PN-ABG-249

REVIEW OF THE PAGASA TROPICAL CYCLONE WARNING SYSTEM

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EXECUTIVE SUMMARY

This report details the results of a review of the Philippine tropical cyclone warning system. In particular, warning message content and structure was analyzed with respect to how well it causes appropriate public response. This analysis considers the findings of other researchers (most notably Mr. Amadore and colleagues of PAGASA) and the body of knowledge about what motivates people to respond. Mr. Holliday was on-scene at PAGASA while warnings were being issued for one of the two major 1984 typhoon disasters (Agnes, November 1984) and he also surveyed a portion of the disaster area. To this extent many of his impressions are first hand.

Mr. Holliday has offered fifteen specific recommendations which, he argues persuasively, should improve public response to PAGASA warnings. All of his recommendations are within the capability of PAGASA to perform with little or no additional assets. Few, if any, appear to require legislative or ministerial level approval or changes. None require additional communications hardware although the full measure of improvement cannot be realized without a reliable communications system.

Probably the most important recommendations are those which suggest technical changes in the public signal system as well as procedural changes in establishing and changing signals. Of slightly lesser importance is a recommended re-phrasing of the signal messages to emphasize the important and to reduce clutter.

Section I
INTRODUCTION

Typhoon damage and casualty statistics in the Philippines indicate a disturbing trend in the proportional increase in loss of life compared to damage in recent decades (Kintanar, et al., 1979). The recent disastrous typhoons Nitang (Ike), and Undang (Agnes) during 1984 in which 1800 deaths occurred, unfortunately, proves further evidence of this trend.

In the case of typhoon Ike (1028 killed) track prediction offered relatively few problems, key warning information was released in sufficient time for precautions to be taken, and post disaster interviews revealed most residents had heard the warnings in repeated radio broadcasts (Amadore and Holliday, 1985). However, few heeded this advice.

The WMO's study of human response to tropical cyclone warnings (WMO, 1982) states that a successful warning system encompasses more than just the preparation and dissemination of warning messages to the population at risk. It must also take into account the human reaction element, and those factors which will trigger an appropriate response to the hazard threat. Thus, a vital function of any warning message is to ensure it produces the desired effect on the audience addressed. The content of the warning, and the wording used is of great importance if it is to be persuasive.

Following recommendations by Sanders (1984), this paper reviews aspects of the present PAGASA warning message content and structure, and offers an analysis of alternatives for developing portions of the domestic bulletin.

Section II

BACKGROUND - CURRENT PRACTICES

1. Area of Responsibility

PAGASA warnings are prepared when tropical cyclones cross westward of 135° east longitude (south of 25° north latitude) and remain east of 115° east longitude in the South China Sea. If the tropical cyclone poses a threat to the islands, Domestic Bulletins are prepared. Bulletins to shipping are issued as long as the storm remains within the area of responsibility.

2. Warning Terminology

The alerting system for domestic interests is delineated into three successive threat levels utilizing a signal numbering system (combining wind condition and time of arrival). Definitions for these signals are given below (WMO, 1982).

a. Public Storm Signal One (PSS #1): Existence of a tropical cyclone. Winds up to 50 KPH (32 kt) may be expected in the display area within 36 hours.

b. Public Storm Signal Two (PSS #2): Tropical cyclone is approaching or passing close to locality. Winds of 60 KPH-100 KPH (32-55 kt) may be expected in the display area within 24 hours.

c. Public Storm Signal Three (PSS #3): The center of the tropical cyclone is expected to pass close to or over the display area. Winds in excess of 100 KPH (55 kt) would be expected over these areas within the next 12 hours.

3. Domestic Bulletin

a. Issuance Times

This warning message is prepared for the general public and disseminated to domestic interests every 6 hours (5 AM, 11AM, 5 PM, and 11 PM). Supplementary advisories may be issued if a severe typhoon threatens Manila, otherwise such advisories are infrequent.

b. Format and Content

The domestic bulletin is structured into a four-part format following an order of specific details first and warning information second. Its contents include the following:

(1) location and characteristics
(2) 12-hr forecast position
(3) signal coverage, and storm effects
(4) precautionary information.

All bulletins begin with a lead paragraph citing the tropical cyclone's location (expressed both as distance and direction relative to a geographic reference point, and as latitude and longitude of the cyclone center), maximum winds near the center (Kph), and the valid time/date of this information. In addiiton, a 12-hour movement forecast [direction (16 points of the compass) and speed (Kph)] is provided including a well-known reference point (island, island group or city).

The second section is short, stating the future location of the cyclone center (12 hours from valid time) in terminology of the preceding paragraph (distance and direction relative to a geographic point, and latitude/longitude).

Bulletins summarize all signal coverage in effect in the third section. The detail of geographical assignment in signal display is dependent on the tropical cyclones relative distance to the archipelago. Storms not of immediate threat (usually PSS#1) require only broader geographic reference such as large islands (i.e., Samar, Leyte) or island groups (i.e., eastern Visayas). For storms of more immediate threat (PSS#2/3), coverage is expressed in specific province listing including smaller offshore islands (i.e., Camarines Norte, Camarines Sur, Albay, Sorsogan and Catanduanes).

Each signal level paragraph includes a brief sentence regarding the threat elements likely to affect a locality. The standard elements used are shown in Table 1, and include general weather, wind gust character, and coastal water conditions. The degree of severity is based upon the signal level assigned.

Precautionary information is assigned to the final paragraph usually of one sentence length which also contains the time of next bulletin issuance. Precautionary advice is given when PSS#2 or #3 are in effect (see Table 1). Under these conditions, the public is advised to "Take all precautions, and watch for the next bulletin".

Table 1

Hazard Elements and Precautionary Information Contained in the Domestic Bulletin

SIGNAL #	General Weather	Wind Conditions	Coastal Water Conditions	Precautions
PSS #1	Occasional Rains/Rains	Occasional Gusty (Less than 60 Kph)	Moderate to Rough	----------
PSS#2	Rains/ Stormy	Gusty/ Strong Gusty (60-100 Kph)	Rough and Dangerous to Small Seacraft	Take all Precautions Watch for next Bulletin
PSS#3	Stormy	Strong/Gusty Very Strong Gusty (above 100 Kph)	Very Rough and Dangerous to all Seacraft	Take all Precautions Watch for next Bulletin

c. Examples of Domestic Bulletins

(1) Typhoon possible threat to the Archipelago

DOMESTIC BULLETIN NUMBER 01
ISSUED AT 10:45 AM 03 NOVEMBER 1984

AT 10:00 AM TODAY, 03 NOVEMBER TYPHOON "UNDANG" WAS LOCATED 1050 KM EAST SOUTHEAST OF BORONGAN, SAMAR OR AT 9.3 DEG NORTH LAT. 134.8 DEG. EAST LONG., WITH MAXIMUM WINDS OF 145 KPH NEAR THE CENTER. IT IS EXPECTED TO MOVE WEST NORTHWEST AT 22 KPH IN THE GENERAL DIRECTION OF SAMAR.

FORECAST POSITION: AT 8PM 03 NOV. 830 KMS EAST SOUTHEAST OF BORONGAN, SAMAR OR AT 9.9 DEG. NORTH LAT. 132.8 DEG, EAST LONG.

PUBLIC STORM SIGNAL NUMBER ONE NOW HOISTED OVER EASTERN VISAYAS AND NORTHEASTERN MINDANAO, WHERE OCCASIONAL RAINS AND OCCASIONAL GUSTY WINDS OF NOT MORE THAN 60 KPH WILL BE EXPERIENCED TOMORROW.

THE NEXT BULLETIN WILL BE ISSUED AT 5 PM TODAY.

(2) Typhoon Passing Close to Archipelago

DOMESTIC BULLETIN NUMBER FIVE
ISSUED AT 10:50 AM JUNE 21, 1985

AT 10AM TODAY 21 JUNE TYPHOON KURING WAS ESTIMATED 540 KM EAST SOUTHEAST OF APARRI CAGAYAN OR AT 16.4 DEG N LAT 126.4 DEG E LONG WITH MAXIMUM WINDS OF 130 KPH NEAR THE CENTER. IT IS EXPECTED TO MOVE WNW AT 18 KPH IN THE GENERAL DIRECTION OF EXTREME NORTHERN LUZON.

FORECAST POSITION:

AT 8PM 21 JUNE 380 KM ESE OF APAPRI CAGAYAN OR AT 17.0 DEG N LAT 124.9 DEG E LONG.

PUBLIC STORM SIGNAL NUMBER TWO NOW HOISTED OVER CAGAYAN AND ISABELA WHICH WILL HAVE RAINS AND GUSTY WINDS TODAY BECOMING STORMY TOMORROW. COASTAL WATERS WILL BECOME ROUGH AND DANGEROUS TO SEA CRAFTS.

PUBLIC STORM SIGNAL NUMBER ONE REMAINS HOISTED OVER METRO MANILA AND REST OF LUZON WHERE OCCASIONAL RAINS AND GUSTY WINDS OF NOT MORE THAN 60 KPH WILL BE EXPERIENCED TODAY. COASTAL WATERS WILL BE MODERATE TO ROUGH.

PUBLIC STORM SIGNAL NUMBER ONE OVER VISAYAS IS NOW LOWERED. THE NEXT BULLETIN WILL BE ISSUED AT 6 PM TODAY.

(3) Typhoon Center will Strike Archipelago

DOMESTIC BULLETIN NUMBER FIVE
ISSUED AT 10:45AM 01 SEPTEMBER 1984

AT 10AM TODAY, 01 SEPTEMBER TYPHOON NITANG WAS ESTIMATED 390 KM EAST OF SURIGAO CITY OR 265 KM EASTSOUTHEAST OF GUIUAN, SAMAR OR AT 09.7 DEG N LAT 129.1 DEG E LONG., WITH MAXIMUM WINDS OF 185 KPH NEAR THE CENTER. IT IS EXPECTED TO MOVE WESTWARD AT 22KPH IN THE GENERAL DIRECTION OF EASTERN VISAYAS AND NORTHEASTERN MINDANAO.

FORECAST POSITION:

AT 8PM, 01 SEPTEMBER - 170 KM EAST OF SURIGAO CITY OR 160 KM SOUTH EAST OF GUIUAN, SAMAR OR AT 09.8 DEG N LAT 127.0 DEG E LONG.

PUBLIC STORM SIGNAL NUMBER THREE NOW HOISTED OVER SURIGAO PROVINCES, INCLUDING DINAGAT ISLAND GROUP, SAMAR AND LEYTE PROVINCES INCLUDING BILIRAN ISLAND, AGUSAN PROVINCES, CAMIGUIN ISLAND, BOHOL AND CEBU WHERE STORMY WEATHER WITH STRONG GUSTY WINDS OF MORE THAN 100 KPH WILL BE EXPERIENCED TONIGHT AND TOMORROW. COASTAL WATERS WILL BE VERY ROUGH AND DANGEROUS TO ALL SEACRAFTS.

PUBLIC STORM SIGNAL NUMBER TWO NOW HOISTED OVER DAVAO OR, BUKIDNON, DAVAO, MISAMIS ORIENTAL, NEGROS, SIQUIJOR ISLAND, MASBATE, ALBAY, SORSOGON AND CATANDUANES INCLUDING BUSIAS ISLAND, WHERE STORMY WEATHER WITH GUSTY WINDS OF 60-100 KPH WILL BE EXPERIENCED TONIGHT AND TOMORROW. COASTAL WATERS WILL BE ROUGH AND DANGEROUS TO SMALL SEACRAFTS.

PUBLIC STORM SIGNAL NUMBER ONE REMAINS HOISTED OVER THE REST OF BICOL REGION AND NOW HOISTED OVER THE REST OF MINDANAO, PANAY PROVINCES AND ROMBLON. THESE AREEAS WILL HAVE OCCASIONAL RAINS AND GUSTY WINDS OF NOT MORE THAN 60 KPH TONIGHT. COASTAL WATERS WILL BE MODERATE TO ROUGH.

TAKE ALL NECESSARY PRECAUTIONS AND WATCH FOR THE NEXT BULLETIN WHICH WILL BE ISSUED AT 5PM TODAY.

4. Shipping Bulletin

a. Issuance Times

This warning message is prepared for shipping in the Philippine area of responsibility and disseminated to marine interests as well as selected PAGASA field offices every 6 hours (5 AM, 11 AM, 5 PM, and 11 PM).

b. Format and Content

The shipping bulletin contains all pertinent storm information in a concise paragraph. Included are the following:

(1) location (latitude/longitude)
(2) surveillance method of center determination (aircraft/satellite, etc.)
(3) radius (km) from center of rough to phenomenal sea conditions
(4) maximum winds near center (m/s)
(5) radius (km) of typhoon force wind conditions [32 m/s (64 kt)]
(6) radius (km) of near gale force wind conditions [13 m/s (26 kt)]
(7) 12 hour forecast direction and speed
(8) 12 hour forecast position (latitude/longitude)
(9) 24-hour forecast position (latitude/longitude)
(10) request for three hourly ship reports

c. Example of Shipping Bulletin

WTPH RPMM 010000Z
T T T TYPHOON WARNING 06

AT 0000 01 SEPTEMBER TYPHOON (8411) WAS ESTIMATED BASED ON SURFACE AND AIRCRAFT REPORTS AT ZERO NINE POINT SEVEN NORTH ONE TWO NINE POINT FIVE EAST ROUGH TO PHENOMENAL SEAS WITHIN FOUR ZERO ZERO KILOMETERS NORTHWEST SEMICIRCLE TWO ZERO ZERO KILOMETERS ELSEWHERE MAXIMUM WINDS FIVE ZERO METERS PER SECOND NEAR CENTER THREE TWO METERS PER SECOND WITHIN ONE ZERO ZERO KILOMETERS ONE THREE METERS PER SECOND WITHIN FOUR ZERO ZERO KILOMETERS NORTHWEST SEMICIRCLE TWO ZERO ZERO KILOMETERS ELSEWHERE FORECAST TO MOVE WEST AT ZERO SIX METERS PER SECOND FORECAST POSITIONS AT 011200Z ZERO NINE POINT EIGHT NORTH ONE TWO SEVEN POINT ZERO EAST AND AT 020000Z ZERO NINE POINT NINE NORTH ONE TWO FOUR POINT SEVEN EAST. ALL SHIPS WITHIN TYPHOON AREA ARE REQUESTED TO SEND THREE HOURLY WEATHER REPORTS TO WEATHER MANILA PD

WEATHER MANILA

d. Comment

Useful information exists in this bulletin for disaster preparedness officials, and PAGASA field representatives concerning extended planning outlooks, and assessment of storm dimensions.

Section III
DOMESTIC BULLETIN REVIEW

1. Method

Familiarization with the development and range of warning message content as well as its impact was obtained by the author through the following methods:

a. Monitored warning message preparation sequence for typhoons Agnes and Bill (1984) at forecast office, and engaged in frequent inquiry and discussion with the principal players in shaping these advisories.

b. Reviewed domestic bulletins (issued since the late 1970's) on file selecting a variety of storm scenarios affecting the archipelago (Table 2). All typhoons responsible for significant loss of life were included.

c. Analyzed conventional surface and aircraft reconnaissance data for typhoons Ike and Agnes (1984) to determine wind condition verification in signal display areas.

d. Engaged in frequent discussion with Typhoon Research Division members regarding public response to warnings.

2. General Observations

a. The domestic bulletin format and the signal system utilized have many advantages, a few principal ones are listed below:

Table 2
List of Tropical Cyclones - Domestic Bulletins Reviewed

TROPICAL CYCLONE	DATE	INTENSITY	AREA AFFECTED
AGNES (Undang)	Oct/Nov 84	Severe Ty	Crossed Visayas
IKE (Nitang)	Aug/Sep 84	Major Ty	Crossed NE Mindanao and Visayas
JUNE (Maring)	Aug 84	Strong T.S.	Crossed northern Luzon
VERA (Bebeng)	Jul 83	Minimal Ty	Crossed Bicol region and southern Luzon
TIP (Auring)	Jul 83	T.D.	Crossed central Bicol region, northern Visayas and southwest Luzon
NANCY (Weling)	Oct 82	Major Ty	Crossed northern Luzon
IRVING (Ruping)	Sep 82	Strong T.S.	Crossed Bicol region and southern Luzon
NELSON (Bising)	Mar 82	Major Ty	Crossed Visayas
KIT (Kading)	Dec 81	T.D.	Approached eastern Visayas and NE Mindanao
LEE (Dinang)	Dec 81	Major Ty	Crossed Bicol region Mindanao and southern Luzon
IRMA (Anding)	Nov 81	Major Ty	Crossed central Luzon
LYNN (Elang)	Jul 81	T.S.	Crossed Bicol region and central Luzon

(1) the standard format organization (fill in the blank) provides ease in message preparation.

(2) economy of wording provides essential basic information and provides message length suitable for constraints of communication system.

(3) warning signal levels combine magnitude of wind conditions with expected temporal onset, and are ideally suited to convey a threat situation with minimal wording.

b. Some warning procedures and message content aspects, however, are not emphasizing layman interpretation aspects nor threat perception. Some observations are listed below:

(1) With few exceptions, little differentiation is noted in bulletin content between a strong tropical storm threatening the Philippines and a major typhoon.

(2) Message frequency does not increase as distance to typhoon landfall decreases.

(3) Message content favors quantitative information with relatively less emphasis on narrative description of threat.

(4) Supplementary messages are few and do not describe in detail the anticipated effects of a typhoon on a localized area followed with specific evacuation recommendations.

(5) During landfall situations the majority of bulletin text is devoted to geographical assignment of signal display areas. Many areas warned fail to verify wind conditions forecast, adversely reflecting on credibility.

SECTION IV
ALTERNATIVE RECOMMENDATIONS

In this section an attempt is made to address, and offer alternatives to current warning practices and message content procedures which may enhance community perception and evaluation of threat advice issued. Findings by post-tropical cyclone disaster surveys of public response in the U.S. and Australia, as well as unstructured post-storm interviews in the Philippines have been relied upon to form the basis for many of the recommendations.

It is suggested that formal sociological surveys regarding message content effectiveness be introduced and conducted frequently in the Philippines. Thereby essential information can be gleaned to further develop effective message structure and wording.

Alternative recommendations developed in this section are grouped into the following general categories: severe threat awareness, areal overwarning, signal lead time, supplementary remarks, storm location and size, message length reduction, message organization, message frequency, local interruption.

1. Severe Threat Awareness

1.a Higher Signal Requirement

Background:

The highest level of threat indicated in the current PAGASA Public Storm Signal (PSS) system is for wind conditions greater than 100 Kph (55 kt). PSS#3 is open ended, signifying wind conditions which could range anywhere across the spectrum from strong tropical storm to severe typhoon. The identifica-

tion of severity is dependent on inclusion of the maximum winds in the lead paragraph of the domestic bulletin. These winds are expressed in kilometers-per-hour. Amadore (1983) however, has noted that such technical terms concerning strength have little or no meaning to the layman, and provide little additional information for threat comprehension.

Climatological statistics show that the Philippine archipelago is struck on the average, by four typhoons and two tropical storms annually. Because of the mesoscale nature of the typhoon's most violent portion, the island's inhabitant's common experience is in the less intense fringe gale areas. There are few individuals north of the 10th parallel who have not experienced these fringe effects once or twice every few years, and received warning coverage of Public Storm Signal (PSS) #3 in their province.

The fact that PSS#3 is issued routinely for every landfalling tropical cyclone of strong tropical storm force or greater, the relatively high frequency, and inadvertent over-warning that occurs can set the stage for complacency. In case of a rural subsistence population some communities cannot afford to risk the loss of a day's work, such as in fishing, and may prefer to "ride out" a storm unless they are persuaded that an approaching threat is quite exceptional.

The critical problem here is to alert and convince the population of a major threat. Special warning criteria which emphasize the threat need to be devised for such situations.

Recommendation:

Revise signal system to include one higher signal--"Great Danger"--to signify the approach of a major typhoon (winds over 180 Kph/95 Kt).

Discussion:

The term "great" has been suggested by Southern (1982) to denote in public warnings those storms of an intense nature, and thereby aid in disaster preparedness.

Selection of the "Great Danger" signal criteria was based on analysis of devastating Philippine typhoons (since 1970) inflicting casualty tolls of 200 or more (Table 3). With few exceptions all typhoons were at levels of 180 Kph (95 kt) sustained wind or greater. This selection is consistent with wind condition thresholds identified by Amadore (1982) (see Appendix) which produced extensive damage to buildings of light materials (a majority of housing types in the islands). It is interesting to note that at these wind speeds, the pressure loading on a particular structure (related to the square of the velocity) is triple and double that exerted at PSS#3 (100 Kph/55 kt) and typhoon (130 Kph/64 kt) thresholds respectively.

4b. Storm Surge

Background:

Past disaster surveys conducted by Amadore and colleagues (1985) following typhoons Nitang (Ike) and Undang (Agnes) in 1984 indicated coastal residents had no comprehension of the powerful interaction of wind force with piling up water to inundate low lying areas. Their perception of the threat was totally confined to the wind. This is an observation found in many countries prone to tropical cyclones where 9 out of 10 deaths are attributed to coastal inundation.

Table 3

Disastrous Philippine Typhoons (1970-1984)

STORM	DEATHS	INTENSITY	DATE
Ike	1028	105 Kt	Sep 84
Agnes	800	120 Kt	Oct 84
Kate	631	105 Kt	Oct 70
Joan	575	130 Kt	Oct 70
Rita	444	115 Kt	Nov 81
Irma	280	105 Kt	Nov 81
Patsy	230	130 Kt	Nov 70
Kelly	210*	55 Kt	Jun/Jul 81
Kit	204	85 Kt	Jan 72
Olga	200	100 Kt	May 76
Lee	188	90 Kt	Dec 81
Georgia	175	120 Kt	Oct 70

*Deaths due to heavy rains/flash flooding

Recommendation:

The Great Danger Signal text should include discussion of storm surge potential and general coastlines to be affected.

Discussion:

Magnitude of storm surge potential is difficult to assess (number of coastlines involved, variety of diurnal tidal ranges, shore topography, rate and direction of center approach). However, there is a general relationship with intensity, and the probability of inundation increases greatly with an intense storm. Recognizable terminology such as "Big Waves" or coastal flooding are preferable to the technical term "storm surge" in the Philippines.

Example:

"Dangerously high tides, and big waves generated by this powerful typhoon will flood coastal sections, especially in the Romblon islands and the northern coast of Panay."

4.c Precautions (Protective Measures)

Background:

Issuance of a warning without explicit advice regarding precautions is not productive. Social sciences studies indicate people need to be told specifically what they should do during a warning in order for it to be effective. In case of potential coastal flooding, and violent winds, evacuation from low lying areas, and housing of weak structure is necessary to minimize casualties. Bulletins currently give generalized recommendations to "seek higher ground for safety"

and/or "take all necessary precautions". Advisories should clearly state which areas should be evacuated and why.

Recommendation:

Great Danger Signal text should include evacuation statements with specific recommendations.

Discussion:

Terms such as "low lying areas" are somewhat vague. Knowledge of one's elevation in relation to the impending storm tide usually is not complete. Evacuation of a specific distance inland (1 km) would provide a better margin of safety.

Example:

Situation--Center 12 hours before landfall:
"Emergency actions are needed immediately to evacuate within 1 km of the shoreline, and protect against extreme winds from this destructive typhoon by seeking shelter in secure buildings."

4d. Reconnaissance Platform

Background

Social surveys have shown that on receipt of warnings, individuals seek confirmation evidence from other sources as to the possible reality of the threat. In the Philippines this confirming information often comes from assessment of environment conditions. Indigenous signs of the approaching danger are recognized in the commencement of periphery gales and rains. Should the weather be fair, credibility of the warning may be questioned.

Recommendation:

Upon raising of PSS#3/Great Danger Signal, highlight the surveillance means of tracking and intensity determination of the typhoon (primarily aircraft reconnaissance or satellite when radar observation is not available).

Discussion:

Skepticism of the warning message may be alleviated when the layman is confronted with positive evidence gathered by a technological detection platform.

Example:

"Aircraft reports indicate typhoon Klaring is intensifying and continues to advance towards the Samar provinces."

2. AREAL OVERWARNING

Background:

Excessive lengths of coastline are overwarned due to state-of-the-art skill limitation in accurately predicting the position of typhoon landfall 24 hours in advance. Amadore (1983) cites many of the complaints of community individuals who openly question the credibility of warnings which failed to materialize. "If warnings are to remain credible, the amount of overwarning must be restricted to an extent consistent with safety" (Simpson and Riehl, 1981). In this light, reducing the initial size of the critical wind envelope (PSS#3 criteria) may prove one incremental step toward diminishing unnecessary area extent of higher level in signal coverage.

Recommendation:

Revise upward the minimum wind condition threshold for PSS#3 to 130 Kph (70 kt).

Discussion:

The current PSS#3 threshold matches that of a strong tropical storm (100 Kph/55 kt). International definition for tropical cyclones of hurricane force is 120 Kph/64 kt. This higher threshold has significance in its potential to seriously impact communities. A damage scale developed by Amadore (1982) (see Appendix) indicates that significant damage to structures (light to medium building materials) does not begin until the 130 Kph (70 kt) range is exceeded. A revision upward would drop sub-typhoon strength storms from consideration.

Further Recommendation:

Evaluation of effective signal coverage for all threat levels be included in verification programs of the accuracy of warnings.

3. SIGNAL LEAD TIME

- Direct upgrade from PSS#1 to PSS#3

Background:

In cases of rapidly advancing typhoons upgrading sequentially from PSS#1 to PSS#2 before issuing PSS#3 6 hours later is a costly exercise in terms of providing meaningful lead times to target area communities. Stepwise progression, in this case, is rapidly overtaken by events. To follow the set sequence only delays critical warning time.

Recommendation:

In situations of rapidly advancing typhoons, consider upgrading signal conditions directly from PSS#1 to PSS#3 in target area.

4. SUPPLEMENTARY REMARKS

Background:

The primary purpose of PSS#1 is to announce an alert, increase public awareness of the approaching storm, and signal communities to watch for further developments.

PSS#1 supplemental text refers to zone weather forecasts only, and is void of precautionary information.
Example: "These areas will have occasional rains, and gusty winds of not more than 60 Kph (32 kt). Coastal waters will be moderate to rough."

These weather conditions cited are not hazardous and not of major consequence. Text space should be utilized for precautionary recommendations.

Recommendation:

Revise PSS#1 accompanying remarks to focus on the alert nature of the signal, and emphasize precautionary information in lieu of zone weather forecasts.

Examples:

Situation--Typhoon in Philippine Sea, PSS#3 has not been issued: "Public storm signal Number One now in effect for the Bicol Region and Samar Island. Typhoon Konsing poses a possible threat to the region late Sunday. Residents should keep in close touch with future bulletins if higher signals are required. Fishermen should not venture far from port."

Situation--Typhoon near landfall PSS#1 displayed in western provinces, message text lengthy (all signals displayed): "Public Storm Signal Number One now in effect for Mindoro and northern Palawan. Fishermen should not venture far from port."

5. STORM LOCATION AND SIZE

5.a. Relative Position Coordinates

Background:

Disaster survey interviews (Carter, 1977) reveal that the public often erroneously perceives reference coordinate points (towns, islands) relative to the tropical cyclone's position (cited in the warning message) as the point that the typhoon will actually strike. The island of Samar is commonly confused as a future impact point because of its outpost location to the Philippine Sea typhoons (Amadore, 1983). Current practice in the Domestic Bulletin is to include one reference point for storms still at sea east of the archipelago.

Recommendation:

Include two geographic reference coordinate points (towns, islands) when citing storm's location (typhoons at sea, east of the archipelago).

Discussion:

The first point would most likely be near the same latitude, and closest to storm, while the second's position may be further east/west downstream or more poleward/equatorward to intersect the predicted track.

Example:

Typhoon Asiang was "estimated 330 km east of Virac, Catanduanes or 1020 km east of Manila."

5.b. Circulation Size

Background:

Amadore (1983) cites public misconception regarding the immensity of a typhoon. Many view the storm as a point which if not headed directly towards them is not seen as dangerous. There is little understanding of the spatial relationship between the center and the dimensions outward of peripheral gales. The domestic bulletin currently does not discuss storm circulation size.

Recommendation:

Introduce storm size dimensions (gale force area) following maximum wind description statement. Focus should be on the sector most likely to affect the coast first.

Example:

"with maximum winds of 260 Kph near the center. Strong winds extend outward 250 km to the northwest."

6. MESSAGE LENGTH REDUCTION

6.a Deletion of Forecast Paragraph

Background

The current forecast position (10 hr) paragraph combined with the lead paragraph on current location focuses too much of the warning message introduction on detail, complicates comprehension, and promotes a mental image of the typhoon as a point. Furthermore, findings by Amadore (1983) indicate the layman has little understanding of latitude/longitude. Deletion of the domestic bulletin's forecast paragraph would help reduce message text length, and provide space for precautionary information.

Recommendation

Delete forecast paragraph in Domestic Bulletin

Discussion:

The 10-hr forecast position, by itself, does not provide significant additional information to the field

operational user. It is suggested that the shipping bulletin be disseminated widely to PAGASA field stations and disaster preparedness officials since it contains both the 12- and 24-hr forecast positions.

6.b. Combining Great Danger and PSS#3 Display Coverage

Background:

The inclusion of both Great Danger signal and PSS#3 coverage in the Domestic Bulletin would serve marginal utility, and only increase message length. Due to the typical horizontal wind profile structure of a well developed typhoon (Simpson and Riehl, 1981) the differentiation between 130 Kph (70 kt) and 180 Kph (95 kt) are too close to be of significance.

Recommendation:

In case of major typhoons (180 Kph/95 kt) delete reference to PSS#3 coverage, and replace with Great Danger signal areal coverage.

Comment:

It is understood that in cases of landfall on eastern islands that western provinces may only require PSS#3 warning. In such instances PSS#1 coverage would probably no longer be in existence providing some space for PSS#3 to be reintroduced.

6.c. Combining PSS#1 and PSS#2 Coverage Areas

Background:

In cases of rapidly advancing typhoons in which landfall is imminent along the eastern zones of the archipelago, PSS#1 and PSS#2 coverage areas become increasingly compressed in the Western provinces (i.e., PSS#2 follows within 6 hours of PSS#1 declaration). To adjust for this rapidly changing situation, and help reduce message text length, it is suggested deleting PSS#1 reference at a certain point in the typhoon's advancement, and declaring PSS#2 for the remaining provinces.

Recommendation:

In situations of rapidly advancing typhoons, with PSS#1 and PSS#2 becoming increasingly compressed geographically in the Western provinces consider combining PSS#1 and PSS#2 coverage areas. Thus PSS#2 may be the initial condition set in some areas.

7. Message Organization

7.a Hierarchy of Order

Background:

Message content should be organized with the most critical information highlighted first, followed by other information in order of decreasing importance (Norton, 1975).

Recommendation:

The following information sequence should be employed in the Domestic Bulletin:

Sequence	Content
1) Critical Information	- highest signal in effect o hazard information o precautionary information
2) Details	- Tropical Cyclones Characteristics (location, movement, size)
3) Other Important Information	- Lesser Signal Notices

7.b. Headliner

Background:

A brief summary statement at the lead of the warning message would assist in comprehension. It would highlight the message's key elements, and flag any major changes from the last bulletin. As the journalist's article, it condenses the story to be told in a few simple words easy to remember. Headliners are currently employed by the U.S. Weather Service in its tropical cyclone warning messages.

Recommendations:

Use headline statements to lead Domestic Bulletins.

Example:

Konsing . . . Extremely Dangerous . . . Bears down on Northern Samar. . . . Threatens Bicol Region.

8. Message Frequency

Background:

Southern (1982) has found that public response to initial warnings is indirect, and taken as a result of mutual consultation. However, he adds "information added progressively to successive warnings encourage personal decision making".

Disaster surveys have found that persons at risk, desire frequent updates on the storm's progress as it nears landfall, with their belief related to the number of warnings received (Pifer, 1977). Current PAGASA practice is for message release every 6 hours. More frequent release is needed during PSS#3 conditions.

Recommendation:

While PSS#3 is displayed, one or more intermediate advisories should be issued between the Domestic Bulletin scheduled releases.

Discussion:

Information during this advanced warning period takes on a new urgency as communities are expected to make definite arrangements for their safety. Frequently, radar surveillance positions are available as the center nears, and crosses through the eastern barrier of islands. Fresh 3-hr

updates of the typhoon's progress adds to the credibility of the warnings.

Content:

It is suggested that content of the immediate advisory be narrative in format and focus on developments directly affecting the highest signal area. Recommended subject categories appear in decreasing order of importance.

1) Introductory summary statement.
2) Information on the danger faced.
3) Recommended precautions.
4) Latest center location (and means determined) accompanied by areal extent of typhoon force winds.

Discussion:

Changes in forward speed such as acceleration should be noted. Statements relating the current storm to memorable past typhoons in the region, or the fact that a rare landfall (Mindanao) is threatened would be useful. Highlighting the case of the intense small diameter storm is important due to the misconception brought by the fair weather ahead of the storm, and the abrupt and rapid rise of wind force that follows.

Example: Intermediate Advisory

PAGASA Radar reports indicate Typhoon Konsing is now bearing down on the Bicol region.

Konsing with maximum winds of 215 Kph is concentrated and extremely dangerous. It will be the strongest typhoon to strike the region in 15 years.

The typhoon will generate coastal flooding and big waves as well as destructive winds during its approach and passage. In areas of the Great Danger Signal, emergency actions are needed immediately to evacuate 1 Km inland of the shoreline, and protect against extreme winds by seeking shelter in secure buildings.

At 7 AM, the center of Konsing was located by PAGASA radar near 13.0 North latitude and 125.0 East longitude or 110 Km southeast of Virac Catandaunes, and 165 Km east of Legaspi. Strong winds (60 Kph) stretch outward from the center 200 Km in all directions.

Konsing is expected to pass close to Legaspi later this morning and cross over the Bicol region in the afternoon.

Keep tuned for later advisories.

Note:

Number of words in example above is 155 compared to domestic bulletin text example on page 9 [Section II3c(3)] which consists of 250 words.

Section V
COMMENTS

Importance of Local Interpretation

Background:

The field PAGASA official is a key communicator in the warning system. His interpretation can enhance the warning message--making the appeal more direct, translating terms for layman understanding and conveying the threat to a personal level. By contrast, a warning message delivered by radio broadcast relay from Manila may be less effective. Because of the source's remote, impersonal nature, residents may be less likely to respond.

Recommendation:

Field PAGASA officials should interface with local radio stations during typhoon threat emergencies as much as possible to broadcast the warning tailored to the local situation.

Discussion:

As a case in point, Kintanar (1984) contrasts the manner of warning message delivery in disastrous typhoon Nitang (1984) between rural Surigao del Norte Province, and the urban Cebu province. On receipt of the warning the meteorologist at Cebu was interviewed at length on radio while at Surigao, the warning message was merely repeated by the radio station's announcers. The resulting loss of life in typhoon Nitang was far more severe in Surigao (490) than in Cebu (28). Although many factors were not in Surigao's favor (first strike on coast, eye passage at nighttime and at high tide, and slightly lesser frequency of typhoon occurrence than

Cebu province), the result of persuasive direct appeal by an influential person (the local meteorologist) over the radio may have had a sizeable impact on establishing credibility, and diminishing both complacency and skepticism of the warning held by the target population.

Section VI
SUMMARY

A review of the current PAGASA warning message content and structure was conducted. This preliminary report identified and discussed alternative measures for developing portions of the domestic bulletin. Implications of the suggested recommendations are that warning information must be tailored to create and strengthen public response to be effective. In summary, the recommended alternative measures included the following:

1. Revise Signal System to include one higher signal--"Great Danger"--to signify the approach of a major typhoon (winds over 180 Kph/95 kt).

2. The Great Danger Signal text should include:
   - o discussion of storm surge potential and general coastlines to be affected.
   - o evacuation statements with specific recommendations.

3. Surveillance platform (aircraft reconnaissance or satellite when radar observation is not available) should be highlighted in text as positive evidence of typhoon's existence during PSS#3 and Great Danger signal situations.

4. Minimum wind condition threshold of PSS#3 should be revised upward to 130 Kph (70 kt) to help reduce overwarning at the higher signal level.

5. Evaluation of effective signal coverage for all threat levels be included in verification programs for accuracy of warnings.

6. In situations of rapidly advancing typhoons, consider upgrading signal conditions directly from PSS#1 to PSS#3 in target area.

7. Revise PSS#1 accompanying remarks to focus on the alert nature of the signal, and emphasize precautionary information in lieu of zone weather forecasts.

8. Introduce two geographic reference coordinate points (towns, islands) when citing storm's location in the Philippine Sea.

9. Introduce storm size dimensions (gale force area) following the maximum wind description statement.

10. Reduce unnecessary information and message length with the following measures:
    - o Delete forecast paragraph
    - o Delete PSS#3 coverage reference when Great Danger signal in effect.
    - o Combine PSS#1 and PSS#2 coverage under certain circumstances.

11. Revise message content order to list highest signal in effect first, followed by details and then lesser signal notices.

12. Introduce headline statements to lead domestic bulletin.

13. Introduce intermediate advisories between the scheduled bulletin releases when PSS#3 is displayed.

14. Content for intermediate advisory should be narrative in format and focus on developments directly affecting the highest signal area.

15. (From Comments Section) Field PAGASA officials should interface with local radio stations during typhoon threat emergencies as much as possible to broadcast warning information tailored to the local situation.

With a look to the future, it is suggested that formal sociological surveys regarding message content effectiveness be introduced and conducted frequently in the Philippines. Thereby essential information can be gleaned to further develop effective message structure and working.

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APPENDIX

TYPHOON DAMAGE SCALE

[from: Amadore, L.A., Damage Pattern of Typhoon Weling (Nancy, 8221), and Ground Truth Verification of its Track. Presented at the Conference/Symposium on Tropical Cyclones of South China Sea at Quezon City, Philippines

Scale No.	Description of Damage	
(1)	VERY LIGHT DAMAGE:	Winds, 60 - 100 KPH (32 - 55 Kt)

No damage to structures. Twigs and some branches of frail trees (ex. ipil-ipil, paper trees, kapok, etc.) are broken. Some banana plants are tilted, a few are stooped or downed.

(2)	LIGHT DAMAGE:	Winds, 100 - 130 KPH (55 - 70 Kt)

Unshielded, old schoolhouses and houses of light materials are partially damaged or unroofed. Some wooden electric posts are tilted or downed. Some banana plants, a few young mango trees, ipil-ipil and similar type of trees are downed or broken.

(3)	LIGHT TO MODERATE DAMAGE	Winds, 130 - 150 KPH (70 - 80 Kt)

Houses of medium-build materials in open field, and some warehouses or bodega-type structures are unroofed. More damage to G.I. roofing of old, dilapidated residential structures and houses of light materials. Most banana plants are downed, some big trees (acacia, mango, etc.) are broken or uprooted, dwarf-type or hybrid coconut trees are tilted or downed.

(4) MODERATE DAMAGE — Winds, 150 - 180 KPH (80 - 95 Kt)

Many houses of medium-built materials are unroofed, some with collapsed walls. Considerable damage to structures of light materials. Some houses of first class materials are partially damaged (residential, business, schoolhouses, hospitals). Almost total damage to banana plantations. Many tall trees are either broken, downed or defoliated.

(5) MODERATE TO HEAVY DAMAGE — Winds, 180 - 200 KPH (95 - 110 Kt)

Increasing damage to structures of first-class materials. Some G.I. roofing and walls are torn off from framed houses. Extensive damage to structures of medium-built materials, buildings of light materials are almost levelled off to the ground. More tall trees are broken, uprooted or defoliated, coconut trees are stooped, broken or uprooted.

(6) HEAVY DAMAGE — Winds, 200 - 230 KPH (110 - 125 Kt)

Most medium-build structures are downed. Extensive damage to low-risk structures. Almost total damage to structures of light materials. Most trees are broken or uprooted.

(7) WIDESPREAD DAMAGE — Wind, > 230 KPH (125 Kt)

Most houses of strong materials are damaged. Almost total damage to structures of medium and light materials. Few plants and trees survive.