PRIORITY NEEDS FOR DYNAMICAL-MODEL CLIMATE PREDICTION: QUESTIONNAIRE FOR SUPPLIERS OF CLIMATE FORECAST SERVICES IN THE ASEAN REGION

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1) Introduction

The first WMO sponsored ASEAN Regional Climate Outlook Forum (ASEANCOF) took place in Singapore in early December 2013. Ahead of this meeting, a questionnaire was circulated to all ASEAN National Meteorological and Hydrological Services (NMHSs) asking a number of questions to determine both the current usage of seasonal forecasting information and the requirements and priorities for additional products. This document summarises the responses and uses the information to determine the over-riding priorities for the region as a whole.

In what follows, the responses to each question will be looked at in turn and some conclusions drawn. An overall summary is provided at the end. Annex A contains a list of the organisations and individuals that completed the questionnaire.

2) QUESTION: What are the main methods used by your centre to provide long-range forecasts for your country or region?

Key: 1=main method, 2=secondary method.

2.1 Monthly forecast: 10-30 days ahead

	BRUNEI	INDONESIA	LAOS	MALAYSIA	MYANMAR	PHILIPPINES	SINGAPORE	THAILAND	VIETNAM	CAMBODIA
1. Issue forecast for this range?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
2. Methods (1=main method, 2=secondary method etc.)										
(a) statistical method(s) for your country or region	1	1	1	-	1	1	-	1	1	
(b) Dynamical model products, including website or data products from international centres	1	2	1	1	1	1	1	1	2	
(c) Other methods	-	-	-	-	2	-	-	Analog Method	-	

2.2 Seasonal forecast: 30 days to 6 months ahead

	BRUNEI	INDONESIA	LAOS	MALAYSIA	MYANMAR	PHILIPPINES	SINGAPORE	THAILAND	VIETNAM	CAMBODIA
1. Issue forecast for this range?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
2. Methods (1=main method, 2=secondary method etc.)										
(a) statistical method(s) for your country or region	1	1	1	2	1	1	1	1	1	
(b) Dynamical model products, including website or data products from international centres	1	2	1	1	1	1	1	1	2	
(c) Other methods	-	2	-	-	2	-	-	Analog Method	Statistical Downscaling Methods	

Summary 2.1 and 2.2: Respondents indicated that in providing monthly and seasonal forecasts for their country or region, both statistical and dynamical methods are used, with greater emphasis on statistical methods. Analog methods are also being used by at least one country.

2.3 Which are the main seasons of interest?

	BRUNEI	INDONESIA	LAOS	MALAYSIA	MYANMAR	PHILIPPINES	SINGAPORE	THAILAND	VIETNAM	CAMBODIA
Seasons of interest	-	ONDJFM AMJJAS	JAS NDJ	ONDJFM MJJA	MJJASO NDJF	MJJAS NDJFM	NDJ JJA FMAM SO	Feb May Oct	JJA DJF	

Summary 2.3: In general, all respondents indicated boreal winter and summer monsoons as seasons of interest but with variations in the season length definitions among countries. Typically the winter monsoon spans or partially spans the ONDJFM period, while the summer monsoon spans or partially spans the AMJJAS period.

3) Question. Who are the most frequent users of your climate services?

*Key: **N** =no contact from this sector, **O** =occasional user (1 or 2 enquiries per year), **R** =regular user (enquiries every 1 or 2 months), **F** =frequent user (enquiries every month or more than once a month)*

	BRUNEI	INDONESIA	LAOS	MALAYSIA	MYANMAR	PHILIPPINES	SINGAPORE	THAILAND	VIETNAM	CAMBODIA
(a) Agriculture/food security (including livestock)	N	F	R, F	R	R	F	N	F	R	
(b) Water resources	N	R	R	F	R	F	R	R	F	
(c) Health	N	O	O	R	F	R	O	R	N	
(d) Energy sector	N	O	R	O	-	F	O	R	F	
(e) Government body/ministry	R	R	R, F	F	R	F	R	R	R	
(f) NGOs	F	O	R	R	F	F	O	R	-	
(g) Organisations in disaster risk management	R	O	R, F	F	F	F	O	R	O	
(h) Other	O	-	-	O	R	R	-	-	-	

Summary 3: Of the groups of users that the countries provide climate services to, those that the countries come into contact with more regularly are Government Bodies/Ministries, Water Resource Managers, organisations in Disaster Risk Management, and users from the Agriculture and Food Security sectors. NGOs and users from the health and energy sectors are also some of the other users that countries work with.

4) QUESTION: What use do you make of long-range dynamical forecast products, including those from international centres?

In the following questions the basic set of global long-range prediction products made available by international centres are referred to as 'basic dynamical products'. Basic dynamical products include those mandatory for WMO Global Producing Centres (GPCs) for Long-range Forecasts and are defined (briefly) below.

Basic dynamical products: predictions of accumulations or averages for a 3-month period (for example, total precipitation for June-July-August, or mean temperature for the period March-April-May). Predictions are expressed as probabilities of three climatologically equi-probable (tercile) categories (below, near, above the long-term average for the location and time of year).

	Basic Dynamical Products	BRUNEI	INDONESIA	LAOS	MALAYSIA	MYANMAR	PHILIPPINES	SINGAPORE	THAILAND	VIETNAM	CAMBODIA
a)	Not aware of these products and never used them										
b)	Know about these products, but have bot used them										
c)	Occasional use of these products to prepare region/national seasonal forecasts				√			√			
d)	Regular use of these products to prepare regional/national seasonal forecasts	√	√	√	√	√	√		√		
e)	Main basis of the centre's national/regional seasonal forecast			√	√		√			√	
f)	Generates own dynamical seasonal forecasts for the country/region										

Summary 4: Most respondents indicated that they regularly use basic dynamical products (e.g. probabilistic forecasts of 3-month average/accumulated rainfall) for making seasonal forecasts. Around half of the respondents indicated that these products form the main basis of their forecasts.

5) QUESTION: What are the priorities for moving beyond the basic dynamical products of Q4?

For example, what *additional* dynamical products would be of most use to your centre to help meet the needs of your users?

For simplicity, please assume that all developments listed below are plausible and would have at least modest levels of skill. This may not be the case at present but the requirements should drive the research and development agenda.

Please rank the general areas listed below in terms of priority.

Key: *1=highest priority, 2= second priority etc, R: rainfall, T: temperature.*

	BRUNEI		INDONESIA		LAOS		MALAYSIA		MYANMAR		PHILIPPINES		SINGAPORE		THAILAND		VIETNAM		CAMBODIA	
Potential General Areas of Improvement	**R**	**T**	**R**	**T**	**R**	**T**	**R**	**T**	**R**	**T**	**R**	**T**	**R**	**T**	**R**	**T**	**R**	**T**	**R**	**T**
Spatial downscaling/tailoring of 3-month means: Develop greater spatial detail (downscaling) and better tailoring of 3-month-mean quantities e.g. probability of exceeding specified seasonal total rainfall/temperature amounts (other than terciles).	1	2	2	-	1	1	1	-	1	1	1	-	2	-	1	1	3	3		
Temporal distributions through the season & 1-month-ahead forecasts: Developing predictions of the temporal distribution through the season, e.g. predictions for timing of monsoon onset and cessation, risk of dry spells, anomalies for each month of the season (rather than 3-month averages). This could include development of extended-range forecasts made to 30 days ahead (1-month ahead), updated each week.	1	2	1	-	-	-	1	-	1	1	1	-	1	-	2	2	2	2		
Frequency of daily extremes: Develop forecasts of the frequency of extreme daily events within the season (e.g. number of days in season with daily rainfall > 90th percentile; number of days in season with Tmax > 90th percentile). This could include likelihood of consecutive days with extremes.	1	2	3	-	-	-	1	-	1	1	1	-	2	-	3	3	1	1		
Others	-	-	-	-	-	-	-	-	-	-	*1	-	-	-	-	-	-	-		

** Forecast of spatial and temporal distribution of rainfall 1-6 months ahead of the season*

Summary 5: Respondents indicated that beyond the basic dynamical products already in use, priorities for further research and development into additional products are,

a) Greater spatial detail (from downscaling).
b) Better tailoring of 3-month means (e.g. probability of exceedance beyond specified amounts)
c) Temporal distributions through the season
d) 1-month means
e) Information on frequency of extremes

These products would be considered very useful for precipitation forecasts and to a lesser degree for temperature.

6) Question: Do you currently use methods to provide predictions of the type listed in Q5?

(If more than one method is used please rank in order of importance: 1=main method, 2= secondary method etc…)

		Method									
	Prediction type	**BRUNEI**	**INDONESIA**	**LAOS**	**MALAYSIA**	**MYANMAR**	**PHILIPPINES**	**SINGAPORE**	**THAILAND**	**VIETNAM**	**CAMBODIA**
a)	Downscaled or tailed prediction of 3-month means	-	1- Dynamic	1- Statistical	1- Dynamical 2- Statistical	1- Analog 2- Statistical 2- Dynamical	-	1- Statistical 2- Dynamical	1- Statistical 2- Dynamical 3- Analog	1- Statistical	
b)	Prediction of temporal distribution through season	-	1- Statistical 2- Dynamical 3- Analog	1- Statistical	-	1- Analog 2- Statistical 2- Dynamical	1- Statistical	-	1- Statistical 2- Dynamical 3- Analog	1- Statistical	
c)	Prediction of the frequency of daily extremes through season	1- Statistical 2- Dynamical	1- Statistical	-	-	1- Analog 2- Statistical 2- Dynamical	-	-	1- Dynamical	-	

Summary 6: Different countries employ different combinations of methods (statistical, dynamical and analog), and at different levels of sophistication, to deliver some of the products listed in Q5. In general, statistical methods are used more widely than dynamical methods, while analog methods are not as commonly used as the other two. Responses from both questions 5 and 6 indicated that products (a) and (b) are in general of higher priority and given greater emphasis relative to the others.

7) Please answer some further questions on the need for temporal rainfall distributions through the season & 1-month-ahead forecasts.

Please rank the importance of predicting the following events. Key: *1,2,3,4 with 1=highest importance.*

		BRUNEI	INDONESIA	LAOS	MALAYSIA	MYANMAR	PHILIPPINES	SINGAPORE	THAILAND	VIETNAM	CAMBODIA
a	Onset timing of the rainy season	1	1	1	1	1	1	1	1	1	
b	Cessation timing of the rainy season	3	3	-	3	2	4	4	2	4	
c	Duration of rainy season (without specific onset/cessation timing)	2	2	-	2	1	2	2	4	2	
d	Risk of dry periods within the rainy season	4	4	-	4	2	3	3	3	3	

Summary 7: Among the 4 types of 'events' participants generally ranked them in the order of priority:

1. Onset timing of the rainy season
2. Duration of rainy season (without specific onset/cessation timing)
3. Cessation timing of the rainy season
4. Risk of dry seasons within the rainy season

This highlights the importance of onset timing and duration of rainy season above other applications in rainfall predictions.

8) Questions on the relative usefulness of monthly and seasonal forecasts.

8.1) Which of the following forecasts are more useful for the majority of applications?

Choices will need to consider the 'trade off' between long-lead on one hand, and forecast precision on the other.

Seasonal		Monthly	
An indication of onset timing 2-3 months ahead of normal onset date	1	A more precise indication of onset timing 2-3 weeks ahead of onset	4
An indication of season cessation (and season duration) 1-2 months ahead of the normal onset date	2	A more precise indication of cessation timing 2-3 weeks ahead of the event	5
A general indication of the likely frequency (but not timing) of dry spells within the season 1-2 months ahead of season start	3	An indication of the timing of dry spells over the next 2-3 weeks, once the season has started	6

(In each row, please tick the box to the right of forecast deemed more useful).

BRUNEI				INDONESIA				LAOS				MALAYSIA				MYANMAR				PHILIPPINES					SINGAPORE				THAILAND				VIETNAM					CAMBODIA			
Seasonal		Monthly		Seasonal		Monthly		Seasonal		Monthly		Seasonal		Monthly		Seasonal		Monthly		Seasonal		Monthly		Cmt	Seasonal		Monthly		Cmt	Seasonal		Monthly		Seasonal		Monthly		Cmt	Seasonal		Monthly	
1		4	√	1		4	√	1	-	4	No	1	√	4	√	1		4	√	1	√	4		*C1	1		4	√	*C3	1	√	4		1	√	4		*C6	1		4	
2		5	√	2		5	√	2	-	5	No	2		5		2		5	√	2		5	√	*C2	2	√	5		*C4	2	√	5		2		5	√	*C7	2		5	
3	√	6		3	√	6		3	-	6	No	3		6		3		6	√	3	√	6	√		3	√	6		*C5	3	√	6		3		6	√		3		6	

Individual country comments on their responses:

C1 - ***Philippines****: Farmers need to decide when to do the land preparation, avail of financing etc.*

C2 - Philippines*: Climate info users need to decide what to do best for the next planting season.*

C3 - Singapore*: 2-3 months of lead time too early ahead for advisory to be issued to end users in hydro sector*

C4 - Singapore*: Usually a general sense of when the season would ease would be good enough.*

C5 - ***Singapore****: Sufficient to know the level of seriousness/ extent of dry spells required pre-season. Within season will timing come in critical.*

C6 - Vietnam*: 1. For Hydrology to control water level in dam to servise to Agricultural*

2. For product of clothes like warm or cool types

C7 - Vietnam*: For reserve water or none*

Summary 8.1: For applications concerning monsoon onset timing, monsoon cessation timing and likely frequency of dry spell, there was a mix of responses in indicating if having forecasts with lead times around 2-3 months ahead (seasonal forecast) would be more useful than having forecasts with lead times 2-3

weeks ahead (monthly forecasts) or vice versa. Responses vary markedly because requirements are application-dependent and different countries have unique requirements.

8.2) Information on the degrees of earliness, lateness and duration of monsoons (*in days*).

	BRUNEI	INDONESIA	LAOS	MALAYSIA	MYANMAR	PHILIPPINES	SINGAPORE	THAILAND	VIETNAM	CAMBODIA
Onset/Cessation:										
1 How many days late (early) must onset (cessation) be before the lateness (earliness) is considered **significant**?	14	20	7	7-14	7-10	10-15	20	-	-	
2 How many days late (early) must onset (cessation) be before it is considered **exceptional** by users (e.g. once in 10 year event)?	30	30	14	14-21	-	15-30	30	-	-	
3 How many days late (early) must onset (cessation) be before it is considered an "extreme" by users (e.g. once in 50 year event)?	60	60	10	21-28	-	> 30	60	-	-	
Duration:										
1 How many weeks longer (shorter) than normal must a season be before it is considered a **significant** lengthening (shortening)?	14	30	14	7-14	14-21	10-15	15-30	-	-	
2 How many weeks longer (shorter) than normal must a season be before it is considered **exceptional** (once in 10 year event)?	30	60	7	14-21	-	15-30	30	-	-	
3 How many weeks longer (shorter) than normal must a season be before it is considered **extreme** (once in 50 year event)?	60	90	14	21-28	-	> 30	90	-	-	

Summary 8.2: For monsoons, respondents indicated in general that if their onsets (cessation) were late (early) by about 15 days, it would be considered *significant*, about 25 days would be considered *exceptional*, and anything longer than about 45 days to be *extrem*e. Similarly for monsoon durations, approximately 15 days longer (shorter) than the normal duration would be considered *significant*, 30 days longer (shorter) would be considered *exceptional* and more than 50 days would be considered *extreme.*

8.3) Information on the duration of dry spells (*in days*).

	BRUNEI	INDONESIA	LAOS	MALAYSIA	MYANMAR	PHILIPPINES	SINGAPORE	THAILAND	VIETNAM	CAMBODIA
1 How many days with little or no rain represent a **significant** dry spell? (give lowest number)	7	20	7	5-10	3-5	21	15-20	7	-	
2 How many days with little or no rain represent an **exceptional** dry spell?	30	30	-	30	-	30-60	30	15	-	
3 How many days with little or no rain represent an **extreme** dry spell?	60	60	21	90	-	> 60	60	30	-	

Summary 8.3: For duration of dry spells, respondents indicated that approximately 10 days of continuous dry days would be considered *significant*, around 30 days would be considered *exceptional*, and around more than 60 days would be considered extreme.

8.4 Temporal Distribution: RAINFALL

For forecasts issued 1 or 2 months ahead of the season start, please indicate the usefulness of the following levels of temporal detail.

(Usefulness: No use , Limited use , Useful , Very useful)

	BRUNEI	INDONESIA	LAOS	MALAYSIA	MYANMAR	PHILIPPINES	SINGAPORE	THAILAND	VIETNAM	CAMBODIA
a) Calendar month sequences predicted ahead of the season (e.g. individual predictions for Jun, Jul and Aug as well as Jun-Aug total.	Very useful	Useful	Useful	Very useful	Useful	Very useful	Very useful	Very useful	Very useful	
b) Predictions for totals in the first half and second half of the season.	Very useful	Useful	-	Useful	Useful	Limited use	Useful	Very useful	Very useful	

8.4 Temporal Distribution: TEMPERATURE

For forecasts issued 1 or 2 months ahead of the season start, please indicate the usefulness of the following levels of temporal detail.

(Usefulness: No use , Limited use , Useful , Very useful)

	BRUNEI	INDONESIA	LAOS	MALAYSIA	MYANMAR	PHILIPPINES	SINGAPORE	THAILAND	VIETNAM	CAMBODIA
a) Calendar month sequences predicted ahead of the season (e.g. individual predictions for Jun, Jul and Aug as well as Jun-Aug mean.	Useful	Useful	Useful	Limited use	Useful	Very useful	*Useful	Very useful	Very useful	
b) Probability that anomalies will be larger in the first or second half of the season.	Useful	Useful	Useful	Limited use	Useful	Limited use	*Useful	Very useful	Very useful	

Summary 8.4: Most respondents indicated that they would find very it useful to have individual month predictions (note WMOLC website already provides these) more so for rainfall than for temperature. Respondents had also indicated that it could be useful to have predictions for rainfall totals in the first half and second half of the season, as well as probability of temperature anomalies being higher in the first or second half of the season

9) Definition and identification of rainy-season onset and cessation.

Key: ***Subjective*** *: e.g. based on observed rainfall, but no quantitative measure used;* ***Objective*** *: e.g. based on rainfall above/below a threshold at selected stations for a continuous period; If* ***Objective*** *or* ***Other*** *method, please give details or a reference.*

	BRUNEI	INDONESIA	LAOS	MALAYSIA	MYANMAR	PHILIPPINES	SINGAPORE	THAILAND	VIETNAM	CAMBODIA
How do you define rainy season onset?	Subjective	Other[1]	Objective	Objective	Objective[2]	Objective	Subjective[3]	Objective[4]	Objective[5]	
How do you define rainy season cessation?	Subjective	Other[6]	Objective	Subjective	Objective[7]	Subjective	Subjective[8]	Objective[9]	Objective[10]	

Notes:

1. ***Indonesia*** *: Rainy season onset if total cumulative rainfall for 10 days > 50 mm and it's should consecutive for 30 days OR total rainfall for 30 days > 150 mm*
2. ***Myanmar*** *: Analog, NWP model, other outputs*
3. ***Singapore*** *: currently exploring more objective ways*
4. ***Thailand*** *: 1. Upper level wind changed to be easterly*
   2. Lower level wind changed to be westerly or southwest wind
   3. amount of rainfall during 5-day must be more than 25 mm
5. ***Vietnam*** *: 100 mm/month to start rainy season*
6. ***Indonesia*** *: Don't define rainy season cessation, but we can define it if we have define dry season onset. Dry season onset begin when total cumulative rainfall for 10-days < 50 mm and it's should consecutive for 30 days OR total rainfall for 30 days < 150 mm*
7. ***Myanmar****: Analog, NWP model, other outputs*
8. ***Singapore*** *: curently exploring more subjective ways*
9. ***Thailand*** *: 1. Reducing rainfall*
   2. The wind patterns were as follows:
   - lower-level winds changed to be easterly and northeasterly.
   - upper-level winds changed to be westerly
10. ***Vietnam*** *: under 100 mm/month to finish rainy season*

Summary 9: While most respondents indicated that they use objective methods to define the onset and cessation of rainy season, identification methods vary across countries with different countries using different thresholds of rainfall and large-scale circulation patterns.

10) Forecasts of wind

Currently GPCs do not make available forecasts of surface or upper level winds. Assuming that there is a usable level of skill in such forecasts (this needs to be assessed for our region), can you please answer the following questions:

	BRUNEI		INDONESIA		LAOS		MALAYSIA		MYANMAR	
Product	**Useful? (Yes/No)**	**Main use of this wind product**	**Useful? (Yes/No)**	**Main use of this wind product**	**Useful? (Yes/No)**	**Main use of this wind product**	**Useful? (Yes/No)**	**Main use of this wind product**	**Useful? (Yes/No)**	**Main use of this wind product**
Near surface winds	Yes	Most requested forecast by marine related users	Yes	-	Yes	-	Yes	-	Yes	
Upper level winds	Yes	useful level: 700	Yes	useful level: 200	Yes	useful level: 900, 850, 700	Yes	useful level: 850, 700, 500, 200	Yes	useful level: 200

	PHILIPPINES		SINGAPORE		THAILAND		VIETNAM		CAMBODIA	
Product	**Useful? (Yes/No)**	**Main use of this wind product**	**Useful? (Yes/No)**	**Main use of this wind product**	**Useful? (Yes/No)**	**Main use of this wind product**	**Useful? (Yes/No)**	**Main use of this wind product**	**Useful? (Yes/No)**	**Main use of this wind product**
Near surface winds	Yes	To most farmers particular during flowering period	Yes	-	Yes	-	-	-		
Upper level winds	Yes	useful level: 1000, 850, 200	Yes	useful level: 850, 925, 700	Yes	useful level: 850, 500, 300, 200	Yes	useful level: 500		

Summary 10: All respondents thought that it would be useful if Global Producing Centres (GPCs) could provide wind forecasts for surface and upper levels. For upper winds, 200 hPa, 300 hPa, 500 hPa, 700 hPa, 850 hPa, 925 hPa levels would be considered useful. Of these, 200 hPa and 850 hPa were the most cited levels. Near-surface wind products have been requested for by users such as those from the marine industry, as well as farmers during the flowering periods.

11) Tropical storm forecasts for the season ahead

	BRUNEI	INDONESIA	LAOS	MALAYSIA	MYANMAR	PHILIPPINES	SINGAPORE	THAILAND	VIETNAM	CAMBODIA
Do you currently make use of long-range forecasts of tropical storm numbers and energy?	No	Yes	No	No	Yes	Yes only for the numbers	No	Yes	Yes	
If yes, state the geographical region that is of most interest:	-	*50W-240W, 30S-30N*	-	-	*Along the coastal areas*	*Philippines area of responsibility*	-	*West Pacific and northern Indian Ocean*	*Center of my country*	
Do you use statistical or dynamical forecasts of tropical storm numbers and energy?	No	Yes statistical forecast	-	-	Yes	Yes only for the numbers	No	Yes	Yes statistical forecast	
What would be the most useful additional long range forecast products in relation to tropical storms?	-	To predict total monthly rainfall	-	-	-	Numbers and probable tropical cyclone tracks	-	SST	The number and average track of storms	

Summary 11: For long-range forecast products of tropical storm (TS) numbers and energy, there are existing efforts to provide such forecasts for countries which are affected by TSs. Some respondents indicated using only statistical tools and forecasting for only TS numbers, but not TS energy. Individual responses indicated that it would be useful to have forecasts for total monthly rainfall contributed by TSs, probable TS tracks and numbers for the season ahead.

12) Do you have an agreed measure defining levels of rainfall that can cause damage/disruption in your country (e.g. more than x mm in y hours or days)?

BRUNEI	INDONESIA	LAOS	MALAYSIA	MYANMAR	PHILIPPINES	SINGAPORE	THAILAND	VIETNAM	CAMBODIA
No	More than 100 mm/day	-	Yes	No, we issue only y hrs or days	Moderate - 2.5-7.5 mm/hr Heavy - 7.6-15 mm/hr Torrential > 30 mm/hr	*See *note*	-	About over 100 mm/day and continuous several days depend on each areas	

**** Note (Singapore):***

- For issuing weather situation report post event - rainfall in 60 minutes recorded is 70 mm or more (or 35 mm or more in 30 minutes) For issuing of warnings, more than.

- For forecasting heavy rainfall ahead of event – if observed rainfall rate is 25 mm/hr and system is 'large' and/or 'stationary'.

Summary 12: Most countries have a way of defining damaging rainfall rates, but thresholds and methods (mm/day or mm/hr) vary for different applications in different countries.

13) Observation datasets used

Which observational datasets do you use to monitor historical and recent climate variability in your country/region?

		BRUNEI	INDONESIA	LAOS	MALAYSIA	MYANMAR	PHILIPPINES	SINGAPORE	THAILAND	VIETNAM	CAMBODIA
a	National observational network	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
B	Station data provided by third party	-	Yes	-	Yes	-	-	Yes	-	-	
c	Re-analysis datasets (eg. ERA-40, ERA-Interim, NCEP, MERRA)	-	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	
d	Monthly gridded observational datasets from external provider (eg. GPCP, GPCC, CAMS-OPI, CRUTEMS, GISS, NCDC, HadISST)	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
e	Daily gridded observational datasets from external providers (eg. GPCP, CPC-Gauge, HadGHCND, HadEX)	-	Yes	-	Yes	Yes	-	Yes	Yes	-	
f	Own gridded datatsets	-	Yes	-	Yes	-	-	No	-	-	
g	Other -please specify	-	-	-	-	-	-	-	-	-	

Summary 13: For monitoring historical and recent climate variability in their country or for the region, most countries will use their national observational network, followed by monthly gridded datasets provided by external parties (e.g. GPCP and NCDC), reanalysis datasets (e.g. ERA-Interim/40, NCEP), and daily-gridded observational datasets (e.g. CPC-gauge, HadEX). Only a few of the countries use station data provided by third-parties or have their own gridded datasets.

14) OVERALL SUMMARY

The respondents indicated that in providing monthly and seasonal forecasts for their country or region, both statistical and dynamical methods are used, with greater emphasis on statistical methods. Analog methods are also used in two countries. In general, all respondents indicated boreal winter and summer monsoons as seasons of interest but with variations in season length definitions among countries. Typically, the boreal winter monsoon season spans or partially spans the months October through March, while the boreal summer monsoon spans or partially spans the months April through September. Of the groups of users that the countries provide climate services to, those that the countries come into contact with more regularly are government bodies/ministries, water resource managers, organisations in disaster risk management, and users from the agriculture and food security sectors. NGOs and users from the health and energy sectors are also some of the others that countries work with.

Most respondents indicated that they regularly use basic dynamical products (e.g. probabilistic forecasts of three-month average/accumulated rainfall) for producing their national seasonal forecasts. Around half of the respondents indicated that these products form the main basis of their forecasts. Respondents indicated that beyond the basic dynamical products already in use, further research and development into additional products is required involving for example: greater spatial detail, better tailoring of three-month means (e.g. probability of exceedances beyond specified amounts), temporal distributions through the season, one-month means and frequency of extremes. These products would be considered very useful for precipitation forecasts and to a lesser degree for temperature.

For applications concerning onset and cessation timing of monsoons, duration of rainy seasons and likely frequency of dry spells, the following priority order emerged for enhanced products (a) onset timing of the rainy season, (b) duration of the rainy season (without specific onset/cessation timing), (c) cessation timing of the rainy season and (d) risk of dry seasons within the rainy season. There was a mix of responses in indicating if having forecasts with lead times of around two to three months (seasonal forecast) would be more useful than having forecasts with lead times of two to three weeks (monthly forecasts) or vice versa. Responses vary markedly because requirements are application-dependent and different countries have unique requirements. Respondents indicated in general that if their onsets (cessation) were late (early) by about 15 days, it would be considered significant, about 25 days would be considered exceptional, and anything longer than about 45 days would be considered extreme. Similarly for monsoon durations, approximately 15 days longer (shorter) than the normal duration would be considered significant, 30 days longer (shorter) would be considered exceptional and more than 50 days would be considered extreme. For duration of dry spells, respondents indicated that approximately 10 days of continuous dry days would be considered significant, around 30 days would be considered exceptional, and around more than 60 days would be considered extreme. Most countries have a way of defining damaging rainfall rates, but thresholds and methods (mm/day or mm/hour) vary for different applications in different countries. While most respondents indicated that they use objective methods to define the onset and cessation of rainy season, identification methods vary across countries with different countries using different thresholds of rainfall and large-scale circulation patterns.

Most respondents indicated that they would find it very useful to have individual month predictions (note WMO LRFMME website already provides these), more so for rainfall than for temperature. Respondents had also indicated that it could be useful to have predictions for rainfall totals in the first half and second half of the season, as well as probability of temperature anomalies being higher in the first or second half of the season.

All respondents thought that it would be useful if GPCs could provide wind forecasts for surface and upper levels. For upper level winds, 200 hPa, 300 hPa, 500 hPa, 700 hPa, 850 hPa and 925 hPa levels would be considered useful. Of these, 200 hPa and 850 hPa were the most cited levels. Near-surface wind products have been requested by users from the marine industry, as well as farmers during the flowering periods.

For long-range forecast products of tropical storm (TS) numbers and energy, there are existing efforts to provide such forecasts for countries which are affected by TSs. Some respondents indicated using only statistical tools and forecasting for only TS numbers, but not TS energy. Individual responses indicated that it would be useful to have forecasts for total monthly rainfall contributed by TSs, probable TS tracks and numbers for the season ahead.

For monitoring historical and recent climate variability in their country or for the region, most countries use their national observational network, followed by monthly gridded datasets provided by external parties (e.g. GPCP and NCDC), reanalysis datasets (e.g. ERA-Interim/40, NCEP), and daily-gridded observational datasets (e.g. CPC-gauge, HadEX). Only a few of the countries use station data provided by third parties or have their own gridded datasets.

The following recommendations were derived from the responses to the questionnaire. There were basically two areas to consider: (a) making better use of what already exists and (b) the development of new products.

(a) Recommendations on making better use of what already exists

To review methodologies and share experience in the following areas:

- Downscaling and producing greater spatial detail in the forecast
- Better tailoring of monthly means to seasons
- Availability of one-month means and advice on use
- Skill information available on the WMO-LC and APCC sites and guidance on how to use it
- Access to monthly forecast products (e.g. from ECMWF)
- Review products currently available for tropical storm numbers, density and energy and suggest enhancements.

(b) Recommendations on the development of new products

- Investigate the capability of the GPC modelling systems to produce skillful forecasts of monsoon onset, rainy season length, risk of extended dry spells and daily extremes. It is noted that there will be different skill levels across the region. Some of this work has been done in other areas of the world.

- Relate the GCM-based onset (and other) definitions to the variety of in-country definitions, and investigate more precise indication of onset timing two to three weeks ahead of onset on an experimental basis.

- Investigate skill of diagnostics from GPC tropical wind forecasts in the Southeast Asia region.

In addition to the above, it was noted that there is a requirement for improved regional climate monitoring in Southeast Asia. A good start has been made by Indonesia with the SACA&D project led by BMKG and this could be taken as the foundation for an enhanced monitoring activity.

ANNEX A

Profile of respondent and respondent's organisation

COUNTRY	Officer Name	Email	Organisation	Department/Section	Job Position	Experience in climate services/prediction	No. of staff work on climate services/ prediction
BRUNEI	HARNINA MORANI	harnina.morani@met.gov.bn harnina.morani@gmail.com	Brunei Darussalam Meteorological Department	Climate Services and Weather Services Division	Meteorological Officer	< 1 Year	6 *(4 Climate Services, 2 Climate Predictions)*
INDONESIA	ROBI MUHARSYAH	robi.muharsyah@gmail.com	BMKG	Center for Climate, Agroclimate and Marine Climate	Staff of Climate Analysis and Information	6 Years	400 *(Total BMKG's Staff ~4500)*
LAOS	CHANTHANA Sinthaly	Sinthaly2@gmail.com	Department of Meteorology and Hydrology	Weather forecasting and aeronautical division	Deputy Head	3 Years	4
MALAYSIA	Norjana binti Jamal	norjana@met.gov.my	MMD	Climatological & Hidrological Section	Meteorological Officer	5 Years	15
MYANMAR	Dr. TIN MAR HTAY	tmarhtay@gmail.com	Department of Meteorology and Hydrology	Meteorological Division, Weather Forecasting Section	Deputy Superintendent	7 Years	10
PHILIPPINES	ANTHONY JOSEPH R LUCERO	dong_lucero@yahoo.com	PAGASA	Climate Monitoring and prediction Section (CLIMPS)	Officer-In-Charge, CLIMPS	28 Years	11
SINGAPORE	Raizan RAHMAT	raizan_rahmat@nea.gov.sg	Meteorological Service Singapore (MSS)	Centre for Climate Research, Singapore (CCRS)	Research Scientist	5 Years	6 *(3 Research, 3 Operational)*
THAILAND	Kornrawee Sitthichivapak	kornrawee@tmd.go.th	Thai Meteorological Department	Climatological Center	The Senior Meteorologist	25 Years	16
VIETNAM	Nguyen Thi Diem Huong	huongdiem.nchmf@gmail.com	National centre for Hydro-Meteorological forecasting	Medium-Long range forecast of division	Forecaster	4 Years	28 *(10 medium-long range forecast, 18 short range forecast)*