MALAWI DRY SPELLS ANTICIPATORY ACTION TRIGGER: QUALITY ASSURANCE REVIEW

CENTRE FOR DISASTER PROTECTION

Government Actuary's Department

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Executive summary

1. GAD has been asked to carry out a quality assurance review of the trigger used in the Malawi dry spells anticipatory action pilot.

2. The objective of the pilot is to mitigate the impact of dry spells on vulnerable, at-risk individuals and communities in Malawi through collective, cross-sectoral anticipatory action. The pilot makes use of a hybrid trigger model, comprising a predictive and observational component.

3. As part of the trigger development analysis was carried out to understand if historical dry spells are correlated with various potential impact factors. The analysis did not show good evidence of dry spells coinciding with need in this context.

4. Further, in respect of the predictive element of the trigger the analyses concluded that most of the dry spells can be detected, but this comes at a very high false alarm rate. However, the analyses also commented that "with a leadtime of 2 months, 50% (2/4) of the dry spells would be forecasted", which appears to contradict that most of the dry spells can be detected for the leadtime chosen for the predictive trigger. Note that the analyses themselves highlighted the low statistical significance of the results presented given there were only a few occurrences of dry spells in the 20 years of data analysed.

5. Given the weak evidence for correlation between the predictive trigger and dry spells, and dry spells and need it would be interesting to re-run the analysis to look at the direct correlation between the triggers and indicators of need (such as IPC 3+ population and ASI).

6. In general, the analyses carried out when developing the trigger are comprehensive and follow a logical process. The documentation of the analyses is thorough and transparent and includes limitations. This will help with shared learning, and monitoring and evaluation. However, we do not feel that the analyses are easily accessible to non-specialist audiences. They would benefit from clear summaries and signposting of conclusions that inform the trigger development.

7. Prima facie, the trigger should lead to objective and timely action based on automated decision making.

8. Although the framework documentation and analyses, and our review highlight several potential issues with the trigger, we recognise the need for pragmatism, and these weaknesses should be balanced against:

   8.1 The advantages of having a simple, easily understood, and objective trigger.

   8.2 There are unlikely to be many alternatives.

   8.3 The benefits of developing an anticipatory action trigger in terms of gathering evidence and experience to facilitate learning and inform future initiatives, particularly within the context of a pilot.

Introduction

9. The Centre for Disaster Protection ("the Centre") and the Foreign, Commonwealth and Development Office ("FCDO") have commissioned GAD to carry out a quality assurance review of the trigger used in the Malawi dry spells anticipatory action pilot ("the pilot"). The trigger was developed by the Centre for Humanitarian Data working with OCHA.

10. The scope of GAD's quality assurance review includes:

- Review of effectiveness and reliability of the proposed trigger and risks associated with it. This will include consideration of:
  - Reliability of data used for trigger development
  - Basis risk (risk that payout will not coincide with need)
  - Assumptions and analysis carried out in trigger design
- Review of proposed process associated with trigger being activated.

11. This paper sets out GAD's comments following our review.

Limitations

12. This paper sets out our high-level comments about the trigger and is limited to the scope set out above. This review does not constitute "sign off" of the trigger.

13. In particular, GAD are not experts in weather and drought so our comments on the predictive nature of the trigger may be limited by this. Advice in this area should be sought from an appropriately qualified person or source.

14. In preparing this paper, GAD has relied on the documents supplied by OCHA, as listed in Annex A. In particular, we have relied on the general completeness and accuracy of the information without independent verification. We have not explicitly reviewed the data or analysis undertaken and have assumed the analysis has been done correctly in line with the documents setting out methodology.

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17. This work has been carried out in accordance with the applicable Technical Actuarial Standard TAS100 issued by the Financial Reporting Council (FRC). The FRC sets technical standards for actuarial work in the UK.

Malawi Dry Spells Anticipatory Action Framework

18. Working with partners, OCHA has facilitated the development of five collective anticipatory action pilots including Malawi (dry spells / floods). Each pilot comprises three core elements: the trigger (the model), the pre-agreed action plan (the delivery), and the pre-arranged financing (the money).

19. The objective of the Malawi dry spells pilot is to mitigate the impact of dry spells on vulnerable, at-risk individuals and communities in Malawi through collective, cross-sectoral anticipatory action. The pilot focuses on three distinct districts in the country's southern region that are characterised by exposure to dry spells, as well as high vulnerability.

20. In this context, dry spells are defined as 14 consecutive days with 0 to 2 millimetres of cumulative rainfall. This definition was provided by the World Food Programme.

21. The model for the 2021/2022 season makes use of a hybrid trigger model, comprising a predictive (stage I) and observational component (stage II).

22. The table below sets out the key features of each component.

	Predictive	Observational
Description	Weather forecasts for monthly cumulative rainfall. The probability is greater than 50% that the cumulative rainfall for the month to be less than 210mm	Observed dry spell. A 14 day period of less than 2mm cumulative rainfall
Location	The rainfall forecast applies to the whole Southern region	Must occur in 3 districts (not necessarily simultaneously) in the Southern region
Months can be triggered	November (for January) or December (for February)	Predominantly January or February. Can be triggered in March if dry spell began by 21 February)
Funding available	$1.4 million USD (20%)	$5.6 million USD (80%)

Multiple triggers allowed	Can only be triggered once during wet season	Can only be triggered once during wet season (and doesn't need predictive trigger to have occurred)
Reporting lag	No lag. Forecasts published middle of month	Typically 2 days after the dry spell has occurred
Funding used for	Protection activities by UNFPA Water, sanitation, and hygiene activities by IOM and UNICEF	Food, security, and livelihood activities by FAO and WFP, including unconditional cash assistance Nutrition activities by UNICEF and WFP

23. We understand that the trigger will be in place for at least the 2021/22 and 2022/23 wet seasons. We also understand the model will be reviewed ahead of the 2022/2023 season where changes could be incorporated.

Analysis underpinning the trigger development

Overview of analyses

1. We are aware of the following analyses that were carried out when developing the trigger:

   1.1 Data analyses to link the occurrence of a dry spell with various climatological indicators (set out in Centre for Humanitarian Data / OCHA paper dated 16 July 2021: Forecasting dry spells in Malawi). The analyses explore the relations with climatic indicators (observational data), the skill of a seasonal and 15-day forecast to predict dry spells, and the ability to observe dry spells in almost real-time. This work uses a list of historical dry spells and rainy seasons that was created as part of this project (see below section 1.2 below).

   1.2 A "groundtruth" dataset of dryspells in Malawi was created to inform the pilot (described in the Centre for Humanitarian Data / OCHA paper dated 21 July 2021: Dry Spells in Malawi). The paper provides a descriptive summary of the dataset.

   1.3 Analysis to understand if historical dry spells are correlated with various potential impact factors (set out in Centre for Humanitarian Data / OCHA / Map Action paper dated 26 April 2021: Exploring potential impacts of dry spells in Malawi). This analysis aimed to understand if historical dry spells are correlated with various potential impact factors, such as food insecurity, agricultural stress, and low crop production.

Commentary

2. In general, the analyses are comprehensive and follow a logical process. The documentation of the analyses is thorough and transparent and includes limitations. This will help with shared learning, and monitoring and evaluation.

3. However, we do not feel that the analyses are easily accessible to non-specialist audiences. They would benefit from clear summaries and signposting of conclusions that inform the trigger development.

4. We have not verified the analyses themselves and have assumed that they have been conducted to a high standard. Annex B sets out a list of actions we would have expect to have been taken as part of the analyses.

Recommendation: *You may wish to cross check the analysis carried out against the actions listed in Annex B.*

Recommendation: *Drawing on actuarial standards and best practice, GAD would be happy to provide further guidance on standard policies and procedures that could support the analyses underlying the development of triggers for anticipatory action. This would support the peer review guidance that you have in place.*

5. The analyses make a number of assumptions and simplifications through the line of sight from the trigger to dry spells to need, that the trigger is ultimately based on. In general, these are well reasoned, however data and empirical evidence are limited.

6. To the extent that these assumptions and simplifications are not borne out in practice, the analyses will not be accurate, and the trigger may not be reliable or effective. We recognise that a pragmatic approach has been taken but suggest that these assumptions and simplifications are revisited as experience and evidence emerges.

Recommendation: *You should revisit assumptions and simplifications as experience and evidence emerges.*

7. The analysis itself highlights the low statistical significance of the results presented given there were only a few occurrences of dry spells in the 20 years of data analysed.

8. Related to the above, we suggest that you consider the relevance of earlier data in the context of climate change, because the frequency of droughts will affect the cost of the triggers.

Recommendation: *You should consider the relevance of earlier data in the context of climate change.*

9. CHIRPS data is used throughout the analyses. As the documentation states this shows good accuracy in Malawi, but overpredicts below 1mm. It would be good to clarify what is meant by this and check that “overpredictions” still correlate with lack of rainfall.

10. The analyses comment that ECMWF’s seasonal forecast is an often used and trusted source and that the data is openly available.

Effectiveness and reliability of the proposed trigger

Basis risk

11. Basis risk is the risk that pay-out will not coincide with need.

12. In this context, the reliability and effectiveness of the trigger depends on:

12.1 The definition of “dry spells” being appropriate and “dry spells” (as defined) coinciding with need

12.2 The trigger correlating to a dry spell. The trigger could be actioned due to a false alarm resulting in an overpayment or the trigger could not be actioned when a dry spell occurs resulting in an underpayment.

Dry spells coinciding with need

13. The analysis carried out to understand if historical dry spells are correlated with various potential impact factors concluded that “dry spell prevalence in a region is positively correlated with the average temperature for that season, and negatively correlated with the minimum WRSI (geospatial water requirements satisfaction index) experienced that season and the total precipitation. The max ASI (agricultural stress index) and total IPC 3+ population (food insecurity) don’t have significant correlations against this dry spell measure.”

14. This analysis does not provide good evidence that dry spells will coincide with need. However, it comments that we should consider these results with a number of limitations in mind, and you should bear in mind comments on simplicity and pragmatism in sections 20 and 21.

15. We understand that as part of the pilot impact will be monitored and evaluated, with learnings shared. This should feed through to ongoing analysis and future iterations of the pilot and trigger.

Correlation between the trigger and a dry spell

16. The analysis carried out to link the occurrence of a dry spell to various climatological indicators indicated that:

16.1 The predictive trigger is expected to be met on average every other year. The analyses concluded that most of the dry spells can be detected, but this comes at a very high false alarm rate. However, the analyses also comment that “with a leadtime of 2 months, 50% (2/4) of the dry spells would be forecasted”, which appears to contradict that most of the dry spells can be detected.

16.2 The observational trigger is expected to be met every four years. As noted in paragraph 31 the analyses shows that the two data sources (ARC2 and CHIRPS) correspond to a large extent, with severe dry spell events detected by both sources.

17. Partly because of the challenges in forecasting dry spells, a hybrid trigger option was chosen which incorporates an observational trigger alongside a predictive trigger. These triggers are independent – the observational trigger can trigger even if the predictive trigger has not.

17.1 We understand that this approach has been taken given the extent that a solely predictive-based trigger would have resulted in false activations. Also, the hybrid option reduces the risk that a predictive trigger will fail to activate appropriate action and a dry spell subsequently occurs. The minority of funds (20%) is associated with the predictive element, which we consider appropriate given the error rate.

17.2 Given the weak evidence for correlation between the predictive trigger and dry spells, and dry spells and need it would be interesting to re-run the analysis to look at the direct correlation between the triggers and indicators of need (such as IPC 3+ population and ASI).

Recommendation: *Consider re-running the analysis to look at the direct correlation between the triggers and indicators of need (such as IPC 3+ and ASI).*

Basis risk impacts

18. Annex C sets out examples of where pay-out may not coincide with need in this context. This includes commentary on the impact and probability and is a starting point for further discussion or analyses (many of the comments are our expectations – we haven't carried out further analysis and we do not have direct expertise in many of these areas).

19. In particular, you should be aware of "cliff-edges" which are inherent in objective triggers like this. Note that for overpayment, you may wish to consider the opportunity cost of funding being used for this initiative rather than elsewhere.

Recommendation: Consider further investigation to populate Annex C with evidence. For the situations we have identified where a dry spell (as defined) may not coincide with need we recommend that you take expert opinion.

Simplicity and pragmatism

20. It is positive that the limitations of the pilot and trigger are recognised in the documentation.

21. The framework documentation and analyses, and our review highlight several potential issues with the trigger. However, we recognise the need for pragmatism, and these weaknesses should be balanced against:

    21.1 The advantages of having a simple, easily understood, and objective trigger.

    21.2 There are unlikely to be many alternatives. In terms of immediacy, rainfall data is likely the best option (for example, NDVI vegetation indices will take longer). There are unlikely to be any better weather forecasts for months ahead. However, it may be worth considering whether the 14-day dry spell definition is sufficiently sophisticated.

    21.3 The benefits of developing an anticipatory action trigger in terms of gathering evidence and experience to facilitate learning and inform future initiatives, particularly within the context of a pilot.

Proposed process associated with the trigger being activated

22. Prima facie, the trigger should lead to objective and timely action based on automated decision making:

    22.1 Both the predictive and observational triggers are well specified and measurable.

    22.2 The activation protocol has been well defined.

22.3 Financing from CERF has been pre-agreed in advance and linked to an action plan (although we expect that there is a more detailed plan than that outlined in the Anticipatory Action Framework), both of which will be actioned by the same trigger.

23. If not already in place, we recommend that internal checking procedures are put in place to ensure that the trigger is activated correctly. For example, any calculations are checked and reviewed before the trigger is activated.

Recommendation: *If not already in place, we recommend that checking procedures are established to ensure the trigger is activated correctly. For example, any underlying calculations are checked and reviewed.*

24. Independent calculation or verification of the trigger may enhance its credibility.

25. The trigger definitions and activation protocol are publicly available, which will allow external scrutiny as well as supporting shared learning, monitoring and evaluation.

26. The process described is objective and does not appear to allow for any subjectivity, discretion, or appeal. Whilst this has many benefits it should be balanced against the basis risk discussed in the previous section and considered in the context that this is a pilot with an untried trigger.

Data

27. Data underlies the process of activating the trigger. To the extent that the data is unreliable then the trigger will not be effective.

Observational trigger

28. The observational trigger uses the data source ARC2 from National Oceanic and Atmospheric Administration (NOAA). The data source uses satellite data combined with (limited) ground station data to estimate rainfall which is then used to determine dry spells for districts in the Southern region based on the definition of a dry spell.

29. Observational data by their nature should be objective and should trigger when dry spells have occurred. However, in the absence of local ground-based observations there will always be some errors in the estimates based on satellite information.

30. An alternative data source, CHIRPS, was considered and ruled out because of a delay in reporting. ARC2 reports results in 2 days compared to 2 months for CHIRPS. We understand that ARC2 may be a less reliable source of data[1] but agree that it is pragmatic to use a less reliable source of data for timely action. However, we recommend that results from ARC2 are continually monitored against the CHIRPS data.

31. The analyses shows that the two data sources correspond to a large extent. They do not fully overlap, but severe dry spell events were detected by both sources.

Recommendation: *We would recommend that results from ARC2 are continually monitored against the CHIRPS data.*

Predictive trigger

[1] https://rmets.onlinelibrary.wiley.com/doi/full/10.1002/qj.3244

32. The predictive trigger uses a probabilistic long-range forecast for the Southern region of Malawi from the European Centre for Medium-Range Weather Forecasts[2] (ECMWF). Forecasts by their nature are based on probabilities and are expected to be incorrect in some years.

33. Therefore, the predictive trigger may not result in need in the future (with this conclusion being backed up by the analysis). We cannot comment on the accuracy of the model underlying the probabilistic forecasts. However, we note the forecast will also depend on the quality of data available to inform the forecasting. Any improvements in quality of data could also benefit the observational trigger and/or underlying analysis when considering changes to the triggers.

34. As noted above, ECMWF's seasonal forecast is an often used and trusted source and that the data is openly available.

35. It is not clear if the ECMWF data has been checked against another source. It would be more robust if demonstrated predictions are in line with other predictions and/or the predictions are in line with the probabilities quoted.

General comments on data

36. To enable the trigger to be objective (see section on trigger activation process) the data should be independent of stakeholders and free from manipulation. We understand that both the ECMWF and ARC2 data sources are independent. On the basis the forecasts are done independently the ECMWF data is free from manipulation and we expect that it would not be possible to manipulate ARC2 data.

[2] https://www.ecmwf.int/

Annex A – Documents on which we have based our review

- Centre for Humanitarian Data / OCHA presentation dated 17 September 2021: AA Trigger Proposal
- Centre for Humanitarian Data / OCHA paper dated 21 July 2021: Dry Spells in Malawi
- Centre for Humanitarian Data / OCHA / Map Action paper dated 26 April 2021: Exploring potential impacts of dry spells in Malawi
- Centre for Humanitarian Data / OCHA paper dated 16 July 2021: Forecasting dry spells in Malawi
- Centre for Humanitarian Data / OCHA paper (undated): Detecting Dry Spells in Malawi – Learnings from developing an anticipatory action trigger
- OCHA paper dated 19 October 2021: Anticipatory Action Framework – Malawi dry spells pilot

Annex B – Recommendations for conducting analysis

This Annex sets out some of our key recommendations for ensuring the quality of analysis

- Calculations should be done as simply as possible to avoid the risk of error. This includes splitting calculations into intermediate stages.
- Calculations should include controls and self-checks
- Calculations should keep the amount of manual input to a minimum. This would include having clear parameters that are variable with calculations automatically following through.
- All calculations should be checked by someone other than the person who produced them by somebody. This should include:
    - Checking data against its source
    - Check calculation using a different method to the original method where possible.
    - Include a ‘back of the envelope’ calculation for reasonableness.
    - Checking outputs match the underlying analysis (e.g. tables, graphs and charts)
- Analysis should have thorough and clear documentation so other people can understand the analysis and be able to provide commentary on its appropriateness.
- A peer review should be considered by somebody independent from the process with the appropriate experience and expertise to carry out the review

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Annex C – Basis risk impacts

Description	Impact on populations	Likelihood of occurring
Prolonged dry spell: a period with cumulative rainfall marginally above 3mm. The crops do not have sufficient water but the trigger has not been met. This could also present itself in 13 day dry spells.	**Malawi** – Negative: potentially vulnerable populations at risk though further research would be required on impact. **Global** – Negative: increased cost of humanitarian aid without Anticipatory Action.	We have not seen analysis of how many times the trigger would have been met if the length of dry spell or amount of rainfall has changed
Prolonged low rainfall: a period where there are no dry spells but cumulative rainfall is considerably lower than average. For example, there was one year where rainfall in January was below 100mm.	**Malawi** – Negative: potentially vulnerable populations at risk though further research would be required on impact. **Global** – Negative: increased cost of humanitarian aid without Anticipatory Action.	Dependent on parameter used but we understand the less than 100mm was a 1 in 20 year event.
Dry spell in wet winter: a 14 day period of 2mm does not cause adverse outcomes. Perhaps because the dry spell occurred towards end and sufficient harvest made or because there was sufficient rainfall before	**Malawi** – Positive: we understand the majority of activities would be beneficial to people regardless of existence of dry spell **Global** – Negative: funding directed to Malawi where a need is not present, or less than	We have not seen analysis on whether the four dry spells that would result in a trigger correlated with significantly increased need in the vulnerable populations

and after so that crop damage did not take place due to reserves	expected, has an opportunity cost for other targets of funding	
Late or early dry spell than window: There is sufficient time to replant and/or harvest collected.	**Malawi** – Negative: potentially vulnerable populations at risk **Global** – Negative: increased cost of humanitarian aid without Anticipatory Action.	We expect this is unlikely due to narrower window included in trigger.
The predictive trigger is met without any dry spells observed.	**Malawi** – Positive: we understand the majority of activities would be beneficial to people regardless of existence of dry spell **Global** – Negative: funding directed to Malawi where a need is not present, or less than expected, has an opportunity cost for other targets of funding	The analysis estimates this would happen around every other year. This would have occurred in 9 out of the last 20 years.
The predictive trigger is met and money spent on some areas where dry spells are not observed.	**Malawi** – Positive: we understand the majority of activities would be beneficial to people regardless of existence of dry spell **Global** – Negative: funding directed to Malawi where a need is not present, or less than expected, has an opportunity cost for other targets of funding	Would expect to be smaller than above as out of the 9 years, there could be dry spells in 1 or 2 districts.
The observational trigger is met without dry spells observed.	**Malawi** – Positive: we understand the majority of activities would be beneficial to people regardless of existence of dry spell **Global** – Negative: funding directed to Malawi where a need is not present, or less than expected, has an opportunity cost for other targets of funding	Analysis could be produced that shows the likelihood of this. Analysis done shows discrepancy between two data sources suggesting there is a risk that this could occur

The observational trigger is met by districts without dry spells observed.	**Malawi** – Positive: we understand the majority of activities would be beneficial to people regardless of existence of dry spell Negative: potentially funding had been directed to wrong districts. E.g. if trigger subsequently met at later date by another district. **Global** – Negative: funding directed to Malawi where a need is not present, or less than expected, has an opportunity cost for other targets of funding	As above
The predictive trigger is not met and a dry spell is later observed.	**Malawi** – Negative: potentially vulnerable populations at risk. Would depend if predictive trigger met in previous year and knowledge retained. **Global** – Negative: increased cost of humanitarian aid without Anticipatory Action	The current design and last 20 years would indicate this would occur in half of the observed dry spells (2 out of 4)
The observational trigger is not met and a dry spell is observed in multiple districts	**Malawi** – Negative: potentially vulnerable populations at risk. **Global** – Negative: increased cost of humanitarian aid without Anticipatory Action	Analysis could be produced that shows the likelihood of this. Analysis done shows discrepancy between two data sources suggesting there is a risk that this could occur
The observational trigger is not met as only one or two districts have dry spells.	**To be investigated –** would it be the case it is set as 3 districts as a smaller population can be supported through other means?	Analysis could be produced that shows the likelihood of this.
The observational trigger is met by districts in need less and more vulnerable districts meet the trigger later where no funding remains.	**Malawi** – Positive for those in trigger: we understand the majority of activities would be beneficial to people regardless of existence of dry spell	Analysis could be produced that shows the likelihood of this.

	Negative for those not in trigger: vulnerable populations at risk unless funds can be redirected given **Global** – Negative: funding directed to Malawi where a need is not present, or less than expected, has an opportunity cost for other targets of funding. Might be increased cost of humanitarian aid without Anticipatory Action in districts not included	

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