Common Implementation Strategy
Working Group F on Floods

Thematic workshop on

Flash Floods and Pluvial Flooding

26, 27, 28 May 2010
Cagliari, Italy

Report on proceedings
& key recommendations

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Publication on CIRCA.

Key messages presented for information to SCG and Water Directors, endorsed by WG F.

Working Group F on Floods

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Executive Summary

As part of a series of workshops looking at the implementation of Directive 2007/60/EC (or 'Floods' Directive; FD) on the assessment and management of flood risks, EC CIS Working Group F (WG F) sponsored a three-day thematic workshop in Cagliari, Italy, at the end of May 2010, on the subject of Flash Floods (FF) and Pluvial Flooding (PF). The event was organized by the Institute for Environmental Protection and Research (ISPRA), the Italian Ministry of Environment and Sardinia Region (Regione Autonoma della Sardegna).

Almost 120 delegates from Member States (MS) and invited speakers across Europe attended the workshop. After the opening ceremony and the presentation of the feedback from MS on a specific questionnaire on FF and PF, the workshop began with a plenary session led by two invited speakers, who provided a characterization of FF and PF events across Europe.

There followed four thematic sessions exploring the topics:

- Events characterization, analysis and approaches to hazard assessment;
- High intensity storms and flood: monitoring, nowcasting and forecasting;
- Structural and non structural measures: planning and prioritization;
- Socio-economic aspects;

Each session ended with parallel discussion groups, and their outcomes were resumed in plenary session.

The workshop was focussed on addressing the problem of the elaboration of risk management plans in the particular case of FF or PF, which are frequently occurring all around Europe. With respect to widespread flooding, these phenomena are in facts so sudden and short in duration that they weaken the risk management operational chain. In fact:

- ➢ the timing and durations of FF and PF reduce possibilities of intervention for risk reducing/mitigating and ask for new approaches in hazard assessment techniques;
- ➢ FF and PF are not a local problem but an EU wide problem, exacerbated by climate change and therefore to be studied in detail to be better addressed in planning policies.

Starting from these considerations, it was concluded that in order to respond to FD requirements the following needs should be satisfied.

1. There is a need to develop a common language among the different science, technical and policy communities dealing with FF and PF.
2. There is a need for improving knowledge and structuring existing information in shared standardized databases. The significant parameters to be monitored and common monitoring methodologies should be defined.
3. In the case of FF there is a lack of standard data, because monitoring networks do not usually cover sites prone to FF, and lack of useful post-event information. For PF, there is a need to understand the role that drainage systems can play in mitigating or exacerbating PF. There is also a need to raise awareness of PF as a potentially serious flood risk..
4. Enhancing monitoring systems, also in order to implement forecasting/warning systems, is necessary. Information on representative past events would be of great help in testing methods for FF and PF forecasting and warning, especially for evaluating the precipitation forecasting system skill.
5. Modifying the classical approach to hazard (and risk) assessment taking into account scenarios and susceptibility and improving assessment of risk to life and economic evaluation of vulnerable assets.
6. Developing a better understanding of phenomena and processes is crucial for selecting the best measures. Communication and participation are the main measures to invest on in order to choose the best other measures to be implemented. The range of possible measures, structural and non-structural, should be widened (e.g. free space, erodible corridor, warnings, delocalization).
7. There is a need for greater emphasis on research in atmospheric processes leading to FF and PF, and in building capacities to monitor and provide better warnings on such kind of events.
8. There is a need for in-depth studies in the causes of FF and PF, especially with a view to the role of climatic changes and human alterations to the catchment.

This report collates the many observations made during the event and presents recommendations under these four thematic sessions. Material and records relating to the workshop activities are presented as a series of appendices.
All the presentations are available on the ISPRA web site at the address: http://www.isprambiente.it/site/en-GB/Archive/Events/Documents/flash_floods.html and on the EU CIRCA web site: http://circa.europa.eu/Members/irc/env/wfd/library?l=/framework_directive/thematic_documents/flood_management/information_exchange/documents_information/cagliari_26-2852010&vm=detailed&sb=Title.

1 Workshop Introduction

1.1 Introduction

The Working Group F on Floods (WG F) of the European Commission (EC), under the umbrella of the Common Implementation Strategy of the Water Framework Directive 2000/60/EC (WFD–CIS) and its working programme, has planned, as part of its mandate, the organization of thematic workshops on specific issues regarding the implementation of the Floods Directive 2007/60/EC (FD) on the assessment and management of flood risks.

In this framework, ISPRA, in co-operation with the European Commission, the Italian Ministry for the Environment and the Protection of Land and Sea (MATTM) and the Sardinia Region, organized on 26–28 May 2010 a workshop on "Flash Floods and Pluvial Flooding" in Cagliari, Sardinia (IT).

An organizing board was set up, composed by three different committees: Working Group F Planning Committee (European Commission, Belgium, Czech Republic, France, Germany, Ireland, Italy and the European Water Association), dealing with strategic issues, a technical-scientific committee dealing with selection of themes and papers, coordination of sessions and outcomes and a national organising committee, dealing with logistics and administrative issues in general (see Appendix C).

1.2 Background

The main objective of FD is the reduction of the destructive effects of floods through the assessment and management of flood risk, respecting fixed deadlines. Member States (MS) must analyze which areas are at serious risk by 2011 and produce flood risk management maps by 2013 and flood risk management plans by the end of 2015.

In elaborating their risk management plans, MS shall consider the entire spectrum of types of flood event, some of which can have disastrous consequences on their territories.

It is accepted practice to perform risk assessment on main rivers and coastal areas, whereas more localized flood events do not always receive similar consideration although their occurrence is quite common across Europe, including many urban areas. High intensity, often localized, phenomena give rise to flash floods (FF) in rivers and watercourses, sometimes severe as in the case of the flash floods in Madeira on 21 February 2010, which claimed over 40 lives. Indeed, there have been many catastrophic FF events in Europe in the last decade, which have caused severe damage and loss of life. Noticeable examples include the events occurred in Spain in 2000 (Montserrat, Catalonia region), Southern France in 2002 (Cévennes), Germany in 2003 (Dresden), Central Romania in 2005, and Italy in 2008 (Cagliari, Sardinia region) and in 2009

(Messina, Sicily region). With respect to widespread flooding, flash floods are characterised by high kinetic energy, resulting in a high threat to life and severe specific (per unit of area) damages to property and infrastructure. They trigger large erosion and sediment transport, and, under appropriate topographic conditions, they lead to the formation of debris flows.

High intensity rainfall can also give rise to pluvial flooding (PF) where overland flows and ponding can occur in areas which were never expected to be at risk of flooding and which can give rise to major damage particularly in urban areas. This was the case in the summer 2007 floods in England which caused over 3 billion Euros of damage. Instances of major damage due to PF also appear to be increasing in other parts of Europe.

Climate change is likely to increase the frequency of extreme rainfall events and hence the risk of both flash floods and pluvial floods. Storm events leading to FF and PF are often characterised by short duration, high intensity and small spatial scales: this poses specific challenges to flood risk management. The need to identify these challenges called for a thematic workshop of WG F examining such particular flood events, namely "Flash Floods and Pluvial Flooding".

1.3 Objectives and Outputs

The workshop aimed at addressing the problems of assessing and, above all, managing flood risk in the peculiar context of FF and PF. The characteristics of these types of flooding were discussed and preliminary definitions were offered at the workshop to assist in achieving a common understanding of the subject.

The workshop core objectives can be summarized as:

- developing a common language shared among all the actors (administrators, researchers, etc.) to characterize this type of phenomena;
- enhancing knowledge and raising awareness of these particular types of floods, in order to obtain the European dimension of the phenomena;
- identifying the main critical areas and gaps to be filled, with particular reference to information and monitoring, forecasting and measures, communication and preparedness, in order to efficiently address the management of the risks posed by these phenomena;
- outlining the emerging needs to complete or enhance practices, with special reference to weak links in the operational chain, so to assist in meeting the requirements of the flood risk management plans due in 2015.

The output of the Workshop is summarized in this report shared and endorsed by WG F and the workshop participants (see Appendix B).

1.4 Workshop Structure

The three-day workshop was structured in four thematic sessions to cover key issues as listed below (appendix A):

Theme 1. Events characterization, analysis and approaches to hazard assessment.
Theme 2. High intensity storms and flood: monitoring, nowcasting and forecasting.
Theme 3. Structural and non structural measures: planning and prioritization.
Theme 4. Socio-economic aspects.

The thematic sessions were preceded with a report on the results of a specific questionnaire on FF and PF answered by MS. Moreover, an introductory plenary session to the general themes took place, where Prof. Marco Borga from University of Padua held a presentation on FF characterization in Europe and Mr. Ronnie Falconer from EWA was invited to present on PF.

Each session comprised an initial plenary session with an average of four invited or submitted papers, followed by breakout group sessions to better discuss thematic issues and develop solutions or recommendations for addressing the identified problems and questions. A final plenary session summarized the conclusions and provided a forum for common discussion.

1.5 Report Structure

This report summarises the main workshop discussions. It is structured in an introductive part, and then it details the thematic sessions and the workshop conclusions.

The report includes appendices containing the workshop programme, the list of delegates and the list of the organizing committees (which are also available online at the Cagliari Workshop home page).
It is complemented with two technical volumes collecting:

- the questionnaire and the analysis of answers;
- abstracts and/or full papers.

All workshop presentations and abstracts (or full papers, if available) from the plenary session and the thematic sessions are available to download from ISPRA's website by using the hyperlink 'Documents', which is present at the bottom of the Cagliari Workshop webpage (http://www.isprambiente.it/site/en-GB/Archive/Events/Documents/flash_floods.html).

These documents are also available on CIRCA: http://circa.europa.eu/Members/irc/env/wfd/library?l=/framework_directive/thematic_documents/flood_management/information_exchange/documents_information/cagliari_26-2852010&vm=detailed&sb=Title.

2 Report on Sessions

2.1 Opening and keynotes

In the opening session a series of institutional greetings and keynotes were presented by EC CIS-WG F leader Maria Brättemark, Italian Ministry of Environment delegate Giorgio Pineschi, ISPRA representative Giuseppina Monacelli and Sardinia Region delegate Maurizio Cittadini.

Tiber River Basin District Authority (RBDA) director, Giorgio Cesari, and the Arno RBDA representative, Marcello Brugioni, talked on past and present Italian institutional scenes regarding flood risk management, explaining how current experiences can support the Art. 13, paragraph 2 of FD request of exemption. Thereafter, Marco Mancini (Polytechnic University of Milan) illustrated the FF event that struck Cagliari, Sardinia (IT), in 2008.

As an introduction to the technical session, ISPRA representative Martina Bussettini reported on the results of the FF and PF questionnaire, previously sent to the registered participants of the workshop and to WG F members.

The answers to the questionnaire underlined the general lack of specific management strategies to address these flood events, because their peculiarity and frequency are not yet well understood and acknowledged. In fact, although the events are locally rare, they appear to be quite frequent at the European scale, which shows the need to develop effective risk management guidance.

The questionnaire also highlighted:

1. the need for a common language of risk to characterize FF and PF;
2. the need to increase knowledge of FF, mostly occurring in ungauged streams (no standard information) and pluvial floods (including efficiency of drainage networks and the role they play in mitigating or exacerbating PF) and also raise awareness of the potential risks they pose;
3. the need to standardize and disseminate information on FF and PF in dynamic and publicly accessible databases.

The outcomes of the questionnaire helped structuring the thematic sessions.

2.2 Plenary session: setting the scene

The scope of this preliminary session was defining and characterising FF and PF in Europe to help a better understanding of such phenomena and their impacts, extent and frequency.

Marco Borga was invited to open the session with a keynote lecture. He presented the results of the EU FP6 HYDRATE project, which allowed to collect detailed and consistent data on FF events so to outline their characteristics in different morphoclimatic regions of Europe, including variations due to climatic forcing and consequently on the magnitude, extent and duration (e.g. Mediterranean vs. Continental regions). Such a comprehensive analysis, subordinate to data availability, is fundamental in order to monitor, forecast and manage FF.

Ronnie Falconer talked on PF. Building on the outcomes of EWA Expert Meeting on PF held in Brussels on 28 October 2009, he illustrated recent experiences in modelling such kind of events for the purpose of risk management planning in compliance with FD. He also referred to the EU funded FloodResilienCity project which is also addressing pluvial flooding as one of its themes.

2.3 Theme 1 – Events characterisation, analysis and approaches to hazard assessment

Theme 1 of the workshop aimed at describing the distinctive physical characteristics of flash flood and pluvial flood processes and their impact on monitoring strategies, data requirements and eventually on hazard assessment and mapping as required in Art. 5 and 6 of FD.

Flash floods usually affect small catchments which are seldom monitored or modelled, so data availability is scarce and post-event surveys almost paramount. Moreover, the complex nature of phenomena, including the characteristics of rainfall events causing flash floods and pluvial floods, and/or the occurrence of hyperconcentrated or debris flows (and/or driftwood), requires a multi-hazard approach, which takes into account susceptibility to geomorphic and ecologic hazards. The approach to hazard (and consequently to risk) assessment vary at different stages of risk assessment (*preliminary flood risk assessment* (Art. 4 and 5, FD); *flood hazard maps and flood risk maps, and flood risk management plans* – Art. 6, 7 and 8, FD), ranging from flood prone areas mapping to areas susceptibility to actual events frequency evaluations. Data and tools requirements, their complexity and accuracy, vary accordingly.

2.3.1 Theme 1 – Plenary session

Theme 1 plenary session, chaired by Marco Borga, explored how event analysis and hazard assessment are developed for FF and PF, through three invited presentations and a specific poster session that took place thereafter. Examples of national experimental methodologies for preliminary flood risk assessment (PFRA) were presented. Moreover, approaches to hazard assessment based on river basin vulnerability or susceptibiity, to be used in PFRA, were illustrated.

David Porter, from Northern Ireland Rivers Agency, UK, presented the technical process leading to PF mapping in Northern Ireland, focussing both on the technical gaps in modelling assumptions, relevant for actual

risk assessment, and public perception of maps and risk associated to such type of events.
Bruno Mazzorana, from Autonomous Province of Bolzano, IT, presented a combined stochastic-deterministic approach to hazard assessment, which takes into account physical critical components of flood events (sediments and/or driftwood loads) whose effects amplify flood impacts. These aspects are generally not included in current hazard assessment procedures, which are therefore likely to provide biased predictions, especially in mountainous areas.

Celia Garcia Montanes, from CEDEX, ES, starting from an overview of FF characteristics in Spain, presented a pilot study of risk mapping and flood prone areas assessment, based not only on results from the hydraulic studies but also on geomorphological and historic references.

The session ended with the presentation of six posters dealing with PFRA and the characterization and analysis of flood events in Czech Republic, France, Germany, and Italy. Participants then convened in 3 moderated parallel sessions, which aimed to analyse the characteristics of FF and PF in terms of linguistics, scales and data requirements and implications on approaches to hazard assessment and mapping.

2.3.2 Theme 1 – Parallel session 1: *Space – time scales and data requirements*

The session, facilitated by Marco Borga and Ronnie Falconer, was characterised by a very vigorous debate, especially when dealing with the definition and characterisation of FF and PF in terms of their space/time scale and impacts.

Definitions were proposed in the workshop outlines, aiming to characterize phenomena from a physical point of view, not to distinguish different kinds of ground effects. In fact, without a sound knowledge of FF/PF physical processes, it is quite hard to capture the cause-effect link necessary to cope with their impacts. Nevertheless, participants tended to focus mainly on impacts.

PROPOSED DEFINITIONS

FLASH FLOOD: a flood that rises and falls quite rapidly with little or no advance warning, usually as the result of intense rainfall over a relatively small area (Glossary of the American Meteorological Society, 2000 edition).
Key aspect of the definition is the ***time scale****: sudden hydrological response to the causative event.*

PLUVIAL FLOODING: direct runoff over land causing local flooding in areas not previously associated with natural or manmade water courses.
Key aspect of the definition is the ***lack of proper drainage network*** *in the area impacted by the flood.*

CONCLUSIONS

- FF are mainly from channelized flow, due to short and intense rainfall events (duration from centre of mass of rainfall to peak discharge less than 10 hours); high flow velocity is an important characteristic.
- FF impact areas usually < 1000 km^2, causing loss of life and large potential damages. Co-occurrence with debris flows amplifies damages and risk to life.
- PF can be due to the same intense rainfall events as flash floods but can also occur during longer lasting events; primarily from overland flow and ponding of land surfaces. Risk can be associated to depth but also high velocity.
- PF impact areas < 1000 km^2; as FF, and may trigger large potential damages.

RECOMMENDATIONS

- Space-time scales are such that both FF and PF require high density rainfall observations (usually radar adjusted by using rain gauges).
- Rainfall monitoring/nowcasting/forecasting essential for both FF and PF: because of this, there is a need to define both the required accuracy and the uncertainty affecting the monitoring/nowcasting/forecasting.
- FF and PF warnings are usually based on threshold analysis defined from analysis of past events: there is a need to extend the information on threshold based on economic and social data.

2.3.3 Theme 1 – Parallel session 2: *Language of risk*

The development of a common language of risk is a pre-requisite to enhance a multi-sectorial and multi-disciplinary approach to FF and PF risk management. This was the base of the discussion undertaken in the second discussion group, chaired by Paul Samuels.

OBSERVATIONS

- Many documents are already available: FLOODsite, UNISDR, WMO, Swiss etc. However, many of these served the aims of specific project.

CONCLUSIONS

- The definition of PF mainly refers to characteristics of the drainage network.
- Definition of FF mainly refers to the space and time scale of the storm event.
- The two definitions incorporate different perspectives.

RECOMMENDATIONS

- Definitions should aid:
  - understanding the natural and social phenomena;
  - create a common understanding across various scientific communities;
  - multilingual understanding;
  - management of floods, in its various steps – before, during, after the event.
- Some terms in FD need further discussion – e.g. extreme events, which have several meaning in different communities.

OPEN QUESTION

- How can we develop a shared language of risk which can be effectively used by several science and management communities, taking into account the variety of the national languages?

2.3.4 Theme 1 – Parallel session 3: *Hazard analysis and assessment*

This session addressed the complex theme of hazard analysis, which is regarded as a necessary step of risk assessment. This group was facilitated by Francesco Comiti.

OBSERVATIONS

- FD aims at risk management and mitigation; in this framework, flood hazard needs to be addressed because this is crucial for risk evaluation and land use planning.
- The spatial scale required for the analysis depends on geographical areas and on the implementation phase of the directive. A multi-scale approach is needed.
- Methodologies for hazard assessment vary according to the nature and scale of the problem.
- Flood hazards include both water inundation and abrupt channel morphological changes (bed and banks erosion).
- Hydrological hazard assessment for flash floods and pluvial floods may prove useful to screen out areas susceptible to flash floods and pluvial floods.

CONCLUSIONS

- Preliminary risk assessment, implicitly incorporating specific hazard assessment, is suitable at small catchment scales, identifying relevant hazard processes (e.g. debris flow vs. water flood); for larger basins a preliminary hazard mapping should be provided.

- This preliminary stage should help prioritize subsequent detailed analysis, but also provide a preliminary hazard mapping for land use planning purposes before the final plans will be available.
- For debris flows, no explicit frequency-intensity analysis is needed at the preliminary risk assessment stage; identification of areas subject to relevant erosion/deposition is suitable at this stage.
- For the preliminary stage, the tools should include analysis of past events documentation, geomorphologic field methods, Digital Terrain Model (DTM)-based indices, expert-based judgment.
- The choice of hazard analysis procedures is up to MS, because of different territorial flood related problems.

RECOMMENDATIONS

- Use of different tools (geomorphologic analysis, hydrodynamic and morphodynamic models, DTM-based indices, expert-based judgement) is needed for hazard assessment and mapping.
- Transport processes other than water (sediment, driftwood) should be included in hazard analysis where appropriate.
- Final hazard maps require the use of numerical models, but their results must be acknowledged to be affected by serious uncertainties. Careful expert judgement is fundamental in evaluating their outputs.
- It is important to include scenario analysis in the final hazard maps. Interaction between flood routing and infrastructures (clogging at bridges, culverts) heavily affects flooding pattern, and the sole use of numerical models may fail to capture such dynamics.
- There is a need to provide a benchmark for numerical models characteristics (e.g. 1D vs. 2D, steady vs. unsteady, fixed vs. mobile bed) to be used in hazard mapping.
- Hazard mitigation measures must be evaluated as to their effectiveness before being implemented.

OPEN QUESTIONS

- Down to which scale (basin size) should hazard maps be produced at the preliminary stage?
- Is it enough just to identify vulnerable "points" at the national level at this preliminary stage, rather than carrying out a rough mapping of flood-prone areas?
- How reliable are morphodynamic models to predict channel changes during FF?

2.4 Theme 2 – High intensity storms and flood: monitoring, nowcasting and forecasting

This thematic session, chaired by Roberto Deidda of University of Cagliari (IT), addressed the topic of monitoring, nowcasting and forecasting high-intensity rainfall events which characterize FF and PF. In particular, both the session and the following three parallel groups focussed on the challenges placed *by localized events occurring on short-time periods.*

An invited talk on the FP7 EU **IMPRINTS** project opened the session. Caroline Wittwer, from SHAPI (FR), illustrated the project challenges and objectives, which include the improvement of the preparedness and the operational risk management of FF and debris flow generating events, the production of methods and tools to be used by practitioners of the emergency agencies and utility companies to provide FF/debris flow forecasting and warnings and the production of a prototype operational platform designed to be used around EU. A demonstration of the proposed methodologies was provided over five selected flash flood prone areas located in the Alps and Mediterranean basin.

Five talks and two posters were then presented by MS delegates.

The first talk, presented by Marco Borga of University of Padua (IT), aimed to demonstrate the feasibility of using radar-derived quantitative precipitation estimates (QPEs) to improve forecasts provided by numerical weather prediction (NWP) and hydrologic models. The work focussed on the FF event that struck the coastal area around Venice (North-eastern Italy) on 26 September 2007. Radar rainfall estimates have been assimilated into the MeteoSwiss 2.2-km COSMO model, showing a positive impact on model capability to capture the main individual organized convective systems and reduce the spatial localization errors. A flood forecasting simulation carried out over one of the tributaries to the Venice lagoon showed that the extension of forecasting lead-time was on the order of the lifetime of the convective systems, i.e. 2-3 hours.

The possible impact of corrected radar data in a flood forecasting system was also one of the main points of the talk presented by Silvano Pecora of ARPA Emilia-Romagna (IT). He presented indeed the hydro-meteorological forecasting system implemented to forecast and control flood propagation along the Po river basin. The system is based on a combined use of deterministic and probabilistic precipitation forecasts, three different hydrologic modelling chains, and observations collected from a dense real-time hydro-meteorological network (incl. water level gauges, rain gauges, temperature gauges and radars).

The operational use of radar data, in combination with rain gauge data, was presented by Jan Danhelka of the Czech Hydrometeorological Institute (CHMI). The entire territory of Czech Republic and the surrounding areas are covered by two C-doppler weather radar which provide rainfall estimates with high resolution in time and space (1 km and 10-5 min.). Even if radars provide the most effective tool for storm detection, they still suffer of underestimating the problem as happened during the June 2009 flood event. The presentation included hints about the now-casting activity, the WarnView tool and the Flash Flood Guidance developed by CHMI to provide real-time evaluation of FF risk based on updated basin saturation fields and dangerous level of precipitation estimated to cause fast surface runoff.

Ad De Roo, EC JRC, presented the first results of a FF early warning system derived from the methodology of the European Flood Alert System (EFAS) and underpinned on the use of the meteorological probabilistic forecasts modelled by the COSMO Limited area Ensemble Prediction System (COSMO LEPS) and of a 30-year continuous COSMO-LEPS hindcast series as reference climatology. This activity, which is carried out in the **IMPRINTS** framework, adopts a nested approach where simulations from the 5-km Pan-European EFAS are employed to trigger 1-km 'regional' EFAS forecasts. The activation of such regional FF system is based on the computation of a 'light' indicator based either on the 5-km hydrological simulation or the measure of accumulated upstream rainfall.

Luca G. Lanza, from University of Genoa (IT), presented the results of the most recent 'WMO Field Intercomparison of Rainfall Intensity Instruments' and the impact of rain gauge measurement accuracy on statistics of extreme events. The resulting high quality 1-minute data set provided by 26 gauges (based on various measuring principles) compared during the intercomparison campaign constitutes an important resource for National Met Services to understand the operational behavior of each instrument.

The two posters presented provided instead a general overview of forecasting activity performed at ISPRA (IT) and at the Functional Centre of Umbria Region (IT).

Delegates were then divided, according to their choice, into three parallel groups, having as discussion topics:

- Monitoring: requirements and techniques, chaired by Marco Borga;
- Precipitation: nowcasting and forecasting, chaired by Marco Casaioli and Stefano Mariani;
- Flood: nowcasting and forecasting, chaired by Ad De Roo.

Given the co-related nature of the above-mentioned topics, it was decided to report together the outcomes of the three groups and to synthesize them as follows.

2.4.1 Theme 2 – Parallel sessions 1-3

Starting definitions, after the Glossary of Meteorological of the American Meteorological Society – 2000

Precipitation nowcast:
A very short-term precipitation forecast, *generally for the next three hours (up to six hours in some Met Services).*

Precipitation forecast*:*
An assessment of the ***future state of the atmosphere with respect to precipitation****. Such assessment is usually made by using numerical weather prediction models.*

Flood forecasting*:*
The use of real-time precipitation and streamflow data in ***rainfall-runoff and streamflow routing models to forecast flow rates and water levels****.*

OBSERVATIONS

- Forecasting and warning systems are a very important non-structural measure for FF and PF risk management, essential to reduce casualties and damages.
- FF and PF are localised and short–duration flood events. Under these conditions, the conventional hydro-meteorological monitoring networks (rain gauges and stream gauges) are generally unlikely to provide accurate estimates of rainfall and runoff response.
- Weather radar monitoring is extremely valuable for rainfall monitoring/nowcasting. Radar calibration usually carried out by means of rain gauges. During FF, there are few or no rain gauges available for this purpose.
- FF forecasting depends critically on capability to account for initial soil moisture conditions. Rainfall and temperature data should be collected continuously to provide model-based estimates of soil moisture status. Continuous monitoring of soil moisture may be an added value.
- Specific preparedness strategies are necessary for both FF and PF. Local characteristics and sudden nature of occurrence of FF and PF are best managed by the local authorities with active and effective involvement of the people at risk and with effective coordination between local, regional & national level.
- The time available for communication is very limited and typically there is no time for learning as the flood develops. The preparedness strategies must capitalise on improvements in FF (and PF) forecasting and warning and, at the same time, adapt to the large uncertainties affecting these forecasts.

CONCLUSIONS

- Due to local characteristics, the small spatial scale and the sudden nature, FF and PF are best managed by local authorities with effective involvement of people at risk. Due to the local rarity, this requires effective methodologies and tools to share experience and methods among different communities and organisation.
- People in FF areas should get used to live with such events: 1) education and training are essential; 2) content of the warning is important; 3) probabilities uncertainty should be communicated to the public in a more effective way.
- FF and PF events, due to their special characteristics and causes of occurrence and need of improved understanding, require a multi-disciplinary approach in risk management.
- Rainfall estimation, nowcasting and forecasting is essential in FF and PF risk management, due to the small size of basins potentially impacted. Weather radar plays a central role in this framework; however radar rainfall estimates still suffer considerable uncertainties, particularly in the mountainous context where flash floods are more frequent.
- NWP models are currently available at spatial and temporal resolutions that make them attractive for hydrological applications also in small watersheds and potentially for FF. However, increasing model resolution does not guarantee a better forecast quality at the smallest spatial and time scales. Thus the skill in predicting precipitation has to be improved (e.g. better initialization). Recent advances in incorporating information from weather radars into the meteorological models to improve rainfall predictions could be a major step forward for finally improving the forecasted rainfall fields.
- Extending forecaster's experience/skill is crucial to improve operational use of tools and methods for FF and PF nowcasting/forecasting. This is particularly the case when using probabilistic approaches and uncertainty quantification.

RECOMMENDATIONS

- Need to improve data availability, density and quality concerning rainfall, water discharges and sediment transport. Anyway, rain gauge networks are complementary to radar networks and should be maintained and improved. Guidelines should be developed and provided concerning the data requirements for FF risk management (for both event-management and long-term risk management).
- Calibration, standardization (e.g. of quality check and data correction methods), update of the stage-discharge relationships are priorities; data exchange (incl. radar data) should be strongly promoted among neighbouring countries.
- Need of research on *i)* QPE from radar and satellite platforms and on *ii*) hydrological prediction in ungauged basins under extreme rainfall at small space/time scales (*it should be included in the next EU funding working programmes – issue to be addressed to DG Research*).

- Research should focus on advancing data assimilation into NWP models, which shows the potential to improve the accuracy of precipitation nowcasts and forecasts in both time and space. This may prove essential at the small scales typical of FF and PF. In a parallel way, research needs to focus on effective ways to quantify uncertainty affecting hydro-meteorological models.
- A common verification framework for precipitation forecast at European scale should be performed, i.e. an intercomparison verification study at European level to assess NWP accuracy and skill in terms of precipitation at different scales – selection of FF events both over Mediterranean and continental Europe.
- Guidelines should be developed and provided concerning the available forecasting systems (e.g. modelling vs. precipitation threshold approach), their preferential scale of application, data requirements and relevant uncertainties. Appropriate tools (i.e. web-based platforms) should be developed to advance and share experience/skill on use of forecasting systems for FF events (which are locally rare).
- Need to develop a common language among the different science and technical communities dealing with FF and PF, and to make a better attempt to understand the public and be understood by the public by changing/improving the language and terminology used. This includes advancing methodologies to present uncertainties to end users.
- Standard use of post-flood survey for FF and PF is recommended to gather flood response data (flow types, flood peak magnitude and time, damages, social response) with the objective to advance understanding of such events (incl. development of data archives) and improve assessment of vulnerability aspects (economical, social, ecological, etc.).

OPEN QUESTIONS

- What should be observed and monitored to advance FF and PF risk management capability? Which are the key variables to monitor at the local scale and which is the resolution required?
- Weather radar is essential for FF and PF monitoring and for nowcasting activities. How to improve the quality of radar rainfall estimates, particularly for high intense rainfall and rough orography, with current technology available in the European countries? Which is the most promising remote sensing technique?
- How to account for uncertainty in hydro-meteorological predictions, arising from many sources of potential errors? How to communicate uncertainty to end users?
- How to increase awareness and preparedness in the communities exposed to potential FF and PF risks?

2.5 Theme 3 - Structural and non structural measures: planning and prioritization

Theme 3 explored the key problem of choosing and implementing measures to address FF and PF risk reduction and management.

This is a very critical aspect because of the small space-time scales of these types of floods and of consequent short time for reaction (warning & alert). In addition to that, the dynamic of FF events is often so complex that assessing and managing the associated hazard and risk becomes extremely difficult. Moreover, the dispersion of elements at risk often limits the sustainability of structural measures, channelling the selection of possible measures towards non-structural ones. Both for FF and PF the type-range of possible measures is therefore very limited (less so for PF) and the optimal choice should derive from an integrated evaluation of physical, environmental and socio-economical aspects.

2.5.1 Theme 3 – Plenary session

The plenary session, chaired by Paul Samuels (HR Wallingford, UK), explored some European and MS experiences in the field of FF and PF risk mitigation measures.

Paul Samuels, project leader of FLOODsite, reported on the outcomes of those FLOODsite tasks dealing with measures classification. This overview helped better understand the reasons of drastic reduction of possible measures for FF/PF with respect to other types of flood.

Mario L.V. Martina, from University of Bologna (IT), presented a probabilistic decision approach for early warning systems based on rainfall threshold values, particularly suitable for FF. Crucial for the system success is the definition of thresholds, to be based on a risk (cost) analysis (accepted level of risk/minimization of costs), inclusive of flood damages and warning systems cost/reduction.

Caroline Wittwer, from SHAPI (FR), presented the national flood warning operational chain and the specific activities aimed to address FF, which centre on enhancing forecasting systems and increasing the river network surveillance extent in partnership with local communities.

Francesco Comiti, from Free University of Bolzano (IT), addressed the issue of debris flow monitoring and warning. He presented the case of an experimental study site for monitoring and testing *advance* and *event warning systems* for FF in steep mountain catchments, where hyperconcentrated and debris flows are triggered/occur. The associated risk can be coped with by a combination of both structural and non-structural measures. This entails investments in long-term monitoring programmes, which will enhance knowledge of these processes. In order to avoid future unsustainable mitigation costs, debris flow hazard should be mapped also in presently unpopulated areas.

Jan Danhelka, from Czech Hydrometeorological Institute, presented the Czech flood warning system and its territorial hierarchical chain, where at the local level FF warning systems are dealt with. He illustrated the current EU funded automatic warning systems programme, focussing on skills and shortcomings.

Martin Kovac, from the Association of Towns and Communities of Slovakia, presented an integrated approach for flood risk reduction that meets other planning objectives such as water protection, climate change adaptation, etc. The approach focuses on risk reduction associated to land use management so as to increase catchments and soil detaining capacities through the implementation of legal measures (mainly natural resources use policies).

2.5.2 Theme 3 – Parallel session 1: *Structural and non-structural measures for flash flood and pluvial flooding risk management*

The session, facilitated by Giuseppe T. Aronica and Roberto Deidda, was characterized by strong participating in the discussion. The issue is so crucial and many are the problems to be addressed that the discussion underwent different degrees of analysis, ranging from glossary (definitions) to measures selection criteria. Moreover, it was quite difficult to focus discussion on FF and PF only and discussion often regarded floods measures in general.

DEFINITIONS (from FLOODsite)

MEASURES: *direct physical interventions usually implemented by flood management authorities.*

INSTRUMENTS: *Changes to the social, financial and institutional context of the flood risk system.*

STRUCTURAL MEASURES: *permanent engineering works intended to reduce the frequency of flooding.*

NON-STRUCTURAL MEASURES: *Instruments; physical interventions which are not permanent or do not necessarily involve traditional engineering works.*

OBSERVATIONS

– Structural measures reduce risk, they are mostly effective but typically present management problems (maintenance costs). They can impact on water bodies status and threaten the achievement of environmental objectives according to WFD.

- Non structural measures reduce vulnerability. They can be permanent and reliable but socially costly (e.g. delocalization) or temporary and less costly but also less reliable (e.g. early or alert warning systems).
- Structural and non-structural measures are erroneously considered as alternative to each other. They should be complimentary and combine to form a portfolio of appropriate measures.

CONCLUSIONS

- Depending on the peculiarity of specific zones and events structural and/or non-structural measures can be selected.
- Combined use of structural and non-structural measures is often required, especially in debris flash floods.
- An integrated evaluation of concurrent and concomitant factors (physical, economical, environmental, social) is needed to select the optimal combination of measures.
- Social acceptance of measures is very relevant to FF risk management.
- Land use planning development should take into account flood hazard maps.

RECOMMENDATIONS

- Cost/benefits and cost/efficiency analysis should be carried out in order to find the optimal combination of measures to be implemented.
- Social acceptance of measures should be taken into account as a factor to be weighed in the analysis together with economic costs, environmental costs and technical feasibility.
- The costs of loss or reduction of WFD environmental objectives should be taken into account by the optimization procedure for FF and PF measures selection. This must be balanced against social need.
- Flood hazard should be mapped also in presently unpopulated areas susceptible to urban development, in order to avoid future unsustainable mitigation costs.

OPEN QUESTIONS

- Should we abolish the terms structural/non-structural measures?

2.5.3 Theme 3 – Parallel session 2: *Preparedness*

This session, chaired by Martina Bussettini and Bernardo Mazzanti, focussed on preparedness as most effective resilience measure to cope with these rapid phenomena where the null lead time leaves no time for effective reaction. The session started with a discussion and clarification on the term “preparedness”, having different meaning among MS, and it gave a clear example of how a common language or at least a common shared translation is needed to address FF and PF risk management issues at the European level.

OBSERVATIONS

– Terminology: "preparedness" has different meanings in EU countries.
– The appropriate behaviour is different in flood events and FF events.
– Communication is a key aspect: media agreement to give warnings, call centres.
– There is a need to raise awareness of pluvial flooding as a potentially serious flood risk.

CONCLUSIONS

– Shared definition for preparedness: pre-alert preparation or something before the event. Preparedness should aim to raise the level of resilience to both FF and PF.
– In terms of understanding, FF and PF are locally rare but regionally frequent so institutional preparedness should be increased.
– Institutional/Public preparedness: warning directly to people (e.g. people are trained to be self sufficient in FF and PF events– this can raise resilience to these types of flooding).
– Education and awareness are very important.

RECOMMENDATIONS

– There should be a common understanding of ways to increase preparedness (including self help measures) and through this raise the level of resilience to both FF and PF.

- The importance of education and awareness raising must be recognised

  Road signs in FF and PF prone areas.

– FF: focus on the flood prone areas according to different lead times.

– Information according to target: message translation from the expert to the public including adaption to local conditions

OPEN QUESTIONS

– How can we identify the "right behaviour" in case of a FF or/and a PF event?

2.6 Theme 4 – Socio-economic aspects

FF and PF physical complexity and abruptness shape flood risk management strategies: preparedness has to be based on communication as well as on social acceptance of risk mitigation measures, especially when they involve disruptive changes in socio-economic structure and assets. Therefore, the need for a specific thematic session addressing the interaction between physical phenomena and society, focussing on flood risk perception and, above all, on flood risk communication and awareness. A particular attention was given to the economic evaluation of flood risk, from the perspective of insurance industry and research.

2.6.1 Theme 4 – Plenary session

Plenary session was coordinated by Bruna De Marchi, from the International Sociology Institute of Gorizia (IT), who stressed the importance of clear communication among all the actors and stakeholders to make their different views and interests explicit and to hopefully integrate their different backgrounds, in order to achieve effectiveness in design and implementation of flood risk management measures.

Communication strategy was one of the issues dealt with by EU FP6 ERA-Net CRUE project: a summary of the activity of which was presented by CRUE Ambassador Wouter Vanneuville (Flemish Government, BE). The CRUE consortium, on the basis of the national programmes and projects on FRM and on the research needs evidenced by each MS present in the consortium, developed the CRUE Research Agenda: Strengthening EU Research for FRM (Vision 2015) having as main objectives to *i*) further integrate the European Research Area to support the implementation of policies on FRM; *ii*) develop evidence and innovation required to underpin sustainable FRM across Europe, reducing the potential for duplication of research effort; and *iii*) improve the integration of knowledge and to develop further the systematic exchange (horizontal and vertical) of information and good practice on flood management research.

The relevant strategic actions identified by the Research Agenda were also the main topics of two Research Funding Initiatives. The first call was on 'Risk assessment and risk management: effectiveness and efficiency of non-structural flood risk management measures'. Seven projects were funded having as target the "land use/spatial planning"; "flood warning" and "perception/evolution of risk". The second call was on 'Flood resilient communities – managing the consequences of flooding'. The funded seven projects focussed on the "improvement of risk awareness and increased public participation"; the "communication of residual risk and uncertainties"; the "interaction of different actors and of local scale and basin scale"; and "tools and improvements for flood event management".

Social acceptance of PF warning services and social setbacks in case of its failure were at the centre of the presentation of Dennis J. Parker, Middlesex University (UK), who illustrated the results of a project exploring the potential for PF warning services with professional responders and the public in England and Wales. If, on the one hand, the valuable lead time of pluvial flood warning services allows preparedness in professional responders, on the other hand, difficulties and constraints in such a service may abate people's reliability in such services. In fact, extreme rainfall forecast uncertainties influence flood warning reliability and response process in a way that may undermine people's confidence not only in this case but also in more consolidated existing fluvial and tidal warning services.

The insurance industry perspective of FF and PF risk assessment was given by Bettina Falkenhagen, German Insurance Association (DE). Insurance industry is promoting policies to cover natural risks, among which floods, but in the case of FF and PF, risk mapping and zoning is still not so reliable to serve as a basis for insuring properties. Data are still insufficient and suitable methods are still to be confidently tested, so research is very much needed in this field.

For long duration floods, flood risk mapping is much more reliable instead, and may be used to identify flood prone areas, vulnerability estimates and simulate flood scenarios areas extent, as in the Flood Insurance Risk Management System (SIGRA) developed by University of Genoa through a project financed by Italian insurance industry (ANIA) and presented by Angela Taramasso. The system eventually calculates insurance and re-insurance related economic parameters.

The three parallel sessions that followed were introduced through a series of open questions, aimed to facilitate discussion.

2.6.2 Theme 4 – Parallel session 1: *Risk perception*

Bruna De Marchi and Paul Samuels animated the discussion on risk perception. The outcomes of this session are synthesized as follows.

OBSERVATIONS

- Concept of risk perception is often misunderstood. Risk perception has been studied in many other contexts apart from floods.
- A strong psychological component and the fact that people do not evaluate risk mathematically result in that two people with the same information will perceive risk differently according to their values, experience, expectations and priorities.
- There is confusion between perception and awareness: awareness may not lead to preparation for a flood.
- Individual denial of risk because unwillingness to accept the implications.
- Many people delegate the safety to the competent "authorities" and lack understanding that risk cannot be eliminated only by physical measures.
- Mismatch in time scales of flood occurrence and lifetime experiences.
- You cannot live with being under "threat" all the time.
- We have transformed "danger" into "risk" which is managed professionally.
- Communication is not enough and it is not just the words.

CONCLUSIONS

- We have to live with "danger".
- "Risk" in "flood risk management" is different from "risk" in "risk perception".
- We must be aware of the communities (often "marginalised") that are exposed to the risk.

RECOMMENDATIONS

- We should concentrate on informing and educating.
- We should aim at producing appropriate behaviour in floods (like learning to drive).
- Post-flood survey should also collect information about social understanding.
- Need to concentrate on avoiding driving into flash floods (many casualties).

OPEN QUESTIONS

- How to assess perception of risk of a community in its various components?
- How can people be concerned about FF or PF events if they have no experience in their area?
- Should we emphasise "danger" or "safety"?
- How does risk perception change with age?

2.6.3 Theme 4 – Parallel session 2: *Communicating risk and creating awareness*

The session was facilitated by Dennis J. Parker through a series of questions.

❖ Why should we communicate risk?
- Knowledge deficit issue?
- Where does the deficit lie?
- Lack of experience; education as a substitute?
- How effective education can be?
- Overcoming denial.

❖ How should we communicate risk?
- Flood risks maps.
- Education at schools.
- Engagement on communities / flood action groups or NGO's.
- Exercises, training. How effective can this be?
- Maintaining high awareness is a continuous process.

❖ How should we communicate uncertainty?
- Probabilistic warnings?
- Public understanding of probability?
- Civil protection or other stakeholders understanding?

OBSERVATIONS

- A large range of stakeholders should be involved (not only public and civil protection but also farmers).
- Should take benefit of consultation on flood risk management plans.
- People forget flood risk, how to retain high level consciousness of flood? We count on images for FF in particular.

- Challenge for FF and PF (source cannot be seen; short lead time): the only way is communication
- FD says: *involve interested parties*. But what about 'un-interested' parties? Getting people involved in the early stage is difficult.
- Different messages if FF-PF or fluvial-coastal flood.

CONCLUSIONS

- Target-fit, flood type specific communication is the only way to raise awareness and retain high level consciousness of flood.
- Awareness of risk does not imply its acceptance.

RECOMMENDATIONS

- Collect together experience on communicating risk.
- Mark protected areas as flood prone areas; using of right language is important.
- Avoid being too complex in presenting flood risk.
- Raise responsibility for self-protection; prepare population with simple reflex.
- Transfer knowledge and understanding to people.
- Use animation and images.

OPEN QUESTIONS

- What is the best way to communicate risk about non fluvial – coastal flooding?

2.6.4 Theme 4 – Parallel session 3: *Resilience to events*

This session on the 'resilience' concept was chaired by Wouter Vanneuville and Angela Celeste Taramasso.

OBSERVATIONS

- Correlation of risk with resilience depending of scale of events.
- Different meaning of resilience in Europe, "live with risk is a culture question".
- Economic aspects correlated to resilience of flood events.

CONCLUSIONS

- Resilience in a FF area is complex: no indication of where and when
- The problem of resilience to FF and PF is also about the "experience" of inhabitants.

RECOMMENDATIONS

- To include resilience aspects in a Flood Management Plans, especially for urban and industrial areas.
- It is necessary to define the different level of risk, acceptable or not acceptable, according to FF and PF events characteristics and susceptibility in different area.

OPEN QUESTIONS

- How to improve the education and level of awareness of individuals and communities.
- What type of measures can we adopt?
- What type of warnings?
- How to produce FF maps in EU countries?
- Necessity of exploring new approaches to define new resilience measures.

3 Workshop Conclusions and Recommendations

1. FF and often PF are characterised by small spatial scales, sudden nature and are highly influenced by local characteristics.
This calls for a specific approach in risk assessment and management in order to comply with FD requirements.

2. Due to their specific time-scale features, FF and PF are best managed by **local** authorities with *effective involvement of the people at risk*. However, there is a need for a **regional** and **national** strategy to deal with FF and PF within the overall integrated flood management policies, duly recognising the subsidiarity principle.
This requires effective methodologies and tools to share experiences and methods among different communities and organisation.

3. Due to the local scale of FF and in many cases PF, structural flood protections may not be available in the potentially impacted catchments, or may leave some communities and properties at high risk. *Implementation of flood warning systems and community self-help programmes is therefore one of the most effective ways to manage FF and PF risk*. However, the sudden nature of these floods makes FF and PF forecasts highly uncertain.

4. FF and PF timing and durations reduce possibilities of intervention for risk reduction/mitigation of risk and require new approaches in hazard assessment techniques;

5. FF and PF risk management integrate different kinds of hazards and vulnerabilities. *A multi-sectorial and multi-disciplinal approach is therefore required to address in an integrated way FF and PF risk management*. There is a need to develop a common language among the different scientific and technical communities dealing with flash floods and pluvial floods.

6. Rainfall estimation, nowcasting and forecasting are essential in FF and PF risk management, due to the often small size of basins potentially impacted. Remote sensing, and in particular weather radar systems, plays a central role in this framework. However, estimates by remote sensing still suffer considerable uncertainties, particularly in the mountainous context where FF events are more frequent. There is a need to *focus research on these aspects in order to increase the efficiency of the systems devoted to monitor FF (and PF) generating storms*.

7. NWP models are currently available at spatial and temporal resolutions that make them attractive for hydrological applications also in small watersheds and potentially for FF (and PF). However, despite the general improvements in weather prediction, the skill in predicting precipitation has to be improved. Recent advances in incorporating information from weather radars into the meteorological models to improve rainfall predictions is a major step towards eventually improving the forecasted rainfall fields.

8. *Standard use of post-flood survey is recommended* to gather flood response data (flow types, flood peak magnitude and time, damages, social response) with the objective to advance understanding FF and

PF events (incl. development of data archives) and improve assessment of vulnerability aspects (economical, social, ecological, etc.).

9. Even the finest monitoring and prediction systems possible are of no value if they do not serve to warn the public. It is necessary to make a better attempt to understand the public and be understood by the public by changing/improving the language and terminology used. This includes advancing methodologies to present uncertainties to end users.

10. To encourage the free exchange of data to a more efficient use of available resources and the rich data legacy that exists in Europe, *certain regulations at the EU level would be useful for sharing the data, particularly in the context of WFD and FD*. Transfer of hydrological information should be embedded in an information feedback cycle which provides benefits for both the data providers and the data users. *Governments and hydrological services should be informed about the benefits of shared information* and about the value-added benefit which can be derived from this.

11. *Formal and informal procedures should be developed to share the experiences in FF and PF management within the regions, the countries, and through an ongoing international exchange on the topic*. Guidelines should be developed and provided concerning the available forecasting systems (e.g. modelling approaches vs. precipitation threshold approaches), their preferential scale of application, data requirements and relevant uncertainties. Appropriate tools (i.e. web-based platforms) should be developed to advance and share experience/skill on use of forecasting systems for FF events (which are locally rare).

12. Experiences in enhancing preparedness to FF and PF should be transferred and discussed. There should be a common understanding of ways to increase preparedness (including self help measures).

13. The importance of education and awareness raising must be recognised and this should play an important role in raising the level of preparedness and ultimately resilience to both FF and PF.

14. *Appropriate legal provisions should be made to clearly define the roles and responsibilities of various institutions at different administrative levels (national, river basin, state, district or local) involved in FF and PF risk management, including the mechanism for flow of data, information, forecasts and warnings.*

WG F THEMATIC WORKSHOP ON FF/PF RISK MANAGEMENT

Useful Web Links

http://circa.europa.eu/Public/irc/env/Home/main – Information on WG F

http://water.europa.eu/ – WISE website for EC data and information on water environment.

http://ec.europa.eu/environment/water/index_en.htm – DG Environment site.

http://www.floodsite.net/ – EC Large scale scientific project on integrated flood risk analysis and management methodologies.

http://ec.europa.eu/environment/water/flood_risk/flood_atlas/index.htm – This is EXCIMAP's website and includes their main output: the Handbook of Good Practices in Flood Mapping.

http://www.crue-eranet.net/ – This is the web site for CRUE ERA-Net which aims to introduce structure within the area of European Flood Research. The web site also lists the research projects funded under the two CRUE Funding Initiatives.

http://www.hydrate.tesaf.unipd.it/ – This is the web site of the HYDRATE project for improving the scientific basis of flash flood forecasting.

http://www.imprints-fp7.eu/ – This is the web site for **IMPRINTS** project which aims to improve operational flash flood and debris flow preparedness and risk management.

http://www.unisdr.org/ – Web site of the United Nations International Strategy for Disaster Reduction, aiming to guide and coordinate the efforts to achieve substantive reduction in disaster losses and build resilient nations and communities as an essential condition for sustainable development.

http://www.wmo.int/ – Web site of the World Meteorological Organization, which is the UN system's authoritative voice on the state and behaviour of the Earth's atmosphere, its interaction with the oceans, the climate it produces and the resulting distribution of water resources.

http://efas-is.jrc.ec.europa.eu/ & http://floods.jrc.ec.europa.eu/efas-flood-forecasts.html – Web sites of the EFAS – European Flood Alert System, developed by the EU Commission – JRC with the support of the EU national and regional Hydrological Services.

http://assets.panda.org/downloads/managingriversintroeng.pdf – Managing Rivers Wisely - Participation/Integration.

http://www.floodresiliencity.eu – Web site of the European funded FloodResilienCity Project.

APPENDICES

A. Workshop Programme

Day 1: 26th May 2010

9:30 *Registration*

OPENING AND KEYNOTES
Chaired by Giuseppina Monacelli, ISPRA, IT

10:30 Welcome from the Working Group F: Maria Brättemark, EU Commission, DG Environment

10:40 Official opening of the conference: Giorgio Pineschi, Ministry for the Environment and Protection of Land and Sea, IT

10:50 Welcome from Sardinia Region: Maurizio Cittadini, Sardinia Region, IT

11:00 **'European Directive Floods 2007/60/CE and river basin planning'**, Giorgio Cesari, Tiber River Basin Authority, IT

11:15 **'From 152/06 national law to flood directive'**, Marcello Brugioni, Arno River Basin Authority, IT

11:30 **'Why Sardinia?'**, Marco Mancini, Politecnico of Milano

12:00 **'Introducing the workshop and questionnaire feedback'**, Martina Bussettini, ISPRA, IT

13:15 *Lunch & Networking*

PLENARY SESSION: SETTING THE SCENE

14:00 **'Characterisation of flash floods in Europe'**, Marco Borga, University of Padua, IT

14:30 **'Pluvial flooding in Europe'**, Ronnie Falconer, EWA, DE

THEME 1 – EVENTS CHARACTERIZATION, ANALYSIS AND APPROACHES TO HAZARD ASSESSMENT
Chaired by Marco Borga, University of Padua, IT

15:00 **'Development of the pluvial flood map for Northern Ireland'**, David Porter, Rivers Agency, UK

15:15 **'Determining flood hazard patterns through a combined stochastic-deterministic approach'**, Bruno Mazzorana, Autonomous Province of Bozen, IT

15:30 **'Example of flash floods in Spain: Palancia river'**, Celia García Montañés, CEDEX, ES

15:45 Poster presentation for Theme 1:

- **'Flash floods in the Czech Republic – event of 2009 & method of flash flood risk evaluation'**, Jan Danhelka, Czech Hydrometeorological Institute, CZ
- **'PFRA of flash flood and pluvial flooding in France'**, Alice Néron, Ministry of Ecology, Energy, Sustainable Development and Sea, FR
- **'Flash flood events on Salerno coast (Southern Tyrrhenian Sea)',** Giovanni Braca, ISPRA, IT
- **'How meaningful is flash flood mapping?'**, Bruno Mazzanti, Arno River Basin Authority, IT
- **'Pluvial floods – criteria for the preliminary flood risk assessment in the south of Germany'**, Bavarian State Ministry of the Environment, DE
- **'Vulnerability assessment of Sardinia (Italy) to extreme rainfall events'**, Antonio Qurico ARPA Sardegna, IT

16:00 *Coffee break & Poster vision*

16:15 Parallel groups:

- Space-time scales and data requirements
- Language of risk
- Hazard analysis and assessment

17:15 Harvesting and discussion

21:00 Social dinner for EU delegates

Day 2: 27th May 2010

THEME 2 – HIGH INTENSITY STORMS AND FLOOD: MONITORING, NOWCASTING AND FORECASTING
Chaired by Roberto Deidda, University of Cagliari, IT

9:15 **'IMPRINTS – IMproving Preparedness and RIsk maNagementT for flash floods and debriS flow events (2009-2012)'**, Caroline Wittwer, SCHAPI, FR

9:30 **'Radar-driven high-resolution hydro-meteorological forecasts of the 26 September 2007 Venice flash flood'**, Marco Borga, University of Padua, IT

9:45 **'Flash flood early warning using ensemble weather forecasts'**, Ad de Roo, EU Commission – JRC

10:00 **'The radar rainfall estimates in a flood forecasting system for the Po river in Italy'**, Silvano Pecora, ARPA Emilia Romagna, IT

10:15 **'Storm rainfall detection and forecasting – the Czech experience'**, Jan Danhelka, Czech Hydrometeorological Institute, CZ

10:30 **'Accuracy of rain intensity measurements and its influence on the statistics of extreme events'**, Luca G. Lanza, University of Genoa, IT

10:45 *Coffee break*

11:05 Parallel groups:

- Monitoring: requirements and techniques
- Precipitation: nowcasting and forecasting
- Flood: forecasting and warning

12:05 Harvesting and discussion

12:35 *Lunch & Networking*

THEME 3 – STRUCTURAL AND NON-STRUCTURAL MEASURES: PLANNING AND PRIORITIZATION

Chaired by Paul Samules, HR Wallingford, UK

14:00 **'FLOODsite – structural and non-structural measures'**, Paul Samuels, HR Wallingford, UK

14:15 **'Flash flood guidance based on rainfall thresholds: An example of a probabilistic decision approach for early warning systems for flash floods'**, Mario L. V. Martina, University of Bologna, IT

14:30 **'Flood warning procedure in France: Current status and evolution to improve flash flood forecasting'**, Caroline Wittwer, SHAPI, FR

14:45 **'Debris flows monitoring and warning systems: A new study site in the Alps'**, Francesco Comiti, Free University of Bozen, IT

15:00 **'Flash flood early warning systems and legislation aspects in the Czech Republic'**, Jan Danhelka, Czech Hydrometeorological Institute, CZ

15:15 **'Local water planning – integrated approach towards flood risks reduction'**, Martin Kováč, Association of Towns and Communities of Slovakia, SK

15:30 Poster presentation for Themes 2, 3 & 4:

- **'Numerical hydro-meteo-marine modelling at ISPRA in the context of the flash-flood events monitoring, forecasting and statistical analysis activities'**, Stefano Mariani, ISPRA, IT
- **'The real time use of soil moisture sensors to improve the accuracy of flood forecasting models and for the detection of the landslides trigger in Umbrian catchments in the territory of competence of the Tiber river Basin Authority'**, Marco Stelluti, Umbria Region, IT
- **'Special Programme – the streams of Graz'**, Land Steiermark, Rudolf Hornich, AU
- **'Detention of heavy rain on an extensive Norwegian sedum roof; July 3rd 2009'**, Bent C. Braskerud, Norwegian Water Resources and Energy Directorate, NO
- **'Debris flows and flash flood, ISPRA experience through mapping and monitoring of mitigation measures and risk reduction in Italy'**, Daniele Spizzichino, ISPRA, IT

- **'Hydrological extremes or sensationalism?'**, Barbara Lastoria, ISPRA, IT
- **'Characteristics of the extreme rainfall event and consequent flash floods in North-east part of Sicily, Italy in October 2009'**, Giuseppe T. Aronica, University of Messina

15:45 *Coffee break & Poster vision*

16:05 Parallel groups:

- Structural and non-structural measures for flash floods and pluvial flooding risk management
- Preparedness and Prioritization

17:05 Harvesting and discussion

Day 3: 28th May 2010

THEME 4 – SOCIO-ECONOMIC ASPECTS
Chaired by Bruna De Marchi Institute of International Sociology of Gorizia, IT

9:40 **'CRUE ERA-Net: International flood research results'**, CRUE Network Ambassador (Wouter Vanneuville, Flemish Government Department of Mobility and Public Works, BE)

9:55 **'Flash flood and pluvial flooding from the point of view of the German and European insurance industry'**, Bettina Falkenhagen, CEA, DE

10:10 **'Flood maps information content for insurance and re-insurance industries'**, Angela Celeste Taramasso, University of Genova, IT

10:25 **'Exploring the potential for pluvial flood warnings with professional responders and the public in England and Wales'**, Dennis J. Parker Middlesex University, UK

10:40 *Coffee break*

11:00 Parallel groups:

- Risk perception
- Communicating risk and creating awareness (public information and risk awareness: training/education of public and stakeholders)
- Resilience to events

12:00 Harvesting and discussion

12:30 Workshop Conclusions

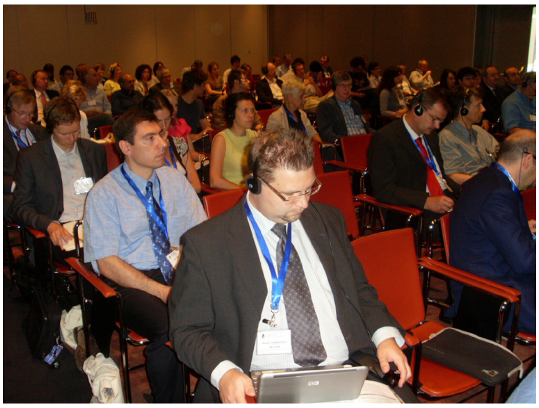
13:00 *Lunch*

B. List of Workshop Delegates

Name	Organization	Country
Mark Adamson	OPW	Ireland
Simonetta Angioni	Sardinia Region	Italy
Darko Anzeljc	Institute for Water of the Republic of Slovenia	Slovenia
Giuseppe T. Aronica	University of Messina	Italy
Cinthja Balia	Sardinia Region	Italy
Andrea Balzano	University of Cagliari	Italy
Marina Barberini	ISPRA	Italy
Antonella Bodini	CNR-IMATI	Italy
Marco Borga	University of Padua	Italy
Alessandra Boy	Sardinia Region	Italy
Giovanni Braca	ISPRA	Italy
Maria Brättemark	European Commission	Belgium
Bent Christen Braskerud	Norwegian Water Resources and Energy Directorate	Norway
Marcello Brugioni	Arno River Basin Authority	Italy
Martina Bussettini	ISPRA	Italy
Giuseppe Canè	Sardinia Region	Italy
Marco Casaioli	ISPRA	Italy
Laura Casicci	Interregional Agency for the Po River	Italy
Giorgio Cesari	Tevere River Basin Authority	Italy
Matteo Cesca	ARPA Veneto	Italy
Jérôme Chemitte	CEA	France
Miriam Chiara	Piedmont Region	Italy
Giorgio Onorato Cicalò	Civil Protection of Sardinia Region	Italy
Salvatore Cinus	Civil Protection of Sardinia Region	Italy
Maurizio Cittadini	Sardinia Region	Italy
Francesco Comiti	Free University of Bozen	Italy
Antonio Quirico Cossu	ARPA Sardegna	Italy
Jan Danhelka	Czech Hydrometeorological Institute	Czech Republic
Bruna De Marchi	Institute of International Sociology of Gorizia	Italy
Ad De Roo	EU Commission – JRC	Italy
Didier De Thysebaert	Service Public de Wallonie	Belgium
Roberto Deidda	University of Cagliari	Italy
Charles Demetriou	Water Development Department	Cyprus
Barbara Dessì	ISPRA	Italy
Carlo Dessy	ARPA Sardegna	Italy
Fabia Diana	ENAS	Italy
Ronnie Falconer	EUROPEAN WATER ASSOCIATION	United Kingdom
Bettina Falkenhagen	CEA	Germany
Sabrina Farris	ISPRA	Italy
Serena Franceschini	Arno River Basin Authority	Italy
Orani Francesco	Proservice S.p.A.	Italy
Francesco Fusto	Centro Funzionale Multirischi - ARPA Calabria	Italy
Giorgio Gaido	Piedmont Region	Italy
Celia García Montañés	CEDEX	Spain
Giovanni Giaconi	Civil Protection of Cagliari Municipality	Italy
Novella Gian Battista	Sardinia Region	Italy

Meike Gierk	Federal Ministry for Environment	Germany
Elena Giusta	ISPRA	Italy
Benedek Göncz	Ministry of Environment and Water	Hungary
Rudolf Hornich	Land Steiermark	Austria
Leila Hutton	Environment Agency	United Kingdom
Krisztina Iványi	VKKI	Hungary
Jean-Pierre Jordan	Federal Office for Environment	Switzerland
Martin Kováč	Association of Towns and Communities of Slovakia	Slovak Republic
Luca G. Lanza	University of Genova	Italy
Barbara Lastoria	ISPRA	Italy
Andrea Lazzari	Hydrographic District Agency of Sardinia Regiona	Italy
Carla Lecca	Sardinia Region	Italy
Christian Leeb	Bavarian State Ministry of the Environment	Germany
Max Linsen	Rijkswaterstaat	The Netherlands
Luciano Loi	Civil Protection of Cagliari Municipality	Italy
Giovanni Luise	Sardinia Region	Italy
Marco Mancini	Politecnico of Milano	Italy
Gianluigi Mancosu	Sardinia Region	Italy
Stefano Mariani	ISPRA	Italy
Mario L. V. Martina	University of Bologna	Italy
Frédérique Martini	Ministry of Ecology, Energy, Sustainable Development and Sea	France
Giuseppe Mascaro	University of Cagliari	Italy
Nadia Mattozzi	ISPRA	Italy
Bernardo Mazzanti	Arno River Basin Authority	Italy
Bruno Mazzorana	Autonomous Province of Bozen	Italy
Giuseppina Monacelli	ISPRA	Italy
Massimo Morea	Liri-Garigliano and Volturno River Basin Authority	Italy
Maria Gabriella Mulas	Sardinia Region	Italy
Stefania Nascimben	Hydrographic District Agency of Sardinia Region	Italy
Barbro Näslund-Landenmark	Swedish Civil Contingencies Agency	Sweden
Loredana Natazzi	Umbria Region	Italy
Alice Néron	Ministry of Ecology, Energy, Sustainable Development and Sea	France
Håkan Nordlander	Swedish Transport Administration	Sweden
Claudia Pandolfo	Umbria Region	Italy
Antti Parjanne	Finnish Environment Institute	Finland
Dennis J. Parker	Middlesex University	United Kingdom
Silvano Pecora	ARPA Emilia Romagna	Italy
Anna Maria Pes	Civil Protection of Cagliari Municipality	Italy
Giorgio Pineschi	Ministry for the Environment and Protection of Land and Sea	Italy
Agostino Pinna	Proservice S.p.A.	Italy
Michela Porcarelli	ISPRA	Italy
David Porter	Rivers Agency	United Kingdom
Giovanni Puligheddu	Sardinia Region	Italy
Francesco Puma	Po River Basin Authority	Italy

Paul Racot	International Meuse Commission	Belgium
Paul Samuels	HR Wallingford	United Kingdom
Corrado Sechi	Sardinia Region	Italy
Valeria Sechi	Sardinia Region	Italy
Aleksandra Seliga	National Water Management Authority	Poland
Roberto Silvano	ENAS	Italy
Rossella Sisti	ISPRA	Italy
Daniele Spizzichino	ISPRA	Italy
Marco Stelluti	Umbria Region	Italy
Hervé Stevenin	Functional Centre of Valle d'Aosta Region	Italy
Árpád Szentiványi	VKKI	Hungary
Angela Celeste Taramasso	University of Genova	Italy
Giovanni Tilocca	Freelance professional	Italy
Riccardo Todde	Sardinia Region	Italy
Francesco Tola	Civil Protection of Sardinia Region	Italy
Carla Virginia Tore	Sardinia Region	Italy
Cristiana Trudu	Lombardia Region	Italy
Wouter Vanneuville	Authorities of Flanders	Belgium
Lorella Vargiu	Sardinia Region	Italy
Francesco Vargiu	Civil Protection of Sardinia Region	Italy
Raffaele Velardo	Liri-Garigliano and Volturno River Basin Authority	Italy
Cristiana Verde	Formez	Italy
Caroline Wittwer	SCHAPI	France




Images of EU delegates during the Workshop Open Ceremony.

Images of EU delegates during the Workshop Thematic Sessions and the social dinner offered by Sardinia Region at Maracalagonis (Cagliari, IT).

C. Committees

WG F Planning Committee:
Maria Brättemark, European Commission, DG Environment
Ad de Roo, European Commission – JRC
Mark Adams, Ireland
Jan Danhelka, Czech Republic
Meike Gierk, Germany
Frédérique Martini, France
Giuseppina Monacelli, Italy
Wouter Vanneuville, Belgium
Ronnie Falconer, EWA

National Technical-Scientific Committee:
Giusy Lombardi, Ministry for the Environment and Protection of Land and Sea, IT
Giovanni Braca, ISPRA, IT
Martina Bussettini, ISPRA, IT
Marco Casaioli, ISPRA, IT
Barbara Lastoria, ISPRA, IT
Stefano Mariani, ISPRA, IT
Giuseppina Monacelli, ISPRA, IT
Silvano Pecora, ARPA Emilia Romagna, IT
Cinzia Balia, District Authorities, IT
Marcello Brugioni, District Authorities, IT
Carlo Ferranti, District Authorities, IT
Massimo Morea, District Authorities, IT
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National Organizing Committee:
Sabrina Farris, ISPRA, IT
Elena Giusta, ISPRA, IT
Rossella Sisti, ISPRA, IT
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