EVALUATION OF THE QUANTITATIVE PRECIPITATION FORECAST (QPF) AS AN INPUT OF THE HYDROLOGICAL MODEL IN THE CZECH REPUBLIC

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***Abstract*:** Quantitative Precipitation Forecast (QPF) may elongate the lead time of the hydrological forecast. The QPF from meteorologist of CHMI was evaluated for years 1999 and 2000. For QPF the Czech Republic is divided into 8 areas, which are meteorologically "homogenous". Each area was evaluated separately using major gauges. One area was evaluated more detailed using all available gauges for the 2000 summer period. The GIS interpolation of the results was made. The main results are that the 80 to 90 percent of QPF differ from the measured precipitation less than 5 mm. Usually little overestimation to 5 mm occurs. The risk of error greater than 15 mm is 6 - 9 % (for QPF over 10 mm) and the risk of error greater than 20 mm is 4 - 5 %. More errors occur in mountain areas and during the summer and early spring. At the end some news and future expectation in precipitation use in hydrology in the Czech Republic (RAMAP, ALADIN input, radar data input) is mentioned. Of course the quality data from the automatic (online) gauges are most welcome as the input for rainfall - runoff modeling anytime. The evaluation of the QPF should continue in the future using longer period even there is the change in the form of QPF emitting.
***Keywords*:** QPF, Czech Republic, Hydrological model input

1. Introduction

The introduction of precipitation forecast and its processing by rainfall-runoff relations enables to prolong the lead time of the hydrological forecast. In this frame, this paper tests the recent quantitative precipitation forecast (QPF) application in hydrological forecasting at Czech Hydrometeorological Institute (CHMI). Also radar rainfall estimate is very promising for operational hydrological modeling due to its spatial distribution, coverage of large areas without gauging and its on-line availability.

1.1. Literature review

The QPF is a relatively new technique and therefore there are no such studies in the Czech literature. The method of QPF emitting is quite unique in every meteorological service in the world, so is in the Czech Republic. Therefore any convenient method was found in foreign literature to. The method applied is based on meteorological statistics (Nosek J. 1972) and consultation with meteorologists of CHMI.

On the other hand radar estimates use in operational hydrology is one of the progressive courses in the field of hydrology. There are many studies for both radar uses in rainfall-runoff modeling and flash flood warning available (some of them were presented at Conference on Radar Meteorology in July 2001). Number of studies on rainfall-runoff modeling with radar data input is based on using distributed rainfall-runoff models with grid resolution accorded to radar data grid resolution (Bell & Moore 1998, Sempere-Torres & Berenguer 2001 etc.). From the operational point of view the studies on “semi-distributed” models are more interesting because these models are usually in use in operational hydrology. CHMI hydrological forecasting system AQUALOG includes SAC-SMA rainfall-runoff model. Which is (both distributed and semi-distributed version of SCA-SMA) also often tested for radar inputs mainly in the USA (f.e. Georgakakos,1999). The SAC-SMA sensitivity to radar rainfall inputs has been tested by Finerthy at all (1997) and others.

2. Approach

2.1. QPF use in operational hydrology in CHMI

The CHMI uses the Hydrological Forecasting System Aqualog of the Elbe River basin discharge forecasting. This uses QPF to prolong its lead time of mountain rivers forecast.

The QPF evaluation is necessary to lower the input errors between the QPF and hydrological model.

2.1.1. Recent practice of QPF emitting for hydrological use

QPF is issued daily in the morning. For that purpose the Czech Republic is divided into eight areas assumed relatively homogenous during each meteorological situation. Precipitation forecast is issued in the form of chart with intervals of minimum and maximum of assumed amounts of rainfall. We have the forecast for all eight areas (SW Mts., NW Mts., N & NE Mts., Bohemia-Moravian Highlands, rest of Bohemia, Jeseniky Mts., Beskydy Mts. and rest of Moravia – see fig. 1) and for different time periods for day 1 (6 am - 12 am, 12 am - 6 pm, 6 pm - 12 pm, 12 pm - 6 am) for day 2 (6 am - 6 pm, 6 pm - 6 am) and sums for day 1, day 2 and day 3 (briefly). Precipitation forecast is the result of the outputs from Aladin (CZ), DWD (D), Bracknell (GB) and other inputs established by forecasting meteorologist (mainly depends on his opinion and experience).

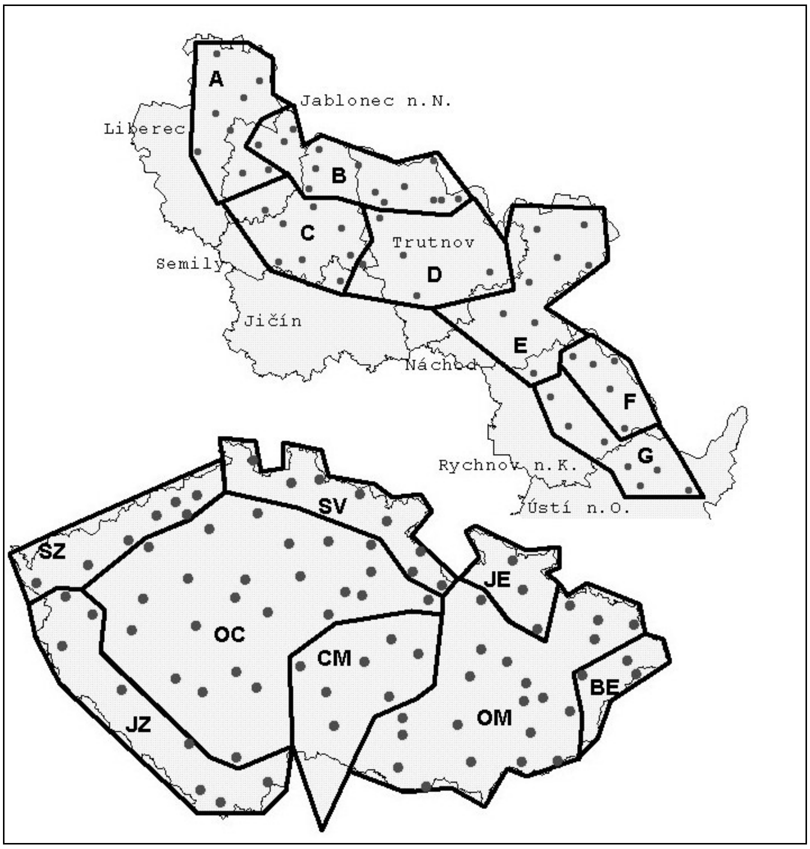

Figure 1. Areas used for QPF evaluation

2.1.2. <u>QPF input from meteorological model ALADIN</u>

The hydrological forecasting system AQUALOG, which is in use at CHMI for discharge forecasting of streams, was recently connected to the meteorological model ALADIN (in fall 2001). Since AQUALOG uses different spatial division and construction with respect to ALADIN, it was necessary to make the special ALADIN output to enter the hydrological model. Therefore the area of the Czech Republic was separated into 33 small sub-areas according to ALADIN's grid field, it's orography, and the catchments borders.

These areas include from 10 up to 30 grids each (one grid resolution is 16 x 16 km). QPF amount is compute for every grid in six hours time step (for 48 hours lead time) and then for every sub-area the average value from all included grids is generated and saved in txt file, which enters AQUALOG system. Because of different time of standard computation of ALADIN's forecast (daily in the midnight) and the hydrological forecast (daily at 7 am of local time) we don't use the first value of QPF (0 – 6 am), but there is no value for 42 – 48 h lead time of AQUALOG input. So the value for 36 – 42 h lead time is used once more even we know there is a possibility of error implementation.

2.2. Methods of QPF evaluation

It is important that QPF data used as inputs into hydrological models should be evaluated. But there is not standard in QPF emitting and so can't in QPF evaluation. Therefore an individual method dependent on QPF data character has to be used.

2.2.1. Evaluation of QPF using INTER and SYNOP gauges

Archived data were rewrite to computer. Eighty-four stations (with daily data sending program – INTER and SYNOP gauges) have been used for evaluation of forecast success.

The QPF enters to hydrological model as a value for few representative stations. These values are interpolated to whole watershed using Thiessen's method of polygons and altitude correction. For that reason direct comparison of the middle of the forecast and measured precipitation (without meditation of the interval length) was made to check if hydrologist could use the middle of forecasted interval as a representative value for the whole watershed. The spatial and temporal distribution of significant differences was observed and linear correlation of QPF and real precipitation for every gauge and every area was made. Former evaluation proved that this method provides approximately the same results in comparison to other methods of evaluation suggested by meteorologists of Central Forecasting Office of CHMI (Danhelka 2001).

2.2.2. Evaluation of the QPF for SV area

The north of Bohemia (SV - see figure 1) was chosen to evaluate QPF based on all rain gauges of this area. The evaluation of summer period (VI - VIII) of the year 2000 was made. SV area was divided into 7 sub-areas (A - G - see figure 1) according to geographical condition. The same method of evaluation as for INTER and SYNOP gauges was used.

2.2.3. ALADIN's QPF evaluation

ALADIN's QPF has been input to hydrological model since November 2001 (that mean it started together with the beginning of hydrological year which starts November 1st in the Czech Republic). We made first evaluation of ALADIN's QPF after those six months. This period can be identify as winter period in the condition of Czech Rep. It means that there is more difficulties in QPF computing and also in precipitation measuring because of snow presence in catchments and the snow – rain dissolution of precipitation. On the other hand summer type storms usually do not occur in this time and we can suppose that there was relatively better homogeneousness in spatial distribution of precipitation in comparison to the summer storm situations.

We chose six sub-areas (a, e, g, p, A, J – see figure 2) in different parts of the Czech Republic and gauges situated in these sub-areas. Those sub-areas are also of different geographical conditions (elevation, exposition etc.). Unfortunately only precipitation data available are daily amounts. Then we compare the ALADIN's QPF to the gauge average in chosen areas. Both the absolute and relative difference was watched for 24 and 48 hours lead time. To eliminate the influence of periods with no or not significant precipitation on lowering the average error set of days with precipitation over 1 mm was used for evaluation to. Also the QPF made by meteorologists for eight areas of the Czech Republic was evaluated the same way. At the end comparison of Aladin's QPF and meteorologist's QPF was made.

A very similar study of ALADIN's QPF evaluation for hydrological use has been made in Slovakia for one of the area (of comparable size) during the summer season of 2001 (Leskova D., Mikulickova M., 2002). One of the methods of from this work has been used to. It implements the hydrological point of view on the evaluation of absolute error in dependency on the amount of precipitation measured (see table 1).

Table 1. Categories of the success of the QPF (Leskova, Mikulickova, 2002).

Acceptable deviation at (of measured precipitation)					
	0 mm	**10 mm**	**20 mm**	**40 mm**	**60 mm**
excellent	5 mm	50 %	40 %	30 %	20 %
satisfactory	7 mm	70 %	60 %	50 %	40 %
poor	10 mm	100 %	80 %	70 %	60 %
unsatisfactory	> 10 mm	> 100 %	> 80 %	> 70 %	> 60 %

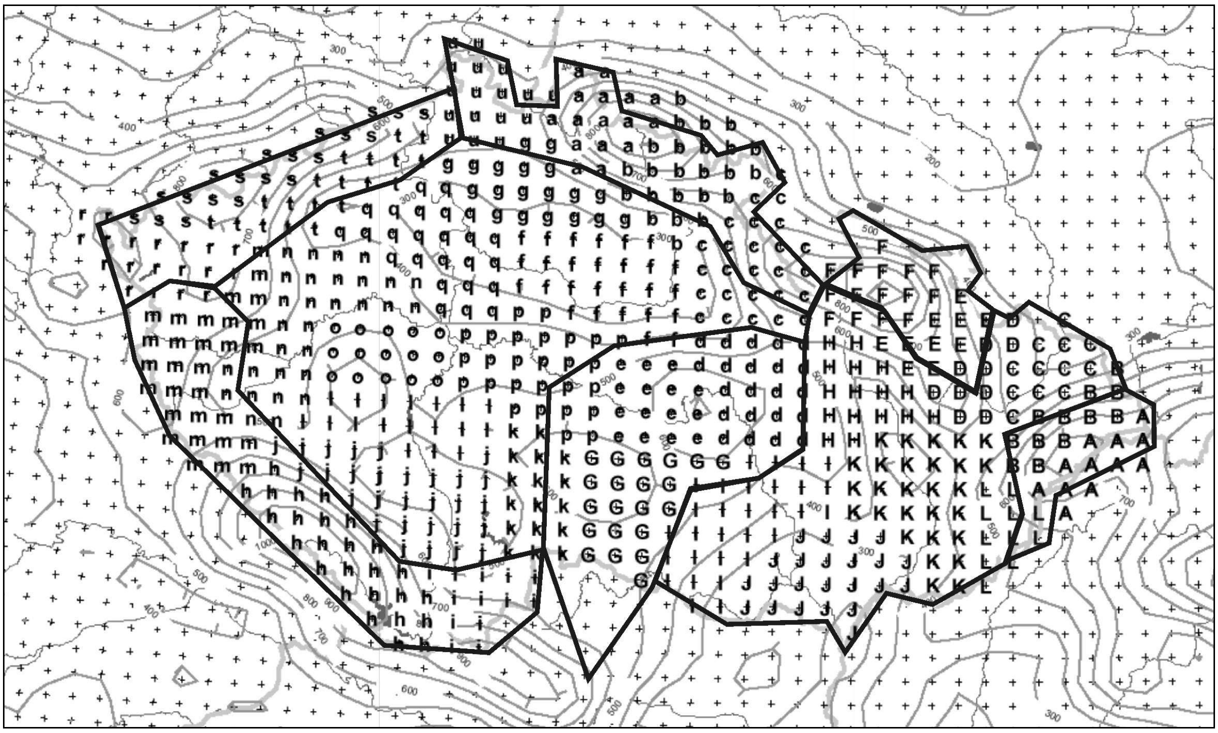

Figure 2. Areas used for ALADIN´s QPF

3. Results

3.1. Evaluation of QPF using INTER and SYNOP gauges

There is not significant difference between the results of 1999 and those of 2000. The one is that of monthly values during the year (figure 3). Nearly 90% of forecast differs from the measured amount less than +/- 5 mm. And forecasted precipitation is usually higher than measured - most of the forecast differences lie within interval (-5; 0). The interval distribution of the differences is quite similar in all eight areas. But error higher than 10 mm occurs more often at mountain areas.

The temporal distribution of the differences in year has a peak in summer (June, July). Mountain areas have one more peak of temporal distribution in spring (February or March). That corresponds well with “usual” time of occurrence of floods (spring floods caused by snow melting and precipitation together and summer floods caused by severe rainstorms or regional rainfalls with longer duration). The highest underestimation occurs in June and July. On the other hand, underestimation higher than 25 mm never occurs from October to April.

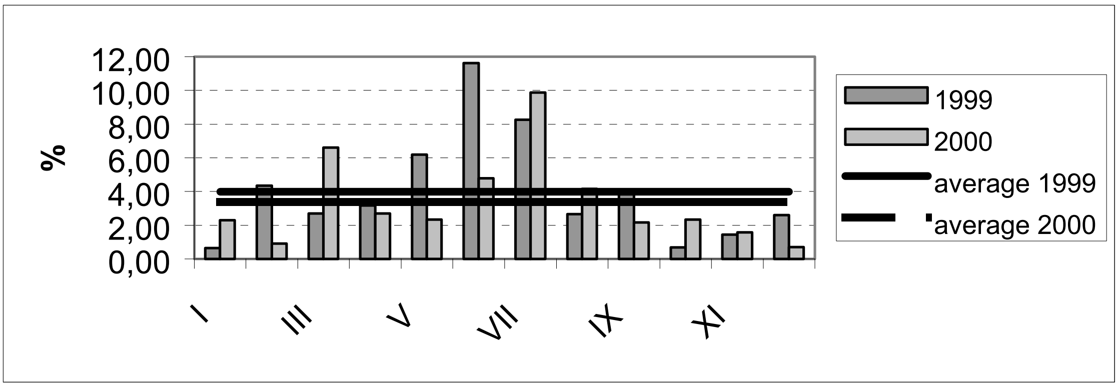

Figure 3. Monthly distribution of error > 10 mm (in percent)

3.2. Evaluation of the QPF for SV area

The main results are that 80 % of the real precipitation is within the interval (+/-5 mm) from the middle of the QPF. It is about 60 using only days with precipitation higher than 10 mm (at least at one gauge). Most of the gauges are overestimated.

The best result of the QPF shows sub-area C and also (quite surprisingly because of higher elevation) sub-areas B and A. East located sub-areas F, E and G (partly) show the worst results.

Statistical khi-square test was made to compare the evaluation of SV and that of all 8 areas. Due to its result (0.05) we can assume that the results of the QPF evaluation for the whole Czech Republic using the INTER gauges is the same as using all rain gauges.
From hydrological point of view is important that the risk of error greater than 15 mm is 6 - 9 % (for QPF over 10 mm) From what about 2 - 4 % will be underestimation. The risk of error greater than 20 mm is 4 - 5 % (1 - 3 %, extremely close to 5 % of underestimation).

3.3. GIS interpretation

We count coefficients K_1 and K_2 for every used gauge ($K_1=\Sigma\ |d_i|$; $K_2 =\Sigma\ d_i$; where d_i is the difference between the middle of the QPF and measured precipitation in day i). These simple coefficients show if the gauge is often forecasted wrong and if the error is great (high value of K,) and if the gauge is over or under estimated usually (K_2). The spatial interpolation of K_1 and K_2 using ArcView GIS was made.

There is no significant difference between spatial distribution of the results for all days and the results for days with precipitation over 10 mm for the whole Czech Rep. The minimum of K_1 covers OC, CM and the southern part of OM areas. While the maximum covers JE and BE areas (the mountain areas generally show the over average values). The areas OC, CM, SZ and the south of OM have minimum values and areas JE and BE have the maximum values of K_1 for the summer period.

The lowest values of K_2 were observed at SZ, JZ and JE during the year 2000. While it's maximum is located at Krkonose Mts. and their southern foothill, at the highest part of Beskydy Mts. and around the city of Ostrava (and also in some other isolated appearance at OC and OM – that should be caused by the specific difference in conditions of the gauge location from the typical condition of the area around this station) for the same period. Spatial distribution of K_1 and K_2 is very similar in the summer period of 2000.

Closer look at the distribution of K_1 and K_2 over the SV area generally shows that the highest values of both of the coefficients occur at the eastern part (F sub-area mainly). While the lowest values occur in the west (C and D sub-areas).

From hydrological point of view, high values of K, in combination with high K_2 values are the most dangerous (QPF is often "wrong" in there areas and high underestimation is more probable). Therefore the biggest danger of unwanted error (high underestimation) is at Orlicke hory Mts. (F sub area).

On the other hand overestimation of the precipitation happen at C and D sub-areas.

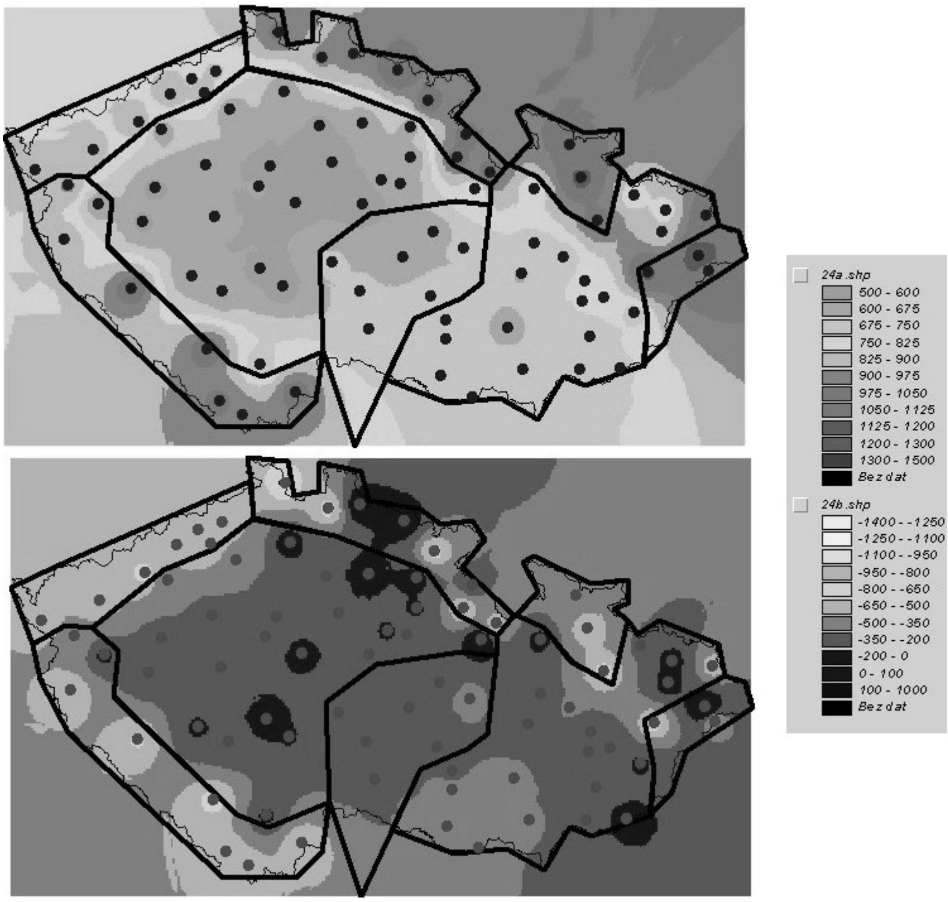

Figure 4. GIS interpolation – above/ dark color indicates areas of often error occurrence, below/ darker areas indicates areas of higher risk of underestimation.

3.4. ALADIN's QPF evaluation results

As mentioned before the ALADIN's QPF evaluation has been made for the winter season (from November to April). During this season snow precipitation often occur what makes QPF much more difficult. Therefore we expected that the result of evaluation is going to be worse than it would be for summer season.

The main results shows that the ALADIN's QPF is usually very accurate for next 24 hours while accuracy of results for 48 h lead time is quite well in lower situated areas but not in mountainous ones. ALADIN slightly overestimates usually, but for area A overestimation is more evident (unsatisfactory results are caused by high overestimations in some days). Overall intervals acceptable difference 5 mm is exceeded only in 1 to 10 % of all cases of forecast for the first day except of area A (19 %). It is from 2 to 15 % (respective 33 % for area A) for days with precipitation over 1 mm only. The results for the second day forecast are much worse because of longer lead time and doubling of the last 6-hours value to synchronize its lead time with the lead time of hydrological forecast.

The direct linear regression (correlation coefficient) of QPF and measured precipitation was made even it is not the very objective from the point of view of hydrological forecasting needs. Nevertheless correlation coefficient is good for the set of all days and 24 h lead time for the most of areas (except A). For other sets the results are much worse.

Even there is good correlation of ALADIN´s and meteorologist´s QPF in areas of higher elevation results of A area evaluation shows the advantage of presence of meterologist's QPF in cases of high overestimation in that area. It seems that relative difference between ALADIN and meteorologist is greater in lower areas but it is probably due to lower values of QPF in those areas.

Table 3 proves that the majority of QPF is of good quality (excellent or satisfactory) from the hydrological point of view. Unsatisfactory quality of QPF occurs mostly in high elevation areas with higher precipitation (A first of all), where the QPF estimation is more difficult, lowland areas are forecasted well.

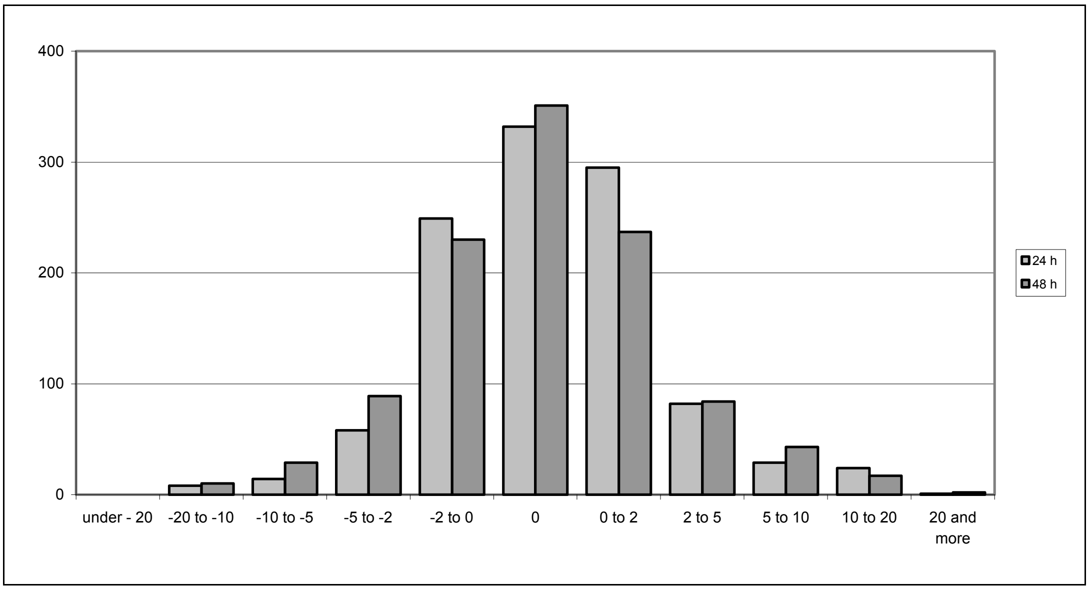

Figure 5. Interval distribution of error of ALADIN´s QPF for 24 hours

Table 3. Categories of success of QPF for 24 hours

	a	e	g	p	A	J
excellent	168	175	173	176	146	180
satisfactory	7	5	7	3	9	1
poor	1	0	0	3	10	1
unsatisfactory	6	2	2	0	17	0
total precipitation	782 mm	310 mm	280 mm	280 mm	428 mm	143 mm

Table 4. Statistical results of ALADIN evaluation

	a		**e**		**g**		**p**		**A**		**J**	
	24	**48**	**24**	**48**	**24**	**48**	**24**	**48**	**24**	**48**	**24**	**48**
Average	0,17	-0,23	0,07	-0,01	0,44	0,15	-0,12	-0,10	1,91	1,38	0,21	0,11
STD	3,76	4,29	2,19	2,95	2,11	2,23	1,73	2,29	6,33	4,94	1,26	1,85
Average 1	0,21	-0,48	0,12	-0,07	1,11	0,40	-0,32	-0,18	3,41	2,81	0,68	0,53
STD 1	4,82	5,67	3,23	4,51	3,36	3,67	2,62	3,54	7,99	6,38	2,19	3,42
0.1 quantil	-2,68		-1,40		-0,79		-1,88		-1,26		-0,59	
0.25 quantil	-0,37		-0,15		-0,10		-0,35		0,00		-0,04	
0.75 quantil	0,87		0,29		0,40		0,20		2,73		0,20	
0.9 quantil	2,70		1,60		2,10		1,00		8,30		1,14	

Average 1 and STD 1 represents values for set of data only of days with precipitation or QPF > 1 mm

4. Radar rainfall estimates use in operational hydrology in CHMI

Radar rainfall estimate presents the way to improve the information about precipitation. It provides the space distributed rainfall field, which can't be provides by rainfall gauges properly. Another advantage of radar estimate is its "continuity" in time and "on-line" data dispose. On the other hand the disadvantage of radar estimate is some inaccuracy caused of the method of rainfall estimating and geographical characteristic of the area of radar radius.

4.1. RAMAP system

RAMAP system is based on interaction between database (ORACLE) and GIS (Webmap) it consists of few different modules. Alert module checks online radar estimates and compare them to the limits (for points and small watersheds in different time step from 1 hour up to 24 hours). If the measured value is higher than the limit the warning for hydrologist is emitted (with all the specifications of the area, estimating value and so on).

The limits for warning are controlled by the other module. We decided to use GIS generated covers of rainfall of different time of occurrence (from 1 to 10 000 years) because of objective limits setting. But still the limits are fully controlled by hydrologists. They can exchange the limits for some areas (from the value of one time of occurrence to another for example) depending on watershed saturation and other watershed conditions.

Another powerful module of RAMAP system is "Maps" module. It enables to work with radar estimates as a GIS cover. Not only the exact localization of rain (including animation) but also a numerical operation as a summarizing and averaging at different areas are very useful for hydrologist's decision making during the flood events. The resolution of radar field (2x2 km) and zoom function of RAMAP are the main assumption of identification of catchments (or districts etc.) stricken by heavy rainfall.

There is a possibility of scale setting to ensure satisfactory scale resolution even for situation of different rainfall types. Another scale is suitable for regional rainfall while another one for rainstorms events.

We can also easily visually compare radar estimates to the measuring of the SYNOP network's gauge (it is planed to use the INTER gauges to). Values measured in the gauges during the same period are shown in the circle in place of gauge location using the same scale as the radar estimate.

More than tree years of experience show that the RAMAP system can improve hydrologist's orientation in actual hydrometeorological situation during the time of flood episodes. Nevertheless no measuring (estimating) system is perfect, so RAMAP is. The evaluation of RAMAP function during winter floods gives much worse results than evaluation of summer episodes. It is caused by troubles of snow-rain precipitation identification and also by the different physical condition of the atmosphere (vertical profile mainly). The parameters of estimate equation are not "right" in winter cases.

It seems that the radar estimate is usually a little higher than precipitation measured in gauging network. But also the error of measurement using automatic gauges could be around 10 – 25 % in cases of intensive rainfalls (measurement is lower than the reality because of the wind, technical construction of the gauge etc.). Therefore we can suppose that the real precipitation is between the gauges measurement and the radar estimate.

4.1.1. Evaluation of RAMAP estimates

A very simple evaluation of RAMAP estimates for the first quarter of 2002 has been made. The upper catchment of Jizera River was chosen for that purpose. This is area with one of the highest annual precipitation amounts in the Czech Republic (the Czech record of daily amount 345 mm was measured here in summer 1897). This is also area with relatively high occurrence of floods or high flows. We expect some underestimation due to the distance from radars and the mountainous character of the area. (In the fact this area is one of the most complicated to estimate for radar meteorologists.)

Thirty-two days with measured precipitation over 5 mm. The average value of tree INTER gauges in this area was compared to RAMAP estimate of average precipitation of upper Jizera River catchment. The correlation plot is in figure 6.

It is evident that RAMAP underestimates precipitation. It seems that the estimates are not very good. Because of the evaluated period is partly winter period the worse results were expected (snow is big complication in radar estimate generation). Therefore we try to separate days with snow and rain precipitation (we had 22 days with rain and 10 days with snow). Unfortunately the exact separation of rainy and snow days is very difficult and precipitation may often differs from place to place as from time to time. Figure 7 shows these two groups with linear interpolation equations. This rain-snow separation proves that the main error occurs in cases of snow precipitation while the rain estimates are quite good quality.

The same evaluation is going to be made for longer period (especially for the summer) and also for other important areas where the radar estimation is more complicate (Sumava Mts.).

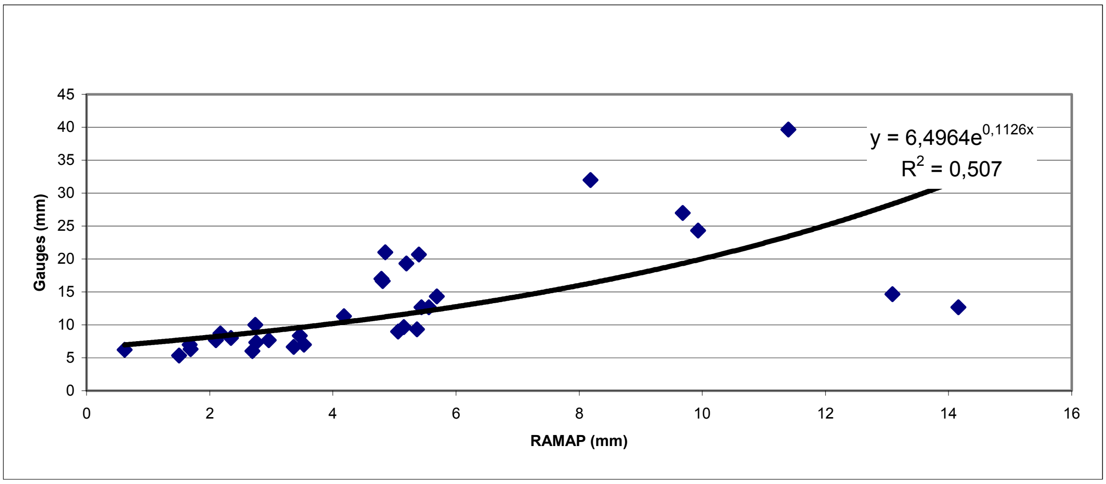

Figure 6. Correlation of RAMAP estimates and measured precipitation

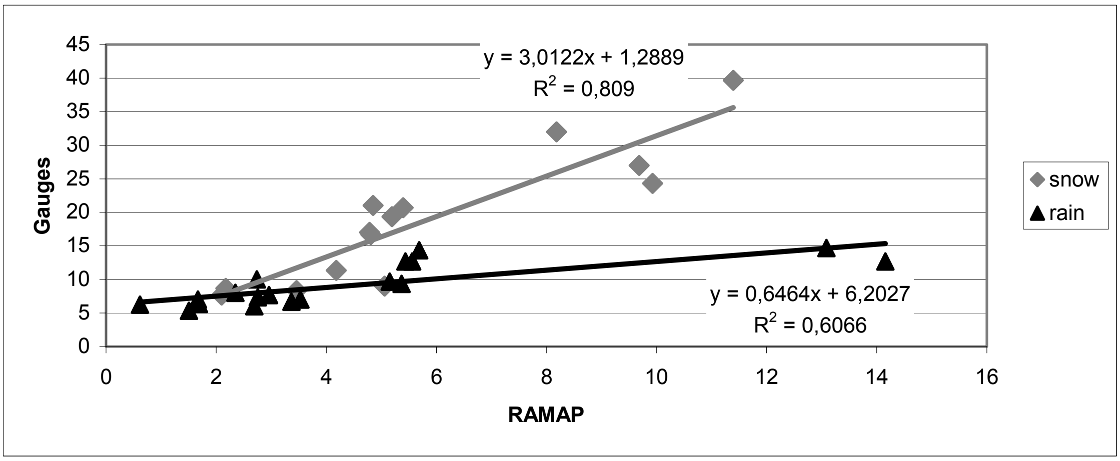

Figure 8. Estimates of snow / rain precipitation

4.2. Use of radar data in rainfall-runoff modeling

Due to radar rainfall estimates spatial and time "continuity" and its "on-line" availability it could to be a very useful and accurate input to rainfall-runoff modeling in near future (keep in mind the difficulties in measuring and the need of radar estimate adjustment). There are many attempts of using radar data in hydrological modeling in the world in last few years (some of them were presented at Conference on Radar Meteorology in July 2001).

The grid resolution of 1 – 5 km^2, time step of 5 – 10 min, precipitation resolution of 1 mm and the accuracy together with fast distribution (max 15 min) to users these are the main demands of the radar data for operational hydrology. All of that is more or less fulfill in the condition of the Czech Republic. With advantage of that the radars and hydrological forecast are operating the same organization – CHMI.

Before trying to use radar data in day-to-day operational hydrology the testing of its impact on the hydrological forecasting system results is necessary. Therefore the project of radar data implementation into rainfall-runoff modeling has started at the end of year 2001.

This project is pointed to test the AQUALOG system (rainfall-runoff model Sacramento SAC-SMA included) sensitivity to radar data input but also some other models or systems are planed to be test (WMS, APIc, HVB). Because of Sacramento implemented in AQUALOG system is not grid based but semi-distributed type of rainfall-runoff model it is necessary to transfer grid radar information to another form. It's made by GIS operation that creates 1-hour rainfall averages for sub-catchments of tested watershed. The area of the sub-catchments should not reach over approximately 200 km^2 but with smaller sub-catchments better results are expected.

The space-time sensitivity of the Sacramento model to radar precipitation input differs in dependency on the used time step and used sub-catchments size (Finerthy et all 1997). The most sensitive to the sub-catchment size is the surface runoff (SUR). The larger are the sub-catchments the smaller is the SUR (for the sub-catchments of approximately 4000 km^2 the surface runoff is only a half of that for the sub-catchments of tens of km^2). Also some other runoff components decrease with sub-catchment size change and as a result the total channel inflow decrease to. The runoff (and its components) volume changes according to used time step. With shorter time step more SUR and total runoff is produced. Therefore a new calibration of the model parameters has to be done for that purpose (recent calibration was made using gauges and precipitation measured in 6 hour time step for larger sub-catchments mainly).

We suppose to use three (of those in table 5) basins with dominant rainfall influence on the runoff for testing. Tested basins are of different size, physical geographical conditions and different position to radars. We also suppose to use more different rainfall-runoff models for every catchment to compare the results of these models.

Table 5. Catchments mentioned to be tested.

STREAM	PROFILE	CURRENT MODEL	RADAR COVERAGE	AREA KM^2	Location
Sazava	Chlistov	APIc SAC-SMA	B + S	794	Bohemian-Moravian Highland
Zdobnice	Slatina	SAC-SMA	B + S	84	NE Bohemia
Dedina	Mitrov	SAC-SMA	B + S	291	NE Bohemia
Cerna	Licov	SAC-SMA	B + S	126	S Bohemia
Blanice	Husinec	SAC-SMA	B	212	Sumava Mts.
Svratka	Zidlochovice	Hydrog	S + B	3 938	Bohemian-Moravian H.
Svratka	Dalecin	Hydrog	S + B	367	Bohemian-Moravian H.

Designed result of this project is to create the base and a benchmark for the next general implementation of radar rainfall estimates in day-to-day hydrological modeling (to be prepared to use in cases of rainstorms and regional precipitation with probability of flood events occurrence). Radar rainfall estimates input enables the use of the most recent data to discharge forecast of the mountain streams during the flood events. That can't be done using gauges data because only data of not enough gauges are available “on-line” in 1-hour time step.

5. Conclusion

The result of the hydrological rainfall - runoff modeling is definitely dependent on the quality of precipitation data, both the measured and forecasted one. Nowadays there are few ideas to improve those inputs to the hydrological modeling in the Czech Republic. The first one is about more detailed (spatially and temporary) QPF input which was bust realized by using the meteorological model ALADIN QPF outputs. The Czech Republic (76 000 km^2) was divided into 33 areas. For each area is made the average of QPF at the points and than is used as a representative value for the whole area. This input can be change according to the result of the consultation with meteorologist during the hydrological model run.

Conclusion of this paper is that QPF used for hydrological modeling are good enough and it's able to use the middle of forecasted interval. But there is not insignificant risk of error especially if the QPF is over 10 mm. The spatial distribution of the error showed peak in the mountain areas while temporal distribution in the summer and the early spring, what both was to be expected. Mountain areas have more precipitation than lowland, and during the year the precipitation maximum occur in summer. The maximum in the early spring is usually not so marked, but it is the period of the floods from snow melting, which became danger in case that there are heavy rains in this period. Therefore some intentional overestimation can take place.

The use of ALADIN’s QPF ensures the objectivity of hydrological model input, but the meteorologist’s QPF remains very important for identify „wrong” (in means of unsubstantiated extent of difference from other meteorological models) QPF of ALADIN.

Another improvement should bring the use of radar precipitation estimates, which can give very quickly spatially distributed information about the latest precipitation. Testing of radar data using have been just started at selected basins in the Czech Republic.

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