End User Activities
Report 1 : Initiating Discussion
Draft

Michael Bruen

1 Introduction and General Considerations

Following a short discussion at the 2nd Carpe Diem project meeting, a two-pronged approach to the involvement of end-users was agreed.

- Survey the existing literature for published information relevant to end-user requirements.
- Contact the project end-users to give them details of the project, to request their comments/input and to give them advance notice that they would be invited to an end-user workshop associated with the 4th project meeting.

This short report gives the present status of both activities and, in particular,summarises the main results of the literature search. There are two important general considerations:

1. End-users see terrestrial radar as one of a number of different alternative technologies providing data for their work. For instance, rain-gauges and space-borne sensors (radar and others) also provide precipitation estimates. The ”positioning” of terrestrial radar must take this into account and emphasise the aspects of radar data which distinguish it from the alternatives, i.e. spatial and temporal resolution, coverage, cost etc. It is almost certain that, where radar is used for precipitation estimation it is in conjunction with and complimenting other technologies. We should be aware of the possibilities and the necessity to position radar products with this in mind. To have a viable role for any particular purpose, terrestrial radar estimates of precipitation must be more useful than satellite estimates and more useful/cost effective than raingauge networks. In fact its position is complimentary to these other sources of rainfall estimates. It is thus useful to compare the properties and usefulness of all these sources of rainfall estimates.
2. When specifying requirements, there is a tendency for end users to expect an equivalent or better performance from radar in all performance measures than other gauging systems. This is demonstrated particularly in the survey by Einfalt and Maul-Kotter (2002), Table 2 below.

2 International experience and requirements

In this section, I summarise some of the most relevant results and comments found in the literature survey, organised by country.

2.1 US experience

The Miami-Dade Water and Sewer Department use Nexrad radar data in an operational system with an hydrological model (SWMM) to model combined sewer overflows. The system is operational but seems to be mainly used to prove ”Act of God” status for overflows caused by severe rainfall so MDWSD can avoid USEPA penalties (Walch and Jelonek, 2002). Their spatial resolution is 2 km, temporal is 15 minute. Some comparisons with ground gauges are made. The radar results are not good for individual time-series at individual locations, but are good for event totals.

Jacquet et al. (2002) reported on 10 years of combined US and French experience. They give a useful comparison of the effects on accuracy of radar grid resolution, comparing the 2km NEXRAD with a 1km CALAMAR system, Table 1

Table 1: Comparison of 1km and 2km systems with raingauges

	NEXRAD 2 km		CALAMAR 1km	
% difference between field raingauge and corresponding radar pixel	Number of storm totals (out of 179)	percentage	Number of storm totals (out of 140)	percentage
within +/- 10%	18	10%	76	54%
within +/- 25%	46	26%	123	88%
within +/- 50%	102	57%	137	98%

Their main suggestions as radar requirements related mainly to the processing aspects:

1. A customization step including the mapping of pixels with radar artifacts such as ground clutter, bright bands, masks etc.
2. Selection of the best radar reflectivity tilt with various types of rain.
3. Merging of data from several radars should be limited to urban watersheds that area far (over 100 km) from the radars and such data are not appropriate for use in urban watersheds.
4. Advection processing, replacing artifacts, clutter and missing images with the rain that is about to pass over those pixels in the next 5 to 12 minutes.
5. Integration of the advected pixels to eliminate the stroboscopic peaks and valleys as a storm passes over urban catchment
6. Extension of the gauge adjustment to a limited zone (ca. 400 km^2)

In 2000, it was estimated that only 16% of US basins had a raingauge network sufficiently dense for hydrological applications, demonstrating the inadequacy of the existing network and, by implication, the need for better areal coverage, which radar can provide. In urban areas, densities of 1 gauge per 4 km^2 have been recommended (Jacquet et al., 2002)

Stevens et al. (2002) indicates that at least 1 km resolution appears to be required for urban CSO systems control

The value of improved rainfall estimates is shown by meeneghan et al. (2002) but their results do not show a clear preference between achieving the improvement through radar or raingauge networks.

Good radar performance (compared to network of gauges) of 2 km grid resolution and hourly time resolution at modelling streamflow was reported in the Oklahoma-Arkansas-Missouri region.

2.2 Australian Experience

Sun et al. (2000) found that cokrieging of radar and raingauge information produced the best estimation of flood flows. Radar information alone (without adjustment did not)

Jordan et al. (2000) reported ”Errors in the streamflow hydrograph are highly dependent upon the overall error in the catchment average rainfall for the duration of the rainfall event. Uncertainties in the spatial and temporal pattern of rainfall measurement error at smaller spatial or temporal scales introduce a very low proportion of teh errors in the flood hydrograph, because the catchment filters out the higher frequency components of the measurement error.”

2.3 UK requirements

Golding (2000) reports ”The current Met Office goal for precipitation observation is an accuracy of 25 % (i.e. RMSF = 1.25) at a spatial resolution of 0.5 km and a temporal resolution of 1 min. This is based on perceived needs for distributed modelling of the precipitation run-off into rapidly responding urban drainage systems. .... such requirements may exceed the limits of what can realistically be measured. They certainly exceed the theoretical limits of what can be deterministically forecast beyond a few minutes ahead, due to the chaotic growth of random perturbation at these scales.”

Borga (2002) found best streamflow simulations for a UK catchment using information from the lowest radar scan and also recommended gauge adjustment of radar rainfall estimates. Hydrological model estimates of floods were more sensitive to radar errors in VPR than errors due to anomalous propagation.

2.4 Italian user requirements

Fattorelli et al. (1996) suggests the appropriate scales for distributed catchment models are from 0.1 to 1 km. The presumption is that the required inputs will be available at that spatial scale.

2.5 German Users’ requirements

Quirmbach and Schultz (2002) suggests that radar is appropriate for small urban catchments if there are no raingauges within 4 km of the catchment or if the catchment has a raingauge density less than 1 gauge per 16 km^2.

Einfalt and Maul-Kotter (2002) gives the results of a survey of users in North Rhine Westphalia, Table 2. It is possible that users are influenced in their expectations by the best performance available in very category, by other technologies.

Table 2: User requirements survey : (source : Einfalt and Maul-Kotter (2002))

Application	Spatial resol. (km)	Temporal resol. (min)	Volume resol. (mm)	Forecast lead (min)	Delivery lag (min)	Mode of delivery
Rainfall runoff models	0.1	1	0.1	-	-	CD
Flood forecasting	10	5	1	4320	15	Internet
Flood warning	10	5	1	4320	15	SMS
Hydraulic simulation	1	5	1	-	-	CD
Insurance proof	1	1	1	-	-	CD
Control of reservoirs and basins	5	15	1	2880	5	Internet
Sewer System Simulation	0.1	1	0.1	120	5	Internet
Areal Rainfall (monthly & annual)			1			CD
Personal organisation during floods	10	15	1	2880	5	Internet
Hydrometric service	10	5	1	720	15	SMS
Detailed data for extreme events	1	1	1	-	-	CD
DSS for planning						CD
Sewage treatment plant operation	10	5	0.1	2880	5	SMS
Determination of fees for rainwater			0.1	-	-	CD
River Basin Management	10	15	1	-	-	CD
Research	1		0.1	-	-	CD

Taschner et al. (2001) compares the runoff predicted by an hydrological model with various source of rainfall estimates, gauges, LAM and radar, Table 3. The disappointing performance of the radar was explained by its distance from the catchment.

2.6 French experience

Faure et al. (2002) demonstrate the qualitative as well as quantitative use of radar in using radar data for managing a detention-settling basin. They determine both potential risks at longer lead times by analysing the entire radar image and confirming risks, at shorter lead times, using a more qualitative analysis for a given basin.

Table 3: Runoff estimation performance with various rainfall estimators (source: Taschner et al. (2001))

Source of rain estimate	Comparison with measured runoff Peak flow (%)	Runoff Volume (%)	Timing of peak (hr.)	Nash-Sutcliffe efficiency
Rain gauge	-9	-13	+/- 6	0.89
SM multiplied	+25	+17	-2	0.82
SM disaggregated	+21	+15	-3	0.83
SM interpolated	+57	+36	-1	0.66
Rain Radar	+51	+29	+8	0.61

3 Carpe Diem end-users

3.1 Confirmed end-users

Details of the confirmed Carpe Diem end-users are shown in Table 4. All of these have been contacted, sent details of the Carpe Diem project and have been asked for their comments and suggestions. They also have been told that they will be invited to an end-users workshop sometime in 2003 (to concide with the CARPE DIEM 4th meeting). Some of these have changed from the original proposal and some individual contact people have changed.

3.2 Potential additional end-users

Since the project started, a number of potential end-users have been brought to my attention, Table 5. I have sent these information about the project and asked for their comments, but have not committed to inviting them to our end-user workshop. This should be decided by the project partners, who may also suggestion additional names, and will, I suppose, depend on budget.

3.3 Current position

At present one detailed response has been received, from Kemijoki Oy (Finland). Radar is not critical to their operation and a 3 hour lead time for forecasts is acceptable to them. The full text of their reply is given below.

FINLAND : Kemijoki Oy 1. Kemijoki Oy owns nearly every power plant located in the River Kemijoki catchment area. Optimization of production of the hydro power plants and minimization of floods are in mutual interests since the storing capacity of the watercourse is relatively small and discharge will have to be run through flood gates during flood. Prevention of flood is in the responsibility of the local authorities, but in practice solid cooperation is done with Kemijoki Oy.

2. From the viewpoint of flood prevention, measures taken in the Lake Kemijrvi are vital. The earlier discharge decisions based on flood forecasts are made, the better damages can be controlled. The demand for quick forecasts in the River Kemijoki catchment area is at its most urgent near the flood peak; regionally it is in the near catchment area of the Lake Kemijrvi, as well as in the catchment area of the River Ounasjoki containing no basins. The updating of forecasts is not equally important in other areas. The optimal time for quick forecasts could be 3 hours. The typical flood peak in the watercourse usually takes place in the spring when snow melts simultaneously with the rain.
3. The development of forecast models on the River Kemijoki has gone on for 20 years. All measures have focused on development of precision, speed and usability of the models. Utilization of weather radar has been one step in this process but any figures for precision can not be given.
4. In the River Kemijoki catchment area, time frequency or spatial resolution are not a major problem compared to very small catchment areas or hydrology of the urban areas.
5. The amount of snow in the spring is a very decisive factor in the emergence of flood.

4 Next tasks

- Obtain as complete a set of response from end-users to enable a thorough analysis.
- Organise end-users workshop at next Carpe Diem meeting.

5 References

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Table 4: Confirmed end-users

IRELAND	Name	Environmental Protection Agency
	Address	Richview Campus, Clonskeagh, Dublin 14.
	Contact person	Mr. Michael McCartaigh
	Email	m.maccarthaigh@epa.ie
ITALY	Name	Reno River Authority- Regione Emilia-Romagna
	Address	Richview Campus, Clonskeagh, Dublin 14.
	Contact person	Ing. Gabriele Strampelli
	Email	gstrambelli@regione.emilia-romagna.it
	Phone	+39 051 284414
ITALY	Name	Institution Civil Protection Service - Regione Emilia-Romagna.
	Address	
	Contact person	MAINETTI MAURIZIO
	Email	mmainetti@regione.emilia-romagna.it
	Phone	+39 051 284885
FINLAND	Name	Kemijoki Oy
	Address	Valtakatu 9-11, PL 8131 - FIN-96101 ROVANIEMI
	Contact person	Mr. Hannu Puranen,
	Email	info@kemijoki.fi
	Phone	+358 16 7401
	Fax	+358 16 740 2325
SWEDEN	Name	Vattenregleringsfretagen
	Address	Fltjgargrnd 11 SE-831 31 STERSUND
	Contact person	Mr. Peter Calla,
	Email	peter.calla@vattenreglering.se
SPAIN	Name	Clavegueram de Barcelona, S.A (CLABSA)
	Address	
	Contact person	Mireia Fageda,
	Email	mireiafageda@clabsa.es
SPAIN	Name	Service Metereologia Catalunya (SMC)
	Address	
	Contact person	Joan Bech,
	Email	jbech@meteocat.com

Table 5: Potential additional end-users

IRELAND	Name	Office of Public Works
	Address	Hatch Street, Dublin, 4
	Contact person	Mr. Mark Adamson,
	Email	mark.adamson@opw.ie
FRANCE	Name	Service Risques Naturels, Hydrometrie et Annonce des Crues
	Address	DIREN Ile de France, 24 Quai d'Austerlitz - 75013 PARIS - FRANCE
	Contact person	Dr. Pierre Javelle,
	Email	pierre.javelle@ile-de-france.environnement.gouv.fr