

The Broads Climate Change Adaptation Approach

Preliminary Draft



**Acting as the Adaptation Plan for the Broads for the
Government's Adaptation Reporting process**

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Broads Authority
Dragonfly House
2 Gilders Way
Norwich NR3 1UB
www.broads-authority.gov.uk
Tel 01603 610734

Broads Climate Change Adaptation Approach – Preliminary Draft

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I. The Broads

The Broads

“...a breathing space for the cure of souls”

The Norfolk and Suffolk Broads is renowned as the UK’s premier wetland, a unique and globally important landscape shaped and nurtured by its inhabitants since at least Roman times. Encompassing an area of 303km², the Broads sits between the peripheral urban areas of Norwich, Great Yarmouth and Lowestoft, with a short coastal strip at Winterton and an estuary at Breydon Water. The low-lying, mainly open and undeveloped landscape of the Broads comprises an interconnected wetland mosaic of rivers, broads, fens, marshes and woodland rich in rare habitats and species, some of which are unique to the area.

The shallow lakes referred to as ‘broads’ originated as great pits dug for peat to provide fuel during medieval times. In the 14th century these peat diggings flooded and became part of an extensive communication network for transporting fuel, building materials including reed for thatch, and livestock and their products, especially wool. The advent of the railways in the mid-19th century and motor vehicles in the 20th century brought most river-borne commerce to an end, but made the Broads accessible as a popular tourist destination for boating holidays, with 200km of navigable, lock-free rivers and open water bodies to be explored and enjoyed.

The importance of the Broads is borne out by a range of national and international designations in recognition of its landscape, nature conservation and cultural features. These special features and the ways in which they provide for local communities and economies are described in more detail throughout this Plan. Particularly important is the role of the Broads, as a member of the UK National Parks family and global network of protected landscapes, in demonstrating how wetland resources can be managed sustainably for the benefit of nature and people.

The Broads Authority

The Broads Authority is a Special Statutory Authority established under the Norfolk and Suffolk Broads Act 1988 with very similar responsibilities to those of the English National Park Authorities. It is the local planning authority for the area and a harbour and navigation authority. It has a duty to manage the Broads for the following three purposes, none of which takes precedence:

- Conserving and enhancing the natural beauty, wildlife and cultural heritage of the Broads;
- Promoting opportunities for the understanding and enjoyment of the special qualities of the Broads by the public; and
- Protecting the interests of navigation

while having regard to:

- The national importance of the Broads as an area of natural beauty and one which affords opportunities for open-air recreation;
- The desirability of protecting the natural resources of the Broads from damage; and
- The needs of agriculture and forestry and the economic and social interests of those who live or work in the Broads.

The Authority also has the duty to:

- (a) Maintain the navigation area for the purposes of navigation to such standard as appears to it to be reasonably required; and
- (b) Take such steps to improve and develop it as it thinks fit. Further provisions for the regulation and management of the navigation area were made through the Broads Authority Act 2009.

The Authority's executive boundary is drawn tightly around the flood plains and lower reaches of the rivers Bure, Yare and Waveney and their tributaries the Thurne, Ant, Wensum and Chet. The map below shows the Broads Authority Executive area (in white) and the wider Broads area considered for adaptation.



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II. The Adaptation Approach

I. Why produce a climate change adaptation plan?

- 1.1 The Earth's climate is changing, and these differences in global temperatures are already altering weather patterns, causing sea levels to rise and increasing the frequency and intensity of extreme weather. Even if greenhouse gas emissions stop today, our past emissions mean changes to the climate will continue for the next 30-40 years.
- 1.2 Altering our behaviour to respond to these impacts of climate change is known as 'adaptation'. It means not only protecting against negative impacts, but also making us better able to take advantage of any benefits. The earlier we start adapting, the less it will cost and the better equipped we will be to cope with these and other potential changes. Successful forward planning – not just responding to emergency situations – will save lives and money.
- 1.3 The Climate Change Act 2008 introduced a new power for the Secretary of State to direct "reporting authorities" (bodies with functions of a public nature such as water and energy utilities) to prepare reports on how they are assessing and acting on the risks and opportunities from a changing climate. In the first round of reporting (2009-11), 91 organisations have been issued with Directions to Report including Natural England, the Environment Agency and the Forestry Commission. Defra also invited certain other bodies to voluntarily produce a similar report. The English National Parks and the Broads Authority accepted this invitation.
- 1.4 The Act also introduced an Adaptation Sub-Committee (ASC) of the independent committee on Climate Change. The role of the ASC includes the preparation of the UK Climate Change Risk Assessment by January 2012 which will enable all UK Administrations to understand the level of risk and prioritise adaptation policy. This is the first assessment in a series that will be updated in 5-year cycles and will draw heavily on existing evidence. In many sectors there are gaps and these will need to be filled for future cycles.

2. A Plan about how the area may need to adapt

- 2.1 While adaptation planning for most of the reporting authorities is focusing primarily on business continuity, the National Park Authorities are looking more at how their particular areas would need to adapt, and are therefore producing high level spatial/features plans. This should start the discussion about how adaptation of the particular features of protected landscapes can be achieved enabling them to retain their special qualities as the inevitable impacts of climate change take effect.
- 2.2 Many climate change impacts will only gradually become noticeable and significant. The exact changes are also hard to predict as they are related to the choices people make in the short term that may ameliorate or exacerbate the inevitable. At this stage, therefore, the main purpose of the Plan is to explore what the vulnerabilities might be and consider what needs to change to enable society to cope with the new ranges of variation. Although following a risk

assessment process, it is vital also to consider benefits and opportunities, with the ultimate goal being to plan ahead and create as many benefits as possible.

- 2.3 At this stage, the main focus is about producing sufficient information to allow a high quality of debate by society to identify early the necessary choices to cope with climate variables. It is as much about identifying what we don't know and need to find out about, along with making choices that create options for dealing with adverse impacts.

3. Who is involved?

- 3.1 In 2009/10 Natural England led on some innovative work considering how the natural environment in the Broads Character Area might be impacted and some possible adaptive responses. Their report, 'Responding to the impacts of climate change on the natural environment: The Broads', is a comprehensive assessment for the natural environment, though it also highlights the importance of looking at socio-economic aspects alongside the environment and the vital need to work in partnership with a wide range of interests.
- 3.2 To ensure the main agencies explored these issues together, the adaptation plan process has been overseen by the Broads Climate Change Adaptation Panel that brought together the Broads Authority, Natural England, the Environment Agency, local authorities, the National Farmers Union and the University of East Anglia. There has also been regular reference to the Broads Forum – a representative forum bringing together 30 different interests in the Broads – to keep the process open, seek advice and check assumptions.
- 3.3 This early debate has led to the production of this preliminary draft adaptation plan, which will be used to stimulate debate with a wide range of interests towards the creation of a comprehensive adaptation plan with wide support. Although led by the core agencies, it has always been the intention to develop an adaptation response with the input and support of the wider society.

4. Core principles in its creation

- 4.1 This draft Plan has been informed by a range of expertise. Natural England's report has been a vital reference document that informed thinking, and heads the list of references used to inform the process.
- 4.2 Many of the concepts of adaptation are no different to the way people in the Broads have reacted to past climate changes and other influences. Yet this relatively new area of science creates the need to react in fresh ways, sometimes using new terminology. To understand the scale and scope of the changes required it was considered useful to provide something tangible for wider interests to react to. Hence the core agencies have produced a 'preliminary draft' as a starting point. This will provide the foundation for dialogue with wider interests to provide deeper understanding and build commitment. The process to date has highlighted gaps in knowledge and thrown up questions where assumptions have had to be made. The principle has therefore been to keep moving forward, noting that when further work clarifies

these gaps or assumptions the process would be reviewed. This Plan therefore needs to be a dynamic document, regularly reviewed and modified according to improving understanding and data.

- 4.3 The ultimate outcome is a set of agreed actions that will enable the Broads, and especially the special qualities that give rise to its recognised national importance, to adapt to the changing climate predicted for the 2080s. Some actions may require early implementation; others may await certain 'trigger events' within the climate. However, in these initial stages of adaptation planning, the first outputs will be a range of options for people to consider with the hope that implementation will bring multiple benefits and retain as many choices for the future as possible. Multiple benefits and cross relating action to other objectives in the Broads Plan 2011 (the key strategic management plan for the Broads) will of course improve the chances of acquiring necessary resources.

5. Methodology

- 5.1 The methodology approved by the Climate Change Adaptation Panel was strongly based on the process created by Atkins for Natural England's pilot work on adaptation of character areas expanded to clearly incorporate socio-economic as well as the environmental aspects. Diagram 1 is a simplification of the methodology (full methodology available in Appendix 1).
- 5.2 As well as the various steps required, there is reference to the need for a good dialogue with a wide range of interests to ensure the information used comes from a variety of perspectives. In undertaking the work, some stages were found not to be as helpful as initially thought, and may be circumvented in future iterations. (For example, although the Landscape Types helped identify the differing nature of parts of the Broads, they were not particularly helpful in prioritising the special qualities to focus on.)
- 5.3 At this stage the process has only reached initial adaptation options. Preliminary work on the next step of choosing the options has shown that the process would be better undertaken as part of the dialogue with other interests and so has not been progressed for the preliminary draft.

Diagram 1: Summary methodology for producing the Broads Climate Change Adaptation Plan



Transparent process informing stakeholders – especially organisations, landowners and Communities of progress made and where they can contribute.
Undertake compelling interpretation to reduce complexity and gain support

6. Content Assumptions

- 6.1 The Plan has used the UK CIP 2009 data as the basis for consideration. The vulnerability assessment considers the changing climate in three time epochs (2020s, 2050s and 2080s) and uses the 'medium emissions' scenario for guidance. (The low emissions scenario is already considered by some as virtually unachievable; and, while the high emissions scenario might suggest the worst the area would need to cope with, the Panel felt it would become a case of acting when certain triggers occurred/conditions were reached rather than making assessments based on specific timeframes or worst case scenarios.)
- 6.2 The focus of the vulnerability assessment is on the special qualities or features of the Broads within the Authority's executive boundary, although the pragmatic boundary for consideration has been the wider area, including some of the higher land beyond the floodplain and with a mind to the full catchment.

7. Landscape types and special qualities

- 7.1 The initial analysis looked at the assets and functions of the area, using the Landscape Character Assessment (LCA) undertaken in 2008 to identify the 13 main landscape types in the Broads. This information was cross related to the 'Vision for the Broads' in the Broads Plan 2004, which was based on extensive consultation with users and residents about what they most valued about the Broads. From this analysis, 13 special qualities were identified, covering the environmental and socio-economic importance of the Broads and capturing the essence of the area. This inevitably is simplistic; as the process is refined and improved a more robust and comprehensive set of qualities may be needed.
- 7.2 The next stage was to take each of the 13 qualities and consider how the likely major climate changes would impact upon it (see appendix 2). This process was undertaken by key officers from the Broads Authority with the support of officers from Natural England, Environment Agency and Norfolk County Council.

8. Vulnerability assessment

- 8.1 The identified impacts were fed into the ENPAA (English National Park Authorities Association) developed 'vulnerability assessment spreadsheet'. This required scoring the likelihood of the impacts occurring (from 1 to 5) and the outcome of those impacts (from a negative -5 to a positive +5). This was undertaken for each of the three time epochs (2020s, 2050s and 2080s) and gave combined figures which could be ranked low, medium or high for both positive opportunities and negative risks. The resultant scoring was reviewed by the same group of officers from the agencies. In all, over 110 potential impacts in 6 major categories were scored, giving results that could theoretically run from +25 through 0 to -25.

9. Summary of vulnerabilities

- 9.1 Rather than continue to look at all impacts, those that scored 12 and above were prioritised for further analysis. This enabled a realistic number to be taken forward and, by adopting a 'high score' filter, should have given more weight to those impacts which were more significant.
- 9.2 This filter process gave 32 potential impacts with a score between -12 and -25 and one scoring over +12. The summary and simple analysis of this information is shown in Appendix 3. The vast majority of the most likely impacts were related to the management of water, with water levels leading to flooding being the greatest risk and issues about poor water quality (due to increased nutrients and higher salt levels) also being significant.
- 9.3 Most impacts only became significant towards the later time epochs when conditions were becoming noticeable. This suggests that, although the process of adaptation should not be put off, there is time for public debate to inform the best choices to make. However, all decisions about future management of these special qualities need to start taking into consideration climate change now to ensure choice remains as wide as possible.

10. Adaptive options

- 10.1 The next step in the process was to consider what adaptive options might be appropriate. To aid this process a template was used that divided adaptation into 5 generic approaches (defend, move, technological, management change, withdraw) to stimulate lateral thinking. At this stage, the viability and acceptability of different approaches were not assessed.
- 10.2 The next step was to use the Climate Adaption Tool developed through the Norfolk Climate Change Partnership to consider the acceptability of the options. This uses a multi-criteria analysis rather than just a simple cost benefit analysis, using a scoring system based on the weighting given to four pairs of acceptability criteria (see Appendix 1). Preliminary work with the officer group showed that the process often required extensive discussion to clarify assumptions and the context for conclusions. Although the process was seen as very valuable in debating the detail of the simplistic adaptation options identified and drawing out the implications of the choices made, it was challenging to succinctly record the assumptions and pathways chosen alongside the score. The scores that were being derived did not always show much variation, suggesting that further discussion would be needed before conclusions could be drawn. It was therefore proposed that this important step should become central to the next stage of dialogue with wider interests. (See the communication approach further on in the Plan)

11. Adaptation options overview

- 11.1 The review of the adaptation plan process by the Climate Change Adaptation Panel reinforced the view that the significant impacts of climate change and sea level rise in the Broads revolved around how to deal with water levels and the predicted increased flooding risk. Consideration of the direction for adaptive options may also be simplified into what the Panel suggests as three future scenarios¹ that should be considered by the wider interests.
- 11.2 The first scenario is what might happen if no major changes are made to current policies and management practices. The approach of land owners, managers and agencies to any current circumstances in the Broads has always been one of adaptation, and there is no such thing as a static picture of 'no change'. However the 'business as usual' approach creates a form of baseline to assess what the continuing effects of a rapidly changing climate might bring.
- 11.3 The second option is to consider a scenario where every effort is made to control and direct the increasing water levels. This approach may be simplified as putting the effort into greater and more effective water control structures such as sluices, higher banks and barriers – resisting the changes and using engineering approaches to dominate.
- 11.4 The third scenario is one that makes more space for water, accommodating and coping with the natural processes of fluctuating water levels. This approach may be simplified as finding areas where excess water can be allowed to go, such as wash-lands temporarily holding excess water.
- 11.5 The third scenario can be further informed by considering where such water-holding can occur. It is likely that, to protect the more natural floodplains higher up the rivers (where some of the most important biodiversity areas exist such as the lowland fens, and where greater threat may occur to scattered properties) then the currently drained and flood-protected marshes in the lower reaches would become prime areas to hold water, requiring a new approach to making these marshes retain their profitability.
- 11.6 The next steps in the process may be to trial the use of the Climate Adaptation Tool to test acceptability of options with wider interests, using these broad brush visions to help stimulate debate about what people might wish to see for the future of the Broads. It is acknowledged that such a process would be hampered by gaps in knowledge and data, requiring further investigation and iteration of the adaptation plan as understanding improves.

12. Dialogue with wider interests

- 12.1 The need to enter into effective dialogue with the wider interests in the Broads is vital to creating a realistic Adaptation Plan. Such a process would bring great benefits especially the ability to combine various perspectives of something that is still relatively difficult to grasp, bringing insight and building a deeper understanding of, and ultimately a deeper commitment to, changes that will be required. It is recognised that the level of understanding of climate change and its impacts is varied, and many different views are expressed. People need to

¹ *Alternative terms could be : 'visions', 'starting points'; 'visualisations'; 'outlines'; 'possi-scapes'*

become comfortable with the terminology and concepts being used. However it is very important to build understanding and facilitate the involvement of all as everybody is likely to be affected.

- 12.2 To agree the core messages and identify the best methods of communication, a communication plan has been developed with partner agencies, showing the joined-up approach from the public sector to this issue. The Plan will be reviewed and refined as assumptions are tested and experience is gained. The draft Communication Plan is detailed in Appendix 4.

13. Next steps

- 13.1 The next steps in the adaptation plan process will be to work with a wide range of interests to assess the identified vulnerabilities for the Broads and discuss the viability and acceptability of adaptation options, based around the visions identified above. This will take place over the next 12 months. Future action can then be redefined and a timetable prepared for the development of the 'preliminary draft' into a supported working document on how the Broads can improve its adaptation to a rapidly changing climate.

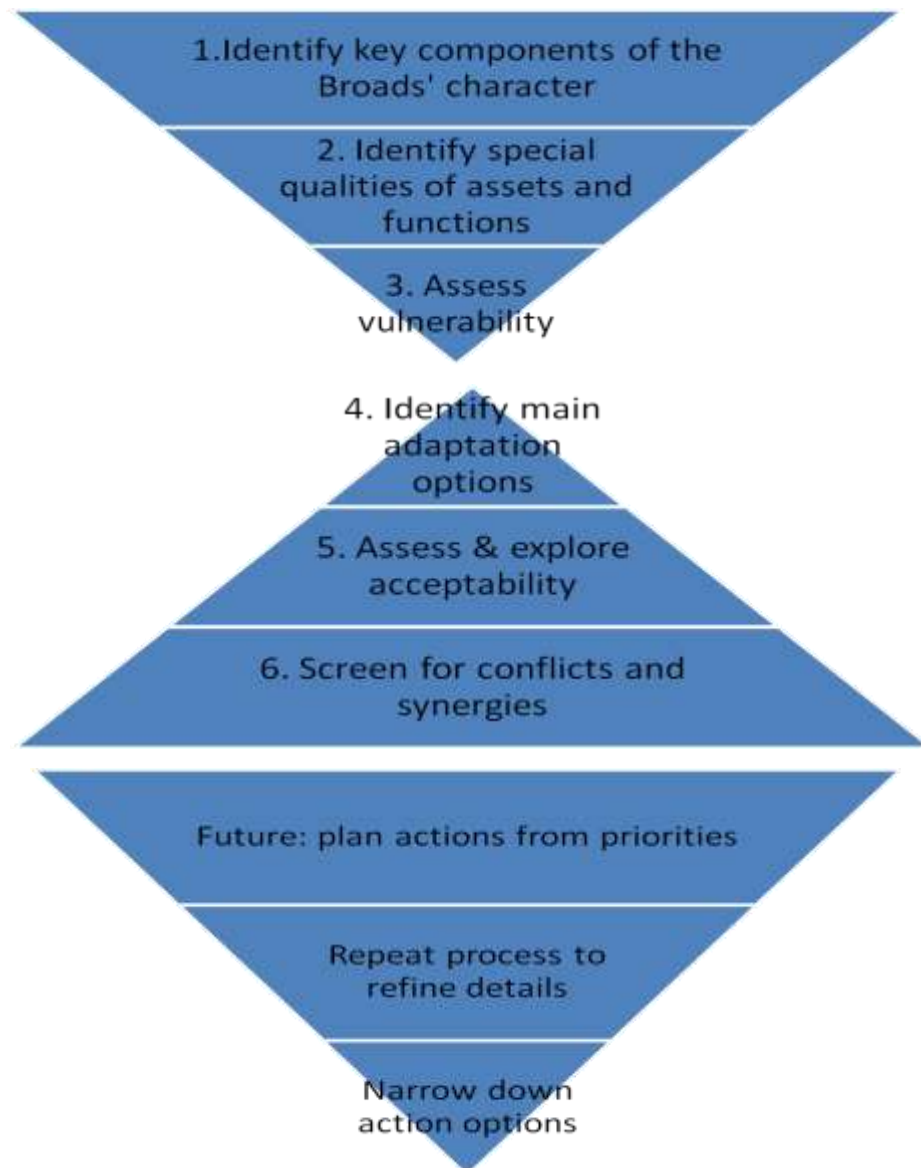
14. Conclusions and recommendations

- 14.1 A variety of forms of analysis has created a simple but encompassing suite of special qualities of the Broads that have been assessed to consider how the predicted climate changes might impact on them. The most significant outcomes have then been analysed to draw out how different actions might enable adaptation to the predicted conditions.
- 14.2 Although this work has been undertaken openly, there is now a need to work with a wider set of people interested in the Broads to check the work and start to explore which options are the most acceptable. This will improve understanding of the likely impacts, the viability of potential options hopefully leading to a set of proposed actions that can be incorporated into policy and implementation plans over time.
- 14.3 This report can also be used to inform the national climate change risk assessment programme and help develop the expertise needed to form area based adaptation plans alongside continuity adaptation plans. Further work is required to develop the Broads Adaptation Plan and then to explore the synergies and conflicts with other Adaptation Plans within the area and the scope of operations.

Appendix 1 - Methodology for the Adaptation Plan

Broads Adaptation Plan – a *DRAFT* methodology
(strongly based on work by Atkins for Natural England)

Figure 1 Broads Climate Change Project methodology



Using the methodology

Step 1: Identify landscape characteristics and functions

The starting point is the identification of the characteristics and functions of the Broads. Firstly there is the landscape character assessment - broad statements which together describe the aspects of the Broads which make it distinctive. (*Start from the Landscape Character Assessment of the Broads undertaken to support the Broads Plan and Local Development Framework.*) This has produced 31 Landscape Character Units at a finer scale than the county landscape character assessment. As this seems too many to cope with, each Character Unit can also be ascribed to a Landscape Character Type of which there are only 13. These are broader headings of landscape and are applicable to other areas away from the Broads.

This will need a review to see if it adequately addresses the socio-economic characteristics adequately – e.g. a boatyards may not feature as characteristic in landscape terms, but their presence in Landscape Character Types/Units (often with a causal relationship with the landscape and environment) will help define the differences and underpin the functions

Functions encompass the full range of ecosystem services identified by the Millennium Ecosystem Assessment (World Resources Institute 2003). Services delivered by an ecosystem or natural area can be identified under the four headings:

- Supporting services - such as nutrient cycling, oxygen production and soil formation. These underpin the provision of the other 'service' categories.
- Provisioning services - such as food, fibre, fuel and water.
- Regulating services - such as climate regulation, water purification and flood protection.
- Cultural services - such as education, recreation, and aesthetic value.

This widely accepted natural environment framework needs to be reviewed to see if it also suits the socio-economic elements. Many important socio-economic elements fall easily under the 4 main headings. For example:

- Farming coming under provisioning services;
- Community buildings or sports areas, historic buildings and features coming under cultural services
- Utility and transport infrastructure coming under supporting services

However it is perhaps unclear and not automatic where economic services such as employment provision (be it through manufacturing or tertiary services) or retail (which provides employment and 'provisions') or the hospitality trade (pubs) might fit. This perhaps needs to be drawn out and noted in a supporting commentary as the detailed process is followed through.

Step 2 - Identify assets and features which contribute to character and function and collectively reflect the special qualities of the Broads

In Step 2, the tangible assets and features which contribute to the characteristics and functions should be identified. The scope of an area based adaptation plan is vast. Many of the assets and features present will be subject to assessment and adaptation planning by specialist interests anyway (e.g. the water companies will be undertaking their own adaptation planning to explore their assets and services). Therefore to enable the Broads Adaptation Plan to be a realistic and achievable activity it should focus on just a range of assets and features that are highly distinctive to the area and create the foundation of its special qualities.

The characteristics and functions identified in Step 1 will be a mix of many things present in the landscape from land form and wildlife, to human constructions and activities. Some will be common to other parts of Norfolk and Suffolk, others just as common in the rest of the country. Therefore the process needs to identify the qualities that particular help define the distinctiveness of the Broads especially those aspects that people value and feel are part of the essence.

There are of course services and features that people greatly value that will have to adapt – such as a rail connection or health services. These will need to adapt to climate change and those adaptations will be repeated in many places albeit in varying ways according to the local details of impacts and decisions. But these service adaptations are either outside of the physical adaptations which will impact on the landscape and character of the Broads or are part of generic change that will be seen in many places. There may of course be adaptations that do affect character – such as changing window sizes to cope with temperature which can impact on vernacular architecture – and these should be brought into the process.

As a starting point for this work, the vision outlined in the Broads Plan can be used. Created following extensive consultation for the Broads Plan 2004 and refined and update, along with further consultation in 2010, the vision seeks to draw out the elements of the area that give it a distinctive feel and are considered vital for the mix of functions it provides.

Step 3 - Assess vulnerability of assets and features

We have a general idea of how the climate might change and some information about the possible consequences for different aspects of the environment. However, consequences of climate change are likely to vary greatly from place to place, not just because of spatial variation in climate change itself, but because vulnerability is also affected by intrinsic features that affect sensitivity to particular changes and by 'adaptive capacity' of different areas. Therefore, we need to go beyond discussing general effects, to start to explore what the consequences of climate change might be for the distinctive elements identified in step 2.

The aim of the vulnerability assessment in this method is to highlight at the Broads scale, assets or features which are potentially more vulnerable to the impacts of climate change than others. The assessment should be seen as a tool for directing adaptation efforts. The uncertain nature of climate change and the response of the environment at the landscape scale make it difficult to make an objective assessment about the relative vulnerability of assets and features. It is recognised that the assessment of vulnerability undertaken is a subjective process. However by initiating the process through involvement of specialists to create a draft that is then open to review and refinement by

those with a clear stake in the Broads, the justification for the assessment is made as transparent as possible. The process will need to be repeated as understanding grows to improve the outcomes. It will also be important in later stages to assess adaptation options to explore whether the action proposed unacceptably alters future choices. If this appears to be the case further study would be needed to seek to ensure permanent narrowing of future choices is the best direction to take.

The assessment should consider each asset or feature in terms of its exposure and sensitivity to climate change and then its adaptive capacity. The method does not require detailed very local bioclimatic data as it recognises that there is a high degree of uncertainty over the response of the environment to changes in climate variables. The frequency and magnitude of exposure of assets or features to the impacts of climate change are likely to be important factors contributing to the vulnerability of an asset. The exposure of an asset or feature may also be modified by micro-climatic factors such as location or aspect. Local knowledge of the Broads and the specific asset or feature is likely to be required to assess exposure of assets.

The sensitivity of an asset or feature to climate change will depend on the degree to which it is affected by change in climate variables. Sensitivity might be modified by the tolerance of the asset or feature to a change in climate variable or its position with respect to its climatic range.

The adaptive capacity of an asset or feature will depend on factors which affect the ability of the asset to adjust or be adjusted to climate change, to moderate potential damage or to take advantage of opportunities.

Using the English National Parks spreadsheet for vulnerability assessment will provide a relative score in terms of scale and likelihood of impact over three time scenarios and encompasses positive impacts and opportunities. This results in a range of scores and a simple colour coding to quickly gauge aspects and produce some form of ranking. This is intended to provide a guide to the relative vulnerabilities rather than an absolute assessment of vulnerability.

The aim of the vulnerability assessment is to assist in the prioritisation of considering adaptation responses within the Broads.

Where possible, the assessment should eventually refer to published evidence regarding the vulnerability of climate change on the environment. This should include local studies and projects where they exist. At the initial and early iterations of this work there may be very limited direct evidence. However the process will start highlighting when knowledge is poor and help steer the process of filling the gaps.

Step 4 - Explore the adaptation options to address the vulnerability

Once the vulnerabilities are assessed options on how to improve the situation can be identified and considered moving down the ranked assets and features depending on the resources available. Rather than seeking to find all the possible variations on what can be done, indicative options reflecting the style of adaptation are probably best at this stage (e.g. a defensive option resisting impacts; a change over time; a step change; technological solution; favouring natural processes etc.)

The options need to be robust enough to be felt they would work, though lateral thinking may contribute options that go past current understanding. However at this stage the test is probably only

‘would they deal with the impact’ with assessment of the range of options to identify acceptable and favoured choices following.

It is possible for adaptive options to solve one issue and exacerbate another. Again these conflicts can be drawn out in future steps but it will be best to very carefully consider whether options that have very clear negative impacts elsewhere are worth considering.

Step 5 – Assess the acceptability of the options

The Norfolk Climate Change Partnership’s Climate Adaptation Tool provides a process to weigh up and score the possible options using a range of factors.

These are divided into four main criteria, each sub divided into two themes, as shown in table 1 below:

Table 1: Acceptability criteria

| | |
|--|--|
| Acceptability | |
| Criteria 1.1: Political acceptability | This criterion examines whether an adaptive response would attract political praise or criticism. When assigning your criteria value, you should consider the extent to which your organisation values its ability to satisfy government targets, strategies and legislation. |
| Criteria 1.2: Social acceptability | This criterion examines whether an adaptive response would attract public praise or criticism. When assigning your criteria value, you should consider the extent to which your organisation values its ability to satisfy public concerns and interests. |
| Economics | |
| Criteria 2.1: Capital investment | This criterion examines whether the initial investment in an adaptive response is economically viable. When assigning your criteria value, you should consider the extent to which your organisation values capital expenditure on staff, materials and other resources. |
| Criteria 2.2: Cost-benefit | This criterion examines whether ongoing costs or benefits from an adaptive Responses are economically viable. When assigning your criteria value, you should consider the extent to which your organisation values long term costs or benefits, and how they might increase or decrease over time. |
| Effects | |
| Criteria 3.1: Suitability | This criterion examines the suitability of an adaptive response in responding to a corresponding risk. When assigning your criteria value, you should consider the extent to which your organisation values the relative success of an adaptive response taking into account uncertainties that might be associated with a given risk. |
| Criteria 3.2: Environment | This criterion examines how an adaptive response might affect the environment. For example, an adaptive response may have positive or negative impacts upon aspects of the environment such as soils, water, air quality, flora, fauna or ecosystem services. When assigning your criteria value, you should consider the extent to which your organisation values the environment and how it might be impacted by an adaptive response. |
| Delivery | |
| Criteria 4.1: | This criterion examines the resource capacity of your organisation for |

| | |
|---|---|
| Resources | Implementing adaptive responses. When assigning your criteria value, you should consider the extent to which your organisation needs to enhance this capacity, taking into account the feasibility of adaptive technology, practicality in delivering an adaptive action and the available expertise. |
| Criteria 4.2: Adaptation network potential | This criterion examines the adaptation network potential of an adaptive response: the potential for it to be delivered in partnership with other organisations facing similar risks. When assigning your criteria value, you should consider the extent to which your organisation values participating in 'adaptation networks', thereby sharing responsibility. |

Through a process of allocating percentages to each criterion the Tool can calculate a cumulative score for each option to give an indication of how acceptable pursuing such a choice might be. Modifying the percentages according to differing criteria allows a different weighting to emerge.

It is unlikely that this step will give you unambiguous answers on how to proceed. It should enable a transparent process to operate that suggests the direction of travel and highlights where further work is needed to properly understand the options given.

Step 6 - Identify adaptation actions under headings of characteristics and functions

In Step 5, potential adaptation actions to respond to the implications for landscape character and function are evaluated in terms of acceptability. The aim of adaptation is to maintain the value or function of the landscape, rather than necessarily trying to maintain, unchanged, the assets and features in it. Adaptation responses should therefore aim to build adaptive capacity and deliver an environment that has the ability to change.

Adaptive management may be a helpful concept to consider when identifying potential adaptation actions. Adaptive management responds to climate change through incremental change or modifying existing management practices in the face of uncertainty. The approach involves making a change to an existing management practice and monitoring the results to ensure the response is effective. As a result of monitoring, the management practice may need to be reviewed again.

Several sets of principles have been developed for adaptation which could be useful as a guide to general approaches. However, these need to be applied and tailored to the specific characteristics and functions of the Broads to develop appropriate adaptation solutions.

This step of the methodology aims to generate a list of potential adaptation actions to address the vulnerability of the character and function of the Broads to the impacts of climate change. At this stage, it is helpful to think broadly about potential actions and not be constrained by questions of cost or delivery as conflicts, synergies and barriers can be identified.

Step 6 - Screen options - identify multiple benefits, options that address multiple aspects of vulnerability and any conflicts

It is important that suggested adaptation actions do not have unintended negative impacts on the environment and that potential conflicts are recognised early. Step 6, therefore, aims to identify conflicts and also synergies between potential actions, i.e. those which may deliver multiple benefits for the character and function of the Broads.

For example, soil conservation measures such as using buffer strips, increasing organic matter content of soils and increasing the period of vegetative cover, are likely to deliver multiple benefits for habitats, agricultural production and water quality. However, a proposal to extend woodland habitat in a river valley may obscure landscape features, impede recreation activities such as sailing or impact on adjoining land management.

Future Steps – steps that need to be re-defined when reached

Once the options have been identified there will need to be a process of prioritisation for implementation taking note of the urgency for action and the benefits accrued. However as understanding of climate change and its impacts grow it will be vital to re-visit the steps above to refine and improve the process. The time scales for this are not certain at this stage.

Communication

Throughout the process described above, there is a vital requirement to ensure openness and transparency. Ultimately, any adaptation needs to be implemented with the commitment of society. Experience has shown that undertaking this analysis away from the public gaze will create barriers that will have to be crossed at some point. The concepts involved are, however, complex and new to most people, and so the production of background information that can be used to initiate and support dialogue with the many interests involved is vital.

Therefore parallel to this methodology there needs to be clear dialogue with wider interests and a programme of involvement that allows the public to play a part. It should also foster commitment to the outcomes and so prepare for some of the difficult choices and changes that are likely if we are to cope with the new parameters of a changing climate. It will also allow a greater range of perspectives and facilitate the inclusion of new and lateral thinking to move from pure risk avoidance into a positive approach to benefit ecosystem services and the quality of life.

Appendix 2 - Special qualities and climate change impacts

| Ref | Special quality asset or function | Climate change variable | Impact |
|------------------|-----------------------------------|--|--|
| SQ1 | Lakes (Broads) | Wetter winters | Higher water levels and flooding of adjoining land More run off from adjacent land into broads Increase duration and depth of flooding |
| | | Drier, hotter summers | Lower water levels – possible pressure to increase winter usage; More plant growth; Stress on fish More tourists opportunities & pressures from them Less flushing |
| | | Extreme events | More bank-side erosion from wave wash Run off impacts + pollution |
| | | Sea level rise | Higher water levels and flooding of adjoining land Less predictability of water levels Moorings and staites threatened Saline incursions changing plant and animal life |
| | | Other | Tourism season extends Non native species invading: problems and possibly benefits |
| Indirect impacts | | As flood defences change to cope, more raised / strengthened banks beside the broads | |

| Ref | Special quality asset or function | Climate change variable | Impact |
|-----|-----------------------------------|-------------------------|--|
| SQ2 | Winding rivers | Wetter winters | Higher water levels and flooding of adjoining land Run off impacts Velocity changes – channel and sedimentation changes Draught on bridges – hard to get under more often |
| | | Drier, hotter summers | Lower water levels; depth impacting on boating? More plant growth; More tourists – opportunities & pressures from them Lower flows not holding back the salt incursion |
| | | Extreme events | More bank-side erosion from higher energy water Run off impacts – pollution and silt |
| | | Sea level rise | Higher water levels and flooding of adjoining land Less predictability of water levels Moorings and staites threatened Saline incursions altering plant & animal life |
| | | Other.... | Arable pumping might increase level of salt coming down the river in the drier summers Non native species: problems and possibly benefits |

| | |
|------------------|--|
| Indirect impacts | As flood defences change to cope, more raised / strengthened banks beside the broads |
|------------------|--|

| Ref | Special quality asset or function | Climate change variable | Impact |
|------------------|---|-------------------------|--|
| SQ3 | Ditches, dykes, drains See above (Treat this category as not natural systems – pump-drained) | Wetter winters | Flooding of adjacent land More pumping |
| | | Drier, hotter summers | Algal/plant blooms; impacts on aquatic wildlife systems; Livestock control harder; |
| | | Extreme events | More pumping; flush out fish nurseries Excessive water sitting on lands when drains back causing pollution problems |
| | | Sea level rise | Altering balance between fresh and brackish water; impact on species |
| | | Other.... | Non native species impacts Too saline and water welfare issue for cattle |
| Indirect impacts | Changing pumping regimes – more or better ones? Sub-division or possibly expansion of drainage cells? Different depths of channels required | | |

| Ref | Special quality asset or function | Climate change variable | Impact |
|-----|-----------------------------------|-------------------------|---|
| SQ4 | Relict estuary / Breydon water | Wetter winters | Tidal pulls; Passage through bridges; Unclear as to navigable boundaries |
| | | Drier, hotter summers | |
| | | Extreme events | More dangerous for navigation |
| | | Sea level rise | Loss of saltmarsh/inter-tidal; change of salinity; tidal fluctuations affecting people and wildlife such as loss of high tide roosts |
| | | Other.... | |

| Ref | Special quality asset or function | Climate change variable | Impact |
|-----|-----------------------------------|-------------------------|---|
| SQ5 | Fen | Wetter winters | Vegetation & invertebrate changes; Management and access issues |
| | | Drier, hotter summers | Vegetation & invertebrate changes; Expansion of scrub, loss of pools/ wet communities Fire risk increases ; Succession change |
| | | Extreme events | Thresholds / tolerances of species and communities exceeded |
| | | Sea level rise | Water quality – direct and indirect over-topping Change of salinity; |

| | | | |
|--|--|-----------|--|
| | | Other.... | Fluctuating wetland – peat chemical changes; carbon store impacts; Viability of management processes |
|--|--|-----------|--|

| Ref | Special quality asset or function | Climate change variable | Impact |
|------------------|-----------------------------------|---|---|
| SQ6 | Grazing marshes | Wetter winters | Grazing: stocking rates; different grazing periods. Different farming practices possible |
| | | Drier, hotter summers | As above – plus stock control Ochre issues in ditches |
| | | Extreme events | Stock impacts – isolation & threats |
| | | Sea level rise | More flood events: salt impacts on vegetation |
| | | Other.... | Livestock diseases Arable/irrigation water supply |
| Indirect effects | | Changes to access routes, bridges across ditches as management practices have to change | |

| Ref | Special quality asset or function | Climate change variable | Impact |
|-----|-----------------------------------|-------------------------|---|
| SQ7 | Wet woodlands | Wetter winters | Complex of species change |
| | | Drier, hotter summers | Expansion of scrub; species change |
| | | Extreme events | More fallen trees perhaps affecting waterways and access |
| | | Sea level rise | Species changes |
| | | Other.... | Pathogens attacking trees Germination of tree seedlings -vulnerability to floods |

| Ref | Special quality asset or function | Climate change variable | Impact |
|------------------|---|--|--|
| SQ8 | Built and buried historic environment (new title) | Wetter winters | Foundations affected ; flood damage |
| | | Drier, hotter summers | Foundations affected; increased fire risk to isolated properties |
| | | Extreme events | More threats to stability & structure |
| | | Sea level rise | Flood threats; chemical impacts from salinity? |
| | | Other.... | Flood effects on mills especially - location as physical structure and context of their significance |
| Indirect effects | | Solutions to built environment impacts might make new areas of land suitable for development | |

| Ref | Special quality asset or function | Climate change variable | Impact |
|-----|--|-------------------------|--|
| SQ9 | Cultural landscape (the context of the human | Wetter winters | Septic tank overflows. Threat to utilities & services |
| | | Drier, hotter summers | Threat to utilities & services |
| | | Extreme events | Getting Insurance harder |

| | | | |
|------------------|-----------------------------|--|--|
| | environment) (new title) | Sea level rise | Flooding of properties and spaces changing their use or viability |
| | | Other.... | Pressures on settlements due to 2 nd homes, less choice; or dereliction and abandonment Impacts on boundaries Direct impacts within settlements depending on position on floodplain (spatial variation) More tourism allowing more viable services Changes to abstraction /water availability |
| Indirect effects | | More flooding effects might raise building lines and make design /materials / style changes as people and property adapts New technology demands e.g. turbines, PV on buildings Changing age profiles or social make up in communities | |

| Ref | Special quality asset or function | Climate change variable | Impact |
|------|--------------------------------------|-------------------------|--|
| SQ10 | Open, rural landscape with big skies | Wetter winters | |
| | | Drier, hotter summers | Succession change with scrub & tree encroachment |
| | | Extreme events | |
| | | Sea level rise | |
| | | Other.... | New energy production turbines & energy transmission Rising of building levels to cope with floods blocking views Changing of views through loss of trees (Surface water reservoirs?) |

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| Ref | Special quality asset or function | Climate change variable | Impact |
|------------------|---|--|--|
| SQ11 | Opportunities for boating and other recreational activities | Wetter winters | Water flows increase – problems at bridges, flooding, moving boats; channels not obvious; Viability of some recreation services challenged (e.g. riverside pubs getting flooded) Rights of way impacts |
| | | Drier, hotter summers | Tourism season longer Heat wave issues for visits |
| | | Extreme events | More danger for boaters More danger for visitors |
| | | Sea level rise | Flooding and flow issues Threat to traditional ‘seaside’ features which may alter approach to the Broads |
| | | Other.... | Plant growth – changes in water and on land altering access choices Danger of algal growth? |
| Indirect impacts | | Flood management might restrict (e.g. barriers) and create (e.g. new cuts, new broads) recreational opportunities Flood storage areas could boost wildlife and tourism | |

| Ref | Special quality asset or function | Climate change variable | Impact |
|------|-----------------------------------|-------------------------|---|
| SQ12 | Riverside economy | Wetter winters | Flooding impacts; possible pollution hazards |
| | | Drier, hotter summers | More tourism, longer seasons |
| | | Extreme events | Possible pollution hazards; Interruptions to services such as utilities or access; dealing with incidents |
| | | Sea level rise | Flooding impacts |
| | | Other.... | Positive opportunities for tourism |

| Ref | Special quality asset or function | Climate change variable | Impact |
|------|-----------------------------------|-------------------------|--------------------------------|
| SQ13 | Peace and tranquillity | Wetter winters | |
| | | Drier, hotter summers | Tourism numbers increase |
| | | Extreme events | |
| | | Sea level rise | |
| | | Other.... | Traffic noise – parking issues |

Appendix 3 - Summary list of higher priority vulnerabilities

1. Impacts noted when they went above '12' in scoring (amber: 12-16; red 20)
2. Amber and red impacts only found in 2050 onwards, and mainly restricted to 2080.
3. One positive aspect scored 12 (fen diversity due to higher water table levels in the wetter, warmer winters – could be hampered by lack of management)
4. Majority of impacts relate to flooding issues
5. These 33 impacts are treated as higher priority for exploring what options are possible for adaptation

| A Access, recreation and tourism | | | |
|----------------------------------|-----------------|-----------------------|----------------------------|
| | Special quality | Climate conditions | Impact 1 |
| 1.1 | Water access | Hotter summers | More plant growth ♣ |
| 1.2 | | Extreme events | Storms affect boats ♣ |
| 1.3 | | | Silt waterways ♣ |
| 1.4 | | Sea level rise | Flooding ♣ |
| 1.5 | | | Draught under bridges ♣ |
| 2.1 | Land access | Wetter warmer winters | Route damage ♣ |
| 2.2 | | Extreme events | Flash floods ♣ |
| 2.3 | | | Damage to infrastructure ♣ |
| 2.4 | | Sea level rise | Flooding threat ♣ |

| B Biodiversity | | | |
|----------------|-----------------|-----------------------|--|
| | Special quality | Climate conditions | Impact 1 |
| 1.1 | Fen | Hotter summers | Scrub growth (♣) |
| 1.2 | | | Fire threat (♣) |
| 1.3 | | Wetter warmer winters | More diversity (♣) (<i>positive</i>) |
| 1.4 | | | Harder management ♣ |
| 1.5 | | Extreme events | Water depth ♣ |
| 1.6 | | | Water fluctuations ♣ |
| 1.7 | | Sea level rise | Water quality decrease ⊕ |
| 1.8 | | | Flooding threat ♣ |
| 2.1 | Open water | Warmer wetter winters | Run off from land ♣ |
| 2.2 | | Extreme events | Greater erosion ♣ |
| 2.3 | | | Run off ♣ |
| 2.4 | | Sea level rise | Water quality ⊕ |
| 2.5 | | | Flooding threat ♣ |

| C Community, culture and economy | | | |
|----------------------------------|-------------------|------------------------|-------------------|
| | Special quality | Climate conditions | Impact 1 |
| 1.1 | Cultural | Wetter, warmer winters | Flooding threat ♣ |
| 1.2 | | Sea level rise | Flooding threat ♣ |
| 2.1 | Riverside economy | Extreme events | Flooding threat ♣ |

| | | | |
|-----|--|----------------|-------------------|
| 2.2 | | Sea level rise | Flooding threat ♠ |
|-----|--|----------------|-------------------|

| F Farming and land management | | | |
|-------------------------------|-----------------|------------------------|-------------------------------|
| | Special quality | Climate conditions | Impact 1 |
| 1.1 | Ditches etc | Wetter, warmer winters | Water needing pumping ♠ |
| 1.2 | | Extreme events | Flash floods ♠ |
| 1.3 | | Sea level rise | Flash floods / water levels ♠ |
| 1.4 | | | Salinity ⊕ |
| 2.1 | Grazing marsh | Hotter summers | Livestock disease 🐛 |
| 2.2 | | Sea level rise | Flooding threat ♠ |

| H Historic environment | | | |
|------------------------|-------------------|--------------------|-------------------|
| | Special quality | Climate conditions | Impact 1 |
| 1.1 | Built environment | Sea level rise | Flooding threat ♠ |

♠ Tackled through water management

(♠) Where the water management is in the 'opposite' direction

⊕ Tackled through water quality

🐛 Tackled by pest management

The majority of the issues require water level management. There are a range of intervention methods to manage the water though they can be simplified to two basic approaches and a first step maybe to see if there is any commonality on which approach is more suited to the Broads (accepting that specific places may require a specific form of management):

- a. Management by constructions – creating water control structures that stop water flowing in the wrong places and allow levels to be 'imposed / modified'; seeking to minimise the change from freshwater
- b. Management by natural processes – working with the processes to direct water to places where space is made for the water; accepting gradual change to more brackish environments in places

However the final adaption options are likely to require:

- a. A mix of approaches between these two broad brush visions.
- b. Action to tackle water quality and water availability aspects as well

Appendix 4 - Communication Plan

Approach to establishing a dialogue about climate change impacts in the Broads with a wide range of interests

What are the underlying messages about climate change we want to share with those interested in the Broads?

| Main Message | Secondary messages | Tertiary messages |
|---|---|--|
| We need to plan for the changing scale and frequency of flooding in the Broads | The Broads are particularly vulnerable to likely climate changes and sea level rise | <ul style="list-style-type: none"> • Intense rainfall periods, wetter winters and higher tides will alter the scale and frequency of flooding events • Coping with the situation can occur at a range of scales |
| | There needs to be a different approach evolved to be able to cope with predicted changes | <ul style="list-style-type: none"> • The scale of change requires a fresh approach to be adopted • A range of approaches is possible from highly engineered protection to living with more natural changes • Society needs to balance cost with benefit • Responding to change has always happened in the Broads |
| | Adaptation options need to recognise other influences will also be affecting choices | <ul style="list-style-type: none"> • Adapting to one thing might help (or hinder) something else • We need to adapt to many types of change and building robustness and resilience will help |
| Planning ahead helps establish ways of coping with a changing climate that brings positive benefits to the Broads | Acting now can lessen the scale of the impacts and helps us cope with the changes | <ul style="list-style-type: none"> • Choices will get harder and more limited the longer we leave altering our way of life • We've always coped with change -it's just that the range of climate will alter more quickly |
| | Understanding likely climate changes allows people to consider essential future changes to our lives | <p>The main threat comes from flooding but the climate changes are</p> <ul style="list-style-type: none"> • Wetter warmer winters • Hotter, drier summers • More extreme weather events • Sea level rise |
| | The Broads Authority is working with partners to help everybody contribute to the adaptation planning | <ul style="list-style-type: none"> • All viewpoints are useful • The more informed you are, the easier it will be to contribute and ensure your interests are covered • The intention is to have an open process so spreading the information and feeding back comments helps |

| | | |
|--|--|---|
| Action is already helping and more people can get involved | Adapting the flood defences and looking for additional benefits through the Broads Flood Alleviation Project | <ul style="list-style-type: none"> • Re-alignment • Heighten and strengthen • Building in more natural defences • Additional benefits to access and nature conservation |
| | Developing methods to help properties cope better with the threat of floods helps | <ul style="list-style-type: none"> • Movable Door barriers • Covers for air bricks • New build designs incorporating options for floating |
| | Connecting habitats and getting them in good condition so wildlife can be more resilient helps | <ul style="list-style-type: none"> • Trials are being explored to see how ideas can turn into reality |
| | Personal action like reducing energy and water consumption, putting an emphasis on local produce are small steps we can all take | <ul style="list-style-type: none"> • Green Tourism Business Scheme helps businesses audit what they do and identifies improvements • Even though personal steps seem small in the big picture, the more people that try the nearer we can get to what is needed |

What do we want from those with an interest in the Broads in terms of helping the climate change adaptation plan move forward?

- A willingness to play a part in considering the implications and adaptive options
- A range of perspectives to be able to look at challenging things in a variety of ways
- A willingness to inform others and draw them into the discussions about option choice and implementation

Who are the main types of people we want to reach? / What methods will be most effective in getting them involved?

| Type of people | Why involve them | Effective methods (see generic list below) <i>Column content to be developed</i> |
|----------------|--|---|
| Broads Forum | <ul style="list-style-type: none"> • Advice on how to approach matter • Overview of pathways and barriers from their direct experience • Important opportunity to use them to reach out to their constituents | |

| | | |
|--------------------------------|--|--|
| BA members & committee members | <ul style="list-style-type: none"> • Formal approval of approach • Leadership role to play | |
| Parish councils | <p>Representative role</p> <p>Formal route into relationship with local communities</p> <p>Leadership role to play</p> <p>Should be a range of community perspectives with an existing structure that can help</p> | |
| District & County Councillors | <p>Leadership role</p> <p>Representative role</p> | |
| Landowners | <p>Owners of land where change may need to happen</p> <p>Major role in facilitating change</p> | |
| Major user groups/societies | <p>Valuable perspectives from specific interests</p> <p>Leadership role within interest</p> <p>Representative role</p> | |
| Other groups/societies | <p>Valuable perspectives from specific interests</p> | |
| Secondary Schools & colleges | <p>Valuable perspectives from specific interests</p> <p>Potentially already informed about issues</p> <p>May have fresh perspectives</p> <p>Ability to reach families through children</p> | |
| Young people | <p>Likely to be the people dealing with much of the necessary change</p> <p>Ability to reach families through children</p> <p>May have fresh perspectives</p> | |
| Public bodies | | |
| Tourism businesses | | |
| | | |

Generic list to be developed

What are the next steps in the communication process?

Detail to be developed