The earthquake, the tsunami and the nuclear meltdown in Japan

Responses from members of the 'Communicating Disaster' research group

During the second week of March 2011 the members of the ZiF Research Group on 'Communicating Disaster', which started its work in October 2010, came together for their usual *jour fixe*. Based on reports and governmental documents they discussed various communicative aspects of the disaster that hit New Orleans as a result of Hurricane Katrina. On March 11, two days after this meeting, the first news arrived with reports of a severe earthquake, a tsunami and subsequent technical problems in a nuclear power plant in Japan. The research group was unsure how to respond. Some of its members thought it would be awkward just to continue with the group's work schedule; for them it would be a strange dissociation to privately follow the events in Japan through the media and to disregard them as a topic for a research group that deals with the communicative aspects of disasters. Other members pointed out that serious research needs time and that any 'quick and dirty' treatment of the events in Japan, dramatic as they may be, is in danger of lacking academic rigour. Eventually the group agreed that its members would be invited to contribute short statements with their responses to the catastrophic events in Japan. These statements vary in many respects; they range from very personal accounts to short analytic considerations. Most of them reveal at which point in time during the unfolding disaster they were written, and in that sense these statements are witness accounts. At the same time these notes are more than just witness documents, since they contain the observations and reflections of academics from a variety of disciplines who all have expertise in the communicative analysis of disasters.

Jörg Bergmann

Disaster as media loops

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(March 12/13, 2011)

"Whatever we know about our society, or indeed about the world in which we live, we know through the mass media"—this statement by Niklas Luhmann, wrong as it is in many respects, is certainly true for disasters of which we do not have first-hand experience. Whatever we know about the earthquake east of the Peninsula of Tōhoku, about the tsunami that struck Japan minutes after that quake, and about the subsequent events in the nuclear power plant near Fukushima, we know through TV-pictures, radio reports, news coverage and the internet. These media reports soon triggered public and scientific discussions about the technical and social implications of the Japanese disaster. But these discussions about the events in Japan disregard the fact that they are entirely based on media reports and on their constructions of the disaster.

In the hours and days after the events in Japan when these notes were written all TV channels interrupted their scheduled programs and virtually turned into 24 hour news channels. Media coverage of the tsunami on all TV channels mainly consisted of a series of unconnected film snippets. This snippet format may be accounted for by certain production constraints (legal and copyright regulations, technical limitations) or aesthetic conventions (raw footage as indication of live-ness). The film snippets usually are characterized by a lack of narrativity, and they focus on strange, spectacular or touching scenes: the tsunami wave sweeping away greenhouses, cars adrift, a man weeping. Through the snippet format these scenes are isolated from their local and temporal contexts, so much so that some scenes from other earthquakes (Kobe) were also included without proper explanation. The spectacular becomes the dominant, if not exclusive meaning of the pictures.

The most striking feature of the early media coverage of the events in Japan is that the film snippets are broadcast and repeated in changed order, so that viewers encounter the same snippets (sometimes with a new commentary voice-over) over and over again even when switching between TV channels or during the hourly news bulletin. Obviously, the endless loops of film snippets are caused by the TV channels' ambition to stay on air in the event of a disaster despite of the lack of up-to-date footage. Since there is no 'new' footage, the available snippets are broadcasted 'anew'. Thus, viewers find themselves caught in a trap: Since there is no 'new' news it appears meaningless to continue viewing, but together with the projection of a possibly dramatic future the very lack of new information is perpetually generating the motive to continue viewing. Spectators keep on watching, but since there is no new news, watching becomes looking and looking turns into staring. The scenes become senseless, merely spectacular events, leaving the viewers mesmerized and paralyzed. While

disasters are events which stimulate the demand for new and up-to-date information, the delivery of no-new news entices the viewer to stay on or frantically switch news channels.

The situation just described is just a single manifestation of a general feature of disaster communication. Disasters are events during which information and its communication—its availability, news value, trustworthiness, reliability—become crucial. Every disaster leads to a dramatic increase in the demand for and at the same time a notorious lack of new information. To distant spectators and media recipients this discrepancy just matters for reasons of their curiosity, sympathy and pity; for relief and emergency organizations, which depend on reliable information in order to take quick action, the lack of current information is a problem; but for disaster victims who are very often cut off from communication networks the (un-)availability of relevant information may be existential.

Experiencing the Sendai earthquake while travelling in China

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My wife who is Japanese and me experienced the Sendai earthquake while travelling in China. We were sitting in a plane from Frankfurt to Beijing when the earthquake and the following tsunami were devastating parts of coastal Honshu. This account was written retrospectively two weeks after the earthquake before being back to Germany.

We arrived in Beijing without knowing about the earthquake and spent half a day exploring the city. Taking a better hotel with internet connection, I found out via the news portal *Spiegel Online* that a severe accident had happened. *Spiegel* reported that the Tokyo Tower was deformed, so that I assumed that the epicenter of the earthquake was in the Tokyo region where my sister-in-law's family lives. We got extremely nervous, hectic and sad—both for our family but also for the assumed disaster created in such densely populated area. Using skype, my wife tried to call her father who lives 600 km south of Tokyo—in suburban Osaka. First the telephone network did not work, probably due to overload. After some minutes my wife finally reached her father who was unaffected by the earthquake. He had already spoken to my sister-in-law's family who suffered from the traffic breakdown in the Tokyo area but was fortunately not physically harmed. Their house was not damaged either. However, others' houses in their suburb were affected, as we found out later in Japanese TV. Following that, I sent a mail to our sons (16 and 18 years old) who are living in Bonn with us, informing them that we arrived safely and that our closer Japanese family was not physically affected. While writing that mail, I confused Japan with China when mentioning the place where we arrived. This created some confusion and worries among our kids and German friends. After the kids expressed their surprise via email, I corrected my mistake.

Our hotel in Beijing allowed receiving Japanese TV, *NHK*, the public national TV program which is typically of rather good quality. We watched through the next couple of hours this program, but

there was little clear information. There were frequent announcements by the government's speaker (wearing a blue color shirt). We saw a snippet many times that night which showed how a tsunami wave was destroying a village at the coast and great number of green houses around the village (taken obviously from the air). Later on more of this type of snippets could be seen. In the following days, *NHK* also presented some aftershocks by allowing its viewers to experience shaking earth mediated by a camera positioned on a window bench.

On the first day *NHK* reported a very low number of dead people—those whose bodies had already been found and registered—if I remember correctly, it started with some 50 or 60. The number rose slowly during the next hours—then quickly to some 1,500. Then suddenly the next day *NHK* mentioned that in a northern Japanese city some 10,000 people were missing. Victims, in the sense of displaced population, were only presented the next day (as far as I can remember). *NHK* did not show dead or seriously injured victims.

While visiting Chinese academic institutions during the next days, I was mainly following the earthquake via German and international media, specifically *Spiegel Online* and *New York Times*, while my wife observed *NHK* and a Japanese newsportal. From the beginning coverage of the problems in the nuclear power station differed greatly. From the first day, I remember that *Spiegel Online* was sensitive to potential dangers of a nuclear power station running out of control. They reported about the first explosion, however, some days later *Spiegel* gave the impression that things were or could come under control. On the first day *NHK* reported about the explosion in the power station—but rather in a marginal note. The dangers seemed to be rather minimized—as far as I could understand from the translations and interpretations of my wife. Later on, also the detection of nuclear fallout and radiation was rather commented to be in a somehow normal range. My wife and me had the impression during the first five days that the problems in the power station could be controlled and the fallout was mainly going to the sea.

Our perception was rather challenged by some mails which I got from friends in Germany (and other parts of the world). Two of my close German friends argued strongly that we should make our family leave Japan—or at least the Tokyo region. When I answered that things did not look so dangerous from our perspective, they said that according to their information already the core of two of the four reactors was melting. They argued it were already a disaster worse than Chernobyl. We got scared, also since we were moving geographically closer to the danger zone (coastal eastern China). The validity of the different assessments was hard to judge—also due to our limited access to news sources. My wife did not communicate these advices and judgments to her family. She did not consider herself to be in a position to give advice from outside the country not knowing the real conditions (though we felt that the Japanese media probably misrepresented the potential dangers).

Heroes or victims? Preconceptions and news reports about disasters

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What may an ordinary German citizen learn about the Sendai earthquake from the TV and newspapers? What do the communicated images of Japan and the Japanese represent; the reality of a disaster or our preconceptions about the people affected?

The reports of the first week were dominated by the typical disaster images. Videos showing shaking walls, the enormous tsunami moving cars, ships and houses like toys. Reports on displaced people surviving in shelters. We learned that food, heating, even water were scarce. Hospitals were without electricity and faced a shortage of drugs. We saw people walking through a debris field trying to find the place where their house once was situated. The German media soon shifted their focus to the destroyed Fukushima nuclear power plant. Water cannons and helicopters helplessly tried to cool down the melting kernel of the reactor blocks and people were evacuated from the area around the reactor. Since then every news program has been presenting an expert for nuclear energy and biology explaining how a nuclear reactors works, what went already wrong and what we have to expect from the destructed power plant. The nuclear threat left only limited space for reports on emergency aid activities and attempts to reconstruct the destroyed infrastructure. However, the implicit message communicated by the media coverage was, that this extreme disaster was so large that even a highly industrialised country like Japan is challenged beyond its limits.

Again and again we heard about the disciplined manner of the Japanese people in the affected areas and in the metropolitan area of Tokyo who were dealing with their hardship and the threat of a nuclear contamination. The Japanese people are praised because of their solidarity and we hear about the "Heroes of Japan" (a heading flashed in a news programme broadcasted by *NTV* at 18.3.2011) who help the displaced and risk their lives to fight against the complete explosion of the reactors. It is indeed impressing how the people handle hardship and threats.

However, we might shortly remember the images of other disasters in the media. For example, during the Haiti earthquake in 2010 the reports presented a government completely out of control of the situation and people who passively bear another burden in the long line of political oppression and extreme poverty. The message was that the affected people were victims and completely in the hands of the international community, unable to survive on their own. Their inactivity was seen as a demonstration of passivity not as discipline.

Ulrich Beck reminded us recently (*Süddeutsche Zeitung* 14.3.2011) that the Chernobyl disaster in 1986 was presented as a "communist disaster" resulting from communist disorganization and jog trot. The helpless actions to contain the meltdown were another proof for the technological backwardness of the Soviet industry. And the people scarificing their lives in the fight against the nuclear disaster were shown as victims of an inhuman regime that tried to compensate their technology failures and technological hubris in ordering firefighters, nuclear experts and laborers on a deadly mission.

According to the reports Haitians were passive, depressed, not able to help themselves. Communists were not able to master the nuclear high-tech and had no respect for human life; but the advanced Japanese were simply overwhelmed by a disaster exceeding any imagination and still managed to be disciplined, full of solidarity and brave up to self-sacrifice.

The Japanese philosopher Kenichi Mishima contested this image of Japan and the Japanese. For him this image is just a projection from a central European perspective (Kenichi Mishima *Verführen Sie mich bitte nicht zum Nationalismus! Frankfurter Rundschau* 20.3.2011). Some recent interviews with Chernobyl "liquidators" (the ones who fought the nuclear disaster) showed that those staff members who survived see their fight to contain the reactor as an expression of their professional attitude. By no means did they see themselves abused by a violent political regime.

The images presented by the media reports follow a kind of hidden agenda that represents our preconception about people and nations. I have the greatest respect for the staff risking their lives in

the nuclear power plant in Fukushima and for the people in the shelters seeking to keep a minimum of self-esteem and composure in Japan.

However, the people in Haiti, Chernobyl and those affected by other disasters earn the same respect, too. We may learn from the media reports as much on our own view at the world as on the events which are reported.

Japan: A tale of two national disasters

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(March 20, 2011)

On 28 October 1891 the Great Nōbi Earthquake struck Japan. In terms of its human cost, with a death toll of between 7–8,000 people it was by no means the largest earthquake disaster in the nation's history. In 1923, for example, the Great Kantō Earthquake killed more than 100,000 people. However, according to historian Gregory Clancey, it was Japan's first truly national 'natural' disaster. At an estimated 8.0 in magnitude the Great Nōbi Earthquake not only caused considerable loss of life and massive destruction to infrastructure (from Tokyo to Osaka), it also rocked the Meiji government to its very foundations.

Before the 1891 earthquake struck, the 23-year-old Meiji government had been self-consciously Western in its outlook. Its modernisation project had seen the hiring of foreign architects and engineers—particularly from Britain—to transform Japan's 'fragile' wooden built environment into something more solid using bricks and mortar. But during the Great Nōbi Earthquake nearly all Western-style brick buildings collapsed, while new communications infrastructure such as railroad bridges and telegraph systems were also destroyed. Transferred without much thought being given to local conditions, European design and materials were shown to be fragile and unsuited to the seismic Japanese environment. In contrast, the survival of seventeenth-century Nagoya Castle and other monumental Tokugawa-period buildings revealed the efficacy of traditional Japanese design in resisting seismicity (although the poorly constructed wooden homes of many ordinary people collapsed). After the catastrophe there was a revival of interest in—and a new appreciation for—traditional Japanese architecture, and Japanese knowledge more generally, as well as some harsh criticism of over-Westernisation.

Press attention largely focused on the destruction of 'foreign' brick and iron structures (rather than Japanese buildings), such as the Nagara River Railroad Bridge, Nagoya Post Office and modern spinning mills in Nagoya and Osaka. The fragility of new Western-style design, and the resilience of pre-modern Japanese structures, was also depicted in popular woodblock prints (with falling industrial chimneys a prominent theme). As Clancey notes in his book *Earthquake Nation* (2006), anti-Western sentiment in the press, allied to the highly visible collapse of the modernisation project, weakened the Meiji government. The *Japan Weekly Mail*, for example, criticised it for failing to properly regulate the building industry. The government was forced to re-evaluate a project that was

clearly unsuited to an earthquake zone. As foreign knowledge had been found wanting, post-disaster there developed a hybrid building style better adapted to Japanese conditions—and less dependent on the ideas of foreign 'experts'—that synthesised the best of past and present design techniques. In addition, Japanese scientists were to become world leaders in seismology by the early twentieth century, and their reports often stressed the superior ability of Japanese-designed buildings to withstand seismic shocks.

Japan's Prime Minister Naoto Kan called the earthquake and tsunami of 11 March 2011, and their aftermath, an "unprecedented national disaster". While official responses to 'natural' catastrophes often characterise them as 'one-off' occurrences, so as not to damage confidence in a society's potential to successfully recover, the 'triple disaster'—earthquake, tsunami and a nuclear crisis—that struck Japan was exceptional. The nation's long experience in dealing with seismic shocks, its engineering know-how and its now rigorous building codes provided a measure of protection. Japan's great buildings did not fall, undoubtedly saving many thousands of lives in urban areas. However, the 40-year-old Fukushima nuclear plant was constructed before recent research showed that the 'Jōgan' earthquake and tsunami of 869 had caused serious flooding (reaching up to 4 kilometres inland). And even the depth of experience acquired by Japan as an 'earthquake nation' was insufficient to prepare adequately for the cascading effects of multiple disasters.

While it is perhaps too soon to talk of learning lessons from a national disaster that is still unfolding, media attention on the struggle to contain radiation from the badly-damaged Fukushima reactors has already prompted a global rethink on nuclear power. Following powerful explosions at the plant, governments around the world have been forced to reflect on the safety of nuclear plants on their soil (even where seismic activity is low). Comprehensive reviews of nuclear facilities are already underway in the USA, Russia, China, Britain and elsewhere, while the German government has taken all reactors operational before 1980 offline as it reconsiders its nuclear strategy. General Electric, the American corporation that designed and built several reactors at the Fukushima plant, has drawn criticism in the press over possible design weaknesses. Although the industry as a whole has recently enjoyed some success in cultivating a safer, greener image—as a source of low-carbon energy production to reduce global warming—the events at Fukushima are likely to damage public confidence in nuclear power for decades to come.

Representations of disaster and development in the Sendai emergency

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(March 20, 2011)

From a development perspective, the Sendai Earthquake and Tsunami raised expectations regards humankind's capacity to deal with larger scale environmental events that occur in contexts of 'higher development'. Some aspirations of development were on the face of it partly confirmed, for whilst

the earthquake was one of the strongest recorded, intense ground-shaking resulted in less damage than recent seismic events in Pakistan, China, Haiti, Chile or New Zealand. Earthquake and Tsunami are presumed, and to a large extent are, within the normal consciousness of people in Japan from an early age. It is a country that has preparedness through specially adapted built environments, community disaster education and civil response systems considered amongst the best. Further, whilst the longer-term impacts from this multi-hazard event remain only partially possible to quantify or qualify, multiple aspects of resilience have already been evident. Personal reports received from Japanese colleagues working with disaster management at this time are both moving and professional. Some engaged in disaster academia also run local NGO operations for recovery and rehabilitation in their communities, and consequently have found themselves personally involved in relief and recovery actions. Others, like us viewing it from further afield, assess and reflect on the forthcoming challenges exposed across the sector. Brief glimpses into the lives of survivors facilitated by TV crews reveal all types of people in Japan engaged with this tragedy, whether emotionally, motivationally or both. Official statements draw on national resolve and the capacity to adapt and recover. The adage 'built back better', though not yet so apparent in the rhetoric, will inevitably become a mantra once the worst of the impact has become more fully systematised. Disorder and raw exposure to the immediate realities of the event are likely to turn to data and to procedure banded around the media, though giving birth also to new meanings and hopes for sustainable development.

Beyond seeing the effects of development on disaster risk, and of disaster on development in Japan at this time lie some clear realities that are likely to influence critical interpretation of what really happened. These constitute underlying truisms beyond the variable representations that can be derived from disaster communication, the basics from which we might begin to reassess development from this crisis. They include three underlying features that divert analyses from 'high development' expectations of disaster mitigation, to challenges for personal, national and international confidence in development itself. Firstly, the magnitude of the hazard crossed thresholds beyond which Japan's development proved insufficient, secondly combined hazards produced threats greater than the sum of their individual parts, and thirdly the very symbols of development itself (i.e. nuclear power plants) proved vulnerable to perpetuating already high human costs still further. Tsunami defence developments were not high enough to hold back the magnitude of the wave produced, and the combined risks of earthquake, tsunami and nuclear impact remained hitherto unknown. Uncertainty prevailed throughout much of the period during, and in the immediate aftermath of these events, with further gaps in understanding and speculation regards possible knock on effects to the economy, stability and nature of a recovery process. These confront the profession whose very mission of disaster risk reduction (drr) includes improving capacity to anticipate and innovate, but which remains far from developed. It is not known when or where the next aftershock will occur. Despite advances in the fields that address these threats, speculations via the media are to be expected for months and years to come, being underlain not only by the vagaries of communication and representation, but by the gaps in science, policy and practice.

Communicating the outcomes of this disaster will therefore be not so much about how Japan's development status managed to offset an even greater disaster, but how its people will now resolve to get further development out of catastrophic experience. To what extent will building back better be about reviewing the mix of benefits and risks in Japan's entire development trajectory, emphasising 'build back significantly different'? Will this be through aid and external assistance, or as with India during the wake of the Indian Ocean Tsunami of 2004, will Japan resist international involvement beyond those temporary search and rescue teams? Should its recovery process draw on less from outside and how will the on-looking media reporters represent for better or worse the process of

endogenous recovery? How will communication with other parts of the world be in the interests of common rights of humanity to know, to understand and to learn from each other, and is there cultural context beyond people's immediate needs that will remain beyond external representations? To consider this we would need to allow time for those who would grieve, reflect and evaluate, and to consider how best to communicate about disaster and development.

Approaching the end of disaster preparedness

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Within the international environmental hazard and risk community Japan is regarded as exemplary, sometimes even as role model. It is infamous for its constant threat of earthquakes and tsunamis, and it has a good reputation for its comprehensive preparedness for so-called 'natural' disasters. Ten thousand confirmed casualties plus more than 17,500 missing is an enormous, inconceivable death toll of the Tōhoku earthquake of March 11, 2011, but an earthquake with the same magnitude in Germany (where nobody expects such strong ground motion) would result in—probably—millions of casualties. By its magnitude, the Tōhoku earthquake was among the top five earthquakes ever recorded in modern times.

Although information about death and destruction in Japan is provisional it is likely that most victims died because of the tidal wave and not as direct effects of the earthquake. The tsunami hit Honshu's eastern coast only minutes after the earthquake, with a very short time for warning and escape. When a tidal wave of this size hits the coast, structural protection like sea walls is almost useless. Those caught by the wave had hardly any chance to survive. It is not known whether the areas destroyed by the tsunami had designated evacuation routes; however, there were only minutes for warning and evacuation in any case.

It is clear that disaster preparedness is a task never fully accomplished, but with regard to the immediate coping with the earthquake and tsunami of March 11, 2011 there is consensus that Japan and its population performed very well.

However, all these 'natural disaster' issues were very soon eclipsed by the news coverage of effects on Japan's nuclear industry. Fukushima Nuclear Power Plant has for some ten days now been top of Germany's news agenda: even when there was no new information it was at the center of the first report in every newscast. And, due to the information strategy of the national government and the owner of the Nuclear Power Plant, there is not much reliable information available. Many of the victims who had survived earthquake and tsunami were further victimized by radiation emitted from the power plant out of control.

While immediately after the Great Hanshin earthquake in 1995 up to one million Japanese from all over the country volunteered in the disaster prone area in and around Kobe, this time the victims received much less help and assistance. Apparently, parts of the disaster zone inside the evacua-

tion radius of 20 kilometers around Fukushima Daiichi power plant did not see much emergency assistance at all. Future debates will probably explore whether international media interest and/or national Japanese emergency management neglected those people and places hit by the tsunami in favor of the nuclear incident.

Two weeks later, the owner of the nuclear power plant is still unable to control the radiation leaks. After the complete break-down of the plant's emergency electricity system, the strategy to regain control over the six reactors plus thousands of tons of nuclear fuel accumulated in 35 years is necessarily improvised, trial and error muddling-through. Basically, it is the wind that determines which areas and which parts of the population become polluted by radiation, be it the Tokyo metropolitan area with its 30 million plus inhabitants or the ocean. Tap water in Tokyo is already polluted. It is only a matter of time for the shortages of food, water and fuel to spread, although so far it affects primarily the 250,000 homeless living in emergency shelters. In time to come the radioactive contamination of the environment could be extensive, especially problematic is the pollution with plutonium used in reactor number three, because 239plutonium is not just infamous for its harmful, peculiar physical and chemical properties in nuclear weapons, but also for its radioactive half-life of more than 24,000 years.

While one can only estimate the spatial and temporal patterns of worldwide nuclear contamination to come, it is clear that the despair and hardship of the affected will be tremendous. Unfortunately, disaster preparedness so helpful in dealing with earthquakes and tsunamis turns out to be absolutely inadequate in face of the ongoing radioactive pollution.

The destruction of Fukushima Nuclear Power Plant: A decision making catastrophe?

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Among the many images that will be remembered from the Sendai earthquake and its catastrophic main and side effects there is a very peculiar one: A humble person dressed in a blue working suit, bowing in front of the Japanese flag, stepping up to a speaker's desk and reporting about the situation in Fukushima, possible developments, and steps already taken and planned for.

For the western correspondents these press conferences were very confusing. The language used by this spokesperson (Cabinet-Secretary Yuka Edano) was described as vague and imprecise, in many instances the information provided was seen as inconsistent and contradictory, concealing as much as confirming. For some commentators this was a clear symptom of faulty decision making processes in the Japanese emergency management organizations that apparently were unable to come up with a clear assessment of the situation and firm and appropriate counter measures.

However, this assessment reveals more about western conceptions of 'how emergency management ought to be done properly' than it is a valid description of shortcomings on the Japanese side:

In almost all western societies emergency management procedures are organized following a model that was developed by the Prussian military during the course of the 19th century. This model requires a central crisis management group, divided into specific functions, which collects and integrates all available information, decides about priorities, allocates resources and takes all other necessary decisions and then communicates these to the forces up front who execute the orders. The centre of this system is the role of the operational staff leader who has a full overview at all times and carries the final responsibility for all decisions.

In civil emergencies, there will be a specifically trained media person that has direct access to these assessments and decisions and therefore can disseminate them immediately.

This model is an expression of the implicit assumption that complexity, intransparency, and dynamics can be managed best by a centralized, hierarchical structure that utilizes and coordinates individual decision making capabilities. There is, however, growing evidence that such a structure may not fit Japanese practices. Rather, Japanese decision making (at least in non-emergency operations) can be described as an extended social process of joint constraint satisfaction where decisions are not 'taken'* but evolve during lengthy discussions of the pros and cons of the available alternatives.

This process is time consuming and often described as not very creative; it guarantees, on the other hand, the commitment of all relevant stake holders. This style also avoids a situation where any person can be singled out as having more influence than the others which would be considered a violation of the principle of balance and, more importantly, impolite.

As of now, we do not know whether the decision making processes in the operation centres dealing with the Fukushima disaster do in fact follow this pattern and whether this pattern is, in turn, responsible for the poor information policy and the apparently slow reaction. We also do not know whether western emergency managers (who offered assistance early but were rejected) with their more decisive approach would have made any difference. The interesting question is whether there can be universal emergency management models at all or, to put it differently, to what extent successful emergency management needs to be embedded in the local cultures of decision making.

* "The idea of a 'decision' is a quintessentially Western idea, an act of hubris to a believer in Eastern philosophy and a joke to the enlightened" (Howard, R., 1980: An assessment of decision analysis. *Operations Research*, 28, 1).

On the problem of 'localizing' (nuclear) disasters

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(March 21, 2011)

Communicating a disaster involves a wide range of symbolic practices, from rather 'global' political and scientific discourses to various forms of interaction in (more or less disturbed) everyday situations. Therefore, as a disaster unfolds, the general knowledge about its characteristics has to be related to manifold social settings and their specific spatial, temporal and practical conditions (like the 'topography' for evacuation or the delivery of relief items, the 'locales' for organizations dealing with technical and natural crises or the signposting of dangerous 'areas'). The communicative task then is not only to make these settings understandable by talking *about* them from an outsider's

perspective but also to act communicatively and practically *within* them, e.g. by guiding peoples' perceptions and nonverbal actions *in situ* by suitable localized means of media and communication (e.g. public signage, locative digital media).

In case of a nuclear crisis these manifold attempts of 'localizing' the disaster communicatively have to cope with at least three challenges of determining the disaster's extensions: Firstly, since radioactive rays cannot be perceived directly by human senses, the collection, visualization, verbalization, dissemination and processing of data and knowledge about radiation is based on (networked) sensor technologies that enhance everyday means of perception, cognition and communication. As sensors have become ever more sensitive, even small traces of radioactivity spreading out from a 'local' trouble source can be detected all over the world within a short period of time. Furthermore, people and their clothing as well as goods and products traveling from irradiated areas into other parts of the world can become subject to widespread measures of control. Communicating a nuclear disaster therefore is largely about defining its extension *in and through practices of making radiation measurable and assessable* (e.g. by negotiating and defining certain boundary values). As sensors successively become part of everyday (public) life, a set of practical and political questions arise: Who is supposed to have access to sensor technologies by means of design and education and thus who will be enabled and empowered to participate in these discourses (Kuznetsov & Paulos 2010)? How are communities, organizations and societies collectively shaping the communicative process of debating and defining boundary values? What are the specific conditions and limitations of different modes and codes (related to cultural contexts) for representing radioactivity visually and acoustically (e.g. by the pace of clicking noises, binary color codes, iconic representations, human languages etc.), and how is 'the message' transformed when one medium is used to make a meaning based on another medium 'readable' in a different way (cf. L. Jäger's concept of 'transcriptivity')?

Secondly, the spatial dimension of a nuclear disaster does not only transform the (semiotic) landscape where it took place and a certain radius of the local environment. Rather, in relation to wind direction and rainfall it is likely that other, distant regions will be affected as well, although it is hard to predict which areas and within what radius will be affected or to what extent. Since this *discontinuous and dynamic landscape of nuclear disaster* is very hard to survey, the open threat of a nuclear contamination and hypothetical or practical precautions (staying inside the house, moving to another region, evacuating people etc.) are likely to trigger communication that is directed at dynamically relating the ongoing process of the disaster to manifold 'local' perspectives (both in the spatial as well as in the social sense).

Finally, the temporal dimension gives rise to the question of which perspective becomes accepted (for a period of time) in the public process of *political decision making* which is also dependent on local resources (e.g. scientists known by the media who are familiar with supporting or questioning nuclear power in national public discourse). On the long run the question becomes relevant of "how present day humans can convey the locations and specific dangers of nuclear waste to their descendants" (R. Posner) over thousands and tens of thousands of years—obviously without being able to know future sensor technology or conventions of reading natural indications or cultural remains, sources and traditions. Turning to the past, one might learn from the deep history of mankind's experiences with traditional technologies about *continuity and transformation in representing and imparting risk-related knowledge* and thus be able to specify the abstract semiotic conditions for communicating disaster in the diachronic dimension. But we will have to be aware of the fact that—even if the warning will be understood—a disaster by definition always exceeds the 'futures' our institutions are prepared to cope with.

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The Fukushima Dai-ichi disaster

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(March 29, 2011)*

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I am a system-safety specialist, discussing disaster with sociologists. One happened—an enormous natural event which triggered a disaster. Let me look at part of it, namely the system-safety disaster at the Fukushima Dai-ichi (Number 1) nuclear power station.

A nuclear power plant is what I call a teleological engineered system. Like a car, or an airplane, it has a purpose, and it is designed by one (or a few) legal actor(s) to fulfil that purpose. As a system, it distinguishes itself from, say, a town, which is a collection of houses, shops, workshops and offices, mostly designed and constructed piecewise, for divergent purposes, indeed purposes which are often contrary, by many actors. Fukushima Dai-ichi has people swarming all over it, designing, specifying, building, operating, maintaining, and filling out all the paperwork which somehow gives us a comfy feeling of organisation aiming to fulfil the purpose. But no longer. Here it is, not producing two watts of what it is supposed to produce, but instead injuring people, threatening to distribute large amounts of its highly toxic component substances above ground, below ground, and in the water. What went wrong?

The technology behind fissive nuclear power is exothermic. The plant requires active cooling at all times, even when not operating. If it is not cooled then an accident is inevitable. Cooling requires power. When the plant is working, maybe from itself. When it is shut down, then from somewhere else. It follows that power supply must be unfailingly reliable in order to avoid an accident.

Primary power comes from outside. The existence of a secondary power system tells us that someone foresaw circumstances in which primary power would be interrupted. (They were right! An earthquake cut primary power; the live reactors, Units 1–3 of 6, shut down as planned.) Can secondary power be interrupted? If so, we need tertiary power … and so on. The tertiary power is trivial—batteries with a life of 8 hours. It follows no one thought secondary power could be interrupted for longer than that. But it was! It was taken out.

Everything else about this disaster follows from that one event: Secondary power was taken out. How? It was in a 'basement', which was flooded by the tsunami. Let us focus on the tsunami for a moment. At time of construction, it seems no one evaluated the tsunami hazard (Marlene Weiss,

Süddeutsche Zeitung 19–10.03.2011). Later they did, but "no one thought of a tsunami that high!". Not so—a tsunami expert brought it up at a meeting at the regulator, NISA, in 2009. He recounts that his concern was—in my words, not his—peremptorily dismissed (David Nakamura and Chico Harlan, *Washington Post*, 23.03.2011). Tsunami experts have expressed their astonishment at the lack of apparent tsunami awareness at the regulator or plant operator (Norimitsu Onishi and James Glanz, *New York Times*, 26.03.2011). It is important to keep in mind that this is just one way the secondary power can be taken out, but not the only way.

Engineers designing, building and operating safety-critical systems are required by standards to perform a hazard analysis (HazAn). A hazard is, roughly speaking, a precursor of an accident, so you have to know first what the accidents are—what the events are which constitute accidents. It is pretty clear to everyone in the nuclear industry that meltdown is an accident and it is equally clear that lack of cooling leads directly to meltdown. (It's not the only one: you have to keep the spent fuel pools cooled, else they evaporate and burn. It's clear that that constitutes an accident event also.) So losing all cooling for a long enough period of time is an event that leads inevitably to an accident. Your secondary power just cannot be taken out for longish periods of time when your primary power is not available. There, that's (part of) a HazAn, with the derived safety requirement. HazAn is no more, and certainly no less, than this kind of reasoning, but you must systematically cover everything.

The next formal step is to ask about mitigation. What can happen to secondary power to take it out? It can fail because it is poorly maintained (mitigation: maintain it properly. This is a known quantity.) It can fail because on-demand systems often fail on demand (mitigation: run it continuously, at low power, so you know it runs when it is asked to cut in). It can fail because a large airplane crashes into it (mitigation: design the building accordingly. This was a consideration for English gas-cooled nuclear plants in the early 1970's). It can fail because of a bomb (mitigation: good security at the gates and perimeters). It can fail because it's flooded. Before someone says "thousand-year tsunami", recall that there are two and a half million gallons of water perched in the air in the spent-fuel pools of the six reactors, which pools just might be breached during an earthquake—but weren't, as it turns out. You should think of that, even if a tsunami doesn't occur to you. (Mitigation: design the secondary power to function while submerged. They do it in submarines, this is a known quantity.)

Maybe such HazAns weren't state of the practice when the plant was built decades ago? HazAns are also required by standards during operations, which were continuing up to March, 2011.

"But no one can think of everything!" That is, though, the purpose of a HazAn. You may make a mistake, of course, in your HazAn. But the reasoning above is routine, one thing following from another; I would require from my students no less.

Now to the point of this shaggy dog story. How did the builders, owners and operators of this plant miss all this for forty years? To answer that question, you don' need an engineer, *you need a sociologist*! There, I said it!

Do you need to answer it? Most certainly you do. It helps you to find other plants, other power companies, where similar things could have happened and could be happening, so we can step in before something equally extreme happens.

You also need somebody to tell you what the consequences of such an extreme event are. Engineers work on experience. Commercial jet transport airplanes are thought of, justifiably, as maybe the most highly reliable complex artifacts ever built. Wings used to fall off (say, from Wellingtons, seventy years ago). They don't any more (or only as a consequence of some other unrecoverable event). Experience makes the difference: we have five to twenty fatal accidents with commercial jet airliners per year to learn from. Compare with nuclear power: we have had three, maybe four, extreme events in fifty years (Windscale, maybe Three Mile Island, Chernobyl, Fukushima 1). Who can tell us what the

consequences are? Two engineering colleagues said: Chernobyl, 60+ fatal. Some medical researchers say: 6,000+ fatal. Greenpeace says: 200,000+ fatal. If the weather had been different, maybe tens of thousands more in Kiev. When the serious estimates of fatalities (alone! then there is the damage to the environment to consider) differ by four orders of magnitude, as here, then the answer seems to be that no one can tell us reliably. Or even what the possible consequences are. The engineering risk calculus of probability times severity doesn't work, either. It gives one answer before Chernobyl, another answer after Chernobyl, and yet another answer after Fukushima. A decision aid is useless if it gives you different answers each time you have an unwanted event. An engineer can't tell you.

Can a sociologist tell us? Maybe not. Then who?

Judging from the color of smoke: What Fukushima tells us about information infrastructure breakdowns and IT development methodologies

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Is there a nuclear meltdown in the Fukushima nuclear power plant? It took until day 17 after the East Japan earthquake and tsunami crisis until this question was answered for at least one of the reactors (No. 2) in Fukushima. The earthquake and its tsunami did not only shatter houses and thousands of lives, but also the trust and confidence in technology and the official communication policies of one of the most advanced nations in the world.

It has been a definitional part of the technological conception of a nuclear power plant to install an information infrastructure that would keep the engineers informed about the processes that go on inside the plant, and to provide them with means to manage all processes. On day 17, the question described above is still so difficult to answer because the sensors, wires and screens that have been built into the plant have been damaged or left without power together with the installations they were to monitor. And suddenly experts trained in electrical engineering and nuclear engineering are judging from the color of smoke (white vs. grey, steam vs. soot) over Block 3 which of its parts are burning or may have undergone problematic structural changes.

Information availability and/or information policies of TEPCO and the Japanese government do not allow us to exactly diagnose the nature of the information infrastructure breakdown that may be going on in the Fukushima facility. But it makes us notice, how dependent on information infrastructures we have become, and how vulnerable we are when IT and monitoring systems break down. From a perspective of the disciplines of Computer Science and Information Systems, Fukushima provides reasons to reconsider the way reliable information systems are developed.

There is no doubt that existing Software Engineering development methods reliably cover the development of the core functionality to make information available where it is needed. But when a

technological system becomes an infrastructure, more is needed. Infrastructures become invisible during use, but upon breakdown they come to the fore, and it becomes a most urgent task to engage in coping and recovery activities. One strategy to deal with these necessities is to take as many steps as possible to prevent any failure—that is what usually guides the development of technical systems. This is a honorable strategy, but it is dangerous to ignore the risk that the unthinkable could become true.

We should therefore reframe the problem and investigate new strategies that reflect the specific human competencies to manage uncertain situations and deal with exceptional breakdown situations. We should consider specific characteristics of IT systems: Computational reflection and IT as a medium. Decentralized IT systems connected to the Internet particularly possess means for computational reflection to observe their own behavior and their connections with other artifacts and infrastructures, and then adapt the behavior to deal with failures of parts of the system. And IT systems are also a medium that may provide status reports about the inner workings and to adapt the system interactively to a new situation. Together with the ability to integrate new components in an ad-hoc manner, this makes IT infrastructures highly flexible. But this flexibility remains useless, if it is not integrated into the improvisation practices of its users.

So, reframing the problem also implies that we should understand more profoundly activities and embodied practice of developing reliable infrastructures as an on-going accomplishment. The sociologist Susan Leigh Star and the historian Geoffrey Bowker investigated in their essay 'How to infrastructure'* the characteristics that constitute an infrastructure, and go beyond a description of the technological entities. They also address the social and organizational arrangements that make a technological system an infrastructure (e.g. shaping and being shaped by conventions, being learned as part of membership to a field of practice). IT systems—now understood as a computationally reflective medium—can do more than other technologies by also supporting activities that allow the articulation, negotiation and change of these social arrangements, e.g. by offering communication channels or by allowing the observation of usages.

Looking at Fukushima and the crucial role information infrastructures play for organizing the coping and recovery work, we see that, on a technological level, we need fault tolerant, decentralized IT systems that consist of autonomous, ad-hoc replaceable components that have independent power supplies. Such systems must be dynamically re-configurable to support for improvisational activities in coping and recovery work. This implies that the system should be able to deliver information about the state of connected sensors and describe the structural state of the plant.

Based on this consideration, we have to investigate into IT systems that make their behavior accountable and provide a support for improvisation, and for unanticipated usage patterns; into IT systems that make use of the reflexive and the media capabilities inherent to the technology; and into IT systems that provide communication means among the relevant stakeholders in order to support improvisational activities of coping and recovery work in a decentralized manner. This investigation has to be complemented by IT development methodologies that do not just focus on a technical system, but include awareness for the social and technological infrastructures they are based upon, and the social and technological infrastructures they are going to support. In the case of a breakdown, less sophisticated technologies should establish links to older infrastructures (e.g. by providing simple video cameras, or by providing printouts about the current state of the plant that could help setting up a low-tech communication system) must be seamlessly includable to increase the resiliency of the information infrastructure as a whole. We also have to consider the role of IT as a second order infrastructure which collects information with regard to improvisational recovery work and where this work was successful, even under extreme conditions as seen in Fukushima.

* Star, Susan L. & Geoffrey Bowker: How to infrastructure. In: Lievrouw, Leah A. & Sonia Livingstine (eds.): *Handbook of New Media—Social Shaping and Consequences of ICTs*, London: SAGE Pub., 2002, 151–162.

So, if at some point judging from the color of smoke becomes an important improvisational activity, information infrastructures can and should be able to support this, too.

Coordination, information, collaboration

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At the time of writing over 35 national humanitarian organisations are assisting official emergency agencies and local volunteers in Japan (SEEDS 2011). Many international Search and Rescue teams support them, as well as transnational organisations gathering, visualising and sharing information (Crisis Commons, Ushahidi, Google, esri, the Harvard Center for Geographic Analysis), including information from public crowdsourcing efforts where individuals plot, for example, local radiation levels (http://www.rdtn.org/).

The scale of destruction, subsequent transport, energy and communications outages, as well as differences in national, organisational and professional cultures and languages make it unsurprising that communication was difficult. But—not for the first time (see e.g. Tierney and Goltz 1997)—professional reflections on response efforts highlight coordination, information, and collaboration as in need of improvement. Like their counterparts in the US after Katrina, local analysts call for a 'total coordination centre' at prefecture level, connected to regional and local coordination points, as well as better efforts to 'share the right information at the right time' (especially with the public), and better collaboration between professional and non-governmental organisations and volunteers (Shaw 2011).

But these demands are not 'natural' responses to 'obvious' and avoidable failings. They are in no small part made possible by everyday experiences and imaginaries of technologically mediated mobile living. In a world where economic, personal and professional relationships are routinely 'stretched' across the globe, socio-technical change has reached deep into the fabric of Japanese society. Observers document new practices of micro-coordinating everyday lives (Ling and Yttri 2002), as well as transformations of intimacy and individuality (Matsuda 2009), and location privacy (Licoppe and Inada 2009). Disaster response, too, is a reflexive nexus for socio-technical innovation—responding to calls for improvements, contributing to transformations of everyday practice and raising expectations. There are many resonances with European innovation efforts and I briefly summarise two projects.

In direct response to the 1995 Hanshin-Awaji earthquake, Hatayama, Kakumoto, and Kameda (2010) developed a 'Risk-Adaptive Regional Management Information System' (RARMIS). As part of a participatory design process, early prototypes of this Geographical Information (GIS) System were deployed after the Kobe earthquake to assist in the administration of financial support for the dismantling of damaged buildings. It mapped owners with properties, records of identification and support granted. The system allowed government clerks to replace paper forms and archives with

digital ones and significantly speeded up the process of recovery. A number of lessons from this early implementation have informed subsequent design iterations. The system:

- should be used also under normal circumstances (to facilitate up-to-date data availability and skills of use)
- should not require expert skills, as novices may need to use it
- must be portable
- should not depend on computer networks (because these can be disrupted)
- should facilitate information integration

Further, efficiency gains should be aimed at service improvement (not a reduction of workforce). The system has since been used in other contexts, e.g. during preventative action during the 2007 Kiyotake Avian Influenza (HPAI) epidemic.

More far-reaching innovations in 'next generation information and communication technology services underlying the resilient society' are envisaged and built by NTT, Asia's largest telecommunications company (Maeda et al. 2010). They bring together location devices, life-logs and bio-sensors, internet, database, search and datamining technologies to map, track and interrogate citizens' movements and personal data. In normal times, such data is expected to be used to provide healthcare, public services, and e-government. At times of crisis, next generation ICT services are envisaged to help locate and support victims and responders. The system is based on cloud computing and ad-hoc networking, which, like Japan's traditional Internet infrastructures, remained largely operational even in the immediate aftermath of the Tōhoku earthquake (Shaw 2011).

It is not yet clear in how far technologies have succeeded or failed to support coordination, information and collaboration in the response efforts in Japan. Moreover, it is not clear whether technologies (or structural innovations) actually can help. The—under normal conditions!—highly complex practices of understanding, orchestrating and visualising needs and activities across distance and professional boundaries (Suchman 1997) may not be 'stretchable' beyond certain limits. However, while we wait for further evaluation reports, more general issues can and should be discussed. Repeated experience of the fragility of communications networks (and technology more generally) has inspired calls for 'graceful augmentation' of traditional emergency response practices and technologies (Jul 2007). Furthermore, there are fears that design and policy efforts to increase the efficiency and security of normal mobile living, preparedness for crises and disaster response are part of a *Faustian* bargain where societies trade in the privacy and civil liberties needed for democratic governance (Elliott and Urry 2010). This could become another creeping but potentially major socio-cultural disaster that cannot be prevented by implementing more advanced technical mechanisms of managing access to personal data, because the social and material cultural practices involved are much too situated, complex and dynamic to be controlled (Nissenbaum 2009). Research and development around disaster response technologies can help address this socio-technical challenge by making innovation around next generation information technology subject to more informed public debate, and by enabling more informed holistic innovation and evaluation through collective experimentation (Bridge project). And people's responses—especially the increasingly widespread use of social media and open source community platforms—highlight that besides dangers, there are also opportunities arising from public socio-technical innovation in disaster coordination, information and collaboration.

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