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SOCIAL SCIENCE RESEARCH ON DISASTER WARNINGS:
Previous Research and a Proposed Model for the Future

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The problem of effectively warning a threatened population prior to a potentially devastating disaster and achieving an appropriate, life-saving response is ancient. God's warning to Noah about some approaching high water was an early example of a successful warning exercise. Furthermore, the problem is pervasive and goes far beyond disasters into the burgeoning field of risk communication.

Obviously, as this conference indicates, it is a problem with significant technological components. However, it is also a problem with significant social and human communication element. In fact, it can be argued that some of the most serious problems inherent in the warning process involve social and human elements, not technological elements.

A Brief History of Social Science Research on Warnings

There is a rather rich body of research that goes back to the 1950's on human and social response to warning, including the early work of Clifford, 1956; Diggory, 1956; Demerath, 1957; Fritz, 1957; Danzig, 1958; Mack and Baker, 1961; Withey, 1962; Williams, 1962; Moore, 1963; and Drabek, 1969. By 1970 it was felt by most disaster researcher that we knew a great deal about the nature of warning messages, the effect of different sources of credibility, different channels for dissemination, and differential response on the part of the public.

However, the vast bulk of this information was not being utilized or was even not known to federal, state and local officials charged with issuing public warnings. This condition changed during the period of 1970 to 1990. The National Weather Service increasingly utilized social science research on effective warning communication and hired disaster researchers as consultants. In addition, significant new studies of warning were undertaken by scholars such as Perry, Lindell, Mileti, Sorenson, leik, Carter and Rogers.

Major Relevant Research Findings

What have we learned from social science research on warnings? Perhaps the most basic finding is the following: A Warning Message That Is Issued is not Necessarily a Warning Message that is Received, Correctly Interpreted, and/or Correctly Acted Upon. This statement is valid even where the technology allows for 100 percent penetration of the target population. We have come to realize that there basically is nothing about the warning process that differs from the normal human communication process.

In both the warning and normal human communication processes, a source encodes a message which is distributed through some channel to a recipient who decodes the message. They are both attempts to obtain isomorphism of meaning. Furthermore, it is realized that there is nothing about the goals of warning process that differs from the goals of other forms of persuasive communication, such as convincing someone to buy a new automobile, vacation in Trinidad, or quit smoking. In other words, those who are in the warning business, must realize that they are actually in the communication and persuasion business. Basically, warning involves an attempt to get members of the public to behave in a certain fashion and do what those who issue the warning messages believe they should do.

Traditionally, in order to gain compliance with a warning message, i.e., to elicit evacuation, sheltering or appropriate pre-impact activity on the part of the public, the Psychodynamic Persuasion Model has ben utilized. This is a model of persuasion or propaganda that is oriented at individuals and is psychologically based. It has been likened to a "hypodermic needle" model in that the individual receives a "shot" which supposedly has some desired effect upon the person. More specifically, this model argues that a message is distributed to a targeted audience. The content of this message is meant to produce psychological fear and anxiety within the audience. This condition results in psychological imbalance and distress. However, the content of the message also includes information on how to relieve fear and anxiety by proposing a remedy or solution. When this remedy or solution is tried, psychological balance is restored. This approach basically tries to "scare the hell out of your target audience, and has been used in advertising and public information campaigns for decades.

However, what it the process does not work? What if the targeted audience does not purchase the car, vacation in Trinidad, or evacuate low lying coastal areas prior to a hurricane. What does social science tell us about where we should look to find the reasons for this lack of success? Allow us to briefly summarize some basic, established social science principles regarding the phases of forecast, dissemination and confirmation or response.

Forecast - Examples of Source Qualities:

With regard to the influence of the source of the warning upon the success of the warning process, we have a number of observations. We know that official sources tend to be believed more than informal sources; however, informal sources are more believed than mass media. Furthermore, it is known that the amount of time it takes an organization to decide to warn the public, which includes hazard detection, is critical to a successful warning process. In addition, the degree of delay in issuing warnings is influenced by:

1. the extent of contradictory information received by decision-makers;

2. the levels of ambiguity, clarity and completeness of the information;

3. the speed of communication flow;

4. the perceived credibility of the source.

Also, it is known that warnings must not be influenced by concerns with mythical behaviour, such as panic or the fear of dangerous evacuation. Finally, research in the United States has shown that the actual capability and practices at the local community level represent a fragmented, poorly linked and frequently ineffective communication system.

Forecast - Examples of Message Qualities:

In general, it has been observed that t the more specific the warning message, the higher the levels of belief on the part of the public. Also the greater the number of warnings received, the greater the belief on the part of the public in the warning message. However, multiple warning messages must be consistent. Any wagueness in messages will be seized upon by the public in light of the normally bias, i.e., people are generally biased to be believe that they are safe, rather than at risk, and treated in a non-threatening way. Finally, a successful warning message must present information that contradicts all the proposed explanations that may offered by the public that deny the validity of the threat.

Dissemination - Examples of Channel Qualities:

It is known that sirens, by themselves, are an inadequate channel for communicating warning messages. The weakness inherent in a simple siren system is that it conveys no message, just an alert. However, sirens, in combination with tone-alert and/or auto-dial telephones, provide the most effective mechanism for penetrating the public and alerting them to danger under the conditions of rapid onset and/or close proximity. Furthermore, while most warnings are initially received by the public through the mass media, the time of day and day of the week during which the message is transmitted critically effects the effectiveness of the alert. Simply put, an effective warning process is facilitated if the warnings are received at a time of day when people are normally tuned to the media, are free from occupational or formal responsibilities, and are in the presence of their family and friends. Finally, with regard to the warning channel, technological failure is rare and is not the source of most problems in most warning situations.

Confirmation - Examples of Receiver Qualities :

The "Normally Bias" is a critical factor that influences the success of the warning process. Basically, it proposes that the initial response is one of scepticism. on the part of the target audience. This sceptical initial reaction is followed by attempts to confirm the validity of the message. This "confirmation behaviour" involves attempts to check the validity of message through other channels, but most importantly with other people. It is also now realized that there is no "magic bullet" with regard to warning messages, i.e., there is no uniform response on the part of the public to the same message. Among the patterns of variation it has been noted that those with prior experience with the specific disaster agent are more likely to believe the message and accept its action proposals than those without experience, as long as they have not previously received a number of false warnings. In addition, belief in the warning message appears to be positively related to socii-economic status. Furthermore, women are more likely to believe than men, and minorities (Blacks and Hispanics) are less likely to believe officials and take appropriate action. Also, the elderly represent a "social dead spot" in the warning system. The elderly are not only less likely to receive warnings than others, but they are also less likely to take protective actions.

Finally, the importance of the group interaction has been noted in previous research. Specifically, it has been observed that the greater the number of contacts with kin, the greater the number of warnings received. Furthermore, the greater the level of community involvement, the greater the number of warning messages received. Also, perceptions of the immediate physical environment influence warning beliefs, particularly the behaviour of other people.

Social Interaction and Group Influences Upon Warning effectiveness

Traditionally, disaster researchers always have viewed the target population of warnings are being the individual person. Our models and approaches have been based upon getting that person to take appropriate action. However, it has long been recognized that a simple stimulus-response model is inadequate for explaining warning effectiveness, because upon receiving the warning message, people communicate it to others, discuss it, interpret it, and take action -- of fail to take action -- in groups and with other people who strongly influence their response.

For example, the literature on evacuation behaviour is very clear that individual people do not evacuate, families do as a unit. In other words, primary groups, such as family, friends, and associates, strongly influence warning beliefs and protective actions. Also, in most disaster situations, a majority of the public hear of the warning message from other people at least one step removed from official sources.

Perhaps the influence of social interaction and groups is most evident in the actions people take to confirm the validity of the warning message. Research has shown that people attempt to confirm the warning message in the following order of probability and importance:

1. contacting family and friends;

2. personal observations;

3. inadvertent or accidental occurrences;

4. contacting officials and authorities.

Research findings from Japan and the United States confirm the importance of social interaction in warning. Findings from Japan indicate that warnings received through neighbourhood associations resulted in greater than 50 percent compliance with evacuation, while those who heard the message from other sources only evacuated at 36 percent. In the United States studies in Charleston, South Carolina following Hurricane Hugo found that the most important factor influencing the decision of a household to evacuate was whether or not they had discussions with other people about the advisability of evacuation. In addition, people's ties to their neighbourhoods had a profound effect upon whether or not they evacuated after receiving the warning. Those neighbourhoods whose residents had a strong attachment to the neighbourhood or place had an all of none response, i.e. they either all evacuated , or no one did.

The Need for a New Conceptualization

These findings indicate that our traditional, individually-oriented models might need to be updated from an interpersonal model of communication to a mass communication model. such a model see the target audience as a group of interacting individuals, not as isolated individuals. It understands that people receive warning messages through a process that has been called "two-step" or multiple-step" flow, in which the message first goes to key opinion leaders who then pass and interpret the message on to opinion seekers and others.

This notion appears to be rather fatalistic and of little use to those in the warning business because it infers that what happens to the message is out of their control, and that there is little they can do. (For example, officials who issue warnings cannot control the level of place attachment that households have for their neighbourhood).

However, there is an alternative persuasion model that is oriented to this problem. It is called a Sociocultural Persuasion Model. As opposed to the previously noted Psychodynamic Persuasion Model, this approach posits that a warning message is issued. This message attempts to define and redefine what is socially defined as an appropriate response, such as not smoking or evacuating an area. This message results in an effective response through conformity to social norms and group expectations. Consensual validation, i.e., apparent consensus on the part of the target audience about the validity of the warning message, is what is sought as opposed to isomorphism of meaning.

Finally, this perspective means that we should alter our approach in warning by working with neighbourhood groups, work groups, associations, and other collectivities in preparation for warning in a manner that is similar to disaster volunteer training programs.

NVI
The Disaster Relief Communications Foundation

Near vertical incidence communications:
A promising application for Disaster Communications.

A summary of papers by experts in this mode.

Summary

How do you communicate with several units all around you at about as much as 500KM radius? Not very easily.

VHF radio has a range of 50KM and is in any case limited by the terrain. Unless you have a good repeater system, you won't be able to contact anyone out of sight, HF radio has the problem that there is a large skip zone between the end of the ground wave area 50KM and the first area of skip contact. 500MK. In between there is nothing. Satellites are the answer but you will have to pay costs which are prohibitive to humanitarian agencies, who are always looking to show a serious efforts to use money wisely.

The answer could be Near Vertical mode (NVIS). This, it seems can promise reliable communications in a circle around your station of about 500MK or so, and it is immune from terrain blocking problems, satellite overload problems, infrastructure failure problems and best of all, costs nothing to run apart from the first cost of the very basic equipment, plus some special antennas. Mobile operation is also possible as is both data and speech modems.

In this report we present copies of papers kindly forwarded by Ham radio operations working with the emergency communications services in the USA. Several experiments have been carried out and have shown the mode to be a great success.

Conclusion

The OTH concept has, in fact, "arrived". The concept is not without problems, however. Serious ones include the LCAC's navigation limitations, the LCAC's lack of near real-time intelligence receiving terminals, the shortage of shipboard communications nets available to the landing force, and the poor state of repair of shipboard communications equipment allotted to the landing force.

This study has pointed out that the success of OTH command and control is dependent upon the use of multiple communications paths. The primary path, again, must be HF. The inherent limitations of the UHF SatCom and the VHF frequency spectrums -susceptibility to jamming and LOS restrictions- are overcome through the use of HF. Despite antenna coupling problems, limited assets, and crypto problems, the HF equipment in place today is capable of providing the crucial command and control circuits needed for an OTH assault.

In the analysis of the MEB scenario, we discussed the similarities between an OTH amphibious assault and a conventional assault. In conventional amphibious operations, intelligence gathering prior to the assault requires a means of communicating over the horizon. Also, helicopter borne assaults are routinely conducted beyond LOS communication range. The OTH amphibious assault also requires a communication means for the command and control of initial LCAC sorties.

Technical developments of the near future will significantly enhance the security, survivability, and reliability of communications. State-of-the-art communication systems, such as the DCT and Have Quick II, have already demonstrated a wide range of applicability. Also, the addition of LOS retransmission capabilities will increase the number of OTH circuits available, in all frequency bands. These systems will enhance the OTH command and control effort and further reduce ATF and landing force vulnerabilities.

Finally, it should be noted that the greatest communications limitations in an OTH assault are not the lack of communications paths or the limitations of current technologies, but rather the insufficient and unreliable communication facilities available on amphibious shipping. This limitation has existed for years and has continually plagued conventional amphibious operations to the extent of undermining the commander's confidence in assault phase communications. In addition, the limited availability of LCACs will seriously hamper the mounting of a MEB-size OTH assault until at last 1992.

HF NVIS: Highly Successful Rarely Used
By LtCol Tilden U. Click, USMC(Ret) and 1stLt Mark W. McCadden

The Marine Corps over-the-horizon (OTH) capability, with its widely deploying and fast-moving schemes of maneuver afloat and ashore, has command, control, and communications (C3) planners evaluating new programs that can meet reliable tactical communications requirements. Satellite communications (SatCom) are often established as the primary means of communication to overcome OTH radio transmission ranges, which can extend 50 to 100 nautical miles from landing beaches. Due to the vulnerability and channel limitations of current satellite systems, alternate methods of OTH communications are being pursued as was noted in the article.

"An Alternative for SatCom" (MCG. Mar87)

One alternative for reliably meeting our short-range (0-200 miles) tactical communication requirements, which is neither new nor widely used within the Marine Corps and Navy, is high frequency (HF) near-vertical-incidence skywave (NVIS). The NVIS concept was recently tested by Fleet Marine Force Atlantic (FMFLant) units with excellent results. A basic overview of the test and significant lessons learned are provided within this article, but first an understanding of HF and NVIS communications should be established.

The Infamous Skipzone

There are two principal paths by which HF radio waves travel from a transmitter to a receiver. One is by groundwave where the signal travels directly from the transmitter to the receiver. The other is by skywave where the signal travels up to an atmospheric layer in the sky called the ionosphere and is reflected back to earth. The skipzone, where no usable signal can be received, is commonly found between the limits of the groundwave range and first skywave contact with the earth. The skipzone, obviously, can cause a great deal of difficulty for communications planners. This phenomenon and the ability of the communicator to eliminate it are discussed by LtCol David M.Fielder, NJARNG, in an Army Communicator, Spring 1986, article. In the article, LtCol Fielder states: "There can be a skipzone if the communicator selects an antenna with too low a radiation angle, but there is no skipzone unless you, the communicator, create it!... We must banish forever the term skipzone and the thinking that created it."

LtCol Fielder knows what he's talking about. More often than not, the antenna that is chosen for tactical short-range HF communications is the vertical whip, simply because it comes with the radio. The vertical whip antenna has low-angle radiation patterns that are vary conducive to groundwave propagation, but skywave reflection back to earth can be expected at a point no less than 100 miles from the transmitting antenna. Therefore, a skipzone has been created the groundwave becomes too weak for communication and ends where the skywave returns to the earth. This gap can vary from 30 to 90 miles in length and thus creates immense communication difficulties in an average-sized amphibious objective area (AOA).

Eliminating the skipzone

The NVIS concept can eliminate the skipzone by providing continuous short-range communications with no such gaps in coverage. Numerous articles and FM 24-18 describe this technique of transmitting HF energy at a very high takeoff angle (70-90 degrees) and letting it reflect back off the ionosphere saturating a small area of the earth. Appendix M of FM 24-18 describes the effect as "similar to taking a hose with a fog nozzle and pointing it straight up. The water falling to the earth covers a circular pattern continuously out to a given distance".

In order to produce strong signals at NVIS angles, antennas must be selected that maximize energy radiated skyward yet minimize groundwave radiation. In order to produce this desired effect, the antennas used will normally be horizontal. The most commonly used NVIS antenna for meeting short-range HF communications is the versatile and efficient horizontal half-wave dipole, also know as a doublet. There are other specially designed antennas that can produce the desired effect, but the standard dipole is the simplest to construct and most widely used for NVIS communications.

Frequency selection for NVIS and all other skywave paths is critical to the successful establishment of communications. Frequency selection is based on a reference point called the critical frequency, above which radiated energy will not be reflected back to the earth by the ionosphere. A frequency selected above this critical frequency will therefore be useless as it burns through the ionosphere and travels on into space. This frequency is also directly related to the angle at which an antenna radiates. The steeper the angle becomes, the lower the critical frequency will be. The ideal angle for NVIS communications is between 70-90 degrees: therefore, the use of low frequencies is a characteristic requirement of NVIS. The optimum frequency for NVIS communications will normally be the 4-8 megahertz range during the day and the 2-4 megahertz range at night.

Testing NVIS

From 12-14 July 1988, FMFLant units conducted an NVIS communications exercise to evaluate the NVIS concept and to determine its suitability for employment as a reliable short-range (0-200 miles) communication procedure in the AOA. The test was conducted in a hub/spoke configuration with the 8th Communication Battalion (hub) controlling the net at Camp Lejeune, NC, and four outlying stations (spokes) located at Beaufort, SC; Norfolk, VA; Cherry Point, NC; and Oak Grove, NC. Two mobile stations were also used and moved throughout the operating area to determine if a skipzone was present.

All stations on the net used the AN/MRC-138 or AN/GRC-193 HF radio set (400 watts) as the primary radio. The manpack AN/PRC-104 HF radio set (20 watts) was also used to test the NVIS concept on low-power transmitters.

All static stations used the horizontal half-wave dipole antenna, while the mobile stations used the standard 32-00 vertical whip antenna (AT-1011/6), the vertical whip in a bent position, and a 32-foot horizontal wire to simulate the use of a 32-foot whip in a horizontal position.

Circuit reliability was calculated for communications between the static stations and was based on a voice transmission and reception every 15 minutes on the hour. Final circuit reliability totals were greater than expected with 100 percent reliability from the 8th Communications Battalion hub at Camp Lejeune to the Norfolk, Cherry Point, and Oak Grove stations. A 67 percent reliability rate was determined from the hub to MCAS Beaufort, but it is important to note that this station was outside the predicted NVIS reliability range by 44 miles.

The mobile stations travelling north and south from the Camp Lejeune hub stopped in 25-mile increments and communicated with 100 percent reliability rate to the hub and to the Cherry Point, Oak Grove, and Norfolk stations on the bent whip antenna and 32-foot horizontal wire with the latter exhibiting superior circuit quality and reliability over all paths. The advantage of using NVIS for short-range HF communications was even more graphically demonstrated during the establishment of a path between Camp Lejeune and Oak Grove (22 miles). The low-power AN/PRC-104 with the standard 10-foot vertical whip was used initially with negative results: upon connection of the 32-foot horizontal wire, loud and clear communications were not only established with Oak Grove, but with all other net stations, including Norfolk (167 miles). A significant finding associated with these results is that NVIS communications are not as dependent on radio power as are vertically polarized antennas. This was clearly demonstrated by the parallel performance of the low-power (AN/PRC-104) and high-power (AN/MRC-138) radios over various paths. This finding reflects how little power it takes to propagate via skywave when using an antenna that produces high angle radiation and little or no ground-wave. In summary, this phase of testing showed that low-power radios can be an extremely effective means of communications in the AOA.

Additional Advantages

In addition to providing a communicator with a highly reliable, short- range, skipzone-free HF communications means. The characteristics of NVIS also afford the following six advantages:

- Terrain does not affect loss of signal. NVIS will work well in mountainous terrain, such as Korea and Norway, where vertical whip antennas often fail to communicate.

- NVIS antennas can be located in terrain-shielded positions, thereby eliminating the need for siting of antennas on high ground where they are easily detected and more vulnerable to enemy action.

- Horizontal antennas used for NVIS communications are less susceptible to interference from atmospheric and manmade noise.

- NVIS communications are harder to jam. Terrain features can be used to block or weaken groundwave jammers, which are subject to path loss.

- NVIS energy is received from above at very steep angles, which makes direction finding from nearby (beyond groundwave) locations more difficult.

- Operators can use low power successfully, thereby lowering the probabilities of intercept and detection.

Summary

This NVIS communications exercise validated the use of NVIS as a communications means within an average-sized AOA and during the OTH assault. Horizontal, high-takeoff-angle antennas will ultimately enhance the reliability of short-range HF communications paths. The first step in exploiting this capability is to emphasize education and training on its proper use. NVIS instruction should be presented in all Marine Corps communications schools and appropriate doctrinal publications should incorporate its use.

Next, the Corps must tailor the NVIS concept to meet its own unique requirements. This entails further testing and the development of field antenna kits,on-the-move mobile antennas, and specially designed U.S. Navy NVIS antennas for shipboard use.

If we are to hone our OTH warfighting capabilities effectively, it is imperative that a reliable and survivable C3 system be established. SatCom, as previously mentioned, has inherent limitations, and therefore HF communications must be viewed as a primary or equal means of communication. With this increased reliance on HF, it becomes increasingly important that we properly train our personnel in the use of NVIS and ultimately ensure that it is incorporated into communications plans to allow for increased proficiency in its use.