Downscaling Water Risk Filter for the UK

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Executive Summary

Downscaling data for the UK is possible and eight out of the nine datasets which could meaningfully be downscaled have been partially or fully downscaled for the UK. Only one dataset, Indicator 6 (Droughts) could not be downscaled, however, CEH are deriving a new dataset which will be available before the end of 2015. The remaining 11 datasets have been retained at their original scale because they represent 'Indicators' which have a single value for the UK.

It is possible to remove bias due to the introduction of downscaled datasets by scaling the 'Index' values derived from expert knowledge. However, this scaling process reduces the differentiation of risk within the country, (where downscaled risk is higher than global risk) or exaggerates the differentiation of risk (where downscaled risk is lower than global risk). In general, for a well regulated country like the UK, the process of downscaling will increase the level of water related risk compared to the global picture. Correcting this bias potentially breaks the link between the Water Risk Filter (WRF) and the policy/regulatory framework in the country. To facilitate the link between the WRF and policy/regulation, a country specific 'Index' is recommended. However, this will inevitably introduce bias and alter the relative risk of countries with downscaled data *versus* those who only have access to the global datasets. In this project both unscaled and scaled 'Indexes' have been generated for each indicator.

Several data related QA issues have been highlighted in the process of doing this project. The most important is that there are a handful of gaps in the data coverage for both the original datasets, currently used in the WRF, and the downscaled datasets derived within this project. These gaps can be infilled 'by hand' by pairing the missing catchment with a neighbour and infilling the missing data with that of it's neighbour. There are two outputs provided from this project, one infilled the other retaining the data gaps. The infilled dataset is more representative, however, if the results were questioned for an infilled catchment it would not be possible to provide evidence to back up the risk score in that catchment.

Using datasets developed by regulators or recognised and accepted by catchment managers will improve the ability of the WRF to influence strategic water management within countries. These datasets enable transnational companies to understand the conceptual model of a catchment that is being used to set policy and guide regulation. However, this does not mean that the conceptual model is correct in any given catchment. The WRF is part of the first phase of a risk assessment, site specific risk assessment (Phase 2) will always be needed if options are to be appraised (Phase 3) and water related risk is to be managed (Phase 4).

OpenData is key to the long term development of meaningful global and national water related risk assessment. Although the Environment Agency has only recently embraced the OpenData principle it has made a very significant difference to the outputs of this project. OpenData enables the true value of information and evidence to be realised. The WRF is an excellent example of how OpenData can enable the wider stakeholder community to promote the strategic aims of policy makers and regulators. A secondary, but still important consideration, is that OpenData reduces the resource required to develop tools like the WRF. This is important when resources are tight and budgets limited.

The WRF tool should be linked to the CaBA website (http://www.catchmentbasedapproach.org/). This will allow a user of the tool in the UK to understand which CaBA catchment they are in; who the lead organisation is and what their delivery plan for the catchment is. This is a very powerful way for transnational companies to engage with local catchment management and the wider aspirations of the communities in which their business or its supply chain are located.

Contents

Downscaling Water Risk Filter for the UK

1.0 Background and aims of the project:

The aim of this project is to identify the most relevant, higher resolution, UK versions of the datasets currently used in the global Water Risk Filter (WRF). These datasets have been sourced and collated so that they can be incorporated into the WRF to allow a quantified, water related risk assessment to be conducted for the UK at a finer resolution than is possible with the globally consistent data.

This is a pilot study which aims to identify the benefits and issues of introducing downscaled data into the WRF. The lessons learnt from this process will inform the future development and use of the WRF tool.

2.0 Data identification, suitability, access and collation:

2.1 The current version of the WRF

The WRF is part of the first phase of a structured risk assessment framework. Green Leaves III, Guidelines for Environmental Risk Assessment and Management (2011), sets out the four phases as:

- Phase 1. Formulate problem. The WRF enables businesses who are unfamiliar with water related risk to develop their conceptual understanding of how their business interacts with the water environment; plan their risk assessment and conduct rapid screening of risk to identify priorities for further assessment, Fig 2.1.
- Phase 2. Assess risk. This is the site specific risk assessment of priority risks.
- Phase 3. Appraise options. Identify options to mitigate risk.
- Phase 4. Address risk. implement preferred options and monitor.

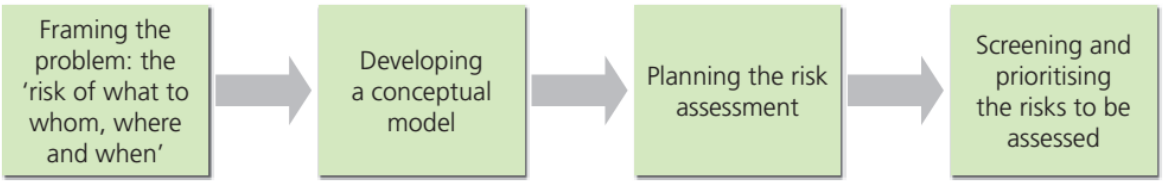

Figure 2.1. Phase 1. Components of the problem formulation stage, after Defra (2011).

The risk filter has two main purposes. Firstly it identifies water related business risk associated with a geographical location; business is the receptor. This enables the business to identify where its supply chain is vulnerable and strategically plan to reduce future, water related, business risk. Secondly the risk filter allows businesses to identify environmental risk; business is the source and the environment is the receptor. In this case the business is the source of the water related risk and the receptors are drinking water, surface water ecology or increased flood risk.

One of the key strengths of the WRF is that it uses consistent global datasets. A user can compare relative risk at locations within a country and from one country to the next. However, this consistency is delivered by using datasets with global coverage and associated large spatial scales.

The scale of the data is critical to the credibility of the underpinning conceptual model, the larger the scale the less representative the conceptual model will be at any given location. The large spatial scale of many of the existing datasets in the WRF means that the risk assessment at any given point may not be using data that is representative of local risk. If data is unrepresentative confidence in the tool, and its outputs, is undermined.

In the UK there are a large number of datasets which would enable a more representative conceptual model to underpin the risk assessments produced by the WRF. This project has focussed on the datasets which are linked to UK water policy and regulation because these datasets represent the conceptual model that is used to strategically manage the water environment.

2.2 What are the properties of the data that has been chosen?

The most important factor when choosing data for this project was whether it is classified as OpenData. There is a growing realisation that the true value of data can only be realised if it is OpenData. This approach allows data to be used more widely and without the restrictions and limitations of licensing. The Environment Agency has embraced this approach and initiated an OpenData Advice Group (oDAG). The Rivers Trust and CaBA are represented on this group by David Johnson. However, neither Scotland (SEPA) nor Wales (NRW) are following the same approach. This difference in policy has had a direct impact in this project where data from England has been used, while data in Scotland, of a similar quality, has not been incorporated due to licensing considerations. Datasets which are classified as OpenData will be provided to the WWF at the end of this project and can be used for other work without restriction. Datasets which are not Open are either subject to generic none commercial licenses or bespoke licenses for this project only.

The second consideration was the purpose for which the data had been compiled. Where possible, data which has been collected to inform regulatory water management have been used as oppose to outputs from academia. This allows the risk assessments from the risk filter to be readily linked to the policies and guidance from the country. For England, Scotland and Wales the key outputs are from the status assessments for the Water Framework directive and the Nitrates Directive. All these datasets were compiled to guide the strategic use and improvement of the water environment in the UK. An additional benefit of this data is that it is used for reporting purposes which means that it is regularly updated. The temporal relevance of the data is also a key consideration if the Water Risk Filter is to be updated and maintained.

Scale is an important consideration. All data used in this project has been mapped to a common scale, HydroBasin12 catchments, http://hydrosheds.org/page/hydrobasins. This means that there is consistency between datasets and potentially between countries if the downscaling process is to be extended. For most datasets used, mapping to a common scale has had little impact because the scale of the data is similar to that of HydroBasin12 . However, for the groundwater and flooding data there has been a significant loss of resolution reflecting the trade off between consistency and resolution. This is discussed in more detail below.

2.3 What format is the new data in?

The original data exported from the WRF consisted of an 'Index' , between 1 and 5, for each 'Indicator' for each HydroBasin6 catchment. The new data has been mapped to HydroBasin12 catchments, for each catchment three pieces of data were generated for each of the 'Indicators':

- **'Score'.** This is the raw data assigned to the HydroBasin12 catchment based on the new datasets described in Section 3. This data is not used in the WRF but it is necessary to

generate the 'Index' for each HydroBasin12 catchment and for QA purposes. This data has not been carried through into the final data output to avoid licensing issues.

- **'Index'.** This is the 'Score' , above, converted into an 'Index' between 1 and 5 for each HydroBasin12 catchment. The 'Index' was assigned based on expert knowledge of what the score means to UK regulators and catchment managers. So, for example, a 'Score' = 'Bad' for the ecological health of a catchment was assigned an 'Index' of 5, while a 'Score' = 'Good' was assigned an 'Index' of 1. The conversion from 'Score' to 'Index' for each 'Indicator' is given in section 3.
- **'Sc_Index'**. Is the 'Index' above scaled to remove bias, see section 4.
- **'Target'.** This is the 'Index' for the HydroBasin6, i.e. the 'Index' from the current WRF. Each HydroBasin12 catchment within a HydroBasin6 catchment is given the same 'Target'. The 'Target' is important as it allows us to calculate any bias which has been introduced into the data through the downscaling process. A full description explaining how this bias was calculated is included in section 4.

2.4 What are the issues we have identified?

Loss of resolution. All data has been mapped to HydroBasin12 catchments. For most datasets this is not a significant issue because the catchments are similar in scale and extent to those used by regulators in the UK for WFD and the Nitrates Directive. However, for flood risk and groundwater HydroBasin12 geometry is quite different from that used by the regulators. This means that for these datasets the risk associated with each catchment represents a risk that is present within the catchment rather than a risk which is distributed across the catchment. For example, the HydroBasin12 version of the groundwater data may be classified as high risk when areas within the HydroBasin12 catchment do not even have groundwater beneath them. For both flood and groundwater data the interpretation of attributed risk class is that it occurs within the catchment rather than across the catchment. In reality this is no different from the other indicators which often represent localised risk within a catchment. The 'one out all out' rule used in much WFD classification work means that monitoring from one tributary can impact the status of the whole catchment. The other impact of the loss of resolution for the flooding and groundwater datasets is that the link between the data used in the WRF and the data used to drive water regulation and policy has been broken. This is potentially significant as it reduces the ability of the WRF to inform trans-national companies about the regulatory landscape in a country for these datasets.

There are data gaps, even within the relatively small and data rich UK. In part these gaps represent differences in approach between England, Scotland and Wales; the key difference being the accessibility of the data and the acceptance of the OpenData principle. However, there are also data gaps in the downscaled data due to lack of monitoring data. Where data gaps are present the 'Score' for that catchment has been set to '99' and the 'Index' set to the same as the 'Target' . Effectively this means that HydroBasin6 data has been used to infill the data gaps. This is a reasonable approach, however, it is important to flag that data from a different source and scale has been used as this has an impact on how reliable the risk assessment will be for that catchment.

Data consistency has been lost. Each new data layer has an associated new legend. This means that the legend used in areas where data has been downscaled should be different in the 'Basin Related Risk Results' section of the WRF. The 'Answer' required in the WRF is specified in section 3 for each 'Indicator'.

Some data incorporates downstream risk while other data does not. The CAMS (Water Resources) data acknowledges that 'Risk' flows downstream. This means that each catchment takes the status

of the worst downstream catchment. This is one interpretation of risk that is widely used in environmental risk assessments and identifies the whole upstream area contributing to observed risk and therefore the area of land where a business could be a source of risk. However, the WFD risk assessment is based on the risk within each individual catchment. In this case a low risk headwater catchment that flows into a higher risk catchment downstream retains its lower risk rating. Again this is a widely used approach in environmental risk assessment and identifies areas of elevated risk with more precision. This is important if the dataset is to be used to target behavioural change. The inconsistency in the datasets collated for this project could be overcome if one of the datasets were remapped, however, this would further degrade the link between the tool and the policy/regulatory framework in the UK.

3.0 Data sources, rational for inclusion and key considerations.

The section below identifies each of the datasets used, including all the information required for the Water Risk Filter. In general different datasets have been identified for Scotland when compared to England and Wales.

3.1 Indicator 1: Annual average water available for abstraction Annual average monthly blue water scarcity in this river basin

England

Risk indicator: Catchment Abstraction Management Strategy (CAMS) water resource status.
Description: Water resources availability at average river flows (Q50) assessed in 2014. Each river in England is assessed to determine the minimum amount of flow required to maintain the ecological health of the river. The status of the river then depends on whether current abstractions allow this minimal flow to be maintained throughout the year.
Source: Environment Agency.
Link: http://www.geostore.com/environment-agency/
License restrictions: OpenData licence
Processing required: CAMS water resource status mapped to HydroBasin12. Each catchment given the dominant status within the catchment if there are more than one CAMS catchment within the Hydroshed.
Legend: Water not available for licensing (5), Restricted water available for licensing (2), Water available for licensing (1)
Downstream risk: Yes. Lowest downstream WFD catchment status
Key considerations: This data is not directly comparable with the Blue Water Scarcity. The maps generated for the tool will not be the same as those used by the regulator in England and Wales due to the use of different catchment boundaries. Catchments which are defined as 'heavily modified' or 'discharge rich' are included in the low risk category

Wales

Risk indicator: Catchment Abstraction Management Strategy (CAMS) water resource status.
Description: Water resources availability at average river flows (Q50) assessed in 2014. Each river in Wales is assessed to determine the minimum amount of flow required to maintain the ecological health of the river. The status of the river then depends on whether current abstractions allow this minimal flow to be maintained throughout the year.
Source: Environment Agency and Natural Resources Wales.
Link: accesstoinformationteam@naturalresourceswales.gov.uk
License restrictions: Licence for this project only.

***Processing required*:** CAMS water resource status mapped to HydroBasin12. Each catchment given the dominant status within the catchment if there are more than one CAMS catchment within the Hydroshed.
***Legend*:** Water not available for licensing (5), Restricted water available for licensing (2), Water available for licensing (1)
Downstream risk: Yes. Lowest downstream WFD catchment status
***Key considerations*:** This data is not directly comparable with the Blue Water Scarcity. The maps generated for the tool will not be the same as those used by the regulator in England and Wales due to the use of different catchment boundaries. Catchments which are defined as 'heavily modified' or 'discharge rich' are included in the low risk category.

Scotland

***Risk Indicator*:** WFD hydology (abstraction) status
***Description*:** The average annual hydrological status of each catchment with respect to abstraction is assessed for the Water Framework Directive using the UKTAG methodology.
***Source*:** Scottish Environmental Protection Agency
***Link*:** http://www.wfduk.org/ and http://www.sepa.org.uk/water/monitoring_and_classification/classification/classification_results.aspx
License restrictions: Licence for this project only (applies to the shapefile of the surface water bodies)
***Processing required*:** WFD hydrology status mapped to HydroBasin12. Each catchment given the dominant status within the catchment if there are more than one WFD catchments within the Hydroshed.
***Legend*:** Bad(5), Poor(4), Moderate(3), Good(2) and High (1).
Downstream risk: No. WFD catchment.
***Key considerations*:** The status thresholds are similar, but not the same, as those used in England and Wales.

3.2 Indicator 2: Annual reliability of abstraction Number of months per year water scarcity exceding 100% in this river basin

England

***Risk indicator*:** Percentage of the time additional consumptive resource may not be available.
***Description*:** New, consumptive abstraction may not be 100% reliable. Reliability information is based on CAMS resource availability and is a way of presenting the reliability of new abstractions at all flows. The availability of water for abstraction within a river varies greatly from high to low flows. By assessing the quantity of water available at different flows it is possible to see when there is a surplus or deficit of water and the associated reliability of an abstraction.
***Source*:** Environment Agency
***Link*:** http://www.geostore.com/environment-agency/
***License restrictions*:** OpenData licence.
***Processing required*:** The percentage reliability is mapped to the HydroBasin12 catchments. Each HydroBasin12 catchment is given the dominant reliability status within that catchment. The percentage reliability is used to identify the number of months where there will not be enough water for additional abstraction.
***Legend*:** Water resource available <30% of the year (5), Water resource available for 30 to 50% of the year (4), Water resource available for 50 to 70% of the year (3), Water resource available for 70 to 95% of the year (2) and Water resource available for more than 95% of the year.
Downstream risk: Yes. Lowest downstream WFD catchment status.

***Key considerations*:** This data is not directly comparable with the Blue Water Scarcity. The maps generated for the tool will not be precisely the same as those used by the regulator in England and Wales due to the use of different catchment boundaries.

Wales

***Retain current dataset*:** No equivalent for Wales currently available. Likely to become available in the future.
***Processing required*:** Map existing data from HydroBasin6 to HydroBasin12 based.
***Key considerations*:** na

Scotland

***Retain current dataset*:** No equivalent for Scotland.
***Processing required*:** Map existing data from HydroBasin6 to HydroBasin12 based.
***Key considerations*:** na

3.3 Indicator : 3 Water available for abstraction at the driest period of the year

England Blue water scarcity in the month in which blue water scarcity is the highest in this river basin

***Risk indicator*:** CAMS water resource status.
***Description*:** Water resources availability at low river flows (Q95) assessed in #2012#. Each river is assessed to determine the minimum amount of flow required to maintain the ecological health of the river. The status of the river then depends on whether abstractions allow this minimal flow to be maintained throughout the year.
***Source*:** Environment Agency and Natural Resources Wales.
***Link*:** http://www.geostore.com/environment-agency/
***License restrictions*:** OpenData licence.
***Processing required*:** CAMS water resource status mapped to HydroBasin12. Each catchment given the dominant status within the catchment if there are more than one CAMS catchment within the Hydroshed.
***Legend*:** Water not available for licensing (5), Restricted water available for licensing (2), Water available for licensing (1)
Downstream risk: Yes. Lowest downstream WFD catchment status.
***Key considerations*:** This data is not directly comparable with the Blue Water Scarcity. The maps generated for the tool will not be the same as those used by the regulator in England and Wales due to the use of different catchment boundaries. Catchments which are defined as 'heavily modified' or 'discharge rich' are included in the low risk category.

Wales

***Risk indicator*:** CAMS water resource status.
***Description*:** Water resources availability at low river flows (Q95) assessed in #2012#. Each river is assessed to determine the minimum amount of flow required to maintain the ecological health of the river. The status of the river then depends on whether abstractions allow this minimal flow to be maintained throughout the year.
***Source*:** Environment Agency and Natural Resources Wales.
***Link*:** accesstoinformationteam@naturalresourceswales.gov.uk
***License restrictions*:** Licence for this project only.
***Processing required*:** CAMS water resource status mapped to HydroBasin12. Each catchment given the dominant status within the catchment if there are more than one CAMS catchment within the Hydroshed.
***Legend*:** Water not available for licensing (5), Restricted water available for licensing (2), Water available for licensing (1)

Downstream risk: Yes. Lowest downstream WFD catchment status.
Key considerations: This data is not directly comparable with the Blue Water Scarcity. The maps generated for the tool will not be the same as those used by the regulator in England and Wales due to the use of different catchment boundaries. Catchments which are defined as 'heavily modified' or 'discharge rich' are included in the low risk category.

Scotland

Retain current dataset: No equivalent for Scotland.
Processing required: Map existing gridded data to HydroBasin12 based on dominant status within the water body.
Key considerations:

3.4 Indicator : 4 Groundwater over abstraction Groundwater overabstraction

England

Risk indicator: WFD quantitative status
Description: The water resource status of groundwater is assessed against five separate tests, each of which are indicators of over abstraction.
Source: Environment Agency.
Link: http://www.geostore.com/environment-agency/
License restrictions: Licence for this project only.
Processing required: WFD quantitative status are mapped to HydroBasin12 catchments. Each Hydroshed catchment is given the dominant GW status within that catchment.
Legend: Poor(5), Good (1) No groundwater (0).
Downstream risk: No. WFD catchment status.
Key considerations: Mapping to HydroBasin12 will mean that the GW boundaries are different from the true outlines of the aquifers. This layer tells the user if there is groundwater in the HydroBasin12 catchment and if this groundwater is over abstracted. The user will need to go to the detailed aquifer maps to understand where the groundwater is within the catchment.

Wales

Risk indicator: WFD quantitative status
Description: The water resource status of groundwater is assessed against five separate tests, each of which are indicators of over abstraction.
Source: Natural Resources Wales.
Link: accesstoinformationteam@naturalresourceswales.gov.uk
License restrictions: Licence for this project only.
Processing required: WFD quantitative status are mapped to HydroBasin12 catchments. Each Hydroshed catchment is given the dominant GW status within that catchment.
Legend: Poor(5), good (1) No groundwater (0).
Downstream risk: No. WFD catchment status.
Key considerations: Mapping to HydroBasin12 will mean that the GW boundaries are different from the true outlines of the aquifers. This layer tells the user if there is groundwater in the HydroBasin12 catchment and if this groundwater is over abstracted. The user will need to go to the detailed aquifer maps to understand where the groundwater is within the catchment.

Scotland

Risk Indicator: WFD hydology (abstraction) status
Description: The average annual quantitative status of each catchment is assessed for the Water Framework Directive using the UKTAG methodology.
Source: Scottish Environmental Protection Agency

Link: http://www.wfduk.org/ and http://www.sepa.org.uk/water/monitoring_and_classification/classification/classification_results.aspx
License restrictions: Licence for Not-For-Profit organisations (applies to the shapefile of the groundwater bodies)
Processing required: WFD hydrology status mapped to HydroBasin12. Each catchment given the dominant status within the catchment if there are more than one WFD catchments within the Hydroshed.
Legend: Poor (5), Good (1) and none aquifer (0).
Downstream risk: No. WFD catchment status.
Key considerations: Mapping to HydroBasin12 will mean that the GW boundaries are different from the true outlines of the aquifers. This layer tells the user if there is groundwater in the HydroBasin12 catchment and if this groundwater is over abstracted. The user will need to go to the detailed aquifer maps to understand where the groundwater is within the catchment.

3.5 Indicator 5: Forecasted impact of climate change

England ,Wales and Scotland

Risk indicator: Percentage change in summer rainfall
Description: The percentage change in summer rainfall per river basin is based on the medium emission scenario for 2050. The 50%ile change does not vary greatly across the UK, -0% to - 2% reduction in summer rainfall, and as a result the UK dataset provides little additional spatial data.
Source: UKCIP09
Link: http://ukclimateprojections.metoffice.gov.uk/21708
License restrictions: Not For Profit licence . The following acknowledgement should be included on the tool. "***© Crown Copyright 2009. The UK Climate Projections (UKCP09) have been made available by the Department for Environment, Food and Rural Affairs (Defra) and the Department of Energy and Climate Change (DECC) under licence from the Met Office, UKCIP, British Atmospheric Data Centre, Newcastle University, University of East Anglia, Environment Agency, Tyndall Centre and Proudman Oceanographic Laboratory. These organisations give no warranties, express or implied, as to the accuracy of the UKCP09 and do not accept any liability for loss or damage, which may arise from reliance upon the UKCP09 and any use of the UKCP09 is undertaken entirely at the users risk.***"
Processing required: Each HS12 catchment is given the class of the river basin in which it sits.
Legend: 0 to -5% change in summer precipitation (1)
Downstream risk: na.
Key considerations: This dataset identifies where water resources may change most significantly at the most water stressed time of the year, however, it does not include a component of adaptability, which is incorporated into the current dataset.

3.6 Indicator 6: Estimated occurrence of droughts (2010-2013), (2011-2013) and (2012-2013)

England, Wales and Scotland

Retain current dataset: No equivalent for England and Wales.
Key considerations: CEH plan to release both gridded and catchment scale drought data for the UK in 2015.

3.7 Indicator 7: Estimated occurrence of floods

England and Wales

Risk indicator: The data shows the floodplain in England and Wales split into 50m x 50m cells, each one allocated to one of four flood risk likelihood categories with respect to flooding from rivers and sea.
Description: The four flood risk likelihood categories are:
- High: each year, there is a chance of flooding of greater than 1 in 30 (3.3%).
- Medium: each year, there is a chance of flooding of between 1 in 30 (3.3%) and 1 in 100 (1%).
- Low: each year, there is a chance of flooding of between 1 in 100 (1%) and 1 in 1000 (0.1%).
- Very Low: each year, there is a chance of flooding of less than 1 in 1000 (0.1%).

Source: Environment Agency and Natural Resources Wales.
Link: http://www.geostore.com/environment-agency/
License restrictions: OpenData licence.
Processing required: The area of medium and high flood risk in each HydroBasin12 catchment. Catchments are then ranked according to the area within each catchment.
Legend: 20% most risky catchments (5), 20 to 40% (4), 40 to 60% (3), 60 to 80% (2) 80 to 100% (1)
Downstream risk: na
Key considerations: This dataset has been processed to allow the user to see relatively how risky their catchment is for flooding from rivers and sea within England and Wales. This does not capture flooding from reservoirs, surface water or groundwater. The choice of 'area' rather than 'percentage area' means that some small HydroBasin12 catchments have an unrepresentatively low risk. The alternative approach using 'percentage area' would underestimate risk in large HydroBasin12 catchments.

Scotland
Retain current dataset: There is an equivalent dataset for Scotland however, the license is extremely restrictive.
Processing required: Map existing data from HydroBasin6 to HydroBasin12.
Key considerations: None

3.8 Indicator 8 General situation of water pollution around the facility

3.8.1 Indicator 8a Nitrogen loading

England
Risk indicator: High nitrate risk.
Description: Areas that are vulnerable to nitrate pollution including land draining to surface water, groundwater and eutrophic waters (2012). The designations are based on monitoring and pressure data and as such represent risk rather than vulnerability.
Source: Environment Agency.
Link: http://www.magic.gov.uk/Datasets/Dataset_Download_NitrateVulnerable.htm
License restrictions: PSMA - Public Sector End User Licence Agreement
v2.0 November 2011 © Crown copyright. For this project only.
Processing required: If a catchment has >50% coverage of NVZ within it then it is high risk, otherwise it is given negligible, but not zero risk.
Legend: NVZ present within HydroBasin12 catchment (5) and NVZ not present within HydroBasin12 catchment (1)
Downstream risk: Yes. Lowest downstream WFD catchment status.
Key considerations: This dataset is called vulnerability, however, it really shows the risk of nitrate pollution based on loading and monitoring.

Wales
Risk indicator: High nitrate risk.

Description: Areas that are vulnerable to nitrate pollution including land draining to surface water, groundwater and eutrophic waters (2013). The designations are based on monitoring and pressure data and as such represent risk rather than vulnerability.
Source: Environment Agency and Natural Resources Wales.
Link: accesstoinformationteam@naturalresourceswales.gov.uk
License restrictions: Licensed for this project only.
Processing required: If a catchment has >50% coverage of NVZ within it then it is high risk, otherwise it is given negligible, but not zero risk.
Legend: NVZ present within HydroBasin12 catchment (5) and NVZ not present within HydroBasin12 catchment (1)
Downstream risk: Yes. Lowest downstream WFD catchment status.
Key considerations: This dataset is called vulnerability, however, it really shows the risk of nitrate pollution based on loading and monitoring.

Scotland

Risk indicator: **High n**itrate risk
Description: Areas that are vulnerable to nitrate pollution including land draining to surface water, groundwater and eutrophic water. The layer
Source: Scottish Government.
Link: http://crtb.sedsh.gov.uk//spatialDataDownload/dload.asp
License restrictions: Scottish Government none commercial license.
Processing required: If a catchment has >50% coverage of NVZ within it then it is high risk, otherwise it is given negligible, but not zero risk.
Legend: NVZ present within HydroBasin12 catchment (5) and NVZ not present within HydroBasin12 catchment (1)
Downstream risk: Yes. Lowest downstream WFD catchment status.
Key considerations: This dataset is called vulnerability, however, it really shows the risk of nitrate pollution based on loading and monitoring.

3.8.2 Indicator 8b Phosphorus loading

England

Risk indicator: **P**hosphorus risk.
Description: **The** WFD assessment of phosphorus concentrations in rivers is a supporting element for the assessment of river ecological status (2014, Cycle II).
Source: Environment Agency.
Link: http://www.geostore.com/environment-agency/
License restrictions: OpenData
Processing required: Map the dominant phosphorus status by area to HydroBasin12 catchments.
Legend: Bad (5), Poor (4), Moderate (3), Good (2 and High or not assessed (1)
Downstream risk: No. WFD catchment status.
Key considerations: The 2014, Cycle II WFD assessment shows a significant decrease in the status of surface water in England when compared to 2013 WFD assessments. This deteriation is due to the use of a revised methodology for assessing pollution due to phosphorus including revised, water body specific, phosphorus targets. This dataset was used, even though it is not consistent with Scotland and Wales, to capture the more realistic assessment of phosphorus risk in England.

Wales

Risk indicator: **P**hosphorus risk.
Description: **The** WFD assessment of phosphorus concentrations in rivers is a supporting element for the assessment of river ecological status. (2013).
Source: Environment Agency.
Link: accesstoinformationteam@naturalresourceswales.gov.uk

License restrictions: License for this project only.
Processing required: Map the dominant phosphorus status by area to HydroBasin12 catchments.
Legend: Bad (5), Poor (4), Moderate (3), Good (2 and High or not assessed (1)
Downstream risk: No. WFD catchment status.
Key considerations: None.

Scotland
Risk Indicator: Phosphorus risk .
Description: **The** WFD assessment of phosphorus concentrations in rivers is a supporting element for the assessment of river ecological status. (2013).
.
Source: Scottish Environmental Protection Agency
Link: http://www.wfduk.org/ and
http://www.sepa.org.uk/water/monitoring_and_classification/classification/classification_results.aspx
License restrictions: Licence for this project only (applies to the shapefile of the surface water bodies)
Processing required: WFD phosphorus status mapped to HydroBasin12. Each catchment given the dominant status within the catchment if there are more than one WFD catchments within the Hydroshed.
Legend: Bad (5), Poor (4), Moderate (3), Good (2 and High or not assessed (1).
Downstream risk: No. WFD catchment status.
Key considerations: None

3.8.3 Indicator 8c Pesticide loading
England ,Wales and Scotland
Risk indicator: **Average p**esticide load per hectare.
Description: The Pesticide usage survey records the amount of pesticides used in each region within the UK.
Source: Fera.
Link: https://secure.fera.defra.gov.uk/pusstats/
License restrictions: Open Government Licence v3.0. nationalarchives.gov.uk/doc/open-government-licence/version/3
Processing required: Map average kg/ha application of total pesticide from each region to the HydroBasin12 catchments within the region.
Legend: >3kg/ha (5), 2 to 3kg/ha (4), 1 to 2 kg/ha (3), 0.5 to 1 kg/ha (2) and < 0.5 kg/ha (1)
Downstream risk: na.
Key considerations: Acknowledge the source of the data from Fera © Crown copyright 2014

3.8.4 Indicator 8d Soil salination
England, Wales and Scotland
Retain current dataset: Soil salination is not a significant issue in the UK.
Key considerations: None

3.8.5 Indicator 8e Organic loading
England
Risk Indicator: Biological Oxygen Demand (BOD)
Description: **The** WFD assessment of BOD in rivers is a supporting element for the assessment of river ecological status (2014, Cycle II). The BOD status of each catchment is assessed for the Water Framework Directive using the UKTAG methodology.

Source: Environment Agency.
Link: http://www.geostore.com/environment-agency/
License restrictions: OpenData
Processing required: Map the dominant BOD status by area to HydroBasin12 catchments.
Legend: Bad (5), Poor (4), Moderate (3), Good (2 and High or not assessed (2)
Downstream risk: No. WFD catchment status.
Key considerations: Dissolved oxygen is not the same as organic loading, however, the detrimental impact of high organic loading is low dissolved oxygen.

Wales
Risk Indicator: Biological Oxygen Demand (BOD)
Description: **The** WFD assessment of BOD rivers is a supporting element for the assessment of river ecological status (2013). The BOD status of each catchment is assessed for the Water Framework Directive using the UKTAG methodology.
Source: Natural Resources Wales.
Link: accesstoinformationteam@naturalresourceswales.gov.uk
License restrictions: License for this project only.
Processing required: Map the dominant BOD status by area to HydroBasin12 catchments.
Legend: Bad (5), Poor (4), Moderate (3), Good (2 and High or not assessed (1)
Downstream risk: No. WFD catchment status.
Key considerations: None.

Scotland
Risk Indicator: Biological Oxygen Demand (BOD)
Description: **The** WFD assessment of BOD in rivers is a supporting element for the assessment of river ecological status (2014, Cycle II). The BOD status of each catchment is assessed for the Water Framework Directive using the UKTAG methodology.
Source: Scottish Environmental Protection Agency
Link: http://www.wfduk.org/ and
http://www.sepa.org.uk/water/monitoring_and_classification/classification/classification_results.aspx
License restrictions: Licence for this project only (applies to the shapefile of the surface water bodies)
Processing required: WFD BOD status mapped to HydroBasin12. Each catchment given the dominant status within the catchment if there are more than one WFD catchments within the Hydroshed.
Legend: Bad (5), Poor (4), Moderate (3), Good (2) and High or not assessed (1).
Downstream risk: No. WFD catchment status.
Key considerations: None

3.8.6 Indicator 8f Sediment loading

England, Wales and Scotland
Retain current dataset: Sediment loss is a significant issue in the UK, however, no spatial datasets could be obtained within this project.
Key considerations: It is likely that Cranfield University could generate a sediment risk map for future versions of the tool.

3.8.7 Indicator 8g Mercury loading

England, Wales and Scotland

***Retain current dataset*:** Mercury loading is not a significant issue in the UK.
***Key considerations*:** No rivers fail for mercury in the UK, however a small number of transitional and coastal waters do fail for mercury in the UK. These are not currently highlighted.

3.8.8 Indicator 8h Potential Acidification

England

***Risk Indicator*:** pH
***Description*: The** WFD assessment of pH in rivers is a supporting element for the assessment of river ecological status (2014, Cycle II). The pH status of each catchment is assessed for the Water Framework Directive using the UKTAG methodology.
***Source*:** Environment Agency.
***Link*:** http://www.geostore.com/environment-agency/
***License restrictions*:** OpenData
***Processing required*:** Map the dominant pH status by area to HydroBasin12 catchments.
***Legend*:** Bad (5), Poor (4), Moderate (3), Good (2) and High or not assessed (1)
Downstream risk: No. WFD catchment status.
***Key considerations*:** None.

Wales

***Risk Indicator*:** pH
***Description*: The** WFD assessment of pH in rivers is a supporting element for the assessment of river ecological status (2013).The pH status of each catchment is assessed for the Water Framework Directive using the UKTAG methodology.
***Source*:** Natural Resources Wales.
Link: accesstoinformationteam@naturalresourceswales.gov.uk
***License restrictions*:** License for this project only.
***Processing required*:** Map the dominant pH status by area to HydroBasin12 catchments.
***Legend*:** Bad (5), Poor (4), Moderate (3), Good (2) and High or not assessed (1)
Downstream risk: No. WFD catchment status.
***Key considerations*:** None.

Scotland

***Risk Indicator*:** pH
***Description*: The** WFD assessment of pH in rivers is a supporting element for the assessment of river ecological status (2013).The pH status of each catchment is assessed for the Water Framework Directive using the UKTAG methodology.
***Source*:** Scottish Environmental Protection Agency
***Link*:** http://www.wfduk.org/ and
http://www.sepa.org.uk/water/monitoring_and_classification/classification/classification_results.aspx
License restrictions: Licence for this project only (applies to the shapefile of the surface water bodies)
***Processing required*:** WFD pH status mapped to HydroBasin12. Each catchment given the dominant status within the catchment if there are more than one WFD catchments within the Hydroshed.
***Legend*:** Bad (5), Poor (4), Moderate (3), Good (2) and High or not assessed (1).
Downstream risk: No. WFD catchment status.
***Key considerations*:** None

3.8.9 Indicator 8i Thermal alteration

England

Risk Indicator: Temperature
Description: **The** WFD assessment of temperature in rivers is a supporting element for the assessment of river ecological status (2014) The temperature status of each catchment is assessed for the Water Framework Directive using the UKTAG methodology.
Source: Environment Agency.
Link: http://www.geostore.com/environment-agency/
License restrictions: OpenData
Processing required: Map the dominant temperature status by area to HydroBasin12 catchments.
Legend: Bad (5), Poor (4), Moderate (3), Good (2 and High or not assessed (1)
Downstream risk: No. WFD catchment status.
Key considerations: Dissolved oxygen is not the same as organic loading, however, the detrimental impact of high organic loading is low dissolved oxygen.

Wales

Risk Indicator: Temperature
Description: **The** WFD assessment of temperature in rivers is a supporting element for the assessment of river ecological status (2013) The temperature status of each catchment is assessed for the Water Framework Directive using the UKTAG methodology.
Source: Natural Resources Wales.
Link: accesstoinformationteam@naturalresourceswales.gov.uk
License restrictions: License for this project only.
Processing required: Map the dominant phosphorus status by area to HydroBasin12 catchments.
Legend: Bad (5), Poor (4), Moderate (3), Good (2 and High or not assessed (1)
Downstream risk: No. WFD catchment status.
Key considerations: None.

Scotland

Risk Indicator: Temperature
Description: **The** WFD assessment of temperature in rivers is a supporting element for the assessment of river ecological status (2013). The temperature status of each catchment is assessed for the Water Framework Directive using the UKTAG methodology.
Source: Scottish Environmental Protection Agency
Link: http://www.wfduk.org/ and http://www.sepa.org.uk/water/monitoring_and_classification/classification/classification_results.aspx
License restrictions: Licence for this project only (applies to the shapefile of the surface water bodies)
Processing required: WFD temperature status mapped to HydroBasin12. Each catchment given the dominant status within the catchment if there are more than one WFD catchments within the Hydroshed.
Legend: Bad (5), Poor (4), Moderate (3), Good (2 and High or not assessed (1).
Downstream risk: No. WFD catchment status.
Key considerations: None

3.9 Indicator 9 Threat to freshwater biodiversity threat around the facility

England

Risk Indicator: Ecological status
Description: The ecological status of each catchment is assessed for the Water Framework Directive using the UKTAG methodology. (2014 Cycle II)
Source: Environment Agency.
Link: http://www.geostore.com/environment-agency/

License restrictions: OpenData
Processing required: Map the dominant ecological status by area to HydroBasin12 catchments.
Downstream risk: No. WFD catchment status.
Legend: Bad (5), Poor (4), Moderate (3), Good (2) and High or not assessed (1)
Key considerations: The ecological status of surface water changed significantly in 2014 due to the Cycle II phosphorus methodology .

Wales
Risk Indicator: Ecological status
Description: The ecological status of each catchment is assessed for the Water Framework Directive using the UKTAG methodology. (2013)
Source: Natural Resources Wales.
Link: accesstoinformationteam@naturalresourceswales.gov.uk
License restrictions: License for this project only.
Processing required: Map the dominant ecological status by area to HydroBasin12 catchments.
Legend: Bad (5), Poor (4), Moderate (3), Good (2) and High or not assessed (1)
Downstream risk: No. WFD catchment status.
Key considerations: None.

Scotland
Risk Indicator: Ecological status
Description: The ecological status of each catchment is assessed for the Water Framework Directive using the UKTAG methodology.
Source: Scottish Environmental Protection Agency
Link: http://www.wfduk.org/ and http://www.sepa.org.uk/water/monitoring_and_classification/classification/classification_results.aspx
License restrictions: Licence for this project only (applies to the shapefile of the surface water bodies)
Processing required: WFD temperature status mapped to HydroBasin12. Each catchment given the dominant status within the catchment if there are more than one WFD catchments within the Hydroshed.
Legend: Bad (5), Poor (4), Moderate (3), Good (2) and High or not assessed (1)
Downstream risk: No. WFD catchment status.
Key considerations: None

3.10 Indicators 9a to 20 which have not been downscaled in this project

3.10.1 Indicator 9a WWF priority basin

England, Wales and Scotland
Retain current dataset: No additional data can be provided which will downscale current data for the UK
Key considerations: None

3.10.2 Indicator 10 Vulnerability of water ecosystems in the country

England, Wales and Scotland
Retain current dataset: No additional data can be provided which will downscale current data for the UK
Key considerations: None

3.10.3 Indicator 11 Access to safe drinking water (% of population)

England, Wales and Scotland

Retain current dataset: No additional data can be provided which will downscale current data for the UK
Key considerations: None

3.10.4 Indicator 12 Access to improved sanitation (% of population)
England, Wales and Scotland
Retain current dataset: No additional data can be provided which will downscale current data for the UK
Key considerations: None

3.10.5 Indicator 13 Dependency on hydropower
England, Wales and Scotland
Retain current dataset: No additional data can be provided which will downscale current data for the UK
Key considerations: None

3.10.6 Indicator 14 Water strategy of local, national and upstream governments, including drought and flood management plans where appropriate
England, Wales and Scotland
Retain current dataset: No additional data can be provided which will downscale current data for the UK
Key considerations: None

3.10.7 Indicator 15 Sophistication and clarity of water related legal framework
England, Wales and Scotland
Retain current dataset: No additional data can be provided which will downscale current data for the UK
Key considerations: None

3.10.8 Indicator 16 Enforcement of water related legal framework
England, Wales and Scotland
Retain current dataset: No additional data can be provided which will downscale current data for the UK
Key considerations: None

3.10.9 Indicator 17 Official forum or platform in which stakeholders come together to discuss water-related issues of basin
England, Wales and Scotland
Retain current dataset: No additional data can be provided which will downscale current data for the UK .
Key considerations: Dataset of CaBA partnerships has been provided this does not alter the score but could be linked to websites from Water Risk Filter.

3.10.10 Indicator 18 Cultural and/or religious importance of local water sources
England, Wales and Scotland
Retain current dataset: No additional data can be provided which will downscale current data for the UK
Key considerations: None

3.10.11 Indicator 19 Exposure of this country to local/national media coverage reporting on criticizing on possible water issues
England, Wales and Scotland

***Retain current dataset*:** No additional data can be provided which will downscale current data for the UK
***Key considerations*:** None

3.10.12 Indicator 20 Exposure of this country to global media coverage reporting on criticizing on possible water issues

England, Wales and Scotland

***Retain current dataset*:** No additional data can be provided which will downscale current data for the UK
***Key considerations*:** None

4.0 Data conversion to avoid statistical bias

The higher resolution datasets collected and described in the previous section have been converted to an 'Index' with a value of 1-5 on an integer scale so that they can be incorporated into the WRF. Where there are gaps in the higher resolution data these have been in filled with the current data.

The 'Index' is based on expert knowledge of the datasets and their meaning to policy makers, regulators and catchment managers in the UK. For example a CAMS status of 'Water not available for licensing' is applied to the most water resource stressed catchments in England and Wales. Businesses who operate, or wish to operate, in these catchments would not be able to increase, and may even have to decrease, abstraction. As a result this CAMS status is given an 'Index' of 5. However, this 'Index' could be the same as that for a catchment in an arid region elsewhere in the world. This is an example of the bias which has been introduced during the downscaling process.

To address this bias the 'Index' scores have been scaled using formula (1) below.

$$Index^{Un-bias} = Index^{bias}\ X\ \frac{\sum_{i=0}^{n} Area_i\ X\ Index_i^{bias}}{\sum_{i=0}^{n} Area_i\ X\ Target_i} \qquad (1)$$

Where:

$Index^{Un-bias}$ is the scaled 'Index' for the downscaled data.

$Index^{bias}$ is the bias 'Index' for the downscaled data based on expert knowledge.

$Area_i$ is the area of the HydroBasin12 catchment .

$Target_i$ is the original 'Index' for the HydroBasin12 based on Global data.

This approach removes any UK scale bias introduced by using the downscaled data. However, the approach breaks the link between the UK regulators understanding of the data and the risk score given in the WRF. For example the downscaled data increased the risk associated with indicator 1 (average water resource availability) by +40%, see table 4.1 below. This means that a catchment which the regulator has identified as having 'No water available for abstraction' would be given a 'High risk' in the WRF rather than 'Very high risk'. At the opposite end the downscaled data reduced the risk associated with indicator 8a (nitrate) by -53%. This means that a catchment which has been identified by the regulator as 'Not in an NVZ' would be given a risk score of 'Low' rather than 'Very Low'.

Indicator	Bias	Change in risk indicator	Regulatory description of downscaled data	WRF description of data
1	+40%	5 => 3.6	'No water available for abstraction at average flows, Q50'	High risk
2	+120%	5 => 2.3	'Water available for less than 30% of the year'	Medium risk
3	+20%	5 => 4.0	'No water available for abstraction at low flows, Q95'	High risk
4	na			
5	0%	na		
6	0%			
7	-10%	1 => 1.3	20% catchments with the lowest flood risk	Very low risk
8a	-50%	1 => 1.5	Not in an NVZ	Low risk
8b	-40%	1 => 1.7	WFD Phosphorus status high	Low risk
8c	-50%	1 => 2.1	Pesticide load < 0.5 kg/Ha	Low risk
8d	0%			
8e	-20%	1 => 1.3	WFD BOD status 'High'	Very low risk
8f	0%			
8g	0%			
8h	-30%	1 => 1.5	WFD pH status 'High'	Low risk
8i	na			
9	-20%	1 => 1.2	WFD ecological status 'High'	Very low risk

Table 4.1. Summary of the bias introduced by downscaling the data and the implications of scaling the 'Index' to remove bias.

For the examples quoted above the scaling methodology does not appear to be introducing any significant issues. The greatest change in 'Indicator' risk score is from 'Very high' to 'Medium' risk for 'Water availability'. All other 'Indicators' move only one risk class, i.e. from 'Very low' to 'Low' when they are scaled to remove bias. As such the interpretation of risk, as presented in the WRF, would be reasonably representative of the downscaled data if the bias was removed. However, there is a lack of transparency which is troubling. The regulatory data has already been mapped spatially so that a common catchment geometry can be used. Scaling the risk further blurs the user's ability to understand the data and link it to the regulatory and policy framework of the country. Both scaled and un-scaled data have been provided in the final project deliverables.

5.0 Conclusions and recommendations

5.1 Conclusions

Downscaling data for the UK is possible and 8 out of the 9 datasets which could meaningfully be downscaled have been partially or fully downscaled for the UK. Only one dataset, Indicator 6 (Droughts) could not be downscaled, however, CEH are deriving a new dataset which will be available before the end of 2015. The remaining 11 datasets have been retained at their original scale because they represent 'Indicators' which have a single value for the UK

OpenData is key to the long term development of meaningful global and national water related risk assessment. Although the Environment Agency has only recently embraced the OpenData principle it has made a very significant difference to the outputs of this project. OpenData enables the true value of information and evidence to be realised. The WRF is an excellent example of how OpenData can enable the wider stakeholder community to promote the strategic aims of policy makers and regulators. A secondary, but still important consideration, is that OpenData reduces the resource required to develop tools like the WRF. This is important when resources are tight and budgets limited.

Using datasets developed by regulators or recognised and accepted by catchment managers will improve the ability of the WRF to influence strategic water management within countries. These datasets enable transnational companies to understand the conceptual model of a catchment that is being used to set policy and guide regulation. However, this does not mean that the conceptual model is correct in any given catchment. The WRF is part of the first phase of a risk assessment, site specific risk assessment (Phase 2) will always be needed if options are to be appraised (Phase 3) and water related risk is to be managed (Phase 4).

To facilitate the link between the WRF and policy/regulation, a country specific 'Index' is recommended. However, this will inevitably introduce bias and alter the relative risk of countries with downscaled data *versus* those who only have access to the global datasets. In this project each 'Indicator' has been given the 'Index' that reflects the regulator/policy makers strategic intensions.

It is possible to remove bias due to the introduction of downscaled datasets by scaling the 'Index' values derived from expert knowledge. However, this scaling process reduces the differentiation of risk within the country, (where downscaled risk is higher than global risk) or exaggerates the differentiation of risk (where downscaled risk is lower than global risk). In general, for a well regulated country like the UK, the process of downscaling will increase the level of water related risk compared to the global picture. Correcting this bias potentially breaks the link between the WRF and the policy/regulatory framework in the country.

Several data related QA issues have been highlighted in the process of doing this project. The most important is that there are a handful of gaps in the data coverage for both the original datasets, currently used in the WRF, and the downscaled datasets derived within this project. These gaps can be filled 'by hand' by pairing the missing catchment with a neighbour and infilling the missing data with that of it's neighbour. There are two outputs provided from this project, one infilled the other retaining the data gaps. The infilled dataset is more representative, however, if the results were questioned for an infilled catchment it would not be possible to provide evidence to back up the risk score in that catchment.

5.2 Recommendations

There are five main recommendations.

Retain 'Basin Related Risk Results' summary but replace the detailed results with the downscaled 'Index' and associated 'Answer'. Do not try to remove the bias introduced by the downscaled data.

This means that the same outputs can be viewed as in the current tool, however, the detailed outputs at HydroBasin12 scale may conflict with the globally consistent outputs at HydroBasin6 scale. It should be possible to present the data so that the apparent conflict is not visible to the end user.

Use downscaled data within countries to provide spatial differentiation of risk as understood by policy makers, regulators and catchment managers within each country. This will introduce bias, however, the HydroBasin6 summary retained above, can be used to strategically plan between catchments.

Link WRF tool to the new CaBA website (http://www.catchmentbasedapproach.org/). This will allow a user of the tool in the UK to understand which CaBA catchment they are in; who the lead organisation is and what their delivery plan for the catchment is. This is a very powerful way for transnational companies to engage with local catchment management and the wider aspirations of the communities in which their business or its supply chain are located.

Use the WRF to lead the user though the next three phases of a structured risk assessment. Green leaves III, Defra (2011) provides an excellent framework for the assessment and mitigation of water related risk. It will be useful to explicitly show users where they are in this process and what they need to do to refine their risk assessment and manage their risk to, and from, the water environment in the UK.

Promote the use of OpenData across the UK environmental and research communities. WWF could become a member of the ODI. http://opendatainstitute.org/ The ODI and the Environment Agency have requested permission to use the WRF as an example of how OpenData can be used to further the environmental aims of data providers.

5.3 Issues which require further consideration.

Six areas have been identified which require further consideration.

Change the language from risk to opportunity by linking the WRF to ecosystem services maps. Many CaBA catchments are developing Ecosystem Services Maps, see Figure 5.1 below. These maps show the opportunity areas within each catchment for the delivery of a variety of provisioning services and present business with a positive alternative; rather than reducing risk they can increase ecosystem services. This approach has significant potential to allow businesses to actively enhance the water environment. The potential for the use of opportunity maps could be explored within the WaterLife project.

No deteriation is a higher priority for UK regulators than improving failing water bodies. The WRF currently identifies 'High' status water bodies as 'Low risk' . This could be interpreted to imply that the water environment of these catchments should be exploited preferentially to those which are at 'High risk'. This leads on directly to the discussion below about vulnerability.

Vulnerability vs. Risk. Vulnerability allows for strategic planning to avoid risk. The approach is most developed in the groundwater community because of time delays in the system, however, it is equally applicable to surface water. Businesses who understand vulnerability can avoid risk rather than managing it.

Downstream connectivity of risk. The downscaled datasets from the UK have highlighted that there are two approaches to the mapping of risk. One which defines the risk at a location and the other which defines the source of a risk at a location. Both approaches are valid and have their uses. It would be possible to incorporate an element of connectivity into the WRF by using the attributes of the HydroBasin12 dataset which identifies upstream catchments. Improve the tool to look downstream and tell you the worst downstream risk and where it is.

Coastal and transitional waterbodies. Water related risk to coastal and transitional waterbodies is not explicitly recognised within the WRF. The latest version of the WFD status released by the Environment Agency on the 24th March 2015 does not address this issue, however it is likely that future data releases will do..

References

Defra. 2011. Guidelines for Environmental Risk Assessment and Management (Green Leaves III)

Annex 1: Datasets to be provided to WWF

Indicator	Dataset	Coverage	Comment
1	Resource_Availability_Sept2014	England	
2	Resource_Availability_Sept2014	England	
3	Resource_Availability_Sept2014	England	
4	Groundwater_WBs & SEPA_data_GW_2012	Scotland	
5	Indicator_5.shp	England, Scotland and Wales	
7	RoFRS_v201412	England	
8a	SG_NitrateVulnerableZones_2002	Scotland	None commercial use license
8b	WFD_RIVER_WB_CATCHMENTS_CYCLE2_DRAFT & WFD_Classification_Status_Cycle2	England	
8c	Indicator_8c.shp	England, Scotland and Wales	Open Government License
8e	WFD_RIVER_WB_CATCHMENTS_CYCLE2_DRAFT & WFD_Classification_Status_Cycle2	England	
8h	WFD_RIVER_WB_CATCHMENTS_CYCLE2_DRAFT & WFD_Classification_Status_Cycle2	England	
8i	WFD_RIVER_WB_CATCHMENTS_CYCLE2_DRAFT & WFD_Classification_Status_Cycle2	England	
9	WFD_RIVER_WB_CATCHMENTS_CYCLE2_DRAFT & WFD_Classification_Status_Cycle2	England	

Annex 2: Datasets used which cannot be provided to WWF

Indicator	Dataset	Coverage	Comment
1	Wales_Resource_Availability_Q50_Q95	Wales	Surface water status data only licensed for this project
1	SEPA_data_rivers_2012	Scotland	Surface water body shapefile only licensed for this project. Status data is available on an open license.
2	Not available	Wales	
2	Not available	Scotland	
3	Wales_Resource_Availability_Q50_Q95	Wales	Surface water status data only licensed for this project
3	Not available	Scotland	
4	Groundwater_Status_Objectives_Final	England and Wales	Groundwater body shapefile licensed for this project only.
7	Not available	Scotland	
8a	Nitrate_Vulnerable_Zones_polygon	England	Licensed for this project only
8a	NVZ_2013	Wales	Licensed for this project only
8a	SG_NitrateVulnerableZones_2002	Scotland	
8b	20150316WFDElementClassificationWales_2013Cycle2	Wales	Surface water status data only licensed for this project
8b	SEPA_data_rivers_2012	Scotland	Surface water body shapefile only licensed for this project. Status data is available on an open license.
8e	20150316WFDElementClassificationWales_2013Cycle2	Wales	Surface water status data only licensed for this project
8e	SEPA_data_rivers_2012	Scotland	Surface water body shapefile only licensed for this project
8h	20150316WFDElementClassificationWales_2013Cycle2	Wales	Surface water

			status data only licensed for this project
8h	**SEPA_data_rivers_2012**	**Scotland**	**Surface water body shapefile only licensed for this project**
8i	**20150316WFDElementClassificationWales_2013Cycle2**	**Wales**	**Surface water status data only licensed for this project**
8i	**SEPA_data_rivers_2012**	**Scotland**	**Surface water body shapefile only licensed for this project**
9	**20150316WFDElementClassificationWales_2013Cycle2**	**Wales**	**Surface water status data only licensed for this project**
9	**SEPA_data_rivers_2012**	**Scotland**	**Surface water body shapefile only licensed for this project**