

Defra/Environment Agency Flood and Coastal Defence R&D Programme



Extreme Rainfall Event Recognition Phase 2

Work Package 5: Establishing a user requirement for a decision-support tool

Analysis report including draft specification of required components for decision-support tool

R&D Technical Report – FD2208



**Defra/Environment Agency
Flood and Coastal Defence R&D Programme**

Extreme Rainfall Event Recognition Phase 2

Work Package 5: Establishing a user requirement for a
decision-support tool

Final report

R&D Technical Report FD2208

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EXECUTIVE SUMMARY

This is the final report for Phase 2 Work Package 5 of Defra funded Extreme Rainfall Recognition Project (FD2208). The objective of this work package is to establish the user requirements for a decision support tool to assist Environment Agency Flood Forecasting and Warning staff to identify catchments at risk of flooding during 'extreme' (distinct from 'severe') events. The work is related to but independent from other work packages, including work package 2, which aims to develop and trial a probabilistic quantitative precipitation forecast.

Work package 5 comprised two consultation phases in which a series of interviews with Environment Agency staff was conducted to assess user requirements for a decision-support tool in relation to current flood forecasting and warning practice. The proposed tool was based on the scoring methodology originally proposed by Professor Chris Collier in Phase 1 (Table 6) which comprised a set of fixed risk flood risk criteria, antecedent conditions, and dynamic meteorological variables. The list was expanded in Phase 2 to include a number of additional variables and a weighting system, after consultation with the EA. A proposed format for a decision-support tool was put forward in an Analysis Report as part of this work package in September 2004.

The outcome of the consultation suggested that whilst Environment Agency would welcome a technique or technology which would assist in risk-assessment and decision support, the benefits of proposed methodology were not sufficiently clear. There was concern that additional information would generate additional operational requirements for FFW staff. Any additional requirements should be assessed in relation to current operational requirements.

Whilst the tool is suited to being run in real-time, the 'off-line' flood susceptibility assessment tool was considered more appropriate than a real-time risk assessment at this stage.

The results of the consultation are discussed in the Analysis Report. This report summarises key findings and makes the following recommendations:

- A pilot study should be carried out for a number of catchments. Subject to Environment Agency participation, catchment characteristics and flood risk information will be compiled and used to populate and weight a flood susceptibility model for a range of catchments.
- Outputs from work package 2 and other packages (especially work package 2 probabilistic forecasts) should be assessed with a view to incorporating them into a dynamic flood susceptibility tool.
- Demonstration of a 'real-time' version of the flood susceptibility assessment tool. This GIS based application could be use to combine GIS-based flood risk maps with meteorological forecasts and observations dynamically in real time.

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1. INTRODUCTION

This report summarises the response to the Analysis Report produced under Phase 2 Work Package 2 of the Extreme Rainfall Event Recognition Project. The Analysis Report summarised the results from structured interviews held with Environment Agency flood forecasting and warning staff, between May and June 2004. The interviews aimed to establish the user requirements for a decision support tool (DST) to assist flood forecasting and warning (FFW) decision making during extreme events, as proposed in phase 1. The proposed DST structure presented in the Analysis Report incorporated a flood susceptibility assessment tool based on fixed flood risk criteria, antecedent conditions criteria, and dynamic risk variables.

This report summarises the second consultation phase in which a combined response to the Analysis Report was received from the EA. It clarifies questions raised during the consultation and includes recommendations for further development based on the consultation and responses.

2. TERMS OF REFERENCE

The terms of reference for this work package are detailed in the csg7 form for this project. These are reproduced below:

“The approach involves two separate stages of consultation with the practitioner (the flood forecasting and warning staff of the EA) before a standard decision support methodology is proposed. This activity will make full use of the close relationship that has been established between Met Office and Environment Agency hydrologists, assisted by use of ex EA staff to undertake the work. It is recognised that a possible outcome is that there is insufficient commonality in the components for aiding decision making across the country and that regional intelligence tables may be superior to a nationwide facility.

- We will gather the existing intelligence tables, or any catchment-specific decision making information that has been documented by flood forecasting and warning teams, to examine the nature of this information and any commonality across the regions. This will require the contractor to meet with EA flood forecasting and warning teams to gather this information and note down any specific uses of this information to the region concerned. During these meetings views and ideas will be sought from practitioners on their perceived requirement for a decision support tool that may provide
 - (i) An indication of a fixed measure of a catchment/river reach/flood warning area susceptibility to flooding,
 - (ii) The impact of flooding within the catchment incorporating factors such as the at-risk population and the capability of response organisations to respond (e.g. is the at-risk community remote?)
 - (iii) An indication of the potential flooding severity within a catchment based on the susceptibility and the rainfall/storm characteristics forecast or expected.
 - (iv) A spatial distribution of risk that would incorporate all of the above.

This consultation will aim to explore the need for such a tool amongst practitioners, clarify the elements that are considered most important, assess whether current intelligence tables used by practitioners can be incorporated into the decision tool and evaluate the priority that such work should be given.

- Results of the consultation will be subjected to a desk study evaluation of the catchment-specific decision-making information to determine the extent of cross-region similarities.
- The findings of the desk study of collated EA information used in intelligence tables or decision making information will be viewed in context with the scoring system components identified in Phase 1 (stationarity of rain, soil moisture deficit etc.) and additional parameters that are considered essential to adequately assess risk, if appropriate. From this analysis the identification of suitable components to make up a cross-regional (England & Wales) decision support tool would be made. It may be found that there are many or only a few components which are applicable for decision support across England & Wales.

The final stage will be to return these findings to the flood forecasting and warning teams in the EA for their comment. The comments received will then be used as approval (or otherwise) of cross-regional (and cross-catchment) components that can be used in a decision support tool across England & Wales. From this, a specification will be proposed that identifies the need for the work, scopes out the elements of the work and outlines an appropriate approach to be taken forward in phase 3.”

3. SUMMARY OF FINDINGS FROM THE TWO CONSULTATION PHASES

A consultation with Environment Agency flood forecasting and warning staff was carried out between April and August 2004. The consultation included interviews with Environment Agency Flood Forecasting and Warning (FFW) staff in all regions except Wales, for which comments were sent by e-mail from EA North West Region. The purpose of the first consultation was to determine the need for a DST and to generate ideas and suggestions for a possible DST in terms of its content, format and integration with existing EA operational procedures. The results of the original consultation are included in the Analysis Report.

The Analysis Report was submitted to the Environment Agency and DEFRA on 30 September for comment. Comments received from the Environment Agency on 29 November included a request for clarification of a number of issues, and re-drafting of some sections. A written response to the comments raised was returned to the Environment Agency in the week commencing 6 December. This document is included in Appendix 1. Comments were received from Defra on 20 December. A summary of issues and conclusions is given below.

3.1 Scope and function

The comments received in the second consultation suggested some issues remained concerning the scope, function, application and delivery of the proposed DST. The Analysis Report proposed a draft specification of a DST, as per the terms of reference for this project. Its content builds on the work of Professor Collier and the 'Table 6' methodology proposed in Phase 1, but incorporates recommendations from the first consultation phase including the separation of 'fixed-risk' and dynamic parameters, a more objective or measurable definition of fixed risk parameters (e.g. structure blockage), and addition of weighting factors to calibrate the risk assessment calculation. The proposed DST was based on a number of fixed risk criteria, antecedent conditions and dynamic variables described in the Analysis Report (Section 5.3) and summarised in Table 4 (reproduced here).

During the first consultation phase it was envisaged that the DST would be in the form of a risk assessment table incorporating a scoring system based on the Phase 1, Table 6 method with enhancements recommended in the Analysis Report (reproduced here as Table 4). The Met Office introduced the idea of a GIS based DST, perhaps running in real time.

An assumption in the proposed DST format was that the Environment Agency would provide all fixed risk variables (Time-to-peak, channel slope, catchment characteristics etc.) and the variable risk parameter rate-of-rise of the upstream level hydrograph. The Met Office would provide meteorological variables in real time. The flood susceptibility scoring of these variables would need to be determined from previous extreme events.

3.2 Off-Line or 'Real-Time'?

A key issue throughout the consultation was whether the proposed DST would be more useful as an offline indicator of catchment flood susceptibility, or as a real-time DST for

use by duty forecasting and warning staff during an event. Comments from the second consultation phase indicated that the immediate requirement would be for an off-line flood susceptibility assessment tool rather than a real-time forecasting and warning tool. The reason for this was because there was insufficient support by users (the EA flood warning duty officers) for the tool as proposed, and insufficient justification for further research to develop the decision-support methodology. Outputs from the other work packages in this project may be better at addressing immediate expectations for real-time extreme event predictions that can be incorporated into existing modelling systems. Demonstration of increased confidence in quantitative precipitation forecasts (QPF) could then lead to the use of the DST in real-time.

3.3 Extreme Events

The proposal for an extreme event DST was generated by Phase 1 of the Extreme Rainfall Event Recognition Project. It was suggested that extreme events should be treated separately from other severe events* in response to the perception that the forecasting and warning thresholds used for severe events may not identify the conditions likely to generate an extreme flood event. These may include particularly heavy, sustained rainfall, caused by relatively stationary meteorological conditions.

The consultation indicated concern that flood duty officers would need to access additional sources of information during an event. Duty Officers already need to access several source of information, including observed data (including radar rainfall), model output, weather forecast, severe weather and heavy rainfall warnings, as well as regional flood forecasting manuals and intelligence tables. Additional operational activities would need to be justified by clear benefits.

Since completion of the original consultation, the Environment Agency announced plans to set up a flash flood register in the wake of the Boscastle flooding in Cornwall (NCE 20 January 2005). A GIS and database of flood risk is be set up to include local criteria which are considered relevant to flood risk. The proposed DST could form the basis for assessing the areas at risk.

1

*the terms 'extreme' and 'severe' are used here as quantified in Table 1 of the Technical Report of Phase 1

Table 4. Proposed table of criteria for inclusion in decision-support tool from the Analysis Report

	Description	Data Availability
Fixed risk catchment criteria		
1	Time-to-Peak. Catchments with short time-to-peak values will be at higher risk from extreme rainfall events due to the speed of response and ability to monitor the resultant increases in flows.	Maps produced by Jeremy Benn Associates can provide the basis to identify rapidly peaking catchments. (0-3 hours)
2	Channel Slope	From maps or DPSBAR from FEH digital elevation model
3	Catchment shape – relationship between drainage path length and catchment area	From maps or FEH DPLBAR/AREA
4	Urban Extent	From maps or URBEXT from FEH
5	At-risk population centres – Catchments where there are significant populations at risk of flooding will have higher fixed risk.	EA information
6	Proximity to Coast – Accounts for risk from coastal flooding	From maps
Antecedent variables		
7	Antecedent Rainfall (e.g. API30 or another antecedent precipitation index). A simple updating method is applied by South West Region, and other Regions have SMD updating in models.	SMD in real time is available in MOSES at 5km resolution
8	Susceptibility to Blockage (related to channel constrictions and the number and type of structures). Phase 1 work suggested a positive correlation between antecedent dry weather and risk of blockage by vegetation.	This information will be available from the Environment Agency, but may require updating from local authority or water company sources.
9	Snow depth and thaw potential, from actual and forecast temperature changes.	MOSES provides a standard update.
Dynamic risk variables		
10	Rainfall Depth from real-time rainfall observations. Some post processing would be required to produce information on accumulations and intensity. Depth/intensity information needs to be considered in conjunction with radar rainfall information.	Available from Environment Agency rain gauges or <i>Nimrod</i> data from the Met Office.
11	Rainfall Duration/Stationarity of rainfall.	From Met Office <i>Nimrod</i> , based on weather radar, NWP and satellite data.
12	Rainfall Direction – Rainfall movement parallel to line of water course considered to increase flood susceptibility relative to perpendicular movement.	From Met Office <i>Nimrod</i> , based on weather radar, NWP and satellite data.
13	SMD or SMI. For example - assign 2 risk levels: of high risk (SMD values < 20mm), and low risk (SMD of c. 20 – 100mm). Higher resolution of soil moisture provided by MOSES likely to better represent catchment wetness than coarser resolution (40 km) provided by MORECS?	MOSES provided hourly at 5km resolution
14	Rate of rise of the upstream level hydrograph rising limb. Assign two or three threshold risk levels based on rate of rise information, steeper rate of rise relating to higher risk.	Available from Environment Agency telemetered river level gauges exist.

4. PROPOSED DST REQUIREMENT

The off-line flood susceptibility tool proposed in this report would be used to assess the susceptibility of catchments to extreme flooding based on (at least) the fixed risk criteria in Table 4, and some critical thresholds of antecedent or dynamic risk variables, thus alerting flood forecasting and warning staff to vulnerable catchments. The underlying scoring system, based on the criteria listed in table 4, provides a risk assessment to support decision making but does not automate decision making to any degree.

It is recommended that the time-to-peak maps produced on behalf of the Environment Agency by Jeremy Benn Associates (JBA) are considered as a baseline element within the flood susceptibility tool. These maps classify all catchments in the UK according to four categories of time to peak (0-3 hours, 3-5 hours, 5-9 hours and more than 9 hours). An example for SW region is shown in Figure 1a. Along with other factors such as population at risk, the time-to peak information could be used to provide a baseline indication of flood susceptibility over which dynamic risk factors (including forecast and observed rainfall) could be overlaid in a GIS (Figure 1b).

Figure 1a: Example Time-to-Peak Map (Reproduced with the permission of the Environment Agency, South West Region)

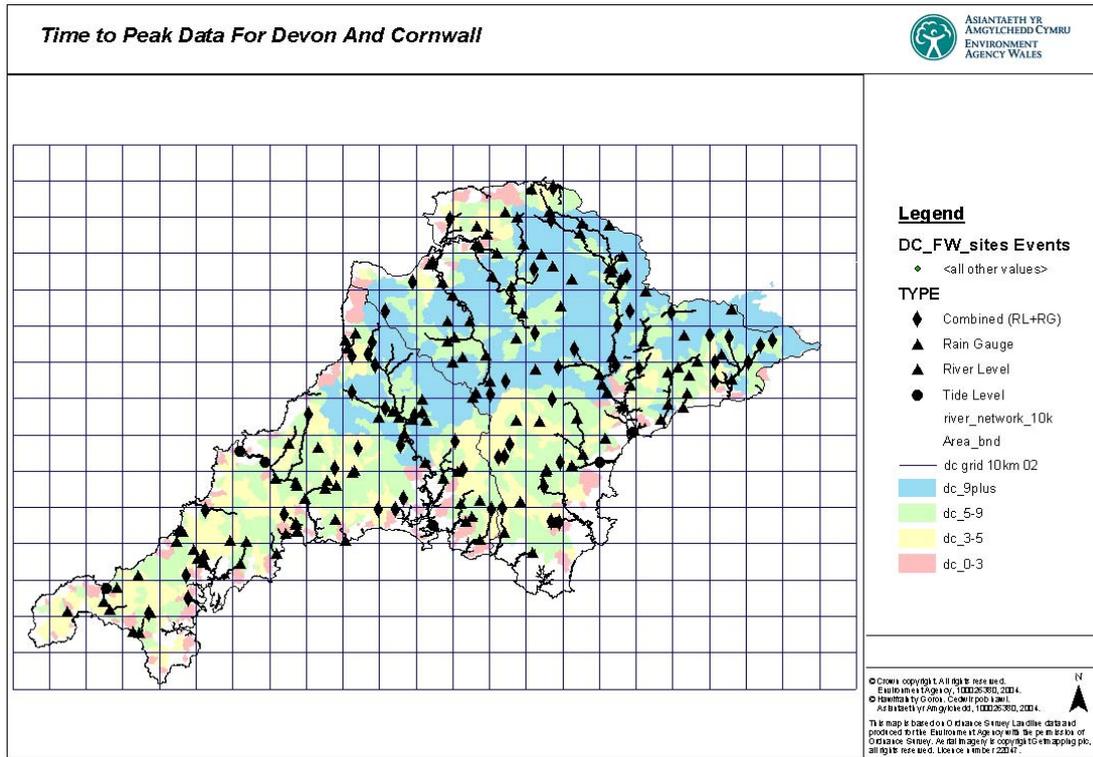
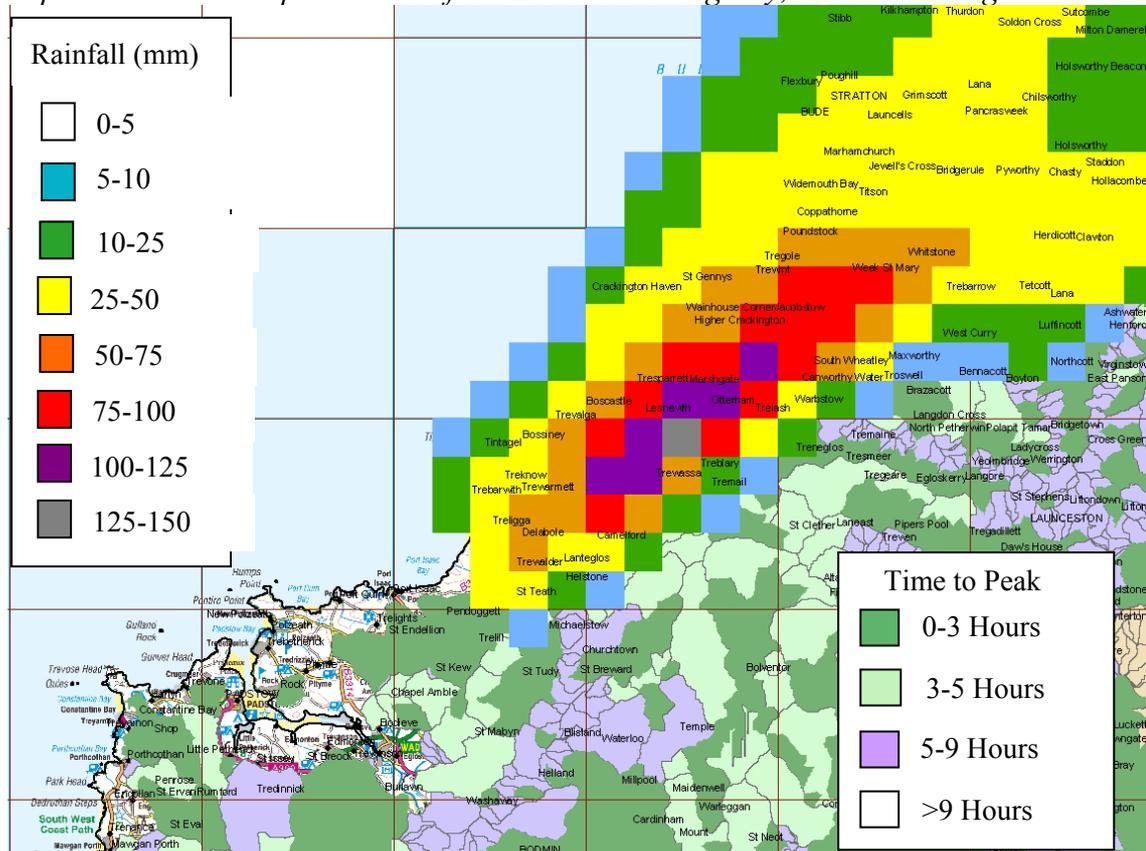


Figure 1b: Nimrod rainfall and Time-to-Peak Map Boscastle August 16 2005
Reproduced with the permission of the Environment Agency, South West Region



5. CONCLUSIONS

- 5.1 A detailed analysis of historic storm events carried out in Phase 1 went some way towards identifying the conditions likely to generate extreme flood events, and proposed a methodology to identify the relative susceptibility of catchments to flooding under extreme conditions. Phase 2 has built on the work of phase 1 by introducing the concept to the EA users and proposing aspects to develop of a tool to suit specific requirements. The findings of the two consultation phases have indicated a requirement for a tool to assess catchment flood susceptibility though stopping short of a real-time decision-support tool for all regions.
- 5.2 Whilst there was positive response by consultees to the proposal for enhanced tools for alerting duty officers to the most severe impacts of extreme rainfall, there was concern that the benefits of the DST were insufficiently demonstrated. The overall impression was that there was insufficient support by users for the tool as proposed, and insufficient justification for further research to develop the decision support methodology. Outputs from the other work packages in this project may be better at addressing immediate expectations for real-time extreme event predictions that can be incorporated into existing modelling systems.
- 5.3 There was some concern that extreme events should be treated separately from ‘ordinary’ severe events, warnings of which are currently covered by the Environment Agency’s four stage flood warning procedures. The EA has been keen to point out that any new tool or technology should fit with current forecast products and should not add complexity to the monitoring requirements of FFW staff. The proposed DST format is to be independent of current forecast products including Nimrod short-range quantitative precipitation forecasts, the 5-day weather forecast, and heavy rainfall and severe weather warnings. However, new products, including probabilistic forecasts, could be incorporated into an operational DST at a later stage if required.
- 5.4 Further work would be required to develop the risk assessment approach to confirm or refute that some catchments are more susceptible than others. This would require compilation of a detailed database of all UK catchments including detailed assessments of flood risk and catchment and water-course characteristics. Much of this work will have already been done by the Environment Agency for regional catchment plans and flood asset management plans. In the short term it is suggested that the assessment of particular flood susceptibility is carried out for a group of pilot catchments to demonstrate the methodology.

6. RECOMMENDATIONS

It is recommended that the EA and Defra Flood and Coastal Defence consider the following activities, potentially as a Phase 3 for the project.

- 6.1 Undertake pilot flood susceptibility mapping studies for a number of catchments in all EA regions which support the initiative. Each pilot study should include catchments of varying characteristics (area, mean channel length and slope, SMD etc.) and should make use of the time-to-peak maps produced by Jeremy Benn Associates. Detailed information on known flood risk (such as structures, populations at risk) would be collected from participating Environment Agency Regions. The flood susceptibility maps should then be tested with historic extreme rainfall event information to assess their usefulness as a decision-support tool for flood warning duty officers. It is recommended that, if successful, the method should be extended across England and Wales.
- 6.2 Carry out a demonstration of a 'real-time' version of the flood susceptibility assessment tool. This would be a GIS based application for use in combining GIS-based flood risk maps with meteorological forecasts and observations dynamically in real time. The outputs from work package 2 and other packages (especially work package 2 probabilistic forecasts) could also be assessed with a view to incorporating them into a dynamic flood susceptibility tool to indicate the composite level of flood risk.
- 6.3 It is recommended that the proposed DST forms the basis for assessing the areas at risk within the planned Flash Flood Register.

APPENDIX 1

Environment Agency response to report on Work Package 5 of the Extreme Rainfall Event Recognition Project, including responses from the Met Office WP5 team provided to the EA.

The Environment Agency welcomes the opportunity to comment further on the work undertaken as part of the above. A general comment is that we felt that there were a number of items which were not clearly defined in the report. This did not help us when we were trying to identify where any product will give benefit to the flood warning service.

Our comments on the report are as follows:

1. We are not clear what is going to be delivered as a 'decision support tool'. We would prefer the report to be recast to refer to the delivery of a risk assessment product, comprised of different datasets.

A. The report distributed to the EA on 30th September 2004 describes the discussions held with EA staff about the need for a decision support tool (DST) and proposes a model for how the DST might look. It does not discuss what will be delivered as this would be the objective of a Phase 3 of this project. The report proposes a draft specification of a DST, as per the terms of reference for this project. The purpose of the consultation is to generate ideas and suggestions for the DST in terms of its content, format and integration with existing EA operational procedures. Its content is based in principle on the 'table 6' methodology proposed by Professor Collier in Phase 1, but incorporating Phase 2 recommendations including the separation of 'fixed risk' and 'real-time risk' parameters, a more objective or measurable definition of fixed risk parameters (e.g. structure blockage), and addition of weighting factors to calibrate the risk assessment calculation. Its format is discussed in paragraph 4h, in which a GIS based format is suggested.

2. Who would provide the data in the product? Will there be different suppliers of the static data (e.g. time-to-peak data) and dynamic data (e.g. rainfall forecasts)?

A. It is envisaged that the Environment Agency would provide all fixed risk variables (Time-to-peak, channel slope, catchment characteristics etc.) and the variable risk parameter rate-of-rise of the upstream level hydrograph. The Met Office would provide a real-time Nimrod based quantitative precipitation forecast and all real-time meteorological variables in the form of data feeds. All variables would be combined in a single tool/product software interface.

3. What form would the product take? Will it be grid-based or polygon-based?

A. This would be determined by the user. Nimrod is currently a grid based product, but data can be converted for a polygon based product if required by the user, for example to represent river catchments for display in a GIS system. Further clarification from the EA would be useful here: although we are aware of the evolution of the National Flood Forecasting Modelling System (NFFMS), it still appears that

many forecast models will remain based on existing Regional models, with NFFMS providing better integration.

4. We need to see a clear methodology of how the product will be derived. Will it be a probabilistic product? This will enable us to assess how we would use the product within the flood warning service (which is based on deterministic forecasting).

A. This user requirements consultation under WP5 aims to derive the most appropriate methodology, and a proposed methodology has been presented in the draft report. The tool/product as presented is independent of the development of probabilistic forecast products (for example under Work Package 2). It would incorporate current deterministic Nimrod forecasts and combine them with other fixed and dynamic risk variables. A scoring system is proposed which would indicate the risk of an extreme flood event. It could in future be run with new products (for example the Short Term Ensemble Prediction System (STEPS), or high resolution meso-scale models).

5. Concerns were also raised regarding the potential for different information to be supplied from different teams within the Met Office, with resultant confusion amongst the end users within the Environment Agency. We would like to see a clear methodology for the delivery of the product, and how consistent delivery will be achieved.

A. Delivery of meteorological inputs to the DST could be via a single data feed delivered direct to a control room or the FFO/FWO's desktop. Updating of real-time variables would be automated and no user input would be required. Updating of fixed-risk variables could be made possible with administrator permissions if necessary. It would not affect other products issued by the Met Office including the 5-day weather forecast, flash warnings, heavy rainfall warnings and severe weather warnings which would continue to be issued. It should be remembered that the DST is for extreme events only and not 'routine' heavy rainfall events.

6. How does this product fit alongside other Met Office products (such as Heavy Rainfall Warnings) provided to the Environment Agency in terms of resolution, lead time, coverage and accuracy? We want to see a seamless service from the Met Office covering the whole range of possible rainfall amounts.

A. Any DST would be an EA tool, not a Met Office one, and its format and make-up would be defined with EA users – as is the purpose of this project.. Existing Met Office services would be unaffected and the resolution, accuracy, lead-times and geographical coverage of forecast products would be unchanged.

7. How does this project fit alongside other Met Office development work? It would be useful to know how other developments may complement this work so that we can identify which situations this product may offer greatest benefit for, and which may be covered through other developments.

A. The development of a risk assessment /decision support tool applies only to extreme events and is independent of other forecast development work (including the development of probabilistic forecasts under WP2). It therefore would incorporate the current (deterministic) Nimrod forecast product, but could in future be run with new products (for example STEPS or high-resolution meso-scale models).

A. The project aims to assist FFO/FWOs in decision making during an extreme event by identifying catchments susceptible to serious flooding, and facilitating the optimal allocation of resources. The tool would provide an objective assessment the susceptibility to flooding which varies with storm dynamics, catchment characteristics and antecedent conditions.

8. We are not clear how Work Package 5 (WP5) fits alongside the work being undertaken in Work Package 2. Will the output from Work Package 2 be included within the WP5 product?

A. Under Phase 2, WP2 is completely independent from WP5. The output from WP2 is currently being trialled, but could in principle be incorporated into the risk assessment/decision support tool under a Phase 3 of the project.

9. What improvements does this product offer over existing services? This information would help us to define our requirements for the product more clearly, and help to identify its potential uses.

A. The proposed format of the DST would combine Environment Agency geographic data (e.g. catchment maps, time-to-peak maps, flood risk 'intelligence tables' etc.) with meteorological forecast data on the FFO/FWO's desktop in real-time. It is understood that this capability does not currently exist. It aims to assist FFO/FWOs in decision making during an extreme event by identifying catchments susceptible to serious flooding, and facilitating the optimal allocation of resources. It aims to reduce the risk of failing to identify (or warn) a community at risk of flooding during an extreme, and perhaps rapidly developing event.

10. It is not clear from the report that a specific application of this product has been identified. A number of potential uses are suggested (e.g. revised Flood Watch messages, ungauged catchments). We do not agree that this product necessarily offers an answer to those situations. We feel that if we gained clarity on some of the above topics then we would be better able to suggest specific uses for the product.

A. See response to comment 9 above. A DST would provide an objective method of assessing catchment flood risk during an extreme event, distinct from severe and less severe events. It is in response to the often rapid development and severe consequences of an extreme event (e.g. Boscastle 2004, Lynmouth 1952), and to provide an indication of flood susceptibility on real-time. If the EA feels that the proposed DST specification does not "offer an answer to [certain] situations" the EA is invited to suggest improvements to the draft DST proposed in this report for incorporation in the final report – that is the purpose of the consultation.

11. Figure 1, and the paragraph immediately above, should be removed. We have a large number of misgivings about using the product on its own as a basis for issuing warnings, and did not feel that it was helpful to speculate on this use of the product at the current time.

A. Figure 1 which was a simple conceptual device and the paragraph above can be removed, although we do not fully understand the objection to what is part of a general discussion of risk-based decision making. The DST would be expected to assist decision making, not to generate an automated response. In that this is a 'user requirements' consultation, the potential use (and usefulness) of a DST is considered fundamental to pursuing its development on behalf of the Environment Agency.

12. A number of regions have expressed concerns that the notes of the regional liaison meetings do not accurately reflect the discussions which have taken place. They would have preferred to have been able comment on the content of this part of the report separately to ensure that any inaccuracies could have been addressed earlier.

A. The distribution of notes was discussed at the consultation meetings. It was agreed to issue a single consultation document to reduce the amount of document management. If there are any inaccuracies we request that the Environment Agency regional staff in question provide corrections which will of course be incorporated in the final document.

13. We are concerned that the format for the product suggested in the report (section 4 (h)) may result in a proliferation of ways of transferring data between the Met. Office and ourselves, and a proliferation in the number of systems which a duty officer may need to monitor. Anything produced as a result of this project should fit in with existing methods of data transfer and, if possible, with existing flood warning systems within the Environment Agency. This will ensure that we do not have to focus on ensuring resilience of, and access to, many different data transfer links (keeping costs down) and do not burden duty officers with too many sources of data to review during an event.

A. This point is duly noted and discussed in the report. The favoured format which came out of the consultation was for a GIS-based tool incorporating a Nimrod-based forecast superimposed over 'layers' of fixed and real-time risk. This would offer the advantage of combining Environment Agency geographic data (e.g. catchment maps, time-to-peak maps, flood risk 'intelligence tables' etc.) with meteorological forecast data on the FFO/FWO's desktop in real-time. It is understood that this capability does not currently exist. The data can be delivered as a real-time data feed to a desktop GIS, or via a web-based software such as EnviroMet. The proposed DST would also aim to formalise and standardise the decision-making methods currently used, e.g. intelligence tables. However, these aspects would be part of a Phase 3 of this project, if Defra support this.

14. We note with interest the comment in the report regarding 'comments by Environment Agency staff suggest a high expectation of forecast accuracy

compared with what can realistically be achieved'. A definitive statement from the Met Office on what can realistically be achieved for each forecast product would be very useful.

A. This was a clear and recurring theme during the consultation. The determination of meteorological forecast accuracy is a complex function of meteorological science and technology, and beyond the scope of WP5. The accuracy of Nimrod quantitative precipitation forecasts depend on the accuracy of observations (from radar, rain gauges and satellite data), and on that of numerical weather prediction (NWP) models. Forecast performance will vary according to the forecast product, meteorological conditions and lead-time. Target levels of spatial and temporal accuracy are specified in the National Weather Radar Arrangement (Memorandum of Understanding) for England & Wales between the Environment Agency and the Met Office. Forecasts are verified against observed data in real-time for specified thresholds and lead-times on a monthly basis and for a 12-month rolling mean.

15. How will the next stage of development be funded? Will there be any on-going costs for the Environment Agency associated with delivery of this product?

A. Please note that the scope of WP5 was to establish a user requirement for a decision support tool in the light of phase 1 recommendations and current practice in the Environment Agency; the scope is defined in detail in the Application for a Research Contract (CSG 7). The final stage is to return the findings to the flood forecasting and warning teams in the EA for their comment. The comments will be used as approval (or otherwise) of cross-regional (and cross catchment) components that can be used in a decision support tool across England and Wales. From this, a specification will be proposed that identifies the need for the work, scopes out the elements of the work and outlines an approach to be taken forward in Phase 3. An assessment of costs to the Environment Agency of developing a DST are outside the scope of this project (Phase 2).

APPENDIX 2 _ Defra Response

The analysis report is a useful summary of work undertaken by Regions in their approach to extreme events and provides some information on the user requirements for a decision support tool. The information is likely to be useful for the development of the other work packages and should be used for reference.

The results of the consultation do not indicate that there is a driving need for an operational decision support tool on the lines proposed and follow up correspondence from the Agency indicates some confusion as to the scope of the work.

Comments from the Agency in the report and in the follow up correspondence indicate that outcomes from the other work packages are more likely to meet expectations and requirements than an operational tool based on Work package 5 proposals.

The consultation did support the idea of a flood vulnerability index for catchments but seemed to have a perception that all catchments are equally susceptible and therefore a system based on fixed- criteria would not be useful. [Defra feels] there is mileage in doing a national risk assessment of catchments based on fixed criteria looking for vulnerability to extreme events, [including] a combination of fixed criteria based on catchment characteristics and possibly combine with meteorological characteristics such as coastal effects (like Boscastle), orographic or other known features.