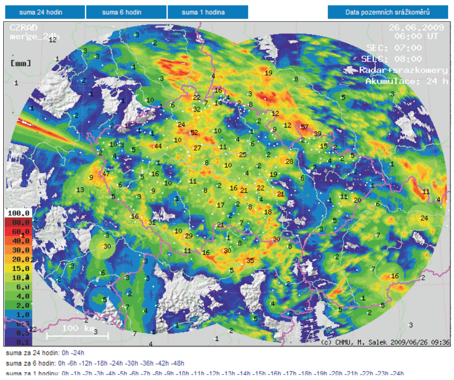
Český národní výbor ČRV ONK pro omezování následků katastrof

CHMI



EARLY WARNING FOR FLASH FLOODS

INTERNATIONAL WORKSHOP

November 1 to 2, 2010

Organized by the Czech Hydrometeorological Institute and the Czech National Committee for Disaster Reduction

ABSTRACTS

Workshop Venue: Premises of CHMI, Na Sabatce, 17, Prague – Komorany
Czech Republic

Český hydrometeorologický ústav
Český národní výbor pro omezování následků katastrof

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International Workshop

Abstracts

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EARLY WARNING FOR FLASH FLOODS

Foreword

Flash Floods (FFs) are among the most destructive types of natural disasters. They might strike with little or practically no warning and could cause losses of lives. The economic losses of FFs by far outweigh investments to prevent or mitigate disasters. They are usually triggered by extreme cloudbursts and storms. Combating FFs is increasingly becoming a high priority in many countries. The losses of lives and property are unacceptable at a time when appropriate technologies and know-how are available to prevent FFs turning into disasters. The Czech Republic was hit by series of flash floods on very large area during the last summer. This disastrous series of FFs showed many problems connected with the speed and very local character of such events. To face better to such dangerous and fast events it is necessary to improve the whole chain beginning with forecasting and warning, followed by dissemination and communication of this information to emergency system at different levels and finally to the prepared and trained public. Therefore, gathering experience people in FFs from more countries can always be very helpful.

Aim of the Workshop:

The Workshop is bringing together experienced people from the European Network of National Platforms (ENNP) countries (France, Germany, Poland and the Czech Republic) together with a representative of the United States. Participants in the workshop directly involved in facing FFs like forecasters from NMHSs, Civil Defense or Fire and Rescue Services, other parts of crisis management systems, local administration and the public could find possibilities of improvement of efficiency and diminishing an impact of such fast and dangerous events like flash floods. A comparison of existing systems for early warning and protection against FFs in ENNP countries and the USA should stimulate discussion aiming to find significant improvement of early warning, dissemination and preparedness for these extremely quick floods. The role of national platforms for disaster risk reduction should be directed towards modern and complex protection against FFs leading to minimization of losses of lives and property in their respective countries.

Organizing Committee:

Ivan Obrusnik, CHMI and Czech National Committee for DR
Radim Tolasz, CHMI
Ludek Prudil, Fire and Rescue Service
Marjan Sandev, CHMI
Jan Kubat, CHMI
Karel Vancura, CHMI and Czech National Committee for DR

Prague, November 1 to 2, 2010 Czech Hydrometeorological Institute

Contents

U.S. National Weather Service Flash Flood Warning Program

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Timely Warning for flash flooding requires a well integrated data, modeling, forecast, and dissemination system. The various data systems, models, forecast techniques, and dissemination approaches currently used and under development in the U.S. will be discussed. Specific topics covered in this overview will include: IFLOWS systems, Precipitation Estimation, Precipitation Forecasting, Ensemble Information, Flash Flood and Headwater Guidance, Site Specific Models, Distributed Model Application, Role of the Forecaster and Forecaster Tools, Coordination, Decision Support, and Warning Dissemination. Also, information on the performance of the NWS Flash Flood Warning program will be presented. The presentation will also summarize outreach and education efforts being undertaken by the National Weather Service and others. This will include the addition of a Service Coordination Hydrologist at each River Forecast Center, use of Customer Advisory Boards, regional and national workshops, training exercises, and production and dissemination of outreach and education materials.

The Weather Warning System of German Weather Service Provider and Special Information for Disaster Control

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The German Weather Service act from September 1998 defines the role of the German Weather Service Provider as National Weather Service of the Federal Republic of Germany. Main task is publishing official warnings previous to severe weather conditions risking public safety and order, especially impending floods. Furthermore the German Weather Service provides support in disaster control to the federal states.
The German Weather Service has generated a policy of weather forecasts targeting at better numeric models and statistic methods. Models and ensemble using convection have proofed advantageous in forecasting heavy rain. Additionally a multi-level warning management system has been established.
The weather warning system allows for weather warning to be differentiated by region and time. Global models indicate dangerous weather conditions 2 until 7 days ahead. The general office in Offenbach publishes this early warning information on a daily basis. This bulletin represents a weeks forecast of dangerous weather conditions and is applicable for the entire area of Federal Republic of Germany. The regional centres release information on weather warning conditions for each federal state five times daily. Depending on the danger of weather conditions warnings are differentiated into several levels of storm warnings like rain, intense rain, continuous rain, thunderstorm with hail or heavy rain. This is levelled down to the administrative districts. An official checklist for each element of weather indicates the warning level once different critical values are reached. The warning contains a free text written by the forecaster, publication time and the duration of validity. Disaster control is based on Germany's political structure and therefore the warning management of German Weather Service Provider is organized along the same structure. Unfortunately riverbeds do not match with political boundaries. Warnings for thunderstorms with heavy rain can usually be given only on very short notice and have a short validity. On days with a high tendency for thunderstorms the warnings might have to be repeated several times per day. As thunderstorms are restricted to a very small geographical area and only a part of the district might experience severe weather conditions. Users not affected by these conditions think of the warnings as false warnings. This proofs dangerous for disaster preparation. A future way out might be warnings with a free graphic configuration depending on the exact location of severe weather conditions.
Free public warning information can be found on the website www.dwd.de and also at www.wettergefahren.de. There is also a warning module which costumers can integrate on their own website. The information is distributed to users via ftp, Fax, SMS and telephone. Warnings of unfavourable weather conditions are also distributed to the media (television, radio) but with the exception of Bavaria they are not legally obliged to publish these warnings.
A website focussed especially on disaster control has been set-up. It bundles all relevant and important information. The website is the heart of the FeWIS – Weather Information System for fire brigades – a system combining all necessary advisory information from different departments and different authorities, e.g. THW, Red Cross, and various Ministries. FeWIS contains customized warnings and graphics as well as text information, and is updated every two minutes. Over 1490 customers used FeWIS in 2010. WebKONRAD – a thunderstorm prediction module – is integrated in the system. Radar data processing provides the most

accurate information on cell intensity and their shifting. WebKONRAD is most important for planning and coordination action forces. The German Weather Services offers special training courses. The program HEARTS **H**azard **E**stimation for **A**ccidental **R**elease of **T**oxic **S**ubstances calculates the dispersion of toxic substances in case of larger accidents involving toxic materials. The user provides date and location of the disaster in an online standard form; the calculation will be executed in Offenbach. Moreover the user can get information about the forest fire danger index, flood waters, and basic climate information for regional risk analyses. Densely populated urban areas like Berlin get additional service regarding warnings for severe weather conditions including short texts with local details and updates every 30-60 minutes. Coordinating offices use the FeWIS-system and thus always have access to up to date information on weather and warnings, in advance of and during disaster.

Flood centre Saxony (LWHZ) gives forecast and warning against danger of flooding. DWD and LWHZ exchange measured values, model data, warnings and special forecast. There are consultations together. The Weather Service in Leipzig has created especially forecasts for river areas in 1984. Probability of exceeding threshold values of precipitation will be forecast, demand on level. Forecast is subjective in using all actual available weather models. An objective method of calculation or statistics exists not. The forecast is in table form, forecast time 36 hours. LWHZ is using this information for planning outflow with empiric scenarios. Take more measurements would be useful for better interpretation of radar and better nowcasting.
The most important forecast is the estimate of risk for precipitation more than 100 mm over 2 until 3 days in advance. That way it is possible prepare of flood danger. But the best weather forecast can't anticipate flash flood disaster.

The Limits of Flash Flood Forecasting in the Conditions of the Czech Republic

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In June/July 2009 the weather in the Czech Republic was influenced by a 12 days lasting baric low located over Mediterranean, which resulted in a sequence of many flash foods. The total damage was estimated to 200 mil. EUR, 15 people died.
Although flash floods are considered to be extremely difficult to forecast, case studies simulating real-time forecasting indicate that at least some of flash floods can be predicted several tenths of minutes in advance. For successful flash flood forecasting, it is necessary to have precipitation nowcasting together with the hydrological model to be able to estimate the development of the flow in the streams in real time. However, according to case studies, even with these tools some forecasts fail.
The main problem is in the estimation of both measured and predicted precipitation. The heavy rainfalls are caused by severe convection that is very discrete in time and space, thus almost impossible to forecast before its initiation. The high uncertainty in the nowcasting of the convective rainfall leads to so called "variant-approach". The several precipitation scenarios are obtained from several different nowcasting methods. These scenarios are then used for calculation of several discharge scenarios. In such a way the forecaster obtains the spread of expected peak discharges. It is necessary to stress that in flash flood forecasting we are not interested in peak discharge, but in the reaching a predefined category of flood emergency..
This method was tested on several case studies from recent years. Despite each location is different and can require different approach (e.g. mountaineous areas where the radar visibility can be very bad), some basic recommendations for flash flood forecasting were set up and will be tested in operation for pilot catchments in following season.

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Flash Flood Awareness and Prevention in Germany

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According to the fourth assessment report of IPCC (2007) based on SRES events the overall summer precipitation is expected to decrease. However, particularly in summer the likelihood of future extreme precipitation events is predicted to significantly increase due to concentration in shorter, more intense rain fall events. Although analyzing and monitoring changes of these extreme events is much more difficult due to the demand of longer data time-series with higher spatial and temporal resolutions in comparison to long-term average climate change projections, the rise of extreme precipitation events in the recent past allegedly helps confirming this conclusion (e.g. in Germany: Bonn-Mehlem 3.7.2010, Oldenburg, 18.8.2010, Osnabruck/Hanover 26.8.2010).
Consequently, the probability of resulting flash floods and the inherent risk involved increase. However, recent studies indicate that the risk awareness among the public is deficient even though these events are not delimited to certain areas as river floods. Instead, flash floods can occur at any time and place but are generally intensified in sealed urban areas and thus, involve a high damage potential. Vulnerability is likewise intensified by exposing more valuable goods and contents and altered uses of infrastructure. For instance, basements and underground infrastructures are more and more equipped with electrical devices, i.e. washing machines, refrigerators and computers. On the other hand, office buildings often come with a basement garage and elevators operated by controllers installed in the basement. The missing awareness of flash floods may be caused by the apparent low probability of occurrence and the short duration of the event. In contrary, the more common and media-covered river flood events are of longer duration and in most cases forecasted with high accuracy several days before a flood wave imperils the specific region and the maximum water level is reached. Thus, a river flood generally attracts more attention and draws additional precautionary measures than sudden, short-term flash flood events.
Structural prevention measures and strategies as provided along watercourses against floods (i.e. dikes/walls and storage reservoirs) do not economically benefit in case of flash floods which are erratic and unpredictable events (KRON 2009, MUNICH RE 2010). Instead, local and very individual protection of buildings with basements and other infrastructure is demanded. Such permanent measures are generally cost-efficient in contrast to potential damages. However, the realization requires a general risk awareness and knowledge of potential counter measures. OERTEL et al. (2009) present data of surveys arranged in four cities located in North Rhine-Westphalia/Germany (i.e. Wuppertal, Dortmund, Cologne and Düsseldorf). All cities, except Dortmund, are located close to rivers or tributaries of larger rivers. The study (Fig. 1) shows that about 50 % of interrogated people live in houses with basements and hence, are potentially at risk of flash floods. 19 % of these people have already been affected by a flooded basement (45 % of the respondents know affected people or relatives). Interestingly, only 3 % declare a river flood to be the source, but 16 % give a flash flood as the reason. Less than one half of the affected people took technical measures after the hazardous event (44 %).

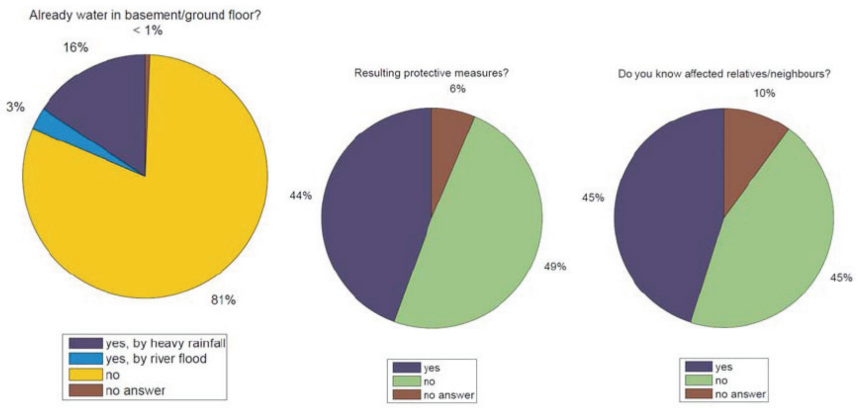

Fig. 1: Results of a survey concerning the flash flood experience in Germany (OERTEL et al. 2009)

Fig. 2 depicts an excerpt of the questionnaire concerning the estimation of flash flood hazard. Obviously, 50 % assess their own situation to be potentially at risk of flash floods. Less than one half would consider ensuring oneself against flash flood damages. Most of the interrogated people did not know that natural hazard insurances generally exist in Germany.

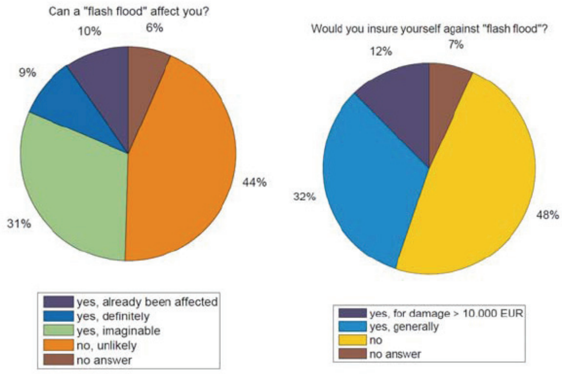

Fig. 2: Results of a survey concerning the flash flood awareness in Germany (OERTEL et al. 2009)

In summary, the survey reveals that flash flood awareness is lacking in Germany. Before considering technical measures for protection and prevention of damages due to flash floods, this public awareness needs to be properly raised in order to ensure an efficient flood management strategy. Public information initiatives calling for optional closing of natural hazard insurances, as recently carried out by the Bavarian State Chancellery, are demanded for broader mainstreaming of knowledge and expertise in other federal states as well as on the European framework level to help efficiently reducing disaster risks stemming from flash floods in the future.

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French Vigilance and Cooperation with Civil Security and Hydrological Services

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The impacts of the storm in 1999 have been very great in France. They have shown the poor efficiency of our warning process. So the authorities decided to update the warning procedure. In the new procedure, Meteo France has to inform simultaneously the general public and the Civil Security services.
The main goal of this awareness is to translate the intensity of forecast meteorological parameter into a risk level. To follow-up the situation, forecast bulletins are dispatched in red or orange level. We write a national bulletin at the same time as the map and others every 6 hours (completed by regional bulletin written every 3 hours)
In this bulletin we give :
metrological information on two mains points :

- the observation of the phenomenon (strength of the wind, rainfall intensity...)
- the forecast, with a particular point asked by the Civil Security "At what time and where will we have the strongest intensity of the phenomenon ? "

consequences and behaviour advices in relationship with the phenomenon.
According to the phenomenon we have many exchanges between Meteo France and technical services of the different ministry (Home Office for the Civil Security, Transport, Health...)
Organization inside Meteo France and production : here you'll find comments about the role of the different met services in France (national, regional, local) and the criteria's used to help the choice of the colors.
Organization with Civil Security services :

- to know the impacts of the meteorological phenomenon
- to know how Meteo France exchanges information with the Civil Security

Organization with the hydrological services
Although hydrological is not the basic mission of Meteo France, our mission include observing, qualifying and forecasting precipitations and other atmospheric parameters, And modelling the interactions between soil and atmosphere, for example with the fine mesh model AROME (2,5km)
With all this information we realize an integrated "vigilance rain flood". The aim of this "vigilance" is to provide an information not only on flash-floods or urban floods but also on river floods and water-table floods. During this time of "vigilance rain flood" we exchange all ours information with the hydrological partner (SCHAPI/SPC). On the meteo chart, in case of heavy rain or flood, the rain part is coming from Meteo France and the flood part is coming from hydrological service.
To conclude I indicate that for the general public and for ours partners, the "vigilance" procedure is a noticeable improvement.

Main French acronym used :

Météo France		
CNP	Centre National de Prévisions	CFO Central Forecast Office
CMIR	Centre Météorologique InterRégional	Regional Meteorological Center
CDM	Centre Département de la Météorologie	Local Meteorological Center

Hydrological services		
SCHAPI	Service Central d'Hydrologie et d'Appui à la Prévision des Inondations	National flooding service
SPC	Service de Prévision des Crues	Regional flooding service or local flooding contact

Civil Security		
COGIC	Centre Opérationnel de Gestion Interministérielle de Crises.	National Civil Security
COZ	Centre Opérationnel de Zone	Regional Civil Security

Hydrological Forecasting and Warning in Case of Flash Flood

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Rainstorms causing flash floods in Central Europe are often of relatively small spatial extent and duration. Therefore the central warning system may fail to deliver the warning on site in time.

This contribution set a legal frame of flood warning service in the Czech Republic - local flood authorities are responsible for information provision and flood managing at local scale according to Water Act in the Czech Republic. They can declare the “flood stage” based on water level in stream, its forecast or even based on precipitation (including its forecast).

Flood forecasting service provided by Czech Hydrometeorological Institute is introduced. We also explain some experience from 2009 flash floods that may lead to enhancement of the early warning system on national level as well as at affected site. For that purpose theoretical ways of development and operating flash flood early warning system are outlined for the condition of the Czech Republic.

Hydrometeorological Extreme Phenomena Monitoring System and Cooperation with Public Administration for Reduction of Flash Flood Consequences (based) on the Example of Middle Odra Basin

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Local extreme phenomena such as rainstorms, blizzards, hailstorms as well as sudden high river and stream stages are a major threat to security causing more and more losses. Flash floods which are a combination of specific factors such as heavy rainfalls, favourable topographic features and land management constitute one of the most serious reasons for local flood losses. Institute of Meteorology and Water Management conducts a constant monitoring of meteorological and hydrological phenomena on Polish territory. Thus, many measurement and observation systems have been implemented in order to allow for effective detection of extreme hydrometeorological phenomena. Furthermore, the systems are to support the process necessary not only for forecasting but warning against them as well. The paper presents current state of the hydrometeorological protection system including cooperation and data transfer with neighbouring countries. Both communication and understanding of hydrometeorological warning service system is crucial in order to work properly. Thus, IMGW crisis management undertakes a wide-ranging cooperation in the field of know-how and experience transfer in the form of joint scientific and technical conferences as well as trainings organized for employees of public administration.

Flash Floods

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Flash floods are primarily unexpected and very fast. Nobody knows the scope, amount of rainfall and effects in advance. If somebody doesn't experiences it firsthand, it's very hard to imagine how destructive spates could be.
In an effort to inform citizens about the impending dangers are often exaggerated predictions presented. In this information is then difficult to orient.
In the first stage the integrated rescue system is not so operational. In these situations is very often lack of basic information, basic humanitarian aid. There are frequent blackouts in electricity, gas and water supplying. Often becomes lack of communication with the outside world.

Flash Floods – Are we able to face such kind of disasters?

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Flash Floods (FFs) – very destructive and dangerous type of floods stroke the Czech Republic in summer 2009. These FFs were triggered by extreme cloudbursts and storms in a large part of the country. These disastrous flash floods revealed some problems and weaknesses in warning and emergency system as well in general preparedness for such quick events. Flash floods are entirely different from river flooding and warning and response as well as preparedness for FFs should be adjusted accordingly to decrease losses of lives and property.
2009 Flash Floods have shown that only a complex and integral emergency system can be efficient. Such a system begins with more precise forecasting and warning, dissemination of warnings to various levels of the state emergency system. The main problems in warning part are uncertainties in prediction of time and place of a strike by FF. Also very high intensity of rainfall and strokes in the late afternoon or at night should be taken into account.
Possibilities of improvement of all parts of warning and emergency system in the Czech Republic especially non-structural measures are reviewed. They include improvement in observation, monitoring, detection and forecast conditions, generation and dissemination of more precise warning products, removing of some shortfalls in dissemination process, better cooperation of national hydrometeorological service with partners in emergency system like Fire and Rescue Service and with responsible regional and community bodies. Very important is also training and education of both active parts of the state emergency system and the public. Finally, coordinating and inspiring role of national disaster reduction platform as well as cooperation among these platforms within European Network of National platforms have been stressed. Therefore, gathering experience people in FFs from more countries has always been very helpful and this workshop about Flash Floods can contribute to the reduction of damages caused by flash floods.

Suggestions and Measures for Reduction of the Floods Impact

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Establish special mode of the forecasting and warning service for the „season of floods", like for example in USA during the „Hurricane Season" (June – November)
Point out the responsibility of the municipal flood authorities for „flood preparedness"
Provide the municipalities, which are endangered by the floods, with automatic warning systems (rainfalls, water levels)
Identify area with potential risk of floods, suggest landscaping, which leads to better retention capacity, environmental friendly measures, agriculture activities, polders, reservoirs, etc.
Involve more the house owners into the flood protection, especially let them be awarded of the potential danger of spate, discuss with them the individual flood plans, inform them how to level up the flood resistibility of their properties
Organize and periodically repeat the practical trainings for municipalities endangered by the floods,
Establish „National training and presentation centre," where the flood preparedness training of municipal representatives and individuals could be done year round

Warning of citizens and rescue during natural disasters

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Warning of citizens immediately before the disaster on exactly specified area very difficult or even impossible with current tolls and systems.

However new information and its mutual use might improve this process. A timely activization of emergency rescue service staff in given territory is very important but complicated task. In addition, the whole process is complicated with very high variability of information in time what affects decision process, not mentioning a connection to economic.

In particular, any error or imprecision degrades atempts to improve the system. The newly proposed methods of cooperation Fire Rescue and CHMI allow a gradual improvement of the system and improve preparedness of integrated emergency system and protection of citizens in the CR

Predict System, to help decision making in flash floods, feedback on floods in Var in 2010

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Abstract : The communication will present the feedback on crises management during event in Var in June 2010
Keywords: flash floods, early warning , feedback on floods, Var

Observing the last dramatical floods in Var in south of France on 15th June 2010, very differents responses and impacts can be identified. 23 death, people missing, more than 50 communities impacted, more than 900 Millions Euros of damages were to declare after the event. Most of human loss, 12 people, were to deplore in Draguignan in Var were 270 mm of rainfall were registered in the city center.

This tragedy reminds all the necessity of prevention, organization and communication.
In term of flood disaster, the fact is that physical protection is necessary but inevitably limited. To manage these kinds of crisis, local authorities need to be able to base their policy against flood on prevention, warnings, post-crisis analysis and feedback from former experience.
While many damages were observed in Draguignan, the event was different in Hyères, Sainte-Maxime, Cogolin, Grimaud or Toulon who behaved to face it by minimizing the effects, and economic impacts of the flood. The fact is that they had prepared their organization to face flood crisis, they had informed the population of what had to be done, they had given security advices, they had reacted from the vigilance information and kept on being informed during the event to adapt their plans and actions: opening security centers, closing roads before they get flooded, evacuating when necessary.
The most relevant example is in Sainte-Maxime where 260 mm of rainfall were registered in the city center, a volume close to the 270 mm registered in Draguignan during the same event. In Sainte-Maxime, no human loss was to deplore, the community was informed, had the information of rainfall intensity and rainfall effects in anticipation and could inform the citizen with the help of the police circulating and communicating in the streets. Getting informed the citizen could elevate and protect their property, evacuate their cars on the hights of the community, and secure themselves and family. Comparing this event with what happened in the same city, Sainte Maxime on 19th September 2009, where hundreds of cars were flooded, the conclusion is that prevention, organization and communication made the difference. Further more this last event was more important with 260 mm of rainfall registered in city center of Sainte Maxime on 15th of june 2010, while 110 mm were registered in September 2009 during the event that caused many damages.
The principle for communities and companies to face these kinds of crisis is to prepare emergency plans, to organize crisis management and reduce risks; to organize themselves or to get help and assistance during crisis to activate and adapt emergency plans with enough of anticipation; and to analyse floods effects and improve emergency plans afterwards.
These organizations have to be coordinated with state services to secure continuity and coherence of information.
In order to reduce risks, and to keep the benefits of these organizations, local communities and companies have to maintain the awareness of risk of the citizens and employees. They also have to maintain their safety plans to keep them constantly operational.
The presentation of the feed-back on floods in Var in june 2010 will expose the organisation of the Predict System.

The Use of Weather Radar for Precipitation Estimation and Nowcasting at the Czech Hydrometeorological Institute (CHMI)

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Forecasting of flash floods is highly dependent on quality of input information about fallen and expected precipitation for several future hours. To obtain high quality precipitation data, it is very useful to combine ordinary rain gage measurements and NWP precipitation forecasts with remote sensing measurements (especially weather radars) and extrapolative nowcasting techniques.

The advantage of weather radars is the surveillance of precipitation over hundreds of thousands square kilometers in (almost) real time, but the physical nature of the radar measurement leads to serious problems with the absolute accuracy of the precipitation estimate. These problems have lead to development of several different correction algorithms that often rely on the surface measurements of the precipitation by rain gauges. One of the correction algorithms has been put into operation in 2003 as one of the outcomes of the CHMI-NWS cooperation activity. The system utilized mean-field-bias correction of original radar estimate and for the combined field a modified algorithm of Double Optimum Estimation originally developed by D.-J. Seo was used. In 2008-2009 a new original algorithm of the estimation was developed, which computes the locally variable bias field that is being used for quick correction of radar estimate and nowcasting. The combined estimate that is being computed only for 1-hour and longer time accumulation employs the concept of regression kriging. The resulting precipitation fields, i.e. locally adjusted radar estimates, combined estimates along with gauge-only fields are a part of national flood warning system which is being upgraded after severe flash floods that hit the Czech Republic in June and July 2009.

Radar echo extrapolation technique, based on well known COTREC method, has been developed at the CHMI. It has been routinely used for qualitative precipitation and severe weather nowcasting since 2003. After extensive evaluation, COTREC quantitative precipitation forecasts (QPF) up to 3h have been routinely used as an operational input into hydrological model HYDROG since spring 2007. Comparison of COTREC QPF with NWP model ALADIN QPF shows better performance of COTREC for lead time 0-1h and 1-2h and similar results for 2-3h. COTREC QPFs for 2-3h have problems mainly in border areas. COTREC method uses two consecutive maximum reflectivity composites of Czech Weather Radar Network (CZRAD) for calculation motion vector fields and adjusted CAPPI 2km reflectivity composite for calculation QPFs. Limited domain of motion vector calculation and precipitation underestimation of CAPPI 2km in farther distance from radar cause obviously deteriorate performance of COTREC QPFs in border areas. To overcome these problems new extrapolation method was developed in the CHMI and is under extensive testing now. New method use NWP model ALADIN to enlarge domain of motion vector calculation and to improve motion vectors in areas without radar echoes. As a reflectivity field to be extrapolated Extended CZRAD composite that includes Czech and some other surrounding radars is also tested.

System of Integrated Warning Service (SIWS) in Czech Hydrometeorological Institute (CHMI)

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CHMI's warning service is a component of Integrated Rescue System of Czech Republic which supplies issuing of warning information for the territory of Czech Republic from both meteorological and hydrological risks point of view. Its main purpose is to inform and warn authorities, media, people and other users of hydrometeorological data about probability of dangerous weather and to protect human lives and property. Currently, emphasis is placed on warnings related to extreme weather, especially to events with rapid progression, as flash flood is. It is therefore necessary to develop tools for early detection of these phenomena, mainly in areas of nowcasting and streamline and speed up information on an imminent threat.

This service is carrying out by meteorological and hydrological forecasting sections (Central and Regional Forecasting Offices) of CHMI in co-operation with Military Weather Service of Army of Czech Republic using concept of System of Integrated Warning Service. Basic component of SIWS is warning information. Outputs from SIWS are available in both ASCI and XML formats immediately after their issuing. Special text information is sending to Integrated Rescue Service, Military Weather Service, local authorities, catchment organizations, media … Warning is given to Web site of CHMI in graphical and tabular format. Notifying message for many users is prepared and distributed automatically by email when warning information is issued. SMS information is also prepared for some users. In 2007 CHMI has become a participant in EMMA project (Meteoalarm) of visualization of warning information on web pages. It is also important to educate authorities, media and other users for better understanding of warning information.

The Robust Method for an Estimate of Runoff Caused by Torrential Rainfall and a Proposal of a Warning System (FFG-CZ)

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Forecasting of torrential rainfall and flash floods remains one of the most challenging tasks for hydrometeorological services. Beside the accuracy it has fulfil aspect of timely issue as well. Flash floods occurrence is determined by many factors. The most important are precipitation intensity, temporal and spatial distribution of rainfall but infiltration and retention properties of soil, land cover, land use and terrain must be also considered.

A functional system for a forecast of runoff caused by torrential rainfall and issuing of warning messages should:

Work with catchments of area close to horizontal size of convectional storm.

Include determination of actual state of potential retention capacity of landscape (e. g. saturation by antecedent precipitation).

Use actual precipitation data in very short time step.

Implement simple rainfall-runoff model for direct runoff estimation in the catchment.

Set a threshold value of runoff or discharge or some multicriteria index, to define a potential risk of flash flood occurrence in some particular region.

Within the research project SP/1c4/16/07 „Implementation of new techniques and stream flow forecasting tools“ (guaranteed by Czech Ministry of Enviroment) a forecasting system for estimation of runoff caused by torrential rainfall is being developed.

System has been developed in common GIS platform (ArcView GIS 3.x from ESRI) using basic available functions for preprocessing and postprocessing of input and output data to and from rainfall-runoff model and a complex tailor made extension that includes the procedures of rainfall-runoff model.

15 minutes radar rainfall estimates serve as meteorological input. The system is prepared also for COTREC based nowcasting data input. System operates in the scale of small catchments, which areas are typically of size about 5 km^2.

Estimation of direct runoff is based on CN method. CN value automatic update based on antecedent precipitation and actual evapotranspiration (rainfall-evapotranspiration-runoff balance) is used to estimate possible runoff from storm.

Transformation of direct runoff to catchment response is realized by Clark’s unit hydrograph.

Rainfall-runoff model parameters were estimated from empirical equations based on selected physio-geographical characteristics of catchments.

Outputs of the system include daily indicative map of precipitation intensity that could cause the direct runoff. However the key output is an estimate of hydrograph for all selected catchment outlets (in cms) including comprehensive information about areal precipitation and runoff amounts (in mm) and time occurrence of peak discharge for each (selected) catchment.

The flash flood risk estimation is based on exceeding 3 defined thresholds defined as ratios between the estimated peak flow and theoretical 100-year flood on particular basin.

The procedure is being tested in central forecasting office of Czech hydrometeorological institute. It proved the underestimation of rainfall by raw radar data and thus the need for real time adjustment of radar estimates based on rain gauge data.

Deep Convective Clouds and their Monitoring by Operational Weather Satellites

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Weather satellites, in contrary to the weather radars, detect the uppermost cloud-top layers only, not the internal structure of deep convective clouds. Thus, they are not capable of detecting precipitation directly; the satellite-based precipitation-related information has to be retrieved indirectly, from cloud-top properties, as observed in various spectral bands. Despite these limitations, numerous satellite-based methods have been developed and tested throughout the last decades, most of them having rather a statistical or probabilistic nature only, none of these providing real precipitation intensity measurements. Because of these limitations, satellite precipitation products are rather used for climatology studies only, not for real-time warnings or nowcasting. This applies namely to areas with reasonable radar coverage; however in countries with no radar observations the satellites are frequently used as the only remote-sensing nowcasting tool.

The only exception from this is the TRMM satellite (http://trmm.gsfc.nasa.gov/) with its Precipitation Radar (PR), which actively scans precipitating clouds from its low-Earth orbit at 250 km wide swath. This satellite is limited by its orbit to low latitudes only (38 S to 38 N), thus can't be used for mid-latitude studies. However, data from this satellite have been widely used for validation of rainfall-related products from other satellites, applicable even at higher latitudes.

Several MSG-based precipitation-related products have been developed within the NWC SAF (SAF in Support to Nowcasting and Very Short Range Forecasting) activities, for overview of these products and their detailed description go to https://www.nwcsaf.org/HD/Main.jsp. However, like all the other satellite-based rainfall-related products, also these have a probabilistic value only, and cannot be used for nowcasting of extreme convective cases.

First of these products is the *Precipitating Clouds* product (PGE04), providing a likelihood that the cloud is precipitating (in %). The other product is *Convective Rainfall Rate* product (PGE05), http://www.nwcsaf.org/HTMLContributions/CRR/Prod_CRR.htm, attempting to estimate the precipitation rate of convective clouds based on IR10.8, WV6.2 and visible bands. The outputs of this product are represented as instantaneous rainfall rate, and hourly accumulations. However, as the cloud-top characteristics in these bands are related namely to cloud-top height and its optical thickness, the rainfall rate retrieved from these is rather very inaccurate and needs further statistical adjustment using a complex of other additional data, such as NWP outputs (wind fields, low level moisture, …), lightning data, etc. Moreover, as some of the basic assumptions of this product are rather too much simplified, these methods will fail namely in case of either severe convection, or in case of long-lived mesoscale convective systems forming large common anvils, hiding the individual convective cells.

Namely the too simplified basic assumptions addressing storm-top characteristics at the IR window and WV absorption bands and several new storm-top features revealed in couple of last years, are among of the main reasons why EUMETSAT and its partners recently stress the need for better understanding of storm-top processes and their manifestation in satellite imagery. To invigorate this research, EUMETSAT and ESSL have agreed in 2007 to establish a *Convection Working Group* (CWG, http://convection.satreponline.org/), bringing together namely (but not only) European, U.S. and South African specialists, involved in research of convective processes, namely from the perspective of satellite observations. The CWG consists of three subgroups, aimed at pre-convective environment, convective initiation, and mature convective clouds. Results of this group, various case studies, technical documents, tutorials, etc. are gradually being published at the CWG website. One of the important aspects of CWG activities is that it brings together researchers and NWC SAF specialists, stimulating the exchange of ideas which might lead to improvement of the NWC SAF operational products.

While the work of the pre-convective environment and convective initiation subgroups is applicable at cloud-free pre-storm areas (which is typically not a case in Central Europe), the mature-convection subgroup addresses namely cases occurring in Central, Western and South-East Europe and Mediterranean. Among the main topics of this subgroup are the characteristics of the IR window brightness temperature (BT) field and some of the features observed here - e.g. the overshooting tops and their automatic detection, the cold rings or cold-U/V shapes and their embedded warm areas, cross-tropopause water vapor transport by deep mid-latitude convection and subsequent moistening of the lower stratosphere (which strongly affects the BT difference (WV-IR), used by the NWC SAF products).

CWG meets regularly since 2007, the next several-day meeting is planned for spring 2012. Finally, CWG experts contribute regularly also to the remote training events, organized within the Eumetcal activities.

Probable Maximum Precipitation

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Heavy precipitation occurs on a variety of time and space scales. In mid-latitude conditions there two mechanisms causing heavy precipitation. In the low pressure frontal systems the characteristic scales are about one day covering an area of 10 to 100 thousand km2. In convective conditions the scale characteristically is smaller, about 10 to 100 km2, with a duration of one hour. This results in distinctly different water volumes to be expected from these two types of weather events : about 1 km3 of water from a frontal system, and about 0.001 km3 from a convective system. In European continental conditions so called „meso-scale convective systems, MSCs“ do occur, bringing amounts of rain in between the two types mentioned before.
To estimate the maximum amount of precipitation from either process requires the knowledge of all the parameters responsible to contribute to its formation. There are several approaches on how to quantify a probable maximum precipitation event. The most widely used one is described by WMO as „... the greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of year, with no allowance made for long-time climatic trends.“ (WMO, 1986).
Heavy precipitation events are known to occur in virtually all parts of the world. Such events are notorious for their subsequent flood events. Disaster mitigation and disaster preparedness need quantitative estimates of maximum precipitation in any given area. This then allows to shape measures, protecting lives and values from any possible adverse effects of such precipitation events. In most cases a cost-benefit analysis will lead to the conclusion, not to consider PMP in real measures. However, even then PMP-estimates give a valuable orientation, if not for the public, so for the specialists in the field and the responsible authorities. Such an information goes beyond simple learning from past events, and has the character of a projection analogue to long-term climate projections. It is noteworthy, that the deduction from past events has several limitations, mainly because in the limited observational period relevant combinations of rare parameters might not have occurred at all.

This means, that methods are needed allowing to estimate the probable maximum precipitation. Such estimates have to be based on the information on all relevant parameters under the assumption that these should be invariant in a certain time climate interval. There are, as already mentioned, several methods available on how to calculate the probable maximum precipitation. The simplest approach is river catchment oriented and combines the maximum observed precipitation amount in a sufficiently long time interval with the maximum probable water vapour content of the atmosphere. Usually these two quantities do not occur simultaneously. The key information on the water vapour content is derived from the surface dew points, wherefrom it is extrapolated to the top of the troposphere. The maximization of the precipitation is achieved by extrapolating the water vapour content to an occurrence level of 1/100 years. This vertically integrated water vapour content is then compared to the values as observed in the maximum the precipitation event. Between these two water vapour contents a difference results, so that an adjustment factor can be found, allowing to estimate the precipitation, then called PMP. In general, precipitation formation in an arbitrary atmospheric layer depends on two quantities, the vertical velocity and the difference of the specific humidity between the bottom and the top of the layer. Interestingly enough, a simple sensitivity study shows, that the amount of liquid water formed (precipitation, if all of it falls out of the layer) depends linearly on the vertical velocity. However, a doubling of the specific humidity at the bottom of the layer, potentially the result of a temperature increase of about 10K, results in an increase of only about 25 % of the liquid water formation. This shows, that a more careful consideration on vertical velocity should be part of PMP-estimates.

Therefore, it is necessary to include both key factors into the calculations of PMP. Any estimates of vertical velocity require a more complex physical description of the precipitation process. This is available with any state-of-the-art numerical weather prediction model. To estimate PMP, it is necessary to find idealized –PMP producing -- initial conditions. Vertical velocity is best approached via the whole three-dimensional wind field, thus relying on the horizontal wind speed as a base information. The maximum temperature and the dew point temperature can be taken from climatological estimates and from available climate forecasts. Model runs resulted in several sets of data, giving estimates of PMP in frontal systems and for orographic conditions. To access the convective case, an additional physical model was applied, based on some available 3D-distributions of water vapour and vertical velocity, resulting in the maximum rain rates for the given initial conditions. Orographic enhancement of precipitation is estimated with either method. The maximum values for convective conditions in central European conditions result in a precipitation rate of about 7 mm/minute, with the maximum duration not very well definable, but definitively being longer than 6 hours.

Flash Floods – Procedure Concept of Area Risk Assessment

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Flash floods from the severe storms that have occurred in years 2009 and 2010 brought material damages and risk for the affected areas inhabitants. Flood risk assessment and prediction are well-developed solutions of the natural hazards but flash floods from severe storms are quite complicated issue in the sense of their proper prediction. Flash floods are beyond the resolution of the numerical weather forecast systems (NWFS). Another big issue is fact, that runoff of flash floods is frequently outside of the river channels. The complex and multi-perspective analysis of the landscape response to the severe storm and high precipitation intensity seems to be effective basis. Results of our work is the prototype of methodology and application of the early warning system based on GIS, fully distributed hydrological modeling and effective analysis of the radar and NWFS products, which could work in the regional scale opposite to local early warning systems. Scalable approach in the temporal, spatial and qualitative scale is amongst the main capabilities of presented system and methodology. First level is the combination of NWFS results with the GIS data of the particular landscape and basin. Second level is the approach based on the distributed models such is SIMWE and TOPMODEL, which produce the raster information about the analyzed spatial domain and third level is the fully distributed and complex modeling based on model MIKE SHE combined with hydrodynamic models MIKE 11 and MIKE FLOOD and urban hydrology and sewer model MIKE URBAN. This approach have apparent capabilities in such types of hydrosynoptic situations, where regional rainfall is combined with the convective processes and precipitation and overland (Hortonian) flow is combined with floods on the major rivers. The last capability of presented system is the production of information for semidistributed models – in sense "which profiles and which rivers will be affected by such situation".

Flash Floods and the Current French Hydrological Early Warning System: What needs to be developed?

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SCHAPI was set in 2003 to launch an early warning system for flood hazard, called "hydrological vigilance". This implies the implementation of common procedures to evaluate the hydrological hazard, the development of production tools and interfaces to communicate the results, as well as a complete reorganization and coordination of the hydrometry and forecasting services at regional level. The network (SCHAPI and the 22 regional services, all together about 250 persons) produces a "flood vigilance map"(http://www.vigicrues.gouv.fr), used by the civil security, all local services, and the public to act quickly with real time information.

The network of this surveillance system covers about 20 500 km of rivers. Since several years, it is important to notice that the floods causing damages occurred mainly outside of the main river courses, under surveillance with the current hydrological vigilance system. It concerns especially overflow of small tributaries, and small scale inland inundations, as well as coastal floods.

In order to improve the anticipation of flash floods, a national master plan has been presented at the Ministry council on July 13, 2010. The plan includes 6 major axes:

vulnerability reduction of dangerous areas : control of urbanization, planning projects including the risk aspects, improvement of existing constructions

forecast – vigilance – surveillance – warning and emergency control

reinforcement of the levees and other protecting structures

review of project management organization for dikes control

reinforcement of the security control of protecting structures

improvement of risk understanding and knowledge, post event studies

A public consultation has been opened until October 1st, 2010, as well as a formal consultation of all stakeholders (prefects, administrations, public institutions, territorial collectivities, private companies, NGO…).

SCHAPI is contributing, together with the competent public institutions, to a detailed project on forecasting and warning issues. It includes a first rainfall alert (operationally produced in 2011 by Météo France), the improvement and enlargement of the radar coverage, the extension of the current river network under surveillance, the support to local communities, the study of an additional warning procedure directed to the communities at risk, the development and improvement of the local safeguard plans, the development of small scale probabilistic numerical meteorological predictions (foreseen for 2015 by Météo France).

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