

EXECUTIVE SUMMARY – YEAR 3

Contract No. EVG1-CT-2001-00037 **Reporting Period:** Year 3: Dec 2003- Nov 2004
Title: IMPACT – Investigation of Extreme Flood Processes and Uncertainty

Objectives:

The IMPACT Project comprises work packages investigating breach formation, flood propagation and sediment movement under extreme flood conditions as well as the effectiveness of using geophysical techniques for assessing flood defence embankment integrity. Each of the ‘process’ areas have been identified as contributing significantly towards uncertainty in flood condition prediction (flood risk management). A fifth area of research combines science from each of the process areas, through consideration of uncertainty within the modelling or prediction process.

Research work on breach formation divided into four areas: field modelling, laboratory modelling, numerical modelling and identifying breach location. With all field and laboratory work completed in Years 1 and 2, key objectives for Year 3 included completion of breach model simulation and analysis, and review of approaches for determining the relative risk of breach location.

Flood propagation research divided broadly into two areas: investigation and modelling of flow through urban areas and modelling of extreme floods along real valley topography. With the former work completed in Years 1 and 2, objectives for Year 3 focus on completion of work investigating flood propagation over natural terrain. This included collation of extensive data for the ‘combined’ project case study for demonstration of state of the art modelling of breach, flood propagation, sediment movement and uncertainty analysis.

Investigation of sediment movement divided into two areas of work, namely near field processes (sediment entrainment and movement) and far field processes (river morphology under extreme flood conditions). Near field conditions were investigated in Years 1-2, hence work in Year 3 focussed on far field processes and simulation.

Research into the use of geophysical investigation techniques for the rapid integrity assessment of linear flood defence embankments continued in Year 3, culminating in identification of a potential approach for use within the flood defence asset management community.

Uncertainty analysis is recognised as an important component of effective flood risk management. Provision of uncertainty information with best estimates of flood conditions (whether water level, time to flooding, bed level changes etc.) allows the risk manager to make a more informed decision. Assessment of modelling uncertainty through use of case study data was undertaken during Year 3 and used as a means to highlight research findings from all process areas.

Scientific Achievements:

Breach Formation

With large quantities of data collected from the field and laboratory tests, the programme of numerical model testing was completed this year, allowing comparison and analysis of model performance. A workshop was held at HR Wallingford (UK) during April 04 to review field, laboratory and modelling data in order to identify breach formation processes and assess model performance. The conclusions from this review form the core of the breach modelling technical review and have allowed quantification of modelling accuracy, identification of best modelling approaches and prioritisation of actions for further model development.

The breach modelling team (workshop) also participated in development of the uncertainty analysis approach and 3 different modellers participated in detailed application of their models for the uncertainty analysis. This work demonstrated insights into breach model performance previously not shown and has



advanced the state of the art for the use of breach formation modelling within the flood risk management community.

Flood Propagation

The focus of analysis during Year 3 has been through the Tous Case study. Considerable modelling work has been undertaken by a number of researchers demonstrating the relative differences between modelling approach, and the strengths and weaknesses of approach. Research concluded that the current numerical approach to modelling was sufficient to reproduce the physical processes that occur during an extreme flood event, but that the quality and density of data required and the power of current PCs were really the limiting factors at present which defined the accuracy to which flood propagation modelling could be practicably undertaken.

Sediment Movement

The performance of modelling approaches for the far field and in particular the case study for the Lake Ha!Ha! failure were assessed. The research concluded that whilst significant advances in understanding of the processes had been made, the performance of the prototype models against real scenarios was limited and further research and development would be required before models appropriate for use within the flood defence community could be made.

Uncertainty Analysis

Considerable progress was made in this final Year for uncertainty analysis. Two case studies were used: the Tous Dam failure event and the Lake Ha!Ha! failure event. The Tous event was used to analyse uncertainty within breach and propagation modelling; the Ha!Ha! event to analyse sediment movement processes – the level of understanding and modelling capability made an assessment of modelling uncertainty for sediment processes pointless.

The analysis undertaken through breach and propagation models demonstrates an indicative level of modelling uncertainty which is relatively high (~30% on water depths), and significant for consideration by end users. The process highlighted where the overall uncertainty in result originates within the modelling process and allows prioritisation of effort for reducing uncertainty in subsequent studies.

Geophysical Monitoring and Case Study Data

Testing of geophysical investigation techniques was completed and focussed upon the use of a new approach using a system developed in the US for military applications, previously unavailable and previously not applied in this situation. The results were promising and suggest that the approach may provide a means for the rapid, non intrusive, integrity assessment of flood defence embankments. Having undertaken initial development and applications within IMPACT, this system now requires further development and refinement before potential applications by the flood defence asset management community.

Breach data collection and analysis in Hungary was completed during Year 3. The relatively poor quality of the data meant that it proved impossible to correlate soil / embankment properties with the formation of a breach (i.e. factors contributing to the risk of breach formation). However, the data analysis did identify breach formation processes and allow correlation between the size and location of a breach for a specific catchment.

Socio-economic relevance and policy implications:

Research under the IMPACT Project contributes towards improved knowledge and understanding of extreme flood processes and in the development of tools for flood risk management. Periodic flooding in European member states reinforces the severe social and economic impacts that such flooding can bring. Through contributing towards improved flood risk management IMPACT helps to reduce these impacts on society.



Conclusions:

Year 3 sees the conclusion of work under the IMPACT Project. Most areas of research have been successful against the original aims. The degree of advancement in knowledge, understanding and modelling ability naturally varies from area to area.

Core findings and conclusions have been drawn from each work package area, always considering the needs of both research communities and end users in industry. Particular attention has been paid to drawing conclusions for end user applications of the research. In many of the work package areas the results presented form the current state of the art for that particular topic.

Keywords:

Breach formation; sediment; morphology; flood propagation; flood risk management; uncertainty; extreme floods; flooding; geophysics.

Publications:

Peer Reviewed Articles:

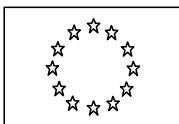
<i>Authors</i>	<i>Date</i>	<i>Title</i>	<i>Journal / Reference / Type</i>
M.A.A. Mohamed, Dr P.G. Samuels, M.W. Morris, Dr G.S. Ghataora	Sept 2002	Improving the Accuracy of prediction of breach formation through embankments dams and flood embankments.	Flow 2002 conference
Paquier, A. Mignot, E.	Dec 2002	Potentialités et limites de la modélisation hydrodynamique bidimensionnelle pour la détermination des zones inondables	Colloque Inondations. Agropolis, Montpellier, France (proceedings to be published in a CDRom)
S. Soares Frazão, D. Lories, S. Taminiau, Y. Zech (UCL)	Aug 2003	Dam-break flow in a channel with a sudden enlargement	Proceedings 30th IAHR Congress, Thessaloniki, Greece, 24-29 August 2003, Vol C-II, pp.221-228.
N. Le Grelle, G. Bertrand, S. Soares Frazão, J.M. Hiver, Y. Zech (Ucl, Lrh Châtelet)	Aug 2003	Flows due to a structure failure on the canal du centre	Proceedings 30th IAHR Congress, Thessaloniki, Greece, 24-29 August 2003, Vol D, pp.543-550.
Balayn, P, Paquier A, Lapuszek M,	Aug. 2003	1-D sediment transport model: representation of mixtures and calibration	Proceedings of 30th IAHR Congress, Thessaloniki, Greece, August 2003, vol. C1, p.557-564
Paquier, A., Mignot, E	Aug. 2003	Use of 2D models to calculate flood water levels: calibration and sensitivity analysis	Proceedings of 30th IAHR Congress, Thessaloniki, Greece, August 2003, vol. C2, p. 95-102
Bellal, B. Spinewine, C. Savary, Y. Zech	Aug 2003	Morphological evolution of steep-sloped river beds in the presence of a hydraulic jump: experimental study	Proceedings 30th IAHR Congress, Thessaloniki, Greece, 24-29 August 2003, Vol. C-II, pp. 133-140



Authors	Date	Title	Journal / Reference / Type
Leal, J.G.A.B.; Ferreira, R.M.L. & Cardoso, A.H.	Aug 2003	Dam-break wave propagation over a cohesionless erodible bed	Proceeding XXX IAHR Congress, Augt. 24–29, Theme C, Vol. II, pp. 261-268, Thessaloniki, Greece
El Kadi, K., Lapuszek, M., Lenar-Matyas, A., Paquier, A., Piwowarczyk- Ogorek, J.	Sept. 2003	One-dimensional sediment transport models: application to Raba River	Proceedings of RCEM 2003, p. 200-210
Haider S., Paquier, A., Morel R. Champagne, J. Y.	2003	Urban flood modelling using computational fluid dynamics	Water and Maritime Engineering, vol. 155, issue WM2, p. 129-135
Paquier, A., Tanguy, J.M., Haider, S., Zhang, B	2003	Estimation des niveaux d'inondation pour une crue éclair en milieu urbain : comparaison de deux modèles hydrodynamiques sur la crue de Nîmes d'octobre 1988.	Revue des Sciences de l'Eau, vol.16 issue 1, p. 79-102
Fraccarollo L., Capart, H., Zech, Y. (2003).	2003	A Godunov method for the computation of erosional shallow water transient	<i>Int. Journal of Numerical Methods in Fluids</i> . Ref 41:951- 976
Spinewine B., Capart H., Zech Y. Larcher M.	2003	Three-dimensional Voronoï imaging methods for the measurement of near-wall particulate flows	Exp. Fluids Ref: 34: 227-241
Capart, T. I. Eldho, S. Y. Huang, D. L. Young, Y. Zech.	2003	Treatment of natural geometry in finite volume river flow computations	Journal of Hydraulic Engineering, American Society of Civil Engineers (ASCE), 2003; vol. 129, n 5, pp. 385-393
Broich, K	Feb 2003	Verfahren zur hydraulischen Berechnung von Damm- und Deichbrüchen	Proceeding of national Symposium on “Sicherheit von dammen und Deichen – Handbuch für Theorie und Praxis. Ed R.A> Hermann and J. Jensen, ISBN 3-936533-09-1, Universität Siegen 7.2.2003
Ferreira, R.M.L.; Leal, J.G.A.B. & Cardoso, A.H.	Aug 2003	Transport of graded sediment in turbulent open-channel flows. A phenomenological approach	Proceeding XXX IAHR Congress, Augt. 24–29, Theme C, Vol. II, pp. 261-268, Thessaloniki, Greece
A. Paquier	2003	Ecoulements de surface lors des fortes inondations en ville	La Houille Blanche, issue 6, 89- 93
Broich, K	Mar 2004	“Modellbildung und Wirkungsanalyse im Hochwasserschutz”	Risiken bei der Bemessung und Bewirtschaftung von Fließgewässern - Risk in Design and Management



<i>Authors</i>	<i>Date</i>	<i>Title</i>	<i>Journal / Reference / Type</i>
			of Rivers and Reservoirs Dresdener Wasserbaukolloquium 18.-19. März 2004 Technische Universität Dresden, Wasserbauliche Mitteilungen, Heft 27
D. Bousmar, N. Wilkin, J.-H. Jacquemart, Y. Zech	2004	Overbank Flow in Symmetrically Narrowing Flood-plains	Journal of Hydraulic Engineering, American Society of Civil Engineers (ASCE) vol. 130, n 4, pp. 305-312
D. Bousmar, Y. Zech	2004	Velocity distribution in non-prismatic compound channels	Water management, Institution of Civil Engineers Vol. 157, June 2004, Issue WM2, pp. 99-108
D. Bousmar, B. Denis, Y. Zech	June 2004	Coherent flow structures in a converging compound channel	Proceedings of River Flow 2004 Conference, Naples, Italy, June 2004 Vol. 1, pp. 423-430
S. Soares Frazão, B. Noël, Y. Zech	June 2004	Experiments of dam-break flow in the presence of obstacles	Proceedings of River Flow 2004 Conference, Naples, Italy, June 2004 Vol. 2, pp. 911-918
N. le Grelle, B. Spinewine, S. Soares Frazão, Y. Zech	June 2004	Non-intrusive imaging measurements of the morphological evolution of a channel during a dam-break flow	Proceedings of River Flow 2004 Conference, Naples, Italy, June 2004 Vol. 2, pp. 977-982
B. Spinewine A. Delobbe, L. Elslander, Y. Zech	June 2004	Experimental investigation of the breach growth process in sand dikes	Proceedings of River Flow 2004 Conference, Naples, Italy, June 2004 Vol 2, pp. 983-991
M. Morris, M. Hassan, Y. Zech, S. Soares Frazão, F. Alcrudo, Z. Boukalova	Sept 2004	CADAM / IMPACT / FLOODSITE	Proceedings of Dam Safety Conference, Phoenix, USA, September 2004 CD-ROM proceedings, 16 pages
Vaskinn KA, Løvoll A, Höeg K, Morris MW, Hanson G, Hassan MAAM	Sept 2004	Physical Modeling Of Breach Formation - Large scale field tests	ASDSO (Association of State Dam Safety Officials) meeting at the Pointe South Mountain Resort in Phoenix Arizona - 26-29 Sept 04.
M. Morris, M. Hassan,	Sept 2004	Breach Formation – Laboratory and numerical modelling	Proceedings of Dam Safety Conference, Phoenix, USA, September 2004 CD-ROM proceedings



Authors	Date	Title	Journal / Reference / Type
F. Alcrudo, S. Soares-Frazão, Y. Zech, G. Testa, A. Paquier, J. Mulet, D. Zuccala, K. Broich	Sept 2004	Flood propagation model development	Proceedings of Dam Safety Conference, Phoenix, USA, September 2004 CD-ROM proceedings, 15 pages
Y. Zech, S. Soares Frazão, B. Spinewine, N. le Grelle, A. Armanini, L. Fraccarollo, M. Larcher, R. Fabrizi, M. Giuliani, A. Paquier, K. El Kadi, R.M. Ferreira, J.G.A.B. Leal, A.H. Cardoso, A.B. Almeida	Sept 2004	Sediment movement model development	Proceedings of Dam Safety Conference, Phoenix, USA, September 2004 CD-ROM proceedings, 16 pages
M. Morris, M. Hassan, F. Alcrudo, Y. Zech, K. Lakhali	Sept 2004	Process uncertainty: assessing and combining uncertainty between models	Proceedings of Dam Safety Conference, Phoenix, USA, September 2004 CD-ROM proceedings, 14 pages
E. Mignot, A. Paquier, N. Rivière	2004	How a 2-D code can simulate urban flood situation	Proceedings of River flow 2004, Napoli, Italy
K. El Kadi, A. Paquier	2004	<i>Simulation and prediction of river morphologic changes using RubarBE</i>	Proceedings of River flow 2004, Napoli, Italy
J. Murillo and P. García-Navarro	2004	<i>Application of a 2D Semi-lagrangian model to unsteady shallow water flow over dry bed</i>	River Flow 2004
Leal, J.G.A.B.; Ferreira, R.M.L.; Cardoso, A.H.	2004	1-D model for dam-break waves over mobile beds.	<i>6th International Conference on Hydrosience and Engineering</i> , Brisbane, Austrália Edited in CD-Rom
Ferreira, R.M.L.; Leal, J.G.A.B.; Cardoso, A.H.	2004	Modelação matemática do transporte de misturas granulométricas. Equações de conservação para modelos unidimensionais.	7 ^o Congresso da Água, Associação Portuguesa de Recursos Hídricos, Lisboa Edited in CD-Rom
Leal, J.G.A.B.; Ferreira, R.M.L.; Cardoso, A.H.	2004	Modelação de ondas de cheia provocadas pela ruptura de barragens. Influência do leito móvel.	7 ^o Congresso da Água, Associação Portuguesa de Recursos Hídricos, Lisboa Edited in CD-Rom
Morris MW & Hassan MAAM	2004	European research on dambreak and extreme flood processes	British Dam Society Conference, Canterbury, UK.



<i>Authors</i>	<i>Date</i>	<i>Title</i>	<i>Journal / Reference / Type</i>
			June 2004
Morris MW, Bramley ME & Smith P	2004	Good practice in design and management of flood embankments	Defra Conference, UK (July 2004)

Non Refereed Literature:

<i>Authors</i>	<i>Date</i>	<i>Title</i>	<i>Journal / Reference / Type</i>
KA Vaskinn Statkraft Grøner AS Aslak Løvoll, Norconsult	Mar 2003	Breaching of embankments. Large scale field test in Røssåga.	Annual meeting in The Norwegian dam-building society. Oslo, Norway Paper / present.
K. Høeg, NGI, A. Løvoll, Norconsult and K.A. Vaskinn, Sweco Grøner		Stability and breaching of embankment dams: field tests on 6 meter high dams	Hydropoeer & dams Issue 1,2004 Article
Aslak Løvoll Norconsult, KA Vaskinn Sweco Grøner AS, Tore Valstad NGI, Anders Søreide, Norconsult		Stability and failure mechanisms of dams. Data report no.4: Stability and breaching of embankment dams	Report
Ferreira, R.M.L.; Leal, J.G.A.B.; Cardoso, A.H.	2004	Modelação matemática do transporte de misturas granulométricas. Equações de fecho.	Congresso Internacional sobre o Rio Minho 2004, Melgaço Edited on CD ROM
Leal, J.G.A.B.; Ferreira, R.M.L.; Cardoso, A.H.	2004	Ensaio de ondas de cheia provocadas pela ruptura de barragens em canais 2-D.	Congresso Internacional sobre o Rio Minho 2004, Melgaço Edited on CD ROM

Others:

<i>Authors</i>	<i>Date</i>	<i>Title</i>	<i>Journal / Reference / Type</i>
Armanini, A., Dalri, C., Fraccarollo, L., Larcher, M., Zorzini, E.	2003	Experimental analysis of the general features of uniform mud-flow	3rd Int. Conf. Debris-Flow Hazard Mitigation, Davos, Switzerland Paper
K:A:Vaskinn Statkraft Grøner AS	6th mai 2003	Presentation of IMPACT/Stability and breaching of rockfill dams	Norwegian Research council: Research days. Oslo Presentation
K:A:Vaskinn Statkraft Grøner AS	21st Aug 2003	Presentation of field test # 3- 2003	EBL Kompetanse. Seminar on Stability and breaching of rockfill dams.



<i>Authors</i>	<i>Date</i>	<i>Title</i>	<i>Journal / Reference / Type</i>
			Mo I Rana Presentation
Aslak Løvoll Norconsult	21st Aug 2003	Presentation of field test # 2- 2003	EBL Kompetanse. Seminar on Stability and breaching of rockfill dams. Mo I Rana Presentation
Tore Valstad NGI	21st Aug 2003	Presentation of field test # 1- 2003	EBL Kompetanse. Seminar on Stability and breaching of rockfill dams. Mo I Rana Presentation
K:A:Vaskinn Statkraft Grøner AS	11th Nov. 2003	Presentation of IMPACT/Stability and breaching of rockfill dams	Norwegian Association of hydropowerplant operators. Trondheim Presentation
Einar Ødemark Statkraft Grøner AS	13th Nov. 2003	Presentation of IMPACT/Stability and breaching of rockfill dams	Norwegian water and energy directorate Oslo Presentation
KA Vaskinn Statkraft Grøner AS, Aslak Løvoll Norconsult Tore Valstad NGI	19th Aug 2003	Presentation of test program 2003. Risk for the environment.	Meeting with the local people in the test –area. Presentation
MW Morris HR Wallingford Ltd.	Feb 2003	Presentation on dambreak. Threats, capabilities and current research.	Surrey County Council Emergency Planning Seminar. Lecture
MW Morris HR Wallingford Ltd.	Jan 2003	Embankment breach: current practice and research.	British Dam Society (Institution of Civil Engineers) 27th Jan 2003, London. Lecture
Arne Forbord, Rana Blad	2003 .08. 19	Large scale field tests in Korgen	Norwegian newspaper Article
TV Norway	2003 .08. 19	Large scale field tests in Korgen	Television program
Aslak Løvoll, Norconsult AS, Norway	2004	Breach formation in embankment dams. Results from Norwegian field tests	EBL Kompetanse: Stability and Breaching of Embankment Dams, 21.-22. October, Oslo Presentation
P. M. Johansen, Norconsult and Tore		Breaching of embankments. Large scale field test in Røssåga.	Annual meeting in The Norwegian dam-building



Authors	Date	Title	Journal / Reference / Type
Valstad NGI			society. Oslo, Norway Presentation
K:A:Vaskinn Statkraft Grøner AS		Large scale field test. Presentation of field test program for 2003.	Norwegian university for Science and Technology Presentation
Silva, P.	2004	<i>SRuptura de barragens. Caracterização do escoamento dado um alargamento brusco a jusante de uma comporta.</i>	Final work project for graduation in Civil Engineering. Instituto Superior Técnico, Lisbon, Portugal (in Portuguese).
Amaral, S.	2004	<i>Experimental Characterization of ID Dam-break Waves over Cohesionless Sediment Beds.</i>	Final work project for graduation in Civil Engineering. Instituto Superior Técnico, Lisbon, Portugal.

Accepted for publication:

Authors	Date	Title	Journal / Reference / Type
Armanini, A., Fraccarollo, L., Larcher, M.	2004	Debris Flow	<i>Encyclopedia of Hydrological Sciences</i> , John Wiley & Sons,
Armanini, A.	2004	Mountain Streams	<i>Encyclopedia of Hydrological Sciences</i> , John Wiley & Sons,
Aronne Armanini, Hervé Capart, Luigi Fraccarollo and Michele Larcher	2004	Rheological stratification in experimental free-surface flows of granular-liquid mixtures	<i>Journal of Fluid Mechanics</i>
Leal, J.G.A.B.; Ferreira, R.M.L.; Cardoso, A.H		Dam-break wave front celerity	<i>Journal of Hydraulic Engineering</i>
Morris MW, Vaskinn KA and Hanson G	2006	Recent advances in predicting breach formation through embankment dams	ICOLD International Congress, Barcelona
Morris MW	2005	IMPACT – Investigation of extreme flood processes and uncertainty – a European Research Project	Defra 40 th Flood and Coastal Management Conference, 2005
C. Dal Cin, L. Moens, Ph. Dierickx, G. Bastin, Y. Zech		An integrated approach for real-time flood-map forecasting on the Belgian Meuse	Natural Hazards Paper



Authors	Date	Title	Journal / Reference / Type
S. Soares Frazão, F. Alcrudo, J. Mulet, B. Noël, G. Testa, Y. Zech		The IMPACT European research project on flood propagation in urban areas : experimental and numerical modelling of the influence of buildings on the flow	Natural Hazards Paper
Hanson G, Temple D, Morris M, Hassan MAAM, Cook K	2005	Simplified breach analysis model for homogeneous embankments II	US Society on Dams 2005 Annual Conference, Salt Lake City, Utah

Future Publications:

Authors	Date	Title	Journal / Reference / Type
Soares Frazão, F. Alcrudo, J. Mulet, B. Noël, G. Testa, Y. Zech.		The IMPACT European research project on flood propagation in urban areas : experimental and numerical modelling of the influence of buildings on the flow	submitted to Natural Hazards
Ferreira, R.L.L.; Leal, J.G.A.B.; cardoso, A.H.,		A Riemann solution for the dam-break wave propagation over a cohesionless mobile bed.	Journal of Fluid Mechanics (Submitted). Journal
Ferreira, R.M.L.; Leal, J.G.A.B. & Cardoso, A.H.	2004	Hydro and Sediment dynamics of Dam-Break Flows. A Conceptual Model	Journal of Fluid Mechanics Paper (to be submtd)
Ferreira, R.M.L.; Leal, J.G.A.B. & Cardoso, A.H.	2004	Hydro and Sediment dynamics of Dam-Break Flows. Analysis of the Wave Structure	Journal of Fluid Mechanics Paper (to be submtd)
K. El Kadi, A. Paquier	2005	<i>One-dimensional model for river morphology changes under unsteady flow</i>	To be submitted to Journal of Hydraulic Research
K. El Kadi	2005	<i>Evolution d'un lit de rivière en fonction des apports</i>	Ph D thesis
E. Mignot	2005	Estimation des risques d'inondation d'une zone urbanisée. - Définition d'une approche adaptée.	Ph D thesis
Partner IST	2005	<i>Simulation of the 1996 flood in Lake Ha!Ha!</i>	International conference
Partner IST	2005	<i>Simulation of the 1996 flood in Lake Ha!Ha! /6</i>	Journal paper
Partner IST	2005	<i>Experimental work on 1D dam-break waves over mobile beds</i>	International conference
Partner IST	2005	mathematical simulation of 2D-H dam-break waves over mobile beds	International conference
Partner IST	2005	<i>Experimental work on 1D dam-</i>	Portuguese journal paper



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		<i>break waves over mobile beds</i>	
Partner IST	2005	mathematical simulation of 2D-H dam-break waves over mobile beds	Portuguese journal paper
Partner H-EUR Aqua	2005	Summary of breach analyses	Hydraulic Engineering Review of Hungary

NOTE:

Details given in the tables above do not include specific publications and presentations made by all team members as part of the IMPACT Project workshops and / or meetings. Four workshops have been held, for which extensive material has been produced. This information may be accessed by the project website (www.impact-project.net) or through the workshop CD ROMS (also available via the website). Reports and documents produced as part of the technical work are also not listed above. Where available, these are listed on the project website.