2019 MARKED THE 10-YEAR ANNIVERSARY OF THE FLOOD FORECASTING CENTRE.

FOREWORD

Mark Russell
Head of Centre

Starting as a joint venture between the Environment Agency and the Met Office to a mature working partnership, that plays a central part in the resilience of England and Wales flood planning and response.

Our anniversary event in Exeter was poignant in that Sir Michael Pitt, author of the 2007 flood review, was a keynote speaker. Having recommended closer working between the partners as part of his review he was able to witness the achievement of his vision. The other key speakers included the Flood Minister Rebecca Pow and the Chief Executives of the partner organisations, Sir James Bevan of the Environment Agency and Professor Penny Endersby of the Met Office. They spoke about the quality of the relationship, the value of the Centre to emergency response as trusted advisors and to a prolonged future at the heart of saving lives and livelihoods.

Our eleventh year proved to be unforgettable as another year of extremes that included the wettest February on record with Storm Ciara, Dennis and Jorge sweeping across England and Wales. This caused flooding that rarely left our TV screens that month showing the severest flooding of a generation in South Wales and prolonged and repeated flooding across some of England and Wales’ largest rivers, including the River Severn, Trent and Ouse.

Winter 19/20 also gave us the opportunity to provide longer range flood forecasts up to 30 days. We were able to support the strategic planning of the Environment Agency and Natural Resources Wales. This showed us that when we can see strong and consistent signals into the future it can help provide confidence to plan operations, whether for flood, other environmental hazards or activities that are impacted by flood risk. We are hoping to learn from this experience and be able to add value to more responder organisations in the future.

We are also looking outwards to new science to provide greater value to our flood forecasts. As a result of a changing climate, the risks and impacts of flooding are likely to increase in coming years and this year fits this pattern. We must continue to invest in our flood forecasting capabilities through collaboration and co-operation within the partnership and involving others to stay safe and thrive. Our focus going into next year is continuing to improve our capability in forecasting surface water flooding that can impact 2.8 million homes in England and Wales. However, as we finish this year, the country and the world are in unprecedented times with the emergence of the coronavirus pandemic. The future is uncertain, but the Flood Forecasting Centre is an exemplar model of a successful working partnership which I believe will be a model for the future.

Mark Russell
Head of Centre

The February storms followed a period of extreme rainfall in the Autumn largely in South Yorkshire and Derbyshire which caused severe flooding along the River Don. During both periods the advice from the Flood Forecasting Centre provided lead time for emergency responders and situational awareness to deploy equipment and resources to the locations at greatest risk. We regularly saw the deployment of barriers along our main rivers and this demonstrated the value of forecasting in protecting communities.

However, these periods presented some of the most complex situations to communicate as we forecast flooding from all sources with repeated flood peaks passing down the rivers. There were two notable periods of flood risk from asset issues during summer 2019 with the flooding at Wainfleet and severe flood risk at Toddbrook Reservoir that led to the evacuation of residents of Whaley Bridge. Both these cases showed the role of engineering assets to the overall flood risk and the Flood Forecasting Centre was able to provide the best intelligence across the partnership to assist with emergency response and recovery.

A feature of 2019/20 was the prolonged nature of the flooding and this period represented one of the busiest periods in the history of the FFC. The stability of the Centre stood up to this test and demonstrated the value in the investment of a professional 24/7 operation staffed with highly qualified experts in the hydrometeorological profession and a letter of thanks to the team from the Prime Minister was a real boost to the Centre during the Toddbrook Reservoir incident. But it also showed the stability and maturity of the working partnership as the Centre is as strong as the relationship and the resilience of the data and intelligence from both the partner organisations.
OVERVIEW OF 2019/20

Figure 1.0 and 1.1
These maps give an overview of our records of observed flood impacts at minor or above level by flood source for 2019/20. The colour of each county represents the number of days with observed impacts from that particular source of flooding. Surface Water flood risk was a feature particularly for south and south west counties. River flooding on larger rivers, especially the Severn, Trent and their tributaries through autumn and February influence the number of days where impacts were recorded. Coastal flooding was not a large feature of the year, except for tidal reaches of the Severn. Groundwater flooding was a strong feature for many days for southern and south east England.

Figure 1.2 and 1.3

Figure 2.0
The calendar shows the highest forecast flood risk from all flood sources for any FGS issued for each calendar day for 2019/20. This highlights specific forecast events throughout the annual review period for England and Wales.

The large number of river impacts in Lincolnshire and the long period of medium (amber) flood risk forecasts were mainly due to flooding in Wainfleet in June, when a river flood defence was damaged. Otherwise, intense downpours from thunderstorms caused some minor and significant surface water and river flood events through the summer. These were often highlighted in the FGS with low likelihood of significant impacts, hence the low rather than medium risk.

Minor coastal and estuarine flooding impacts occurred simultaneously with inland flooding on at least four occasions through the year. These were during spring tides at the end of September, twice in February and also in March. Prolonged and widespread rain in the autumn resulted in some local groundwater flooding impacts across North Lincolnshire and the wet winter that followed caused prolonged groundwater flooding issues in parts of the south of England from mid-February well into March. This resulted in low risk (yellow) flood risk forecasts continuing long after the river flooding had subsided.

February 2020 was the wettest February on record since 1862 for England (Met Office) and had the highest combined river outflow of any month in England ever recorded (UK Centre of Ecology and Hydrology). When combined with the autumn 2019 floods this resulted in the busiest sustained period of heightened flood risk (September to March) for the FFC since Summer 2012.
Customer research into product development has focussed on two main areas. Firstly, a collaboration with the Met Office team responsible for upgrading the Hazard Manager platform to develop how the FGS will be displayed and accessed. This involved online surveys and face to face interviews to inform the piece and continues to engage customers. Secondly, research has focused on how customers can get more value from the Flood Outlook service, based on interviews with users and an online survey.

In 2019 the FFC celebrated its 10th anniversary. Customers, government stakeholders, past and present FFC team members and Met Office and Environment Agency staff gathered in Exeter on the 4th October to mark the event. On the day we were able to reflect on the development and achievement of the FFC over the past decade, how the Centre’s science and technical expertise has evolved and improved, and our contribution to protecting lives and infrastructure. In the afternoon we looked to the future with Ian Lisk, chair of the Natural Hazards Partnership hosting a panel discussion on ‘How can the FFC and wider flood resilience community meet the challenges posed by future extremes of weather?’

We were pleased to welcome Sir Michael Pitt, Author of the Pitt Review and Rebecca Pow MP, Defra Floods Minister to join us and speak on the day. As well as Chief Executives from both parent organisations, Professor Penny Endersby and Sir James Bevan.

During 2019/20 the FFC began implementing a stakeholder engagement strategy, aiming to:
- Adopt a continuous process of user engagement
- Use insights to improve the reach and effectiveness of services
- Raise FFC profile within parent organisations
- Effectively and consistently communicate with external stakeholders, and
- Embrace a culture of stakeholder engagement.

The main areas of work that have progressed during the year include:
- Mapping stakeholders to form a basis for the strategy
- Refreshing branding and introducing this to our office space, products and communications
- Incorporating stakeholder engagement into Whole Centre Planning, particularly to support service development and resource prioritisation
- Preparing for the introduction of a Customer Relationship Management (CRM) system so our customer information is more easily accessible, including new Trello based approaches for managing and recording our engagement activities.
- Piloting a new approach for strengthening our key customer relationships through a ‘relationship manager’ approach, and
- Developing FFC values, vision and purpose statements and using these to inform new articles and posters.

Images (opposite):
Above — Sir James Bevan, Rebecca Pow MP and Professor Penny Endersby at the 10 year anniversary event, October 2019.
Below — Whaley Bridge, Derbyshire, 31st July 2019.
AUGUST

NORTHUMBERLAND
SURFACE WATER AND RIVER FLOODING

There were also spells of heavy rain across Wales and the north of England on 9/10 August and the north-east of England on 27 August bringing some significant flooding impacts. The river Rede flooded 30 homes in Otterburn, Northumberland in the former event, and surface water flooding affected the main street of Crawcrook, also in Northumberland, during the latter event. The possibility of significant flooding impacts was flagged in the FGS four days before the first event and the day before the second event, which did have possible minor impacts indicated from four days beforehand.

JUNE RAINFALL AND WAINFLEET FLOODING

Following some dry months, June brought thunderstorms with risks from surface water flooding and from rapidly responding smaller catchments. This progressed to widespread persistent rainfall from the East, quite unusual both for the season and in prevailing direction. These conditions brought the first medium risk (amber) FGS since July 2018 in England, and since November 2018 for Storm Calum over South Wales.

The amber FGS on 10 June was for the risk of surface water flooding from thunderstorms over South East England. These materialised with one rain gauge in Kent recording 86mm in 6 hours which resulted in significant travel disruption on major roads. The risk then continued through the week with widespread rainfall in Eastern areas with some areas of Lincolnshire experiencing widespread rainfall of over 100mm – the highest recorded gauge showing 156mm in total.

The amber FGS from 15 – 22 June reflected the flood incident in Wainfleet – where the river flood defence was compromised resulting in widespread local flooding to properties. It proved difficult to repair the defence whilst flows remained high and floodplains inundated locally. FFC provided key forecasting advice to responders to assist with the planning and response.

NORTHERN ENGLAND FLOODING AND TODDBROOK RESERVOIR INCIDENT

Hot conditions late in July (with a new maximum UK temperature also recorded) culminated in widespread thunderstorms and heavy rain, especially across the north of England. There were numerous reports of surface water flooding and some river flooding from 27 to 31 July from Cheshire and Greater Manchester across to West and North Yorkshire and Leicestershire, with up to 40 properties flooded in Calderdale.

Low risk (Yellow) FGSs were issued before these events signalling possible significant inland flooding and providing a day’s notice.

After all this rain, a Major Incident was declared on 1 August after the identification of a possible failure of a major reservoir at Toddbrook, Derbyshire. The FFC were able to assist immediately in the forecasting of rainfall, providing bespoke forecasts for local responders and FFC partners. In the longer term, the FFC assisted the Canal and Rivers Trust (who manage the reservoir) by sharing forecasting products with them as an interim arrangement, again supported by the local forecasting centre. The FFC briefed a series of COBR meetings as part of our national support of this high-profile incident which lasted almost a week.

Responders were complementary over the service provided and the FFC received a letter of thanks from the Prime Minister.
AUTUMN 2019

FLOODS

There were three notable flood periods in the autumn. The first was 25/26 October, when widespread rainfall across high ground in Wales and central parts of England resulted in some significant flooding, and some very wet catchments after a wet summer and start to autumn.

With high sensitivity to further rainfall, the next event on the 7/8 November, resulted in further significant flooding across South Yorkshire and the East Midlands, with ongoing significant impacts continuing until mid-November, mainly at Fishlake in South Yorkshire. This was a major multi-agency flood incident; FFC forecasts provided good lead time and responders were prepared. The third flood period in mid-November was initially forecast to again affect Northern England. However, the forecast developed, and the risk ultimately moved further south, affecting central and southern England.

The autumn 2019 floods saw the FFC advise on five COBR meetings, some chaired by the Prime Minister, as well as the first activation of the new National Flood Response Operational Centre to support COBR.

Following this prolonged wet period, FFC continued to highlight the increased sensitivity to rainfall, the state of catchments and periods of heightened flood risk through the Flood Outlook and further advisory telecons, including another COBR meeting to prepare for the Christmas period.

FEBRUARY 2020

FLOODS

STORMS CIARA, DENNIS AND JORGE

Multi-regional and multi-source flooding occurred. River flooding was often accompanied by surface water flooding and many parts of England and Wales were affected, with some severe flooding in south Wales and the Midlands and significant flooding elsewhere. Notable too was the persistence of groundwater flooding impacts, mainly in the south of England which lasted into March. Coastal and estuarine flooding impacts occurred simultaneously with inland flooding during both spring tide periods in February and the main spring tides in March as high river levels coincided with high sea levels.

Communicating forecast, ongoing and repeat flooding across large and small catchments, sometimes for long periods, resulted in the most complicated FGSs ever issued by FFC. FFC again advised on multiple government and national briefings, with numerous EA Incident Management calls (NOIMTS), Government Lead Government Department calls and full ministerial chaired COBRs. Numerous briefings were also undertaken to help the new Secretary of State for Environment get up to speed in the middle of a sustained flood event.
TIMELINESS, ACCURACY AND LEAD TIME

FGS TIMELINESS

The FGS was issued after the 11:00am target time on several occasions this year, falling below the target of 95% at key times. The target time was usually only missed by a matter of minutes rather than longer delays. These instances are generally characterised by the complexity of the flood risk forecast that needs communicating rather than underlying modelling, forecasting or IT infrastructure capabilities. This is reflected in the November and February statistics in Figure 3.0.

The dominant issue is incorporating changes between the draft FGS and final FGS. It is a real challenge to portray accurately ongoing and new flood risks and to communicate multiple sources of flood risk concurrently in a clear and consistent manner when the situation is constantly developing, and situational updates are being received. These key periods have been reviewed and work to reduce the peak morning workload across the forecasting community is being undertaken to improve timeliness for next winter.

The probability of detection (PoD) statistics (based on the last 36 months) are all above target at the end of 2019/20. The river PoD has increased markedly since this time last year (up from 42%) and the surface water statistic has gone up a little too (up from 66%). There were nearly 500 more flood observations from April 2017 - March 2020 than April 2016 - March 2019 largely due to the busy autumn and winter period this year. The Coastal PoD is very similar to last year. There was some groundwater flooding over the winter, and this was also well forecast in FGS, with a 97% PoD. Overall, these statistics reflect the good guidance provided in the FGS, especially during the autumn and winter flooding events.

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LESSONS IDENTIFIED

FOLLOWING THE AUTUMN AND FEBRUARY FLOOD PERIODS WE UNDERTOOK REVIEWS AND IDENTIFIED HIGH LEVEL LEARNING POINTS AS FOLLOWS:

AUTUMN FLOODS

THREE POINTS HAVE BEEN IDENTIFIED:

1. **Readiness** – how we keep overall situational awareness during prolonged seasonal events when daily production can be the focus. This includes from shift to shift as well as week to week for forecasters and duty managers.

2. **Rainfall Scenarios** – events reinforced known problems with rainfall scenarios i.e. manually condensing ensemble forecast output to show limited scenarios which may not reflect the highest risk.

3. **Complex Forecasts** – there were good examples of comprises to keep the overall flood narrative clear - but a couple of examples of late and complex changes from local forecast centres and the guidance unit. Some compromises lost locally important details for some areas.

FEBRUARY EVENTS

FIVE POINTS HAVE BEEN IDENTIFIED:

1. **Flood Outlook** – this period showed some better performance for some of our longer-term forecasts in the fortnightly Flood Outlook product. As this capability improves, we should seek a wider audience for this information to add more value for planning ahead of sustained flood events.

2. **FGS Complexity** – February saw some extremely complex and long statements with forecast, ongoing and return flooding for communities affected. Multiple peaks on longer rivers were also difficult to message, along with covering the range of impacts anticipated. We can draw on this experience to provide better guidance to forecasters on how to deal with complex stories to help us meet timeliness and accuracy targets.

3. **Online FGS** – February 2020 saw increased use of the online version of the FGS on Hazard Manager, notably being used for briefings into the National Flood Response Centre. We can review and develop the use of this online information to help our customers more fully understand likelihood, impacts and uncertainty in forecasts to enable earlier responses.

4. **England and Wales Overview** – the February event reinforced the value of having an overview of rainfall and flow across England and Wales in the FGS – we should continue to ensure our systems help support our assessment in a streamlined way.

5. **Confidence in modelling** – it is difficult to apply and communicate a national or regional event with high likelihood of significant/severe impacts into a specific catchment clearly enough to help escalate risk on the FGS. Whilst Grid 2 Grid and other models gave good guidance at longer lead times, we didn’t always use and communicate this information consistently to set out the risk assessment early enough or at a high enough risk level.

SERVICE DEVELOPMENT AND IMPROVEMENT

RESPONDER COMMUNITY SERVICES – FLOOD GUIDANCE STATEMENT (FGS)

In Spring 2019, the FGS went through Phase 4 of its development lifecycle focusing on fixing bugs, deficiencies and pieces of maintenance within the FGS, its production and dissemination systems and admin and customer registration portals. This addressed issues following feedback from customers and hydrometeorologists, refining the user experience and ensuring customer data remained protected under the current GDPR laws.

After a successful procurement Softwire have been responsible for the third line support and maintenance since October 2019 and work is now progressing to the next phase of the FGS development lifecycle, scheduled to take place in 2021.

GOVERNMENT & PARTNERS SERVICES – FLOOD OUTLOOK BRIEFINGS

During the autumn and winter, when there were a number of flood events, we were able to identify a possible prolonged and heightened flood risk in the Flood Outlook using a combination of our understanding of the hydrological response, seasonal forecast information from the Met Office and organisational awareness of our customers. We provided additional briefings to support this forecast which enabled partners to consider strategic response plans. In addition, we produced an online video for Environment Agency staff as part of winter resilience messages and we supported briefings to National Duty Managers and Flood Duty Managers. At the request of SEPA we have shared our approach. The Flood Outlook provided good guidance throughout the period. This has been a successful example of providing greater value on our existing set of products. We are looking forward to working with partners to gather feedback from these activities for the future development of the product.

FLOOD MODELLING – IMPLEMENTATION OF NEW COASTAL SURGE MODEL

A new coastal surge model was brought in to replace an old model that had been in operation for over 20 years. The NEMO-surge AMM7 model has modern open source code which will allow future changes and improvements to surge modelling that had become very difficult within the aging software code of the old model. The implementation was coordinated with the Met Office and all UKCFF partners (EA, NRW, SEPA and DARDNI) and provides deterministic and ensemble surge forecasts around the UK coast.

With NEMO-surge AMM7, now embedded into operational use, we have focused on a small review of current coastal forecasting visualisation tools exploring opportunities for rationalisation and decommissioning of those no longer needed. Whilst this work has been completed, we are considering broadening the scope marginally to include known areas of improvement required in coastal observations and modelling to support the FFC’s assessment of coastal flood risk. Widening the scope will provide us with a more robust assessment of service improvement priorities for the FFC in coastal flood risk forecasting.

FLOOD FORECASTING – THE NEW INCIDENT MANAGEMENT FORECAST SYSTEM (IMFS)

We worked closely with the Environment Agency team to introduce a new DELFT FEWS based flood forecasting system for England – IMFS. This system will host our national river model, Grid-2-Grid, and completely replace our current Hydromet Services for England. We have developed and tested rainfall scenarios for the new hydromet services functionality. We have also remained flexible to the changing timescales of the IMFS project as a whole. We have attended various workshops and video conferences, perhaps most crucial was a meeting with the IMFS core team and Deltares in November, enabling us to define the coastal scenario methodology. Testing was programmed and delivered in February, alongside the heightened operational period.

We have continued to work closely with Natural Resources Wales to ensure we can continue to produce and deliver current Hydromet Services as new ways of working are developed to deliver new services to their DELFT FEWS Wales system.

FLOOD IMPACTS – FLOOD EVENT IMPACT LIBRARY

The Flood Event Impact Library, holding indexed information on past events to assist with calibrating the scale of potential impacts forecast for the 5 days covered in the FGS, is in the final stages of development. The design work and a training video is nearing completion to allow it to be added to our duty hydromet toolkit and available for operational use during the next year.

FLOOD IMPACTS – USING TWITTER TO PROVIDE ACCESS TO IMPACTS OF FLOODING

The FFC are in the final stages of setting-up a one-year arrangement with a team at the University of Exeter to trial a SocialSensing tool they have developed with our support. The tool provides real-time access to social impacts of floods in England and Wales, based on social media (Twitter) activity. Content is collected, filtered for relevance and geolocated using machine learning. The user display shows aggregate maps of activity levels, updated in real-time, in spatial gridded format (fine/coarse resolution) or by local administrative area. The system has been co-developed with the FFC to meet needs for forecast validation and real-time situation awareness. Extensive validation has been successfully performed and user trials with FFC generated highly positive feedback. Recent developments include extending the geographic scope into Scotland and Northern Ireland (and therefore making the tool useful for our Met Office Public Weather Service partners) and porting the tool into a more operationally supported environment. Our operational trial will commence in April with the aim of providing the FFC with a more efficient flood impact data collection capability.
QUALIFICATIONS

Good progress has been made this year by the three hydromets currently working towards the Regulated Qualifications Framework (RQF) in operational hydrometeorology and flood forecasting. Much of the outstanding work required assessments to be conducted on hazardous shifts; this has certainly been possible during the last year.

INTERNATIONAL LINKS

Discussions have progressed on how the FFC and the Environment Agency should best fit in with the World Meteorological Organisation (WMO). The Met Office has had significant roles within the WMO for many years, but it is a good time to take stock given the restructuring of the WMO. It was agreed that Mark Russell will take the Environment Agency/FFC lead as Head of Centre, liaising with Jane Wardle as the Met Office International Relations Manager.

Despite significant flooding across England, and the ongoing devastating bush fires across Victoria, New South Wales and Queensland, several teleconferences with the Australian Bureau of Meteorology occurred this year, further progressing the MoU activities.

OUR PEOPLE

INDUSTRIAL PLACEMENTS

During 19/20 the Centre has continued to trial a 12-month industrial placement as part of a sandwich degree. This builds on the successes of the 3-month summer placements that have been running for many years. The 12 month placement has the added advantage of greater ownership and responsibility of projects within the FFC, as well as exposure to both parent organisations. It also promotes the FFC, Met Office and Environment Agency as great places to work for talented individuals. This year, the position attracted over 75 applications, with the successful candidate having to make the difficult choice between a Met Office and this FFC placement.
FORWARD LOOK

OUR UPDATED THEME STATEMENTS FOR THE COMING YEAR (20/21)
DESCRIBING WHERE WE WILL PUT OUR EFFORTS:

OPERATIONAL PLANNING AND DELIVERY
Maintain 24/7 service and ensure continued resilience of operational systems. Maintain staff competencies and support continued development of the operational skills. Through assessing the performance of operational delivery, seek ways to continuously improve operational efficiency and effectiveness. Delivery will act as the pathway for the whole centre planning into operational service, embedding any new operational tools, systems and ways of working. Delivery will also undertake continuous improvement of operational services, recommending any improvements needed back to the whole centre planning process.

EXPLOITING SCIENCE AND TECHNOLOGY
Being informed by our partners further develop and improve our products and services in a joined-up way, influencing and exploiting new science, technology and visualisation. Enhance our identification and scaling of flood events from multiple sources and concurrent flooding at increased lead times by fully embedding and optimising probabilistic forecasting. Influence the research and development of integrated hydrological modelling systems to support flood risk assessment.

PEOPLE AND VALUES
We will enhance our work on succession planning and people development, offering a wider range of flexible opportunities to work with the centre fostering ever greater collaboration and innovation.

FUNDING OUR AMBITION
Steered by our Joint Steering Group, we use our new 5-year business case to inform SR20 for future service provision, clearly prioritising surface water improvements in conjunction with wider programmes.

ENGAGEMENT AND SERVICES
Maintain our engagement with increased direction from stakeholder evidence and transform how we do this more efficiently with more re-use and sharing of material produced for wider stakeholder benefit. Improve our current Flood Guidance Service online with some targeted improvements to look, feel and accessibility as part of lifecycle management. Improve and broaden training materials available to customers. Improve our website and our public offering to reflect devolved administrations and increase awareness of our open data feed availability with targeted efforts to increase its uptake.