Adapting to Climate Change:
Guidance for Flood and Coastal Erosion Risk Management Authorities in Wales

December 2017
This guidance has been prepared by Natural Resources Wales on behalf of the Welsh Government. Its purpose is to assist Risk Management Authorities in Wales consider the impacts of climate change when planning and developing flood and coastal erosion risk management projects and strategies.

For enquiries please contact the Flood and Coastal Erosion Risk Management team, within the Welsh Government by emailing: Floodcoastalrisk@gov.wales
Contents

1 Introduction .................................................................................................................. 1

2 Transitional arrangements .......................................................................................... 3

3 Provision of climate change allowances ....................................................................... 5
   3.1 Scheme Design ....................................................................................................... 5
   3.2 Sensitivity Testing ................................................................................................. 6

4 Limitations and Managing Exceptions .......................................................................... 6

Annex 1 .............................................................................................................................. 7

Climate Change Allowances ............................................................................................ 7
   1. Changes to river flood flows by river basin district .............................................. 7
   2. Change to extreme rainfall .................................................................................... 8
   3. Change to relative mean sea levels ....................................................................... 9
   4. Change to storm surge .......................................................................................... 10
   5. Change to wave climate ....................................................................................... 10

Annex 2 .............................................................................................................................. 12

Worked Examples ............................................................................................................. 12
   1. Fluvial Example .................................................................................................... 12
   2. Tidal Example ....................................................................................................... 13

References: ....................................................................................................................... 15
1 Introduction

This guidance is provided as supplementary information to the Welsh Government’s forthcoming Flood and Coastal Erosion Risk Management (FCERM) Business Case Guidance.

It replaces the 2011 version of ‘Adapting to Climate Change: Guidance for Flood & Coastal Erosion Risk Management Authorities in Wales’. It also supports the National Strategy for Flood and Coastal Erosion Risk Management in Wales (2011) and should be used to consider climate change within the development of all flood and coastal erosion risk management (FCERM) projects or strategies.

For river flood flows, extreme rainfall and storm surges, this guidance reflects an assessment of UKCP09 data undertaken by the Environment Agency between 2013 and 2015, which produced more representative climate change allowances for England and Wales.

As a result of this assessment, there have been no changes to the climate change allowances for wave height, storm surge or peak rainfall intensity. There have however been small changes to peak river flow allowances in the three River Basin Districts that cover Wales. The 50th (Central) and 90th (Upper) percentiles are presented in this guidance. Please note: the 50th (Central) percentile was previously referred to as the ‘change factor’ in earlier versions of this document.

The science behind climate change projections for sea level rise has changed substantially since the publication of UKCP09, which has led to greater confidence in projections of global mean sea level. For this reason, the Met Office recommended that users avoid using UKCP09 for sea level rise climate change allowances. The projections presented in this guidance therefore do not reflect UKCP09 data (based on the Intergovernmental Panel on Climate Change (IPCC) fourth assessment report, 2007), but are consistent with the latest global sea level rise predictions and the IPCC Fifth Assessment Report (AR5; IPCC, 2013) (Met Office, 2016).

Given the long lifetime and high cost of the built environment and many FCERM measures, it is imperative that plans and investment projects consider, in an appropriate way, the changing risks over the coming century. This includes accommodating adaptation to a changing climate where appropriate.

There are two approaches for managing climate change:

- Managed Adaptive
- Precautionary Approach

Guidance on how to apply these approaches can be found in the Environment Agency’s 2010 Flood and Coastal Erosion Risk Management Appraisal Guidance

---

2 http://ukclimateprojections.metoffice.gov.uk/media.jsp?mediaid=88739&filetype=pdf
Adapting to Climate Change: Guidance for Flood and Coastal Erosion Risk Management Authorities

(FCERM-AG), as well as the Welsh Government’s forthcoming FCERM Business Case Guidance.

Please note: The climate change allowances presented in this revised guidance align with those provided by the Welsh Government for use in Flood Consequence Assessments submitted in support of relevant planning applications and to inform development plan allocations.

1.1 Schemes requiring Flood and Coastal Erosion Risk Management Grant Funding

The purpose of this advice is to ensure that economically credible business cases, which are consistent in their application of the uncertainties associated with climate change, can be made to support Welsh Government investment decisions. This will ensure sustainable investment decisions which align with the aspirations of the Wellbeing of Future Generations Act.

This advice is specifically intended for projects or strategies seeking Welsh Government FCERM Grant Funding. However, Risk Management Authorities (RMA) in Wales may also find this information useful in developing plans and making FCERM investment decisions even if there is no intention of applying for central government funding.

A Risk Management Authority may decide to recommend an investment decision that is not based on the climate change allowances in this advice. However, where a FCERM Grant Funding contribution is being sought the investment business case supporting the application must develop at least one option based on the advised climate change allowances. This is required to demonstrate the implications of using alternative climate change allowances which may influence the outcome of the application. Such an approach also ensures that the implications of alternative approaches to risk assessment and management can be more consistently compared and communicated.

It is recommended that RMAs making FCERM investment decisions which do not attract grant funding also follow this approach.

---

2 Transitional arrangements

This advice should be applied to all new business cases from December 2017.

For business cases, which are already in development Table 1 below explains how and when to apply the revised allowances provided in this guidance. This is required to ensure the revised figures would not lead to different decisions.

Any queries regarding the application of this guidance during the transitional period should be directed to Welsh Government Flood and Coastal Risk Branch.

<table>
<thead>
<tr>
<th>Scheme Development Stage</th>
<th>Assumption</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCERM-AG / FCDPAG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• New PAR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• PAR in development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• New Business Case</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• SOC/OBC in development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Hydraulic Modelling/Economic Appraisal work not yet commenced.</td>
<td>Appraise scheme using the revised allowances within this guidance document.</td>
<td></td>
</tr>
<tr>
<td>• PAR Completed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Detailed Design in Development</td>
<td>Economic Appraisal completed in OBC using climate change allowances from 2011 guidance.</td>
<td>Assess preferred option against revised allowances within this guidance to ensure that results would not lead to significantly different decisions at Detailed Design stage. Undertake Detailed Design using revised allowances if work not too far progressed to allow this.</td>
</tr>
<tr>
<td>• Detailed Design Complete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Scheme Construction Ready</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Detailed Design completed using allowances from 2011 guidance.</td>
<td>Consider the implications of using the revised allowances within this guidance and report any significant findings to the relevant funding authority.</td>
<td></td>
</tr>
<tr>
<td>• Existing approved plans and strategies</td>
<td>Plans or Strategies are subject to ongoing review process.</td>
<td>At next review, appraise plan or strategy using the revised allowances within this guidance document.</td>
</tr>
</tbody>
</table>

Table 1 - Use of revised climate change allowances at each stage of the 5BCM

SOC – Strategic Outline Case
OBC – Outline Business Case
PAR – Project Appraisal Report
FCDPAG – Flood and Coastal Defence Project Appraisal Guidance – 2001
FCERM-AG – Flood and Coastal Erosion Risk Management Appraisal Guidance 2010
**Please note:** Climate change projections are currently being reviewed through the UKCP18 project. Outputs from this project will become available over the next couple of years, however in the interim, the allowances presented in this guidance should be used.
3 Provision of climate change allowances

What are the climate change allowances?

To assess the potential impact of climate change on extreme rainfall, river flood flows, sea level rise and storm surges, climate change allowances are provided in Annex 1. These allowances quantify the potential change (as either mm or percentage increase, depending on the variable) to a 1961-90 baseline.

Given the complexity of the science around climatic projections, there continues to be significant uncertainties attributed to climate change allowances. For this reason, climate change allowances are presented as a range of possibilities (Central and Upper) to reflect the potential variation in climate change impacts over three epochs from the present day to 2115 and beyond.

It is recommended that the long-term sustainability and resilience of flood risk management options are assessed against these allowances covering the whole of the decision lifetime, rather than base options solely on the central estimate.

The focus of this document is to inform the design and resilience of flood and coastal risk management schemes, which should consider credible and reasonable climate change impacts.

Climate change allowances for river flood flows, extreme rainfall, mean relative sea level rise and wave climate are provided in the relevant tables in Annex 1.

Please note: the values for fluvial flows and sea level rise have changed from those presented in the previous guidance.

3.1 Scheme Design

For river flood flows, extreme rainfall and storm surge, this advice provides the Central (50th percentile) and Upper (90th percentile) climate change allowances.

Fluvial risk management schemes should be designed to the Central Allowance (formerly referred to as the ‘change factor’ in previous versions of this document) presented in Table 2 (Annex 1).

Coastal risk management schemes should be designed to the single regional allowance for Wales presented in Table 7 (Annex 1), which is consistent with the latest global projections for sea level rise.
3.2 Sensitivity Testing

The Welsh Government recommend that a full appreciation of climate uncertainty is considered when planning and designing FCERM schemes. Appropriate sensitivity testing against potential future climate change impacts will help RMAs to determine and plan for appropriate mitigation measures within the scheme design (e.g. through a strategy for managed adaptation) – thereby encouraging the use of managed adaptation.

For fluvial risk management schemes, sensitivity testing should be undertaken against the Upper Allowance (90th percentile) to consider longer term sensitivity to future climate change impacts. (See Section 2, Annex1)

For sea level rise, the low probability extreme scenario (H++) is provided to help RMAs understand the potential extent of the future risks. Additional sensitivity testing is not normally required for sea level rise. (See Section 3, Annex1)

Annex 2 of this advice provides examples for both fluvial and coastal flood risk management proposals to guide RMAs through the process of considering climate change impacts. This should help RMAs make full use of the information from Annex 1.

4 Limitations and Managing Exceptions

The climate change allowances provided have been derived from national scale research. There may be cases where local evidence supports the use of other local change factors. In such cases decision makers may use alternative change factors where robust science supports this. Where national grant funding is being sought, the Welsh Government will need to be satisfied that the science is indeed sufficiently robust to support such an exception.

It will be up to the RMA to consider the most appropriate local evidence and justify exceptions on a case-by-case basis. The rationale for using other data and the implications should be transparent and recorded within the plan or investment decision documentation.
Annex 1
Climate Change Allowances

1. Changes to river flood flows by river basin district

The information provided in Table 2 is derived for change to river flow likelihood of a 1 in 50 (2%) chance of occurring in any year. For extrapolation of these projections to other events, the research suggested that the regional allowances are likely to remain relatively constant with increasing return periods.

The climate change allowances provided correspond to the central estimate of change from the research. The projections are percentage changes to a 1961-90 baseline.

<table>
<thead>
<tr>
<th></th>
<th>Total potential change anticipated for the 2020s (2015 to 2039)</th>
<th>Total potential change anticipated for the 2050s (2040 to 2069)</th>
<th>Total potential change anticipated for the 2080s (2070 to 2115)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Severn</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper (90th)</td>
<td>25%</td>
<td>40%</td>
<td>70%</td>
</tr>
<tr>
<td>Central (50th)</td>
<td>10%</td>
<td>20%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>West Wales</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper (90th)</td>
<td>25%</td>
<td>40%</td>
<td>75%</td>
</tr>
<tr>
<td>Central (50th)</td>
<td>15%</td>
<td>25%</td>
<td>30%</td>
</tr>
<tr>
<td><strong>Dee</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper (90th)</td>
<td>20%</td>
<td>30%</td>
<td>45%</td>
</tr>
<tr>
<td>Central (50th)</td>
<td>10%</td>
<td>15%</td>
<td>20%</td>
</tr>
</tbody>
</table>

Table 2: Changes to river flood flows by river basin district (use 1961-90 baseline)

The illustration provided in Figure 1, shows how the projections for changes in river flow may be plotted and used in typical assessments.
Adapting to Climate Change: Guidance for Flood and Coastal Erosion Risk Management Authorities

1.1 H++ limits

The H++ scenario provides an estimate of river flood flow change beyond the Upper allowance. This is beyond the likely range but within physical plausibility. However, there is no current requirement to undertake sensitivity testing against the H++ scenario for fluvial risk management schemes in Wales.

Although research has shown that a very small number of modelled catchments within each river basin district in Wales show significantly greater increases to river flood flows than the standard catchment, it is not possible to say how likely the H++ scenario is. Furthermore, we are not yet able to provide guidance to help RMAs determine whether they may be managing a non-standard catchment.

2. Change to extreme rainfall

Although qualitative statements can be made as to whether extreme rainfall is likely to increase or decrease over the UK in the future, there is still considerable uncertainty regarding the magnitude of these changes locally. UKCP09 provides useful information on change to rainfall across the UK accessible through the user interface. This information is most robust for more common events such as changes to the wettest day of a season.

Typically, for flood management purposes the concern is less frequent (but greater impact) events such as those that have a 1 in 20 annual chance of occurring or rarer. Developing quantitative predictions of future changes for such extreme rainfall at the local scale remains a key challenge for climate scientists.

Only maximum daily total rainfall data have been considered from the climate model projections. Although it is not possible to know how rainfall at hourly...
timescales may change, it is recommended that changes to rainfall intensity presented in Table 3 are used as the best available estimate.

<table>
<thead>
<tr>
<th>Applies across all of Wales</th>
<th>Total potential change anticipated for 2020s (2015-2039)</th>
<th>Total potential change anticipated for 2050s (2040-2069)</th>
<th>Total potential change anticipated for 2080s (2070-2115)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper estimate</td>
<td>10%</td>
<td>20%</td>
<td>40%</td>
</tr>
<tr>
<td>Central estimate</td>
<td>5%</td>
<td>10%</td>
<td>20%</td>
</tr>
</tbody>
</table>

**Table 3 - Change to extreme rainfall intensity compared to a 1961-90 baseline**

As with river flood flows, it is recommended that the 2080s changes are used when considering any time beyond 2115. These ranges should be used in assessments in a similar way to the illustration (Figure 1) set out for river flows.

The peak rainfall intensity ranges should be used for small catchments and urban/local drainage sites. For river catchments over 5km², the peak flow ranges should be used.

3. **Change to relative mean sea levels**

A single regional allowance for the annual change for the Welsh coastline is presented in Table 4. It is recommended that RMAs use these figures for their investment decisions. These projections are consistent with the latest global predictions for sea level rise. The rate of change is projected to increase in each epoch.

Projections beyond 2115 should be derived by extrapolating beyond 2115.

<table>
<thead>
<tr>
<th></th>
<th>Sea level rise mm/yr up to 2025</th>
<th>Sea level rise mm/yr 2026 to 2055</th>
<th>Sea level rise mm/yr 2056 to 2085</th>
<th>Sea level rise mm/yr 2086 to 2116</th>
</tr>
</thead>
<tbody>
<tr>
<td>H++ scenario</td>
<td>6</td>
<td>12.5</td>
<td>24</td>
<td>33</td>
</tr>
<tr>
<td>Annual change (mm/yr)</td>
<td>3.5</td>
<td>8.0</td>
<td>11.5</td>
<td>14.5</td>
</tr>
</tbody>
</table>

**Table 4 - Mean sea level allowance (compared to 1990 baseline, includes land movements)**

*Table 4 also provides the H++ scenario as presented within the UKCP09 marine report to provide users with estimates of sea level rise increase beyond the likely range but within physical plausibility.*

It is envisaged that only where the consequences of flooding or erosion could be extreme would the H++ scenario need to be considered within assessments for sensitivity purposes covering the period to 2115.
4. Change to storm surge

As well as a global increase to Mean Sea Level, climate change is expected to change weather patterns, with an increase in the frequency and magnitude of severe weather events, including storm surge. Storm surge can be defined as ‘the temporary and localised increases in sea level above that of the predicted tide which occur during such weather systems’. They can vary from a few centimetres in height to several metres, depending on the severity of the weather event and can often lead to coastal flooding if they coincide with a high tide. As climate change is expected to increase the likelihood of stormy weather, storm surges are also anticipated to become larger for any given return period. However, the changes at this time are considered to be marginal and in many locations cannot be distinguished from natural variability1.

There is also still considerable uncertainty associated with future storm surge modelling. Given this uncertainty, coupled with the negligible predicted increases, there is no current requirement at this time to incorporate an allowance for increased storm surge when estimating design flood levels for future scenarios.

5. Change to wave climate

Change to wave climate is presented within UKCP09. There are large uncertainties in wave climate especially with the projected extreme values.

Projections of changes to wave climate in UKCP09 are given for return periods up to 50 years. Projections of longer return period wave heights will reflect the same pattern of change but with larger error bars. Changes in wave period and direction are small and more difficult to interpret.

Due to the significant uncertainty both to the future position of the storm track over the UK and the projections of wave climate within UKCP09, it is recommended that RMAs employ a sensitivity analysis to understand the impact on flood risk and coastal change, and the form of any feasible options. Recommended national precautionary sensitivity ranges for offshore wind speed and wave height are presented in Table 5.

1 Around the UK the size of surge expected to occur on average about once in 50 years is projected to increase by less than 0.9mm/yr over the 21st century. In most locations this trend cannot be distinguished from natural variability” (UKCP09 Marine & Climate Change Predictions Report June 2009)
Table 5 - Recommended national precautionary sensitivity ranges for offshore wind speed and wave height.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>1990-2025</th>
<th>2025-2055</th>
<th>2055-2085</th>
<th>2085-2115</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offshore wind speed allowance</td>
<td>+5%</td>
<td></td>
<td>+10%</td>
<td></td>
</tr>
<tr>
<td>Extreme wave height allowance</td>
<td>+5%</td>
<td></td>
<td>+10%</td>
<td></td>
</tr>
</tbody>
</table>

Please note: Wave climate is not being assessed under UKCP18. These figures are not expected to change in the foreseeable future.
Annex 2
Worked Examples

This annex provides worked examples for applying climate change projections in Flood and Coastal Erosion Risk Management

The quantified information provided in Annex 1 sets out the climate change allowances to use when assessing future flood or coastal risks and uncertainty arising from climate change. The following fluvial and tidal examples are provided to support Annex 1 and the wider principles set out within the guidance.

1. Fluvial Example

The example below provides guidance on how to apply the climate change allowances set out in Annex 1 for a proposed flood alleviation scheme within the West Wales River Basin District.

1. Derive site specific flood hydrology following the latest methods and completing NRW’s proforma (available on the NRW website).

2. Apply the appropriate increases based on epochs of interest.

3. Test these against the upper bound increases to understand possible future impacts and scheme sensitivity to acceleration of climate change.

4. Use selected hydraulic model method to create flood extents, depths, etc

<table>
<thead>
<tr>
<th>Study Year</th>
<th>2017</th>
<th>Selected Increase for all Annual Exceedance Probabilities</th>
<th>Design Flow</th>
<th>Sensitivity or Mitigation testing for upper bound</th>
<th>Design Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ 20 years</td>
<td>2037</td>
<td>+15%</td>
<td>213 cumecs</td>
<td>+25%</td>
<td>231 cumecs</td>
</tr>
<tr>
<td>+ 50 years</td>
<td>2067</td>
<td>+25%</td>
<td>231 cumecs</td>
<td>+40%</td>
<td>259 cumecs</td>
</tr>
<tr>
<td>+ 75 years</td>
<td>2092</td>
<td>+30%</td>
<td>241 cumecs</td>
<td>+75%</td>
<td>324 cumecs</td>
</tr>
<tr>
<td>+ 100 years</td>
<td>2117</td>
<td>+30%</td>
<td>241 cumecs</td>
<td></td>
<td>324 cumecs</td>
</tr>
</tbody>
</table>

Table 6 - Example Cumulative Fluvial Increase Calculation

Adapting to Climate Change: Guidance for Flood and Coastal Erosion Risk Management Authorities
2. Tidal Example

The example below provides guidance on how to apply the climate change allowances set out in Annex 1 for a tidal design level.

1. Determine required return period / standard of protection for defence e.g. 1:200yr.

2. Obtain appropriate tide level estimate for location being assessed from “coastal flood boundaries” dataset \(^1\) e.g. T\(_{200} = 6.15\)m AOD.

3. Determine epoch for climate change (i.e. defence life) e.g. 75 years (2092).

4. The base year for the extreme sea levels from “coastal flood boundaries” report is 2008. Update these estimates to required year using climate change allowances e.g. (for a 75yr lifetime of defence) T\(_{200} (2092) = 6.15\)m + 0.746mm = 6.896m AOD, see Table 7.

5. **Please note:** Although the extreme sea levels from the “coastal flood boundaries” dataset are quoted to 2 decimal places, they are only considered accurate to 1 decimal place. Practitioners should therefore round up the final extreme sea level value to 1 decimal place e.g. T\(_{200} (2092) = 6.896\)m AOD = 6.9m AOD.

6. As a means of addressing the uncertainty associated with extreme sea level estimation, the “coastal flood boundaries” dataset also includes confidence intervals for each location where a sea level has been estimated. These confidence intervals can be used, if required, as a sensitivity test. e.g. confidence interval at location being assessed = +/- 0.3m, therefore T\(_{200} = 6.9m + 0.3m = 7.2m\) AOD.

7. Using the above data a summary table can be prepared for the location in question e.g. see Table 8.

8. The estimates provided from the “coastal flood boundaries” dataset are known as “still water levels”. The impact of any localised wave action at the site being assessed will also need to be considered as part of the coastal engineering design, as well as any allowance for freeboard. *(N.B. With an increase in sea level due to climate change, water depths at the toe of a Sea Defence will increase. In some cases, the effect of “depth-limitation” on wave heights could be reduced, allowing larger waves to impact on the defence).*

---

\(^1\) “coastal flood boundary conditions for uk mainland and islands – project sc060064” published by environment agency / defra in feb 2011. this document is due to be updated in autumn 2017
<table>
<thead>
<tr>
<th>Period</th>
<th>mm increase</th>
<th>Cumulative Rise</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009 - 2025</td>
<td>17 years x 3.5mm/yr</td>
<td>59.5 mm</td>
</tr>
<tr>
<td>2026 - 2055</td>
<td>30 years x 8.0mm/yr</td>
<td>240 mm</td>
</tr>
<tr>
<td>2056 - 2085</td>
<td>30 years x 11.5mm/yr</td>
<td>345 mm</td>
</tr>
<tr>
<td>2086 -2092</td>
<td>7 years x 14.5mm/yr</td>
<td>101.5mm</td>
</tr>
<tr>
<td>2092 future Sea Level</td>
<td>add</td>
<td>746mm</td>
</tr>
</tbody>
</table>

Table 7: Example Cumulative Sea Level Rise Calculation

<table>
<thead>
<tr>
<th></th>
<th>Design Level (median value)</th>
<th>Design Level (Upper confidence)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline T200 (2008)</td>
<td>6.15mAOD</td>
<td></td>
</tr>
<tr>
<td>Present Day (2017)</td>
<td>6.15m AOD + (9yrs x 3.5mm)  = 6.18m AOD Round up to 1 D.P. <strong>6.2m AOD</strong></td>
<td>+0.3m = <strong>6.5m AOD</strong></td>
</tr>
<tr>
<td>Future Scenario (2092)</td>
<td>6.15m AOD + 746mm = 6.896m AOD Round up to 1 D.P. <strong>6.9m AOD</strong></td>
<td>+0.3m = <strong>7.2m AOD</strong></td>
</tr>
</tbody>
</table>

Table 8: Example Present and Future Still Water Levels
References:


iii. Sea level rise and its possible impacts given a ‘beyond 4 degree C world’ in the twenty-first century, Nicholls et al, 2011


vii. Sea level rise and its possible impacts given a ‘beyond 4 degree C world’ in the twenty-first century, Nicholls et al, 2011


xvi. Changing intensity of rainfall over Britain, Tim Osborn and Douglas Maraun, Climatic Research Unit Information Sheet no. 15
