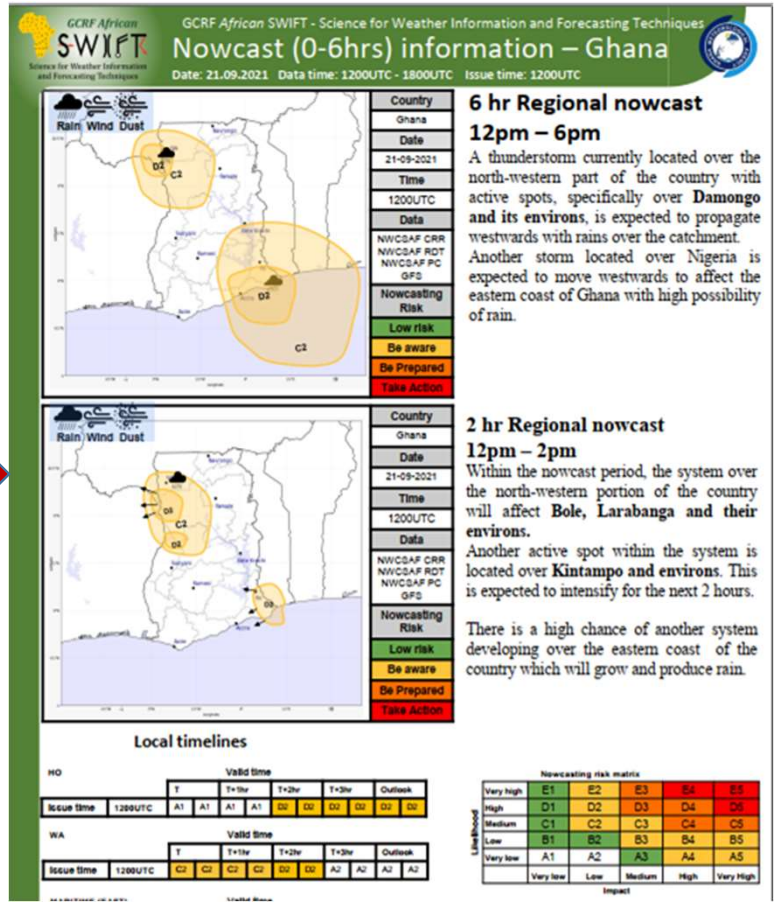
QUESTIONAIRE FOR GLOBAL CHALLENGES RESEARCH FUND AFRICAN SCIENCE FOR WEATHER INFORMATION AND FORECASTING TECHNIQUES (GCRF AFRICAN SWIFT)

is research is being carried out by the Ghana Meteorology Agency (GMet), Accra on behalf of CRF African-SWIFT to develop sustainable African weather forecasting capability which will hance Ghana's weather forecasting to save lives and properties and improve the country's onomy.

ur time spent in providing answers to the questions below will be highly appreciated. All views/ formation provided will be strictly treated as confidential.

A. Personal Information
1. Region: .....
2. District: .....
3. Phone Number: .....
4. Gender: a) Male [ ] b) Female [ ]

Survey



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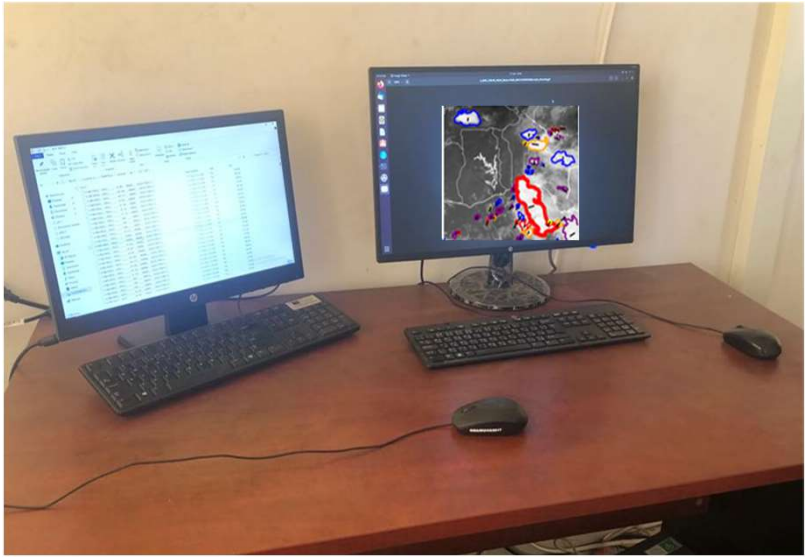
NWCSAF Installation

NWCSAF successfully installed in Ghana

NWCSAF for Ghana

GMet

Aid Operational & Research



KNUST

Aid Research

- KNUST helped install GMet NWCSAF (in-country self-reliance)
- Capacity building for Researchers on NWCSAF installation
- Forecasters and Researchers skills and knowledge enhanced on the use of NWCSAF products

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TB3 Co-production Workshops on Nowcast and Synoptic Forecast

Pre-Testbed 3 in Accra in 2021

Testbed 3 in Accra in 2021

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Capacity Building on Nowcasting (Impact-Based Forecasting)

CRR products used for weather warning before TB3

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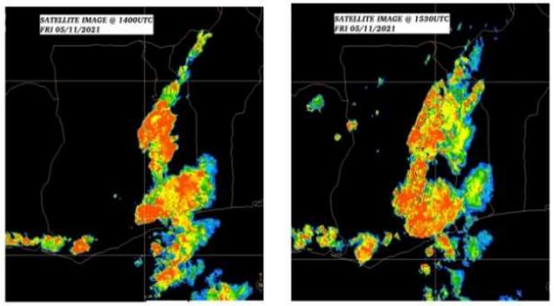
www.meteo.gov.gh / +233 302543252 / info@meteo.gov.gh/kiamo@meteo.gov.gh

WEATHER UPDATE_ 05/11/2021

- ✓ The storm indicated in the earlier update issued at 1245 UTC today November 5 2021 is currently engulfing most places within the eastern parts of Ghana.
- ✓ The storm is expected to continue moving to the west to affect areas within the ***Bono, Bono East, Ahafo, Northern, Savannah, Central and Western regions.*** Thunder with moderate to heavy rain and strong winds are expected over most parts of the aforementioned regions.
- ✓ Estimated time of occurrence is between **1600 UTC** and **1900 UTC** (4 pm and 7 pm).



Update on the rainstorm will be given when necessary.

PROBABILITY OF OCCURRENCE: 60%

ISSUED AT **1600 UTC** (4:00 PM)

DATE: **05/11/2021**

SIGNED

Forecasters and Research Scientists **working together** to generate nowcast and synoptic forecast for users during TB3 Co-production workshop in Ghana

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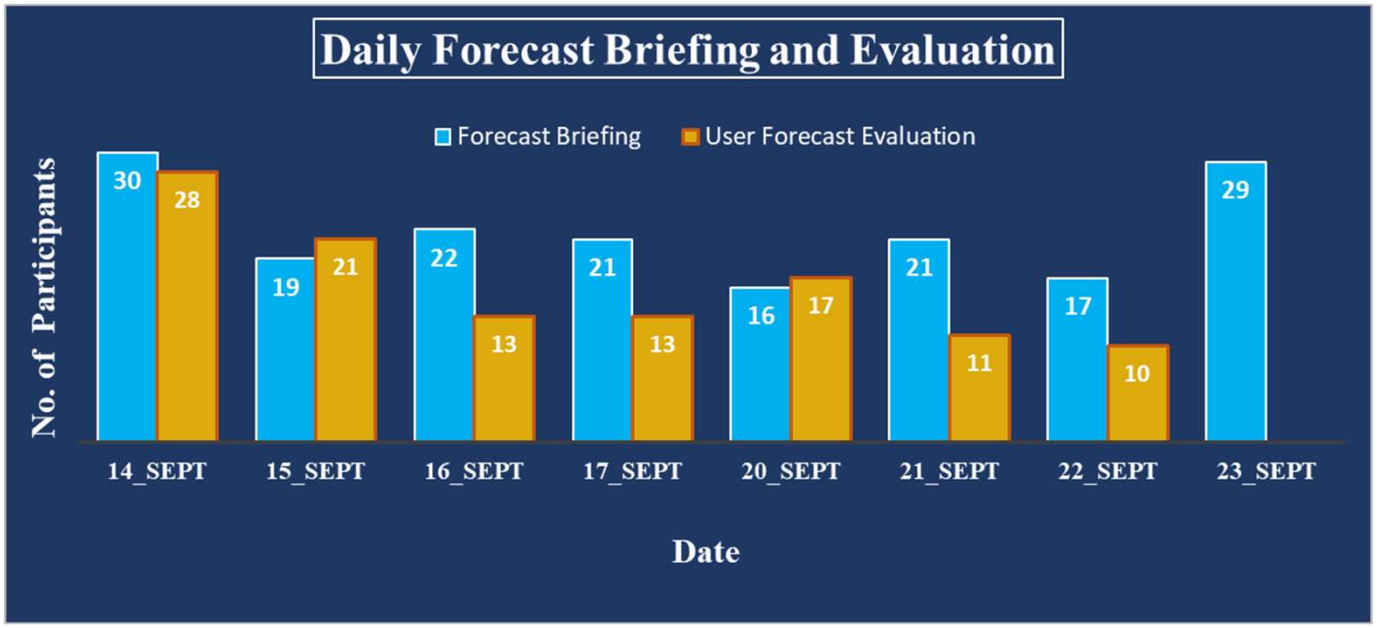
User Forecast Briefing & Evaluation



- Local user forecast briefing is held 14:00 UTC each day.
- Nowcast, Synoptic and Marine forecasts were sent to users 3 times daily
- Forecast were sent to users via WhatsApp (**GMet Forecast Evaluation**) and Email as pdf
- Evaluation links were sent to users to evaluate the forecasts

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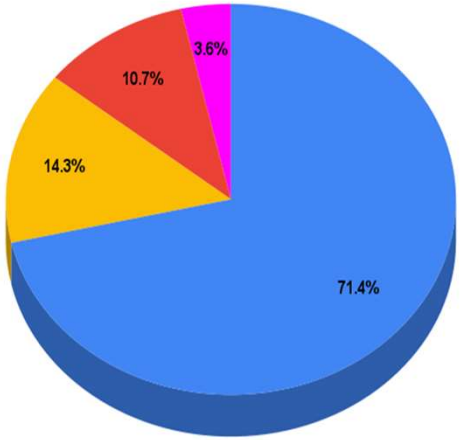
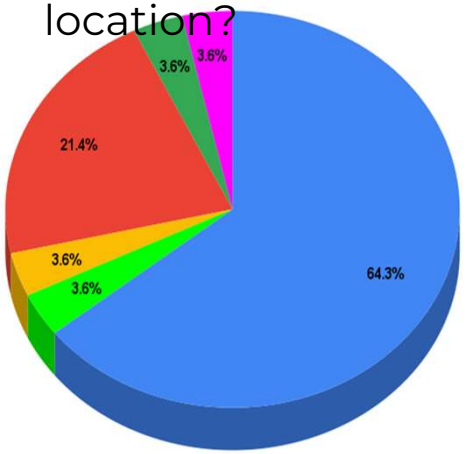
14th and 15th Sept 2021 Impact-Based Forecast

a. What weather conditions did you expect based on the forecast?

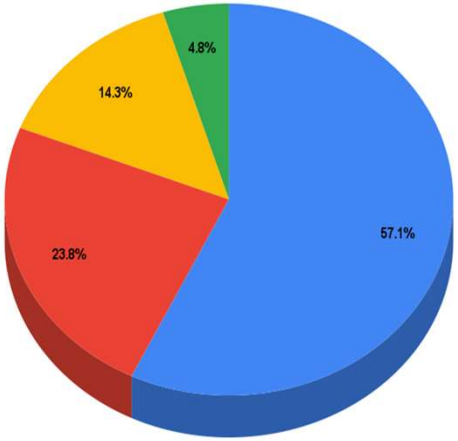
b. What weather conditions were actually experienced in your location?

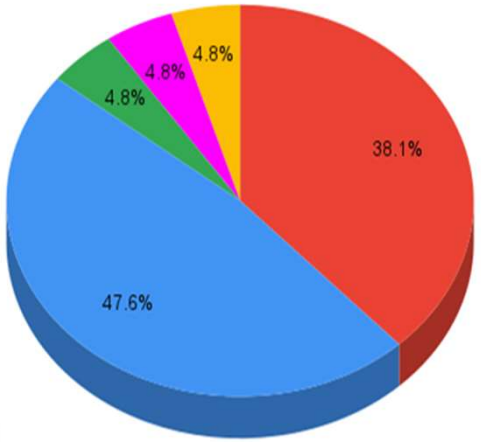
14th Sept 2021





15th Sept 2021





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Contingency Table and Skill Score

Weather expected based on forecast and actual event experienced by user

14-Sep-2021

		User Observation		
		Rain	No Rain	Total
Forecast	Rain	19	7	26
	No Rain	1	1	2
	Total	20	8	28

15-Sep-2021

		User Observation		
		Rain	No Rain	Total
Forecast	Rain	14	5	19
	No Rain	0	2	2
	Total	14	7	21

		Observations		
		Rain	No Rain	Total
Forecast	Rain	Hits	False Alarms	Forecast yes
	No Rain	Misses	Correct Negatives	Forecast no
	Total	Observed yes	Observed no	Total

Skill Scores	14-Sep-21	15-Sep-21
Percent correct	0.714	0.762
Hit rate	0.950	1.000
False alarm ratio	0.269	0.263
False Alarm Rate	0.875	0.714
Freq bias	1.300	1.357
Threat Score	0.704	0.737
Equitable threat score	0.051	0.211

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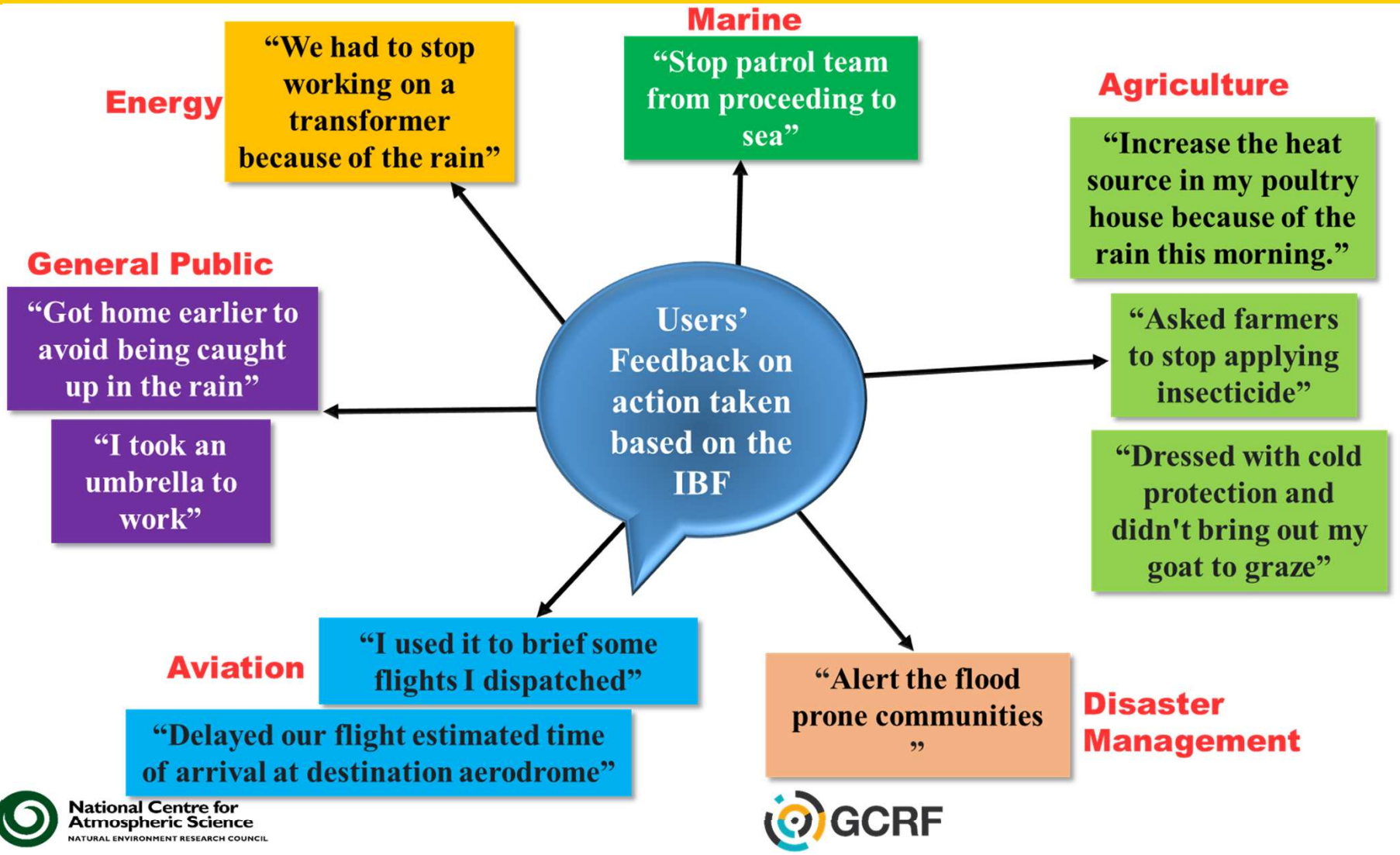
Forecast Impact on Decision Making



Nowcast has made great economic impact on the different sectors for socio-economic development

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Users' Feedback on Nowcast

- *"We didn't know we can access these NWCSAF products here in GMet as we also depend on US for it"-Aviation*

- *"We want nowcast to be generated for the marine sector to enhance safe operation and decision making"*

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Training

Marine Forecast

GHANA METEOROLOGICAL AGENCY

P. O. Box LG 87, Accra
Tel: +233-302-543252 / 307010019
Digital Address: GA-485-3581
Email: info@meteo.gov.gh
Website: www.meteo.gov.gh
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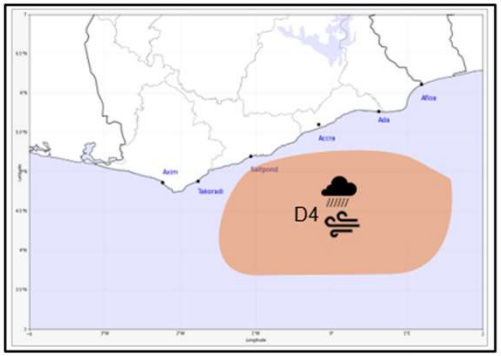
Facebook: Ghana Meteorological Agency (GMet)

COASTAL & MARITIME FORECAST FOR GHANA

IMPACT-BASED FORECAST 1800 - 0000 UTC 21092021



Date
4/10/2021
Time Issued
1200 PM
Valid From
1200 PM
Nowcasting Risk
Take Action
Be Prepared
Be aware
Low risk
No risk

Weather Forecasting Risk Table

Likelihood	Impact: Very low	Low	Medium	High	Very High
Very high	E1	E2	E3	E4	E5
High	D1	D2	D3	D4	D5
Medium	C1	C2	C3	C4	C5
Low	B1	B2	B3	B4	B5
Very low	A1	A2	A3	A4	A5

Weather Icons: Rain, Wind, Dust, Hail

State of the Sea: Calm

Time	Surface Wind	Visibility	Sea Surface Temperature	Sig. Wave Height	Tide	Wave Current
24 hours	SW 10KT MAX 25 KT	(4 – 10) km	(24 – 28) °C	(1.0 – 1.3) meters	(0.4 – 1.8) meters	Average: 0.25 Max: 0.35 – 0.60
48 hours	SW 10KT MAX 25 KT	(5 – 10) km	(23 – 28) °C	(1.2 – 1.7) meters	(0.5 – 1.7) meters	Average: 0.24 Max: 0.35 – 0.60

WEATHER SUMMARY

Most parts of the country will be cloudy with the possibility of thunderstorms or rains. Higher intensity is however expected over the southwestern parts of the country. Early morning mist will be experienced tomorrow over the forest and high ground areas of Southern Ghana. Rains are likely over parts of the Eastern, Volta and Greater Accra regions in the morning.

SIGNED: Ghana Meteorological Agency, Marine Forecast Office, Accra

Training for Forecasters post TB 3

Ghana Meteorological Agency
Forecaster's Training on New Forecast Products
Venue: Conference Room
Date: 2nd and 3rd November 2021
Time: 9:00 am to 4:00 pm

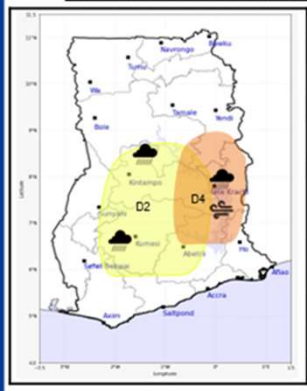
Time (UTC)	Program Outline	
0830 - 0900	Registration	Facilitators
	Opening Ceremony	
0900 - 0904	Opening Prayer	Ms. Debora Acheapong
0905 - 0915	Message by Ag. Director-General	Mr. Eric Asuman
0915 - 0920	Message by Deputy Director for SM&F	Mr. Joseph Portuphy
0920 - 0925	Group Photograph	All participants
0925 - 0940	**Coffee Break**	
0940 - 1000	Brief presentation on WIDS, Vizkit Tool, New Impact-based forecast template	Ms. Maureen A. Ahiataku
1000 - 1100	Load and update of forecasts into the WIDS	Mr. Joshua Asamoah/ Mr. Vincent Antwi
1100 - 0100	Generating of Impact-based forecasts/NWCSAF	Mr. Asamoah, Mr. Ansah and Mr. Cudjoe
0100 - 0200	**Lunch**	
0200 - 0300	Forecast Verification and Evaluation	Mr. Bashiru Yahaya and Ms. Maureen A. Ahiataku
0300 - 0330	Running of SSP and five-day forecasts model	Mr. Samuel Owusu Ansah
0330 - 0400	Introduction to the Deweatra	Mr. Samuel Owusu Ansah

Weather Warning

GHANA METEOROLOGICAL AGENCY

P. O. Box LG 87, Accra
Tel: +233-302-543252 / 307010019
Digital Address: GA-485-3581
Email: info@meteo.gov.gh
Website: www.meteo.gov.gh
Twitter:@GhanaMet
Facebook: Ghana Meteorological Agency (GMet)

IMPACT-BASED WEATHER WARNING FOR GHANA



Date
4/10/2021
Time Issued
12:00 PM
Valid From
14:00 PM
Nowcasting Risk
Take Action
Be Prepared
Be aware
Low risk
No risk

SUMMARY

Some rainstorms are developing within the southern parts of the country and will be accompanied with strong winds. The storms are expected to slowly move and affect most areas within the forest and the transition sectors. However, few areas within the coastal sector will experience cloudy conditions.

Weather Forecasting Risk Table

Likelihood	Impact: Very low	Low	Medium	High	Very High
Very high	E1	E2	E3	E4	E5
High	D1	D2	D3	D4	D5
Medium	C1	C2	C3	C4	C5
Low	B1	B2	B3	B4	B5
Very low	A1	A2	A3	A4	A5

Weather Icons: Rain, Wind, Dust, Hail

Areas To Be Affected / Valid Time	T+2hr	T+4hr	T+6hr	Outlook
T=1400UTC: Kpando, Hohoe, Kete Krachi	D2	D4	D4	D4
T=1400UTC: Kumasi, Ejisu, Wenchi, Sunyani, Abetifi, Sefwi Bekwai	D2	D2	D2	D2
T=1400UTC:				
T=1400UTC:				

SIGNED: Ghana Meteorological Agency. Central Analysis and Forecasting Office (CAFO)

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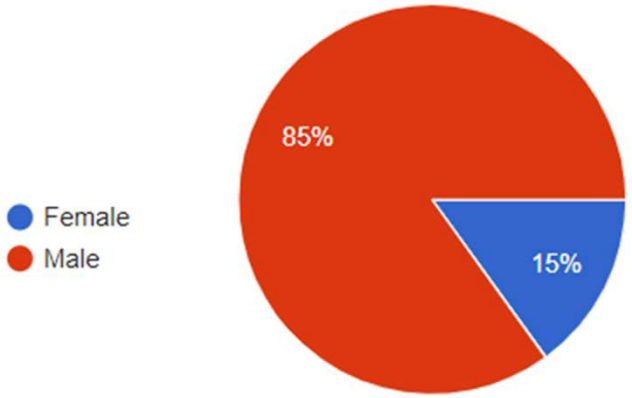
Users Feedback on Impact-Based Forecast Template

Some results from a survey via social media by GMet on the new forecast templates. A total of **280** people responded

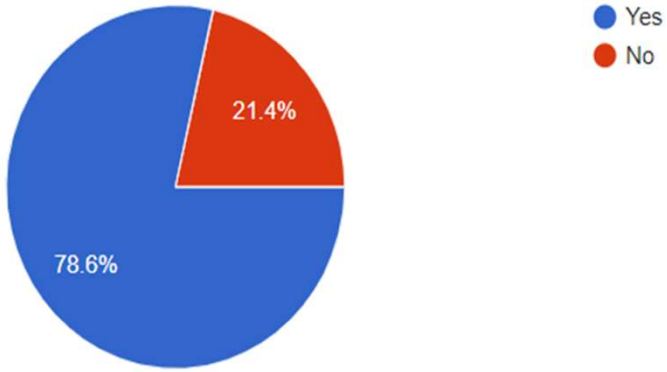
Q1. Gender

280 responses



Q6. Would you prefer this impact-based forecast map as weather warning template for better decision making?

280 responses



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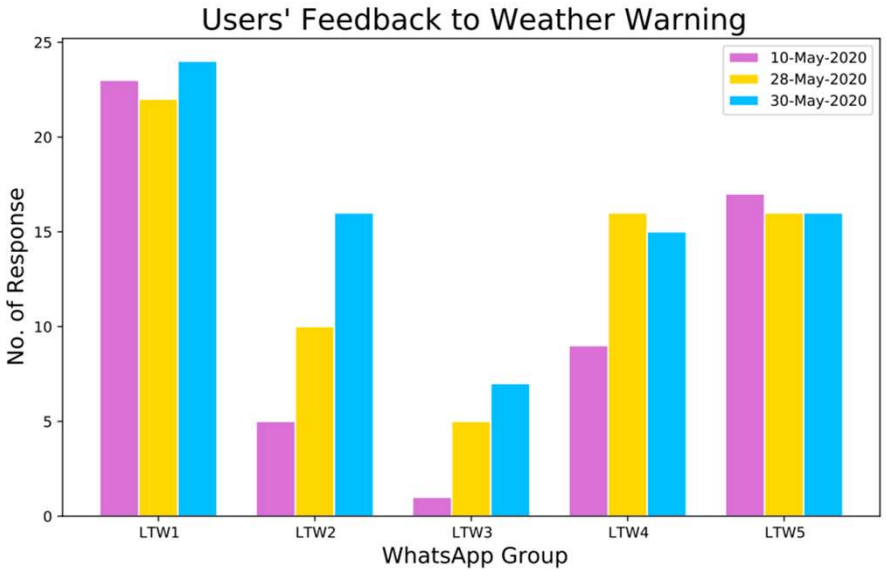
Impact of Users Feedback on Forecast Evaluation (Citizen Science)



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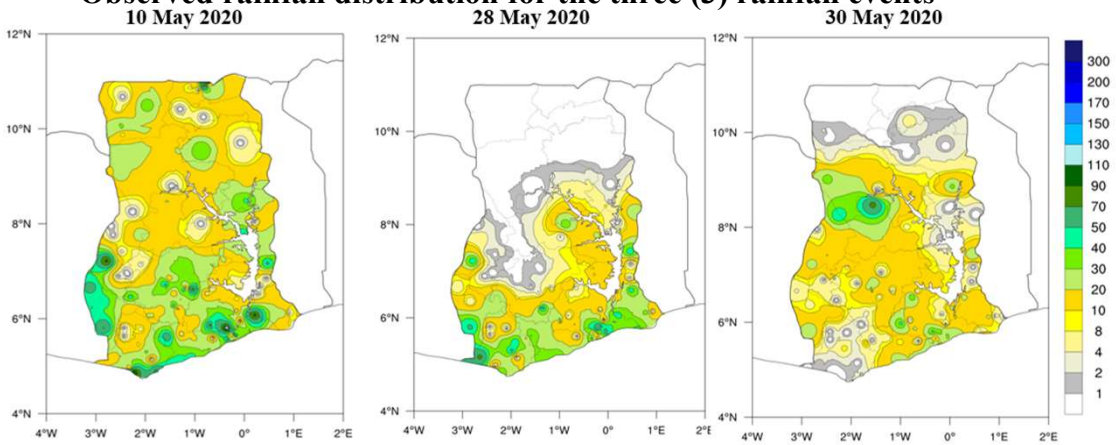
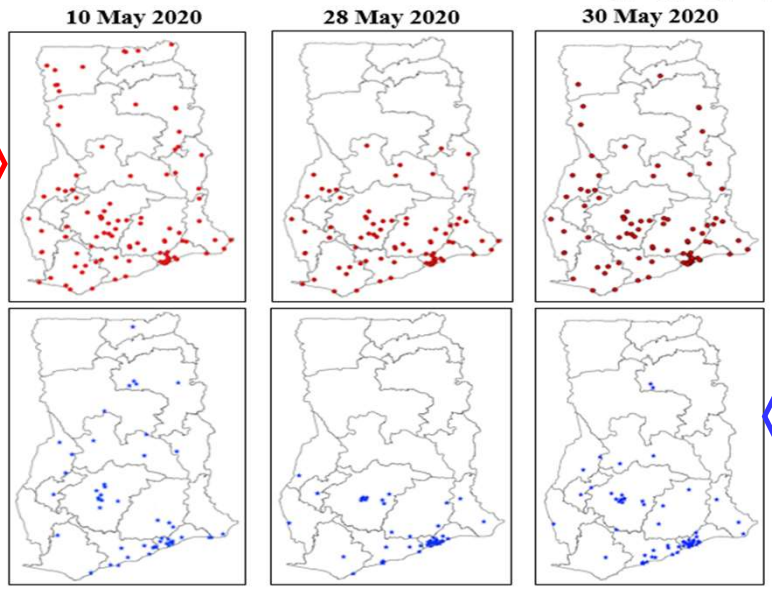
Observed rainfall distribution for the three (3) rainfall events



Spatial distribution map for the **Observation stations (RED)**



Spatial distribution map for **Users' Feedback (BLUE)**

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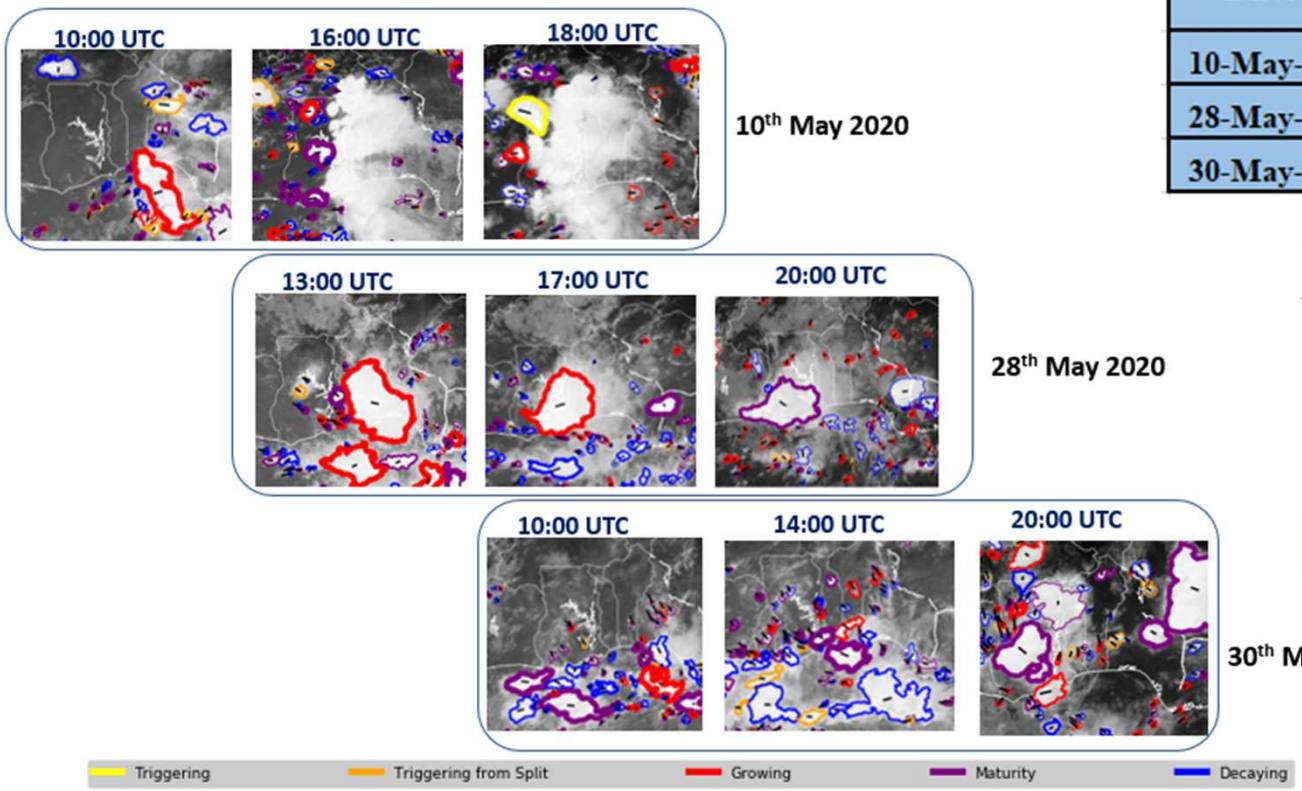
Skill score

NWCSAF Rapidly Developing Thunderstorms (RDT) images



Skill score statistics of the rainfall events

Date	Accuracy	POD	FAR	Frequency Bais
10-May-20	0.92	1.00	0.07	1.08
28-May-20	0.80	1.00	0.19	1.24
30-May-20	0.83	1.00	0.17	1.21

The fraction of forecast (weather warning) were correct and have a skill score between 0.8 and 0.9 for the accuracy (percent correct) for the three selected dates.

WORLD METEOROLOGICAL ORGANIZATION

HIWeather | Internal Access

Citizen Science Project

HIW community is interested

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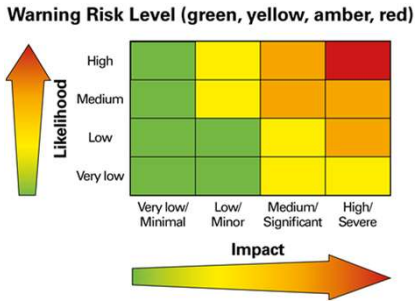
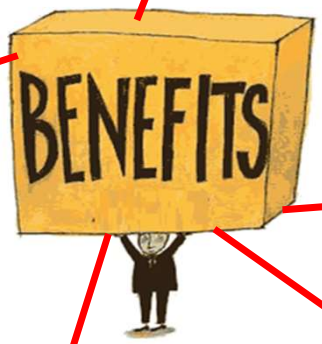
Conclusion



- Developed an SOP for Public Nowcasting

- NWCSAF aid nowcasting in GMet especial for Impact-Based forecasting
- Helped strengthen collaboration between GMet and KNUST



- Support research in both KNUST and GMet

- Improved Users' knowledge on Nowcasting
- Help users to make informed decision

- Support aeronautic Nowcasting

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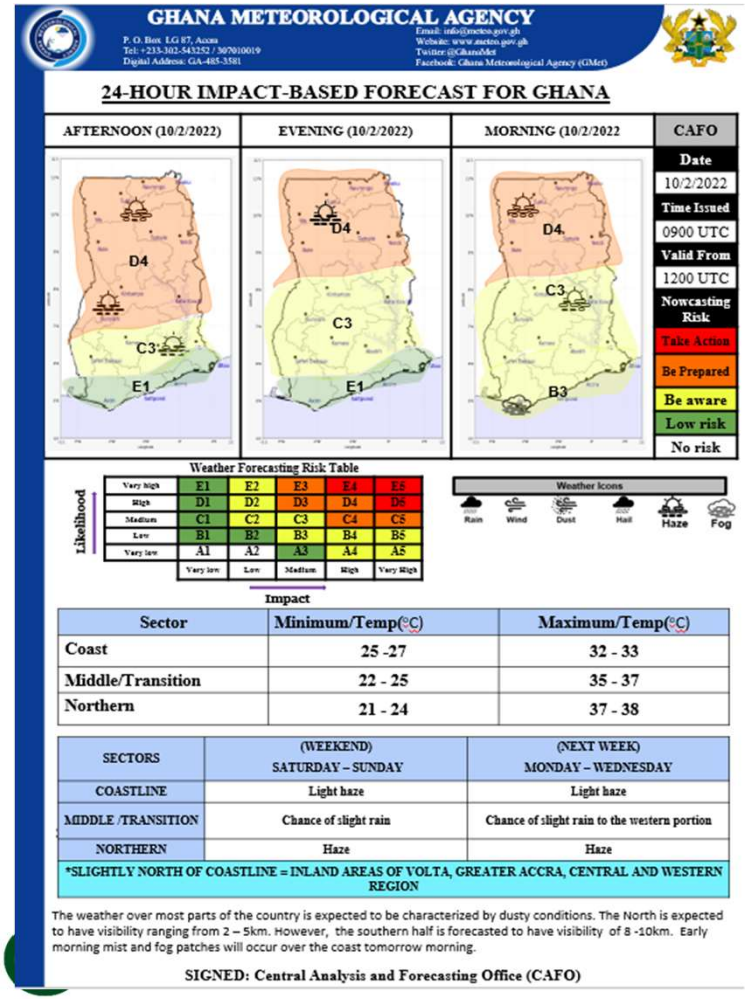
The Way Forward

Impact-based forecast made during SWIFT Science meeting 2022



GHANA METEOROLOGICAL AGENCY

P. O. Box LG 87, Accra
Tel: +233-302-543252 / 307010019
Digital Address: GA-485-3581

Email: info@meteo.gov.gh
Website: www.meteo.gov.gh
Twitter:@GhanaMet
Facebook: Ghana Meteorological Agency (GMet)

24-HOUR IMPACT-BASED FORECAST FOR GHANA

AFTERNOON (10/2/2022)	EVENING (10/2/2022)	MORNING (10/2/2022	CAFO
			Date
			10/2/2022
			Time Issued
			0900 UTC
			Valid From
			1200 UTC
			Nowcasting Risk
			Take Action
			Be Prepared
			Be aware
			Low risk
			No risk

Weather Forecasting Risk Table

Likelihood	Impact				
Very high	E1	E2	E3	E4	E5
High	D1	D2	D3	D4	D5
Medium	C1	C2	C3	C4	C5
Low	B1	B2	B3	B4	B5
Very low	A1	A2	A3	A4	A5
	Very low	Low	Medium	High	Very High

Weather Icons: Rain, Wind, Dust, Hail, Haze, Fog

Sector	Minimum/Temp(°C)	Maximum/Temp(°C)
Coast	25 -27	32 - 33
Middle/Transition	22 - 25	35 - 37
Northern	21 - 24	37 - 38

SECTORS	(WEEKEND) SATURDAY – SUNDAY	(NEXT WEEK) MONDAY – WEDNESDAY
COASTLINE	Light haze	Light haze
MIDDLE /TRANSITION	Chance of slight rain	Chance of slight rain to the western portion
NORTHERN	Haze	Haze

*SLIGHTLY NORTH OF COASTLINE = INLAND AREAS OF VOLTA, GREATER ACCRA, CENTRAL AND WESTERN REGION

The weather over most parts of the country is expected to be characterized by dusty conditions. The North is expected to have visibility ranging from 2 – 5km. However, the southern half is forecasted to have visibility of 8 -10km. Early morning mist and fog patches will occur over the coast tomorrow morning.

SIGNED: Central Analysis and Forecasting Office (CAFO)

- Impacts based forecasts will be generated for Ghana, including use of nowcast products for generation of HIW warnings
- Require continued Capacity building for forecasters to enhance impacts-based forecasting
- Ongoing science & social-science research can inform both nowcast products and their use. e.g
  - Evaluation of NWCSAF product (CRR, RTD and PC-PH) for 28 June 2018 rainfall in Ghana (Nowcast)
  - Evaluation of CRR products over Ghana for synoptic forecast

  Research to contribute to the NWCSAF products and community (e.g Dry season nowcast)

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Funder Acknowledgement

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Thank You!

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