**Q&A Australian rainfall and runoff: to the extreme!**

| Question | Answer(s) |
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| should we be allowing for 1 in 500 events where typically we'd consider 1 in 100 (based on the increase in severity and frequency of flooding) | The essence of risk analysis is to balance the costs of mitigation against the expected damage costs due to flooding. The higher the consequences, the rarer the design risks that we should be designing for. However, given the climate crisis we should be allowing for an increase in flood risks in the future, and one way this can be done is to adopt a rarer level of design risks in our current designs. |
| should we be allowing for 1 in 500 events where typically we'd consider 1 in 100 (based on the increase in severity and frequency of flooding) | Hi Raees,<br>The short answer is yes, but the long answer is largely dependant on consequence & risk. From the perspective of an insurer, we consider the full range of possible events up to the PMF. The large and extreme events in some cases don't significantly contribute to damages, and in some cases contribute very strongly. The key is moving to a risk-based approach across the full spectrum of possible events, rather than blindly adopting a standard design flood event & ignoring the consequences of larger events |
| Have we underestimated our design rainfalls? | Generally, I think our current design rainfalls provide a good indication of the risks of rainfall extremes, as observed in the historic record (ie they are not underestimated). However, given the climate crisis, we do need to consider increasing design rainfalls to better represent rainfall risks in the future (due to a warming climate) |
| Have we underestimated our design rainfalls? | In an analysis of historical rainfalls in SEQld since 1893, I was amazed the number of occasions when the rainfall exceeded 1 in 2000. This included gauges which were used in the 216 review. |
| | 2016 review |
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| Any comment on the NSW Planning Minister recently scrapping the requirement to consider the risks of floods and fires before building new homes? | live answered |
| Any comment on the NSW Planning Minister recently scrapping the requirement to consider the risks of floods and fires before building new homes? | The Planning Minister scrapped new "Planning Principles" that included resilience to extreme weather and climate change. There are still plenty of requirements to address flood risk and bushfire risk in the NSW planning system. |
| Any comment on the NSW Planning Minister recently scrapping the requirement to consider the risks of floods and fires before building new homes? | I understand there are other requirements but the position of the Minister seems to be that risk of flooding is not a major issue. |
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| Has there been any thoughts about any possible correlation between the intensity of coastal rainfall and the local width of the East Australian Current? It used to extend to the southern end of NSW, but now reaches to south of Tasmania. | This has been investigated and in general the warmer the coastal sea surface temperature to more rain within coastal storms. |
| | The EAC is a bit more complicated as it has many eddies, wiggles and moves around through time. So the coincidence of the EAC and a single storm is somewhat rare. |
| | Thank you, Jason. I was thinking more along the lines of broad or average width, using the graduated eyeball approach for a line of best fit, perhaps? Details like eddies would be too small scale, i'd suggest. |
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| How is ARR best kept up to date with regards to potential changes in rainfall intensities due to climate change? | I am not sure of exactly the best way but it certainly needs to be regularly updated as we improve our knowledge of climate change, the abilities of our climate models and the level of confidence in our projections. An effort to update AR&R climate advice every 5-10 years would probably be appropriate. |
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| There is insufficient information in flood risk management plans that Councils produce on flood warning time for different parts of the floodplain. What is your advice on this for consultants writing flood emergency management plans? | Like in Parramatta CBD now! |

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| 20 | Realistically, what is the solution to ensure we don't see the same or even similar level of damage sustained in recent floods? Million dollar question hey? | Natural disaster damages have always increased. Fundamentally because there is more stuff to damage. I dont expect this to change and flood damage will go up in the future. We can still do things to minimise damages, and perhaps on a per captia basis, we can get flood damages ot trend downwards. |
| 21 | Are we expecting the Bureau to update the design rainfall IFDs to incorporate the latest rainfalls of the last few years? I note that there were significant events in the late 1800's and early 1900's and much of these rainfalls are not included in the current design rainfall estimates. Now some more extreme events are part of the record, these influence the AEP estimates. | It would be prudent to regularly re-visit design IFDs as new information becomes available, however it is impractical to do this after every extreme event. We need to recognise that IFD estimates are based on a "random sample" of rainfall events, and the best way of accommodating this inherent uncertainty is to consider the upper/lower limits of the IFD curves. While the BoM does not provide these, there are various practical ways of analysing historical data to inform such uncertainties. These recent (2022) rainfalls are quite likely to be within the 90% confidence limits of our existing IFDs. |
| **22** | | |
| 23 | There has been a few people and organisations doing some great advocacy for increased government spending on flood preparedness, but to date Australia still spends way more money on recovery. How do we convince government to reconsider this inbalance? | Agreed - we need a substantial body of public opinion to persuade goverments to rebalance their spending |
| 24 | There has been a few people and organisations doing some great advocacy for increased government spending on flood preparedness, but to date Australia still spends way more money on recovery. How do we convince government to reconsider this inbalance? | Psychologically, it's best to build in plans for rebuilding or moving houses that can be put forward immediately after the flood, when people are more likely to grab onto it. |
| 25 | I was wondering if BOM is going to review Design Rainfall Data (2016) incorporating recorded rainfall data of the recent event (Feb 2022). | See answ to Q17 and Q21 |
| **26** | | |
| 27 | Good afternoon panel, how do we know without doubt that these floods, without written records, that these flood events did not happen back say 1000 years previous or even before. | We know larger events have happened before gauge records. The odds that we have recorded the highest flood event anywhere in australia is quite low! We can see evidence of larger events in the geological records, and i believe also in aboriginal history. Where we can, we will include paleo flood estimates in FFAs to get a better idea of rare events. |
| 28 | | |
| 29 | How can we ensure people living in flood affected areas, such as Lismore, can obtain flood insurance? Presently it is so expensive it is essentially not available. | Hi Leanne, the key to making insurance affordable is reducing the underlying risk, either through adaptation, mitigation or retreat.<br>A property with Annual Average Losses of $5,000 per year will always cost at least $5,000 a year to insure, whether through a private insurance contract, a government-run insurance pool, or through self-insurance. The only difference is who pays (private landowners, governments, taxpayers) and when (prior to an event with costs spread over time, or after an event as a lump sum).<br><br>Insurers generally support the looking at a range of options to improve affordability, but any regulatory or policy intervention around insurance will only be a stop-gap only to buy us some time to address & reduce the underlying risk. |
| **30** | How can hydroloical and hydraulic support be stregthen to emergency services during operations? This is to improve advice to incident controlers for warning messages and response actions (evacuation etc) | We had our Council modeller embedded in our emergency ops centre throughout the floods helping with this. |
| 31 | How did the recent flood inundation/s seen in Northern NSW (on the ground) compare to the modelled predictions in recent flood studies recently completed (Richmond River, Wilsons River, Tweed River etc). What sort of varience in flood depths was there. Were there anomalies? | live answered |
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| 40 | Did misinterpretation of the meteorology by BOM play a role in underestimating the rainfalls and corresponding predicted flood level (e.g. in Lismore)- was their prediction related to IFDs? | Based on James' comments- when large rains are predicted should there be a team of meteorologists, hydrologists and flood modellers updating the community on a likely flood level? (context- Lismore was told the flood would reach about 11.5m when it finally reached 14.4m) |
| 41 | Did misinterpretation of the meteorology by BOM play a role in underestimating the rainfalls and corresponding predicted flood level (e.g. in Lismore)- was their prediction related to IFDs? | BoM doesnt predict to IFD's. Predicts levels....is this enough probably not, as the general person also needs to know what impact that level has |
| **42** | Did misinterpretation of the meteorology by BOM play a role in underestimating the rainfalls and corresponding predicted flood level (e.g. in Lismore)- was their prediction related to IFDs? | Kate, the BoM does provide this service for certain locations...including Lismore. however i think the messaging may be lacking for the general user of the information. |
| 43 | | |
| 44 | Was this event an atmospheric river event? (ie. similar to the "Pinapple Express" in that sends extremely moisturer from Hawaii to the west coast of North America during many major events) | ski.com.au weather forum showed some good total precipitable water animations showing the moisture movements for this event |
| 45 | Was this event an atmospheric river event? (ie. similar to the "Pinapple Express" in that sends extremely moisturer from Hawaii to the west coast of North America during many major events) | https://www.ski.com.au/xf/threads/upper-low-and-surface-trough-se-qld-ne-nsw-heavy-rain-22nd-feb-early-march-2022.91123/ |
| **46** | Was this event an atmospheric river event? (ie. similar to the "Pinapple Express" in that sends extremely moisturer from Hawaii to the west coast of North America during many major events) | Salient concept in relation to the ocean river as well: i.e.theEast Coast Current and associated Southern Oscillation trends..... |
| 47 | We typically apply IFD rainfall into calibrated models to obtain estimates of design flood levels. Given the recent flood events, does the panel still believe this approach can provide realistic estimates of floods for rare AEPs? | I think so. And I think IFDs should be factored where appropriate. |
| 48 | | |
| 49 | Any likelihood on the increase from 5%rainfall intensity increase/degree temperature increase in ARR | Published research indicates that the % increase required varies with storm duration (and possibly severity). Possibly a better average estimate today is 7% rather than 5%, but this is an area of ongoing research. |
| **50** | We are talking about a 1 in 2000 AEP. How sure is that 1 in 2000 AEP is accurate given we are have only had guaging for 50 to 100 years? Does anyone know if we have been though a macro-trend (50 to 100 years) of low or high rainfall? | The current IFD estimates use "regional pooling" which is a well accepted statistical technique for estimating rare events from short at-site records. It is quite defensible to derive AEPs out to 1 in 2000 from such statistical analyses .... and indeed there are defensible ways of deriving rainfalls with much rarer events. |
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| 53 | Moreton Bay Regional Council LGA did observe flood water levels that are classified as extreme. We also observed extreme rainfall - however it was for long durations that exceeded the critical durations of our coastal catchments. I would like to know whether there is any current research into relating specific meteorological weather "set-ups" with IFD's. IFD's seem somewhat independant of particular weather system. | The IFDs as a final product are independent of the weather systems even though there is inherent meteorological and storm based insights into how the IFDs were derived. |
| **54** | | |
| 55 | Is there merit in reviewing the existing statistical approaches used to derive current IFD estimates? If so, is there merit in using a piecewise approach to reflect the different meteorological phenomena experienced in different regions/catchments? | Question for the BoM. but yes, i think there is merit in reviewing the IFDs and methodology. particularly how they handle long duration storms. |
| 56 | Long term records are at a limited number of points, and short duration high intensity storm cells often miss them. Rain radar gives the opportuity to identify and quantify these cells. How is that more comprehensive data affecting our view of critical extreme rainfall intensities? | The opportunities for spatial information from radar are great but there are lots of practical considerations to using radar data quantatively - there is a lot of uncertainty in converting the radar reflectivity to a rainfall rate |
| 57 | Are Design IFDs going to be reviewed in light of these extreme events, also some more on additional gauges to capture spatial variability which i think was quite evident in this event | See answ to Q17 and Q21 |

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| 58 | Does AEP has the same meaning/concept as Average Recurrence Interval (ARI)? | http://www.bom.gov.au/water/designRainfalls/rainfallEvents/why100years.shtml |
| 59 | Has there been some mis-understanding in the media between flood level/frequency and rainfall intensity/frequency? Were the floods due to an extreme rainfall event or due to surface hydrology? | The floods were due to very intense rainfalls (and some interaction with tide levels in places) but there is no direct correspondance in AEP between the rainfalls and the floods. |
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| 62 | The terms 1:500 or 1:1000 events still result misinterpretation of severity of rainfall in public that those events would occur in this interval. Is there any better ways of expression of severity avoid the misinterpretation? | the user interface to flood management should target the mindset of planners who make dnagerous constructions not just drivers near dangerous culverts if it suddenly rains during a snow melt. no? |
| 63 | I would advocate that we rethink residential development preparation. We need to ensure that builds do not get into trouble. | |
| 64 | Given the short observational data (<100 years or 40 in many cases), how do we best agree upon a standardised format/approach to include available longer palaeoclimate time series data which shows far greater variability and extremes than we have observed in this period? | I've mentioned in another answer, yes, we can use paleo flood studies to get a better idea of rare flood events, but it's not always available - the geology needs to suit. |
| 65 | We are talking about AEP and looking at rainfall IFDs - what happens when the water hits the ground is just as important - the influence of development on floodplains, tidal levels etc will affect what the estimate of AEP for a catchment ultimately is - has anyone estimated AEP for individual system or key affected areas? | We should proceed very cautiously with such estimates so that they can use the best (QA/QCd) information available. Attempting to do this quickly can result in misleading information being released to the wider community |
| 66 | who is to lead the necessary discussion (technical, social and political) as to what is the "new" design probabilty for defining flood prone land and setting planning regulations - is 1%AEP still relevant - after revisions to ifd and design flood assessment - should it be increased to 0.2% or even more extreme - what does the community think ? | Thete is absolutely no reason to pick a single number - it has to be based on impact that is deemed unacceptable. The Netherlands is the exemplar. |
| 67 | who is to lead the necessary discussion (technical, social and political) as to what is the "new" design probabilty for defining flood prone land and setting planning regulations - is 1%AEP still relevant - after revisions to ifd and design flood assessment - should it be increased to 0.2% or even more extreme - what does the community think ? | Agree. How do we relate codes for houses (wind code?) to flood designs (1%). For a lifetime of say 100 years (more are making this milestone) there is a likelihood of that is better than even chance of experiencing a 1% flood, this surely means designing for 1% floods seems to design to fail in many people's lifetime for those living in 7% of houses below the 1% flood level. |
| 68 | Is 1% AEP standard now the elephant in the room? | i think the question should be is how accurate do you think your 1% AEP is |
| 69 | Is 1% AEP standard now the elephant in the room? | definitely need to move away from this standard given uncertainty in 1% AEP estimates and floodplain sensitivity to changes in rainfall. As Mark said though, standards need to consider a range of flood events for different infrastructure/developments. |
| 70 | every coin has two sides, how about our floods, should we conserve the floodwater for dry years, maybe next year? | you mean, keep everyone flooded? |
| 71 | It may be hard, or we shouldn't try to quantify climate change contribution to a specific and individual evnet, given cliamte change's granular and continous nature. Using a reference time period for long term forecast and quantification of climate change contributiion is probably the closest one we have got so far? | Climate change attribution is a developing area of science which tries to quantify the contribution made by climate change to observed events. But, in my opinion, such estimates are subject to high uncertainty. |
| 72 | Allan Herring: The most useful predictive rainfall during the recent event was the high quality data from the BoM. The problem is translating the 'extreme" forecast rainfall into impact maps in a short time frame. | |
| 73 | In designing dams we consider the PMF and very low probability events because the consequence of realizing those events is catastrophic. We have seen what has happened on the North Coast of NSW and SEQ. Should we be designing/planning considering flood events on a similar basis, not necessarily no building on flood plains but only allowing development if the probability is extremely low and adequate evacuation routes above PMF are also included in that development. | In designing dams we consider the PMF and very low probability events because the consequence of realizing those events is catastrophic. We have seen what has happened on the North Coast of NSW and SEQ. Should we be designing/planning considering flood events on a similar basis, not necessarily no building on flood plains but only allowing development if the probability is extremely low and adequate evacuation routes above PMF are also included in that development. |

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| 74 | In designing dams we consider the PMF and very low probability events because the consequence of realizing those events is catastrophic. We have seen what has happened on the North Coast of NSW and SEQ. Should we be designing/planning considering flood events on a similar basis, not necessarily no building on flood plains but only allowing development if the probability is extremely low and adequate evacuation routes above PMF are also included in that development. | Physical PMP not statistical one ;) |
| 75 | | |
| 76 | Why do some of the private weather prediction institutes like "Higgins Storm Chasing" and others give different reports to the QLD governments. Recently, the private institutes were more accurate and faster at giving the warning to the SEQ towns. Any comment? | Private weather predictors just look at similar meteorological prediction data that the BoM does. Note that higgins are not trained meteorologists either...read their about section. They have a habit of going high on their predictions, so will probably be more accurate when extreme events actually come off....They don't always come off however. |
| 77 | Why do some of the private weather prediction institutes like "Higgins Storm Chasing" and others give different reports to the QLD governments. Recently, the private institutes were more accurate and faster at giving the warning to the SEQ towns. Any comment? | Extreme events are the most difficult to predict, and the weather models normally underpredict these events. |
| 78 | How does the recent event compare with design temporal patterns of historical big events we are currently using? | |
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| 80 | Is it possible that strong La Nina events which have saturated catchments which are then combined with extensive areas of an adjacent ocean with relatively high water temperature; can be the cause of these events? | La Nina and saturated catchments definitely increase flood risks in general; this could be tested for this event. |
| 81 | | |
| 82 | Can we stop focusing on climate change and discuss things like storm on storm events, where the second storm effectively produces 100% runoff due to the excess water from the first storm not getting away? | Climate change will definitely impact on 1) antecedent conditions and 2) frequency (and inter-arrival times) of storm events, so there is no ignoring that. The impact of changed antecedent conditions due to a prior event is very much a focus when analysing past events (as would be required when reviewing the 2022 floods). |
| 83 | Still a missing link between larger climate assessment and forecasting of potential rainfalls needed. We have short records and although some organisations are assessing other geological data to assess how wet years were over the last 1000yrs...Design comes back to cost/benefit no matter how big we re-assess the 1% AEP event to be.. | |
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| 86 | Rain bomb used in the media is not good terminology. | |
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| 88 | Krey, can you please spell out EY, AEP, ARI for non experts | quickly- the Annual Exceedence probabilty (e.g. a 1% storm) = the % chance of an event being equalled or exceeded in any given year (1% AEP = ~~1 in~~ 100 year Annual Reoccurance Interval ARI) |
| 89 | | And EY: Average number of exceedances per year |
| 90 | | |
| 91 | I'm constantly shocked by the number of people who didn't think their property would flood. How can we improve flood awareness? | I'm constantly shocked by the number of people who didn't think their property would flood. How can we improve flood awareness? |
| 92 | | Many homeowners first realise they have a flood risk either when water starts coming through the door, or when they recieve their insurance renewal notice which flags a high flood premium. I would advocate for mandatory notification around whether land is subject to FLOOD RISK, rather than subject to FLOOD PLANNING CONTROLS. |
| 93 | As a Disaster Resilience & Recovery Planning Coordinator for an Clarence Valley Council LGA that experienced major flooding of the Clarence River, feed by two other major river systems. The Grafton Township was saved from catastrophic flooding by a levee with only 20cm from overtopping, what happens if Councils only response is to raise/extend levees? | Check out the level gauge at Fry St. It says top of levee is now 1 in 20. This flood was just above levee there and sandbags held it |

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| **94** | Bryson - I agree with you point about the declines in the SW of WA but this is not necessary the case with case in the NW of WA NRM Regions. Here the projections are indicating risks that range every where from a dryer to a wetter climate. More importantly they are projecting more extreme extremes in rainfall and temperature (but with a lack of confidence/certainty in how extreme especially in regards to rainfall) and more intense cyclones (but less frequent). | Hi Jacquie - before making my statement I said something along the lines that "in Perth where I live ..." I should have been more specific about Perth's location (SW WA). |
| 95 | To take account of spatial and temporal distribution, we should also need to look at peak flood flow frequency. | |
| 96 | The Bureau of Meterology had records of rainfall intensities around Brisbane (e.g Mt Glorious) on morning of 27th of Feb that were similar to what resulted in upper catchments above Lismore late 27th/early 28th of Feb (e.g. Dunoon, Goonengerry). Why did these not result in more conservative (i.e. extreme) flood warnings for Lismore and northern rivers earlier? Flood warnings were updated while people were asleep in bed. | |
| 97 | Should indigenous stories be sought out to get an idea of longer term exteme historical events? | Yes, I could not agree more |
| **98** | Allan Herring: Not once did I hear BoM refer to teh event in SE Qld as an East Coast Low event. | To clarify I was talking more of the flooding in the Hawkesbury and Newcastle specifically with the communication about East Coast Lows |
| 99 | Given the recent flooding in eastern Australia, Is the flood industry satisfied that ARR19 IFDs are fit for purpose or do these need to be urgently reviewed in light of this data? | I'm mostly familiar with Qld IFDs, and we've found they are generally a bit low and we have needed to factor them up in order to match FFA estimates, even when we've had over 100 years of good stream gauge records. |
| 100 | | |
| 101 | This all reminds me of Hurricane Harvey in Houston area (2017). From the comments referenced here to what it sounds like the media has latched on to, it all takes me back! | Sorry, not a question, just a comment! |
| **102** | This all reminds me of Hurricane Harvey in Houston area (2017). From the comments referenced here to what it sounds like the media has latched on to, it all takes me back! | Good comment. These are significant events that shape our collective understanding of hazards and how to best prevent, prepare and respond. |
| 103 | Lismore seemed to be affected by a very large flood, but how widespread was flooding of that scale across the east coast? | I have not done an analysis, but due to the storm system it seemed pretty widespread. This is often the case, we get La Nina years that are wetter than average at many sites and then due to an event moving over the system means many sites record rare events together |
| 104 | Are there any updates being considered on the ARR2019 guidelines in response to the recent flood events? Considering we seem to observe a lot more rare events in the recent years. | Bryson currently commenting now: funding is a big issue. |
| 105 | what other measures aside from increases to freeboard should we be considering for providing better immunity to future developments? | what other measures aside from increases to freeboard should we be considering for providing better immunity to future developments? |
| **106** | what other measures aside from increases to freeboard should we be considering for providing better immunity to future developments? | sensitivity for each location (not just a fixed freeboard amount)as Cathie and Mark discussed. Evacuation pathways are important, mitigation structures to increase storage, ... |
| 107 | Should we being using palaeoflood hydrological applications in reconstructing rare and extreme events? | yes, we use paleo flood events sometimes, but the geology has to suit. we can identify large flood event levels going back 1000-2000 years and including them in an FFA can help reduce the uncertainty in the 1% AEP estimates by up to 50%. but again, very reliant on geology. |
| 108 | Should we being using palaeoflood hydrological applications in reconstructing rare and extreme events? | Ah thank you, do you know what specific geologic features that are required? |
| 109 | Should ARR also require provision of dry cells in all culverts (say 2m x 2m min / dry banks under bridges as standard (say at an ARI 1:10)? This would help wildlife, livestock and potentially people can avoid being trapped and potentially drowned? It would also help convey a more intense major flood and help protect infrastructure. Keen on everyone's views on this. | Hi Andrew, I am not sure about this design suggestion. A 1:10 is the sort of 'nuisance' flooding which I imagine is easier for wildlife to escape than the much rarer events that has been discussed here - some of the videos showing water levels at or above treelines. |

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| 110 | Should ARR also require provision of dry cells in all culverts (say 2m x 2m min / dry banks under bridges as standard (say at an ARI 1:10)? This would help wildlife, livestock and potentially people can avoid being trapped and potentially drowned? It would also help convey a more intense major flood and help protect infrastructure. Keen on everyone's views on this. | I understand that - but if wildlife perishes in smaller floods and we can help reduce mortality for those events, the populations are more likely to withstand a far less frequent larger event with high mortality. My suggestion is we provide for wildlife movement (in addition to flood conveyance) as standard. And the wildlife movement infrastructure acts as an additional relief valve during major floods. As the floods rise wildlife uses the wildlife underpasses to get away from areas of entrapment, and the additioanal flood conveyance capacity provides some relief. Much of what I have observed int eh Logan flooding in particular is the barrier effect caused by major roads holding floodwaters back - creating a higher level in those catchments. |
| 111 | Should ARR also require provision of dry cells in all culverts (say 2m x 2m min / dry banks under bridges as standard (say at an ARI 1:10)? This would help wildlife, livestock and potentially people can avoid being trapped and potentially drowned? It would also help convey a more intense major flood and help protect infrastructure. Keen on everyone's views on this. | Thanks for your response btw. I just don't want broader considerations (and their potential sidfe benefits) to be overlooked. We need to treat the conveyance of water under roads in a more wholistic mult-disciplinary manner in my view. |
| 112 | I suspect most FFA's would need IFD factorisation in order to get best fit.. | Hi, not sure what you mean by factorisation. |
| 113 | isnt it obvious that we need some recognition of non stationary so the IDF curves can recognise higher risks today than in the past in order to properly estimate present risks without undue emphasis on a differeng past? | I think there was some comment by Fiona earlier in the session, and some comment from Bryson about climate models. Climate models can add valuable insight and it is something for us to actively track very closely over coming decades so we can best design for the future. |
| 114 | How does the reliability of rain and flood probabilities compare with other design events that engineers use e.g. wind and cyclones? | I am not well informed about wind-design, but these attributes all relate to 'storm' weather events and therefore have similar challenges, that each weather event is unique. Cyclones have only had good tracking since the satellite era, so also have short records. Wind is perhaps simpler in that the response of a building is well understood whereas the response of a catchment to rainfall is highly complicated since it depends on prior rainfall events as well as many land-use changes over time and other catchment processes (groundwater, etc.) |
| 115 | Extreme rainfall magnitudes are increasing every year.Even after following design guidelines, our structures can get damaged. Can we design structures bsased on acceptable flood damages(to be specified in design codes)and undertake repairs through annual maintenance budgets? | That is indeed the challenge of good planning and design - but it is very difficult. Part of the challenge is that there is minimal data and significant uncertainty on specifying what the true risk is, as well as the fact that it changes with land-use change over time and, yes, a non-stationary climate. |
| 116 | Extreme rainfall magnitudes are increasing every year.Even after following design guidelines, our structures can get damaged. Can we design structures bsased on acceptable flood damages(to be specified in design codes)and undertake repairs through annual maintenance budgets? | Acceptable changes to land-use plans should be notified.Flood damages to structures are mainly caused to changes to land-use plans due to rapid urbanisation . |
| 117 | IFD is being discussed, but we need to include Area as well. My suspicion is that the recent areal rainfall exceeded what we knew about areal rainfall. | Agreed, but it takes care and time to analyse the severity of areal rainfall events |
| 118 | there are more than 1000 rain gauges. Should we expect one to see a 1 in 1000 year event each year? | the gauges are not independent so not exactly every year, but this line of thinking is useful and explains why there is always something 'extreme' in the news (many places, many timescales, many hazards). |
| 119 | there are more than 1000 rain gauges. Should we expect one to see a 1 in 1000 year event each year? | On this logic, we ought to give every Australian a rain gauge and catch a ~ 1 in 25 million year event each year. [I disagree with this response for our raingauge observations are highly correlated - as per above point] :) |
| 120 | Allan Herring: This event was not just at one gauge. They were repeated at multiple locations over large areas of SE Qld and Northern NSW. | |
| 121 | How does urbanisation affect flood levels Typically you would expect it to increase likelyhood of flooding however I feel like | |
| 122 | There have been a number of questions about the issue but have not focussed on the key issue. What is unique about this event and how does it impact on the design process? | I agree James. 'Forensic' meteorological studies would be most useful. |

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| 124 | Perhaps we could just update our IFDs every 5 or 10 years. They may not change, or only change slightly. We will use the updated IFDs for designs. And if each iteration is rapidly changing (in one direction, more extreme) across specific regions, then we need to consider what next. I am sure many in this call may have explored this in hindcast. And for design further into the future, say 50+ years, perhaps a general rule of thumb (recommended by the profession) of say 10 or 20% higher peak, or xx lower return period, or need to design for yy longer return period. Engineers are used to dealing with these uncertainties!? | Hi Francis - the current edition of ARR was developed with a view to being updated according to the timeframe you mention. Getting the funding required for a future update is not going to be easy. |
| 125 | I am new in IFD curves, but I am wondering if they should include storm types (e.g. frontal, convective,.. storms) in their analyses. I am thinking that their lack of usability can be improved by considering the storm types and also including compound events even with the exisiting data. | To date they haven't included event types but this is an active research area. |
| **126** | I am new in IFD curves, but I am wondering if they should include storm types (e.g. frontal, convective,.. storms) in their analyses. I am thinking that their lack of usability can be improved by considering the storm types and also including compound events even with the exisiting data. | thank you good to know |
| 127 | FFA assumes RANDOM samples. Undertaking a revision of a frequency curve (rainfall or peak discharge) immediately after a major flood or storm is no longer a random sample. I'm pleased to see the beginning of Bayesian analyses. | Also assumes stationarity. Given climatic cycles, are the random sample stationary? |
| 128 | In relation to Cathie's comment - Is freeboard to include uncertainty, or is it to account for wave action? | In relation to Cathie's comment - Is freeboard to include uncertainty, or is it to account for wave action? |
| 129 | Instead of floorboards in floodplains, why can't we have houses on pillers with a standard Height limit. To control dwelling numbers, the number of dwellings on slite can be manadated through Local Environmental Plans. | |
| **130** | We need to communicate flood risk better as well. The 1% chance event (if accurately predicted) has a 26% chance of being equaled or exceed in a 30 year period. | Agreed. # times in the Life of a mortgage, or # times in an 80 year life span are something the community might better understand. |
| 131 | We need to communicate flood risk better as well. The 1% chance event (if accurately predicted) has a 26% chance of being equaled or exceed in a 30 year period. | definitely the most misunderstood part of flooding. |
| 132 | Are there any changes proposed for Floodplain Risk management and flood development controls for councils considering climate change or impacts of these extreme events in future | |
| 133 | It is disappointing to see hydrology and flood experts of this panel don't (can't) answer one single question with confidence. Among all the panellists, I only found James Weidmann who has actually done some preparation for this session. The rest have nothing to add. | Hyrology is based on statistics and also many uncertainties! |
| **134** | It is disappointing to see hydrology and flood experts of this panel don't (can't) answer one single question with confidence. Among all the panellists, I only found James Weidmann who has actually done some preparation for this session. The rest have nothing to add. | Flooding, rainfall, stormwater design deal with “probabilities”. There is no certainty in any of it. the process involves making best guesses based on historical information. Keep in mind that historical data may well be superseded with every subsequent data set when considering climate change. If you want certainty, hydraulics and hydrology is not for you. |
| 135 | | |
| 136 | Given that the flood events are getting more severe and we can't predict natural disasters accurately beforehand, will floor levels still work in the future. | |
| 137 | bridges have a 1 in 2000yr stability check. Does anyone know how bridges held up in the recent events? | bridges have a 1 in 2000yr stability check. Does anyone know how bridges held up in the recent events? |
| **138** | I'm from Lismore and not aware of breach events, just longer duration high intensity rainfall in upper catchment than previous | I'm from Lismore and not aware of breach events, just longer duration high intensity rainfall in upper catchment than previous |
| 139 | Levees don't work in all floodplains. For example, the Hawkesbury has a "Bathtub Effect", any amount of levee will not work here. The Hawkesbury also suffers the impact of overdevelopment from other LGAs as the run-offs flow through the rivers ending up at the Hawkesbury River. | |

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| 140 | There is 7% more moisture in the atmosphere, due to a 1 degree temperature rise. 2 degrees will be 14%. Shouldn't we be looking at how much this means we need to raise the event/probability curves? | ARR2019 has recommendations on how to consider climate change in design. The first step is to consider an increase in rainfall intensity of 5% per degree of temperature increase. This is lower than the clausius-claperyon rate of 7% that you mention Steve but there is reasearch that at the shortest durations increases in some parts of the world could be up to 15% per degree of tempereature increase |
| 141 | There is 7% more moisture in the atmosphere, due to a 1 degree temperature rise. 2 degrees will be 14%. Shouldn't we be looking at how much this means we need to raise the event/probability curves? | Thanks Fiona. Yep, that is what I found in my research |
| **142** | The NSW Government has announced an independent Flood Inquiry in response to recent flood events, with the former Police Commissioner Mick Fuller and Mary O'Kane appointed. The inquiry's ToR include recommendations re floodplain management and potential changes to planning regulations, etc with the panel due to report back by 30 June on the key questions. At the same time, an Update to NSW Floodplain Development Manual (2015) has been updated and is now on public exhibiton. However there is growing concern from a no of communities re the adequacy of data particularly for the Hawkesbury-Nepean and Parramatta River, etc. The provisions in the Updated Manuel suggest that PMF should not be used. From a layperson perspective what feedback can the panel suggest, given there is growing public concerns that the provisions are not adequate given the increase and frequency of events, particularly on flood plains in urban enviroments. | And yet Jeanette, as others have mentioned above, the NSW has a draft Natural Disasters Clause currently on exhibition for possible adoption into Council LEP's to permit re-building of dwellings affected by flooding and bushfire with no apparent regard to flooding or bushfire provisions. |
| 143 | The NSW Government has announced an independent Flood Inquiry in response to recent flood events, with the former Police Commissioner Mick Fuller and Mary O'Kane appointed. The inquiry's ToR include recommendations re floodplain management and potential changes to planning regulations, etc with the panel due to report back by 30 June on the key questions. At the same time, an Update to NSW Floodplain Development Manual (2015) has been updated and is now on public exhibiton. However there is growing concern from a no of communities re the adequacy of data particularly for the Hawkesbury-Nepean and Parramatta River, etc. The provisions in the Updated Manuel suggest that PMF should not be used. From a layperson perspective what feedback can the panel suggest, given there is growing public concerns that the provisions are not adequate given the increase and frequency of events, particularly on flood plains in urban enviroments. | Good question thanks! |
| 144 | A silly question maybe. But there seems to be a fundamental mismatch between observed vs modelled data. As the duration of the event increases, the curve of duration vs depth are not matching with the observed data. Is this normal? The difference will be even greater if one would use non-log for the Y (depth) axis. | |
| 145 | Allan Herring: Question for Danny Rose. The 1893 flood was the flood of record in much of eastern Australia. How did that flood level in Lismore? | Can't answer for Lismore, but in Murwillumbah there were some very big floods in the 1890s. But they haven't been factored in due to lack of data and only anecdotal evidence. |
| **146** | | |
| 147 | | |
| 148 | | |
| 149 | On the discussion of the adequacy of the 1% AEP, I have seen proponents consider different aspects of a project with respect to different AEP events. Should it be a matter of consequence/risk that pushes for a certain flood extent to be used? How would one determine the more appropriate choice? | I think mine has been addressed above, thanks. |
| **150** | One useful thing the profession could do would be to give some guidance on how to include climate change scenarios in to hydrological modelling, water resource and infrastructure planning and design. At the moment, different states use different approaches and different entities within a state use different approaches- often lacking in consistency and coherence. This does not help to build trust and understanding and risks proposals being individually picked off. | Are there some lessons from the way climate change is being considered in wind loading codes? |

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| 151 | Hawkesbury's flood evacuation routes gets flooded and cuts off before even the people can be evacuated. The government need to upgrade the flood evacuatgion routes in the floodplains. | Yes, and likewise further south on the Parramatta River & Parramatta CBD. |
| 152 | Allan Herring: Question for the experts. How many of you have tried to drive down a flooded road during rainfall at 60 mm/hr? Evacuation during extreme events such as the most recent on e is not necessarily a realistic option. | Let alone the panic, screaming kids, uncertainty and barking dog in the back |
| 153 | Agree on that Krey, this has been considered in local area modelling tools for flood action plans for the SES.\ | |
| **154** | NSW SES has been reviewing the flood evacuations routes since the past decade. Nothing has been finalised yet. | |
| 155 | | |
| 156 | | |
| 157 | would you agree that talking in terms of 'AEP' is great when you dont have to talk to the public but maybe not so great for members of public who dont often talk about "probability"? Should we use TAB is paying $X.XX? | I talk in terms of gambling to get communities to understand concepts |
| **158** | | I agree. it would make sense. |
| 159 | with unpredictability of human behaviour in these events how can we then include psychological behavior modelling within hydrological modelling? | with unpredictability of human behaviour in these events how can we then include psychological behavior modelling within hydrological modelling? |
| 160 | | this is the concept of argent based models |
| 161 | Government has too many bureacratic red-tapes, when it come to extreme events and evacuation. For example, during the March 2022 event, people were sitting on roofs for more than 24 hours waiting to be evacuated and the Sydney Helicopters ( more than 20 helicopters in the hanger) were waiting for the government direction. | |
| **162** | As a meteorologist having spent 5 years of my life dedicated to ARR 1987 and PMP, I see the discussion still asking the same types of questions. In ARR 87 we tried to consider more than just the statistics, but looked heavily at the storm mechanisms and impacts on terrain (btw it is not always more intense at higher elevations which is a misinterpretation for short TS storm mechanisms. Also some of the nothern Aust rainfall populations were double….ie TC and monsoonal. Perhaps with climate change, east coast lows can be analysed in a similar way. In ARR 87 we looked for climate chane impacts on IFD and couldn't see a signal, but I assume that if that has/hasn't been done recently, I would consider it would show up above the noise.<br>Fiona is spot on in terms of uncertainly around IFD estimates.<br>Also, the Royal Commission into the Natural Disasters occurring for the 2019-20 tragic bushfires was quite clear on the climate change impacts. Fire experts know the impact and plan for it. We don't need to wait. | Hi Ray - we still couldn't see a clear climate change signal at the time of calculating the new IFDs for durations longer than 12 hours. For shorter durations there aren't many gauges with long enough records to be able to do much trend testing. But there were signficant increasing trends at the shortest durations (e.g. 6 minutes) at those gauges but we just don't have enough data at sub daily durations to be able to include those trends in the IFDs. Also if you only use part of the record, thinking that the older data is no longer valid then you run into issue of more uncertainty in the estimates |
| 163 | With regard to emergency response during a flood event we need well calibrated models that can quickly forecast river levels based on live rainfall and river conditions - who, if anyone, is doing this well? | FloodMapp has been commissioned by govt for mapping in Brisbane |
| 164 | Noted :) I only mentioned given I was deep in asssesing BoMs future climate projections for a location in the Pilbara - I am looking at events within these projections that are well in excess of anything we have historically seen (both in volume and duration). I am not a flood modeller but the uncertainty associated these projected extremes also presents issues in regards to our ability to representlng the future potential risk to the reliability of our sources. | I agree |
| 165 | We have done work using an agent-based model to investigate vehicular flood evacuation from a river PMF across an entire LGA. The model shows how many vehicles can evacuate in time/ how many get caught in floodwaters. The amount of warning time available can be one of the big issues. | |

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| **166** | In going fwd, I strongly agree with Mark's point that the flood industry needs to better consider the outcomes of sensitivity analysis on flood risk planning decisions. All too often we see industry experts undertake sensitivity but make no recommendations to enable the uncertainties/confidence limits to be integrated. As an industry that the community trust to manage their flood related risks, we need to more confidently recommend actions that err on the side of caution when we the know the consequences are unacceptable, especially when the standard 0.5m freeboard is inadequate to manage the risk uncertainty. | |
| 167 | | |
| 168 | Early on there was talk about accuracy of language should we consider a better understanding of "prediction" as we try to provide warnings to communities. Having called 3 evacuations in Lismore because of the high risk posed by a prediction that didn't eventuate I can confirm a lack of understanding of the fact its a prediction not a fact | yes, prediction carries with it uncertainty and there is always a chance of a false warning, so communication plans always carefully consider these factors since too many false warnings and people will start to ignore them. |
| 169 | Transport agencies typically fast track flood investigations to save time and avoid the need to build costly hydraulic structures. Any comments about that? | It is not clear, but there is a large community of hydrologists involved in design that relate back to intensity-frequency-design data derived by the bureau of meteorology. There is always a need to communicate risks clearly and my experience is that designers are neutral and the structure is as big as it needs to be and cost comes later. |
| **170** | Development is very politicised and is seem as a money making system for the government. We are just creating a land use disaster in the floodplains. It should also be noted how developments out of flood plains are affecting the flood events. Too many impervious areas are created and trees are removed as a result of development that reduces the natural soaking characteristics of the soil. Apart from its natural geographic disadvantage, Hawkesbury has become a collateral to the overdevelopment in the Western Sydney. | |
| 171 | Is it time we introduce colour coded road pavements in replacement of signage to educate roads users and locals of flood prone roadways? | Thats a novel idea (I like it), but it could compete with other ideas such as lightening asphalt to combat urban heat islanding...? Flooding could take precedence though... |
| 172 | Regarding rebuilding in flood plains, in Christchurch New Zealand after the Canterbury Earthquakes 2011, significant areas of the city were "Red Zoned" due to the risk of future liquefaction and that the land had settled and made it more flood prone. The insurance companies worked with the goverment to buy out those properties at market rate because it de-risked the insurance companies portfolios and they would rather pay out the full sum insured once rather than rebuild and pay out over and over again. There is an opportunity immediately post disaster before money is spent on rebuilding to buy out these at risk properties so those people are caahed up to move on effectively | Hi Cameron,<br>Spending post-disaster definitely makes economic sense where property is significantly damaged or written off. One factor influenging the difference between NZ post-EQ and AU post-flood would be the insurance landscape. In NZ, the government was contractually "on risk" for a massive loss due to the earthquake insurance pool and their buy-out of a failed insurer, and was therefore able to step in with authority and facilitate the red-zoning. You also had one less level of government. In Australia, the government is not formally "on risk" for private property, and therefore has less skin in the game and less incentive to act with authority. |
| 173 | Regarding rebuilding in flood plains, in Christchurch New Zealand after the Canterbury Earthquakes 2011, significant areas of the city were "Red Zoned" due to the risk of future liquefaction and that the land had settled and made it more flood prone. The insurance companies worked with the goverment to buy out those properties at market rate because it de-risked the insurance companies portfolios and they would rather pay out the full sum insured once rather than rebuild and pay out over and over again. There is an opportunity immediately post disaster before money is spent on rebuilding to buy out these at risk properties so those people are caahed up to move on effectively | Great point Andrew, EQC and the buyout of AMI becoming Southern Insurance did put the Govt and insurers on the same page to never be on the hook again |
| **174** | Thoughts on the fact that the SES Incident Management Centre for the Northern Rivers is being stood up again for the forecast rain event for the end of this week! | |

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| 175 | Should the focus be shifted from modelling to observed flow, e.g., placing level and flow gauges with 5-min or 1-min reading timeupstream from cities and acting upon that information? Also, I believe that an increase in the institutional cooperation between the technical agencies and people on the ground would be the solution for road blocks and localised alerts. | Modelling for design is different to modelling for operational purposes. Any data would be advantageous |
| 176 | | Sure. My question was directed to the discussion around the operational side of things (and saving lives), including the flood alert system |
| 177 | Good question thanks! | |
| **178** | Should we just stick with the frequency descriptor, don't use the statistical terminology for the public? | a return period is a statistical descriptor, not a deterministic period between events |
| 179 | Should we just stick with the frequency descriptor, don't use the statistical terminology for the public? | Yes but the general public dont understand the nuances. Just talk rare/extreme |
| 180 | | |
| 181 | In countries with way less hydrological data (i.e., both temporally and spatially, and particularly in terms of streamflow data), what would you recommend as the first priority (other than getting more data) to address the changing risks of extreme events? | prevent the flood planes ;) |
| **182** | In countries with way less hydrological data (i.e., both temporally and spatially, and particularly in terms of streamflow data), what would you recommend as the first priority (other than getting more data) to address the changing risks of extreme events? | True! :) But unfortunately there are already millions and millions living in poorly monitored flood plains.. |
| 183 | In countries with way less hydrological data (i.e., both temporally and spatially, and particularly in terms of streamflow data), what would you recommend as the first priority (other than getting more data) to address the changing risks of extreme events? | and the next 2 billion people expected till 2050 are not going to live in rich countries... |
| 184 | In countries with way less hydrological data (i.e., both temporally and spatially, and particularly in terms of streamflow data), what would you recommend as the first priority (other than getting more data) to address the changing risks of extreme events? | Develop capacity, for example, trained hydrologists could make good use of satellite derived products. Also, time-bound campaigns could be used to improve calibration of models even though they are only a limited snapshot, and then combine with satellite data. |
| 185 | In countries with way less hydrological data (i.e., both temporally and spatially, and particularly in terms of streamflow data), what would you recommend as the first priority (other than getting more data) to address the changing risks of extreme events? | Building off Michael's suggestion, we can also leverage renalysis data and numerical weather prediction models more and do more evaluation of these products where there is local data. |
| **186** | In countries with way less hydrological data (i.e., both temporally and spatially, and particularly in terms of streamflow data), what would you recommend as the first priority (other than getting more data) to address the changing risks of extreme events? | thanks! |
| 187 | When will the government put an end to concrete slab on ground construction in the floodplain. It is not adaptable and should not be allowed to happen. Only state or feds can make this legislated. | |
| 188 | Do we have to be more prepared for the next La Nina esspecially back to back La Nina's? | In general, there is a need for better preparation. I appreciated the commentary earlier that we cannot really use the term 'unprecedented' and that we should better foresee and plan for these events. |
| 189 | Should we using more of modern technolodgy - IoT, AI, etc., to create a more extensive network of sensors capturing actual rain data and river/creek data in ral time feeding into AI that can quickly alert residents on the need to move and help guide Incident Management Centres | There are many challenges to large events, here a lot of discussion has focussed on planning and design. Real-time data has less value there, but there are good uses for it as you note. We have good radar coverage which gives a detailed picture of magnitudes and we do have ALERT systems based on streamflow. Improving those systems is valuable and so "yes" I agree. How to best harness and manage that data to inform a communication strategy is also something that requires serious consideration, not just 'more data' but needs to be used well to give reliable communication. |
| **190** | Me too, indigenous knowledge can provide longer term data. And we can use models to test the rainfall conditions needed for such an event to occur | yes! i would love to some day come across a catchment floody study where this is possible. we know large flood have happened in the past, and we can see them in the geological record, but if we could use indigenous knowledge about very old floods that would be amazing - though i've never seen it and suspect it would be a rare opportunity. |
| 191 | Me too, indigenous knowledge can provide longer term data. And we can use models to test the rainfall conditions needed for such an event to occur | It is something we are starting to do for groundwater here in NZ - and I think there is huge potential. |

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| 192 | There was some discussion about this, but my two-cents is that they are the best 'current' information and a sigificant improvement over the prior estimates. There will be regional discrepancies, but what is really needed is a production system so they can be updated routinely rather than wait for the next 'big' update. Also, note the discussion about uncertainty, the problem is often under-considered. There was a plot shown earler with a % change by including a new data point, but still *well* within the existing sensitivity limits. Also, Fiona/James commenting now about sensitivity/uncertainty. | |
| 193 | Can you share how the industry should convey to the public what the chance of a 1% event is in their lifetime? When we use the term 1% it sounds very rare and unlikely. Over a lifetime it turns out a 1% AEP event suddenly doesn't seem rare at all. | Chris, over a 70 year perriod, a 1% event has a 1 in 2 chance of occurring and a 1 in 6 chance of occurring twice |
| **194** | | There is a 53% chance that a 1%AEP flood will be exceeded in our lifetime (of, say, 75 years). It is a 63% chance in 100 years. So really, it would be surprising if we didn't see one! |
| 195 | | Yep. This is exactly what I'm refering to. the industry need to frame things in this manner during flood education so it is more easily understood by the public. |
| 196 | | I frame it in the 30 year morgage timeframe for my friends when they ask me for advice - that works well |
| 197 | if you dont disregard thr early data then we are understating current risks and overstating our confidence. Both have predictable results aka repeating past mistakes. | |
| **198** | Seems that we have nowhere near the data we need so, as an engineer, should we apply the precautionary principle and lift our curves 15% per degree of warming? | I think we have an abundance of data - the bigger problem for us is how we use it in decision making. |
| 199 | How long or how many floods will a building structure in a floodplain sustain before it will fail? Given the cost of building a house and if additional flood sustainable materials are used then the cost goes up. So most houses in the flood plains are just normal buildings. | |
| 200 | Martin, what are the recommendations of your project in giving the river to flow? | Don't build in winterbeds of the rivers. Moving housing away from the rivers. |
| 201 | | And perhaps re-engaging floodplain wetlands? |
| **202** | Yes, there are many uncertainties, and another useful role for the profession to help the planners and decision makers better understand those uncertainties and what they mean for outcomes to be achieved. Not all climate and hydrological uncertainties lead to the same extent of outcome uncertainties. Understanding that also helps the decision makers consider whether more money should be invested in trying to reduce an/or better understand those uncertainties and explain them | |
| 203 | Hi Krey, to give an answer to Martin's question, I worked on a conceptual study for nature based solutions at lismore looking at getting floodwater out of the channel and into floodplain wetlands further upstream. The idea of the study was to look at attenuating events <5%AEP. for an event of this magnitude I dont think it would be possible given the volumes of water we are talking about. | |
| 204 | | |
| 205 | http://australiasevereweather.com/floods/lismore_flood_pictures_reports.htm | |
| **206** | there is an undiscussed link beween floodplain mgmt and wildlife habitat magement | |
| 207 | Thanks Ball et al | |
| 208 | Great Webinar! Thank you All. | |
| 209 | thanks | |