Defending Fairbourne Costs Less Than Surrender

Stuart Marsh May 2022

- " Improving the resilience of communities at risk of flooding now and under climate change scenarios is a priority for planning authorities."

  Technical Advice Note 15 Development, flooding and coastal erosion. December 2021 Section 13 'Resilience':- 13.1

- "It is particularly important that we protect homes from flooding, when we know the devastating impact it can have on health and well-being. This Government is committed to protecting more than 45,000 homes at risk of flooding this term, while planning policy and decisions will determine whether or not new homes are placed in areas at risk of flooding"

  Julie James, Minister for Climate Change:- letter to Local Authority Chief Executives and Heads of Planning...23/11/2021

Defending Fairbourne Costs Less Than Surrender

A Plan For Fairbourne's Future

Executive Summary

An investigation, carried out by the civil engineering company Royal Haskoning, reached the conclusion that Fairbourne is at serious risk of flooding due to climate change and sea level rise. A decision was taken by Gwynedd County Council to abandon and demolish the village within the next 30 years, with all residents forced to move elsewhere.

The report produced by Royal Haskoning, published in 2018, painted a very bleak picture of Fairbourne's future. This was picked up by various news media who published articles claiming that Fairbourne's residents would be the UK's first "climate refugees". This theme was also taken up by several TV programmes and even inspired a Radio 4 play. The resulting planning blight on the village has been seriously affecting the people who live in Fairbourne. In late 2021 a local expert on climate and flooding became aware of the gravity of the situation and offered to look again at the threat posed by climate change. Following field work and detailed computer modelling, a new report is now available which offers a realistic and optimistic view of Fairbourne's future. Demolishing a perfectly viable village would be an expensive knee-jerk reaction to an alarmist report when for a modest cost Fairbourne can be kept safe for the foreseeable future.

Contents

Appendices

West Wales Shoreline Management Plan - The View From Fairbourne

(It should be noted that The Shoreline Management Plan -SMP- is not a statuary document)

The policy put forward in the West Wales Shoreline Management Plan 2:

"...relocation of property owners and businesses from Fairbourne"

was clearly a red flag. A red flag that pointed to a totally unacceptable impact on the people of Fairbourne, and even without a leap of imagination, pointed to the fact that this would be a situation that, politically, could only ever be portrayed as a negative.

It is not the function of a bureaucracy to question received wisdom but rather to be informed by it. Gwynedd therefore acted on the report's recommendation and did not question the data used by the report's authors. Best practice would be to request a peer review with a brief to seek out the most up to date studies and specifically to include those relating to the hydrology of the Mawddach Valley from its headwaters to its estuary.

That there was no impact study is regrettable, especially so since the concept of Planning Blight has been well established for the last 6 decades:

> *Planning Blight. N (Government, Politics & Diplomacy) the harmful effects of uncertainty about likely restrictions on the types and extent of future development in a particular area on the quality of life of its inhabitants and the normal growth of its business and community enterprises.*

However, given that this policy was presented to the people of Fairbourne by Gwynedd as a decision to cease to defend the village from flooding and to decommission it at some point in the future, it does not take an impact report to see its effects.

Whilst the impact can be seen in monetary terms - a 40% drop in property values - it is more accurately measured in crushed hopes and smashed plans.

> *" At the start of the SMP process Royal Haskoning DHV, building on their long term association with the Welsh coastline, gathered all existing data for the area. The team then conducted in-depth analysis of coastal processes, examining existing defences, the surrounding environment and land use issues – all essential elements to develop the required level of understanding"*.
>
> Emma Moses, Director Water, Royal Haskoning DHV UK.

The two crucial points made by Emma Moses are, firstly that Haskoning used existing data. From this it can be legitimately inferred that there was no budget for original research, that off the shelf data was used. This data has been superceded by current research . Secondly, Haskoning's plans and proposals were made prior to the 2016 works carried out by Natural Resources Wales. Put simply, an expert using flawed data will reach flawed conclusions and make flawed proposals..

In summary, it is probably true to say that Fairbourne has been the victim of good intentions.

For all the above reasons Arthog Community Council has commissioned a pro bono report to:

A) Evaluate all the potential causative risks of the flooding of Fairbourne. Specifically risks from the sea, from the estuary, from the rivers Henddol and Morfa and within the coastal lowland at Fairbourne.

B) Present proposals that would cost effectively defend Fairbourne. Specifically proposals that meet all the risks up to and beyond 2065 and which will also form a foundation that can be built on to meet any future challenges.

A peer review of the report was also commissioned.

2. Profile of report author Dr Graham Hall

Graham Hall graduated from Aberystwyth University with a B.Sc. degree in geology and chemistry, and has taught computer science for many years at Coleg Meirion-Dwyfor in Dolgellau. During this time he developed a research interest in the physical geography of North Wales. He completed a Master of Mathematics degree specialising in fluid dynamics, then progressed to a PhD research project at Bangor University, undertaking meteorological and hydrological modelling of the Mawddach river catchment.

During this project, he presented papers at a number of international conferences. Of particular relevance to issues of flooding in Fairbourne were: a paper on rainfall patterns over the Welsh coastal mountains, given at a meeting of the American Meteorological Society in New Orleans; and a paper on tidal flows in the Mawddach estuary, given at the International Conference on Estuary Hydrology held in Guangzhou, China.

After retiring from teaching, he is now writing a text book which examines the use of general systems theory and mathematical modelling in geomorphological research. He is a Fellow of the Geological Society and Chartered Mathematician.

For a full list of Dr Hall's papers and publications please see appendix 1.

3. Summary Of Risks And Commentary

Current and future flood risks to Fairbourne, up to and beyond the year 2065:

Risks from the sea

Discussion:- Designing for projected sea level rise:- The Welsh Government publication “Adapting to Climate Change” August 2021 advises sea level rise at year 2100 of 0.76 to 1.03 metres. It should be noted that this is based on the most extreme projection of the worst case scenario. That is the most extreme projection for a scenario where there is no mitigation efforts to reduce

greenhouse gas emissions. Whilst this is a logical criterion for new development, when considering flood defences, in situations where it is possible to take an Adaptive Engineering approach, it is more realistic for it to be taken as a goal. Adaptive Engineering is the approach whereby engineered defences are designed so that they can form the foundation for further works to meet increased challenges. Given that the 'most likely' projection for sea level rise, does not give a rise of 1.1 metres until around 2200, it may be seen that it is more cost effective to defend for the most likely scenario whilst building in adaptive capacity.:- Projections are based on United Kingdom Climate Projections 2018 Marine Report.

- The shingle storm beach in front of Fairbourne village is stable, and north of the village it is slightly increasing in volume. The mass of the storm beach is enormous, and the sea wall is in satisfactory condition. There is a negligible risk of failure during the current century.

- Marine erosion is taking place to the south of Fairbourne at Friog, A breach of the sea wall occurred at Friog, but was to some extent caused by previous excavation of the landward side of the shingle bank to provide flat ground for a group of huts. The sea wall has been rebuilt and now provides a good degree of protection. It is recommended that the landward profile of the shingle bank be restored by replacement of the shingle.

- There is currently no risk of failure of the sea defences south of Fairbourne. In the extremely unlikely event of a future breach in the sea embankment, any flooding would be localised to the agricultural land south of the village.

- Some measures are recommended to protect the section of coast between Friog and Fairbourne village from further coastal erosion. Possible methods include: the addition of rock material to the storm beach; or the construction of groynes or an offshore reef to stabilise the beach and allow sediment to accumulate naturally.

- Wave overtopping in front of Fairbourne village is negligible.

- Some wave overtopping may occur between Fairbourne and Friog, and could potentially cause localised surface water flooding. This problem could be avoided by raising the height of the sea wall by one metre over this section of the foreshore. Allowing for sea level rise, this work might be advisable by the year 2040.

Risks from the estuary

- The estuary flood embankment between Fairbourne and Morfa Mawddach has recently been strengthened and provides good protection from high tidal levels in the estuary.

- Field observations and hydrological modeling have shown that floods on the rivers Mawddach and Wnion at the head of the estuary cause no increase to maximum tidal levels at Fairbourne, and may be discounted as a flood risk.

- Allowing for sea level rise, it might be advisable to increase the height of the estuary embankment by one metre over the section between Fairbourne golf course and the proposed new flood embankment to the east of the village. This work may be necessary by the year 2040.

Risks from the rivers Henddol and Morfa

- The river Henddol drains hills above Friog. It descends to the coastal plain, and has been diverted around Fairbourne to reach the estuary north of the village.

- In the proposed flood protection scheme, the Afon Henddol would be redirected eastwards away from the village. A new flood embankment would remove any flood risk due to this river.

- The Afon Morfa drains hills above Ynysgyffylog. It crosses the coastal plain to the estuary, and can cause flooding of farmland during storm events. The proposed flood embankment would protect Fairbourne village from any risk of flooding from the Afon Morfa.

- Steps could be taken to reduce flooding from the Afon Morfa by increasing the cross section of the river channel, and the discharge capacity of the estuary tidal gate.

Risks within the coastal lowland at Fairbourne

- The soils of the coastal lowland at Fairbourne are generally well drained, with a high sand content. The village drainage ditch network currently handles storm rainfall effectively, so there is little risk of surface water flooding.

- The proposed flood protection scheme would greatly reduce the risk of surface water flooding by eliminating any possible overflow from the Afon Henddol

- Water will inevitably enter the Fairbourne flood protection area during storm events. This will be from direct rainfall, and from some wave overtopping at the highest tidal level. The village drainage ditch network, combined with a proposed interception pond, can handle the maximum predicted volumes without surface water flooding affecting the village.

- Some groundwater flow occurs beneath the sea wall and estuary embankment at high tide, but the effect on the water table beneath the village is very small. Even allowing for sea level rise, this is unlikely to cause any surface water flooding.

Commentary on the publication 'Fairbourne Preliminary Coastal Adaptation Masterplan'

produced by Gwynedd County Council and based on data provided by the civil engineering company Royal Haskening:

- *'Fairbourne village has been developed over a low lying area at the mouth of the estuary, backed by steeply rising land; there is no opportunity for roll bock of the community, with little or no opportunity for local protection to property or partial set back of defences; there is little scope for more traditional approaches to adaptation.*

There is an immediate risk that must be managed, resulting from a combination of risks, including coastal change and coastal flooding, tidal and fluvial risk, surface and ground water.'

The current flood risk to Fairbourne is actually very low. The shingle storm beach provides an excellent natural defence, and the sea wall and estuary embankment are in good condition and of adequate height.

- *'The scale of change — The risk affects the whole community. At present any failure in the defences could result in total inundation of the village, with substantial risk to life and major economic damages.'*

The risk to Fairbourne is being massively exaggerated. The chance of catastrophic failure of the sea defences is negligible. Even in the extremely unlikely event of such a failure, water would enter the village drainage network and there would be very little risk to residents.

- *'Much of the village is built to land below the level of a 1 in 1 year tidal event. In the future much of the area would be below normal tidal levels. There is a continuing need to manage the present risk and a need to adapt to future risk.'*

This is not a problem. The natural shingle storm beach, the sea wall and the estuary embankment protect the village at high tide. Sea defences carry out this function in many low lying coastal regions of the world, perhaps most notably in the Netherlands.

- *'Beyond 2055, the costs increase significantly. The initial tranche of improvements (including the potential need to address tidal locking issues associated with fluvial and ground water), amounts to an additional cost in the order of £53,000,000, with further costs in the order of £51,000,000 to maintain defences over 100 years. The combined works to provide protection over 100 years have been estimated to be in the order of £115,000,000.'*

Costs of flood defence works have been massively exaggerated. The village of Fairbourne can be effectively defended by construction of a new flood embankment, re-routing of the Afon Henddol, and a modest increase in height by 1m of some sections of the sea embankment and estuary embankment. The total costs of these works are unlikely to exceed £10 million.

- *'Over the longer term, it will be less likely that fluvial (river) flows are able to drain during a tide over low water (i.e. tidal locking), affecting surface and groundwater. Water may need to be pumped away from the area.'*

This problem is easily solved. Predictions of sea level rise indicate that natural drainage from Fairbourne into the estuary can continue until late this century. If pumping is then needed, the necessary power could be generated locally from renewable sources such as wind or tidal turbines.

4. Summary Of Peer Review

Dr Graham Hall has produced a thorough report on the risk of flooding Fairbourne Village. It assesses the current protection in place as well as putting forward relatively low-cost alternative additions. Compared to the current suggestion of a village re-location, these additions would be more cost effective and have the advantage of using natural processes to gain considerably greater protection. Supplementary measures include reinstating the drainage ditches and upgrading the tidal gate, which will have additional advantages for the adjacent agricultural land. The measures suggested would not impact on the local SSSI Arthog bog. Other measures such as reducing wave energy with use of groynes or an offshore reef are again comparatively low-cost and known to be an effective approach.

The author has run data for a range of scenarios in support of the proposed additions, and the models have been well designed and based on worst case conditions. The suggested additions would provide effective protection at least until 2065 and likely well beyond.

On the other hand, the proposed relocation of Fairbourne village is heavily reliant on model predictions rather than evidence-based data. Figures and tables of data purporting to support the predictions are stated as fact but not evidence based. Use of terms such as 'may', 'might', 'potentially', 'could', 'perhaps' and 'suggests' are used liberally in the reports and documents that make these predictions. The terminology used are indicators of a level of uncertainty that is not being considered with decision making. The tidal flood data from 2011 used in the decision-making was again from models without real world testing, and consequently lacks precision. This report is out of date since the 2016 flood alleviation work, so no longer relevant.

The most interesting and relevant findings from Dr Hall’s report was that the risk to the village is not from sea level rise or extreme storm surges but from surface runoff from heavy rainfall events inland. Hall's report takes this into account and has covered all flooding issues. The main flood risk area is the caravan park to the south of the village at the Friog corner where there is evidence of erosion, and caravans are, by definition, homes that are mobile.

The range of alternatives presented in the report are all viable approaches. One or several of these would significantly reduce flood risk to the village and therefore a managed retreat is an unnecessary action.

5. Conclusions And Recommendations From Dr Hall's Two Reports

It would be technically feasible to protect the village from further flooding until the year 2065 and well beyond.

The cost should be reasonable, as most of the required infrastructure is already in place and in a good state of repair.

Flood modeling for the period up to the year 2065 should allow for a sea level rise of 0.5m compared to the present day, and a possible storm surge height of 2.5m to allow for increased storm intensity due to climate change. This represents the worst case scenario,

NB: Gwynedd's decision to, at some future date, decommission Fairbourne is invalidated for the following two key reasons

- The flood models for Fairbourne published by Royal Haskoning (2012) and Robbins (2011) are considered to now be invalid.

- The models take no account of the flood alleviation scheme carried out by Natural Resources Wales in 2016 which has very significantly reduced the flood risk from the Mawddach Estuary and from the Afon Henddol.

The village of Fairbourne remains at some risk of flooding from rivers and streams which descend from the hills and cross the coastal lowland to reach the estuary. A new flood protection boundary is proposed for Fairbourne which would exclude the Afon Henddol and other streams, eliminating the risk from river flooding.

The full proposed flood protection boundary would be made up from the existing sea defences and estuary embankment, the railway embankment, and a new section of embankment which would be constructed across agricultural land between the railway and the estuary.

The majority of the proposed flood protection area in and around Fairbourne village is underlain by estuary deposits of mixed sand and clay. This material drains reasonably well after a rain storm, so surface water flooding is not a problem. Modeling by Buss (2018) predicts that the extent of surface water flooding is unlikely to increase in the period up to and beyond 2065.

A small area in the south of the proposed flood protection area at Friog is underlain by peat. This material has poor drainage properties and is likely to become waterlogged after heavy rain. The area is currently occupied by a mobile home park. If an opportunity exists to relocate the mobile homes to a field further north underlain by estuary sand and clay, it is recommended that this is done.

The ground elevation of Fairbourne village and the surrounding agricultural land is approximately at the level of the maximum spring tide. This is not of immediate concern, since the storm beach and sea wall extend for 4.5m above this level, and the estuary embankment extends for 2.8m above this level. These structures currently provide adequate protection for the village against sea and estuary flooding.

The Ro Wen shingle spit in front of Fairbourne village is currently stable. Observations and modeling by Phillips et al. (2017) predict no significant changes to the storm beach profiles up to and beyond the year 2065.

To the south of Fairbourne village at Friog corner, coastal erosion has actively eroded the storm beach. This led to the failure of the sea wall and inflow of sea water. The sea wall has now been repaired and substantially strengthened by Natural Resources Wales, and is providing effective protection from flooding. However, there is a continuing problem of coastal erosion at this location.

It is recommended that actions be taken to reduce or prevent erosion by the regular addition of rock material in front of the sea wall, or by the construction of beach groynes or an offshore reef to encourage natural deposition of beach sediment.

Overtopping of the sea wall by storm waves is not a significant problem, and is seen only to the south of Fairbourne village. Further north, the storm beach is better developed and provides effective natural protection against storm waves. Modeling indicates that this situation is unlikely to change in the period up to and beyond 2065. In the unlikely event that climate change leads to storm wave overtopping in front of Fairbourne village, it would not be a major engineering task to locally raise the height of the sea wall by a modest amount such as one metre.

The estuary embankment to the north of Fairbourne village has recently been reconstructed by Natural Resources Wales, and provides good protection from estuary flooding. Modeling indicates that the embankment height will be adequate up to the year 2065, but sea level rise may then require the height to be raised by one metre to ensure that no overtopping will occur.

The south eastern boundary of the proposed Fairbourne flood protection area would be formed by the embankment of the railway. Although descending to only 2 metres above the elevation of Fairbourne village, modeling indicates that this would be adequate to prevent any inflow of water from the surrounding fields.

The Afon Henddol runs alongside the railway embankment for part of its course in a large channel constructed during the 2016 flood alleviation work, and at other points the river banks have been raised and strengthened. The river is not expected to present any flood risk to Fairbourne village.

Between Friog and Fairbourne, four small culverts carry streams underneath the railway embankment. In the proposed scheme, these culverts should be blocked to prevent any risk of flood water inflow to Fairbourne village during a storm.

Work would be carried out to construct a new embankment to the east of Fairbourne village, linking the railway with the estuary embankment. For part of its course, this would run alongside a series of flooded pits, dug during the 2015 flood alleviation scheme to provide clay for the construction works. The new embankment would have a similar height and profile to the estuary embankment.

The Afon Henddol would be re-routed across agricultural land to the east of Fairbourne to reach the existing tidal gate of the Afon Morfa, This gate allows discharge of river water at low tide, but closes to prevent inflow of estuary water when the tide rises. It will be necessary to increase the capacity of the tidal gate to allow for the higher volume of flow of the Afon Henddol. This might be done by reconstructing the existing estuary outfall, or by building an additional floodgate through the estuary embankment nearby.

The Fairbourne flood protection area will generally be isolated from surrounding bodies of water, but water may enter due to direct rainfall or occasional overtopping by sea waves during a storm. This water will be conducted through the existing network of drainage ditches in and around the village, to reach the tidal gate alongside the golf course where it will discharge at low tide into the estuary. The tidal gate will have more than adequate capacity up to 2065 and beyond, since it was designed to handle much larger flow volumes from the Afon Henddol.

It is proposed that the area of clay pits alongside the new embankment will be developed as a water retention pond. This would act as a buffer for temporary storage of flood water during periods of high tide when discharge into the estuary is not possible. The retention pond would be connected directly to the existing drainage ditch network.

Modeling indicates that the current network of drainage ditches, linked to the water retention pond, would allow the effective discharge of water into the estuary through the flood gate under the worst case storm conditions predicted for 2065. No surface water flooding is expected within the village or surrounding fields.

Excavation of the water retention pond will provide clay, whilst excavation of the new channel for the Afon Henddol to the tidal gate will provide sand and clay estuary deposits. These materials should be suitable for use in the construction of the new flood embankment.

6. Discussion Of Time Scale

A key outcome of Dr Hall's analysis is that the proposed interventions can be implemented over time. Thus the proposals are not of necessity a single, one off project that would normally be contracted out to an engineering firm. Also they do not of necessity fall into one budget period.

Furthermore most of the proposals can be implemented by Welsh government agencies such as Natural Resources Wales, specifically the works needed to protect Fairbourne from hillside run-off, and Gwynedd agencies such as the highways authority, specifically the creation of the French drain to run along the side of the road parallel to the beach.

Considering the infrastructure dealing with hillside run-off, it is important to look at the timescale for maintenance. In relation to this it is important to be realistic about the impact of years of imposed austerity and cuts. All organisations strive to continue to function despite adverse conditions, in this instance a reduction in resources. Thus NHS nurses frequently work unpaid overtime and maintenance schedules get extended. The drainage network in Fairbourne needs to be routinely maintained. In order to ensure this is carried out cost effectively, an option for consideration is to sub contract routine maintenance to a contractor within the Fairbourne/Arthog area with overview from the Community Council. This would eliminate such overheads as transport to the site and should ensure a quick response to problems as they arise – in itself a cost saving.

For a more in depth understanding of timescale please refer to the report 'Protection of Fairbourne village from flooding' pages 52 – 53 'Monitoring and maintenance in the period up to the year 2065 and beyond'

Full Reports

1. Report part 1: Protection of Fairbourne Village From Flooding
   Graham Hall. December 2021.

2. Report part 2: Investigating the Protection of Fairbourne Village From Flooding.
   Graham Hall. January 2022.

3. Peer Review: Refereed Report: Protection of Fairbourne Village From Flooding. Dr Graham Hall
   Dr Veronica Edmund-Brown

All reports may be accessed at Dr Graham Hall's website:

www.grahamhall.org/fairbourne.html

7. Fairbourne and Barmouth:- projections of sea level rise ranges and timescales and their impact on policy

It would seem that the guidance on sea level rise that is given in the Welsh government publication *'Adapting to Climate Change*' Table 4 has lead to very problematic misinterpretations and assumptions.

One example is this quote from Lisa Goodier, who, at the time she was interviewed, was responsible for Gwynedd Council's planning for the decommissioning of Fairbourne. Published in The Guardian May 18/2019 referring to decommissioning the village of Fairbourne she states:

> *"Based on the current rates of sea level rise, we are planning to start in 2045"*

The current sea level rise as measured by tidal gauges around the world, together with satellite information, is shown to be from 3.2 millimetres to 3.7 millimetres per year that would mean a rise from 2019 to 2045 of 83.2mm up to 96.2mm.

> **So a high of approximately 3¾ inches.**
>
> **Clearly a minimal threat to Fairbourne.**

Lisa Goodier and Gwynedd Council have taken the hypothetical projection prescribed in *'Adapting to Climate Change*' as a reliable prediction. The key reason that the guidance in *Adapting to Climate Change* has had a misleading impact on the discussions about the future of Fairbourne, is that the projection selected by the Welsh government for sea level rise is based on the scenario where green house gas emissions carry on unabated – no Paris agreement or other initiative - so no action for mitigation is taken.

This together with the fact that only the extreme end of the projection range is used..... It is based on the worst outcome of the worst scenario.

(NB: It should be noted that in the West Wales Shoreline Management Plan 2, the recommendation for North Barmouth is 'Managed Retreat' from 2055, meaning that it will be abandoned to the sea from this date.)

The Projections

The 2018 report from the Met Office UKCP 18 (UK Climate Projections 2018) produced a range of projections for future sea level rises related to different scenarios or sets of data, the most significant, or most indicative, of which is green house gas emissions, specifically CO_2.

The relationships between various CO_2 levels, their impact on global warming and outcomes are complex. The UKCP 18 report uses the term Representative Concentration Pathway (RCP) to summarise and present their findings and relates a range of predicted sea level rises to them.

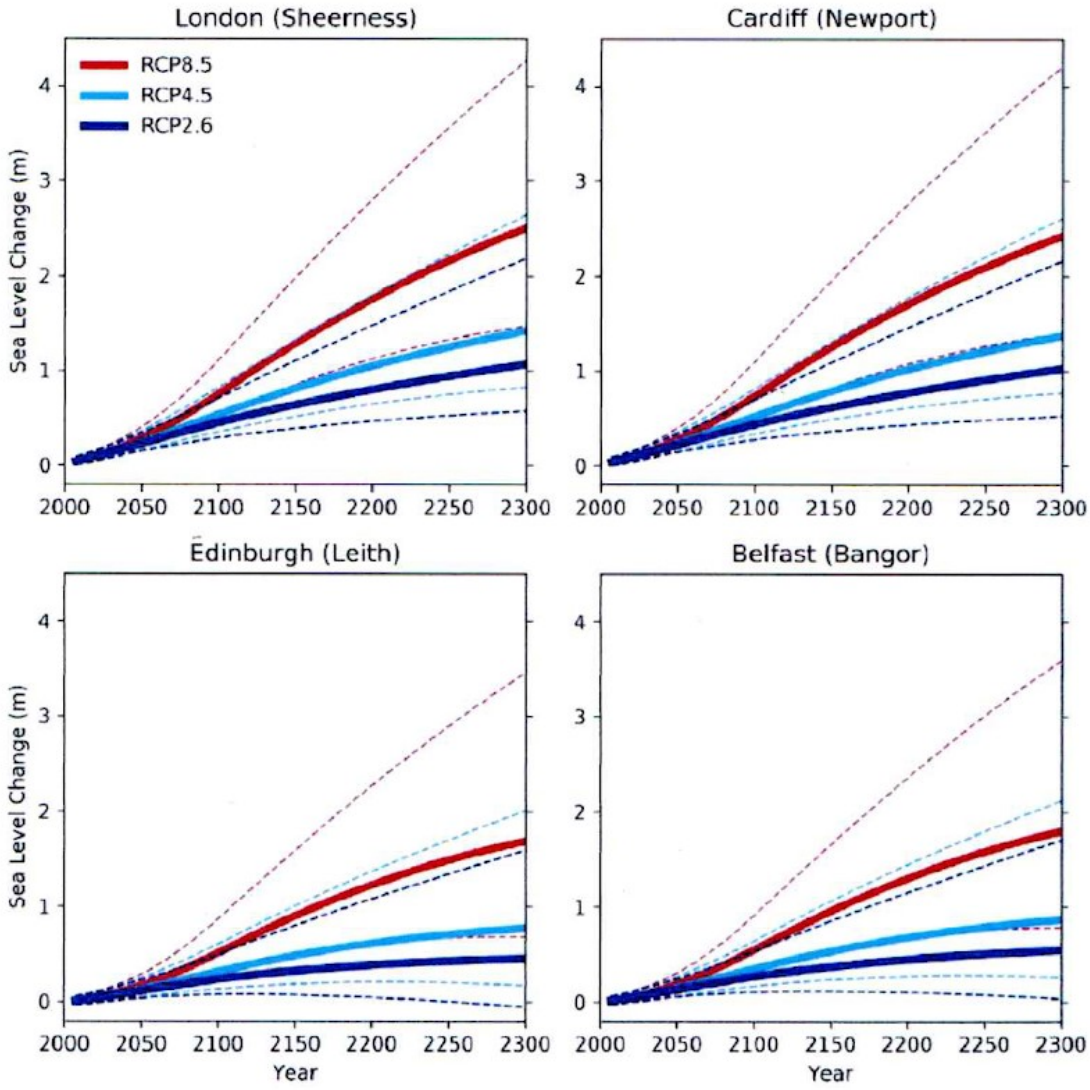

Figure 4.2.3. Time series of the time-mean sea level change for UK capital cities, based on the nearest class A tide gauge location (indicated in brackets). The solid lines indicate the central estimate and dashed lines indicate the range for each RCP as indicated in the legend. All projections are presented relative to a baseline period of 1981-2000.

In the above graph the worst outcome of the worst case scenario, as chosen by Gwynedd Council and the Welsh Government, is shown as the dotted red line. That is the upper limit of RCP 8.5

Fortunately the RCPs can be related to concentrations of CO_2 in the atmosphere and so can easily be monitored. This together with ongoing tidal gauge readings , means that one can plan for, and adapt to, what is actually happening.

It should be noted that a far-sighted Adaptive Engineering approach is necessary from the outset.

RCP2.6.....421 parts per million (PPM)

RCP4.5.....538 ppm

RCP6.0.....670 ppm

RCP8.5.....936 ppm.

NB:-The current concentration of CO_2, measured at Mauna Loa observatory Hawaii in March 2021 was 417.14. But it is continuing to rise.

'Adapting to Climate Change' uses the most extreme scenario for sea level rise and the highest, but less likely, of the projection range.

Very significantly the guidance given to Risk Management Authorities (RMAs) in Wales, referring to table 4, is that these figures for sea level rise should be used.

> *"RMAs should use the relevant allowances in their scheme appraisals to help inform their investment decisions"*

The most likely projection, as considered by the Met Office, based on the assumption that by the end of the century green house gas emissions will stabilise and start to fall, is shown in light blue. The most likely part of this projection is shown in the solid light blue line.

Looking at the graph for the year 2100 it is easy to see that the extreme projection is around 3 times greater than the most likely projection which has the far lower value of less than half a metre... < 0.5m.

It may seem sensible to take the worst case scenario as a basis for planning to meet the challenge of rising sea levels. However, when this hypothetical projection is applied to the real world, it becomes apparent that there are two components to the projection which have very different impacts on planning and associated outcomes.

Firstly: The Absolute or Target Rise in Sea Level:- The increase in sea level by 2100, as given for this projection as shown in table 4 of Adapting to Climate Change, is, for the top of the range, 1.03 metres. For 2120 it is 1.23 metres (The Welsh Government has advised to work to 1.1metres.)

To put it simplistically you build a wall at least 1.1 metres higher than existing defences...

But you could err on the side of caution and build it 2 metres higher. In reality it may take 200 years for sea rise to reach these levels but then nothing is really lost, the communities being protected are safe and have not been negatively affected. So it doesn't really matter that the projection was not what actually happened as the communities were protected anyway.

Secondly: Rate of Sea Level Rise:- Unlike the target/absolute rise, the difference between a hypothetical and actual rate of rise has a dramatic affect on the timescale for planning. With a hypothetical rate approximately three times that of the actual rate, the timescale for action is dramatically shortened and has lead to the disaster policy of decommissioning Fairbourne.

GIVEN THE PROBLEMS AS ANALYSED ABOVE, IT IS THE MORAL DUTY OF THE WELSH GOVERNMENT TO JUSTIFY ITS CHOICE OF THE WORST CASE SCENARIO AS A MODEL FOR ADAPTION TO CLIMATE CHANGE.

WORKING TO THE MOST LIKELY PROJECTION MEANS THAT THERE IS TIME TO COMPLETLY RETHINK AND DEVELOP THE WELSH AND UK GOVERNMENTS' APPROACH TO CLIMATE CHANGE ADAPTION.

Conclusion

It is instructive to consider this quote from the Intergovernmental Panel on Climate Change:-

Predictability in a chaotic system. (IPCC TAR 2001 14.2.2)

> *"The climate system is particularly challenging since it is known that components in the system are inherently chaotic, there are feedbacks that could potentially switch sign, and there are central processes that affect the system in a complicated, non-linear manner.*
>
> *These complex,chaotic, non-linear dynamics are an inherent aspect of the climate system. In climate research and modelling, we should recognise that we are dealing with a coupled non-linear chaotic system, and therefore that the long-term prediction of future climate states is not possible."*

There are several points to take from this:-

A. Any government or authority making a prediction, on any component of the results of climate change, should do so with humility and welcome constructive criticism and alternate analysis with the aim of achieving the best outcomes.

B. Any strategy, any plan, must allow for uncertainty: to coin a phrase, to 'plan for change changing'.

C. Any strategy should , given that uncertainty means that there is no one approach that can be relied on for best outcomes, be multi faceted, multi disciplinary, multi dimensional, and always take into account the wider situation beyond any localised plan.

THE PEOPLE OF FAIRBOURNE ARE NOT CLIMATE CHANGE DENIERS, THEY ARE NOT A BUNCH OF KING CANUTES.

THEY WANT SOUND SCIENCE, AN HONEST AND OPEN APPROACH AND THE OPPORTUNITY TO GENUINELY COLLABORATE.

APPENDICES

1:- Dr Hall's research papers and publications

2:- Julie James, Minister for Climate Change:- letter to Local Authorities
23 November 21

3:- Technical Advice Note 15 Development, flooding and coastal erosion December 2021:- Section 13 Resilient Design.

1:- Dr Hall's research papers and publications

- Hall G. and Cratchley R., 2005.
  Modelling frontal and convective rainfall distributions over North Wales. Proceedings of the 2005 WRF/MM5 User's Workshop, National Centre for Atmospheric Research, Boulder, Colorado.
- Hall G. and Cratchley R., 2005.
  The role of forestry in flood management in a Welsh upland catchment. Proceedings of the 45th Congress of the European Regional Science Association, Amsterdam.
- Hall G. and Cratchley R., 2006.
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2:- Julie James :- Letter to Local Authorities.

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To
All Local Authority Chief Executives
All Local Planning Authority Heads of Planning
23 November 2021

Dear colleagues

Technical Advice Note (TAN) 15: Development, flooding and coastal erosion

Flooding is the clearest evidence of the impact of climate change on Wales. The threat is already present and will increase in both severity and frequency, with a predicted sea level rise of approximately 1.11metres and an increase in rainfall intensity causing increased peak river flows of between 20% and 30% by 2120. In response to climate change the Welsh Government and many local authorities have declared climate change emergencies.

Given the immediate and serious challenges posed by the climate emergency, a 'business as usual' approach to delivering for our communities and economy is no longer a viable option. Taking meaningful action to address climate change will mean taking difficult and sometimes unpopular decisions. For anyone who remains unconvinced, the COP26 summit has demonstrated the severity of the worldwide situation, and the need for practical actions to mitigate the impacts of climate change and adapt to its inevitable consequences.

The planning system is at the forefront of responding to the climate emergency and ensuring the well-being of current and future generations. The decisions local planning authorities make today will have a profound effect on how we adapt to climate change now and in the future. To ensure the planning system plays a full part in adaptation to climate change a new version of TAN 15 was made available on 28 September 2021, in advance of its coming into effect and formal publication on 1 December. The new TAN 15 is accompanied by the Flood Map for Planning, which builds on the Flood Risk Assessment Wales map and includes allowances for climate change. On their publication, they will replace the 2004 version of TAN 15 and the Development Advice Map (which does not include climate change allowances), as well as Technical Advice Note 14: Coastal Planning.

TAN 15 and the Flood Map for Planning take us in the right direction, towards a more resilient society and economy. It is particularly important that we protect homes from flooding, when we know the devastating impact it can have on health and well-being. This Government is committed to protecting more than 45,000 homes at risk of flooding this term, while planning policy and decisions will determine whether or not new homes are placed in areas at risk of flooding. The Flood Map for Planning represents a markedly different context for planning decisions compared to the existing framework which must inform the planning system. The new TAN has the potential to impact on a variety of development schemes at different stages of the planning process. These include flood defence schemes whose funding is reliant on gaining planning permission this financial year, and projects that support town centres to recover from the Covid-19 pandemic.

To enable local planning authorities to consider fully the impact of the climate change projections on their respective areas, I am **suspending the coming into force of the new TAN 15 and Flood Map for Planning until 1st June 2023.** The existing TAN 15, published in 2004, and the Development Advice Map will continue in the meantime as the framework for assessing flood risk. Policy 8 of *Future Wales – the national plan 2040* provides the context for local authorities to consider the impact of flooding on national and regional growth areas and devise appropriate mitigation strategies. It is imperative that local planning authorities use the suspension to develop a more detailed understanding of the consequences of flooding, and therefore **I require every local planning authority to complete work to review, within the next 12 months, the Strategic Flood Consequences Assessments (SFCAs) for their area, either individually or on a regional basis**. I also require each local authority, working in partnership with other flood risk management authorities where appropriate to identify a pipeline of priority flood risk management schemes to address flood risk and vulnerability, as well as an assessment and specific assurances on the effective delivery of SuDS Approval Body functions. This work must be informed by the Flood Map for Planning and a full range of climate change projections to provide a finer grain assessment of the consequences of flooding, identify appropriate mitigations and to refine the Flood Map through the map challenge process. I will be setting in place a mechanism by which progress on

the review of SFCAs is monitored within the timeframe set out above. There will be no further extension to the coming into force date for the TAN beyond June 2023 and, to be clear the new Flood Map for Planning will form the basis of the TAN at that time.

The outcome of this work should be that every local authority considers options and identifies its preferred ways to adapt to increased flood risks caused by climate change. In addition to the potential need for flood management schemes to which I refer above, local authorities may need to consider relocation of infrastructure, site specific resilience measures or new green infrastructure

The Chief Planner and Deputy Director of Water, Flood and Coal Tip Safety will be writing to you again shortly, setting out the procedural implications of this letter in the context of development plan, development management processes, and flood risk management delivery.

Yours sincerely

Julie James AS/MS
Y Gweinidog Newid Hinsawdd Minister for Climate Change

3:- Technical Advice Note 15 Section 13.

13.1 Improving the resilience of communities at risk of flooding now and under potential climate change scenarios is a priority for planning authorities. Design considerations will be a key factor when determining whether development is acceptable in flood risk areas. The most effective solutions will combine both site-level and property-level resilience measures. Strategic and detailed Flood Consequences Assessments should provide advice on which measures offer the best and most appropriate protection from flooding.

13.2 Planning and building regulations have a complementary role in flood management and the use of flood mitigation and damage resistant measures will be required as part of ensuring the consequences of flooding are acceptable. Any new development in Zones 2 and 3 and the TAN 15 Defended Zones must have resilience to flood built-in at site and property level.

13.3 At the property-level, the aim should be to minimise the amount of water that can enter a property using resistance measures, and limit the damage caused if water does enter using resilience measures. Simple design features, such as raising floor levels, while ensuring that inclusive access is maintained, or keeping electrical circuits above levels likely to be affected by flooding, can enable buildings to resist and cope with flooding better. The use of appropriate materials will also improve the resilience of a development, for example by avoiding the use of carpets in ground floor areas.

13.4 Higher density and mixed use developments can offer greater potential for resilient design. For instance, ground floor areas may be able to accommodate less vulnerable elements of the development, such as commercial uses, provided that highly vulnerable uses on upper

floors have satisfactory access and egress arrangements in the event of flooding, and providing the whole building meets the relevant tests in sections 10 and 11.

13.5 Site-level resistance and resilience measures should have the twin aim of reducing the amount of flood water that can enter the site and effectively managing any water that does reach the site so it does not impact on households and other occupiers/users. The latter element is known as 'designing for exceedance'. It can involve using green infrastructure, highways and pavements to channel and redirect water, and using open spaces or car parks to temporarily store excess water. The integration of sustainable drainage systems (SuDS) into developments is an opportunity to achieve multiple positive outcomes, by combining crucial drainage and flood defence assets with green infrastructure and high quality public realm.

Advice on incorporating resistance and resilience into development through design is available from the Construction Industry Research and Information Association (CIRIA), including a Code of Practice and Guidance for Property Flood Resilience.15

New or improved flood defence infrastructure

13.6 The Welsh Government and Risk Management Authorities invest significant amounts of public money to upgrade and provide new flood defence infrastructure every year. This investment seeks to provide existing homes, communities and businesses with better protection from flooding. New flood defence infrastructure is only intended to protect existing places and communities that are already at risk of flooding. Constructing new defence infrastructure to enable new development is not acceptable as it removes valuable flood storage areas and places more households and businesses at risk of flooding. New development may, in principle, be located in areas where existing flood defence infrastructure has been strengthened to the extent that it becomes a TAN 15 Defended Zone (see Figure 2).

13.7 The use of natural flood management schemes is a key priority to deliver more natural means of providing protection from flooding.16 There will however be circumstances where Risk Management Authorities are justified in proposing new or improved engineered flood defences to better protect existing communities from flooding and the effects of flooding.

13.8 Flood defence infrastructure will normally have the effect of diverting water away from a development, which can lead to increasing the risk of flooding elsewhere. Full and careful consideration of the benefits and detrimental impacts, both on and off site (sometimes beyond the boundaries of a local authority), must be undertaken when new or improved flood defence infrastructure is proposed. Planning authorities must be satisfied the benefits to the protected area clearly outweigh any negative effects elsewhere.

13.9 The provision of compensatory floodplain is an effective way of avoiding detrimental impacts elsewhere, but is not always a feasible option. Increasing the risk or severity of flooding elsewhere may be acceptable where the impact is on undeveloped or unoccupied land. If the affected land is existing functional floodplain the benefit of strengthening flood protection to residential properties will normally outweigh the negative impact of more intense flooding on the floodplain. Where flood defence infrastructure would lead to an increase in risk to properties already in flood risk areas, the Flood Consequences Assessment will inform the planning authority's decision. Planning authorities should carefully consider whether the

increased risk under different flood scenarios is reasonable and tolerable, using the guidance set out in section 11. If detriment to third party land is to be accepted all affected landowners must be informed. This will enable them to provide their views and, separate to the planning process, enable them to potentially negotiate compensation.

13.10 New or improved flood defence infrastructure should not cause properties located elsewhere currently at little or no risk (Zone 1) to be put at risk of flooding (Zone 2 or Zone 3).

13.11 Investment in new or improved flood defences should seek to achieve wider social, economic and environmental benefits, such as carbon storage, recreation, biodiversity improvements and social wellbeing. These will enable Risk Management Authorities to demonstrate delivery against their well-being goals, and duties under the Environment (Wales) Act 2016. Investments in flood defence infrastructure may deliver greater overall value when combined with other investment, for example in active travel infrastructure, public realm improvements or regeneration schemes.