



*Office
International
de l'Eau*



**EVALUATION OF THE IMPACT OF FLOODS
AND ASSOCIATED PROTECTION POLICIES**

Contract n° 07.0501/2004/389669

Final Report
Annexes

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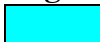


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Bibliography

Codification rule

- *FLP documents refer to flood policies*
- *FLM documents refer to measures*
- *FLD documents refer to damages*
- *FLE documents refer to economics*

Legend

-  Documents related to the Rhine basin
-  Documents related to the Loire basin
-  Documents related to flash floods basins

Literature on flood policies

Title	Author	Year	Full reference	Key words	Type	Code
Background paper	Dworak T., Hansen W., Kraemer R. A.	2003	Precautionary flood protection in Europe, International workshop, 5-6 February 2003, Bonn, 6p	Flood management plan - Precautionary measures - Integrated policies - European policy	E	FLP01
Workshop report	Dworak T., Hansen W., Kraemer R. A.	2003	Precautionary flood protection in Europe, International workshop, 5-6 February 2003, Bonn, 10p	Flood management plan - Precautionary measures - Integrated policies - European policy	E	FLP01b
The European flood approach	Dworak T., Hansen W.	2003	International Conference "Towards natural flood reduction strategies", Warsaw, 6-13 Sept. 2003, 6p	European strategy - WFD - Financial sources	E	FLP02
Flood risk management - Flood prevention, protection and mitigation	European Commission	2004	Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions, COM(2004)472 final, 11p	European strategy - EU Action programme - Flood risk management plans - Flood risk maps	E	FLP03
Flood risk to people - Phase 1	Ramsbottom D., Floyd P., Penning-Rowsell E.	2003	R&D Technical report, DEFRA-Environment Agency, FD2317, 117p	Flood risk mapping - Harm to people - Flood risk assessment	E	FLP04
Flood risk and development - A sustainable and appropriate approach	Adamson M., Cussen N.	2003	Irish National hydrology Seminar 2003, 12p	Flood risk management - Flood management plans - Ireland	E	FLP05
Report of the flood policy review group	Parlon T. (lead author)	2003	Irish Office of public works, 2003, 236 p	Best practice - Roles & responsibilities of the main state bodies - Cost of measures	E	FLP06
Health aspects of natural flood defences	Leenen E. J. T. M.	2003	International Conference "Towards natural flood reduction strategies", Warsaw, 6-13 Sept. 2003, 5p	Health risk assessment - Risk management Environmental circumstances	E	FLP07
Risque d'inondation : une notion probabiliste complexe pour le citoyen	Gendreau N., Grelot F., Garçon R., Duband D.	2003	Ingénieries n°34, June 2003, pp17-24	Flood risk perception - Public participation - Risk mapping	E	FLP08
Rhin 2020 - Programme pour le développement durable du Rhin	CIPR	2001	CIPR, 27p	Rhine basin - Action plan - Flood policy	E	FLP09
Le Plan Loire grandeur nature dans la perspectives des contrats de plan Etat-Région 2000-2006	Préfet coordonateur du bassin Loire-Bretagne	1999	Préfecture de bassin Loire-Bretagne, 34p	Loire basin (France) - Vulnerability - Crisis management - Protection	E	FLP10
Synthèse des propositions pour une stratégie globale de réduction des risques d'inondation par les crues fortes en Loire moyenne	Equipe pluridisciplinaire Plan Loire Grandeur Nature	1999	Equipe pluridisciplinaire Plan Loire Grandeur Nature, 60p	Loire basin (France) - Damages - Culture of risk - Flood policy-making	E	FLP11
L'aménagement de la Loire dans la deuxième moitié du 20ème siècle	Thépot R.	2003	Etablissement public Loire, 10p	Loire basin (France) - Historical analysis	E	FLP12
Crues fortes en Loire moyenne: mieux comprendre leurs origines, leurs conséquences et les moyens de s'en prémunir	Clericy O.	2004	DIREN Centre, draft document, 17p	Loire basin (France) - Origins of floods - Practical advice - Flood policy explanation	E	FLP13
Eléments pour comprendre la nécessité de conduire d'ici 2006 des études du risque d'inondation sur certains secteurs de la Loire moyenne	Equipe pluridisciplinaire Plan Loire Grandeur Nature	2004	Equipe pluridisciplinaire Plan Loire Grandeur Nature, working paper, 37p	Loire basin (France) - Vulnerability - Working programme - Open decision-making process	E	FLP14
Programmation des crédits PIRLGN "volet sécurité" pour la région Centre	Equipe pluridisciplinaire Plan Loire Grandeur Nature	2000	Equipe pluridisciplinaire Plan Loire grandeur nature, 34p (slides)	Loire basin (France) - Diagnosis - Mid-term strategy - Cost of measures appraisal	E	FLP15

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La Loire en crue	Equipe pluridisciplinaire Plan Loire Grandeur Nature	2004	Equipe Pluridisciplinaire Plan Loire Grandeur Nature, 41p	Loire basin (France) - Protection - Prevention - History of floods - Description of events	E	FLP16
Les causes des inondations répétitives ou exceptionnelles et les conséquences des intempéries	Galley R.	2001	Commission d'enquête sur les causes des inondations exceptionnelles, Assemblée nationale	Origins of floods - Types of measures - Damages - French policy	E	FLP17
Les causes des inondations et les moyens d'y remédier	Mariani T.	1994	Commission d'enquête sur les causes des inondations et les moyens d'y remédier, Assemblée nationale	Origins of floods - Types of measures - Damages - French policy	E	FLP18
La prévention des inondations en France	Cour des Comptes	1999	Rapport public, Cour des Comptes	Flood hazard - Vulnerability - Economic assessment - French policy	E	FLP19
Les inondations de la Somme	Deneux M.	2001	Commission d'enquête sur les inondations de la Somme, 190p - Annexes 399p	Somme basin (France) - Characterisation of the flood - Types of measures - Recommendations	E	FLP20 FLP20b
Les enseignements des crues de novembre 1999 et la lutte contre les inondations en France	Vinet F.	2003	in "Crues et inondations dans la France méditerranéenne", Editions du Temps, 224p (pp161-176)	Languedoc basins (France) - Flash floods - Flood risk management	E	FLP21
Les retours d'expérience des inondations catastrophiques et les inspections des services déconcentrés en charge des risques naturels	Collective paper	2002	Inspection générale de l'administration, Conseil général des Ponts et Chaussées, Conseil général du génie rural, des eaux et des forêts, Inspection générale de l'environnement, 21p	French policy - Recommendations for flood policy	E	FLP22
A l'épreuve d'une catastrophe - Les inondations de novembre 1999 dans le midi de la France	Vidal-Naquet P.-A., Calvet F.	2000	CERPE, SAFEGE-CETIIS, Ministère de l'aménagement du territoire et de l'environnement, 31p	Culture of risk - Citizens behaviour - Public participation	E	FLP23
Flood risk - A government perspective	Purnell R.	2002	Civil engineering 150, may 2002, pp10-14	Flood hazard - Reduction of vulnerability - UK policy	E	FLP24
Guidelines for reducing flood losses	Pilon P. J., Davis D., Halliday R., Paulson R.	2004	International strategy for disaster reduction, United Nations, 87p	Flood disaster management - Flood response system - Socio-economic aspects	E	FLP25
Floods across Europe - Flood hazard assessment, modelling and management	Penning-Rowsell E., Fordham M.	1994	Middlesex University Press, 214p	Flood policies - Vulnerability - Hazard appraisal - Hazard management	P	FLP26
La perception sociale des risques naturels	Roy A.	2005	IFEN, Les données de l'environnement n°99, Janvier 2005, 4p	Risk perception - Natural hazard	E	FLP27
Gewässerschutz- und Hochwasserschutzrecht – Ein Vergleich zwischen Deutschland	Kramer M., Brauweiler H.-Ch. (eds)	2000	Polen und Tschechien . Wiesbaden			FLP28
Lessons learned - Autumn 2000 floods	Environment Agency	2000	Environment Agency, 68p	Post event study - English policy - Recommendations for flood policy	E	FLP29

Literature on measures

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L'annonce des crues en France	Ben Ali N.	2000	Synthèse ENGREF-OIE, 24p	Flood forecasting - Alert	E	FLM01
The faulty solution of anti-flood measures	Ostaficzuk S., Ostrowski M.	2003	International Conference "Towards natural flood reduction strategies", Warsaw, 6-13 Sept. 2003, 8p	Non structural measures - Flood hazard factors - Mitigation measures - Retention of water	E	FLM02
Best practices on flood prevention, protection and mitigation	European core group on flood protection of the Water Directors	2003	29p	European policy - Best practices - Flood management plan - River flood - Flash floods	E	FLM03
Dynamic slowdown : from integrated management to flood mitigation	Poulard C., Ghavasieh A. R., Gamerith V., Szczesny J., Witkowska H.	2003	International Conference "Towards natural flood reduction strategies", Warsaw, 6-13 Sept. 2003, 6p	Dynamic slow down - Mitigation measures - Retention of water	E	FLM04
Standardised risk maps for better integrated risk assessment in the European Community	Stuive H. P.	2003	International Conference "Towards natural flood reduction strategies", Warsaw, 6-13 Sept. 2003, 6p	Riskmaps - Non-structural measures - Mitigation measures - Risk assessment	E	FLM05
Flood risk and vulnerability in a changing world	Kundzewicz Z., Menzel L.	2003	International Conference "Towards natural flood reduction strategies", Warsaw, 6-13 Sept. 2003, 8p	Flood risk vulnerability - Preparedness - Natural flood protection	E	FLM06
Integrated washland management for flood defence and biodiversity	Hess T. M., Morris J., Gowing D. G., Leeds-Harrison P. B., Bannister N., Vivash R. M. N., Wade M.	2003	International Conference "Towards natural flood reduction strategies", Warsaw, 6-13 Sept. 2003, 7p	Hydraulic matrix - Habitat matrix - Washland management - UK	E	FLM07
Precautionary and sustainable flood protection in Germany - Strategies and instruments of spatial planning	Friesecke F.	2004	3rd FID Regional Conference, Jakarta, 3-7 October 2004, 17p	Flood management - Spatial planning - Risk mapping - Germany	E	FLM08
Plan d'action contre les inondations	CIPR	1998	CIPR, 30p	Rhine basin - Measures - Management plan - Cost of implementation	P	FLM09
Mise en œuvre du plan d'action contre les inondations jusqu'en 2000	CIPR	2001	CIPR, 31p	Rhine basin - Measures - Management plan - Cost of implementation	E	FLM10
The "Action plan on flood defence" of the International Commission for the Protection of the Rhine as an example for European co-operation	Petrascheck A.	2003	Precautionary flood protection in Europe, International workshop, 5-6 February 2003, Bonn, 27p	Rhine basin - Measures - Management plan - Cost of implementation - Reduction of vulnerability	E	FLM11
Non structural flood plain management: measures and their effectiveness	CIPR	2002	CIPR, 50p.	Rhine basin - Measures - Reduction of vulnerability	E	FLM12
Flood damage modelling in the Netherlands. Damage reduction by non-structural measures	Den Heijer F., De Bruin K.		Delft Hydraulics	Rhine basin - Non-structural measures - Damage reduction - Netherlands	E	FLM13
Flood risk reduction strategy along the river Loire	Camp'huis N.-G.	2003	Precautionary flood protection in Europe, International workshop, 5-6 February 2003, Bonn, 15p	Loire basin (France) - Reduction of vulnerability - Prevention measures	E	FLM14
Plan LoireGrandeur Nature - Tableau de bord - Etat au 31 décembre 2002	Secrétariat général du Plan Loire	2003	Préfecture de la Région centre, DIREN Centre, 242 p	Loire basin (France) - Regional measures - Cost of implementation	E	FLM15
Plan LoireGrandeur Nature - Tableau de bord - Etat au 31 décembre 2003	Secrétariat général du Plan Loire	2004	Préfecture de la Région centre, DIREN Centre, 330 p	Loire basin (France) - Regional measures - Cost of implementation	E	FLM16

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Réduire le risque d'inondation en Loire moyenne: ce qui doit être fait!	Equipe pluridisciplinaire Plan Loire Grandeur Nature	2002	Equipe pluridisciplinaire Plan Loire Grandeur Nature, draft document, 16p	Loire basin (France) - Measures - Reduction of vulnerability	E	FLM17
Utiliser les vals pour écréter les crues et réduire les inondations. Comment et à quelles conditions?	Camp'huis N.-G.	2002	Equipe pluridisciplinaire Plan Loire Grandeur Nature, draft document, 6p	Loire basin (France) - Peak run-off reduction - Non-structural measure	E	FLM18
Note au comité technique - Diminution des atteintes majeures pour les crues centennales	Camp'huis N.-G.	1998	Equipe pluridisciplinaire Plan Loire Grandeur Nature, Working paper, 5p	Loire basin (France) - 100 year return flood - Diminution of major damages	E	FLM19
Propositions techniques pour des simulations visant à éviter les atteintes majeures pour les crues centennales	Camp'huis N.-G.	1998	Equipe pluridisciplinaire Plan Loire Grandeur Nature, Working paper, 20p	Loire basin (France) - 100 year return flood - Diminution of major damages - Technical options	E	FLM20
Document sur la stratégie de réduction des risques d'inondation par les crues fortes et son influence sur la programmation	Equipe pluridisciplinaire Plan Loire Grandeur Nature	2000	Equipe pluridisciplinaire Plan Loire Grandeur Nature, Working paper, 10p	Loire basin (France) - Socio-economic issues - Cost of measures appraisal - Comparison of scenarios	E	FLM21
Réduire la vulnérabilité à l'inondation des territoires inondables	Equipe pluridisciplinaire Plan Loire Grandeur Nature	2002	Equipe pluridisciplinaire Plan Loire Grandeur Nature, 5p	Loire basin (France) - Reduction of vulnerability - Action programme	E	FLM22
Le modèle Loire moyenne HYDRA 1998	Equipe pluridisciplinaire Plan Loire Grandeur Nature	2004	Equipe pluridisciplinaire Plan Loire Grandeur Nature, 33p	Loire basin (France) - Modelling - Flood hazard map	E	FLM23
Les enseignements du modèle Loire moyenne	Equipe pluridisciplinaire Plan Loire Grandeur Nature	2004	Equipe pluridisciplinaire Plan Loire Grandeur Nature, 65p	Loire basin (France) - Hydraulic model - Damage simulation	E	FLM24
Restaurer et entretenir le lit de la Loire	Equipe pluridisciplinaire Plan Loire Grandeur Nature	2004	Equipe pluridisciplinaire Plan Loire Grandeur Nature, 44p	Loire basin (France) - Scenarios - River maintenance	E	FLM25
Le système de levées de la Loire moyenne	Hydratec	2003	Equipe pluridisciplinaire Plan Loire Grandeur Nature, 64p	Loire basin (France) - Dykes - Weirs - Modelling	E	FLM26
La Loire et ses levées	Camp'huis N.-G.	2004	Equipe pluridisciplinaire Plan Loire Grandeur Nature, 7p	Loire basin (France) - Dykes - Functioning - Maintenance	E	FLM27
La Loire et ses déversoirs	Camp'huis N.-G.	2004	Equipe pluridisciplinaire Plan Loire Grandeur Nature, 7p	Loire basin (France) - Weirs - Functioning - Maintenance	E	FLM28
Propositions préalables à la définition d'une stratégie globale de réduction des risques dus aux crues du Rhône	Hydratec	2003	Etablissement public territorial de bassin "Territoire Rhône", 99p	Rhône basin (France) - Characterisation of flood hazard - Protection measures - Prevention measures	E	FLM29
Le ralentissement dynamique pour la prévention des inondations	Dunglas J. (lead author)	2004	Ministère de l'écologie et du développement durable, CEMAGREF, 131p	Dynamic slowdown - Methodology for designing works - CBA	E	FLM30
Retour d'expérience sur les inondations du Sud-Est de septembre 2002	Huet P.	2003	Annales des Mines - Responsabilité et environnement, Octobre 2003, pp 63-72	Languedoc basin (France) - Feedback analysis - Methodology - Flash flood	E	FLM31
Inondations et coulées boueuses en Seine-Maritime - Propositions pour un plan d'action	Merle J.-P., Huet P., Martin X., Verrel J.-L., Rat M., Boutin J.-N., Bourget B., Varret J.	2001	Inspection générale de l'environnement, IGE/00/032, 70p - Annexes 43p	Seine-Maritime basin (France) - Feedback analysis - Action plan - Cost of measures	E	FLM32 FLM32b
Les risques inondations en Rhône-Alpes : de la connaissance à la prévention	Direction régionale de l'environnement	2004	Direction régionale de l'environnement de Rhône-Alpes, Ministère de l'écologie et du développement durable, 36p	Rhône basin (France) - Characterisation of flood hazard - Protection measures - Prevention measures	E	FLM33
Travaux post-crues : bien analyser pour mieux agir	Michelot J.-L., Malavoi J.-R., Gendreau N.	1999	GRAIE, 24p	Rhône basin (France) - Emergency works - Feedback - Recommendations	E	FLM34

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Synthèse des évaluations socio-économiques des instruments de prévention des inondations	Bruno Ledoux Consultants, CEREVE, CEMAGREF	2004	Ministère de l'écologie et du développement durable, D4E, 185p	Economic appraisal of measures - Comparison of methodologies - Comparison of national approaches	E	FLM35
Projet de plan de prévention des inondations sur le bassin de la Vidourle	Conseil général du Gard (lead author)	2003	Conseil général du Gard, Conseil général de l'Hérault, Syndicat mixte interdépartemental d'aménagement et de mise en valeur du Vidourle et de ses affluents, 39p	Vidourle basin (France) - Flash flood - Characterisation of local flood risk - Action plan - Estimation of costs	E	FLM36
Charte de gestion du risque inondation sur les bassins versants de l'Aisne et de l'Oise	Entente interdépartementale Oise-Aisne	2001	Entente interdépartementale Oise-Aisne, 19p	Aisne & Oise basins (France) - Action plan - Financial plan	E	FLM37
Les crues des 12, 13 et 14 novembre 1999 dans les départements de l'Aude, de l'Hérault, des Pyrénées Orientales et du Tarn	Lefrou C., Martin X., Labarthe J.-P., Varret J., Mazière B., Tordjeman R., Feunteun R.	2000	Conseil général des Ponts et Chaussées, Inspection générale de l'environnement, 140p	Languedoc basins (France) - Feedback analysis - Flash flood - Recommendations	E	FLM38
Retour d'expérience sur la gestion post-catastrophe dans les départements de l'Aude et du Tarn	Ledoux B.	2000	Ministère de l'aménagement du territoire et de l'environnement, DPPR, 70p	Languedoc basins (France) - Crisis management - Emergency measures	E	FLM39
Torrents : une veille permanente	Roy N. (lead author)	1997	Institut des risques majeurs, Risque information n°8, avril 1997, 27p	Flash floods - Characterisation - Specific measures	E	FLM40
Plan global frente a inundaciones en la ribera del Jucar : propuesta de actuacion	Confederacion hidrografica del Jucar	2000	Confederacion hidrografica del Jucar, 81p	Jucar basin (Spain) - Flash floods - Action plan - Recommended measures	E	FLM41
Cartografia de riesgo de inundacion en la ribera del Jucar	Confederacion hidrografica del Jucar	2002	Confederacion hidrografica del Jucar, 25p	Jucar basin (Spain) - Flood risk mapping	E	FLM42
The use of historical flood information in the English Midlands to improve risk assessment	Williams A., Archer D.	2002	Hydrological Sciences Journal 47(1), 2002, pp67-76	Midlands basin (UK) - Flood risk - Frequency analysis - Historical data	E	FLM43
Dam-break flood emergency management system	Rodrigues A. S., Santos M. A., Santos A. D., Rocha F.	2002	Water resources management, 16, 2002, pp489-503	Flood hazard - Emergency planning	E	FLM44
Risk-based floodplain management : a case study from Greece	Ganoulis J.	2003	International journal of river basin management, Vol 1, n°1, 2003, pp41-47	Giofyros basin (Greece) - Flood control - Risk analysis	E	FLM45
Benefits of flow-data for flood-protection design	Cordery I., Cloke P. S.	1994	J.IWEM 1994, 8, February, pp33-38	Flood mitigation measures - Value of stream-flow data - Methodology	E	FLM46
Plan d'action inondations Meuse - Rapport d'avancement 1995-2001	Groupe de travail pour la prévention des inondations dans le bassin de la Meuse	2001	Commission internationale pour la protection de la Meuse, 48p	Meuse basin - Implementation of the action plan - Description of measures taken - Investments	E	FLM47
Gestion de l'inondabilité et protection des lieux habités du Val de Saône	Syndicat mixte Saône et Doubs	2002	Syndicat mixte Saône et Doubs, 21p	Saône basin (France) - Reduction of vulnerability - Description of measures - Cost of measures	E	FLM48
Rheinland-Pfalz - Haushaltplan für die Haushaltsjahre 2005/2006	Ministerium für Umwelt und Forsten	2004	Einzelpan 14, Ministerium für Umwelt und Forsten, 288p	Rhine basin - Flood policy - Cost of measures	E	FLM49
Aktionsplan Hochwasser im Einzugsgebiet der Nahe	Ministerium für Umwelt und Forsten	2001	Ministerium für Umwelt und Forsten, 33p	Rhine basin - Flood action plan	E	FLM50
Hochwasserverschärfung und Vulnerabilität	Schmidtke R.	2004	Praktikerseminar "Wirtschaftlichkeitsbetrachtungen in Hochwasserschutzplanungen", Stuttgart, 29-30 Nov 2004, 12p	Vulnerability diagnosis - Reduction of vulnerability	E	FLM51

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Hochwassergefährdung am Ober- und Mittelrhein	Bund-Länder working group	1995	Wasser- und Schifffahrtsverwaltung des Bundes - Wasserwirtschaftsverwaltungen der Länder Baden-Württemberg, Hessen und Rheinland-Pfalz, 30p	Rhine basin - Cost of measures	P	FLM52
Constat et stratégie pour le plan d'action contre les inondations	ICPR	1995	ICPR, 40p	Rhine basin - Action plan - Strategy	P	FLM53
Annonce et prévision des crues dans le bassin du Rhin - Etat actuel et propositions d'amélioration	ICPR	1997	ICPR, 29p	Rhine basin - Flood forecasting - Proposals for improvements	E	FLM54
Wirtschaftlichkeitsbetrachtungen in Hochwasserschutzplanungen	Schmidtke R.	2004	Wasserwirtschaft 9/2004, pp16-20	Flood action plan - Economic assessment - Methodology	P	FLM55
Estimation de l'impact de la rétention des eaux dans le bassin du Rhin	ICPR	1999	ICPR, 39p	Rhine basin - Prevention measures - Retention - Floodplain flooding	P	FLM56
Bewertungsgutachten für Deichbauvorhaben an der Festlandküste	Bundesminister für Ernährung Landwirtschaft und Forsten	1990	Bundesminister für Ernährung Landwirtschaft und Forsten, 149p		P	FLM57
Living with floods - Resilience strategies for flood risk management and multiple land use in the lower Rhine River basin	Vis M., Klijn F., Van Buuren M.	2001	Netherlands centre for river studies	Rhine basin - Risk management strategies - Resilience - Alternative options - Comparison	P	FLM58
Living with floods - Resilience strategies for flood risk management and multiple land use in the lower Rhine River basin	Vis M., Klijn F., Van Buuren M.	2001	Netherlands centre for river studies, Executive summary, 34p	Rhine basin - Risk management strategies - Resilience - Alternative options - Comparison	E	FLM58b
Regional scale analysis	Klaus J., Pflügner W., Schmidtke R.	1994	EUROflood project, Technical annex 3, 73p	Regional flood policy - Modelling - Socio-economic damage appraisal	P	FLM59
Plan d'action inondations Meuse	Groupe de travail pour la prévention des inondations dans le bassin de la Meuse	1998	Commission internationale pour la protection de la Meuse, 60p	Meuse basin - Definition of action plan Protection measures - Water retention	P	FLM60
Stratégie d'aménagement hydraulique pour réduire le risque	Entente interdépartementale Oise-Aisne	2001	Entente interdépartementale Oise-Aisne, 17p	Aisne & Oise basins (France) - Flood hazard - Hydraulic works	P	FLM61
Construction de critères d'évaluation de scénarios de gestion de crues fortes en Loire moyenne	Azibi A.R.	1997	Université Paris Dauphine-DEA103, rapport de stage, 57p	Loire basin - Scenarios - Multi-criteria analysis - Determination of relevant criteria	P	FLM62
Plan d'action contre les inondations dans le bassin Moselle-Sarre	CIPMS	1997	CIPMS	Moselle-Sarre basin - Action plan - Planification of measures	E	FLM63 FLM63b
Farms adaptation to changes in flood risk: a management approach	Pivot J.-M., Josien E., Martin P.	2002	Journal of Hydrology 267 (2002), pp.12-25	Flood expansion areas - Impact on agriculture - Farms management - Uncertainty	E	FLM64
Non-structural flood protection - A challenge	Menzel L., Kundzewicz Z.W.	2003	International Conference "Towards natural flood reduction strategies", Warsaw, 6-13 Sept. 2003, 5p	Vulnerability - Non-structural measures - Natural flood reduction measures	E	FLM65
Guidelines for rehabilitation and management of floodplains - Ecology and safety combined	Wolters H.A., Platteeuw M. Schoor M. M.	2001	Netherlands centre for river studies, 185p	Ecological rehabilitation of floodplains - Technical guidelines - Flood policy	E	FLM66
Economics of streamflow data collection	Cordery I., Cloke P. S.	1992	Water international 17(92), pp.28-32	Costs and benefits of data collection	E	FLM67
Flood management and development opportunities - New flood warning schemes	Bayes C.	2003	Scottish Environment Protection Agency, SEPA70/03, 11p	Clyde, Irvine, Kelvin basin (UK) - Early warning systems - Forecasting measures	E	FLM68

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Mise en œuvre du plan d'action contre les inondations en 2001 et 2002	ICPR	2003	ICPR, 10p	Rhine basin - Measures - Management plan - Interim evaluation of implementation	E	FLM69
De l'atlas des zones inondables aux plans de prévention des risques. Bilan 2001 en Rhône-Alpes	Direction régionale de l'environnement	2001	Direction régionale de l'environnement de Rhône-Alpes, Ministère de l'écologie et du développement durable, 16p	Hazard mapping - Contents - Usefulness	E	FLM70
Resilient flood risk management strategies	de Bruijn K. M., Klijn F.	2001	IRMA SPONGE, Living with floods paper, 9p	Resilience - Vulnerability - Impacts of flood	E	FLM71
La sécurité des digues du delta du Rhône - Politique de constructibilité derrière les digues	Balland P., Martin X., Monadier P., Thibault M., Portier B., Laurain C., Nassiet Y., Rober de Saint-Vincent E.	2004	Inspection générale de l'environnement, IGE/03/069, Ministère de l'écologie et du développement durable, 154p	Rhône basin - Feedback analysis - Dykes maintenance	E	FLM72
Baden-Württemberg - Haushaltplan für die Haushaltsjahre 2004	Finanzministerium Baden-Württemberg	2004	Einzelpan 10, Ministerium für Umwelt und Verkehr, 308p	Rhine basin - Flood policy - Cost of measures	E	FLM73
Ausgaben für technischen Hochwasserschutz für einige Regierungsbezirke in Baden-Württemberg	Die jeweilige Gewässerdirektion		Maßnahmen des Landes für technischen Hochwasserschutz an Gewässern I. Ordnung und Rhein und dafür erforderliche Investitionen	Rhine basin - Flood policy - Cost of measures	E	FLM74
Köln - Wirtschaftsplan 2004/2005	Finanzamt Köln	2004		Rhine basin - Flood policy - Cost of measures - Cologne	E	FLM75
Umsetzung des Aktionsplan Hochwasser in Rheinland-Pfalz	Ministerium für Umwelt und Forsten	2000	Ministerium für Umwelt und Forsten, 100p	Rhine basin - Flood action plan	E	FLM76
Aktionsplan Hochwasser im Einzugsgebiet der Sieg	Staatliches Umweltamt Siegen	2000	Ministerium für Umwelt und Forsten, 130p	Rhine basin - Flood action plan	E	FLM77
Aktionsplan Hochwasser im Einzugsgebiet der Lenne	Staatliches Umweltamt Hagen	2001	Ministerium für Umwelt und Forsten, 130p	Rhine basin - Flood action plan	E	FLM78
Aktionsplan Hochwasser im Einzugsgebiet der Lippe	Ministerium für Umwelt und Forsten	2002	Ministerium für Umwelt und Forsten, 154p	Rhine basin - Flood action plan	E	FLM79
Plan d'action contre les inondations dans le bassin de la Moselle et de la Sarre - Mise en œuvre 1998-2000	CIPMS	2002	CIPMS, 40p	Moselle-Sarre basin - Action plan - Interim evaluation of implementation	E	FLM80
Entente Oise-Aisne - Rapport d'activités 2003	Entente interdépartementale Oise-Aisne	2004	Entente interdépartementale Oise-Aisne, 52p	Oise-Aisne basin - Action plan - Interim evaluation of implementation	E	FLM81
Sichern und wiederherstellen von Hochwasserrückhalteflächen: Fallstudie Köln	UBA F and E	2003	Umwelt Bundesamt 201 F +E 201 16 116 8p.	Lowlands, Aue, Rhein, danger avoidance, Köln, structural protection measures	E	FLM82
Hochwasser-Aktionsplan Lippe: Grundlagen, Überflutungsgebiete, Schadenspotential, Defizite und Maßnahmen	Hydratec Aachen	2002	Staatlichen Umweltamtes Lippe in Kooperation mit Lippeverband Wasserverband Obere Lippe (Dez 2002), 154p.	Flood action plans, Hydraulic Models, Flood statistics, Flood dangers, Flood prevention, Deficits	E	FLM83
Gewässerdirektion Südlicher Oberrhein/Hochrhein: Maßnahmen des Landes für technischen Hochwasserschutz an Gewässern I Ordnung und Rhein und dafür erforderliche Investitionen	Regierungsbezirk Freiburg	2002	Gewässerdirektion Sudlicher Oberrhein/Hochrhein, 3p	Costs, Reservoirs, Dikes, Dams, Object protection	E	FLM84

Title	Author	Year	Full reference	Key words	Type	Code
Gewässerdirektion Nordlicher Oberrhein: Maßnahmen des Landes für technischen Hochwasserschutz an Gewässern I Ordnung, Rhein und Neckar und dafür erforderliche Investitionen	Regierungsbezirk Karlsruhe	2002	Gewässerdirektion Nordlicher Oberrhein, 3p	Costs, Reservoirs, Dikes, Dams, Object protection	E	FLM85
Heiden: Wenn die Strasse zum Fluss wird	Bundesamt für Wasser und Geologie	2004	Heiden: Wenn die Strasse zum Fluss wird (2004), 4p.	Flood simulation, catchment areas, events of loss	E	FLM86
Malcaltone: Wurzelwerk statt Betonbau	Bundesamt für Wasser und Geologie	2004	Malcaltone: Wurzelwerk statt Betonbau (2004), 4p.	Engineering and Biological Measures, Flood protection concepts	E	FLM87

Literature on damages

Title	Author	Year	Full reference	Key words	Type	Code
Les crues meurtrières, du Roussillon aux Cévennes	Antoine J.-M., Desailly B., Gazelle F.	2001	Annales de Géographie, n°622, Nov-Dec 2001, 19p	Languedoc basins (France) - Casualties - Flash floods	E	FLD01
Mapping the impacts of recent natural disasters and technological accidents in Europe	Sauri D. (lead author)	2003	European Environment Agency, Environmental Issue Report n°35, 54p	Damages - Environmental impact - Recent major flood events	E	FLD02
Atlas de l'aléa d'inondation et des dommages potentiels en cas de crues extrêmes sur le Rhin	CIPR		CIPR, 13p + maps	Rhine basin - Damage maps - Cost of the damages - Methodology for calculation	E	FLD03
Evaluation des enjeux et des dommages potentiels liés aux inondations en Loire moyenne. Méthode et principaux résultats	Devayx-Ros C.	2000	Equipe pluridisciplinaire Plan Loire grandeur nature, 65p	Loire basin (France) - Damages appraisal - Vulnerability - Methodology for calculation	E	FLD04
Mission d'expertise sur les crues de décembre 2000 et janvier 2001 en Bretagne	Huet P., Roussel P., Martin X., Bourget B., Varret J., Guellec J., Monadier P., Sauzey P., Teyssier A.	2001	Ministère de l'intérieur, Ministère de l'équipement, des transports et du logement, Ministère de l'agriculture et de la pêche, Ministère de l'aménagement du territoire et de l'environnement, 144p.	Bretagne basins (France) - Damages appraisal - Ex-post analysis - Prevention policy	E	FLD05
Enjeux, dommages et éléments d'une stratégie	Equipe pluridisciplinaire Plan Loire Grandeur Nature	2004	Equipe pluridisciplinaire Plan Loire Grandeur Nature, 50p	Loire basin (France) - Damages appraisal - Vulnerability - Methodology for calculation	E	FLD06
Dommages des crues, bassin de la Moselle	BCEOM	1990	BCEOM, 31p	Moselle basin (France) - Damages - Economic appraisal - Industry, agriculture, urban sectors	E	FLD07
Estimation des dégâts après "grands événements"	EDATER	2001	Ministère de l'aménagement du territoire et de l'environnement, DPPR, 84p.	France - Damages appraisal - Methodology - Feedback expertise	E	FLD08
Rapport de la mission d'expertise sur les crues d'avril 2001 du bassin de la Somme	Lefrou C. (lead author)	2001	Ministère de l'intérieur, Ministère de l'équipement, des transports et du logement, Ministère de l'agriculture et de la pêche, Ministère de l'aménagement du territoire et de l'environnement, 83p. - Annexes 8p	Somme basin (France) - Damages appraisal - Ex-post analysis - Prevention policy	E	FLD09 FLD09b
La prise en compte des incertitudes dans l'estimation du coût des dommages dus aux inondations	Gaume E., Hubert G., Torterotot J.-P.	2000	La Houille Blanche, 3/4-2000, pp76-82	Loire basin (France) - Damages appraisal - Integration of uncertainty	E	FLD10
Intangible flood damage quantification	Lekuthai A., Vongvisessomjai S.	2001	Water resources management 15, pp343-362	Thailand - Intangible damage assessment - Anxiety	E	FLD11
Multi-coloured manual	Flood Hazard Research Centre	2002	Flood Hazard Research Centre, 43p (chapter 4)	UK - Damage - Residential houses - Social impact	E	FLD12
Ermittlung der Hochwasserschadenpotentiale in Bad Kreuznach und Wirtschaftlichkeits-betrachtung zum geplanten Schutz	Rodriguez E.	2004	Hochwasserschutz Bad Kreuznach, Rhineland-Palatinate Ministry of Environment and Forestry, 2p		E	FLD13
Etude d'efficacité. France et Belgique. Rapport final	Perrin J.-F., Gendreau N.	2001	CEMAGREF, ICPR-IRMA, 81p	Meuse basin - Damage appraisal - Reference costs - Reduction of vulnerability	E	FLD14
Wirksamkeitsstudie. Status Quo und Trendanalyse sowie Fallstudien zu den Teilräumen	Boettcher, R., Schlenkhoff, A., Löwenberg, A.	2001	Björnnsen Beratende Ingenieure, ICPR, 92p	Rhine basin -	E	FLD15

Title	Author	Year	Full reference	Key words	Type	Code
Auswertung der Schadendaten des Oderhochwassers 1997	ICPR	2002	ICPR, 32p	Rhine basin -	E	FLD16
Wirksamkeitsstudie. Beitrag der Schweiz	Burlando P., Ruf W.	2001	ETH, ICPR, 106p	Rhine basin - Switzerland	E	FLD17
Schadenanalyse und Schadenverminderung im Siedlungsbereich	Pasche, E., Geissler, T.R.	2001	Technische Universität Hamburg-Harburg - ICPR, 328p	Rhine basin -	E	FLD18
Atlas des enjeux socio-économiques exposés au risque d'inondation en Loire moyenne	Equipe pluridisciplinaire Plan Loire Grandeur Nature	2000	Equipe pluridisciplinaire Plan Loire Grandeur Nature, 240p	Loire basin - Damages - Flood hazard mapping	P	FLD19
Conséquences économiques d'une inondation de la Loire sur le secteur agricole du Val d'Authion - Evaluation des dommages potentiels unitaires par hectare de culture et par tête de cheptel	Lambert V.	1997	INA-PG (rapport de stage), Equipe Pluridisciplinaire Plan Loire Grandeur Nature, 28p+annexes	Loire basin - Appraisal of damages to agriculture - Unitary costs	P	FLD20
Vers une évaluation de la vulnérabilité de l'agriculture aux inondations	Bombrun H.	1999	AScA, Ministère de l'aménagement du territoire et de l'environnement, 49p + annexes	Loire basin - Appraisal of damages to agriculture - Typology of damages	P	FLD21
Vers une évaluation de la vulnérabilité de l'agriculture aux inondations	Bligny C.	1999	AScA, Ministère de l'aménagement du territoire et de l'environnement, 44p + annexes	Loire basin - Appraisal of damages to agriculture - Typology of damages	P	FLD22
Inondations de Novembre 1999 dans le Sud de la France - Estimation des dommages des crues et cartographies des zones inondées	BCEOM	2000	Ministère de l'aménagement du territoire et de l'environnement, DPRM, 25p.	Aude basin - Flash floods - Appraisal of damages	E	FLD23
Ermittlung wirtschaftlicher Nachteile für die Landwirtschaft durch die Schaffung von Retentionsraum	Schätzl R., Hoffmann H.	2003	HW 47.2003, H.2, pp.52-58	Danube & Main basins - Extension of retention capacities - Cost for agriculture	E	FLD24
The hidden impacts of flooding: experiences from two English communities	Tapsell S.	2001	Intergated water resources management, 272-2001, pp.319-324	Oxfordshire - Intangible damages - Stress - Vulnerability	E	FLD25
Le coût du risque... L'évaluation des impacts socio-économiques des inondations	Hubert G., Ledoux B. (lead authors)	1999	Presses de l'École nationale des Ponts et Chaussées, 232p	Damages appraisal - Case studies - Methodologies	P	FLD26
Analyse des retours d'expérience des inondations : Bretagne et Saône	EDATER, Ledoux B.	2002	Agence de l'eau Loire-Bretagne, Equipe Pluridisciplinaire Plan Loire Grandeur Nature, final report, 16p	Feedback analysis - Surveys - Individuals' behaviours - Damages	E	FLD27
Retour d'expérience sur l'inondation de l'habitat et de l'habitant : enquête en Bretagne et sur la Saône - Vol. I Saône	EDATER, Ledoux B.	2002	Agence de l'eau Loire-Bretagne, Equipe Pluridisciplinaire Plan Loire Grandeur Nature, 52p	Feedback analysis - Surveys - Individuals' behaviours - Damages	E	FLD28
Retour d'expérience sur l'inondation de l'habitat et de l'habitant : enquête en Bretagne et sur la Saône - Vol. II Bretagne	EDATER, Ledoux B.	2002	Agence de l'eau Loire-Bretagne, Equipe Pluridisciplinaire Plan Loire Grandeur Nature, 69p	Feedback analysis - Surveys - Individuals' behaviours - Damages	E	FLD29
Eléments d'analyse des répercussions des inondations de novembre 1999 sur les activités agricoles des départements de l'Aude, des Pyrénées Orientales et du Tarn	Beauduceau N.	2001	Equipe Pluridisciplinaire Plan Loire Grandeur Nature, 112p	South-Est of France - Feedback analysis - Damages to agriculture	E	FLD30
Resilient strategies for flood risk in the Netherlands	Vis M., Klijn F., de Bruijn K. M., Van Buuren M.	2003	International journal of river basin management, Vol.1, N°1 (2003), pp33-40	Resilience - Non structural measures - Damages	E	FLD31

Title	Author	Year	Full reference	Key words	Type	Code
Hochwasserschutz an Fließgewässern	Bundesamt für Wasser und Geologie	2001	Bundesamt für Wasser und Geologie	Alle Flüsse Schweiz	E	FLD32
Einige Fallbeispiele zum Hochwasserschutz in der Schweiz	Bundesamt für Wasser und Geologie	2002	Bundesamt für Wasser und Geologie	Alle Flüsse Schweiz	P	FLD33
Methode zur Berechnung des Schadenpotentials	Bundesamt für Wasser und Geologie	2002	Bundesamt für Wasser und Geologie	Gesamte Schweiz	P	FLD34
Methoden des risikobasierten Planens und Handelns bei der Naturgefahren-abwehr	ETH Zürich	2004	Eidgenössische Technische Hochschule Zürich	Gesamte Schweiz	P	FLD35
Risikoanalyse bei gravitativen Naturgefahren	Bundesamt für Umwelt, Wald und Land-wirtschaft, Schweiz	1999	Bundesamt für Umwelt, Wald und Landwirtschaft,	Rhine- Schweiz	P	FLD36
Methoden zur Analyse und Bewertung von Naturgefahren	Bundesamt für Umwelt, Wald und Land-wirtschaft, Schweiz	1998	Umwelt-materialien Nr. 85 Naturgefahren Bundesamt für Umwelt, Wald und Landwirtschaft, p.244	Rhine- Schweiz	P	FLD37
Handlungsempfehlungen zur Erstellung von Hochwasseraktionsplänen	LAWA	2000	Länderarbeitsgemeinschaft Wasser, 12p	Action plan - Guideline - LAWA	P	FLD38
Ermittlung der Hochwasserschadenspotenziale in den überflutungsgefährdeten Gebieten der Stadt Köln	Rodriguez R., P. Zeisler	1998	Gutachten im Auftrag der Stadt Köln, Hochwasserschutzzentrale	Damage Potential - Rhine - Cologne - structural measures	P	FLD39
Vers une évaluation de la vulnérabilité de l'agriculture aux inondations	Barbut L., Laurans Y. (lead authors)	2002	AScA, Ministère de l'aménagement du territoire et de l'environnement, 64p	French basins - Appraisal of damages to agriculture - Typology of damages	E	FLD40
Revision to economic appraisal on reflecting socio-economic equity in appraisal and appraisal of human related intangible impacts of flooding	DEFRA	2004	FCDPAG3, Supplementary note to operating authorities, 10p	UK - Intangible damages - Integration in economic appraisal of damages	E	FLD41
Hochwasserschadenspotenziale	Schmidke R.	1999	"Extreme naturereignisse und Wasserwirtschaft - Niederschlag und Abfluss" International Symposium, München, May 1999, pp127-138		P	FLD42

Literature on economic aspects

Title	Author	Year	Full reference	Key words	Type	Code
Evaluations économiques de la réduction du risque d'inondation	Grelot F., Guillaume B., Gendreau N.	2003	La houille blanche, n°3-2003, pp96-101	Economic valuation - Contingent valuation method - Willingness to pay - France	E	FLE01
Options appraisal report: lessons for floodplain appraisal	Dickie I.	2001	Wise use of floodplains, LIFE Environment project, Royal society for the protection of birds, 151p	Agricultural land values - Economic appraisal of wetlands - UK	E	FLE02
Reactivating floodplains, the socio-economic aspects	Mostert E.	2003	Precautionary flood protection in Europe, International workshop, 5-6 February 2003, Bonn, 14p	Floodplain reactivation - Costs of the measures - Awareness of flood risk - Acceptanc of flood risk	E	FLE03
Gestion du risque d'inondation et méthode inondabilité : une perspective socio-économique	Gendreau N., Longhini M., Combe P.-M.	1998	Ingénieries EAT n°14, June 1998, pp3-15	Vulnerability - Inondabilité method - Maximum acceptable risk - Flood risk management	E	FLE04
Gestion préventive des inondations : quels outils économiques pour l'aide à la décision ?	Grelot F., Guillaume B., Gendreau N.	2002	Ingénieries EAT n°29, March 2002, pp27-36	Economic tools - Flood risk preventive management - Decision making - CBA - Multi-criteria analysis - France	E	FLE05
L'analyse "coûts-avantages" et l'analyse multicritère dans une problématique de comparaison de scénarios d'aménagement à long terme	Devaux-Ros C.	1997	Equipe pluridisciplinaire Plan Loire grandeur nature, 4p	Damage appraisal - Multi-criteria analysis - CAA - Decision-making process	E	FLE06
Programmation des crédits PIRLGN "volet sécurité" pour la région Centre	Equipe pluridisciplinaire Plan Loire Grandeur Nature	2000	Equipe pluridisciplinaire Plan Loire grandeur nature, 34p	Loire basin (France) - Cost of measures appraisal	P	FLE07
The benefit-cost analysis of river maintenance	Dunderdale J.A.L., Morris J.	1997	J. CIWEM n°11, 1997, pp423-430	CBA - River maintenance - Flood defence	E	FLE08
Cost-benefit analysis of flood-plain zoning	Ouellette P., Leblanc D., El-Jabi N., Rousselle J.	1988	Journal of water resources, n°1988-3, pp326-334	CBA - Flood risk mapping - Canada	E	FLE09
Downstream economic benefits from stormwater management	Braden J. B., Johnston D. M.	2004	Journal of water resources planning and management, november-december 2004, pp498-505	USA - Benefits transfer method - Benefits of on-site retention - Benefits for flood mitigation	E	FLE10
Financial and economic measurement of environmental factors	Boddington M. A. B.	1993	J.IWEM, 1993, 7, pp125-133	Ouse Washes (UK) - CBA - Flood protection -	E	FLE11
Evaluation des enjeux socio-économiques de la protection contre les inondations par les eaux de la Seine et de la Marne dans le secteur continu d'Ile de France	Institution interdépartementale des barrages réservoirs du bassin de la Seine	1993	Institution interdépartementale des barrages réservoirs du bassin de la Seine, 17p	Seine & Marne basins (France) - Socio-economic benefits of flood protection - Benefits of reservoirs	E	FLE12
Evaluating the intangible benefits and costs of a flood alleviation proposal	Green C. H., Penning-Rowell C.	1985	Royal zoological society - River Engineering section (presentation paper), 20p	Intangible benefits - Methodology for appraisal	E	FLE13
L'évaluation économique des risques torrentiels : intérêts et limites pour les choix collectifs de prévention	Brochot S., Duclos P., Bouzit M.	2003	Ingénieries, special issue, pp53-68	CBA - Flash floods - Evaluation of protection scenarios	E	FLE14
Floodplains and housing values: implications for flood mitigation projects	Shultz S. D., Fridgen P. M.	2001	Journal of the American water resources association, Vol.37, N°3, 2001, pp595-603	Hedonic valuation method - Flood mitigation projects - Economic gains and losses	E	FLE15
Willingness to pay for flood and ecological risk reduction in an urban watershed	Clark D.E., Novotny V., Griffin R., Booth D., Bartosova A., Daun M.C., Hutchinson M.	2002	Water Science and Technology Vol45 n°9, pp235-242	USA - WTP model - 100 year floodplain	E	FLE16

Title	Author	Year	Full reference	Key words	Type	Code
Participation du public à la gestion préventive des inondations : utilisation d'une échelle de crue pour l'estimation des consentements à payer	Grelot F., Guillaume B., Achard V., Gendreau N.	2003	Ingénieries n° spécial, pp21-31	Le Mans (F) - WTP assessment - Acceptability	E	FLE17
Übersichtskarten der Überschwemmungsgefährdung und der möglichen Vermögensschäden am Rhein	Rodriguez R., Pflügner W.	2001	ICPR, 44p	Rhine-	E	FLE18
Economic dimensions of washland creation in England : a case from Somerset	Morris J., Leeds Harrison P. B., Lawson C., Alsop D., Vivash R., Bailey A.P.	2003	International Conference "Towards natural flood reduction strategies", Warsaw, 6-13 Sept. 2003, 5p	Somerset basin (UK) - Cost and benefit of washland creation - Farmers income	E	FLE19
Cost-benefit analysis of wetland restoration	Dubgaard A.	2003	International Conference "Towards natural flood reduction strategies", Warsaw, 6-13 Sept. 2003, 10p	Skjern river (DK) - CBA - Transfer methods	E	FLE20
The economic values of the World's wetlands	Schuyt K., Brander L.	2004	WWF, 32p	Functions of wetlands - Economic values	E	FLE21
L'évaluation économique de politiques alternatives dans le domaine de la prévention des dommages dus aux inondations	Liebel E., Fichou S., Vidal J.-P., Laglaine V.	1995	Agence de l'eau Loire-Bretagne, 85p + annexes	Loire basin - CBA - Comparison of scenarios	P	FLE22
Integrated ecological, economic and social impact assessment of alternative flood control policies in the Netherlands	Brouwer, R. Remco van Ek	2004	Ecological Economics 50 (2004) 1– 21	Flood control; Floodplain restoration; Land use changes; Integrated assessment; Cost– benefit analysis; Multi-criteria analysis	E	FLE23
Vorsorgender Hochwasserschutz im Rheingebiet - welchen Beitrag leistet das DFNK?	M. Disse, M. Hammer, B. Merz, A. Thieken,	2001	2. Forum Katastrophenvorsorge "Extreme Naturereignisse - Folgen, Vorsorge, Werkzeuge", Leipzig, 24-26 September 2001	Flood risk analysis, probabilistic modelling system, risk curves, North-Rhine/Westphalia, Rhein, dyke breaches, precautionary flood defence	E	FLE24
Assessment of Flood Damages and Benefits of Remedial Actions: "What are the Weak Links?": With application to the Loire	Blois, C.D.G, Wind, H.G.	1996	60	Flood damage models, damage assessment, flood alleviation measures, reducing uncertainty	E	FLE25
Risk assessment and water management	Boumaa. J.J., Francois, D., Troch, P	2003	Environmental Modelling & Software 20 (2005) 141e151	Risk assessment; Water management; Cost-benefit analysis; Flooding; Valuation	E	FLE26
Associated benefits and costs of the Canadian Flood Damage Reduction Program	Loe, R, Wojtanowski, D.	2000	Applied Geography 21 (2001) 1–21	Flood Damage Reduction Program; Floodplain management; Ontario, Canada; Policy delphi; program evaluation	E	FLE27
Klimaänderungen und Hochwasser: Ergebnisse einer DFNK-Studie im Rheingebiet	Menzel L., Bürger G., Schwandt, D.	2001	2. Forum Katastrophenvorsorge "Extreme Naturereignisse - Folgen, Vorsorge, Werkzeuge", Leipzig, 24-26 September 2001	hydrological model HBV-D, regionalization of global atmospheric circulation fields, Rhine, "Expanded Downscaling" (EDS), Global Circulation Models (GCMs)	E	FLE28
Land use and flood protection: contrasting approaches and outcomes in France and in England and Wales	Pottier,N., Penning-Rowsell, E., Tunstall, S., Hubert, G.	2005	Applied Geography 25 (2005) 1–27	Flood risk; Flood mitigation; Land use policy; England and Wales; France	E	FLE29
Ein probabilistischer Modellansatz zur Abschätzung von Hochwasserrisiken und ihren Unsicherheiten	Thieken, A., Merz, B., Blöschl, G.	2001	2. Forum Katastrophenvorsorge "Extreme Naturereignisse - Folgen, Vorsorge, Werkzeuge", Leipzig, 24-26 September 2001	flood disaster chain, hydrological load, hydraulic transformation, damage estimation, Cologne.	E	FLE30

Fiches on measures

The Rhine basin

Switzerland, Germany, France, Luxembourg, Netherlands, EU

Brief description of the basin

Length of the watercourse: 1.320 km

Surface of the basin: 185.000 km²

- Germany: ~100 000 km²
- Switzerland, France, Netherlands: 20 000 to 30 000 km² each
- Austria, Luxembourg: ~2.500 km² each
- Italy, Liechtenstein, Belgium: very limited share

Number of inhabitants: almost 50 millions

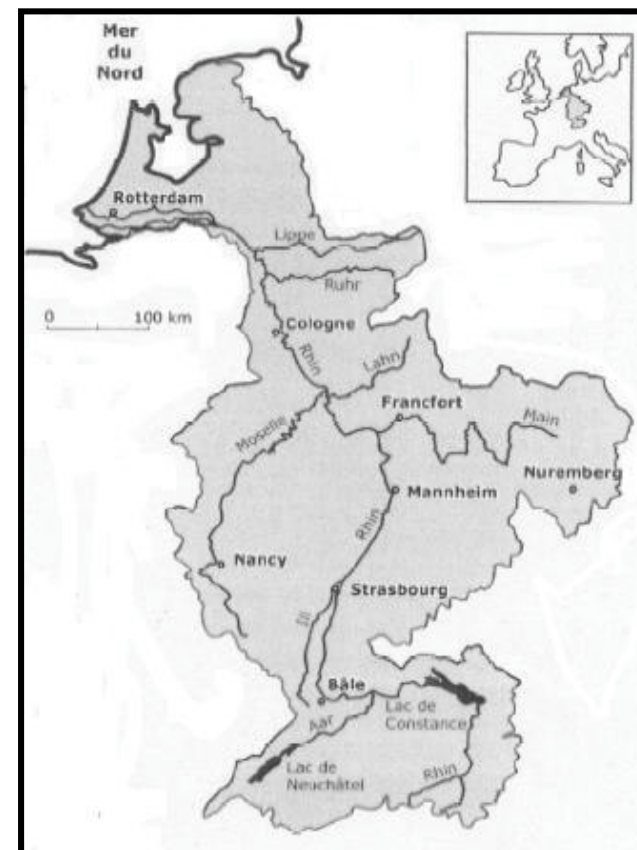
Six main stretches:

- Alpine Rhine: from high Rhine to Constance lake
- Upper Rhine: from the Constance lake to Basel
- Rhin supérieur: from Bâle to Bingen
- Middle Rhine: from Bingen to Cologne
- Lower Rhine: from Cologne to Lobith
- Delta: from Lobith to the sea

Main tributaries:

- Aare (CH)
- Ill (F)
- Neckar, Main, Nahe, Moselle, Ruhr, Lippe (D)

Co-operation institution: International commission for the protection of the Rhine



Original riverbed has been strongly modified by human activity that spreads on 80% of the flood plain. This has increased flood risk, together with works that have changed the morphology of the riverbed. E.g. recalibration has reduced the overall length by more than 100 km and causes acceleration of the flow. E.g. works built for navigation and hydroelectricity (dams...).

Rhine Basin - General overview of the action plan

Policy option	Basin flood management policy
Measure	Action plan
Location	Rhine basin

Fiche Code	BAS01
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Source of information	Plan d'action contre les inondations
Reference	FLM09

Description	a) Flood risk mapping and communication – INFa-01 b) Flood forecasting and early warning systems – INFb-01 c) Measures reducing impact of flooding – PREa-01 d) Limit the use of floodplains – PREb-01 e) Increasing retention capability of soils – PREc-01 f) Reduce level of flooding for given run-off – PROb-01 g) Increasing retention capability of floodplains and wetlands – PROc-01
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	Costs		Comments
Direct costs	Capital	a: 60 000 000 € e: 1 890 000 000 € b: 12 000 000 € f: 1 418 000 000 € c: 0 g: 7 215 000 000 € d: 1 705 000 000 €	Overall cost of the plan for the 1998-2020 period is 12 300 000 000 € c: cost is to be born by individuals, companies, farmers... in order to reduce their vulnerability to flood risk
	Operation		
	Maintenance		

	Description	Costs	Comments
Benefits	Avoided damages	Altogether, measures set in the plan shall lead to the reduction of damages by up to 25% by 2020	41 225 000 000 € Calculation based on estimates of potential damages contained in the Rhine atlas: 164 900 M€ at Rhine scale.
	Others	Reducing extreme flood levels downstream the impounded section by up to 70 cm by 2020 Increasing of flood awareness: drafting risk maps for 100 % of the floodplains & flood prone areas by the year 2005 Improvement of the flood warning system: prolong the warning lead time by 100 % until 2005.	Achievement of these goals will contribute altogether to the reduction of damages.

Policy option	Information
Measure	Flood risk mapping and communication
Location	Rhine basin

Fiche Code	INFa-01
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Source of information	Plan d'action contre les inondations
Reference	FLM09

Description	Prevention measures for the planification phase: establish flood hazard maps and damages maps
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	Costs		Comments
Direct costs	Capital	60 000 000 €	
	Operation		
	Maintenance		

	Description	Value	Comments	
Benefits	Avoided damages	No increase of risk of damages Contribution to the overall benefits of the plan together with measures INFb-01, PROc-01, PREa-01, PREb-01, PREc-01. Altogether, these measures shall lead to the reduction of damages by up to 25% by 2020	41 225 000 000 €	Calculation based on estimates of potential damages contained in the Rhine atlas: 164 900 M€ at Rhine scale.
	Others	Reduction of soil erosion. Increased awareness of flood hazard		

ICPR has established atlas and maps at Rhine scale and encourages member states to do the same and to update these documents. A specific effort has been made to develop an atlas of damages, by combining the identification of areas concerned by risk of floods and (gross) economic estimates of exposed stakes [FLD03]. The fundamental idea from ICPR was to provide a good view of the situation at Rhine scale, though it may be approximate on some aspects. This atlas was intended as an information document; it remains too general to be used as a basis to determine local measures. In line with objective n°3 of the Rhine action plan [FLM09], ICPR expected member states to build on this example to elaborate local atlas that would be much more detailed and accurate, what has been done. In most countries, this is in line with national policies requiring the establishment of risk maps.

It is not planned to update the Rhine Atlas as information at such a large scale remains relevant. However, national or local atlas are updated by member states, as local changes (e.g.: changes in land uses) need to be taken into account for local policy-making.

Policy option	Information
Measure	Flood forecasting and early warning systems
Location	Rhine basin

Fiche Code	INFb-01
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Source of information	Plan d'action contre les inondations
Reference	FLM09

Description	a) Improve forecasting b) Improve transnational co-operation
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	Costs		Comments
Direct costs	Capital	a: 12 000 000 €	
	Operation		
	Maintenance		

	Description	Value	Comments	
Benefits	Avoided damages	Contribution to the overall benefits of the plan together with measures INFa-01, PROc-01, PREa-01, PREb-01, PREc-01. Altogether, these measures shall lead to the reduction of damages by up to 25% by 2020	41 225 000 000 €	Calculation based on estimates of potential damages contained in the Rhine atlas: 164 900 M€ at Rhine scale.
	Others	Forecasting period extended by up to 100% Improvement of warning systems Improvement of riparians' security		

This measure has a specific dimension in the Rhine context, as it requires co-operation among member states in order to ensure exchange and information, then optimisation of the efforts (e.g. use of reservoirs). The basis for this policy at Rhine scale have been set in a dedicated document in 1997 [FLM54].

First evaluation of the implementation of the action plan issued in 2000 [FLM10] showed that first goals have been achieved: extension of forecasting period by 50% by year 2000. One key question here is the reliability of the information proposed: German forecasting centres have indicated that due to limits of weather forecasts, information on flood on extended periods remain in many cases estimates rather than forecasts [FLM69]. However, efforts on models and co-operation with weather forecast specialists shall make it possible to provide reliable information up to 7 days in advance. In the Netherlands, the same type of efforts will ensure to reach the goal ie. 4 days forecasting period by 2005.

Policy option	Prevention
Measure	Limit the use of floodplains
Location	Rhine basin

Fiche Code	PREa-01
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Source of information	Plan d'action contre les inondations
Reference	FLM09

Description	Extensification of agriculture (3 900 km ²)
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	Costs		Comments
Direct costs	Capital	1 705 000 000 €	
	Operation		
	Maintenance		

	Description	Value	Comments	
Benefits	Avoided damages	Contribution to the overall benefits of the plan together with measures INFa-01, INFb-01, PROc-01, PREb-01, PREc-01. Altogether, these measures shall lead to the reduction of damages by up to 25% by 2020	41 225 000 000 €	Calculation based on estimates of potential damages contained in the Rhine atlas: 164 900 M€ at Rhine scale.
	Others	Limited local effect Restoration of habitats; development of new ones; recharge of groundwater bodies		

Such actions require significant effort to communicate with professionals and to involve them in the decision-making process. Although at Rhine scale such a measure can certainly be estimated only in terms of investment costs, implementation will require indirect costs in practice, such as human resources. E.g.: see the Vidourle action plan [FLM36]: 2 full-time jobs are dedicated to co-operation and concertation with farmers in order to involve them in flood policy and to assist them in adapting professional methods to flood hazard. Vidourle basin covers only 850 km².

Policy option	Prevention
Measure	Increasing retention capability of soils
Location	Rhine basin

Fiche Code	PREb-01
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Source of information	Plan d'action contre les inondations
Reference	FLM09

Description	Reduce impervious areas (2 500 km ²)
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		Costs	Comments
Direct costs	Capital	1 890 000 000 €	
	Operation		
	Maintenance		

		Description	Value	Comments
Benefits	Avoided damages	Contribution to the overall benefits of the plan together with measures INFa-01, INFb-01, PROc-01, PREa-01, PREc-01. Altogether, these measures shall lead to the reduction of damages by up to 25% by 2020	41 225 000 000 €	Calculation based on estimates of potential damages contained in the Rhine atlas: 164 900 M€ at Rhine scale.
	Others	Limited local benefit. Together with measure PREc-01, reduction of flood level by up to 10 cm Reduced volumes of water in sewage systems		Benefits for actions a to e is estimated including benefits from measures PREa-01 and PREb-01

The same comment as for fiche PREa-01 may be made: such measure is to be carried out at local scale and will thus require significant effort in practice. The 2000 evaluation of the implementation of the plan shows that 10 km² have been covered when the goal was 90.

Policy option	Prevention
Measure	Increasing retention capability of floodplains and wetlands
Location	Rhine basin

Fiche Code	PREc-01
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Source of information	Plan d'action contre les inondations
Reference	FLM09

Description	Actions applying to the Rhine basin	Actions applying to the fluvial corridor
	a) Restore streams (11 000 km) c) Develop nature, re-afforest (3.500 km ²) b) Re-revitalise flood plains (1 000 km ²) d) Create works for retention of floods (73 millions m ³)	e) Re-vitalise flood plains (160 km ²) f) Create works for retention of floods (364 millions m ³)

		Costs	Comments
Direct costs	Capital	a: 1 160 000 000 € e: 1 450 000 000 € b: 2 030 000 000 € f: 960 000 000 € c: 680 000 000 € d: 935 000 000 €	Overall cost of this measure: 7 215 000 000 €
	Operation		
	Maintenance		

		Description	Value	Comments
Benefits	Avoided damages	Contribution to the overall benefits of the plan together with measures INFa-01, INFb-01, PROc-01, PREa-01, PREb-01. Altogether, these measures shall lead to the reduction of damages by up to 25% by 2020	41 225 000 000 €	Calculation based on estimates of potential damages contained in the Rhine atlas: 164 900 M€ at Rhine scale.
	Others	a to d: limited local benefit. Altogether, reduction of flood level by up to 10 cm e: reduction of flood level by 15 to 25 cm f: reduction of flood level by 45 to 60 cm Restoration of habitats; development of new ones; recharge of groundwater bodies		Benefits for actions a to d is estimated including benefits from measures PREa-01 and PREb-01

One key measure contributing to the reduction of flood levels is to develop floodplains, what is however often very difficult in practice. Indeed such actions often require that public authorities buy riparian properties. Procedures for doing so are generally long and complex, and in many cases such parcels are often expensive depending on existing activities. This may seriously hinder the implementation of flood prevention policies.

Policy option	Protection
Measure	Reduce level of flooding for given run-off
Location	Rhine basin

Fiche Code	PROb-01
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Source of information	Plan d'action contre les inondations
Reference	FLM09

Description	Maintenance and strengthening of dykes (1115 km)
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	Costs		Comments
Direct costs	Capital	1 418 000 000 €	
	Operation		
	Maintenance		

	Description	Costs	Comments	
Benefits	Avoided damages	Reduction of the risk of damages Contribution to the overall benefits of the plan together with measures INFa-01, INFb-01, PROc-01, PREa-01, PREb-01, PREc-01. Altogether, these measures shall lead to the reduction of damages by up to 25% by 2020	41 225 000 000 €	Calculation based on estimates of potential damages contained in the Rhine atlas: 164 900 M€ at Rhine scale.
	Others	Security of people living behind dykes increased		

Efforts regarding the reduction of maximum flood depth downstream the impounded section (reduce extreme flood levels by up to 30 cm by 2005 and by up to 70 cm by 2020) are fruitful. These goals shall be achievable provided that member states keep on investing on these issue. First assessment made in 2000 was encouraging [FLM10] and the 2005 evaluation will soon give an updated vision.

Policy option	Protection
Measure	Measures reducing impact of flooding
Location	Rhine basin

Fiche Code	PROc-01
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Source of information	Plan d'action contre les inondations
Reference	FLM09

Description	Adapt activities to flood hazard
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	Costs	Comments
Direct costs	Capital	No estimate: cost is to be born by individuals, companies, farmers... in order to reduce their vulnerability to flood risk
	Operation	
	Maintenance	

	Description	Value	Comments
Benefits	Avoided damages	41 225 000 000 €	Calculation based on estimates of potential damages contained in the Rhine atlas: 164 900 M€ at Rhine scale.
	Others	Reduction of erosion	

Measures regarding the reduction of damages are national ones, and have to be implemented at local scale. Estimates of the costs of the damages widely depend on local factors: type of activities and constructions, economic development, etc. Rhine atlas of damages puts it clearly: estimates on the costs of potential damages to housing, though approximate, ranger from 222 to 340€/m² [FLD03].

ICPR brought a significant contribution issuing a dedicated publication that details several types of basic measures that can be taken at building scale in order to reduce damages [FLM12]. This document is based on national projects, and widely integrates lessons learnt from recent floods (e.g. in Germany and the Netherlands in 1993 and 1995, in Switzerland in 1999). It proposes estimates of the respective efficiency of such measures.

Regarding the general goal set at Rhine level (reduction of potential damage by 25% by year 2020), it appears unlikely that the objectives in terms of reduction of damage risks will be achieved as reference values increase year after year. Indeed, as economic value of exposed goods will considerably increase until 2020 compared to 1995 (reference year), it always requires more and more stringent measures to achieve the same goal. This is an external factor not linked to the efforts made.

Rhine Basin – Local Examples

Policy option	Prevention
Measure	Increasing retention capability of floodplains and wetlands
Location	Rhine basin, City of Cologne, NRW, Germany

Fiche Code	PREc-02
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Source of information	Haushalt der Stadt Köln
Reference	FM70

Description	Creation of a retention pool and a constraining dam
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	Costs		Comments
Direct costs	Capital	35.8 M Euro	Area 2,5 km ² and volumetric capacity ca. 8 Mio. m ³
	Operation	Not separately calculated	
	Maintenance	Not separately calculated	

	Description	Costs	Comments
Indirect costs	Loss of potential revenue	Not estimated	

	Description	Value	Comments
Benefits	Avoided damages	Contribution to the overall benefits of the action plan	
	Others	Increasing ecological value for river habitat	

Policy option	Prevention
Measure	Increasing retention areas
Location	Rhine basin, City of Cologne, NRW, Germany

Fiche Code	PREc-03
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Source of information	"Sichern und Wiederherstellen von Hochwasserrückhalteflächen – Fallstudie Köln"; Haushalt der Stadt Köln
Reference	FM71, FM70

Description	Create retention areas within the City of Cologne by backward dyke relocation
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	Costs		Comments
Direct costs	Capital	19.2 M Euro	Area 158 ha and volumetric capacity ca. 4.5 Mio. m ³
	Operation	Not separately calculated	
	Maintenance	Not separately calculated	

	Description	Costs	Comments
Indirect costs	loss of potential revenue		not calculated

	Description	Value	Comments
Benefits	Avoided damages	Contribution to the overall benefits of the action plan	
	Others	Increasing ecological value for river habitat	

Policy option	Protection
Measure	Measures to reduce peak run-off
Location	Rhine basin, North Rhine Westfalia, Germany

Fiche Code	PROa-01
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Source of information	Hochwasser Aktionsplan Lippe
Reference	FLM72

Description	Retention pool (Tallesee)
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		Costs	Comments
Direct costs	Capital	Mean value: 1,7 Euro per m ³ of retention capacity River-Extension: 175.000 Euro Total cost: 1,025 M Euro	Retention area of 500.000 m ³ (technical difficulties during construction have not been calculated separately. The measure is therefore likely to be more expensive)
	Operation	Not separately calculated	
	Maintenance	Not separately calculated	

		Description	Value	Comments
Benefits	Avoided damages	Contribution to the overall benefits of the action plan	Damage potential: Between 471.664 and 12.739.507 Euro (HQ5 to HQ100) Estimated damage per year: Between 70.820 and 506.260 Euro (HQ5 to HQ100)	The basin of Lippe river consists of 12 sections. The damage potential and estimated damage have been summed up for all 12 sections to get an overall value. The contribution of individual measures to the avoided damage is not assessed.
	Others			

Policy option	Protection
Measure	Measures reducing impact of flooding
Location	Rhine basin, Switzerland

Fiche Code	PROa-02
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Source of information	“Heiden: Wenn die Strasse zum Fluss wird” project description published by the Federal Agency for Water and Geology
Reference	FLM75

Description	Enlargement of a bed load collector
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		Costs	Comments
Direct costs	Capital	649.8 M Euro	Capacity of the collector 600 m ³ In case of flooding the collector has to be emptied regularly to keep functioning
	Operation	Not calculated	
	Maintenance	Not calculated	

		Description	Value	Comments
Benefits				

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	Avoided damages			Trigger for this measure was a flood causing 9.4 M Euro damage
	Others			

Policy option	Protection
Measure	Reduce level of flooding for given run-off
Location	Rhine basin, Baden Württemberg, Germany

Fiche Code	PROb-02
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Source of information	Maßnahmen des Landes für technischen Hochwasserschutz
Reference	FLM73, FLM74

Description	Construction of retention pools
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	Costs		Comments
Direct costs	Capital	1. 370.2 m Euro 2. 206.1 m Euro	1. Water Authority “Südlicher Oberrhein/Hochrein” (10 retention pools, no volumetric capacity given) 2. Water Authority “Nördlicher Oberrhein” (13 retention pools, no volumetric capacity given)
	Operation	Not separately calculated	
	Maintenance	Not separately calculated	

Benefits		Description	Costs	Comments
	Avoided damages	Contribution to the overall benefits of the action plan		
	Others			

Policy option	Protection
Measure	Reduce level of flooding for given run-off
Location	Rhine basin, North Rhine Westfalia, Germany

Fiche Code	PROb-03
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Source of information	Hochwasser Aktionsplan Lippe
Reference	FLM72

Description	a) Dyke /increase of dyke b) Wall (lime sand brick)	c) Wall (concrete) d) Partly mobile flood protection
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	Costs		Comments
Direct costs	Capital	a) 56 Euro per m ³ b) 207 Euro per m ² c) 234 Euro per m ² d) 770 Euro per m ²	a) volume and therefore cost differ depending on the shape of the dyke b) - c) cost rise more than proportionally with higher walls d) the costs of this measure have been obtained by comparing costs of different suppliers
	Operation	Not separately calculated	

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	Maintenance	Not separately calculated	
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		Description	Value	Comments
Benefits	Avoided damages	Contribution to the overall benefits of the action plan	Damage potential: Between 471.664 and 12.739.507 Euro (HQ5 to HQ100) Estimated damage per year: Between 70.820 and 506.260 Euro (HQ5 to HQ100)	The basin of Lippe river consists of 12 sections. The damage potential and estimated damage have been summed up for all 12 sections to get an overall value. The contribution of individual measures to the avoided damage is not assessed.
	Others			

Policy option	Integrated Project
Measure	Reduce level of flooding for given run-off
Location	Rhine basin, The Netherlands

Fiche Code	PROb-04
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Source of information	Water in Focus (online)
Reference	www.waterinbeeld.nl

Description	“Space for the Rivers” includes backward dyke relocation, removing hydraulic obstacles from the floodway, lowering of groynes and many other measures.
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	Costs		Comments
Direct costs	Capital	2.0 m Euro (including operation and maintenance)	Several measures (spatial and technical) are combined to reach a statutory safety standard. Measures have to be compared in a Strategic Environmental Effect Report and a CBA. Procedure is simplified for small technical projects.
	Operation	Included above	
	Maintenance	Included above	

	Description	Value	Comments
Benefits	Avoided damages	Material losses and operational losses are accounted for. A monetarised valuation for victims and non-material losses is optional.	
	Others		

Policy option	Protection
Measure	Measures reducing impact of flooding
Location	Rhine basin, City of Cologne, NRW, Germany

Fiche Code	PROc-02
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Source of information	Haushalt der Stadt Köln
Reference	FM70

Description	Heightening the dyke with a sheet pile wall to protect from HQ200 flood
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	Costs		Comments
Direct costs	Capital	16.7 M Euro	About 6 km
	Operation	Not separately calculated	
	Maintenance	Not separately calculated	

	Description	Value	Comments
Benefits	Avoided damages	Contribution to the overall benefits of the action plan	
	Others		

Policy option	Protection
Measure	Measures reducing impact of flooding
Location	Rhine basin, City of Cologne, NRW, Germany

Fiche Code	PROc-03
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Source of information	Haushalt der Stadt Köln
Reference	FM70

Description	Building a flood protection wall with mobile doors to protect from a HQ200 flood
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	Costs		Comments
	Direct costs	Capital	
	Operation	Not separately calculated	
	Maintenance	Not separately calculated	

Policy option	Protection
Measure	Measures reducing impacts of flooding
Location	Rhine basin, North Rhine Westfalia, Germany

Fiche Code	PROc-04
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Source of information	Hochwasser Aktionsplan Lippe
Reference	FLM72

Description	Protection of individual objects (usage of sandbags and precisely tailored sealings)
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	Costs		Comments
Direct costs	Capital	500 – 5.000 Euro	cost per object for flood depths between 0.1 m and >1.5 m
	Operation	Not separately calculated	
	Maintenance	Not separately calculated	

	Description	Value	Comments
Benefits	Avoided damages	Contribution to the overall benefits of the action plan Damage potential: Between 471.664 and 12.739.507 Euro (HQ5 to HQ100) Estimated damage per year: Between 70.820 and 506.260 Euro (HQ5 to HQ100)	The basin of Lippe river consists of 12 sections. The damage potential and estimated damage have been summed up for all 12 sections to get an overall value. The contribution of individual measures to the avoided damage is not assessed.
	Others		

Policy option	Protection
Measure	Measures reducing impact of flooding I
Location	Rhine basin, Baden Württemberg, Germany

Fiche Code	PROc-05
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Source of information	Maßnahmen des Landes für technischen Hochwasserschutz
Reference	FLM73, FLM74

Description	Dyke and Dam Construction
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	Costs		Comments
Direct costs	Capital	1. 78.0 m Euro 2. 88.7 m Euro	1. Water Authority “Südlicher Oberrhein/Hochrein” (12 dykes and dams) 2. Water Authority “Nördlicher Oberrhein” (23 dykes and dams)
	Operation	Not separately calculated	
	Maintenance	Not separately calculated	

Benefits		Description	Value	Comments
	Avoided damages	Contribution to the overall benefits of the action plan		
	Others			

Policy option	Protection
Measure	Measures reducing impact of flooding II
Location	Rhine basin, Baden Württemberg, Germany

Fiche Code	PROc-06
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Source of information	Maßnahmen des Landes für technischen Hochwasserschutz
Reference	FLM73, FLM74

Description	Object Protection
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	Costs		Comments
Direct costs	Capital	1. 14.7 m Euro 2. 48.5 m Euro	1. Water Authority “Südlicher Oberrhein/Hochrein” (17 object protection measures) 2. Water Authority “Nördlicher Oberrhein” (68 object protection measures)
	Operation	Not separately calculated	
	Maintenance	Not separately calculated	

Benefits		Description	Value	Comments
	Avoided damages	Contribution to the overall benefits of the action plan		
	Others			

Policy option	Protection
Measure	Measures reducing impact of flooding and reducing level for given run-off
Location	Rhine basin, Switzerland

Fiche Code	PROc-07
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Source of information	“ Malcantone: Wurzelwerk statt Betonbau” project description published by the Federal Agency for Water and Geology
Reference	FLM76

Description	Building and refurbishing dams, river widening, flattening river banks, exchanging neophytes with typical plants
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	Costs		Comments
Direct costs	Capital	3.15 M Euro	Measure increased discharge capacity from < 110 m ³ to 180 m ³
	Operation	Not separately calculated	
	Maintenance	Not separately calculated	

	Description	Value	Comments
Benefits	Avoided damages		Trigger for this measure was a flood (> HQ30) causing 4.4 M Euro damage
	Others	Ecological enhancement of the river habitat	

The Loire basin

France

Brief description of the basin

Length of the watercourse: 1.012 km

Surface of the basin: 117.000 km²

Number of inhabitants: 7,8 millions

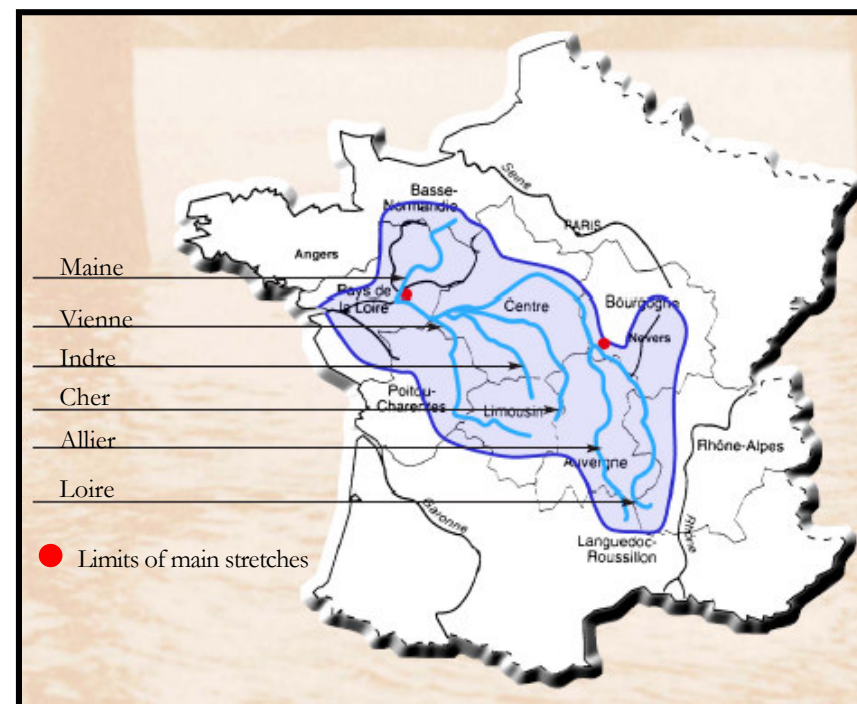
Three main stretches:

- Upper Loire
- Middle Loire
- Estuarine

Main tributaries:

- Maine
- Vienne
- Indre
- Cher
- Allier

Co-operation institutions: Equipe Pluridisciplinaire Plan Loire Grandeur Nature (elaboration of policy); Etablissement public Loire (operation of works)



Three types of flood may occur in the Loire basin [FLP16]:

- flash floods in some small watersheds, caused by local intense rainfalls. Such events only occur in the upper part of the Loire basin, under Mediterranean influence. In 1980, such rainfalls caused a rise of the level of water of 6cm / minute.
- oceanic floods caused by long heavy rainfalls on most parts of the basin. Such floods generally occur in sub-basins in the north and the west of the Loire basin; however when several rainfalls of this type occur one after each other, lower Loire may be under threat of severe floods
- mixed floods, when both types of events occur simultaneously. All major floods in the basin were of this type (in the 19th century esp.), and caused damages mainly in the middle Loire. Water flow has then reached up to 8000m³/s in worst cases. Such floods occur in May-June and from late September until early December.

There hasn't been any severe flood for a very long time, and awareness is very low. The "reference event" is 1856 flood. The flood itself was a big one (combined with groundwater flood) but not the biggest one (~170 years return period). What made it so severe was that dykes were broken in 150 places (23 km) thus becoming useless. Cities of Tours and Orléans were totally flooded and Middle Loire area (1500 km²) was under 1 to 2 meters of water.

Loire basin - General overview of the action plan

Policy option	Basin flood management policy
Measure	Action plan
Location	Loire basin

Fiche Code	BAS02
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Source of information	Synthèse des propositions pour une stratégie globale de réduction des risques d'inondation par les crues fortes en Loire moyenne
Reference	FLP11

Description	a) Flood forecasting and early warning systems – INFb-02 b) Public awareness on best practices – INFc-01 c) Establishment of an emergency plan – INFd-01	d) Limit the use of floodplains – PREa-02 e) Measures to reduce peak run-off – PROa-01 f) Reduce level of flooding for given run-off – PROb-05	g) Measures reducing impact of flooding – PROc-08 h) Implementation of emergency plans – EME01
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	Costs		Comments
Direct costs	Capital	a+c+h: 7 600 000 € b+d+g: 61 000 000 to 76 000 000 € e: 87 500 000 to 175 000 000 € f: 148 400 000 to 324 000 000 €	Overall capital cost of the action plan rises up to 583 000 000 € Level of investment depends on the level of security sought: - to face flood with 100-year return period: between 122 000 and 305 000 M€ - to face flood with 170-year return period: between 230 000 and 460 000 M€ - to face flood with 500-year return period: between 305 000 and 583 000 M€ The highest investment would ensure protection of the entire Middle Loire for flood with 200-year return period.
	Operation	a+c+h: 1 200 000 € d: 760 000 € b+d+g: 760 000 € e: 2 560 000 - 3 760 000 €	Annual overall operation cost is between 5 280 000 and 6 480 000 €. This amount depends on the level of investment rather than on the flood return period. It is approximately twice the current annual expense (figure 1999).
	Maintenance		

	Description	Costs	Comments
Benefits	Avoided damages b+d+g: the reduction of vulnerability of existing stakes could lead to a 10 to 15% reduction of damages h: Efficient post-crisis management could lead to a 10 to 15% reduction of damages		h: inadequate crisis management is likely to increase damages by 10 to 100%
	Others e: flood peak shaving potential ranks between 600 - 900 m ³ /s for flood with respectively 50 - 1000 return period. Flood level reduction is between 20 - 50 cm upstream Tours and between 5 - 20 cm downstream, what is significant esp. in urban areas where riverbed is narrow.		f: poor maintenance of riverbed may lead to increase of river flow by 30 - 70 cm, esp. where the stream is narrow (urban sectors)

Policy option	Information
Measure	Flood forecasting and early warning systems
Location	Loire basin

Fiche Code	INFb-02
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Source of information	Synthèse des propositions pour une stratégie globale de réduction des risques d'inondation par les crues fortes en Loire moyenne
Reference	FLP11

Description	Improvement of modelling tools combined with weather forecasts Intensification of the prevention of floods by developing early warning procedures
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	Costs		Comments
Direct costs	Capital	7 600 000 €	Costs include measures INFd-01 and EME01
	Operation	1 200 000 € / yr	Costs include measures INFd-01 and EME01
	Maintenance		

Prediction capacity is essential: it widely determines the capacity to face the crisis. Main threat is a plain flood that would develop progressively, thus anticipation and alert are fundamental.

Since 1985, a forecasting system has been operated at Loire scale (the 'CRISTAL' system). Following measures taken recently, it includes now 188 stations measuring continuously the level of water in rivers and dams and 68 stations measuring rainfalls (respectively 125 and 55 in 1999). This needs to be supplemented by efforts in understanding the hydraulic characters of the Loire, in order to be able to work in real time, and in integrating climatic data.

Measures for the dissemination of this information will also have to be defined.

Policy option	Information
Measure	Public awareness on best practices
Location	Loire basin

Fiche Code	INFc-01
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Source of information	Synthèse des propositions pour une stratégie globale de réduction des risques d'inondation par les crues fortes en Loire moyenne
Reference	FLP11

Description	Information of citizens Training of professionals involved in flood management (in particular during flood events)
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	Costs		Comments
Direct costs	Capital	61 000 000 to 76 000 000 €	Costs include measures PREa-02 and PROc-02
	Operation	760 000 € / yr	
	Maintenance		

		Description	Costs	Comments
Benefits	Avoided damages	The reduction of vulnerability of existing stakes could lead to a 10 to 15% reduction of damages		Estimated benefit generated together with measures PREa-02 and PROc-02
	Others			

As there has been no serious flood on the middle Loire since 1907, it is not clear whether decision-makers will be able to understand and analyse properly data that would be provided in time of flood. In such times, figures and data may appear unbelievable compared to common knowledge about the river and usual figures. Yet, they have to be taken seriously in order to cope with crisis properly. Such a situation was observed in the Oder flood in Poland in 1997 and was a factor aggravating the damages. Preparedness is essential, not only in terms of behaviour but also regarding the acceptance of the idea that flood may occur and may be severe. This applies to all actors involved: decision-makers, the public, etc.

Policy option	Information
Measure	Establishment of an emergency plan
Location	Loire basin

Fiche Code	INFd-01
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Source of information	Synthèse des propositions pour une stratégie globale de réduction des risques d'inondation par les crues fortes en Loire moyenne
Reference	FLP11

Description	Improve anticipation capacity on flooding of most sensitive sites: roads, hospitals, selected industries, etc. Organisation of human resources involved in emergency situations Training exercises involving the population
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	Costs		Comments
Direct costs	Capital	7 600 000 €	Costs include measures INFb-02 and EME01
	Operation	1 200 000 € / yr	Costs include measures INFb-02 and EME01
	Maintenance		

Culture of the risk is not enough: crisis situation shall be organised and properly managed. This measure includes *ex-ante* actions: preparation of local emergency plans in all municipalities, organisation of all people who would participate to their implementation (at Loire scale, this means that this shall be organised no matter administrative borders between regions, departments...), etc. Training exercises would be highly useful (and would also improve the awareness of the flood hazard).

All these actions would be combined with post-crisis measures (see fiche EME-01 below).

Policy option	Prevention
Measure	Limit the use of floodplains
Location	Loire basin

Fiche Code	PREa-02
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Source of information	Synthèse des propositions pour une stratégie globale de réduction des risques d'inondation par les crues fortes en Loire moyenne
Reference	FLP11

Description	Definition with local authorities of a adapted spatial planning taking into account flood risk (less intensive use of land...) Adapted land use control in most exposed areas (e.g. downstream of weirs).
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	Costs		Comments
Direct costs	Capital	61 000 000 to 76 000 000 €	Costs include measures INFc-01 and PROc-02
	Operation	760 000 € / yr	
	Maintenance		

		Description	Costs	Comments
Benefits	Avoided damages	The reduction of vulnerability of existing stakes could lead to a 10 to 15% reduction of damages		Estimated benefit generated together with measures INFc-01 and PROc-02
	Others			

This measure is a fundamental aspect of the “basic set of measures” considered in the comparison of scenarios. It requires awareness from decision-makers and integration of flood hazard in land planning policies: types of use of land, planification in order to pre-empt available land, etc. Concertation at local scale is thus essential among municipalities to organise their development in co-operation. This applies in particular to the 50 municipalities that are completely located in flood prone areas: though it is not realistic to relocate all population nor to completely stop their development, it is not possible to do as if no risk would exist. It is thus necessary to find a solution in between.

The implementation of such a measure would require a lot of concertation efforts at very local scale, thus the availability of dedicated human resources.

Policy option	Protection
Measure	Measures to reduce peak run-off
Location	Loire basin

Fiche Code	PROa-01
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Source of information	Synthèse des propositions pour une stratégie globale de réduction des risques d'inondation par les crues fortes en Loire moyenne
Reference	FLP11

Description	a) New weirs b) Flood peak shaving work (" <i>Le Veurdre</i> ").
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	Costs		Comments
Direct costs	Capital	a: 11 500 000 to 23 000 000 € b: 76 000 000 to 152 000 000 €	
	Operation	b: 760 000 € /yr	a: included in maintenance of existing dykes
	Maintenance		

	Description	Value	Comments
Benefits	Avoided damages		
	Others	Flood peak shaving potential ranks between 600 and 900 m ³ /s for flood with respectively 50 and 1000 years return period. Flood level reduction is between 20 and 50 cm upstream Tours and between 5 and 20 cm downstream, what is significant esp. in urban areas where riverbed is narrow. Direct consequence is the reduction of the risk of overflow and of dyke breakdown.	

Weirs and levees are very traditional in all the Loire basin and date back to Middle Age [FLM27][FLM28]. One key question nowadays is whether or not building a new reservoir, *Le Veurdre*. Combined with other measures, it would significantly contribute to reducing effects of floods (see scenario 4). One key finding is that this work alone would not be a solution: though it would reduce level of flood in several circumstances, it would have no impact on the main issue, the vulnerability of dykes and levees.

This option is very politically sensitive and rather expensive: 10 years ago, estimates were between 75 and 150 M€, depending widely on the implementation of accompanying measures. Although the preparation of the construction of this reservoir was one of the goals of the *Equipe Pluridisciplinaire* when it was set up 10 years ago, decision on this issue has been postponed several times since then and official deadline is now 2006.

Policy option	Protection
Measure	Reduce level of flooding for given run-off
Location	Loire basin

Fiche Code	PROb-05
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Source of information	Synthèse des propositions pour une stratégie globale de réduction des risques d'inondation par les crues fortes en Loire moyenne
Reference	FLP11

Description	<p>a) “Basic measures” Ensure frequent (at least annual) control of dykes and of riverbed relief, esp. following each flood event. The entire stream shall be checked but 60 priority sites (130 km) have been listed. Improve the knowledge of the Loire ecosystem in order to optimise river maintenance works</p> <p>b) Local protection Maintenance of basis and tops of existing dykes, reinforcement of benchterraces; creation of local protection works (low dykes...) with constant concern for downstream consequences</p>
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	Costs		Comments
Direct costs	Capital	a: 11 400 000 to 19 000 000 € b: 137 000 000 to 305 000 000 €	The overall cost of this measure is between 148 400 000 and 324 000 000 €
	Operation	a: 1 800 000 to 3 000 000 € / yr b: 760 000 € / yr	The overall operation cost of this measure is between 2 560 000 and 3 760 000 €
	Maintenance		

	Description	Costs	Comments
Benefits	Avoided damages		
	Others	a: Poor maintenance of riverbed may lead to increase of river flow by 30 to 70 cm, esp. where the stream is narrow (urban sectors)	

History and hydraulic studies [FLM26] showed the high vulnerability of dykes in case of severe flood, and their resistance is one of the key uncertainties in such situation: it would widely determine the level of damages. This is not only a matter of maintenance: hydraulic phenomena are such that pressure on dykes is then very high and huge amounts of sediments are moved in the riverbed relief, thus weakening dykes basis. Yet, maintenance is essential in order to make dykes as reliable as possible as they are theoretically most efficient in the case of floods with return period of less than 100 years, i.e. the most frequent ones.

This includes continuous restoration of existing dykes and levees, reinforcement of some elements, localised extensions, etc. Priority should be given to most exposed areas, always considering the consequences in downstream sectors.

Policy option	Protection
Measure	Measures reducing impact of flooding
Location	Loire basin

Fiche Code	PROc-08
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Source of information	Synthèse des propositions pour une stratégie globale de réduction des risques d'inondation par les crues fortes en Loire moyenne
Reference	FLP11

Description	Reduction of the vulnerability of exposed goods: support to vulnerability diagnosis (esp. in industrial sector) and to concrete improvement measures
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	Costs		Comments
Direct costs	Capital	61 000 000 to 76 000 000 €	Costs include measures INFc-01 and PREa-02
	Operation	760 000 € / yr	
	Maintenance		

	Description	Costs	Comments
Benefits	Avoided damages	The reduction of vulnerability of existing stakes could lead to a 10 to 15% reduction of damages	Estimated benefit generated together with measures INFc-01 and PREa-02
	Others		

This measure (combined with INFc-02 and PREa-02) is another fundamental aspect of the “basic set of measures” considered in the comparison of scenarios. It has to be combined with measures reducing the risk of breach in dykes and levees and improving the local protection of most exposed stakes. This measure will not reduce the scale of the flood or the number of sites where specific actions will be necessary in case of flood. Yet, this measure will reduce damages on all types of flooded goods and will ease crisis management.

As damages to economic activities would account for ~60% of all damages, whatever the return period considered, efforts should be made in this sector in priority.

A detailed methodology has been developed to this purpose and experiments have been made: diagnosis is carried out in companies in order to identify stakes exposed to different levels of water, then measures for the reduction of vulnerability are proposed. The idea is to develop a self-diagnosis toolbox.

Policy option	Emergency measures
Measure	Implementation of emergency plans
Location	Loire basin

Fiche Code	EME01
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Source of information	Synthèse des propositions pour une stratégie globale de réduction des risques d'inondation par les crues fortes en Loire moyenne
Reference	FLP11

Description	Organisation of first actions when level of flood begins to come down: planification of priority measures to reduce damages, surveillance of flood protection works...
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	Costs		Comments
Direct costs	Capital	7 600 000 €	Costs include measures INFb-02 and INFd-01
	Operation	1 200 000 € / yr	
	Maintenance		

	Description	Costs	Comments
Benefits	Avoided damages	Efficient post-crisis management could lead to a 10 to 15% reduction of damages Inadequate crisis management is likely to increase damages by 10 to 100%	
	Others		

This aspect is essential given the impact it may have on the level of damages.

This measure includes several *ex-post* actions as crisis management is not only a matter of rescue in the very first hours.

It is important to identify in plans what stakes are most sensitive in times of flood so that emergency measures may be implemented when the flood is there (e.g. removal of most fragile machines...). Such very quick actions will directly determine the level of damages and the capacity to restart activities following the flood. It is also necessary to take into account that dykes and levees remain very vulnerable and should be controlled continuously even when water depth reduces. Thus inhabitants may not come back immediately. The same applies to economic activities. Insurance companies may also play a significant role in such situations. All this has to be organised precisely in advance.

The Vidourle basin

France

Brief description of the basin

Length of the main watercourse: 100 km

Surface of the basin: 850 km²

Number of inhabitants: 110 000

Co-operation institution: Syndicat Mixte Interdépartemental d'aménagement et de mise en valeur du Vidourle et de ses Affluents

Vidourle river connects the Cévennes mountains to the Mediterranean sea. Four main stretches are identified:

- the upper-Vidourle (A), with very strong hillsides (>30‰): altitude decreases by 800 m in the first 10 km. The Vidourle has a moderate width and is located in a V-like deep and narrow valley.
- a combination of underground course and of plates (B) where the flow is strongly reduced;
- middle Vidourle (C) where the river goes over hills and collects water from several small tributaries that may contribute to severe floods in case of heavy rains
- low Vidourle (D) where the river is diked and goes across a long-shore plain, which is a natural deltaic floodplain.

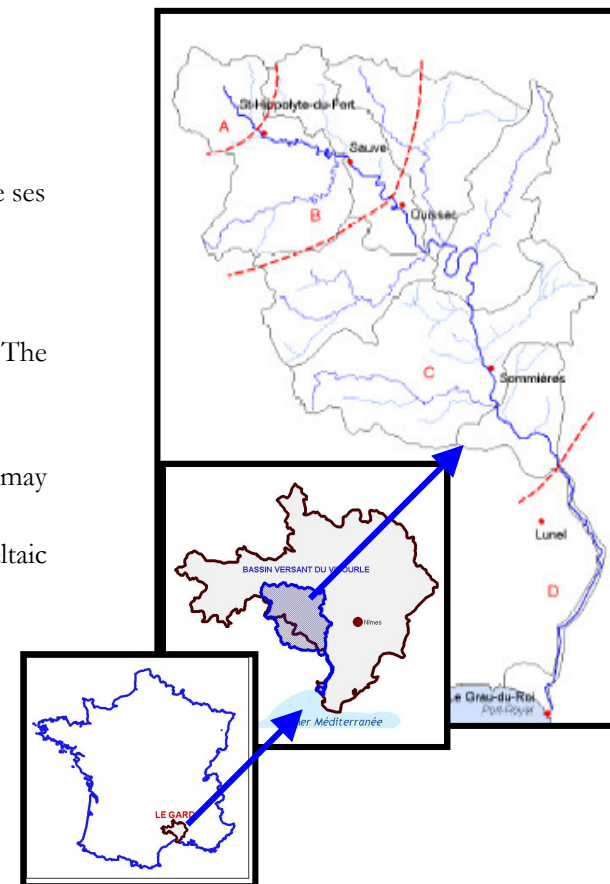
Vidourle has a very irregular regimen: the summer low tide is very marked and the floods (especially autumnal and wintry) provoked by important rains, are sudden and large-scale. This specific context (geographic, hydrologic, climatic...) leads to potentially very severe flash floods.

E.g. extreme rainfalls started in the area on September 8th 2002 at noon. In the following 24 hours, an average of 400 mm has fallen on the Vidourle basin. Flood alert levels were reached between 7 and 15 hours after the beginning of the rain depending on the areas, and maximum depth was much higher than centennial events. 2 days later, all rivers were back within the limits of their minor beds.

Note: this event was considered as “*exceptional*” and covered a much wider area than the Vidourle basin alone. 21 people were killed and damages amounted for more than 1000 M€ [FLM38].

Reduction of flood risk has long been one of the key actions carried out by the *Syndicat du Vidourle*. Efforts were increased following September 2002 flood and a 4-year (2003-2007) action plan on floods was designed [FLM36]. Contents are detailed in the following fiches.

One key issue is the identification of a leading authority to ensure the implementation of the plan: there already exist several institutions that are involved in flood policies in one way or another (few *syndicats*, 2 *départements*, 94 municipalities, etc.). Overall co-ordination is thus necessary.



Vidourle basin - General overview of the action plan

Policy option	Basin flood management policy
Measure	Action plan
Location	Vidourle basin (F)

Fiche Code	BAS06
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Source of information	Projet de plan de prévention des inondations sur le bassin de la Vidourle
Reference	FLM36

Description	a) Flood forecasting and early warning systems - INFb-03 b) Public awareness on best practices - INFc-02 c) Establishment of an emergency plan - INFd-02	d) Measures to reduce peak run-off - PROa-02 e) Reduce level of flooding for given run-off - PROb-06 f) Measures reducing impact of flooding - PROc-09
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		Costs			Comments
Direct costs	Capital	a: 190 000 € b: 50 000 €	c: 950 000 € d: 9 250 000 €	e: 10 370 000 € f: 6 000 000 €	Overall investment costs are estimated for 26 810 000 € i.e. 93% of the overall costs.
	Operation	a: 80 000 €			
	Maintenance				

		Description	Costs		Comments
Indirect costs	b: 5 persons full-time	e: 1 person full-time	b: 800 000 €	e: 160 000 €	Indirect costs only include wages for the duration of the plan. They amount for 1 940 000 € i.e. 7% of the overall costs.
	c: 1 person full-time	f: 2 persons full-time	c: 160 000 €	f: 320 000 €	
	d: 3 persons full-time		d: 500 000 €		

		Description	Comments
Benefits	Avoided damages		
	Others	Share of rainwater shaved: - approx. 16% of rainfall in each sub-basin for 10-year return period rains - approx. 18% of rainfalls at basin scale in case of 50-year return period rains	Benefit expected from measure d.
		Better knowledge of risk and of stakes Securisation of dykes Reduction of hazard in 2 towns Dynamic slowdown of floods	Benefit expected from measure e.

The plan has been set in 2002, following very severe floods in the area (21 persons killed – >1000 M€ damages). It covers a 4-year period (2003-2007).

A key aspect of the plan is that 7% of the overall costs are clearly awarded to human resources, with the creation of 12 full-time jobs. This stresses on the importance of the human factor as part of flood policies: infrastructures and equipment are not all.

This flood policy was submitted as part of a tender from the central government and was awarded a 40% grant in 2003.

Policy option	Information
Measure	Flood forecasting and early warning systems
Location	Vidourle basin (F)

Fiche Code	INFb-03
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Source of information	Projet de plan de prévention des inondations sur le bassin de la Vidourle
Reference	FLM36

Description	a) Extension of monitoring networks (6 new gauging stations) b) Elaboration of a hydraulic model c) Improvement of early warning systems: new procedures, training of authorities in charge of the dissemination of alert messages...
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		Costs	Comments
Direct costs	Capital	a: 90 000 € b: 60 000 € c: 40 000 €	
	Operation	c: 20 000 € / yr	
	Maintenance		

Flood forecasting and early warning are difficult tasks in the context of flash floods: in 2002, it only took 7 to 15 hours for water to reach flood alert levels since the beginning of the rainfalls.

The most innovative proposal of the action plan with regards to this issue is to set a server online available to mayors that would help them determine the need to implement local emergency plans even before official alerts are launched. Local plans would define levels of actions to be taken depending on the intensity of the flood event. Specific training would be ensured to get the most of this system.

Discussions with people following September 2002 flood showed that alert is only taken seriously once: if alert is launched and that no serious (or supposedly so) event comes, many people consider that alert messages are not reliable. Then, they will not behave properly the next time an alert is launched.

Policy option	Information
Measure	Public awareness on best practices
Location	Vidourle basin (F)

Fiche Code	INFc-02
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Source of information	Projet de plan de prévention des inondations sur le bassin de la Vidourle
Reference	FLM36

Description	a) 50 permanent marks of floods b) Several ways of disseminating information to the population: leaflets on municipal emergency plans, public meetings (40 to 80/yr), articles in local and municipal newspapers, exhibition... c) Information in schools d) Creation of an Observatory of flood risk to collect data
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	Costs		Comments
Direct costs	Capital	a: 15 000 € b: 35 000 €	
	Operation		c:
	Maintenance		

	Description	Costs	Comments
Indirect costs	b: 1 person full-time (basis : 40 000 € / yr)	b: 160 000 €	c: goal set is 1 meeting / year / class in 450 classes (11000 pupils)
	c: 3 persons full-time (basis: 120 000 € / yr)	c: 480 000 €	
	d: 1 person full-time (basis: 40 000 € / yr)	d: 160 000 €	

The proposed Observatory would play as a local resource centre on flood risk: collection of detailed data on past events, dissemination of information to decision-makers and to the population, follow-up of the implementation of the action plan, etc.

Surveys following the September 2002 flood showed that even when people know that flood may occur, they often don't believe that it creates serious hazard and they are not aware of how violent the flood might be. This leads to risky behaviours and slow reactions when flood comes.

It is planned to carry out a biennial survey to determine to level of awareness and of preparedness of the population. This will help designing communications measures in the most efficient way.

Policy option	Information
Measure	Establishment of an emergency plan
Location	Vidourle basin (F)

Fiche Code	INFd-02
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Source of information	Projet de plan de prévention des inondations sur le bassin de la Vidourle
Reference	FLM36

Description	a) Definition of municipal emergency plans b) Elaboration of a specific road plan to regulate traffic in case of flood
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	Costs		Comments
Direct costs	Capital	a: 800 000 € b: 150 000 €	a: elaboration of 27 plans (7/year) to cover 15 badly prepared villages with moderate risk and 12 with severe risk
	Operation		
	Maintenance		

Indirect costs	Description	Costs	Comments
	a: 1 person full-time (basis : 40 000 € / yr)	160 000 €	

As flash flood are very sudden and last for a short time, it is necessary to organise precisely emergency plans. These include the identification of “who does what?” but also all practical information such as where people and livestock shall take refuge in time of flood, what materials means shall be made available (and where? when?), how would people be evacuated and where to, etc.

It is proposed to set a common scheme at basin scale so that elaboration of plans would co-ordinated and plans would be homogeneous.

The same statements apply to road plans and similar actions would be taken.

Policy option	Protection
Measure	Measures to reduce peak run-off
Location	Vidourle basin (F)

Fiche Code	PROa-02
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Source of information	Projet de plan de prévention des inondations sur le bassin de la Vidourle
Reference	FLM36

Description	a) Creation of new reservoirs: up to 52 of 200 000 m ³ average capacity + 10 of 1,5Mm ³ average capacity. Total planned capacity: 25 Mm ³ . b) Re-activation of 5 floodplain areas. Planned capacity: 16 Mm ³	c) Overall definition studies for 70 potential sites. d) Concertation with farmers in floodplain areas in order to associate them to protection actions: riverbed and floodplain restoration...
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	Costs		Comments
Direct costs	Capital	a: 7 000 000 € b: 2 000 000 € c: 250 000 €	a, b: full implementation of the plan shall last for 15 to 20 years. Costs estimates only cover the action plan period (2003-2007) and include only 7 reservoirs + 2 floodplains
	Operation		
	Maintenance		

	Description	Costs	Comments
Indirect costs	a+b: 2 persons full-time (basis: 85 000 € / yr)	a: 340 000 €	
	d: 1 person full-time (basis: 40 000 € / yr)	d: 160 000 €	

	Description	Value	Comments
Benefits	Avoided damages		
	Others	Share of rainwater shaved: - approx. 16% of rainfall in each sub-basin for 10-year return period rains - approx. 18% of rainfalls at basin scale in case of 50-year return period rains	

Several reservoirs already exist and provide an overall capacity of 30 Mm³. They were efficient during September 2002 flood, though they are designed for more frequent (thus less severe) events. There also are 5300 ha of wetlands and floodplains in the basin that stored lots of water and slowed the flood in the lower part of the basin.

Extension of retention capacities is very expensive and requires some time (studies, construction). As the plan will last for 4 years, only a limited part of the new capacity can be made available. However, it is planned that studies will be launched in order to ensure that all capacities are built within 15 to 20 years. Local geography make it possible to build a significant number of reservoirs disseminated all over the basin, as tributaries may contribute very significantly to flood risk, due to very local rainfalls. It is intended that 10 sites would be created during the plan period, for an overall capacity of 5 to 6 Mm³.

Policy option	Protection
Measure	Reduce level of flooding for given run-off
Location	Vidourle basin (F)

Fiche Code	PROb-06
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Source of information	Projet de plan de prévention des inondations sur le bassin de la Vidourle
Reference	FLM36

Description	a) Hydraulic studies, including determination of stakes b) Maintenance of existing dykes	c) Extension of existing works d) Construction of new dykes
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	Costs		Comments
Direct costs	Capital	a: 370 000 € c: 3 000 000 € b: 5 000 000 € d: 2 000 000 €	
	Operation		
	Maintenance		

Indirect costs	Description	Costs	Comments
	b: 1 person full-time (basis: 40 000 € / yr)	160 000 €	

	Description	Costs	Comments
Benefits	Avoided damages		
	Others	Better knowledge of risk and of stakes Securisation of dykes Reduction of hazard in 2 towns Dynamic slowdown of floods	

Policy option	Protection
Measure	Measures reducing impact of flooding
Location	Vidourle basin (F)

Fiche Code	PROc-09
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Source of information	Projet de plan de prévention des inondations sur le bassin de la Vidourle
Reference	FLM36

Description	a) Relocation of most exposed stakes (up to 40 individual houses) b) Plan for reducing vulnerability in 300 houses	c) Adaptation of agricultural methods to integrate vulnerability
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		Costs	Comments
Direct costs	Capital	a: 3 000 000 € b: 3 000 000 €	
	Operation		
	Maintenance		

		Description	Costs	Comments
Indirect costs	b: 1 person full-time (basis: 40 000 € / yr)		160 000 €	
	c: 1 person full-time (basis: 40 000 € / yr)		160 000 €	

Action a) is widely depending on the possibility to benefit from a national financial scheme for relocation of buildings exposed to natural hazards. In practice, as resources are limited, conditions for use are restrictive and complex. This is why a local contribution would be needed. On the basis of 40 houses, planned expense amount to 75000€/house i.e. between 40 and 60% of the cost of a house.

Under action b), it is proposed to identify areas at stake in order to design measures for reducing vulnerability of houses. Such programmes would include identification of required measures and subsidies to private owners during a limited period (3 to 4 years) so that houses are secured in the short-term.

Concertation with farmers started right after the 2002 flood. It is planned to adapt activities in flood prone areas:

- re-locate some activities in different areas, less exposed to flood risk;
- adapt cultural methods taking into account the flood hazard.

A detailed mapping is needed in order to characterise existing activities (e.g. lot of vineyards) and consider their respective constraints before starting relocation. The action plan only integrates indirect costs for such action, i.e. human resources required to organise this process, inform and negotiate with farmers, etc.

The Moselle-Sarre basin

France, Germany, Luxembourg

Brief description of the basin

Length of the watercourse: 520 km

Surface of the basin: 28.000 km²

Countries crossed:

- France:
- Germany
- Luxembourg

The Moselle is the main tributary of the Rhine; the confluence is in Coblence.

Main tributaries:

- Sarre
- Sûre

Co-operation institution: International Commissions for the protection of Moselle and Sarre

Concern for floods dates back to 1985, when a dedicated working group was set up. Its target was to determine the hydrology of floods and to formulate recommendations for prevention policies.

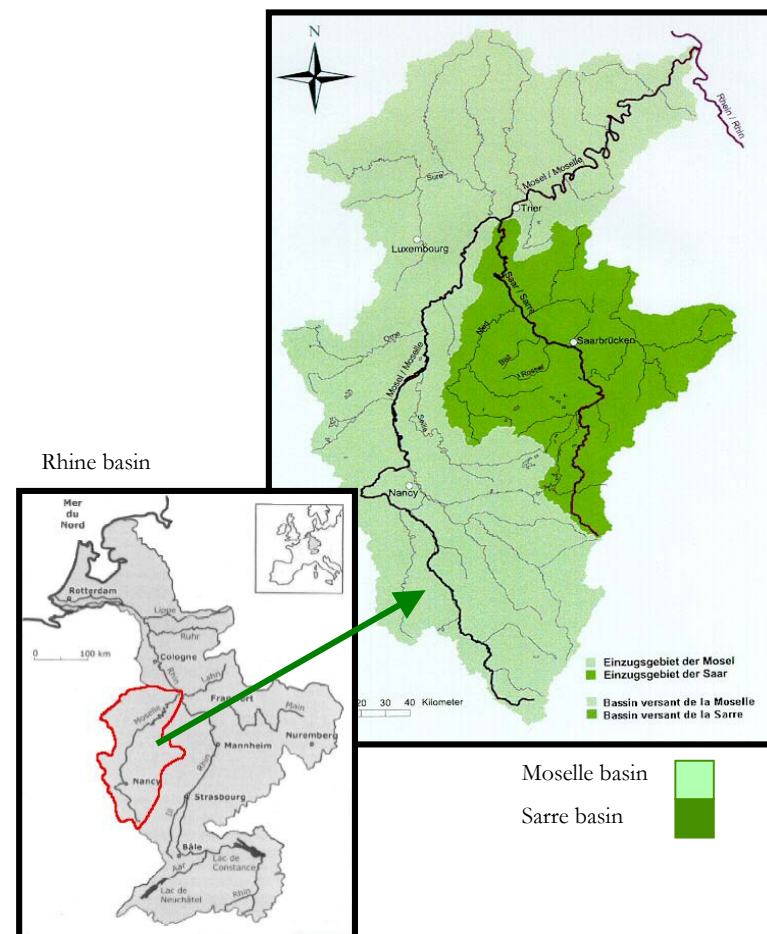
In 1987, an intergovernmental agreement between France, Germany and Luxembourg was signed in order to establish an automatic information system on water levels in the Moselle basin.

Following severe floods in 1993 and 1995, French, German, Belgian, Luxembourgese and Dutch ministries for the environment asked International Commissions for the protection of Moselle and Sarre to prepare an action plan on floods (Arles declaration, February 4th 1995). This document was officially adopted by member states in 1998.

The action plan

The plan sets three priorities:

- reduction of the risk of damages
- continuation of the improvement of flood forecasting and announcement systems
- increasing the retention of water in particular on the tributaries of the Moselle and the Sarre rivers.



All measures taken for the implementation of the action plan must be compatible with goals sets with regards to protection and restoration of aquatic and terrestrial environment. Improvement of ecosystems shall be a horizontal measure, included in all plans.

Measures shall ensure the combination water management, land planning, agriculture and forestry approaches.

Parallel to public policies, individual prevention shall be reinforced. This applies both to individuals and economic activities and refers to building methods, to the protection of goods and to the prevention of pollution of water in case of floods.

A specific character of the Moselle-Sarre basin is that significant reduction of damages can only be achieved through measures applying to activities ran along the riverbeds as there are very limited possibilities to have influence on floods themselves. Then, policy shall aim at flood prone areas management rather than at floods management.

Based on these statements, 5 basic principles for the prevention of floods and the management of flood prone areas are set:

- overall action based on solidarity
- raising of risk awareness
- take water into account
- retention of water in the all basin
- provide space for water.

Given the overall goals set at basin scale, following operational goals have been defined (reference year: 1998):

- reduction of the risk of damages: no increase by 2000, -10% by the year 2005; -25% by the year 2020
- improve the flood forecasting and announcement systems: increase warning lead time up to 12h until 2000 and up to 24h until 2005

The action programme, as detailed below, includes 3 sets of measures combining these 2 operational goals with a third group of measures aiming at increasing the capacity of retention of water, based both on storage and extension of floodplains. The overall cost of implementation of the plan is estimated at 500 M€ until 2020.

Moselle-Sarre basin - General overview of the action plan

Policy option	Basin flood management policy
Measure	Action plan
Location	Moselle – Sarre basin

Fiche Code	BAS05
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Source of information	Plan d'action contre les inondations dans le bassin Moselle-Sarre
Reference	FLM63b

Description	a) Flood risk mapping and communication – INFa-02 b) Flood forecasting and early warning systems – INFb-04 c) Increasing retention capability of soils - PREb-02 d) Increasing retention capability of floodplains and wetlands – PREc-04 e) Measures reducing impact of flooding – PROc-10
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	Costs		Comments
Direct costs	Capital	a: included in measure e b: 3 000 000 € c: included in measure d d: 432 000 000 € e: 65 000 000 €	Full implementation of the plan between 1998 and 2020 will lead to a 500 M€ expense. Budget by 2000 was 54,5 M€; by 2005 it is 224 M€
	Operation		
	Maintenance		

		Description	Costs	Comments
Benefits	Avoided damages	Overall implementation of the action plan shall lead to the reduction of damages by 25% by 2020 (with reference to 1998 situation)		No estimate of the cost of damages is provided
	Others	Optimisation of the functioning of gauging stations and of warning systems. Improvement of emergency plans Extension of forecasting period. Up to 12 hours by 2000 and up to 24 hours by 2005. Increasing of riparian populations' security Increasing of awareness of populations		

Policy option	Information
Measure	Flood risk mapping and communication
Location	Moselle-Sarre basin

Fiche Code	INFa-02
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Source of information	Plan d'action contre les inondations dans le bassin Moselle-Sarre
Reference	FLM63b

Description	a) Elaboration of maps for identification of flood risk and for estimation of damages b) Information of public at large and of pupils
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	Costs	Comments
Direct costs	Capital	No direct estimate: this measure is part of a more general priority on “reducing the risk of damages”, 65 M€ (see measure PROc-04)
	Operation	
	Maintenance	

	Description	Value	Comments
Benefits	Avoided damages	Overall implementation of the action plan shall lead to the reduction of damages by 25% by 2020 (with reference to 1998 situation)	
	Others	Awareness of the population Preservation of historic urban sectors	

Policy option	Information
Measure	Flood forecasting and early warning systems
Location	Moselle-Sarre basin

Fiche Code	INFb-04
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Source of information	Plan d'action contre les inondations dans le bassin Moselle-Sarre
Reference	FLM63b

Description	<p>a) Elaboration of forecasting models</p> <p>b) Creation of expert systems to optimise flood announcement</p> <p>c) Development of common basis for interpretation of data</p> <p>d) Production of data (hydrology, weather)</p>	<p>e) Improvement of quantitative forecasts using radar images</p> <p>f) Improvement of hydrologic models</p> <p>g) Improvement of co-operation among forecasting centres</p> <p>h) Continuation of the implementation of international conventions</p>
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	Costs		Comments
Direct costs	Capital	3 000 000 €	Financial estimate for the overall duration of the plan (1998-2020). 0,5 M€ between 1998 and 2000; 2,7 M€ between 1998 and 2005
	Operation		
	Maintenance		

		Description	Costs	Comments
Benefits	Avoided damages	Overall implementation of the action plan shall lead to the reduction of damages by 25% by 2020 (with reference to 1998 situation)		
	Others	<p>Optimisation of the functioning of gauging stations and of warning systems.</p> <p>Improve emergency plans</p> <p>Extension of forecasting period. Up to 12 hours by 2000 and up to 24 hours by 2005.</p> <p>Increasing of riparian populations' security</p>		

Policy option	Prevention
Measure	Increasing retention capability of soils
Location	Moselle-Sarre basin

Fiche Code	PREb-03
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Source of information	Plan d'action contre les inondations dans le bassin Moselle-Sarre
Reference	FLM63b

Description	<p>a) Limitation of the extension of impervious areas</p> <p>b) Regulatory control of infiltration of rain water in already constructed rural areas</p> <p>c) Adaptation of infrastructures and of constructed areas in order to ensure infiltration of rainwater</p>
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	Costs		Comments
Direct costs	Capital		No direct estimate: this measure is part of a more general priority on “increasing the retention capacity in the basin”, 432 M€ (see measure PREc-04)
	Operation		
	Maintenance		

		Description	Costs	Comments
Benefits	Avoided damages	Overall implementation of the action plan shall lead to the reduction of damages by 25% by 2020 (with reference to 1998 situation)		
	Others	Limited local impacts		This measures applies to a 160 km ² area.

Policy option	Prevention
Measure	Increasing retention capability of floodplains and wetlands
Location	Moselle – Sarre basin

Fiche Code	PREc-04
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Source of information	Plan d'action contre les inondations dans le bassin Moselle-Sarre
Reference	FLM63b

Description	a) Restore streams (1 643 km) b) Re-revitalise flood plains (70 km ²) c) Increase retention capacity of agricultural sectors (270 km ²)	d) Increase retention capacity of forest areas (77,5 km ²) d) Consider the creation of new retention basins (6 millions m ³)
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	Costs		Comments
Direct costs	Capital	432 000 000 €	This amount includes actions carried out in order to reduce vulnerability and to increase retention capability of soils. It refers to full implementation of the plan by 2020. Planned expenses by 2000 were 32 M€ and 184 M€ by 2005.
	Operation		
	Maintenance		

	Description	Costs	Comments
Benefits	Avoided damages	Overall implementation of the action plan shall lead to the reduction of damages by 25% by 2020 (with reference to 1998 situation)	
	Others	Limited local benefit. Restoration of habitats; development of new ones; recharge of groundwater bodies, prevention of erosion	

Policy option	Protection
Measure	Measures reducing impact of flooding
Location	Moselle-Sarre basin

Fiche Code	PROc-10
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Source of information	Plan d'action contre les inondations dans le bassin Moselle-Sarre
Reference	FLM63b

Description	<p>a) Identification of hazardous areas and implementation of relevant protection</p> <p>b) Maintenance of protection infrastructures</p> <p>c) Control of the development of vulnerability</p>
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	Costs		Comments
Direct costs	Capital	65 000 000 €	Financial estimate for the overall duration of the plan (1998-2020). 22 M€ between 1998 and 2000; 37 M€ between 1998 and 2005
	Operation		
	Maintenance		

	Description	Costs	Comments
Benefits	Avoided damages	Overall implementation of the action plan shall lead to the reduction of damages by 25% by 2020 (with reference to 1998 situation)	
	Others	Increased awareness of populations	

The Oise-Aisne basin

France

Brief description of the basin

Length of the watercourse: 340 km (Oise)

Surface of the basin: 17.000 km²

Number of inhabitants: 2 150 000

Three main stretches:

- Upper Oise
- Aisne
- Lower Oise, with the lowest part being navigable

Main tributaries:

- Aisne (confluence in Compiègne)
- Aire

Co-operation institution: Entente Oise-Aisne

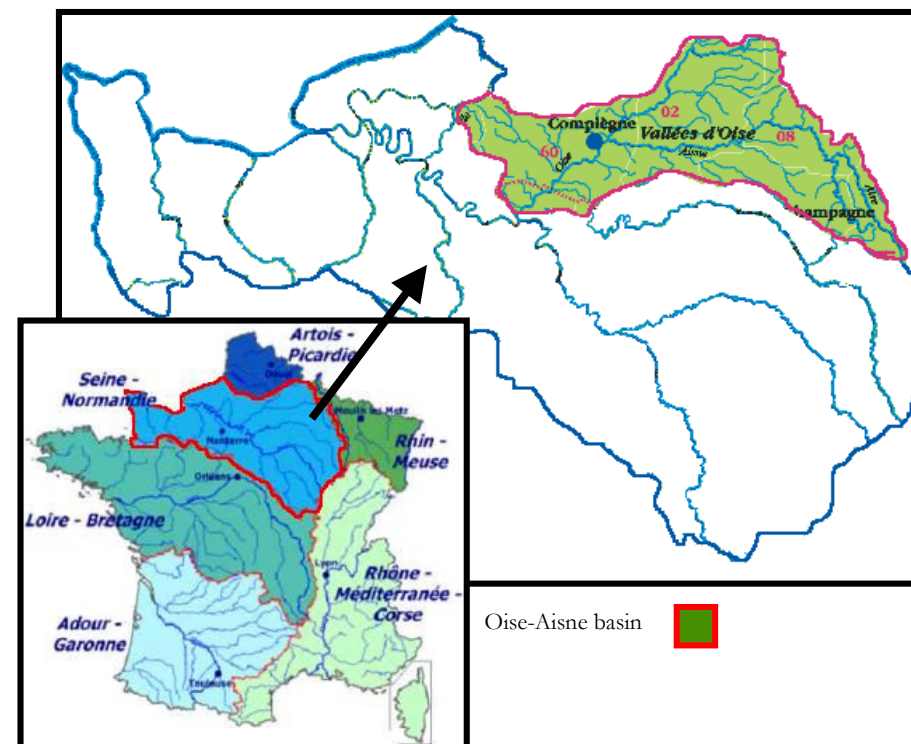
The Oise is a tributary of the Seine.

In 1993 and 1995, severe floods occurred in the Oise and Aisne basins as well as in their tributaries. A feedback analysis showed that such events may happen 2 to 4 times per century and that a coherent policy would very likely significantly reduce their consequences. It was thus decided to elaborate an action plan that associated all actors and was based on reinforced co-operation between the Oise-Aisne Entente (existing group of local authorities), the Water agency and State agencies and services concerned with floods (environment, navigation...).

On first stage, a Charter was passed among these 3 partners in order to formalise their respective involvement [FLM37]. Initial Charter was signed for 6-year time (2000-2006) as this period fitted with that of “*contrats de plan*”, contracts signed every 6 years between central government and each region in order to determine common projects and associated funding schemes. Interim assessment of the implementation of the Charter was planned in year 2003 [FLM81] in order to adjust financial support whenever necessary and to start determining the conditions for the renewing of the Charter after 2006.

Six fundamental goals have been set:

- information and security of people and goods
- prevention of damages in urbanised flood prone areas



- management of navigated rivers
- preservation and restoration of floodplains
- strategy for hydraulic works in order to reduce flood risk
- co-ordination and follow-up of the Charter

Five important technical principles have been set and shall underpin the design and the implementation of the measures:

- large works, such as reservoirs, that were favoured in the past years, are acknowledged as inadequate to current goals set to flood policy in the basin
- overflow areas have to be compatible with existing economic activities (esp. agriculture) and with the natural environment.
- floodplains shall be preserved in priority
- dynamic slowdown concept [FLM04][FLM30] shall be applied to all works whenever possible
- local protection works will only be developed if they don't have a negative impact on the situation of up and downstream areas regarding floods, save relevant compensation is provided.

Aisne-Oise basin - General overview of the action plan

Policy option	Basin flood management policy
Measure	Action plan
Location	Oise-Aisne basin (France)

Fiche Code	BAS04
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Source of information	Charte de gestion du risque inondation sur les bassins versants de l'Aisne et de l'Oise
Reference	FLM37

Description	<p>a) Flood forecasting and early warning systems – INFb-05</p> <p>b) Public awareness on best practices – INFc-03</p> <p>c) Limit the use of floodplains – PREa-03</p> <p>d) Increasing retention capability of soils – PREb-03</p>	<p>e) Increasing retention capability of floodplains and wetlands – PREc-05</p> <p>f) Measures to reduce peak run-off - PROa-03</p> <p>g) Reduce level of flooding for given run-off – PROb-07</p>
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	Costs		Comments
Direct costs	Capital	a: 3,5 M€ b: 1 M€ c: 0,56 M€	e: 21,2 M€ f: 124,25 M€ g: 21 M€
	Operation		
	Maintenance		
			Overall cost of the action plan would amount to 172 M€ d: no estimate as measures shall be included in agriculture policy

Policy option	Information
Measure	Flood forecasting and early warning systems
Location	Oise-Aisne basin (France)

Fiche Code	INFb-05
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Source of information	Charte de gestion du risque inondation sur les bassins versants de l'Aisne et de l'Oise
Reference	FLM37

Description	a) Improve forecasting capacities b) Improve means of alert and announcement of floods
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	Costs		Comments
Direct costs	Capital	a: 2 400 000 € b: 1 100 000 €	a: estimates for a radar + upgraded hydraulic model b: modernisation of gauging stations
	Operation		
	Maintenance		

Policy option	Information
Measure	Public awareness on best practices
Location	Oise-Aisne basin (France)

Fiche Code	INFc-03
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Source of information	Charte de gestion du risque inondation sur les bassins versants de l'Aisne et de l'Oise
Reference	FLM37

Description	Several ways of disseminating information (website, hotline...), permanent flood marks...
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	Costs		Comments
Direct costs	Capital	1 000 000 €	
	Operation		
	Maintenance		

Policy option	Prevention
Measure	Limit the use of floodplains
Location	Oise-Aisne basin (France)

Fiche Code	PREa-03
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Source of information	Charte de gestion du risque inondation sur les bassins versants de l'Aisne et de l'Oise
Reference	FLM37

Description	Comprehensive coverage of the areas located in the basin with statutory documents including flood risk mapping and associated rules regarding land use.
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	Costs		Comments
Direct costs	Capital	560 000 €	
	Operation		
	Maintenance		

Policy option	Prevention
Measure	Increasing retention capability of soils
Location	Oise-Aisne basin (France)

Fiche Code	PREb-03
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Source of information	Charte de gestion du risque inondation sur les bassins versants de l'Aisne et de l'Oise
Reference	FLM37

Description	Promote and support all actions that contribute to slow down flood speed and to increase retention capacity: afforestation, adaptation of agricultural practices, development of grass areas on riverbanks...
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	Costs		Comments
Direct costs	Capital		No estimate. Relevant actions shall be included within agri-environmental measures. Further support may be provided to such actions.
	Operation		
	Maintenance		

Policy option	Prevention
Measure	Increasing retention capability of floodplains and wetlands
Location	Oise-Aisne basin (France)

Fiche Code	PREc-05
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Source of information	Charte de gestion du risque inondation sur les bassins versants de l'Aisne et de l'Oise
Reference	FLM37

Description	<p>a) Promote river maintenance both by public authorities and private riparians</p> <p>b) Improve knowledge of local wetlands and optimise management rules and methods</p>
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	Costs		Comments
Direct costs	Capital	<p>a: 21 000 000 €</p> <p>b: 200 000 €</p>	<p>a: figure don't include private maintenance. However, incentive subsidies will be made available.</p> <p>b: cost of a comprehensive study</p>
	Operation		
	Maintenance		

Policy option	Protection
Measure	Measures to reduce peak run-off
Location	Oise-Aisne basin (France)

Fiche Code	PROa-03
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Source of information	Charte de gestion du risque inondation sur les bassins versants de l'Aisne et de l'Oise
Reference	FLM37

Description	<p>a) Reconstruction of 7 19th century dams and improvement of dams management for optimised control of surface curve in case of flood</p> <p>b) Dredging of the channel in order to restore ancient depth (4m instead of 3,50) and extraction of sediments (750 000 m3).</p> <p>c) Research programme to determine potential for new flood peak shaving works and their combination with existing activities (agriculture, industry)</p> <p>d) Building of reservoirs dedicated to peak flow storage</p>
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	Costs		Comments
Direct costs	Capital	a: 97 000 000 € c: 250 000 € d: 27 000 000 €	b: no estimate provided. Costs will include adequate disposal of contaminated sediments (estimate: 750 000 m3) d: cost of works induced by the implementation of the “Charte de gestion” (i.e. the action plan) by 2006. By 2012, a comprehensive strategy for dynamic slowdown will be implemented. This will lead to a wider investment for an overall amount of 69 M€: 11 M€ for priority works (2000-2004) + 58 m€ for other works (2002-2012). The 27 M€ budget includes both the priority actions and a first part of the medium term works.
	Operation	d: 220 000 € / yr	
	Maintenance		

Indirect costs	Description	Costs	Comments

Benefits	Description	Value	Comments
	Avoided damages Others Reduction of the level of water (compared to 1993 flood): - by up to 20 cm (15 cm in most places) due to priority works - by 15 to 45 cm (over 30 cm in most places) by 2012 when all works will be done		

Policy option	Protection
Measure	Reduce level of flooding for given run-off
Location	Oise-Aisne basin (France)

Fiche Code	PROb-07
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Source of information	Charte de gestion du risque inondation sur les bassins versants de l'Aisne et de l'Oise
Reference	FLM37

Description	Close protection of very dense settlements areas : construction of dykes as close as possible to most at-risk settlement areas, pumping stations...
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	Costs		Comments
	Direct costs	Capital	
	Operation		
	Maintenance		

The Saône-Doubs basin

France

Brief description of the basin

Length of the watercourse: 482 km

Surface of the basin: 29 950 km²

Number of inhabitants: 71 000 (in the floodplain – “Val de Saône”)

Five main stretches:

- Upper Saône
- Wine growing basin of Bourgogne and Beaujolais
- Upper Doubs and upper Loue
- Lower Doubs
- Left side of the Saône between Doubs and Rhône (Bresse and Dombes)

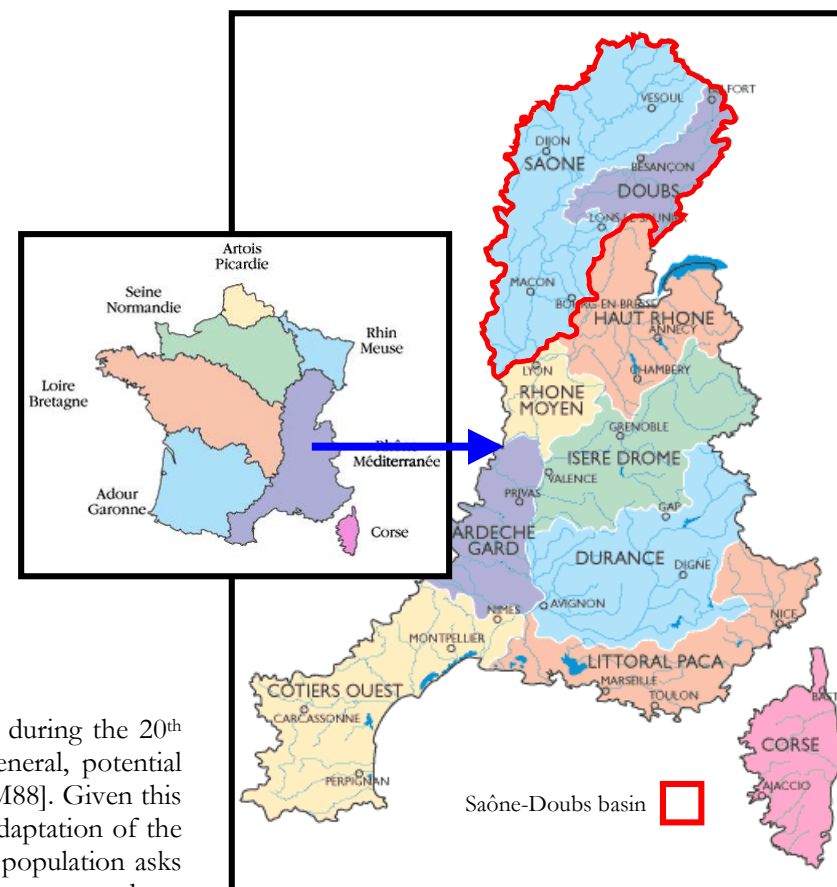
Main tributaries:

- Doubs
- 53 tributaries altogether

The Saône is the main tributary of the Rhône.

Co-operation institution: Syndicat Mixte Saône-Doubs

As floodplain is very wide in the Saône (up to 8 km), very frequent (108 flood events during the 20th century) and long-lasting floods occur. Though human lives are not threatened in general, potential damages have estimated at 4 000 M€ at basin scale in the case of a centennial flood [FLM88]. Given this specific context, floods have shaped local landscape and are part of the basin culture (adaptation of the agriculture, social acceptance...). Yet, people demand is rather contradictory nowadays: population asks for the combination of the reduction of the impact of floods (both on settlement areas and on agricultural sector) and of the preservation of this typical landscapes (wetlands, flood plains...).



Saône basin - General overview of the action plan

Policy option	Basin flood management policy
Measure	Action plan
Location	Saône – Doubs basin (France)

Fiche Code	BAS03
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Source of information	Gestion de l'inondabilité et protection des lieux habités du Val de Saône
Reference	FLM48

Description	a) Flood forecasting and early warning systems – INFb-06 b) Public awareness on best practices – INFc-03 c) Measures to reduce peak run-off – PROa-04	d) Reduce level of flooding for given run-off – PROb-08 e) Measures reducing impact of flooding – PROC-11 f) Increasing retention capability of floodplains and wetlands – PREc-06
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		Costs		Comments
Direct costs	Capital	a: 704 000 € b: 369 000 € c: 130 000 €	d: 16 240 000 € e: 14 300 000 € f: 5 082 000 €	Overall cost of the plan 36 825 000 € This estimate includes only measures that are under the responsibility of the basin authority in charge of flood policy. Costs of other measures (e.g.: under state's responsibility) are not accounted. General approach focuses on the reduction of vulnerability.
	Operation			
	Maintenance			

Policy option	Information
Measure	Flood forecasting and early warning systems
Location	Saône – Doubs basin (France)

Fiche Code	INFb-06
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Source of information	Gestion de l'inondabilité et protection des lieux habités du Val de Saône
Reference	FLM48

Description	a) Improve existing knowledge: 2 flowmeters b) Optimisation of information flow: flood early warning automatic system for the information of citizens at municipal scale
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	Costs		Comments
Direct costs	Capital	a : 228 000 € b : 476 000 €	b) 17 000 € / municipality with 50 to 80 persons directly concerned by flood hazard (28 municipalities)
	Operation		
	Maintenance		

Policy option	Information
Measure	Public awareness on best practices
Location	Saône – Doubs basin (France)

Fiche Code	INFc-03
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Source of information	Gestion de l'inondabilité et protection des lieux habités du Val de Saône
Reference	FLM48

Description	a) Annual information leaflet on the functioning of the Saône basin and on major hazards b) Improve the memory of flood with permanent floods marks on selected previously flooded buildings c) Publication of leaflets, guidance books d) Further information: “animator” in charge of the implementation of this policy
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	Costs		Comments	
Direct costs	Capital	a: 15 000 € b: 72 000 € c: 57 000 €	Overall cost of the measure is 369 000 € for the plan period (5 years) a: unitary cost: 3 000 € / year b: unitary cost: 1 800 €	
	Operation	d: 225 000 €		d: estimates for salary of the animator on a 5-year basis (duration of the prevention plan): 45 000 € / yr
	Maintenance			

Policy option	Protection
Measure	Measures to reduce peak run-off
Location	Saône – Doubs basin (France)

Fiche Code	PROa-04
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Source of information	Gestion de l'inondabilité et protection des lieux habités du Val de Saône
Reference	FLM48

Description	Automatic dam operation system
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	Costs		Comments
Direct costs	Capital	130 000 €	
	Operation		
	Maintenance		

Policy option	Protection
Measure	Reduce level of flooding for given run-off
Location	Saône – Doubs basin (France)

Fiche Code	PROb-08
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Source of information	Gestion de l'inondabilité et protection des lieux habités du Val de Saône
Reference	FLM48

Description	Close protection of very dense settlements areas : construction of dykes as close as possible to most at-risk settlement areas, pumping stations...
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	Costs		Comments
Direct costs	Capital	16 240 000 €	Measure implemented in 12 municipalities
	Operation		
	Maintenance		

Policy option	Protection
Measure	Measures reducing impact of flooding
Location	Saône – Doubs basin (France)

Fiche Code	PROc-11
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Source of information	Gestion de l'inondabilité et protection des lieux habités du Val de Saône
Reference	FLM48

Description	a) Diagnosis of vulnerability for houses, professional buildings and farms b) Measures for the reduction of vulnerability for houses, professional buildings and farms	c) Ensure access to settlement areas when flooded: heighten the level of 15 roads d) Detailed hydraulic study to simulate impact of floods on projects at-risk
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		Costs	Comments
Direct costs	Capital	a: 840 000 € b: 8 800 000 € c: 4 260 000 € d: 400 000 €	a) Cost of diagnosis: <1000€ / house; <2500€ / professional buildings. Potential beneficiaries: 95 companies / shops / services; 35 farms; 520 houses b) Investment costs for measures for the reduction of vulnerability estimated with reference costs: 20 000 € / professional building; 12 000 € / house. Action proposed: 60% subsidies from the state and local authorities.
	Operation		
	Maintenance		

Policy option	Prevention
Measure	Increasing retention capability of floodplains and wetlands
Location	Saône – Doubs basin (France)

Fiche Code	PREc-06
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Source of information	Gestion de l'inondabilité et protection des lieux habités du Val de Saône
Reference	FLM48

Description	a) Research project on reaches b) Restoration and adaptation of floodplains c) Preservation of floodplains: creation of a 1000 ha retention area	As part of a distinct environmental action programme, the restoration and maintenance of several stretches of the river Saône is planned (9 700 000 €). This action will also contribute to flood policy.
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		Costs	Comments
Direct costs	Capital	a: 152 000 € b: 3 430 000 € c: 1 500 000 €	Overall cost of the measure is b: unitary cost: 190 000 € / 1000 ha
	Operation		
	Maintenance		

Tables of damages

Information on damages caused by 4 floods (CH, F), based on post event surveys

1999 flood in the District of Bern, Switzerland

Description of the flood	Year	Source
The flood was mainly due to 2 events : - Plentiful snowfall during the winter then rough cast iron of snows at the beginning of May because of a consequent increase of the temperature. - Then very severe meteorological event with stark rain on an already saturated soil during 5 days. Type of flood: plain flood	Mai 1999	FLD17

Overall evaluation of damages

Taking into account the whole flooded area in the district of Bern, i.e. 11 municipalities, the amount of damages amounted for 97,5M€, of which 39 M€ only for buildings: housing, public buildings, agricultural and industrial infrastructures. Thun and Bern were the two most damaged cities. The amount of cleaning-up (expenses of reconstruction not included) was around 1M€ in the city of Bern only. A Swiss private insurance company provided data on costs and damages.

Area	Type of damages	Housing and individuals properties	Economic activities	Agriculture	Public buildings	Networks			Intangible damages		Total
						Roads	Water utilities	Others	Human	Environment	
District of Bern	Costs (x1000€)	25 000	6 150	1 030	4 800	1 750		1 000	-		39 730
	%	63 %	15.4 %	2.6 %	12.1 %	4.4 %		2.5 %			100%
City of Bern	Costs (x1000€)	4 700	500	35	575	30		55	-		5 895
	%	80 %	8.3 %	0.6 %	9.7 %	0.5 %		0.9 %			100%
City of Thun	Costs (x1000€)	12 300	2 460	45	3 560	720		360	-		19 445
	%	63.3 %	12.7 %	0.2 %	18.3 %	3.7 %		1.8 %	-		100%

The next table shows the differences between the damages to buildings due to the flood itself and those due to subterranean waters in the district of Bern.

Type of damages	Total	Damages €		% of damage	
		average	median	average	median
Flood	214	40 300	25 350	10.1	6.9
Subterranean waters	837	12 350	5 850	3.3	1.4

That was to show that it is advisable to take duly into account as well the push of waters as subterranean waters, ebb of sewage and waters of infiltration when setting measures of protection against floods.

1- Damages to individual properties

In the whole area concerned

Type	Number of claim	Average cost in €
Furniture	148	7 400
Cleaning-up	49	910

2- Damages to economic activities

In the whole area concerned

Type	Number of claim	Average cost in €
Furniture	12	51 000
Cleaning-up	4	3 575
Disruption of activity	7	111 800

Restaurants and hotels, often situated next to rivers, were most severely damaged. In the district of Bern, 24.4 % of the amount of damages to “Economic Activities” (see first table) concerned hotels and 20.8% concerned restaurants.

Measures considered after the flood (*no information about the financial aspect or the importance given to each measures*) :

- ✓ Communication to the population;
- ✓ Implementation of specific education in high schools and colleges specialized in the field of natural disasters;
- ✓ Implementation of emergency plans dedicated to the citizens, the companies and the administration;
- ✓ Implementation of a specific organization dedicated to the realization of these emergency plans;
- ✓ Elaboration of emergency exercises;
- ✓ Involvement of the elected members;
- ✓ Storage of equipment like sandbags;
- ✓ Pumps made permanently available;
- ✓ Implementation of warning systems;
- ✓ Construction of dikes or other barrier against the ascent of waters
- ✓ Specific protection of transformers;

All this was implement with co-ordination between the different administrative scales.

2000 flood in Bretagne, France

Description of the flood	Year	Source
One flood per month between September 2000 and March 2001. Most severe events in December and January. Type of flood: plain flood Peak instantaneous flow: 30-50 years return period Biggest volume of water flowed in 10 consecutive 10 days: 70 years return period 1200 persons were evacuated at least once.	Dec 2000 Jan 2001	FLD05 Feedback report

Table 1- Evaluation of damages

Type of damage	Housing and individual properties	Economic activities	Agriculture	Public buildings - Infrastructures	Networks			Intangible damages	
					Roads	Telephone	Electricity	Human	Environment
Costs	65 M€	44 M€	5 M€	44m€	12 m€	No estimates	No estimates	-	No estimates
Comments			Lots of uncovered soils: reduced vulnerability	Several rescue centres, hospitals, schools, museums... flooded including one flood announcement centre	Hundreds of roads flooded, including major connections and urban rings	Up to 40000 people disconnected for 2 days Reduction of vulnerability since 1995 flood	Up to 3500 people disconnected	No casualties. Surveys showed that immaterial damages (stress, anxiety, etc.) are often considered as worse than material ones. Some nervous breakdowns occurred.	Erosion (lots of uncovered soils in winter): sediments in rivers + wash-off of soils Local pollution (fuel tanks...)

Estimates for insured damages: between 106 M€ (source: insurance companies) and 158 M€ (source: surveys). Average: 132 M€.

Table 2- Damages to individuals and economic activities

Figures based on insurance companies' data

Damage	Number of claims (%)	Amount (%)	Average cost (€)	Average cost 1988-1999 (€)
Housing	65	25	4 100	4 200
Vehicles	15	5	3 200	
Professionals	20	70	34 300	9 650

Damage to housing represent two-thirds of claims but only 25% in amount of damage.

On the opposite, damages to professionals account for only 20% of claims but for 70% in terms of amount of damage.

Table 3- Comparison with recent events

Department	Economic activities		Housing	
	Average cost 2000-2001 (€)	Average cost 1988-1999 (€)	Average cost 2000-2001 (€)	Average cost 1988-1999 (€)
Côte d'Armor	9 200	6 500	2 400	3 700
Finistère	38 400	13 900	5 000	4 100
Ille et Vilaine	15 000	13 600	3 500	4 900
Morbihan	42 000	9 100	3 200	3 500

2001 flood in Somme, France

Description of the flood	Year	Source
Combination of 2 main factors: <ul style="list-style-type: none"> - exceptional meteorological event: heavy rainfalls between October 2000 and April 2001 with a 100-year return period - specific geological structure of the area: very permeable chalky subsoil, already saturated with water. Type of flood: plain flood Long lasting phenomena: <ul style="list-style-type: none"> - very local flood over March - slow extension by the end of March - faster extension until mid-April - stabilisation until mid-May - slow fall from mid-May (44 houses still flooded in late June) 	April 2001	FLD09 Feedback report

Overall evaluation of damages

Type of damages	Houses and individuals properties	Economic activities	Agriculture	Public buildings	Networks			Intangible damages		Total
					Roads	Water utilities	Others	Human	Environment	
Costs	30,5 M€ (1)	10 M€ (1)	7 M€	no data	55 M€	1 M€	38 M€	0 victim	35 M€	176,5 M€
%	17%	6%	4%	-	31%	<1%	22%	-	20%	100%

(1) Amounts of indemnification paid by insurance companies, based on first estimates. Final figures certainly (much) higher.

1- Damages to housing and individual properties

Up to 2 800 houses were flooded at the peak of the crisis of which 730 were evacuated (up to 1100 people).

In most cases (1 600), average damage was below 4 600 € / house. At least 33 houses shall be rebuilt, for an average cost of 106 000 € (1 150 €/m²).

Altogether, 250 families have been relocated in mobile homes either temporarily or for few months.

Damages to vehicles amount for 20% (33,5M€).

2- Damages to economic activities

Number of firms and businesses flooded	200
Cost of damages	10 M€
Firms and businesses that have temporarily stopped their activity	
- number	28
- number of employees	244
- number of hours compensated	19 000
- compensation paid by public subsidies	85 000 €

Costs include only indemnification paid by insurance companies.

In average, economic activities had proper coverage for buildings and machines but not for stocks and for consequences of the disruption of activity.

Some businesses have not been flooded but suffered indirect damages when their customers were. Such costs are not included.

3- Damages to agriculture

Number of claims	440 (3819 ha)
Indemnification (M€)	6
<i>Amount / ha</i>	<i>1 570 €</i>
Damages to market gardening	26 ha
Number of claims	14
Indemnification	170 000 €
<i>Amount / ha</i>	<i>6 500 €</i>
Estimated damages	380 000 €
<i>Amount / ha</i>	<i>14 600 €</i>

Figures are only first estimates, based on indemnification, thus partial.

Most areas flooded are prairies (57% of areas for which claims were declared) and winter crops (43%). As flood lasted for months, these areas suffered very significant damages: all plants have been destroyed and the structure of soils altered. It is estimated that production in these prairies would be lowered for 2 to 3 years.

4- Damages to networks

Roads	12 M€ where directly flooded 44 M€ where “simply” damaged
Railways	2,3 M€ of which 0,5 M€ for equipment 0,6 M€ for disruption of activity 1,2 M€ for infrastructure
Electricity	0,55 M€ of which 0,5 M€ for equipment 0,05 M€ for discounts made to customers who suffered from floods
Water utilities	1 M€
Waste disposal plant	3 M€

5- Intangible damages

A- Health and well-being

Due to the exceptional duration of the flood (some areas remained flooded for up to 6 months), 250 families were relocated for months, mainly in mobile homes. In the meantime, tens of homes had to be rebuilt. Both factors generated psychological significant “damages”.

B- Damages to the environment

Estimates for costs of damages to the Somme channel amount for 35 M€, of which 2 M€ were emergency expenses (pumping, repairing of dykes...).

As part of post-crisis measures, short-term expenses for emergency works amounted for 4 M€.

1999 flood in Languedoc-Roussillon, France

Description of the flood	Year	Source
Very severe meteorological event, exceptional in such a large area although locally some areas have already faced such event 3 or 4 times in the last 100 years. Type of flood: flash flood Unfortunate combination of several factors: <ul style="list-style-type: none"> - very quick increase of level upstream (flash flood type) - failure of a dyke and of a bank material along a railway - very violent storm on the coastal part of the basin Return period estimated between 50 and 100 years.	Nov 1999	FLM38 Feedback report

Overall evaluation of damages

Type of damages	Housing and individuals properties	Economic activities	Agriculture	Public buildings	Networks			Intangible damages		Total
					Roads	Water utilities	Others	Human	Environment	
Costs	167,7M€	85,7M€	52,2 M€	13,1 M€	118,3 M€	20,5M€	30,5M€	35 victims	42,5 M€	530,5M€
%	31%	16%	10%	3%	22%	4%	6%	-	8%	100%

Damages to vehicles amount for 20% of damages to individual properties and for 6% of all damages of the flood.

Cost of the overall damages in the 20 municipalities most damaged range between 10 and 60€ per inhabitant.

1- Damages to individual properties

Damages to vehicles amount for 20% (33,5M€).

Sector	Upper basins	Middle and lower basins
Type of flood	Flash flood: quick and violent	Plain flood: slow and long
Type of damages	Destruction of buildings Deposit of mud, waste, (pieces of) trees... Goods destroyed Intangible damages: personal goods (pictures, jewels, family souvenirs...), papers (contracts, check books...)	Soaking of buildings: medium/long term damages Goods destroyed Intangible damages: personal goods (pictures, jewels, family souvenirs...), papers (contracts, check books...)

2- Damages to economic activities

Number of firms and businesses flooded	988
Cost of damages	85,7 M€
Firms and businesses that have ceased their activity	
- number	9
- number of employees	43
Firms and businesses that have partially restarted their activity	
- number	8
- number of employees	89
Firms and businesses that have temporarily stopped their activity	
- number	246
- number of employees	1 626
- number of hours compensated	237 200

Figures estimated 6 months after the floods. Good reliability

Included: estimates of damages due to disruption of activity.

Not included: liberal professions, loss of customers, absence of flooded employees...

3- Damages to agriculture

Number of claims	5754
Of which - vineyards	4659 (5700 ha)
- market gardening	577
- arboriculture	18
- others	178
Cost of damages (M€)	52,2
<i>Per type of culture</i>	
- vineyards	38,1
- market gardening	11,6
- arboriculture	0,5
- others	2
<i>Per type of damage</i>	
- land	20
- plants	10
- others	12
- crops	10,2

Main causes of damages identified:

- submersion,
- lifting of crops by the current,
- deposit of mud and waste,
- erosion,
- infrastructures for irrigation

Figures estimated 6 months after the floods. Good reliability

4- Damages to public buildings

Damages to all types of public buildings amount for 13 M€. Several sensitive buildings have been seriously flooded: rescue and emergency centres, police stations, schools, retirement homes...

5- Damages to networks

Railways	15 M€ (of which 7,5M€ for equipment)
Electricity	6 M€
Navigation	6,1 M€
Telecommunications	3,8 M€

6- Intangible damages

A- Casualties

35 people died in several circumstances.

Location of death Cause of death	Home	In car	Out of car (but connected to car)	Other	Total
Drowning	7	7	8	4	26
Malaise	1	1	0	2	4
Shock	1	0	0	0	1
Mudflow	4	0	0	0	4
Total	13	8	8	6	35

Half of deaths are linked to the use of vehicles, thus to bad knowledge of associated risks. This shall be taken into account in designing information policies. 6150 persons have been evacuated, of whom 150 were facing vital risk. Some also refused to be evacuated.

B- Damages to the environment

Severe impact:

- thousands of trees lifted and transported by the current
- waste disposal sites flooded
- gold mine flooded; break of a settling basin containing sand contaminated with arsenic
- obsolete industrial zones flooded; drums taken by the current...

Psychological impact of the destruction of natural heritage