PRELIMINARY WORK BY DIAC TOWARDS THINKING CLEARLY AND COMMUNICATING EFFECTIVELY ABOUT RISK

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ABSTRACT

Following the Mount Polley Tailings Breach in August 2014, many practising engineers asked themselves: "Could a dam failure like this happen in Alberta?" To address this question, the Alberta Chamber of Resources (ACR) appointed a task force of leading engineers, which became known as the Alberta Dam Integrity Advisory Committee (DIAC), who examined dam safety in the province in detail during a two-day workshop, looking for areas in which attention to dam integrity could be improved. One of the key actions of the task force was the development and publication of a White Paper on Dam Safety and Risk Communication: Thinking Clearly and Communicating Effectively about Risk.

The purpose of this paper is to summarize the content of the proposed White Paper, to provide an update on its progress and development, and to inform a wider audience of dam engineers and related specialists at this conference, who are invited to provide critique and comment on the approach. The content of the paper follows the rationale and approach as developed by the DIAC Risk Subcommittee drafting team, to answer the following questions about dam safety risk communication: 1) Why this discussion now? 2) What and who is at risk? 3) Why do you need to communicate? 4)Who do you need to communicate/engage with, when and how? 5) What are the challenges, particularly for dam operators in communicating risk? 6) What principles are essential to the communication of risk?

RÉSUMÉ

Suite à la rupture de la digue à résidus miniers à la mine de Mount Polley en août 2014, nombre d'ingénieurs se sontdemandé: « Une telle rupture de digue pourrait-elle survenir en Alberta? ». Afin de répondre à cette question, la *Alberta Chamber of Resources* (ACR) a donné un mandat à un groupe de travail composé d'ingénieurs éminents, qui qui est devenu connu sous le nom de *Alberta Dam Integrity Advisory Committee* (DIAC), qui ont examiné en détail la sécurité des barrages miniers de la province à la recherche de manières d'améliorer l'attention portée à l'intégrité des barrages lors d'une session intensive de deux jours. Une des actions principales entreprise par le groupe de travail fût le développement et la publication du *Papier Blanc sur la sécurité des barrages et la communication du risque: Penser clairement et communiquer le risque efficacement*.

L'objectif du présent article est de résumer le contenu actuel du *Papier Blanc* afin de fournir une mise à jour de son progrès et de son développement, ainsi que d'informer un plus large public d'ingénieurs en barrages et divers experts du domaine présents à la conférence. Tous sont invités à commenter et critiquer cette approche. Le contenu du présent article suit la logique et l'approche telles que développées par l'équipe de rédaction du sous-comité pour le risque du DIAC afin de répondre aux questions suivantes à propos de la communication du risque en sécurité de barrages: 1) Pourquoi avoir cette discussion maintenant? 2) Quoi et qui sont à risque? 3) Pourquoi devons-nous communiquer? 4) Avec qui devons-nous communiquer/discuter, quand et comment? 5) Quels sont les défis reliés à la communication du risque, particulièrement pour les opérateurs de barrages? 6) Quels principes sont essentiels à la communication du risque?

1 WHY THIS WHITE PAPER NOW?

1.1 Introduction

1.1.1 Establishment of DIAC

In 2014, the Alberta Chamber of Resources (ACR) appointed a task force to address the question: "Could a dam failure like Mount Polley happen in Alberta?" The task force convened a workshop in which leading engineers examined dam safety in the province in detail, looking for gaps, and areas in which attention to dam integrity could be improved. From these efforts, ACR established the Alberta Dam Integrity Advisory Committee (DIAC), a standing committee which includes senior technical staff of ACR Member Companies. One of the key actions of DIAC was to develop and publish a White Paper on Dam Safety and Risk Communication: Thinking Clearly and Communicating Effectively about Risk.

1.1.2 Purpose of the White Paper

All engineered works, dams included, have some small potential for failure. In Alberta, dam owners are responsible for assessing risks, mitigating them to acceptably low levels, and communicating clearly about those risks with regulators and the public. The proposed White Paper is intended to aid dam owners, operators, managers, designers and regulators in understanding and applying risk communication principles and approaches to improve dam integrity.

1.1.3 Purpose of this Conference Paper at CDA 2019

This paper at CDA 2019 in Calgary, is intended as a summary of the work done to date, towards publication of a more detailed White Paper on the same topic. The intention of the authors is to invite comment and input from conference delegates, for the ongoing work of drafting the White Paper.

1.2 Background

Over the past few years, the world has witnessed a number of high profile dam failures; vivid images have made the concept of risk progressively less abstract in the minds of the Alberta public and dam engineers alike. It has become correspondingly more important to communicate more effectively about technical facts and judgements on one hand, and about societal values on the other hand.

In addition, several developments within Alberta added to the motivation for DIAC to prepare the White Paper and this summary conference paper:

- Multiple observations that technical experts do not communicate about risk in the same way with each other, regulators or the public. This may leave potential gaps in the understanding between assessments by engineers and perceptions of risk by potentially affected individuals or the general public.
- Interest in generally encouraging the enhanced use of risk-based methods for dam safety management, which when applied effectively, can achieve significant risk reduction at a reasonable societal cost.
- The desire to specifically support the development and application of risk-informed policies, procedures and approaches as provincial dam safety legislation and regulation was updated.
- Recent international high-profile tailings dam failures that have resulted in significant environmental damage and loss of life.

1.3 The Imperative of Common Understanding

DIAC is concerned that without more proactive thinking and intentional communication about risk, the public discourse on risk-benefit could become polarized. Erosion of public confidence could in turn lead to overly conservative dam structures and operations without commensurate improvements in productivity, reliability and safety.

Risks are not static or absolute and are not perceived uniformly by all stakeholders. Perceptions of risk – and of risk mitigation – can be amplified or attenuated by such factors as proximity, recency, vulnerability, knowledge, scale, tone, etc. depending on stakeholder or public understandings, perspectives and preferences – and can evolve over time.

Considerable judgement is required to produce engineering risk assessments which combine assessment of the probability of a failure-inducing event with assessment of the potential consequences from the event, for comparison with some acceptable level or threshold of risk. Communication of these intangible judgements is not easy but is important. An informed dialogue is essential: corporate decision-makers, regulators and the public need to understand when reasonable judgements have been made; conversely, engineers and owners need to understand when increased conservatism is required. As a number of failures in the past few years have illustrated, an informed dialogue is perhaps overdue for projects which present high risk of catastrophic consequences: loss of life, and environmental and economic impacts.

1.4 Rethinking High Consequence Risks

It is profoundly sobering that, during the period in which the DIAC White Paper was first conceived, over 250 people perished in the Brumadinho dam failure in January 2019. In addition, it had only been about a year since the near failure of the Oroville water dam spillway in northern California, which resulted in the evacuation of about 180,000 people from the area downstream of the dam. Two years prior to that, the Fundão tailings dam failure in Brazil led to the loss of 19 lives and resulted in billions of dollars in damage to public infrastructure and the environment (Morgenstern et al. 2016).

Closer to home, the after-effects are still being felt from two tailings dam failures at Mount Polley (Province of British Columbia 2015) and Obed Mountain, AB (Cooke et al. 2016) in 2014 and 2013. Fortunately, neither resulted in loss of life but they have served to sensitize Alberta dam engineers to the reality that risks do result in consequences, some of which may be extreme.

It is time for dam engineers to rethink the societal acceptability, and thus the professional acceptability, of the current ways we think about and talk about risks as "extreme consequences" which may gradate towards "unbearable consequences". Engineers cannot solve this alone, but we can provide proactive leadership by considering the right-hand portion of the F-N plot, where "F" is the frequency of fatal events and "N" is the number of fatalities (Bowles 2007), as beyond the limits of analytical decision-making and moving the discourse into the realm of societal values. We can invite and facilitate the needed conversation between engineering experts, corporate decision-makers, regulators and the public.

Leading thinkers have called upon the profession to change course (Boswell and Sobkowicz 2016; Rigbey 2015). It is the view of the authors that Canadian engineering professionals should exert leadership in rethinking how we conceptualize extreme consequence risks and how we dialogue with other stakeholders about facts, judgements and values. DIAC will continue to discuss and explore how progress towards these lofty ideals can be made in a practical manner.

1.5 Resources

It was clear to the authors that a first step towards effective communication of risk associated with dam safety was to define common language and terms. A glossary of terms and definitions to aid the understanding and communication of risk and risk assessments, has been developed, and will be included in the final version of the White Paper but will not be included in this paper, for want of space.

A review of existing scientific research and case history literature resulted in relevant references that could be grouped into three main categories:

- the general assessment of risk and its management,
- risk assessment for earth slopes, embankments and dams,
- communication of risk with the public and other stakeholders.

There was markedly less information specifically aimed at communication of risk in regard to dam safety, which reinforced the need for this paper.

2 WHY DO WE NEED TO COMMUNICATE?

Managing risk effectively is the responsibility of dam ownership and requires risk communication (MAC 2017). Changing federal and provincial regulations make risk communication even more central (Government of Canada 2018). Thus, stakeholders must be included in risk management processes (estimation, evaluation, reduction) to involve them in the design and decision-making process and prepare them for upcoming operational phases, including possible emergencies (MAC 2016), see Figure 1. Including stakeholders early and often will help establish and maintain social license to operate with key constituents.

Figure 1: Dam Safety Risk Management Framework (revised from ASDSO webinar, following Mullen and Wilson 2018)

While risk communication is as much an art as a science, there are best practices for effective communication (Jardine 2008a). This includes open, two-way communication between the organization and the public, engagement of all stakeholders, continuous evaluation, action on recommendations, and timely, truthful and comprehensive dissemination of information, which creates trust amongst all stakeholders (Fischhoff 1995; Gurabardhi et al. 2005; Jardine 2008b; 2008c). This list of best practices is

by no means all encompassing. Organizations must be resilient and creative in their communication strategies for specific risks, once they have created space for conversation.

Most research focuses on risk communication with the public, who need to be informed of environmental, health and industrial risks that could affect them (Fischhoff 1995; Lundgren and McMakin 2013). Communication is used to both increase and decrease publicly perceived levels of risk. On occasion, people overestimate the risk of a hazard (such as plane crashes) to create unfounded fear, and in other cases people underestimate hazards (such as texting while driving) to create dangerous apathy. Risk communicators aim to realign public perceptions such that public responses are more appropriate (i.e., managed fear of flying, avoidance of distractions while driving).

As with public communication, intra-organizational risk communication is also a challenge, to ensure that workers respond appropriately to occupational health and safety risks. One reason for this is that risk perceptions tend to be higher when the risk is unknown, involuntary, unfamiliar, catastrophic, acute, and not individually controllable (Boholm 1998; Boswell et al. 2000; Sandman 1993; Slovic 1987).

In most workplaces, the occupational hazards are believed to be known and the workers voluntarily do the job, as in Canada: they have the right to refuse unsafe work, they are familiar with the work, they may be subject to chronic exposure, and they individually control their interaction - creating an optimism bias. These factors tend to decrease workers' perceptions of risk, lead to apathy and a failure for designed precautions, engineering or administrative, to be appropriately implemented. One of the jobs of the risk communicator is to keep people worried (Sandman 1987).

Risk communication and consultation are an integral part of each risk management step, to better identify hazards and estimate, evaluate, and control risks. A lack of stakeholder consultation over what and who is at risk, prevents the coherent, comprehensive management, and communication of key risks (Eaton 2018). For example, risk managers have tended to focus on catastrophic failures leading to environmental and public health risks, while overlooking worker safety, resulting from more frequent hazards such as leaking tailings transportation systems, soft ground, or icing (Baker et al. 2018). If workers are not consulted, their knowledge of changing site conditions such as seasonality, as-builts versus design drawings and operating practices are not considered, leading to hazards being unidentified, a loss of containment, and workplace fatalities. The Mount Polley disaster was a result of inadequate hazard identification from incomplete site investigation, a buttress sub-excavation being left unfilled, embankment geometry being too steep, insufficient beaches and too much water in the TSF supernatant.

Unforeseen events often have the most negative consequences, such as the Fukushima Daiichi nuclear disaster or the BP Macondo spill. These types of events are categorized as: completely unknown (unknown unknowns); unknown by the risk assessor but known to other stakeholders (unknown knowns); or judged as extremely improbable (Aven and Krohn 2014). Events become more known, when organizations expand their consultation to include other stakeholder groups and their monitoring to broader industry and related events: see feedback arrows in Figure 1 (Aven 2015; Bjerga and Aven 2015). This creates resilience in risk management systems by enhancing organizational ability to: 1) monitor what is going on, including their own performance; 2) anticipate risk events and opportunities; 3) respond to regular and irregular threats in a flexible manner; and 4) learn from their own and others' experiences (Hollnagel et al. 2006).

3 WHO AND WHAT IS AT RISK?

Within the context of an organization and its influences (industry, supply chain, community, regulatory regime), the following must first be identified: the nature of hazards, failure modes and probabilities and

consequences to determine who and what is at risk. Those affected include: 1) Employees, who are those exposed to the hazard in exchange for economic or professional gain, 2) Users, who are those exposed to the hazard in exchange for gain or to address a need, and 3) Public, who are people exposed to the hazard without being aware of any direct benefit in exchange. This grouping is fundamentally important in defining voluntary versus involuntary risk levels and risks versus benefit trade-offs (Renn 2008), which are then used to characterize the type of risk. Risks are often categorized as safety (to workers, public), environmental, financial loss, reputational, and reliability (to suppliers, to customers, to owners) and then evaluated in a risk matrix, developed by risk managers. However, engineers, politicians, economists and members of the public all have differing risk definitions and tolerances. Engineers cannot alone determine risk acceptability (Rigbey 2017).

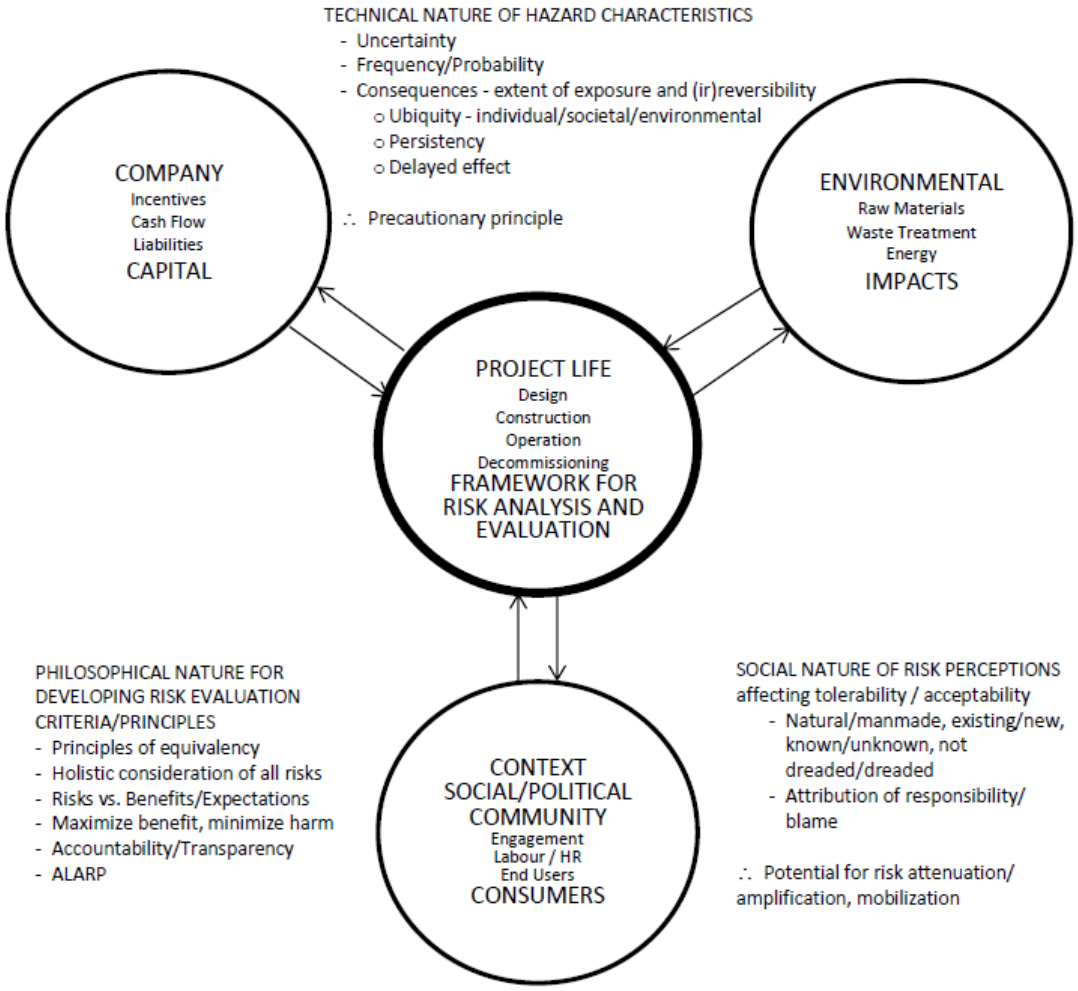

Figure 2: Aspects to be considered when developing proposed risk to life evaluation criteria (Macchiotta and Lefsrud forthcoming)

Thus, establishing the context for managing the risks associated with a project also includes identifying stakeholders – any person or organization who can affect or be affected by a decision or activity (ISO 2009). In similar fashion to ISO (International Organization for Standardization), the Mining Association of Canada (MAC 2017) defines "Communities of Interest" to "include all individuals and groups who have an interest in, or believe they may be affected by, decisions respecting the management of operations." These can be external stakeholders such as suppliers, shareholders, customers, regulators, or members of

the public, or, they may be stakeholders internal to the organization such as employees, managers, and owners.

Evaluating whether the risk is unacceptably high requires the development of risk acceptability thresholds for the organizational, environmental, and social/political context of the project (Macciotta and Lefsrud forthcoming; after Fell 1994; Fell et al. 2005; Leroi et al. 2005; Rowe 1977). As shown in Figure 2, any framework for the development of risk evaluation criteria needs to consider three main aspects in an integrative manner (Aven 2016; Renn 2008): 1) the characteristics of the system being analysed, including the project owner, project, and its environment: a task which is technical in nature; 2) the social, political, economic and cultural context; 3) the principles for developing risk evaluation criteria.

4 WITH WHOM DO YOU NEED TO COMMUNICATE – WHEN AND HOW?

Regular, ordinary communication is the essential foundation of important extra-ordinary risk communication, should it ever become necessary with stakeholders and the general public. The short answer to the titular question above is "everybody" and "regularly". Fortunately, the information needs of the general public (i.e., the overwhelming majority of "everybody"), are met by routine communications such as company websites, media releases or coverage, association websites, etc.

This paper focuses on communicating with two smaller groups. First, a relatively small proportion of the regional population which is interested in but not directly affected by a dam, either by its normal operations or by potential incidents. Second, a usually smaller proportion of the regional population which is interested in and directly affected by normal operations and/or potential incidents. The latter group is typically included as stakeholders.

The two groups are conceptually illustrated by the circles at the right side of Figure 3. The interested-but-not-directly-affected group are dispersed among the general public and cannot be proactively contacted. Their information needs can be met by anticipating their queries and providing credible information on the company or dam website, for example, sustainability reports, operating permits, and summaries of annual reviews. In contrast, the directly-affected group can be identified through reliance on dam operations (e.g., irrigation water users) or proximity to physical risks (e.g., landowners within the flood inundation zone). Their general information needs can be met as above, but they should also be on a contact list so communication can be proactive in case of important messages or emergency alerts.

The left side of Figure 3 illustrates internal communications about dam safety and risk. Dam engineers on staff or retained as consultants, manage the operations, analyze the performance and evaluate the associated potential risks. They are overseen internally by the corporate management structure, headed by the Accountable Executive (Boswell and Martens 2017). The Independent Review (IR) (previously known as Geotechnical Review Board) is now expanded into a "systematic evaluation of all technical, management and governance aspects of a tailings facility across the life cycle by competent, objective, third-party reviewer(s)" (i.e., IRs) (MAC 2019).

In contrast, the public do not have training in geotechnical engineering, neither do they have familiarity with norms and standards for a dam. As information moves from internal to external, it must be translated into plain English, with context provided, to make the communication meaningful for non-experts. A foundational principle is illustrated by the solid and dashed arrows in Figure 3, where understanding is achieved only when communication is two-way.

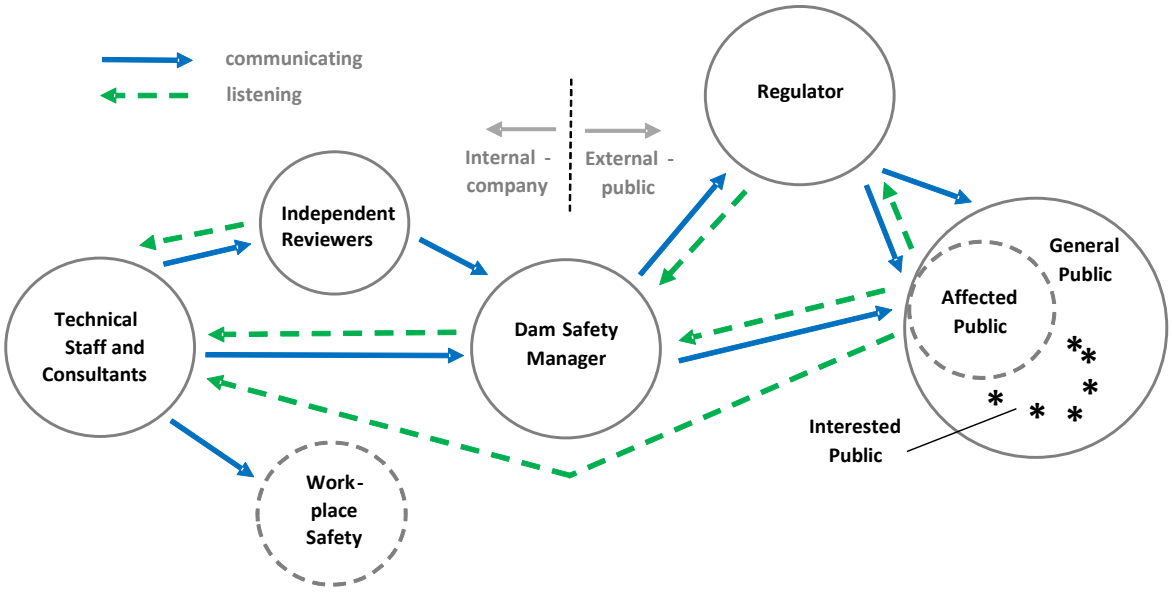

Figure 3: Risk Communication "System"

Communications with key stakeholders, such as regulators, emergency managers, first responders, elected officials, media, etc. are as important as communications with the public, but are more technical in nature. The content is typically defined by regulatory requirements or emergency response plans or requires more transparency or auto release of information regarding safety of the structure. However, attentive listening to stakeholders is vital to successful communication.

Effective communication with the public must address both facts and perspectives. Two-way communication is essential to understand the differing perspectives and be aware of additional information or context required to address questions or uncertainties.

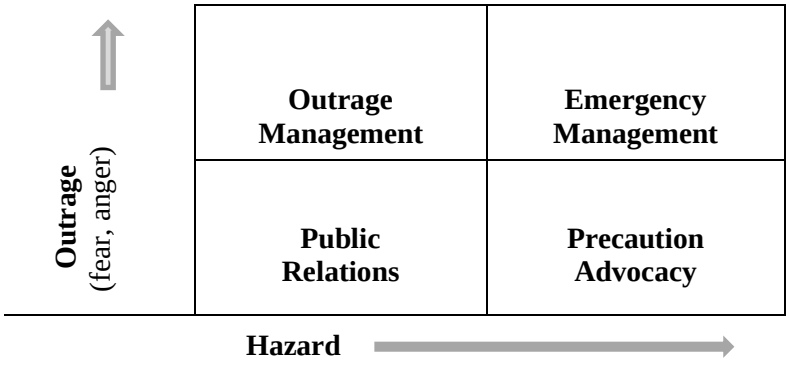

Figure 4: Receptor Communication Environments

In addition to differing perceptions about dam safety risk, interpretation of communications is also affected by the state of mind of the general public recipients, particularly when the communication is about a possible or an imminent disruption to their normal routines, e.g., irrigation water rationing or evacuation alert for residents of an inundation zone. Dr. Peter Sandman, a consultant to the U.S. Association of State Dam Safety Officials, describes this as "outrage" (www.psandman.com) and characterizes four types of communication environment as shown in Figure 4.

5 STANDARDIZED TERMINOLOGY AND LANGUAGE LADDERS

A key building block for clear communication is a lexicon, which is understood in the same way by all stakeholders. For instance, when the Regulatory Compliance Status and Performance of a particular dam is referenced as "Very Good" or "Fair", all parties should understand what those descriptors imply. Some terminology is already widely accepted and widely understood, such as the consequence ratings (2017) developed by the Canadian Dam Association (CDA) (CDA 2013 as amended).

Terminology to describe regulatory reporting and compliance has been defined by the Government of Alberta (2018a, b, as amended). DIAC endorses this standardized terminology in Alberta, and the "language ladders" which describe levels of conformance from "very good" through "very poor" with descriptors to indicate the type and degree of non-conformance (and the appropriate degree of concern about the condition, performance, operation or reporting of the dam). Through this paper and the White Paper under development, DIAC is aiming to initiate a conversation about adopting or tweaking this terminology on a national level.

DIAC will endeavor to develop a full list of proposed standardized terminology for use in Alberta in an effort to align the industry in terminology and descriptor use. This list will not be presented in this paper but will be available in the White Paper.

6 WHAT ARE THE CHALLENGES IN COMMUNICATING RISK?

The communication needs of various stakeholder groups vary greatly and therefore the challenges in communicating risk to each of these groups also vary greatly. Outlined below are the main challenges in communicating risk to both external and internal stakeholder groups, including the public, engineers and technical experts including IRs, the owners/executives and the regulators.

Some stakeholders have bona fide interests but are external to the company and may be more familiar with the subject matter. Sometimes stakeholders have competing interests or hold different values which can make it difficult to achieve two-way communication. Each of these groups is included in the first category (Section 6.1) below because they are external to the company.

6.1 Public and External Stakeholders (External to Company)

1) Raising awareness of risk without prompting an overreaction.
   - "The act of communicating unwelcome information to interested and affected parties will cause initial alarm" (Boswell et al. 2000).
2) Drama beats data.
   - Very difficult to communicate engineering risk for the first time, to an audience unfamiliar with the topic of dams and dam safety.
   - Over reliance on scientific data invariably erodes rather than advances public trust on emotive issues.
   - Vested interests (media, action groups, property owners) may use selective information for their own ends, sensationalized in the mainstream or social media.
3) The need for risk communication often only arises for the first time after an incident or a failure. In other words, public awareness of dams is limited until something goes wrong.
4) The development of public trust is not easily won and requires painstaking and systematic commitment over years.

5) Unless the receiver is involved in the process that is designed to communicate risk, the message will fall on deaf ears (Boswell et al. 2000).
6) Certain aspects of public communication require great precaution. If mismanaged, they can cause substantial outrage, derailment, delays and cost.
    - Ill-conceived or badly planned public meetings.
    - Litigation and legal challenges.
    - Mainstream media.
    - Social media.
    - Integration with political processes, advocacy, lobbying and awareness of election dynamics.
7) Communicating with populations at risk.
    - How does one explain the quantification of loss of human life to a community at risk?
    - Understanding and use of vulnerability, in risk assessment and analysis.
    - The myth of absolute safety (Rigbey 2015).
8) The value of dams is now being critically examined by society.
9) The jargon used in the dam safety industry is not understood by the public and is even understood differently by different dam sectors.
    - "Making the complex simple" (Mullen and Wilson 2018).

6.2 Engineers and Technical Experts (Internal to Company)

1) The skills required (for communication of engineering risk associated with dams) do not form part of usual engineering academic training or experience. The following academic fields of study have been found to add value for engineering teams:
    - Sociology; ethnology (the study of the characteristics of various peoples and the differences and relationships between them).
    - Industrial and community psychology.
    - Organizational behaviour.
    - Communication: media relations; community relations; stakeholder engagement; crisis communication.
2) Disinterest or reluctance within a dam owner's own work force to engage with the public or be directly involved.
3) Resourcing (human resources, equipment, materials and funding) for addressing the needs of risk communication may be scarce, under-resourced or unsupported.
4) The need for risk communication and associated budgets often only arises for the first time after an incident or a failure. Employee and executive awareness of dams may be limited until something goes wrong.
5) Development of a sound risk communication system and team requires understanding, careful planning, resourcing and time.
6) Engineers and dam owners sometimes do not understand the risks they are trying to communicate due to a lack of awareness of certain technical aspects of dam safety (unknown failure modes, unforeseen hazards, uncertainty).
7) A plethora of published material on risk communication, without peer review (Rigbey 2015).
8) The lifespan of many dams (especially tailings dams) may follow a rising risk profile. This demands regular revisitation and updating of risk communication procedures.
9) Normalization of deviance and normalization of imponderable consequences (Boswell and Sobkowicz 2018).

6.3 Regulators (External to Company)

1) (While Alberta may be becoming a rare exception), the requirement for risk communication may not initially be understood or sufficiently acknowledged and resourced by regulators or their political leadership, and may be considered "nice to have" (Boswell and Sobkowicz 2018).
2) Development of a sound risk communication system and team requires understanding, careful planning, resourcing and time.
3) Over-reliance on lagging indicators especially in the public domain (Boswell and Sobkowicz 2018).

6.4 Owners and Executives (Internal to Company)

1) The requirement for risk communication may not initially be known or understood by dam owners and executives.
2) Disinterest and reluctance to engage with the public.
3) Concern about potentially adverse impact on company share price and initially adverse impact on corporate image, until comprehensive risk communication procedures and systems are fully established.

7 PRELIMINARY RISK COMMUNICATION PRINCIPLES

7.1 Principles for Risk Criteria Development

Selecting the principles that would lead to a clear framework for risk criteria development should address three important considerations: 1) the need to regulate risks posed by nature and development; 2) risk thresholds to aid in evaluating the real urgency for mitigation strategies, since risks deemed as not tolerable would require mitigation to assure a minimum quality of life; and 3) the uncertainties inherent to a system that must be considered during assessment and management, including precautionary approaches when required. Several principles are embedded within this (Aven 2016; Vanem 2012), including:

1) Absolute risk criterion: The level of risk itself is studied and the risk criterion is formulated as a maximum level of risk that should not be exceeded, without regard to the cost and benefit associated with it.
2) Precautionary principle: If consequences may be irreversible, scientific uncertainty is not a justification for postponing cost-effective mitigation measures. If the uncertainty and consequences are too great, then it may be best not to accept the risk at all.
3) The principle of equivalency: Risk should be compared with known levels of risks from similar activities or systems that are widely regarded as acceptable or tolerable, to ensure that an equal level of risk is achieved. Similarly, comparisons can be made with historic data, natural disasters and life expectancy.
4) The holistic principle: Decisions regarding safety on behalf of the public should be based on a holistic consideration of all risks, and be applied across the complete range of hazards. Only when the total risk the public is exposed to is properly assessed, can the proposed risk reduction measures be evaluated, and risk criteria be established. Given the difficulties and effort this would require, the principle is applied at the scale of the system being analysed and requires simplification (such as apportioning and scaling).
5) The ALARP principle: Risks should be managed to be As Low As Reasonably Practicable (ALARP). Both risk levels and the cost associated with mitigating the risk are considered, and all risk reduction measures should be implemented as long as the cost of implementing them is

reasonably practicable according to cost effectiveness considerations. This requires the weighing of risks versus benefits/expectations, with a maximization of benefit and minimization of harm.

6) The accountability principle: Transparent and clearly defined criteria, which should be quantitative rather than qualitative and based on objective assessments (as far as possible) rather than subjective interpretation of risk. The formulation of the criteria should be explicit, rendering little room for different interpretations of the evaluation criteria themselves.

The framework should be consistent with these principles listed above and with common practice in other industries. As such, it considers proposing threshold values for acceptable and tolerable risks as well as considering risks to be assessed in terms of the individual risk and societal risk.

7.2 Principles for Risk Communication

The overarching challenge in communicating with the public about dam safety and risk is, the public complacency which ensues from "ordinary" operations. After decades or generations of no incidents, it is not always easy to keep the affected public engaged in their part of two-way communications. While not an urgent matter, it is important.

Below are five safety and risk communication principles against which dam owners can "test" their communications systems and procedures:

1) The only effective communication is two-way communication: readily accessible listening channels from stakeholders are equally important to simple, clear information flow from dam owners.
   - "Do we have readily accessible listening channels from stakeholders?"
2) Communication is about people, their perceptions and their frame of mind. Facts are necessary but not sufficient to achieve understanding.
   - "Do we use our listening channels or other stakeholder engagement to understand and address perceptions and frames of mind?"
3) Trust is earned by regular engagement via "ordinary" communications which are clear and trustworthy: intentional effort and ongoing resources are required due to complacency generated by normalcy.
   - "Do we measure engagement of the affected public, and their assessment of the clarity of our communications?"
4) In addition to technical information, the public requires contextual information and interpretive aids in order to understand the meaning of the information.
   - "Do we provide simple-but-not-oversimplified comparisons and metaphors for non-technical audiences?"
5) Even with "technical" stakeholders, clarity of terminology is vital when communicating with regulators, first responders and emergency managers.
   - "Are we aligned with industry-standard terminology and language ladders?"

8 PROPOSED WAY FORWARD FOR THE WHITE PAPER

Over the past four years, the formulation of thought required to advance the White Paper to this point has been substantial. While the thinking, collaborating and drafting progress has been encouraging, much remains to be done – in further drafting, commenting, editing and reviewing the White Paper. It is anticipated that the following steps will be completed by the drafting subcommittee of DIAC in the next months:

- Comment received on the CDA paper, and the proposed approach to the DIAC White Paper.

- Subsequent revisions to the DIAC White Paper, based on comments received, and the further work completed by the subcommittee.
- Publication of the DIAC White Paper: Thinking Clearly and Communicating Effectively about Dam Safety and Risk.

9 ACKNOWLEDGEMENTS

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