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Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

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BOGLAND: Sustainable Management of Peatlands in Ireland

STRIVE

Environmental Protection Agency Programme

2007-2013

SSTI Strategy for Science, Technology and Innovation

Comhshaol, Oidhreacht agus Rialtas Áitiúil
Environment, Heritage and Local Government

Environmental Protection Agency

The Environmental Protection Agency (EPA) is a statutory body responsible for protecting the environment in Ireland. We regulate and police activities that might otherwise cause pollution. We ensure there is solid information on environmental trends so that necessary actions are taken. Our priorities are protecting the Irish environment and ensuring that development is sustainable.

The EPA is an independent public body established in July 1993 under the Environmental Protection Agency Act, 1992. Its sponsor in Government is the Department of the Environment, Heritage and Local Government.

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- Office of Environmental Enforcement
- Office of Environmental Assessment
- Office of Communications and Corporate Services

The EPA is assisted by an Advisory Committee of twelve members who meet several times a year to discuss issues of concern and offer advice to the Board.

EPA STRIVE Programme 2007–2013

BOGLAND: Sustainable Management of Peatlands in Ireland

STRIVE Report

End of Project Report available for download on http://erc.epa.ie/safer/reports

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The EPA STRIVE Programme addresses the need for research in Ireland to inform policymakers and other stakeholders on a range of questions in relation to environmental protection. These reports are intended as contributions to the necessary debate on the protection of the environment.

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Executive Summary

Peatlands are Ireland's last great area of wilderness, hovering between land and water, providing unusual habitats for their unique and specialist flora and fauna. Peatlands cover a large part of the land surface in the Republic of Ireland, occurring as raised bogs, blanket bogs and fens, and forming cultural landscape icons in many parts of the country. The BOGLAND project was funded as part of the Sustainable Development Research Programme of the Environmental Protection Agency (EPA) to reveal the global significance of this national resource and the dilemmas of peatland management, utilisation and conservation.

Section 1 provides a comprehensive overview of what Irish peatlands are and what their contribution to the next generations should be. Associated concepts and definitions of terms used in Ireland are presented in order to facilitate communication and clear decisions.

In Section 2, the focus is on building on existing data regarding the biodiversity of peatlands and their associated abiotic environment (soil and water). New surveys of birds, aquatic and terrestrial invertebrates, as well as vegetation and micro-organisms comprised critical information against which the effectiveness of future management practices of peatlands (e.g. conservation, restoration) can be measured. This research demonstrated that peatlands support few but unusual and rare species with exceptional adaptation. As species new to Ireland and indeed one new to science were discovered, it is clear that the contribution of Irish peatlands to biodiversity is not yet fully understood. Meanwhile, biodiversity indicators, such as protected species, but also habitat heterogeneity can inform whether a peatland site is:

1. Suffering from degradation;

2. Healthy; or

3. In the process of recovery.

These indicators should be used for future assessment of all the peatlands, starting with state-owned sites, in order to draw up individual restoration and management plans that will maximise their natural functions, not least their unique biodiversity.

In Section 3, a newly constructed map shows that peat soils cover 20.6% of the national land area and contain more than 75% of the national soil organic carbon. It was revealed that near-intact peatlands may actively sequester c. 57,402 t C/year over the whole country. However, damaged peatlands are a persistent source of carbon dioxide (CO_2) and, at the national level, Irish peatlands are a large net source of carbon, estimated currently at around 2.64 Mt C/year. In view of these findings, it is clear that carbon dynamics should be a key driver of policies for peatland management. Active and remedial management options, such as avoiding drainage (conserving) and re-wetting (full restoration or paludiculture[1]) may be effective ways to maintain the carbon storage of peatlands and to recreate conditions whereby the peatland may actively sequester carbon in the future.

This investigation into peatland utilisation showed that neither past nor current management of peatlands in Ireland has been sustainable. Disturbances in the form of industrial and domestic peat extraction, private afforestation, overgrazing, wind farms and recreational activities have had and are having major negative impacts on the hydrology and ecology of these habitats. Natural peatlands, which are hydrologically and ecologically intact, have become rare and are being further threatened. The biggest threat to peatlands in the 21st century is likely to be climate change and its associated policies, e.g. wind farms. Rigorous examination and guidance for their full impact assessment (including a new technique developed in this project to test peat strength) are urgently required.

Not only mismanagement, but also legislative inertia, has led to a majority of the Irish peatlands being damaged and in deteriorating conditions. Conservation management has only succeeded in fully protecting a

1. Growing biomass in a wet environment.

small area of peatland while designated (thus legally protected) areas continue to be damaged by turf cutting due to lack of law enforcement.

The management of the Irish peatland resource is a complex task comprising large areas of various habitats exhibiting a range of status (from near-intact to very degraded), involving a mixture of stakeholders and which are affected by many different (sometime contradicting) policies. In order to achieve sustainable management of peatlands, their ecosystem services (biodiversity, carbon storage and sink, archive value, etc.) should underpin policy. This is demonstrated in Section 4, where an economic analysis has revealed that peatlands are public goods that deliver benefits of great economic and social value (primarily in relation to carbon storage, biodiversity, amenity and landscape). However, these are often ignored by the general public and can sometimes work in conflicting directions. While there is a lack of public awareness regarding certain functions of peatlands (e.g. the contribution of peat extraction to increased carbon dioxide emissions in the atmosphere and related current climate change), people's attitudes to peatlands are changing. The results of this survey indicated general public support for:

1. The protection of peatlands;
2. The transformation of industrial cutaways into uses that encourage wildlife and green energy production; and
3. A willingness to pay for the establishment of a dedicated National Peatland Park.

However, people still attach a social value to the domestic cutting of peat and do not always recognise a contradiction with peatland preservation. This study has identified considerable ambiguity and lack of understanding as to the significance of the peatland resource and, in particular, its role in provision of ecosystem services. It is time to open the debate and actively involve the public, especially the local communities, in drawing future management options for peatlands and, in particular, industrial cutaway peatlands.

The BOGLAND project has demonstrated the compelling evidence of the importance of Ireland's peatland resource in terms of:

1. Being an extensive resource and carbon store;
2. The negative potential of degraded peatlands to augment the greenhouse effect;
3. The positive role of natural and restored peatlands to actively sequester carbon from the atmosphere;
4. The role of peatlands in watershed management;
5. Their contribution to biodiversity; and
6. Their essential attributes that confer them with a cultural and informative function.

In conclusion, managing peatlands sustainably, so that they can deliver all these benefits, will require a mixture of economic instruments, regulation and institutional design but, most of all, it requires immediate action.

This collation of physical, environmental, social, economic and institutional information provides a comprehensive guidance for the development of a support framework or *protocol* for the sustainable management of peatlands, which is presented in Section 5 of the report. The protocol delivers an action plan or set of recommendations that should be used to draft a much-needed National Peatland Policy that should ensure that this natural heritage is not lost in the future, but that it is safeguarded and enhanced during a challenging period of economic transition. In short, any vision of the future of Ireland must include maintaining and enhancing one of its last natural resource: peatlands. This protocol aims to succeed in achieving such a vision that serves the needs of the people and preserves what nature gives us pro bono.

Main Findings of the BOGLAND Project

Irish peatlands attributes

- Peatlands support rare and threatened species with exceptional adaptation and more species are yet to be discovered. In this study, two species new to Ireland were identified, a mite (*Limnozetes amnicus*) and a caddisfly (*Erotesis baltica*), and another species of mite is possibly new to science.

- The loss (and ongoing degradation) of Irish peatlands equates to a loss of biodiversity at regional, national and international levels.

- The loss of biodiversity is observed from a mesotope level (entire ecosystems such as raised bogs and fens have been almost all damaged) to a microtope level (species and particularly habitats).

- The drivers of biodiversity change are projected to remain constant or even increase in the near future and this represents a major challenge for the protection of peatlands.

- Using new modelling methodologies, it was estimated that peat soils cover 1,466,469 ha or 20.6% of the national land area.

- Irish peatlands are a huge carbon store, likely containing more than 75% of the soil organic carbon in Ireland.

- Natural peatlands act as a long-term carbon store and play an important role in the regulation of the global climate by actively removing carbon from the atmosphere, but this important function is reversed (i.e. there is a net release of carbon) when the peatland is damaged. This study's investigations showed that near-intact peatlands may actively sequester, on average, 57,402 t C/year (equivalent to 0.21 Mt CO_2). However, losses of carbon from degraded peatlands and associated activities (e.g. combustion of peat) mean that, at a national level, Irish peatlands are a large net source of carbon estimated at 2.64 Mt C/year (equivalent to 9.66 Mt CO_2).

Status of Irish peatlands

- Peat soils currently occur under different land uses, forest, grassland, agricultural crops, as well as a range of degraded peatland ecosystems from industrial cutaway bogs to overgrazed blanket bogs. Very few peatlands remain in their natural state (i.e. near intact).

- All Irish peatlands have been impacted by natural and anthropogenic disturbances over the course of their history, but the worst damage occurred in the 20th century. The biggest disturbances in the 21st century are domestic peat extraction, private afforestation, wind farms, recreational activities, invasive species and agricultural policies (e.g. farmers moving away from agri-environmental schemes in order to cut turf).

- There are no more intact raised bog landscapes in Ireland. The current area of active raised bog stands at a mere 2,000 ha, less than 6% of the protected raised bog area. It is estimated that between 2% and 4% (40–80 ha) of this active area is being lost every year mainly as a result of turf cutting. Even if turf cutting were to cease, peat oxidation would continue (due to drainage) unless measures were employed to stop and revert the deterioration.

- The area of active blanket bogs is still unknown but is likely to be a small fraction of the currently protected blanket bog area and is also likely to decrease in the future due to the aforementioned disturbances.

- Most protected peatlands are insufficiently protected from a hydrological aspect because the boundaries of the designated site do not match the eco-hydrological boundaries. The conservation and restoration of these peatlands in terms of active area and fully functioning ecosystem is thus jeopardised. Cost-effective management of protected sites requires extended cognisance of local hydro-ecology of the site and surrounding areas.

- Being degraded to various degrees, the vast majority of Irish peatlands are critically at risk of future disturbances, such as climate change. Predicted changes are likely to affect low Atlantic blanket bogs in the west of Ireland the least, while the areas showing greatest changes in precipitation and temperature are the areas containing basin peat in the Midlands.

Peatland management

- In the case of ongoing turf cutting on protected sites, acquisition would be a better option (value for money) than compensation. If the State acquires the land, it not only has full ownership of the turbary rights but holds also the management rights. This would allow restoration work to be carried out, for example.

- Several peat failures on blanket bogs were associated with wind-farm developments and this has questioned the ability of the Environmental Impact Assessment (EIA) process to fully assess the likely environmental impacts. Peat strength is a complex attribute of peatlands and varies at each site and thus requires a stability assessment to be carried out as part of the EIA. Such assessment should utilise the UCD-DSS[2] technique which has been developed within the BOGLAND project. It is a simple shear device that allows the strength of peat to be assessed in a mode of deformation.

- Sheep grazing on hill and mountain peatlands can be sustainably managed using a stocking density based on habitats that are most likely to be used and by acknowledging seasonal variations in vegetation cover and composition.

Socio-economic and institutional aspects of peatlands

- Policies affecting peatlands have been determined only by the market value of peat, namely the value of peat as combustible fuel. These policies are at odds with the other international and national government policies and conventions, specifically those addressing climate change, biodiversity protection and environmental sustainability.

- A number of governmental departments, in particular the Department of Communications, Energy and Natural Resources and the Department of the Environment, Heritage and Local Government, have key policy responsibilities that shape how peatlands are managed but these are often in conflict.

- While a legal and administrative structure exists in Ireland to help the decision-making process, the absence of a national policy relevant to peatlands and the inadequate public administration functions (including funding) to administer current legislation are major obstacles to conservation targets and principles.

- The economic valuation study showed a positive willingness to pay for peatland protection. However, this willingness to pay appears to be higher for a dedicated National Peatlands Park and is not restricted to peatland restoration alone.

- Willingness to pay for the protection of raised and blanket bogs appears to be less than the amounts that are currently spent by the State on protection, suggesting that current spending fails to pass a cost–benefit analysis.

- The cost of burning peat (either industrially or for domestic purpose) is very high in terms of carbon loss. However, the social aspects of peat use are very complex and solutions will have to consider the cultural attachment to turf cutting.

- The new generation of peat-fuelled power stations has been designed to run on biomass. While biomass is marginally economic, it suffers from supply constraints.

- Wind farms on lowland industrial cutaway peatlands perform poorly financially in comparison with those on elevated and coastal sites, but cutaway sites do have major advantages and could be supported by policy (in particular regulatory instruments). Such after-use of cutaways would not necessarily interfere with other uses such as peatland restoration or wildlife options, which were perceived positively by local people in the ethnographic studies carried out within this project.

Peatland and people

- People attach a social value to the domestic cutting of peat, but do not always recognise a contradiction with peatland preservation.

- There is a clear information deficit regarding the ecosystem services of peatlands and how these

2. University College Dublin's direct simple shear technique.

benefit the public in general. However, people's perception of peatlands is changing.

- There is no public awareness of the relationship between peatland and carbon and the contribution of peat extraction to climate change.
- The value of peatlands as an ecosystem providing crucial ecological, hydrological and other services has generally been disregarded by the public, mainly because it was not communicated in any meaningful way.
- There appears to be a willingness amongst many people living in local communities to participate in the future after-use of industrial peatlands. These preferred after-uses include amenity, wildlife and wind energy options. However, there does seem to be a need for government or national institutions to take a lead in demonstrating what peatland after-uses are being seriously considered.

Recommendations

The BOGLAND project revealed not only the global significance of Irish peatlands and the dilemmas of peatland management and utilisation but also engaged the general and local public as well as stakeholders in peatland discussions. This collation of information provides a strong scientific and socio-economic evidence base, ready to be translated into instruments to assist decision making. In that regard, an action plan or set of recommendations is presented, with the aim of managing peatlands sustainably. The top 10 critical recommendations emerging from this protocol and requiring immediate actions by the Government have been identified as follows:

1. **A much needed National Peatland Strategy**
   A National Peatland Strategy is clearly required if the proposed protocol for sustainable management of peatlands is to be implemented. The ensuing National Peatland Policy should be integrated into other government policies, such as the Climate Change Policy, the Renewable Energy Policy, the Strategy for Invasive Species and the Water Framework Directive. The Peatland Strategy would be subject to the requirement of the Strategic Environmental Assessment Directive.

2. **More protected peatlands**
   All remaining areas of *priority habitat* peatlands (active and degraded raised bogs and blanket bogs) should be declared as Special Areas of Conservation (SACs) and more peatland sites (including fens) should be designated under adequate legal protection.

   (i) Attention should be paid to maintaining the integrity of these peatland habitats to ensure the survival of the unique biodiversity that they sustain.

   (ii) The establishment of a network of protected areas representing the geographical distribution of peatland types should be a priority in order to offset climate change threats.

3. **Proactive management of protected sites**
   Designated peatland sites should be appropriately managed with a view to increasing the total area of *near-intact* peatlands and reversing the trend of these endangered habitats. A range of key peatland sites representing all types of peatlands should be identified for proactive management to achieve biodiversity targets at different levels – genetic, species, habitat and ecosystem. This requires that management plans are to be *readily* drawn for *all* designated peatland sites (in particular one of the largest sites: Ox Mountains Bogs SAC).

4. **Enforcement of regulations**
   Strict protection of natural peatland sites that have been designated for conservation is critical for the maintenance of their carbon storage and sequestration capacity and associated ecosystem functions. This means stopping and removing any disturbances on these sites if there is any hope of maintaining or restoring the full functioning status of the peatland.

   (i) Where there is a current illegal disturbance on a protected site, it should be *immediately* removed by enforcement of the law. This means that the Cessation of Turf Cutting Scheme should be fully implemented on the 55 raised bogs designated as SACs and be given full political back-up.

(ii) As a matter of priority, 'sausage machine' cutting should be banned and the ban should be *enforced* on all protected sites.

(iii) The cessation of turf cutting on other designated sites (blanket bogs) should be immediately addressed and solutions proposed from a forum of adequate representatives.

5. **Restoration of protected peatlands to stop carbon loss**

   Peat oxidation is induced by drainage of peatlands and releases carbon to the atmosphere. Peat oxidation should be stopped or at best reduced in all protected peatlands through the following actions:

   (i) A programme to restore peatlands designated for conservation, which are not in favourable conditions, should be initiated. As a matter of priority, state-owned peatlands should first be assessed and individual restoration and management plans should be drawn up to maximise the natural functions of the site, particularly in relation to biodiversity, greenhouse gas emissions and water management; and

   (ii) Restoration work needs sufficient time and resource to take cognisance of the local hydrogeology which has often very localised conditions.

6. **Management of non-designated peatlands to stop carbon loss**

   Opportunities to restore degraded non-designated peatlands should be immediately explored as protected peatlands are only a minor part of the total area of peatlands. Carbon is constantly emitted to the atmosphere from drained peatlands and several management options should be explored, for example:

   (i) Restoration of degraded non-designated peatlands should follow an adaptive management approach as each site is different in terms of site condition (e.g. how deep it is drained), historical disturbance, geographical location (catchment), ownership and local demands; and

   (ii) Water management in degraded peatlands should be optimised (reduce drainage) in order to combat carbon dioxide emissions from peat oxidation and preserve the palaeo-information within the peat.

7. **Review of the peat industry**

   It has been internationally recognised that subsidies that promote excessive and destructive uses of peatlands and their ecosystem services should be eliminated. Therefore, the Public Service Obligation Levy allocated to the peat industry should be reviewed since the continued carbon emissions from peat burning are contrary to the national interest.

   (i) This review should be carried out as part of a cost–benefit analysis at a macroeconomic level of peat extraction and its role in modern Ireland.

   (ii) A portion of the taxpayer monies given to the peat industry could be channelled to a new institution charged with the management and restoration of the country's peatlands.

8. **A code of good practice**

   A code of good practice for development on peatlands should be produced and systematically used for assessing any development proposals involving peatlands. Such a code should emphasise the current legislation framework (EIA, Appropriate Assessment (AA), Integrated Pollution Prevention Control (IPPC) licensing) within which projects/plans can proceed and include evidence-based guidance for the relevant authorities (see Recommendations 12–16). Such a code could, for example, impose a maximum permitted drainage level for ongoing authorised activities on peatlands, as well as define best practices for the development of wind farms on blanket bogs.

9. **A National Peatland Park for the people**

   The creation of a National Peatland Park, pushed forward by local communities, deserves serious consideration and commands a degree of support from the Government. This proposed park could provide an opportunity to develop a centre of excellence for applied integrated peatland research and a national database for peatland-related data and information as well as communicating information regarding peatlands.

10. Peatland Strategy Working Group

The development of a National Peatland Strategy should be carried out through the establishment of a special working group whose main role would be to co-ordinate the development of a consensus that charts the way forward and draft a National Peatland Strategy from which a Statement of Policy could later be issued.

(i) Such a group should be set the task to develop a code of best practice for development on peatlands (see Recommendation 8), with an immediate objective of looking into wind-farm developments on blanket bogs.

(ii) It should also take the lead in demonstrating what after-uses are being seriously considered for the industrial cutaway peatlands in Bord na Móna's ownership and aid the drawing up of an after-use policy (see Recommendations 30–32).

(iii) It should establish a National Co-Ordinated Integrated Management, Monitoring and Enforcement Network to provide the framework necessary to achieve sustainable management and protection of Ireland's national peatlands biodiversity resource.

Other recommendations are presented below. Their remit may not only lie with the Government and governmental agencies but also with the industry, non-governmental organisations (NGOs) and academia or other research institutions.

Policy and regulation

11. The Environmental Impact Assessment Directive specifies that thresholds do not preclude sensitive areas and as such peatlands are to be considered sensitive areas for *any* development and thus require an EIA. It is therefore recommended that *all* commercial peat-cutting enterprises (i.e. no threshold) should require planning permission (and therefore an EIA). Enforcement action against unauthorised peat extraction should be pursued.

12. While an amendment to the Planning and Development Regulations (SI No. 539, 2001) set a lower threshold requirement of 10 ha for planning permission for peat extraction, the current threshold imposed by the IPPC licensing to restore or rehabilitate a site remains at 50 ha and thus should also be reduced to 10 ha.

13. To ensure compliance with the requirement of Article 6 of the Habitats Directive, further guidance should be developed to carry out AA of plans or projects involving peatlands. Special attention should be given where exploitive utilisation (including turf cutting) is taking place on or near protected sites. Emphasis should be put on the need to address cumulative/in-combination effects (e.g. wind farms). In addition, the assimilative capacity of the peatland to absorb impacts should be considered.

14. Policy regarding wind-farm developments on state-owned forests should be properly appraised by a group of independent experts on an individual case basis (life-cycle analysis) as the renewable energy sector should not be developed at the expense of the protection of endangered habitats. Wind-farm development on *designated* mountain blanket bogs should be avoided by correctly applying the AA process.

15. Particular guidance should be given in the case of an EIA for wind-farm developments on peatlands (see Recommendation 10). It should follow the guidance from the European Union Commission regarding such development on Natura 2000 sites and the wind energy guidelines of the DOEHLG (2006)[3], especially with regards to road construction, fragmentation of the habitats and ground investigation. These guidelines include an assessment of the peat strength over the profile depth. New guidance should refer to new tools developed within the BOGLAND project that should be used in stability assessment. The UCD-

3. DOEHLG, 2006. *Wind Energy Development Guidelines*. Department of Environmental, Heritage and Local Government, Stationary Office, Dublin, Ireland.

DSS technique is a direct simple shear device that allows the strength of peat to be assessed in a mode of deformation that is appropriate for stability assessment. Further collaborative research work should be pursued between academia and practitioners in order to help in drafting best practices.

16. The aforementioned code of good practice (Recommendation 8) could necessitate the establishment of an environmental system management (ESM) for all peatland-related development. An ESM monitors and controls the impact of an enterprise's activities on the environment by establishing an environmental policy with objectives and procedures (similar to the ISO 14001 standard) which could then be audited by the EPA.

17. The Government should engage in a review of the use of peat in the horticultural industry and actively promote the use of peat-free horticultural growing medium in the *retail* market on the basis that these are sustainable products. While there is not at present a technically, environmentally suitable alternative material that could replace peat in professional horticultural crop production, Ireland should lead research in this area and economic incentives should be applied to compete with non-sustainable horticultural peat.

18. Avoiding carbon loss from degraded peat soils through peatland conservation, restoration and paludiculture should be supported by Ireland for the next commitment periods of the Kyoto Protocol after 2012. Meanwhile, Ireland should work towards realising the asset value of peatlands through remuneration of the emissions avoided from peat soils via linkage with the European Carbon Trading Scheme.

19. Wind-farm development and paludiculture (especially cultivation of *Sphagnum* moss) should be encouraged on industrial cutaway peatlands through tax relief.

Peatland management

20. No form of peat cutting should be allowed within an agri-environment scheme agreement.

21. Measures to reduce peat oxidation (and thus carbon loss) from degraded peatlands should be introduced at a management plan level and in other agri-environmental policies.

22. Burning of peatland vegetation as a management practice to facilitate the extraction of the peat or to increase the population of grouse (promoting heather growth) should be strictly controlled. Agreement (the like of which has been established for the Slieve Bloom SAC) should be readily established and the Muirburn Code (Scottish Natural Heritage, 2005[4]) should be used as best practice in using fire as a management tool to avoid accidental fire and additional carbon emissions. Such activity should be reviewed under the scope of the Environmental Liabilities Directive (e.g. when the peat fire goes out of control).

23. Sheep grazing on hill and mountain peatlands can be sustainably managed using a stocking density based on habitats that are most likely to be used and by acknowledging seasonal variations in vegetation cover and composition. This information should be communicated accordingly.

24. Relevant authorities should ensure that forest policies and management plans continue to protect and enhance peatland habitats and associated species (see Recommendation 28).

25. Any invasive species should be actively removed from protected sites and appropriate long-term management set out to keep invasive species away from these sites.

26. It should be ensured that peatlands (including cutaway peatlands) are fully included in the development of River Basin Management Plans and that they are appropriately assessed in Strategy Environmental Assessment of County Council Development Plans.

State-owned peatlands

27. The present management of state-owned

4. Scottish Natural Heritage, 2005. *The Peatlands of Caithness and Sutherland, Management Strategy 2005–2015*. Scottish Natural Heritage, Edinburgh, Scotland.

peatland areas should be evaluated and alternative management options aimed at increasing the natural functions of peatlands should be implemented. Where the current disturbance has not impacted on the major functions of the peatland (see criteria in Section 3-7.2), the disturbance should be maintained at an acceptable level and monitored in order to retain most of the ecosystem services provided by the site. For example, grazing at a managed intensity and controlled turf cutting on blanket bogs could represent such management options. This option requires, however, strict surveillance.

28. The management options regarding state-owned forested peatlands should be critically reviewed. Management options identified by Coillte regarding the western peatland forests should be fully implemented in view of managing this national asset in the most sustainable fashion. Western forested peatlands which are commercially unproductive should be candidates for:

(i) Restoration of the peatland ecosystem;

(ii) Long-term retention of the trees (in effect leave these areas to nature); or

(iii) Used to promote the regeneration of native scrubs on reforestation sites together with continuous cover.

The effect of these management options on greenhouse gas emissions and on peat oxidation rates should be investigated.

Industrial cutaway peatlands (their after-use)

29. The first option for after-use of cutaway peatlands should be to promote, where possible, the return to a natural functioning peatland ecosystem. While restoring past ecosystems may be difficult, the option of creating new semi-natural habitats is considered the easiest and most likely after-use for the majority of these cutaway bogs. The favoured management option in this case should involve re-wetting (i.e. paludiculture) or wetland creation.

30. New production techniques, such as paludiculture, should be developed and promoted to generate production benefits from cutaway and cutover peatlands provided that these activities represent the best environmentally sustainable option. Paludiculture is probably the after-use option that can have the most benefit from a climate mitigation point of view – avoiding carbon emissions from the degraded peatland, from the displaced fossil fuels, and also from its transport. Ireland should take the lead in this expanding area of research.

31. The enhancement of cutaway peatlands for flood storage and flood attenuation should be investigated. This aspect should be reviewed as part of the national programme of Flood Risk Management Plans being rolled out under the Floods Directive.

Peatlands and people

32. Peatland awareness programmes and education material should be developed and promoted through a wide variety of media – information sharing (TV programmes, website, DVDs, etc.), education packs (financial support to the Irish Peatland Conservation Council education programme), workshops, posters in public places. Clear 'peatland messages' should be provided for use across a wide range of media.

33. It is critical that a national institution take a lead in communicating information regarding peatlands. With the removal of governmental support for communication of environmental information (ENFO), it is critical that NGOs fill this gap and communicate this knowledge and that the Government adequately supports this task. In particular, awareness and education could be easily promoted by the improvement of public access at certain peatland sites (collaboration with Coillte, LIFE project).

34. With the complex discussion surrounding turf cutting, governmental institutions should communicate early and extensively to the stakeholders so that they become familiarised with the benefits of peatlands other than for fuel.

35. Traditional, indigenous knowledge of peat and peatlands, as well as relevant scientific findings and data, should be clearly communicated and made available to the public and to decision makers. This would also help dialogue between all the stakeholders, who may not be sufficiently aware of the information and views held by others. Information from all sources is crucial if more effective ecosystem management strategies are to be introduced. This could be harnessed through the National Peatland Park (see Recommendation 9).

36. Local communities have a very important role as stewards of peatland resources and should be involved in activities to restore and sustain their use. Local committees and other vested groups should be consulted in order to balance local concerns with the wider public 'good'. The greater the responsibility, accountability, participation and use of local knowledge, the better the management and likely positive outcomes.

37. Research on peatlands should be pursued. As a priority, an inventory of the condition of all peatlands (including those not designated) should be carried out. A methodology/approach should be developed to systematically investigate and quantify the environmental supporting conditions and hydro-ecological linkages which can be peculiar to any given peatland. This is in order to develop restoration or other management plans tailored to the site and aimed at achieving a fully functioning peatland site (see Recommendation 38).

38. There is a need to identify and review practical peatland restoration projects and techniques to assess their effectiveness in terms of hydrology, carbon storage and sequestration potential and biodiversity.

39. Finally, adequate funding and mechanisms to support sustainable management of peatlands should be provided.

The BOGLAND report provided large-scale analysis and findings that demonstrated that the Irish State needs to change the way in which the peatland resource is currently viewed and managed if it wishes to secure the multiple benefits offered by these natural ecosystems and avoid the costly consequences of further unsustainable management of peatland.

Section 1

General Introduction

1-1 Context

Peatlands have been in the Irish landscape since the last Ice Age and, together with a remnant of primeval forests, they form our oldest natural heritage. Irish peatlands are the country's last great area of wilderness, hovering between land and water, providing unusual habitats for their unique and specialist flora and fauna. They cover a large area of the land surface, occurring as raised bogs, blanket bogs or fens and forming cultural landscape icons in many parts of the country (e.g. Connemara, Ox Mountains, Slieve Bloom). Peatlands have accumulated peat over millennia, creating an important economic raw material on which the livelihoods of certain rural populations have critically depended. This accumulated peat mass makes peatlands a fascinating historical archive of past environmental and cultural change. More importantly, in view of recent climate change, peatlands store a large amount of carbon that is released to the atmosphere should the peatlands degrade, for instance by exploiting the peat. Peatlands are the most space-effective carbon stores of all terrestrial ecosystems (Dise, 2009). Over centuries, peatlands slowly remove and store more carbon than they produce and therefore they exert a net cooling effect on the global climate (Frolking et al., 2006). Once degraded, this process is reversed. Along with many other benefits provided by peatlands, these ecosystem services have generally remained unnoticed being largely invisible to the naked eye. This has resulted in a lack of appreciation of the need for cautious management.

Peatlands and Irish people have been closely connected by a long history of cultural and economic development. In the distant past, peat landscapes were both feared and respected as wilderness areas and often linked to traditional culture, rituals and worship (Feehan et al., 2008). In modern times, peatlands have commonly been treated as wastelands that are of no use unless they are drained or excavated. Irish peatlands have been afforested, cut over by domestic cutting, cut away by industrial peat extraction, eroded by overgrazing and agricultural reclamation, damaged by infrastructural developments and invaded by non-native species. To add to this destructive scene, climate change is likely to threaten further the survival of these ecosystems (Belyea and Malmer, 2004; Jones et al., 2006). At the dawn of the 21st century, the dilemmas facing the peatland resource have been heightened with only few 'near-intact' or 'natural' peatlands remaining in the Irish landscape, which are likely to be further damaged, be it directly by humans or by global changes. These are challenging times for Irish peatlands and therefore questions have to be asked:

- What will be the contribution of Irish peatlands to the next generations?
- How should peatlands be managed and utilised to ensure that this natural heritage is not lost – indeed that it should be enhanced?

The peatlands issue has stood out as of sufficiently high profile that, in addition to their scientific interest, they have captured the attention of the Irish Government which funded the BOGLAND project to produce a protocol for the sustainable management of peatlands.

1-2 Background

1-2.1 What is Sustainability?

The meaning of ‘sustainability’ was disseminated at the Rio 1992 UN conference where a framework was set for a long-term vision of sustainability in which economic growth, social cohesion and environmental protection go hand in hand and are mutually supporting (see the Glossary for further definitions). The ultimate objective of such ‘sustainable development’ was that the needs of the present generation should be met without compromising the ability of future generations to meet their own needs. Since Rio, several international policies, legislation and action plans have been developed to implement such commitment. The European Union Sustainable Development Strategy (EU SDS) (European Council, 2006) reaffirmed the strong political willingness to move onto the sustainability path. A recent review of the strategy underlines the fact that the EU has indeed mainstreamed sustainable development into a broad range of its policies (European Commission, 2009). In particular, the EU has taken a lead in the fight against climate change and the promotion of a low-carbon economy. At the same time, unsustainable trends persist in many areas and efforts need to be intensified. In response to the economic and financial crisis (2008), the EU Commission launched a major *Recovery Plan* (European Commission, 2008), with the focus on so-called green measures to help to revive the economy and create jobs. In the medium and long term, they also aim to stimulate new technologies and reduce our negative impact on climate, natural resources and ecosystems. Indeed, “*times of crisis shouldn’t be wasted*” (Paul Romer, Economist at Stanford) and applying the concept of ‘sustainability’ to a new model for growing the standard of living and interacting with nature seems to be an opportunity not to be missed.

In Ireland, the Environmental Protection Agency (EPA) has taken the role of overseeing the articulation and overall development of the sustainability framework, by funding research to inform such global commitments. Through the various research studies currently being carried out, sustainable development can be seen as one of the main challenges facing Ireland in the 21st century (EPA, 2008a). In 2011, with a backdrop of measures to combat economic recession, the question of whether Ireland is moving away from or towards sustainability is disputable.

1-2.2 How to Apply Sustainability to the Management of a Natural Resource

Examples of *lack* of sustainability can be found in Ireland as early as the Neolithic Age. At the Céide Fields in County Mayo, archaeologists have exposed residues of a highly productive farming culture, seemingly undermined by the interrelated effects of climate change and nutrient depletion (Caulfield et al., 1998). When the soil became too degraded, the population left and conditions were propitious for peat to form. This historical treasure was thus engulfed and protected under the bog for millennia. The Irish peatland resources have in turn been degraded through natural but mainly human-induced disturbances. Irish peatlands have become vulnerable and it has been discussed in various research ecological fora that ‘vulnerability’ can be understood as being in the opposite trajectory to ‘sustainability’. According to Daly (1990), “*non-renewable resources should not be depleted at rates higher than the development rate of renewable substitutes: i.e. part of the resources’ revenues should be invested in renewable substitutes so that when the non-renewable resources become unavailable, the renewable substitutes can take over completely*”. In the case of peatlands, a non-renewable natural resource, this economic principle is violated because various peat and peatland values (biodiversity, landscape, historical archives) cannot be completely regenerated or substituted for, if at all. A more appropriate definition could therefore be as follows: a system can be said to be sustainable if it allows the well-being of future generations to be at least as high as that of the present generation. Well-being, in this definition, comprises a combination of *financial*, *social*, *environmental* and *institutional* components. A balance between these four pillars of 'sustainability' needs to be achieved if the sustainable management of peatlands is to be developed successfully.

1-2.3 Sustainable Management of Irish Peatlands through Time

The maps and reports of the Bog Commissioners (1809–1814) were a milestone in the management of peatlands of Ireland. Early in the 19th century, sustainable management meant that bogs had to be drained and reclaimed so that food could be produced and a livelihood could be given to the following generations in poor areas. The meaning of sustainable management has changed since then, many times. To secure the future economy of Ireland, burning the peat for fuel was seen as sustainable management in the mid-20th century, providing not only the only indigenous energy at the time but also employment in non-industrialised areas. Since then, the meaning has changed more dramatically, mainly due to the fact that we now know that peatlands are a finite source, to enjoy or to destroy. They provide more functions than previously acknowledged. They embody landscape and cultural values. They are also reservoirs of natural diversity and historical information. They are a space-effective carbon store and their role in carbon regulation is critical in view of the challenges of global warming. In addition, a new generation of peatlands, the 'industrial cutaway peatlands', have recently appeared in the Irish scenery and their after-use will create opportunities for creating landscapes that are tailored to meet demand of a more sustainability-focused society. In the context of achieving sustainable development for Ireland in the 21st century, managing peatlands is even more challenging as we need to integrate current as well as future ecological, economic and social conditions at all geographic scales. It also has to acknowledge that 'change' is endemic, whether by natural forces or by humans or some combinations.

1-2.4 Premise

The premise behind this project is that Irish peatlands, in their various manifestations and stages of development and conditions, comprise an important natural resource that can offer many wide-ranging functions and that should be managed with the aim of sustaining the environmental and ecological goods and services they provide as well as the human communities that use them. One of the most pertinent reasons for the need of a protocol for sustainable peatland management is that peatlands are very often inadequately recognised as specific and valuable ecosystems in relation to biodiversity, climate change or culture. Like sustainable agriculture and forestry, sustainable management of peatlands needs to take a multifunctional approach. This means that all values, not only ecologic or economic ones are taken into consideration in decision making and planning. People's sense of place and their relationship with nature and the environment are critical in this regard.

1-3 Research Objectives and Structure

1-3.1 Overall Aims

This large-scaled integrated study, informally known as the 'BOGLAND project' was funded as a 4-year 'sustainable development' project by the National Development Plan through the Environmental Research Technological Development and Innovation (ERTDI) research programme. Its overall objective was to develop guidance in the development of strategies for the sustainable future management of peatlands in Ireland. To this effect, this report aims to provide a synthesis of knowledge on this key natural resource, the important functions and roles that peatland ecosystems perform, their various utilisation, and how attitudes and policies affect them. This report presents recommendations on the development and the planning of peatland management that could be used as an information source in drafting laws and regulations and ultimately a *peatland policy* for Ireland. Finally, but not least, it is hoped that this report can communicate the reality of Irish peatlands to the public and Irish Government as well as academia in a clear and unambiguous fashion.

1-3.2 Structure of the Research: Main Objectives and Components

The overall aims of the project were addressed by:

- Characterising the peatlands resource: their physical and ecological characteristics and their trends;
- Evaluating the goods and services they provide (ecosystem services);
- Assessing the vulnerability of their functions; and
- Understanding their socio-cultural and economic attributes.

Policy recommendations for sustainable management options were then presented – within the current policy context – with the aim of delivering healthy ecosystems and taking into account their socio-economic and cultural services (Fig. 1-3.1).

As a multi-disciplinary research study, the BOGLAND project sought to collate available information and

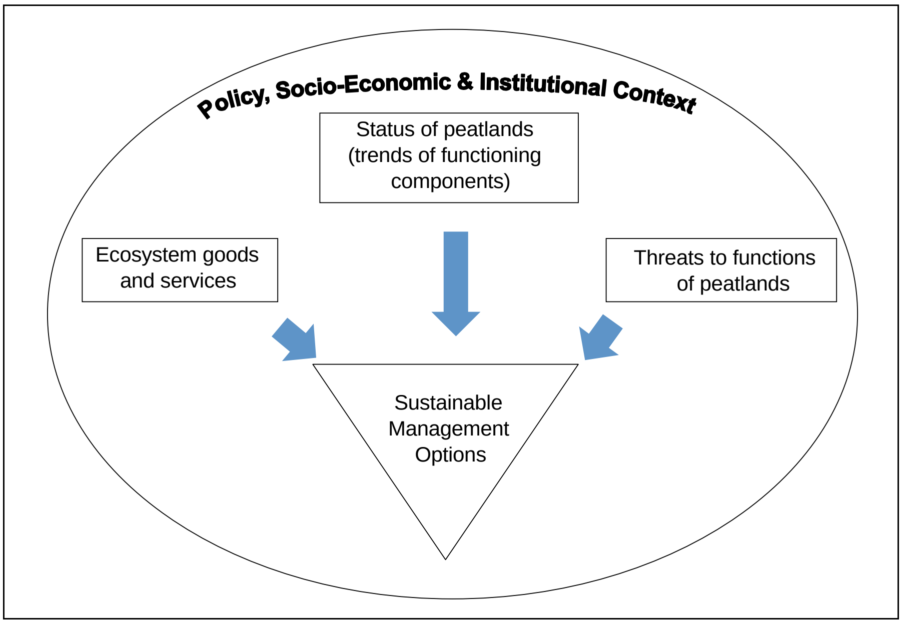

Figure 1-3.1. Main research dimensions to develop a protocol for the sustainable management of peatlands.

attempted to fill information gaps that exist on Irish peatlands by asking broad questions:

- What is this resource called 'peatlands' characterised by?
- What are its benefits and values (e.g. ecological, socio-cultural and economic)?
- What are the current pressures and threats to this resource and concerns for its future?
- What are the current policies and do they give rise to tensions?

The research work was conducted in four sub-projects (Fig. 1-3.2), with the core research work focusing on three areas:

1. Biodiversity;
2. Characterisation of the physical peatland resource and its use; and
3. Socio-cultural, economic aspects and institutional policy.

1-3.2.1 Peatland biodiversity

This work built on the considerable body of existing information on vascular plant communities and macro-fauna (birds) of Irish peatlands. Vegetation can be used as a visible indicator of disturbance and is one of the simplest observable characteristics to assess the condition and development of a peatland. Birds, on the other hand, are a conspicuous biodiversity indicator which will respond to management actions. Soil and aquatic invertebrates have also an important role to play in the functioning of peatlands and were studied in detail in this project as little work had been carried out so far. Biodiversity is not limited to the 'visible' diversity present on the bog surface and the significance of the micro-organisms found in Irish peatland biodiversity was also assessed and quantified.

1-3.2.2 Characterisation of the physical peatland resource and its use

An estimation of the extent and depth of the peat resource was required in order to improve estimates of the magnitude of the Irish peatland carbon reservoir. This sub-project aimed to improve modelling exercises in order to produce up-to-date maps of peat soil extent, peat depths and estimate its carbon store. The impact of climate change scenarios on peatlands was explored depending on their geographical location. This study also examined peatland vulnerability to human-induced interferences (wind farms, sheep grazing, extraction, afforestation, etc.) with respect to:

- Physical aspects (e.g. peat strength);
- Greenhouse gas (GHG) fluxes; and
- Hydrological features.

In essence, this sub-project endeavoured to report on the physical criteria used for the assessment of sustainable management options.

1-3.2.3 Socio-cultural, economic and institutional policy

This sub-project aimed to develop an understanding of the values of peatlands within the Irish public in general and how the contribution of peatlands can be characterised in social, economic and environmental terms by indicators over time. This was done through:

- The examination of communities linked to peatland areas, rural development, archaeology and culture and tourism;
- The economic valuation of resource uses, market and non-market values including carbon sink; and
- The appraisal of relevant policies.

In addition, an in-depth case study was carried out in an area largely dominated by industrial cutaway peatlands with a view to producing a blueprint on community and stakeholder involvement in the future of peatlands. Conflict management, perception and representation and valuation are the key components of socio-economics, where social and natural sciences can co-operate, particularly at the scale of landscape management. This particular research work required a close examination of the interface between people, communities and peatlands. Such research had never been carried out before in Ireland with regard to peatlands. It described the first attempt to quantify the relationships between people and peatlands.

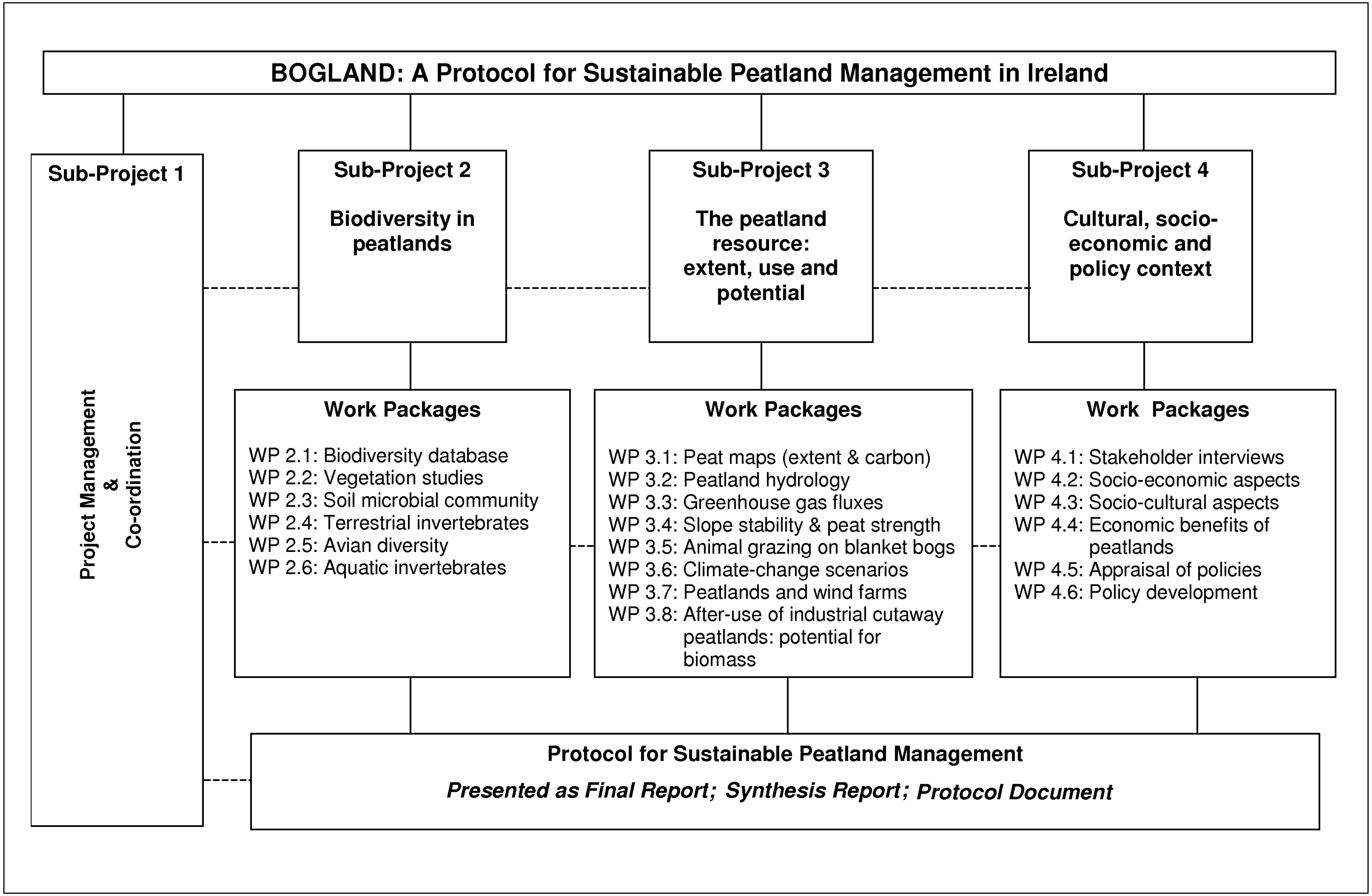

Figure 1-3.2. Research strands of the BOGLAND project.

1-3.3 Project Benefits and Difficulties

The BOGLAND project helped in detecting changes and trends in the quantity and quality of the peatland resource by producing baseline data against which to assess policy and management options. Thus, the project helped in bridging the gap between scientific priorities and the real world of management. It has brought together diverse knowledge on peatland features, functions and services from different sources, through a multidisciplinary task force. The key management aspects were based on 'integration across disciplines' and 'consultation of all parties'. A particular strength of the project was the collaboration of representatives from government, non-government and scientific bodies, as well as other stakeholders.

Difficulties arose due to different understandings of the terms associated with peatlands. The project needed to clarify and work with similar concepts and definitions. A workshop and consultation were therefore carried out and main concepts and definitions used throughout the report are defined in Section 1-7, while other terms are found in the Glossary. Another difficulty arose from the fact that a long-term perspective is required to see how peatlands respond to management options or impacts (e.g. land-use changes). It is thus important to view the results and findings of the project as part of ongoing monitoring and research work which is required to record progress on achieving sustainable development.

1-4 What are Peatlands?

Peatlands are wetland ecosystems that are characterised by the accumulation of organic matter called peat which derives from dead and decaying plant material under high water saturation conditions. Peat accumulates where the production of plant material exceeds decay. Water is the most important factor limiting decay. Most peatlands that exist today formed in the last 10,000 years (since the last ice age) and have developed under climatic conditions whereby precipitation exceeded evapotranspiration or in areas of impeded drainage. In natural peatlands, peat accumulates at a rate of approximately 0.5–1 mm/year (or 5–10 m over 10,000 years) with strong local variations (Clymo, 1992). There are different types of peatlands, depending on geographic region, terrain and vegetation type. In Ireland, the major distinction is between bogs (which receive nutrients only from precipitation and thus are nutrient poor) and fens (which receive nutrients from surface or groundwater as well as precipitation and tend to be more calcium and nutrient rich, although poor fens exist also). The difference between a bog and a fen is represented in Fig. 1-4.1. The key characteristics of a peatland include waterlogged conditions, development of specific vegetation and the consequent formation and storage of peat (defined in Section 1-7). The interconnection and interdependencies between water, plants and peat are critical to the survival of the peatlands and therefore make them vulnerable to a wide range of disturbances.

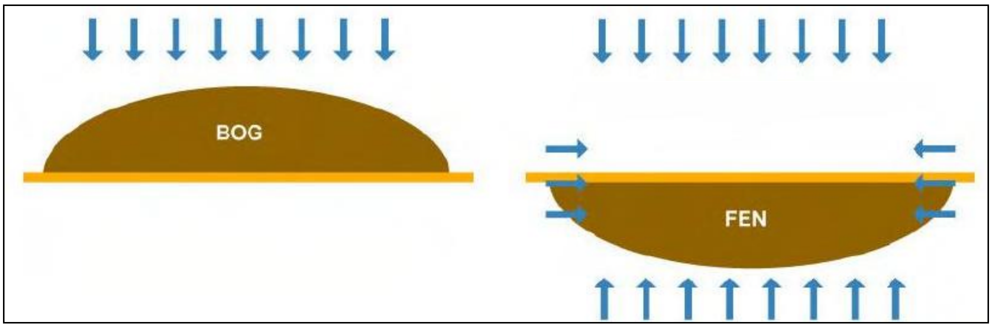

Figure 1-4.1. Schematic representation and classical difference between 'bog' and 'fen'. Brown = peat; arrow = water flow (adapted from Joosten (2008)).

1-5 Global Peatlands

Peatlands cover 4 million km^2 worldwide, and represent a third of the global wetland resource (Parish et al., 2007). They are found in all parts of the world but predominately in the boreal, subarctic and tropical zones. While the majority of peatlands are found in Eurasia and North America (Fig. 1-5.1), peatlands are also found in remarkable places such as Patagonia, Ethiopia, Table Mountain in South Africa, Mongolia and Iran.

Peatlands are major contributors to the biological diversity of regions throughout the world and provide a variety of goods and services in the form of forestry, energy, flood mitigation and maintaining reliable supplies of clean water. In light of future climate change, the most important function of peatlands in the 21st century is that of a carbon store and sink. Covering only about 3% of the Earth's land area, they hold the equivalent of half of the carbon that is in the atmosphere as carbon dioxide (CO_2) (Dise, 2009). It is estimated that the carbon stored in peatlands represents some 25% of the world soil carbon pool (i.e. 3–3.5 times the amount of carbon stored in the tropical rainforests (Parish et al., 2007)).

Peatlands have been degraded and continue to be degraded all over the world. Western Europe has already lost over 90% of its original natural peatlands. In Southeast Asia, up to 95% of the tropical peat swamp forests have been affected by logging, deforestation, drainage and agriculture (Miettinen and Liew, 2010a,b). In a recent assessment, it was estimated that, globally, natural peatlands are being destroyed at a rate of 4,000 km^2/year (Parish et al., 2007). People have commonly treated peatlands as wastelands, using them in many destructive ways, without taking the long-term environmental and related socio-economic impacts into account. The main human impacts on peatlands worldwide include drainage for agriculture, cattle ranching and forestry, peat extraction, infrastructure developments, pollution and fires. The key economic, cultural and environmental role of peatlands in many human societies has called for a 'wise-use' approach that minimises irreversible damage and sustains their capacity to deliver ecosystem services and resources for future generations (Joosten and Clarke, 2002; Parish et al., 2007).

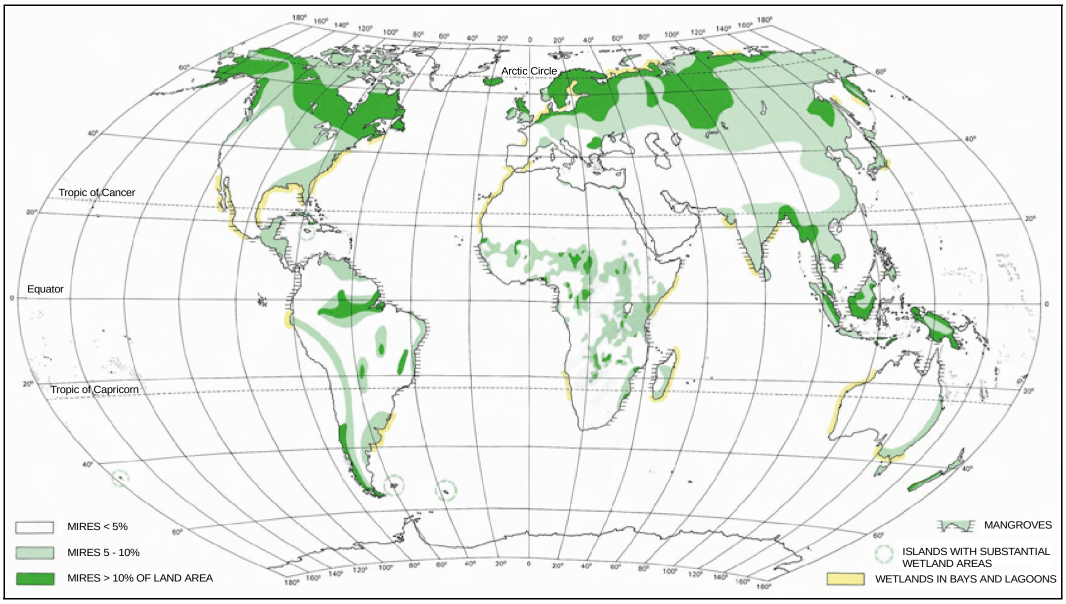

Figure 1-5.1. Distribution of peatlands in the world. Adapted from Lappalainen (1996), permission to reprint from the International Peat Society.

1-6 Irish Peatlands

According to the Heritage Council classification (Fossitt, 2000) – a standard scheme for identifying, describing and classifying wildlife habitats in Ireland – peatlands (of which subgroups exist: bogs and fens) are identified as one of 11 broad habitat groups. The BOGLAND report follows this classification and, therefore, *heath* habitats, which constitute a separate habitat group under the classification, are not considered a peatland habitat in this report. However, these are often associated with bogs and *wet heath* is listed as Annex 1 of the Habitats Directive.

Hammond (1981) recorded that peatlands covered a total area of 1.17 million ha or 17% of the area of the Republic of Ireland. This original area (also called maximum Holocene presence) corresponds to a high percentage cover enjoyed by other countries in Europe (see Table 1-6.1).

Much of this area has been extensively modified by humans. Peat has been used in Ireland since prehistoric times, but since the advent of industrial peat extraction, the process has accelerated and within a few decades most of the larger raised bogs in the Irish Midlands will have been exploited. In 1979, Hammond recorded that around 56% of the original area of bogs was still 'unmodified'. However, all Irish peatlands to date have been affected by peat cutting, grazing or fire to one extent or another. In a recent assessment, it was estimated that only 10% of the original raised bog and 28% of the original blanket peatland resource are deemed suitable for conservation (Malone and O'Connell, 2009). Irish peatlands fall into four categories (three of which are shown in Fig. 1-6.1):

1. Fen;
2. Raised bog;
3. Atlantic blanket bog; and
4. Mountain blanket bog.

Table 1-6.1. Maximum Holocene presence of peatland in European countries (after Joosten (2009)).

Country	Country area (km^2)	Max. Holocene mire area (km^2)	Max. Holocene mire area (%)
Netherlands	41,526	15,000	36
Finland	338,145	96,000	28
Estonia	45,227	11,000	24
Denmark	43,094	10,000	23
Ireland	**70,273**	**12,000**	**17**
Iceland	103,000	18,000	17
Sweden	449,964	70,000	16
Belarus	207,595	29,390	14
Latvia	63,700	7,000	11

1-6.1 Fens

Fens are peatlands that formed from vegetation receiving a constant influx of base-rich groundwaters and therefore can be described as minerotrophic (fed by groundwater). Fen peats in Ireland have usually a relatively high pH but some remain acidic, with a pH ranging from 4.5 to 8.0 (Doyle and Ó Críodáin, 2003). Fen peats are mineral rich, with a relatively high ash content (10–20%) and a relatively shallow peat depth (c. 2 m). The vegetation is generally species rich and largely dominated by tall herbs, rushes and grasses, with brown mosses a feature of the ground layer. There is a notable absence of *Sphagnum* species. While a fen can be seen as a transitional ecosystem en route to becoming a raised bog, they are rarely seen to progress in this natural direction due to human-induced disturbances, be it reclamation for agriculture, roadworks or landfilling. Natural fens are rare, as 97% of the country's fens have been drained for agriculture (Foss et al., 2001). While fens of conservation importance still occur right across the country, their current extent is estimated at 20,180 ha (Foss, 2007).

1-6.2 Raised Bogs

At the end of the last glacial period 10,000 years ago, the retreating ice left behind an undulating topography,

Figure 1-6.1. Examples of (a) mountain blanket bog, (b) Atlantic blanket bog, and (c) a fen.

resulting in the formation of shallow lakes across much of central Ireland. These lakes received nutrient-rich groundwater derived from calcareous glacial drift. Reeds and sedges encroached around the lake edges; their remains only partly decomposing under the water, in time formed a thick layer of reed peat. The continuous process elevated the surface above the level of the surrounding groundwater and peat-moss species, solely fed by rain, took over and continued to grow upward. The result was a dome-shape peat mass called raised bogs averaging 7 m in depth. Raised bogs were originally fens that became buried under ombrotrophic peat mosses (*Sphagnum* species). The vegetation, dominated by these bryophytes, keeps the peat surface waterlogged as the peat moss, growing above the water table has a very large water-holding capacity. Furthermore, peat mosses maintain an acidic environment that favours continued *Sphagnum* establishment. Other plant species found on raised bogs are: heather (*Calluna vulgaris* [L.] Hull), bog cotton (*Eriophorum angustifolium* Honckeny and *Eriophorum vaginatum* L.E.), and several species of sundew and orchids. Raised bogs are found mainly in the Midlands under moderate rainfall between 750 and 1,000 mm/year. While they originally covered 311,300 ha, a quarter of all peatlands (Hammond, 1981), raised bogs have been extensively damaged in the 20th century, being particularly suitable for industrial peat extraction. However, Ireland is still home to some of the nicest examples of raised bog in Western Europe and its bogs have been recognised as being of national and international conservation importance.

1-6.3 Blanket Bogs

Although raised bogs are at particular risk in Ireland, it is blanket bogs which are the rarer ecosystems at international level. Blanket bogs are restricted to oceanic areas of constant high rainfall and no distinctly dry summer period. Globally, they cover only 10 million ha and can only be found in Norway, Newfoundland, Alaska, Kamchatka, Japan, Tierra del Fuego, the Falkland Islands, Tasmania, New Zealand, Britain and Ireland (Lindsay, 1995) and in mountains of some other countries. Ireland has the largest coverage of blanket bogs in Europe (original cover was estimated at 773,860 ha – two-thirds of the original peatland cover in Ireland (Hammond, 1981)) and these bogs are distinctive landscape features of the western seaboard and mountainous areas.

Blanket bogs developed about 4,000 years ago but some are currently being initiated. They are most widespread in areas where the annual rainfall is greater than 1,250 mm and the number of rain days exceed 225. Like raised bogs, blanket bogs are ombrotrophic or rain fed, and as a result their pH lies between 3.5 and 4.2. The average depth of peat is 2.5 m over an underlying acidic mineral soil. Natural blanket bogs are dominated by *Eriophorum* species, black bog rush (*Schoenus nigricans* L.) (only low-level Atlantic blanket bog), purple moor-grass, lousewort, bell heather, the bryophytes *Campylopus atrovirens* and *Pleurozia purpurea*. These species also occur in raised bogs, but generally only around the edges, where ecological conditions resemble those typical of blanket bogs (Feehan et al., 2008). The peat in a blanket bog is generally very dense and highly decomposed throughout the peat profile, resulting in a very slow downward movement of water through the peat.

There are two types of *blanket* bogs in Ireland, split roughly half and half in terms of original area:

1. ***Atlantic blanket bogs*** are found in low-lying coastal plains and valleys in mountainous areas of western counties, below 200 m OD. They are particularly well developed in Counties Donegal, Mayo, Galway, Kerry, Clare and Sligo. Their vegetation is clearly distinct from raised bog and mountain blanket bogs (White and Doyle, 1982).

2. ***Mountain blanket bogs*** occur on relatively flat terrain (across mountain plateaux and gentle slopes) in the higher Irish mountains above 200 m OD and are distributed more widely than Atlantic blanket bog.

1-7 Concepts and Definitions

Unambiguous concepts and definitions of terms facilitate communication and clear decisions. This is even more valid for peatland science and policy. In Ireland, the multitude of terms is complicated by the fact that different peatland soils are assigned to different soil series. A workshop was organised at the onset of the BOGLAND project in order to compile a set of terms/definitions regarding peatlands that will be binding for all the partners in the project. The terminology regarding peat, peat soils and peatlands was agreed by national expert groups.[1] Further definitions are given under a different heading or group of terms and these definitions are specific to Ireland but ongoing discussions on accepted definitions are currently taking place within international peat-related organisations (for example, the Terminology Working Group set up by the International Peat Society (IPS) and the International Mire Conservation Group (IMCG)). An extended list of terms used in the project can be found in the Glossary.

1. **Peat, peat soils and peatlands**

   Peat: sedentarily accumulated material consisting of at least 30% (dry mass) of dead organic material.

   Peat soil: soil that contains peat over a depth of at least 45 cm on undrained land and 30 cm deep on drained land; the depth requirement does not apply in the event that the peat layer is directly over bedrock.

   Peatland: a geographical area (with or without vegetation) where peat soil occurs naturally. For mapping purposes, a peatland should cover a minimum spatial extent of 1 ha.

2. **Peatlands and bogs**

   There have been several different schemes proposed for the classification of peatlands in Ireland. The accepted one is Hammond (1984), in which three types are distinguished: **fens**, **raised bogs** and **blanket bogs** (Hammond, 1984). Blanket bogs can be further classified into two categories: **Atlantic blanket bogs**, **mountain blanket bogs**. The terms ‘peatland’ and ‘bog’ are not interchangeable.

   High bog: area of a raised bog that forms/formed the dome.

   Definitions of further concepts associated with peatlands (e.g. minerotrophic and ombrotrophic) can be found in the Glossary.

3. **Status of peatlands**

   Active peatlands or **mires:** peatlands on which peat is currently forming and accumulating. All active peatlands (mires) are peatlands but peatlands that are no longer accumulating peat would no longer be considered mires.

   Intact, pristine and virgin peatlands: the terms ‘virgin’, ‘pristine’ and ‘intact’ have been used in several studies in relation to sites that look unmodified, uncut (as visible to the eye) and where no obvious factor is currently degrading the peatland. These terms are best avoided for use of habitat description such as peatlands in an Irish context. Most Irish peatlands are ‘humanised’ landscapes which have evolved, indeed sometimes originated, in close association with land-use systems. It would be impossible to find an Irish peatland that has never been grazed or been used in some way by humans (e.g. burning).

   Near-intact peatlands: in this report, the terms ‘near-intact’ and ‘natural’ peatlands are interchangeable and are used to refer to peatlands that are hydrologically and ecologically

1. Including representatives of Teagasc, National Parks and Wildlife Service (NPWS), Bord na Móna, Soil Science Department (University College Dublin (UCD)), Biosystems Engineering (UCD), Biology and Environment (UCD), Environmental Engineering (Trinity College Dublin (TCD)) and National University of Ireland, Galway.

intact, i.e. in which the eco-hydrology has not been in the recent past visibly affected by human activity and therefore includes 'active' or 'peat-forming' areas or is in the process of regenerating such habitats. A natural peatland thus requires a combination of components to be present in order to carry out all the functions and ecosystem services usually attributed to such ecosystems.

Priority habitat: a subset of the habitats listed in Annex I of the EU Habitats Directive. These are habitats that are in danger of disappearance and whose natural range mainly falls within the territory of the EU. These habitats are of the highest conservation status and require measures to ensure that their favourable conservation status is maintained.

Favourable conservation status: the conservation status of a natural habitat will be taken as favourable when its natural range and areas it covers within that range are stable or increasing, and the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and the conservation status of its typical species is favourable. See 'Conservation status' in the Glossary for further details on methods for assessing conservation status in the context of the Habitats Directive.

Protected sites/areas: include all the sites/areas designated for conservation in Ireland – Natura 2000 sites (Special Areas of Conservation (SACs) and Special Protection Areas (SPAs)) as well as all the Natural Heritage Areas (NHAs).

Peatland of conservation value: a peatland site which is either formally designated under EU or Irish law or proposed for designation. All natural peatlands are of conservation value. However, the reverse is not necessarily true. A degraded peatland can be of conservation value if it can realistically be managed to reach a natural peatland status or to maintain an adjunct natural area.

It should be noted therefore that the area of peatlands of conservation value is much larger than the area of natural peatlands. For example, Clara Bog is a peatland of an estimated area of 665 ha; the area estimated of conservation value (a nature reserve) is 460 ha; the area estimated as an active raised bog or 'natural' bog (NPWS, 2005 Raised Bog Monitoring Project) is 100 ha. According to this 2005 survey this area has declined by 46 ha since 1992 when the Habitats Directive was first implemented. In this example, over 3.5 ha of active raised bog have been lost every year.

Degraded peatland: a peatland where any on-site or off-site activity has/had a negative impact on the natural functions and values (e.g. carbon storage, ability to sequester carbon, biodiversity, archives).

4. Peatland management

Industrial cutaway peatland: a peatland where peat is being/has been extracted by industrial means. Peat extraction is the term used in this report to refer to peat production[2], peat mining or peat harvesting.

Cutover peatland: a peatland where peat is being/has been removed through turf cutting by hand or small-scale mechanical peat extraction. Cutover areas are usually made of a mosaic of cut areas, face banks, pools, drainage ditches, uncut areas, scrubs, grassland.

Abandoned peatland: drained cutaway or cutover peatland that has been abandoned and left to spontaneous development.

Reclaimed peatland: peatland where land use has led to a substantial alteration of hydrological conditions and plant growth, e.g. afforestation or agricultural activities.

Restored peatland: formerly drained peatland where human activities have led or are expected

2. Peat production is the term widely used in Ireland within the industry and is defined as the overall management or the processes and methods used to produce peat for commercial operations.

to lead to a recovery of its natural functions and values.

Re-wetted peatland: formerly drained peatland where human activities or spontaneous developments have led to a rise in the water table.

Regenerated peatland: degraded peatland where spontaneous development has led to the regeneration of peat-forming conditions.

Section 2

Integrating Biodiversity Protection and Sustainable Management of Irish Peatlands

2-1 Background

Despite some recent improvements in the development of tools and availability of data, biodiversity remains difficult to quantify and species new to Ireland are still being discovered (see Chapters 2.4 and 2.6, End of Project Report). However, precise answers are seldom needed to devise an effective understanding of the location of particular components of biodiversity, its changes over space and time, the drivers responsible for such change, the consequences of such change for ecosystem services and human well-being, and the options available in response to such change.

Research in this project concentrated on a variety of measurements of biodiversity, from mesotope to microtope levels, including species richness (i.e. the number of species in a given area), the abundance of specific taxa (birds, aquatic and terrestrial invertebrates) and the profiling of the microbial diversity. These assessments have helped in selecting 'indicator species', defined as a species that is sensitive to habitat quality and that can be monitored to provide insights into trends in habitat quality (EEA, 2007). In this way, the status of an indicator species is used to infer the status of many other species that depend on similar habitat and, as such, is an important tool for assessing ecosystem conditions and trends. However, no single indicator captures all the dimensions of biodiversity, which in the case of peatlands is significant at all levels from microbes to landscape.

2-2 The Components of Peatland Biodiversity in Ireland

2-2.1 Landscape Biodiversity

Peatlands are exceptional natural entities. They are local illustrations of a unique combination of habitats with a unique biodiversity and natural heritage value. The biodiversity of peatlands has to be ascertained on all levels of organisation – from gene to the landscape level (see Chapter 2.1, End of Project Report). This multi-levelled approach (adopted by the Convention on Biological Diversity) is particularly suited to valuing peatlands with respect to biodiversity conservation, as not only the rareness of individual species has to be assessed but also the rareness of habitats and entire regions.

In Ireland, peatlands create distinctive upland and lowland landscapes; for example, the character of the west of Ireland is largely determined by the extensive cover of blanket bogs. These vast expanses of bogs in certain parts of Counties Galway and Mayo might look species poor (i.e. no alpha diversity), but they contribute considerably to international landscape biodiversity (gamma diversity). Due to its location at the western edge of Europe, Ireland, together with the UK, represents the heartland of the world blanket bog resource. Therefore, Ireland has a clear international responsibility for the conservation of such exceptional landscape biodiversity.

2-2.2 Habitat Biodiversity

The scope of this project allowed the investigation of different types of peatlands found in Ireland – as classified in the Heritage Council (Fossitt, 2000) – namely fens, raised bogs, Atlantic blanket bogs and mountain blanket bogs. Wet heath, which is often associated with peatlands, is a separate habitat group of conservation importance but has not been included in the scope of this project. Although all are peatland ecosystems, biodiversity elements were found to vary between each type. The main division is between bogs and fens; while the bogs are similar to fens in terms of avian and invertebrate diversity, they contrast with fens, which exhibit much higher species richness and abundance. This dichotomy is not surprising as historically the peatlands have always first been classified as either ‘bog’ or ‘fen’. Although fens encompass less than 8% of all peatlands in Ireland, both bogs and fens are equally important in terms of peatland biodiversity conservation, as they form very diverse ecosystems, each with its unique biodiversity. Today, undamaged fens are rare in Ireland and in contrast with bogs, far less information is available on these peatland types. A systematic assessment of all remaining fens is urgently needed (Foss, 2007).

Peatlands come in various shapes and forms, representing a unique range of habitats from calcareous-rich fens to acidic bogs, many of them being identified as ‘priority’ habitats under the Habitats Directive (EC Directive on the Conservation of Habitats, Flora and Fauna 92/43/EEC) because they are particularly threatened in Europe. No less than three bog habitats, two fen habitats and six other habitats associated with peatlands are listed in Annex 1 of the Habitats Directive. This represents almost 20% of the total number of habitat types in Ireland (59), whose conservation requires the designation of SAC. There are currently 162,582 ha of peatlands designated as SACs (Douglas et al., 2008) out of a total 1,350,000 ha (14%) in Ireland (including maritime areas). The lack of representativeness of peatland types is an important issue to be addressed in programmes of biodiversity conservation.

2-2.3 Site Biodiversity

At the level of individual sites, each peatland has a unique character. The variation in the characteristic features of each peatland site is related to:

- Geographical position (there are obvious geographical gradients across the country);
- Peatland structure: morphology, mode of development, source of plant nutrients;
- Distribution of habitats (hummocks, lawns and pools and other open-water habitats);
- Extent of the peatland;

- Environmental conditions (i.e. degradation levels and consequent ecological status, e.g. water-table level);
- Management practices (conservation history, past, present and future threats); and
- Management in the surrounding land area and hydrological catchment.

Site biodiversity has been ascertained in the studies of terrestrial, aquatic and microbial diversity on the 12 core study sites in the BOGLAND project. Between-site variation was especially evident amongst fens. Each fen site studied appeared to be unique in many characteristics. Also, the location (in both the east–west and the north–south gradients) influenced the biodiversity found at each blanket bog site.

For both fens and bogs, habitat heterogeneity (variety within site) appeared to be the main reason explaining variety between sites. For example, the community structure and composition of aquatic invertebrates differed significantly between the pools and *Sphagnum* hollows found in bogs. Therefore, sites containing both habitats have a higher diversity. Similarly, recorded bird species were associated with different aspects of the peatland habitat (presence of pools for example). The diversity of micro-habitats in a peatland generally increases with its size and, because of this, larger peatlands tend to be more species rich. However, patterns of species diversity vary greatly among taxonomic groups as each responds to a particular set of environmental gradients. Environmental conditions appeared to be the main driver of microbial diversity in the peat (see Chapter 2.3, End of Project Report). Degradation often increased habitat diversity (see Section 2-2.5), but at the detriment of rare and protected habitats usually found in intact sites. Given this high complexity of factors and associated heterogeneity, there is substantial scope for greater protection of more peatland sites in order to protect biodiversity.

2-2.4 Species Biodiversity

Peatlands host a diversity of species and life forms (Bellamy, 1986; O'Connell, 1987; Doyle and Ó Críodáin, 2003; Feehan, 2004; Feehan et al., 2008). The floral and faunal species found on peatlands represent a considerable resource within the biodiversity of Ireland, some of them being endemic and rare at a global scale. Life forms on peatlands are of great interest because of the necessary adaptation to such harsh environmental conditions, e.g. the peat-forming *Sphagnum* mosses, the carnivorous plants such as sundew (*Drosera* spp.), bladderwort (*Utricularia* spp.) and butterwort (*Pinguicula* spp.), the symbiotic lichens and other adapted species such as bog myrtle (*Myrica gale*) and the many species of sedges such as bog cotton (*Eriophorum* spp.), white beak sedge (*Rhynchospora alba*), deer sedge (*Scirpus cespitosus*) and black bog rush (*Schoenus nigricans*). Some plant species found on peatlands are on priority conservation lists (*Red Data Books* being compiled by the NPWS), eight plant taxa being cited in the Habitats Directive: two vascular plant species, two moss species, one liverwort species and three entire genera (Table 2-2.1). Most of these species have been identified in the core study sites including the rare yellow marsh saxifrage (*Saxifraga hirculus*) which is associated with base-rich flushes within blanket bogs and is present only in County Mayo (including two of the core studied sites: Owenirragh Bog and Bellacorick Flush) and County Antrim.

With regards to peatland fauna, six species, including four invertebrates, are cited in the Habitats Directive (Table 2-2.1). The range of animals and birds that use peatlands for feeding, breeding and refuge is considerable but very few taxa are restricted to peatlands. Being acidic, waterlogged and with low nutrient availability, bogs are especially hostile for many species. The bird study (see Chapter 2.5, End of Project Report) confirmed that peatlands are species poor compared with other habitats whereas more species of birds were recorded on fens than on bogs. Only 21 breeding bird species were recorded in this study, with meadow pipit (*Anthus pratensis*) and skylark (*Alauda arvensis*) accounting for over 80% of all birds recorded. Despite this relatively low avian species diversity, Irish peatlands are of enormous value due to the presence of species of high conservation concern such as red grouse (*Lagopus lagopus*) and Eurasian curlew (*Numenius arquata*). Other species found on peatlands, including golden plover (*Pluvialis apricaria*), Greenland white-fronted goose (*Anser albifrons flavirostris*), hen harrier (*Circus*

Table 2-2.1. Peatland habitats and species (excluding birds) listed in the annexes of the Habitats Directive as requiring special protection status and their overall status as assessed by the National Parks and Wildlife Service (NPWS, 2008) (see ‘Conservation status’ in the Glossary for definitions).

	Name	Code	Overall status
Habitats	Active raised bog[1]	7110	Bad
	Degraded raised bog	7120	Poor
	Blanket bog[1]	7130	Bad
	Alkaline fen	7230	Bad
	Cladium fens[1]	7210	Bad
	Transition mires	7140	Bad
	Rhynchosporion depressions	7150	Good
	Wet heath	4010	Bad
	Dry heath	4030	Poor
	Alpine and sub-alpine heath	4060	Poor
	Bog woodland[1]	91D0	Poor
Faunal species	Geyer’s whorl snail (*Vertigo geyeri*)	1013	Poor
	Narrow-mouthed whorl snail (*Vertigo angustior*)	1014	Poor
	Desmoulins’ whorl snail (*Vertigo mounlinsiana*)	1016	Bad
	Marsh fritillary (*Euphydryas aurinia*)	1065	Poor
	Otter (*Lutra lutra*)	1355	Poor
	Irish hare (*Lepus timidus hibernicus*)	1334	Poor
Floral species	Slender green feather-moss (*Hamatocaulis vernicosus*)	1393	Good
	Marsh saxifrage (*Saxifraga hirculus*)	1528	Good
	Petalwort (*Petalophyllum ralfsii*)	1395	Good
	Slender naiad (*Najas flexilis*)	1833	Poor
	White cushion moss (*Leucobryum glaucum*)	1400	Poor
	Sphagnum genus	1409	Poor
	Lycopodium species	1413	Poor
	Cladonia species	5113	Poor

[1]EU Priority habitats requiring particular protection because their global distribution largely falls within the EU and because they are in danger of disappearance.

cyaneus), peregrine falcon (*Falco peregrinus*) and merlin (*Falco columbarius*), are protected species listed in Annex 1 of the EC Directive on Conservation of Wild Birds 1979.

While the number of invertebrate species was also found to be low, communities differed between the peatland types, with several species recorded from only one type of peatland. Only three species of spider were found on all four peatland types. Mites on the other hand showed an unusual high diversity, with one species, *Limnozetes amnicus* (Behan-Pelletier), recovered from Ballygisheen, County Kerry, being a new species for Ireland (confirmed by Valerie Behan-Pelletier in 2008) and another species found at Pollardstown Fen, possibly being new to science (see Chapter 2.4, End of Project Report). It is likely that more species of invertebrates have remained unrecorded due to their poor level of study in Ireland. A beetle species new to Ireland (*Ochthebius nilssoni*) was recorded from a fen in County Clare – until now it was thought to occur only in Scandinavia (O'Callaghan et al., 2009). The assemblage of aquatic invertebrates is also poor, but considering the acidic nature of the ombrotrophic bog water and the variation in wetness within and between sites, the diversity of such biota is very significant. In this project, a water beetle species (*Ilybius chalconatus*), listed as vulnerable in the recently published *Ireland Red List No. 1 – Water beetles*, was found in Clara Bog (see Chapter 2.6, End of Project Report). In addition, fens displayed a much higher diversity of aquatic species than bogs with a new record for Ireland of a caddis fly species (*Erotesis baltica* McLachlan) which was discovered in Scragh Bog (verified by Dr James P. O'Connor of the Natural History Museum in 2009).

In contrast with the birds and animals, initial findings from this project showed that the soil microfauna and microflora probably constitute the richest repertoire of biodiversity in peatlands. While reliable species identification has yet to be established by cloning analysis, the profiling of the general archaeal and bacterial communities found in peat showed great diversity between peatland types, between individual sites and between micro-forms within each site (see Chapter 2.3, End of Project Report).

Peatlands thus support few but unusual species with exceptional adaptation and more species have yet to be discovered. With the contribution of Irish peatlands to biodiversity not yet fully understood, the occurrence of rare and threatened species (as well as possible unknown species) should provide important incentives for the protection of peatlands.

2-2.5 New Diversity from Degraded Peatlands

It is worth noting that high species diversity does not always go hand in hand with naturalness or intact state. All peatlands in Ireland have been affected and/or degraded to some degree by human activities. In peatlands that have long histories of traditional extensive management, these uses may have contributed significantly to the development and maintenance of species biodiversity. However, this is at the cost of loss of rare species and other services that the intact peatland provides.

The range of degraded peatlands is vast and eclectic, from industrial cutaway raised bog to afforested or overgrazed blanket bog. Farrell (2008) described succinctly their main characteristics, extent and distribution, and concluded that the potential of cutaway peatlands to enhance the national biodiversity resource is significant. Industrial cutaway peatlands, located mainly in the Midlands, that have been abandoned to nature have produced one of the richest reservoirs of biodiversity in the region. The mosaic of cutaway peatland habitats (some of high conservation status) gives a unique diversity of plants and animal species (Feehan, 2004; Pearce-Higgins and Grant, 2006; Higgins et al., 2007; Buckley, 2008; Copland et al., 2008; Lally et al., 2008). For example, grey partridge (*Perdix perdix*) and lapwing (*Vanellus vanellus*), both Red-Listed species in Ireland, have retreated to the cutaway peatlands because agricultural landscapes can no longer support breeding populations. Degraded peatlands and in particular cutaway peatlands form thus a new component of peatland biodiversity which requires special attention in the context of the National Biodiversity Plan (NBP) and particularly in Local Biodiversity Plans in the counties where they occur. For example, Offaly County Council has already recognised the heritage value of the Lough Boora Parklands (a complex of rehabilitated industrial cutaway peatlands) for biodiversity and amenity and has set to protect and conserve such areas in its Development Plan (Offaly County Council, 2009).

Summary Findings

- *Ireland is home to rare raised bogs and blanket bogs of international importance and therefore Ireland has a clear international responsibility for the conservation of such exceptional landscape biodiversity.*
- *There is substantial scope for greater protection of more peatland sites in order to protect more biodiversity.*
- *Conservation programmes for biodiversity need to include all peatland types in a representative manner.*
- *Peatlands support few but unusual and rare species with exceptional adaptation and more species have yet to be discovered.*

2-3 Current Trends and Drivers of Peatland Biodiversity

2-3.1 Status of Peatland Biodiversity

The Millennium Ecosystem Assessment on Biodiversity (2005) reports that "*changes in biodiversity due to human activities were more rapid in the past 50 years than at any time in human history. Projections and scenarios indicate that these rates will continue, or accelerate in the future*". It adds that "*the degradation and loss of wetlands* [including peatlands] *is more rapid than that of other ecosystems*". The global peatland resource has suffered severe degradation with the loss of many peatland habitats. Western Europe has already lost over 90% of its original mire extent and central Europe over 50% (CC-GAP, 2005). The destruction of large areas of European peatlands in the past is repeating itself in the 21st century in developed countries: in Southeast Asia up to 70% of the tropical peat swamp forests have been significantly degraded and natural peatlands in southern and eastern Africa are under severe threat of conversion and degradation (CC-GAP, 2005). Since peatlands constitute habitats of unique flora and fauna which contribute significantly to the gene pool, the loss of peatlands in Ireland equates to loss of biodiversity at regional, national and international levels.

In Ireland, at least one species of higher plant found on raised bogs (*Scheuchzeria palustris*) has become extinct in the last 50 years (Cross, 1990). The recent overall assessment (NPWS, 2008) of rare species associated with peatlands shows that their status is 'bad' with urgent action needed, for example, for the Desmoulins' whorl snail which was assessed as 'bad' (Table 2-2.1). The assessment of peatland habitats presents an even bleaker picture, with all being rated as having poor or bad overall status. The overall objective within the Habitats Directive is to achieve and maintain favourable conservation status for the habitats and species of EU community interest and thus to contribute towards maintaining biodiversity of natural habitat and of wild fauna and flora in the territory of the Member States. Favourable conservation status is described as a situation where a habitat type or species is prospering (in both quality (structure and function) and extent/population) and has good prospects to do so in the future (EU Habitats Committee, 2003). The assessment surveys undertaken by the NPWS to identify suitable peatlands for conservation and monitor their status over time (Douglas et al., 2008), together with additional studies undertaken to investigate the processes underlying their deterioration and recovery (Schouten, 2002; Fernandez Valverde et al., 2005), show that Irish peatlands are altogether at risk. Blanket bogs and raised bogs together with fens were once extensive habitats in Ireland and it has been estimated that overall only 15% are in near-intact state (Table 2-3.1). It is therefore more alarming to see that at the mesotope level of biodiversity, entire ecosystems such

Table 2-3.1. Summary data on the extent of peatlands and their protection status in Ireland.

	Total original area[1]	Near-intact	% of original cover	Protected area (NHA + SAC)	% of original cover	Total area of conservation importance
Blanket bogs	773,860	143,248	18%	182,063	23.5%	216,599[5]
Raised bogs	311,300	21,519[2]	7%	35,000[4]	11.2%	50,000[6]
Fens	92,500	10,307[3]	11%	18,470	20%	20,912[5]
Total	**1,177,660**	**175,074**	**15%**	**235,533**	**20%**	

[1]After Hammond (1981).
[2]Includes 1,945 ha of active bog (peat forming) (NPWS, 2007a).
[3]The present extent of fens has been estimated at 22,180 ha (Foss, 2007).
[4]Includes cutover, cutaway and mineral peat–mineral transition.
[5]Malone and O'Connell (2009).
[6]This is the area of uncut high raised bogs as monitored by the NPWS (2007a). However, the Irish Peatland Conservation Council estimates that only 31,754 ha are worthy of conservation (Malone and O'Connell, 2009).
NHA, National Heritage Area; SAC, Special Area of Conservation.

as intact raised bogs and fens have almost disappeared in Ireland. All near-intact peatlands are currently protected and together with other degraded peatland habitats and associated habitats (see Table 2-3.1). The combined protected area of peatland habitats is estimated to be just 20% of the original resource or some 235,533 ha. This area is at a discrepancy with a shadow list of peatland sites proposed for designation by a group of non-governmental organisations (NGOs) based on their own assessment of conservation importance, covering an area of 266,578 ha over 736 sites (Malone and O'Connell, 2009). With only 1,945 ha of raised bog qualifying as peat-forming habitat (active) and less than a fifth of its original blanket bog area in near-intact condition, the trends of peatland biodiversity losses in Ireland are perturbing. According to the NPWS (2008), the protection of peatlands and their biodiversity is an enormous challenge facing Ireland today. This view is shared at an international level as a European review of Ireland's biodiversity concluded that the conservation status of many of the most important habitats and species (including peatlands) gives cause for concern (EPA, 2008b). It appears thus that the aims of the NBP, which would lead to a significant reduction in the rate of biodiversity loss by 2010, have failed. In the case of peatlands, the magnitude of the challenge of improving their status is demonstrated by the numerous direct drivers of biodiversity change which are projected to either remain constant or even increase in the near future.

2-3.2 Drivers of Peatland Biodiversity Loss

Ireland's peatland biodiversity is not static but profoundly dynamic as a result of human usage of the land as well as natural processes and events. The variety of floral and faunal communities has been much changed or reduced by a combination of pressures and threats. The drivers of peatland biodiversity change are:

1. Habitat change (reclamation for agriculture, afforestation, drainage, overgrazing, erosion, quarrying, wind-farm development, dumping, burning, recreation in the form of walking, horse riding, quads, etc.);

2. Exploitation (industrial extraction for fuel and horticulture and domestic turf cutting);

3. Nutrient pollution;

4. Invasive species; and

5. Climate change.

These drivers of biodiversity change are not independent in that some are the direct result of biodiversity change itself (e.g. invasive species). Some of these threats have had serious impact on peatland biodiversity in the past (habitat change), some are currently causing biodiversity loss (turf cutting and nutrient pollution) and other threats are likely to cause severe damage in the future (climate change and invasive species). Overall, the most critical drivers of biodiversity change (1, 2 and 3 above) are projected to remain constant or even increase in the near future and this represents a major challenge for the protection of peatlands. These drivers are broached upon in detail in Section 3-3.

Summary Findings

- *The loss of peatlands in Ireland equates to a loss of biodiversity at regional, national and international levels.*

- *The loss of biodiversity is observed from mesotope level (entire ecosystems such as raised bogs and fens have been almost all damaged) to microtope level (species and particularly habitats).*

- *The drivers of biodiversity change are projected to remain constant or even increase in the near future and this represents a major challenge for the protection of peatlands.*

2-4 Indicators of Biodiversity

2-4.1 De Facto Peatland Biodiversity Indicators

A powerful tool in tracking the impacts of policies on biodiversity is the use of indicators (Coll et al., 2009). At EU level, the European Environmental Agency (EEA) has developed a headline set of biodiversity indicators to assess achievement of the 2010 target (EEA, 2007). Indicators have been developed for the sustainable management of Irish plantation forests (Iremonger et al., 2007), but further development of indicators at national level is needed to inform the public and decision makers on biodiversity, the effectiveness of conservation measures and progress made in halting biodiversity loss (EPA, 2008b). Although the biodiversity perspective has only recently been applied to environmental policy and management problems, biodiversity indicators can also be identified for assessing the conditions of peatlands and therefore can help in achieving sustainable management.

Following the findings of this report, as well as published literature, a list was compiled showing positive and negative indicators of biodiversity relevant to peatlands in Ireland (Table 2-4.1). The presence of protected species is a de facto good indicator of biodiversity and thus of general health of the site. They can indicate whether the peatland can provide the wide range of services naturally attached to the biodiversity of such ecosystems. Several protected bird species can be identified as de facto biodiversity indicators. The red grouse (*Lagopus lagopus*) is the only bird species that is found solely on peatlands in Ireland and Britain. Together with the Eurasian curlew (*Numenius arquata*) and the golden plover (*Pluvialis apricaria*), these species are of high conservation concern according to the BirdWatch Ireland's Red List (http://www.birdwatchireland.ie/). Red grouse, curlew and golden plover are relatively easy to detect and identify and are therefore well suited as indicators of near-intact peatland biodiversity. Other Red Data and legally protected faunal species may also be considered de facto indicators, although their monitoring may be more difficult to carry out. Some of these rare and threatened species can also be found in 'degraded' peatland and thus cannot be used in singular to assess the quality of a site. For instance, golden plover also favours industrial cutaway peatlands.

Table 2-4.1. Indicators of biodiversity and sustainability of peatland (covering all types of peatlands).

Compositional	Functional
Positive indicators: • All the protected species listed in Table 2-2.1 (Habitats Directive), plus: • *Lagopus lagopus* • *Numenius arquata* • *Pluvialis apricaria* • *Schoenus nigricans* • *Pinguicula lusitanica* • *Campylopus atrovirens* • *Pleurozia purpurea*	***Positive indicators:*** • Habitat heterogeneity: pools, *Sphagnum* hollows, flushes, lakes and soak systems • Presence of micro-forms: lawns, hummocks and hollows
Negative indicators: • Presence and growth form of trees • Presence of *Rhododendron ponticum* • Presence of lumbricid earthworms • Abundance of *Molinia caerulea* and *Narthecium ossifragum* in raised bogs	***Negative indicators:*** • Loss of vegetation cover (bare peat) • Drains and peat-cutting banks • Gullies and hags • Trampling • Burning

2-4.2 Mesotope Level: Habitat Heterogeneity

The presence/absence and general condition of a variety of habitats (see Table 2-4.1) that are usually found in natural peatlands are good indicators of the condition (degraded, near natural, etc.) of the ecosystems and also inform on their biodiversity status. For example, the avian and invertebrate studies carried out in this project demonstrated that the maintenance of habitat heterogeneity is important in order to retain the range (collection) of species. Species like red grouse and curlew were most abundant where vegetation structure and cover was relatively heterogeneous (within the limit of habitat variety). The community structure and composition of aquatic invertebrates was also clearly different between pools and *Sphagnum* hollows. The maintenance of characteristic habitats found on natural peatlands is therefore important in order to preserve and enhance overall biodiversity. Habitat heterogeneity is a good indicator of biodiversity as habitats are easier to identify than particular species and can inform quickly on the biodiversity status of the site.

2-4.3 Microtope Level: Change in Species Composition

Natural habitat heterogeneity should be distinguished from the mosaic of habitats that is created by degradation processes. Drainage and turf cutting lead to the disappearance of the various 'true' habitats of natural peatlands (first laggs and edges of bogs, later more central bog ecotopes) and the creation of new habitats. While characteristic species can still be present in degraded peatlands the species dominant in natural peatlands – for example spiders (Koponen, 1979), carabid beetles (Främbs, 1990) and aquatic macro-invertebrates (van Duinen et al., 2003, 2004) – generally decline and non-typical species increase. This was confirmed in the terrestrial invertebrate study carried out in this project which demonstrated that characteristic peatland beetles, such as *Carabus clatratus* and *Carabus granulatus*, which are dominant in near-intact bogs, are less dominant or absent in degraded (turf-cutting) mountain blanket bogs and replaced by human-induced mosaic-habitat species, such as members of the genus *Pterostichus*. Therefore, such a change in species composition is a good indicator of a change in management.

It is important to note that the presence of human-induced mosaic-habitat species does not preclude the presence of characteristic species, these being perhaps more difficult to find. In some cases, the simple presence of a species that would otherwise be absent (negative indicator) in natural peatlands can immediately inform on the status of a peatland site. For example, the absence of trees is a characteristic trait of Irish peatlands. This is due to the climatic conditions that have prevailed in Ireland during large parts of the Holocene (indeed peatlands in continental Europe are often – to some extent – naturally wooded). The spread of trees on a bog – be it native broadleaves such as birch or willow, or exotic conifers species planted there – is a clear indicator of the drop in water table that will have considerable implications for the biodiversity reservoir of these sites. The invasion of trees onto bogs is therefore a good indicator of degradation. Another less conspicuous example is that of lumbricid earthworms, which are absent from the acid peat of undamaged bogs. The findings of a new project on soil biodiversity in Ireland confirmed that no earthworms were present in all eight peatlands under study (Schmidt et al., 2011). One species was present in an afforested peatland whereas nine earthworm species were recorded in a reclaimed cutaway peatland (Curry and Schmidt, 2006). These examples confirm that increased species richness is not necessarily a positive indication of habitat quality, or of conservation value.

Irish peatlands are a good case in point to illustrate the fact that biodiversity is not about the number of species but about the difference (i.e. diversity of information). The degradation of a bog will lead to more species which make it less different from surrounding ecosystems – i.e. an increase in diversity at site level implies a loss of biodiversity at landscape level.

2-4.4 Plant Species as Major Indicator of Biodiversity

The flora of peatlands is perhaps the most noticeable indicator of biodiversity and loss of vegetation cover (i.e. bare peat) is an easily identified, firm indicator (albeit negative) (see Chapter 2.2, End of Project

Report). On the other hand, rare and protected plant species are firm positive indicators. For example, the marsh saxifrage, which is listed in the Habitats Directive (92/43/EEC) and protected under the Wildlife (Amendment) Act (2000), was once widely distributed across Europe but is now declining and under considerable threat. It is currently only found in blanket bogs in County Mayo. It should be noted however that some rare and protected flora can occur in pockets within a degraded blanket bog system. On the other hand, typical bog flora may be considered common, yet they define much of the habitat and their area and range are good indicators of active bog. The assessment of the vegetation of any peatland will indicate rapidly the current condition of the peatland and, in many instances, past management practices can be interpreted based on the floristic component and the condition of the vegetation. Similarly, the vegetation is intimately associated with the other characteristics vital to the sustainability of the peatland, such as drainage, nutrient fluxes, and/or other disturbances. More importantly perhaps, plants, in particular *Sphagnum* spp., are drivers of peat accumulation, carbon sequestration and hydrological regulation, and are therefore indicators of critical functions. Negative impacts on certain, few, typical peatland plants can alter the natural ecosystem functions. Consequently, any change in vegetation can either be a cause of, or reflect, changes in characteristic features of a healthy peatland. Therefore, plant species that are natural to each peatland type become a good indicator not only of biodiversity but also of general sustainability of peatlands.

Summary Findings

- *Biodiversity indicators, such as protected species, can inform whether a peatland site is suffering from degradation, is healthy or is in the process of recovery.*
- *An increase in species diversity at site level due to degradation implies a loss of biodiversity on the landscape level.*
- *Habitat heterogeneity is a good indicator of the quality of peatlands. Maintaining the range of characteristic habitats is essential in order to preserve and enhance overall peatland biodiversity.*
- *Plant species that are natural to each peatland type are good indicators not only of biodiversity but also of general sustainability of peatlands.*

2-5 Biodiversity Protection and Sustainable Management of Peatland

2-5.1 What Is the Future of Peatland Biodiversity in Ireland?

After nearly a century of afforestation, half a century of agriculture intensification and a decade of economic boom, it comes as no surprise that the Irish biodiversity is under significant pressure. Since 1992 and the introduction of the Habitats Directive into European law, Ireland is obliged to protect species and habitats at risk. In 2002, the Irish Government adopted the first ever NBP, covering a 5-year period, 2002–2006, and setting out a series of 91 actions for the conservation and sustainable use of Ireland's biodiversity. A review of the NBP (Biodiversity & Policy Unit, 2005) and an assessment of the status of habitats and species protected under the Habitats Directive (NPWS, 2008) presented a bleak picture for the future of biodiversity in Ireland, especially for peatlands. The review of the NBP concluded that:

1. Biodiversity loss is occurring at an increasingly rapid rate and therefore demands effective and timely action; and that

2. Pressures on biodiversity are increasing with growth in population, use of resources and change in land use, urbanisation, road building and infrastructure development.

Climate change and threat of invasive species are also adding to the complexity of biodiversity management.

It is fair to say that less peatland biodiversity would exist today had not communities (e.g. Wetland Wilderness Park Committee), NGOs (e.g. Irish Peatland Conservation Council, BirdWatch Ireland) and government bodies (e.g. NPWS) taken actions to protect particular sites. However, significant actions building on current initiatives are needed to reverse the trend of biodiversity loss and ecosystem degradation. The law requires that Ireland sets about improving the situation. In the case of a *business-as-usual* scenario, with no proper response to such environmental problems, pressures by economic development and other human activities would rapidly increase further habitat loss caused by land-use changes and would lead to continued decline in the local and global diversity of species, habitats and landscapes that are enshrined in peatland ecosystems.

It is true that, over a large area of Ireland, the original habitat conditions have been greatly and sometimes irreversibly altered by human activity. The future of nature is inevitably entwined with that of human development. However, it is interesting to dwell for a moment on what would happen to Ireland if it were '*left to nature'*. In this implausible scenario, Cross (2006) suggested that Ireland would indeed become an island of peatlands. When investigating the potential natural vegetation of Ireland, i.e. "*the vegetation that would finally develop in a given habitat if all human influences on the site and its immediate surroundings would stop at once and if the terminal stage would be reached at once*", Cross concluded that peatlands would be the second most extensive potential natural vegetation type after forests. Like other botanists before him (Praeger, 1934; Webb, 1983), he substantiated the peculiarities and uniqueness of the Irish flora arising from its geographical location and relative isolation. Overall, Ireland could have an area of potential natural mires greater than in any other European country at these latitudes, with Atlantic raised bogs having their European headquarters in Ireland.

2-5.2 What Targets Should Be Achieved?

Costanza et al. (2000) suggest that to manage the Earth's 'environmental portfolio', policies should aim at:

- Preserving our natural capital;
- Not putting ecosystem services at risk; and
- Having 'environmental insurance'.

Without doubt, Ireland needs to improve the situation of its current biodiversity portfolio (Biodiversity & Policy Unit, 2005; NPWS, 2008; Coll et al., 2009), starting with the recognition of the importance of peatlands to the maintenance of global diversity of ecosystems and species and the protection of more peatlands and their associated biodiversity for future generations. Because it is difficult to protect a fifth of the land resource due to pressures by economic development and other human activities, feasible targets have to be set and appropriate response options have to be developed and designed to enhance both the conservation and sustainable use of peatlands. Such targets would be part of the overarching aims of a National Peatland Policy. The proposed targets should be prioritised according to an appropriate timescale, following Ireland's obligations under the Convention on Biological Diversity (CBD) and subsequent agreement by the EU (2020 targets, Ghent 2010). This is a proactive approach – *What targets do we want to achieve and what do we need to achieve them? –* as opposed to the current reactive approach – *We have found a resource (species, habitat) and we need to manage it (conserve, maintain, use).*

In view of drafting a National Peatland Strategy, the following targets have been drafted in relation to peatland biodiversity:

- To maintain the existing extent and overall distribution of all blanket bogs, raised bogs and fens currently in favourable conditions.

- To improve the status of peatland habitats that were assessed as 'bad' in the latest NPWS assessment (with prioritised target sites and timescale).

- To maintain rare species and rare habitats protected under the Habitats Directive (1992) and the Wildlife (Amendment) Act (2000) and improve their status.

- To increase the area of 'active raised bog' by improving the 'degraded raised bog' designated areas.

- To increase the range of protected peatland habitats, including fens.

- To maintain and restore the network and landscape integrity of peatlands.

- To increase the awareness of peatland and associated biodiversity.

- To implement measures to minimise, or facilitate the adaptation to the potential effects of climate change.

2-5.3 Response Options to Protect Biodiversity and Promote Sustainable Use of Peatlands in Ireland

2-5.3.1 Area protection

Response 1: All remaining areas of *priority habitat* peatlands (active and degraded raised bogs and blanket bogs) should be declared as SACs and more peatland sites (including fens) should be designated under legal protection.

This requires that the legal designation to SACs, NHAs and SPAs of all peatlands where such habitats occur is fully completed. The Irish Peatland Conservation Council, in its Peatland Conservation Plan 2020 for Ireland, presented a full inventory of peatlands of European Conservation Importance in Ireland. This plan should help the Government to achieve this target. Acquisition by the State is the best form of protection as property implies fully controlled management rights. However, appropriate resources must be allocated to the effective management of the land. Acquiring more EU Natura sites will enhance not only the conservation value of Ireland's biodiversity but also enhance ecological coherence and the interconnectivity of the EU Natura 2000 network, which is key to the long-term survival of many species and habitats. As predicted, negative effects of climate change for Ireland's terrestrial habitats include changes in the distribution of species and the possible extinction of vulnerable species (EPA, 2008b) – the larger the network of protected sites, the better Ireland's biodiversity will be able to adapt to such pressure.

This network of protected areas should be representative of the types of peatlands, range, area, structure and functions occurring in Ireland. For example, Sottocornola et al. (2008) carried out an in-depth vegetation study of an Atlantic blanket bog in County Kerry (Balligasheen, a BOGLAND core site and part of an SAC) and recommended that even small areas and remnants of Atlantic blanket bogs are worthy of conservation and that this should include not only the centre part but also the natural borders of the bog so as to increase the plant biodiversity of the conserved area.

Increasing the areas under protection would necessarily involve consultation with landowners and additional direct payment which have been found to be more effective than indirect incentives (see Section 4). Acquiring more sites would require spending a lot more money than currently allocated. It is estimated that the NPWS spends ~€35 million per year on protection (through purchase or management). This is the same amount given to refurbishment and construction projects within the prison system in Ireland for 2011, while the annual policy cost for the Rural Environment Protection Scheme (REPS) is ~€310 million – based on annual expenditure in 2007 (DAFF, 2007). It is questionable whether this outlay spent directly on biodiversity protection is sufficient to maintain the ecosystem services that biodiversity provides to the Irish economy and which has been estimated (heavily conditioned) at €2.6 billion per year (Bullock et al., 2008). The Government should ensure an integrated and effective approach to funding the protection of such sites under the Convention on Biological Biodiversity and associated Local Biodiversity Action Plans. It has been acknowledged that the CBD target to reduce the rate of biodiversity loss by 2010 has not been achieved (EEA, 2009; Mace et al., 2010) and that currently developed indicators show that Ireland is still doing 'badly' and in particular the overall status of EU-listed peatland habitats remains unfavourable (NPWS, 2008; Government of Ireland, 2010). Ireland should build on the momentum created by 2010 and set out more specific targets (Mace et al., 2010), such as those presented here for peatlands.

Response 2: The integrity of priority peatland habitats should be maintained or restored to ensure the survival of the unique biodiversity that they sustain.

This requires first and foremost that site-specific conservation plans and measures be produced for all protected sites. It also necessitates ensuring that all existing biodiversity laws, policies and strategies are implemented across the island to maintain, restore or create habitats as well as resilient populations of species in healthy habitats. The need for enforcement of legislation is critical at local, national and international levels. Illegal activities on protected sites should thus be opposed by the Government. The main cause of ongoing damage, degradation or infringements on Natura 2000 sites has been the reluctance by Ireland to implement adequately the Appropriate Assessment (AA) obligations under Article 6(3) of the Habitats Directive. Appropriate Assessment is a focused and detailed impact assessment of the implications of a plan or project, alone or in combination with other plans and projects, on the integrity of a Natura 2000 site in view of its conservation objectives and should be carried out by the competent authority. However, planning authorities and other state agencies often ignored or sought to avoid such requirements. While a Circular Letter and a Guidance Manual (NPWS, 2009) were sent to all state agencies informing of the necessity to undertake AA and of their responsibility to act diligently to ensure full compliance with the obligations of the Habitats Directive, the Government is required to commit enough resources to the implementation of the Directive so that the protection of Ireland's natural heritage may not be jeopardised by mere political resistance. The NPWS research section has already launched a monitoring programme to record major activities that impact the integrity of designated sites and the annexed habitats and species that are harboured within the sites. Many local-scale management efforts have also followed up monitoring in place to determine the effect of the management measures. However, scientific programmes to monitor conservation status (i.e. to ensure that a representative sample of the national resource of the targeted habitats or species is being protected) need to be deployed for all types of peatlands, including blanket bogs and fens. So far, only 48 raised bogs are monitored, showing that the area of active raised bog had decreased by over 35% between 1995 and 2005. While regular assessment is critical, only actions in terms of management activities (as set in conservation plans) can address and hopefully reverse the negative trends. This would require monitoring and development of new indicators to measure the impact of conservation measures. The aforementioned indicators of peatland biodiversity should be part of the National Biodiversity Strategy indicator set.

This response option would also require an increase in the area of land managed for biodiversity and other environmental benefits, including areas for buffering and linkage outside the protected area network (hydrological watershed).

2-5.3.2 Management of peatlands for biodiversity conservation

Response 3: Key peatland sites should be identified for positive management to achieve biodiversity targets at different levels: genetic community, species, habitat, ecosystem.

Using the knowledge-based information currently available, the Government should develop and disseminate best advice on management of key peatland sites in order to represent the full diversity of these habitats and associated species in Ireland. Full pictures of biodiversity need to be acquired for each key site in order to choose preferred management for the specified objectives. Conflicts may arise in the type of management needed to conserve particular species. For example, the red grouse is the only species in Ireland totally confined to peatlands and thus major efforts should be made to maintain populations in current breeding areas through preventing the degradation of existing habitats. In certain areas, active habitat management may be appropriate, including such measures as heather burning and predator control. However, active management of all upland peatlands would not be encouraged as it is impractical and also heather burning and predator control can have negative effects on other biodiversity, including meadow pipit and skylark populations which decrease as a result. It can thus be argued that we should conserve Ireland's peatlands so that common species such as meadow pipit and skylark, which are now associated with agricultural land, may be seen in their natural habitat. Therefore, a full picture of the status of protected species and achievable targets (e.g. how many peatland sites should be managed to protect exclusively the red grouse) must be acquired before management options can be drawn.

Response 4: Designated 'active raised bogs' and 'degraded raised bogs' should be appropriately managed and restored to increase the total area of *near-intact* raised bogs.

The combined area of active and degraded raised bog currently stands at 21,500 ha (Douglas et al., 2008). However, only 9% is deemed 'active', i.e. supporting a significant area of vegetation that is normally peat forming. 'Degraded raised bogs' have been defined as a habitat that can be restored to active bog within 30 years (European Commission, 2003). The status of both habitats has been assessed as 'bad'. Therefore the Government needs to ensure that restoration work is carried out if the target of active raised bog (i.e. near-intact raised bog) is to be achieved and reverse the current negative trends. Out of 128 protected sites, 22 raised bogs have undergone restoration work with various degrees of success. A complete survey of all designated raised bogs needs to be undertaken to determine their level of degradation. Then, a strategic review of restoration opportunities must be carried out in order to prioritise sites with potential to enhance biodiversity and thus improve status. This will also require the proper identification of costs and required sources of funding.

Response 5: Designated active blanket bogs and degraded blanket bogs should be appropriately managed and restored to increase the total area of *near-intact* blanket bogs.

Unlike raised bog, the extent and condition of the blanket bog resource is largely unknown. A survey of all designated blanket bogs is required to determine their level of degradation and potential for restoration. Restoration works have been carried out successfully on a very small number of blanket bogs – mostly state owned (e.g. Ballygisheen, County Kerry). However, such work needs to be expanded and appropriate funding made available as usually large areas are involved and because the bulk of the blanket bogs is privately owned. A strategic review of sites that could be restored, as outlined above for raised bog areas, should be carried out to enable cost–benefit analysis in terms of required expenditure and benefits (social, economic and environmental). One of the main obstacles to this response is the fact that many blanket bogs are in commonage. The surveys and resurveys of the commonage areas (Douglas et al., 2008) should give a good picture of the efficacy of the management plans set up as part of the Commonage Framework Plans. Sheep stock reductions and certain management responses associated with REPS should be monitored to assess their true effects.

2-5.3.3 Response options to address threats and drivers of biodiversity loss

Response 6: The threats and causes of degradation should be evaluated on all protected peatland sites as well as those proposed for designation.

Protected areas are extremely important parts of programmes to protect and enhance biodiversity. However, protected areas are not sufficient per se unless threats and causes of degradation (i.e. drivers of biodiversity changes) are addressed and 'enabling conditions' (i.e. legal framework) are established. Management of all peatlands requires an accurate assessment of all threats and pressures.

Response 7: Subsidies that promote excessive and destructive uses of peatlands and their ecosystem services should be revised.

Significant improvements can be made to mitigate biodiversity loss and ecosystem degradation by removing or redirecting economic subsidies in relation to peat extraction, afforestation of peat soils, agricultural activities (reclamation and overstocking), and development of infrastructure (roads, wind farms, pipelines).

2-5.3.4 Awareness, education and research

Response 8: Traditional knowledge as well as relevant scientific findings and data on peatlands should be made available to all of society but particularly stakeholders and decision makers, thus raising awareness and understanding of peatland habitats and associated biodiversity.

Education and communication programmes have both informed and changed attitudes towards biodiversity conservation and have improved implementation responses (Millennium Ecosystem Assessment, 2005). Information regarding the biodiversity value but also conservation status of *all* peatlands (not just designated or popular bog types) should be communicated clearly to the public and to decision makers.

Peatland awareness programmes and education material should be developed and promoted through a wide variety of media. Awareness and education could also be promoted by the improvement of public access at certain appropriate sites.

Response 9: Further peatland research should be supported.

One of the main shortcomings already identified in relation to managing Ireland's biodiversity is the lack of data to provide baseline and up-to-date information on the distribution and abundance of certain species and habitats (EPA, 2008a). As discovered within this project, species found on peatlands are new to Ireland and new to science. While this project set a baseline of biodiversity data for birds and terrestrial and aquatic invertebrates, there is a clear lack of long-term data sets covering other taxa that can be extended into the future and from which trends can be observed. Seasonal assessment is also very important in assessing the overall biodiversity of these ecosystems. Research should be continued, aiming at a better understanding of the distribution and composition of the biodiversity of peatlands beyond the more obvious plant, animal and bird species. Also, the investigation of less studied habitats, such as blanket bogs and fens, should be a priority. The improved mapping and monitoring of blanket bog habitats especially is required in order to quantify the extent and condition of the resource and for prioritising conservation efforts. Overall, future work is required in order to update present information systems to improve access to scattered information on all aspects of biodiversity of peatlands. Research into improving the success and efficiency of restoration work is also critical in Ireland.

2-5.3.5 Integrated policies

Response 10: Consideration for the protection and conservation of peatland biodiversity should be integrated across government policies, such as climate change policy, renewable energy policy, strategy for invasive species and Water Framework Directive.

The success or failure of many of these responses will be largely influenced by the various institutional frameworks already in place. All these policies have considerable implications for the biodiversity reservoir associated with peatlands. New policies dealing with climate change and renewable energy can be in conflict with biodiversity conservation objectives and these are broached further in Sections 4 and 5. Given the fact that peatlands are intrinsically linked to hydrological features, integrations and synergies with the Water Framework Directive are inevitable. Similarly, peatlands are very susceptible to invasion of non-native species when they have already been degraded (e.g. drained for turf cutting) and concerted efforts with the NPWS and the new Invasive Species Ireland project to enforce legislation, as well as to act on the ground, should be developed.

2-6 Conclusion

This section on peatland biodiversity gave baseline information on the biodiversity components of a sample of Irish peatlands and its associated abiotic environment (soil and water). Bird, aquatic and terrestrial invertebrates, as well as vegetation community and species, data and microbial ribotype profiles comprise critical information against which the effectiveness of future management practices of peatlands (e.g. conservation, restoration) can be measured.

Peatlands are a valuable ecosystem from a national, European and global perspective. The last century and particularly the last half-century have been the most destructive for peatlands. It has taken the same amount of time to realise that the degradation of these ecosystems and the disappearance and even extinction of species are not in the interest of human well-being at large, especially not of future generations. Therefore, it is vital to reverse the trends, halt further loss of priority habitat and species, and implement a protocol for the sustainable management of peatlands (see Section 5). This should include the development of a National Peatland Strategy so that the remaining peatlands of Ireland are protected and managed (conservation also involves restoration of damaged areas as stated in the Habitats Directive) in order to maintain the integrity of these habitats and ensure the survival of the unique biodiversity that they sustain. The conservation and sustainable management of peatlands will make a very significant contribution towards Ireland's obligations under the CBD and subsequent agreement by the EU (2020 targets, Ghent 2010). Actions to revert the loss of peatland biodiversity are difficult to execute and may require more targeted and strategic approaches. Finance, expertise, knowledge and partnerships with other sectors will be required in order to have a significant impact and for implementation of the responses to be carried out to the best possible effect. Peatlands should be a priority and management plans should be central, and an urgent requirement, for the development of biodiversity policy.

Section 3

Characteristics, Disturbances and Management of Irish Peatlands

3-1 Introduction

Humans have always relied on natural resources (renewable and non-renewable) to survive on this planet. While natural resources are incessantly influenced by natural forces, changing human conditions drive changes in the way that these resources are viewed and utilised. Peatlands are no exception. They are a natural resource forming a living, dynamic landscape, responding to topography, changing climate, and human influence. As the world's peatland resource is being increasingly investigated and assessed (Parish et al., 2008) and new, critical scientific information revealed (see Farrell and Feehan, 2008), peatlands are being acclaimed as one of the most important natural ecosystems in the world.

Peatlands have been part of the Irish landscape since the last Ice Age but sometimes they have originated in close association with land-use systems, e.g. the Neolithic farmers in North Mayo (Moore, 1973; Molloy and O'Connell, 1995). 'Bog' is an Irish word, derived from the word '*bogach*' meaning soft ground (Feehan et al., 2008) and despite having been used since prehistoric times, peatlands are still among the most characteristic landscape features of Ireland, part of the natural heritage and deemed to be the country's last great area of wilderness (Feehan et al., 2008).

- What are the characteristics of peatlands and peat resources in Ireland?
- What natural functions do they perform and how are they affected by natural and human-induced disturbances?
- Can they be sustainably used?

This section of the BOGLAND project aimed to answer these questions by integrating existing knowledge and by filling in known gaps about the physical peatland resource in Ireland. Although the state of knowledge of Irish peatlands has significantly grown since the 1980s, with certain raised bogs receiving specific international attention (Schouten, 2008), a comprehensive assessment of this natural resource was timely as knowledge of the physical characteristics of the different peatland types is critical in planning their future management.

3-2 Irish Peatlands: a Significant, but Degraded Resource

3-2.1 Extent of Irish Peatlands

Ireland has always been described in textbooks as a ‘boggy’ country (Aalen et al., 1997; Viney, 2003; Feehan et al., 2008) and it is not without reason that the Nobel Prize-winning poet Seamus Heaney chose ‘bogs’ as a landscape icon for Ireland (Heaney, 1969). The first great survey of Ireland’s peatland was carried out between 1809 and 1814 under the supervision of a government-appointed Commission (Bog Commissioners 1809–1814). The main objective at this time was in reclaiming the peatlands for agriculture. More than 100 years later, the Geological Survey published a map of peat bogs and coalfields in Ireland that reflected the practical requirement for that time (Anonymous, 1921). Another 50 years later, detailed new surveys were carried out, principally in the Midlands, in preparation for the mechanical extraction of the peat by Bord na Móna (Barry et al., 1973). Hammond’s Peatland Map of Ireland, with its associated Soil Survey Bulletin, was the first publication that classified the extent of the various peat types in the country, a prerequisite, as the author points out, “*for the future development of our peat resources*” (Hammond, 1981). The attention was still very much fixed on the ultimate land-use potential of peatlands, namely the utilisation of the peat for energy generation.

The focus of peatland mapping changed after Ireland signed the Kyoto Protocol in 2002. While the importance of peatlands as a dynamic global carbon pool had been accepted for more than a decade (Gorham, 1991), it was recognised that the role of Irish peatlands within the national carbon budget needed to be understood and evaluated. Therefore, a new mapping exercise had to be undertaken to quantify the spatial extent of this important resource. In compiling this new map, the authors used a rule-based methodology implemented as a series of hierarchical rules in ArcGIS in order to estimate the extent of contemporary peat soils in Ireland (Connolly et al., 2007). They used three existing soil and land-cover maps:

1. The Peatland Map of Ireland (Hammond, 1981);
2. The General Soil Map of Ireland (Gardiner and Radford, 1980); and
3. Land-use cover map from the Coordination of Information on the Environment (CORINE) 1990 (O'Sullivan, 1994).

The first version of the map called the Derived Irish Peat Map (DIPMV1) was produced at a pixel resolution of 100 m, with an overall reliability of 75% and showed Ireland’s peatland resource to cover 950,000 ha or 13.8% of the national land area. This figure was lower than the previous inventory by Hammond (1981), which showed that peatlands covered 17.2% of the Republic of Ireland or 1,340,000 ha. Hammond’s map was compiled using disparate sources of data, ranging from soil and aerial photo surveys to historical data. The Connolly et al. DIPMV1 map excluded industrial cutaway peatlands (roughly estimated at 100,000 ha) as well as peatlands on slopes >25° (where peat is thought not to accumulate (Tallis, 1998)). Therefore, neither map is likely to represent the total extent of peat soils in Ireland.

New spatial data in the form of the Indicative Soil Map of Ireland (ISMI) (Reamonn Fealy, Teagasc, personal communication, 2006) and CORINE 2000 (EPA, 2003) were made available, requiring a necessary recalculation of the spatial extent of peat soil in Ireland. Both maps are more detailed in relation to peat soil than the General Soil Map or CORINE 1990. However, there are still some difficulties. The ISMI has a mapping unit of 1 ha, while CORINE 2000 has a mapping unit of 25 ha. In addition, a remote-sensing approach, such as that adopted for CORINE land cover, cannot identify soil depth. CORINE Peat Bog Class 4.1.2 is defined as “*peatland consisting mainly of decomposed moss and vegetation matter and may or may not be exploited*”.

As part of the BOGLAND project, the authors of the first DIPM (DIPMV1) used these new sources of map data to create a second version of the map (DIPMV2)

(Fig. 3-2.1). For this mapping exercise, a peatland was defined as a geographical area of a minimum of 1 ha where peat soil occurs. The rules-based decision tree methodology developed by Connolly et al. (2007) to integrate multi-source data in a GIS was adapted in order to utilise the new data sources (Connolly and Holden, 2009). In preliminary versions of the DIPMV2, it became clear that the inclusion of the new data brought in a number of new peat soil areas particularly in the 'drumlin belt' of Counties Cavan, Monaghan and Louth. However, due to the size and uncertainty surrounding these small peat soil areas, a spatial filter model was developed to screen out peat soil areas of less than 7 ha until more accurate information becomes available. As with the DIPMV1, fens were also excluded from this exercise due to their very limited extent. The current map (DIPMV2) (Connolly and Holden, 2009) estimates that peat soils cover 1,466,469 ha or 20.6% of the national land area with an overall accuracy of 88%. Given the aforementioned provisions (exclusion of <7 ha in certain counties as well as fens), the total extent of peat soils is likely to be higher. The flexibility of the DIPM methodology means that as new map data sources become available, new

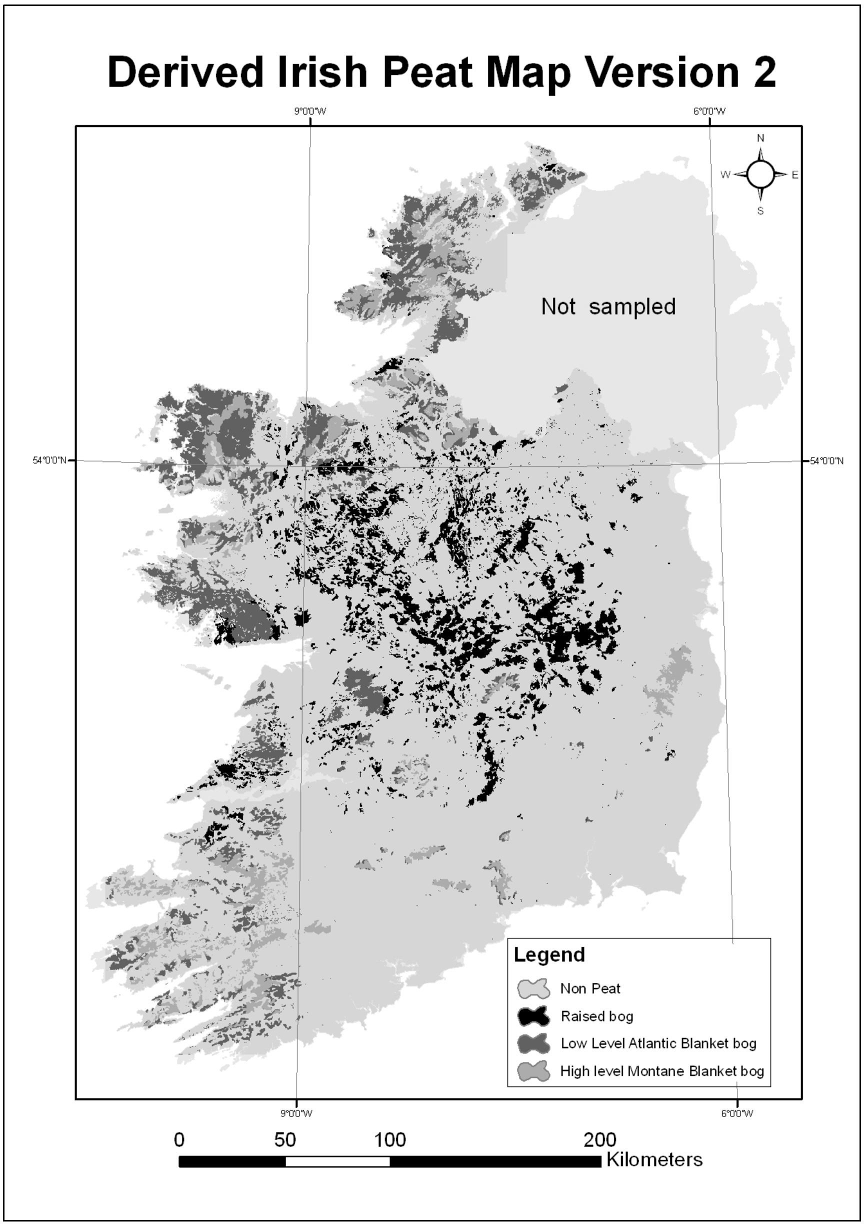

Figure 3-2.1. The Derived Irish Peat Map Version 2.

versions of the DIPM can be created thus updating national peat soil extent data. Initial analysis by category of peatlands shows that 36.7% of peat soils correspond to raised bogs (including cutaway and cutover), 22.7% correspond to high-level mountain blanket bog and 40.6% (the highest proportion) correspond to low-level Atlantic blanket bogs.

3-2.2 Status of Irish Peatlands

The new figures of spatial extent offer an impression that Irish peatlands are a thriving abundant resource. However, it has been widely acknowledged that most Irish peatlands have been degraded to various extents. In his Peatland Map of Ireland, Hammond (1981) identified man-modified peatlands (defined as "*those areas where the bogland surface has been physically disturbed and natural vegetation altered*") which, at the time, represented 47% of the total extent. Latest reports show that less than 15% of the original extent shown in Hammond's map is in near-intact condition (Crushell, 2002; Foss, 2007; Douglas et al., 2008). Recent work by the NPWS showed that all but 2,000 ha of parts of raised bogs (0.6%) have been so damaged by drainage, cutting and burning that they are no longer active, i.e. forming peat (Fernandez Valverde et al., 2005). While Ryan and Cross (1984) estimated that there were approximately 517,231 ha of blanket bog suffering from low-level disturbance (i.e. near-intact) in 1982, the best current extent can be considered to be confined to the SACs and NHAs. They cover an area of just 222,052 ha and a markedly small proportion of this is likely to be considered near-intact blanket bog. The area of active blanket bog is currently unknown as different parts of a blanket bog system can be active or inactive at different times, depending on topographic, climatic and anthropogenic factors. Research directed towards assessing the extent of active blanket bog is required. According to various Conservation Status Assessment Reports carried out in Ireland under the Habitats Directive (NPWS, 2007a,b,c), the extent of near-intact peatlands has seen an accelerating decrease since the middle of the 20th century with a significant decline since the 1980s. It has been estimated that 2–4% of active bog disappear every year (Jim Ryan, NPWS, personal communication, 2009). Figures associated with conservation designation are currently the only possible evaluation of the status of Irish peatlands. Therefore, with 222,052 ha of combined SACs and NHAs containing peatlands, only 15% of the extent of peat soils in Ireland (based on DIPMV2, see Fig. 3-2.1) can be deemed to suffer low disturbance (near-intact), with the extent of 'active' or 'peat-forming' likely to be noticeably less. Change of vegetation due to disturbance is also a clear indicator of the status of a peatland (see Chapter 2.9, End of Project Report). An EPA project is currently developing a new applied remote-sensing protocol for monitoring disturbance of peatland vegetation in Ireland, which will estimate the proportion of Irish peatlands that are 'visibly' disturbed (Dr John Connolly, UCD, personal communication, 2010).

Summary Findings

- *A new peat soil map has been constructed from several sources and shows that peatlands cover 1,466,469 ha or 20.6% of the national land area.*
- *While being a significant resource, the rate of change of status of Irish peatlands has increased dramatically in the 20th century, leaving a disproportionately small amount of near-intact peatlands, including a much reduced peat-forming area that needs to be inventoried across the whole peatland extent.*

3-3 Past, Present and Future Disturbances of Irish Peatlands

3-3.1 Introduction

Disturbance can be defined as discrete events in space and time that disrupt ecosystem structure (Pickett and White, 1985). Disturbances are a function of both natural conditions and human activities. It is worth noting here that many apparently pristine ecosystems have been subject to past disturbance (natural or anthropogenic) – as disclosed by palaeo-ecological studies (Huntley, 1991) – and Irish peatlands are no exception. Natural events (including past climate change) have inescapably impacted on peatlands over the course of their history. Dendrochronology and radiocarbon dating have shown that pine trees covered Irish raised bogs for a period of least 500 years sometime between 2500 and 1800 BC (Feehan et al., 2008). When the climate got wetter again, peat engulfed these ancient forests. Peatlands have been disturbed in other ways by past climate change: peat failures (bog bursts) have been occurring in Ireland since the Early Bronze Age, and have been associated with natural factors such as high-intensity or prolonged rainfall (Boylan et al., 2008a; Dykes, 2008).

The human-related impact on peatlands is nothing new and Irish peatlands can be described as deeply humanised landscapes that have evolved, indeed sometimes originated, in close association with land-use systems. For example, tree clearance by humans has been implicated in the initiation of peatland growth in the western part of the country (Moore, 1993; Molloy and O'Connell, 1995; Caulfield, 2004). Nevertheless, anthropogenic disturbances of peatlands have been mainly destructive. While humans have utilised Irish peatlands since prehistoric times, the increasing scale and rate of disturbance which occurred in the 20th century have clearly contributed to the current situation whereby only a small amount of peatland remains in an intact or undamaged condition. In the 21st century, the problems of peatland disturbances have far-reaching implications for Ireland's environment and socio-economic well-being and are the main reasons why a strategy for their sustainable management and further policy development are required. In this section, the most common past, present and likely future human-related disturbances of Irish peatlands and their spatial and temporal trends are reviewed.

3-3.2 Land Uses

3-3.2.1 Peat extraction

Peat has been extracted and used as a source of energy for at least the last two millennia. Since the establishment of the state-sponsored Turf Development Board in 1935, and its replacement in 1946 by Bord na Móna, peat extraction has intensified. Bord na Móna is the main industrial producer of peat energy and supplier of peat products in Ireland. Three other medium-sized companies and some 30 smaller producers also extract peat moss for horticultural products. It has been estimated that a total of 100,000 ha of peatlands are being utilised for industrial peat extraction in Ireland (Fitzgerald, 2006). However, the total area of peatlands currently being affected by domestic peat extraction (mechanical and hand-cutting) remains unknown. Overall, peat extraction is likely to have affected over half a million hectares of peatlands or 85% of the original raised bogs and 45% of the original blanket bogs (Fernandez Valverde et al., 2006; Malone and O'Connell, 2009). Peat is currently being extracted for:

- Electricity generation in condensing power plants;
- Fuel for domestic heating (briquettes and turf);
- Horticultural products; and as
- Raw material for chemical products, bedding material, filter and absorbent material.

Ireland's reliance on peat for electricity generation has been steadily falling over the last decade and currently 8.5% of the electricity production is covered by Bord na Móna's three peat-burning fluidised-bed-based plants (using 3 million tonnes of peat per year to produce 378 MW at an efficiency of 38%). Dependence on imported energy is, and will remain, a feature of the Irish energy situation. Current energy sources for electricity generation are gas (40%), coal (24%), oil (12%) and peat (8.5%). As peat is more expensive and emits more carbon dioxide per unit energy than other fossil fuels, it is only of interest as an energy source for domestic socio-economic reasons. Peat extraction offers a degree of security of domestic energy supply together with the regional social benefits of employment in the rural community. In order to compete with cheaper fuel, the Irish Government subsidises the energy-peat production sector and, in order to reduce its carbon dioxide emissions, the Government has introduced a target of 30% co-firing with biomass materials for the three peat-fired generating stations by 2015. Even with the introduction of a carbon tax, peat will continue to be burned for energy production until 2020 and most likely beyond this time, at a smaller scale. However, while peat reserves are decreasing, the impacts of peat extraction for energy production are also likely to decrease as Bord na Móna has given a commitment that no new bogs will be affected.

Briquettes and sod turf production have been estimated at 0.6 million tonnes/year, half of which is produced by Bord na Móna (Hourican, 2003). With the introduction of a carbon tax on commercial peat briquettes in 2010, a sharp increase in small commercial peat cutting took place and farmers have left the environmental agricultural scheme on the premise that there is more money to be made in cutting turf (this is currently banned under the REPS). Domestic peat cutting or turbary is a notable feature in the Irish landscape and has been carried out for centuries and is likely to continue. So far, it is estimated that 471,247 ha of blanket and raised bogs have been affected by this process (Malone and O'Connell, 2009), including protected peatlands (Fernandez Valverde et al., 2006). Mechanisation of the process has allowed for more peat to be extracted over a wider area of bog and also on a semi-commercial basis. This is not an issue confined to raised bogs as Conoghan (2000) reported the dramatic rise in the use of the excavator and hopper methods of peat extraction on blanket bogs since the mid-1980s. This activity is very much associated with a black market economy as only 15% or so of the privately produced sod peat is traded (Fitzgerald, 2006). While the Government has appointed a committee to phase out turf cutting on designated sites, domestic turf cutting will continue around the country and is likely to increase in the future (see Section 4).

Peat is also being extracted for horticultural products and despite a strong campaign to replace peat in domestic horticultural products in the UK, utilisation of horticultural peat is actually increasing globally. Ireland and other countries, such as Canada and the Baltic States (Turetsky and St. Louise, 2006), are producing more horticultural peat than ever. In Europe, approximately 90% of all growing media for the professional and amateur markets are peat based (Joosten and Clarke, 2002). Peat exports have also increased in Ireland, with contracts won to supply peat to horticultural businesses in Europe but also for the mushroom industry (peat is used as a component of mushroom casing) in South Africa and America. In 2003, it was estimated that Irish moss peat producers sold 2.6 million cubic metres of horticultural-grade peat with an estimated total turnover of €48 million. Peat extraction for horticultural products has deleterious impacts on smaller bogs (all larger bogs having been utilised by Bord na Móna for mining for electricity), but this activity is likely to continue, if not increase, due to market demand.

3-3.2.2 Agriculture: reclamation and grazing

Agriculture has been a common land use of Irish peatlands for several centuries. Reclamation of peatlands for agriculture was accelerated during the 18th and 19th centuries as a result of population pressures (Feehan and O'Donovan, 1996) and has accounted for a considerable loss in the peatland cover in Ireland over the years, with a clear increasing eastward gradient. Almost all Irish fens have been altered by agricultural reclamation (Hammond, 1981). Those that have survived have indirectly been disturbed, e.g. through the use of fertiliser in the surrounding lands, which has resulted in negative impacts on the diversity of smaller peatland sites, especially isolated fens, such as Scragh Bog (County Westmeath) (O'Connell, 1980). Some raised bogs and cutovers lying close to farm holdings or centres of population (Counties Dublin, Kildare and Wicklow) have been drained and reclaimed for arable and grassland farming. While grant aid for agricultural reclamation of blanket bogs of conservation importance has ceased, the Irish Peatland Conservation Council has estimated that 15% of the peatlands of conservation importance are still affected by agricultural reclamation (Malone and O'Connell, 2009). The practice is likely to continue, albeit at a declining rate.

Currently, agricultural activity on peat soils is largely confined to grassland production and the grazing of cattle or sheep. Sheep grazing affects a significant area of Irish peatlands and was therefore investigated as part of the BOGLAND project (see Chapter 3.6, End of Project Report). Blanket bogs have been extensively grazed throughout their history. However, the EU Headage Grant Scheme has intensified grazing patterns with an upsurge of sheep numbers in the 1980s and early 1990s. In recent years, the threat from overgrazing has somewhat receded with the introduction of the REPS and the decoupling of the Common Agriculture Policy (CAP) subsidies (translated into the National Farm Plan Scheme). While the full implementation of these schemes is likely to decrease the negative impacts caused by overstocking on areas that have not incurred severe damage, it is unlikely to improve the situation in very damaged, eroding sites (NPWS, 2007c). Work carried out in the Peak District in the UK showed that poorly vegetated or bare areas will likely continue to suffer from past mismanagement unless grazing is completely stopped and active restoration techniques are used to revegetate the site (Evans, 2005). Grant et al. (1985) observed that extreme care is required at stocking rates greater than one sheep per hectare to avoid overgrazing in blanket bogs. Evans (2005) suggested that in order to curtail erosion, a stocking rate of 0.4 sheep per hectare is more appropriate. However, a general panacea for all peatlands damaged by overgrazing is not possible as every peatland is unique and requires an individually tailored management plan. BOGLAND studies demonstrated that sheep grazing on hill and mountain peatlands can be sustainably managed using a stocking density based on the habitats that are most likely to be used, and by acknowledging seasonal variations in vegetation cover and composition (Williams, 2008). Land-use management relating to sheep grazing on the western hill and mountain peatlands (and heaths) remains a complex issue that needs further monitoring.

3-3.2.3 Forestry

In an effort to increase the forest cover in Ireland, considerable areas of peatlands have been afforested with coniferous species, such as Sitka spruce (*Picea sitchensis*), lodgepole pine (*Pinus contorta*) and Norway spruce (*Picea abies*) over the last decades. Most planting was carried out on lowland and montane blanket bogs where, despite financial incentives (planting and maintenance grants), economic viability is still marginal (Renou and Farrell, 2005). Today, 43% of the total forest estate is located on peat soils with blanket bogs accounting for the largest proportion of afforested peatlands (62% or some 218,850 ha) and raised bogs a further 74,080 ha (Black et al., 2008).

Recently, afforestation rates, including on peat soils, have dramatically decreased (Forest Service, 2007). This is partly because of biodiversity enrichment incentives within afforestation grant and premium schemes that favour the planting of broadleaved species on productive mineral soils. In addition, the Forest Service biodiversity strategy stipulates that peatland areas, which are designated as SACs or SPAs, are not considered for afforestation grants; NHAs may also be excluded if the proposed development is incompatible with their protection (McAree, 2002). While the Forest Service scheme also screens against planting on areas of deep peat, 4,000 ha of peatlands were afforested in 2005, some of which were locally important biodiversity sites (Malone and O'Connell, 2009). Although the threat to blanket bogs from afforestation is officially declining, private afforestation is likely to continue on non-designated blanket bogs.

Elsewhere, Coillte has been actively involved in restoring 2,500 ha of afforested blanket bogs and raised bogs through the LIFE programme (Delaney, 2008). In addition, Coillte's Strategy for the Future Management of Low Production Forests details a protocol agreed for 43,000 ha of western peatland forests deemed uneconomic and unsustainable (Tiernan, 2008). The Strategy requires that these areas be replanted with minimal inputs while others will be managed with the aim of restoring a bog ecosystem.

3-3.2.4 Wind farms and other infrastructural developments

Peatlands are generally uninhabited, which makes them attractive for a wide variety of land-use options, including urban, industrial and infrastructural development, as well as dumping. Fens have been mostly subject to dumping or landfill because of their low-lying nature. They have often been filled in so as to create drier ground conditions and make a site more suitable for subsequent development such as housing (Foss, 2007). Other industrial developments (quarries, industrial developments or road constructions) have impacted on peatlands in a very limited, but increasing number of sites. The construction of a gas pipeline, crossing County Mayo from west to east, has impacted on peatland areas, in particular Glencullen blanket bog where several flushes have been affected by the direct construction of the pipe, leading to severe peat cracking and irreversible hydrological changes (Paul Johnston, TCD, personal communication, 2007).

Other infrastructural developments that are on the increase in Ireland are wind farms. The Irish climate is ideally suited for both peatlands and wind farms: in 2009, 39 of the 73 wind farms were located on upland peatland areas, the oldest one being located on an industrially extracted blanket bog (Renou-Wilson and Farrell, 2009). Only two of these are located within a designated conservation area, but 18 are within a short distance (<2 km) from designated blanket bogs (NPWS, 2008). Given that the national policy is to promote renewable energy, in particular wind, in order to decrease dependency on imported fossil fuels and to reduce carbon emissions, the threat of wind farms on peatlands is likely to increase, albeit away from designated sites.

As part of the BOGLAND project, wind-farm developments on peatlands were reviewed (see Chapter 3.8, End of Project Report). It was strongly proposed that degraded peatlands, such as the industrial peat extraction areas in the Irish Midlands, are to be selected as alternative locations for wind-farm development (Farrell, 2004; Renou-Wilson and Farrell, 2009). Furthermore, it was concluded that lessons learned from past developments and ongoing monitoring have been applied in adapting guidelines for planning authorities and Environmental Impact Assessment (EIA) (DOEHLG, 2006). The vulnerability of peatland habitats is emphasised in the guideline documents, and because environmental issues involving wind farms on peatlands (impacts on biodiversity, loss of wilderness, peat stability and erosion) are predictable, a rigorous examination of any future development, using these guidelines, should prevent any wind-farm proposals from being granted on sensitive upland peatland sites (Renou-Wilson and Farrell, 2009). Because wind-farm developments have been associated with peat slope failures in the recent past (e.g. Derrybrien, see Lindsay and Bragg, 2004), the assessment of primary risk factors (Dykes, 2008) and slope stability has been advocated in order to avoid such a geohazard (see Section 3-6.5). Slope stability was subject to investigation as part of the BOGLAND project (see Chapter 3.3, End of Project Report), resulting in tools being developed to assess the strength of peat in a mode of deformation appropriate for stability assessments and to assess the profile of peat strength with depth (Boylan et al., 2008a; Boylan and Long, 2010). Further work is needed to implement these new tools which, together with strict adherence to the guidelines, should decrease future risks of peat failures from excavations and associated drainage works for the turbines or from loading of the peat by ‘floating’ gravel access roads and placement of excavated peat spoil. In addition, the European Commission (EC) is currently producing guidelines regarding wind farms and Natura 2000 sites which should be applied when EIAs and AAs are carried out.

3-3.3 Recreation/Tourism

Peatlands provide space for recreation, tourism and even military exercises. In past years, the number of tourists interested in outdoor activities has increased and, with it, the impact of trampling on blanket bogs, which was until then confined to National Parks (Wicklow, Glenveagh and Connemara), started spreading onto other peatland areas of conservation importance. Upland blanket bogs, some designated, have been unacceptably degraded, with the impact likened to overgrazing (MacGowan and Doyle, 1997). A Swiss study showed that 10 min of experimental trampling repeated only three times a year for 3 years almost destroyed the *Sphagnum* vegetation cover of a raised bog (Borcard and Matthey, 1995). In Ireland, the number of bipeds (walkers, climbers, cyclists) and other quadrupeds (quad bikers, horse riders) is likely to increase in the future, as is the demand for more access from these users. Negative impacts of such use are often caused by the lack of a visitor management plan or lack of public awareness. An Irish survey showed that upland walkers do not have high levels of ecological knowledge of blanket bog habitats (Murphy et al., 2008). However, the study showed that most walkers were willing to pay and to volunteer time for blanket bog conservation. Communication efforts, as well as appropriate development (board walks), should help counteract negative impacts from these activities. However, the damage by quad bikes is more severe, localised and on the increase. It urgently requires action from the Department of the Environment, Community and Local Government to draft amendments to the Habitats legislation to address this problematic issue especially as such disturbance is unacceptable on legally protected sites. Because it is difficult to apprehend the offenders, it has been proposed that county councils should enact by-laws to re-enforce national legislation and add a layer of local authority protection. Such by-laws might enable council's environment units to be called out to deal with reported incidents of illegal activities (e.g. biking, burning, etc.).

3-3.4 Pollution

Both airborne and water-borne pollution can disturb peatland ecosystems. Because ombrotrophic bogs rely on atmospheric water supply, aerial pollution is potentially damaging. However, nutrient run-off can have a much more significant impact on minerotrophic peatlands, such as fens which are groundwater fed. An increased supply of nitrogen, either through aerial pollution or run-off from agricultural and urban sources, has caused changes in peatland plant communities (Tomassen et al., 2004). Similar impacts have been caused by phosphorus leaching from afforested peatlands (Anderson, 2001). While water-related pollution is likely to remain critical to all peatlands, especially fens, the impact of aerial industrial pollution is much reduced in Ireland due to favourable wind regimes (Aherne and Farrell, 2002).

3-3.5 Invasive Species

A recent worldwide study showed that, on average, there are 50 non-indigenous species per country which have a negative impact on biodiversity (McGeoch et al., 2010). Ireland is no exception – invasive species occur in every peatland habitat (Malone and O'Connell, 2009). They pose a threat to the native flora and fauna of peatlands and thus the general sustainability of these ecosystems. While the harsh peatland environment often restricts colonisation by other species, human-related activities, such as vegetation clearance, drainage, fertilisation and overgrazing, have increased the vulnerability of peatlands to alien and non-native species invasion. The main species so far recorded as being a problem for peatland conservation include rhododendron (*Rhododendron ponticum*), pitcher plant (*Sarracenia purpurea*), and giant rhubarb (*Gunnera tinctoria*). The latter is a particular threat to blanket bogs in County Mayo, where a leaflet was produced and distributed to landowners by the County Council in order to control and prevent further spread of the species. A number of designated peatland sites are already known to be impacted by invasive plant species, e.g. the pitcher plant has invaded a raised bog SAC at Mounds Bog (Malone and O'Connell, 2009). Compelling evidence has shown that this threat is increasing globally (Hulme, 2009) and it is likely to increase in the case of Irish peatlands as these are further affected by climate change (Jones et al., 2006).

3-3.6 Climate Change

3-3.6.1 Peatlands and climate change feedback mechanism

There is a fundamental relationship between peatlands and climate. The influence of climate on the initiation and development of peatland ecosystems has been well documented (e.g. Almquist-Jacobson and Foster, 1995; Ellis and Tallis, 2000; Gignac et al., 2000). Climate is the most important determinant of the distribution and character of peatlands, affecting their location, typology and biodiversity. In turn, peatlands affect climate via a series of feedback effects including sequestration of carbon dioxide, emission of methane, increased albedo and microclimate alteration (Mäkilä et al., 2001; Belyea and Malmer, 2004).This constant feedback mechanism between climate and peatlands means that while peatland can regulate the global climate, changes in climate will also significantly affect how peatlands function (Strack, 2008).

3-3.6.2 Peatlands and past climate change

Past climate changes have affected peatland distribution and existing peatlands began to grow after the last glaciations, where there was an excess of precipitation over evapotranspiration (Moore and Bellamy, 1974). Peatlands started growing in Ireland 10,000 years ago and they have, over this period, persevered in accumulating peat, a unique record of their own development as well as changes in the climate. Palaeo-ecological studies of peat show that the vegetation, growth rate (carbon accumulation) and hydrology of peatlands were all altered by past climate change. This, in turn, can help in making predictions for future climate change.

3-3.6.3 Peatlands and global climate change

Over the last 200 years, there has been a considerable increase in the atmospheric concentration of carbon dioxide and methane, primarily as a consequence of increased burning of fossil fuels (oil, coal, natural gas, peat, etc.) and land-use change. The increased concentration of these gases is believed to be responsible for the rise in mean global temperatures by around 0.76°C over that time period (IPCC, 2007). Model predictions suggest that the concentration of these gases in the atmosphere will continue to increase over the next century, concomitant with an increase in mean global temperatures of around 0.2°C per decade (IPCC, 2007). Despite the considerable uncertainties surrounding future climate projections, the rate and complexity of recent change in our climate are beyond our experience. The implications of a changing climate for peatlands are likely to be complex. While natural peatlands showed resilience to the climate changes that have occurred in the past (Charman et al., 2006), the rate and magnitude of predicted future climate changes and extreme events may push many peatlands over their threshold of adaptation. The effects of recent climate change are already apparent in the melting of permafrost peatlands (Camill, 2005) and changing vegetation patterns in temperate peatlands (Chapman et al., 2001; Gunnarsson et al., 2002).

3-3.6.4 Climate change predictions and Irish peatlands

Regional Climate Models predict that the climate in Ireland will continue to undergo changes over the next 100 years, with scenarios suggesting major increases in temperature, changes in precipitation patterns (increase in winter rainfall and reduction in summer rainfall) and other phenomena such as more intense storms and occasional downpours (McGrath et al., 2005). Such predictions have major implications for Irish peatlands. A modelling study by Jones et al. (2006), based on climatic envelopes, has suggested that predicted changes in climate are likely to result in a severe diminution of the Irish peatland cover by 2075. As part of the BOGLAND project, climate change scenarios data were analysed specifically looking at the sensitivity of different Irish peatlands (see Chapter 3.7, End of Project Report). Findings revealed that climate change impacts will depend on the situation of individual peatlands, especially its geographical location. Peatlands located in areas where precipitation will remain high in the winter together with cool temperatures (north-west areas) will be less at risk. Therefore, predicted changes are likely to affect low Atlantic blanket bogs in the west of Ireland the least, while the areas showing the greatest changes in precipitation and temperature are the areas containing basin peat in the Midlands.

Without doubt, these changes are expected to place peatlands under severe stress with significant impacts on the peatland carbon store and GHG fluxes (see Section 3-5.5) and biodiversity (see Chapter 2.7, End of Project Report). Increased rainfall intensity will likely enhance peatland erosion in susceptible areas. Thus, in upland peatlands, whilst increased precipitation may lead to optimal conditions for carbon sequestration, there is also an increased possibility of erosion and a subsequent loss of organic carbon (Heathwaite, 1993). Erosion may also be enhanced in peatlands subject to desiccation, especially where there are other pressures such as overgrazing, tourist trampling, etc. Overall, degraded peatlands are likely to be more vulnerable than intact peatlands and thus the vast majority of Irish peatlands are critically at risk of future climate change predictions.

Summary Findings

- *All Irish peatlands have been impacted by natural and anthropogenic disturbances over the course of their history. However, the scale and rate of human activities affecting peatlands have dramatically increased in the 20th century.*
- *Disturbances have affected (or will affect) peatlands differently in terms of geographical location, time and intensity.*
- *The main anthropogenic disturbances of peatlands include peat extraction (both industrial for energy and horticulture and domestic for heating), agriculture and forestry.*
- *Other disturbances that can have severe localised impacts include trampling from tourists and other recreation activities, wind-farm and other infrastructural developments, invasive species and pollution.*
- *It is important to understand the nature, magnitude and future trends of each of these disturbances if management strategies are to be developed.*
- *Being degraded to various degrees, the vast majority of Irish peatlands are critically at risk of future disturbances such as climate change. Predicted changes are likely to affect low Atlantic blanket bogs in the west of Ireland the least while the areas showing greatest changes in precipitation and temperature are the areas containing basin peat in the Midlands.*
- *Sheep grazing on hill and mountain peatlands can be sustainably managed using a stocking density based on habitats that are most likely to be used and by acknowledging seasonal variations in vegetation cover and composition.*
- *Tools have been developed to be used in stability assessment for infrastructural development on peatlands (e.g. wind farms).*

3-4 Review of Impacts of Disturbances on Peatlands

3-4.1 Impacts on Essential Physical Characteristics of Peatlands – Water and Vegetation

Human disturbances often affect two features that are essential to the sustainability of the peatlands: *water* and *vegetation*. As peatlands consist largely of water, hydrological processes play a central role and, together with vegetation types, they are at the basis of any sustainable peatland ecosystem. The water-table level is – on average over the long-term – near the surface. Water levels that are too low or too high are detrimental to peatland ecosystems (Ivanov, 1981; Charman, 2002; Heathwaite and Gottlich, 2003). This means that disturbances, which substantially lower or raise the water level in peatlands (drainage in afforestation, agriculture reclamation, peat extraction, damming and impact of climate change), will negatively affect the peat hydrological properties and associated functions. Drainage of peatlands alters the hydro-physical and biogeochemical properties of peat soils and these changes are often irreversible. Drainage leads to oxidation, subsidence and compaction of the peat. Water flow connects the catchment area with the peatland and changes in groundwater supply (e.g. drainage at the periphery of a raised bog due to turf cutting) will further disrupt peatland functioning. High water-table levels mean that anaerobic conditions prevail so that peat decomposition is very slow. A drop in the water-table levels permits aeration which leads to oxidation and mineralisation of the uppermost peat layers, increasing emissions of carbon dioxide and release of nutrients. The amount of water in the system will also critically influence peat strength and thus the risk of peat failure (see Chapter 3.3, End of Project Report).

Hydrological properties of the peatland will, in turn, affect the type of vegetation growing on the surface of the peatland which, in turn, will affect the peat type occurring at the surface and its hydrology. This natural feedback means that any direct removal of the vegetation (afforestation, peat extraction, invasive species) or indirect impact due to hydrological changes (drainage, climate change) will affect the sustainability of the peatland.

3-4.2 Impacts on Functions and Sustainability of Peatlands

A system that is functioning properly is one that will persist despite natural environmental fluctuations (Palmer et al., 1997). Therefore, the major functions of a peatland must be preserved for the sustainability of the ecosystem. A variety of disturbances, mainly land use, influence peatland ecosystems and the disturbances that affect the main natural functions of a peatland should be considered the most critical. Many disturbances result in similar effects on peatlands' natural functions and these relate in general to:

- Biodiversity (species, habitats and landscape) – see Chapter 2.7, End of Project Report;
- Carbon stock and carbon sink function – see Chapter 3.4, End of Project Report;
- Hydrology – see Chapter 3.2, End of Project Report; and
- Cultural and informative function (the anaerobic environment preserves archaeological and palaeo-environmental archives in the peat) – see Chapter 4.4, End of Project Report.

Disturbance levels vary between minor to severe alteration of the physical form and natural functioning of the peatland ecosystem. The gradient from natural to highly disturbed is continuous but can be generally described in categories (Table 3-4.1). Similarly, a site suffering from a certain disturbance may change from one disturbance level to another over time. For example, tourist trampling over a long period can result in impacts similar to that of overgrazing. A general assessment of the direct impacts of various disturbances on the natural functions of Irish peatlands is summarised in Table 3-4.2. Their impacts may be more or less severe given the extent and the duration of the disturbance.

Table 3-4.1 Gradient of disturbance levels (adapted from Warner (1996); Charman (2002)).

Disturbance level	Description	Example
Natural	• Ecology and hydrology unaffected by current human activity	• Light grazing from low-density stocking of sheep on blanket bogs
Minor disturbance	• Some influence of humans in the distant past or very minor levels of recent or current disturbance • Peatlands have retained same type and form as they would have in the absence of disturbance	• Tourist trampling
Moderate disturbance	• Disturbance in the past or present sufficient to alter the type or form of peatlands • A naturally functioning peatland is retained but its structure may be changed and the functions are altered	• Invasive species or pollution event affecting part of the site
Major disturbance	• Human activity has altered the structure and form of the peatland • These changes have resulted in a shift in hydrology, and a shift in dominant species, resulting in species impoverishment • Natural functions are compromised	• Afforestation of open blanket bogs • Overgrazing
Highly disturbed (artificial)	• Damage has almost completely destroyed the original peatland.	• Peat extraction

3-4.3 Cumulative Impacts

Peatlands are vulnerable to cumulative impacts. For example, there is an increased threat of invasive species on drained peatlands. Another example is the risk of peat failure, which is increased in overgrazed or eroded peatlands. The cumulative effects of disturbances on peatland structure and function are far from understood as a whole and may be accentuated further with climate change. In addition, little is known about the long-term effect of certain disturbances. It is recognised, for instance, that the reclamation of certain peatland sites for agriculture is unsustainable, leading to the compaction and subsidence of the peat soil to a point that it can no longer act as a growing medium. Long-term studies are critical in assessing the long-term cumulative influence of certain disturbances on peatlands' natural functions.

3-4.4 Wider Impacts of Peatland Disturbances

Peatland disturbances not only impact on the peatland itself but can also have serious consequences for other ecosystems in the catchment and at the wider landscape level. Afforestation has many direct impacts in terms of hydrology and carbon cycling (see Section 3-5.4.3) but it also has wider impacts outside the boundary of the peatlands, principally because of the quality of the water draining from the afforested areas. Peatland catchments are particularly sensitive to changes in water chemistry and there is currently concern in relation to mobilisation of nutrients from peat soils following clear-felling in peatland catchments and effects on salmonid waters and subsequent effects on protected species such as the freshwater pearl mussel (*Margaritifera margaritifera*). Similar concerns of degraded water quality in peatland catchments arise from overgrazing as the loss of plant cover leads to exposure of bare peat surfaces and subsequent erosion of peat. This, in turn, leads to acidification of lakes and siltation of the spawning beds of salmonids in these regions. At a landscape level, afforestation leads to dramatic visual changes from a treeless landscape to a densely wooded forest. Afforestation also leads to the fragmentation of the habitat, particularly severe in Connemara, Mayo and Kerry. Overgrazing and erosion leading to large tracts of black peat being exposed have also a significantly wider negative effect on the landscape and its touristic value.

Table 3-4.2. Level of impact of various disturbances on natural functions of peatlands and their current trend (down arrow, decreasing threat; up arrow increasing threat; levelled arrow, same threat as in the past).

	Industrial peat extraction for fuel	Horticultural peat extraction	Domestic peat cutting	Agriculture: reclamation	Agriculture: grazing	Forestry	Recreation – tourism	Invasive species	Climate change
Current trend	↓	→	↑	↓	↓	→	↑	↑	↑
General level of disturbance on the peatland[1]	Highly disturbed	Highly disturbed	Major	Major	Minor–major	Major	Moderate	Minor	Minor–Major
Impact on:									
Biodiversity	Very high	Very high	High	Medium–high	Very high	Very high	Medium–high	High	Medium
Carbon store function	Very high	Very high	Very high	High	Low	Very high	Very high	Low	Low
Carbon sink function	Very high	Very high	Very high	High	Low	Very high	Very high	Low	Low
Hydrology	Very high	Very high	Very high	High	Low	Very high	Very high	Low	Low
Cultural and informative function	Very high	Very high	Medium	Low	Low	Low	Medium	Low	Medium

[1]See Table 3-4.1.

Summary Findings

- *Impact levels from disturbances vary between minor to severe alteration of the physical form and natural functioning of the peatland ecosystem.*
- *Past management has affected most of the natural functions of peatlands: biodiversity, carbon storage, carbon sink, hydrological and cultural and information functions.*
- *Peatlands are vulnerable to cumulative impacts and their disturbance can have negative repercussions on the wider environment.*

3-5 Irish Peatlands, Carbon and Greenhouse Gas

3-5.1 Peatlands: a Huge Carbon Store

Peatlands store carbon in different parts of their ecosystem (biomass, litter, peat layer, mineral subsoil layer and pore water), with each pool having its own dynamics and turnover. The peat layer is a main long-term store of carbon as peat largely consists of organic material (by definition more than 30% of the dry mass), with a carbon content ranging from 48% to 63% (Heathwaite and Gottlich, 2003) – an average of 51% can be calculated from various Irish peat analyses (Hammond, 1981; Tomlinson, 2005; Renou-Wilson et al., 2008). Recent estimates show that worldwide, peatlands have accumulated between 274 and 550 billion tonnes of atmospheric carbon (Gorham, 1991; Immirzi et al., 1992; Lappalainen, 1996; Sheng et al., 2004; Vasander and Kettunen, 2006). Estimates in carbon pools vary widely depending on assumptions of the extent and depth of peatlands, as well as lack of adequate data on bulk density of different peat deposits (Charman, 2002; Turunen et al., 2002). However, despite those uncertainties, the global peatland carbon store represents approximately a third of the global soil carbon pool (Carter and Scholes, 2000). The carbon content in the peat is also equivalent to 75% of all atmospheric carbon (mainly in the form of carbon dioxide and methane) – estimated in 1990 to be 750 billion tonnes (Houghton, 1997).

The extent of the soil carbon store in Irish peatlands has only recently been investigated. Using the General Soil Map (Gardiner and Radford, 1980) and a series of county maps to calculate the extent of peatlands and relying on disparate data sources to estimate peat depth, Tomlinson (2005) estimated that Irish peatlands had a carbon stock of 1,071 Mt in 2000. Eaton et al. (2007) estimated the peat carbon stock to be almost 50% higher at 1,503 Mt, using the peat bog category from CORINE 2000, carbon density from Cruickshank (1995) and the average depth values from Hammond (1981). These two estimates account for 53% (Tomlinson, 2005) and 62% (Eaton et al., 2008) of the total soil organic carbon (SOC) stock present in Ireland. Cruickshank et al. (1998) calculated the peat SOC stock for Northern Ireland to be 162.1 Mt, accounting for 42% of the total soil carbon stock on only 15% of the land area.

Given these high proportions, it was critical to improve the accuracy of these estimates by, firstly, using the new peat soils maps (Connolly and Holden, 2009) and, secondly, by developing a model to predict peat depths as the data are usually inconsistent in quality and coverage, an issue raised by both Tomlinson (2005) and Eaton et al. (2008). While intact raised bog depth can be reasonably modelled (Ingram, 1982) and has been well investigated for peat extraction purposes, peat depth on blanket peatlands varies considerably due to the undulating base mineral surface and, therefore, requires sampling over large areas. As part of the BOGLAND project, a study was initiated to develop a robust method to predict the depth of peat soil in blanket peatlands from elevation and disturbance data. Holden and Connolly (2011) developed a Peat Depth Model and, combined with the map of peatland spatial extent, the DIPMV2 (Connolly and Holden, 2009), they estimated that blanket peatland in the Wicklow Mountains contained 2.3 Mt C. This compares with the previously published values ranging from 0.45 Mt C (Eaton et al., 2008) to 2.18 Mt C (Tomlinson 2005). This suggests that the peatland SOC stock for Ireland has to date been underestimated. If the modelled data used in this study are extrapolated for all blanket bogs, the national blanket bog carbon stock is estimated to be around 1,073 Mt. When adding Tomlinson’s figure for basin peat SOC to the new blanket bog SOC figure, the total peat soil carbon stock is estimated at 1,566 Mt. This figure is higher than all aforementioned estimates. This research improved the accuracy of several parameters, such as the spatial extent of peat soils and peat depth of blanket bogs, thus including deeper peat layers with higher carbon content. Despite this, the model could be further refined with new countrywide peat depth data which would lead to even more accurate estimates of Ireland’s peat SOC stocks. Without a doubt, Irish peatlands are a huge carbon store, containing more than 75% of all the SOC in Ireland. Such a resource should therefore be carefully managed as the size and functioning as well as disturbance of any large carbon pool is of importance to future climate change.

3-5.2 Carbon Budget and Gas Exchange

Peatlands have accumulated and stored carbon in the peat over thousands of years. Irish peatlands developed in the post-glacial period (Holocene) after the recession of the ice sheets some 10,000 years ago and have accumulated peat and thus carbon, since then, albeit at variable rates. The main processes of carbon sequestration, export and transformation are summarised in Fig. 3-5.1. Atmospheric carbon dioxide is the main input of carbon into the system, as plants convert it into plant biomass through photosynthesis. A large amount of carbon is also released back to the atmosphere through the respiration of the vegetation and the peat (carbon dioxide), and as methane produced in the oxygen-deficient zone below the water level. As the plant biomass decays, some of the carbon is retained in the peat while dissolved and particulate organic carbon may be exported via run-off. In peatlands, the decay of the organic matter occurs at a faster rate within the aerobic zone above the water level than in the anaerobic layer below the water level. However, because of continuous, albeit very slow, decomposition of peat (unless frozen), this carbon store will diminish inevitably if no additional organic material is formed above. Therefore, active peat formation in peatlands and thus a positive carbon balance is a prerequisite for the long-term maintenance of the peat carbon store.

In order for the carbon stock to continue to increase, the rate of carbon sequestration in peatlands should be greater than the total rate of carbon losses. Large variations regarding both rates have been recorded spatially and temporally. There has been great endeavour to understand processes of carbon sequestration and losses in peatlands (Alm et al., 1997; Bubier et al., 1998; Waddington and Roulet, 2000; Vasander and Kettunen, 2006), the most important of which concerns the amounts and controls of gas emissions, mainly carbon dioxide and methane. Intact peatlands act as long-term carbon dioxide sinks (Mäkilä, 1997; Clymo et al., 1998; Belyea and Malmer, 2004), although the annual increment may be relatively small (Sottocornola and Kiely, 2005; Laine et al., 2006) and may shift between carbon sinks and sources from year to year or even season to season (Alm et al., 1999; Holden et al., 2006a; Roulet et al., 2007). Furthermore, they are also a significant source of

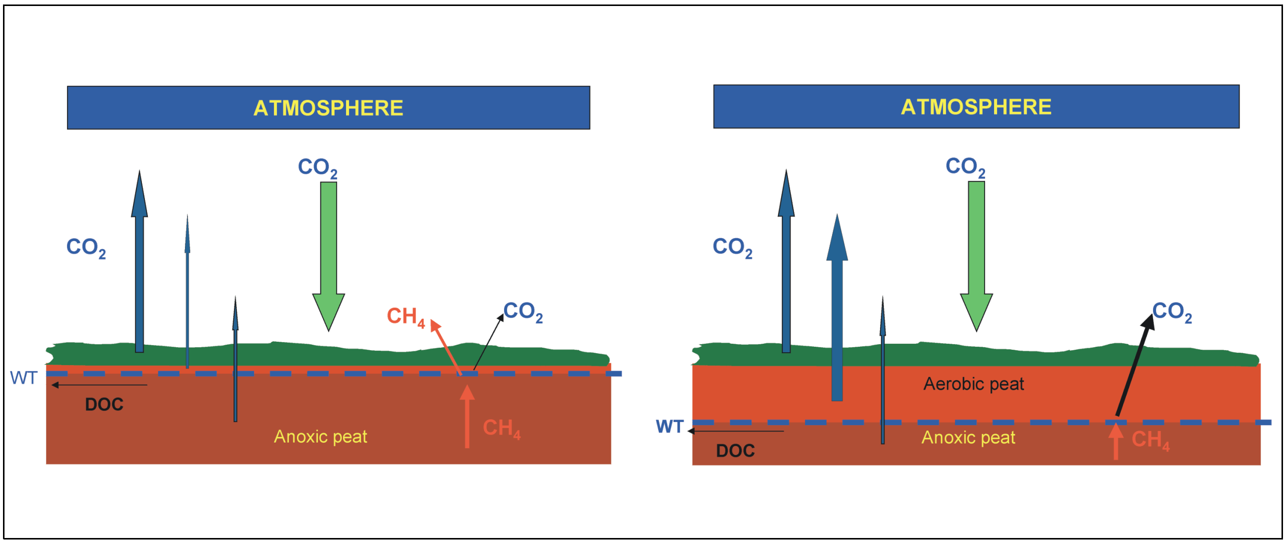

Figure 3-5.1. A simplified representation of the carbon dynamics in a peatland. The level of the water table (WT) is critical to the amount of carbon dioxide (CO_2) released by the aerobic peat (peat oxidation) and the amount of methane (CH_4) emitted by the anoxic peat.

methane (Huttunen et al., 2003; Laine et al., 2007a) as a consequence of the anoxic conditions within the peat body that provide a suitable environment for the microbial breakdown of plant litter and root exudates. Overall, intact peatlands act as long-term carbon stores, primarily as a result of a persistently high water table, which creates conditions within the peat, whereby the amount of carbon fixed by the peatland vegetation during photosynthesis is greater than that released through ecosystem respiration, methane emissions and leaching/surface run-off of dissolved organic carbon (DOC) and fire events. The complete carbon budget of a small upland blanket peat catchment (including near-intact and degraded peatlands) from the North Pennines (UK) showed that the largest single component of the budget was the fixation of carbon dioxide and that overall it accumulated nearly 15 g C/m^2/year (Worrall et al., 2003). Using various recent and ongoing studies, Joosten (2008) estimated the present-day rate of carbon sequestration in natural peatlands of the world to be just below 100 Mt C/year and, together with the large stock of carbon they harbour, it is clear that peatlands play an important role in the regulation of the global climate.

3-5.3 Forested Peatlands, Carbon and Greenhouse Gas

3-5.3.1 Background

The national forest area has dramatically increased in Ireland since the 1950s and a third of it (some 267,000 ha) has been planted since 1990 (classified as ‘Kyoto forests’). According to the Forest Service National Forest Inventory (NFI), 43% of the total forest estate is located on peat soils (Black et al., 2008). Most forests on peatland in Ireland are located on blanket bogs (both mountain and Atlantic), with a small proportion occurring on either raised or on industrial cutaway bogs. While large tracts of natural blanket bogs were afforested between the 1950s and 1980s/90s, the last decade has also seen the afforestation by private landowners of smaller areas of blanket bogs – most of which are likely to have been degraded to some extent by previous human activities (turf cutting, animal grazing). Given the various pre-afforestation conditions of the peatland, there exist many profiles of forested peatlands throughout the country, e.g. forests on peatlands with high or low water-table levels, forests on degraded peatland (cutover, cutaway) and/or derived grassland from peatland, as well as older plantations on peatland of unknown pre-planting conditions. Peatlands of various status and conditions (initial carbon balance) are likely to respond differently to the effects of afforestation in terms of GHG emissions and overall carbon balance. The effect of forestry on the carbon budget of peatland ecosystems is a complex issue and a workshop has been initiated as part of the BOGLAND project to achieve a consensus and synthesis amongst the research community at large so that it is reflected in clear recommendations in the areas of management, research and policy (see Chapter 3.5, End of Project Report).

3-5.3.2 Impact of planting trees on bogs

Afforestation on blanket bogs generally involves a series of ground-preparation practices that include ploughing or mounding using excavators (with some additional drainage work) and is often followed by fertilisation. The critical and immediate hydro-ecological effects are changes in the vegetation composition (Anderson and Patterson, 2000; Charman, 2002) and lowering of the water table (Byrne and Farrell, 1997). Such land-use change has direct consequences for the carbon balance of these peatland sites. The drainage of peat soils releases carbon dioxide by oxidation of the organic matter in the aerobic layer, although this loss of carbon can be partially or entirely offset by greater inputs of organic matter from above, i.e. in the vegetation, tree layer and root biomass, or by a decrease in the natural fluxes of methane and the likely increase of methane consumption at the site. When the trees are harvested and removed, the carbon sequestrated in the biomass is lost from the ecosystem and it will take around 30 years (with average growth rate) before the restocked forests replace this lost carbon store (Minkkinen et al., 2008).

Afforestation is thus a once-off value in terms of carbon mitigation and sustainable management of the forests is required to offset potential long-term carbon losses. Current reforestation is usually carried out following windrowing of brash and sometimes mounding. Coillte does not generally drain western peatland forests for the second rotation. Following clear-felling, a small rise of the water table may slightly reduce methane consumption on a blanket bog but increased nitrous oxide emissions have been recorded especially from the slash piles (Minkkinen et al., 2008). After felling, ground-preparation practices and decomposition of harvest residues can lead to increased leaching of DOC and nutrients.

3-5.3.3 GHG exchanges

The gas exchange processes observed in a forested peatland are complex and can vary a lot in time and space. Overall, GHG fluxes may change in multiple ways, compared with those observed in a natural Irish peatland (i.e. treeless). These changes, which occur during the first rotation, are due to:

- A change of carbon dioxide emissions from the peat soils due to increased peat oxidation, the significance of which depends on the initial conditions of the peatlands (Minkkinen and Laine, 1998; Hargreaves et al., 2003);
- A decrease of methane emissions from the peat soils (Fowler et al., 1995);
- A small increase of nitrous oxide, depending on peat types and fertilisation (richer peat soils may emit more nitrous oxide) (Regina et al., 1998; von Arnold et al., 2005; Alm et al., 2007);
- An increase of the biomass carbon store which is either stored, recycled via decomposition or removed by harvesting and subsequently replenished through reforestation. A gain of carbon in tree biomass occurs during the first rotation and reforestation is required to sustain this initial gain;
- A small initial increase of the litter carbon store. The accumulated litter from trees and ground vegetation is partly quickly decomposed (returning carbon dioxide to atmosphere) but a recalcitrant fraction may remain in the soil for a longer period (Minkkinen and Laine, 1998); and
- Clear-felling, which disturbs the GHG balance further by decreasing primary production and inducing increased nitrous oxide emissions. If the site is totally deforested and not replanted, all the carbon stock in the trees is lost from the site.

Therefore, afforestation exerts a considerable influence on the carbon balance in natural or undrained peatlands which have been, for the most part, acting as modest sinks (Sottocornola and Kiely, 2005). However, from the current literature, it is likely that over the first rotation period, forested peatlands are likely to be a carbon sink despite significant soil carbon dioxide emissions from peat oxidation, particularly at the start of the process (Minkkinen et al., 2002; Hargreaves et al., 2003; Byrne and Farrell, 2005). Clearly, the strength of this sink will vary greatly depending on various factors – most importantly tree stand development and site characteristics, as well as management practices, all of which will have an impact on the various carbon pools in the systems, most importantly the trees and the soil.

3-5.3.4 Soil carbon pool and emissions from peat oxidation

The number of reliable studies dealing with GHG fluxes from forestry peatlands in the Atlantic temperate region is extremely low. Hargreaves et al. (2003) demonstrated that, in Scotland, carbon loss from peat oxidation could reach up to 14.6 t CO_2/ha/year and that, after 15 years, the peat substrate was still a small but persistent source of carbon (~1.1 t C/ha/year or 4 t CO_2/ha/year). While the rate of peat oxidation has not been measured in Ireland, such oxidation leads inevitably to a decrease of the peat carbon store, the extent of which is also unknown. It has been suggested that, in Finland, the rate of oxidation declines as the remaining organic matter becomes more recalcitrant, i.e. deeper peats are more resistant to decay (Minkkinen and Laine, 1998). Minkkinen (1999) also demonstrated that the oxidation of the peat may be limited if the water table does not drop too low (i.e. the aerobic layer remains shallow). There are many uncertainties in relation to peat oxidation figures due to different water regimes, pre-existing peat types, past, current, future climate, management activities and, thus, the dynamic of this efflux will also change over time. While using Hargreaves's figures (2003) for peat oxidation from Irish forested peatlands may be conservative (since peatlands that are currently afforested may be degraded rather than in intact conditions), assuming peat oxidation is zero for the rest of the rotation, as reported in the National

Inventory Report (McGettigan et al., 2009), may not be representative and adequate. More research is required to quantify how much peat is oxidised for different peat types (from intact to degraded peats) and during the whole forest rotation.

In addition, heterotrophic soil respiration has been found to be much higher in peat soils with a long history of soil preparation (Minkkinen et al., 2008). Therefore, minimising the intensity of soil disturbance would help decrease peat oxidation and soil carbon losses.

3-5.3.5 LULUCF[3] Reporting

Under the United Nations Framework Convention on Climate Change (UNFCCC), Ireland has to report estimates of emissions and sinks of GHG from all land-use sectors and land-use change and forestry (known as LULUCF data). Under Article 3.3 of the Kyoto Protocol, the GHG emissions by sources and removals by sinks associated with direct human-induced land-use change and forestry activities (limited to afforestation, reforestation and deforestation since 1990) shall be reported in a transparent and verifiable manner. Afforested peatlands are therefore included in the National Inventory Report (McGettigan et al., 2009). Under the Intergovernmental Panel for Climate Change (IPCC) Good Practice Guidance (IPCC, 2003), Ireland reports LULUCF data (under the Kyoto Protocol, Articles 3.3 and 3.4) using the Tier 1 level (IPCC default emission factors per area), except for forestry where Tier 2 for soil carbon pool and Tier 3 for all other pools are used. Tier 2 uses emissions factors that are country/regional specific and high-resolution land area data. Tier 3 uses higher-order methods, including models and inventory measurements systems and high-resolution activity data. In order to do this, the full carbon balance of all forested peatlands needs to be ascertained. The net carbon stock change is estimated using the CARBWARE model developed by COFORD. However, no emission factor specific to Ireland has been determined for the peat oxidation in peat soils. Therefore, the CARBWARE model uses the guidance of published emission factors for blanket peatlands in the UK (Hargreaves et al., 2003) and a figure of 4 t C/ha/year (14.6 t CO_2/ha/year) is applied over a transition period of 4 years. Estimates for peat oxidation following drainage in temperate peatlands is reported to vary from 1 to 4 t C/ha/year (Hargreaves et al., 2003). Sensitivity analysis using CARBWARE model simulations for afforested peatlands suggests that emissions due to peat oxidation, over these reported ranges, varied from 0.05 to 0.08 Mt CO_2 in 2008 (McGettigan et al., 2009). Emissions from peat oxidation were similar to those associated with deforestation of peat forests (0.068 Mt CO_2)

Reported peat oxidation losses represent an emission of 5% (of the gross carbon ecosystem flux) in relation to the net carbon balance of the afforested peatland area, which was a net sink of 1.2 Mt CO_2 in 2008 (McGettigan et al., 2009). Although soil carbon dioxide emissions from peat oxidation are relatively small, more research is required to quantify peat oxidation emissions for different peat types (from natural to degraded peats), under different climatic conditions and different types of management, and characterise how these dynamics change following drainage and forest establishment. Furthermore, there is currently no guidance (IPCC, 2003) on reporting other potential losses of GHG due to run-off of DOC or changes in methane emissions. Clearly this warrants further investigation.

3-5.3.6 Forested industrial cutaway peatlands

Peat extraction transforms a natural peatland which acts as a modest carbon sink into a cutaway ecosystem which is a large source of carbon dioxide (2–5 t C/ha/year) (Waddington and McNeil, 2002; Alm et al., 2007; Wilson et al., 2007). Unless they are restored or rehabilitated into a carbon sink ecosystem, cutaway peatlands could remain a significant source even with the regeneration of dryland habitats (Wilson and Farrell, 2007). On some cutaway peatlands, commercial forest crops can be established which may sequester more carbon than is lost by the degraded ecosystem. Certain products from such forest crops could also be used for energy to offset fossil fuels. While a positive carbon balance was recorded from a Sitka spruce cutaway peatland by Byrne et al. (2007), further results are expected from Norway spruce planted on deeper cutaway peatlands (BOGFOR project – 2010). Unlike blanket bogs, cutaway peatlands are already a source of carbon dioxide and afforestation on certain sites where re-wetting is not

3. LULUCF, land use, land-use change and forestry.

feasible can therefore become a win–win land-use change contributing to climate change mitigation in Ireland. However, land-use decisions regarding cutaways are currently not based on carbon sequestration parameters. The type of cutaways that might be afforested into the future will depend on future peat extraction policy, which will affect the timing and profile of industrial cutaway ready for after-use (see Chapter 3.9, End of Project Report).

3-5.4 Impacts of Other Land-Use Changes on Carbon Cycling

3-5.4.1 Peat extraction

In order to facilitate industrial extraction of the peat, drainage ditches are installed to lower the water table and reduce the moisture content of the peat from approximately 95% to 80% (Bord na Móna, www.bnm.ie). The installation of drainage ditches increases the depth of the oxic zone in the upper layers of the peatland (Waddington et al., 2001) resulting in higher losses of carbon dioxide. After a number of years, the top layer (vegetation and fibrous peat) at the surface is removed in order to facilitate the removal of the more highly decomposed peat. In the case of horticultural peat, the slightly decomposed *Sphagnum* at the top is extracted. In all cases, this disrupts hydrological processes, adding to the severe changes brought about by drainage, i.e. peat shrinkage, compression, reduced hydraulic conductivity and pore size, etc. (Price and Schlotzhauer, 1999; Price et al., 2003). However, more importantly, both drainage and peat extraction remove the carbon sequestering capability of the system (Waddington and Roulet, 2000). Peat extraction transforms the peatland into a significant source of carbon dioxide (Rodhe and Svensson, 1995; Sundh et al., 2000), but may result in a small uptake of methane from the bare peat surface although drainage ditches may remain a significant methane source (Minkkinen and Laine, 2006). Under the UNFCCC, Ireland reports emissions from peatlands in use for peat extraction. However, two issues arise from the current methodology:

1. The area reported is the area of cutaway peatland in production currently owned by Bord na Móna (other small-scale commercial enterprises and domestic turf-cutting areas are not included); and
2. The carbon emission factor used as default value 0.25 t C/ha given by the IPCC good practice guidelines and which is adopted in the National Inventory Report (McGettigan et al., 2009) is much lower than values of 2.5–3 t C/ha recorded by Wilson et al. (2007) in Ireland on Bord na Móna cutaway peatlands and elsewhere (Couwenberg, 2009).

Domestic cutting of peat has been a notable feature of the Irish landscape. Traditionally, the upper fibrous layer of peat was removed and the peat was hand-cut from a bank face with a sleán. This produced a landscape of varying peat depths, characterised by banks and low-lying areas where the peat has been removed. In recent times, hand-cutting has largely been superseded by the use of tractor-mounted harvesters. Two methods have been generally employed. In the first, the peat is extruded onto the surface of the peatland from narrow openings made in the peat by a chain cutter (Foss et al., 2001). This practice has a number of deleterious effects on the peatland:

- The vegetation is damaged as the tractor is repeatedly driven across the surface of the peatland in the process of extracting the peat (Wheeler and Shaw, 1995);
- The acrotelm and catotelm are compressed by the passing of the tractor over the surface (Cooper et al., 2001), resulting in a reduction of pore size and an increase in bulk density; and
- It creates deep crevices within the peat that function indirectly as drainage ditches. As the peat dries out, the crevices are further deepened and cracking of the peat is accentuated leading to a severe drop in the water table. This practice is now prohibited on peatlands that are designated as SACs (Foss et al., 2001).

The second method of extraction involves the block-cutting of the peat at the margins of the peatland. The milled peat is placed into a tractor-mounted hopper and the peat is extruded on the surface. The latter method, still used in some SACs, e.g. Clara Bog, County Offaly, results in large emissions of carbon dioxide to the atmosphere (Wilson, 2008).

3-5.4.2 Agriculture

Agriculture on peat soils is largely confined to grassland production and the grazing of cattle or sheep. This may result in large emissions of GHGs due to the drainage of the peat soils (carbon dioxide), enteric fermentation associated with grazing ruminants (methane) and nitrous oxide emissions from fertiliser applications (Wilson et al., 2009). In the 1980s and 1990s, the primary threat to the carbon store in Irish peatlands from agriculture was from overgrazing of the more vulnerable upland peatlands. However, the impact on carbon dynamics in Ireland has not been quantified. High livestock stocking rates (in this case encouraged by financial incentives under the EU's CAP) may have three major impacts on carbon dynamics in peatlands:

1. Intensive grazing removes much of the peatland vegetation cover. This results in a reduction in the carbon sequestering capacity of the peatland (i.e. less photosynthesis is likely to take place), as well as a decrease in the amount of organic matter input available for peat formation (Garnett et al., 2000);

2. Trampling by the sheep may cause compaction of the peat and result in a disturbance of hydrological functioning, with a corresponding deleterious impact on carbon cycling (Garnett et al., 2000); and

3. High stocking rates have been linked to severe soil erosion. Large losses of DOC have been associated with erosion in the Pennines in the UK (Evans et al., 2006). While monitoring DOC levels in a blanket bog in the UK, Worrall et al. (2007) reported no significant difference between ungrazed areas and those maintained at low stocking rates.

Greenhouse gas emissions from organic soils under grassland are currently being monitored at various sites in Ireland to assess the total carbon budget of these ecosystems (EPA-funded project: www.ucd.ie/calisto). Currently, Ireland reports emissions from this land use using IPCC default values.

3-5.4.3 Fires

In tropical peatlands, the threat posed by fire to the carbon store is of major regional and global importance (Maltby and Immirzi, 1993; Page et al., 2002). In Ireland, the threat from fire is considerably less but could increase with climate change. Periodically, peatlands have undergone burning either from carelessness by the public or to facilitate the extraction of the peat or to increase the population of grouse. The loss of carbon from fire in Ireland has not been quantified. However, work in North America and Finland has suggested that between 2.1 and 3.2 kg C/m^2 could be released during a single fire event (Pitkänen et al., 1999; Turetsky and Wieder, 2001; Turetsky et al., 2002; Benscoter and Wieder, 2003) and that the burned peatland is likely to be a net carbon source for some time afterwards as a result of the loss of the vegetation cover (Turetsky et al., 2002). Ireland needs to carry out research in this particular area.

3-5.4.4 Wind farms

The use of peatlands as sites for the establishment of wind farms has received much attention. The carbon balance of a wind-farm development on a peatland is a highly contentious issue within that debate (Couwenberg and Joosten, 2007; Nayak et al., 2008). On the one hand, carbon emissions are saved by offsetting fossil fuel sources; however, the carbon sequestration and storage function of part of the peatland is lost, and carbon is also released by building and maintaining the wind farm. Issues with carbon balance figures stemmed from the fact that various studies used different starting point (e.g. whether the peatland was already afforested or not) and different parameters in life-cycle analysis (the type of fossil fuel it is displacing may have different levels of emissions). Overall, the debate has shown that the carbon balance is positive, only when large-scale erosion and peat failures can be avoided (i.e. when guidelines as described in Chapter 3.8, End of Project Report, are rigorously applied). In particular, degraded sites that could benefit from restoration in parts of the site need to be assessed on a case-by-case basis.

3-5.4.5 Restoration

In recent years, the restoration of the environmental conditions (i.e. water table, vegetation recolonisation) to promote the return of the carbon sink function in peatlands damaged by peat extraction or afforestation has received much interest globally (Komulainen et al., 1998, 1999; Tuittila et al., 2000; Waddington et al., 2003; Bortoluzzi et al., 2006; Yli-Petäys et al., 2007) but has been slower to develop in Ireland where the alkaline sub-peat substrate remaining after the cessation of industrial peat extraction is not suitable for recolonisation by ombrotrophic bog species, such as *Sphagna* (Renou et al., 2006). As such, there are no published data available in Ireland as to how carbon gas dynamics are affected by restoration, although studies are ongoing at an industrial cutaway at Bellacorick, County Mayo (www.ucd.ie/carbonrestore). Instead, the focus has been to identify a range of new land-use options following the ending of industrial peat extraction that may provide further socio-economic or amenity values (Egan, 2006). In 1999, a suite of carbon gas exchange studies was initiated under the Bord na Móna-funded CARBAL project (Wilson and Farrell, 2007) in afforested, naturally regenerated and re-wetted cutaway peatlands. The results showed that there were considerable differences in the ability of the new ecosystems to sequester carbon (Table 3-5.1). For example, Byrne et al. (2007) reported that a 19-year-old Sitka spruce afforested cutaway peatland was a sink for carbon dioxide but that a naturally regenerated birch/willow woodland of the same age was a large source of carbon dioxide (Byrne et al., 2007). The discrepancy in values was attributable to differences in stand productivity and site management (Wilson and Farrell, 2007), with much larger amounts of carbon sequestered by the Sitka spruce stand. In both peatlands, the authors reported large losses of soil carbon dioxide from the residual peat, as have other studies in Finland (Mäkiranta et al., 2007) and Sweden (Tagesson and Lindroth, 2007). To date, there is no information as to how the carbon exchange is likely to change over the lifetime of an afforested or naturally regenerated stand on cutaway peatland. Re-wetting of the cutaway to promote wildlife and/or amenity interests has been suggested in geographic areas where it is not economically viable to continue to drain the peatland. As part of the CARBAL project, a re-wetted cutaway in County Offaly was studied over a 2-year period. The failure to maintain a sufficiently high water table throughout the year resulted in large annual losses of carbon (Wilson et al., 2007).

3-5.5 Impacts of Climate Change on Carbon Cycling

The effect of a changing global climate on carbon gas dynamics in peatlands in general is uncertain. Some predictive models suggest an increase in peat accumulation as a result of warmer and wetter conditions (Frolking et al., 2001) and a decrease if there were a drought during the growing season (Griffis and Rouse, 2001). Higher losses of DOC from the peatland may also occur as a result of higher temperatures (Freeman et al., 2001) and drought conditions brought about by increased activity of the enzyme phenol oxidase, activated by a water-table drawdown (Worrall et al., 2005). Other studies have suggested that increased atmospheric carbon dioxide levels may lead to both increased plant productivity (Kang et al., 2001; Saarnio et al., 2003) and a subsequent increase in soil respiration (Norby, 1997) and methane emissions (Dacey et al., 1994; Saarnio and Silvola, 1999). Warmer drier climates have also been predicted to lead to lower water tables and decreased methane emissions (Whalen and Reeburgh, 1990).

In Ireland, the predictions of warmer temperatures, coupled with lower summer rainfall (see Section 3-3.6.4) could result in higher rates of evapotranspiration, a subsequent drop in the water level within the peatland, increased emissions of carbon dioxide and decreased emissions of methane. Thus, while a rise in temperatures may increase peatland productivity by lengthening growing seasons, such productivity may be moderated by enhanced moisture stress on the peatland vegetation, particularly the *Sphagnum* mosses. Work by Laine et al. (2006) found that drought conditions at any time would lead to lower rates of carbon sequestration. Similarly, research by Wilson et al. (2007) at a re-wetted industrial cutaway peatland in County Offaly suggested that degraded/re-wetted peatlands may be particularly vulnerable to changes in climate.

3-5.6 Are Irish Peatland Ecosystems Sequestering Carbon?

Irish peatlands remain poorly studied in comparison with peatlands elsewhere in regard to impacts on carbon cycling (Laine et al., 1996; Alm et al., 1997;

Bubier et al., 1998; Tuittila et al., 1999; Sundh et al., 2000). Wilson et al. (2011) (see Chapter 3.4, End of Project Report) reviewed all the carbon studies on Irish peatlands and concluded that baseline data sets of carbon gas exchange for both intact and damaged peatlands are scarce and that the only long-term studies existing at present occur on a single lowland blanket bog in County Kerry (Sottocornola and Kiely, 2005, 2010; Laine et al., 2007a,b). Ongoing research at this site has shown that the near-intact Atlantic blanket bog is currently actively sequestering carbon dioxide (Laine et al., 2006; Sottocornola and Kiely, 2010) and, while releasing methane (Laine et al., 2007a), the carbon balance is positive (i.e. uptake of carbon). Recent work on the same blanket bog, however, shows that the annual export of DOC could be a significant component of the overall carbon budget (Koehler et al., 2009). Short-term studies at other natural peatland types have reported small annual losses of carbon dioxide and methane for the duration of the study (Wilson, 2008). In Ireland, the majority of carbon gas flux studies on peatlands have been carried out on degraded peatlands and the results show a wide range in annual values (see Chapter 3.4, End of Project Report). Large losses of carbon have been reported for peatland margins impacted by domestic turf cutting, with emissions of carbon dioxide six to seven times higher than in an adjacent natural peatland (Wilson, 2008). In contrast, afforestation of an industrial cutaway peatland may result in a net annual carbon sink (Byrne et al., 2007).

An assessment as to whether, as a national resource, Irish peatlands are currently sequestering carbon was carried out within the BOGLAND project. Previous studies have attempted to provide an estimate but were hindered by the absence of Irish field studies at the time and were therefore forced to rely on studies from other climatic areas (Ward et al., 2007). Following a comprehensive literature review, peatlands were divided into a range of land-use categories (Table 3-5.1) and annual carbon gas fluxes (tonnes carbon per year) were calculated for each category based on published carbon gas flux studies and on area coverage from a range of sources.

The results show that, nationally, near-intact peatlands (protected and non-protected) may actively sequester around 57,402 t C/year. However, this is offset by the large losses of carbon associated with peatlands that have been degraded by domestic peat extraction (808,385 t C/year) and industrial peat extraction (275,800 t C/year), as well as losses associated with domestic peat combustion (323,025 t C/year) and combustion at the three peat-fired power stations (752,268 t C/year). Furthermore, whilst emissions may not necessarily occur within the State, emissions of carbon dioxide from peat extracted for horticultural use may release around 517,500 t C/year. These results suggest that, at the national level, Irish peatlands are likely to be a source of around 2.64 Mt C/year to the atmosphere (Wilson et al., 2011), although large information gaps still exist, particularly in land-use categories such as forested peatlands and agriculture.

This research, corroborated by others studies elsewhere (Strack, 2008), demonstrates that efforts should be made to actively repair damaged peatlands to minimise the persistent loss of carbon dioxide and to create conditions whereby the peatland may actively sequester carbon in the future. Cuts in carbon emissions made by avoiding peat soil degradation have been actively recognised and supported by national and international bodies and have been discussed at the Climate Change talks.

Table 3-5.1. Area (ha) and estimated annual carbon gas flux (t C/year) from the major land-use categories of Irish peatlands. Positive carbon flux values indicate a net uptake of carbon by the peatland. Negative values indicate a net loss of carbon from the peatland to the atmosphere (Wilson et al., 2011).

Land-use category	Area (ha)	Flux values (t C/ha)	Annual carbon gas flux (t C/year)
Near-intact peatland	227,784[1]	0.25	+57,402
Agriculture	345,606		nd
Forestry	293,000[2]		nd
Cutover peatland	468,629[3]	1.72	–808,385
Industrial peat extraction			
Production fields, etc.	100,000[4]	27.5	–275,800
Cutaway peatland			
Forestry	16,450[2]	1.25	+20,562
Regenerated	4,250	5.25	– 22,313
Alkaline wetland	4,250	4.33	– 18,402
Acid wetland	6,500		nd
Related activities			
Domestic combustion	–	–	–323,025[5]
Industrial combustion	–	–	–752,268[6]
Horticulture	–	–	–517,500[7]
Total	**1,466,469[8]**		**2,639,729**

[1]Douglas et al. (2008), Malone and O'Connell (2009), includes protected and unprotected areas (see Table 5-2.1).
[2]Forest Service (2007).
[3]EPA/Teagasc (2006).
[4]Fitzgerald (2006).
[5]Adapted from Howley and Ó'Gallachóir (2009).
[6]See http://www.epa.ie.
[7]Adapted from Clarke (2006).
[8]Connolly et al. (this report and Connolly and Holden, 2009).
nd, no published studies exist at present.

Summary Findings

- *Irish peatlands are a huge carbon store, containing more than 75% of all the national soil organic carbon.*
- *A constant, high water table, which restricts aerobic decay, is a prerequisite for sequestration and long-term storage of carbon in peatlands.*
- *Natural/Undamaged peatlands help to regulate the global climate by actively removing carbon from the atmosphere but this function is reversed (i.e. there is a net release of carbon) when the peatland is damaged.*
- *Near-intact peatlands may actively sequester on average 57,402 t C/year over the whole country.*
- *A raised bog area damaged by domestic peat cutting emits six to seven times more carbon dioxide than in a near-intact part of the peatland via peat oxidation.*
- *As the majority are degraded to some extent, Irish peatlands are a large source of carbon, estimated currently at around 2.64 Mt C/year (without accounting for peat soils under forestry and agriculture).*
- *Damaged peatlands result in a persistent loss of carbon dioxide and remedial management, including full restoration, may be effective in maintaining the carbon storage of peatlands and to recreate conditions whereby the peatland may actively sequester carbon in the future.*
- *The carbon cycling of degraded peatlands may be more vulnerable to future climatic changes than that of natural peatlands.*

3-6 Irish Peatlands and Water

3-6.1 No Water, No Peat, No Peatlands

Peatlands are essentially a hydrological entity and can be considered to be wetlands that accumulate peat when the water table remains close to the surface for much of the year and where the normal amplitude of water-table fluctuation is relatively small. Water is the single most important factor to enable peat accumulation and water logging is a prerequisite environmental parameter for peat formation and preservation. In most cases, a peatland consists of over 95% water by weight – prompting the analogy that there are less solids in peat than in milk, gram for gram. A raised bog can be akin to a giant bubble of water held together by a mass of living and dead plant material (Charman, 2002). Changes in the hydrological regime that sustains the peatland will invariably disturb the normal hydro-ecological functioning of the peatland. Therefore, hydrologic conditions are extremely important for the maintenance of the peatland's structure and function. As part of the BOGLAND project, researchers have carried out a synthesis of the literature on the hydrology and hydro-geology of Irish peatlands and an analysis of appropriate hydrological indicators which are required for relatively intact (protected and being restored) as well as cutaway peatlands in the light of sustainable management objectives.

3-6.2 Hydrology and Water Balance

The water balance of an area dictates the form, or type, of peatland that develops. As peat is decaying organic matter that has accumulated under saturated conditions, its formation occurs in areas of positive water balance (Holden et al., 2004), where the volume of water entering the system (e.g. precipitation, surface run-off, groundwater upwelling) is greater than that leaving the system (e.g. run-off, seepage to groundwater, interception and evaporation). Not all those components of the water balance operate in all peatlands. The traditional division between fens and bogs applies also in hydrological terms. Fens are connected to regional groundwater flows and, thus, have water and nutrients moving into and out of the ecosystem, whereas bogs are hydrologically isolated and rely on precipitation as the only water and nutrient input source (Lafleur et al., 2005). Bogs may therefore be considered to be ombrotrophic because their vegetation thrives under heavy precipitation, thereby making them acidic (pH < 4) and are said to be oligotrophic because the nutrient supply is low and contain low amounts of calcium and magnesium. Fens are considered to be minerotrophic because of the supply of minerals by inflowing water and are said to be rheophilous or soligenous because of the flow of water through the body of the fen, thereby making fens less acidic than bogs and also with a tendency to be base rich. This invariably controls the vegetation present on the surface of the peatland, with characteristic vegetation types, such as *Sphagnum*, which are more tolerant of conditions of acidity and scarcity of nutrients, dominant on bogs and vegetation indicative of nutrient-rich groundwater, such as various sedge and reed species, dominant on fens. The chemical quality of the water is therefore also important in differentiating between bogs and fens (Dooge, 1975).

Due to their mode of formation and the presence of an underlying relatively impermeable substratum, such as a significant thickness of lacustrine clay, bogs are generally isolated from the regional groundwater table and therefore receive or discharge minimal water to the groundwater table, though this is not always the case with recent research on Clara Bog indicating a 'support' function from regional groundwater. The water balance of fens, however, is intrinsically linked to water levels in adjacent groundwater bodies. While effective rainfall (i.e. infiltrating water that is not lost to evapotranspiration or surface water outflow) is generally the sole water source/input in bogs, groundwater is often the predominant water source in fens.

3-6.3 Water Movement

It is essential to identify which water-transfer/supply mechanisms are operating in a peatland and which of these are the most important in maintaining the ecology present and the peatland's functions. Precipitation on raised bogs and blanket bogs is the dominant water-transfer mechanism supplying the ecosystem with nutrients. However, fens, flush systems on blanket bogs where there is a localised connection with groundwater, lagg zones and soak systems on raised bogs represent peatlands where water movement is linked to an extraneous source. Whether movement of groundwater to or from a peatland is an important mechanism depends not only on the presence of an aquifer/groundwater body, but also on the nature of the soils and rocks between the aquifer and the peatland (Acreman and Miller, 2006). The characteristics of the peatland soil and underlying substratum determine the rate of subsurface water movement, the infiltration rate (either from precipitation or inundation) and the retention of water within the peatland (Gilvear and Bradley, 2000). The hydrology of each peatland is thus influenced by the unique combination of regional geology and peat composition.

Though groundwater input to raised bogs and blanket bogs is minimal to the extent that it is generally exempt from a water-balance equation, the internal structure of the bog body is crucial in bog hydrological dynamics. In raised bogs, and to a lesser extent blanket bogs, micro-topography on the bog surface is an important control on surface water movements on the bog surface, and therefore on the surface water run-off component in the water-balance equation. Raised bogs, particularly functioning raised bogs, may simply be differentiated into two layers, an 'active' layer, or acrotelm, and an underlying 'inactive' layer, or catotelm, which forms the main bog body (Ingram, 1978). Essentially the catotelm is composed of peat layers in different stages of decay and with different botanical components (Ivanov, 1981), whereas the acrotelm is a relatively thin (varies in thickness from <10 to 70 cm) layer which is composed of actively growing vegetation and peat material that has not yet fully decomposed. As such, the acrotelm is the 'peat-making' part of the bog (Ivanov, 1981) that is periodically aerated (Ingram, 1983) and where the majority of the bogs biological activity occurs (Ingram, 1982). Significantly, it is also the zone where water and heat exchange occurs due to the physical properties of the acrotelm and the plant cover that it supports (Ivanov, 1981). In contrast, the catotelm is an anaerobic layer due to the permanently waterlogged nature of the peat deposits and the imperceptibly slow rate of diagenesis (Ingram, 1982). The concept of the acrotelm and catotelm is referred to as the theory of diplotelmy, the processes that are crucial in raised bog hydrology and their conservation.

In terms of water-balance calculation, and despite its limited thickness, the acrotelm, rather than the catotelm, is the crucial zone in raised bog hydrology (Van der Schaaf, 2002). Lateral discharge of water through the catotelm body is minimal – between 0.5 and 1.0 mm/year according to Van der Schaaf (1999) – due to its extremely low permeability, whereas the phreatic, or 'free', water table is contained within the acrotelm and is therefore the regulating system for the outflow of water from a raised bog (Van der Schaaf, 2004).

3-6.4 Hydrology and Peatland Sustainability

The sustainability of peatlands is intimately related to the understanding of their role as wetlands. As such, the hydrology is a key context within which to consider sustainability. The functioning of peatlands, including their role in maintaining biodiversity, in controlling their GHG/carbon emissions, and in attenuation of water quality, depends upon maintaining near-natural hydrological conditions. Understanding the water balance of a given peatland is thus the key to its maintenance, or to its restoration where it has been cut away or partially impacted by cutting. Bogs and fens, by their composition and position in the hydrological cycle, are particularly sensitive to anthropogenic activities and pressures. Even slight changes in their hydrological regime can impact on hydro-ecological functioning.

3-6.4.1 Hydrological criteria

Peat in its natural condition can only be sustained when the balance of inflows sufficiently exceeds the outflows which, in turn, will partly depend upon the morphology of the particular peatland. Where natural drainage is less constrained by topography as in blanket peats, a net rainfall (rainfall evapotranspiration) of 1,000 mm/year prevails although in the steeper gradients of mountain bogs, evidence shows that some 1,300 mm/year are needed. However, where topography constrains drainage such as in raised bogs, less excess rainfall is required, down to as little as 300 mm/year. Fen peats are essentially driven by groundwater/nutrient inputs and the recharge and upgradient hydro-geological storage feeding seepages and springs governs the sustainability of fens.

While the broad water-balance conditions for a peat wetland can be seen from mapping the relevant hydrological parameters, specific local conditions are often unique to the particular peatlands. An important characteristic in the functioning of active peatlands is the acrotelm which is a self-regulating layer on bogs and fens, storage in which regulates the amount of discharge from the bog. It is a crucial zone in both blanket and raised bog hydrology. Storm flows will be attenuated and delayed within the acrotelm of both raised bogs and fens. The Irish–Dutch research conclusively found that a well-developed acrotelm is effective in keeping water inside a raised bog and in attenuating the response of collecting streams and drains to high rainfall/storm events (Schouten, 2002). However, where there is an absence of a functioning acrotelm layer, surface run-off is increased and the bog no longer attenuates water flow. The preservation of a functioning acrotelm with a significant thickness (>0.2 m) is also important if a bog is to be considered 'active' and therefore retain the capacity to accumulate peat and continue to serve its function as a carbon store. Subsidence of raised bogs, which results from shrinkage of peat due to drainage, and can extend hundreds of metres from a face bank, is therefore a critical issue and the greatest challenge in raised bog/peatland conservation.

3-6.4.2 Hydro-ecological criteria

Pollardstown Fen demonstrates the intrinsic link between surface hydrology on the fen and the regional groundwater table in the adjacent aquifer (Kuczyñska, 2008). Hydrological requirements of both bogs and fens are ultimately linked to the needs of dependent ecology. The hydro-ecological indicator species, the mollusc *Vertigo geyeri*, occurs within specific seepage zones at the margin of the fen and has been shown to be very sensitive to even slight changes in groundwater discharge, highlighting the importance of understanding hydro-ecological linkages on peatland habitats. The correlation between the needs of a particular 'key' species and the relevant hydrological drivers is a further key criterion in determining the sustainability of a particular peatland habitat. *Sphagnum* may also be considered a hydro-ecological indicator species on raised bogs as it will only develop in specific environments where water is allowed to accumulate and where acrotelm gradients allow.

3-6.4.3 Cutaway peatlands

Similar criteria also apply to cutaway peatlands but their management requires an understanding of how the natural hydrological conditions have been altered by the removal of significant thicknesses of peat. Large-scale peat extraction frequently occurs on raised bogs and those in the Shannon catchment are characterised by a piezometric head from the underlying regional groundwater (in tills, gravels and limestone bedrock) naturally occurring within the peat of the original bogs. A consequence of peat extraction is that the piezometric head now occurs above the base of the cutaway, causing artesian conditions and potential springs where the basal marl is breached. Thus, 'restoration' or rehabilitation needs to consider carefully the strategy and management objectives for any recreated wetland habitat because the water quality within and beneath the wetland could differ markedly and may now interconnect. This effect tends to diminish eastwards from the Shannon as the bogs are drainable by gravity and the regional piezometric head falls below the basal clays. In the cutaway bogs of North Mayo, the success of restoration still needs to take cognisance of the local hydro-geology which is on quite different rock types from the Midlands and has often very localised conditions.

3-6.4.4 Further work on hydrological indicators

Isolated, but significant, research over many years has been undertaken in Ireland to identify more precisely what the appropriate hydrological indicators should be. This work has been undertaken particularly for raised bogs, encapsulated in the research undertaken on the raised bogs in County Offaly (Clara and Raheenmore) partly under the aegis of the Dutch–Irish project, which has continued for over 20 years (Schouten, 2002). Moreover, hydrological sustainability of fen peatland has been explored extensively in Pollardstown Fen, County Kildare, (Kuczyñska, 2008) and in smaller locations within blanket bogs in North Mayo (Regan, 2007). Nevertheless, the hydrological understanding of peatland functioning is still needed in the face of often complex hydro-geological conditions. The stimulus for improving this understanding is coming from the EU Water Framework Directive, which requires quantification of the linkages between wetland habitats and the relevant environmental/hydrological supporting conditions. The Directive is driving research and action in the area of protection of wetland habitats that are sustained by regional groundwater flows. Such systems are considered to be 'groundwater-dependent terrestrial ecosystems' (GWDTEs) and an understanding of their 'environmental supporting conditions', which are represented by their dependency on the prevailing hydrological regime, is essential for their conservation. Consequent restoration measures can be developed when the wetland is considered to be at risk of 'significant damage' due to local anthropogenic pressures (Regan and Johnson, 2010).

3-6.5 Hydrology and Peat Failures

3-6.5.1 Bog flows and peat failures

Peat failures are known to occur throughout the world, but 80% of reported events have occurred in the British Isles (Dykes and Kirk, 2006). Countries such as Russia and Canada have extensive peatland areas, and it is considered very likely that many peat failures occur in these places but, due to remoteness and sparse populations, such events go largely unreported. Notwithstanding the above, there appears to be more reported peat failures from Ireland than other countries. Failures have been reported from both blanket and raised bogs throughout the island of Ireland (Creighton, 2006).

There are a number of mass movement classifications which include a description of peat failure (Hutchinson, 1988; Dykes and Warburton, 2007). Hutchinson (1988) defines two types of failure in peat, namely bog flow (more commonly referred to as bog burst) and peat slide. Bog flow involves large quantities of water and peat debris that flow downslope usually following existing surface water channels. Large-scale bog flows are usually associated with raised bogs, where there is an upper fibrous layer over a lower body of weak amorphous peat. It appears that the peat is in a near-fluid state prior to failure, possibly due to build-up of hydrostatic pressure within the peat mass (Colhoun et al., 1965; Alexander et al., 1986). Peat slides comprise a mass of intact peat that moves bodily downslope, usually over a comparatively short distance. Slides occur on a discrete shear plane usually located at depth and generally close to or at the base of the peat. The peat above the shear plane moves as an intact mass, which usually breaks into smaller pieces. Records indicate that slides usually affect blanket bogs (Mitchell, 1938; Dykes and Kirk, 2001).

As part of the BOGLAND project, researchers have reviewed peat slope failures in Ireland (Boylan et al., 2008a) and the possible cause factors involved. They have sought to define the strength of peat in a manner that is appropriate for engineering stability assessments (Boylan and Long, 2006) and to develop tools which characterise peat strength with depth (see Chapter 3.3, End of Project Report).

3-6.5.2 Causal factors

The occurrence of peat failure can in many cases, but not always, be explained by the presence of trigger factors, such as intense rainfall, loading of the peat surface or excavation of peat deposits and the presence of pre-existing factors such as morphological, geomorphological, hydrological and geological characteristics (Boylan et al., 2008a). High-intensity rainfall or periods of prolonged rainfall are the most common cited causal factor for peat failures. The recent failures that occurred at Pollatomish, County Mayo, and the Shetland Islands on the same night in September 2003 occurred during a period of intense localised rainfall (Long and Jennings, 2006; Dykes and Warburton, 2008). Shrinkage and cracking of the peat surface as a result of the dry summer beforehand may also predispose the location to failure by providing pathways for the rainfall to the base of the peat. Colhoun et al. (1965) report a failure that occurred in County Antrim when 5.5 cm of rain fell in a 24-h period.

Sudden loading of the peat surface has been a trigger factor for peat failure in Ireland (AGEC, 2004) and also in Canada (Hungr and Evans, 1985). Failure is initiated by a bearing-type failure beneath the loaded area, resulting in development of shear planes within the peat mass below the loaded area. The failed peat effectively loses strength and increases the active pressure on the peat downslope. This leads to a progressive failure of the peat downslope and, in some cases, can lead to an escalating and runway failure. At Derrybrien, County Galway, the placement of a relatively small load on the peat surface led to a failure involving 450,000 m^3 of peat (AGEC, 2004).

Excavation into peat is a common practice carried out mostly for either drainage or extraction of peat for fuel. Sollas et al. (1897) and Praeger (1897) describe the tragic failure in County Kerry in which eight people perished when a 3-m-high turf cutting gave way after a heavy downpour of rain. Natural excavation of peat due to stream undercutting has also been cited as a contributory factor in failure (Delap et al., 1932, Mitchell, 1935). Tomlinson (1981) describes a failure in County Fermanagh where a 1-m-deep ditch intersected the source area of the slide. It was considered likely that the ditch created a weakness and encouraged water to flow and eventually the failure.

A common feature of many failures is for slides to be initiated in depressions and watercourses of rivers (Delap et al., 1932; AGEC, 2004). During the early stages of peat development, peat formed first in waterlogged depressions and in channels where water flowed. This peat formed under high nutrient conditions from the surrounding mineral soils, causing an increased level of humification in these depressions. The degradation of peat strength with increased decomposition may make these locations more prone to failure. The susceptibility of these channels to failure would be exacerbated by the concentration of run-off waters within the peat mass at these locations.

The hydrology of blanket bogs and interference with them have been seen to be significant in the vast majority of peat failures. With the saturated hydraulic conductivity of peat being relatively low in the range of 10^{-5} to 10^{-10} m/s, decreasing significantly with humification (Ingram, 1983), blanket bogs use a network of macropores and pipes to transport water within the peat mass (Holden et al., 2006b). The presence of natural pipes at the level of the failure surface is a common feature of slides, most recently at Pollatomish (Long and Jennings, 2006), where Murphy (2004) used ground-penetrating radar (GPR) to identify pipes at the level of a failure surface. Warburton et al. (2004), who reviewed a number of hydrological aspects of peat mass movements, concluded that a better understanding of the basic hydrology of peat and peat slopes is still required before it can be realistically modelled.

3-6.5.3 Assessing peat strength to prevent bog failure

As part of the BOGLAND project, a direct simple shear device known as the UCD-DSS[4] was designed and developed to test peat specimens at the low effective stresses representative of the in-situ condition (see Section 3, Chapter 3.3, End of Project Report and Boylan et al., 2008b). This device allows the strength of peat to be assessed in a mode of deformation that is appropriate for stability assessment. It has a strong advantage in that peat strength can be measured rapidly and continuously over the profile depth. However, as many engineers will be unfamiliar with the techniques, it is necessary to continue to trial/promote the equipment on a variety of Irish peat sites to demonstrate the usefulness and consistency of the results. Ultimately the aim should be to include use of these techniques in future policy-making processes.

3-6.6 Conclusions

One of the major characteristics of a natural peatland is permanent waterlogging. Without water, there would be no peat and no peatlands. Peatlands play key roles in water supply and storage and, in some cases, in flood controls. Any changes in rainfall and water balance will affect peat accumulation and decay rates. Therefore, water is the crucial element sustaining peatland ecosystems in Ireland, and understanding how a particular peatland system works hydrologically is imperative for its management and long-term sustainability. The components of the peatland water

4. University College Dublin's direct simple shear technique – a Direct Simple Shear Apparatus which has been developed within the BOGLAND project (Boylan and Long, 2009). It is a simple shear device using image analysis techniques (e.g. Particle Image Velocimetry) that allow the testing of peat soils at low effective stresses representative of the in-situ condition.

balance, as dictated by its position in the hydrological cycle, are the basic framework on which to assess how a particular peatland system is maintained and functions. The mechanism by which water is supplied to the peatland is controlled by geological and geomorphological factors. As such, the hydrodynamics of bogs and fens are determined by the characteristics of their main water sources and sinks, and the interaction of these with the topography of the site and peat. Indeed, the nature of peat as a medium and its unique hydrological properties within the bog body control how water moves into, through and out of a peatland.

Identifying ecological indicators in tandem with hydrological indicator information, whether on the margins of a fen or on the surface of a raised bog, is crucial for assessing the long-term sustainability of a peatland, whether relatively intact or cutaway. The environmental supporting conditions will differ in contrasting peatlands, but the identification of such conditions should inform how the peatland should be managed and maintained. A policy for peatland management must take account of the required hydrological supporting conditions. While much is known about these conditions now in Ireland, there remains a need to develop a methodology or approach to systematically investigate and quantify the hydro-ecological linkages which, nevertheless, may be peculiar to a given peatland. In turn, appropriate criteria will depend upon the overall policy objectives for peatland management. The use of industrial cutaway peatlands for flood attenuations is discussed in Section 4.

Summary Findings

- *Natural peatlands are essentially wetlands, i.e. hydrological systems, and their ecological functioning is primarily dependent upon the dynamics of the hydrological flows.*
- *Peat is a naturally developing medium which requires prolonged saturated conditions and the maintenance of those conditions requires a good understanding and management of the components of the hydrological cycle as well as the characteristics of the peat itself.*
- *Quantifying the water balance is critical to the sustainable management of protected peatlands as well as to peatlands in the process of being restored.*
- *In bog hydrology, the acrotelm is the crucial zone and is where the majority of ecological and hydrological processes and functions occur; its maintenance and/or restoration is an imperative of sustainability.*
- *Maintenance of the hydrological dynamics is also vital for the maintenance of other functions such as control of carbon emissions and water quality.*
- *The hydrology of blanket bogs and interference with it (e.g. wind-farm and associated development) have been seen to be significant in a vast majority of peat failures.*
- *Tools have been developed to assess the strength of peat in a mode of deformation appropriate for stability assessments and to assess the profile of peat strength with depth. Such techniques should be used in any Environmental Impact Assessment related to wind-farm development on peatlands.*

3-7 Options for the Sustainable Management of Peatlands

3-7.1 Current Management Practices

Irish peatlands cover a considerable extent of the land surface and their beneficial functions extend well beyond their physical boundaries. Peatlands are not a static resource; they are profoundly dynamic as a result of natural processes and events and in particular due to human uses. Human disturbances have caused a significant area of the peatland resource to be degraded and the current state of Irish peatlands is alarming. Various management activities have been used on peatlands in order to achieve different objectives and which have affected the functioning of these sites in different ways. Current uses of peatlands involve the following objectives:

1. To exploit the peat resource;
2. To convert the land to a different state;
3. To protect and conserve;
4. To restore to the extent feasible; and
5. To utilise the resource sustainably.

The extent to which these objectives are applied varies in terms of peatland types, geographic representation and the extent of the area involved. For example, the exploitation of the peat resource concerns the majority of raised bogs in the Midlands while conversion into forestry, for example, has been mainly an option for western blanket bogs. The fifth management option ‘To utilise the resource sustainably’ has only been recently opted for as in the Commonage Framework Agreements which ensure sustainable levels of grazing on blanket bogs. Other agreements (management plans) are currently being drawn up by the NPWS regarding other large blanket bogs of conservation importance. Given the poor status of priority habitats (designated for conservation and protection) and ongoing human-related impacts, proactive intervention is urgently required. A better balance between these management options will need to be reached if the peatland resource is to be managed sustainably. There are many questions that need to be answered with regards to current management:

- How much peat extraction should be permitted in consideration of how much resource is left and how much damage has already been done in certain areas?
- Are the direct economic returns of activities, such as forestry, greater than the loss of other uses and values of the same peatland areas?
- Is low-input agricultural use of some upland peatlands sustainable?
- How much of the degraded peatland needs to be conserved and restored and what criteria should be applied?
- To what extent do global values such as carbon stores and biodiversity override local needs such as turf cutting?

While the BOGLAND project endeavoured to answer some of these questions, most of them are inevitably complex and require a well-informed dialogue among those concerned with the management of peatlands. In the last 10 years, the concept of *wise use of peatlands* has emerged and encompasses the use, conservation and management of peatlands, taking into consideration all the values at global, national and local scales. The concept of *wise use of mires and peatlands* is defined in the book of the same title as “*those uses of peatlands for which reasonable people now and in the future will not attribute blame*” (Joosten and Clarke, 2002). This concept has been recently pushed to the forefront with the publication of a *Strategy for Responsible Management of Peatlands 2011* (Clarke and Rieley, 2011). Future management options of Irish peatlands should be based on this principle.

3-7.2 Criteria to Manage Peatlands Sustainably

Peatlands are extremely sensitive to any kind of management options as they affect a range of natural functions. The BOGLAND project came some way in demonstrating to managers and decision makers the compelling evidence of the importance of Ireland's peatland resource as a major carbon store, the role of natural (intact) and restored peatlands as carbon sinks (albeit very small), the potential of degraded peatlands to augment the greenhouse effect, the role of peatlands in watershed management, their contribution to biodiversity, and their essential attributes that confer on them a cultural and informative function. Peatland management approaches that preserve the major natural functions of peatlands should be promoted and these functions should be recognised as criteria for sustainable peatland management. As such, it necessitates that peatlands are managed in order to:

- Maintain the carbon store in the peat;
- Enable carbon dioxide sequestration and carbon accumulation in the peat;
- Minimise carbon dioxide emissions from the peat;
- Reduce the risk and impacts of climate change;
- Maintain water storage, water control and water supply in catchments;
- Continue their natural role in watershed management, river basin management and flood control schemes;
- Represent the range of peatland habitats which contribute to biodiversity (from genetic to landscape levels), rural economy, quality of life and culture; and
- Maintain the archaeological and palaeo-ecological information contained within the peat.

These functional objectives should be considered as criteria to be used to appraise management options against the 'sustainable' or 'wise-use' principle. The higher the number of functional objectives that are achieved, the less unsustainable the management activity is likely to be. Conversely, a management activity that does not fulfil any of these functional objectives ought to be considered unsustainable.

3-7.3 Response Options to Manage Irish Peatlands

3-7.3.1 Area protection, conservation management

Response 1: Legally protected peatlands should be assessed against the aforementioned functional criteria and individual management plans should be drawn up to maximise the natural functions of the site.

This management option is a 'low-hanging fruit' strategy for the sustainable management of peatlands. All legally protected sites should be managed as 'ace cards' where it should be possible to reap all the benefits from all the natural functions of natural peatlands, including reducing the risk and impacts of climate change. This option shall require restricted uses in order to prevent likely disturbance and, where necessary, restoration using active management. In the case of protected raised bogs, a complete cessation of turf cutting should be applied and monitored. Restorative management will also be required on the degraded parts of the site (see Section 3-7.3.3).

A more flexible approach should be advocated for protected blanket bogs. Unlike raised bogs, the size and mosaic of the peatland habitats together with their socio-economic context may render the restriction of disturbances and successful restoration practices difficult. Managing these sites so that close-to-natural conditions prevail and delivery of ecosystem services is realised may be possible through passive or active management. A lead-in period to ban turf cutting from designated blanket bogs should be established and, in the meantime, a mechanism should be available to stop this disturbance where this is obviously threatening the natural functions of the peatlands. Payment under the Single Farm Payment requires the farmer to keep lands in 'good agricultural and environmental condition'. Together with a continued low market value of hill sheep and an informative communication campaign detailing possible funded restoration activities, these incentives should encourage a sustainable management of protected upland peatlands by the farmers.

Response 2: Given the poor status of priority peatland habitats during the recent assessment for the Habitats Directive, a pressing management option ought to further designate and fully protect all the remaining raised bog habitats that are either (1) near intact or (2) *degraded*, but still capable of natural regeneration.

The current conservation network is mostly confined to individual sites that have happened to remain nearly intact in the main part, with degraded parts mostly on the margins. This is because of the tradition of management of Irish peatlands for conservation that concentrates on the *maintenance* of the peatland status rather than *restoration*, as well as the insufficient recognition of the need to protect peatlands as whole landscape ecosystems. While it could be argued that resources would be better employed in the conservation of existing near-intact sites, the opportunity is now becoming scarce. Some degraded peatland sites have been identified by NGOs as worthy of conservation and ought to be included in the larger network of protected peatland sites. This option will allow more chance for peatland restoration activities to take place and thus more peatland areas to properly function.

3-7.3.2 Disturbance management

Managing disturbed peatlands should begin with the management of the disturbance itself. Four possible response strategies are available for disturbed peatlands:

1. **Response 3: Stop the current disturbance.**
   The first option of stopping current disturbance ought to be applied in all degraded designated peatlands sites and other degraded sites that have been conferred with a conservation value but which are not currently designated. This option should also apply to most sites where restoration would be relatively easily carried out and should be particularly promoted on state-owned peatland areas. Where restoration is not feasible, removing the disturbance and maintaining the site so that it is not further degraded will be the best possible management option.

2. **Response 4: Maintain the current disturbance at a managed intensity.**
   This second option entails maintaining the disturbance at an acceptable level in order to retain most of the ecosystem services provided by the site. This involves an assessment and monitoring of the disturbance levels and long-term impacts as well as the recognisance of the necessary conditions for the existing ecosystem services to be maintained. It applies to most degraded peatlands where restoration is not possible and where the present uses will not critically lead to the destruction of the major functions of peatlands. Grazing at a managed intensity and controlled turf cutting on blanket bogs could represent such management options.

3. **Response 5: Allow the disturbance to continue and then manage the site.** This third option ought to be practised only with cutaway peatlands (currently or waiting to be exploited) and involves waiting until the economic value of the site is exploited before attempting to re-establish any kind of functioning peatland ecosystem (see Section 3-7.3.4). However, it should be stated that raised bogs, which have been drained for peat extraction but are not yet cutaway, may have the potential to be fully restored (see Section 3-7.3.3 restoration of Killamuck Bog, Abbeyleix, County Laois). This management option needs to be critically assessed as it implies the irreversible elimination of some of the functions of the peatlands, for example that of the palaeo-ecological record. In addition, this option should be backed up by stricter legislation regarding the promotion of restoration/rehabilitation measures after cessation of peat extraction. Currently, any peat producer operating on 50 ha or more must apply to the EPA for an Integrated Pollution Prevention Control (IPPC) licence. Compliance with such a licence means that Bord na Móna and other large commercial companies must submit a plan for the post-industrial rehabilitation of each peatland unit. However, many commercial peat extraction

developments fall below this current threshold (50 ha) and thus are not required to restore or rehabilitate the site.

4. **Response 6: Prevent future disturbances.** While several instruments (planning law, EIA, licensing) regulate most developments and can thus prevent future unacceptable damage, an environmental system management (ESM) programme should be established for all peatland-related development. An ESM monitors and controls the impact of an enterprise's activities on the environment. It usually consists of establishing an environmental policy, with objectives and procedures that can then be audited. An example of an internationally accepted standard for ESMs is the ISO 14001 standard. Smaller companies, which may not have the resources to seek such a standard, could implement simple but effective systems that could be audited by the EPA.

3-7.3.3 Manage Irish peatlands for climate change mitigation and adaptation

While there are still too many uncertainties in the magnitude and the direction of potential changes to arrive at a final conclusion on the reaction of peatlands to climate change, the strong relationship between the two entities means that some alterations will take place. It can be ascertained, however, that human activities, such as vegetation clearance, drainage, overgrazing and turf cutting, have increased the vulnerability of peatlands to climate change.

Response 7: Decrease the vulnerability of Irish peatlands.

Degraded peatlands are a liability. A substantial programme of drainage, blockage and wetting or re-wetting is needed in order to reduce carbon losses from degraded peatlands. While a full restoration programme would be difficult for many peatlands, a combination of management options, such as conserving, maintaining, restoring and rehabilitating degraded peatlands, can form a strategy to mitigate impacts of climate change. Such precautionary policy takes into account the climate regulatory function of peatlands, especially their role as major long-term stores of carbon.

Response 8: The establishment of a network of protected areas representing the geographical distribution of peatland types should be a priority in order to offset climate change threats.

Climate change will affect peatlands differently depending on their geographical location. The combined effect of changes in climate and resultant local changes in hydrology will have consequences for the overall distribution and ecology of plants and animals that inhabit peatlands or use peatlands as a significant part of their life cycles. Thus, there may be concern over the ecological changes occurring in the bogs on which a conservation status has been declared. An obvious underpinning issue is that future climatic shifts could result in changes to species range dynamics, which will reduce the relevance of present fixed protected areas for future conservation strategies (Coll et al., 2009). Therefore, it is critical that peatland areas are protected in various geographical locations and that these areas have their quality status maintained or improved in order to maximise their resilience to changes.

3-7.3.4 Restoration: a challenging peatland management option

Restoration has been so far a relatively minor part of peatland management activities. Peatland restoration includes here any form of management that is attempting to bring about significant *change* rather than simply *maintaining* a peatland ecosystem. It involves a combination of processes that lead to the re-establishment of desired peatland functions and, in some cases, structure and form. Peatland restoration approaches are numerous and, so far, efforts and technologies in Ireland have been focused on restoring designated raised bogs and cutaway blanket bogs (Farrell, 2006). Initial bog restoration projects in Ireland were led by a joint working group of Irish and Dutch scientists who gave a comprehensive overview of the problems with respect to management and restoration of Irish raised bogs. The main challenges identified were to overcome impacts of drainage at different levels, including superficial drainage by ditches cut in the surface of the bog, drainage of the marginal zones as a result of peat extraction, marginal drainage by deep ditches, and arterial drainage schemes (Schouten, 2002). To date, the NPWS has carried out restoration work on 14 raised bogs (Fernandez Valverde et al., 2006). The Irish Peatland Conservation Council has also successfully restored damaged raised bogs, albeit on a small scale but which provide a unique educational function (O'Connell, 2008). A Bord na Móna industrial cutaway blanket bog in Bellacorick, County Mayo, is also a case study of restoration of peat-forming ecosystems on a large scale, see Section 3-7.3.5 (Farrell and Doyle, 2003; Farrell, 2006). In addition, recent work on restoring afforested blanket bogs as well as raised bogs has been initiated by Coillte under the LIFE programme and has shown so far promising results (Delaney, 2008). Restoration applies also to fens (e.g. Pollardstown Fen, County Kildare).

Response 9: All the protected sites should be first and foremost restored to their full functioning status so that as many as possible raised and blanket bogs in their natural state are passed on to the next generation and contribute to mitigate the impacts of climate change.

The ultimate objective for these sites should be to restore the site to a fully functional peatland. While this could be a difficult task, it should be attempted as much as possible on these protected sites so that the efforts and timescale required (over 30 years in most cases) are not compromised. This option will require ultimately some hydrological management as correct hydrological conditions (keeping the water table near the surface) are critical for the success of peatland restoration. This, in turn, may require managing the whole catchment so that the integrity of the priority habitat is maintained. The key to successful restoration is first of all the setting of well-stated and realistic goals which will form part of a broader comprehensive and rigorous process for planning, developing, implementing and evaluating the restoration project. Impacts and possibilities of restoration management are still poorly known but as research is increasing and more sites are being restored, such management should become more and more successful.

Response 10: Restoration of degraded peatlands should follow an adaptive management approach as each site is different in terms of site condition, historical disturbance, geographical location, ownership and local demands.

This means that opportunities to restore a peatland should be sought outside the mitigation/compensation for negative eco-impacts highlighted under the EIA process or Article 6(4) of the EU Habitats Directive or under compliance with the IPPC licensing. If peatlands are rare habitats in a particular area, it should be prioritised that any degraded peatlands in that location should be considered for restoration. Elsewhere, a site that may be deemed too degraded to warrant any restoration project by conservation authorities should still be considered for restorative management if other attributes, such as local demands and ownership, are favourable. A recent example of adaptive restorative management was demonstrated at Killamuck Bog near Abbeyleix, County Laois, where local pressure and the design of a strategic management plan by stakeholders were the main drivers of the restoration process. The raised bog, owned by Bord na Móna, had been previously proposed for horticulture peat extraction and initial drainage had profoundly damaged the hydrology of the site. In the first phase of the restoration project, Bord na Móna blocked the drains with peat dams. This intervention was successful in raising the water table to levels that would allow the bog to ecologically function again. In the second phase of the project, a local community group, together with stakeholders and conservation bodies (Irish Peatland Conservation Council and NPWS), started working to maximise the biodiversity of the site in order to use it for amenity purpose. At c. €900/ha, this bog was restored at a record low cost (Jim Ryan, NPWS, personal communication, 2007) and demonstrates that this form of management is very promising. It has been acknowledged, however, that many degraded peatlands are beyond 'restoration' potential as a sufficient amount of peat (including acid peat) needs to be left in situ for a good restoration programme. In addition, peatland restoration, and conservation for that matter, requires a functioning hydrological unit. This is more likely to be the case if the site is located in a small catchment (e.g. small raised bogs) or in a natural landscape.

3-7.3.5 Industrial cutaway peatlands: a degraded resource full of promise

There are currently several management options for the industrial cutaway peatlands. In 2009, some 24%

(19,550 ha) of Bord na Móna's landholding had reached the cutaway stage and had been rehabilitated into alternative uses:

- 8,500 ha of cutaway bog mosaic including alkaline wetland (poor fen, open water, tall herb swamp and reed bed) with birch woodland (wet and dry stands). These areas are rehabilitated either by active targeted rehabilitation work and/or natural processes of colonisation and stabilisation;
- 6,500 ha of rehabilitated Atlantic blanket bog (Oweninny Bogs), consisting of acidic wetland mosaic of poor fen, peat-forming vegetation, wet heath and wet grassland;
- 4,000 ha of forestry, including a very small amount of biomass crops; and
- 550 ha of other after-uses: landfill, sand/gravel quarry, commercial and other niche uses.

Management choices for the remaining 50,000 ha of industrial cutaway peatlands which are currently in production include:

- Low management input (i.e. allowing natural revegetation);
- Medium management input (re-wetting using restoration techniques); and
- High levels of management input (i.e. substantially altering the cutaway medium with the expectation that it will return yields, e.g. forestry or biomass crops).

Other minor options that may affect a very small proportion of cutaways are landfilling and large-scale development (e.g. motorways and airports). Predictions so far would suggest that 30% would be birch woodland and 10% other after-uses, most likely involving wind-farm developments (Catherine Farrell, Bord na Móna, personal communication, 2010).

Response 11: The first option for after-use of cutaway peatlands ought to promote, where possible, the return to a natural functioning peatland ecosystem.

Peat-forming conditions often develop locally in cutaways (Feehan et al., 2008). Spontaneous regeneration of peat-forming vegetation occurred on a Bord na Móna industrial cutaway blanket bog in the west of Ireland where full restoration techniques (e.g. drain blocking, ridging on gravel hills and slopes, stabilisation of the peat through acceleration of revegetation) have enhanced peat-forming conditions (Farrell and Doyle, 2003). However, the scope of restoration of peat-forming ecosystems on industrial cutaway milled raised bogs in the Midlands is limited as conditions for spontaneous *Sphagnum* regeneration occur less naturally. The current climate in the Irish Midlands is drier than the climate prevailing when the raised bogs developed and thus less conducive to successful restoration (Robroek et al., 2007). Other hydro-physical characteristics are essential to facilitate the restoration of peat-forming conditions on cutaway raised bogs. At least 1.5 m of fen peat must be left behind, and the flow of water out of the system must be staunched by the blocking up of drains, but without preventing surface run-off and system-linked discharge which maintain the oligotrophic status of the ecosystem. Where necessary, peat dams may be erected to retain water. A further requirement is a seed bank; under natural conditions, this would be provided by the adjacent intact bog. These requirements underline the importance of planning for regeneration from an early stage. A survey to identify sites with restoration potential should be carried out over the whole cutaway peatland resource (owned by Bord na Móna and other private companies).

Response 12: While restoring ecosystems to what they were prior to the disturbance may be difficult, the option of regeneration of new semi-natural habitats is considered the easiest and most likely after-use for the majority of these cutaway bogs.

The favoured management option in this case should involve re-wetting in order to create wetland habitats that represent an ecosystem occurring in the region (poor fen, rich fen, reed beds, open water such as lakes). Other management options would involve the regeneration of dryland habitats: acid grassland, heathland and birch woodland (Renou-Wilson et al., 2010). Topographical surveys of the bogs would suggest that 44,000 ha (60%) of the midland cutaways would become alkaline wetlands (McNally, 2008). These new habitats would be able to be part of a mosaic of land use, including other compatible developments, such as wind farms.

Response 13: Managing cutaway peatlands for climate change mitigation.

Peat extraction transforms the peatland into a significant source of carbon dioxide which is likely to increase with climate change predictions. Unless it is restored or rehabilitated as a carbon sink ecosystem, cutaway peatland could remain a significant carbon source even with the regeneration of dryland habitats (Wilson and Farrell, 2007; Renou-Wilson et al., 2010). A strategy to mitigate climate change would involve growing a crop that sequesters more carbon than is lost by the degraded ecosystem and could also be used for energy to offset fossil fuels. Such a strategy has been brought forward rapidly without any sound scientific assessment and was therefore further investigated in the BOGLAND project (see Chapter 3.9, End of Project Report). The authors concluded that several agro-climatic obstacles preclude the reclamation of industrial cutaway peatlands for the growth of energy crops such as willow and *Miscanthus*. The intensive management required in growing energy crops in terms of cleaning weeds and fertiliser application, as well as the uncertain yield due to climatic conditions (late-spring frost) and variable peat substrate, is a key obstacle. The short time window to harvest energy crops is also a major problem as weather conditions are usually poor in March/April. It is also likely that these production systems will release more GHG to the atmosphere (from the oxidation of the peat after cultivation and the application of fertiliser releasing nitrous oxide) than fossil fuels (Shurpali et al., 2008). On the other hand, forestry and paludiculture present potential sustainable management options for cutaway peatlands. Naturally regenerated birch and scrub could be managed with low-cost inputs in order to increase yield which would help the carbon balance of these ecosystems (so far being carbon sources). Paludiculture is probably the after-use option that can have the most benefit from a climate mitigation point of view: avoiding carbon emissions from the degraded peatland by re-wetting, from the displaced fossil fuels and also from the transports of peat/biomass (Wichtmann and Joosten, 2007). While harvesting still remains a major obstacle to growing biomass on re-wetted peatlands, paludiculture offers far more advantages than any other after-uses. While initial results from Bord na Móna exploratory trials show poor yield of reed canary grass, further research using different seed sources and other species and appropriate regimes of fertilisation should be encouraged. In addition, paludiculture with tree crops such as alder should be further explored. Finally, the BOGLAND study concluded that major obstacles preclude any soon development of algae production on cutaways, mainly due to climatic, substrate conditions and required inputs affecting yields.

In conclusion, any particular option for cutaways will only provide an element to any climate change mitigation strategy if it is economically, environmentally and socially sustainable, which remains to be ascertained.

3-7.3.6 Peatland knowledge

Response 14: Several critical information gaps have been filled by research carried out within the BOGLAND project. Further 'unknowns' have been raised which warrant further investigations, some of which are urgently required:

- Quantify the conditions of all protected peatlands and especially prioritise efforts for their restoration.
- Improve the mapping of blanket bogs and assess the area of active blanket bog.
- Investigate low-cost sustainable techniques to restore designated bogs to stop losses of active raised bog and increase its area.
- Assess the potential role of blanket bog degradation and predisposing factors in relation to landslides.
- Monitor hydrology and GHG in key peatland sites to observe change in peatlands at an early stage (in the context of climate change mitigation policy).
- Determine emission by peat oxidation in various forested peatlands and examine all GHG emissions from forested peatlands and how they are affected by management activities, in particular re-wetting and replanting with other species (pine, alder) and restoration.

- Carry out scientific trials to assess the potential of paludiculture on industrial cutaway peatlands.

3-7.4 Conclusion

This research had significantly increased knowledge of the physical characteristics of the different Irish peatland types, which is critical in planning their future management. While many disturbances occurred in the past and are unlikely to be repeated in quite the same way in the future, it is important to understand the nature and magnitude and future trends of all likely disturbances if we are to develop effective strategies for remedial management of damaged peatland sites and to predict responses to any future proposal for peatland development. Without doubt, actions are required to address past mismanagement, as well as developing effective strategies to address current and likely future impacts. The management of the Irish peatland resource is a complex task involving large areas of various habitats exhibiting a range of condition status and involving a mixture of stakeholders. In order to achieve sustainable management of peatlands, ecosystem services or functions (see Section 3-7.2 for criteria for sustainable management) should underpin policy. In particular, it is clear that carbon dynamics should be key drivers of policies for peatland management. This has already been enshrined in many international conventions and strategies (see Chapter 4.5, End of Project Report). For example, the proposed definition of peatland degradation, adapted from The Ramsar Convention on Wetlands, is: "*Any on-site or off-site activity that negatively impacts the peatland's function as carbon store or ability to sequester carbon and greenhouse gases such as conversion or reclamation to agriculture, agro-forestry or forestry that involve enhanced drainage or artificial inundation or removal of natural vegetation*". Similarly, the proposed definition of peatland restoration is: "*Any on-site or off-site activity that positively impacts the ability of a degraded peatland to function as carbon store or its ability to sequester or capture carbon and greenhouse gases or any other of its natural functions and values*".

While this research provided some critical information on the quantification and description of the peatland resource in Ireland, the quality status of the various peatlands needs to be investigated as a matter of urgency. The cause(s) of the damage should also be assessed so that various sustainable management options are proposed. While a strategy solely based on restoration is not realistic, protection, maintaining, restoring or rehabilitating peatlands should all be applied where and when possible as a priority management option. Both Bord na Móna and Coillte, together with NGOs and government bodies, have led the way in peatland restoration research and implementation. These changes, together with greater environmental concern (climate change and biodiversity convention), have changed the emphasis for peatland resource management. The future of the Irish peatland resource relies on a better balancing of current management options. This requires that, at all times, those concerned with the management of peatlands should follow the principle of 'wise use' in their discussions and decisions.

Section 4:

Peatlands, People and Policies

4-1 Introduction

There are numerous aspects to sustainable development and natural resources such as peatlands and their associated ecosystem services. This report has already explored the various biophysical dimensions and eco-hydrological relationships within peatland systems in Ireland. However, sustainability involves a wider discussion, especially where the ecological relationships interface with society and how it is governed. Therefore, this section of the BOGLAND project sought to understand the relationships between people and peatlands and their associated past and possible future policies. The main aim was to understand the values the Irish public in general, and communities in peatland areas in particular, bring to choices concerning these environments, how the contribution of peatlands can be characterised in social, economic and environmental terms by indicators over time, and how they should be managed to maintain or enhance their economic, social and environmental functions. This was addressed through three dimensions:

1. **Socio-cultural**: examination of the roles and needs of communities linked to peatland areas, rural development, socio-cultural values, behaviour of stakeholders, and community involvement in the future of cutaway peatlands;

2. **Economic**: valuation of resource uses (including future uses and market and non-market values); and

3. **Institutional**: examination of relevant international and national policies, how they are implemented and their impact on peatlands.

While most of this section is descriptive, namely developing an understanding of the socio-cultural and economic issues and perspective at local and national levels, it is also prescriptive, addressing how to move the peatland sustainability agenda forward.

4-2 Socio-Cultural and Economic Surveys

4-2.1 Background

The last decades have seen a substantial change in the way the future of peatlands (included cutaway peatlands) has been envisaged. On the one hand, it becomes clear that the prospects for economic uses (peat extraction, agriculture, forestry) are seen to be much more limited and, on the other hand, the non-production values assume ever-greater prominence (Feehan, 2002; Feehan et al., 2008). The understanding of the roles and needs of communities living around peatlands, as of their cultural values and behaviour in the light of these changes, was limited and in critical need of re-evaluation. The research was motivated by an existing proposal (see Section 4-2.4) to create large areas of wilderness on industrially mined peatland landscapes that are currently owned and managed by Bord na Móna (Feehan, 2004). Until recently, Bord na Móna was the semi-state company responsible for peat extraction and associated rural development. It now predicts that much of its holdings will become exhausted – or 'cutaway' – within the next 30–50 years, although climate change policies, the changing global energy market, and upward technological opportunities may shorten or lengthen this estimation. Now privatised, Bord na Móna must seek commercial uses for all its holdings, or dispose of them, and, while operations are now subject to strict licensing that ensures that the cutaway landscapes are left in a safe condition, the company has no legal obligations for their after-use. There are, therefore, opportunities for creating new landscapes tailored to meet the modern demands of a more sustainability focused society. It is also evident, though, that there are significant policy deficits in the area of land-use change, landscape planning and community participation. In the first instance, it was clear from the outset of the BOGLAND project that there would need to be a close examination of the interface between people, communities and peatlands. Such research had never been carried out before in Ireland – or elsewhere – with regard to peatlands. It describes the first attempt to quantify the relationships between people and peatlands.

4-2.2 Sociological Research

Researching human attitudes requires a different kind of empirical analysis. Social research is "*complex, diverse and pluralistic. The way it is conducted, its goals and its basic assumptions vary significantly*" (Sarantakos, 2005). Unlike the life sciences, the human sciences must operate from a different epistemological and ontological standpoint. Social research has been refined and improved upon over the decades and today it uses a range of sophisticated research tools to elicit human responses, to identify human perceptions and to quantify social interactions at all levels. The BOGLAND research broadly used two methodologies that are common in socio-cultural and socio-economic research – qualitative and quantitative.

- *Qualitative* research is essentially an interpretivist approach where the researcher interacts with his/her subject, i.e. people. The researcher retains a non-participant stance by acting as an observer. Data are acquired and interpreted from numerous sources and thus qualitative research is highly adaptable (which it needs to be) and holistic. It enables research to be carried out on small groups or individuals and, by interacting with the subject, qualitative research cannot be replicated, as the research subject will have changed during the process. However, qualitative research removes bias by eliciting hidden, less obvious rationalities and commonalities through continued re-analysis of data.

- *Quantitative* research aims to bring a more specially designed empiricism to social research. The research is designed to be objective and less participative than qualitative research. Often quantitative research takes the form of standardised questionnaires where data are acquired on preferences and opinions based on scale assessments (e.g. Likert scales), or by selection of most/least-favoured options based on a range of scenarios (choice experiments). Other approaches look at the subjects' willingness to accept or pay for a scenario and thus a broad picture of attitudes of which the scenario is constructed. Data can, in this manner, be subject to comparative analytical processes and statistical analysis.

4-2.3 Objectives of the Surveys

This section of the BOGLAND project is concerned with stakeholder perceptions, especially those that lead to participation in planning (and possibly managing) the new landscapes that will emerge in what are now industrially mined peatlands. Citizen collaboration and participation are key elements of sustainable development policies (CBD, 1992) and are shown to be valuable, perhaps vital, in restoring wetlands (Porter and Salvesen, 1995). The socio-economic and socio-cultural work packages adopted different research approaches, aimed at providing a complementary analysis and revealing the public's understanding of peatlands and the values that are associated with them. Both work packages drew on information collected in the same focus groups and both packages used face-to-face surveys, although, in the case of the socio-cultural work package, these were supplemented substantially with qualitative and semi-structured interview sessions with people living in the Irish Midlands.

The principal objectives of the surveys undertaken for the socio-economic work package were:

- To provide an assessment of the public benefits of peatlands as they are perceived by the public; and
- To quantify this perception in terms of people's willingness to pay (WTP) for existing peatland conservation programmes and future after-use possibilities.

The principal objectives of the surveys undertaken for the socio-cultural work package were:

- To gather, for the first time, attitudes towards peatlands in Ireland, in this case at a local level;
- To quantify perceptions of peat landscapes and community opinions on after-use proposals, as well as garnering new proposals; and
- To establish a blueprint for amenity and biodiversity after-use.

4-2.4 Survey Methodologies

Three principal survey methodologies were utilised, namely:

1. Quantitative surveying at a national level, aimed at identifying the perceived public benefits of a national policy on peatland protection;
2. Quantitative surveying at regional level on the opinions of the wider community on the perceived public benefits of various peatland after-uses in the industrial cutaway peatlands in a case study area; and
3. Qualitative surveying at a local level, aimed at identifying the local perceived public benefits for the after-use of industrial cutaway peatlands in the case study area (Counties Longford and Roscommon).

The socio-economic component of the project consisted of a National Survey and a Regional Survey (see Chapters 4.2 and 4.3 and Annex 4.2a, End of Project Report). The National Survey addressed both intact raised and blanket peatlands. The Regional Survey examined attitudes towards industrially milled raised peatlands and their after-uses in the Midlands, including a prospective National Wetlands Wilderness Park.[5] The bulk of respondents interviewed for the National Survey lived in urban areas as reflected in national demographic patterns. For the Regional Survey, sampling was from across a central belt of Ireland, but with the greater concentration drawn from the central study area concentrated on Counties Longford and Roscommon. The questionnaires used in both surveys contained specific questions designed to determine people's existing knowledge of peatlands while being accompanied by colour information packs

5. During this research, and because of the early findings of the research, the working title of National Wetlands Wilderness Park was renamed The National Peatlands Park.

describing the current state of peatlands and alternative futures. Both questionnaires included sections designed to determine respondents' WTP for peatland protection or for the after-use of industrial peatlands, respectively. In the scenarios presented in the Regional Survey, after-use could involve industrial peatlands being permitted to revert to a natural state for both amenity and biodiversity purposes. This survey also included a choice experiment exercise designed to determine which particular characteristics of a future park would be most valued.

The case study surveys used several methodologies and were aimed at a specific geographically defined area. Selected local residents participated in a series of focus group sessions and numerous individuals who resided within the peatland systems were interviewed at length. In addition, numerous professional, academic and political stakeholders were interviewed in a series of open interviews. The notion of a National Wetlands Wilderness Park was used to stimulate conversation and to elicit responses that could be analysed to reveal local opinion on peatlands and their after-uses. In order to provide a comparison with non-residents of the Midlands area, the original proposal had been to distribute both questionnaires at the same time, but problems with the implementation of the National Survey led to these being undertaken a second time 6 months later.

4-2.5 Survey Results

4-2.5.1 Socio-economic aspects

The results from the two surveys indicated support for a National Peatlands Park to be located in the Midlands and a national policy of protection for both raised and blanket bogs. However, the mean average WTP was higher for the former after-use possibility despite its more confined geographical area, and the acceptance by most respondents that this would also entail the permanent conversion of some areas to open water, wetlands or woodland. The likelihood of being willing to pay was also less than in the National Survey, although to some degree this could reflect the intervention of the economic recession between the final implementation times of the two surveys.

Both surveys indicated an appreciation of many of the public goods provided by peatlands, but a rather ambivalent attitude towards their value and a varying, but rather poor perception of peatlands and the threats that they face. In this first instance, it must be noted that willingness to support peatland protection is not universal. A reasonably large number of respondents to the Regional Survey favoured a strategy of no intervention (20.6%) while a slightly higher proportion of respondents were unwilling to pay for any such policy (25.3%). Indeed, the proportion favouring no intervention was greater for local respondents and could be supplemented also by others who were 'don't knows'.

The accompanying information pack noted that, in practice, physical conditions would determine the eventual mixture of peatland, woodland, open water and other wetlands (reed beds) that could result in a Peatlands Park. Nevertheless, peatland restoration was the scenario that received the highest percentage of first preferences (32.6%). It was also the scenario that received the greatest proportion of second choices. However, an environment with more open water and reed beds was also popular. A small majority of respondents selecting the two wetland scenarios preferred that such an environment be designed with an emphasis on active recreation. Others, though, disliked this scenario to an extent that ensured a more natural wetland environment was the preferred of the two.

In the Midlands location that had been proposed for a Peatlands Park, a greater proportion of local respondents (40.0%) preferred the restoration scenario. A wetland environment was less popular, especially the scenario of active recreation and tourism despite the absence of many tourism destinations in the area at present. Respondents who cut turf represented nearly three-quarters of individuals living in the core sample area, so it is not too surprising that the above results are mirrored for this subset too. A sizeable one-quarter of these turf cutters also preferred a policy of no intervention, while just as many were inclined to rank this scenario last. Although these proportions were similar to those who do not cut turf, there is clearly varying opinions on the future of the bogs even within the turf-cutting community.

Peat cutting also featured strongly amongst the results for the choice experiment that was designed to provide further evidence of the preferred composition of a Peatlands Park. Of the nine park attributes included in the experiment, the attribute level that elicited the highest preference was one of continued peat cutting. Even the attribute level of some continued industrial cutting was preferred to a policy of no cutting. Furthermore, a medium (25 years) time frame for the Peatlands Park establishment was preferred to one of a short time frame. Although the results for the wildlife and recreation attributes fell short of the significance threshold, their relative magnitude indicated that positive utility would be associated with visitor facilities and a modest range of recreation activities and trails. However, excepting the peat-cutting attribute, the overall results indicate rather poor consistency of preferences in relation to the eventual appearance of a National Peatlands Park.

4-2.5.2 Socio-cultural aspects

Focus group surveys of residents of the Longford/ Roscommon area indicated a high appreciation of peatlands and of peat extraction, with numerous participants having a detailed knowledge of the processes involved. There was considerable anxiety over planning and other environmental issues but peatlands were not viewed as being part of any problems – there was no knowledge of peatlands and carbon, for example. Thus, while local people were aware of what peatlands were, they were unaware of their ecological values and their natural capital potential. When images were used to stimulate discussions, the idea of an amenity and biodiversity after-use scored highly.

Ethnographic interviews yielded a vast array of opinions and many were of the view that the industrial peatlands had yielded their wealth to the nation and should now be returned to nature. There was a high awareness of peatland processes and a long history of inter-associations between people and peatlands in Ireland. Opinion was varied on the morphology of any new landscapes, but most were willing to participate to bring this to fruition.

Key stakeholders were all broadly of the opinion that industrial peatlands ought to be used for rebuilding natural capital – biodiversity, carbon capture, flood prevention and so on. The wider community of stakeholders believed that these landscapes have a high potential for ecological restoration and would benefit biodiversity in Ireland. However, while there was consensus in principle, closer examination of the discourses of the key stakeholders yielded evidence that there may be conflict in practice. Much of the potential conflict derives from the policy vacuum for the after-use of peatlands and the lack of suitable mechanisms for ensuring long-term arrangements.

The complementary sociological questionnaire issued at the same time as the National Survey indicated a high level of familiarity with peatlands and peatland processes. There was a varied opinion on the after-use of peatlands but most respondents listed ‘amenity’ and ‘wildness’ as the preferred options. This was followed by support for ‘green industry’ and multifunctional uses. Respondents were as willing to participate in their most favoured after-use option as their existing voluntary actions locally. Thus, it may be assumed that if industrial peatlands were to be used for amenity and re-wilding, there would be considerable supportive activity nationally. The vast majority of those surveyed believed that the Irish Government had done little to protect peatlands and that local people are key to the protection of bogs.

These surveys all show that future amenity and biodiversity (as part of a National Peatlands Park for example) can only be achieved in a collaborative manner, with both the community and governmental institutions being equally involved and mutually complementary. Indeed, in the restoration of industrial peatlands to a wild state, with the participation and collaboration of all stakeholders, there is the potential for the process to both augment existing social capital and to create new social capital networks. This provides an added value to the process that was not anticipated at the outset and may serve to focus attention on long-term policy creation with this in mind.

4-2.5.3 Synthesis between the two surveys

The two work packages were expected to complement one another and, in several cases, this is indeed the case. The socio-cultural work package observes that local interviewees recognise the non-use value of peatlands contrary to the common perception that rural communities are more motivated by productivist considerations. By comparison, analysis of the WTP within the socio-economic surveys reveals a greater likelihood of people being willing to pay higher sums towards a Peatlands Park amongst urban than rural dwellers. However, environmental attitudes are almost as influential while social class and income also play a significant part in determining the relative size of WTP. Generally, WTP also declined for respondents living at greater distance from a bog. Both socio-economic surveys revealed a degree of ambivalence towards peatlands, while the later timing of the final National Survey demonstrated a vulnerability to exogenous economic circumstances, albeit of the prevalence of being willing to pay rather than of average payment levels amongst those who were willing to pay.

The socio-cultural surveys show that there is an appreciation locally and nationally of the non-use values of peatland, including amenity, ecology and landscape, and that this translates into support for wildlife conservation and amenity after-uses. This desire is also reflected in the output from the socio-economic survey and in the positive WTP to bring about this change. On the other hand, it must be noted that a significant minority of respondents, including local residents, were content for there to be no intervention in industrially mined peatlands. The definition of 'local' also includes urban residents living in towns such as Longford and Roscommon and so there is not a direct comparison with the respondents to the socio-cultural work package.

A further element of comparison relates to people's understanding of peatlands and the options for their management. This understanding could be expected to be higher amongst people living in the local rural area, but it is not clear from the socio-economic results that this extended to future management options. There was a slightly higher level of preference amongst local people for peatland restoration over wetland creation, but no more evidence that these respondents had distinct preferences for what a National Peatlands Park should contain in the way of the mix of facilities and amenities. To an extent this represents the novelty of the Peatlands Park scenario in that the socio-cultural study revealed no local awareness of any such concept. Furthermore, the socio-cultural work package revealed the uncertainty of many local people over peatland functions and a lack of awareness of alternative futures. While there are obvious opportunities for collaborative planning between local people and institutional bodies in the future management of peatlands, there does seem to be a need for the latter to take a lead in demonstrating that, firstly, after-use scenarios are being considered, and, secondly, what these futures could be. This offers communities the opportunity to become engaged in a planning process *prior* to the cessation of peat extraction.

The preference for continued household peat cutting amongst both local and non-local respondents in the socio-economic survey clearly demonstrates the perceived social importance of this activity or possibly an unwillingness to deny others this traditional right. In the socio-cultural work package, there was concern that traditions may be lost and this would be a tragic occurrence. The information pack accompanying the National Survey clearly noted that the national area of natural peatland is diminishing. It added that peat cutting is detrimental in this respect, but did not emphasise the connection with household cutting given our desire to understand respondents' own perceptions of this activity. It would appear, therefore, that many respondents do not see a contradiction between household cutting and the decline in the area and ecological integrity of peatlands. Clearly, at one level, there is a contradiction. However, it would be quite consistent for people without a full understanding of peatland processes to support continued cutting and, at the same time, to express an appreciation of the wildlife value of peatlands. Viewed from another level, there is no contradiction. So many peatlands in Ireland have been modified by human activity that they can now be considered to be a distinctive cultural landscape of which peat cutting is an important part. This may have implications for Ireland's ratification of the European Landscape Convention (2000). Thus, policy makers must determine just how much peat cutting is sustainable and will need to argue the case for alternative options if it is not.

Possibly more contradictory was the lower disutility identified in the socio-economic survey for industrial peat extraction compared with no cutting. However, the relative values are more likely to reflect a rejection of the notion of no cutting rather than an acceptance of industrial cutting. Some local survey respondents would have family and/or friends employed by Bord na Móna or may be working for the company themselves. In such circumstances, it is understandable that they might tolerate some continued extraction while agreeing to a gradual medium-term transition to a Peatlands Park.

By comparison, the socio-cultural work package results indicated an acceptance that the peatland is changing from a productivist environment to a non-productive landscape. The results also indicated an affection for, and attachment to, peatland landscapes as a natural environment. As noted above, the finding does not necessarily conflict with the household cutting of peat which is viewed by many to be benign. Neither does it necessarily conflict with an approval of change in the medium term. People are generally adverse to the concept of a sudden change where familiar surroundings are concerned.

All the fieldwork, with the exception of the final National Survey, was carried out prior to the economic recession (2008). The local survey results indicated an acceptance that the after-use of peatlands will not provide the same large-scale employment as for earlier decades. Non-use values were clearly recognised, although productive options were not ruled out. Furthermore, compared with earlier versions, the final (during recession) National Survey indicated an increased belief in the value of peatlands for fuel and a greater priority for policies that provide for development and employment. Specifically, both the socio-economic and socio-cultural work packages found considerable support for wind energy projects. At first this appears unusual because there have often been instances of antagonism towards wind farms in upland areas (including blanket bog). However, now that Bord na Móna is semi-privatised it has embarked on seeking alternative industries as peat resources begin to dwindle. Thus, the use of cutaway peatlands for wind farming is becoming a strong possibility. In the same way that many local people interviewed for the socio-cultural work package perceived no conflict between domestic peat cutting, amenity and landscape, it could be that many people may perceive little or no contradiction with wind-farm developments. By comparison, there seems to be greater antipathy towards the more familiar land use of forestry. This may be because forestry is perceived as having a more interventionist or irreversible impact on an open landscape. It is a perception that could extend to the alternative of biomass crops as reflected in the lacklustre support for biomass in the socio-cultural work package. On the other hand, this response could just reflect low awareness of this land use.

Overall, the two work packages demonstrate support for the protection of peatlands and for future after-uses at both local and national levels. The support is not universal although, to some extent, this appears to reflect a low awareness of peatlands or a concern that future policies could preclude domestic peat cutting. Neither is this support immune to exogenous economic circumstances. There appears to be a willingness amongst many people living in local communities to participate in the future after-use of industrial cutaway peatlands. These preferred after-uses include amenity, wildlife and wind energy options. However, there does seem to be a need for government or national institutions to take a lead in demonstrating what peatland after-uses are being seriously considered.

Summary Findings

- *Ethnographic interviews yielded a vast array of opinions but showed in general that attitude towards peatlands are changing. Many were of the opinion that the industrial peatlands had yielded their wealth to the nation and should now be returned to nature. The results from the surveys indicated support for:*
  - *(i) A National Peatlands Park to be located in the Midlands; and*
  - *(ii) A national policy of protection for both raised and blanket bogs.*
- *Both surveys indicated an appreciation of many of the public goods provided by peatlands, but a rather ambivalent attitude towards their value and a poor perception of peatlands and the threats that they face.*
- *Key stakeholders were all broadly of the opinion that industrial cutaway peatlands ought to be used for rebuilding natural capital – biodiversity, carbon capture, flood prevention, etc.*
- *The wider community of stakeholders believed that industrial cutaway peatlands have a high potential for ecological restoration and would benefit biodiversity in Ireland. In addition, the results support active participation of the local communities in the future after-uses of industrial cutaway peatlands.*

4-3 Valuing Social and Economic Benefits of Peatlands

4-3.1 Background

Before drawing up policy recommendations, there is a need to combine the output from the socio-economic and socio-cultural work packages with information on the wider economic value of peatlands. The various economic and social benefits of peatlands (otherwise known as public goods) needed to be examined as a means to demonstrate the true value of an asset for which only a few outputs are represented by market goods, the most fundamental of which is peat as fuel. Other peatland outputs are represented by non-market goods and services and a fuller understanding of these is needed as a first step towards devising a policy for the sustainability of peatlands and for peatland after-use.

4-3.2 Socio-Economic Values of Peatlands

Peatlands provide various benefits of value to human beings, namely:

- A direct use value from the accumulated peat for extraction (e.g. fuel, horticultural medium);
- A direct ecological use value (e.g. bird watching, nature appreciation);
- A direct landscape and cultural value (the cultural landscape);
- Protection of archaeological heritage (through the preservation properties of peat);
- Hydrological and water quality benefits (water storage, filtering); and
- Carbon storage and sequestration.

Peatlands have an intrinsic ecological value, but our interest from an economic perspective is in quantifying those components that contribute to the welfare of human beings. Of the above ecosystem services, the only good that has a direct market value is the peat extracted for energy or horticultural use and, to a minor degree, for other industrial uses such as insulation material and therapeutic compounds. Although technically an ecosystem service, the benefits of peat extraction do not compare with other ecosystem services within a practical time frame as the extremely slow rate of peat accumulation ensures that peat extraction is not a sustainable activity. However, peat extraction does have an economic and a social value. The output from both the socio-economic and socio-cultural work packages demonstrates that part of the cultural value of peatlands is derived from the traditional association between people and the bog as a source of household fuel and, within the last century, as a source of industrial energy. The other benefits are public goods. As such, they do not have associated market prices through which scarcity can be signalled. Instead, various economic techniques are available to demonstrate the value of these services. Insofar as these economic values can be quantified, the ecological, landscape and cultural services of peatlands can only be assessed in terms of their perceived contribution to welfare using utility valuation methods. They can be categorised as cultural ecosystem services. The archaeological benefits fall into the same category but, to a large extent, are unquantifiable through economic methods. Hydrological benefits are an example of a regulating ecosystem service in that peatlands can moderate run-off with potential relevance to farm output and property, although these benefits are subject to site conditions. Carbon storage and sequestration form a regulating ecosystem service that is only now beginning to be understood and which, most certainly, has been undervalued in the past. When peatland conservation organisations were first established, the benefits of carbon sequestration and carbon storage by peatlands were only being slowly acknowledged whereas they may prove to be the most significant of all peatland benefits and the ones of most tangible economic relevance to policy makers. Ironically, these peatland services are at risk of being undermined by climate change (Jones et al., 2006). Indeed, degraded peatlands do contribute to climate change through the release of carbon dioxide, a process that may be accelerated by climate change.

In summary, at a practical level, the value of peatlands has hitherto been realised in terms of the value of extracted peat as well as land use (for agriculture and forestry). Conversely, the other services are maximised where the peatland is in intact or relatively intact condition. As such, there is a conflict as one benefit entails the gradual loss of peatland while the other is highest where the peatland is wholly or largely intact. Both sets of economic benefits are valid and must be considered if optimal policy solutions for sustainable management are to be devised. However, without a price by which the value of non-market services can be compared, there is a risk that such goods will be undervalued and, consequently, overused to an extent that an inefficient and inequitable outcome is realised to the detriment of overall social welfare.

4-3.3 Socio-Cultural Values of Peatlands

A quantification of the ecological and landscape benefits was included amongst the objectives of the two aforementioned surveys. As mentioned, the questionnaires for both the Regional and National Surveys were accompanied by an information pack which described the extent of raised and blanket bog in Ireland, its condition and the threats it faces from peat extraction, forestry and overgrazing. However, the information packs did not enter into detail about the archaeological, hydrological or carbon sequestration benefits of peatlands about which there are complex and varied opinions amongst both scientists and the public. Both questionnaires included utility valuation questions designed to determine people's WTP for alternative peatland futures.

4-3.3.1 The Regional Survey

Respondents to this questionnaire indicated a mean WTP of €79 per household per year for policies designed to achieve a Peatlands Park. If aggregated by the number of households across the central belt of Ireland that was included in the sample, total WTP would amount to approximately €16 million per year based on the 69% of respondents who provided a true positive WTP figure. Asked about scenarios for a Peatlands Park, a majority of respondents preferred a policy of peatland restoration, a scenario that received 32.6% of first choices, but also a large number of second choice rankings. A small majority of respondents preferring the wetland environment, ranked a scenario of active tourism most highly. However, others disliked this alternative to an extent that a wetland scenario with emphasis on wildlife, amenity and less intrusive forms of recreation was the more preferred of the two. A higher proportion (40%) of the respondents living close to the study area preferred the restoration scenario. A landscape characterised by reed bed and open water was less popular, together with the scenario of active recreation and tourism. Respondents who cut turf represented nearly three-quarters of those individuals living in the core sample area, so it is not too surprising that the above results are mirrored for this subset. However, a sizeable one-quarter of both peat cutters and non-peat cutters also preferred a policy of no intervention.

A choice experiment followed the contingent valuation question in the Regional Survey. This presented respondents with three alternatives, namely the no intervention scenario and two future alternatives generic to either a wetland or peatland environment. Each alternative comprised seven attributes, namely:

1. The range of activities possible;
2. The extent of trails;
3. The time to maturity of the park landscape;
4. The amount of peat cutting permitted;
5. The visibility of wildlife;
6. The rarity or uniqueness of wildlife; and
7. Taxation cost.

Each attribute contained three levels of provision, varied for each respondent using an underlying factorial design. The only exception was the taxation cost attribute, the level of which was determined by the respondent's answer to the preceding WTP question.

The model fit for the experiment was rather poor and the number of significant attributes was few, but the results included a highly significant positive coefficient for a policy of some continued household cutting compared with an equally significant, but negative coefficient for no cutting, the latter implying that at least some respondents considered no cutting to be adverse. A policy of some continued industrial cutting had a positive parameter but possessed only a small coefficient. In addition, there was a significant positive coefficient for the medium-length time period of 25 years over which the Peatlands Park was to mature. The coefficients for wildlife and recreation fell short of the significance threshold, but their relative magnitude is plausible, suggesting that positive utility is associated with visitor facilities for easy viewing of wildlife and with a modest range of recreation activities and trails.

4-3.3.2 The National Survey

The National Survey was originally conducted at the same time as the Regional Survey. However, it subsequently transpired that the contingent valuation question had been asked incorrectly and a second survey had to be undertaken. Although the timing of this final questionnaire followed the onset of the economic recession, many of the non-valuation questions from the two surveys can be compared to indicate the impact of this exogenous factor.

Selecting the same approach to utility estimation, the final National Survey indicated a mean WTP of €56 per household per year (see Chapter 4.2, End of Project Report). After the follow-up payment question, 51% of respondents were willing to pay for the protection of peatlands, although 62% were willing to pay in principle. If aggregated to the total number of households in Ireland, the mean WTP figure implies a utility value from peatland protection of €53 million per year. Such a figure would go some way to protecting many peatlands. However, it is less than the sums that are even now being spent on peatland protection, suggesting that this activity has a negative benefit–cost ratio from the perspective of the public.

The individual average WTP figure from the National Survey, which asked about peatlands throughout the country, is less than the value obtained in the Regional Survey despite the geographically constrained extent of a prospective Peatlands Park. The proportion willing to pay in principle (before being confronted with the hypothetical bid levels) was also less than the 68% recorded from the former survey. The difference in WTP values could arise from the nature of the topic, namely, that a strategy of reuse of cutaways and the creation of a Peatlands Park was being presented and may have been perceived to represent a more distinct package than a broad policy of peatland protection. On the other hand, the difference could simply be due to the effect of the recession on people's readiness to pay additional tax. If WTP values are modified to reflect true zero bids, the relative difference is retained, but the respective mean values from the Regional and National Surveys are €38 and €51, respectively, per household per year.

Aside from the valuation questions, the responses to other questions in the surveys dealing with attitudes and awareness of peatlands were similar. The main differences were clearly due to exogenous economic circumstances in that a greater proportion of respondents were inclined to favour policies that benefit employment or rural development and to answer that peatlands were more important as a source of fuel than as heritage. General agreement with the need to protect peatlands was also less than the pre-recession survey, with the respective percentages being 62% and 75%. Nevertheless, more than half of the respondents were willing to pay the final bid with which they were presented with only a negligible number claiming that this final bid amount was too much.

4-3.3.3 Motivations for peatland protection and restoration based on socio-economic surveys

The survey results demonstrated that peatlands provide a significant public benefit. Increased taxes were proposed as the payment vehicle through which peatland policy could be achieved. The cumulative value of these hypothetical payments provides evidence that peatlands contribute to people's utility and that people are supportive of expenditure that aims to protect peatland as a public good. The nature of the policy measures to be taken is another issue, but could conceivably involve compensation payments to the owners of turbary rights (i.e. private individuals with rights to cut peat) or direct expenditure on restoration or protection in the case of either privately managed peatland or the bogs controlled by Bord na Móna. The main ambiguity is that there is varying opinion amongst the public on what types of after-use would be most desirable in a National Peatlands Park. The information pack noted that, in practice, a combination of landscapes is likely to develop given varying ground conditions and the status of the remaining peatland. The presence of mixed views amongst respondents on what constitutes a preferred landscape strengthens the case for ensuring a variety of landscapes of which peatland restoration appears to be the single most preferred component.

From the analysis of the National Survey, it appears that respondents' interest in the environment was most motivated by considerations of personal health. However, they were almost as likely to acknowledge threats to the environment and the well-being of future generations. Clearly, threats and future generations are relevant to peatland protection, although this question was asked in advance of respondents being given the information pack on peatlands. Landscape, wildlife or recreation issues are also relevant to peatlands and were secondary factors as regards people's environmental motivations. This is to be expected in that the first three issues of health, threats and future generations are more general to the population rather than to people's varying individual tastes.

Based on the survey results, the two public goods that underlie people's WTP for either after-use or peatland protection would appear to be landscape and wildlife. The outcome is supported by the results from the socio-cultural work package. In both studies, these benefits are accompanied by what could be described as a third public good, namely that of knowing that peatlands will be available for domestic peat cutting. In economics parlance, these benefits together comprise both passive use (e.g. interest in the landscape and wildlife) and direct use (e.g. peat cutting) and values.

- ***Landscape***
  The landscape benefits of peatlands are probably the easiest public good to communicate to people (in a survey) in that peatlands are a distinct feature of the Irish landscape. People are familiar with peatlands. They might appreciate the colour that peatlands contribute to a landscape that is now dominated by monocultural grasslands. On the other hand, they could view the bog landscape in a negative context as empty or symbolic of a wasteland.

  From a local perspective, household peat cutting is of social value to many people and would be an undisputable element of the Irish landscape. It cannot be assumed that people draw a distinction between intact and degraded peatlands in relation to this activity. A worked or mined peatland may be subjected to ugly scarring or bare peat, but often the more visible damage from household cutting is restricted to a particular edge of the peatland. Peatlands are a cultural landscape by virtue of their association with a rural way of life, particularly given earlier generations' dependence on the bog and the time spent in extracting peat for fuel.

- ***Ecology***
  There is some latent understanding of the ecological value of peatlands (natural biodiversity). Peatlands are not an obvious habitat for many of the more visible forms of wildlife such as flocks of birds or larger animals. Rather, peatlands have a particular value in terms of species that are rare in a European context. Most fundamentally, the specialist peatland flora has the further value of providing the infrastructure for species interactions without which there would be no bog. The ecology is therefore critical to the sustainability of peatlands and, consequently, to all the other ecosystem services it provides.

- ***Buried archaeology***
  In addition to landscape, wildlife and the cultural values associated with peat cutting, it can be assumed that many people value the archaeological finds that have been recovered from peatlands over the years. As archaeological or palaeo-archaeological values were not addressed in the survey, it is not clear how far people value the preservation properties of peatlands or the artefacts themselves. Certainly, intact peatlands have the effect of preserving artefacts in situ. However, it is usually only through extraction that such finds have been recovered. Remains in higher layers can be quickly exposed to oxidation or desiccation while mechanical peat extraction obviously puts these at risk of

destruction. Indeed, there does appear to have been a reduction in the number of artefacts found since the advent of mechanical cutting.

Without doubt, many artefacts have been lost forever without having been seen or recorded. Others remain unknown and protected below the level of the bog. The professional archaeologist has an interest in ensuring that such artefacts remain in situ or, at least, that they are revealed only gradually without damage by heavy machinery. It is possible that this further expression of cultural value is not fully appreciated by the public in relation to peatlands as many artefacts have been removed from the context in which they were found. Amongst the exceptions is the Corlea Trackway in County Longford which remains in situ.

Unfortunately, we are not aware of any published valuation studies that have addressed the value of uncovered peatland remains. The closest illustration of this value is provided from a study by Bille et al. (2006) who applied economic valuation to the protection of archaeological artefacts on a wetland in Denmark as distinct from their salvage or tourism value. Their study reports an average WTP per household through increased taxation of €160/ year.

In both the socio-economic and socio-cultural surveys, the positive interest shown by people in both amenity and landscape coincided with positive attitudes towards the domestic cutting of turf. A good proportion of the people cutting peat also valued bogs as heritage, while regarding both as compatible. Furthermore, no negative comments were made in relation to the industrial extraction of peat, perhaps because livelihoods or local communities have been sustained by this activity. Despite support for these direct or productive uses, few people made reference to alternative options for after-uses that could be perceived as delivering development or employment. In part, this may reflect a resignation that the area's peat resource is largely exhausted. By comparison, forestry was unpopular possibly because it is perceived as having an intrusive impact on the peatland landscape. However, there was support for wind farms as a productive alternative. This support was also reflected in answers to a question included in the socio-economic Regional Survey. It may therefore be the case that many respondents do not see any contradiction between wind turbines and the passive landscape and wildlife uses provided by the bog. If so, perceptions of wind energy uses are similar to those for domestic peat cutting in that this is a productive use that is perceived to be socially or physically compatible with the peatland landscape and ecology.

4-3.4 Hydrological Values

Peatlands provide a prospective ecosystem service and public good in terms of their hydrological functions. Both fens and bogs are of value for their water storage and filtering role. Catchments with extensive areas of peatland would be more likely to maintain supplies of water during short periods of drought. However, there is varying opinion on their role in mitigating flooding which would be the primary public good in a country accustomed to high rainfall and its consequences.

It has been argued that peatlands can moderate run-off and, in doing so, reduce the risk of downstream flooding and the social cost this would involve. As such, they would be providing a regulating ecosystem service, an indirect economic use value. The UK Environment Agency (Environment Agency, 2007) has previously allocated funds to peatland restoration in acceptance of these presumed hydrological benefits.

However, fens and bogs will 'process' water differently. While fens receive water from an external source and can increase their water-holding capacity (i.e. through flooding), downward seepage is prevented in natural bogs, causing water to accumulate around the margins following periods of high rainfall. While acknowledging that diverse views exist on the capacity of peatlands to moderate run-off, Holden (2005) argues that peatlands (mostly blanket bogs) tend to exacerbate run-off under conditions of high rainfall while failing to provide a regular base flow in dry periods. This view holds that, while peatlands may be primarily water, this very saturation means that they are not significant buffers against flooding and so provide no hydrological benefit (see Chapter 3.2, End of Project Report). Therefore, depending on one's assessment of the true relative hydrological situation for intact and damaged peatlands, the impact of restoration could be reflected in either additional social costs due to flood damage or social benefits in terms of flood damage avoided. An assessment of the direction and scale of these costs (or benefits) requires further investigation. The need for information should be a priority in the context of the Water Framework Directive and climate change. A recent study by Murphy et al. (2008) foresaw an increase in both the frequency and magnitude of flood events as a consequence of climate change. By the 2020s, nearly all catchments studied will display an increase in the frequency of flood events that have hitherto tended to occur once every 50 years. For example, under a medium-high emissions scenario, such an event on the Rivers Inny, Brosna or Suck – each of which empty into the Shannon – is likely to occur every 3–4 years by the 2080s. Both Strategic Environmental Assessment (SEA) and local authority planning controls are supposed to take account of flood risk. So far, the Draft Guidelines for Planning Authorities on Flood Risk Management (Office of Public Works, 2008) recommend against the extensive development of flood plains. However, while the Guidelines propose justification tests for any development in a flood risk area, they do not specifically address raised bogs or fens, many of which are to be found in flood plain areas. Neither do they deal with developments outside of flood risk areas that could affect flooding elsewhere, an omission that also applies to peatlands and peat extraction. Instead, it is assumed that land-use matters will be identified within regional SEAs or by River Basin Management Groups. A quantification of flood risk depends both on the likelihood of flooding and its consequences (Office of Public Works, 2008). For areas in the immediate vicinity of peatlands, the impact may be minor and restricted to farmland, farm infrastructure and buildings. In the centre and west of Ireland where most bogs are located, farmland is often of marginal value. Consequently, while the individual impact on farm enterprises may be high, the economic costs are low, as has been acknowledged by cost–benefit analysis previously undertaken on behalf of the Office of Public Works by the Comptroller & Auditor General and others (Office of Public Works, 1997). However, while the local implications may be modest, they can be acutely realised by people living in the affected area. There are significant economic values associated with impacts on human welfare, as can be demonstrated both in terms of people's WTP to avoid such risks and in the willingness of the administrative authorities to spend considerable sums on flood protection. An example is provided by the political fall-out from the UK Environment Agency's acknowledged lack of preparedness for the extreme rainfall conditions experienced in England in 2007, the costs of which were estimated at £1.5 and £2 billion according to the Chartered Institute of Loss Adjusters and the Association of British Insurers (The Times Online, 2007). Insurance claims for flood damage in Ireland in November 2009 are estimated to exceed €250 million according to Hibernian Aviva (30 November 2009) in addition to the direct expenditure by the public authorities that will now be necessary to protect against future flooding.

At the present time, there is insufficient evidence to calculate the additional flood risk and share of costs that originate from peatland degradation and the drainage associated with peat cutting, either at national level or for identified locations. Were such an adverse relationship to be demonstrated, this would strengthen the case both for peatland restoration and for the use of either regulation or economic instruments such as compensation in return for a cessation of peat cutting. Potentially, industrially cutaway peatlands could act as a buffer against flooding. For instance, the lower elevation of the cutaway along the Shannon means they could be used to store water during times of flood risk. In practice, this could require some direct management of water levels so as to permit flooding over the extensive area available, although manipulation of the water table could expose bare peat banks leading to increased carbon emissions. On the other hand, there are also some additional benefits in terms of habitat and by being able to manage water levels on navigable sections of the Shannon. There are also possible interactions to be considered with regard to mitigation of any adverse impacts on river flow due to the large-scale abstraction project being proposed for either Lough Ree or Lough Derg (Dublin City Council, 2008). Indeed, one option for this project involves the use of a cutaway in County Westmeath for possible storage of water being transported to Dublin.

4-3.5 Carbon Values

Peatlands are massive stores of carbon which has accumulated in situ over long periods of time. The capacity of peatlands to sequester carbon dioxide is modest in a short time frame and varies each year depending on seasonal conditions (see Chapter 3.4, End of Project Report and Section 3, this report). Sequestration also requires the peatland to be in near natural condition or, at least, of good hydrological status. Unfortunately, as most Irish peatlands have been degraded to one degree or another, the area of peatland that is likely to be emitting carbon dioxide is greater than that which is sequestering the GHG (Wilson, 2008). Nonetheless, natural or restored peatlands offer a major regulating ecosystem service which, along with emission avoidance by preventing drainage and degradation in the first place, can provide indirect economic use value as a buffer against climate change, but has been largely overlooked by policy makers to date. Several management strategies could affect this service.

4-3.5.1 The cost of carbon emissions from industrial peat cutting

Peat is used for both electricity production and as a domestic fuel, either as industrially produced briquettes or sod peat/turf. The high usage of peat is one reason Ireland has been estimated to have higher carbon dioxide emissions per kilowatt hour of electricity than the UK or US, namely 607 g/kWh compared with between 430 and 461 g/kWh for the UK (Kenny and Gray, 2009). Similarly, these authors have estimated our carbon footprint based on household carbon dioxide emissions from all domestic energy use at 6,432 kg C/year, a figure that compares poorly with the UK at 5,735 kg C/year, in part because of a widespread dependence on peat fuel. Nevertheless, these emissions have fallen in recent years. Largely because of the spread of more convenient fuels, such as oil and gas, the share of peat has fallen to only 4.9% of Total Primary Energy Requirements (TPER). Nevertheless, Moles et al. (2008) note that the carbon footprint is much higher for smaller settlements that are not connected to the gas network. The use of peat in the Midlands and within rural settlements also remains high.

From the perspective of the social costs and benefits of carbon, the ideal first step to reducing peatland emissions would be if Bord na Móna were to cease peat extraction for use in power stations. Peat is the most carbon intensive of the fuels used to generate electricity in Ireland. A cessation of peat burning for electricity would immediately lead to an annual reduction in carbon emissions of 864,000 t. At a carbon price of €20/t prevailing for much of 2008, this saving would be worth over €17 million per year were the balance to be filled by renewable energy. The estimates are, though, affected by the vulnerability of the current European Union Emissions Trading Scheme (EU ETS) to economic circumstances. This vulnerability was demonstrated by the fall in the price of carbon to less than €10/t in response to the global economic recession and the subsequent recovery to about €15. A price of €15/t is currently being used as a conservative benchmark in much policy analysis. In addition, a cessation of industrial peat extraction for electricity would release the majority of cutaways for possible restoration and thus change the carbon balance of this land use from currently being a large carbon dioxide emitter.

Requiring Bord na Móna to cease peat extraction for burning in power stations is an example of a command and control instrument, although the difficulty of implementation could be softened by ETS savings. There would also be financial savings from avoidance of the need to subsidise peat use. At present, the Government is subsidising an activity with negative environmental and social costs.

Subvention is carried out through the Public Service Obligation (PSO), whereby electricity consumers pay a levy towards both the continued use of peat and to develop the use of renewable energies. For peat, the subvention has been necessary to cover the capital costs of peat-fired power stations. Previously, the subvention also helped to cover the substantial public debts accumulated by Bord na Móna before it achieved profitability in recent years. The main argument for the subvention has been that there are social benefits (strategic, regional development and employment) from being able to use an indigenous fuel. Indeed, a recent report on Ireland's energy security (Purvin and O'Cleirigh, 2008) noted that annual energy imports amount to €6 billion, with imported oil accounting for 60% of Ireland's energy needs. As peat provides an alternative domestic source of energy, its use helps to reduce the import bill. However, while this argument made sense during the Oil Crisis of the 1970s, alternative renewable energy technologies energies are now rapidly coming on stream. The use, and relative subsidisation, of carbon-intensive fuels lead to social costs such as health impacts. The EC has estimated the pollution social cost of peat as being equivalent to 3.2 cent/kWh (compared with 5.7 cent for coal but only 1.6 cent for gas) (European Commission, 2001). Were this social cost to be added to the price of electricity in accordance with the Polluter Pays Principle, it would be sufficient to double the cost per kilowatt hour. For Ireland, Douthwaite and Healy (2005) estimate the social cost of the use of peat for energy to be €80 million per year for electricity generation and €27 million for domestic heating uses. These figures do not, though, include the social cost of climate change due to GHG emissions, which could dwarf the benefits that arise from the use of an indigenous fuel.

Rather than reducing dependence on peat for energy, policy has actually encouraged its continued use through the construction (and subsidisation) of three peat-fired power stations at Lanesborough (County Longford), and Edenderry and Shannonbridge (both in County Offaly). A detailed cost–benefit analysis concluded that the "*continued use of peat deprives Ireland of a negative cost option for lowering emissions and hence raises compliance costs in the rest of the economy*" (ERM, 2008). Looking ahead, most of the future energy supply scenarios now being considered by the Department of Communications, Energy and Natural Resources (DCENR, 2008b) envisage an increased reliance on gas and renewable energies, with most of the latter expected to come from indigenous sources such as wind or wave. The argument for continued use of peat therefore rests less with security of supply and its role as an indigenous fuel, and more on considerations of diversity of supply and regional benefits.

4-3.5.2 The cost of carbon emissions from domestic turf cutting

To further reduce domestic carbon emissions, the State could require that all domestic peat cutting cease. On the basis of the estimates in Section 3-5, this would save 500,000 t of carbon each year and be worth €10 million at an ETS price of €20/t. However, it is a figure that must be measured against the private benefits of peat use for households in the rural community. Local investigation puts the price paid for peat by turbary owners to local contractors for the cutting and delivery of (dry) turf at approximately €60/t, or between €300 and €600/year given an average usage of 5–10 t. Viewed in comparison with the price of heating oil, purchases of peat therefore represent a saving of €600–1,000/year to the average household. However, in most rural communities, the majority of purchases are by individuals who rely on contractors only to deposit the cut turf beside their own plot (bank). In this case, the freshly cut sod turf deposits cost just €12–13/t (dry peat is assumed to be one-third to one-half this weight) and the saving would be even greater at up to €1,360/year at the household level. Considering both sources of household peat, the value of purchases is probably close to the Central Statistics Office Household Survey estimate of €37 million per year, but the relevant consideration at the household level is the saving that can be made on alternative fuel purchases. This is a widely realised private benefit.

More formally, assuming a tonnes oil equivalence (toe) for sod peat of 0.12 (Sustainable Energy Ireland, 2009), and with kerosene selling at around €378/t, 1.6 million tonnes of turf cut (Shier, 1996) from an individual's own bank would be worth at least €72 million per year in terms of the equivalent cost of heating oil, or a saving of at least €52 million per year before taking into account such factors as its inconvenience (storage, cleaning, etc.). If, instead of the estimate of 1.6 million tonnes, we adopt the Sustainable Energy Ireland figure of 913,000 t (O'Leary et al., 2008), the net saving in terms of the next most likely heating alternative (assuming roundwood is not available) is still at least €30 million per year. This figure represents a minimum as it is less than the former estimate due to the relative definition of sod peat used by Sustainable Energy Ireland and of wet/dry peat as described by contractors.[6] Based on either estimate, it is a significant sum and one that is higher than the equivalent carbon value at current prices. It is also a benefit that is realised directly as a financial saving by many rural households.

The Government could use economic instruments to internalise the external costs of peatland loss and carbon dioxide emissions by taxing sales of turf or by levelling a tax on contractors. Such taxes, or charges, would be in accordance with the Polluter Pays Principle. However, while, in principle, this would act as a disincentive to purchases of peat, sales or cutting are typically arranged informally. Therefore, a charge would be difficult and unpopular to apply. It would be just as unpopular for the Government to apply regulation by proscribing all cutting. Alternatively, a command and control approach could be adopted by regulating any new cuttings. Indeed, an EIA is already needed for new peat extraction above a threshold of 10 ha. However, almost all household peat extraction is proceeding incrementally at levels below this threshold. Other possible solutions include tax concessions in return for withholding from extraction or to provide turbary owners with rights to cut on non-designated sites (although this would not reduce carbon dioxide emissions).

Each of these possible solutions has its own problems and each would be unpopular. Furthermore, an information failure exists in that the wider population is unaware of the social benefits that could be achieved through a cessation of peat cutting and of carbon emissions. As demonstrated by both the socio-economic and socio-cultural surveys, domestic peat cutting is perceived as a social good rather than a social cost. Therefore, while, in principle, the wider social benefits of a cessation should be greater than the private benefits in that the social cost of climate change is far higher, the social benefits as realised in terms of the public's utility at this moment in time are significant. Policy must therefore proceed cautiously to maintain social acceptance.

6. toe for sod peat. A discrepancy arises due to the definition of sod peat by SEI (i.e. toe of 0.12) and wet peat (2–3 times weight of dry peat) as defined by contractors.

The main policy option to date has been cautious in purchasing rights or offering annual compensation for not cutting. A cessation of peat cutting has been proposed on only 31 designated raised bogs in the short term, although former ministers have stated that cutting on all designated sites (SACs and NHAs) should cease in 2014. It is also clear that Ireland is in breach of the Habitats Directive in relation to the application of AA on all projects and plans affecting designated sites. For the time being, the holders of turbary rights on the selected SACs have been offered what would appear to be levels of compensation that are reasonable when compared with the value of the peat:

- Freehold purchase starting at €3,500 on the first acre; or
- Compensation for not exercising leasehold rights beginning at €2,975 for the first acre (or part thereof), continuing at €2,550/acre thereafter and accompanied by annual payments of €600.

However, from the perspective of turbary owners, the purchase of rights could deny future options in relation to fuel availability. For instance, some turbary rights owners renewed their cutting of peat when heating oil prices rose sharply in 2007/2008. Effective compensation would therefore need to exceed the value of the peat and be measured in terms of the cost of alternative heating fuels. In principle, for a peat bank that is 3 m deep, the stock of peat on each acre would be worth €142,000 (assuming that dried sod peat averages 38% the weight of wet peat). However, as it could take 500 years for a single household to burn its acre of turf, a more practical approach would be to consider the amount of peat that each turbary owner can expect to mine in a realistically short period. For example, if each turbary owner personally burns 5 t of peat in his/her household each year, a half metre cut from a 10-m wide strip would be sufficient to keep that household warm for almost 1 year. A turbary owner could choose to compare the level of NPWS compensation with the value of this peat. A more practical comparison would be with the approximately €1,360 the rights owner could be saving himself on purchases of heating oil each year. At this rate, the present value represented by the cost of alternative fuels over 20 years would be nearly €17,000, assuming a discount rate of 5%. At this rate, the compensation levels currently being paid on SACs look less appealing unless the turbary owner has other reasons for wanting to stop peat cutting.

Even where there is an economic case for continuing to cut turf, this is often not the primary consideration for turbary owners. Rather, the ethnographic work undertaken for the BOGLAND project indicated that many people have a cultural attachment to the bogs, and to turf cutting, which they are very reluctant to give up. From their perspective, they are responsible both for continuing a long tradition of cutting and for preserving this right for future generations of their family. Furthermore, they could perceive that an acceptance of compensation would place pressure on others to do the same while also making it practically more difficult to make a communal decision to allow the bog to be cut. For one thing, the use of machinery in modern peat extraction makes it more difficult to opt out of peat-cutting arrangements. More relevant, though, is the pressure to conformity that exists in many rural communities in Ireland and which makes it difficult to contemplate such a decision. There may be no communal management of the bog, but these social relations are an important part of the turbary owner's utility function (Grundtvig and Furubotn, 1974).

Therefore, the reluctance of most turbary owners to accept compensation arises from a mix of cultural factors and property rights. The right to cut is worth more to its owners than the peat itself. Giving up that right means ending an association with the bog that might go back many generations and which would risk the censure of friends and neighbours.

Largely as a consequence of these considerations, only 5–10% of the 20,000 turbary owners on all 139 raised bog SACs and NHAs have accepted the compensation package. While it is a fact that only around 2,500 of these people actually cut peat (49 plots are actively cut in Clara out of a possible 449 turbary rights owners based on Land Registry), an opt out, even by a minority of individuals, still makes it difficult to implement a strategy of restoration. For these reasons, the Department of the Environment, Community and Local Government has established a working group to propose measures that would successfully bring about a cessation of cutting on designated sites. The option of compulsory purchase is also being examined for situations where successful implementation requires that no opt-outs occur. Even where compensation does occur, there is a moral hazard to consider. Whatever the innocence of their intentions, turbary owners have been responsible for the destruction of many peatlands' ecological functions and for transforming such ecosystems from carbon sinks to emitters of GHGs. For the rest of society, this should be a significant cost even if it is one that is not widely realised at present. Given the weakness of the incentive offered by compensation, an improved balance of social costs and benefits could be achieved through the compulsory purchase of property rights.

On the other hand, as noted earlier, there is an argument for involving local communities in the decision-making process where this affects natural resources like peatlands. In the developing world, it has been argued that the participation of people living in the vicinity of wildlife parks has helped to reduce the incidence of poaching. This participation has sometimes been encouraged by incentives that allow local people to share in the income from tourism or game hunting. Ironically, these types of strategies have not always been attempted in developed countries. A possible option for peatlands is to replace cutting with an income stream other than state compensation. Indeed, a possible opportunity could come from a marketable value placed on 'carbon loss avoidance' (see Section 4-5.3.6).

4-3.5.5.3 Carbon pricing and alternatives to industrial peat extraction

Emissions trading and carbon taxes

Climate change policy in the EU (and therefore Ireland) has two strands. The first is the EU ETS which is an EU-wide scheme covering the power sector and heavy industry, including cement, oil refining, ceramics and glass, and pulp and paper.[7] The second addresses the non-trading sectors (agriculture, heat in buildings and industry, transport, waste); each Member State is allocated a cap for its emissions from the non-trading

7. Details on EU ETS – history, development and performance – are available in Ellerman et al. (2010).

sectors, and Member States are free to devise whatever policy mix they judge appropriate to meet this cap. Emissions from peat burning in power stations are covered under EU ETS. Each installation is given a quota expressed as allowances of tonnes of carbon dioxide per year. If they exceed this quota, they must buy allowances to cover their additional emissions. If their emissions are lower than their allocation, they can sell the surplus to others. This trading produces a price per tonne of carbon dioxide which expresses, albeit very imperfectly, the scarcity value of the atmosphere as a sink for GHGs. Because peat is the most carbon-intensive form of electricity production, it means that it requires more allowances per unit of output than alternative sources, and notably electricity generated from natural gas, which is relatively carbon efficient. In the early stages of EU ETS, the financial implications were not too onerous, because installations got a free allocation covering about 85% of their emissions; however, from 2013, they will have to buy most of their allowances, and this will place peat at a serious competitive disadvantage.

As regards the non-trading sectors (which include energy used for heat), the cap for Ireland (–20% by 2020 from a 2005 base) is extremely onerous. As in the case of the EU ETS, because of the carbon intensity of peat relative to all other fuels, there will be increasing pressure to reduce emissions from this source. In December 2009, a carbon tax was introduced on emissions from all carbon dioxide emissions from the non-trading sectors, which would add about 10% to the price of peat briquettes. However, while coal and peat are covered, they are subject to a ministerial order, which has not yet been issued. One of the big potential problems is smuggling of coal across the border from Northern Ireland.

At the carbon price of €20/t prevailing in early 2008, biomass alternatives would have needed to cost less than €3.90 + €6.13 per GJ (delivery + carbon cost) to be competitive with peat (Shier, 2008). The fall in carbon prices experienced in 2008 will have reduced the relative cost of peat for the time being. However, it is likely that prices will rise again once economic growth recommences. When this happens, the effect of the carbon levy will be to ensure that the price of peat is close to the threshold for some renewable energy alternatives.

Biomass

The new generation of peat-fired power stations has been designed to permit co-firing with biomass fuels. Bord na Móna's purchase of the Edenderry peat-fired power plant in 2007 coincided with the company's purchase of Advanced Environmental Solutions (AES) which processes environmental waste, including waste wood material that can be used for co-firing. There is however a problem of supply constraints. The main indigenous sources of biomass include roundwood, wood pellets, forest residue, sawmill residue, energy crops, green waste and meat and bonemeal. At present, supplies of these biofuels are insufficient to meet the co-firing requirement of 7.1 PJ/year (Shier, 2008). The ambitious target set by the Forest Service to afforest 20,000 ha/year by 2035 (Forest Service, 2007) has been met so far with difficulties. Alternatively, greater supplies of residue from clearfell or roundwood thinnings could be obtained as the recent national forest inventory revealed that only 69% of the sampled area of 240,000 ha has been thinned. At current prices, forest owners have so far been reluctant to thin their plantations. Furthermore, the use of wood for power generation would need to compete for supplies of wood pellets for domestic heating demand. While it seems that the co-firing target (and thus continued use of peat) can only be achieved through imports, it should be noted that the principal rationale for PSO support has been the status of peat as an indigenous fuel.

As part of the BOGLAND project, industrial cutaway peatlands were investigated for their potential utilisation as a base for biomass production for energy (see Chapter 3.9, End of Project Report, and Section 3, this report). Cutaway peatlands offer many advantages for biomass production over agricultural land in that they are usually located close to a power station and electricity grid, they usually have a good transport infrastructure, and the flat long terrain make them ideal for mechanised extraction. More significantly perhaps, cutaways have the potential to be used for biofuel production without competing with food production. However, results from exploratory trials showed that the poor yield of both willow and

Miscanthus make them unlikely contenders. More importantly, biomass from growing energy crops on industrial cutaway is not an economic option, having a tentative cost, in advance of further trials, of €8.00–9.00/GJ. At a carbon price of €20/t, subvention of biomass alternatives would be required up to €35/t (Shier, 2008).

Commercial forestry that can be established on cutaway peatlands presenting suitable planting conditions will be able to provide some biomass material. Certain species such as birch and alder should be chosen to quickly produce satisfactory yields of biomass for energy (Renou-Wilson et al., 2008). Naturally regenerated birch may be a better option to minimise costs but is a long-term and uncertain enterprise in terms of producing sufficient yields (see Section 3-7.3).

Wind energy

Wind farms could represent an alternative energy source located on industrial cutaway peatlands and Bord na Móna has been examining its options in relation to wind, including pursuit of its ambitions to expand its wind farm on industrial cutaway peatlands in north-west Mayo. Like biomass, extensive uptake of wind power generation is helped by higher prices of competing energies and a higher carbon price. Wind energy has benefited from the liberalisation of the electricity sector in that an All-Island single market has been created, requiring the established distributors to accept supplies from other enterprises. Electricity prices remain high in Ireland relative to continental Europe but, overall, liberalisation is estimated to have permitted real price reductions over time of 15–30% across Europe (Ó'Gallachóir et al., 2002). This has had the effect of further distancing the viability of wind energy, requiring that the industry be supported by regulatory and financial incentives such as the PSO. Amongst these regulatory incentives has been an Alternative Energy Requirement (AER) to provide renewables with an assured right to supply electricity upon a successful tender. This is combined with an effective subsidy available through REFIT, the Renewable Energy Feed-In Tariff, by which renewables receive a guarantee of sales at an additional payment of 15% of the reference price.[8] These payments determine the relative viability of wind energy, but are of a scale that has so far confined most generation to reliable, high wind velocity sites such as uplands, including blanket bogs. The sites have a comparative advantage over low-lying sites such as the Midlands cutaway.

Further expansion of wind generation is feasible and is being encouraged by the Department of Communications, Energy and Natural Resources. Its relative appeal, compared with biofuels, should ensure that wind will play by far the greatest part in the Government's objective of increasing the supply of energy from renewables. This target has recently been increased from 33% to 40% by 2020. There are, however, limitations on the capacity of wind to satisfy or exceed these targets due to the difficulty that operators will have in maintaining system stability when such a large proportion of energy is derived from an intermittent source. At the very least, major investments to both upgrade and extend the distribution network would be needed to allow enough energy to be sourced when required (McCarthy, 1996; DCENR, 2008a). The national system of equating supply and demand within half-hour periods also works to the disadvantage of an irregular power source such as wind. While a geographical dispersal of wind-farm sites could facilitate regular supplies, differences in wind capacity and wind timing around Ireland are small (RESG, 2008). Nevertheless, the All-Island Grid Study (DCENR, 2008b) argued that, with sufficient investment, a 42% penetration of renewables (mainly wind) by 2020 was possible along with a 25% reduction in carbon dioxide emissions. However, the report acknowledged that there was no assurance, at present, that a contribution from wind of 6 GW could be exceeded. It argued that some continued reliance on conventional sources would be necessary, but from gas rather than oil, coal or peat.

Potentially, peatland cutaway could be used for wind generation, displaying major advantages:

- The land is owned by Bord na Móna;

8. This premium includes a payment for energy wind generators to supply to the grid, a capacity payment to help cover the additional generation capacity they have provided, and a baseline constraints payment to compensate for the power they have available at times when the network is operating at capacity.

- The available land area is large;
- Most commercially worked peatlands are located close to power stations and, therefore, to the distribution network; and
- There are diminished problems of obtaining planning permission.

These are ace cards for the erection of wind farms on industrial cutaway peatlands. In addition, refusals of planning permission in scenic upland areas have undermined many individual wind-farm proposals. Objections by adjacent landowners to power-line connections and landscape considerations have been factors in this regard, although the latter problem has diminished somewhat since new siting criteria were recommended by the Renewable Energy Strategy Group (RESG, 2000). The Group also recommended the removal of upper size limits on large farms, noting that this would potentially reduce the number of grid connections that would be required. Potentially, this recommendation benefits the use of cutaways for wind farms.

However, the development of wind farms on cutaway peatlands has been constrained by the poorer reliability and slower wind velocity of lowland areas. The exception is Bellacorick in County Mayo where Bord na Móna has developed a 21-turbine 645-MW wind farm on a blanket bog site where the mean average annual wind speed of 7.28 m/s has been identified as making it the best site in the country. Bord na Móna has ambitious plans for its expansion, but while the site is connected to the 110-kV line associated with the former peat-fired power station, expansion has so far been constrained by its remoteness from most electricity consumers and the cost of capacity expansion. Other peatland locations in the Midlands experience lower wind speeds and would typically operate at lower levels of installed capacity. Suppliers would potentially be outbid by other sites in the AER process. As with biomass, much depends on international carbon prices and renewables policy, both of which could be designed to maximise the public benefits. A higher long-term carbon price could overcome the cost constraint. So too would a more favourable feed-in tariff for peatlands or secondary supports such as financial or tax incentives, although both risk accusations of being anti-competitive and of favouring a single entity such as Bord na Móna. Should peatland sites become economic, scattered, tall wind turbines similar to those used in uplands are the more likely means of generation as technology and turbine supply constraints have pushed aside the previous vision of large numbers of small turbines. Bord na Móna has prepared plans for just such a wind farm on one of its Midlands bogs. Lisheen Mine, located on a lowland bog near Thurles, already has a working wind farm.

If future circumstances favour wind energy from cutaway sites, this does not eliminate other uses for peatland. With careful site preparation, environmental objectives could coincide with peatland restoration where possible or high biodiversity ecosystems or paludiculture for energy biomass or *Sphagnum* farming as an alternative for peat for horticulture. Even allowing for the foundations required for tall wind turbines, the small number of turbines now anticipated should have a lower impact on peatland hydrology than the former expectation of large numbers of turbines. While accepting that there are few working examples of wind farms on lowland bogs, the socio-cultural study undertaken for the BOGLAND project revealed no local objection on landscape grounds. Wildlife could be affected by turbines if wetlands are allowed to develop, but this could be managed by careful siting considerations. Should lowland wind farms become an option, the use of such sites for such a purpose could strengthen the rationale for restoration and, possibly, subject to their future viability, even provide a financial input to this process.

Clearly, renewable energy alternatives using industrial cutaway peatlands need to be researched as they encompass serious issues such as:

- Finding alternative sources for energy other than fossil fuels, hence, security of energy supply for Ireland;
- Potential area for development of strategy for combating of climate change; and finally
- Potential area for economic sustainability to replace a resource-limited peat industry.

4-3.6 Conclusions

This economic analysis has revealed that peatlands provide various functions and ecosystem services of economic and social value. Many of these outputs are under threat from the effects of peat extraction and future climate change. The BOGLAND socio-cultural work package revealed that people living in areas of current and former industrial peat workings, value the protection and sustainable use of peatlands. The socio-economic work package demonstrated that people generally valued peatlands as a public good for the landscape, ecological and recreation benefits they provide. Furthermore, the project has revealed that, where peat has been extensively extracted in the Midlands, the public value the rehabilitation of the cutaway through conversion to either a peatland or wetland landscape. A proportion of the public also values the restoration of raised bog to an extent sufficient to cover the cost of this restoration over significant areas, but less perhaps than the proposed level of expenditure that would be associated with compensation measures.

The survey results are of value because, so far, most of the pressure for peatland conservation has come from the EC and from voluntary pressure groups with modest membership. The BOGLAND survey results indicate general support for peatland protection, although the individual mean WTP value obtained for a national policy of peatland protection was less than that for a geographically localised transformation of industrial cutaway.

In these respects, there is an information gap that must first be tackled. There appears to be little discrimination between the two fundamental types of peatlands as well as an absence of concept of what could happen to peatlands once they have been extracted. In addition, there is majority support for continued extraction of domestic fuel, an activity that is perceived to have a social or cultural value. There is no public awareness of the contribution of peat extraction to climate change.

In terms of regulatory and economic instruments, the State has so far supported the development of indigenous peat energy through the use of subsidies or subvention, largely paid for by a charge on customer electricity bills. As such, policy has been facilitating the loss of peatland and for reasons that are social and political rather than environmental. Restoration of cutaway is now supported through the regulatory command and control mechanisms, albeit only to a minimum threshold. Peatland protection has so far been restricted to the designation of a small number of sites as SACs, but this designation has afforded them little protection from continued domestic cutting. Compensation is being promoted to encourage the owners of turbary rights to relinquish these, but has been unsuccessful in achieving high compliance given the absence of a clear government commitment to a moratorium on peat cutting combined with prevailing social obligations, the relative high cost of alternative heating fuels and the inadequacy of prevailing compensation levels to overcome perceived property rights. Furthermore, the NPWS is still required to manage the peatlands for which compensation payments have been made. The situation is currently being re-examined within the Department of the Environment, Community and Local Government. However, it is clear that economic instruments will not work unless backed by a clear commitment to a cessation of peat cutting.

Summary Findings

- *There is a positive utility and a positive willingness to pay for peatland protection. However, this willingness to pay appears to be higher for a dedicated National Peatlands Park and is not restricted to peatland restoration alone.*
- *Willingness to pay for the protection of raised and blanket bogs appears to be less than the amounts that are currently spent by the State on protection, suggesting that current spending fails to pass a benefit–cost analysis.*
- *People attach a social value to the domestic cutting of peat, but do not always recognise a contradiction with peatland preservation.*
- *The cost of burning peat (either industrially or for domestic purpose) is very high in terms of carbon loss. However, the social aspects of peat use are very complex and solutions will have to consider the cultural attachment to turf cutting.*
- *There is no public awareness of the relationship between peatland and carbon and the contribution of peat extraction to climate change.*
- *The new generation of peat-fuelled power stations has been designed to run on biomass. While biomass is marginally economic, it suffers from supply constraints, questioning its sustainability.*
- *Wind farms on lowland industrial cutaway peatlands perform poorly financially in comparison with elevated and coastal sites, but cutaway sites do have major advantages and could be supported by policy.*
- *Wind farms of cutaway would not necessarily interfere with other use such as peatland restoration or wildlife options which were perceived positively by local people in the BOGLAND project.*

4-4 Review and Appraisal of Policies Affecting Irish Peatlands

4-4.1 Background

Global initiatives and European legislations reflect the considerable concern and importance regarding peatlands and their sustainable management. These agreements gave significant momentum towards the conservation of peatlands which has been campaigned for by many organisations, either at public or governmental level. However, several initiatives (conventions or directives) show evidence of deficiencies in their content (being unsatisfactory in their level of action or being counterproductive) and in their implementation at national level which hamper their success. The various international and national legislations that affect Irish peatlands were reviewed by Renou (1999) but need to be reappraised in today's context. Indeed, in this 10-year period, while Ireland has still not developed any direct policy regarding its peatlands, an increasing number of policies have direct effect on these ecosystems (climate change, renewable energy). These were reviewed as part of the BOGLAND project and their appraisal summarised below (see Chapter 4.5, End of Project Report for more details on each policy).

4-4.2 International Policies

4-4.2.1 Ramsar Convention and Global Action on Peatlands

The Ramsar Convention was ratified in 1984 and was the first international agreement to place emphasis on habitat conservation. Its primary focus is on wetlands of international importance, including peatlands. Signatories are called upon to list important wetlands, the main requirements for which being that they are of botanical, hydrological or zoological importance, or that they regularly hold wildfowl numbering over 20,000 birds. The Convention places an emphasis on the 'wise use' of peatlands rather than on blanket preservation. By this is meant that consideration should be given to conservation needs within strategic land-use planning and environmental assessment. In 2002, Resolution VIII.17 asked the contracting parties to adopt the Guidelines for Global Action on Peatlands (GAP) which recommend a series of priority approaches and activities for global action on the wise use and management of peatlands (Ramsar, 2002). In addition, the Resolution on Climate Change and Wetlands (Ramsar Convention Secretariat, 2004) gave specific recognition to the need to protect and restore peatlands in relation to their role in carbon storage. Peatland issues can be addressed through the GAP or through the new Ramsar Strategic Plan 2009–2015. However, a weakness is that the Convention lacks a financial instrument with which to promote outright protection or wise use.

4-4.2.2 United Nations Convention on Biological Diversity

The Convention on Biological Diversity (CBD) followed on from the Earth Summit in Rio de Janeiro in 1992 and has the objective of achieving, by the year 2010, a significant reduction in the rate of biodiversity loss. It is directed at the protection of biodiversity through in-situ conservation, the assessment of development impacts on biodiversity, sustainable use and public awareness. Signatories are required to commit to national programmes to protect biodiversity. The CBD, through its decision on Biodiversity and Climate Change at COP 7 (Kuala Lumpur, 2004), has supported action to minimise peatland degradation, as well as promote the restoration of peatlands due to their significance as carbon stores and/or ability to sequester carbon. Following the adoption of the Convention, various Local Biodiversity Plans have been prepared on a county basis and include an inventory of peatlands amongst their objectives (Counties Longford, Mayo, Offaly, Monaghan have completed their peatland inventory). Coillte has also been amongst the first landowners to undertake biodiversity inventory. The Forest Service and the NPWS have recently agreed to review and co-ordinate forestry planting in designated areas established to protect the hen harrier, a rare raptor requiring a mix of young forestry and blanket bog. However, a review of the Plan by an informal Biodiversity Working Group of COMHAR concluded that pressures on biodiversity in Ireland are increasing and the Plan falls short of achieving its targets for 2010 (Biodiversity & Policy Unit, 2005). A clear recommendation is that the Government should ensure an integrated and effective approach to funding the protection of designated sites under its obligation to achieve biodiversity targets under the CBD and associated Local Biodiversity Action Plans.

4-4.2.3 United Nations Framework Convention on Climate Change

The UNFCCC is more commonly known for the Kyoto Protocol (KP) on climate change agreed in 1997 and which commits signatories to targets on reduced GHG emissions. Although primarily directed at reducing emissions, the Agreement is also relevant to carbon sinks as each country has responsibility for verifying its net emissions, taking into account any carbon sequestration. In other words, the KP accepts terrestrial sinks for GHGs as offsets for fossil fuel emissions. Only carbon sequestered in living biomass (various land uses can be accounted for by choosing the associated activities under Article 3.4 KP) is currently considered, but the KP contains a provision for the possible future inclusion of other land uses and soils. As a result, there has been increasing reference to peatland in the deliberations of the UNFCCC, although there have not yet been specific decisions relating to peatlands. While acting as a carbon sink in their natural state, intact peatlands are currently only of relevance to the Protocol in relation to the release of additional GHGs as a consequence of peat extraction or desiccation. However, peatlands' principal value is as a *store* of carbon rather than a means of sequestration. This store is vulnerable to degradation in a manner similar to the carbon contained in a virgin tropical forest. The relevance of peatlands to climate change adaptation and mitigation has been recognised by the IPCC and more and more countries (parties to the Convention such as Australia, Belarus, Iceland, Japan, Switzerland and New Zealand) see the importance of addressing emissions from degraded peatlands and recognise the huge cost-effective potential of restoring drained peatlands. They are demanding that peatland restoration and emissions from peatland loss (following change of land use) are considered as an additional activity for account under the new Protocol. At the latest meeting in Cancun (December 2010), unanimity was reached among LULUCF negotiations on the definition and content of a new activity that is now called 'peatland re-wetting and drainage'[9]. The outcome of these talks will be critical for Ireland. Inclusion of peatland emissions in the accounting rules will create a huge momentum for peatland restoration and conservation. There will be a need for proper definition and accounting techniques and principles, i.e. accounting for peatland restoration should be balanced by accounting for peatland degradation. The main issue is that reliable figures are needed that relate changes in peat stocks and GHG emissions to peat types, water levels and land-use activities. Finland has already published land-use-specific emission factors with respect to peatland use, which could be applied to Tier 3 reporting (Alm et al., 2007). Eddy covariance techniques, as well as long-term time series, estimating peat volumes and subsidence combined with modelling approaches are required to arrive at better estimates for emission parameters. More research will provide information in the next couple of years but further work needs to be initiated not only in the emissions measurements but also in the assessment of the condition of peatlands. The IPCC convened a scoping meeting in April 2011 to arrive at new guidance for emission factors for peatlands.

4-4.3 European Legislation

As well as the various international agreements, there are several European Directives that are relevant to peatlands. These Directives could be argued to be more binding than agreements made at international level in that they are potentially enforceable through the European Court. In addition, the Maastricht

9. The definition of the new activity is ((FCCC/KP/AWG/2010/CRP.4/Rev.4): *"Rewetting and drainage" is a system of practices for rewetting and draining on land with organic soil that covers a minimum area of 1 hectare. The activity applies to all lands that have been drained and/or rewetted since 1990 and that are not accounted for under any other activity as defined in this appendix, where drainage is the direct human-induced lowering of the soil water table and rewetting is the direct human-induced partial or total reversal of drainage.*

Agreement of 1992 formally committed the European Union to the concept of sustainable development. Member States are required to ensure that development policies have due regard to sustainability.

The significant EU policies impacting on peatlands are:

- Council Directive on the Conservation of Wild Birds (79/409/EEC);
- Council Directive on the Conservation of Natural Habitats and of Wild Flora and Fauna (92/43/EEC);
- Environmental Impact Assessment (EIA) Directive (85/337/EEC, amended 2003);
- Strategic Environmental Assessment (SEA) Directive (2001/42/EC);
- Environmental Liability Directive (2004/35/EC)
- Water Framework Directive (2000/60/EC);
- European Landscape Convention (also known as the Florence Convention, 2000); and
- EU Soils Thematic Strategy (2006).

While EU policies have become more integrated since the implementation of Agenda 21 as cross-compliance and sustainable development have been given more tangible consideration, several European land-use policies have, for many years, been contradictory. A glaring example of a counter-productive European measure can be found in the EU farm subsidy schemes such as the Sheep Headage Payments and Ewe Premiums. Such incentives from the CAP ran counter to peatland conservation or indeed sustainable management as increased numbers of sheep meant that large tracts of sensitive blanket bog and associated habitats were overgrazed. By 1990, sheep numbers had risen to 8.8 million from just 3.3 million in 1989 (Douglas, 1998). This translated into an increase of 96% and 85% in Counties Galway and Mayo, respectively (Doyle and Ó Críodáin, 2003), where blanket bogs have been the most severely overgrazed. Geerling and van Gestel (1998) estimated that 27% of upland south Mayo and Connemara was extremely overgrazed. Sheep numbers have since gradually fallen due to the replacement of headage with area-based payments. New Commonage Framework Agreements should also have the effect of reducing the extent of land designated as Degraded Area. Furthermore, an additional 20% payment is payable to farmers in the REPS whose peatland is designated as a SAC, NHA or SPA; REPS farmers with land in designated sites also have the option to enter an NPWS stewardship scheme. However, to be successful, these policy measures do require that accurate assessment of grazing pressure is made based on the fragility of the environment and subsequent implementation of stock reduction (Douglas, 1998).

There are several other examples of counter-productive EU legislation that have afflicted peatlands. The LEADER programme (co-financed by the European Union) financially supported private companies to extract peat from actively growing bogs which were proposed as SACs. Before new restrictions and reforms of the CAP, peatlands were drained and converted to forestry or agriculture with the assistance of grants such as those provided under the EU Less Favoured Area Policy on land improvement. Since the removal of EU grants for land reclamation, together with the ring-fencing of subsidy payments to within the existing farmed area, it is no longer economic to convert peatlands to agriculture.

While the amended EIA Directive and transposed Irish regulations (SI No. 538/2001) deal with cumulative impacts of peat extraction, cumulative impact of afforestation is not similarly regulated. While any afforestation over 50 ha must have an EIA carried out, a single landowner who plants adjacent blocks that exceed this threshold does not have to undertake an EIA if there is a 500-m gap between them or if a 3-year time period elapses between each block planted by a single owner or if the adjacent blocks are planted by different landowners.

However, the forestry threat appears to have receded since the Forest Service’s yield class requirements for grant support effectively preclude forestry on upland bogs (although there are sometimes issues with local interpretation of these classes). Forestry proposals on or near to SACs must now be referred to the NPWS for approval. The state forestry company, Coillte, is currently engaged in a major LIFE project aiming to restore planted blanket bogs located in the west of Ireland where tree growth has been poor. Although the rehabilitation of these degraded sites into active blanket bog habitat may take decades, there are some encouraging signs that peatland ecological functions are returning (Delaney, 2008). The European funding through the LIFE financial instrument has been very important in the conservation and restoration of peatlands, although perhaps not endowed with sufficient resources. On the other hand, other EU financial instruments (through the Structural Funds or the VALOREN programme for example) promoted private peat extraction in small bogs as well as helping towards the construction of a state-of-the-art peat power station in Edenderry.

While the EU reviewed the environmental safeguards attached to its structural funds (through cross-compliance), new and future policies could also be in conflict with current conservation policies which can affect peatlands indirectly. For example, there are some current mitigation policies in relation to climate change that could potentially have a negative impact on peatlands unless the proper evaluations are undertaken. The drive towards decreasing GHG emissions means that changes in land use may not be fully and properly assessed. As such, an SEA of new plans and programmes born out of climate change or renewable energy policies should be carried out. It is critical that the encouragement of renewable energy (biofuels and wind energy) is linked with site selection criteria so as to avoid negative impacts on sensitive sites such as peatlands. While wind farms are currently subject to an EIA and SEA (County Development Plan), a number of such developments have been criticised for having failed to investigate site conditions or to adequately rehabilitate surrounding areas (see Chapter 3.9, End of Project Report). Therefore, there still exists major conflict between conservation policy and energy development policy, which highlights the fact that the issue of renewable energy sources and the concept of sustainability and conservation for future generations have not been adequately addressed at international or indeed national level.

4-4.4 Difficulties with Irish Legislation

While various European directives have been transposed into national law, with more or less success, Ireland has a number of national policies that impact directly on peatlands and come directly into conflict with the objectives of certain directives. For example, land drainage and reclamation have been supported over the years by several acts and schemes, including the 1945 Arterial Drainage Act, the Farm Improvement Programme and the Programme for Western Development. The Government policy of large-scale afforestation in the 1990s (Forest Service, 1996) drove forestry on more peatlands, representing between 46% and 51% of the total afforestation between 1990 and 2000 (Black et al., 2008). The Turf Development Act (1946) established a Peat Board (Bord na Móna) with the responsibility of developing and managing the most productive Irish bogs and was given the possibility to use compulsory purchase. A grand aid scheme under the revised Turf Development Act (1981) enabled private owners to extract peat from smaller bogs that had been left untouched until then. The same Turf Development Act protects Bord na Móna from prosecution, which is an example of Ireland's parallel legislation undermining European legal safeguards and is the subject of infringement complaints by the Commission.

However, the case for peatland conservation is increasingly being underpinned by European and international policies and conventions and this is reflected in the Turf Development Act of 1998 which introduced provisions to ensure that peat extraction by Bord na Móna "*activities are so conducted as to afford appropriate protection for the environment and the archaeological heritage*". In addition, Ireland has the enviable situation whereby a semi-state agency, Bord na Móna, was able to introduce a conservation policy. As well as blanket bog of conservation value, Bord na Móna has recently transferred areas of cutaway peatlands to the NPWS for the protection of the grey partridge, a rare bird species found only on cutaway peatlands in Ireland. Conservation designation and the setting aside and restoration of less profitable peatlands by the industry (Bord na Móna and Coillte) have allowed the state to progress towards its 1990 target to acquire and conserve 10,000 ha of raised bog and 40,000 ha of blanket bog (Treacy, 1990). Indeed, in Ireland, it appears that acquisition is still the best form of protection. Even parts of the national parks that are not owned by the State are not fully protected as Ireland is still lacking a National Park Legislation (drafted in 1998, the bill was subsequently scrapped; Killarney National Park is the only national park with statutory protection under the Bourne Vincent Act). However, when the funds are scarce, 'designation' as imposed by various EU Directives has replaced 'acquisition' as the best form of conservation but not necessarily protection. It is fair to say that traditional nature conservation techniques such as acquisition, designation and planning control are legal mechanisms which, at best, have been difficult to implement in Ireland and, at worse, have come head to head with other national law.

4-4.4.1 Protection of designated areas: AA

The Department of the Environment, Community and Local Government is responsible for the designation of conservation sites in Ireland which is required under European law and national Irish laws. Certain activities within these sites can only be carried out with the permission of the Minister for the Environment, Community and Local Government, and these 'Notifiable Actions' vary depending on the type of habitat on the site. However, designation of a site as a SAC or an SPA (otherwise known as Natura 2000 sites) has far more wide-ranging implications and requirements in relation to designation and protection of designated areas have been met with difficulties across Europe and not least in Ireland. The Natura 2000 network in Ireland is made up of European sites which include SACs and SPAs, both of which are fully protected by law from when the Minister gives notice of his intention to designate the sites. Full protection of a site is also guaranteed in Ireland on land designated as Nature Reserves, SPAs and NHAs (since the Wildlife Amendment Bill, 1999). Despite this, within a single year (2001), the Irish Peatland Conservation Council reported damage on 71 SACs, including that from fundamental activities such as turf cutting, drainage, peat moss extraction and afforestation. This lack of protection of designated sites appears to have several root causes:

- Failure to provide adequate funds for their management;
- Lack of notification to the owner of the conservation interest of the area in question leading to involuntary degradation; and
- An unwillingness to interfere with other projects and/or the absence of adequate procedures to protect sites in private ownership other than with the agreement of the owner.

However, the main cause of ongoing damage, degradation or infringements on Natura 2000 sites has been the reluctance by Ireland to implement adequately the AA obligations under Article 6(3) of the Habitats Directive. Appropriate Assessment is a focused and detailed impact assessment of the implications of a plan or project, alone or in combination with other plans and projects, on the integrity of a Natura 2000 site in view of its conservation objectives and should be carried out by the competent authority. However, planning authorities and other state agencies often ignored or sought to avoid such requirements. In 2008, a ruling from the European Court of Justice (C-418/04) clarified, amongst other things, that Ireland had not correctly transposed the Habitats Directive by not providing explicitly for AA of land-use plans as well as projects. Following this, Commission litigation against Ireland, a Circular Letter and a guidance manual were sent to all state agencies informing of the necessity to undertake AA and of their responsibility to act diligently to ensure full compliance with the obligations of the Habitats Directive (NPWS, 2009). The Commission view remains that Ireland does not commit enough resources to the implementation of the Directive and that the protection of Ireland's natural heritage is jeopardised by political resistance. For example, turf cutting on SAC raised bogs should by EU law undergo an AA in addition to any peat extraction on any designated sites even though they may be considered a sub-threshold development under the EIA Directive. Work to amend the way in which the Habitats Directive is transposed into Irish law and thus force local and planning authorities to undertake AA of plans and projects is at an advanced stage and should address these issues.

4-4.4.2 Planning policy

Aside from sites that are managed directly by the NPWS, the Office of Public Works or NGOs, implementation of environmental policy in Ireland often rests with the local planning authorities. Irish environmental policy is not well presented in this respect in that it is typically distinct from planning policy, as national legislation has isolated nature conservation (Irish Wildlife Act) from the mainstream of land-use change (Planning Acts). The physical planning process which is concerned with the allocation of land for competing uses in the interests of common good, provides an ideal framework for the integration of nature conservation interests but this has not happened because of the specific focus of the Planning and Developments Acts (2000–2007). However, planning does have to take account of European Directives, particularly the EIA, SEA and Habitats Directives. The EIA Directive stipulates that thresholds do not exclude classes of project and all projects (regardless of threshold) should have an EIA if they are carried out in *sensitive* areas. Although the European Court ruled that peat extraction was not exempt from the requirement for an environmental assessment, it has proven difficult to apply to working bogs at a practical level. Not only is this difficult to identify in the case of incremental extraction, but there have been several cases where moss peat extraction has gone ahead on areas greater than 10 ha without an EIA. In addition, any site drained before 2001 is exempt, as well as any site which has been drained for more than 7 years. Local authorities claim that the exemptions for peat extraction are so 'generous' that it cannot be stopped. The prospect that planning permission may be required, together with the possibility of an EIA, has been enough to cause much resentment among many people with turbary rights.

4-4.4.3 Turbary rights

Turbary or the right of private individuals to cut turf for domestic use has been carried on for centuries in Ireland. These rights came about with the resettlement of confiscated land or by prescription. Prescription is a legal term meaning that if a person is able to demonstrate that he/she cuts turf without secrecy, without permission and without force continuously for a period of 30 years the/she has a turbary right. This implies that not all turbary rights will be formally registered. So far, it is estimated that 471,247 ha of blanket and raised bogs have been affected by this process (Malone and O'Connell, 2009). According to the NPWS, turf cutting affects every raised bog of conservation importance in Ireland. The NPWS has shown that over a third of active raised bog (1,000 ha) has been lost as a direct result of turf cutting taking place within protected peatlands (Fernandez Valverde et al., 2006). It is important to point out that turbary rights are incompatible with the management, restoration and future conservation of any important sites worthy of conservation as they directly and indirectly affect negatively the whole ecosystem (not only where the peat is cut). More importantly, small-scale peat cutting has led to a severe diminution of Ireland's peatland carbon store (Wilson, 2008). Most ongoing cutting is not subject to any environmental constraints. The incremental nature of these operations makes it difficult for outsiders to judge how large an area is intended for extraction. Furthermore, the scale of new ventures often falls below the 10-ha threshold required for an EIA even though this threshold has been reduced from its previous level.

Typically small peatlands are owned by a handful of adjacent landowners, but rights to peat cutting (turbary) are spread more widely through the population. Although turbary rights owners cut a common resource, the resource is not a 'common property'. Turbary owners have rights to a demarcated strip of the resource, but are not subject to rules that "*require, forbid or permit specific actions for more than a single individual*" (Ostrom, 1986). They have operational rights to extract the resource, but there are no collective rights that can be used to regulate use or to exclude other resource owners. Crucially, the peatland is not a renewable resource. The peatland ecology may be dependent on the actions of others, but the ability to extract peat is not. In these ways, peatland is different from a free access resource such as a fishery.

The one area in which turbary owners typically choose to act in unison is the manner in which drains are dug and peat is mechanically extracted. This is arranged for a group of holdings. Even if individual owners have no interest in using the peat themselves, they will benefit from receiving a share of the proceeds. If a strip is unclaimed – perhaps because the turbary owner is living elsewhere or is unknown – it will likely be cut along with those of everybody else.

One million tonnes of peat are believed to be cut each year for domestic fuel (Shier, 1996), and it seems likely that demand could increase as the price of oil fluctuates and also for the only reason of keeping the rights to cut turf. In 1999, the Irish Government introduced the Cessation of Turf Cutting Scheme which offered a series of compensation packages to private turf cutters, including options between:

- The purchase of the bog;
- The purchase of the turbary rights;
- An annual payment for 10 years or an offer of another turf plot in the area; and
- A once-off disturbance payment.

The Scheme does not apply to any designated blanket bog sites at the moment, except where turf cutting is found to be seriously affecting the conservation value of the site. The Scheme so far has cost €23 million and involved a very small number of turbary rights holders. Typically, complex ownership and proof of turbary rights complicated negotiations.

In addition, there was no real incentive as the Scheme gave a 10-year notice or derogation to cease cutting turf on 32 designated raised bogs. Another 10-year derogation for a further 21 raised bog SACs applied in 2002 and thus cessation of turf cutting on these sites should be implemented in 2012. In 2009, conflict between turbary rights holders and legally binding conservation policies fully erupted and was largely mediated in favour of the turf cutters. The government formed an inter-departmental working group with the aim to fully implement the scheme which is estimated to require up to €250 million to compensate all remaining turbary rights holders on the 32 raised bog SACs. This group has so far failed to provide any sustainable solutions to the conflict. In the meantime, communication from the various state bodies regarding the Scheme and its objectives has failed to inform the public about the financial implication of not protecting designated sites and more importantly the long-term damage of the peatland resource.

4-4.4.4 Implementation and enforcement of policies

There is an amount of international and national legislation that directly and indirectly bears on the development and outcome of a framework for the sustainable management of peatlands. Nevertheless, deficiencies or conflicts in these legislations can seriously impede any prospects of effective actions. In addition, there are major problems with their implementation. The central reason for this might be the lack of political will to provide resources for implementation. Any effective policy would require public support and thus public awareness. State authorities have often been reluctant to play an active role in keeping the public informed. More importantly, information and integration of policies across state bodies have also been clearly lacking. Virtually all governmental institutions suffer from the same problem: they are vertically orientated, dealing separately with education, agriculture, energy, finance and the environment. The peatland issue is, however, horizontal and does not fit neatly into the boxes allocated by the Government because it is affected by so many sectors. Co-operation between the sectors involved in planning for the future management of peatlands will be critical in addition to communication with all stakeholders.

4-4.5 National Strategies Relating to Cutaway Peatlands

National guidelines for the preparation of Biodiversity Action Plans include a brief reference on cutaway peatlands as being suitable for the creation of wetlands and woodland habitats (Heritage Council, 2003). Few local Biodiversity Action Plans have been prepared by the local authorities for each Irish county, but one Local Heritage and Biodiversity Action Plan, prepared for County Offaly, does include cutaway peatlands as being areas with ecological potential (Offaly County Council, 2005). This Plan is supported by evidence from trial areas of natural regeneration and experimentation with wetland types that are located in that county (Rowlands and Feehan, 2000; Feehan, 2004; The Lough Boora Parklands Group, 2006). The

Irish National Spatial Strategy (NSS) views industrial peatlands as suitable mainly for wind farming (Government of Ireland, 2002) and fails to recognise current debates in landscape ecology that revolve around the utility of multiple-use landscapes (Phillips, 1999; Fry, 2003). Under the licensing requirements for mines to operate in Ireland (IPPC, which is administered and policed by the Irish EPA), there is a requirement for peat extractors to return the landscape to a safe and stable condition. There is no external requirement for Bord na Móna to establish measures for natural regeneration. The statutory planning regulations may offer a potential window of opportunity for instituting wise after-use policies. For example, it could be argued that, under Part 4 (4) of the Planning and Development Act (Government of Ireland, 2000) "*Protecting features of the landscape which are of major importance for wild fauna and flora*" could be interpreted for cutaway landscapes that are permitted to regenerate naturally, as it has already been shown that these landscapes often have a high ecological potential, in the short to medium term. There are few other national policies that address adequately the residual landscapes on mined areas in Ireland. Thus, it is clear that a policy vacuum exists and planning for after-use is mostly carried out on an ad-hoc, situation-specific basis.

4-4.6 Conclusion

International conventions as well as European and national policies have had a principal role in promoting an argument for peatland conservation amongst policy makers, in raising awareness generally, and in ensuring that those peatlands of key conservation interest are preserved. In order to move the agenda of sustainable management of peatlands forward, a series of conceptual, legal and infrastructural constraints must be recognised and addressed:

- Conflict with other national policies drawn up by various sectors: energy policies, agriculture and forestry policies, planning policies and most importantly financial policies;
- Lack of cross-sectoral working groups;
- Drawbacks with traditional protection techniques (acquisition and designation); limitation to the protection of semi-intact peatlands;
- Lack of financial resources;
- Lack of policy-relevant scientific information;
- Lack of community awareness; and
- Lack of background complementary policies, land use and landscape in particular.

While legal and administrative structures exist in Ireland to help the decision-making process regarding peatland, there is no national policy relevant to peatlands and indeed public administration functions are deemed not adequate to administer current legislation. Overall, it is clear that Irish peatlands will still continue to be damaged in the absence of a proper policy – the like of which has already been implemented in other countries such as Northern Ireland – or at least an integrated approach of initiatives that balance economic, environmental and social objectives.

Summary Findings

- *Policies affecting peatlands have been determined only by the market value of peat, namely the value of peat as combustible fuel.*
- *These policies are at odds with the other international and national government policies and conventions, specifically those addressing climate change, biodiversity protection and environmental sustainability.*
- *While a legal and administrative structure exists in Ireland to help the decision-making process, the absence of a national policy for peatlands and the inadequate public administration functions (including funding) to administer current legislation are major obstacles to the sustainable management of peatlands.*

4-5 Socio-Economic and Institutional Approach to the Development of a Peatland Policy

4-5.1 Introduction

Peatlands are an environmental asset, but also a social and economic resource. As such, any framework for their management must deal with the socio-economic and institutional process. Irish peatlands have been the subject of social and economic policy to promote self-reliance in energy, regional development and employment. Peatlands have habitually been cut for fuel at a domestic level, but they have also been developed on a large scale over the past 60 years as an indigenous source of energy for electricity generation. In the Midlands, this peat-industry-related employment has enabled many small farmers to earn enough money to keep their farms while providing an economic stimulus in small towns and rural areas (Joosten and Clarke, 2002). In more recent times, the grazing of peatlands, supported by the generous sheep headage payments available in the 1980s and 1990s, helped to sustain many small upland farms. Similarly, the afforestation of peatlands in the west of Ireland in the 1980s was also a socio-economic policy, utilising peatlands for rural income and employment benefits.

Securing regional employment and development remains an objective of Government. However, as the condition of peatlands has deteriorated, the social and environmental value of the peatland environment in situ has increased. These values are founded on the ecosystem services provided by peatlands and have gone largely unrecognised by policy. Peatlands supply public goods, including biodiversity, carbon storage and, in certain situations, hydrological functions. They are also a quintessential and valued component of the cultural landscape of Ireland. These public goods are not valued in the marketplace, and therefore there is no incentive to sustain their provision. Policy needs to compensate for this market failure.

Peat extraction (industrial or domestic) and drainage for other land uses tend to reduce the provision of public goods of biodiversity, landscape and carbon storage. There are trade-offs between conservation values, economic gains, and social needs that have to be acknowledged and public or social benefits can sometimes work in conflicting directions (as noted in the case of domestic peat cutting). The public's understanding of the value of peatlands is changing. The policies that currently influence peatlands are outdated and largely irrelevant to the needs of modern society. It is a fundamental tenet of economics that scarce resources increase in value, but this is no guarantee that the management of natural resources will respond to changes in value where public goods are concerned. Regulatory and economic instruments are needed to incentivise the conservation and sustainable use of peatlands and to achieve a better balance between the various objectives.

4-5.2 Current Trends

The key context for the development of a peatland policy relates to:

- Existing policies;
- Area and ownership;
- Economic activity associated with peat extraction and other peatland use; and
- Associated non-market services.

Currently, there exists an uneasy balance between outdated policies that seek to exploit peat as a source of energy despite its evident inefficiency and high external costs, and a sticking plaster of conservation directed to protect a few bogs of designated conservation status. There is no clear policy for the management of peatland environments (natural or degraded to various extents) or indeed for the after-use of industrial cutaway peatlands. In the future, it is likely that some peatlands will receive more extensive protection, either through NHA or SAC designation. Designation of all the remaining peatlands of conservation value should be pursued as the best nature conservation and protection policy. Even within core designated sites (NATURA 2000 network), there is still a considerable job required to bring about favourable conservation status. While a small area of peatlands is in state ownership (just under 70,000 ha) and therefore enjoys full protection, current conservation policy is not effective due to inadequate financial support for management and restoration, lack of law enforcement and insufficient advocacy. In addition, the majority of privately owned cutover bogs will remain degraded. The hydrology of many of these worked bogs is unlikely to recover without a cessation of cutting and restoration work, typically a costly process involving the blocking of drains and re-wetting. So far, only minimal resources have become available for conservation and it seems inevitable that many bogs will continue to deteriorate and to gradually dry out.

An even more pessimistic scenario is presented by climate change. If realised, warmer and drier spells will accentuate the drying out of all bogs and possibly seal the fate of many degraded bogs. Conservation organisations may be placed in a position of having to continually hydrate and maintain the more valued ecosystems. Alternatively, policy could acknowledge the threat faced by climate change and recognise the carbon storage value of bogs such that the use of peat for fuel will be wound down before existing commercial bogs are exhausted.

The state forestry company Coillte owns the largest peatland area in Ireland but this is for the most part under tree crop. Current afforestation is effectively suspended on western peatlands with the withdrawal of afforestation grants from the Forest Service of this site type. Coillte has been actively involved in restoring 2,500 ha of afforested blanket bogs and raised bogs through the LIFE programme (see Section 4-5.3.3). In addition, Coillte's strategy for the future management of low production forests details a protocol agreed for 43,000 ha of western peatland forests deemed uneconomic and unsustainable (Tiernan, 2008). The strategy requires that these areas be replanted with minimal inputs while others will be managed with the aim of restoring a bog ecosystem.

Bord na Móna's peatlands are in the majority industrial cutaway peatlands but raised bogs constitute 6% of its holding. These bogs have for the most part been drained, but may still have the capacity to be restored (as seen in Killamuck Bog, near Abbeyleix, County Laois). Some industrial cutaways with suitable hydrology and significant depths of peat left in situ could also have potential for restoration. A landscape of industrial cutaways is likely to develop as the harvestable peat is gradually exhausted. Without management and a clear after-use policy, areas of the Midlands and north-west will risk being more widely perceived as 'wastelands' than the bogs they replaced. The Turf Development Act (1998) requires that Bord na Móna should "*afford appropriate protection for the environment and archaeological heritage*". Furthermore, the licensing of the organisation's operations requires it to rehabilitate the landscape to a safe and stable condition. Bord na Móna has itself allocated €10.8 million to this end and has been experimenting with peatland restoration. An alternative future is one where these large areas of cutaway are managed for conservation and amenity. A few peatlands could potentially be restored to something resembling their former condition, over a long time scale. Other areas could be managed as a mix of open water, wetlands (including paludiculture), wet and dry woodlands and plantation forestry. The concept of a National Wetlands Park is one that has received support from the Oireachtas, although no significant funding has yet been forthcoming. Conservationists would like to see the early establishment of a significant area of parkland over the next 10 years, but this is an ambition that is at odds with Bord na Móna's current strategy of incremental strip extraction. Nevertheless, all sides agree that some level of active management will eventually have to be applied to the industrial cutaway peatland areas.

4-5.3 Regulatory and Socio-Economic Instruments

To achieve the objective of a sustainable future for peatlands, new and imaginative policies will be needed. Governments that wish to ensure the protection or sustainable use of natural resources have a variety of regulatory and economic instruments at their disposal. These various policy options require that the economic value of peatlands is taken into account and that peatlands are managed with a view to the overall public good, including costs and benefits and their incidence – i.e. who pays and who gains. The appropriateness of these policy options is discussed below informed by the insights provided by the other work packages of the BOGLAND project. These options (which are not mutually exclusive) include:

- Regulation, i.e. command and control mechanisms;
- Direct investment or compensation;
- Voluntary agreements;
- Subsidies;
- Taxes or charges;
- Tradable permits; and
- Information.

4-5.3.1 Regulation

An example of regulation is provided by the rehabilitation requirements set by the aforementioned Turf Development Act and the EPA. Another example is the prohibition of the damaging 'sausage machine' method of mechanically extruding peat onto the surface of the bog. This method has a severe impact on the ecological quality of peatlands and has been prohibited on peatlands designated as SACs. However, it has not been banned from other peatlands.

The EIA Directive provides an example of regulation. The Directive requires that an impact assessment be carried out where peat extraction exceeds a threshold of 10 ha. Indeed, the Directive requires that an assessment be carried out whenever a sensitive area is at risk even if the area threshold is not met. A properly implemented EIA would highlight ecological values that are at risk. On the other hand, there are exemptions for sites that have been drained for more than 7 years or which were developed prior to 2001, i.e. most cutover bogs. Therefore, good practice guidelines for EIA on peatlands should be initiated in order to enforce the regulation properly. Ireland has been found to be in breach of the EIA Directive on several occasions, not least in relation to peatlands (European Court of Justice ruling case C215/06) and it is the Commission's view that improvements are needed in Ireland's legislation on impact assessments.

Under current legislation, Ireland has the capacity to protect at least those peatlands that have been designated as SACs. In principle, as discussed in Chapter 2.7 of the End of Project Report, the Habitats Directive gives statutory authorities the right to require that all activities on designated peatlands undergo an AA. This regulation is complementary to the EIA and can also apply in certain cases below the threshold set by the EIA Directive, for example turf cutting. However, while Irish law is in the process of being amended to facilitate the implementation of AA, it is not clear how successfully it can be implemented, especially by local authorities.

In all cases, regulation requires enforcement. This is a practical prospect where cutaway is managed by a single entity such as Bord na Móna. Nonetheless, enforcement has been less successful in relation to the designation of SACs. Mindful of both the social implications of a sudden cessation of turf cutting and of the reaction of influential rural interest groups, the Government allowed a 10-year derogation before the turf-cutting ban was to come into force on 32 SACs. This delay removed the incentive for many private turf cutters to enter into the Cessation of Turf Cutting Scheme (see Section 4-5.3.2).

4-5.3.2 Direct investment – compensation

In principle, the State has the capacity to compulsory purchase turbary rights as demonstrated by the Turf Development Act of 1946. In more recent years, the Irish Government has agreed to purchase and thus definitely protect a proportion of the nation's peatlands, amounting to 10,000 ha of raised bogs and 40,000 ha of blanket bog (Treacy, 1990). In the case of the Cessation of Turf Cutting Scheme (DOEHLG, 2004), the Government offered a variety of incentives, amongst which was the direct purchase of the bog or the purchase of turbary rights and compensation. However, the 10-year derogation removed much of the incentive for the turf cutters to enter into the scheme, while it is likely that the scheme compensated some turbary owners who didn't cut turf in the first place.

Where the purchase involves the bulk of the peatland as a hydrological entity, there is the prospect of providing full protection or restoration. However, where the bog has been largely degraded, adequate protection still requires continuing direct investment in rehabilitation. Sufficient funds will need to be committed to this end on designated peatlands. The allocation of these funds should be determined by pragmatism guided by the benefits and costs of expenditure. In other words, funds should be targeted in relation to the ecological value of individual peatlands, their capacity to return to a situation of water retention or of net carbon sequestration and the expected effectiveness of the physical measures of protection. In the first instance, funds should be directed at preventing further deterioration and then at rehabilitation, except in circumstances where an individual peatland can be returned to a situation of net sequestration through modest new expenditure.

The Cessation of Turf Cutting Scheme was backed by the offer of compensation, the levels of which were deemed generous in absolute terms and in relation to the value of the peat. However, uptake by turf cutters has been affected by the relative cost of switching to other fuels, while both turf cutters and non-turf cutters were affected by the subjective value of property rights possession and by social implications of being seen to enter into the Cessation Scheme. Furthermore, the objective of peatland protection is undermined by the continued cutting by rights holders who choose not to accept compensation (see Chapter 4.4, End of Project Report). In 2009, the Government reiterated its intention of stopping peat cutting on 32 designated bogs, to be followed by a cessation of cutting on a further 21 raised bogs in 2012. It has set up an inter-departmental working group to decide on how the policy can be implemented. Although the Government has prevaricated over the 10-year derogation period prior to 2009, the interval does mean that peatland communities in these areas are conscious of the situation. The best strategy now would be for government to implement the legislation. Any other alternative would simply involve further delay and threats from Europe, while the suspicion of continued procrastination would fail to secure the support of local communities. A problem, however, is the cost. It has been estimated that €70 million would be required to compensate turbary rights holders on the first tranche of the 32 designated raised bogs (based on the rates being paid in the Cessation Scheme). It would cost an additional €180 million to acquire all the other designated areas affected by domestic turf cutting. This is a very substantial sum in the current economic environment. It is also an amount that is far in excess of the level of public benefits identified by the BOGLAND national public survey for protecting *all* Ireland's peatlands. Furthermore, as only a minority of turbary rights holders actively cut peat, there is a moral hazard in compensating these individuals along with the deadweight bill of compensating everybody else. Acquisition would in fact be a better option (value for money) than compensation. This is because if the State acquires the land, it not only has full ownership of the turbary rights but holds also the management rights. This would, for example, allow restoration work to be carried out.

4-5.3.3 Voluntary agreements

Both Bord na Móna and the semi-state forestry company, Coillte, have accepted designation in the case of a few bogs that they own. In other cases, they have adopted voluntary agreement to restore a small number of bogs of high conservation interest. Most of these bogs were of low economic value (be it for peat extraction or forestry). In some cases, these agreements have also been supported through financial incentives in terms of European funding, e.g. through the LIFE project. The next round of LIFE+ funding, for which Coillte has applied to restore a further 650 ha, will help continue these incentives.

Another example of a voluntary agreement is provided by the agreed phasing out of peat as a horticultural growing medium in the UK. The Growing Media Initiative, launched in 1999 under the Biodiversity Action Plan and the UK Government's Habitat Action Plan, committed companies to "*working towards 90% peat reduction in the UK horticulture retail market*" by 2010. The initiative has been vigorously promoted by the UK's Horticultural Trade Association with government support and the backing of big national DIY stores. In response, the growing media industry has entered a new era of innovation, using a variety of materials (mostly from waste) as garden peat alternatives. Bord na Móna has also joined the

Growing Media Initiative and has developed its own waste composting centre to develop peat-diluted and peat-free growing media. In the long term, this should have a positive impact in reducing the overall requirement for peat. However, the changeover to alternative growing media has been much slower in the professional horticulture market. The absence of regulation in respect to peat *use* has meant that the British horticultural industry has begun increasing its imports of peat, much of these from Ireland (Joosten and Clarke, 2002). Such an initiative should be reviewed and examined for application here in Ireland.

4-5.3.4 Subsidies

The economic instrument of subsidisation has been used very successfully in relation to peatlands. However, this instrument has not been used to protect peatlands, but rather to underwrite the means of their exploitation. In the Turf Act of 1981, subsidies (and grants), were used to enable private turf cutters to develop smaller peatlands for turf cutting. Bord na Móna was also once subsidised through preferential loans, complemented by direct public investment in roads and railways to remove peat. Subsidies are still used to allow peat fuel and the construction of peat-fired power stations to be competitive with other cheaper fuels. For 2009, the annual subvention raised through the PSO levy on electricity consumers was estimated at over €93 million. The comparable figure for renewable energies was €72 million. The subsidies available through the PSO serve different ends. Whereas some go to the promotion of renewable energies, those allocated to the peat industry are based on peat's former value as an indigenous fuel supply and the promotion of regional employment and development. In the first instance, this subsidy should be removed over a fixed period of time as the continued carbon emissions from peat burning are contrary to the national interest, a reliable energy supply can be supplied by a mix of indigenous natural gas and renewables (including potentially biomass for co-firing) and modern regional development can be secured by alternative means. The subsidy should be supplanted by the Government through conventional methods such as tax relief on wind-farm investment to allow wind farms on cutaway peatlands to compete for energy contracts on comparable terms with terrestrial and offshore farms. The Government's Energy White Paper (2007) acknowledges the need to balance social benefits and costs. The maximisation of such benefits in the long term is poorly served by continued financial support to the peat industry.

4-5.3.5 Taxes or charges

Environmental economists generally favour the use of taxes or charges on activities that contribute external environmental or social costs as their imposition conforms to the Polluter Pays Principle. This Principle is advocated by the OECD (Organisation for Economic Co-operation and Development) and has been agreed by its members, including Ireland. Priced in relation to the levels of an external social cost, taxes or charges communicate an incentive to reduce the level of the damaging activity. In principle, a carbon tax would certainly affect the viability of peat as a source of fuel. Peat is amongst the most carbon intensive of fuels, at least in terms of emissions.

In its budget in late 2009, the Government introduced a new carbon tax. The tax has applied to sales of peat briquettes and to heating oil from May 2010. However, in this case, the tax could actually have the converse result in that much peat could be either cut directly by rural turbary owners or purchased from contractors. Nobody knows precisely how much peat is cut each year by rural contractors and much of this is purchased through the informal market. It has been estimated that only 15% of the privately produced sod peat is traded (Fitzgerald, 2006). Consequently, little of this peat will attract a carbon tax. Domestically produced peat that escapes the carbon tax will be favoured relative to competing fossil fuels (mainly natural gas and coal) to which the tax applies, with the result that cutting could actually increase in the short term.

4-5.3.6 Tradable permits

Like all energy installations, peat-fired power stations have been allocated allowances for free until 2012 on the EU ETS. The scheme aims to provide utilities with a continuous price incentive to move away from energy with high carbon emissions. From 2013, all electricity generation plants, including the peat-fired stations, will be subject to auctioning rather than free allocation. Due to the necessity to pass on this cost of purchasing allowances to cover the high emissions, the peat-generated electricity will become more expensive. It has been suggested that some of the revenues generated by the sale of allowances to the industry will be recirculated back to the national treasury. It is stated in the Revised ETS Directive (2009/29/EC) that 50% of these revenues *should* be used for climate-related activities. This is a mechanism by which funding for the protection of peatland carbon stocks (through management or active restoration for example) might be found. While this allocation of revenues is a matter for national policy, there are some discussions at international levels that may create additional incentives to pursue a peatland policy. The inclusion of Wetlands, and in particular wetland restoration, within any post-Kyoto agreement would create a mechanism by which enhanced carbon sinks (or reduced carbon loss) might be accounted for as part of compliance with agreed targets (IPCC, 2010, 2011).

4-5.3.7 Information, education and public participation

Inevitably, many of the proposed economic instruments will be unpopular within peatland communities and the wider rural constituency. It is therefore essential that it is combined with a strategy of information, education and engagement. At present, the value of peatlands is perceived by a portion of the public only in terms of their biodiversity. The time is opportune to highlight the importance of peatlands' other ecosystem services, in particular their role in helping to forestall climate change. However, while recent severe weather has raised the profile of climate change, these arguments will still face a widespread scepticism. There is, therefore, a need to discuss peatlands in terms of their status as a national asset in allowing Ireland to meet its international commitments. The argument is akin to earlier calls on the public at the time when peatlands were secured for industrial cutting as an indigenous national resource.

The need for environmental education should be married with a simultaneous programme to engender the active participation of peatland communities. The socio-cultural work package within the BOGLAND project demonstrated that peatland communities could be receptive to genuine efforts to secure their participation, at least as regards the after-use of cutaway. This process will be more challenging in areas of cutover peatland, but if communities are to be discouraged from continuing with an activity that has such a long social and cultural lineage, this participation should be combined with visible investment in social and economic infrastructure. The National Rural Development Programme commits resources to precisely this form of development as a means of rural diversification away from a reliance on primary sectors. The Department of Agriculture, Fisheries and Food and the Department of Community, Rural and Gaeltacht Affairs have much experience in rural development initiatives of a social nature. Through an inter-departmental approach, these types of initiatives could be combined with efforts to secure investment in economic and communications infrastructure across the Midlands area most affected by a cessation of peat cutting.

4-5.4 Future Socio-Economic Strategies

A variety of complementary measures will be needed to ensure the future sustainable management of peatlands. These can be characterised as the four Is:

1. Institutions;
2. Incentives;
3. Investments; and
4. Information.

As regards *institutions*, one problem at present is that there is no organisation responsible for developing and implementing an integrated policy that works towards delivering the greatest net benefit from the resource in ways that are sustainable. This is inadequate given that peatlands yield a variety of market and non-market goods and services. A number of government departments, including most centrally the Department of Communications, Energy and Natural Resources (energy) and the Department of the Environment, Community and Local Government (national parks and wildlife, biodiversity, climate change, water planning), have key policy responsibilities that shape how peatlands are used. Bord na Móna is the most obvious and pervasive face 'on the ground.' However, its principal activities of producing horticultural products or of supplying peat for the production of electricity can be in conflict with national policy in relation to services provided by undeveloped peatlands, including carbon storage and with the country's international obligation to reduce GHG emissions. A way forward to address the institutional issue would be for the Department of Communications, Energy and Natural Resources and the Department of the Environment, Community and Local Government to lead the development of a policy framework that embraces the key market and non-market functions. This would require an amendment of the relevant acts to allow Bord na Móna to manage peatlands to deliver the full economic value from peatland, i.e. carbon storage, amenity and biodiversity, rather than the existing portfolio of commercial use of peat which by definition is not sustainable. It should extract, where possible, an income from these associated services, but would need initial support from the Government, both financially and through a co-ordinated policy strategy.[10]

The new peatland institution could be charged with the management of other bogs that have been cut over for domestic turf and which either have some prospect of restoration or which represent deep stores of carbon. Similarly, it would be actively involved in management decisions for forested peatlands and other degraded state-owned peatlands. It is within the capacity of the State to allocate this responsibility. The other option is that without effective management, many peatlands would continue to degrade and emit carbon.

Regarding *incentives*, the key actors need to have the right incentives to 'automatically' deliver desired outcomes – if the incentives are wrong, then desired outcomes will not be delivered. The carbon storage functions of peatlands need to be remunerated, and one mechanism could be to use some of the aforementioned revenues from the auctioning of allowances in the EU ETS to compensate for this function. International climate policy offers some precedent in that payment for conserving carbon in situ is beginning to be taken seriously. The Copenhagen Accord, which emerged from the International Climate Change Conference of the Parties in Copenhagen (December 2009), proposed that developing countries receive carbon credits for maintaining their forests. As many of these forests are on peatland soils, it is a logical extension that any such system of credits should extend to peat soils in developed countries too. It is possible that credits will be allowed for carbon storage through peatland conservation once the protocol is renegotiated in 2012. Indeed, European policy may precede whatever is negotiated in the protocol. It is possible that policy will permit Ireland to treat sequestration, or possibly the prevention of peat oxidation, as a carbon credit against its total emissions.

Industrial cutaway peatlands have potential for wind energy, and, in some locations beside the Shannon, potential for flood moderation. The exploitation of both activities provides a public good and would be sensitive to incentives. Being low-lying, the Midlands industrial cutaways are not ideal for wind energy generation, but the sites are located at the heart of an electricity infrastructure. Bare cutaway peatlands provide no ecosystem services, so the risk of environmental impacts and conflicts is low. Furthermore, the public in these areas appears to be supportive. Once again, there are precedents in the form of the incentives provided for offshore wind energy where the exposure to wind is good, but the infrastructure is non-existent and investment is costly. The peat energy industry, meanwhile, is already supported through the PSO.

As regards *investments*, delivery of designated sites which are adequately managed, the development of alternatives to peat, and low-elevation wind farms, all require investment in R&D and in infrastructure. Here again, one possible solution would be to maintain the aggregate level of PSO for a few years, but to use a portion of these funds to invest in a peatland resource that would sustain economic activity, carbon storage and the delivery of ecosystem services.

Finally, as regards *information*, informed policy makers and public are essential. The choices, the trade-offs, their costs, their benefits, and the ways in which they can be delivered need to be properly communicated if local and national support is to be secured. The peatlands in their various manifestations and stages of

10. There is an interesting precedent in the US, where the mandate of the Army Corps of Engineers was successfully broadened from the provision of water infrastructure for flood control and power generation and management to include recreation and the relevant ecosystem services.

development comprise an important resource, but the BOGLAND project has identified considerable ambiguity and lack of understanding as to the significance of the asset, and in particular its role in the provision of ecosystem services, notwithstanding broad support for conservation and restoration. Developing and delivering on a policy framework to continue to improve this information, and to provide better bases for decisions, both locally and nationally, should be the next step.

Summary Findings

- *Managing peatlands so that they can deliver all the benefits (primarily in relation to carbon storage, biodiversity, amenity and landscape) will require a mixture of economic instruments, regulation and institutional design, namely:*
  - *Realising the asset value of peatlands through remuneration of the emissions avoided from peat soils via linkage with the European Carbon Trading Scheme;*
  - *Exploiting the potential of industrial cutaway peatlands as land for paludiculture, as a source of wind energy and for flood moderation supported by price transfers backed by regulatory instruments;*
  - *Channelling these resources to a new institution charged with the management and restoration of the country's peatlands; and*
  - *Opening the debate and actively involving the public, and peatland communities especially, in the future wise use of Ireland's peatlands.*
- *This study has identified considerable ambiguity and lack of understanding as to the significance of the peatland resource, and in particular its role in the provision of ecosystem services. It is time to open the debate and actively involve the public, especially the local communities, in drawing future management options for peatlands, especially industrial cutaway peatlands.*
- *Ireland should lead the way in realising the asset value of peatlands through remuneration of the emissions avoided from peat soils via linkage with the European Carbon Trading Scheme.*
- *In the case of ongoing turf cutting on protected sites, acquisition would be a better option (value for money) than compensation. This is because if the State acquires the land, it not only has full ownership of the turbary rights but holds also the management rights. This would, for example, allow restoration work to be carried out.*

Section 5:

Protocol for the Sustainable Management of Peatlands in Ireland

5-1 Developing a Protocol for the Sustainable Management of Peatlands

5-1.1 Support Framework and Key Aims of the Protocol

The scientific investigations (e.g. biodiversity assessments, GHG emissions monitoring, mapping and analysis of physical characteristics, socio-economic surveys) carried out within the BOGLAND project revealed the global significance of a national resource and the dilemmas of peatland management, utilisation and conservation. The main part of this report presented the backdrop of the exceptional features of peatlands which includes the provision of benefits traditionally ignored in decision making. In this large-scale analysis, the general and local public, as well as stakeholders, were engaged in peatland discussions. This collation of information provides a comprehensive guidance for the 'sustainable' management of peatlands and needs to be translated into instruments to assist decision making. The BOGLAND project provided a strong scientific and socio-economic evidence base, a prerequisite to advise political decision making (Fig. 5-1.1). A support framework or *protocol* for the sustainable management of peatlands necessitates the drafting of an action plan (set of recommendations) for managing peatlands and the articulation of a vision for a peatland policy. First, however, key aims need to be presented in the current context together with an analysis of the main existing issues and obstacles to the successful sustainable management of peatlands.

Ultimately, this protocol aims to support the promotion of the sustainable management of peatlands. A system is said to be sustainable if it allows the well-being of future generations to be at least as high as that of the present generation. Well-being, in this definition, comprises a combination of financial (measured by per capita income, employment, etc.), social (measured by education level, life expectancy, health, etc.) and environmental (measured by quality of environmental endowments, including air, water, soil, flora and fauna) criteria. A system can also be defined as sustainable if it is not vulnerable and thus not threatened. The sustainable management of the peatland resource is a highly desirable objective towards which Ireland should aim. However, the Irish landscape is the product of many centuries of human interference and,

Baseline analysis (data acquired in this project)

Action Plan:

1. Awareness of current situation
2. Management options
3. Policy instrument options
4. Improvement of our scientific understanding

Vision of future (targets):

Sustainable management of the peatland resource

'*Towards a peatland policy*'

Figure 5-1.1. Evidence-based policy development for Irish peatlands.

in the case of peatlands, it has been significantly degraded as a result of a wide range of disturbances. The BOGLAND report has found that past and current management of peatlands in Ireland has not been generally sustainable and has had major negative impacts on the ecosystem services that they provide (biodiversity, climate, past knowledge, etc.). Natural peatlands, which are hydrologically and ecologically intact, have become rare and are being further threatened. Past mismanagement has led to the majority of the Irish peatlands being damaged or becoming deteriorated. Conservation management in its traditional form (designation) was also very limited, resulting in a small area of peatland enjoying protection, at least on paper. Indeed, designated areas continue to be damaged (Table 5-1.1). A protocol for the sustainable management of peatlands should ensure that, while a substantial part is already irreversibly lost, what remains of this natural heritage should be enhanced. In short, any vision of the future must include maintaining and enhancing one of Ireland's last natural ecosystems – *peatlands*. This protocol aims to succeed in achieving such vision that serves the needs of humans and preserves nature.

Table 5-1.1. Management of Irish peatlands through time.

Past	Present	Future 'with the objectives of achieving'
• Conservation of a very small proportion of the peatlands • Conversion of the peatlands to a different state • Fixed, short-term economic uses prevailed and were even subsidised • Long-term economic uses of ecosystem services such as carbon storage and biodiversity function ignored and un-remunerated	• A large natural resource of local, national and international importance but hydrologically and ecologically intact peatlands have become rare (some types even extinct!) • Damaged and deteriorating conditions of the majority of Irish peatlands (bad states of threatened EU priority habitats) • Peatlands are vulnerable as some current uses are not sustainable	• A strategy to manage peatlands sustainably with the means of achieving more desirable outcomes than their continued loss and by regularly adapting measures against future global changes • To utilise the resource as long as sustainability is maintained

5-2 Synopsis of Current Situation

5-2.1 The State of Irish Peatlands in 2010

- Ireland remains one of the heartlands of blanket bogs in the world but is barely holding on to its unique raised bogs.
- While new species are still being discovered in bogs and fens across the country, it can be assumed that the contribution of Irish peatlands to biodiversity is not yet fully understood.
- Peat soils cover 20.6% of the national land area and contain more than 75% of the total soil organic carbon in Ireland but this asset is under great pressure.
- Natural peatlands act as a long-term carbon store and play an important role in the regulation of the global climate by actively removing carbon from the atmosphere, but this important function is reversed (i.e. there is a net release of carbon) when the peatland is damaged.
- All Irish peatlands (raised bogs, blanket bogs and fens) have been impacted by natural and anthropogenic disturbances over the course of their history. Peat soils now occur under different land uses – forest, grassland, agricultural crops – as well as a range of degraded peatland ecosystems, from industrial cutaway bogs to overgrazed blanket bogs, and a very small area of active peatland (near intact).
- While being a significant resource, the degradation of peat soils witnessed in the 20th century has left a disproportionately small amount of near-intact peatlands and a much reduced mire area or active peatland where peat formation is ongoing. Of the 15% of the peat soils extent that are currently protected, less than three-quarters are in near-intact condition and of that a smaller proportion is active (Table 5-2.1).
- The area of active raised bog has decreased by over 35% between 1995 and 2005. It is estimated that between 2% and 4% of this active area continues to be lost every year since then. While turf cutting continues, it is reasonable to expect that the area of active bog will continue to decrease (this decline will in fact continue for

Table 5-2.1. Distribution of Irish bogs (ha) in 2010 (sources from the National Parks and Wildlife Service (NPWS), Coillte and Bord na Móna).

Category	Total area (Hammond, 1981)	Protected peatlands	Protected near intact	Unprotected, of conservation value	NPWS ownership	Coillte ownership	Bord na Móna ownership
Raised	237,190	35,000	21,519 [2]	28,481[3]	7,000	31,725[5]	5,302[7]
Blanket	765,890	182,063	143,248	34,536[4]	34,339	188,334[6]	7,383
Industrial cutaway	82,080[1]	–	–	–	–	12,450	74,193
Total	**1,085,160**	**203,582**	**164,767**	**63,017**	**41,339**	**232,509**	**86,878**

[1]Includes 74,110 ha of industrial cutaway raised bog and 7,970 ha of industrial cutaway blanket bog.
[2]Includes 1,945 ha of active bog (supporting a significant area of vegetation that is normally peat forming) (NPWS, 2007a).
[3]Total area of uncut high bog (50,000 ha) minus area of protected uncut high bog (21,519 ha) (NPWS, 2007a).
[4]Total area of blanket bog of conservation value (Malone and O'Connell, 2009) minus protected areas.
[5]Includes 570 ha of restored bogs.
[6]Includes 2,000 ha of restored bogs.
[7]Mostly hydrologically damaged but includes some restored areas. Bord na Móna sold nearly 7,000 ha of raised bogs of conservation value to the NPWS.

several decades after cutting and drainage ceases).

- The boundaries of most protected peatlands are hydrologically deficient and do not allow adequate hydrological management of the designated sites. Therefore, their restoration in terms of increasing the active area (that is fully functioning) is jeopardised.

- Since the 1950s, there has been a sharp decline in the area of Irish peatlands of conservation importance which has arisen as a result of human exploitation of the resource.

- The last century saw:

  - The introduction of mechanised turf extraction schemes (both industrial and domestic);

  - Afforestation schemes;

  - Intensification of agriculture through the CAP; and

  - Land reclamation through drainage schemes, all of which contributed to the dramatic decline in natural peatlands.

- The biggest disturbances of Irish peatlands in the 21st century are: industrial and domestic peat extraction, private afforestation (afforestation of western peatlands by Coillte has been suspended), wind-farm and associated infrastructural developments, recreation activities, invasive species and climate change.

- More than a third of Irish bogs (excluding fens) are state owned (Table 5-2.1).

- Being degraded to various degrees, the vast majority of Irish peatlands are critically at risk of future disturbances such as climate change. Predicted changes are likely to affect low Atlantic blanket bogs in the west of Ireland the least while the areas showing greatest changes in precipitation and temperature are the areas containing basin peat in the Midlands.

5-2.2 Main Obstacles to Sustainable Peatland Management

The main obstacles to the sustainable management of peatlands in Ireland are summarised here:

- A number of government departments, in particular the Department of Communications, Energy and Natural Resources (energy) and the Department of the Environment, Community and Local Government (national parks and wildlife, biodiversity, climate change, water planning), have key policy responsibilities that shape how peatlands are managed. These are often in conflict.

- While a legal and administrative structure exists in Ireland to help decision-making processes (EU Directives on environmental issues and land use planning have been ratified), the absence of a national policy relevant to peatlands and inadequate public administration functions (including funding) to administer current legislation (e.g. peat cutting on SACs) are major obstacles to conservation targets.

- Based on our economic analysis, it was concluded that acquisition ought to be a more cost-effective process than the compensation scheme to stop turbary rights holders from cutting turf on protected bogs.

- Poor communication (e.g. contacts with turbary rights owners regarding turf cutting on protected sites are insufficient).

- Lack of public awareness and understanding.

- Poorly planned renewable energy schemes (mistakenly promoting wind farms on upland blanket bogs).

- Unregulated voluntary carbon market.

- Poor prediction of climate change at the regional level.

- Market-driven peat extraction for horticulture.

- Management of the surrounding land area and hydrological catchment often ignores the needs of the peatland site.

- The management of peatland has often been led by single-interest groups that are often insufficiently informed about the wider consequences of inappropriate actions.

This situation, together with the poor conditions of the majority of Ireland's peatlands, calls for a national framework for their sustainable management, coalescing environmental, social, economic and institutional objectives.

5-3 Action Plan

The targets set around managing Irish peatlands have changed through time and will continue to change as they integrate future ecological, economic and social conditions. However, overarching targets have been highlighted within this protocol for the sustainable management of peatlands and the preferred means or actions of achieving these targets are presented below, under seven headings:

1. Managing peatlands for biodiversity (MPB);
2. Managing peatlands for carbon, climate and archives (MPC);
3. Managing peatlands for water (MPW);
4. Managing peatlands for other land uses (MPL);
5. Managing state-owned peatlands (MPS);
6. Managing peatlands using socio-economic instruments (MPE); and
7. Managing peatlands for and with the people (MPP).

The responsibility for each action may rely on one or several parties working together for this action plan to be successful. These include: the industry sector (including Bord na Móna, Coillte and other private companies), local and national government and agencies (EPA, NPWS), NGOs and universities and other bodies engaged in research (e.g. socio-economic). In the 'Actions' outlined below for the sustainable management of peatlands, the following abbreviations are used: IND, Industry sector; GOV, Government and its agencies; RES, Research bodies.

5-3.1 Management of Peatlands for Biodiversity (MPB)

5-3.1.1 Observations

Peatlands are exceptional natural entities. They are local illustrations of a unique combination of habitats with a unique biodiversity and natural heritage value. Peatlands are a valuable ecosystem from a national, European and global perspective. The last century and particularly the last half-century have been the most destructive for peatlands. It has taken the same amount of time to realise that the degradation of these ecosystems and the disappearance and even extinction of species are not in the interest of human well-being at large, especially not of future generations. The loss of peatlands in Ireland equates to a loss of biodiversity at regional, national and international levels. Therefore, it is vital to reverse the trends, halt further loss of priority habitats and species, and protect the last intact peatlands. The drivers of biodiversity change are projected to either remain constant or even increase in the near future and this represents a major challenge for the protection of peatlands. The sustainable management of peatlands which necessitates a new approach to the protection of natural and degraded ecosystems ought to make a very significant contribution towards Ireland's obligations under the CBD.

5-3.1.2 Targets

- To maintain the current extent and overall distribution of all blanket bogs, raised bogs and fens currently in favourable conditions (Actions MPB1, 2, 3);
- To improve the status of peatland habitats which were assessed as 'bad' in the latest NPWS assessment (with prioritised target sites and timescale) (Actions MPB2, 3, 4);
- To maintain the number of rare species and rare habitats protected under the Habitats Directive (1992) and the Wildlife (Amendment) Act (2000) and improve their status (Actions MPB1, 2);
- To increase the area of 'Active raised bog' by improving the areas designated as 'Degraded raised bog' (Actions MPB1, 2, 3);
- To increase the range of protected peatland habitats, including fens (Actions MPB1, 4);

- To maintain the network and landscape integrity of peatlands (Actions MPB1, 4);
- To avoid further loss of protected peatlands by removing their threats (Action MPB6);
- To increase the awareness of peatlands and associated biodiversity: maintain, restore and enhance the range, network and integrity of peatland habitats, some of which are unique to Ireland (Actions MPB2, 4, 7, 8);
- To protect and enhance biodiversity at different levels: from landscape to genetic (Actions MPB1, 2, 4);
- To improve our understanding of the variety of peatlands at all levels and associated habitats (Actions MPB2, 4, 5, 8); and
- To develop a conservation strategy as part of the general national peatland strategy (Actions MPB1, 2, 6, 7).

5-3.1.3 Actions – 1. Management of peatlands for biodiversity (MPB)

		Priority	Remit	Link
MPB1:	All remaining areas of priority habitat peatlands (active and degraded raised bogs and blanket bogs) should be declared as SACs and more peatland sites (including fens) should be designated under adequate legal protection. Attention should be paid to maintaining the integrity of these peatland habitats to ensure the survival of the unique biodiversity that they sustain.	High	GOV	MPB4 MPC10
MPB2:	Designated peatland sites should be appropriately managed and restored to increase the total area of near-intact peatlands. A range of key peatland sites representing all types of peatlands should be identified for positive management to achieve biodiversity targets at different levels: genetic, species, habitat and ecosystem.	High	GOV	MPC2 MPC3
MPB3:	The threats and causes of degradation should be evaluated on all protected peatland sites (included those proposed for designation). The Habitats Directive gives statutory authorities the right to require that all activities on designated peatlands undergo an AA. While Irish law is in the process of being amended to facilitate the implementation of AA, all activities pertaining to protected peatlands should undergo an AA (including turf cutting).	High	GOV	MPC2
MPB4:	An inventory of the condition of all peatlands (including those not designated) should be developed.	Medium	GOV RES	MPB1 MPC3 MPS2
MPB5:	Wet heaths are often associated with blanket bogs and are listed in Annex 1of the Habitats Directive as an important habitat to protect. An assessment of the disturbance to these habitats is required as they have serious consequences in terms of carbon loss and water quality.	Medium	GOV RES	
MPB6:	Subsidies that promote excessive and destructive uses of peatlands and their ecosystem services should be eliminated.	High	GOV	MPL8 MPE5 MPE9
MPB7:	Consideration for the protection and conservation of peatland biodiversity should be integrated into other government policies, such as climate change policy, renewable energy policy, strategy for invasive species and the Water Framework Directive.	Medium	GOV	MPC7
MPB8:	Traditional knowledge as well as relevant scientific findings and data should be made available to all of society but particularly stakeholders and decision makers, thus raising awareness and understanding of peatland habitats and associated biodiversity.	Low	GOV NGOs	MPP3 MPP7

5-3.2 Management of Peatlands for Carbon, Climate and Archives (MPC)

5-3.2.1 Observations

Irish peatlands are a huge carbon store, containing more than 75% of the national soil organic carbon. A constant high water table that restricts aerobic decay is a prerequisite for long-term storage of carbon in peatlands and preserving the information stored in the peat (archaeological and palaeo-environmental archives).

Peat soils are sensitive to degradation processes such as erosion, compaction and contamination. Studies in the BOGLAND project demonstrated that natural or undamaged peatlands help to regulate the global climate by actively removing carbon from the atmosphere but this important function is reversed (i.e. there is a net release of carbon) when the peatland is damaged. Disturbances, such as peat extraction, drainage or flooding, have considerable impact on carbon cycling within the peat soil with implications for their potential for sequestration and storage of carbon. Peat extraction transforms a natural peatland, which acts as a modest carbon sink, into a cutaway ecosystem which is a large source of carbon dioxide. An area of raised bog damaged by domestic peat cutting may emit as much as six to seven times more carbon dioxide than in a near-intact part of the peatland, due to peat oxidation intensified by the lowering of the water table.

In addition, the carbon cycling of degraded peatlands may be particularly vulnerable to future changes in climatic inputs compared to intact peatlands. However, considerable uncertainty exist in predicting the effects of future climate change on the carbon stores within peatlands, partly due to the complexity of the climatic system itself but also as a result of response variations both between and within individual peatlands.

Restoration may be an effective way to reduce carbon dioxide emission and maintain the carbon storage of peatlands. While natural peatlands are able to buffer the impact of external perturbations such as small changes in climate, they are unlikely to survive as carbon sinks, with large magnitudes of changes in precipitation and temperature.

5-3.2.2 Targets

- To retain, enhance and maximise the value of peatland as a carbon store (Actions MPC1, 2, 3, 6, 7, 10);
- To promote carbon dioxide absorption by the peatland vegetation and to encourage carbon accumulation in the peat (Actions MPC2, 3, 9, 10);
- To decrease carbon emissions and other carbon loss (through fluvial, erosion or burning processes) from degraded peatlands (including cutovers and cutaways) (Actions MPC1, 2, 3, 4, 6, 7, 9, 10);
- To restore the hydrological integrity of degraded peatlands (Actions MPC1, 2, 3);
- To safeguard the archaeological and palaeo-environmental information stored in the peat (Actions MPC1, 2); and
- To mitigate potential climate change effects including the spread of invasive species (Actions MPC2, 5, 8, 10).

5-3.2.3 Actions – 2. Management of peatlands for carbon, climate and archives (MPC)

		Priority	Remit	Link
MPC1:	Strict protection of peatlands sites that have been designated for conservation is critical for the maintenance of their carbon storage and sequestration capacity and associated ecosystem functions. This requires (1) stopping and removing any disturbances on these sites, and (2) setting up a management plan with the aim of maintaining the active peatland system and restoring the full functioning status of the peatland.	High	GOV	MPB2 MPB3
MPC2:	Peat oxidation should be stopped in all protected peatlands as well as in degraded peatlands where possible as protected peatlands are only a minor part of the total area of peatlands. This requires a programme of restoration which should follow an adaptive management approach, i.e. assessing individual sites and developing individual management plans to maximise the natural functions of each as each peatland is different.	High	GOV	MPC1 MPB4 MPS1 MPS2 MPW3
MPC3:	In order to combat carbon dioxide emissions from peat oxidation, water management in degraded peatlands should be optimised (reduce drainage) and preserve the palaeo-information within the peat. Water management for restoration purposes needs sufficient time and resources to take cognisance of the local hydro-geology which has often very localised conditions.	High	GOV	MPC1 MPC2 MPW2 MPW3

MPC4:	Invasive species should be actively removed from protected sites and appropriate long-term management should be set out for those sites in relation to updated climate change scenarios.	Medium	GOV	MPB1 MPC1
MPC5:	An appropriate form of rehabilitation or restoration should be a licensing condition for any exploitive use of peatlands.	High	GOV	MPL6
MPC6:	Measures to reduce peat (carbon) loss from degradation such as erosion should be introduced at management plan level (e.g. commonage) and in other policies (agri-environmental).	Medium	GOV	MPB7
MPC7:	Burning of peatland as a management practice to facilitate the extraction of the peat or to increase the population of grouse (promoting heather growth) should be strictly controlled. The Muirburn Code (Scottish Natural Heritage, 2005) should be used as best practice in using fire as a management tool to avoid accidental fire and additional carbon emissions.	Medium	GOV	
MPC8:	The establishment of a network of protected areas representing the geographical distribution of peatland types should be a priority in order to off-set climate change threats.	High	GOV	MPB1
MPC9:	The first option for after-use of cutaway peatlands should be to promote, where possible, the return to a natural functioning peatland ecosystem. The favoured management option should therefore involve re-wetting or the creation of a wetland.	Medium	GOV	
MPC10:	New production techniques such as paludiculture (growing biomass in a wet environment) should be developed and promoted to generate production benefits from cutaway and cutover peatlands without diminishing their environmental functions. Paludiculture is probably the after-use option that can have the most benefit from a climate mitigation point of view: avoiding carbon emissions from the degraded peatland, from the displaced fossil fuels and also from its transports.	Medium	GOV IND RES	MPE4

5-3.3 Management of Peatland for Water (MPW)

5-3.3.1 Observations

Natural peatlands are essentially wetlands, i.e. hydrological systems, and their ecological functioning is primarily dependent upon the dynamics of water flow. Water is the single most important factor enabling peat accumulation and a waterlogging condition is a prerequisite for peat formation and preservation.

Changes in the hydrological regime that sustains the peatland will invariably disturb the normal hydro-ecological functioning of the peatland. Restoration of the hydrology is also vital for the maintenance of other functions such as control of carbon emissions and attenuation of water quality. The ability of peatlands to regulate water flow is contentious. In fact, blanket bogs tend to exacerbate run-off under conditions of high rainfall while failing to provide a regular base flow in dry periods. Under normal weather conditions, they may provide some beneficial regulatory effect on water flows downstream. Some fens can act as transition areas for water, providing storage and maintaining base flows to the downstream system. Bogs and fens often have complex modes of water transport (depending on peat properties and conditions) and identifying these pathways is crucial if saturated conditions in the peat and its dependent ecology are to be maintained.

5-3.3.2 Targets

- To preserve and restore the hydrological status of protected peatlands in a catchment (Actions MPW1, 2, 3);
- To restore water levels and flow regimes as close to the natural conditions as possible in all protected sites (Action MPW2);
- To avoid unnecessary drainage in forested peatlands and other peatland activities that lead to deterioration of the quality and quantity of the water (Action MPW3); and
- To maximise the use of cutaway peatlands for water regulation (Action MPW4).

5-3.3.3 Actions – 3. Management of peatland for water (MPW)

		Priority	Remit	Link
MPW1:	It should be ensured that peatlands (including cutaway peatlands) are fully included in the development of River Basin Management Plans and that they are appropriately assessed in Strategic Environmental Assessment of County Council Development Plans.	Medium	GOV	MPL1
MPW2:	A methodology/approach should be developed to systematically investigate and quantify the environmental supporting conditions and hydro-ecological linkages that can be peculiar to any given peatland.	Medium	GOV RES	MPC3
MPW3:	An appropriate water-table level (i.e. drainage) should be adopted as good practice on utilised peatlands	Medium	GOV RES	MPC3
MPW4:	The enhancement of cutaway peatlands for flood storage and attenuation should be investigated.	Low	GOV RES	

5-3.4 Management of Peatlands for Other Land Uses (MPL)

5-3.4.1 Observations

Peatlands are extremely sensitive to any kind of management options that affect the range of natural functions they have been providing since the last ice age, and have come under serious threat in the last 50 years or so. The BOGLAND project came some way in demonstrating to managers and decision makers the compelling evidence of the importance of Ireland's peatland resource as a major carbon store, the role of natural (intact) peatlands as carbon sinks, the large GHG emissions from degraded peatlands, the role of peatlands in watershed management, their contribution to biodiversity and the attributes that confer on them a cultural and informative function. Therefore, peatland management approaches that preserve or restore the major natural functions of peatlands should be promoted. The past management of peatlands often implied other land uses, which have aimed at exploiting the economic resource and in most cases affected deeply the natural functions of peatlands. While many of the serious and extensive impacts in relation to peat extraction and peatland use for forestry and agriculture occurred in the past and are unlikely to be repeated in quite the same way in the future, any development on a peatland should be carefully evaluated in order to balance the various values involved.

5-3.4.2 Targets

- To implement strict planning control of all types of development (exploitive uses) on peatlands (Actions MPL1, 2, 3, 4, 5, 6, 7, 10, 11);
- To minimise peatland habitat loss due to illegal and ill-planned developments or associated side-effects (Actions MPL1, 2, 3, 4, 5, 7, 8, 10, 11);
- To enforce current legislation regarding unauthorised activities on peatlands (Actions MPL5, 7); and
- To implement sustainable farming regimes on all priority habitats (Actions MPL8, 9).

5-3.4.3 Actions – 4. Management of peatlands for other land uses (MPL)

		Priority	Remit	Link
MPL1:	A code of good practice for development on peatlands should be produced and systematically used for assessing any development proposals involving peatlands. Such a code should emphasise the current legislation framework (EIA, AA, IPPC licensing) within which any developments can proceed and include evidence-based guidance for the relevant authorities, including the following recommendations.	High	GOV	MPE1
MPL2:	Good practice guidance for EIA involving peatlands should be developed. The EIA Directive specifies that thresholds do not preclude sensitive areas and as such peatlands are to be considered sensitive areas for any development and thus require an EIA.	High	GOV	MPL4

MPL3:	Wind-farm development on mountain blanket bogs of conservation value should be banned. Particular guidance should be given in the case of an EIA for wind-farm developments on peatlands. Such EIA should follow the guidance from the EU Commission regarding such development on Natura 2000 sites and the wind energy guidelines of the DOEHLG (2006), especially with regards to road construction, fragmentation of the habitats and ground investigation. The guidelines include an assessment of the peat strength over the profile depth. Such tools have been developed within the BOGLAND project and should be used in stability assessment. The UCD-DSS technique is a direct simple shear device that allows the strength of peat to be assessed in a mode of deformation that is appropriate for stability assessment.	High	GOV NGOs RES	MPE1
MPL4:	Appropriate Assessment should be carried out where exploitative utilisation is taking place on or near protected sites, regardless of the size of the development. An EIA should not suffice in this case.	High	GOV	MPB3
MPL5:	All commercial peat-cutting enterprises should require planning permission and a licence. Enforcement against unauthorised peat extraction should be pursued.	High	GOV	MPS3 MPE1 MPE2 MPE3
MPL6:	Licensing requirements should be tightened so that sites of 10 ha or more need to be restored or rehabilitated after peat extraction.	High	GOV	MPC5
MPL7:	Sausage machine cutting should be banned on all protected sites and this ban should be enforced.	High	GOV	MPE9
MPL8:	No form of peat cutting should occur within an agri-environment scheme.	High	GOV	MPB7
MPL9:	Sheep grazing on hill and mountain peatlands can be sustainably managed using a stocking density based on habitats and by acknowledging seasonal variations in vegetation cover and composition.	Medium	GOV	MPS4
MPL10:	Relevant authorities should ensure that forest policies and other land-use management plans continue to protect and enhance peatlands.	Low	GOV	MPS5
MPL11:	The aforementioned code of good practice may necessitate an ESM programme to be established for all peatland-related development. An ESM programme monitors and controls the impact of an enterprise's activities on the environment by establishing an environmental policy with objectives and procedures (the similar to ISO 14001 standard) which could then be audited by the EPA.	Low	GOV	MPL1

5-3.5 Management of State-Owned Peatlands (MPS)

5-3.5.1 Targets

- To achieve, maintain and take the lead in good management practices on state-owned peatlands (Actions MPS1, 2, 3, 4, 5, 6, 7);
- To increase the proportion of natural peatlands and reduce carbon emissions from state-owned land (Actions MPS1, 2, 4);
- To carry out good practices for the sustainable management of forested peatlands in state ownership (Actions MPS5, 6); and
- To reduce conflicts between governmental policies (Actions MPS5, 6, 7, 8).

5-3.5.2 Actions – 5. Management of state-owned peatlands (MPS)

		Priority	Remit	Link
MPS1:	The present management of state-owned peatlands should be evaluated and alternative management options aimed at increasing the natural functions of peatlands should be implemented.	High	GOV	MPB1 MPB2
MPS2:	An assessment of state-owned raised bogs and blanket bogs should be carried out not only in the context of the Habitats Directive but with the aim of applying best management practices. Management options should be appraised against functional criteria. A range of response options may apply depending on the type and level of impact of the disturbances.	High	GOV	MPB4 MPC2

MPS3:	Where the current disturbance is illegal, it should be immediately removed by enforcing the law as good governance and law enforcement are key to the sustainable management of peatlands.	High	GOV	
MPS4:	Where the current disturbance has not impacted on the major functions of the peatland (e.g. appropriate grazing intensity, controlled turf cutting), the disturbance should be maintained at an acceptable level as a management option and should be monitored.	High	GOV	MPL9
MPS5:	The management options regarding state-owned forested peatlands should be critically reviewed and management options identified by Coillte regarding the western peatland forests fully implemented in view of managing this national asset in the most sustainable fashion.	Medium	GOV	MPL10
MPS6:	Western forested peatlands which are commercially unproductive should be candidates for either (1) restoration of peatland ecosystems, (2) long-term retention of trees, or (3) promoting regenerating native scrub. The effects of these management options on GHG emissions, especially peat oxidation, should be investigated.	Medium	GOV RES	MPS5 MPL10
MPS7:	Policy regarding wind-farm developments on state-owned forests (on peat) should be seriously appraised by a group of independent experts in each case (life-cycle analysis).	High	GOV	MPL1 MPL11
MPS8:	A government or national institution (National Working Group) should be developed to take the lead in demonstrating what after-uses are being seriously considered for industrial cutaway peatlands. An after-use policy considering the public's preferred options, namely amenity, wildlife and wind energy options, should be drafted.	Medium	GOV NGOs	MPE3 MPP5 MPP8

5-3.6 Management of Peatlands Using Socio-Economic and Policy Instruments (MPE)

5-3.6.1 Observations

The BOGLAND project findings demonstrate that the sustainable management of peatlands is difficult, given that the policies currently influencing peatlands are outdated and largely irrelevant to the needs of a modern Irish society whose understanding of the value of peatlands is changing. Regulatory and economic instruments are needed to achieve a balance between the various objectives and to achieve a sustainable use of the peatland resource including a satisfactory level of peatland conservation. There is a conflict between the short-term socio-economic benefits of utilising peatlands and the peat resource and the long-term social and environmental value of peatlands in situ and in functioning conditions.

The introduction of the carbon tax on domestic fuels may have produced a perverse incentive for the increased private peat extraction. Much of this activity exists in the informal economy and the tax coupled with a more general increase in conventional fuel costs may have changed behaviour. Evidence for this is, however, only anecdotal at present.

The past socio-economic policy to utilise the peatland resource to promote self-reliance in energy, regional development and employment may still be realised with a shift from peat extraction to green industries on cutaway peatlands. These include appropriate wind-farm developments, paludiculture (in particular the cultivation of *Sphagnum* moss for use as a growing medium to replace horticultural peat), and the growth of alder for the provision of biomass material in peat-fired power plants. All these activities should be incentivised as they could replace a non-sustainable, finite peat extraction industry.

Peat is amongst the most carbon intensive of fuels. Like all energy installations, peat-fired power stations have been allocated allowances for free until 2012 on the EU ETS. The scheme aims to provide utilities with a continuous price incentive to move away from energy with high carbon emissions. From 2013, all electricity generation plants, including the peat-fired stations, will be subject to auctioning rather than free allocation. Due to the necessity to pass on this cost of purchasing allowances to cover the high emissions, the peat-generated electricity will become more expensive. It has been suggested that some of the revenues generated by the sale of allowances to the industry will be recirculated back to the national treasury. It is stated in the Revised ETS Directive (2009/29/EC) that 50% of these revenues *should* be used for climate-related activities. This is a mechanism by which funding for the protection of peatland carbon stocks (through management or active restoration for example) might be found. While this allocation of revenues is a matter for national policy, there are some discussions at international levels that may create additional incentives to pursue a peatland policy. The inclusion of Wetlands, and in particular wetland restoration, within any post-Kyoto agreement would create a mechanism by which enhanced carbon sinks (or reduced carbon loss) might be accounted for as part of compliance with agreed targets (IPCC, 2010, 2011).

5-3.6.2 Targets

- To incentivise low carbon emissions industries (Actions MPE1, 2, 6, 7, 8, 9);
- To move away from non-renewable, non-sustainable, peat-based industries (Actions MPE1, 2, 3, 4, 5, 8); and
- To promote cutaway peatland after-use for green industries (Actions MPE6, 7).

5-3.6.3 Actions – 6. Management of peatlands using socio-economic and policy instruments (MPE)

		Priority	Remit	Link
MPE1:	Management of peatlands for economic requirements should be in accordance with relevant international legislation and conventions, national laws and regulations.	High	GOV IND	MPL1 MPL4 MPL5
MPE2:	The Cessation of Turf Cutting Scheme should be fully implemented on *all* the raised bogs designated as SACs and be given full political back-up.	High	GOV	MPL5 MPE3
MPE3:	The cessation of turf cutting on other designated sites (blanket bogs) should be immediately assessed and solutions proposed from a forum of adequate representatives.	High	GOV	MPS3
MPE4:	A cost–benefit analysis at the macroeconomic level should be carried out in relation to peat extraction and its role in modern Ireland.	Medium	GOV	MPE8
MPE5:	The PSO levy allocated to the peat industry should be reviewed in the view that the continued carbon emissions from peat burning are contrary to national interest. A portion of these funds could be used to invest in the peatland resource that would bring a sustainable economic activity, carbon storage and the delivery of other ecosystem services.	Medium	GOV	MPE9
MPE6:	Carbon storage through peatland conservation, restoration and paludiculture should be supported by Ireland for the next commitment periods of the Kyoto Protocol.	Medium	GOV	
MPE7:	Wind-farm development and cultivation of *Sphagnum* moss should be encouraged on industrial cutaway peatlands through tax relief.	Medium	GOV IND	MPE5 MPE6
MPE8:	The government should engage in a review of the use of peat in the horticultural industry and phase out the use of peat as a horticultural growing medium at least in the retail market. While there is not at present a technically, environmentally suitable alternative material that could replace peat in professional horticultural crop production, Ireland should lead research in this area and economic incentives should be applied to compete with non-sustainable horticultural peat.	Medium	GOV IND	MPE4
MPE9:	Adequate funding and mechanisms to support sustainable management of peatlands should be provided.	High	GOV	MPE5

5-3.7 Management of Peatlands for and with the People (MPP)

5-3.7.1 Observations

There is a clear information deficit regarding the public benefits of peatlands and the relationship between peatlands and people is changing. People have commonly treated peatlands as wastelands, using them in many destructive ways, without taking the long-term environmental and related socio-economic impacts into account. Interestingly, the surveys carried out and the focus group discussions within the BOGLAND project demonstrated support for the protection of peatlands at both local and national levels. The results from the two surveys also indicated support for a National Peatlands Park to be located in the Midlands. However, the value of peatlands as an ecosystem providing crucial ecological, hydrological and other services has generally been disregarded by the public, mainly because it was not communicated in any meaningful way. Currently, a very significant information deficit applies to the carbon sequestration and carbon storage benefits of peatlands and the significant contribution that these make in regulating the global climate. Also, most people do not realise how few intact peatlands remain. The surveys conducted within the BOGLAND project showed that many people do not see a contradiction between the cutting of peat, particularly domestic cutting, and the value that they place on peatlands. It was also found that decisions about management of peatlands are often made remotely and by interest groups who may be insufficiently informed about the local conditions and consequences of inappropriate actions. A fundamental requirement to the sustainable management of peatlands is the raising of public awareness of their importance and their active participation at all stages of the strategy development.

5-3.7.2 Targets

- To increase awareness of the ecosystem services provided by peatlands (Actions MPP1, 2, 3);
- To increase communication to stakeholders, especially turbary rights holders and people living near peatlands (Actions MPP4, 5, 7, 8); and
- To generate informed debates about peatlands in national and local media (Actions MPP5, 6, 7, 8).

5-3.7.3 Actions – 7. Management of peatlands for and with the people (MPP)

		Priority	Remit	Link
MPP1:	Peatland awareness programmes and educational material should be developed and promoted through a wide variety of media: information sharing (website, DVDs, etc.), education packs (see Irish Peatland Conservation Council), workshops, posters in public places. Clear 'peatland messages' should be provided for use across a wide range of media.	High	GOV NGOs	MPP7
MPP2:	Awareness and education could also be promoted by the improvement of public access at certain appropriate sites.	Low	GOV NGOs	
MPP3:	Traditional, indigenous knowledge of peat and peatlands as well as relevant scientific findings and data should be clearly communicated and made available to the public and to decision makers. This would also help dialogue between all the stakeholders, who may not be sufficiently aware of the information and views held by others. Information from all sources is crucial if more effective ecosystem management strategies are to be introduced.	Medium	GOV NGOs RES	MPP8
MPP4:	Local communities have a very important role as stewards of peatland resources and should be effectively involved in activities to restore and sustain the use of these resources. Local committees and other vested groups should be consulted in order to balance local concerns with the wider public 'good'. The closer the management is to the ecosystem, the greater the responsibility, accountability, participation and use of local knowledge.	Medium	GOV	
MPP5:	Governmental institutions should communicate early and extensively to the stakeholders so that they become familiarised with the benefits of peatlands other than for fuel.	Medium	GOV	MPS8
MPP6:	The Government should advocate the communication of environmental information, in particular that of peatlands, either through the promotion of its web-based information channels or through the support to NGOs that communicate this knowledge at all levels (in particular education).	Low	GOV NGOs	
MPP7:	It is critical that a national institution takes a lead in communicating information regarding peatlands.	High	GOV	MPP1
MPP8:	The creation of a National Peatlands Park deserves serious consideration and commands a degree of support from the Government.	Medium	GOV	MPS8

5-4 A Peatland Strategy Working Group

The BOGLAND report provided main analysis and findings that demonstrated that the Irish State needs to change the way the peatland resource is currently viewed and managed if it wishes to secure the multiple benefits offered by these natural ecosystems and avoid the costly consequences of further peatland deterioration.

A National Peatland Strategy is clearly required if the protocol for sustainable management of peatlands is to be implemented. The development of such a strategy should be carried out through the establishment of a special working group (National Peatland Strategy Working Group) whose main role would be to co-ordinate the development of a consensus that charts the way forward. In essence, the Working Group should be responsible for developing and implementing a strategy that works towards delivering the greatest net benefits (market and non-market) from the peatland resource in ways that are sustainable, that is by optimising the balance between the different aforementioned targets and necessary actions.

The remit of the National Peatland Strategy Working Group should include:

- To make a proposal for a national peatland strategy, taking into consideration the need for the long- and short-term uses of these ecosystems and the existing national, EU and international obligations and policies;
- To suggest means of implementing this strategy by evaluating the functionality of different licensing procedures with regards to the different uses of peatlands;
- To review and set up effective enforcement of procedures as well as evaluate different environmental permit proceedings required in the uses of peatlands;
- To lead the development of a policy framework that embraces the key market and non-market functions;
- To set up a management unit with appropriate experts for restoring degraded bogs and safeguarding their carbon stores;
- To make a decision on state-owned peatlands, especially those owned by Coillte and Bord na Móna;
- To take the lead in identifying sustainable utilisation and management options with regards to industrial cutaway peatlands, taking on board the findings of the BOGLAND report; and
- To make suggestions, when needed, for the sustainable use and management of peatlands.

The Working Group needs to operate across an array of administration units and embrace the exceptionally large number and wide range of stakeholders. It should be initiated by both the Departments of Communication, Energy and Natural Resources and the Department of the Environment, Community and Local Government (with, as main actors, the EPA and NPWS) and include the Department of Finance. To kick-start this exercise, the working group should initiate small workshops on specific themes in relation to each peatland identified in the protocol (or action plan).

5-5 Further Research

Any decision making ought to be based on sufficient and adequate information. Peatland management issues are invariably complex and cross-disciplinary. There are many gaps in knowledge from disciplines or sectors other than those most directly linked to peatlands. The BOGLAND project made great progress towards a greater understanding of Irish peatlands from the perspective of various society and scientific disciplines: biodiversity, physical resource and, for the first time, socio-economic and cultural relationships. The project highlighted specific aspects from each strand which necessitate further research (see Annex 5.1a, End of Project Report). Critical research areas that need immediate attention are presented below. Ideally, these strands should be regrouped under the umbrella of a centre of expertise for peatlands which would create a research network to improve knowledge and understanding of peatland conditions and their functions, particularly in relation to GHG emissions and water management.

Critical research areas that should be urgently addressed are:

- Investigation of the GHG emissions from peat soils under various management practices (to be used towards Tier 3 reporting of the Kyoto Protocol);
- Identification and review of practical peatland restoration projects and techniques to assess their effectiveness in terms of hydrology, carbon storage and sequestration potential and biodiversity at all levels;
- Quantification of the actual extent of domestic peat cutting, especially on blanket bogs;
- Classification and identification of all peatlands along a degradation scale;
- Research and development into alternative material to replace peat in horticultural and other products;
- Investigation of the cultivation of *Sphagnum* moss and more generally paludiculture on degraded peatlands; and
- Research wet heaths which are often associated with blanket bogs and are listed in Annex 1 of the Habitats Directive as important habitats to protect. An assessment of the disturbance to these habitats is required as they have serious consequences in terms of carbon loss and water quality.

5-6 General Conclusion

The BOGLAND project focused on assimilating and synthesising the scientific information needed to inform policy about Irish peatlands. It revealed the global significance of this national resource and the dilemmas of peatland management, utilisation and conservation. The project yielded a lot of information on many aspects of peatlands covering the four pillars of sustainability: environmental, social, economic and institutional. Scientific chapters are available in full in the End of Project Report, while the main findings have been compiled in this report.

Technical information about the services provided/affected by peatland use and management should now be readily presented to politicians and influential decision makers, with a clear impression of the consequence of alternative decisions and policies. Increasing the awareness (particularly to the wider public) of the current situation and possible future scenarios (backed up by enhanced scientific understanding) is critical to this evidence-based policy development. The *protocol* delivers an action plan or set of recommendations which should be used to draft a much-needed National Peatland Policy, which should ensure that this natural heritage is not lost in the future, but that it is safeguarded and enhanced during a challenging period of economic transition. In short, any vision of the future of Ireland must include the maintenance and enhancement of one of its last natural resources: peatlands. This protocol aims to succeed in achieving such a vision that serves the needs of the people and preserves our natural heritage.

Ireland can decide today how its peatlands, this unique natural resource, will look in 2050. To achieve sustainable management of peatlands, the vision we should aspire to is outlined below.

Irish Peatlands: 2050

- *A good awareness by Irish people of the multiple benefits brought by peatlands and recognition of peatlands as an important natural resource providing valuable ecosystem services.*
- *Active management by the Government and other stakeholders to maximise peatland functions especially the storage and accumulation of carbon.*
- *Responsible treatment of peatlands used for agriculture, forestry and commercial operations.*
- *Integration of climate impacts into decisions on economic activities on peatlands.*
- *Favourable conservation status attained for all protected peatlands.*
- *Cutaway peatlands restored where possible and embryonic bogs once again growing in Ireland. Where conditions are not favourable for restoration, cutaway peatlands rehabilitated to suit the needs and aspirations of the local population, including amenity, wildlife and green energy options.*

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See www.ucd.ie/bogland for all other types of publications.

Acronyms and Annotations

AA	Appropriate Assessment
AER	Alternative Energy Requirement
AES	Advanced Environmental Solutions
C	Carbon
CAP	Common Agriculture Policy
CBD	Convention on Biological Diversity
CH_4	Methane
CO_2	Carbon dioxide
DIPMV1	Derived Irish Peat Map – Version 1
DOC	Dissolved organic carbon
DSS	Direct Simple Shear
EC	European Commission
EEA	European Environmental Agency
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
ERTDI	Environmental Research Technological Development and Innovation
ESM	Environmental system management
ETS	Emissions Trading Scheme
EU	European Union
GAP	Global Action on Peatlands
GHG	Greenhouse gas
GPR	Ground-penetrating radar
GWDTE	Groundwater-dependent terrestrial ecosystem
IMCG	International Mire Conservation Group
IPCC	International Panel for Climate Change
IPPC	Integrated Pollution Prevention Control
IPS	International Peat Society
ISMI	Indicative Soil Map of Ireland
KP	Kyoto Protocol
Ktoe	Kilotonne of oil equivalent
LULUCF	Land use, land-use change and forestry
MPB	Management of peatlands for biodiversity

MPC	Management of peatlands for carbon, climate and archives
MPE	Management of peatlands using socio-economic and policy instruments
MPL	Management of peatlands for other land uses
MPP	Management of peatlands for and with the people
MPS	Management of state-owned peatlands (MPS
MPW	Management of peatland for water
NBP	National Biodiversity Plan
NFI	National Forest Inventory
NGO	Non-governmental organisation
NHA	Natural Heritage Area
NPWS	National Parks and Wildlife Service
NSS	National Spatial Strategy
OD	Ordnance Datum
OECD	Organisation for Economic Co-operation and Development
pH	Pondus hydrogenii
PSO	Public Service Obligation
REFIT	Renewable Energy Feed-In Tariff
REPS	Rural Environment Protection Scheme
RESG	Renewable Energy Strategy Group
SAC	Special Area of Conservation
SDS	Sustainable Development Strategy
SEA	Strategic Environmental Assessment
SOC	Soil organic carbon
SPA	Special Protection Area
TCD	Trinity College, Dublin
toe	Tonne of oil equivalent
TPER	Total Primary Energy Requirements
UCD	University College Dublin
UCD-DSS	University College Dublin Direct Simple Shear Apparatus
UNFCCC	United Nations Framework Convention on Climate Change
WTP	Willingness to pay

Glossary

Acrotelm	The living, actively growing upper layer of a raised bog, the surface of which is composed mainly of living bog mosses (*Sphagnum* spp.). The presence of the acrotelm is vital to a raised bog as this is the peat-forming and water-storing layer of the bog.
Active or peat forming	According to the Interpretation Manual of the Habitats Directive, the term Active must be taken to mean still supporting a significant area of vegetation that is normally peat forming.
Afforestation	The planting of trees over an area of previously unplanted ground.
Alkalinity	The acid-neutralising capacity of a water, found by titration of all bases, usually with a strong acid, expressed as milligrams calcium carbonate per litre.
Anion	An atom or group of atoms that carries a negative charge as a result of having gained one or more electrons.
Biodiversity	Refers to the diversity of all living things at genetic, species and ecosystem levels.
Bog	
Carr	A shrub-covered fen.
Catchment/Catchment area	1. An area from which surface run-off is carried away by a single drainage system. 2. The area of land bounded by watersheds draining into a river, basin or reservoir.
Cation	An atom or group of atoms the carries a positive charge as a result of having lost one or more electrons.
Climate	Weather averaged over a long period of time in a location.
Climate change (anthropogenic)	A change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is, in addition to natural climate variability, observed over comparable time periods.
Community (in vegetation studies)	A well-defined assemblage of plants and/or animals, clearly distinguishable from other such assemblages.
Conservation status	The sum of the influences acting on a habitat and its typical species that may affect its long-term distribution, structure and functions. Also refers to the long-term survival of its typical species within the European territory of the Member States. Methods for assessing conservation status were drawn up by the European Topic Centre for Nature Conservation in conjunction with the Scientific Group of the Habitats Directive. It involves the application of ‘good’, ‘poor’ or ‘bad’ to four parameters for habitats and species (NPWS, 2008).

Cutaway peatland (industrial)	A peatland where peat is being/has been extracted by industrial means. Peat extraction is the term used in this report to refer to peat production, peat mining or peat harvesting. (Peat production is the term widely used in Ireland within the industry and is defined as the overall management or the processes and methods used to produce peat for commercial operations.)
Cutover peatland	A peatland where peat is being/has been removed through turf cutting by hand or small-scale mechanical peat extraction. Cutover areas are usually made of a mosaic of cut areas, face banks, pools, drainage ditches, uncut areas, scrubs, grassland.
Disturbance	A discrete event, either natural or human induced, that causes a change in the existing condition of an ecological system.
Ecosystem	Refers to the combined physical and biological components of an environment. An ecosystem is a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.
Ecosystem services	Fundamental life-support services upon which human civilisation depends. Examples of direct ecosystem services are pollination, provision of wood, and erosion prevention. Indirect services could be considered climate moderation, nutrient cycling, and detoxifying natural substances. The services and goods an ecosystem provides are often undervalued as many of them are without market value.
Favourable conservation status	The conservation status of a natural habitat will be taken as favourable when its natural range and the areas it covers within that range are stable or increasing, and the specific structure and functions that are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and the conservation status of its typical species is favourable.
Flushes	Wet areas maintained by the seepage of water down slopes of various gradient, usually very localised where nutrient enrichment occurs. Butterworts are particularly noticeable in flushes.
Habitat	The environment in which an animal or plant lives, generally defined in terms of vegetation and physical features.
Habitats Directive (Council Directive 92/43/EEC)	The Directive on the Conservation of Natural Habitats and of Wild Flora and Fauna. This Directive seeks to legally protect wildlife and its habitats. It was transposed into Irish Law in 1997 and is currently being revised.
Hardness	The sum of the calcium and magnesium cations expressed as milligrams.
High bog	Area of a raised bog which forms/formed the dome.
Hummock	A small raised mound formed by the upward growth of *Sphagnum* moss.
Invasive species	Species of plants or animals that have been introduced, usually by people, outside their natural range.

Lagg	The margin surrounding a *Sphagnum*-dominated peatland located between the peatland itself and mineral soils, typically supporting swampy vegetation (sedges and/or shrubs).
Lawn	An area in which the ground vegetation extends from well-consolidated peat and forms wet flat areas with little relief.
Local people	Any individuals or groups of people in an area who are affected directly or indirectly by peatland management decisions.
Migration	A cyclic movement of animals between separated areas that are used during different seasons.
Minerotrophic	Used to describe both vegetation communities and peats that derive nutrients from the geosphere.
Mire	Peatlands on which peat is currently forming and accumulating.
Mitigation	Technological change and substitution that reduce resource inputs and emissions per unit of output. Although several social, economic and technological policies would produce an emission reduction, with respect to climate change, mitigation means implementing policies to reduce greenhouse gas emissions and enhance sinks (IPCC, 2007).
Moor	In Britain, used to mean bleak, uncultivated upland, not necessarily peaty, often heather covered.
Mosaic (habitat mosaic)	Spatial configuration of habitats within a landscape, generally formed by patches arranged within a matrix.
Moss (peat moss)	Synonymous with a *Sphagnum*-dominated peat type.
NHA (Natural Heritage Area)	Basic designation under the Wildlife Amendment Bill 1999 for areas that are important for wildlife conservation.
NPWS (National Parks and Wildlife Service)	Government agency with responsibility for nature conservation and implementation of the Government's conservation policy.
Oligotrophic	Refers to any environment that offers little to sustain life. This term is usually used to describe bodies of water or soils with very low nutrient levels.
Ombrotrophic	Refers to a type of peatland that receives all of its water and nutrients from precipitation falling directly on its surface. The word translates to 'rain fed'. Such peatlands are hydrologically isolated from the surrounding landscape and are home to organisms tolerant of acidic, low-nutrient environments. The vegetation of ombrotrophic peatlands is dominated by *Sphagnum* moss.
Paludiculture	Paludiculture or 'wet cultivation' is the cultivation of biomass on wet and re-wetted peatlands (agriculture and forestry under wet conditions).
Paludification	The formation of waterlogged conditions; also refers to peat accumulation that starts directly over a formerly dry mineral soil; also refers to expansion of peatland into surrounding uplands.

Peat Sedentarily accumulated material consisting of at least 30% (dry mass) of dead organic material

Peatland A geographical area (with or without vegetation) where peat soil occurs naturally. For mapping purposes, a peatland should cover a minimum spatial extent of 1 ha.

Active peatlands or mires: Peatlands on which peat is currently forming and accumulating. All active peatlands (mires) are peatlands but peatlands that are no longer accumulating peat would no longer be considered mires.

Intact, pristine and virgin peatlands: The terms 'virgin', 'pristine' and 'intact' have been used in several studies in relation to sites that look unmodified, uncut (as visible to the eye) and where no obvious factor is currently degrading the peatland. These terms are best avoided for use of habitat description such as peatlands in an Irish context. Most Irish peatlands are 'humanised' landscapes that have evolved, indeed sometimes originated, in close association with land-use systems. It would be impossible to find an Irish peatland that has never been grazed or used in some way by humans (e.g. burning).

Near-intact peatlands: In this report, the terms 'near-intact' and 'natural' peatlands are interchangeable and are used to refer to peatlands that are hydrologically and ecologically intact, i.e. in which the eco-hydrology, in the recent past, has not been visibly affected by human activity and therefore includes active or peat-forming areas or is in the process of regenerating such a habitat. A natural peatland thus requires a combination of components to be present in order to carry out all the functions and ecosystem services usually attributed to such ecosystems.

Peat soil Soil that contains peat over a depth of at least 45 cm on undrained land and 30 cm on drained land; the depth requirement does not apply in the event that the peat layer is directly over bedrock.

pH pH is a measure of the hydrogen ion activity of a solution.

Preservation Maintenance and enhancement of specific biological, social or cultural values.

Priority habitat A subset of the habitats listed in Annex I of the EU Habitats Directive. These are habitats that are in danger of disappearance and whose natural range mainly falls within the territory of the European Union. These habitats are of the highest conservation status and require measures to ensure that their favourable conservation status is maintained.

Protected area An area of land and/or an aquatic ecosystem especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, managed through legal or other effective means**.** In this report, the term 'protected areas' includes all Natura 2000 sites (SACs and SPAs) as well as all the NHAs.

Raised bog	A bog shaped like a dome or elevated above the surrounding land and which only receives moisture from the atmosphere.
Reclaimed peatland	Peatland where a land-use change (and management action) has occurred, e.g. through afforestation or agricultural activities.
Regenerated peatland	Degraded peatland where spontaneous development has led to the regeneration of peat-forming conditions.
Rehabilitated peatland	*See* Restored peatland.
REPS **(Rural Environment Protection Scheme)**	This is an agri-environmental programme that each EU Member State is legally required to carry out and which seeks to draw up agreements with farmers, according to the type of farming, landscape and features on the land.
Resilience	A tendency to maintain integrity when subject to disturbance.
Resistance **(connectivity context)**	The inverse of permeability.
Responsible peatland management	Responsible peatland management is the balanced stewardship of the environmental, social and economic values of peatlands in accordance with local, regional and global aspirations.
Restored peatland	Formerly drained peatland where human activities have led or are expected to lead to a recovery of its natural functions and values.
Re-wetted peatland	Formerly drained peatland where human activities or spontaneous developments have led to a rise in the water table.
SAC (Special Area of Conservation)	An area that has been selected from the prime example of wildlife conservation areas in Ireland (legally required by the Habitats Directive). A cSAC is a candidate special area of conservation.
Site	A peatland area usually well defined by its boundary that has been chosen for study within this project.
SPA **(Special Protected Area)**	An area that has been designated to ensure the conservation of certain categories of birds (legally required by the European Birds Directive).
Stakeholders	All persons and organisations having a direct interest.
Sustainability	Although the concept of sustainability has been around for a long time, it became more widely used in the 1980s. In 1983, the Secretary-General of the UN established a commission called the World Commission on the Environment and Development (frequently referred to as the Brundtland Commission), which was asked to look at the world's environmental problems and propose a global agenda for addressing them. As a result, the Brundtland Commission defined sustainable development as development that meets the needs of the present without compromising the ability of future generations. The Food and Agriculture Organisation of the United Nations (FAO, 1991) provides a definition of sustainable agriculture as:

	"*a system which involves the management and conservation of the natural resource base, and the orientation of technical and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development conserves land, water, plant and animal genetic resources and it is economically viable and socially acceptable*".
Terrestrialisation	The accumulation of sediments and peats in open water.
Topogenous	Originated as a result of the features of an area.
Turbary	Term used to describe the right to cut turf on a particular area of bog. These rights came about with the resettlement of confiscated land or by prescription. Prescription is a legal term meaning that if a person is able to demonstrate that he/she has cut turf without secrecy, without permission and without force continuously for a period of 30 years he/she has a turbary right. This implies that not all turbary rights are formally registered (see more in Section 4-3).

An Ghníomhaireacht um Chaomhnú Comhshaoil

Is í an Gníomhaireacht um Chaomhnú Comhshaoil (EPA) comhlachta reachtúil a chosnaíonn an comhshaol do mhuintir na tíre go léir. Rialaímid agus déanaimid maoirsiú ar ghníomhaíochtaí a d'fhéadfadh truailliú a chruthú murach sin. Cinntímid go bhfuil eolas cruinn ann ar threochtaí comhshaoil ionas go nglactar aon chéim is gá. Is iad na príomh-nithe a bhfuilimid gníomhach leo ná comhshaol na hÉireann a chosaint agus cinntiú go bhfuil forbairt inbhuanaithe.

Is comhlacht poiblí neamhspleách í an Ghníomhaireacht um Chaomhnú Comhshaoil (EPA) a bunaíodh i mí Iúil 1993 faoin Acht fán nGníomhaireacht um Chaomhnú Comhshaoil 1992. Ó thaobh an Rialtais, is í an Roinn Comhshaoil agus Rialtais Áitiúil a dhéanann urraíocht uirthi.

ÁR bhFREAGRACHTAÍ

CEADÚNÚ

Bíonn ceadúnais á n-eisiúint againn i gcomhair na nithe seo a leanas chun a chinntiú nach mbíonn astuithe uathu ag cur sláinte an phobail ná an comhshaol i mbaol:

- áiseanna dramhaíola (m.sh., líonadh talún, loisceoirí, stáisiúin aistrithe dramhaíola);
- gníomhaíochtaí tionsclaíocha ar scála mór (m.sh., déantúsaíocht cógaisíochta, déantúsaíocht stroighne, stáisiúin chumhachta);
- diantalmhaíocht;
- úsáid faoi shrian agus scaoileadh smachtaithe Orgánach Géinathraithe (GMO);
- mór-áiseanna stórais peitreail.
- Scardadh dramhuisce

FEIDHMIÚ COMHSHAOIL NÁISIÚNTA

- Stiúradh os cionn 2,000 iniúchadh agus cigireacht de áiseanna a fuair ceadúnas ón nGníomhaireacht gach bliain.
- Maoirsiú freagrachtaí cosanta comhshaoil údarás áitiúla thar sé earnáil - aer, fuaim, dramhaíl, dramhuisce agus caighdeán uisce.
- Obair le húdaráis áitiúla agus leis na Gardaí chun stop a chur le gníomhaíocht mhídhleathach dramhaíola trí comhordú a dhéanamh ar líonra forfheidhmithe náisiúnta, díriú isteach ar chiontóirí, stiúradh fiosrúcháin agus maoirsiú leigheas na bhfadhbanna.
- An dlí a chur orthu siúd a bhriseann dlí comhshaoil agus a dhéanann dochar don chomhshaol mar thoradh ar a ngníomhaíochtaí.

MONATÓIREACHT, ANAILÍS AGUS TUAIRISCIÚ AR AN GCOMHSHAOL

- Monatóireacht ar chaighdeán aeir agus caighdeáin aibhneacha, locha, uiscí taoide agus uiscí talaimh; leibhéil agus sruth aibhneacha a thomhas.
- Tuairisciú neamhspleách chun cabhrú le rialtais náisiúnta agus áitiúla cinntí a dhéanamh.

RIALÚ ASTUITHE GÁIS CEAPTHA TEASA NA HÉIREANN

- Cainníochtú astuithe gáis ceaptha teasa na hÉireann i gcomhthéacs ár dtiomantas Kyoto.
- Cur i bhfeidhm na Treorach um Thrádáil Astuithe, a bhfuil baint aige le hos cionn 100 cuideachta atá ina mór-ghineadóirí dé-ocsaíd charbóin in Éirinn.

TAIGHDE AGUS FORBAIRT COMHSHAOIL

- Taighde ar shaincheisteanna comhshaoil a chomhordú (cosúil le caighdéan aeir agus uisce, athrú aeráide, bithéagsúlacht, teicneolaíochtaí comhshaoil).

MEASÚNÚ STRAITÉISEACH COMHSHAOIL

- Ag déanamh measúnú ar thionchar phleananna agus chláracha ar chomhshaol na hÉireann (cosúil le pleananna bainistíochta dramhaíola agus forbartha).

PLEANÁIL, OIDEACHAS AGUS TREOIR CHOMHSHAOIL

- Treoir a thabhairt don phobal agus do thionscal ar cheisteanna comhshaoil éagsúla (m.sh., iarratais ar cheadúnais, seachaint dramhaíola agus rialacháin chomhshaoil).
- Eolas níos fearr ar an gcomhshaol a scaipeadh (trí cláracha teilifíse comhshaoil agus pacáistí acmhainne do bhunscoileanna agus do mheánscoileanna).

BAINISTÍOCHT DRAMHAÍOLA FHORGHNÍOMHACH

- Cur chun cinn seachaint agus laghdú dramhaíola trí chomhordú An Chláir Náisiúnta um Chosc Dramhaíola, lena n-áirítear cur i bhfeidhm na dTionscnamh Freagrachta Táirgeoirí.
- Cur i bhfeidhm Rialachán ar nós na treoracha maidir le Trealamh Leictreach agus Leictreonach Caite agus le Srianadh Substaintí Guaiseacha agus substaintí a dhéanann ídiú ar an gcrios ózóin.
- Plean Náisiúnta Bainistíochta um Dramhaíl Ghuaiseach a fhorbairt chun dramhaíl ghuaiseach a sheachaint agus a bhainistiú.

STRUCHTÚR NA GNÍOMHAIREACHTA

Bunaíodh an Ghníomhaireacht i 1993 chun comhshaol na hÉireann a chosaint. Tá an eagraíocht á bhainistiú ag Bord lánaimseartha, ar a bhfuil Príomhstiúrthóir agus ceithre Stiúrthóir.

Tá obair na Gníomhaireachta ar siúl trí ceithre Oifig:

- An Oifig Aeráide, Ceadúnaithe agus Úsáide Acmhainní
- An Oifig um Fhorfheidhmiúchán Comhshaoil
- An Oifig um Measúnacht Comhshaoil
- An Oifig Cumarsáide agus Seirbhísí Corparáide

Tá Coiste Comhairleach ag an nGníomhaireacht le cabhrú léi. Tá dáréag ball air agus tagann siad le chéile cúpla uair in aghaidh na bliana le plé a dhéanamh ar cheisteanna ar ábhar imní iad agus le comhairle a thabhairt don Bhord.

NDP
National Development Plan 2007 - 2013

Science, Technology, Research and Innovation for the Environment (STRIVE) 2007-2013

The Science, Technology, Research and Innovation for the Environment (STRIVE) programme covers the period 2007 to 2013.

The programme comprises three key measures: Sustainable Development, Cleaner Production and Environmental Technologies, and A Healthy Environment; together with two supporting measures: EPA Environmental Research Centre (ERC) and Capacity & Capability Building. The seven principal thematic areas for the programme are Climate Change; Waste, Resource Management and Chemicals; Water Quality and the Aquatic Environment; Air Quality, Atmospheric Deposition and Noise; Impacts on Biodiversity; Soils and Land-use; and Socio-economic Considerations. In addition, other emerging issues will be addressed as the need arises.

The funding for the programme (approximately €100 million) comes from the Environmental Research Sub-Programme of the National Development Plan (NDP), the Inter-Departmental Committee for the Strategy for Science, Technology and Innovation (IDC-SSTI); and EPA core funding and co-funding by economic sectors.

The EPA has a statutory role to co-ordinate environmental research in Ireland and is organising and administering the STRIVE programme on behalf of the Department of the Environment, Heritage and Local Government.

epa
Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

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