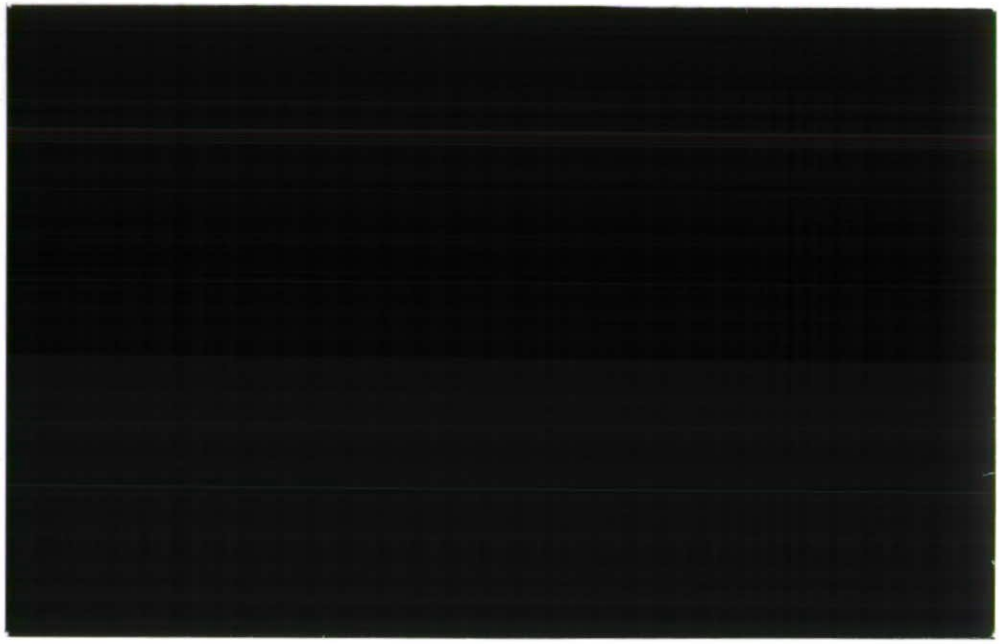
Institute of Hydrology



Natural Environment Research Council


Natural
Environment
Research
Council

Ministry of Agriculture
Fisheries and Food
Flood and Coastal Defence Division

FD04: Flood Hydrology
FD05: Environment

Institute of Hydrology

Annual Review

11 October 1994

MAFF Flood and Coastal Defence Division

Annual Review of
River Flood Protection Commission

11 October 1994
Institute of Hydrology

CONTENT

The papers take the broad format set in previous Annual Reviews. After an introduction to the year, brief progress reports are presented for ongoing research projects. These are followed by project proposals (numbered PP1 to PP4) for new work to commence in April 1995. At the end of the volume, financial summary tables serve as a key to how the current and proposed programmes relate to MAFF strategies for river flood protection research.

Introductory review

Background

The previous Annual Review was held on 22 November 1993. Funding for research in 1994/95 was confirmed by MAFF on 17 December, with final details of the work to be undertaken agreed on 11 February 1994.

Progress

Development of a Flood Estimation Handbook is now under way, and MAFF is convening a Research Advisory Group to watch over the relevant research projects. The FSR rainfall-runoff technique has been strengthened during the year: new methods for response time estimation were published in June (IH Report No. 124) and procedures for estimating percentage runoff using the HOST soil classification were finalized in July (Report to MAFF).

The IH Digital Terrain Model (IHDTM) has been consolidated through reworking of the river network data for Yorkshire. Except in fenland areas, automatic derivation of catchment information is now feasible throughout England and Wales.

MAFF's strategy for flood and coastal defence - published during the year - gives top priority to flood warning systems. The Institute has now compiled a menu for future research in real-time flood forecasting, warning and control. The review identifies strategic items of research which are dependent on renewed of funding for this area of the Commission.

Research projects ending in March 1994 have been satisfactorily concluded. An outstanding output is the major report "Continuous monitoring of soil moisture for flood hydrology". MAFF is not incurring the costs associated with its completion, which is now expected in November.

Changes

The Institute of Hydrology has found the current arrangements for administration of the Commission to be generally satisfactory. There is therefore some regret that the annual cycle of programme agreement, reporting and review is to be changed. The existing system is now well understood at Project Leader level, leading to little wasted effort.

The deeper regret is that - while admirable in other respects - the move to earlier confirmation of budgets for the succeeding financial year may reduce flexibility and could obstruct the incorporation of new initiatives in some projects. Will it be possible in appropriate cases to adjust the technical content of the programme at a later date?

Changes in management structures within IH were implemented during the year (see Fig. 1). The reorganization is already leading to a strengthening of the Commission. Benefits appear to be most obvious in the regrouping of applied scientists in the Engineering Hydrology Division, and the greater recognition of data science in an Information Hydrology Division. Much of the Institute's research on catchment modelling is now co-ordinated by Pam Naden, complementing her leadership of the development of an advanced method of flood estimation based on continuous simulation modelling. Duncan Reed has succeeded Frank Law as co-ordinator of the MAFF Commission; David Marshall continues in the role of progress chaser.

The Institute now forms part of the NERC Centre for Ecology and Hydrology (Fig.1), with the new arrangements to be confirmed in the wake of the scrutiny of government science.

Events

The December 1993/January 1994 period saw major floods on a quickly responding catchment at Polperro (Cornwall), the very slowly responding Lavant catchment at Chichester (West Sussex) and - most famously - the Moselle at Cochem and the middle Rhine at Koblenz (Germany). The hydrogeological conditions which were a feature of the Lavant flood highlight the difficulty of generalizing flood frequency estimation in catchments where groundwater-surfacewater interactions in extreme events can be radically different to those in lesser floods.

Several exceptional rainfalls were noted this summer, including: 52 mm in 15 minutes at Teviothead (Borders Region) on 24 June, and 146.1 mm in one rain-day at Ditchingham (Norfolk) on 31 August.

Trends

From obscurity a year ago, the land-cover classification developed by the Institute of Terrestrial Ecology (ITE) is cited in no fewer than four progress reports. Developed from Landsat imagery, the data are of high spatial resolution and are already proving valuable to scientists concerned with land-use effects. However, the distinction of urban areas must be improved if the classification is to be hailed as a breakthrough for flood analysis.

Trends in the Environment Commission (FD05) have been to fewer projects and, in assessing the ecological impact of river improvement works, to consider a range of non-fish indicator species. A subcontract has allowed collaboration with Dr Nigel Holmes (Alconbury Environmental Consultants).

It has become evident this year that French researchers and engineers are vigorously promoting the Gradex method as a European standard for reservoir flood estimation. Although not of immediate concern to MAFF, the development illustrates a further benefit of sustaining strong research teams in key topic areas: that of scrutinizing and deflecting inferior methods.

It is always a pleasure when an unexpected by-product arises from targeted research. The year has seen the development of a technique for standardizing peaks-over-threshold flood data to neutralize "period of record" effects. These had been hampering the indexing of flood regime needed to classify catchments for regional flood frequency estimation. The spin-off is that, because the standardization has been carried out jointly across all catchments, a summary can be obtained of long-term variation in flood occurrence in the UK. This should be of interest to students of climate change.

Dr Duncan W Reed
9 September 1994

Centre for Ecology & Hydrology

W B Wilkinson

Institute of Freshwater Ecology

Institute of Terrestrial Ecology

Institute of Virology & Environmental Microbiology

Institute of Hydrology
A G P Debney

HYDROLOGICAL PROCESSSES
J S Wallace

Global Processes
J H C Gash

Vegetation & Soil Processes
J M Roberts

Sustainable Agrohydrology
C H Batchelor

Impacts of Global Change
N W Arnell

ENVIRONMENTAL HYDROLOGY
P G Whitehead

Water Quality Systems
A Jenkins

Pollution Hydrology
R J Williams

Hydrochemistry
C Neal

Catchment Distributed Modelling
P S Naden

ENGINEERING HYDROLOGY
A Gustard

Flow Regimes & Environmental Managemen
A Gustard

Flood & Storm Hazard
D W Reed

Systems Modelling
R J Moore

Water Resource Systems
F A K Farquharson

INFORMATION HYDROLOGY
F M Law

National Water Archive
M L Lees

Hydrology Software
Y P Parks

Hydrologic GIS
R V Moore

Information Services
C Kirby

Library
S B Wharton

IAHS
P Kisby

LAND-USE & EXPERIMENTAL HYDROLOGY
I R Calder

Land Use and Water Efficiency
M Robinson

Experimental Catchments
Wales:
J A Hudson
Scotland:
R C Johnson

Sediment & Waterborne Fluxes
G J L Leeks

Instrumentation
J D Cooper

Workshop
A C Warwick

COMMUNITY SCIENCE

TIGER
M A Beran

LOIS
G J L Leeks

ADMINISTRATION
A D R Gray

Finance
H M Wood

Establishments
S A Fenton

Site Services
J R Fraser

Fig. 1

Progress reports

PROJECT:	FD0402 Real-time flow forecasting
CONTRACTOR:	Institute of Hydrology
PROJECT STAFF:	Mr R J Moore, Dr D A Jones, Mr R M Austin, Miss V A Bell, Mrs D S Carrington
MAFF RESPONSIBLE OFFICER:	Mr J Goudie
DATE:	1 September 1994

Progress

The document "Strategic Research and Development needs for real-time flood forecasting, warning and control" has been produced in draft form for discussion with MAFF. This identifies 13 areas of opportunity for R&D from which a selection will be made to form the basis of a 4 year work programme on flood forecasting, warning and control.

The joint MAFF/NRA project on improved methods for snowmelt forecasting has made progress on updating the database, to include events from winter 1993/94, and on preliminary work concerning a topographic-based technique for mapping snow water equivalent, supported by the IHDTM and Landsat imagery.

MAFF support to the HYREX Special Topic has continued. The HYREX database continues to grow, and incorporates radar data for the Cobbacombe and Wardon Hill radars, raingauge and AWS data from the Brue catchment and Meteosat data from IH's receiving station. These data are available to the HYREX community via File Transfer Protocol remote access to a guest area on IH's UNIX network. Exploratory comparisons have been made between radar and raingauge data to support the network design study. Extensions of the high resolution physics-based rainfall forecasting model have been made and evaluated using the June 1993 period of convective storms.

Progress on HYREX and the IH Grid rainfall-runoff model (which utilises IHDTM, Landsat and radar data) has been reported at the European Geophysical Society meeting in Grenoble.

Publications

Moore, R.J. 1994. Applications of weather radar data to hydrology and water resources. WMO/TD report, World Meteorological Organisation Regional Association VI. (Europe) Working Group on Hydrology, October 1993, 26pp.

Anon 1994. Methods for short-period precipitation and flow forecasting incorporating radar data. Report by the Institute of Hydrology to NERC, HYREX Special Topic Project T04072A, January 1994, 4pp.

Anon 1994. Design of radar/raingauge networks for hydrological use. Report by the Institute of Hydrology to NERC, HYREX Special Topic Project T04072A, January 1994, 3pp.

Moore, R.J., Bell, V., Roberts, G.A. & Morris, D.G. 1994. Development of distributed flood forecasting models using weather radar and digital terrain data. R&D Note 252, Research Contractor: Institute of Hydrology, National Rivers Authority, 144pp.

Moore, R.J., Carrington, D.S., Jones, D.A., Stewart, E.J., Hatton, R. & Aucott, L. 1994. The UK HYREX Project. Annales Geophysicae, Part II Oceans, Atmosphere, Hydrology & Nonlinear Geophysics, 19th General Assembly, Grenoble, May 1994, Supplement II to Volume 12, HS2/OA13 Precipitation measurements, modelling and forecasting, C 402.

Bell, V.A. & Moore, R.J. 1994. A distributed flood forecasting model using weather radar and digital terrain data. Annales Geophysicae, Part II Oceans, Atmosphere, Hydrology & Nonlinear Geophysics, 19th General Assembly, Grenoble, May 1994, Supplement II to Volume 12, HS1 Open Session on Hydrology, C 393.

Moore, R.J. 1994. Real-time flood forecasting. NERC news, January 1994, 27-29.

Moore, R.J. 1994. WMO Commission for Hydrology Working Group on Hydrological Forecasting and Applications for Water Management, First Session, 7-11 February 1994, UK Met. Office, Bracknell. Report by IAHS representative, IAHS Newsletter, 2 pp.

Institute of Hydrology 1994. Development of improved methods for snowmelt forecasting: Progress Report November 1993 to June 1994, 16pp.

Institute of Hydrology 1994. Strategic Research and Development needs for real-time flood forecasting, warning and control, Report to MAFF Flood Defence Division, Draft, 13pp.

PROJECT:	FD0403 Metadata Cataloguing and Exchange of Specialist Data
CONTRACTOR:	Institute of Hydrology
PROJECT STAFF:	Mr M L Lees, Mrs M C Clayton, Mr D G Morris, Mr R W Flavin, Mrs B Gannon, Mr T M G Spijkers, Mr T J Marsh
MAFF RESPONSIBLE OFFICER:	Mr J Goudie
DATE:	6 September 1994

Objective

To support MAFF research through specialist flood-related databases, including time series and spatial information, and to make such data known to the flood defence community.

Progress

The project coordinates the growing benefits of investment by others in digitised river networks, the Institute of Hydrology Digital Terrain Model (IHDTM), and from developments in catchment characteristics by GIS projects. Its links to ITE have speeded access to that Institute's land cover map. The IHDTM for England and Wales has just been completed with the re-digitising of Yorkshire rivers; however, pumped land drainage areas remain to be tackled. The nature of the project means that its output is a family of updated computer files available over a network. The spatial data are highly relevant to the major MAFF-funded research projects, including FD0402, FD0404, FD0409 and FD0416.

The project acquires a copy of the national daily rainfall archive twice a year from the Met. Office. The cost is shared between this project and NERC's own budget for the National Water Archive at IH. The archive is quality controlled through its use at IH with comments fed back to the Met. Office for potential action. The information is held on IH's networked database server within ORACLE tables so that SQL queries can readily recover specific parts of it for use within other projects. Where possible, and in response to specific requests, short duration rain data are acquired, although acquisition of time-series datasets is now more often undertaken as part of the relevant research project.

The Representative Basin Catalogue is relatively static at about 4400 flood events from over 300 selected catchments. The flexibility of the retrieval system has been reduced somewhat following the change from IBM mainframe to the current UNIX client-sever network; attention is to be given to generating user-friendly routes to access the data.

No satisfactory avenue has been found for regularly acquiring and archiving rainfall radar images (and the associated telemetered calibration raingauge data) that encompass major storms of flood significance. What can be achieved is now seen through the Met. Office MIST technology and IH's HYRAD software (for NRA-Yorkshire). However, the lack of a formal national weather radar archive from which rainstorm extracts could be taken is restrictive. Indeed it is now clear that the move to continuous flood simulation will give an impetus for such an archive rather than the previously envisaged event-based segmentation (which was conceived primarily in response to external user enquiries). Formal MAFF/NRA/NERC discussions to seek funding for a radar archive are warranted.

The National Water Archive (NWA) was publicised within the 1992 'Hydrological data UK Yearbook'. Details of retrievals (and those from the Peaks-over-Threshold and Annual Maxima series, compiled under MAFF funding) may accompany the enclosure of similar material for the National River Flow Archive in the 1993 Yearbook. The NWA holdings have been entered into the NERC Corporate Data Catalogue - a metadata catalogue held at Swindon - which will shortly enter the public domain via the GENIE (ESRC) project. Entries into other catalogues include Infoclima and Infohydro for the WMO.

Publications

Marsh, T.J. *et al.* 1993. UK Hydrological Data 1992 Yearbook. Institute of Hydrology.

Marsh, T.J., Monkhouse, R.A., Arnell, N.W., Lees, M.L., Reynard, N.S. *et al.* 1994. The 1988-92 Drought. Institute of Hydrology.

PROJECT:	FD0404 Flood hydrograph estimation procedures
CONTRACTOR:	Institute of Hydrology
PROJECT STAFF:	Dr P S Naden, Dr D B Boorman, Dr A F Calver, Miss H A Houghton-Carr, Mrs B Gannon, Mr T Spijkers
MAFF RESPONSIBLE OFFICER:	Mr J Goudie
DATE:	30 August 1994

Progress

Work has been completed on mapping the Hydrology of Soil Types (HOST) and on the application of HOST to flood estimation in the context of FSR methods (refer FD0415).

A report is almost complete on the performance of six relatively simple daily rainfall-runoff models on 25 catchments (Houghton-Carr and Arnell, 1994). One of the models which performed well in this study was a simplified probability distributed model (Moore, 1985). A detailed exploration of the performance of this model with regard to flood estimation on two catchments was therefore undertaken (Spijkers and Naden, 1994). This work, together with other considerations, reinforced the need for sub-daily flow and rainfall data. Accordingly, data collection was initiated.

For the collection of hourly data, catchments were selected on the basis of the length and quality of both rainfall and flow records and on the presence of a dominant HOST class. This led to the identification of 56 catchments across the UK. The data collection was divided into two stages with 18 catchments, covering 11 HOST classes, identified in the first phase. Data collection for these catchments is nearly complete and the data loaded onto Oracle tables; however, some information from NRA Thames Region is outstanding. Extensive quality checks of the data are now in progress.

Exploration of a new formulation for continuous flow modelling has been introduced into the project on the basis of promising early results reported in Calver (1993). The key feature of the method is a dual transfer function approach based on approximations to the physical mechanisms of runoff generation. DTM data are used to define areas of catchments contributing to runoff at varying rates. Parameters can be input from existing sources or determined in a constrained optimisation procedure.

PROJECT:	FD0409 Statistical methods of flood estimation
CONTRACTOR:	Institute of Hydrology
PROJECT STAFF:	Dr D W Reed, Mr D C W Marshall, Mr A C Bayliss, Mrs T K Jones
MAFF RESPONSIBLE OFFICER:	Mr J Goudie
DATE:	2 September 1994

Objective

To develop a new generalization of flood frequency to form Volume 3 of the Flood Estimation Handbook.

Progress

The transition has been made from predecessor projects to research fully oriented toward the development of a new generalization of flood frequency estimation based on the statistical analysis of peak flows.

Some minor inconsistencies in the computerized holdings of flood peak data have been rectified. A decision was taken to "break" tied events in the flood database to overcome anomalies in the extraction of peaks-over-threshold events. A scheme was devised to ensure that the changes made were minimal and unobtrusive, yet ensured that the original data were retained for reference.

Software has been produced for listing and displaying the data in a manner suitable for dissemination to gauging authorities, for validation and comment.

A formal analysis of the magnitudes and inter-event times of peaks-over-threshold floods is almost complete. A type of permutation test has been used to identify those catchments for which the flood series exhibits significant long-term trend in magnitudes or inter-event times and will be reported as a Flood Estimation Handbook Note.

Research on the characterization of the variability of flood occurrence has continued and a report drafted. The analysis has revealed that climate fluctuations have a pronounced effect both on the index of flood irregularity (CVRI) and on other derived indices of flood regime. The effect is important because different gauging stations offer different chronological periods for analysis. A major standardization of the peaks-over-threshold flood dataset has therefore been undertaken. For this, a hierarchical scheme was devised by which analysis thresholds have been adjusted for all 857 series in the UK dataset, so that each yields an equivalent of four peaks per year over a standard reference period: the 20 water-years commencing 1 October 1963. The standardization is to be reported as an FEH Note.

The need to standardize the flood series prior to analysis has delayed the preliminary classification of catchments into groups according to flood regime. However, useful experience has been gained of classification methods using trial datasets.

Publications

Bayliss, A.C. (drafted) On the variability of flood occurrence. Report to MAFF.

Reed, D.W. 1994. Plans for the Flood Estimation Handbook. Paper to MAFF Conf. of River and Coastal Engineers, 4-6 July 1994, Loughborough, 8.3.1-8.3.8.

Reed, D.W. 1994. On the Gradex method of estimating extreme floods. Dams & Reservoirs, June 1994, 17-19.

Reed, D.W., Bayliss, A.C., Jones, T.K., Marshall, D.C.W. & Rollason, S.J. 1994. Statistical flood frequency estimation. Progress report to MAFF.

PROJECT:	FD0412 Flood response of large catchments with respect to climate and land-use change
CONTRACTOR:	Institute of Hydrology
PROJECT STAFF:	Dr P S Naden, Mrs S M Crooks, Mrs B Gannon
MAFF RESPONSIBLE OFFICER:	Mr J Goudie
DATE:	30 August 1994

Objective

To estimate the effect of climate and land-use change on the flood response of large catchments.

Progress

Land-cover data for the Trent, Severn and Thames river basins have been purchased from the Institute of Terrestrial Ecology. The 25 land-cover classes provided have been regrouped into six classes with different evapotranspiration losses, as calculated by the UK Meteorological Office Rainfall-Evapotranspiration Calculation System (MORECS). Daily MORECS data have been purchased for the six different land-cover types for four sites in the Trent, Severn and Thames areas for the period 1985-1992. These have been supplemented by IH data for Plynlimon, Wallingford and Grendon Underwood. To serve as a baseline for the study, lumped linear models for a range of flood events have also been fitted.

The strategy adopted for the modelling (Naden, 1994) is to use a combination of network routing, as in Naden (1992; 1993), and daily rainfall-runoff modelling of small catchments which are representative components of the three large catchments. Distributed network width functions, used in the flow routing, have been produced for both ITE land-cover classes and HOST soil classes. Twenty-nine small catchments representative of the HOST soil classes within the Trent (8), Severn (8) and Thames (13) basins have been selected for daily rainfall-runoff modelling, and flow data and catchment average rainfalls for the 1985-1992 period obtained. Two models are currently being considered: the probability distributed model of Moore (1985) and IHACRES (Jakeman *et al.*, 1990). The key considerations in the choice of model are the effectiveness of the fit and the potential for treating land-use change. This latter criterion has required some development of these models.

Publications

Crooks, S.M. 1994. Application of unit hydrographs to large catchments. Internal report, Institute of Hydrology.

Rycraft, N.A. 1994. Development of network width functions using Arc/Info: overlays on gridded spatial data. Spatial Data Secondment Report No. 4, Institute of Hydrology.

Naden, P.S. 1994. Floods in large basins. Article in Flood and Coastal Defence newsletter, MAFF, April 1994.

Naden, P.S. 1994. Modelling strategy adopted in FD0412. Note to MAFF.

PROJECT:	FD0413 Urban impacts on flood runoff in medium scale mixed catchments
CONTRACTOR:	Institute of Hydrology
PROJECT STAFF:	Mr J C Packman
MAFF RESPONSIBLE OFFICER:	Mr J Goudie
DATE:	7 September 1994

[Report delayed by staff illness]

PROJECT:	FD0413 Urban impacts on flood runoff in medium scale mixed catchments
CONTRACTOR:	Institute of Hydrology
PROJECT STAFF:	Mr J C Packman
MAFF RESPONSIBLE OFFICER:	Mr J Goudie
DATE:	6 October 1994

Objective

To develop methods of flood estimation for mixed urban/rural catchments and catchment planning. To verify such methods via a comprehensive case study of the 'Bracknell' catchment, including effects of local drainage throttles, storage ponds, areal rainfall distribution, and seasonal response patterns.

Progress

Due to other commitments, little analytical input was scheduled for this project in the first part of the year. Unfortunately, staff illness has reduced this input further, but a major input is scheduled for the second part of the year. The field monitoring programme has continued throughout, though additional field monitors for the wooded/agricultural subcatchments (purchased at the start of the financial year) showed problems which have delayed their installation. Data from the main gauges for the period mid 1993 to March 1994 have been collected at IH. The data exist in a number of different formats (depending on the instrument makers data retrieval software) and need to be stored in a common database accessible from the modelling software. IH's urban runoff database (WURD) needs some small extensions to access long timeseries of data efficiently. There has been no further progress in overlaying the sewer database on the 1:10000 OS digital maps. On the modelling side, changing to a new version of the graphics software (for better presentation of time series data) has temporarily disabled the model, though these problems should be resolved soon, and with further improvements to the off-line pond routines, it should be possible to demonstrate the model by December. However, the continued lack of spillage to the Oldbury pond means there is unlikely to be enough data to assess pond performance this year.

PROJECT:	FD0414 Flood Estimation Handbook: Overview and co-ordination
CONTRACTOR:	Institute of Hydrology
PROJECT STAFF:	Dr D W Reed
MAFF RESPONSIBLE OFFICER:	Mr J Goudie
DATE:	2 September 1994

Objective

To co-ordinate development of the Flood Estimation Handbook and to produce Volume 1: "Overview and co-ordination of methods".

Progress

A proposal to extend the Flood Estimation Handbook to Northern Ireland was formulated, for which funding (Department of Agriculture, Northern Ireland) was confirmed in July 1994. In the absence of a clear response to the inter-agency planning meeting held to discuss the Handbook in November 1993, a detailed proposal and supporting statements were put to the Scottish Office Environment Department in May 1994. The reply, though sympathetic to the work proposed, indicated budget difficulties in funding extension of the Handbook to Scotland from April 1995. Contacts are being maintained in the hope that the Scottish Office may be able to arrange alternative funding.

A paper describing the Flood Estimation Handbook research programme was presented to the 1994 MAFF Conference of River and Coastal Engineers.

Consideration has been given to the characterization of urban land cover for use in automated flood estimation procedures, and a Flood Estimation Handbook Note drafted. Although the Institute of Terrestrial Ecology's spatially detailed digital land-cover classification is now available, it appears to be deficient in that some rural areas are mistakenly classified as urban.

The Flood Estimation Handbook research programme has been summarized in a leaflet prepared by MAFF, and the formation of a Research Advisory Committee put in hand.

Publications

MAFF 1994. New developments in flood estimation. Flood and Coastal Defence Research leaflet, July 1994.

Reed, D.W. 1994. Plans for the Flood Estimation Handbook. Paper to MAFF Conf. of River and Coastal Engineers, 4-6 July 1994, Loughborough, 8.3.1-8.3.8.

Reed, D.W. 1994. Mapping urbanization for flood frequency estimation. Flood Estimation Handbook Note 6, July 1994.

PROJECT:	FD0415 Consolidation of FSR rainfall-runoff method
CONTRACTOR:	Institute of Hydrology
PROJECT STAFF:	Miss H A Houghton-Carr, Dr D W Reed
MAFF RESPONSIBLE OFFICER:	Mr J Goudie
DATE:	8 August 1994

Progress

This new project is element C4 of the flood estimation research strategy: production of a comprehensive technical rewrite of the FSR rainfall-runoff method to form Volume 4 of the Flood Estimation Handbook. The primary objective for this year has been met with the publication of the reports detailing revisions to the FSR rainfall-runoff method.

Accurate estimation of flood parameters on small lowland catchments is known to be difficult, and the small catchment flood estimation project aimed to examine the response to rainfall of small catchments and to derive improved flood estimation equations where possible. New equations were derived for estimation of the instantaneous unit hydrograph time-to-peak and the mean annual flood. The time-to-peak estimation equation recommended can be applied to catchments of any size.

The second publication describes the development of a hydrologically-based classification of soils in the UK. The classification was based on conceptual models of the processes that occur in soils and, where appropriate, substrate. The resulting scheme has 29 classes, based on 11 response models. Applications of the classification have been developed that lead to improved estimates of parameters required in flood and low flow estimation procedures.

Publications

Marshall, D.C.W. & Bayliss, A.C., 1994. Flood estimation for small catchments. Report No. 124, Institute of Hydrology, Wallingford, 73pp.

Boorman, D.B., Gannon, B., Gustard, A., Hollis, J.M. & Lilly, A., 1994. Hydrological aspects of the HOST classification of soils. Report to MAFF, Institute of Hydrology, Wallingford, 106pp + Appendices.

PROJECT:	FD0416 Catchment characterization for flood estimation
CONTRACTOR:	Institute of Hydrology
PROJECT STAFF:	Mr A C Bayliss, Dr D W Reed, Mr D G Morris
MAFF RESPONSIBLE OFFICER:	Mr J Goudie
DATE:	30 August 1994

Objective

By recourse to the Institute of Hydrology digital terrain model (IHDTM), and additional data sources, to develop new catchment characteristics and assess the scope for their automated extraction and use in Flood Estimation Handbook procedures.

Progress

The identification of catchments suitable for inclusion in the study has started. The search is for medium to large rural catchments where the length of record allows accurate definition of the mean annual flood (QBAR), and the stream network digitized from 1:50 000 OS maps compares well with the actual network. The first milestone (March 1995) is to assess the feasibility of jointly deriving an equation for the estimation of QBAR from catchment characteristics and a model for synthesizing stream networks from DTM drainage paths.

Publications

None.

Publications

Spijkers, T. & Naden, P.S. 1994. Continuous rainfall-runoff modelling for flood estimation: initial thoughts and data requirements. Report to MAFF, 37pp.

Houghton-Carr, H. & Arnell, N.W. 1994. Comparison of simple conceptual daily rainfall-runoff models. Report to MAFF, (in press).

PROJECT:	FD0417 Confluence flood joint probability
CONTRACTOR:	Institute of Hydrology
PROJECT STAFF:	Mr I J Dwyer, Dr D W Reed
MAFF RESPONSIBLE OFFICER:	Mr J Goudie
DATE:	1 September 1994

Objective

To develop short-cut solutions to an important class of joint probability problems: flood design at river confluences.

Progress

The identification of possible study sites has begun. A meeting with engineers at Bullen and Partners, Bradford, has been arranged for 21 September 1994 to discuss their experiences of flood design at particular river confluences. A literature search is in progress.

Publications

None.

PROJECT:	FD0418 Flood risk areas map of England and Wales
CONTRACTOR:	Institute of Hydrology
PROJECT STAFF:	Mr D G Morris, Mr R W Flavin, Dr P S Naden
MAFF RESPONSIBLE OFFICER:	Mr J Goudie
DATE:	11 August 1994

Objective

To identify urban areas within the natural limits of the 100-year flood.

Progress

The ITE land-cover classification of Great Britain is currently under review; the accuracy of elements designated as urban is being assessed.

Effort is currently being directed toward completion of the Institute of Hydrology Digital Terrain Model (IHDTM), the two outstanding areas being Yorkshire and parts of East Anglia.

Following project approval on 15 July 1994, a full task list has been assembled and a method for estimating flood depth selected.

Publications

None.

PROJECT:	FD0505 Assessment and design of habitat improvement/restoration procedures for river flood defence schemes.
CONTRACTOR:	Institute of Hydrology
PROJECT STAFF:	Dr I W Johnson, Mr C R N Elliott
MAFF RESPONSIBLE OFFICER:	Mr A Swash
DATE:	30 August 1994

Objective

To apply the Physical HABitat SIMulation (PHABSIM) model to the assessment of habitat improvement/restoration procedures used in flood defence works.

Progress

The pre-scheme PHABSIM survey of the river Wey site has been completed and a stage recording system installed on the most downstream study transect. The water surface level data obtained from the system, combined with flow data from an NRA gauging station upstream of the study site, will allow the calibration of the PHABSIM model in both the pre- and post-scheme scenarios. The information collected thus far has been entered into a computer database, quality controlled and formatted, ready for use with PHABSIM. The post-scheme data collection programme will commence when the habitat restoration/improvement works have been completed.

Dr Nigel Holmes of Alconbury Environmental Consultants has commenced work on a sub-contract directed toward the generation of habitat suitability data for a number of ecologically important aquatic plant species; this will address the need for the identification of non-fish indicator species (deferred milestone). The terms of reference agreed include the production of habitat suitability indices for 75+ species, and an analysis of the significance of key habitat variables to a sub-set of species considered to be of primary importance in the design of environmentally sympathetic flood defence works.

Publications

None.

New proposals

PROPOSAL:	*PP1* *Systematic investigation of flood transfer losses in England and Wales*
CONTRACTOR:	Institute of Hydrology
PROJECT STAFF:	Dr A Calver
MAFF RESPONSIBLE OFFICER:	Mr J Goudie
DATE:	1 September 1994

Objective

To obtain a better understanding of the significance of bank storage in modifying flood flows.

Background

Floods in many parts of England and Wales do not flow along impermeable channels: rather, the material surrounding the river is permeable or semi-permeable and water is transferred between rivers and surrounding materials. During the transmission of a flood, increased river stages promote 'bank losses' from river to flood plain deposits. This can occur, under appropriate circumstances, for in-channel floods and for overbank flooding.

The bank loss augments groundwater and can return in part to maintain channel base flow. Examples of reported values of bank loss are a maximum daily mean value of 2.35 m^3/s per 1000 m of the Rhine near Koblenz (Ubell, 1987), and an average loss of 1.3%/mile for 'medium to large' streams in west Kansas (Jordan, 1978). In terms of exploitation of this feature, the *artificial* increase in bank storage is reported to be under consideration in Germany as a method of alleviating high flood stages (Giebel and Hommes, 1988).

Early work in the UK on transmission losses in the context of river regulation (see, for example, Jackson and Bailey, 1979) did not distinguish between bank storage and evapo-transpiration losses. Gardner (1990) addressed ecological aspects of flood plain water levels without specific reference to bank losses. *Ad hoc* reference to channel bank transfers is made in some groundwater investigations (see, for example, Watt *et al*, 1987), and the relation of channel bank transfers to water quality considerations has recently been highlighted (Younger *et al*, 1993).

The wider significance of the assessment of flood transmission losses, beyond flood routing considerations, is therefore the recognition of the interdependence of surface and groundwater regimes in water resource evaluation (with respect both to quantity and quality) and the implications for bank design.

Proposal

Bank losses have not been looked at systematically in the UK. We aim here to demonstrate how assessment can be made on a countrywide basis but feel it prudent to apply the procedure, in the first instance, to an important test region. It is suggested that the Anglian region affords a good demonstration because of the existence of extensive areas of permeable strata, an acceptable degree of understanding of the processes of surface and groundwater interaction (see, for example, Lloyd *et al* 1982; Calver, 1990), and the inclusion of lowland levéed river channels.

Digital river elevation data held at IH, in conjunction with National Water Archive flow data, offer scope to carry out a comprehensive evaluation of the flood transmission loss term. Water level data in flood plain deposits exist in a somewhat *ad hoc* manner and need to be systematised. The magnitude of the transfer term is a function of material permeabilities. These data are available on archive at Wallingford as a result of collating work on aquifer properties undertaken by the British Geological Survey. Values of channel bed and bank lining permeabilities are, however, rarer and require literature searches, and fieldwork to the degree that costings allow.

The methodology of calculating the transfer term is expected to be similar to that of Ubell (1987) and/or Hunt (1990) where open channel hydraulic equations are coupled with those of porous media flow.

Output from this project would appear to be most sensibly presented in computer-held map format: the river network will be classified with respect to transmission losses.

Programme

Core:

1. Amassing and quality checking of on-site data: river levels, river flood stage variation, aquifer permeabilities.

2. Consideration of best route to the less systematic data: water levels in flood plain materials, bed permeabilities, channel geometry, groundwater influences.

3. Implementation of bank storage calculation methodologies: coding, assessment, modification, production runs.

4. Result presentation for use by wider audience of researchers and practitioners.

Options:

The core programme may be supplemented by either or both of the following options. These can be undertaken concurrently or after consideration of the results of the core programme: the costings below assume the latter case.

A. A field validation programme is offered as an option at a key site. This is an experiment rarely done and involves flood plain observation boreholes in association with river stage monitoring.

B. Extension of the procedure from the test region to the rest of England and Wales.

Project Milestones

time from start (suggested start date 1 April 1995)

1 year	Report on data collection: on-site quality control; choice of off-site sources and their acquisition and checking.
2 years	Report on choice of bank loss calculation methodologies.
3 years	Final report on bank storage findings in test region, accompanied by mapped results.

Options: if option A and B included, and initiated after 3 years

4 years	Report on field validation experiment.
5 years	Final report and maps of extension of findings from test region to rest of England and Wales.

Estimated Cost (£k)

year	1	2	3	4	5
core	58	58	58	--	--
+ option A	--	--	--	50	30
+ option B	--	--	--	55	55

References

Calver, A. 1990. Stream head migration: an indicator of runoff processes on chalklands. Catena, 17, 399-408.

Gardner, C. M. K. 1990. The water regime of wildlife habitats: a case study at Yarnton Mead. Paper presented to MAFF Conference of River and Coastal Engineers, Loughborough.

Giebel, H. and Hommes, A. 1988. Interaction process between surface and ground water - advanced valuations for the Neuwied basin. Deutsche Gewasserkundliche Mitteilungen, 32, 18-27.

Hunt, B. 1990. An approximation for the bank storage effect. Water Resources Research, 26, 2769-2775.

Jackson, H. B. & Bailey, R. A. 1979. Some practical aspects of river regulation in England and Wales. Journal of the Institution of Water Engineers and Scientists, 33, 183-199.

Jordan, P. R. 1978. Loss of high flows by seepage from stream channels in Kansas. Kansas Water News, 21, 30-40.

Lloyd, J. W., Harker, D. & Baxendale, R. A. 1981. Recharge mechanisms and groundwater flow in the chalk and drift deposits of southern East Anglia. Quarterly Journal of Engineering Geology, 14, 87-96.

Ubell, K. 1987. Surface and ground water interaction - part II. Deutsche Gewasserkundliche Mitteilungen, 31, 142-148.

Watt, G. D., Mellanby, J. F., Wonderen, J. J. van & Burley, M. J. 1987. Groundwater investigations in the Lower Spey valley, near Fochabers. Journal of the Institution of Water and Environmental Management, 1, 89-103.

Younger, P. L., Mackay, R. & Connorton, B. J. 1993. Streambed sediment as a barrier to groundwater pollution: insights from fieldwork and modelling in the River Thames basin. Journal of the Institution of Water and Environmental Management, 7, 577-585.

PROPOSAL:	*PP2* *Real-time flood forecasting, control and warning*
CONTRACTOR:	Institute of Hydrology
PROJECT STAFF:	Mr R J Moore, Dr D A Jones, Mr R M Austin, Mrs D S Carrington, Miss V A Bell
MAFF RESPONSIBLE OFFICER:	Mr J Goudie
DATE:	1 September 1994

Background

The review of strategic R & D needs for real-time flood forecasting, warning and control, currently available in draft form (attached), has identified 13 topic areas deserving investigation over the next four years. The twin aims will be to advance and review the state-of-the-art to meet the strategic research needs of the MAFF Flood Defence Division.

Proposed Work

Discussions are ongoing concerning the selection and priority to be given to each of the 13 research topics identified in the draft review of R & D needs in this area.

Project Milestones

Supply work schedule of priority topics Apr 1995

Thereafter: report annually on progress

Estimated Cost (£k)

1995/96	95
1996/97	95
1997/98	95
1998/99	95

PROPOSAL:	*PP3* *Generation of spatially consistent rainfall series: supervision of research*
CONTRACTOR:	Institute of Hydrology
PROJECT STAFF:	Dr D A Jones, Dr P S Naden
MAFF RESPONSIBLE OFFICER:	Mr J Goudie
DATE:	1 September 1994

Background

The Flood Estimation Research Strategy prepared for MAFF in 1993 identified, within Area D, three projects which when combined, will yield an advanced method of flood estimation based on continuous simulation modelling. The most important project is to develop suitable catchment models, and, from April 1994, FD0404 research has been dedicated to this new objective. However, research to develop a method of generating spatially consistent rainfall series is also crucial, and the Strategy document proposed that a start on this project should be made in 1995/96.

Proposed Work

It is assumed that MAFF will wish to put this self-contained but specialized project out to open contract. The proposal is therefore that IH will specify the research to be undertaken, assist MAFF (if required) to vet the bids submitted, and, once a contract is let, ensure that the research provides methods that meet the functional requirement.

Project Milestones

Supply specification to MAFF	Jun	1995

Estimated Cost (£k)

1995/96	10
1996/97	10
1997/98	10

PROPOSAL:	*PP4* *Integrating environmental performance assessment in the hydraulic design of flood channels*
CONTRACTOR:	Institute of Hydrology
PROJECT STAFF:	Dr I W Johnson, Mr C R N Elliott
MAFF RESPONSIBLE OFFICER:	Mr A Swash
DATE:	1 September 1994

Context

Hydraulic models are frequently used to predict flood channel conveyance but provide no information regarding the 'environmental value' of the channel in terms of its suitability for sustaining acceptable biodiversity and population levels of aquatic fauna and flora. Hydraulic modelling of 'environmentally friendly' channels (Ackers Report B4.5, B4.7) is the subject of continuing research, but as yet techniques for assessing environmental performance are unavailable.

Under previous MAFF commissions FD0503 and FD0505, the Instream Flow Incremental Methodology (IFIM) using the Physical HABitat SIMulation (PHABSIM) model has been applied to quantitatively assess the environmental impact/benefit of a channel regrading (Poyle Channel, Middlesex) and a habitat improvement scheme (R. Wey, Surrey). In both cases the assessment approach has used pre and post-scheme PHABSIM surveys. This is necessary because the hydraulic models within PHABSIM do not have the capacity to predict hydraulic properties resulting from proposed alterations to the channel.

Proposed Research

The project will provide an interface between the IFIM/PHABSIM procedure and 'state of the art' hydraulic models, currently in use within the water industry or under development. Particular reference will be made to models designed specifically for modelling 'environmentally friendly' channels. An integrated hydro-ecological channel design procedure will allow optimisation of environmental performance at the hydraulic design stage.

Research Items

1. Review of available hydraulic models and assessment of applicability for interfacing with PHABSIM. Identification of preferred models and additional data requirements/interpolation procedures for these models.

2. Review of existing habitat suitability data and consolidation into a database. Identification of additional habitat data requirements, eg. bird species, mammals.

3. Interfacing of outputs of preferred hydraulic models with PHABSIM habitat simulation models. The interface will allow a choice of input file format according to the source of the hydraulic input data.

4. Testing of integrated design procedure by application to one or more proposed flood defence schemes to be selected in liaison with MAFF. Existing data from Project FD0505 could also be incorporated at this stage. The basis of the testing procedure will be to compare results from the predictive modelling with a detailed PHABSIM post-scheme assessment using field observations of hydraulic variables at a number of different discharges.

Project Milestones

Research Item	Start Date		End Date	
Item 1	Apr	1995	Sep	1995
Item 2	Apr	1995	Sep	1995
Interim Report			Oct	1995
Item 3	Oct	1995	Jul	1996
Item 4	Jul	1996	Dec	1997
Final Report			Mar	1998

Estimated Cost (£k)

1995/96	47
1996/97	50
1997/98	40

Financial tables

MAFF Flood and Coastal Defence Division
River Flood Protection Commission at IH

Financial Summary, 1994/95 (£)

Strat-egy	Project	Leader	Staff charges	Recurrent & capital	Network computing	Total
F	FD0402	RJM	64,100	1,500	4,400	70,000
	FD0403	MLL	28,400	10,400	1,200	40,000
D2	FD0404	PSN	98,000	11,000	11,000	120,000
C3	FD0409	DWR	106,400	2,600	11,000	120,000
E2	FD0412	PSN	52,100	2,900	5,000	60,000
E1	FD0413	JCP	66,000	9,400	4,600	80,000
C1	FD0414	DWR	28,400	1,100	500	30,000
C4	FD0415	HAHC	12,950	250	1,800	15,000
C5	FD0416	ACB	77,900	2,100	5,000	85,000
E3	FD0417	IJD	18,600	400	1,000	20,000
	FD0418	DGM	28,400	3,000	3,000	34,400
FD04 Flood Hydrology			***581,250***	***44,650***	***48,500***	***674,400***
	FD0505	IWJ	30,300[1]	15,200[1]	1,500[1]	47,000
FD05 Environment			***30,300***	***15,200***	***1,500***	***47,000***
TOTAL			**611,550**	**59,850**	**50,000**	**721,400**

[1] Figure amended for subcontract to Alconbury Environmental Consultants

Strategy references

C Consolidation of generalized methods in Flood Estimation Handbook
- C1 Overview and co-ordination
- C2 Rainfall frequency estimation (funded by NRA)
- C3 Statistical methods of flood estimation
- C4 Restatement of FSR rainfall-runoff method
- C5 Catchment characterization

D Development of advanced method of flood estimation based on continuous simulation modelling
- D1 Generation of spatially consistent rainfall series
- D2 Development of suitable catchment models
- D3 Blending frequency analysis of modelled runoff with observed flood data

E Exceptional topics in flood estimation
- E1 Urban studies related to catchment planning
- E2 Impact of land use and climate change on flood estimates on large catchments
- E3 Flood estimation at confluences

F Flood forecasting, warning and control

MAFF Flood and Coastal Defence Division
River Flood Protection Commission at IH

Proposed Financial Budget, 1995/96 (£)

Strat-egy	Project	Leader	Staff charges	Recurrent & capital	Network computing	Total
.	FD0403	MLL	28,800	10,000	1,200	40,000
D2	FD0404	PSN	97,000	12,000	11,000	120,000
C3	FD0409	DWR	104,000	5,000	11,000	120,000
E2	FD0412	PSN	25,500	2,000	2,500	30,000
E1	FD0413	JCP	70,700	4,700	4,600	80,000
C1	FD0414	DWR	28,000	1,500	500	30,000
C4	FD0415	HAHC	12,800	400	1,800	15,000
C5	FD0416	ACB	77,500	2,500	5,000	85,000
E3	FD0417	IJD	26,600	900	2,500	30,000[1]
	PP1	AC	47,000	7,000	4,000	58,000
F	PP2	RJM	85,000	2,000	8,000	95,000
D1	PP3	DAJ	8,700	800	500	10,000
FD04 Flood Hydrology			***611,600***	***48,800***	***52,600***	***713,000***
	PP4	IWJ	42,000	2,500	2,500	47,000
FD05 Environment			***42,000***	***2,500***	***2,500***	***47,000***
TOTAL			**653,600**	**51,300**	**55,100**	**760,000**

[1] Assumes start in October 1995, on satisfactory review of 1st phase.

Phase 1 review
FD0415
17500 500 2000 20000

Strategy references

C Consolidation of generalized methods in Flood Estimation Handb
- C1 Overview and co-ordination
- C2 Rainfall frequency estimation (funded by NRA)
- C3 Statistical methods of flood estimation
- C4 Restatement of FSR rainfall-runoff method
- C5 Catchment characterization

D Development of advanced method of flood estimation based on continuous simulation modelling
- D1 Generation of spatially consistent rainfall series
- D2 Development of suitable catchment models
- D3 Blending frequency analysis of modelled runoff with observed flood data

E Exceptional topics in flood estimation
- E1 Urban studies related to catchment planning
- E2 Impact of land use and climate change on flood estimates on large catchments
- E3 Flood estimation at confluences

F Flood forecasting, warning and control

MAFF Flood and Coastal Defence Division
River Flood Protection Commission at IH

Forward Look, 1995/96 prices (£000)

Strat-egy	Project	Leader	1995/96	1996/97	1997/98	1998/99
	FD0403	MLL	40	40	40	40
D2	FD0404	PSN	120	120	120	150
C3	FD0409	DWR	120	100	-	-
E2	FD0412	PSN	30	-	-	-
E1	FD0413	JCP	80	70	70	70
C1	FD0414	DWR	30	30	60	30
C4	FD0415	HAHC	15	60	-	-
C5	FD0416	ACB	85	50	-	-
E3	FD0417	IJD	30	60	60	30
	PP1	AC	58	58	58	105
F	PP2	RJM	95	95	95	95
D1	PP3	DAJ	10	10	10	-
New initiatives			-	30	200	200
FD04 Flood Hydrology			***713***	***723***	***713***	***720***
	PP4	IWJ	47	50	40	-
New initiatives			-	20	60	60
FD05 Environment			***47***	***70***	***100***	***60***
TOTAL			**760**	**793**	**813**	**780**

Strategy references

C Consolidation of generalized methods in Flood Estimation Handbook
- C1 Overview and co-ordination
- C2 Rainfall frequency estimation (funded by NRA)
- C3 Statistical methods of flood estimation
- C4 Restatement of FSR rainfall-runoff method
- C5 Catchment characterization

D Development of advanced method of flood estimation based on continuous simulation modelling
- D1 Generation of spatially consistent rainfall series
- D2 Development of suitable catchment models
- D3 Blending frequency analysis of modelled runoff with observed flood data

E Exceptional topics in flood estimation
- E1 Urban studies related to catchment planning
- E2 Impact of land use and climate change on flood estimates on large catchments
- E3 Flood estimation at confluences

F Flood forecasting, warning and control