Submission to the Productivity Commission's Public Inquiry of Natural Disaster Funding

Associate Professor Stephen J Robson

Mr David Templeman

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Contact Details

A/Prof Stephen J Robson
Suite 2, John James Medical Centre
175 Strickland Crescent
Deakin ACT 2600

Intent of the submission

The Productivity Commission ('the Commission') has been asked to develop findings on several issues, including on the sustainability and effectiveness of current arrangements for funding natural disaster mitigation, resilience and recovery initiatives. The Commission will consider all options to improve their coherence, effectiveness and sustainability.

This submission is focused on mitigation and resilience and in particular on warning communication systems. It calls for greater use of cost-benefit analysis in determining investment in Early Warning Systems (EWS). There are indications of market failure because of problems associated with current telephone-based warning communications systems across Australia. We believe that proper multi-jurisdictional consideration of a radio-based warning system is warranted (via a thorough economic cost-benefit analysis). Benefit/cost ratios of EWS are likely much higher than other mitigation proposals, especially post-event interventions which are typically very costly. On the face of it we consider the benefit/cost ratio of a radio EWS (our YellowBird system which is detailed later in the submission) is higher than the current telephone-based EWS. We are not suggesting YellowBird should replace the current telephone-based warning system, but instead **enhance it** and thereby provide **an inexpensive additional level of redundancy to current radio and other warning arrangements.** Diverse and multiple dissemination methods/channels must be used to increase the chance of messages reaching all affected persons in a hazard scenario. A multi-channel approach increases notification capabilities and makes EWS less vulnerable to breakdowns or congestions of specific communication means.

Authors of the submission

Associate Professor Stephen Robson works with the Australian National University Medical School. He is a former officer of the Royal Australian Navy and holds the degree of Master of Public Health. His doctorate was conferred by the University of New South Wales.

Mr David Templeman was Director General of Emergency Management Australia (EMA) from 2000-2006, and was subsequently Chief Executive Officer of the peak public health body the Alcohol and other Drugs Council of Australia (ADCA) until 2014. He has served as a senior volunteer on the National Staff of St John Ambulance Australia as National Emergency Management Adviser since 2006. He is the co-author of *Taking a punch: Building a more resilient Australia*.[†]

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[†]Templeman D, Bergin A. *Taking a punch: Building a more resilient Australia*. 2008; Australian Strategic Policy Institute [Stretegic Insights 39].

Background

Recent large scale natural disasters affecting various areas of Australia have demonstrated a requirement for robust and reliable communication systems. Of particular relevance to Australia are weather events such as severe cyclones and storms, floods, storm surges, and bushfires.

Recent reports have highlighted that climate change is likely to be associated with an increase in the frequency and severity of the impact of natural disasters.[1] Even if the uncertainties inherent in modelling the potential effects of climate change are put aside, disaster losses are likely to increase because of the rising value and concentrations of property assets in exposed locations. Such large concentrations of property and people at risk pose particular challenges for emergency management in terms of the number of people that may need to be evacuated in the case of an impending disaster[2], as seen in early April 2014 with grave predictions about Cyclone Ita's potential impact on North Queensland.

It is unlikely that any human strategy will affect the frequency and severity of severe weather-related disasters in the foreseeable future. However, mitigation of the effects of natural disasters through embedded resilience strategies in planning and infrastructure investments is likely to be the best way of reducing risk. An important element of risk reduction is the provision of **warning** and **consistency in message**.

The importance of warning

There is clear evidence that provision of early warning saves lives.[3-8] Warning is needed not only in the **lead up** phase to disasters, but also to provide both warnings and community information **during disasters**, and in the **recovery phase**.

Large-scale natural disasters affecting various areas of Australia - Queensland, Victoria, and Western Australia in particular - have clearly demonstrated the requirement for robust and reliable communication systems. Warning systems not only save lives, but having embedded reliable warning systems with which individuals and communities are familiar builds a culture of resilience.

When individuals and communities know to trust their warning systems, it frees emergency services personnel who might be required to deliver warning messages by door-knocking and similar activities. These personnel can then concentrate their activities on other vital activities. The Black Saturday fires in Victoria in February 2009 clearly demonstrated the lack of effective warning and above all, community complacency.

The maintenance of lines-of-communication during and after a disaster presents tremendous problems within current emergency warning arrangements. For example, the Recovery Task Force for Cyclone Larry encountered massive yet predictable problems with communications. The Task Force's *Report*[9] included the following observations:

> "Disruption of the normal communications channels and sources of information for people is one of the first impacts in most natural disasters ...

> "The immediate (and it might be said in many disasters, inevitable) loss of mains power means that the instant, pervasive reach of the mass media falls away sharply – not even the ubiquitous World Wide Web will work.
>
> "In this regard, contingency plans for post-disaster communications have to focus even more clearly on redundant means of transmitting and receiving vital information. This is important from several points of view – the safety of life and limb, directing relief efforts by broadcast, and helping maintain and restore public confidence in the disaster area and preventing panic.
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> "In the case of Larry, not enough people had heeded the advice to have battery- operated radios on hand. Televisions, phones and the Internet were down because of the lack of power and many people observed to the Task Force that, in among all their wants and needs, this lack of broadcast information was the most disconcerting."

Final recommendations contained in the Cosgrove Report[9] include the following:

> Recommendation 4
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> That consideration be given to additional ways and means to improve broadcast capability into disaster-affected regions, particularly for the early aftermath of any disaster when a loss of power characterises the event.
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>> "... while radio networks, especially the ABC provided great public service by their emergency information broadcasts, experience shows that this information may need to be broadcast exclusively and repetitively for days and even weeks. In this regard, it would be useful to consider emulation a system used in other countries, namely the availability of specific, 'emergency-only' radio broadcast frequencies in disaster-prone areas, to be activated and operated where necessary as an adjunct to normal broadcasting."
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> Recommendation 6
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> An early and high priority task in recovery from a natural disaster should be the development of a co-ordinated, succinct, practical and flexible public communications plan.

The need for cost-benefit analysis in determining risk management options

In 2013, Deloitte Access Economics was commissioned to prepare '*Building our nation's resilience to natural disasters*', a comprehensive paper calling for greater collaboration between Governments, business and communities so as to reduce Australia's vulnerability to natural disasters.[10] **Recommendation 3** of the Deloitte report called for the identification and prioritisation of pre-disaster investment activities that deliver a positive net impact on future budget outlays. Deloitte further recommended that a program of mitigation activity should be developed based on cost-benefit analysis that demonstrates a clear positive outcome from investing in pre-disaster resilience measures.

A simple cost-benefit analysis (CBA) demonstrates how government funds would be saved in the long run by bringing forward expenditure on natural disaster recovery and placing a greater level of investment in pre-disaster resilience measures. As Deloitte put it:

> Assume, for example, that carefully targeted programs of resilience expenditure in the order of $250 m per annum achieved an overall Benefit-Cost Ratio (BCR) of around 1.25. This implies that this program of expenditure would incur costs in the order of $5.3 billion over the period to 2050 (present value terms) but would generate budget savings in the order of $12.2 billion for all levels of government (or $9.8 billion when looking at the Australian Government budget only). If successfully implemented, this intervention could see Australian and state government expenditure on natural disaster response, fall by more than 50% by 2050.[10]

Cost-benefit analyses will inform actions that will tend to lead to the best possible outcomes. Inefficiencies in any of these dimensions diminish effective risk management and community wellbeing.

Conducting a CBA for natural disaster resilience is not significantly different from other cost benefits analyses. The overall approach for natural disaster resilience is to estimate the economic costs of a natural disaster a baseline, and under a policy of improved resilience. The approach for estimating economic costs of a natural disaster is well established and is clearly outlined by the Bureau of Transport Economics.[11] Deliotte Access Economics has updated the BTE report. If these steps are followed a CBA can be developed which will clearly show the expected costs and benefits of any resilience measure.

The United Nations Inter-Agency Secretariat of the International Strategy for Disaster Reduction (UNISDR) underlines the importance of developing cost-benefit models for EWS.[12] Even though benefit/cost ratios for EWS are difficult to construct, the evidence that the easiest prevention and mitigation is achieved by developing effective early warning systems is overwhelming.[13-15]

Current warning communications systems in Australia – qualitative cost-benefit comparison

The National SMS-based warning system: Emergency Alert

The Emergency Alert system provides location-based warning SMS messages. This system has been used to send millions of warning messages in hundreds of emergency situations. However, the recent *Senate Inquiry into the capacity of communication networks and emergency warning systems to deal with emergencies and natural disasters*[16] reported that:

> "Numerous … submitters were critical of Emergency Alert: the absence of a capacity to determine the location of telephone handsets in the alert area, as well as the need for certain telephone handsets (cordless landline telephones and mobile telephones) to have **access to power and be turned on in order to receive an alert were of specific concern**. This led to discussion of location-based mobile telephone emergency alerts as well as other systems and technologies used to issue emergency alerts."

The existing Emergency Alert system has had investments of close to $100 million dollars, for development, ongoing contractual payments to Telstra and other bodies, and issue of warnings (**Attachment 1**).

Despite the National Emergency Alert system, guides to disaster preparedness, such as that issued by the ACT Emergency Services Authority, invariably give the following advice: **"A battery-operated radio is the most reliable way to receive information if the power fails."**

There are a number of important disadvantages of the Emergency Alert and other similar systems that have severely compromised their value in rapidly-evolving large scale disasters.

1. Complete reliance upon intact infrastructure, in particular power and mobile phone towers.
2. Reliance on complex computing resources.
3. As recent events in Australia, New Zealand, Japan and the United States have demonstrated, the mobile phone network is usually the first to fail. Even when there is partial service, the system is overloaded and fails quickly. Thus, initial warnings may be issued but the follow-up warnings after the initial disaster often cannot be issued. The vulnerability of computer-based telephony and internet warning systems was highlighted in the recent Christchurch earthquakes. The mobile telephone system failed early, leaving residents dependent upon the National Radio Network for emergency information.
4. The Emergency Alert system typically instructs warning recipients to turn on and monitor their radios.
5. There are large and ongoing costs of maintaining the system and issuing warnings.
6. Mobile phone handsets may be switched off, or the intended recipients simply ignore the text messages, or simply don't hear them.
7. The system is particularly unsuited to older people, people with hearing and visual disabilities, those with disabilities such as arthritis limiting their use of mobile devices, and those from non-English speaking backgrounds.

In response to Hurricane Katrina, and in light of the issues noted above, the state of Louisiana built a dedicated and robust 700 MHz digital radio system costing $250 million dollars, and taking over four years to complete.[17]

The YellowBird ALERT*

The YellowBird (YB) ALERT was invented by Associate Professor Stephen Robson after his own experiences with the Canberra bushfire emergency in 2003. It uses the existing radio broadcasting infrastructure present in every country in the world. The system has the primary purpose of disseminating emergency warning in rapidly-evolving natural and other disasters. It allows any radio or broadcast platform to remotely 'switch on' or 'wake up' radios, including the radio component of mobile telephones and other mobile devices.

To accomplish this, the radio station transmits an audible 'triggering tone' that activates and switches on the YB chip. Subsequent to the triggering tone, a 'location datastream' is broadcast – this may specify the boundaries of a polygon, or perhaps a pre-determined zone. The YB chip uses 'location-awareness' by interrogating a GPS chip, and determines if it is within the area of risk. If so, it switches the radio on and activates a loud alarm and flashing lights to draw attention. The monitoring and 'wake-up' functions are likely to be a software modification to a mobile device.

Trials of the YellowBird system, conducted in the Australian Capital Territory in associated with ACT Emergency Services Agency (ESA), reported 100% success of the system (**Attachment 2**).

The unique advantages of Yellow Bird ALERT were recognized when it won the 2010 Insurance Council of Australia's 'Annual National Resilience Award.'(**Attachment 3**) The Yellow Bird ALERT design has also won the 'Digital Home' Award at Electronics Future Awards 2010 (**Attachment 4**), and was recognized by the London Institute of Engineering and Technology Innovations Competition 2010 by its nomination in two categories: Information Technology, and Sustainability.

Some of the advantages of the Yellow Bird ALERT system are as follows**:**

1. Minimal cost

The broadcast infrastructure for radio already exists and functions throughout the world. There is thus no infrastructure to set up, nor any ongoing maintenance cost to Governments for the broadcast infrastructure. YellowBird ALERT chips are likely to cost as little as $1 in mass production, and could be fitted to radios (particularly now that digital radio is being rolled out). Although different mobile devices have different capacity, it is likely that adding a 'wake up and warn' capacity using YellowBird technology would require a software change in radio-equipped mobile telephones, possibly with the use of an 'app' that notifies the telephone of the appropriate radio band and frequency for a specific location. There are no ongoing costs after the initial purchase, apart from replacement of batteries in radios, a situation analogous to home smoke alarms.

2. The broadcast infrastructure, AM and FM radio, is robust and functioning already

The YellowBird ALERT radio system uses a single tone, broadcast on standard AM and FM radio frequencies by existing radio broadcast stations.

3. Reliable reception of emergency warnings

Where radio can be received, the YellowBird ALERT will trigger the emergency alarm and light, and switch on the radio. This ability is further advanced at night, with sky wave propagation of AM signal.

4. Reliable function in adverse conditions

The YellowBird ALERT radio is designed to be robust, and 'user-friendly' for visually impaired and mobility impaired (*eg*, arthritis limiting hand function). Radio transmitters are rarely affected by local power supply interruptions.

5. Familiarity and ease of use

Virtually every person in the world is familiar and comfortable with radio. There is no period of adjustment or learning required.

6. No requirement for computer systems

There is **no requirement** at all for potentially vulnerable computer systems with YellowBird ALERT. Emergency Control centres notify radio stations to broadcast emergency warnings, and to preface all warnings with the YellowBird tone. YellowBird ALERT radios detect the alert tone, and switch radios on for all emergency messages.

Potential for YellowBird to enhance current warning systems

The current SMS-based Emergency Alert system is costly, and relies on intact power and telephone systems. It is well-recognised that power and telephone infrastructure are very commonly affected in natural disasters. The YellowBird system would involve minimal running costs for Governments, and would allow instantaneous 'wake up and warning' even in the face of complete and prolonged failure of power and telephone infrastructure. It would be specially suited to warning society's most vulnerable – older people, and those with visual and hearing impairment, for example.

The United States National Association of Broadcasters (USNAB) has already made submissions to the United States Congress about the value of radio-warning in mobile telephones and other mobile devices.(**Attachment 5**) Because it would be possible to develop the YellowBird system to provide 'wake up and warn' in mobile devices, working through the telephone's radio component when the mobile network has failed, allowing telephones to remain switched off (to preserve battery life) and 'wake up' when triggered by YellowBird signals, immune to failure of the telephone network. Mobile telephones could thus be 'disaster ready' at essentially no cost to their owners, or to Government.

Qualitative cost-benefit analysis of the economic impact of early warning systems - likelihood that a warning is received.

System / Criteria	YellowBird ALERT	Telephone-based warning systems
Limitations	Access only to people with receivers	• Congestion during high traffic periods is highly likely to cause delays in messages reaching target populations within the desired time for short lead time hazards. • Third party reliance may also cause this option to be more vulnerable. • Only has potential to reach those with mobile phones. Mobile phone reception not available in many rural/remote areas, and reception not 100% guaranteed in urban areas (eg, shopping centres, "reception black spots") • Relies upon infrastructure remaining intact. • Mobile telephone towers have variable reception and batteries will fail within hours completely degrading the system with any prolonged power outages. • Potentially difficult for operators and susceptible to operator error (ACT Government operators recently accused of using system incorrectly recently resulting in failure of system, Mitchell Fire Sept 2011)
Time-frame	• Minutes	• Hours to target specific regions, this is assuming no congestion (includes coordination time across carriers). With an existing numbers database smaller areas can be reached faster.

Heads-up and Instruction	• Both heads-up and instruction	• Heads up only. Individuals must have a telephone/mobile for initial warning and then have access to radio, television or internet to receive further information.
Effectiveness residents	• Yes, if have receiver	• Depends on mobile coverage. • The report from the ACT Emergency Services Agency on a 2011 chemical fire emergency revealed that, even with perfectly intact power and telephone, and using the location-based SMS system, only about two-thirds of SMS messages got through.
Effectiveness transients	• Yes, depending on receiver units	• No
Effectiveness for the vulnerable & immobile	• Simple to use.	• Some individuals (visually impaired, elderly etc) may have difficulty with mobile telephone use.
Robustness/resilience	• Existing AM/FM radio stations reach almost the entire Australian population, especially applicable to rural and remote areas but also immediate coverage to the large populations in dense urban cities. • Not reliant upon intact telecommunications systems or power; AM radio transmission is almost always possible even during prolonged power outages due to single tower generators. • Not reliant upon intact computing resource networks. • Radio turns on to provide initial emergency warning and is automatically tuned to station providing emergency information broadcast.	• Currently SMS services can be slowed considerably during unplanned high traffic periods, congestion would be exacerbated as those who receive messages forward them to others and call others for confirmation. It relies on telecommunication infrastructure being in place, and functioning. • Current system has recommended limit of 50,000 calls for a single campaign (as per the Recommended Use Guide, as discovered in recent failing during fire event in ACT)

	• Instantaneous messaging to all radios in broadcast area, no limit on number for any broadcast.	
Ongoing effectiveness throughout a disaster	• Yes – broadcast message can be updated	• If congestion issues do not arise and infrastructure failure does not occur updated messages could be provided.
Target population	• All with YB capability	• All with mobile phones (switched on). • Currently locational targeting of SMS messaging is either not possible or would take several hours to achieve. This means a warning via SMS text messaging must be very specific with regards to stating the areas under threat. • This contributes to the potential of congestion/delivery delay. • The reach of SMS text messaging systems are reliant on the numbers.
Terrain suitability	• All	• Some parts of Australia have no or limited mobile coverage.
Population density	• All	• All
Costs	• Radios stations: no cost; • Emergency service organisations: no cost • Costs associated with production and dissemination of chips. • Ongoing effort (practice exercises, awareness)	• Depends on the agreement with carriers. • Costs for a national system and database. Cost per message sent. • Limited number of messages per hour. • Ongoing planning and exercising effort. • Government: Initial budgets of up to $50M, and ongoing contract and usage costs. • Emergency service organisations: Ongoing training and significant usage costs. • Comples computing to assimilate telephone

		numbers and addresses, and to co-ordinate message dissemination.
Hazards	• Can cover all hazards	• All hazards but not those with short lead times.
Potential benefits (including but not limited to avoidance of damage to buildings, infrastructure, crops, livestock, death, injury, psychological stress).	• Given the above (few limitations, excellent coverage, robustness) higher benefits, both tangible and intangible.	• Given the above (many limitations, lower coverage and problems with robustness), lower benefits, both tangible and intangible.

Summary

The YellowBird ALERT is a software/hardware system that aims to provide emergency authorities with a unique tool to disseminate emergency warning through radio broadcasts. This could be either with dedicated radio warning units, or ultimately as a software modification in mobile phones and other mobile devices. It is likely that the chip could be integrated in other radios at manufacture, through a licencing system. In due course, the system could be used in WLAN system management. Essentially, we are discussing something which is very simple, low cost and readily adaptable for use in any device capable of receiving radio transmission. It is analogous to a smoke alarm, staying 'asleep' until activated to warn a person or persons about an event which is about impact where they are currently located.

This submission calls for greater use of cost-benefit analysis in determining investment in EWS. There are indications of market failure because of problems associated with current telephone-based warning communications systems across Australia. We consider proper multi-jurisdictional consideration of a radio-based warning system is warranted (via a thorough economic cost-benefit analysis). Benefit/cost ratios of EWS are likely much higher than other mitigation proposals, especially post event interventions which are typically very costly. On the face of it we consider the benefit/cost ratio of a radio EWS (our YellowBird system) is higher than the current telephone-based EWS. We are not suggesting YellowBird should replace the current telephone-based warning system but instead enhance it. Diverse and multiple dissemination methods / channels must be used to increase the chance of messages reaching all affected persons in a hazard scenario. A multi-channel approach increases notification capabilities and makes EWS less vulnerable to breakdowns or congestions of specific communication means.

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