LECTURE NOTES: EMGT 234

MIXED MESSAGES IN RISK COMMUNICATION

SOURCE:

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1. INTRODUCTION

Effective communication on environmental risk issues requires commonly understood concepts and terminology.

Recurring Theme in Risk Communication:
General frustration of risk managers and affected parties in conveying and understanding risk information.

Why?

1. Technical Words have a very different "common" and/or "dictionary" meaning:

- Words or phrases redefined by "experts" to have a specific technical meaning,
- Scientific words that have transferred into the nonscientific language where they have been given a more general or completely different meaning.

2. The concepts being communicated are frequently interpreted in a different context by affected parties.

Result:
Words have different meanings to different people.

Risk managers may sending "mixed messages" in their communication of risk issues by not recognizing that their audience is interpreting the information differently.

Several words and expressions known to cause confusion in risk communication will be addressed:

Primary concepts:

- "risk",
- "safety vs. zero risk",
- "probability".

Derived concepts:

- "significant vs. nonsignificant",
- "negative vs. positive results",
- "conservative assumptions",
- "population vs. individual risk",
- "relative vs. absolute risk",
- "association vs. causation".

> Common understanding of terminology confusion is necessary condition for successful risk communication.

NOT A SUFFICIENT CONDITION!

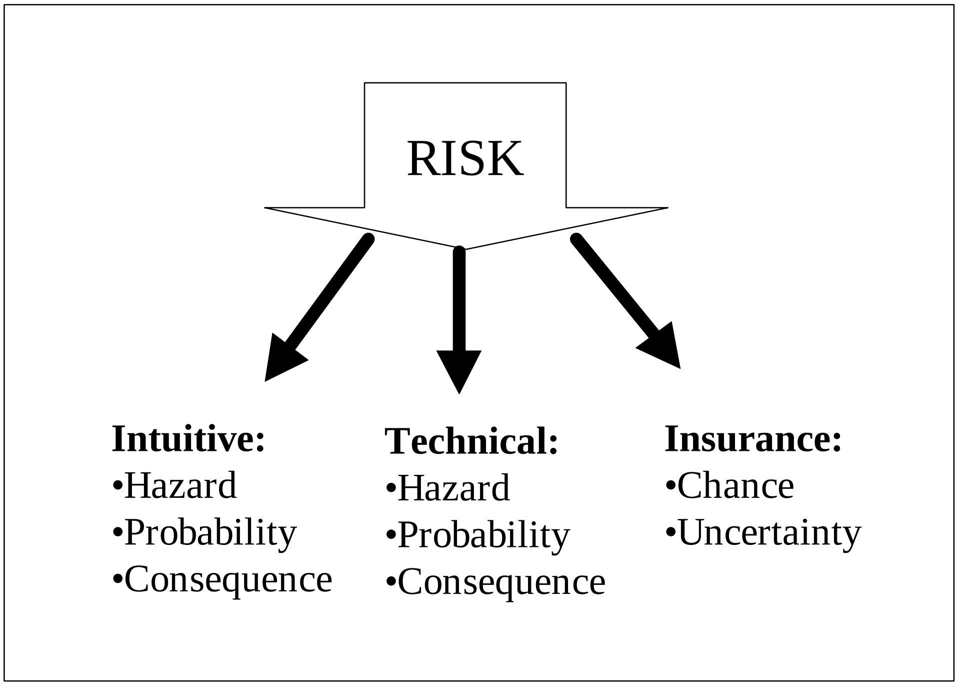
Successful Risk Communication requires platform:

- Based on trust, by exchange of information between risk managers and all parties.
- Based on trust, by developing a process which **effectively** involves the stakeholders.

> **Platform of trust** will reduce time needed for decision making and result in more readily implemented risk management recommendations.

2. PRIMARY CONCEPTS

2.1. Meanings of Risk:



Conclusion:

- Widespread use of the word, but no common understanding prior.
- To reach a consensus on need to define risk relative to its context.

Examples:

- **Context of Health & Environmental Risk:**

The event/situation in question has a potential for undesirable consequences. Risk in that case refers to **uncertainty** in the event happening and the magnitude of the consequence.

- **Context of Insurance\Financial Risk:**

Refers solely to the probability of occurrence. Also referred to as "Single Dimensional Risk".

- **Context for lay people:**

Risk involves complex qualitative considerations, such as judgments about dread, catastrophic potential, uncertainty, controllability, equity and risk to future generations.

Slovic:
"Definition of Risk is an Exercise of Power
as the definition will ultimately define
the plausible risk management actions."

2.2. Safety vs. Zero Risk

Interpretation of "Safety" involves personal value judgements, making it a very individualized concept.

Example:

The safety dilemma has been a difficult issue for the problem of exposure to carcinogens:

Hrudey and Krewski demonstrated that:

"Using conservative upper bound assumptions for quantitative cancer risk assessment, there are certainly **nonzero carcinogen exposure levels** whose corresponding **nonzero risk** is so insignificantly small as to be *arguably safe*.

Malcolm Dawson:

"a safe level is one that you do not need to worry about."

Majority of the public, 1 in 5 toxicologists, **agree or strongly agree** with the statement:

"There is no safe level of exposure
to a cancer causing agent."

Conclusions:

- Some scientists and regulators are reluctant to admit to the possibility of **a safe level of exposure** to a carcinogen suggests that some may be equating **"safety"** with **"zero"** risk.
- If **no criteria** can be specified at which exposure can be considered **"safe",** the public may logically conclude that exposure is **"unsafe"** and needs to be completely avoided. This may not be the intended message.
- Definition of "Safety" requires definition just as the concept "Risk" does.

"Complete avoidance would require an explicit defense of its practicality"

2.3. Probability

3 characterizations of probability (Kleindorfer et al.):

Classical: "The probability of getting exactly two heads upon three independent flips of a fair coin is 3/8."
Frequency: "The probability of dying in a car accident on a random day, trip and road in the United States is I out of 4,000,000."
Subjective: "The probability that the United States is still a democracy in the year 2060 is 0.7"

Question:
Is this consistent with Kaplan's Paper?

Risk Assessment Observations by Author:
Do we Agree or not Agree?

1. The "objective" aspirations of risk assessment seek a classical or frequency concept of probability (=data driven analysis). Agree not Agree?

2. Unfortunately, most realistic risk assessment situations involve more complex predictions which will not allow the simplifying assumptions needed for the classical analysis and may require the use of subjective probability.

3. Overconfidence by scientists in their ability to judge probability and characterize uncertainty has been demonstrated and must be considered in communicating risk.

4. Confidence in risk assessments may be grounded in frequency-based probability estimates.

5. However, if a particular risk assessment must rely primarily on judgment and inference (i.e., subjective probabilities) attaching the confidence associated with frequency-based probability estimates would not be justified.

Additional Observations:

6. Databases have been constructed with particular purposes in mind, risk assessment not necessarily one of them. Field definitions need to be carefully considered.

7. Entry of Accident Reports in an Accident database requires a subjective judgment in terms of it classification. Database data may need to be verified by paper records for accuracy.

8. Higher Confidence associated with primarily data driven (=frequency) based risk assessments relative to those using data + subjective judgment is based on the premise that "data is good"

9. Confidence in Risk Assessment should not be based on the type of approach, but based on completeness, i.e. use of all available information (data + expert judgment), involvement of all stakeholders, peer review, etc.

10. Risk managers must be careful with their own familiarity with probability expressions as a risk 1e-6, or one in a million.

Crouch and Wilson:
"No one is born with an intuitive understanding of one in a million. It is an acquisition which can only be made by comparison."

11. Expressing risk as numbers without an accompanying consequence or time frame is a major source of confusion.

Example:
"one in a million risk" rather than a "one in a million lifetime cancer risk" can be readily confused with annual risk or risk of other outcomes.

12. There is potential for confusion arising from people hearing or thinking "probable" when "probability" is discussed.

Most risk assessments involve estimation and discussion of very low probabilities. Using the term probability may create an unintended impression of likelihood and reality for the public.

3. DERIVED CONCEPTS

3.1 significant vs. nonsignificant

Statistical methods have considerable potential for misunderstanding.

Example Hypothesis Testing:

X, Y random variables with mean m_X and m_Y

$$H_0 : m_X = m_Y \qquad H_1 : m_X \neq m_Y$$

- Suppose you have $X_1, \cdots, X_n$ (=set of random variables with same distribution as X) and $Y_1, \cdots, Y_n$ (=set of random variables with same distribution of Y).
- Introduce:

$$T(X_1, \cdots, X_n, Y_1, \cdots, Y_n)$$

As $X_1, \cdots, X_n$ and $Y_1, \cdots, Y_n$ are random (i.e. have a probability distribution) it follows that $T(X_1, \cdots, X_n, Y_1, \cdots, Y_n)$ is random (i.e. has a probability distribution).

- $T(X_1, \cdots, X_n, Y_1, \cdots, Y_n)$ may depend on the distribution of X and Y = parametric statistics.

- In special cases $T(X_1, \cdots, X_n, Y_1, \cdots, Y_n)$ does not depend on the distribution of X and Y = non-parametric statistics.

This often requires invoking the central limit theorem and requires large amounts of data. **Beware of these methods when small amounts of data is available!**

- Calculate:

$$\Pr(T(X_1,\cdots,X_n,Y_1,\cdots,Y_n)) \le t \mid H_0)$$

i.e. assuming that the null-hypothesis H_0 is true.

- Observe data $(x_1,\cdots,x_n,y_1,\cdots,y_n)$ and calculate

$$\Pr(T(X_1,\cdots,X_n,Y_1,\cdots,Y_n)) \le T(x_1,\cdots,x_n,y_1,\cdots,y_n) \mid H_0)$$

- 5% significant level and double sided test: If

$$2.5\% \le \Pr(T(X_1,\cdots,X_n,Y_1,\cdots,Y_n)) \le T(x_1,\cdots,x_n,y_1,\cdots,y_n) \mid H_0) \le 97.5\%$$

you accept that the null-hypothesis H_0 is true. Otherwise you reject the null-hypothesis H_0 and accept the alternative hypothesis $H_{1.}$

- Significance Level (also p-value) is typically specified:

$$\Pr(\text{H}_0 \text{ is rejected} \mid \text{H}_0 \text{ is true}) \text{ - Type 1 error.}$$

- Following quantities can be calculated:

$$\Pr(\text{H}_1 \text{ is rejected} \mid \text{H}_1 \text{ is true}) \text{ - Type 2 error}$$
$$\Pr(\text{H}_0 \text{ is rejected} \mid \text{H}_1 \text{ is true}) \text{ - Statistical Power}$$

- Statistical power depends on p-value and sample size.

- If Statistical Power is low there is a high chance of incorrectly accepting the null-hypothesis H_0

- "Statistical Significance" only concludes whether trends in data are caused by factors other than random variation.

Misinterpretations with Hypothesis Testing:

- Set significance level is 5%. After learning the data the hypothesis is rejected. One often know concludes that therefore there is less than 5% that the null-hypothesis H_0 is true. What is wrong with this conclusion?

- A 95 % confidence interval for, e.g. the mean, is often interpreted (always?) by the public that there is a 95% chance that the mean is within this interval. Whereas in fact a 95% confidence interval **is a realization of a random interval** that on average 95 out of a 100 times will contain the mean value.

- In common language the word "significant" is often understood as "important or "noteworthy" and may incorrectly attributed to expressions like "statistically significant" or "statistical nonsignificance".

3.2 negative vs. positive results

- Epidemiological and laboratory testing for diseases:

Positive Result means **presence of the disease**.

- As a result, Risk assessment Terminology emerged where:

Positive results in the scientific data indicates
presence of disease or **death**

Clearly, a non-desirable result, whereas the public interprets positive as a desirable results.

- In a context of growing animal rights movements, using "positive" to indicate the presense of disease is likely to become more controversial and undesirable.

3.3 Conservative Assumptions

"Conservatism":
Selection of assumptions, parameter estimates,
models, or procedures that ensure that
resulting estimates are upper bounds on risk.

- Results in "Worst Case Scenario" type analyses.
- A compounded set of worst case assumptions may indicate an extremely unlikely event.

- Unless uncertainty associated with each conservative assumption is known upper bound values may be interpreted as likely risk estimates.

- Even when risk managers are aware of the assumptions, the public may not be aware of these assumptions later on.

- Conservative Risk Estimate often interpreted as lower bound on actual risk.

- "Conservative" may be interpreted as "traditional" or "established", rather than worst case.

- Political meaning of "Conservative" = "Reactionary". Opposite to meaning of being cautious.

Current Trend in Risk Assessment:
Use reasonable assumptions tested in a stakeholder environment rather than worst case assumptions.

- New Techniques often involve **using Monte Carlo methods** (involve random sampling) may create an image of risk managers **gambling or playing** with serious public health issues.

- Reference to **fuzzy arithmetic** may convey an image of **fuzzy thinking**, which is unlikely to develop confidence.

3.4 Population vs. Individual Risk

Risk Managers are concerned with the risk posed to a population.

Public is concerned about individual (i.e. personal risk).

- If 1% of the population is **at risk** is likely to contract cancer than the individual might interpret this as he has 1% chance of attracting cancer.

What is wrong with the above interpretation?

The assessment is based for the group as a whole. Within this group **individual differences** may lead to higher risk for some and lower risk to others, averaging to 1% group risk.

- Investigation into individual risk (personal risk) are generally not feasible for ethical, technological, and economic, statistical reasons.

3.5 Relative Risk vs. Absolute Risk

Table. Evaluation of Data from Epidemiological Studies

	Disease		
Exposure	**Yes**	**No**	**Total**
Yes	**a**	**b**	**a+b**
No	**c**	**d**	**c+d**
Total	**a+c**	**b+d**	

$$RRI = \frac{I_e}{I_0} = \frac{\frac{a}{a+b}}{\frac{c}{c+d}}$$

- This type of reporting (Relative Risk Increase) is increasingly common in popular media

Why do you think this is the case?

Example:
Introduction of a new chemical results in : RRI = 3.0, i.e. your risk of attracting the disease is increased by 200% when you are exposed to the chemical.

Does this mean that the introduction of the chemical is risky?

Answer: Not if I_0 was very small to begin with.

- Relative Risk needs to be contrasted with Absolute Risk Increase.

$$ARI = I_e - I_0$$

- For **public** to make individual decisions on whether to avoid exposure the **RRI** is useful information.

- Risk managers seeking to protect public health must make **societal decisions** based on **ARI**.

3.6 Association vs. Causation

Example:

Test:
Incidence of cancer in the population
of smokers and non-smokers

Result:
High correlation (=strong association) between
the incidence of cancer people who smoke.

Question?
Can we conclude from this information
that smoking **causes** cancer?

- Causation can only be concluded when one **completely understands** the physicall processes and interactions between these processes. Even when laboratory animals are tested in a controlled environment, high correlations only indicate association and **not causation**.

- Results from epidemiology studies with highly correlated results are often expressed as:

Smoking has been "linked" to cancer.

Words like"linked" convey a much stronger message of implied causation than warranted by the evidence.

4. STRATEGIES FOR IDENTIFYING AND DEALING WITH "MIXED MESSAGES" PROBLEMS

Major problem :
Being able recognize the "jargon" as a risk manager.

Suggestions :

1. Search your writing for words like those in this article and determine the potential for sources of confusion.

2. Periodically test your own understanding of the words in your writing.

3. Listen to other nonscientific discussions like news stories or political debates for other meanings of words you use in your risk communications.

4. Pretest a planned risk communication presentation to a friend unfamiliar with risk assessment procedures. Ask them to identify words that are confusing.

5. Discuss the subject matter with your "mock" audience after the presentation to discover unrecognized areas of misunderstanding.

6. Actively seek & prepare explanations for words which are critical to your message.

7. Informal discussions with affected parties following the actual risk communication exercise could be used to determine if the receivers "got the message".

Strategies for alleviating misunderstandings:

1. Substitute a more easily understood term if doing so will not mislead.

Example: "positive result" = "subjects contracting the disease."

2. If difficult term is the best choice, use it and fully define it.

Example: Could be effective in explaining the concept and limitations of "conservative assumptions."

3. Give examples of the intended meaning of the term and contrast these with potential misuses or misunderstandings of the term.

Example: Interpreting "population risk" as "individual risk" is based on uniformity assumption. Give examples of "individuating factors" which show the weakness of this assumption.

4. Use "translating strategies"

Example: Use comparisons to make numerical estimates more understandable.

5. Be consistent in the use of defined terminology.

Example: if you are using the word "significant" in a statistical context, do not simultaneously use the word in its dictionary context. Use e.g. substantial instead.