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CSIRO Submission 14/507

Inquiry into Natural Disaster Funding

Productivity Commission, Australian Government

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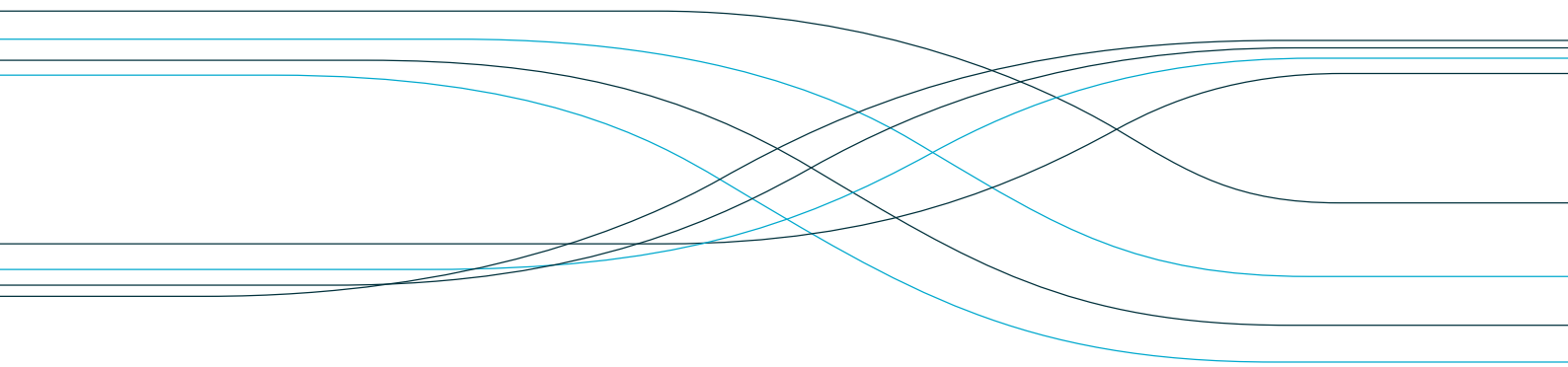

Contents

1. Executive Summary

Australia is renowned as a country of extremes that have very significant impacts on industries, businesses, communities, natural and built assets and individuals. We remain poorly adapted to many types of extreme events, despite our long experience of them. With a growing population and evidence of increasing climate hazards [Section 3, Attachment A], significant impacts are likely to be exacerbated in future.

There is a continuum of responses to natural disaster, from response to an extreme weather event in progress, to recovery from an event, and to reducing damage from an event through better preparedness [Section 5]. In this submission CSIRO provides recommendations for improved situational awareness that could contribute to the response and recovery phases [Section 4], and recommendations pointing to determining where and how much investment is needed to mitigate future risks [Section 5, ToR 5]; both of these deserve further investigation.

Section 5 presents evidence that quantifies the degree to which some infrastructure is not prepared for today's variability, and that shows this maladjustment will get worse in future in the absence of action. We show that many actions are 'no regrets' actions, and these have large net present value in reducing future damages for relatively low investments (at least an order of magnitude less that the costs of action). These cost savings reinforce the purpose of this Productivity Commission Inquiry, and also emphasises the emergent benefits to government of acting to ensure that better adaptation occurs, whether through public investment or through stronger conditions on private investment.

Section 5 also presents recent research on attitudes to risk management, and on aspects of understanding how to achieve an effective and sustainable balance between natural disaster recovery and adaptation expenditure. There is also research on allocation of risk and how this can be accounted for in public-private partnerships, especially where long-term risks are concerned. Section 6 notes that further insights will soon be available from a workshop on disaster mitigation.

2. Introduction

CSIRO welcomes the opportunity to comment on and provide input to the Productivity Commission's Inquiry into *Natural Disaster Funding*.

CSIRO provides comprehensive, rigorous science to help Australians understand, respond to and plan for natural disasters. We have significant research activities, nationally and internationally, which have helped us to better understand the causes and impacts of extreme weather events, and tools and techniques to help appropriately prepare for and respond to natural disasters. This information is used to work closely with governments, industry, and the community to develop practical and effective options for disaster prevention, preparedness, response and recovery. Our response to the inquiry draws on this very broad range of scientific work.

Our comments have been prepared by a team of scientists from across CSIRO with experience and international recognition in many facets of climate-related research. This submission is focused on sections where CSIRO has undertaken research that is published or in the public domain. We would welcome the opportunity to discuss any areas in more depth with the Committee.

In January 2013 CSIRO provided a submission to the Australian Senate Inquiry into *Recent trends in and preparedness for extreme weather events*[1]. A number of key points and references provided in this submission are also relevant to the current inquiry. The Executive Summary is provided as Attachment A.

[1] https://senate.aph.gov.au/submissions/comittees/viewdocument.aspx?id=7aa84650-bca0-43bd-9ecd-61782b884256

3. State of the Climate 2014

In March 2014 the Bureau of Meteorology and CSIRO released the third biennial *State of the Climate* report. It provides a summary of observations of Australia's climate and analysis of the factors that influence it, as well as future climate scenarios. Australia's climate has warmed by 0.9°C since 1910, and the frequency of extreme weather has changed, with more extreme heat and fewer cool extremes. Other key facts from *State of the Climate 2014* include:

- Rainfall averaged across Australia has slightly increased since 1900, with the largest increases in the northwest since 1970.
- Rainfall has declined since 1970 in the southwest, dominated by reduced winter rainfall. Autumn and early winter rainfall has mostly been below average in the southeast since 1990.
- Extreme fire weather has increased, and the fire season has lengthened, across large parts of Australia since the 1970s.
- Global mean temperature has risen by 0.85°C from 1880 to 2012.
- The amount of heat stored in the global oceans has increased, and global mean sea level has risen by 225 mm from 1880 to 2012.
- Annual average global atmospheric carbon dioxide concentrations reached 95 parts per million (ppm) in 2013 and concentrations of the other major greenhouse gases are at their highest levels for at least 800 000 years.
- Australian temperatures are projected to continue to increase, with more extremely hot days and fewer extremely cool days.
- Average rainfall in southern Australia is projected to decrease, and heavy rainfall is projected to increase over most parts of Australia.
- Sea-level rise and ocean acidification are projected to continue.

References

The 16 page *State of the Climate 2014* report is available at http://www.csiro.au/State-of-the-Climate-2014

4. Supporting national situation awareness

1. *The sustainability and effectiveness of current arrangements for funding natural disaster mitigation, resilience and recovery initiatives, including – where directly relevant to an improved funding model – the management of disaster relief and recovery*

CSIRO has identified a need within the emergency services for investment in improved situational awareness, specifically related to disaster response.

A complete picture of national situation awareness in natural hazard based disaster management is a challenge at any time. Disaster response and relief managers need to integrate information from multiple disparate systems, used by a multitude of agencies across the country. To create a useful environmental picture to underpin national planning, preparedness, response, and recovery (PPRR) activities for natural hazards, it would be helpful if we were able to exchange data, models and services across organisational boundaries. Seamless exchange and integration of 'big data' would provide better support in decision-making. Although this is typically seen as an information and communication technology issue, there is also a significant social dimension to this challenge, including the policy, governance and organisational and institutional arrangements that contribute to realising a solution to data sharing.

The key findings from a two-day workshop on "Building a System of Systems for Disaster Management" (hosted by CSIRO at the Australian Emergency Management Institute facilities in Mt Macedon, VIC from 27-28th November 2013) are outlined in an issues statement at http://www.csiro.au/systemofsystems. They are built on the collective views of more than 60 people from 35 organisations. The issues statement covers the key areas that enable a comprehensive and timely picture of situation awareness and highlight some of the research and organisational opportunities for the disaster management community.

A clear demand emerged at the workshop for a system comprising the multiple other systems that enable the integration of services and information/data across the breadth of agencies and stakeholders involved in disasters in all stages of the PPRR process. The issues statement articulates several challenges, which include the need for systems to aid data and information flows between agencies, and for assistance with big data challenges experienced with using information from social media sources.

The CSIRO, with the disaster management community represented at the workshop, is keen to resolve these issues to ensure better, more timely information to those that need it before, during and after a natural disaster. We propose that investment into enabling solutions to tackle the challenges outlined in the issues statement would aid Australia's disaster management community in achieving situation awareness and thereby improve impact recovery.

References

System of Systems for Disaster Management: Issues Statement (2014)
http://www.csiro.au/systemofsystems

All Hazards: Digital Technology & Services for Disaster Management (2012)
http://www.csiro.au/Outcomes/ICT-and-Services/People-and-businesses/Disaster-Management-Report.aspx

5. Funding to prepare our cities for natural disasters

2. *Risk management measures available to and being taken by asset owners – including the purchase of insurance by individuals, business and state, territory and local governments, as well as self-insurance options*

Adaptation to climate change in urban areas requires people in the public and private sector to manage complex problems in uncertain conditions. The property development industry consists of a diverse range of people with considerable financial, political and/or technical resources. CSIRO conducted a survey to scope the perceptions and preferences in relation to climate adaptation of a sub-set of groups associated with the property development industry in Australia. The survey explored: participation and capacity; effectiveness of current polices; risks and opportunities; and cost-sharing considerations, as perceived by these groups.

Results indicate that developers and their interest groups are seeking greater levels of participation and joint decision-making in public-adaptation policy and its implementation. The results also suggest that while developers and their service providers recognise a shift towards greater levels of responsibility and cost sharing for adaptation, perceptions of operational ambiguities and financial risks hinder progress in this area.

References

Taylor, BM, Harman, BP, Heyenga, S. and McAllister, RRJ. (2012): Property Developers and Urban Adaptation: Conceptual and Empirical Perspectives on Governance, *Urban Policy and Research*, 30:1, 5-24 http://dx.doi.org/10.1080/08111146.2011.639178

4. *Options to achieve an effective and sustainable balance of natural disaster recovery and mitigation expenditure to build the resilience of communities, including through improved risk assessments. The options should assess the relationship between improved mitigation and the cost of general insurance. In doing this, the Commission should consider:*

How business, the community, Commonwealth, state, territory and local governments can most effectively fund natural disaster recovery and mitigation initiatives;

How to ensure the right incentives are in place to support cost-effective decision making within and across all levels of government, business, non-government organisations and private individuals;

Mechanisms and models to prioritise mitigation opportunities and evaluate the costs and benefits of a range of mitigation options;

Options for urban planning, land use policy and infrastructure investment that support cost-effective risk management and understanding of the changes to the risk profile;

Options to fund identified natural disaster recovery and mitigation needs, including thresholds for triggering Commonwealth assistance to the states and territories;

Achieving an effective and sustainable balance of natural disaster recovery and mitigation expenditure to build the resilience of Australian communities requires (1) an understanding of the likely costs of natural disasters and mitigation actions, and (2) an understanding of the capacity of communities, different scales of government, and disaster management institutions to economically and equitably manage risk (Fletcher *et al.* 2013). Disasters affect different people

and organisation within the governance system differently, and engaging everyone in the system is vital to ensure equitable management of natural disaster risk.

A key part of ensuring effective and sustainable management of disaster risk is understanding all potential costs associated with a disaster, and how different mitigation options can avoid some or all of those costs. The impact of flooding events on infrastructure such as roads, businesses and private and public buildings has been considered (e.g. Wang *et al*. 2010), and the current devaluation of residential property due to inundation risk has been measured. Rambaldi et al. (2013) found that properties at the edge of the ARI 100 year inundation region were worth 1.28% less than equivalent properties secure from inundation, and properties within the inundation region experienced an additional 5.45% devaluation per metre of inundation they were expected to experience during an ARI 100 year event. Although this current level of risk is already internalised in property markets, the increased economic cost of land devaluation is likely to be extremely important if the frequency or intensity of inundation events is perceived by property markets to change over time. For instance, if sea levels rise 0.2m by 2030 and 0.5 m by 2070, the effect within the residential sector of land devaluation has been calculated to be of a similar magnitude to current estimates of infrastructure damage.

In addition to the importance of reliably estimating total risk, understanding the distribution of the risk of disasters across communities, the public and private sector, and different levels of government will be vital to effective and sustainable natural disaster management. For disasters such as coastal inundation and storm surge, both the risk and the potential benefits of adaptation vary strongly within and between coastal communities (Fletcher *et al.* 2013). Understanding who is at risk, what their capacities and responsibilities are for managing risk, and who is likely to benefit from adaptation will be a key part of designing disaster management response that is funded equitably across private, commercial and government sectors. For finely structured distributions of risk, such as those in Australia's coastal zone, detailed household-level studies can be used to calculate the distribution of risks (Fletcher *et al.* 2013). However, although each coastal community has its own distribution of risk and capacity to manage that risk, many Australian coastal communities share some broadly similar characteristics. Fletcher *et al.* (2013) used a typology of Australian coastal communities based on the total economic risk of coastal inundation, the distribution of that risk in the community, and the potential of the community to afford to self-fund a community scale adaptation (such as a sea wall) to summarise the details of risk in each community and recommend an appropriate adaptation response to manage the risk of coastal inundation in that community economically, equitably and affordably.

As well as the economic costs of managing natural disasters, there are governance factors that currently operate as disincentives for the effective management of risks, such as coastal flooding at local scales. For instance, contentious decisions about coastal development proposals in the hazard zone being made by local government could benefit from a supportive planning policy and legislative framework (e.g. on sea-level rise planning benchmarks). In the absence of such a framework, local governments carry many of the financial, legal and political risks associated with restricting coastal development in areas subject to likely increases in flooding and coastal erosion. These include being subject to compensation claims if attempts to 'down-zone' land are seen to reduce development potential to private landholders (Fletcher *et al.* 2013; Harman *et al*. 2014).

In urban and infrastructure development, public-private partnerships are a long-standing instrument to share financial risk in the development, construction and operating phases of major projects. There is scope to consider how these partnerships might be adapted to account for risk-

sharing over time; that is, in the on-ongoing maintenance and management of infrastructure. Chen *et al*. (2013) identify a number of different cross-sectoral partnership configurations under the three phases of disaster management: building resilience, response, and recovery. The types of partnerships include, but are not limited to: contractual and non-contractual partnerships for critical infrastructure; public-private partnerships for physical reconstruction; government-civil society partnerships for building resilience; and inter-sectoral partnerships for learning (Chen *et al*., 2013).

References

Chen, J, Chen, THY, Vertinsky, I, Yumagulova, L. and Park, C. (2013). Public–Private Partnerships for the Development of Disaster Resilient Communities. *Journal of Contingencies and Crisis Management*, 21 (3): 130-143.

Fletcher, CS, Taylor, BM, Rambaldi, AN, Harman, BP, Heyenga, S, Ganegodage, KR, Lipkin, F and McAllister, RRJ. (2013). *Costs and coasts: An empirical assessment of physical and Institutional climate adaptation pathways*. National Climate Change Adaptation Research Facility, Gold Coast, 53 pp. http://www.nccarf.edu.au/publications/costs-and-coasts-climate-adaptation

Harman, B, Heyenga. S, Taylor, B. and Fletcher, C. (In press). Global lessons for adapting coastal communities to protect against storm surge inundation. *Journal of Coastal Research,* DOI: 10.2112/JCOASTRES-D-13-00095.1 (online November 2013).

Rambaldi, AN, Fletcher, CS, Collins, K, and McAllister, RRJ. (2013). Housing shadow prices in an inundation prone suburb. *Urban Studies* 50:1889–1905. http://usj.sagepub.com/content/50/9/1889

Wang X, Stafford Smith M, McAllister RRJ, Leitch A, McFallan S. and Meharg S. (2010). Coastal inundation under climate change: a case study in South East Queensland. CSIRO Climate Adaptation Flagship Working paper No. 6. http://www.csiro.au/Organisation-Structure/Flagships/Climate-Adaptation-Flagship/CAF-working-papers.aspx

5. *Projected medium and long term impacts of identified options on the Australian economy and costs for governments as compared to impacts of the current funding arrangements;*

CSIRO has recently completed a project[2] for the Department of the Environment, which will be described in more detail in their submission. The project explores the current and future risks to residential housing from four hazards – coastal inundation, extreme winds, bushfire, and inland flooding – at a national scale, modelled at Statistical Local Area level and reported at State and Statistical Division levels. The study assesses the damages avoided by a series of disaster mitigation measures, comparing a reactive and anticipatory policy stance to a baseline of repairing to current standards; the study allowed for future changes in risk due to increases in population and changes in climate.

[2] CSIRO (2014). Policy Analysis Summary – national responses to current and future hazards to Residential Housing, CSIRO, Australia (in review).

The study shows:

(i) For residential housing (currently worth around $5tn in total), present value of expected direct damages in the absence of mitigation are substantial.

(ii) At least half of these direct damages can be avoided through proactive intervention[3] and the costs of intervention are at least an order of magnitude less than the damages avoided, in present value terms. A lesser but still significant benefit is achieved through a reactive response[4].

(iii) In all cases the majority of benefits come from a small number of Statistical Divisions, enabling highly targeted interventions that are likely to have much higher returns on investment than the Australian average.

(iv) In the majority of cases, most of the benefit is immediate; that is, residential housing is significantly under-adapted to current conditions, so that mitigation investment has 'no regrets' benefits as well as greatly protecting against future change.

(v) In general the analysis is very conservative in its assessment of benefits relative to costs, and includes neither indirect costs nor much other infrastructure entrained by housing.

These analyses support the case for the Productivity Commission's inquiry, but also begin to provide the quantitative basis for assessing what the balance should be between: (a) accepting contingency funding of disasters; (b) investing in better response and recovery from existing impacts from extreme events of a given magnitude; and (c) proactive investment in long-term mitigation measures to reduce the impacts of such events.

While this analysis makes the case for the Commonwealth paying attention to this balance of investments, it does not necessarily follow that the Commonwealth should invest financial capital in mitigation (e.g. as a part of infrastructure financing, etc), as opposed to investing political capital in regulation (e.g. building standards, more enforcement of planning requirements) or encouragement (e.g. education and information availability) for others to invest in mitigation. However, ancillary studies in progress seek to assess the emergent impacts of extreme events on the Commonwealth budget through lost tax revenue, lost access to capital markets due to declining credit ratings, declining ability to insure, or direct costs as insurer of last resort. These are likely to imply a greater benefit to action from Commonwealth (and State) governments than appears from narrow assessments of individual events and their responses, even after compensatory GDP responses. More detail on these studies in progress can be supplied on request.

This study indicates that further targeted studies in the more critical parts of the continent (see point (iii) above) are now needed to ascertain what specific measures could be undertaken to best benefit by whom in each region, and to assess who then should bear the costs and residual risks. These would then provide some highly targeted guidelines for potential investment.

[3] Proactive intervention implies that actions are taken on the basis of best information about the future risks

[4] Reactive response implies that actions are taken on the basis of best information about risks to date

6. CSIRO/AGD Disaster mitigation workshop

In May the CSIRO and the Attorney General's Department held a workshop intended to inform the ongoing work program of the Australia-New Zealand Emergency Management Committee (ANZEMC) with respect to natural disaster mitigation and as input into this Productivity Commission inquiry. The workshop report will be available by the end of June and can be provided separately on request by the Commissioners.

Attachment A: Executive summary, Submission to Senate inquiry *Recent trends in and preparedness for extreme weather events*

CSIRO provided a written submission to the Australian Government Senate Environment and Communications References Committee inquiry into *Recent trends in and preparedness for extreme weather events.* CSIRO also meet with the Senate Committee at a public hearing. Below is the Executive Summary from the CSIRO submission (full submission available at website provided below).

Executive Summary

CSIRO undertakes a wide range of research on weather and climate, its impacts, and how we can adapt to both current climate and that of the future.

Australia experiences a highly variable climate: our climate includes a range of extreme events which add up to considerable economic, social and environmental impact. Given this large natural variability in weather and climate, it is often difficult to detect a trend in extreme events or it takes a long time for the trend to become statistically significant. However, there is now strong evidence globally that during the past 50 years there has been a change in temperature extremes with fewer cold days and nights and more hot days, hot nights and heatwaves. This warming trend has flow on consequences for other events such as bushfires with an observed tendency towards more days of high forest fire danger in the last few decades. Trends in rainfall extremes are much less certain, though the IPCC reported in 2012 a statistically significant increase in the number of heavy precipitation events in many regions of the world.

Future climate change impacts will increasingly be experienced first through extreme events rather than gradual changes in mean temperature or rainfall. For example, heatwaves: the number of days over 35^{o}C is expected to increase significantly by 2030 for many locations in Australia. Also rainfall: despite the general tendency for decreases, or little change in seasonal-average rainfall in the future for much of Australia, increases in extreme daily rainfall are expected over most of the continent in the future. Likewise, tropical cyclones are likely to become more intense with a decrease in frequency. And dry extremes: drought occurrence is expected to increase over most of southern Australia, especially in south-western Australia.

Extreme events place a huge financial, social and emotional burden on individuals, communities, industry and the government. Better preparing for extreme events through planning, engineering and awareness has proved to be effective in reducing their cost. For example, cyclone building codes in northern Australia are very effective at reducing damage from high intensity wind events. Cost-benefit analyses demonstrate that under a changed climate it is cost effective to put in place stronger engineering codes, especially in sub-tropical regions.

Increased vulnerability to extreme events is not just related to climate change. Planning regulations that place more people in vulnerable areas will lead to greatly increased costs of extreme events. For example, in south-east Queensland, based on current development patterns, the number of residential buildings affected by a 1 in 100 year storm tide inundation event nearly doubles in 2030 compared with today. Sea level rise accounts for only a small amount of this increased exposure in 2030 but by 2070 it is a much more significant contributor to the projected damages.

Human health is an important consideration in the context of extreme events. Heatwaves in particular can lead to considerable loss of life in today's climate. As the climate warms and heatwaves become frequent the effect on years of life lost increases gradually but then starts to rise rapidly once mean temperatures increase beyond 2^{o}C.

Emergency services agencies can be better equipped through having in place better forecasting and modelling tools and early warning systems for a wide range of extreme events, including heatwaves, bushfires, floods, and inundation events. These forecasting and modelling tools are developing rapidly and with information systems technologies are increasingly able to be deployed in real time.

Finally, it is important to understand the impacts of existing extreme weather and climate events and use these as a window into determining how to respond to future climate change in an enhanced greenhouse world.

Reference

Submission to the Australian Government Senate Environment and Communications References Committee inquiry into *Recent trends in and preparedness for extreme weather events.* https://senate.aph.gov.au/submissions/comittees/viewdocument.aspx?id=7aa84650-bca0-43bd-9ecd-61782b884256

What needs to be done

Better preparedness and resilience

Future emphasis should be on determining the appropriate balance between raising the resilience of Australia's social and physical infrastructure, compared to emergency response and recovery. CSIRO can make a significant difference by;

- Developing a national database and mapping of vulnerability and resilience to extreme events and how this changes in response to economic, demographic and meteorological factors.
- Quantifying the costs and benefits of a range of preparedness and response options for mitigating impacts of extreme events.
- Developing innovative engineering solutions for communities, built assets and key infrastructure such as new materials and designs for houses and retrofitting of existing buildings.
- Designing ecological solutions (such as stabilised dune vegetation) for coastal communities to protect homes and critical infrastructure.

Improving disaster management and speeding recovery

It is critical for emergency planners to know where to allocate resources across Prevention, Preparation, Response and Recovery to increase community safety and reduce the costs and social effects of emergencies and disasters.

CSIRO can develop technologies that deliver integrated 'one stop' solutions to disaster managers. The Disaster Management Decision Support Platform will better equip emergency planners and response coordinators with information to aid their decision making process and thus speed up recovery efforts.

A combined approach to animal, human and environmental health

Animal to human viruses are highly unpredictable. Epidemics can place unexpected and intense demands on a nation's healthcare system and can cause enormous social and economic disruption.

'One-Health' describes a collaborative approach to developing holistic health strategies for people, animals and the environment. The One-Health approach will be critically important for our preparedness for the next viral pandemic.

Developing a coordinated research response is essential to enhancing Australia's preparedness and in reducing the risk of pandemics.

The challenge is to get ahead of the new viruses that may emerge. A better understanding of virus-host-human-environmental interactions will help lead to faster, more sensitive and novel surveillance tools that may radically change the risk management of emerging infectious diseases within Australia and globally. Hand-held tools for rapid, 'in the field' testing and disease diagnosis are soon to be trialed.

CSIRO's research for the future is focused on novel vaccines, anti-virals, therapeutics and development of disease resistant animals to break the chain of virus transmission and limit the wide-ranging impacts that a new disease can have in our interconnected and highly mobile world.

> Only by working together as 'team Australia' can we make appropriate policy and investment decisions, based on good evidence and innovate technologies, so that Australian communities are more resilient to extreme events.

YOUR CSIRO

Australia is founding its future on science and innovation. Its national science agency, CSIRO, is a powerhouse of ideas, technologies and skills for building prosperity, growth, health and sustainability. It serves governments, industries, business and communities across the nation.

FOR FURTHER INFORMATION

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How we can better prepare for and recover from extreme events

May 2013

The issues and challenges we face

Extreme weather events and natural disasters have an enormous impact on Australia's economy, social fabric and environment. In the last four years more than 550 people lost their lives in natural disasters and the costs of repairing public and private infrastructure, insurance claims and lost productivity run to tens of billions of dollars.

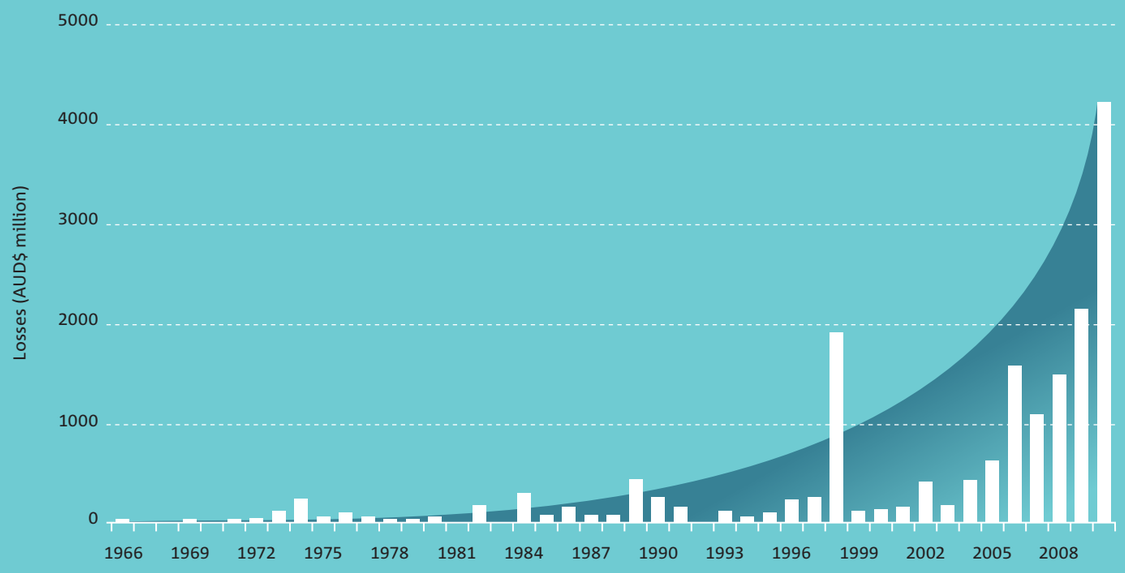
Although extreme weather events get the most attention, sudden and unexpected disease or pest outbreaks can also heavily impact human health, the economy and the environment: agriculture, tourism and water supplies all depend on the integrity of our biosecurity systems.

The economic costs of extreme events are increasing. The level of infrastructure investment in vulnerable locations has been growing as more people make their homes in floodplains and along coastlines. Extreme events are expected to become more intense and more frequent. Increasing numbers of imported and exported goods have also increased the risk of unexpected pest or disease outbreaks.

Over decades we have developed approaches to better prepare for and manage the impacts of extreme events: new cyclone building codes, improved warning systems, greater coordination between emergency management responses, strong border protection, and improved pest and disease surveillance inside our borders.

CSIRO plays a critical role in helping improve natural preparedness and resilience; better managing the impacts of extreme events as they unfold and developing solutions to faster, more sustainable recovery.

CSIRO harnesses the breadth of digital technology, modeling, engineering, planning, biological, ecological, social and economic skills and brings them together to deliver an integrated 'all-hazards' approach to dealing with extreme events.



INSURANCE LOSSES DUE TO EXTREME WEATHER EVENTS WEATHER EVENTS OVER LAST 40YRS (SOURCE: RISK FRONTTIERS ANALYSIS OF ICA DATA)

What we are doing now

CSIRO is working with our partners in industry and government to improve Australia's preparedness and response to extreme events.

UNDERSTANDING BUSHFIRE BEHAVIOUR

We undertake work on advancing fire spread prediction and bushfire suppression systems by using sophisticated data analysis techniques and computer modeling. Working with state land management, rural fire agencies and other research agencies, our scientists apply knowledge of bushfire dynamics to real events and help predict risks.

Knowledge gained from our evaluation of the Black Saturday fires provides valuable insights into the physical processes involved in high intensity fire behaviour in eucalypt forests. This information is being used by fire and emergency management agencies to help reduce the likelihood of catastrophic fires and provide more effective early warning systems.

EMERGENCY SITUATION AWARENESS

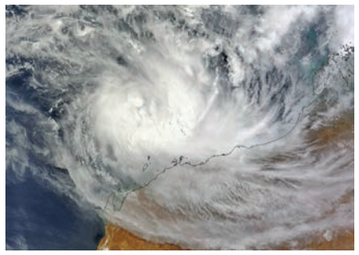
Social media channels provide a new, rich source of information that can provide disaster managers and emergency response agencies with real-time awareness of developing situations. We have developed services to collect, detect, assess, simplify and report situation information in near real-time. Our Emergency Situational Awareness (ESA) software detects unusual behaviour in the Twitter stream and quickly alerts the user when a disaster event is being broadcast.

Co-developed with the Australian Government's Crisis Coordination Centre, ESA is now being used by emergency managers in New South Wales, Victoria and Queensland.

IMPROVING WEATHER AND CLIMATE FORECASTS

A cutting edge model of the planet's earth-ocean-atmosphere interactions known as 'ACCESS' has been developed to increase the accuracy of weather forecasts and climate analysis. Developed by CSIRO scientists and the Bureau of Meteorology in collaboration with the UK Met Office, the model is used by Australian climate and weather forecasters and researchers, and was deployed to great effect during the Victorian floods of September 2010 and those in New South Wales in 2012.

ACCESS data underpinned long-term climate scenarios developed by Australian scientists for the Intergovernmental Panel on Climate Change reports out in 2013–2014, and its climate simulations have been used in more than 60 published climate studies in the past year alone.



SAFEGUARDING AUSTRALIA FROM INFECTIOUS DISEASES

In an increasingly connected world, the risk of a pandemic affecting the lives of millions of people is very real.

The SARS epidemic of 2003 is an example of a previously unknown virus causing worldwide chaos. During the global epidemic, the secure containment capability of CSIRO's Australian Animal Health Laboratory allowed our scientists to play a critical role in the identification of the SARS virus and later identify that bats are the most likely hosts of the virus responsible for SARS.

With 70% of emerging infectious diseases in humans coming from animals, the work of CSIRO's biosecurity research teams is critical to help control or prevent viruses that evolve in animals and spread to humans, such as the Hendra virus and avian influenza. We have also developed and brought to market a vaccine for Hendra virus.