

Annexes:

Concept Paper for a Dam-related Hazard Warning System in Sri Lanka

A Participatory Study on Actions Required to Avoid and Mitigate Dam Disasters

<http://www.iirneasia.net/2006/01/Dam-Safety-Concept-Paper-Released/>

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Annex A Consultation Process Input

Annex A: Consultation process input		
Comment/Suggestion and Source	Response	Explanation
Governance		
One agency should be entrusted with dam oversight. <i>???, Irrigation Department</i>	Accepted with caveat	The agency must not, for reasons of potential interference, be involved in owning/operating dams.
Attempts in the past to create legislation have not progressed past legal drafts stage. <i>Mr de Silva?, speaker #2 in open forum</i>	Noted	
In the past steps have been taken by a Presidential Commission toward establishing a regulatory body. <i>KSR de Silva, Director General of Irrigation & President, Sri Lanka National Committee on Large Dams</i>	Noted	
We need to pass and implement a Dams and Reservoir Safety Act. <i>???, 4th speaker, 2nd presentation</i>	Accepted	
At one time there was a water tax being levied. When we realized that we didn't know where that money was going, we collected several petitions and filed a case in the Supreme Court. When we collect money, it must remain in that particular district. It cannot go to the treasury. That will be the last we see of it. <i>P.B.S. Dabare, Basnayake of the Kawudulu Tank</i>	Accept	This thinking is applicable to reservoirs that have irrigation as the primary use. The principle of user pays must be applied to all dams, including those used for multiple purposes
There are around three tanks in our area, which supply water to over 500h of farming land. These tanks are under the Mahaweli Project. When we told the relevant officials they said that there is no money. Our society has funds of around Rs 100,000. We try to do the necessary maintenance. If there are any non-governmental organizations that could step in to help us, that would mean a lot. <i>President of the Farmer Society in Dingalweva, Polonnaruwa community meeting</i>	Noted	The level of specificity does not fit this paper. However, this reinforces the previous comment indicating the willingness of those living in proximity of reservoirs to accept the costs and responsibilities of maintenance, contrary to Colombo-based activist thinking.
The government (or an organization acting for it) should take steps to improve the living standards in areas affected by Kantale, including installing better safeguards against future emergencies. <i>Participant, speaker # 18, Kandy community meeting</i>	Noted	Development activities are beyond the scope of this project; however the emergency management system in Kantale does need to be improved.
We should make public maps of at-risk areas of towns and villages, showing where businesses and buildings and facilities are, so that if a disaster happens we will know who owned what and how to rebuild and rehabilitate the areas. <i>Digana resident, speaker #4 at Kandy community forum</i>	Noted	Shows willingness of residents to act in the absence of government response. Obviously, second or third best solutions.
Though the owner and operator may be different entities (GoSL vs. Mahaweli Authority), dam oversight is nil. There is no regulation therefore no	Accepted	

<p>best practices are implemented in Sri Lanka. <i>Nimal Wickremeratne, Sri Lanka Committee on Large Dams</i></p>		
<p>We need a regulatory body under government, not with the owners. New dam plans, safety, and environmental clearances should be sought through this entity. <i>??, speaker #9 open forum (lady!)</i></p>	<p>Accepted</p>	
<p>There are many factors beyond the control of owner/operators. Several of these are political. These entities will have to work in collaboration with government institutions and law enforcers. <i>Mr. Amarasekera, Irrigation Department</i></p>	<p>Accepted</p>	
<p>In other countries, for advice/ authority for technical matters in this area, Institution of Engineers and National Committees of Large Dams are the accepted widely. But I am not sure in Sri Lanka how matured they are to take up that role. <i>Badra Kamaladasa, Deputy Director (Dam Safety), Department of Irrigation</i></p>	<p>Noted</p>	
<p>All roadways above or over major dams should be owned and operated by the Irrigation Dept. <i>M. Amarasekera, Irrigation Department</i></p>	<p>Not accepted</p>	<p>That would make the Irrigation Department a road authority. DHU can evolve appropriate solutions, case by case.</p>
<p>The Government needs to instigate precautionary measures in respect of major dams in hill country in view of spreading of rumors and incorrect news on earthquakes. <i>L. P. J. W. H. Abayasinghe, HAO&M Engineer-in-Charge, MASL</i></p>	<p>Noted</p>	
<p>If it is necessary to cover major dams owned by Department of Irrigation and CEB, it would be best to introduce a Reservoir Act as described by the Activity 6 report of the Consultant, M/s Jacobs GIBBs. <i>L. P. J. W. H. Abayasinghe, HAO&M Engineer-in-Charge, MASL</i></p>	<p>Accepted</p>	
<p>We cannot confidently state that inspections are adequate in respect of other Mahaweli dams. In this situations, DG/MASL can issue instructions to dam operators advising them to conduct inspections. The Dam Safety Unit can provide required technical inputs. <i>L. P. J. W. H. Abayasinghe, HAO&M Engineer-in-Charge, MASL</i></p>	<p>Partially agree</p>	<p>Some entity must direct operators to undertake inspections; should this be the Mahaveli Authority or DHU?</p>
<p>The Dam operator should know that the safety of the dam is his primary function. He should be aware of what to look for during his regular inspections and possible remedial measures to prevent disasters. He must be provided with adequate training and refresher courses. <i>L. V. Talagala, Lanka Hydraulic Institute</i></p>	<p>Partially agree</p>	<p>Dam operator's primary function is operating the dam: safety is an important function. Agree on training; but responsibility should lie with operator, not others.</p>
<p>The MASL and other principal dam owners have achieved progress in dam safety oversight and technology transfer through the Dam Safety and Reservoir Conservation Project (DSRCP) funded by the World Bank, including preparation of a draft "Reservoir Act for Sri Lanka" along the lines of the</p>	<p>Noted</p>	<p>Contra to many other inputs. Suggests there is no cause for concern.</p>

Reservoir Act 1975 of UK. In 1994 the World Bank rated activities of DSRC as "Highly Satisfactory." <i>Nimal Wickramaratne, Director for HAO&M, MASL</i>		
We as dam owners lack necessary resources to improve dam safety oversight, specially funds. Risk reduction or improvement of safety level of dams require finances and technical know-how. Because funding is inadequate, it is essential to form recommendations that leads to ensure recovery of costs. The paper looks into cost recovery plans, but there is no indication of a suitable solution. More attention is required on cost recovery issues. Cost recovery should be discussed in the light of proposed "National Water Resources Policy" and National Water Resources Authority. <i>Nimal Wickramaratne, Director for HAO&M, MASL</i>	Accepted	Agree more depth required in financing discussion; but money itself is not enough. Institutional reform is essential.
As dams regulate natural flows of rivers for the benefit of many uses like irrigation, drinking water, electricity, sanitation etc; the principle of "user pays and polluter pays" need to be applied. <i>Nimal Wickramaratne, Director for HAO&M, MASL</i>	Accepted	
As a cost recovery method, we propose that water rights should be allocated to dam owners depending on their ability to regulate natural flows. They should be allowed to re-allocate to direct users or end users. The method of water allocation and recovery of cost involved in storage and distribution can be regulated by NWRA. As all dams are owned by the Government, owner can bear part or all costs of operation and maintenance. But operators should have the right to recover O&M costs. <i>Nimal Wickramaratne, Director for HAO&M, MASL</i>	Accepted	
There should be provisions in proposed laws to define roles and responsibilities of dam owners, dam operator and the dam safety regulator. <i>Nimal Wickramaratne, Director for HAO&M, MASL</i>	Accepted	
The present MASL "Dam Safety Management Centre" was formed with a view to convert it to a regulatory body in the event that Govt. decides to enact a Reservoir Act. A draft act was prepared and forwarded to the Ministry. <i>Nimal Wickramaratne, Director for HAO&M, MASL</i>	Noted	
The appropriate place for the proposed DHU would be the proposed NWRA considering the nature of expertise required for both organizations. <i>Nimal Wickramaratne, Director for HAO&M, MASL</i>	Noted	But does this solve the problems of ensuring independence and positioning it so it can mediate among different government entities?
"Federal Guidelines for Dam Safety" published by Federal Emergency Management Agency of US presents recommendation to improve dam safety. It would help to form firm recommendation in the final report. <i>Nimal Wickramaratne, Director for HAO&M, MASL</i>	Not accepted	The level of detail maybe too much for this Concept Paper. Agree it could be referred to when the DHU draws up detailed procedures.
Being an agricultural country, the economy depends on the existing dam/reservoir system. There is a serious concern over the management and safety of major water related assets owned by various government organisations.	Accepted	Would be true even if we reduce agriculture's contribution to GDP

<p><i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>		
<p>Present management has been limited to operation and limited maintenance due to lack of funding. At the first public hearing of the World Commission of Dams in December 1999, Mahaweli Authority explains that they cannot manage the existing system in a natural disaster.</p>	<p>Noted</p>	<p>Contradicts first Nimal Wickramaratne comment above.</p>
<p><i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>		
<p>At the first public hearing of the World Commission of Dams held in Colombo 1999, it was proposed that Sri Lanka establish a flood warning and forecasting system, conduct hazard mapping in anticipated inundation areas, install a micro-seismic network, and create a public awareness and warning system.</p>	<p>Noted</p>	<p>How do we get from proposal to implementation? This is the challenge for this document too.</p>
<p><i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>		
<p>Priority for the monitoring and maintenance of the Dam Sector is low at the National level, which will have adverse impacts on the safety and operations.</p>	<p>Noted</p>	<p>Intention is to change this.</p>
<p><i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>		
<p>In the summary of findings of Kantale Dam failure 'Senior officers, including Professor Thurairajah, suggested that inspection and maintenance of bunds should be given over to an independent authority.'</p>	<p>Accepted partially.</p>	<p>Regulation of inspections should be with independent body, but actual inspections should be with operator.</p>
<p><i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>		
<p>The World Commission of Dams (WCD) had 5 regional public hearings globally to formulate uniform criteria for the dam/reservoir sector under five principal headlines: equity, efficiency, participatory decision making, sustainability, and accountability. The first public hearing was held in Colombo, December 1999, with the South Asian sector.</p>	<p>Noted</p>	
<p><i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>		
<p>The World Commission of Dams had two objectives: to review the development effectiveness of large dams and assess alternatives for water resources and energy development; and to develop internationally acceptable guidelines and standards, for the planning, design, appraisal, construction, operation, monitoring and decommissioning of dams.</p>	<p>Noted</p>	
<p><i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>		
<p>Supervisory staff must pay attention to their responsibilities to inspect the dams and assure adherence by operating staff to correct O&M</p>	<p>Accepted, but . . .</p>	<p>Issues of internal governance within dam operators are difficult to address; possibly</p>

standing orders. Senior staff are neglectful of these duties. <i>L. V. Talagala, Lanka Hydraulic Institute</i>		introducing private sector incentives?
The standing orders should contain inspection procedure, format of inspection report, action taken, supervising officers' actions etc. An Emergency action plan is also necessary. <i>L. V. Talagala, Lanka Hydraulic Institute</i>	Accepted	
ICTs		
Communications stations should have secure intranet or local networks prepared for emergency usage. <i>Mr. Jayasooriya Udukumbura, participant, Gampola community meeting</i>	Accepted	
New technology hasn't come into this field of observation and safety monitoring as much as it should. There is a lot of potential in applications for warning communication, risk management, etc. <i>Mr Jayatilake, former Irrigation Board Director</i>	Accepted	
Laser scanning technology would be key in producing good inundation maps. <i>Nimal Wickremeratne, Sri Lanka Committee on Large Dams</i>	Noted	
We must consider the cost of new technologies in the context of a developing country. <i>??, Sinhala, speaker #1 presentation #4</i>	Accepted	
Motes are not a very expensive technology and are going to get cheaper very quickly. <i>Anura Jayasumana, Professor of Electrical and Computer Engineering & Computer Science, Colorado State University, USA</i>	Noted	Would have to be tested in context of a pilot project.
Must consider whether mote technology can be supported with existing ICT capacity, including internet coverage, bandwidth, and power. <i>Divakar Goswami, LIRNEasia</i>	Noted	Would have to be tested in context of a pilot project.
Several dams already have sensors, most of which are not working. Given that there are already problems with maintenance of sensing and other infrastructure, we should focus our resources on these already-costly problem areas. <i>Mr Dharmasena, former director, Irrigation Board</i>	Partially agree, but...	As technology progresses, costly maintenance of old technology becomes moot. With small cheap items like motes there is no need to maintain extant sensors, one replaces components.
There are potential mote applications for landslides as well, as the sensors can monitor pressure and temperature. <i>Anura Jayasumana, Professor of Electrical and Computer Engineering & Computer Science, Colorado State University, USA</i>	Agreed, but outside scope	
During the 1947 floods in Gampola, it was difficult to warn residents or gather emergency responders because communications facilities hadn't been developed. Today these facilities exist. <i>Ranjith de Silva, participant, Gampola community forum</i>	Accepted	
Some notes on motes: the battery can use solar power or bridge vibration-charging in Sri Lanka; an advantage is that there is no required infrastructure, because they are wireless; they are capable of some	Noted	

<p>data processing and so do not simply relate data back to centre. <i>Anura Jayasumana, Professor of Electrical and Computer Engineering & Computer Science, Colorado State University, USA</i></p>		
<p>There is no substitute for regular, comprehensive and intelligent inspection by the onsite engineer-in-charge. It is impractical to cover the dam with sophisticated instruments to ensure reliability at all times. <i>L. V. Talagala, Lanka Hydraulic Institute</i></p>	Agree	<p>Recognize importance of human factor; however, there could be value in a pilot project with new technology</p>
<p>Because few major dams were built after the 1980s, there has been little opportunity to Sri Lankan engineers to get experience of new technology and risk assessment methods. We thus support the proposed pilot project. <i>Nimal Wickramaratne, Director for HAO&M, MASL</i></p>	Noted	<p>Reinforces case for pilot project</p>
<p>Inundation map with flood damage parameters that indicate hazard potential is required for effective implementation of an emergency action plan. Preparation of accurate inundation map is very costly without using a technology similar to LIDAR (Light Detection and Ranging: www.lidar.co.uk). As it involves a new technology transfer, we suggest a pilot study for preparation of inundation maps with the use of latest software like CADAM and aerial scanning of flood planes using aerial laser scanning technology. <i>Nimal Wickramaratne, Director for HAO&M, MASL</i></p>	Noted	<p>The level of detail is beyond this Paper, but useful for follow up work.</p>
<p>The EWS should be able to cover Mahaweli River from Kotmale to Mahiyangana. The length to be covered by EWS would be around 60 km. The EWS need to be activated through a radio data link. As line of sight needs to be maintained between two stations, it would be required to establish number of relay stations. Embankment Dam Instrumentation Manual of USBR says transmission via the GOES (Geostationary Operating Environmental Satellite) can be very cost effective and efficient. As cost of data transmission through satellite links need to be compared with the cost of UHF radio link, a feasibility study need to be done with a help of an expert having experience on data communication in similar situations. <i>Nimal Wickramaratne, Director for HAO&M, MASL</i></p>	Noted	<p>The level of detail is beyond this Paper, but useful for follow up work.</p>
<p>Dam monitoring creates a long-term understanding of the structure's behaviour under various loading possibilities. Modern dams have incorporated several types of instrumentation to monitor the behaviour of the structure with varying water loads, but ancient and recent smaller dams have not. <i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>	Noted	<p>Distinction suggests the value of two pilots, one for modern dams and another for ancient dams.</p>
<p>Though modern dams can be monitored to a greater extent, there is no scientific way of monitoring the behaviour of ancient and recent dams. <i>S. Karunaratne, former Director and Executive</i></p>	Noted	<p>Distinction suggests the value of two pilots, one for modern dams and another for ancient dams.</p>

<i>Director for Dams, MASL; advisor to Technical Services of Mahaweli</i>		
The data acquisition instrumentation systems are poor, and poorly interpreted, as there are too few capable professionals. Little importance is placed on the daily data acquisition of hydrological and technical instrumentation. Missing data is a serious issue on forecasting the behaviour of structural components. <i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i>	Noted	Raises questions of capacity and sustainability. Should we be looking at systems where most of the intelligence is embedded internally?
We must examine the available facilities of the technical and scientific organisations of the country, as there is a need to get various services to maintain safety standards. <i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i>	Noted	Raises questions of capacity and sustainability. Should we be looking at systems where most of the intelligence is embedded internally?
We need a comprehensive, all-hazards warning system, utilizing data collections systems that can collect remote data informing the activation of the EWS. It is, therefore, necessary to get services of a Consultant who is familiar with Automated Data Acquisition Systems. <i>L. P. J. W. H. Abayasinghe, HAO&M Engineer-in-Charge, MASL</i>	Noted	Appropriate for next stage
Requirements for Establishment of Emergency Preparedness Plan: 1. Computer programs to forecast Attenuated Intensity at dam sites when location and magnitude of an earthquake is given and to simulate dam break scenarios, and technical assistance to calibrate such programs. 2. Strong-Motion Accelerometers that would trigger at different attenuated intensities at major reservoirs. 3. Early Warning System. 4. Technical advice to develop inundation maps with velocity-depth regions. 5. Resources required to mark the dangerous zones on the ground. 6. Data Acquisition System that can withstand disaster conditions. <i>L. P. J. W. H. Abayasinghe, HAO&M Engineer-in-Charge, MASL</i>	Noted	Appropriate for consideration at next stage
MASL do not have an EWS at present. As a result, it is not possible to give an adequate warning to people living within dangerous zone along the Mahaweli River. The dangerous zone is defined considering the velocity and the depth of flood water at various locations along the river. MASL need to acquire technology required to acquire inexpensive means of topographic survey of river flood plane. Further, we need to select a suitable software package comparing number of packages like ILDWAV, DAMBRK.UK and CADAM (Annex2, Page 7). <i>Nimal Wickramaratne, Director for HAO&M, MASL</i>	Noted	

<p>At present there are no proper warning systems. Upon the release of waters, dam personnel will inform a limited area according to the facilities available. We must consider the level and mode of communication facility that will spread warnings of any incident in an event of a failure. <i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>	Accepted	
Technical and Environmental Problems		
<p>Roadways upon bunds, in particular the Kantale bund, are heavily loaded and speed limits not always observed. This needs to be further studied. <i>Mr Dharmasena, former director, Irrigation Department</i></p>	Noted	Mediation between conflicting uses and multiple entities shall be part of the responsibilities of the DHU.
<p>There are rumors that the Victoria Dam has cracks in its wall. I and my neighbors are afraid about that. Many rumors have circulated; engineers should look into the problems so that the community is informed. <i>Digana resident, speaker #4 at Kandy community forum</i></p>	Noted	Made unsuccessful inquiries from Professor Kapila Dahanayake, Geology, U of Peradeniya.
<p>There are 89 cracks in the geologic plate on which Sri Lanka rests. Nine of these are near reservoirs and tanks. If an earthquake happens these are going to be major hazard sites. We should install earthquake-detection equipment along these fault lines. <i>Ahangama Arachchi, participant, Kandy community forum</i></p>	Noted	Conflicting views exist. Action will have to be taken on the context of an overall risk assessment program.
<p>Especially with masonry structures of old/ancient dams, the road-loading must be analyzed as mortar may lose strength over time due to vibrations. <i>Mr Sabanda?, CCT? (2nd speaker open forum)</i></p>	Too detailed for present report	Conflicting views exist. Action will have to be taken on the context of an overall risk assessment program.
<p>If the road surface is unaffected, the below-ground state of the dam should be safe. <i>KSR de Silva, Director General of Irrigation & President, Sri Lanka National Committee on Large Dams</i></p>	Too detailed for present report	See above.
<p>The presence of snakes and other physical impediments makes it difficult to survey and monitor dam works especially with ancient and restored bunds <i>??, Irrigation Department</i></p>	Accepted	Possible opportunity for technology.
<p>Field staff of dam sites may inappropriately take holidays. The Kantale staff at the time of the breach may have been off celebrating Avurudhu. Adequate staff levels must be maintained. <i>??, Irrigation Department</i></p>	Accepted	Must be dealt with as part of Standing Orders.
<p>Necessary to update ancient dams with modern technology. <i>DWR Weerakoon, former Director, Irrigation Board</i></p>	Partially accepted	Modern technology alone will not ensure adequate safety levels; oversight is needed.
<p>The tension of the cables on Kotmale dam was never checked until 3 years ago; not sure if it has now been checked. <i>Mr. Harinanda, former CEB ??</i></p>	Noted	Action will have to be taken on the context of an overall risk assessment program.
<p>Automated systems dealing with water levels and sluice opening mechanisms are not set to proper automation guidelines. <i>Nimal Wickremeratne, Director, Headworks of the</i></p>	Noted	Action will have to be taken on the context of an overall risk assessment program.

<i>Mahaweli Authority</i>		
Dams may be hydraulically imbalanced, with spillways designed unrealistically with respect to flooding. There have been cases of flooding due to wrong operation of reservoir gates. <i>Mr Dharmasena, former director, Irrigation Department</i>	Noted	Action will have to be taken on the context of an overall risk assessment program.
Concrete aging is a major safety problem. At some dams it is possible to clearly see the deterioration that has taken place. <i>??, Irrigation Board (speaker #4, open forum)</i>	Noted	Action will have to be taken on the context of an overall risk assessment program.
Cutting down trees and installing tube wells cause natural springs to dry up. Local people need to be educated about these problems. <i>Participant, speaker #13, Kandy community forum</i>	Beyond the scope of present activity	
Farmer associations should be contacted or formed to develop safer ways of farming, i.e., ways that do not increase the likelihood of landslides or reservoir silting. <i>Participant, speaker #14, Kandy community forum</i>	Noted	Could be included in local education programs.
Most long-lived and large trees, like pines, have been cut in upcountry villages, causing dramatically increased landslides. <i>Participant, speaker #10, Kandy community forum</i>	Noted	
Because modern and ancient dams are structurally different (modern being from about 25 years ago), may need to use different systems to monitor them <i>??, speaker #7 open forum</i>	Partially accepted, but...	Action will have to be taken on the context of an overall risk assessment program.
As engineers we should be able to assess risk within calculable parameters, notably the bund-road loading problems. <i>Mr Amaresekera, Irrigation Board</i>	Noted	
The official main Kandy-Trincomalee road should be shifted off the Kantale bund as the heavy vehicle traffic is a danger to the dam. The government should divert all traffic, especially heavy vehicles. <i>Participant, speaker # 5 at Kandy community forum</i>	Partially accepted, but...	Action will have to be taken on the context of an overall risk assessment program. See below.
Kantale heavy traffic diversion project is underway, including the installation of vibration-measuring sensors on the current road. <i>KSR de Silva, Director General of Irrigation & President, Sri Lanka National Committee on Large Dams</i>	Noted	
Many hazards and problems arise through human-created geographical features. Engineers should take environmental change into account. For example, landslides are more common in an area after a dam has been built. <i>Mr. Dassanayake, participant, Kandy community forum</i>	Noted	Action will have to be taken on the context of an overall risk assessment program.
After a dam is built, it usually is tested to produce guidelines for maximum pressure safely allowable. Engineers must follow these specification reports. If they follow the guides the dam will be safe. <i>Donald Ranaweera, Peradeniya resident, Kandy community forum</i>	Agree in principle, but...	The Standing Orders must include up-to-date analyses of such guidelines. Even with good guidelines, however, additional safety oversight is necessary.

Filling marshland and building on the resulting land has caused a great number of problems and is a practice that should be discontinued. <i>Palitha Atigala, participant, Kandy community forum</i>	Beyond the scope of present activity	
It is not possible to know exactly how fast concrete deteriorates—the method of the dam’s construction and the maintenance schedule adhered to are the most important of several factors in trying to predict decay status. <i>Badra Kamaladasa, Deputy Director (Dam Safety), Department of Irrigation</i>	Noted	Action will have to be taken on the context of an overall risk assessment program.
Building Hill Country reservoirs is most problematic and hazardous for those living far below in the watershed, i.e., not in the hill country. One way this happens is that the deforestation resulting from development projects causes natural springs to dry up and also causes landslides. <i>Mr. Dassanayake, participant, Kandy community forum</i>	Noted	
The Kotmale dam has cracks in it already and if it breaks will be destructive, especially for Gampola. Gampola is like a basin that can catch flooding water from several sources. <i>Chamitha Cooray, participant, Gampola community forum</i>	Noted	Action will have to be taken on the context of an overall risk assessment program.
The Kotmale dam was built with high tech mechanisms, as are most new dams. However if engineers are reluctant to do their work, i.e. inspect the sluice channels and enter crawlspaces, it could be disastrous regardless of the technology’s sophistication. <i>Participant, speaker # 6, Gampola community meeting</i>	Accepted	
If there was another flood like the ‘47 floods, it would now be more disastrous, because people have built homes in low-lying areas. <i>Participant, speaker # 7, Gampola community meeting</i>	Noted	
There are several streams in and around Kandy that are polluted and need to be cleaned up. However even with purification systems people may not want to drink/use these waters as they are thought to be so dirty. An example of this is the Katugastota water purification plan. <i>Participant, speaker # 18, Kandy community meeting</i>	Beyond the scope of present activity	
Standard design specifications call for dams to be able to withstand up to 5-6 on the Richter scale. <i>KSR de Silva, Director General of Irrigation & President, Sri Lanka National Committee on Large Dams</i>	Noted	But see Abayasinghe comments below
The Victoria and Randenigala dams are sited on ‘regional lineaments’ of 15 km and 20 km respectively. Reservoir Induced Seismicity has been observed in many parts of the world and there are more than 70 known cases of Reservoir-induced earthquakes. <i>L. P. J. W. H. Abayasinghe, HAO&M Engineer-in-Charge, MASL</i>	Noted	Should be addressed in context of overall risk assessment

<p>Prof. Vithanage agitated for micro-seismic monitoring after a 1995 earthquake. However, MASL and M/s. Jacobs GIBBs analyzed available data and design standards and found the Mahaweli dams safe under expected seismic activity for the foreseeable future. The US Geological Survey (USGS) does not predict further major earthquakes. Additionally, MASL has found no effects of Reservoir Induced Seismicity (Earthquakes) for a period of five years after impounding of the last constructed reservoir. Hence, there is no reason to be worried about reservoir induced earthquakes.</p> <p><i>L. P. J. W. H. Abayasinghe, HAO&M Engineer-in-Charge, MASL</i></p>	Noted	Should be addressed in context of overall risk assessment
<p>Because information regarding earthquakes above 3.0 on the Richter scale are available freely on-line at the USGS/NEIC (National Earthquake Information Center) website, there is no need for MASL to establish a seismic network.</p> <p><i>L. P. J. W. H. Abayasinghe, HAO&M Engineer-in-Charge, MASL</i></p>	Accepted	The question of how individual operators get this information on a timely basis needs to be addressed.
<p>Earthquake waves travel at speeds between 3 to 7 km per second. An earthquake originating 300km from Sri Lanka could reach our dam sites within two minutes. Hence, we must look for equipment that can help us to activate an early warning system.</p> <p><i>L. P. J. W. H. Abayasinghe, HAO&M Engineer-in-Charge, MASL</i></p>	Noted	But see KSR de Silva comments above.
<p>Any dam has a risk of failure due to various factors. According to ICOLD's 1983 "Safety of Existing Dams – Evaluation and Improvement," dam failures are most often due to poor structural integrity of the dam and foundation and poor management of water flows according to the hydrological requirements.</p> <p><i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>	Accepted	
<p>During the 32 dam inspection conducted under World Bank funding (MRRP project), seepage and leakage were observed in many embankment dams, cracking and settlement in concrete dams and deformation and settlements in modern rock-fill dams.</p> <p><i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>	Noted	Underlines the need for implementation actions.
<p>To evaluate the exact situation we must conduct many engineering practical tests such as soil mechanics, strength of concrete, rock mechanics, operation of outlet works, and non-structural factors. We also need to prepare exact cost estimates for remedial repair works. A basic cost estimate was prepared for the 32 dams inspected under the MRRP Project.</p> <p><i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>	Noted	If this information is readily available, it would form the basis of risk assessment work.
<p>The details of the foundation conditions are not</p>	Noted	

<p>available for ancient dams, as these dams have been renovated and re-renovated during last few centuries. Certain ancient irrigation dams have been structurally enhanced to provide more water though this has created adverse structural safety conditions.</p> <p><i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>		
<p>Along the central part of main Mahaweli Dam system, earth tremors were felt in 1993-98. Residents felt most of these incidents. Geologists explained that these tremors might occur due to an imposed water load on the sub-surface due to large reservoir bodies. These incidents have alarmed the public.</p> <p><i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>	Noted	Public consultations confirmed this
<p>The owners of each dam are responsible for monitoring the dam and its appurtenant structures from the time it is built, during its initial filling, and throughout its useful lifetime. The recent and ancient dam sector has a high inadequacy in monitoring practices. Certain monitoring instrumentation is observed to have decayed and malfunctioned.</p> <p><i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>	Noted	
<p>The ancient sluice barrels which principally failed in the Kantale dam are not peculiar to that dam. They are found in almost all the ancient dams in the country, including Basawakkulama, Nuwara Wewa, Thisawewa, Nachchaduwa, Giritale, Minneriya, Parakrama Samudra and several other ancient tanks.</p> <p><i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>	Accepted	Raises serious concerns
<p>"Have you seen water leakage at Samanala wewa Dam ? Have you seen the Sink hole in the reservoir where water get into the leak ? Dam Hight = 107m, Area = 900H Rock fill clay core type".</p> <p><i>H.S.Somathilaka Chief Engineer Samanalawewa Power Station</i></p>	Noted	Disturbing. Raises questions about whether government is asleep at the switch.
<p>Urgent repair needs cannot be postponed. Several dam/reservoir systems have reached a major rehabilitation stage, due to lack of maintenance and repair works.</p> <p><i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>	Accepted	Raises serious concerns
<p>There are 103 river basins in the country. Out of these many have been exploited to a great extent. The highly integrated water resources system has been developing for centuries and becomes more complex day by day.</p>	Noted	

<p><i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>		
<p>The recently constructed Samanalawewa dam was constructed for the purpose of power generation and to regulate irrigation and flood waters and has a serious safety issue, as there is an excessive leakage through the natural embankment.</p> <p><i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>	<p>Accepted</p>	<p>Confirmed by e-mail from engineer in charge</p>
<p>Dams and their appurtenant structures need to be monitored periodically to check the maintenance and operational systems by technically competent staff. The maintenance practices should be intensified. Vulnerable remedial repairs must be carried out promptly using available funds.</p> <p><i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>		
<p>Disaster Preparedness</p>		
<p>Confidential analysis of the dam break possibilities a must. With publicity, the area residents will needlessly scare population.</p> <p><i>Mr Dharmasena, Irrigation Board</i></p>	<p>Partially agree, but...</p>	<p>Confidentiality is questionable; the public has the right to know answers to these queries and locals are also already preparing their own inundation plans</p>
<p>Having experienced the aftermath of the Kantale disaster as a Sarvodaya officer, it is crucial to have an early warnings system for dam disasters.</p> <p><i>Mr. Dissanayake, Sarvodaya Kandy</i></p>	<p>Accepted</p>	
<p>The owner of each dam should prepare built drawings as part of their standard operations documentation (standing orders).</p> <p><i>??, consultation; responder # 5 in presentation #2</i></p>		
<p>For Gampola, there are many threats besides a potential Kotmale breach. Mahaweli overflows, for example, would pool in Gampola.</p> <p><i>Mr. Vitachchi, former Mayor of Gampola</i></p>	<p>Noted</p>	<p>Action will have to be taken on the context of an overall risk assessment program, in this case not for the structure, but for a human settlement</p>
<p>There was an inspection done of the Parakrama Samudraya recently and we were told that there was no danger. But now there is a leak. And they say there is no danger. Nothing is done on the community level.</p> <p><i>G.W. Rupasissa, Human Rights Community Education Centre, Chairman, Polonnaruwa</i></p>	<p>Accepted</p>	<p>Indicates high levels of knowledge among local residents and a desire to be informed.</p>
<p>Whenever they open the sluice gates of the Kavudulla tank there has been a lot of damage. I can't imagine what it would be like if there was a breach in these gates. This tank is our means of survival. We need a signal or communication system in place.</p> <p><i>Premakumara, participant, Polonnaruwa community meeting</i></p>	<p>Accepted</p>	<p>Need for better procedures to handle excess water</p>
<p>The risk of flooding when the sluice gates are opened has grown because people have filled the land and built houses everywhere. Furthermore,</p>	<p>Noted</p>	<p>Action will have to be taken on the context of an overall risk assessment program.</p>

<p>when a large tank overflows the smaller ones beneath it can also burst. The damage could be ten times greater now. <i>Sarvodaya Man, Polonnaruwa</i></p>		
<p>When the sluice gate is opened, at least half the village is easily submerged by water. If a breach occurs the whole village might be submerged. <i>Abdul Wahab, participant, Polonnaruwa community meeting</i></p>	Noted	Serious problems exist, even in the absence of major hazards.
<p>What the Polonnaruwa dam authorities do is they measure the water level and release water whenever they feel like it. When this happens a lot of the village goes under water. They don't use the old sluice gates, instead they use the new one, which was built in 1962. They should fix the old gates. <i>P.B.S. Dabare, Basnayake of the Kawudulu Tank</i></p>	Noted	Action will have to be taken on the context of an overall risk assessment program.
<p>If a dam breach occurs it tends to have a sequential effect. It's a system the smaller tanks can burst too. Then it will be like a tsunami. <i>Participant #6, Polonnaruwa community meeting</i></p>	Accepted	
<p>The banks of the [Parakrama Samudra] tank are getting submerged, because the water level is rising due to the silt at the bottom of the tank. If the tank requires to be emptied in order to clear the silt then someone should do it and help restore the tank. <i>Anulawathi Wijewardena, Secretary of the Farmer Society in Puranagirthalegama</i></p>	Accepted	Raises question of siltage reducing capacity. Action will have to be taken on the context of an overall risk assessment program.
<p>Need to make provincial councils aware of their dam safety obligations. Dam owners are supposed to supply local councils with safety reports. <i>Mr Harinanda (?), former CEB</i></p>	Accepted	Important point re lower levels of government; the problem is not limited to central government.
<p>We can't block the existing leaks [in the Parakrama Samudra bund], we need help. If the dam bursts around 20-25 villages will drown. It will be like a tsunami. We should have a signal system in place, to warn people. In the North East regions there is a kind of siren system that is used to communicate. It would be good if we can have something like that method of communication in place. <i>Gamini Ekanayake, Deputy Principal of the Kalugasdamana Maha Vidyalaya, Polonnaruwa</i></p>	Accepted	
<p>It would be nice if there was something like an army prepared for disaster response. <i>P.B.S. Dabare, Basnayake of the Kawudulu Tank</i></p>	Noted	The importance of first responders must not be overlooked.
<p>Minimum force dam-break analysis should be done especially for small dams, given that earthquakes were not considered a threat at the time many of them were designed. <i>??, speaker #9 open forum (lady)</i></p>	Noted	Action will have to be taken on the context of an overall risk assessment program.
<p>It is necessary to carry out dam break analysis, especially for Kotmale and Victoria dams. Wide publicity will create panic in people, but it needs to be done. <i>Mr. Dharmasena, Irrigation Board</i></p>	Accepted	Panic issue needs to be balanced in relation to people's right to know.
<p>1:10000 map analysis has been done on Mahaweli areas. If we have the maps, then we can prepare better inundation projections. We need detailed</p>	Noted	Action will have to be taken on the context of an overall risk assessment program. DHU may

<p>topographic info to do this. Currently no capacity to carry out flood damage parameters map. <i>Nimal Wickremeratne, Director, Headworks of the Mahaweli Authority</i></p>		mandate for Mahaveli System.
<p>Flood protection should not be left out of the hazard-management scheme. <i>DWR Weerakoon, former director, Irrigation Board</i></p>	Accepted	
<p>The World Bank funded a dam safety project 1 year ago in which preliminary dam break analysis has been done. But <i>detailed</i> dam break analysis has to be done. <i>Mr de Silva, Director General, Irrigation Board</i></p>	Noted	
<p>Safety is essentially a question of dam structure preservation but ultimately is for the benefit of people. <i>Mr Dharmasena, former director, Irrigation Department</i></p>	Accepted	
<p>We must also identify other disasters that would affect dams, e.g. earthquakes. <i>??, 4th speaker, 2nd presentation</i></p>	Accepted	Action will have to be taken on the context of an overall risk assessment program.
<p>In the case of a breach at Kotmale, the nearby Army camps would be able to convey messages to civilians, but would need preparatory training for this type of role. <i>Gen. Major Palpola (retired), former Army</i></p>	Accepted	
<p>Goals of disaster response plans should include not only saving lives but also food and medicine distributions. <i>Gen. Major Palpola (retired), former Army</i></p>	Noted	This is task for Minister of Disaster Management and DMC under President.
<p>We need pre-trained emergency responders and emergency leaders. <i>Participant, speaker # 4, Gampola community meeting</i></p>	Accepted	This is task for Minister of Disaster Management and DMC under President.
<p>We do have some makeshift disaster management systems in place, which we tested out when there were cyclones. <i>Participant #10, Polonnaruwa community meeting</i></p>	Noted	This is task for Minister of Disaster Management and DMC under President.
<p>Emergency preparedness training should include a systematic, step-by-step approach to all sizes of problems, from a gas leak at home (for example), to village and regional disasters. <i>Mr. Ubeyratne Perera, Kotmale Radio Station</i></p>	Beyond the scope of present activity	This is task for Minister of Disaster Management and DMC under President.
<p>The Government Agents assigned to each reservoir should be trained in safety measures. <i>Mr. Ubeyratne Perera, Kotmale Radio Station</i></p>	Accepted	
<p>Dam break modeling and inundation mapping are prerequisites for risk assessment. This requires several types of data input. <i>L. V. Talagala, Lanka Hydraulic Institute</i></p>	Noted	Possibly useful in next stage of work
<p>The dam operator should have the authority to requisition resources from other agencies, in order to take mitigatory emergency action to prevent a disaster, when such a possibility is identified. The dam operator should be aware of his authority and how to exercise such an authority. <i>L. V. Talagala, Lanka Hydraulic Institute</i></p>	Noted with qualifications	Expropriation is serious. Best done in the context of mutual aid agreements that are part of DHU approved plans.
<p>We believe report on "Development of Rescue Actions Based on Dam-Break Flood Analysis"</p>	Noted	For next stage.

published by Finnish Environment Institute in June 2001 would help authors to suggest future actions in the final report (www.vyh.fi/eng/fei/fei.html). <i>Nimal Wickramaratne, Director for HAO&M, MASL</i>		
The government must identify and prepare locations to be used as shelter/safety and first-aid treatment sites in case of an emergency. <i>Palitha Atigala, participant, Kandy community forum</i>	Beyond the scope of present activity	This is task for Minister of Disaster Management and DMC under President.
Local people must be educated on basic disaster response practices, especially First Aid and evacuation procedures., in order to save their own and others' lives. <i>Participant, speaker #15, Kandy community forum</i>	Accepted	This is task for Minister of Disaster Management and DMC under President.
Prevention is better than cure. Serious damage had been caused by paddy cultivators' usages, which government could be quicker to control. <i>Mr Amaresekera, Irrigation Board</i>	Accepted	
The main hazard problem in the Kandy area is not dams but landslides. They are often caused by human actions so prevention through education is largely possible. <i>Participant, speaker #6 at Kandy community forum</i>	Beyond the scope of present activity	
Tsunami not the only type of disaster to be worried over; there is greater chance of earthquakes from now on. Floods and landslides remain a threat. <i>Mr Dharmasena, former director, Irrigation Department</i>	Accepted	
Three types of risk assessment are currently in practice. They include Subjective Assessment, in which only the most specifically-relevant factors are used to assess a problem and determine a solution; Index-based Assessment, which allows a ranking, rating, or scoring of a number of dams through a systematic evaluation of the factors affecting safety; and Formal Assessment, which estimates occurrence frequencies, relative likelihood of different levels of response and damage, and the various components of cost consequences. <i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i>	Noted	
Risk assessment generally involves the following steps: -Identification of the events that can lead to dam failure and evaluation of their (relative) likelihood. -Identification of the modes of failure that might result from the initiating events. -Evaluation of the likelihood that a dam failure will occur under a given level of loading. -Determination of the consequences of failure for each potential failure mode. -Calculation of the risk costs. <i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i>	Noted	
Target populated cities under the Mahaweli Dams are Gampola, Kandy, Mahiyangana and Polonnaruwa. The existing dam system benefits	Accepted	

<p>these cities by controlling floods and water supply, but the cities may be vulnerable in a serious flooding situation or any other natural disaster. <i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>		
<p>We must conduct risk assessment of selected vulnerable dams to check the failure conditions and to take mitigative measures. The most vulnerable dams can be classified as dams located in major rivers such as Mahaweli, Kelani, Walawe, Kalaoya etc. <i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>	Accepted	
Community involvement		
<p>Operational systems malfunctions, balance of water distribution for Power and Irrigation sector, leakage and its costly repairs, conveyance system problems, and uncertainty of dam safety have brought an unrest among the rural farming section. <i>S. Karunaratne, former Director and Executive Director for Dams, MASL; advisor to Technical Services of Mahaweli</i></p>	Noted	
<p>Farmer associations should be contacted or formed to develop safer ways of farming, i.e., ways that do not increase the likelihood of landslides or reservoir silting. <i>Participant, speaker #14, Kandy community forum</i></p>	Noted, but...	These concerns shall be only part of the local education programs proposed in the paper.
<p>Developing an Early Warning System requires local and community-organization input; should be a cooperative venture because neither government nor local organizations nor people can do it alone. <i>Mr. Dassanayake, Sarvodaya Kandy</i></p>	Accepted	
<p>We must join hands to protect what is ours. We, as a community, must be responsible. If we are to move forward we have to stop pointing fingers and be responsible. The authorities will not lose anything; they have their monthly pay. We are the ones who stand to lose everything. We have to have a disaster mitigation system in place. We are the ones who stand to lose; our lives, our lands. The loss is ours. <i>Sarvodaya Man, Polonnaruwa community meeting</i></p>	Noted	It is laudable that community groups join in the effort to preserve and maintain the reservoirs; however the ultimate responsibility (as stated by several other respondents) rests with the government authorities.
<p>There should be local committees that visit potential trouble-spots, speak with residents on hazards, and develop prevention measures. These committees should be independent to prevent political pressure around their activities. <i>Participant, speaker # 21, Kandy community meeting</i></p>	Noted, but...	Local participation is key but the form it takes (committees versus extant organizations, e.g.) is not within the scope of this paper.
<p>After providing local residents with education on potential hazards, we must take their input on developing strategies for prevention and response. <i>Palitha Atigala, participant, Kandy community forum</i></p>	Accepted	
<p>Disaster response committees must be provided or organized throughout rural villages and networked together. <i>Martin Tilakarage, retired schoolteacher</i></p>	Beyond the scope of present activity	This is a valid goal but beyond the purview of the proposed Dam Hazards Unit.
<p>An example of local disaster preparedness: In</p>	Noted	

<p>several Ampara district villages there had been a wild-elephant warning system worked out by the village headmen and linked with drum and voice communication.</p> <p><i>Martin Tilakarage, retired schoolteacher</i></p>		
<p>Local organizations like the Lions Club and Rotary Club can help set up emergency response plans and good communications.</p> <p><i>Martin Tilakarage, retired schoolteacher</i></p>	Accepted	
<p>There is no point maintaining these tanks at a community level. There must be a program at the national level to protect the low lying tanks from those at above them.</p> <p>At one point they were going to build a dam across the Mahaweli river. We can't stop the upper Kothmale project. We can't maintain a tank. There must be steps taken at a national level. Lone communities can't do it.</p> <p><i>G.W. Rupatissa, Human Rights Community Education Centre, Chairman, Polonnaruwa</i></p>	Accepted	
<p>We must join hands to protect what is ours. We, as a community, must be responsible. If we are to move forward we have to stop pointing fingers and be responsible. The authorities will not lose anything; they have their monthly pay. We are the ones who stand to lose everything. We have to have a disaster mitigation system in place. We are the ones who stand to lose; our lives, our lands. The loss is ours.</p> <p><i>Sarvodaya Man, Polonnaruwa community meeting</i></p>	Noted	It is laudable that community groups join in the effort to preserve and maintain the reservoirs; however the ultimate responsibility (as stated by several other respondents) rests with the government authorities.
<p>There should be community meetings held for people to hypothesize about potential dangers and then classify them according to the probability. This will help develop good plans.</p> <p><i>Mr. Lakshman, participant, Gampola community meeting</i></p>	Beyond the scope of present activity	This is task for Minister of Disaster Management and DMC under President.
<p>Families should be trained in evacuation routes and communities should hold evacuation drills and "disaster rehearsals." Army camps should have sirens that can signal an evacuation call.</p> <p><i>Mr. Weerasekera, participant, Gampola community meeting</i></p>	Beyond the scope of present activity	This is task for Minister of Disaster Management and DMC under President.
<p>We should add crisis management to school curricula and teach children how to respond to different dangers. Many schools have a Red Cross society, which could take on this teaching role. Also schools can broaden their activities through reservoir education and monitoring.</p> <p><i>Mr. S. Albert, vice-principle, Jinnah College, Gampola</i></p>	Beyond the scope of present activity	This is task for Minister of Disaster Management and DMC under President.
<p>School cadet corps and Scouts groups should be trained for emergency response. This would improve the mental and physical fitness of students.</p> <p><i>Year 12 student, Vidyartha College, Kandy</i></p>	Beyond the scope of present activity	This is task for Minister of Disaster Management and DMC under President.

Annex B Comments on Interim Concept Paper: H.A.L.S Yapa, Hydro Tasmania, Australia

Comments correspond to Paragraph numbers on the paper

1. Background

Ref Para 2 line 2- Sri Lanka requires an empowered and efficient **DAM SAFETY REGULATORY AUTHORITY** to serve as the focal point

2. Executive Summary

2.2 Line 1: Among the **possible** negative outcomes of under funding of and lack of emphasis on dam asset management (including operation and maintenance) are **catastrophic failure of a dam resulting in loss of life and property damage to the environment, affecting the well-being of the community including loss of the benefits provided to the dam. These negative outcomes can be caused by the incorrect or lack of proper operating and maintenance procedures, and lack of maintenance and required upgrades to relatively new or ageing dams, minimal education**

Line 6: Replace “overhaul” by **upgrades**

2.3 Line 1 to 2.4: The key to dam safety is have a adequate and **PROPERLY RESOURCED** dam safety program that ensures:

- **That the dams are operated and maintained in a safe manner (that there be correct standing operating procedures for normal operation and maintenance and emergency operating procedures in place to manage emergencies and these are reviewed annually. That the operators are trained and competent)**
- **The hazard posed by each dam is known and regularly reviewed (Dam break studies are done and the population at risk identified and possible damage to property and other infrastructure identified and costed). That is, that the hazard category of each dam be identified.**
- **Appropriate dam surveillance programmes are implemented (depending on hazard category of the dam)**
- **Dam safety emergency plans are prepared and where appropriate warning information and inundation maps are provided to emergency response agencies to assist in downstream emergency planning and response by these agencies.**
- **Appropriately qualified, trained and experienced personnel are engaged on dam design, construction, operation and maintenance and on dam inspections and surveillance - (Applying appropriate expertise)**

- **Suitable regulatory and governance structures and internal reporting procedures are in place.**
- **Dam safety reviews are undertaken at the appropriate time (Despite an appearance of strength and invulnerability dams do age with time. The design basis on which they were designed will also change with increase of knowledge and technology. Hence a comprehensive review of its structural, hydraulic, hydrological and geotechnical design and its behaviour (through its records of operation and maintenance and surveillance records) should be undertaken.**
- **Dam safety risk assessments are undertaken and risks addressed on a priority basis (by required dam upgrades).**

- **That the dam safety programme be QUALITY ASSURED by periodic independent review.**
- **Making the public aware of dams and dam safety issues**
- **Consulting the public about their concerns**

2.5 Line 1: Replace “signs of a breach” by signs of any **unusual occurrence behaviour or signs of distress.**

2.6. This paragraph seems to imply that sophisticated instrumentation is required to monitor dams. This is **completely wrong.**

Instrumentation can never replace AN OBSERVANT EYE ATTACHED TO AN INTELLIGENT BRAIN.

What is needed is competent and trained personnel complemented by instrumentation.

This Paragraph also seems to imply that once installed instrumentation can be left to function on their own.

All instrumentation including the simplest flow measuring weir needs periodic attention for example to clean collected debris and sediment out etc. More sophisticated instruments also need regular attention to ensure correct functioning.

The implication in line 3 that somehow “lower level staff” are incompetent is unfair and unjustified. Sri Lankans are mostly highly educated when compared to other countries. In New Zealand and Australia surveillance staff generally are at GCE (OL) level in education. This level of education for surveillance staff in Sri Lanka is easily available. **The key is however adequate training and guidance.**

2.7 IT MUST BE EMPHASISED THAT REGULAR (frequency of observation depending on the dam hazard category) VISUAL OBSERVATION CAN NEVER BE REPLACED BY INSTRUMENTATION. An extreme hazard dam for example

must have daily routine visual surveillance in addition to its routine instrumentation monitoring. A low hazard dam would need to be monitored only once a month

I am not sure what the writer refers to as advanced dam hazard monitoring and detection equipment. Most instrumentation used to monitor dams are relatively simple. The communication of the information gathered by the instrument/s may be slightly more sophisticated.

2.14: The role of the DHU is not clear is it dam safety including detection and monitoring or only regulation, dispute resolution and standard setting as described in 2.15. Item 3.9 also implies that the DHU would carry out the monitoring and surveillance of dams.

DAM SAFETY SHOULD BE THE RESPONSIBILITY OF THE RESPECTIVE OWNERS WHO OWN THE ASSETS AND HAVE TO MANAGE THE RISK.

THERE SHOULD BE A REGULATORY BODY FOR EXAMPLE LIKE THE OVERSIGHT PROVIDED BY THE FEDERAL ENERGY REGULATORY COMMISSION (FERC) USA OR THE NEW SOUTH WALES DAM SAFETY COMMITTEE IN AUSTRALIA THAT ENSURES COMPLIANCE WITH DAM SAFETY REGULATIONS PROMULGATED IN THIS INSTANCE BY THE SRI LANKA GOVERNMENT. THESE REGULATIONS WILL IN MOST PART BE BASED ON BEST PRACTICE AS RECOMMENDED BY ICOLD, ANCOLD ETC AND PERHAPS SLNCOLD.

2.16: It has to be emphasised that all dams pose some risk to the community and people downstream of the dam. No dam is or ever will be a 100% safe.

In this context it better to replace the words “judged to be dangerous” by the words “judged to pose an unacceptable risk”.

In this case the acceptability or unacceptability of the risk will be determined by the dam owner and the community (represented in this case by the Regulator).

3. Introduction and Rationale

3.8 Line 2: The negative outcomes have been a lack of or neglect of and under funding of a proper asset management programme for these major (dam) assets. The asset management programme includes among other things implementation of correct operating and maintenance procedures, including a comprehensive dam safety programme as per my comments on Items 2.3 and 2.4.

3.9 The last line of this item and Item 3.10 together imply that the DHU would have the responsibility of monitoring and warning. This would be incorrect and impractical.

The various responsibilities and functions related to dam safety should be carefully separated. These are:

- A. Responsibility for the dam safety programme including the regular monitoring and surveillance.
- B. Responsibility for the emergency management of an incident (emergency) at the dam
- C. Responsibility for warning the downstream agencies that there is an emergency condition at the dam.
- D. Downstream response (warning the population, evacuation etc)
- E. Regulation of the compliance with dam safety regulations by dam owners

A to C above should be the responsibility of the dam owner.

D is the responsibility of downstream agencies of which the DHU (preferably called the DAM SAFETY REGULATORY AUTHORITY (DRA)) is part.

E is clearly the responsibility of the DHU (or DRA).

3.10 The last line implies that the DHU would develop hazard-detection and warning systems.

This again is impractical because hazard detection and warning systems are developed either as a result of design considerations at design stage or as a result of engineering/risk assessment of the dam carried out as part of the dam safety programme. Both are functions that are the responsibility of the dam builder/owner.

3.11 As discussed in my comments earlier instrumentation can never replace VISUAL OBSERVATIONS.

Item 3.11 also implies that the DHU carries out the day to day monitoring of instrumentation to detect hazards.

This is impractical because the readings have to be plotted and checked for trends then if there is an anomaly the instrument itself checked out and/or a surveillance person sent out to check the reason for the alarm.

The day to day monitoring of the dam instrumentation and its surveillance should be the responsibility of the dam owner or owners and its/their dam safety group.

The process of emergency management include detection, analysis and decision making, and response. The last of these, response, includes actions to manage the emergency at the dam as well as warning downstream agencies who will then warn the population and evacuate as necessary.

IT IS BEST TO LOOK AT HOW DAMS ARE MANAGED ELSEWHERE (OVERSEAS) FOR LESSONS LEARNED AND BEST PRACTICE.

4. Parameters of an Early Warning System

4.1 This item implies that just by having instrumentation that is monitored 24 hours of the day will ensure early detection of impending dam failure or breach. This is not strictly correct. The alarm raised by say for example high seepage flows or high pore pressure readings or high movements or stresses have to be checked out physically on site.

4.2 The process of early warning is:

A)

- Hazard detection
- Hazard identification and evaluation (analysis)
- Decision making
- Response including mitigation actions and issue of warnings

B)

- Dissemination of warning including evacuation etc

C)

- Public education

As discussed earlier:

A) is the responsibility of the owner

B) is the responsibility of downstream response agencies

C) is the responsibility of the owner as well as the downstream response agencies

4.1 Hazard Prevention – Dam Safety

Dam Safety Hazard prevention requires a comprehensive dam safety programme as discussed and listed under item 1 of my comments and not only the items as listed under 4.4.1 to 4.4.6

Other comments on 4.4.1 to 4.4.6 are as below.

4.4.1 Hazard prevention will come under Standard Operating Procedures for Operation and Maintenance and hazard mitigation will come under Emergency Action or Management Plans. Notification and Warning is under the Emergency Action Plan for the relevant dam.

4.4.3 Risk Assessment consists of Risk Analysis, Risk Evaluation and Comparison of the risks against tolerable risk policies leading to a decision

recommendation . Depending on the decision risk reducing measures may be needed (ANCOLD).

Dam break studies and inundation mapping are only a small part of the process of risk assessment.

4.4.4 Remedial actions subsequent to a risk assessment would be required upgrades to comply with a required level of risk reduction.

4.4.5 Safe operation of the dam would be operation of the dam and its equipment in such a manner that there is no uncontrolled releases of water.

Correct operation and maintenance procedures would include such items as ensuring that the spillway approach is free of debris and undertaking regular maintenance etc.

4.7 Risk Assessment and Vulnerability Analysis

4.7.2. In addition to the cost of the dam itself the loss of service to the community must be taken into account. For example loss of irrigation water, loss of power generation etc. Additionally in a commercial environment the loss of credibility to the owner and also the political impact need to be considered.

4.8 Detection and Monitoring

4.8.4. Conduits through dams have long been known as a point or area of weakness susceptible to piping. A weakness in the Kantalai inspection particularly was non inspection of what are termed “normally submerged features”. There should be a protocol to examine **critical** normally submerged features at dams at least once in 5 years as practised by the USBR.

4.8.8 to 4.8.11. While it is theoretically attractive to install instrumentation and remotely monitor them, there are lots of problems that need to be taken into account e.g false readings due to electrical or electronic failure, zero drift, telecommunication failure, air in the piezometer system, lightning strike etc etc. All these mean that regular human intervention is required – for regular maintenance.

Also as mentioned earlier there is no replacement FOR AN OBSERVANT EYE ATTACHED TO AN INTELLIGENT BRAIN IN THE CASE OF DAM SAFETY.

Annex C Expert Consultation Agenda: 20 May 2005

Expert Consultation on Early Warning System for Dam Related Hazards Distance Learning Centre, SLIDA Premises, May 20 th , 2005		
Time	Session	Moderator/Speaker
9.00 -9.30	Arrival of participants and tea	
9.30-9.45	Welcome and introduction	Rohan Samarajiva, Executive Director, LIRNEasia and Director, Vanguard Foundation
9.45-10.00 10.00-10.30	Presentation: <i>Nineteen years later, what lessons have been learnt from the Kantale breach (and what changes have been implemented)?</i> Discussion	D W R Weerakoon, Former Director General of Irrigation and Secretary, Presidential Commission on the Kantale Dam Breach
10.30-10.45 10.45-11.15	Presentation: <i>What are international best practices in dam safety?</i> Discussion	Nimal Wickramaratne, Director, Headworks of the Mahaweli Authority
11:15-11.30	Presentation: <i>Current situation of dam management in Sri Lanka</i>	Badra Kamaladasa, Deputy Director (Dam Safety), Department of Irrigation
11:30-11:45 11:45-12:15	Presentation: <i>What are some innovative technologies for hazard detection in dams?</i> Discussion	Tissa Illangasekare, AMAX Distinguished Chair of Environmental Science & Engineering & Professor of Civil Engineering; Director, Center for Experimental Study of Subsurface Environmental Processes (CESEP) Colorado School of Mines, USA & Anura Jayasumana, Professor of Electrical and Computer Engineering & Computer Science, Colorado State University, USA
12:15-12:35	Open Forum	Chaired by: K.S.R. De Silva, Director General of Irrigation & President, Sri Lanka National Committee on Large Dams
12:35-12.45	Summary and conclusion	Rohan Samarajiva, Executive Director, LIRNEasia & Director, Vanguard Foundation

Annex D Expert Consultation Invitation letter

Vanguard Centre for Disaster Preparedness



April 28, 2005

Dear Sir/Madam,

LIRNEasia and Vanguard Foundation, in collaboration with the Sri Lanka National Committee of Large Dams, are conducting an Expert Consultation as the basis of developing a concept paper on an *Early Warning System for Dam Related Hazards*. All Sri Lankan experts on dam management and safety are being invited to this event.

The present work build on the *National Early Warning System: Sri Lanka (NEWS:SL)*, a participatory concept paper for the design of an effective all-hazard public warning (This paper is available on our website: <http://www.lirneasia.net/2005/03/national-early-warning-system/>). This concept paper has been presented to the Presidential Commission of Inquiry and the Parliamentary Select Committee on the tsunami and to the Chairman of TAFREN. In the concept paper, we committed to undertake a similar consultation/education process on dam safety, inclusive of hazard detection and warning, to demonstrate the all-hazards approach and to respond to an urgent need identified by experts.

We believe that as an expert in dam-related issues you could make a significant contribution to the success of this event. We invite you to share your expertise on issues surrounding dam safety that will emerge from the presentations and discussion.

Attached is the tentative program for your information. Details of the venue and date are stated below.

Date : May 20, 2005
Time : 9:00 AM-12:45 PM
Venue : Distance Learning Center (DLC), SLIDA Campus, Malalasekera Mavatha, Colombo 7

**Vanguard Center for Disaster Preparedness
Vanguard Foundation**

95 Castle Street, Colombo 8, Sri Lanka
T +94 (011) 461 4333, F +94 (011) 461 4376

www.vanguardfoundation.com, vcdp@vanguardfoundation.com

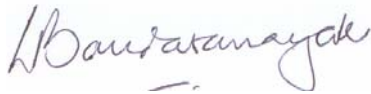
We look forward to your acceptance.

Warm regards

Yours truly,



Rohan Samarajiva
Executive Director
LIRNEasia



Lakshaman Bandaranayake
Executive Director
Vanguard Foundation

Vanguard Foundation

Vanguard Management Services (Pvt) Limited, floated **Vanguard Foundation** (under incorporation-www.vanguardfoundationlanka.org), to conceptualize and implement its corporate efforts in the areas of disaster relief, rehabilitation and preparedness. The Vanguard Foundation would promote activities, polices, and market based initiatives that would improve national disaster preparedness, mitigation strategies, and the flow of expertise to meet and deal with a wide variety of national disasters.

LIRNEasia

LIRNEasia, a regional ICT policy and regulation capacity building organization, incorporated as a non-profit organization under section 21 of the Companies Act, No. 17 of 1982 in 2004 and funded at present by the International Development Research Centre of Canada and *infoDev*, a unit of the World Bank. The organization is physically located in Colombo but works throughout the Asian region. Its primary functions are research, training and informed intervention in policy and regulatory proceedings. Its current projects include research in India, Nepal, Bangladesh and Indonesia. More information: www.lirneasia.net

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**Annex E Sample Public Consultation (town meeting) invitation
Letter: Gampola, 2 July 2005***

* Similar public consultations were held in Kandy and Polonnaruwa



June 15, 2005

Dear Sir/Madam,

**Vanguard Foundation- LIRNEasia Town Meeting on Early Warning System for Dam
Related Hazards on 2nd July 2005**

Vanguard Foundation and LIRNEasia, in collaboration with the Sri Lanka National Committee of Large Dams and the Intermediate Technology Development Group and with the support of the Canada Fund for Local Initiatives, will conduct a Town Meeting in **Gampola**, at the Town Hall six months to the day from Sri Lanka's greatest natural disaster to obtain public input for a concept paper on an *Early Warning System for Dam Related Hazards*. Should you accept our invitation, we will send you a copy of executive summary of the draft concept paper, prepared on the basis of local and international expert input.¹

The present work builds on the *National Early Warning System: Sri Lanka (NEWS:SL)*, a *participatory concept paper for the design of an effective all-hazard public warning*.² This concept paper has been presented to the Presidential Commission of Inquiry and the Parliamentary Select Committee on the tsunami and to the Chairman of TAFREN. In the concept paper, we committed to undertake a similar consultation/education process on dam safety, inclusive of hazard detection and warning, to demonstrate the all-hazards approach and to respond to an urgent need identified by experts. The Chairman of TAFREN indicated strong government interest in our findings which he wanted us to submit as quickly as possible.

We believe that as an opinion leader living downstream of a large dam you have the knowledge and interest to participate in this public consultation process and make a

¹ The complete document in English will be available at www.lirneasia.net. The final text will be translated into Sinhala and possibly Tamil.

² This paper is available on this website: <http://www.lirneasia.net/2005/03/national-early-warning-system/>

significant contribution to the success of this event. As such we would like to invite you to participate in this event, details of which are given below.

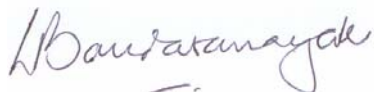
Date : July 2, 2005
Time : 16:00
Venue : Town Hall
Language: Sinhala
RSVP : ajithr@vanguardlanka.com (M) 0776541289

The areas of discussions of the Town Meeting will include;

- What lessons were learnt from the 1986 Kantale dam breach?
- What are the parameters of an effective dam hazard detection and monitoring system?
- What are the parameters of an appropriate warning system?
- What is an appropriate governance and implementation model?
- What can downstream communities do to mitigate and prepare for potential dam-related hazards?

We earnestly request your participation at this forum and look forward to your contribution towards developing a concept paper on a national Early Warning System for Dam Related Hazards, which we intend to submit to the Government of Sri Lanka in August 2005 or earlier.

Yours truly,



Lakshaman Bandaranayake
Executive Director
Vanguard Foundation



Rohan Samarajiva
Executive Director
LIRNEasia

Vanguard Foundation:

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corporate efforts in the areas of disaster relief, rehabilitation and preparedness. The Vanguard Foundation would promote activities, policies, and market based initiatives that would improve national disaster preparedness, mitigation strategies, and the flow of expertise to meet and deal with a wide variety of national disasters.

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Annex F Public Consultation (town meeting) Agenda: Kandy, 2 July 2005

Public Consultation on Early Warning System for Dam Related Hazards and Safety Sarvodaya District Headquarters, Kandy, July 2, 2005 (Saturday) Entire session conducted in Sinhala		
Time	Session	Moderator/Speaker
09:30	Arrival of participants and tea	
10:00-10:15	Welcome and introduction	Lakshaman Bandaranayake, Executive Director ,Vanguard Foundation
10:15-10:30	<i>Oral histories of survivors from Kantale dam breach of 1986</i>	An audio- visual presentation
10:30-10:45	Initial reactions to oral histories	Moderated by panel (ITDG & Sarvodaya)
10:45-11:00	Presentation of draft concept paper on an <i>Early Warning System for Dam Related Hazards</i>	Rohan Samarajiva, Executive Director, LIRNEasia
11:00-11:30	Feedback by participants	Moderated by Rohan Samarajiva
11:30-11:45	Concerns of the community	PB Abeykoon, Attorney at Law, Gampola
11:45- 12:15	Interactive session on role of community organizations	Responses by ITDG & Sarvodaya
12:15-13:00	Open Forum: Discussion of overall issues	Moderated by Rohan Samarajiva

**Annex G Public Consultation (town meeting) Agenda:
Polonnaruwa, 16 July 2005**

Public Consultation on Early Warning System for Dam Related Hazards and Safety Sarvodaya Centre, Polonnaruwa, July 16, 2005 (Saturday) Entire session conducted in Sinhala		
Time	Session	Moderator/Speaker
09:30	Arrival of participants and tea	
10:00-10:05	Welcome	Mr Nanayakkara, Co-ordinator, Sarvodaya , Polonnaruwa Lakshaman Bandaranayake, Executive Director ,Vanguard Foundation
10:05-10:15	Introduction	
10:15-10:30	<i>Oral histories of survivors from Kantale dam breach of 1986</i>	An audio- visual presentation
10:30-10:45	Initial reactions to oral histories	Moderated by panel (ITDG & Sarvodaya)
10:45-11:00	Presentation of draft concept paper on an <i>Early Warning System for Dam Related Hazards</i>	Rohan Samarajiva, Executive Director, LIRNEasia
11:00-11.30	Feedback by participants	Moderated by Rohan Samarajiva
11:30-11:45	Concerns of the community	PB Abeykoon, Attorney at Law, Civil Society
11:45- 12.15	Interactive session on role of community organizations	Responses by ITDG (Ms Dhammika De Silva) & Sarvodaya (Navaratne Dissanayake)
12:15-13:00	Open Forum: Discussion of overall issues	Moderated by Rohan Samarajiva

Annex H Media Conference Agenda: 10 August, 2005



Dam Related Hazard Warning Systems in Sri Lanka

Agenda – Media Conference

Sri Lanka Foundation Institute, 10.00 am – 12 p.m Wednesday , August 10, 2005

Time	Session	Moderator/Speaker
9.30 -10.00	Arrival of participants and tea	
10.00-10.10	Welcome and introduction	Lakshaman Bandaranayake, Executive Director ,Vanguard Foundation
10.10-10.30	Oral histories of survivors from Kantale dam breach of 1986	An audio- visual presentation
10.30-10.50	Speeches by people from affected areas	<ul style="list-style-type: none"> • G.W. Rupathissa- Polonnaruwa • Chandrathilake Premakumara- Polonnaruwa • Representative form Kandy • P B Abaykoon (Attorney at Law) - Gampola
10.50 – 11.00	Video on responses received during Town meetings	
11.00 – 11.20	Summary of Report	Rohan Samarajiva, Executive Director, LIRNEasia
11.20 - 11.30	Presentation by SLNCOLD	S Karunaratne
11.30 - 12.00	Open Forum: Discussion of overall issues	Moderated by Rohan Samarajiva & Badra Kamaladasa
12.00 - 12.05	Vote of thanks, declare conference closed, closing remarks	Luxman Siriwardena
12.05 +	Lunch	



CANADIAN INTERNATIONAL DEVELOPMENT AGENCY
AGENCE CANADIENNE DE DEVELOPPEMENT INTERNATIONAL



LIRNE asia
Learning Initiatives on Reforms for Network Economies

<p style="text-align: center;">ජලාශ ආශ්‍රිත පූර්ව අනතුරු හැඟවීමේ පද්ධතිය සහ ආරක්‍ෂාව</p> <p style="text-align: center;">සම්බන්ධ මාධ්‍ය හමුව</p> <p style="text-align: center;">හතය පත්‍රය</p> <p style="text-align: center;">ශ්‍රී ලංකා පදනම් ආයතනය, 2005 අගෝස්තු මස 10 වෙනි බදාදා පෙ.ව. 10.00 - 12.00</p>		
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10.50 – 11.00 11.00 – 11.20 11.20 - 11.30 11.30 - 12.00	ප්‍රජා සමූහ වලට සහභාගී වූවන්ගේ ප්‍රතිචාර වැව් බැම්ම ආශ්‍රිත පූර්ව අනතුරු හැඟවීමේ සම්බන්ධ කෙටුම්පත ඉදිරිපත් කිරීම SLNCOLD ආයතනයේ දෘශ්‍ය ඉදිරිපත් කිරීමක් සහභාගී වූවන්ගේ ප්‍රතිචාර ලබා ගැනීම	ශ්‍රව්‍ය දෘශ්‍ය ඉදිරිපත් කිරීමක් රොහාන් සමරසිව විධායක අධ්‍යක්ෂ ලර්න් ඒෂියා ඉදිරිපත් කිරීම - එස්. කරුණාරත්න මෙහෙයවීම - රොහාන් සමරසිව , හදු කමලදාස
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Annex I Press Conference invitation letter: 10, August 2005



August 1, 2005

Dear Sir / Madam

We kindly invite you to a Press Conference being organized by LIRNEasia and Vanguard Foundation, in collaboration with Sarvodaya, the Sri Lanka National Committee of Large Dams and ITDG South Asia to present an interim concept paper on an *Early Warning System for Dam Related Hazards*.

The concept paper was developed in consultation with local and international dam experts. Community meetings were held in three Sri Lankan cities that lie significantly in the flood path of the Mahaweli dam system, Kandy, Gampola, and Polonnaruwa. The purpose of these meetings was to raise awareness of on dam safety issues and to receive input from this most important set of stakeholders. We believe this paper will be of significant value to policymakers in formulating and implementing **Actions Required to Avoid and Mitigate Dam Disasters**.

By participating in this media conference, we believe you could make a significant contribution towards increasing public awareness on dam related hazards and the necessary actions needed to make Sri Lankan dams safer.

Attached is the tentative program for your information along with the executive summary of the interim concept paper. The web edition of the complete report is available at www.lirneasia.net. Details of the venue and date are stated below.

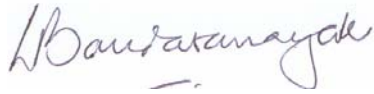
Date : August 10 ,2005
Time : 10:00 AM-12:00 Noon
Venue : Auditorium, Sri Lanaka Foundation Institute

We look forward to your presence.

Warm regards

Yours truly,

**Vanguard Foundation
(Under incorporation)**



Lakshaman Bandaranayake
Executive Director

LIRNEasia



Rohan Samarajiva
Executive Director

Organizations

Vanguard Foundation www.vanguardfoundationlanka.org (under incorporation) Vanguard Management Services (Pvt) Limited the managing company of Etv and producers of Lanka Business Report and Lanka Business Online, floated **Vanguard Foundation** (www.vanguardfoundationlanka.org), to conceptualize and implement its corporate efforts in the areas of disaster relief, rehabilitation and preparedness. The Vanguard Foundation would promote activities, policies, and market based initiatives that would improve national disaster preparedness, mitigation strategies, and the flow of expertise to meet and deal with a wide variety of national disasters.

LIRNEasia www.lirneasia.net

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Major Contributors

Prof Rohan Samarajiva

Executive Director, LIRNEasia. Former Director General of the Telecom Regulatory Commission, Prof Samarajiva led the local team of researchers involved in developing the concept paper. He was led the work on a pilot project on the use of telecommunications in disaster and emergency situations in Sri Lanka in 1999 and chaired an ad hoc committee to resolve contentious language in the Tampere Convention on Emergency Telecommunications in 1998. He has published on the regulatory aspects of disaster management. He co-authored the concept paper.

Divakar Goswami

Director for Organizational Development & Projects, LIRNEasia. He is project manager for projects undertaken by LIRNEasia in the region. He also works as a consultant on externally funded ICT projects. Before joining LIRNEasia, Divakar was a researcher at the Economics of Infrastructures section at the Delft University of Technology, Netherlands.

Rebecca Ennen

Ms Ennen is a graduate of Swarthmore College and an alumna of the United States-Sri Lanka Fulbright Program. She co-authored the concept paper.

The document includes the substantive contributions of many other persons, Sri Lankan as well as foreign, that are reflected in the acknowledgements.