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**DESIGNING DAM SAFETIES: PERSPECTIVES ON LARGE SCALE DAMS
WITHIN THE INTRA-ACTIONS OF TECHNOLOGY, NATURE AND HUMAN
DECISION MAKING**

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ABSTRACT

Analyzing the *intra-actions* between the actors involved, this paper presents results from interviews and participatory observations with local authorities, local inhabitants, power companies representatives as well as dam operators. We argue that the Swedish model for dam safety currently is suffering from a major deficiency as the expertise and understanding of the technical constructions remain among the dam owners and that the societal authority in charge of supervising the dam owners work have no capability of achieving the same level of understanding and thus to take informed and relevant decisions. Furthermore we argue that the lack of technical understanding of dams and hydropower outside of the dam sector has become a huge threat to dam safety as state representatives and political decision makers currently allow and even encourage mining exploitation both next to high risk classified hydropower dams and even within existing hydropower reservoirs.

We argue that the actual challenge to safeguard an increased dam safety is by bridging the gap between the multitude of different actors—engineers/operators, users, political decision makers - in order to generate new understandings and new methodologies to deal with risk, safety and security. It is necessary to bridge the gaps between the sectors and actors involved, and that this should be done through investment in close collaboration between the dam sector and engineering research on the one hand and social sciences and humanities on the other – to ensure understandings of political decision making as well as of technical artifacts and water flows.

The geographical focus is on two rivers – the Ume River and the Lule River in the north of Sweden. Both rivers are of major importance for national production of electricity, and the rivers are water suppliers for a large amount of inhabitants.

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INTRODUCTION

The concept “intra-action” (Barad 2003) describes a togetherness or connection between human bodies, machine, nature, and the surrounding environment. The concept indicates that all the involved actors have equal importance at a given moment. For instance it is well known that the temperature of the river water influences the flow to and through the power plants and at hydropower plants in cold climates, during the time of the year when the ice is forming, mistakes and misjudgments may cause severe disturbances. (Cf Lia 1997) It is at this point up to the human actors – the dam operators – to judge on how to adjust the power production to ensure a safe operation. This judgment is based on that specific persons experience and knowledge about water flows and the capacity of the technical instruments. If there is a group of operators dealing with the decision, apart from experiences and knowledges, the issue of social hierarchy comes into play. In brief, it might not be the best founded decision that is taken, it might be a decision based on social hierarchy. Apart from this social hierarchy, also the outside temperature may impact on technical instrumentation providing data which may be difficult to interpret. This gives that the continuous interpretation of these relationships by the human operators in their every minute decision making in regard to the power production – and thereby managing the water level, is a matter of complex intra-actions between water, technical instruments, and human actors. Ultimately there is also political decision making in regard to the norms for dam safety that are at stake, along with the surrounding society’s supervision of the hydropower dam owners own work to maintain a high level of dam safety.

Within Swedish legislation in regard to dam safety, the dam owners, and thereby the dam operators, are responsible for making sure that the dams are safely operated. The dam owners are also responsible for maintaining the dams and reservoirs in good shape, to eliminate risks for dam failures. Within the Swedish model of dam safety, the County Administrative Boards – who are the extended arm of the government and thus a national authority but operate on a regional level - are responsible for ensuring that this is the case. In this paper we argue that this model is suffering from a problem, as the expertise and understanding of the technical constructions remain within the dam owning companies, and that the County Administrative Boards have little or no capability of achieving the same level of understanding as the dam owners themselves.

Secondly, another issue at stake of equal importance is the activities around and on the dams and reservoirs which are not within the control of the dam owners but which may seriously affect the dams and reservoir and eventually cause a dam failure. Those activities are for instance the use of the dam as roads, and new exploitations such as mining. The last decade mining operations have increased tremendously with an extensive number of permits for exploration, granted by the Swedish Mining Inspectorate (Bergsstaten).

This paper presents research results from interviews and participatory observations with local authorities, local inhabitants, power companies’ representatives as well as dam operators within power companies. Within this work we have also reviewed mining applications and permits including the environmental impact studies attached to these; technical reports, rescue and emergency evacuation plans, and the different evaluations and inquiries that have been made in regard to dam safety in Sweden during the last two decades. (e.g. SOU 2012:46; Svenska kraftnät, 2010a 2010b & 2011)

COMMUNICATION OF DANGERS IN REGARD TO WATER

One of the major issues of hydropower is to continuously deal with the dangers of water. It may seem as an oversimplified issue, as to the dam industry, dam operators, hydropower engineers at all levels, this is a well-known issue. The usage of water to produce electricity is at the same time a never ending work with keeping the water under control. However, one problem we have identified within the research project is that this understanding of the dangers and risks with water is difficult to communicate to both local decision making outside of the dam sector as well as into local and national political decision making. We have found that despite that within the Swedish expertise on dams, there is a great knowledge in regard to extreme water flows, the risk for floods and also risks for dam failures within the dam sector, it is difficult to translate these understandings into changing the actual setting for dam safety work within Sweden.

The case of dam safety supervision organization in Sweden

We find a specific case at display in the organization of dam safety supervision. The Swedish model of dam safety is based on self-regulation by the dam owners. There is no specific law on dam safety, instead several different statutes are applicable. The central principle is that the person who pursues an activity in regard to water should plan and monitor the operations through self-regulation, with the aim to prevent failures which may cause harm to other people and/or to the environment. Thereby dam owners are supposed to have a safety management plan to secure dam safety, with inspections of the technical facilities as well as organization and routines. To ensure that this work is being done, within the Swedish model for dam safety, according to the Environmental Code, the County Administrative Boards are the operative

Supervising dam safety is part of this task, along with the work for emergency evacuation preparedness. The County Administrative Boards are supposed to verify that the dam owners are following the legal framework and the conditions of their permits for water operations. This includes making sure that the dam owners are fulfilling the maintenance, making sure that the technical installations are safe and the dams are safely operated. (Svenska Kraftnät 2010b) Furthermore, the County Administrative Boards are supposed to summarize yearly reports by the dam owner on the county level and report to Svenska Kraftnät, the national authority. (Svenska kraftnät, 2010b). The County Administrative Boards are thus the national authority within Sweden in charge of safeguarding that the self-regulation is sufficiently ensured. Yet, this national authority is fragmented as it is located on regional level, where each County Administrative Board is in charge of organizing the work. There is no central function in charge of ensuring collaboration and exchange of knowledge between the different County Administrative Boards. Each County Administrative Board appoints or recruits one or several persons to work with dam safety related issues.

Since 1998, Svenska Kraftnät has the responsibility to provide guidance on authorities' supervision of dam safety according to the Environmental Code, as well as for dam owners. However, Svenska Kraftnät has no legal powers of enforcing anything on a dam owner.

In our case study, interviewing officials within the County Administrative Boards in Västerbotten and Norrbotten, we find that it stands out as obvious that the task cannot be

fulfilled as required. The time and resources allocated to such work is much too small in comparison to the task. Interviews also indicate that the competence among the County Administrative Board officials is far too low. The staff does not have the technical competence to understand the dam constructions nor the operation of the dams. Within the County Administrative Boards in Norrbotten and Västerbotten, there are commonly several persons who have this task on their desks. The tasks are separated into providing permits for water activities on the one hand, and to perform supervision and plan for emergency evacuation in case of dam failure on the other. Commonly it is when a person is assigned the specific task of supervision that his or her technical competence is developed. However, the time provided for internal training is rather small in regard to the complexity of dam operations and designs. (AA, BB, Idenfors et al 2012)

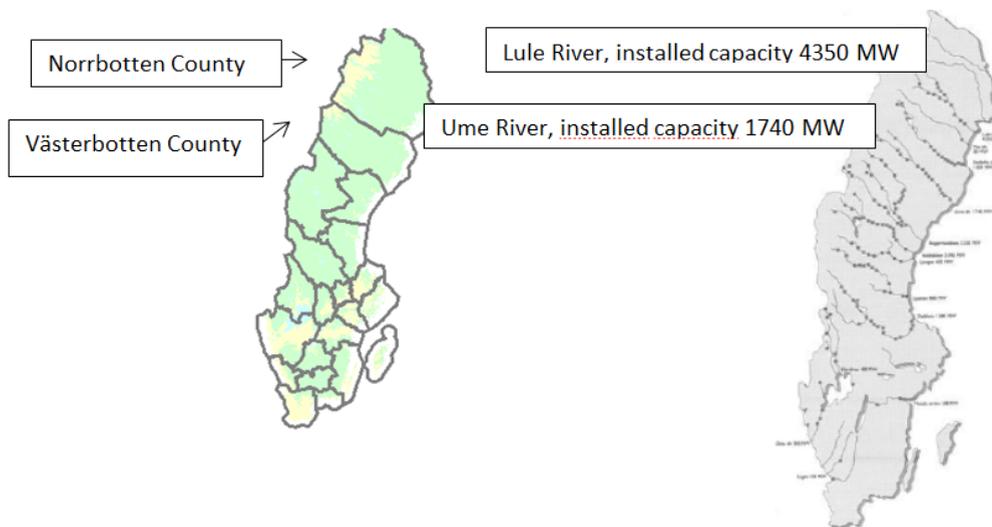


Figure 1. To the left; Map of Sweden – with the 21 Counties marked by borders. Source: <http://www.gis.lst.se/istgis/admingranskartan/> to the right: map of Sweden with hydropower plants larger than 20 MW marked by dots. Source: [Svensk Energi](#), 2010.

Our findings in this matter are however neither new nor controversial. Several earlier reports indicating that the task to act as operative supervising authority is currently beyond the competence and capacity of the County Administrative Board have been published; Swedish National Audit Office (2007) report on dam safety; the Commission on Climate and Vulnerability (SOU 2007:60) and also by the recently published Commission on Dam Safety (SOU 2012:46, p 22). The Swedish National Audit Office (2007) argued that the actual activity of dam safety supervision by the County Administrative Board is limited to “reviewing the form that the dam owner send in once per year and then send it further on to Svenska Kraftnät” (2007, p.7). In our interviews we find that the situation per 2010-2012 remains the same. (Idenfors et al 2012, AA, BB)

Knowing this dilemma of knowledge transfer – of communication – is thus a problem repeatedly identified. The remaining problem in this regard is how to solve this dilemma, that

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is how to establish a supervision where the supervisors have the same or at least an acceptable level of understanding of dam designs, dam operations and thereby dam safety. The recommendation by the Swedish Commission on Dam Safety (SOU 2012:46) was to suggest the establishment of a position for a specific dam safety official within eight (out of the 21) different County Administrative Boards. This means that the eight counties with the largest number of high risk dams should have a full time employment and that the person employed should be person with a certain set of competences; “The dam safety official needs to have competence within dam construction and dam safety. Apart from this the needs competence within supervision methodology and legislation.” (SOU 2012:46, p. 26) The commission also argues for more financial resources made available for this work, that the time allocated to dam safety supervision should be made into a specific time report code and also that the different supervisors should collaborate within a network to strengthen each other’s competences and understandings. (SOU 2012:46, p. 289-291)

Our interviews with representatives of the County Administrative Boards in Norrbotten and Västerbotten, provide an understanding of the difficulty in establishing such a dam official position as well as to find such a person to fill such position. Our interviews indicate that the current organization of the County Administrative Boards would not facilitate such a solution. To recruit a person with such a high competence to work within the very specific setting that is the County Administrative Board is highly difficult. For instance the Norrbotten County Administrative Board had an employee who was specialist on dams during a decade. This was a person who himself because of his own interest initiated a PhD program on dam constructions, and due to his specific training was appointed the task as dam safety official during 10 years. (AA) The person himself in our interview explained that the legislation regulating issues related hydropower and dam safety did not provide many tools for him to fulfill his tasks. He also opted to leave this position in 2008 as he found that it was hard to make use of his competence within the field to work with dam safety issues. (AA) When this person left the County Administrative Board, the Board suffered a severe loss of competence. (BB,FF). The employee taking up the responsibility was not a new recruitment but an employee who had been working with environmental pollution and now – by 2010 – had recently been assigned to take on dam safety issues. (BB, FF) This indicates that the competence on dam safety within the County Administrative Board is very vulnerable; it is hard to recruit, and difficult maintain such competence. When losing highly educated competence, it is very difficult to replace.

In this regard it is of importance to analyze how the latest governmental initiative in regard to the organization of dam safety has played out. Svenska Kraftnät has since many years called for an increased attention to these matters. In their report to the government in 2010 (Svenska Kraftnät 2010 b) the recommendation was to transfer the task of supervision guidance to the existing Swedish national authority - the Swedish Civil Contingencies Agency which deals with other issues of environmental risks and hazards within society. Yet, the recommendation from the Commission on Dam Safety was despite this request that the task remain within Svenska Kraftnät. The recommendation was challenged by the expert from Svenska Kraftnät on the Commission who added in a reservation to the commission final report in this regard. (SOU 2012:46, p. 455) What is of importance to note in this regard are the differing opinions in regard to the organization, and how the warnings and alerts by the current national authority with guidance responsibility for Swedish dam safety – Svenska Kraftnät –at this point seem to

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pass unheard. However, the future of the organization of dam safety supervision within Sweden is by early 2013 still open for negotiation and remains to be settled.

Part Conclusion: Earlier Swedish work in regard to dam safety work supervision by the authorities along with the findings within our research work indicates the enormous complexities of finding a satisfying organization for the supervision work. In the national review (SOU 2012:46) as well as in earlier investigations of dam safety in Sweden, the complexity of dam design, dam operation and dam safety work is stressed. We find that one of the most important problems to address in this regard is the issue of transfer of knowledges and understanding of the dam constructions and operations between the different actors involved, i.e. the dam sector and its expertise on the one hand, and the societal supervisory functions on the other. We find that there is a problem of communication of knowledge and understanding that needs to be addressed and dealt with.

The case of planning for mining operations within two existing high risk hydropower dams in Sweden: Rönnbäcken and Kallak

Another case that displays the difficulty of communicating dangers in regard to water and dam constructions between the dam sector and the surrounding society and political decision making sphere are the plans for mining exploitations within existing hydropower reservoirs and close to dams.

The Rönnbäck Nickel Mining project by a high risk dam - Västerbotten Having the support of the Swedish state and government, since 2007 the Rönnbäck Nickel Mining Project in Tärnaby is in the process for opening. If started this will be the first nickel mine in Sweden since world war two and is expected have several open day pits and sand and waste water ponds located within the existing hydropower reservoir Gardiken on the Ume River. The Gardiken reservoir is regulated via the Gardikfors hydropower dam and power plant. Gardikfors is a so called class 1 dam - that is the highest risk category within the Swedish system. (Persson 2012; Statens Geotekniska Institut 2011). The reservoir Gardiken has a regulation amplitude of 20 meters and a storage capacity of approximately 875 Mm³, which makes it the ninth largest reservoir within Sweden.(IGE Nordic AB 2010). Gardiken and Gardikfors are furthermore located downstream of several other dams and reservoirs –Abelvattnet, Överuman, Klippen, Ajaure and Gejmån. Of these Abelvattnet and Ajaure are classified to be within the highest consequence group of dams/reservoirs. The location of Gardiken/Gardikfors downstream several high risk dams means that not only is there a risk for the mine to cause disturbance and dam failure to Gardiken/Gardikfors, also a dam failure in any of the upstream dams may cause failure to the planned mine and tailing dams.

In October 2012, the mining project received the Exploitation Concession from the Swedish Mining Inspectorate (Bergsstaten 2012), a concession valid for 25 years. In our investigations we have found that the dam safety unit within the dam owner of Gardiken/Gardikfors, Vattenfall which is owned by the Swedish government, has not been informed about nor consulted in regard to the mining exploitation plans and possible detrimental effects in regard to dam safety. (GG) The situation remained the same by April 2013. (II) Meanwhile, the environmental impact study by IGE Mountain Nordic AB has been approved by the County Administrative Board, despite that there is no mention in the environmental impact study of any safety conflict with the existing high risk dam Gardikfors nor the Gardiken reservoir or the

upstream dams and reservoirs. (IGE Mountain 2010; Bergstaten 2012) Apart from one political party represented in the local decision making forums and in the Swedish Parliament, Miljöpartiet – the Environment Party, there also seems to be no local political party opposition nor questioning in terms of safety questions, to the planned mine. (Juslin 2012) Instead, there is a strong local support to the mining explorations from local and national political parties, including the Swedish government. (Persson, 2012) There exist a local opposition group, who have raised concerns on the issues of destruction of reindeer grazing lands and migration routes, as well as the feared environmental impacts on water quality. The issue of dam safety aspects has been addressed only by Öhman and Thunqvist (Öhman and Thunqvist, 2012).



Figure 2. Location of the Nickel Mining project on the regulated Ume River

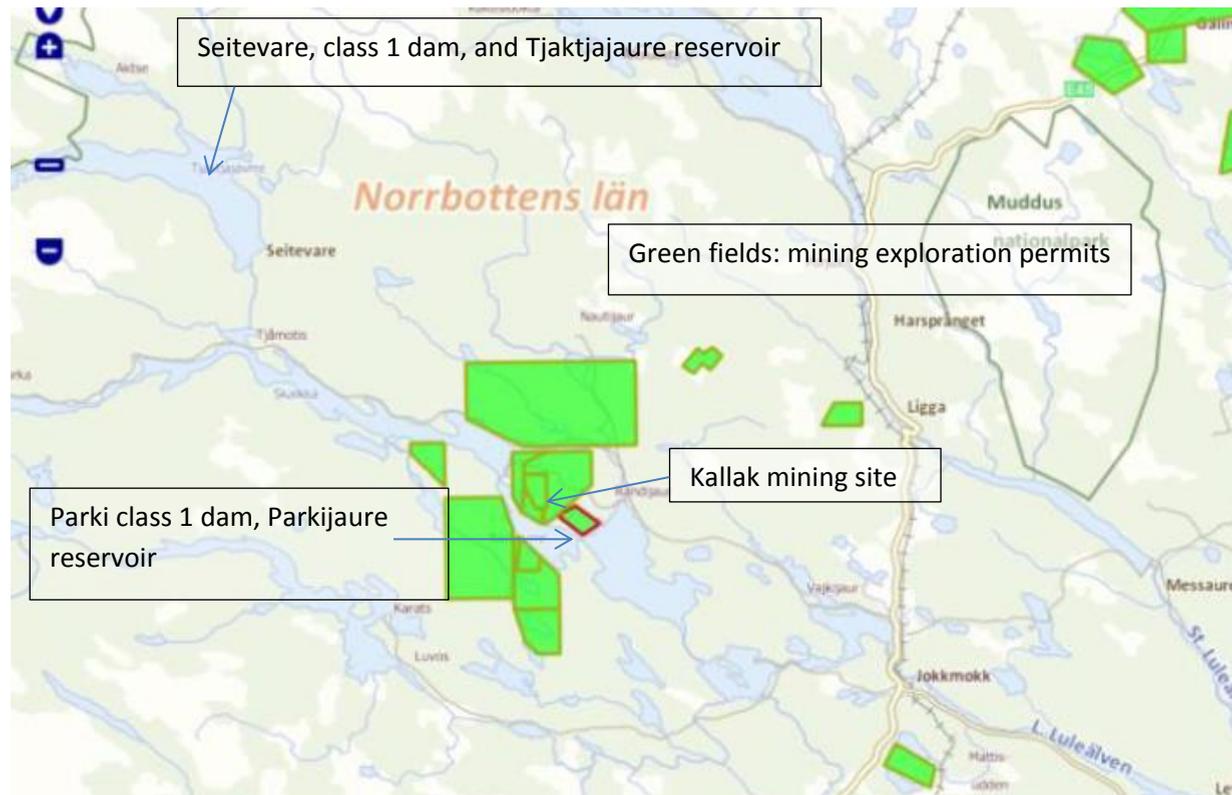


Figure 3. The exploration permits next to Parki dam and Parkijaure reservoir on the Lule River. Source: www.sgu.se

The Beowulf Mine Iron Ore Project at Kallak – Parki class 1A dam A similar case is currently under way in the Lule River, within the municipality of Jokkmokk. In direct connection to a high risk dam -Parki - and reservoir- Parkijaure - also owned by the Swedish state owned power company Vattenfall, prospecting for iron ore has been going on since 2010. The Parki dam is a category 1A dam – the highest risk category within the Swedish system. Parkijaure has a total storage capacity of 475 Mm³ and a yearly production of 85 GW/year. The regulation amplitude is 9 meters. (Hifab 2012) Also in this case, no consultations appear to have been made with the dam owner Vattenfall dam safety unit. (GG, II) The mining exploration company received in October 2012 permit for test mining of 2000 tonnes from the Norrbotten County Administrative Board, also in this case based on an environmental impact study that does not touch upon the possible conflicts with dam safety. There was one single appeal in regard to this permit, in this case one of the authors of this paper, who had earlier raised warnings in regard to this venture and its possible impacts, asking for more precautions in regard to dam safety in particular. (Öhman 2012b) Test mining is to be initiated during the summer of 2013, and an application for exploitation concession has been sent to the Mining Inspectorate. (Bergsstaten, 2013) Furthermore, Öhman has been in touch with both local Rescue Services and the mayor of Lule municipality, which is downstream of the planned mining exploitation and a city that may be flooded if a dam failure occurs at Parki, with the concerns. So far, there has been no response seeming to take the concerns seriously. (DD,HH) There is a local opposition against the mining exploitation, although their concerns is focused

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mainly on the local environment , rights for reindeer herding as well as risks for toxic pollution of water courses. (Lundberg, 2012) There is no local political party who has taken a stance in regard to the mining exploitations, although a seminar was organised by one political party, the Norrbotten county branch of Miljöpartiet, in Luleå on January 19th, 2013. (Bergström 2012)

Discussion: Comparing dangers of water with dangers of nuclear power

We have found that despite several alerts, reports and commissions on increased risks for extreme water flows – due to climate change - and also the official reports on deficiencies in dam safety supervision, water seems to not be considered as a dangerous and possibly life threatening element by the political decision makers nor local or national officials. Risk and hazards in regard to activities within the water courses seem to be more or less left without concern.

Interviews and conversations with local political decision makers, such as the mayors of the cities of Luleå and Boden at the Lule River indicate that they see no immediate call for more action than earlier. The recent development with the planning for mining exploitations within existing high risk dams on the Ume and Lule Rivers, has so far not become an issue of political questioning, nor questioning from the supervising authorities. Compared with the work going on in regard to nuclear safety, there is a huge difference in number of persons involved. Sweden has 10 000 dams, of which almost 200 are classified as high risk dams. Apart from the County Administrative Boards, where there is as mentioned, no specific expertise also a national authority is available, to advice dam owners and Svenska Kraftnät. Whereas this at a first glance may seem to be enough to safeguard the supervision to maintain a high level of dam safety, the number of persons actually working with this is no more than two, both experts within the dam sector.

This can be compared with the situation for nuclear power, today limited to ten reactors, in three different plants, in the southern parts of Sweden. Yet, to ensure nuclear safety and radiation protection (and also nuclear non-proliferation) in Sweden, there is one specific authority - the Swedish Radiation Safety Authority. It is located under the Ministry of Environment and has a national responsibility within the areas of nuclear safety, radiation protection and nuclear non-proliferation. This authority has 300 employees with expertise in fields such as engineering, natural and behavioural sciences, law, economics and communications. (Strålsäkerhetsmyndigheten 2012). To understand the deficiencies within the Swedish model for dam safety supervision, and the shortcomings in regard to the planning for establishment of mining ventures within existing high risk dams, we find that one possible way is to look at the concept of water and the common experiences of water within Sweden.

Sweden is a country with an abundant amount of fresh water. There is little need for irrigation, and the majority of Swedish inhabitants have had safe access to potable water for about half a century. (Svenskt Vatten 2005) So far Sweden has not had any major disasters in regard to dam failures. Despite more than a century of hydropower constructions and 10 000 dams, where the majority are hydropower dams, Sweden has so far been spared from any major disaster related to dam failure. (SOU 2012:46, p.75) Our research project has been able to

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identify the challenge of communication of dangers and understanding of dam design and operations between the dam sector on the one hand, and the surrounding society – political decision makers, local and national officials on the other. However the next step would be to further address this challenge by further analyzing their different understandings and modes of communication. We find that it is to a large extent an issue far beyond technical details and artifacts, a task that requires competence in social sciences and the humanities to collaborate with natural sciences and engineering. We therefore call for an investment into research and practical work aiming at bridging the gaps between the dam sector and engineering sciences on the one hand, and social sciences/humanities on the other, with the aim to facilitate the communication and understandings of the multitude of actors involved and the intra-actions in dam safety– the ultimate aim being to safeguard a high quality of the dam safety work, operations and supervision within the Swedish context. The research project DAMMED: Security, Risk and Resilience around the Dams of Sub-Arctica (2010-2012), has so far been the only research project addressing these aspects. Based on our results we argue that there is need for a continuation and increased work in this direction.

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HH Email manager of Rescue Services, Luleå Municipality, Nov. 2012.

II Personal conversation representatives of Vattenfall Dam Safety Dept, April 2013.