The International Journal *of* Meteorology

www.ijmet.org

Volume 37, number 367 January/February 2012

The severe blizzard and ice storm in January 1982 in Ireland

Rainfall variabilities in rain-fed rice in India

Weather and Me from Australia!

To advertise on these pages email Advertising Manager,
Paul Messenger - advertise@ijmet.org

The International Journal *of* Meteorology

Volume 37 - 2012
numbers 367 - 376

Telephone: +44 (0) 7813 075509
Fax: +44 (0) 870 706 1858
Email: editorial@ijmet.org

www.ijmet.org
ISSN 1748-2992 [since 1975]

IJMet Online
www.ijmet.org/online/ 2012 Volume 37 - two extra issues (issue 1 and 2)

Voluntarily Run
"An international magazine for everyone interested in weather and climate, and in their influence on the human and physical environment."

The International Journal *of* Meteorology

Editor-in-chief: SAMANTHA J. A. HALL (B. A. Hons)
sam@ijmet.org

January/February 2012, Vol. 37, No. 367

Photography:

Cover: © Keith Hall, *winter snow 2011*
Inside Rear: © Philip Carden, *sunset over Winsford, Cheshire UK*
Rear: © Howard Kirby, *wintry scenes*

Send your photos to Howard Kirby and why not do a *Focus On...* piece?

CONTENTS

Editorial Assistants:
MATTHEW CLARK *matthew@ijmet.org;*
PAUL DOMAILLE *paul@ijmet.org;*
SANDRA SPILLANE *sandra@ijmet.org*
DAWN CUNDY *editorial@ijmet.org*

Sub-Editor and Marketing Manager:
NICOLA PARSONS *marketing@ijmet.org*

Photography Director: HOWARD KIRBY *howard@ijmet.org*
Assistant Photograph Editor: MATT DOBSON

THE INTERNATIONAL JOURNAL *OF* METEOROLOGY

Published in association with The Tornado and Storm Research Organisation (TORRO)
a privately supported research body, serving the international public interest

Editor-in-chief: Samantha J. A. Hall, International Editorial Office, 20 Massey Avenue, Lymm, Cheshire, WA13 0PJ, United Kingdom
sam@ijmet.org / editorial@ijmet.org

NOTES AND GUIDELINES FOR SUBMISSION

Research papers, letters, books and scientific reports for review, news items, conference information, advertising and other communications on all aspects of meteorology are to be addressed to the appropriate member of staff and the Editor in the first instance. Authors should send their contributions initially by email to editorial@ijmet.org. On some occasions Figures/Photos will be requested by CD. This speeds up processing and correspondence, and allows for efficient minor editing and agreed major editing. Contributions should be prepared in 9pt arial font on MS Word (clear all styles), language UK English. Every paper must commence with a short abstract summarising its significant and original content and contain full contact details. Keywords relevant to the paper are also appreciated. **References** should be referred to in the text by the author's name and year of publication, e.g. Browning *et al.* (1995). Responsibility for opinions expressed in articles rests with the authors who should obtain copyright permission where necessary. Please note that page charges may have to be imposed for some articles containing special artwork, complex equations, or numerous photographs, diagrams or maps. Authors must consult recent issues of the journal as a guide to the layout of papers. All **figures**, diagrams, photos, etc must be supplied as independent graphic files separate to each other and from the text file with no embedded captions. An example article can be found at http://www.ijmet.org/Contributions.htm. All contributors receive a free copy of the Journal their work features and colour versions can be viewed and downloaded from http://www.ijmet.org/online/ after online subscription.

All figures require numbered **captions** and the captions are to be collected in sequence at the end of the paper. Each **table** should be numbered and bear a title - please ensure your tables have correctly positioned lines, are no wider than 130mm, and avoid using Excel if possible. **Photographs** should be emailed to our Photography Director howard@ijmet.org as digital originals where possible or as high resolution .jpg or .tiff files digitised to at least 300 dpi. Please include as much detail as possible about the photograph(s) for inclusion in the Journal and supply contact details.

Back issues may be purchased singly or as complete volumes. Some issues are now out of print but digital issues can be obtained **online -** http://www.ijmet.org/online/. IJMet Online is separate to the print subscription and includes current and past volumes that can be viewed and downloaded as part of your IJMet Online subscription. Individual articles are also available for purchase to view and download online. Online advantages include: full colour, instant access, and two extra issues per year.

Please note that for universal citation purposes the recommended abbreviation for **The Journal of Meteorology (ISSN 0307-5966) was *J. Meteorology, UK*.** The recommended abbreviation for **The International Journal of Meteorology (ISSN 1748-2992) is *Int. J. Meteorology, UK.***

The International Journal of Meteorology is a non-profit making research periodical. Donations and bequests are always gratefully welcomed and go towards expanding the publication and supporting valuable research and awards in the field of severe weather and climate.

Published by Artetech Publishing Company, UK.

ISSN 1748-2992

EDITORIAL

May I first begin by thanking everyone for standing by us through these difficult times. We are contributing to severe weather research more than ever before with IJMet Online and a widening global readership.

The future is looking exciting for IJMet and TORRO. The new improved website for IJMet which is being professionally redesigned is coming on well and I very much look forward to launching this site. If there is anything in particular readers would like to see on there, please contact us! There will be a rolling news reel, featuring weather news, IJMet news and more. A special plugin for current weather conditions in your area is being trialled and of course information on editions of IJMet, content, requests, dates of publication and news on any delays will still be available. For photographers there are plans for a special page just for weather photographs and your own personal websites. Keep up-to-date with news on this and the new website in general! As always as we are a voluntary organisation, the website will be updated as often as possible.

Unfortunately, I am being forced to put the price up for new subscribers once Royal Mail announce the amount of the rise in April. Please look out for this on the website. Those in a renewal period before April, and any new subscribers before this time will not be affected. This also applies to agencies and institutions, but the new price will be in place for any payments after this date. I sincerely apologise for this, however it is an unavoidable change. I am working hard to try and minimise the increase as much as possible and am considering different ways of keeping costs down for all readers of IJMet. Nevertheless, please remember your subscription is still the first and most valued contribution, keeping this prestigious Journal in press and severe weather science in research.

The best way to avoid the price rise is to subscribe to IJMet Online at www.ijmet.org/online/. With two extra issues per year, full colour drawings and pictures throughout, downloadable PDFs and/or viewable via Flash on your browser, IJMet Online offers everything the print version does (and more), but without the hassle of lost journals and postage costs, especially to oversees subscribers. In addition, the automatic renew button allows online readers to continue their subscription every 30 days without having to manually renew and this can be cancelled at any time. IJMet Online has been vital in keeping the journal in print (thanks to Cloudware Hosting's impeccable service and no set-up cost). It is proving to be a all round, a truly excellent product for everyone involved. Please contact us if you have any questions.

I'd like to welcome our newest member of the team, Dawn Cundy. A TORRO member who's enthusiasm is infectious. Dawn kindly came forward asking if we would like any help with articles, and she has agreed kindly to join our editorial team. A warm welcome will be given to Dawn from everyone, I am sure. Her stormchasing experience in 2010 was one she will never forget – look out for an article on her chase adventures this year.

Please continue to contribute articles, pictures and manuscripts and remember we cater for anyone interested in the weather, so please don't be worried about submissions! Also remember to interact with us on Twitter (@IJMet) (a huge thanks to Rob Kemp and Howard Kirby who help to look after our Tweets!), Facebook and Linked In! Here's to another year and let's hope it's a good one with interesting weather to research and document. I wonder what the British weather will give the Olympians for the London 2012 Olympic Games! Finally, I wish everyone health and happiness for 2012. Thank you for your continued unwavering support.

Samantha Hall

THE SEVERE BLIZZARD AND ICE STORM OF 8-9 JANUARY 1982 IN CENTRAL AND SOUTHERN UK AND IRELAND

By JONATHAN D. C. WEBB

(jonathan.webb@torro.org.uk)

Abstract: Between 7 and 9 January 1982, a complex frontal system pushed northeastwards into a bitterly cold low level easterly airflow across England, Wales and Ireland. As the frontal zone stalled, 36-48 hours of continuous wintry precipitation occurred with over 30cm of snow and severe drifting across a large area of Wales and the western Midlands. Close to the main frontal zone, a significant glazed frost (ice storm) event affected southwest England and the far southwest of Wales.

Keywords: blizzard, ice storm, winter storm, glaze.

INTRODUCTION

Between 7 and 9 January 1982, a complex Atlantic frontal system attempted to push northeastwards into an increasingly cold low level easterly airflow across England, Wales and Ireland. As the frontal zone stalled, small breakaway depressions contributed to 36-48 hours of continuous wintry precipitation. Much was in the form of heavy, drifting snow (with a severe blizzard across much of Wales) but close to the second frontal zone, a significant glazed frost (ice storm) event affected southwest England and the far southwest of Wales. Although most of Scotland was outside the impact of this specific winter storm, heavy snow showers affected coastal areas (in the deep cold air) with intense frosts inland over the snow cover which had originated from falls on the 4th-5th.

SYNOPTIC BACKGROUND

Lyall (1982) described the general background to the event, while Browning (1984) presented a detailed analysis of the snowstorm based on the Malvern radar. At 1200h on the 7th January, a major depression Low D (982 mb) was slow moving in the Atlantic at 30°W, 48°N, with a trailing frontal zone extending to Biscay and then southeast across western and southeastern France to north Italy. On France's Atlantic coast, the noon temperature of -1 °C at Brest contrasted with a balmy 19 °C at Biarritz! Subsequently, a series of frontal waves ran eastwards along this frontal system as it pushed slowly into southwest England with at least two developing into discrete depression centres. By 1800h on 7th, one new depression (Low 'L') had formed on the triple point and by midnight this was situated just southwest of Ireland from whence it drifted eastwards to lie over the Celtic Sea for much of the 8th (Figure 1). Although this centre filled after 1800h on 8th, another breakaway low 'M' followed in its wake and at 0000h on the 9th was centred just southwest of Ireland in an almost identical position to low 'L' 24 hours earlier (maintaining a very active frontal zone). Although low M in turn filled up on the morning of the 9th, the 1200h chart for the 9th showed the frontal system still straddling the southwest peninsula with yet another small triple point wave depression over northeast France. By now the frontal system was aligned more west to east than northwest to southeast, this 'pivot' clearing the snow from northwest England, northernmost Wales and northeast Ireland overnight on the 8th-9th.

The upper air thickness analysis for 1200 UTC (all times refer to UTC) on the 7th showed much of Scotland in very cold sub 516dam air and there was a substantial pool of extremely cold (sub 498dam) air over southern Scandinavia.

The chart already indicated a very steep thermal gradient across southwestern Britain, a scenario usually resulting in very active frontal systems. At 1200 UTC on the 8th the bulk of Scotland remained in sub 516dam air (indicating the reluctance of the very cold air to give way). Meanwhile the north-south temperature gradient had further steepened across England and Wales with the 522dam (thickness) isoline lying from Morecombe Bay to the Humber and the 546dam line from the tip of Cornwall to Guernsey!

Precipitation, increasingly snow, associated with the first occluding front, spread slowly across Cornwall in the afternoon of the 7th. St Mawgan reported 2cm of snow lying at 1800h. The evening of the 7th saw a steady northeastward progression of the snow across southwest England and south Wales, onset times including Chivenor (near Barnstaple) by 1750h (initially as sleet but with snow within an hour), Pembroke 1830h, Brawdy by 1850h, Towy Castle (Carmarthen) 1900h, the Swansea area 1900-1930h, Cardiff/Rhoose airport 1950h, Aberporth 2020h, Newport 2100h, the Bristol/Bath area 2100-2215h, Tenbury Wells (Worcestershire) 2300h and Oxford 2400h. Overnight the broad snow belt accelerated northeast (into increasingly cold low level air) across the rest of Wales and much of the Midlands. Blizzard conditions became widespread, e.g. at Cardiff/Rhoose, mean winds reached 30kn for the hour 0300-0400 UTC with a gust to 47 kn in continuous moderate snow and temperatures between -1 and -2 °C. Meanwhile, in a sign of things to come, Guernsey Airport reported freezing rain at 0000h on the 8th following earlier snow. By 0600h on the 8th January light snow had reached south Lincolnshire (Coningsby) and west Norfolk (Marham) but that was broadly the furthest northeast it came. Marham only reported a trace of lying snow on both the 8th and 9th (despite two periods of light snow) while the very wintry scenes in the Lincoln area over the following few days were, instead, the result of extensive hoar frost and rime (see cover photo of *Weather,* December, 1983).

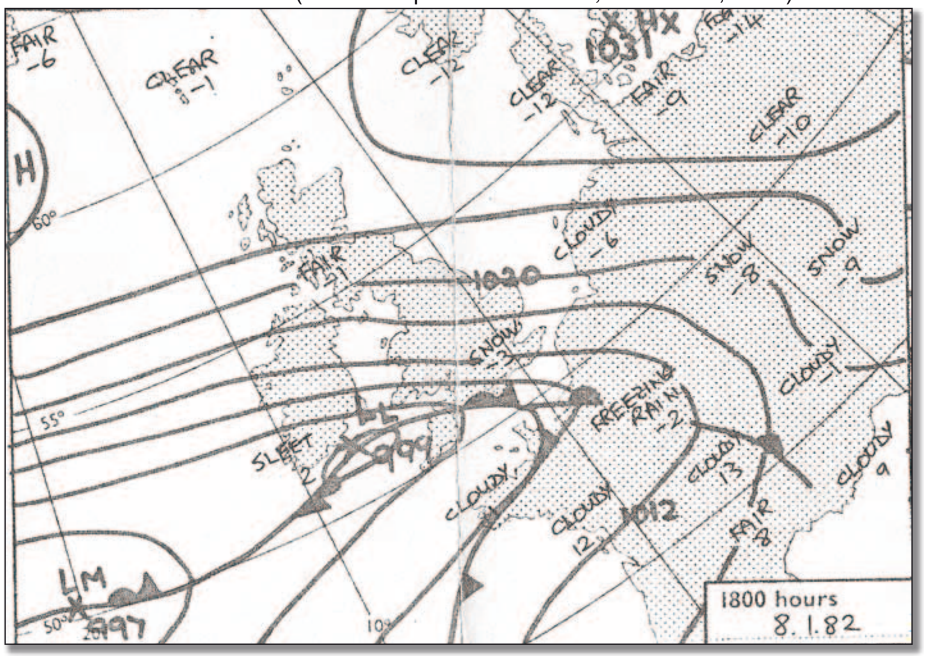


Figure 1. Surface synoptic chart for 1800 UTC on 8 January 1982, from the Daily Weather Summary (© Crown Copyright 1982, the Met Office).

The 1200h UKMO chart for 8th (London Weather Centre, 1982) shows an occluded front lying across north Wales and into the north Midlands. This first feature marked no evident change in surface winds or temperatures as the strong low level easterly winds continued to advect very cold air westwards from northern Europe; however, upper air ascents indicate a steady rise in temperatures aloft south of this feature. In contrast, a second frontal zone was associated with a very marked change in surface temperatures and wind direction as it moved slowly and very erratically north across the far southwest of England as the small frontal waves formed and moved eastwards in the 500 mb flow. At 1800h on 8th, this frontal zone (Figure 1) reached its furthest northward extent (Browning, 1984) before receding south as the intensely cold low level easterly airflow re-asserted itself. At 1800h, the temperature was 9.2 °C (with a recent maximum of 9.8 °C) at Hartland Point compared to -1.5 °C at Mumbles Head on the other side of the Bristol Channel. Even more remarkably, at 1700h the temperature at Hartland was 9.2 °C while Chivenor, just the other side of Bideford Bay, was 1.1 °C. Although manual observations at Chivenor ceased for the weekend after 1700h, automatic wind data is available later into the evening which confirms the site remained on the 'cold' side of the frontal system in easterly surface winds. In south Wales, Mumbles Head reported slight sleet and moderate sleet respectively at the 1700 and 1800h synoptic observations with the temperature at -1.5 °C; otherwise hourly synoptic and past weather reports indicated that all precipitation at Mumbles was snow, often heavy.

'WET' BLIZZARD AND GLAZE EPISODE IN SOUTHWEST ENGLAND AND PEMBROKESHIRE.

The main period of glaze occurred as the bitterly cold (sub 0 °C) surface air returned southwestwards; this low level windflow backed slightly towards the northeast and undercut the influx of milder air (Table 1). Doe (2004) referred to the glaze in north Devon with accounts and photographs of ice loading on overhead electricity lines.

In the Pembroke area, the overnight blizzard (0900h mean snow depths 15 cm at Orielton and 14 cm at Milford Haven) left drifts up to 2-3 metres on the morning of the 8th eg between Cosheston and Pembroke Dock (Jones, 1982). Milford Haven (Conservancy Board) recorded several gusts to 50 kn between 0200h and 1200h with 51 kn at 0642h; temperatures were steady at 0.0 to 0.4 °C. An ice storm began at Cosheston at 1800h on the 8th and the following morning broken telephone lines were encased in 3.5 cm of ice (Jones, 1982). At Milford Haven temperatures fell below 0 °C by 2100h on the 8th and the station reported light freezing rain at 2100h on the 8th and at 0000h on the 9th; by 0300h precipitation had reverted to snow and by 0900h the temperature was down to -4.6 °C. The 0900h snow depth on the 9th was slightly reduced at 11 cm (12 cm on the 10th) but a little further inland at Orielton Field Station the mean depth had increased to 21 cm.

The area of glaze extended across mid and north Devon, then eastwards through Somerset (south of the Mendips-Quantocks-Brendons) to Salisbury Plain and the Bournemouth area. At Chawleigh (168 m), mid Devon, a severe blizzard began at 1830h on the 8th and the 2050h observation there recorded 5 cm of lying snow with drifts to 0.4 m. Nearby Burrington (163 m) recorded a gust of 58 kn. The overnight blizzard left an average of 15 cm snow at Chawleigh at 0850h on the 8th with drifts to 2 metres. Ice pellets were reported at the observation time and a day maximum of 0.6 °C was recorded. By the 2050h observation the observer reported moderate freezing rain at -1.2 °C and the 0850h observation on the 9th noted "1 cm of glazed ice" overnight with the snow depth now 12 cm. Moderate freezing drizzle was falling with a temperature of -4.0 °C! Precipitation turned to mostly light snow during the day, this increasing the snow depth to 14cm by 0850 on the 10th.

At Exeter airport, blizzard conditions were also experienced overnight on the 7th-8th with gusts of 47 kn at 2206h on the 7th and 43 kn at the 0200 observation on the 8th; 9cm of snow was lying by 0600h and precipitation was measured at 12.4mm of rain and melted snow, snow having turned to sleet between 0500 and 0600 UTC. Subsequent observations are shown in Table 1a. Rain and sleet fell during daylight hours and then, after continuous moderate rain from 1900 to 2200h with temperatures just above 0 °C, the glaze event began by 2250h when sleet was observed with the temperature just below 0 °C. At 0900h on the 9th there was still 4 cm of snow lying and the Daily Register noted "PPN freezing on ground, ice glaze on all surfaces, anemometer frozen, directions estimated". By 1130h on the 9th, freezing drizzle had turned to light snow which persisted through until 2030h, increasing the snow depth back up to 7 cm.

Exeter Airport (period of glaze is shaded)					
Time	Temp °C	Weather	Time	Temp °C	Weather
0500	0.4	s◦s◦	0000	-1.2	r◦s◦
0600	0.7	rs	0100	-1.7	r◦s◦
0700	1.5	rs	0200	-2.0	rr
0800	1.7	rs	0300	-1.9	r◦r◦
0900	1.8	rs	0400	-2.1	r◦r◦
1000	1.9	rs	0500	-2.2	r◦r◦
1100	2.0	rs	0600	-2.0	dd
1200	2.4	rs	0700	-2.1	dd
1300	2.9		0800	-2.4	dd
1400	2.7	r◦	0900	-2.8	dd
1500	3.3	rs	1000	-2.5	dd
1600	2.8	r◦r◦	1100	-2.2	
1700	2.7	rr	1200	-2.5	
1800	2.6	r◦r◦	1300	-2.5	s◦s◦
1900	2.3	rr	1400	-2.5	s◦s◦
2000	1.3	rr	1500	-2.5	s◦s◦
2100	1.0	rr	1600	-2.5	s◦s◦
2200	0.3	rr	1700	-2.8	s◦s◦
2300	-0.6	r◦s◦	1800	-2.6	s◦s◦

Table 1a. Temperatures and Weather, Exeter airport, 0500 UTC on 8 January 1982 to 1800 UTC on 9 January 1982. Weather recorded in Beaufort letters (r = rain, d = drizzle, s = snow, h = ice pellets, ks = drifting snow).

At Chivenor, 5 cm of snow fell overnight on the 7th-8th; the midnight observation was continuous moderate snow, mean wind 31 kn gusting 48 kn, dry bulb temperature 0.2 °C, wet bulb -0.4 °C with "ice" and "frequent power failures" noted in the register.

Ice pellets (indicative of a shallower warm layer than freezing rain) were occasionally reported, e.g. at Chawleigh (see above) and also at Hartland Point at 1200h and 1300h on the 9th, appropriately during the transition from freezing rain to snow (Table 1b).

At equivalent altitudes temperatures were slightly lower over Pembrokeshire than across Devon so the glaze commenced slightly earlier at low levels. However, Exeter airport is relatively low lying compared to much of the county of Devon and, assuming an average winter lapse rate below the warm nose, it is likely that freezing precipitation began about 2 hours earlier at the 150-200 m level, a point supported by the Chawleigh report above (NB that Exeter was reporting moderate rain in the two hours prior to temperatures dropping below 0 °C).

Yeovilton, Somerset, reported freezing rain or drizzle from 0000h to 0700h on the 9th (Table 1c). Glaze also affected Dorset, Hampshire and south Wiltshire overnight the 8th-9th although the freezing precipitation was mostly reported as drizzle, confirming the smaller accumulations indicated by the radar further east (Browning, 1983).

Indeed, drifting snow was the major hazard on Salisbury Plain. Boscombe Down reported 10 cm of level snow at 0900h on the 8th after the overnight blizzard when winds gusted to 45 kn at 0254h. Further accumulations resulted in a depth of 14 cm at 0900h on the 9th with drifts of 0.9 to 1.2 m. However, a comparable overnight blizzard had occurred here just 4 years earlier on 18-19 February 1978 (Brown, 1978). Slight freezing rain was reported at 0000 and 0100 on 9 January 1982 then freezing drizzle (mainly light) from 0200-0800h, this reverting to moderate snow at the 0900h observation.

Hartland Point (period of glaze is shaded)					
Time	Temp °C	Weather	Time	Temp °C	Weather
0500	0.3	r◦r◦	0000	0.6	rr
0600	0.3	r◦r◦	0100	0.3	rr
0700	0.8	r◦r◦	0200	0.0	rr
0800	0.8	r◦r◦	0300	-0.8	rr
0900	1.2	r◦r◦	0400	-1.0	r◦r◦
1000	1.3	r◦r◦	0500	-1.2	rr
1100	1.5	rr	0600	-1.8	rr
1200	2.0	rr	0700	-1.8	rr
1300	2.4	rr	0800	-2.1	rr
1400	4.2		0900	-2.8	rr
1500	5.6		1000	-2.8	rr
1600	9.1	ir	1100	-3.0	r◦s◦
1700	9.2	r◦r◦	1200	-2.9	h
1800	9.2	r◦r◦	1300	-3.2	h
1900	9.2		1400	-2.4	ss
2000	4.8		1500	-2.4	ss
2100	4.0		1600	-2.7	ss
2200	1.5	r◦r◦	1700	-2.3	s◦s◦
2300	1.0	rr	1800	-2.9	s◦s◦

Table 1b. Temperatures and Weather, Hartland Point, 0500 UTC on 8 January 1982 to 1800 UTC on 9 January 1982.

Yeovilton (period of glaze is shaded)					
Time	Temp °C	Weather	Time	Temp °C	Weather
0500	-1.1	ks◦	0000	-2.9	r◦
0600	-0.9	k	0100	-2.5	r◦
0700	-1.1	ks◦	0200	-2.5	r◦
0800	-0.7	is◦	0300	-2.6	d◦
0900	-0.8	is◦	0400	-2.5	d◦
1000	-0.5	s◦s◦	0500	-2.5	r◦
1100	-0.2	ks◦	0600	-2.4	r◦
1200	0.0		0700	-2.9	d◦
1300	0.2	ks◦	0800	-2.8	d◦
1400	0.1	ks◦	0900	-2.9	d◦
1500	0.4	ks◦	1000	-2.9	d◦
1600	0.5	ks◦	1100	-2.8	d◦
1700	0.1		1200	-2.6	h◦
1800	-0.2	ks◦	1300	-2.8	is◦
1900	-0.9	ks◦	1400	-2.9	s◦s◦
2000	-1.1	ks◦	1500	-2.9	s◦s◦
2100	-1.8	r◦	1600	-3.0	s◦s◦
2200	-2.3		1700	-3.0	s◦s◦
2300	-2.6	r◦	1800	-3.2	s◦s◦

Table 1c. Temperatures and Weather, Yeovilton, 0500 UTC on 8 January 1982 to 1800 UTC on 9 January 1982.

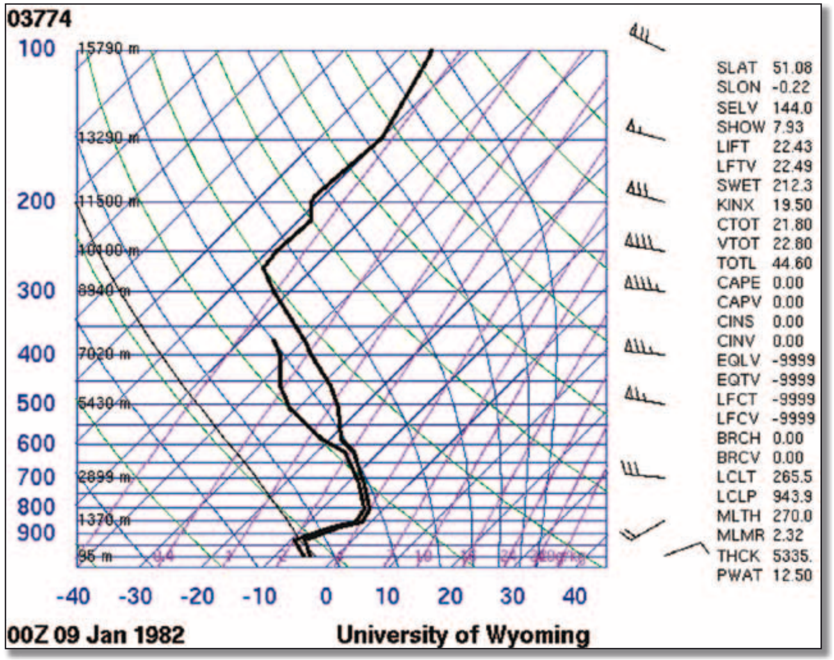


Figure 2. Upper air ascent for Crawley, 0000 UTC on 9 January 1982. © University of Wyoming, USA.

The Crawley ascent for 0000 UTC on the 9th (Figure 2) very clearly indicates the warm 'nose', although the radiosonde was just east of the zone where the 'nose' pushed the temperature above 0 °C; hence adjacent Gatwick was reporting continuous slight snow at -4 °C at the time. The ECMWF Reanalysis of vertical temperatures show the extent of the 0 °C isotherm at 925 mb height at 0000 UTC on 9 January 1982 (Figure 3 when the main glaze zone was across Devon and Somerset (comparative surface temperatures are included in Tables 1a to 1c).

The glaze and 'mixed precipitation' zone tended to migrate further southwest later on the 9th. Plymouth reported ice pellets at 1600 UTC followed by light snow by 1700h; St Mawgan (Newquay) reported light freezing rain at 1600h and ice pellets at 1800h.

GREAT SNOWSTORM ACROSS WALES, CENTRAL ENGLAND AND NORTH WESSEX, AND EASTERN IRELAND - SNOW DEPTHS OBSERVED

Figure 4 shows maximum 'level' snow depths during 8-10 January 1982. Very little snow had been lying across Wales, central and southern England at 0900h on the 7th (see below) so nearly all snow (certainly at altitudes below 200 m) was attributable to this winter storm. The extent of deep snow can be compared with maps of mean depths following other historic snowstorms in the central and southern UK such as 18-20 January 1881 (Eden, 2008) and 18-20 February 1978 (Burt, 1978).

At Exton Met Office auxiliary weather station, on the Brendon Hills on the eastern edge of Exmoor, snow was reported at every three-hourly observation from 1800h on the 7th to 0000h on the 10th with 60 cm of undrifted snow recorded by 0900h on the 10th. More than 40 hours of continuous snow was observed across a large area of south Wales, Wessex and the south Midlands.

Rhoose recorded snow in 46 successive hourly observations from 2000h on the 7th to 1800h on the 9th; all but the first were of continuous snow, while accompanying temperatures were -3 °C or below from 1800h on the 8th onwards.

Conditions in south and west Wales reached extreme 'white out' levels in more exposed locations. Hourly observations at Mumbles Head show visibility below 100 m in continuous heavy snow from 2300h on the 7th to 0200h on the 8th inclusive with the mean wind speed reaching 45 kn at 0300h. At RAE Aberporth (133 m asl), where 10 cm of level snow had fallen by 0900h on 8th, the mean hourly wind reached 44 kn for 1000 to 1100 UTC with a gust of 65 kn at 1112h. The 1100h observation also reported continuous heavy snow, temperature -2.2 °C and visibility 20 metres! At 1800h Bardsey Island lighthouse was reporting a mean wind of 50 kn in continuous moderate snow!

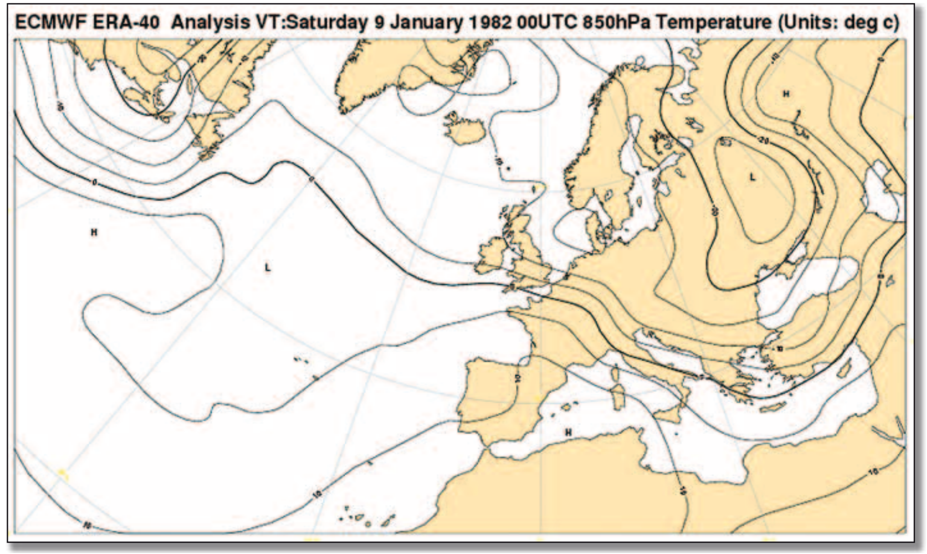


Figure 3. 925 mb temperature Reanalysis, 9 January 1982, 0000 UTC, data provided courtesy of ECMWF - ERA Interim Analysis. 0 °C isotherm indicated by thick line across southwest England.

Maximum level snow depths in *Wales* included 90 cm at Cwmbargoed (372 m asl), Mid Glamorgan, with 3 m drifts; 71 cm at Towy Castle (84 m asl), Carmarthen; 69 cm at Merthyr Tydfil (235 m asl), Mid Glamorgan, with 1.8 m drifts; 69 cm at Pontypool (362 m), Gwent; 61 cm at Newport (45 m), Gwent; 61 cm at Evancoyd (227 m asl), Powys, and 60 cm at Penmaen (87 m asl), on The Gower, West Glamorgan, with drifts to 2.1m. Of the aforementioned locations only Evancoyd (with 5 cm) had any pre-existing snow cover at 0900 UTC on the 7th January. At Towy Castle, Carmarthen, fine powdery snow began to fall at 1900h on the 7th (Smith, C – *Pers Comm*). By the 0900h observation time on the 8th, an average depth of 22 cm had accumulated. This morning observation recorded moderate snow falling, mean wind speed 25 kn northeasterly and temperature -1.9 °C. By 0900h on 9th snow had reached a mean depth of 56 cm and the observation recorded a mean wind of 18 kn with temperature -4.6 °C. By the time snow ceased at 1400h on the 9th, the 'level' depth was 71 cm and drifts of 3 to 6 metres were observed in the vicinity. The maximum temperatures on the 9th and 10th were -4.0 and -2.6 °C respectively. Ice floes were a prominent feature of the River Towy over the next few days (Figure 5). The main road from Carmarthen to Llanelli was completely blocked hedge to hedge with buried cars and vans and small lanes were impassable with 6 m drifts.

Elsewhere in Wales, passengers were rescued by helicopter from a train marooned on the Cambrian coast line near Tywyn. Roofs of buildings collapsed under the sheer weight of snow, among them the Sofia Gardens pavilion in Cardiff (Perry, 1982).

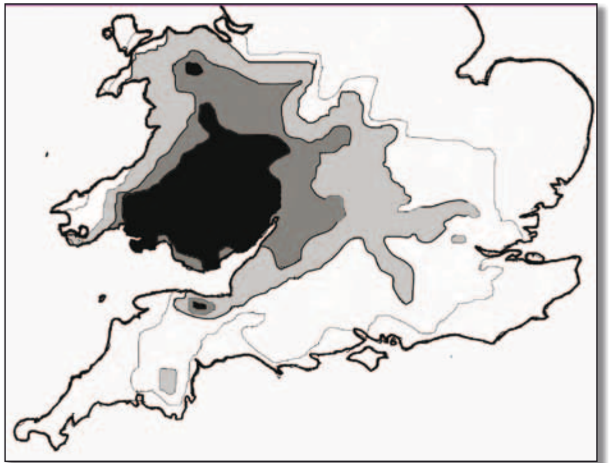


Figure 4. Maximum snow depths (centimetres) 8-10 January 1982. Isopleths for depths in excess of 10 cm, e.g. light grey shade=over 20 cm, dark grey=over 30 cm, black=over 40 cm.

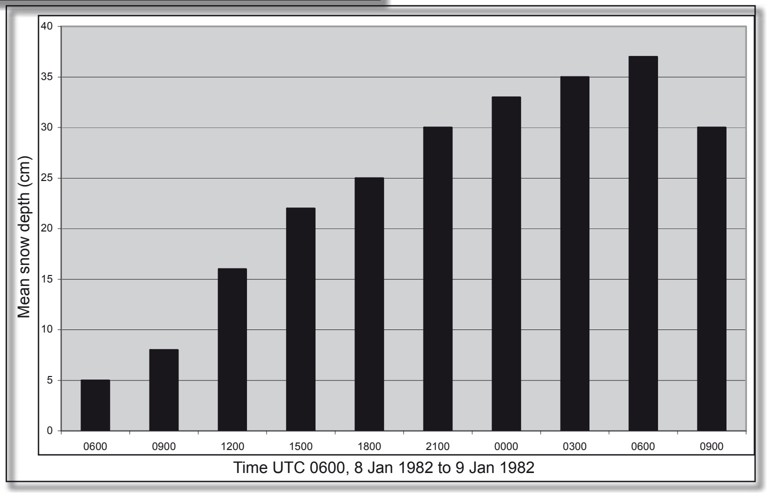


Figure 5. Snow depths at Birmingham/Elmdon airport 8-9 January 1982, based on information supplied by the Met Office.

In the Swansea/Gower area, the mean depths (e.g. 30-40 cm in the city and 60 cm at Penmaen on the Gower) were considerably more than anything else recorded in the past 65 years, a period including the other notable blizzards in 1947, 1963 and 1978. In 1947, the snowstorm of 4-5 March left 13 cm at Fairwood Common (near the airport). The heaviest fall in 1963 also gave 13 cm in the city on 5-6 February while the blizzard of 18-19 February 1978 gave average depths ranging from 5 to 20 cm in the area.

In *England*, 76 cm was measured at Berry Hill in the Forest of Dean (232 m), Gloucester, 67 cm at Longtown (172 m), Herefordshire, and 60 cm at Exton (329 m) on Exmoor, Somerset; the only existing snow lying at these locations at 0900h on the 7th was 2 cm at Exton. The southwest Midlands were most affected but over 20 cm also fell over a much wider area from north Somerset eastwards to the Chilterns and parts of London and northwards across the east Midlands to Leicestershire.

For lower levels, Figure 5 shows the snow accumulations at Birmingham/Elmdon airport (98 m) which were recorded during three-hourly observations. Light snow began just before 0100h on the 8th, becoming moderate between 0300 and 0400h. 37 cm had accumulated by 0600h on the 9th, the snow evidently compacting back to 30 cm by 0900h. At Birmingham University/Edgbaston (130 m), 36 cm measured on the 9th (with drifts over 2 m) was the greatest depth since March 1947 and the most from a single snowfall since January 1941 (Woodcock, 1988) (NB The Birmingham University site change referred to in the Woodcock reference.) Drifts up to 4 m were noted at Tenbury Wells (90 m asl), Worcestershire, where the average depth reached 46 cm (Sholl, A – *COL Bulletin, January 1982*). Similar size drifts were observed at Bromyard (144 m), Herefordshire, and 2 metre drifts were observed at Martley (53 m), Worcestershire.

Figure 6. Looking north along the River Towy and railway line from East Marsh, Carmarthen, 11 January 1982, Deeply drifted snow and ice floes on the River Towy © D. Chris Smith (1982).

In *Ireland*, heavy snow fell for much of the 8th accompanied by strong to gale force easterly winds. At Dublin airport, 25 cm had fallen by 0000h on the 9th. At Knockroe, Co Monaghan, snow began around 0500h on the 8th, petering out between 2200 and 2230h; at 0900h on the 9th the snow depth averaged 18 cm with the strong easterly winds causing drifts of 0.6 to 0.9 metres (Skeath, H – *Pers Comm*). Armagh Observatory recorded 22 cm, but further north Belfast/Aldergrove had a maximum depth of only 4 cm (1200h on the 8th), albeit sufficient (with gusts to 49 kn at 1424h) to disrupt flights. Three Monaghan buses were stranded in Dublin over the weekend. In south Monaghan, milk collections were severely disrupted as most routes were impassable with drifts reported as 3 m deep. Snowdrifts up to 3 m were also reported in south Armagh where 200 people were rescued from cars on the main road from Newry to the border. In the Wicklow mountains south of Dublin, drifts of 6 m were reported.

Like the Belfast area, the *Isle of Man* was on the fringe of the blizzard but still experienced a harsh winter's day on the 8th with 3 cm of snow accumulating at Ronaldsway airport where winds gusted to 53 kn at 0818.

PREVIOUS GLAZE/ICE STORM EVENTS

By far the most extreme such event recorded in Britain (in terms of both ice accumulations and aerial extent) was on 27-28 January 1940 (Cave, 1940; Brooks and Douglas, 1956). This event was also associated with an historic snowstorm just northeast of the glaze zone (Hawke, 1940).

Pike (1996 and 2002) described more recent events: two each in January 1963 and in December 1995-January 1996. The December 1995 episode was considerably more widespread than that of January 1982. Other significant glaze events occurred in December 1927, March 1947, January 1966 and February 1978. It is probably no coincidence that all of these events have been across Wales, the Midlands and southern England as the southern UK is most likely to experience warm advection aloft being undercut by intensely cold continental air.

IMMEDIATE AFTERMATH: INTENSE COLD

Following the retreat of the frontal zone southwards, a series of exceptionally cold nights followed with record low minima (Roach and Brownscombe, 1984; Burt, 1984). At Newport, Shropshire, 30 cm of fresh powdery snow and a day maximum of -3.6 °C were ideal pre-conditions for the -26.1 °C recorded there overnight on the 9th-10th, the all time record low for England.

ACKNOWLEDGEMENTS

Special thanks to: Paul Brown for synoptic data; to David Smart for correspondence on the event; to Chris Smith (Carmarthen) and Henry Skeath (Monaghan) for their accounts of the storm; to Glyn Hughes at the National Meteorological Library and Archives for providing copies of station daily registers. Snow depth data was sourced from the Met Office Land Stations Dataset, courtesy of BADC with additional data from the Climatological Observers' Link bulletin for 1982, the Daily Weather Summary of the Met Office and from the 1982 Snow Survey of Great Britain (Met Office). Some original observers' returns were checked (courtesy of the Met Office Archives).

REFERENCES

BROWNING, K. A. (1983) Air motion and precipitation growth in a major snowstorm. *Quart. J. Royal Met. Soc.,* 109, pp225-242.
BROOKS, C.E.P. and DOUGLAS, C.K.M. (1956): Glazed frost of January 1940. Meteorological Office Geophysical Memoirs, 12, No. 98, HMSO London.
BROWN, P. (1978) The West Country blizzard of 18/19 February 1978 as observed at Boscombe Down, Wiltshire. *J. of Meteorology, UK,* 3, 33, 285-286.
BURT, S. D. (1978) The blizzards of February 1978 in south western Bristain. *J of Meteorology, UK,* 3, 33, 261-278.
CAVE, C. J. (1940) The ice storm of January 27-29, 1940. *Quart. J. Royal Met. Soc.,* 66, 143-150.
DOE, R K. (2004) Ice accretion and snow loading to electricity cables and the snowstorm of 7-10 January 1982. *J. of Meteorology UK* 29, 286, 58-65.
EDEN, P. (2008) *British Weather Disasters*, Continuum Books UK, London.
HAWKE, E J. (1940). The snowstorm and drifts of January 26-29, 1940, in the northern Chilterns *Quart. J. Royal Met. Soc.,* 66, 152-153.
JONES, I (1982) The snowfall in south Pembrokeshire 7/8 January 1982. Climatological Observers Link 141, p14
LONDON WEATHER CENTRE (1982), *Daily Weather Summary,* January 1982.
LYALL, IT. (1982) The exceptional cold spell of January 1982 in the UK. *J. of Meteorology, UK,* 7, 69, 155-159.
MAYES, J. and POWELL, J. (2003) The climate of Gower, South Wales: a 40-year perspective, *Weather* 58, Issue 8, 303-309.
PERRY, A. (1982) The South Wales blizzards of January 1982: impact and precedent. *J. of Meteorology, UK,* 7, 68, 113-115.
PIKE, W. S. (1996) The ice storms of late December 1995. *J. of Meteorology, UK* 21, 209, 207-217.
PIKE, W. S. (2002). Winter 1962-63, a 40 year perspective, part 2. The blizzards and ice storms of 2-3 January and 19-20 January 1963. *J. of Meteorology, UK* 27, 274, 365-374.
Roach, W and Brownscombe, J. (1984). Possible causes of the extreme cold during winter 1981-82. Weather 39, 362-372
SHOLL, A (1982) The January cold spell at Tenbury Wells. Climatological Observers Link 141, p 11-12
WOODCOCK, A. K. (1988) Recent heavy snowfalls in Birmingham. *Weather* 43, 5, 211-212.

ANALYSIS OF RAINFALL VARIABILITY IN THE CHARACTERISTICS OF RAIN-FED RICE CONDITIONS IN EASTERN INDIA

P.K. SINGH, L.S. RATHORE, K.K. SINGH, D.V.BHASKAR RAO*, A.K. BAXLA and A.K. BHARGAV

Agromet Service Cell, Mausam Bhavan, IMD, Lodhi Road, New Delhi, India.
** Retd. Professor, Andhra University, Visakhapattnam, India*

Abstract: The rainfall and crop data of Eastern India were analyzed, namely Orissa, West Bengal, Assam, Jharkhand, East Uttar Pradesh, East Madhya Pradesh, Chhattisgrah and Bihar. The rain-fed rice is the main crop grown in this region. The greater part of the area in eastern Uttar Pradesh, Madhya Pradesh, Chhattisgrah, Bihar and Orissa where LGP varies from 19 to 24 weeks, in the southwestern border of eastern Uttar Pradesh it varies from only 17 to 18 weeks. It is observed that lowest productivity of less 5 q per ha in eastern Madhya Pradesh. In general, the rice yields are less than 10 q per ha in Chhattisgrah, Jharkhand, Orissa, north Bihar, western parts of Assam and northwestern portion of eastern Uttar Pradesh. The highest yield levels of 20 to 25 q per ha is seen in the middle parts of Uttar Pradesh and West Bengal. The productivity level remains at 10 to 15 q per ha in Orissa, Assam and eastern Uttar Pradesh.

It is generally observed that low productivity of 1 t per ha have been mostly observed in semi-arid to dry sub-humid type of climate with LGP varying 90-120 to 120-150 days. The highest productivity of 2-3 t per ha are recorded in hot sub-humid to humid regions of West Bengal where LGP vary from 150 to 200 days. The productivity was the order of 1 to 2 t/ha in hot sub-humid to humid regions of Assam, Orissa and West Bengal. Also the hot dry sub-humid climates in Uttar Pradesh and Bihar recorded the productivity of 1 to 2 t per ha.

Keywords: rainfall, rain, rain-fed rice, drought, India.

INTRODUCTION

The rain-fed agro-ecosystem occupies the major cropped areas in India. Out of the 142 M ha net sown area in the country, nearly two-thirds, i.e. 90 M ha is under rain-fed agriculture. Nearly 67 M ha of rain-fed areas receive mean annual precipitation in the range of 500-1500 mm with a high degree of variability leading to low productivity and stability of rain-fed crops. Rain-fed agro-ecosystem, which contributes to about 45 % of agricultural production, is entirely at the mercy of the monsoon activity over the country and is overwhelmed with problems of mid-season drought and associated impacts on the crop productivity. Most of the regions in the rain-fed agro-ecosystem experience moderate to severe drought conditions of a prolonged nature once in 2-5 years. Apart from the prolonged drought, inadequate and erratic distribution of rainfall often exposes the plants to a shortage of desired levels of moisture, and thus plant growth takes place under below optimum conditions (Raj, *et al*., 2004; and Raman Rao, 1997).

As a result, the productivity levels remain low over the rain-fed regions and hardly cross 1 t ha^{-1} at most of the farmers' fields. The proper understanding and efficient utilization of the natural resources, especially of the weather, is, therefore, of great concern, so improvements and sustainability of agriculture in the rain-fed agro-ecosystem is needed.

The rain-fed agro-ecosystem covers the agro-ecological regions 3 to 10 (arid to sub-humid) i.e. including Assam, West Bengal, Orissa, Jharkhand, Bihar and Uttar Pradesh (Rajendra Prasad, *et al*., 1990). It also includes parts of humid and per humid regions of eastern and northeast India where crops are grown under rain-fed conditions (Rao, *et al*., 1996; Katyal, *et al*., 1996b; and Gangopadhyaya, *et al*., 1965). Although a substantial amount of rainfall is available, which at times becomes excessive leading to flooding due to inadequate drainage. Hence, these regions encounter a particular type of agri-management problem; whereby they are entirely rain-fed, and this type of farm management is different from in-arid and semi-arid regions.

The rain-fed agro-ecosystem is characterized by frequent moisture stress periods during the cropping season due to breaks in monsoon rains or early withdrawal of monsoon. The drought periods occasionally, extends to more than one month and often occurs during the latter ends of the rainy season in August, extending into September and merging with the withdrawal of the monsoon (Srivastava, *et al.,* 1989).

MATERIAL AND METHODS

The daily rainfall data and crop data were collected at eastern India namely Orissa, West Bengal, Assam, Bihar, Jharkhand, Eastern Uttar Pradesh, Eastern Madhya Pradesh and Chhattisgrah and analysis using computer program, computations of weekly averages, monthly and annual values has been worked out and also the probabilities of receiving different amounts of rainfall at weekly intervals have been computed (Biswas, 1982; Kulandaivelu, 1984; and Singh, 2009). The total crop season from germination of seedling to maturity is expected to be completed in 17 weeks. Out of which the water required for crops during the last two weeks before harvesting is negligible. Hence, the rain dependent crop period of rain-fed rice crop will be 15 weeks only (seedling 3 weeks, vegetative, reproductive and maturity 4 weeks each).

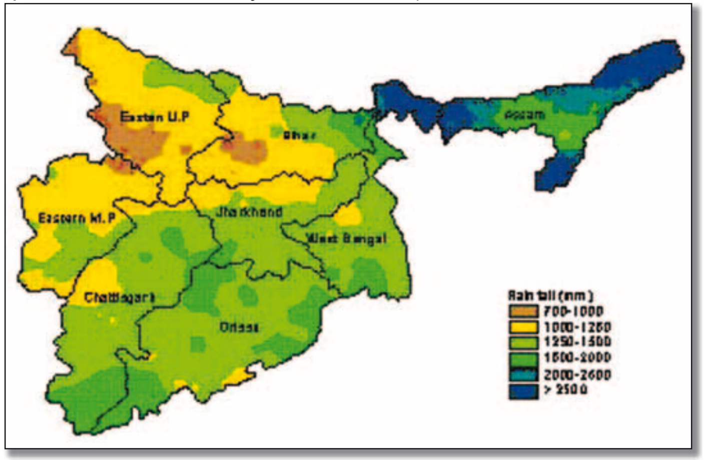


Figure 1. Average annual rainfall in eastern India.

The weekly water requirements of rice crop under upland conditions up to the seedling stage (3 weeks) is assumed to be 100 mm while it is 50 mm per week for the rest of the period. Hence, the water needs of the seasons (15 weeks) works out to be 700 mm. From the weekly rainfall amount at different probabilities (70, 60, 50 and 30 %) of different stations spread over the study region, the rainfall at 60 % (dependable precipitation) probability has been considered to compute the water availability at different growth stages against the demand.

Therefore, percentages of rainwater availability for different phenophases at each station have been worked out (Sastry, 1976). Using spatial interpolation techniques in GIS, rainwater availability maps for all the growth stages, *viz*., seedling, vegetative, reproductive and maturity have been prepared (Kar, *et al*., 2005; ESRI, 1998; and Ramana, *et al*., 1993). Therefore, it is assumed that the season begins if the cumulative rainfall received over a period of three consecutive weeks is at least 100 mm and above.

To compute the annual and seasonal rainfall from the average weekly rainfall data at each station, total annual rainfall values (1-52 weeks), monsoon period (24-30 weeks) and post-monsoon period (40-48 weeks) have been computed for each station. The spatial distribution of seasonal (monsoon and post-monsoon) and annual rainfall maps has been prepared using GIS interpolation analysis (Kar, *et al*., 2005; and Katyal, *et al*., 1996b). Thematic maps for all the basic parameters and the derivatives have been prepared using GIS package. The spatial variability maps of mean productivity and its changes over the 30 year period for the entire study area have been prepared. Similar maps for each state have also been prepared.

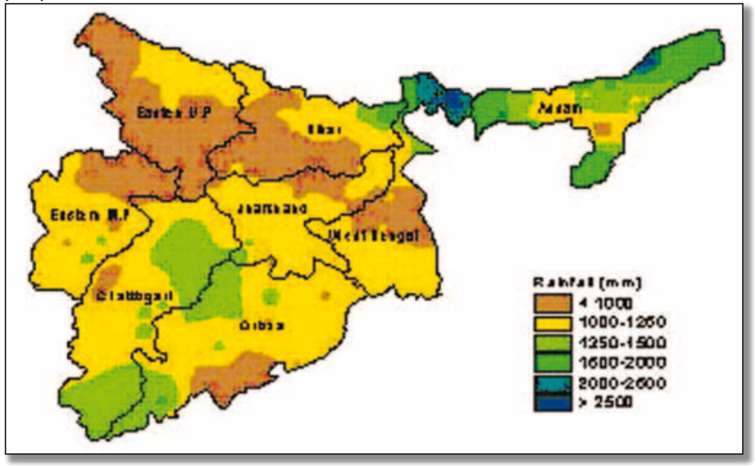


Figure 2. Average monsoon rainfall pattern in eastern India.

RESULTS AND DISCUSSION

Rainfall pattern and variability in Eastern India

The rainfall is the most important parameter under tropical climate conditions. Therefore, analysis of rainfall with respect to distribution in different seasons assumes greater significance. Maps showing the distribution of annual rainfall and in different seasons have been worked out and presented in Figures 1-3, respectively. Similarly, rainfall maps for the same period have been prepared for 60 % probability level, which is considered as dependable precipitation and are shown in Figures 4-6.

The average annual rainfall of the study area (Figure 1) shows that the rainfall varies from 700 mm in the western parts of eastern Uttar Pradesh to greater than 2500 mm per year in Assam. Greater part of the region comprising Chhattisgrah, Orissa, West Bengal, Bihar and Jharkhand receives a rainfall of about 1250 mm per year. The monsoonal rainfall pattern (Figure 2) indicated that except in eastern Uttar Pradesh, Bihar, Jharkhand and West Bengal, coastal Orissa, the seasonal rainfall is above 1000 mm. The highest rainfall is received in Assam. The quantum of post-monsoon rainfall is low (<100 mm) over greater parts of the region (Figure 3). Few coastal districts in Orissa received the rainfall of about 200-300 mm due to occurrence of cyclones.

© THE INTERNATIONAL JOURNAL OF METEOROLOGY
January/February 2012, Vol.37, No.367

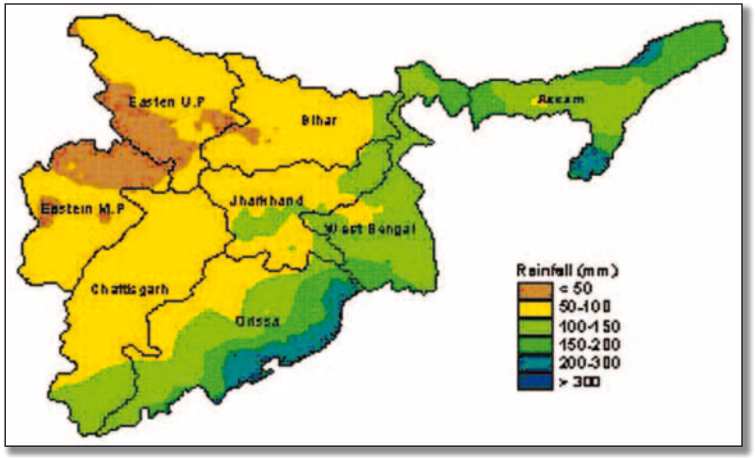


Figure 3. Average post-monsoon rainfall pattern in eastern India.

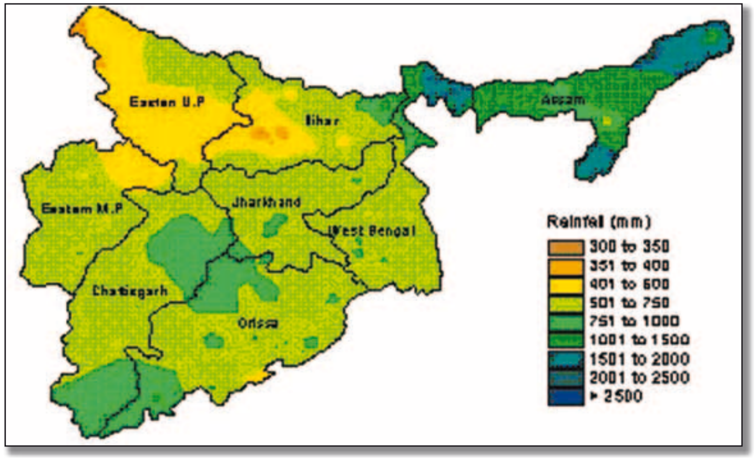


Figure 4. Annual rainfall (60 % probability) rainfall pattern in eastern India.

Probability pattern and variability in Eastern India

It is observed from the figures that annual rainfall of 60 % probability (Figure 4) as expected is higher towards north eastern region compared to western parts of the study area. The greater part of the region is expected to have a rainfall amount of 500-750 mm. Majority of the area in eastern Uttar Pradesh, parts of Bihar and Madhya Pradesh can receive only about 500 mm of rain, which indicates that the failure of crop under rain-fed conditions is not uncommon. Similarly, higher amounts of rainfall of 750-1000 mm in forest areas of Chhattisgrah and Orissa can be seen as potential zones of higher productivity provided other conditions are conducive. Monsoon rainfall (Figure 5) pattern follows the similar pattern as that of annual rainfall. However, some coastal districts in Orissa have recorded lower amounts of 400 to 500 mm indicating possible water stress condition. The post-monsoon season (October-November) rainfall scenario, Figure 6 shows that except in the coastal districts of Orissa and parts of Assam, insignificant rainfall amount of less than 20 mm can only be possible in the entire region, which may not be contributing significantly for the crops growing in post-monsoon season.


© Peter Kirk

Commencement rainy season growing pattern in Eastern India

Knowledge on the commencement and end of growing season and its duration is useful for planning efficient cropping pattern and also to introduce new varieties matching with the length of growing period (LGP). From the MAI values obtained from water balance computations carried out for different stations spread over the study region, maps showing commencement and end of season (weeks) are given in Figure 7 and 10. It is observed from the Figure 7 that the commencement for growing period starts as early as between 10-17 standard meteorological weeks in Assam and the adjoining areas. This is due to occurrence of rainfall during March due to northwest disturbances, which are largely isolated showers. These showers are useful for summer crops. The influence of such phenomena with occasional summer thundershowers is also seen in parts of West Bengal and in hilly regions of Indo-Gangetic Bengal up to the 22nd week (end of May). In the 23rd week (1st week of June), Bihar, Jharkhand, West Bengal and northern Orissa are found to be conducive for commencement of the season. In general start of the season delays as one move towards west. Though greater Bihar, Uttar Pradesh, Madhya Pradesh and Orissa have conditions favorable for sowing by the 24th week (mid-June), the extreme western part of the study region in Uttar Pradesh and eastern Madhya Pradesh will have a delayed start as the arrival of monsoon in to these regions is late compared to its neighboring areas in the eastern parts.

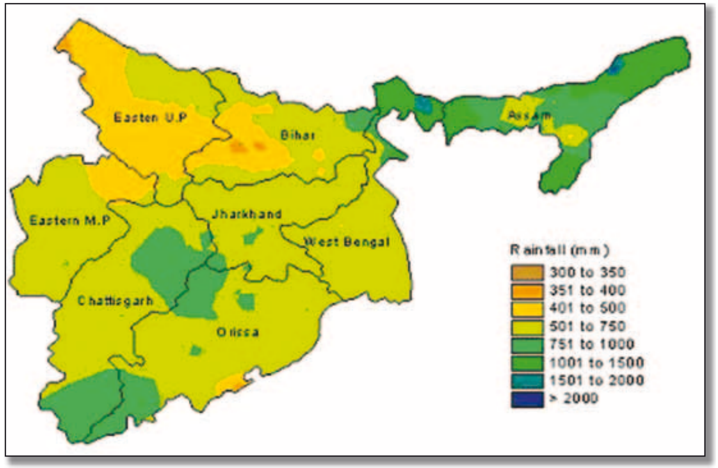


Figure 5. Monsoon rainfall (60 % probability) pattern in eastern India.

Cessation rainy season growing pattern in Eastern India

The cessation of the rainy season (Figure 8) where AE/PE values are <0.5 follows closely to that of the withdrawal of monsoon season. It is seen as early as by the 42nd week (mid October) in the eastern parts of Uttar Pradesh and slowly moves towards east. By the beginning of November (45th week), the season ends from more than 50 percent of the area. The coastal parts of Orissa, West Bengal, the season ends by November (48th week). This is mostly due to the availability of residual moisture due to occurrence of cyclonic storms during October. In Assam too, the season ends by November due to extended period of rainy season.

Length of growing period (LGP) pattern in Eastern India

The difference between the commencement and cessation of growing season computes the average length of LGP at each station.

The LGP map (Figure 9) prepared from spatial interpolation techniques in GIS indicated that highest number of growing weeks of about 37-39 weeks are observed in the extreme eastern parts of Assam where double cropping is possible under rain-fed conditions. It will be around 35-36 weeks in the western parts of Assam and adjoining West Bengal. Perhaps, here too, double cropping is possible under rain-fed conditions with supplemental irrigations at the critical crop growth stages. It varied between 25 to 30 weeks in coastal Orissa. In parts of Jharkhand, Bihar and West Bengal where a long standing crop can be taken up successfully without subjecting it to moisture stress. Greater parts of the area in eastern Uttar Pradesh, Madhya Pradesh, Chhattisgrah, Bihar and Orissa where LGP varies from 19 to 24 weeks whereas it is only 17 to 18 weeks in the southwestern border of eastern Uttar Pradesh.

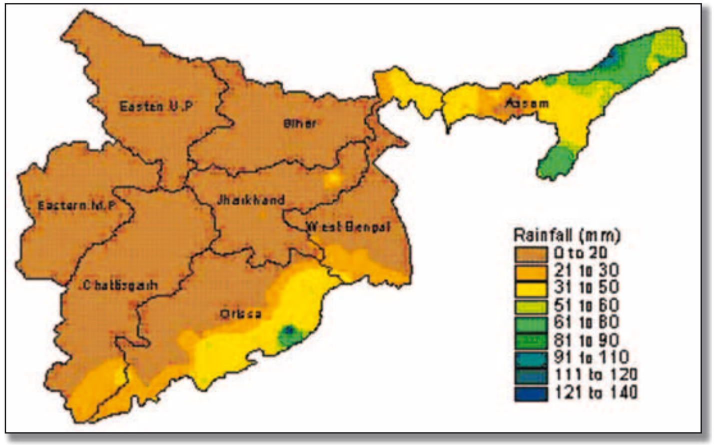


Figure 6. Post monsoon rainfall (60 % probability) pattern in eastern India.

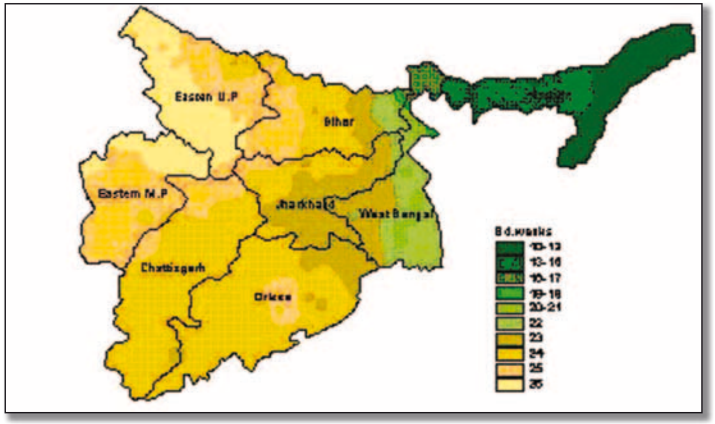


Figure 7. Commencement of growing period for rain-fed rice in eastern India.

Rainwater Availability at Different Crop Growth Stages

In spite of the receipt of high rainfall of above 1200 mm over the study area, which is expected to meet the water needs of the rice crop, the productivity under rain-fed conditions is not satisfactory. The average yield works out to be around 1 t per hectare. Therefore, to study the conditions leading to record such low productivity values, availability of dependable rainwater (rainfall at 60 % probability) at different crop growth stages as against the demand has been worked out.

The water requirement of rice under upland conditions is assumed to be 50 mm per week after initial establishment and the total water need worked out to be 700 mm.

Spatial maps showing the rainwater availability expressed as percentages of the water requirement at 60 probabilities for the entire crop growth period and at important growth stages, *viz*., vegetative, reproductive and maturity phases have been prepared and shown as Figures 10-13, respectively. It is observed from the Figure 10 that the rainwater satisfied the demand to an extent of about 100 % over greater part of the study region. Even it exceeds more than 100 percent in some parts Chhattisgrah, Orissa and Jharkhand and the entire Assam. However, in some southern coastal parts of Orissa and entire eastern Uttar Pradesh, parts of Bihar and eastern Madhya Pradesh and in central parts of West Bengal, the rainwater could meet the demand up to 75 %. These above conditions for the entire crop season appear to be satisfactory to record reasonably good yields of above 2 t per ha. In reality, the rainwater maps prepared for different crop stages have been discussed below.

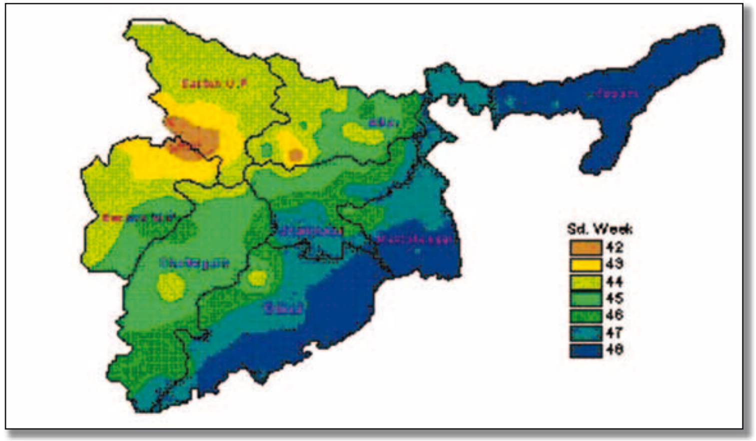


Figure 8. End of growing period for rain-fed rice in eastern India.

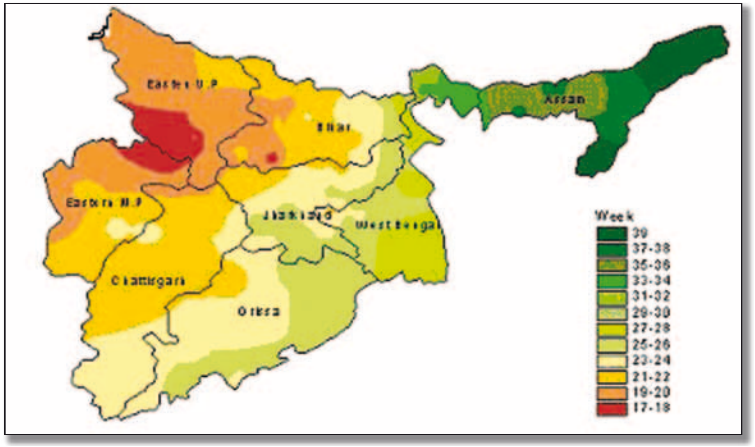


Figure 9. Length of growing period for rain-fed rice in eastern India.

The rainwater availability map at the vegetative phase (Figure 11) showed that the water availability is more than the demand in almost the entire region of the study area.

It is 76 to 100 % over eastern Bihar, parts of Jharkhand, West Bengal and coastal districts of Orissa. In general, the rainfall received at vegetative stage in the entire study region is sufficient to meet the crop water needs and is found to be not a limiting factor in the final yield. Figure 14 showing the rainwater availability at reproductive stage indicated that except in some parts of Uttar Pradesh, Bihar, northern parts of Madhya Pradesh, central parts of West Bengal and southern coastal districts of Orissa. The rainwater satisfies the entire water need of the crop (greater than 76 %). However, in some small pockets in eastern Uttar Pradesh and in coastal Orissa, the rain availability is in between 26 to 50 percent indicating the initiation stress period. At the maturity phase, (Figure 13) which almost coincides with the withdrawal phase of the monsoon indicates the lower water availability of any rainwater (<25 % of the actual demand) in the entire eastern Uttar Pradesh and small part of Bihar, half of part of eastern Madhya Pradesh.

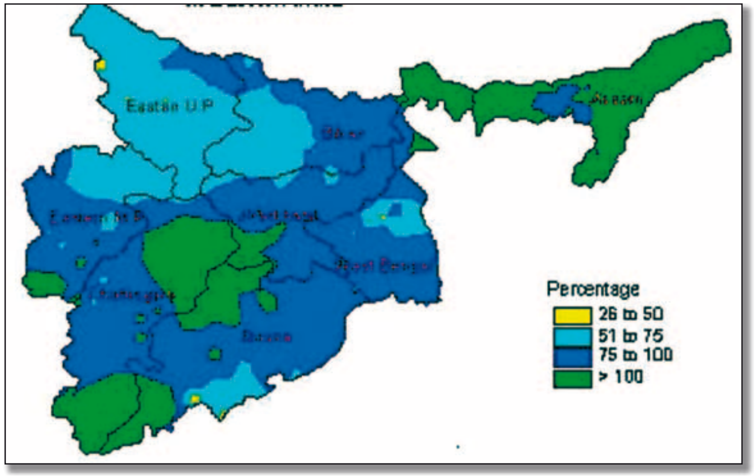


Figure 10. Rainfall availability (as percentage of requirement) at 60 % probability during the total crop growth period for rain-fed rice in eastern India.

Small portions in West Bengal and in Orissa too have the possibility of having very low rainwater availability indicating severe water stress conditions. It is in between 26 to 50 % in parts of Bihar and Chhattisgrah. Except in the Assam region, and in parts of forest regions in the southern portion of Chhattisgrah and in central Orissa, the water availability is in between 51 to 75 %, indicating a strong possibility of water stress maturity phase. The above analysis has brought out clearly that water stress conditions during the maturity phase is found to be one of the major climate constraints in observing lower productivity in these regions. Probably better crop management strategies like advancing the sowing or transplanting and better fertilizer application and timely weeding may improve crop performance. Perhaps, raising nurseries wherever water resources are available and transplanting the seedlings immediately after rains will improve the rainwater use efficiency in these regions. The contributions of other climatic constraints, *viz*., and lower levels of radiation regime may also contribute significantly in recording lower yields.

Spatial Variability of rice productivity pattern in Eastern India

The spatial variability of mean rice productivity map has been generated using GIS and presented in Figure 14 Also the percent changes in the productivity over the years have also been computed and map has been prepared and presented in Figure 15 It is observed that lowest productivity of less 5 q per ha in eastern Madhya Pradesh.

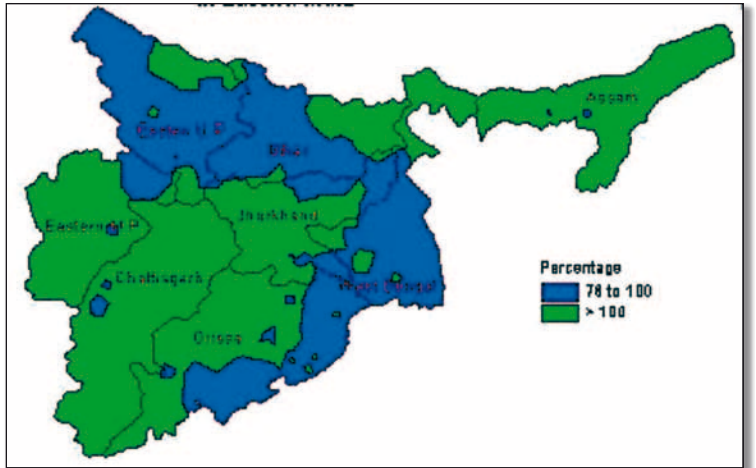


Figure 11. Rainwater availability (as percentage of requirement) at 60 % probability during the vegatitive period for rain-fed rice in eastern India.

In general, the rice yields are less than 10 q per ha in Chhattisgrah, Jharkhand, Orissa, north Bihar, western parts of Assam and northwestern portion of eastern Uttar Pradesh. Highest yield levels of 20 to 25 q per ha is seen in the middle parts of Uttar Pradesh and West Bengal. The productivity level remains at 10 to15 q per ha in Orissa, Assam and eastern Uttar Pradesh. The percent change in rice productivity (Figure 15) over the period 1970 to 1998 in each district indicated that over the past 28 years period, about 50 to 100 percent increase in productivity has been noticed in almost entire region except in parts of West Bengal and eastern Uttar Pradesh were spectacular increase in productivity of the order of 100 to 300 percent has been witnessed. This may largely be due to increased irrigation facility over the past few years and practicing better crop management techniques and use of high yielding varieties. It is surprising to notice that a few districts, *viz.,* Seoni, Dhanbad, Karbianglong and Golaghat in Madhya Pradesh, Jharkhand and Assam have shown negative growth rate.

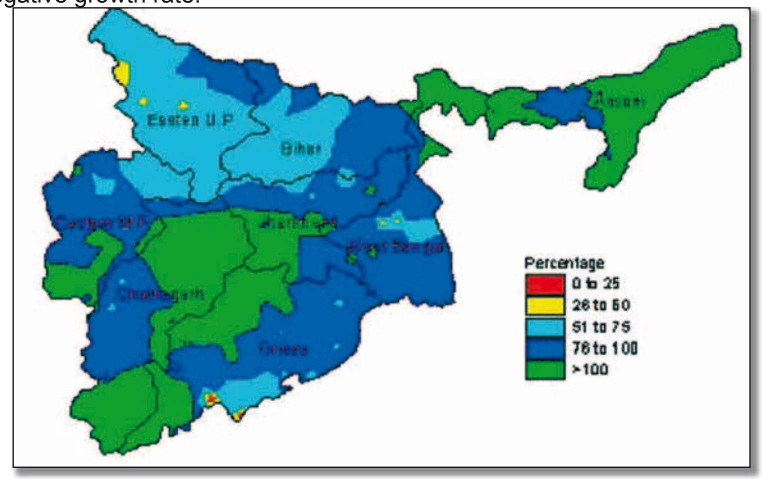


Figure 12. Rainwater availability (as percentage of requirement) at 60 % probability during the reproductive period for rain-fed rice in eastern India.

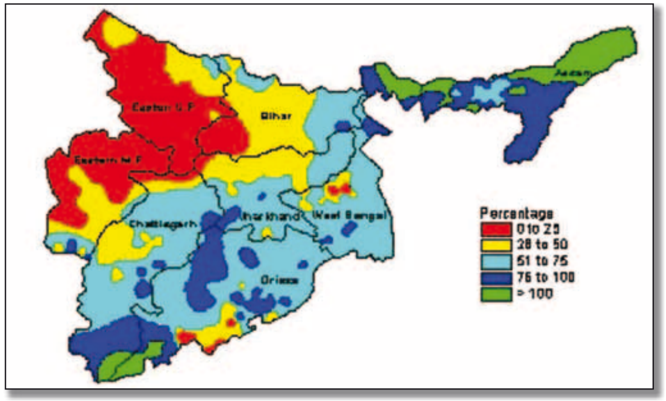


Figure 13. Rainwater availability (as percentage of requirement) 60 % probability during the maturity period for rain-fed rice in eastern India.

Variability of rice crop productivity in different agro-ecological regions

In order to explain the variability of Rice crop productivity in terms of different agro-ecological regions, the productivity map has been superimposed on agro-ecological sub-regions map prepared by NBSS and LUP and is presented in Figure 16. Though it is difficult to interpret the variability of productivity on the agro-system basis, it is generally observed that low productivity of 1 t per ha have been mostly noticed in semi-arid to dry sub-humid type of climate with LGP varying 90-120 to 120-150 days. The highest productivity of 2-3 t per ha are recorded in hot sub-humid to humid regions of West Bengal where LGP vary from 150 to 200 days. The productivity was the order of 1 to 2 t per ha in hot sub-humid to humid regions of Assam, Orissa and West Bengal. Also the hot dry sub-humid climates in Uttar Pradesh and Bihar recorded the productivity of 1-2 t per ha. As the productivity data is being the combined data of both irrigated and rain-fed, perhaps, the separation of irrigated crop yields from the original data sets may improve the interpretation in a better way.

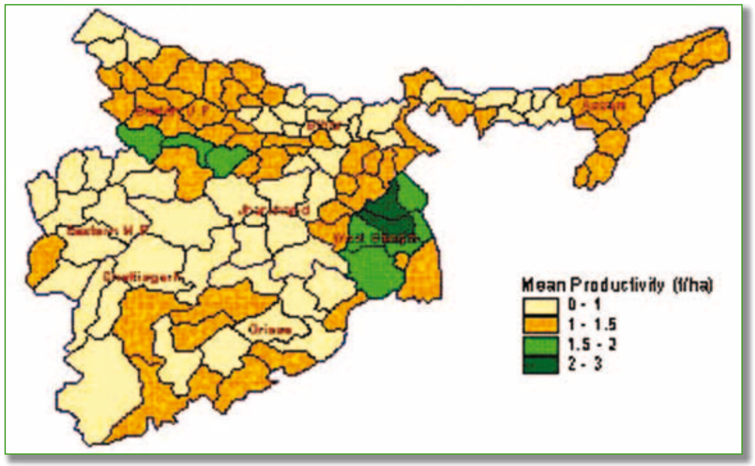


Figure 14. Mean rice productivity in eastern India.

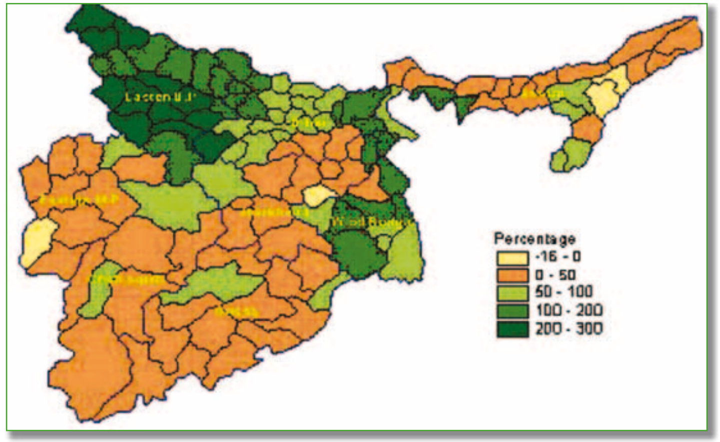


Figure 15. Changes in rice productivity from 1970 to 1998 over eastern India.

CONCLUSION

Rainfall is the most important parameter under tropical climate condition. Therefore, analysis of rainfall with respect to distribution in different seasons assumes greater significance. The greater part of the region comprising Chhattisgrah, Orissa, West Bengal, Bihar and Jharkhand receives a rainfall of about 1250 mm per year.

The knowledge on the commencement and end of growing season and its duration is useful for planning efficient cropping pattern and also to introduce new varieties matching with the length of growing period (LGP). It varied between 25 to 30 weeks in coastal Orissa. The parts of Jharkhand, Bihar and West Bengal where one crop of long duration can be taken up successfully without subjecting to moisture stress.

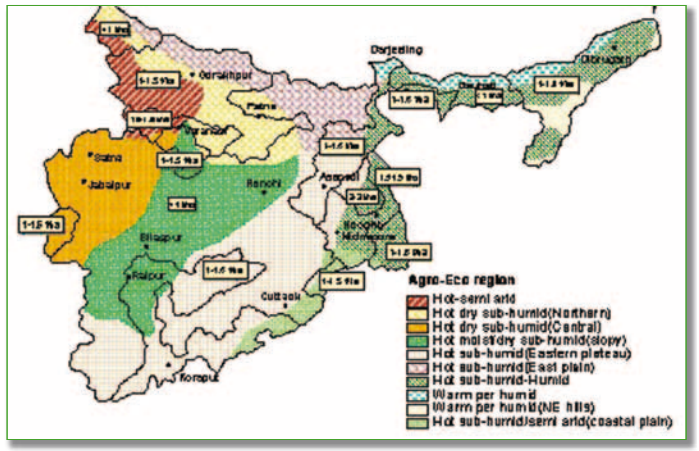


Figure 15. Mean rice productivity (tfha) in different agro-eco regions of eastern India (based on data from the period 1970-1998).

The greater part of the area in eastern Uttar Pradesh, Madhya Pradesh, Chhattisgrah, Bihar and Orissa LGP varies from 19-24 weeks whereas it varies only 17-18 weeks in the southwestern border in east Uttar Pradesh. It is observed that lowest productivity of less 5 q per ha in eastern Madhya Pradesh. In general, the rice yields are less than 10 q per ha in Chhattisgrah, Jharkhand, Orissa, north Bihar, western parts of Assam and northwestern portion of eastern Uttar Pradesh. The highest yield levels of 20 to 25 q per ha were seen in the central areas of Uttar Pradesh and West Bengal. The productivity level remains at 10-15 q per ha in Orissa, Assam and eastern Uttar Pradesh.

The percentage change in rice productivity (Figure 15) over the period 1970 to 1998 in each district indicated that over the past 28 years, about a 50 to 100 % increase in productivity has been noticed in almost the entire region except in parts of West Bengal and eastern Uttar Pradesh were a spectacular increase in productivity of the order of 100 to 300 % has been witnessed. This may largely be due to an increase in irrigation facilities over the previous few years and practicing better crop management techniques along with the use of high yielding varieties.

It is difficult to interpret the variability of productivity on the agro-system basis, it is generally observed that low productivity of 1 t per ha have been mostly observed in semi-arid to dry sub-humid climate conditions, with LGP varying 90-120 to 120-150 days. The highest productivity of 2-3 t per ha are recorded in hot sub-humid to humid regions of West Bengal where LGP varies from 150 to 200 days. The productivity was of the order of 1-2 t per ha in hot sub-humid to humid regions of Assam, Orissa and West Bengal. Also the hot dry sub-humid climates in Uttar Pradesh and Bihar recorded the productivity of 1-2 t per ha. As the productivity data is the combined data of both irrigated and rain-fed crops, perhaps, the separation of irrigated crop yields from the original datasets may improve the interpretation in a better way in future studies.

REFERENCES

BISWAS, B. C. (1982) Agroclimatic classification on the basis of moisture availability index and its application to the dry farming tract of Gujarat,. *Mausam*. 3 , 4 465-469.

ENVIRONMENT SYSTEM RESEARCH INSTITUTE (ESRI) (1998) *Introduction to Arc View GIS*. ESRI, Redlands, C.A.

GANGOPADHYAYA, M. and SARKAR, R.P. (1965) Influence of rainfall distributation on the yield of wheat crop. *Agric. Meteorol*. 2, 331-350.

KAR, G. and VERMA, H.N. (2005) GIS based crop water management analysis for Eastern Ghats and costal region. *Indian Journal of Soil Cons*. 33, 1, 1-7.

KATYAL, J.C., NARAYANA REDDY, M. and VIRMANI, S.M. (1996b) *A case study on the spatial and temporal dynamic of area and productivity of sorghum and pigeonpea in India through GIS. The world Bank*- NARP Report on Resource Characterization of Rain-fed Farming Systems in Peninsular India. Hyderabad, India: CRIDA.

KULANDAIVELU, R. (1984) Probability analysis and its application in evolving cropping system for Coimbatore, *Mausam*. 35, 3, 257-258.

RAJENDRA PRASAD and DATAR, S.V. (1990) Qualitative agroclimatic assessment of rain-fed crops. *Mausam*, 41, 1, 65-68.

RAJ, SHAMMI and DEY, S.K. (2004) Spatial analysis of rainfall variability over the northeast with respect to rubber cultivation. *Journal of Agrometeorology* 6, 52-57.

RAMAN RAO, B.V (1997) *Agroecological based cropping strategies for topical rain-fed areas in India*. Lecture notes on training course on Agrometeorology aspects of agricultural production. February 1997, CRIDA, Hyderabad.

RAMAN RAO, B.V. KATYAL, J.C., U.S.VICTOR, SRIVASTAVA, N.N and VIJAYA KUMAR, P. (1993) Rainfall variability and its impacts on crop yields at Hyderabad-An agroclimatic case study. *Indian Journal of Dryland Agriculture Research and Development*. 8, 2, 98-108.

RAO, G.G.S.N. and RAJPUT, R.K. (1996) Rice Yields during kharif season as influenced by weather; [*in*] *Pro. Int. Sym. on water management in arid and semi Arid Zone HAU*, Hisar. pp100-108.

SASTRY, P.S.N.(1976) *Climate and crop planning with particular reference to the rainfall*. Proc.of the Symp. On Climate and Rice, IRRI. 51-63.

P.K.SINGH, L.S.RATHORE, K.K.SINGH, A.K.GUPTA, A.K.BAXLA and B. ATHIYAMAN.2008. Rainfall probability analysis using Markovchain model in Sabour region of Bihar. *Journal of Agrometeorology* 10, 2, 213-217.

SRIVASTAVA, N.N., VICTOR, U.S and RAMANA, RAO, B.V.1989. Commencement of growing session and productivity of groundnut in Rajkot district. *Mausam*, 40, 4, 399-402.

TORRO TORNADO DIVISION REPORT: September-October 2011

By PAUL R. BROWN and G. TERENCE MEADEN

Changeable westerly weather prevailed in September 2011 but high pressure produced a remarkable heatwave at the end of the month. Three tornadoes were recorded plus another in the Irish Republic, two of these beginning or ending as waterspouts; there was one other waterspout and three reports of funnel clouds. In October winds were mainly from between west and south apart from an anticyclonic spell in mid-month. There were two tornadoes, two waterspouts, one eddy whirlwind, and three reports of funnel clouds.

WS+FCs2011Sep04 *Dyfi Estuary, Merionethshire (c 52° 32’ N 4° 05’ W, SN 5995)*

John Mason of TORRO saw and photographed more than a dozen funnel clouds from the Dyfi Estuary this day, at least one of which appears to have reached the water surface; they formed, sometimes two or more simultaneously, over a period of an hour around 0900 GMT, dropping from a bank of Cumulus congestus lying southwest to northeast just off the coast. At 1200 GMT a low, 993 mb, was moving into western Ireland while a waving front lay north-south over eastern England. Between these two systems the weather was mainly dry.

FC2011Sep05 *Stornoway, Isle of Lewis, Ross & Cromarty (c 58° 13’ N 6° 21’ W, NB 4533)*

Stornoway Airport reported a funnel cloud in the vicinity in the 1450 GMT METAR. At 1200 GMT the previous day’s low from western Ireland had moved into the North Sea and become absorbed by a developing low, 998 mb, off northeast Scotland. Showers affected much of Britain while more persistent rain moved into Ireland ahead of a new warm front.

WS-TN2011Sep10 *Polruan, Cornwall (50° 20’ N 4° 38’ W, SX 123511 to SX 129515)*

John Pask of TORRO first heard about this on a local radio station, and an account was later published in the *Cornish Guardian* (14th September). The waterspout passed through the harbour in the Fowey Estuary during the evening, where it sank seven boats and capsized three; about 10 small tenders were also capsized and a yacht was blown from its mooring. A witness, Mr John Barley, said: “... all of a sudden there was a massive roar ... it sounded like the engine of an aeroplane ... I looked outside ... and then I realised it was a waterspout ...”. He gave the time as just before 9.45 pm (2045 GMT) but the assistant harbourmaster gave it as 2230 (2130 GMT). John Pask paid a visit to the area, but found no evidence of damage on shore. The track appears to have been about 700 m over water from near the old Blockhouse northeastwards to Penleath Point.

At 1800 GMT a large low, 970 mb, was centred west of Ireland and a returning maritime Polar airmass covered the British Isles; a shower trough crossed Cornwall in mid-evening. There were heavy showers on the trough and a scattering elsewhere.

FC2011Sep16/I *Maghera, County Derry (54° 50’ N 6° 41’ W, C 8500)*

David Smart of TORRO drew our attention to a photograph of a large ragged funnel cloud taken by Mr Martin McKenna at 1644 GMT.

At 1200 GMT a broad trough extended southeast across Ireland from a low, 991 mb, southwest of Iceland; an occluded front had recently cleared the east coast of Ireland.

There was a band of quite heavy rain on the front, and scattered showers behind it, which became more widespread and heavier over the north of Ireland later in the afternoon.

fc2011Sep16/II *Acomb, York, Yorkshire (53° 57' N 1° 08' W, SE 5751)*

Ms Laura Elliott sent in a report of a thunderstorm at 1800 GMT in which "clouds were moving fast towards each other making a funnel".

TN2011Sep17 *Lytham St Anne's, Lancashire (53° 45' N 3° 00' W, SD 340278)*

The Editor, Samantha Hall, was contacted by a lady who reported that two large brick walls had been blown down in Channing Road and Eddington Road at 0630 GMT. A site investigation by Ms Hall later confirmed that a short-lived tornado had occurred: witnesses saw 'a whirlwind going down the road' swirling bins and rubbish about; one of the walls that had come down was 1.5 metres high and 15 metres in length; twisted and broken branches were seen along the track, some roof tiles had been removed, and there was damage to a chimney stack. Force T1.

At 0600 GMT a low, 993 mb, was moving slowly east over the Hebrides and its occluded front was crossing the Irish Sea. The front was poorly defined by precipitation but there were showers in many western areas, some of them heavy and thundery (especially over Lancashire about the time of the tornado).

TN2011Sep21 *Maybole, Ayrshire (55° 21' N 4° 42' W, NS 285102)*

BBC Scotland reported that nine caravans had been blown over by the wind at the Ranch Caravan Site at Maybole at 1120 GMT; two people received minor injuries. Witnesses described the gust as a 'whirlwind'. Dave Hancox of TORRO visited the site on the 23rd, and the conclusion was that the damage had probably been caused by a tornado of less than one kilometre length and width about 20 metres. Force T3.

At 1200 GMT a low, 980 mb, was slow-moving near the Faeroe Islands and a cold front was moving east across Scotland and Ireland. The tornado evidently occurred on this front, which had just cleared Ayrshire at 1200 GMT. There was a band of quite heavy showers on the front, some orographic rain ahead of it, and further showers behind.

FC2011Oct06 *Chartham Hatch, Kent (51° 16' N 1° 01' E, TR 1056)*

Ms Stefanie Hambrook sent in a report of a funnel cloud seen over Chartham Hatch (time of day not stated). At 1200 GMT a brisk west to northwesterly airstream covered the British Isles associated with a large low, 975 mb, in the Norwegian Sea. Showers, some of them thundery, were widespread in the north and west but much more isolated elsewhere.

EW2011Oct17 *Carlingford Lough, County Down (54° 04' N 6° 12' W, J 1815)*

A report on *Ulster Television News* included film of an eddy whirlwind (known locally as the 'Carlingford kettle') over Carlingford Lough, taken by Mr Matthew McGrath at Killowen at about 1300 GMT.

At 1200 GMT a low, 977 mb, was slow-moving near the Faeroe Islands; a shallow but rapidly deepening frontal wave was moving quickly northeast across Ireland, the cold front of which crossed Down between 1300 and 1400 GMT before moving across southern Scotland and northern England later in the afternoon, accompanied by a narrow band of heavy rain.

TN2011Oct17/I *Whitehaven, Cumbria (54° 32' N 3° 35' W, NX 975166 to NX 980170)*

The *News and Star* of the 18th October reported that a 'tornado' had removed the roof of the Tamalder Nursery School, in Meadow Road, Mirehouse; the roof landed on a motor car, damaging it beyond repair. A witness, Mr Ryan Tegg, said: "It picked up everything in the yard, pebbles and stuff off the floor, it was just like a twister. As quickly as it came it had gone. Then we heard a massive bang ... Then a woman came running out of the nursery screaming saying the roof has come off and there are kids inside". In a separate report, Ms Kristen Maudling from Cockermouth informed us of severe winds associated with a hailstorm at 1530-1545 GMT.

Clifford Rowley of TORRO and a local member of the UKweatherworld, Ms Tina Clark, investigated the scene on the 21st and confirmed that a tornado had occurred at about 1540 GMT. Evidence of twisted trees was found at the cemetery, and there was a clear path of damage to roofs and gardens from there in a northeasterly direction to Meadow Road, thence to Esk Avenue, a distance of 0.6 km. Force T1-2. (They also went to Cockermouth but found no evidence of a tornado there.)

TN2011Oct17/II *Templand, Dumfriesshire (55° 10' N 3° 26' W, c NY 084861)*

The *Dumfries and Galloway Standard* (21st October) reported that a tornado had passed over Templand just after 1500 GMT on Monday. Eight houses were damaged, including that of Helen Davison and Graeme Davison in Main Road, where tiles were removed from the roof, damaging parked motor cars as they fell, and the garden shed and greenhouse were also badly damaged. Mrs Davison said: "We heard a noise and my husband said 'that's the roof' and I told him not to be stupid. We went to the window to have a look and we could see a funnel. Things were blowing everywhere". Force T1.

FCs2011Oct25/I *Plymouth, Devon (50° 23' N 4° 08' W, SX 4855)*

This funnel cloud was reported on local television and in the *Plymouth Herald* of the 26th October, where it was said to have been photographed over North Hill, but we have not seen the picture (the television account suggested there was more than one funnel). The time of day is unknown.

At 1200 GMT a complex low, 976 mb, was centred west of Ireland and a returning maritime Polar airmass with shower troughs covered most of Britain (except the far northeast). There were scattered, locally heavy, showers, some of which turned thundery later.

2FC2011Oct25/II *Middle Wallop, Hampshire (c 51° 09' N 1° 34' W, SU 3039)*

The 1250 GMT METAR from Middle Wallop Airfield reported 'funnel cloud in the vicinity', and a photograph received via the Meteorological Office, although of poor quality, appears to show two simultaneous funnels.

WS2011Oct25 *Bexhill, East Sussex (c 50° 50' N 0° 28' E, TQ 7406)*

The BBC showed a picture of a long tapering funnel cloud reaching nearly to the sea, with disturbance of the water surface beneath it. It was photographed by Mr Neil Cunningham just after 1500 GMT and lasted about five minutes. The report was repeated in the Argus of the 26th October, which included several other pictures.

WS2011Oct26 *Ventnor, Isle of Wight (c 50° 35' N 1° 13' W, SZ 5677)*

The *Isle of Wight News* internet site published a photograph of a waterspout taken by Mr Barry Grant in the morning.

The picture shows a funnel descending from a shower cloud and disturbance of the sea surface beneath it. At 1200 GMT the previous day's low, now 984 mb, was still west of Ireland and an unstable southwesterly airstream continued to affect most of Britain. There were showers, locally thundery, on windward coasts, some of which spread inland.

Tornado in the Irish Republic

TN-WS2011Sep16 *Clogherhead, County Louth (53° 47' N 6° 15' W to c 53° 51' N 6° 14' W, O 154835 to circa O 1690)*

Following a rather vague initial report of this event, Dr John Tyrrell of TORRO conducted a site investigation which confirmed that a tornado began on the southwestern edge of Clogherhead and moved approximately north before passing out to sea as a waterspout. Much of the damage was to gardens and was of a minor nature, but in the north of the village it lifted and destroyed a newly-built pigeon loft, indicating a force of T2. Its track from there to the coast was marked by debris that had been carried from the village, and it was then observed passing over the sea, first in a northnortheast direction, finally turning to the northnorthwest; the total track over land and sea was about 7 km. The time was not stated directly but appears to have been about 1000 GMT. (See the *Maghera* entry above for the synoptic situation.)

WEATHER STATION READINGS IN BERGENFIELD NEW JERSEY, NEW YORK, USA: JULY 2011

By RUDY NICKMANN

July was hot and dry in Bergenfield. The average temperature of 79.5 °F (26.4 °C) was the third highest recorded since 1983 and 4.2 °F (2.3 °C) above the long-term average. Only July 1999 and 2010 saw warmer July temperatures. Maximum readings topped 90 °F (32.2 °C) on 17 days. The 21st, 22nd and 23rd each set a new daily high temperature record, peaking at 104 °F (40.0 °C) on the 22nd. This heat was accompanied by high levels of humidity leading to a dangerously elevated heat-humidity index. This month will be remembered its uncomfortable tropical-like conditions. Precipitation was about 40% of normal. I measured a total of 1.87" (47.5 mm).

	ENGLISH UNITS								METRIC UNITS				
	TEMPERATURE			PRECIPITATION			WIND		TEMPERATURE			PRECIP	
DAY	MAX	MIN	AVG	RAIN	SNOW	SC	GUST	DIR	MAX	MIN	AVG	RAIN	SNOW
1	84	57	71				13	NE	28.9	13.9	21.4		
2	89	62	76				12	NW	31.7	16.7	24.2		
3	76	69	73	0.29			10	SSE	24.4	20.6	22.5	7.4	
4	89	70	80				14	WNW	31.7	21.1	26.4		
5	90	62	76				16	WNW	32.2	16.7	24.4		
6	93	66	80				19	SSE	33.9	18.9	26.4		
7	90	70	80	T			13	SE	32.2	21.1	26.7	T	
8	86	68	77	0.33			14	ESE	30.0	20.0	25.0	8.4	
9	89	67	78				17	NW	31.7	19.4	25.6		
10	89	62	76				11	SE	31.7	16.7	24.2		
11	94	68	81				20	WSW	34.4	20.0	27.2		
12	95	78	87				19	WNW	35.0	25.6	30.3		
13	88	68	78	0.03			29	WNW	31.1	20.0	25.6	0.8	
14	85	62	74				17	NW	29.4	16.7	23.1		
15	88	62	75				12	SW	31.1	16.7	23.9		
16	92	64	78				13	WNW	33.3	17.8	25.6		
17	94	69	82	T			15	WSW	34.4	20.6	27.5	T	
18	97	75	86				18	WNW	36.1	23.9	30.0		
19	93	74	84				11	NE	33.9	23.3	28.6		
20	92	71	82				14	SE	33.3	21.7	27.5		
21	101	75	88				17	SSW	38.3	23.9	31.1		
22	104	82	93				15	WNW	40.0	27.8	33.9		
23	98	79	89				16	WNW	36.7	26.1	31.4		
24	90	79	85	T			14	WSW	32.2	26.1	29.2	T	
25	79	68	74	0.32			13	SE	26.1	20.0	23.1	8.1	
26	92	68	80	0.30			16	W	33.3	20.0	26.7	7.6	
27	86	63	75				16	NW	30.0	17.2	23.6		
28	88	66	77				11	SE	31.1	18.9	25.0		
29	86	71	79	0.60			11	SW	30.0	21.7	25.8	15.2	
30	93	70	82				17	NW	33.9	21.1	27.5		
31	92	65	79				11	WNW	33.3	18.3	25.8		
AVG	90.4	68.7	79.5						32.4	20.4	26.4		
SUM				1.87								47.5	
MAX	104	82	93	0.60			29	WNW	40.0	27.8	33.9	15.2	
MIN	76	57	71						24.4	13.9	21.4		

Weather station data for Bergenfield, New Jersey, USA.
Note, peak gusts are shown in mph.
**SC = Snow Cover.*

WEATHER AND ME

MICHAEL BATH

(http://www.lightningphotography.com/)

Personal Info
DOB 21 Mar 1967, Married to Alison, daughter Katrina 20, son David 14.

Born Melbourne, Victoria, family moved to Ballina, NSW at the beginning of 1981. I was 14 at the time and started year nine at Ballina High School.

At school I got involved in the school magazine through a new friend developing photos using a darkroom setup. I was not the photographer for that but soon started to use my father's film SLR camera. I didn't seem to be interested in typical shots, rather night time pictures (I had a fascination with astronomy for many years) and time exposures - pictures of fireworks, night time street scenes - that sort of thing. At the same time, geography classes led to my interest in meteorology - in particular tropical cyclones and rainfall events as they impact the region where I live.

It wasn't until college years where I completed an Associate diploma in business computing that I became obsessed with both the weather and photography. In 1987 two major floods hit the city of Lismore (about 30ks inland from Ballina). The CBD was completely inundated

Plate 1. Inundation of flooding in Lismore. More photos can be found at: http://australiasevereweather.com/photography/photos/1987/

I used the camera to document that event then just had to work out what causes floods. That led to research into all the floods that have hit Lismore. A work in progress is here: http://australiasevereweather.com/floods/

So I soon built up a great knowledge of severe weather that causes floods. I researched from the Bureau of Meteorology and local newspaper article archives. I also started tracking all tropical cyclones:

http://australiasevereweather.com/cyclones/

But it wasn't enough. Now that I was hooked on severe weather, the odd flood and cyclone was just too infrequent. Fortunately, the Northern Rivers region of Northeast NSW is a hotspot for thunderstorms during the warmer months. So I started watching and photographing storms in late 1988. My first attempt at lightning photography was a success and I was hooked for life.

Plate 2. My first ever lightning photograph taken in Balina, NSW on 2 December 1988, more including this one can be found here: http://www.lightningphotography.com/lightning/lightning0003.html

I had to move to Sydney for work (computer programmer) in January 1989. That gave me the opportunity to learn more weather as I was able to visit the Sydney Bureau of Meteorology office. Sydney also gets lots of thunderstorms so the passion for lightning and weather photography grew.

Alison and I were married in Sep 1989 and moved to a unit which had a massive view of the sky - fantastic! Easy to point the camera at the ever changing sky canvas from there.

We moved to the western suburbs of Sydney in March 2001 to be closer to Alison's school as a teacher. The views had diminished but the western parts of Sydney get far more thunderstorms. I attended a Bureau of Meteorology storm spotter training session mid 1993 and met Jimmy Deguara. He was just as obsessed with storms and wanted to chase them. Fortunately he lived only a few suburbs away - which was lucky given the massive size of Sydney.

I also attended weather meetings run by AMOS. I made contacts at Macquarie University where the meetings were held and this also opened up the internet quite early to me in late 1995. My thunderstorm and storm chasing related newsletter Storm News also began mid 1995.

The internet certainly opened up opportunities and provided a massive hit of weather data that I'd never been able to see before. I set up Lightning Photography website in May 1996 and Jimmy and I established Australian Severe Weather (ASW) website towards the end of that year. ASW grew quickly as our storm chasing reports and weather photography were added.

The Aussie-weather email-based discussion group was set up in 1998. This was a turning point in finding and communicating with other weather enthusiasts from around the country. Several keen members of the list met in Sydney and soon established the Australian Severe Weather Association. Weather discussion is still going on the email list but also on several web-based forums and Facebook.

http://forum.weatherzone.com.au/

Alison got a transfer to a school in Lismore in early 1999 so that was our ticket back to the country and the great storm chasing areas of NE NSW. I finished my programming work and soon got a job monitoring the media from home. We lived at Wollongbar for a year before building a home on acreage at McLeans Ridges. Webcam view here: http://australiasevereweather.com/video/webcam.htm.

Plate 3. View from webcam at 0329 hrs taken from a UK computer!

During 2003 I became a member of the NSW State Emergency Service - not in a rescue role but as weather adviser to the Richmond Tweed division headquarters. The division looks after 11 SES units covering the Tweed, Brunswick and Richmond river areas and also the upper Clarence River - basically all of the Northern Rivers region north of Grafton and the northeast part of the Northern Tablelands.

In October 2007 the city of Lismore was hit by a massive hailstorm then two weeks later the nearby village of Dunoon was struck by a tornado. Shortly after this an article appeared in the local newspaper about a Gold Coast business recently set up to provide early warnings of thunderstorm threats via text message. My media job was coming to an end so I contacted the Early Warning Network and managed to get a job. It suited me perfectly: monitoring severe weather around the country and issuing alerts to people, some website work and programming. I now had a job that matched what I did in my free time!

I continue to chase thunderstorms, floods and Northern Tablelands snow (bit of a novelty when you live 20 mins away from the beaches of Byron Bay) whenever possible and with a couple of other guys who live nearby.

I've chased tornadoes in Tornado Alley USA in 2010 and am also headed out there this spring for more.

I never undertook any formal training in meteorology or photography - all my skills are self taught with severe weather and lightning photography my passion.

© THE INTERNATIONAL JOURNAL OF METEOROLOGY
January/February 2012, Vol.37, No.367

BOOK REVIEWS

By PETER ROGERS

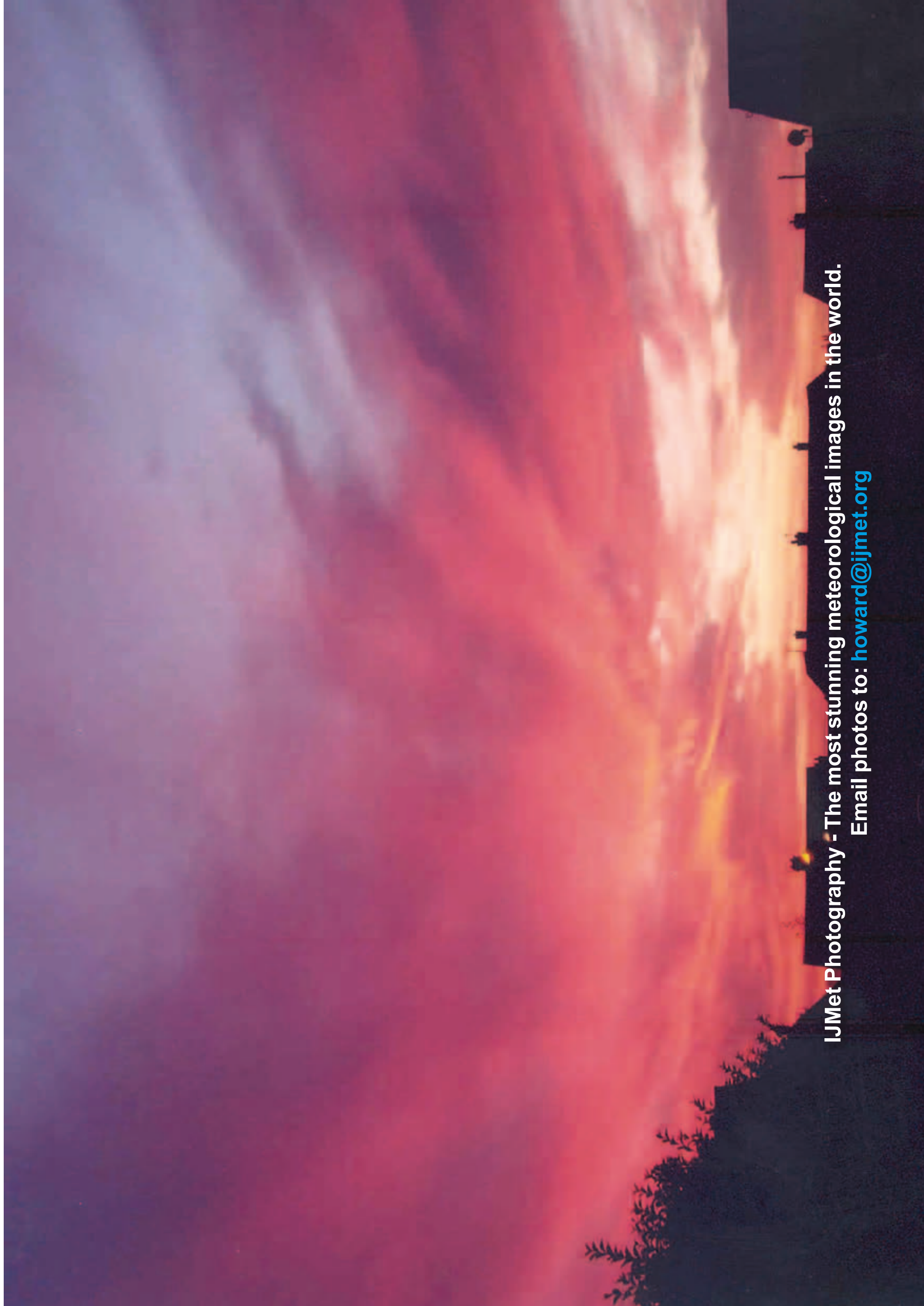
FROZEN BRITAIN by Ian McCaskill and Paul Hudson ISBN 978 1905080 98 4. (2011) *Great Northern Books*, PO Box 213, Ilkley, LS 29 9WS pbk pp160 £12.99.

In 2006, the authors produced a hard-back called, **"Frozen in Time: the Years When Britain Shivered"** which described "The Worst Winters in History"; "The Snowiest Winter-1947"; "The Coldest Winter 1962/63" and "The Winter of Discontent " which covered the severe winter of 1978/79. The book described each winter in vivid detail and was illustrated with excellent black and white photographs. Now, five years later, the same authors have produced a paper-back edition, which however is much more than a mere reprint. For, although the text seems to have been minimally altered, some of the photographs have been reproduced in a larger format which makes them even more impressive, and others have been replaced. Far more importantly, however, the authors have added an entirely new chapter covering the severe winters of 2009/10 and 2010/11, this time illustrated with equally vivid colour photographs. Interestingly, the final chapter in the hardback, which was entitled "Epilogue: Could it Happen Again?" has been renamed "Epitaph: How Often Will it Happen Again?", and of course, entirely re-written.

When I reviewed the hard-back, I was very enthusiastic, highly recommending it, and I have no hesitation in being equally enthusiastic about this sequel. Apart from anything else, five years on, this edition (admittedly in paperback) retails at £3 less than its predecessor! Even if you bought the hard-back, it is well worth buying the paperback which could hardly be more up-to-date.

AMENDMENTS AND APOLOGIES TO *Issue 36, 366, December 2011*

The photographs credited to Howard Kirby (*Lenticulars over Black Mountains)* Should have been credited to © Peter Kirk. n addition, a few mistakes got through the printing process. I full regret these mistakes and sincerely apologise for the oversights. Thank you. *Samantha Hall*.



www.ijmet.org
See all photos and charts in colour: www.ijmet.org/online

"An international magazine for everyone interested in weather and climate, and in their influence on the human and physical environment."

ISSN 1748-2992